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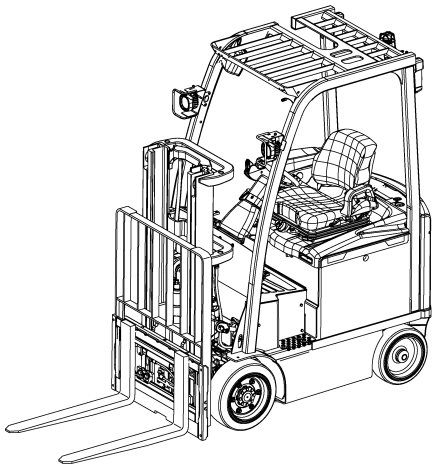
DIAGNOSTIC TROUBLESHOOTING MANUAL

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN (J80-100XN) [A970];
A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203];
J1.5-2.0XNT (J30-40XNT) [K160];
E4.0-5.5XN, E5.0XNS (E80-120XV, E100XNS) [A099]



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HYSTER

PART NO. 1688885 **9000 SRM 1377**

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SAFETY PRECAUTIONS
TROUBLESHOOTING PROCEDURES

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a condition that can cause immediate death or injury!

CAUTION

Indicates a condition that can cause property damage!

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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SECTION 9080 - SUPPLEMENTARY DATA
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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN (J80-100XN) [A970];
A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203];
J1.5-2.0XNT (J30-40XNT) [K160];
E4.0-5.5XN, E5.0XNS (E80-120XV, E100XNS) [A099]

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How To Use This Troubleshooting Manual

GENERAL INSTRUCTIONS AND SAFETY INFORMATION

WARNING

DO NOT add to or modify the lift truck. Any modification that affects the safe operation of the truck cannot be undertaken without written authorization of the Hyster company.

Any change to the lift truck, the tires, or its equipment can change the lifting capacity. The lift truck must be rated as equipped and the nameplate must show the new rating capacity.

WARNING

The technician must be aware of, and follow, all general safety precautions that are published in the Operating Manual and that are posted as Safety Decals on and in the lift truck.

Before starting, the technician should be familiar with certain policies, requirements, and instructions used in the troubleshooting procedures. Using the troubleshooting procedures correctly helps the technician to perform the procedure safely and prevents damage to the machine and support equipment.

HOW TO USE DIAGNOSTIC TROUBLESHOOTING MANUAL

Manual Layout:

Sections: The manual is divided into eight sections, each representing a major system, functional area, or specific operation on the lift truck.

- 9010 – Operational Diagnostic Procedures
- 9025 – Traction Motor
- 9030 – Electrical System
- 9035 – Drive Axle/Unit
- 9050 – Hydraulic Systems
- 9060 – Operator's Station
- 9070 – Front End (Mast) and Chassis
- 9080 – Supplementary Data

Groups: The sections of the manual are further subdivided into groups, where applicable, that identify specific functions, operating criteria, or maintenance tasks.

- 01 – Introduction to the Troubleshooting Manual
- 03 – General Maintenance/Diagnostic Data
- 05 – Operational Checkout
- 10 – Principles of Operation
- 20 – Diagnostic Trouble Codes
- 30 – Observed Symptoms
- 33 – Observed Symptoms – Gear Pump
- 43 – Test and Adjustments – Gear Pump
- 50 – Abbreviation and Acronyms
- 55 – Icons and Graphics
- 70 – Fault Mode Indicator Reference

For Diagnostic Trouble Code listings, see Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.

NOTE: Not all groups will appear in all sections.

Supplementary Data: The supplementary data section of the manual includes information and data that apply to many sections or groups and is stored here for access by all users of the manual. This data includes, but is not limited to:

- Abbreviations and Acronyms
- Special Tools List
- Fault Mode Indication Reference Table
- Supplier Specification Data

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GENERAL INSTRUCTIONS

1. Become familiar with the content, layout, and access provisions of data in this manual. This will improve your efficiency and decrease the time required to resolve the problems.
2. Use all sections of the manual for relevant information on the subject system.
3. Once you begin a troubleshooting procedure, do not skip steps.
4. If you reach the end of a procedure without resolving the problem and you are not directed to another procedure contact Resident Service Engineering through the Contact Management System.
5. Do not limit yourself, remember to apply your own experience and knowledge to assist in resolving the problems, but do not compromise safety in doing so.
6. Most of the cross-reference data in the manual will be electronically linked for rapid and easy access. Use the links wherever the cursor highlights an item as a linkable option.

As an example of this linking option:

Assume that during a procedure or test, it is necessary to refer to a different section of manual, in this case, the Light Circuit Check in the Operational Checkout part of this manual.

The instruction would read, "refer to, or see" followed by text identifying what the reference is (for hard-copy, paper manual use). When the cursor is placed over the text, it will then indicate that it is active, and left-clicking will direct the system to take you directly to that reference.

Try it using the process below:

See Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-5.
When you have reviewed the reference document or manual, and need to return to the troubleshooting procedure, the "BACK" button will permit you to do this.

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SERVICE MANUAL LOOKUP

The following service manuals are referenced throughout this manual. Be sure to have the correct service manual for your lift truck model.

AC Motor Repair 0620SRM1385

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

AC Motor Repair 0620SRM1515

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Brake System 1800SRM1332

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Brake System 1800SRM1359

- E2.2-3.5XN (E45-70XN) (A268)

Brake System 1800SRM1438

- E1.6-2.0XN (E30-40XN) (A269)

Brake System 1800SRM1518

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Capacities and Specifications 8000SRM1340

- J1.5-2.0XNT (J30-40XNT) (K160)

Capacities and Specifications 8000SRM1374

- E2.2-3.5XN (E45-70XN) (A268)

Capacities And Specifications 8000SRM1375

- J2.2-3.5XN (J45-70XN) (A276)

Capacities and Specifications 8000SRM1376

- J1.6-2.0XN (J30-40XN) (A935)

Capacities and Specifications 8000SRM1443

- E1.6-2.0XN (E30-40XN) (A269)

Capacities and Specifications 8000SRM1527

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Capacities and Specifications 8000SRM1542

- J4.0-5.0XN (A970)

Capacities and Specifications 8000SRM1578

- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564) 2100SRM1382

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Cylinder Repair (Mast S/N B551, B555, B559) 2100SRM1440

- E1.6-2.0XN (E30-40XN) (A269)

Cylinder Repair (Mast S/N A270, A271, A272, C661, C662, C663) 2100SRM1521

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Diagrams 8000SRM1341

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Diagrams 8000SRM1384

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Diagrams 8000SRM1528

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Drive Axle Repair 1300SRM1575

- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Drive Axle, Speed Reducer, and Differential 1300SRM1366

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)

Electrical System 2200SRM1337

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Electrical System 2200SRM1369

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Electrical System 2200SRM1524

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Frame 0100SRM1329

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Frame 0100SRM1342

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Frame 0100SRM1514

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Hydraulic System 1900SRM1333

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Hydraulic System 1900SRM1367

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Hydraulic System 1900SRM1519

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

ALL LIFT TRUCK MODELS

Industrial Battery 2240SRM0001

ALL LIFT TRUCK MODELS

Load Axle 1300SRM1516

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Main Control Valves 2000SRM1334

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Main Control Valves 2000SRM1439

- E1.6-2.0XN (E30-40XN) (A269)

Main Control Valves 2000SRM1520

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)

Mast Repair (S/N A270, A271, A272) 4000SRM1386

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

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Mast Repair (S/N B551, B555, and B559) 4000SRM1441

- E1.6-2.0XN (E30-40XN) (A269)

Mast Repair (S/N A270, A271, A272, C661, C662, and C663) 4000SRM1525

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54) 4000SRM1540

- J4.0-5.0XN (A970)

Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754) 4000SRM1576

- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Operator's Cab 0100SRM1446

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Periodic Maintenance 8000SRM1339

- J1.5-2.0XNT (J30-40XNT) (K160)

Periodic Maintenance 8000SRM1364

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1372

- J2.2-3.5XN (J45-70XN) (A276)

Periodic Maintenance 8000SRM1373

- J1.6-2.0XN (J30-40XN) (A935)

Periodic Maintenance 8000SRM1442

- E1.6-2.0XN (E30-40XN) (A269)

Periodic Maintenance 8000SRM1541

- J4.0-5.0XN (A970)

Periodic Maintenance 8000SRM1526

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Periodic Maintenance 8000SRM1577

- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Steering Axle 1600SRM1360

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J1.6-2.0XN (J30-40XN) (A935)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Steering System 1600SRM1331

- J1.5-2.0XNT (J30-40XNT) (K160)

Steering System 1600SRM1363

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J1.6-2.0XN (J30-40XN) (A935)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Steering System 1600SRM1517

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Transaxle 1300SRM1330

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Transaxle 1300SRM1370

- J2.2-3.5XN (J45-70XN) (A276)

Transaxle 1300SRM1539

- J4.0-5.0XN (A970)

User Interface Service Technician 2200SRM1336

ALL LIFT TRUCK MODELS

User Interface Supervisor 2200SRM1335

ALL LIFT TRUCK MODELS

Wire Harness Repair 2200SRM1128

ALL LIFT TRUCK MODELS

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CONVENTIONAL BATTERY BOX (CBB) UNITS

The Operator's seat is higher due to the position of the battery box which sits above the axles for these units. See Figure 9000-01-1.

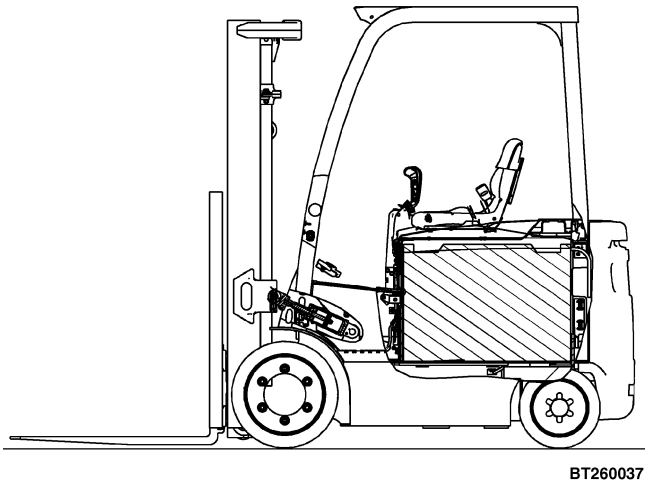

Figure 9000-01-1. Conventional Battery Box

Hyster Unit Code	European Model Designation	America Model Designation
A269	E1.6-2.0XN	E30-40XN
A268	E2.2-3.5XN	E45-70XN
A099	E4.0-5.5XN, E4.5XNS	E80-120XN, E100XNS

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DROP BATTERY BOX (DBB) UNITS

The battery is “dropped” between the front and rear axles (or wheels) for these units. See Figure 9000-01-2.

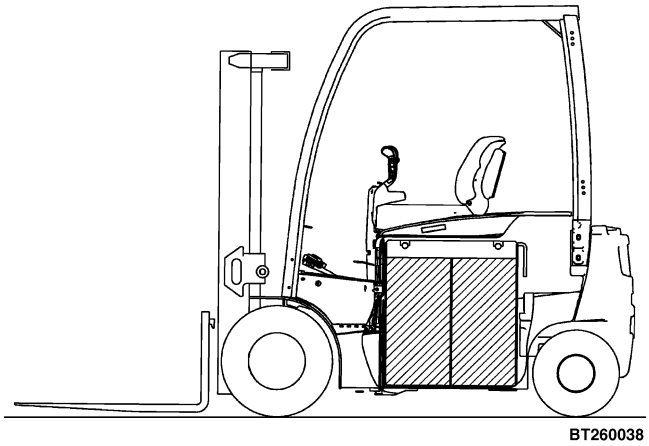

Figure 9000-01-2. Drop Battery Box

Hyster Unit Code	European Model Designation	America Model Designation
D203	A1.3XNT, A1.5XNT	A25XNT, A30XNT
K160	J1.5-2.0XNT	J30-40XNT
A935	J1.6-2.0XN	J30-40XN
A276	J2.2-3.5XN	J45-70XN
A970	J4.0-5.0XN	J80-100XN

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SECTION 9010

OPERATIONAL DIAGNOSTIC PROCEDURES

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Group 05

Operational Checkout

Operational Checkout Procedures

These procedures are designed so technicians can make a quick check of the operation of the machine while sitting in operator's seat.

WARNING

Be sure to read the warnings prior to performing the checkout procedures.

WARNING

Before operating the lift truck, FASTEN YOUR SEAT BELT.

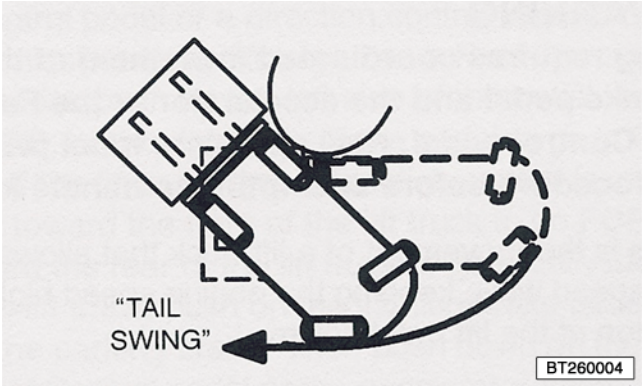
There are a number of operations, if not performed carefully, that can cause the lift truck to tip. If you have not read the WARNING page in front of the Operating Manual, do so NOW. As you study the following information about how to properly operate a lift truck, remember the Warnings.

WARNING

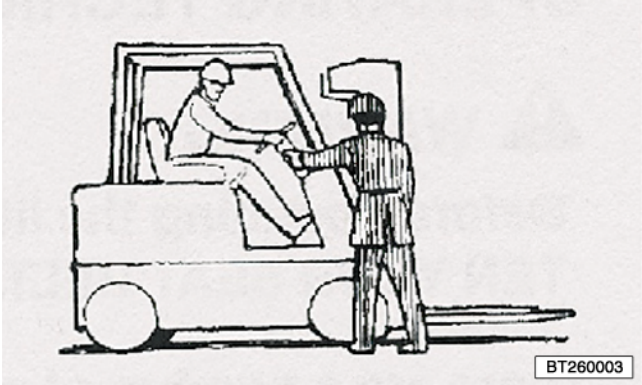
Mast parts are heavy and can move. Distances between parts are small. Serious injury or death can result if part of the body is hit by parts of the mast or the carriage.

- **Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Also make sure the power is OFF and the key is removed. Fasten a DO NOT OPERATE tag in the operator's compartment.**
- **Be careful of the forks. When the mast is raised, the forks can be at a height that may cause an injury.**
- **DO NOT climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.**
- **DO NOT use blocks to support the mast weldments nor to restrain their movement.**
- **Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in the correct Service Manual for the mast.**

Adequate space is required to do the driving checks. Some checks require the lift truck and other major components to be at operating temperature.



Before performing the operational checkout, complete the INSPECTION BEFORE OPERATION in the **Operating Manual**.



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Before starting operational checkout, talk to the operator and check Diagnostic Trouble Codes (DTC) using the Display Panel (DP). See Troubleshooting Guidelines and Procedures. All DTCs must be corrected or cleared before starting this checkout.

No special tools or gauges are needed. Always start sequence from left to right. Before doing check, read each check completely.

At the end of each check, a question is asked:

- If the answer indicates the check is OK, you will be instructed to go to next check.
- If the answer indicates that the check is not OK, you will be given a required SRM repair or be linked to the test to perform.

When a problem is found, stop operational checkout and correct it before going to the next check. Repeat check after repair to confirm repair was successful before proceeding with the remaining checks.

CHECK	PROCEDURE	ACTION
Key Icon Illuminated	Turn Keyless Start Switch or Key Switch to **ON** position with park brake applied. ***Does the Key Icon appear on the Display and remain illuminated?***	**YES:** Shut key **OFF**. Wait 30 seconds for power cycling then turn key **ON**. Key icon should not stay lit. **NO:** Display power is OK. Go to next step.
Wrench Icon Illuminated	Turn Keyless Start Switch or Key Switch to **ON** position with park brake applied. ***Does the Wrench Icon appear on the Display and remain illuminated?***	**YES:** Reinstall newest version of software. See **User Interface Supervisor** 2200SRM1335 or **User Interface Service Technician** 2200SRM1336. **NO:** Display power is OK. Go to next step.
Display Panel (DP) Check	1. Turn key or keyless switch to **ON** position. 2. Check display for any DTCs. See Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6. ***Are any DTCs displayed?***	**YES:** Refer to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6. **NO:** DTCs are OK. Go to next check.

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Operator Presence System Check	**NOTE:** This procedure requires Service Password. Operator presence sensor requires a minimum of 45.4 kg (100 lb) to actuate. 1. While operator is in seat, power truck **ON**. 2. See Display Panel Flowchart. At the Display Panel, Enter Main Display, enter password, scroll to Diagnostics, **Enter**. 3. Scroll to Seat Symbol **Enter**. Read display. ***Does display show 1.4 volts or greater?*** *Continue:* While operator is out of seat, power truck **ON**. ***Does display show less than 0.8 volts?*** **NOTE:** BEFORE PROCEEDING TO NEXT CHECK, RETURN TO SEAT AND FASTEN SEAT BELT.	**YES:** Continue with this procedure. **NO:** Go to DTC 12816, Seat Sensor Out of Range Low (OORL) or DTC 12819 and troubleshoot per procedure. **YES:** Operator presence sensor is OK. Go to next check. **NO:** Operator presence sensor has failed. Replace seat sensor. See **Electrical System** 2200SRM1337.

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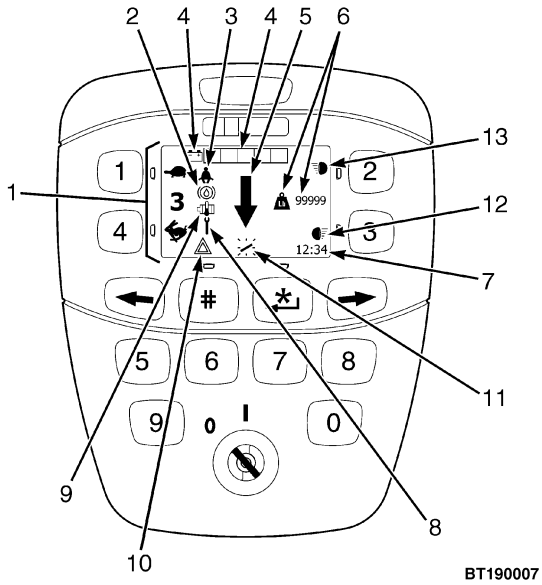
Display Backlight and Icon Power Check	 1. INDICATOR LIGHT, PERFORMANCE MODE 2. WARNING LIGHT, LOW BRAKE FLUID 3. WARNING LIGHT, FASTEN SEAT BELT 4. INDICATOR LIGHT, BATTERY DISPLAY INDICATOR (BDI) 5. INDICATOR LIGHT, DIRECTION INDICATORS 6. INDICATOR LIGHT, LOAD WEIGHT 7. INDICATOR LIGHT, SYSTEM TIME 8. WARNING LIGHT, SERVICE DUE LIGHT 9. WARNING LIGHT, MOTOR TEMPERATURE HIGH WARNING 10. INDICATOR LIGHT, HAZARD FLASHERS 11. INDICATOR LIGHT, STEER ANGLE 12. INDICATOR LIGHT, FRONT WORK LIGHTS 13. INDICATOR LIGHT, REAR WORK LIGHTS Turn Keyless Start Switch or Key Switch to **ON** position with park brake applied. ***Do the Display Backlight and icons appear on the LCD screen?*** **NOTE:** Fasten seat belt, icon will turn off after 10 seconds. *Continue:*	**YES:** Display power is OK. Go to next step. **NO:** See No Display/No Truck Operation.

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Light Circuit Check	1. Turn front and rear work light switches ON. ***Do lights turn on?***	**YES:** Go to next check. **NO:** Refer to Observed Symptom, Lights Inoperative.
Horn Circuit Check	**NOTE:** There can be up to three horn buttons on the lift truck: 1. Steering Wheel 2. Right Rear Grab Handle 3. MLM Armrest Press horn button. ***Does horn sound?***	**YES:** Horn is OK. Go to next check. **NO:** Refer to Observed Symptoms, Observed Symptoms, Horn Failure, Page 9030-30-32.
Backup Alarm Check (If equipped)	1. With lift truck running, apply service brake. 2. Release park brake. 3. Select reverse direction. ***Does backup alarm sound?***	**YES:** Back up alarm is OK. Go to next check. **NO:** Check wiring connections.
Heater Check (If equipped)	1. Turn key switch to **ON** position. 2. Check display for any error codes. ***Are any error codes displayed?***	**YES:** Correct error codes. See **Electrical System** 2200SRM1337 or **Electrical System** 2200SRM1369 . **NO:** Heater is okay. Go to next check.

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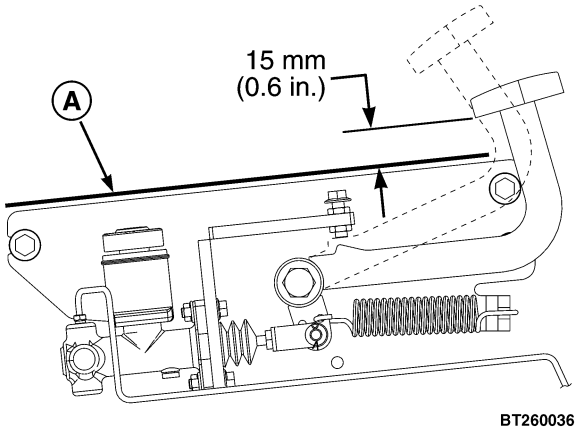
Brake Pedal Check	 **A.** TOP OF FLOOR MAT 1. With lift truck running, release park brake. 2. Depress and hold brake pedal with approximately 45.4 kg (100 lb) force. 3. Measure pedal distance from floor mat as shown in the illustration. ***Does brake pedal remain at least 15 mm (0.6 in.) off floor mat?***	**YES:** Brake adjustment is OK. Go to next check. **NO:** Adjust brakes. see **Brake System** 1800SRM1332.
Park Brake Sensor Check	1. With lift truck running, release park brake. 2. Slowly apply park brake and note when park brake display comes ON. ***Does display come on before park brake reaches first click of engagement?***	**YES:** Park brake sensor is OK. Go to next check. **NO:** Adjust park brake, see **Brake System** 1800SRM1332.

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Park Brake Check	 BT260002 **WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.** 1. Stop lift truck in an uphill direction with rated load on 15% grade or less, and apply park brake. 2. Shut lift truck **OFF** and note if machine remains static. 3. Start lift truck and remove rated load. 4. Position lift truck with No Load in a downhill direction, on 15% grade or less, and apply park brake. 5. Shut lift truck **OFF** and note if machine remains static. ***Does machine remain static on grade in both directions?***	**YES:** Park brake is OK. Go to next check. **NO:** Adjust park brake, see **Brake System** 1800SRM1332.

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Brake and Axle Drag Check	**NOTE:** Move truck to level surface before performing the following steps. 1. Raise lift truck until drive tires are off ground. Support lift truck using suitable shop standard. (See "How to Raise Drive Tire" procedure in **Operating Manual**.) 2. Shut lift truck **OFF** and release park brake. Handle provided under floor plate to manually release the park brake. 3. Check brakes for dragging. ***Are the brakes dragging?***	**YES:** Repair brakes. See **Brake System** 1800SRM1359. **NO:** Brakes are OK. Continue with this procedure.
	Continue: Manually turn one tire by hand. ***Does the tire turn with moderate force and does the other tire turn in the opposite direction?***	**YES:** Axle is OK. Adjust park brake back to correct setting. Go to next check. **NO:** If opposite wheel does not turn, differential is damaged. If equipped, remove differential cover and inspect. See **Transaxle** 1300SRM1330.
Priority Flow Divider Valve Check	1. Turn steering wheel to right axle stop and then back to left axle stop in one continuous cycle while raising lift carriage. ***Does carriage lift speed decrease while steering?***	**YES:** Continue with this procedure. **NO:** If no steering, flow divider spool is stuck. Remove, clean, and inspect spool. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
	Continued: 2. Release steering wheel. ***Does carriage lift speed increase when not steering?***	**YES:** Flow divider is OK. Go to next check. **NO:** Inspect and clean relief valves. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

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Mast Cushion Check - Free Lift Cylinder	**NOTE:** This check applies to free lift cylinders. 1. Raise forks at maximum lift speed with no load. 2. When free cylinder reaches top of stroke, observe transition to main lift cylinder phase and speed of free lift rod during transition. ***Does free lift rod speed slow and does hissing sound come from top of cylinder, with no audible impact at top of stroke?***	**YES:** Free lift is OK. Go to next check. **NO:** Remove oil fill port screw at top of free lift cylinder; add 100 cc (3.40 oz) of hydraulic oil. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
Lift Drift Check	Ensure the following before starting procedure: • Truck operating on flat surface. • Hydraulic oil at operating temperature. **WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.** • Secured capacity load on forks. 1. Install angle meter on mast and position mast at approximately 90° angle to ground. 2. Raise mast until approximately 75 mm (3 in.) of main lift cylinder rods are exposed on mast. Record this measurement. 3. Shut lift truck **OFF**. 4. After 5 minutes, measure mast main lift cylinder drop. ***Does main lift cylinder rod retract more than 50 mm (2 in.)?***	**YES:** Go to Lift Cylinder Leakage Test to isolate if problem is in cylinder or control valve. **NO:** Main cylinder drift is OK. Continue with this procedure.
	Continue: 5. Raise free lift cylinder approximately 75 mm (3 in.) and mark cylinder rod to record movement. 6. After 5 minutes, measure free lift cylinder drop. ***Does free lift drop more than 50 mm (2 in.)?***	**YES:** Go to Lift Cylinder Leakage Test to isolate if problem is in cylinder or control valve. **NO:** Free lift drift is OK. Go to next check.

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Lift/Tilt Mast Adjustment Check	Ensure the following before starting procedure: • Truck operating on flat surface. • Adequate overhead clearance to raise forks to maximum height. • No load on forks. 1. Raise forks to maximum height. ***Does the top sections of mast kick to one side at maximum height?***	**YES:** Shim lift cylinders. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Mast cylinder is adjusted OK. Continue with this procedure.
	Continue: 2. Slowly tilt the mast full forward and then full backward at maximum height and observe movement of mast. ***Does the top sections of mast make noise during tilting and show excessive movement of mast sections?***	**YES:** Shim and adjust mast. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Mast shimming is OK. Go to next check.
Tilt Function Drift Check	Ensure the following before starting procedure: • Truck operating on flat surface. • Hydraulic oil at operating temperature. **WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.** • Secured capacity load on forks. 1. Raise mast approximately 300 mm (12 in.) off floor. 2. Install angle meter on mast and position mast at approximately 90° angle to ground. 3. Ensure lift truck is **OFF**. 4. After 5 minutes, measure mast angle and compare to original reading. ***Does mast tilt drift more than 2 degrees in 5 minutes?***	**YES:** Go to Tilt Cylinder Leakage Test to confirm if cylinder or control valve is leaking. **NO:** Tilt drift is OK. Go to next check.

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Tilt Racking Check	Actuate mast back tilt function until hydraulic valve goes over relief. ***Do both sides of mast stop evenly?***	**YES:** Tilt stops are adjusted OK. Go to next check. **NO:** Adjust tilt stops. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386.
Tilt Function, Tilt Lock Piston	**WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.** 1. Put secured capacity load on forks and raise forks approximately 1 m (3 ft). 2. Tilt load back to tilt stop. 3. Move tilt lever to tilt forks forward full stroke and observe speed. ***Can tilt speed be controlled?***	**YES:** Tilt lock is OK. Go to next check. **NO:** Repair tilt lock piston valve in tilt spool. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
Mast Cushion Check - Main Lift Cylinder	Ensure the following before starting procedure: • Truck operating on flat surface. • Adequate overhead clearance to raise forks to maximum height. **WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.** • Secured capacity load on forks. 1. Raise forks to maximum height of main lift cylinders. 2. Lower forks as fast as possible and observe cylinder rod as main lift cylinders reach bottom of stroke. ***Does fork speed slow and does a hissing sound come from cylinder at bottom of stroke?***	**YES:** Piston ring is OK. Go to next check. **NO:** Inspect and clean piston ring. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

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Mast Channel Check	**NOTE:** This is a visual check of the mast to determine if parts are worn or out of adjustment. 1. Raise mast to full height without load and shut lift truck **OFF**. 2. Inspect outer and inner channels for wear pattern and gouging. 3. Move forks to lowered position. 4. Inspect the inner channel wear pattern for wear or gouging. ***Do channels show signs of excess wear?***	**YES:** Repair mast channels. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Mast wear is OK. Continue with this procedure.
	Continue: 5. Inspect spacing between channels. ***Is the channel spacing even on each side?***	**YES:** Channel spacing is OK. Go to next check. **NO:** Adjust or repair mast. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386.
Mast Mounting Check	1. Move mast to lowered position and shut lift ruck **OFF**. 2. Inspect the mounting hardware at axle. 3. Push the top of mast by hand while off the lift truck and note any movement of lift truck. **NOTE:** If the mast mounting is loose, mast will move without moving truck frame. ***Is the mast mounting loose?***	**YES:** Inspect and repair mast mounting. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Mast mounting is OK. Go to next check.

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Chain and Header Hose Adjustment Check	Ensure the following before starting procedure: • Truck operating on flat surface. • Hydraulic oil at operating temperature. • No load on forks. 1. Install angle meter on mast and position mast at approximately 90° angle to ground. 2. Raise and lower forks through two complete lift cycles. 3. Lower forks to lowest position. **NOTE:** The carriage safety stop does not make contact at full extension, but that a minimum gap of 6 mm (0.25 in.) remains. **NOTE:** The correct fork height adjustment is approximately 6 mm (0.25 in.) off floor. ***Does the heel of forks touch the floor?***	**YES:** Adjust lift chains. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Chains are adjusted OK. Continue with this procedure.
	Continue: 4. Look at condition of hoses as they go over sheaves. ***Are the hoses compressed?***	**YES:** Adjust header hoses. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Hose tension is OK. Continue with this procedure.
	Continue: 5. Inspect contact of hoses with any crossmember or load backrest near sheave area. ***Are the hoses contacting any crossmember or the load backrest?***	**YES:** Adjust header hoses. **NO:** Hose adjustment is OK. Go to next check.

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Chain Sheave Check	1. Lower forks. Shut lift truck **OFF**. 2. Inspect wear pattern on chain sheaves. ***Does sheave show a wear pattern without side wear?***	**YES:** Chain sheaves are OK. Go to next check. **NO:** Replace chain sheaves. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386.
Carriage Adjustment Check	1. Lower forks to approximately 50 mm (2 in.) off ground. Shut lift truck **OFF**. 2. Rock the carriage frame side to side. ***Does carriage move more than 0.5 mm (0.020 in.) at tightest point?***	**YES:** Adjust or repair carriage bearings. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Carriage adjustment is OK. Go to next check.
Carriage Adjustment Check (Standard and Integral Side Shift)	1. Lower forks. Shut lift truck **OFF**. 2. Inspect wear on carriage stop. ***Does carriage stop show a wear pattern on it?***	**YES:** Chains are out of adjustment. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Checks complete.
Steering Relief Valve Low Pressure Check	1. Turn key switch to **ON** position. 2. Position steer axle wheels straight to start check. 3. Turn steering wheel stop-to-stop in both directions. ***Does steer axle wheels turn stop-to-stop without stopping?***	**YES:** Relief pressure is OK. Go to next check. **NO:** If steer axle wheels do not turn stop-to-stop, pressure is too low. Adjust steering relief pressure. Go to Steering Relief Pressure Test and Adjustment.

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SECTION 9025
TRACTION MOTOR

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Group 10

Principles of Operation

Traction Motor

PRINCIPLES OF OPERATION

All electric forklift trucks covered by this manual use three-phase alternating current (AC) induction traction motors. AC motors are all very similar motors used across the product line, but do vary in some ways. This Principles of Operation will identify the significant differences.

The AC induction motor is an electrical device which uses an AC current provided to a wire wound stator supplied by a DC to AC inverter to induce north and south magnetic poles to an internal rotating device in a controlled environment. The reaction between the internal rotor and stator creates a push-pull effect on the rotor causing the rotor to turn, creating a force to do mechanical work.

In lift trucks the DC current is provided by the lead acid battery. The DC (direct current) voltage is changed to AC (alternating current) by the traction motor controller. By changing the frequency of the AC power to the motor, the motor speed can be controlled. This job is done by the traction motor controller. The controller also manages the direction of the motor and thus the lift truck. It works in conjunction with the VSM.

A speed sensor is used to detect and communicate the speed and direction of the rotor to the controller. This is done by sending electric pulses on two separate channels to the controller. The controller knows the direction of the motor by which channel's signal it receives first. It knows the speed by the frequency of the pulses. The controller's software continually monitors this information. Using this feedback, the AC motor control system can provide regenerative braking, controlled acceleration and deceleration. By changing the frequency of the AC power to the motor, which is also managed by the motor controller, the motor speed can be controlled.

These AC motors have a temperature sensor built into the stator to monitor motor temperature and provide continual temperature feedback to the thermal management system. That system is designed to protect components from failure due to overheating. If the motor winding temperature reaches its specified limit, the VSM signals the traction controller to reduce the motor performance or may even disable traction to protect the motor. When the traction system components are in thermal management, there is no affect on the hydraulic system performance. The connector for this temperature sensor is serviceable, but the sensor itself is not.

The rotor shaft extends out each side of the traction motor. The drive end head interfaces to the drive unit or drive axle, depending upon configuration. For lift trucks A935, A268, A269, and A099 a short, round section of the shaft protrudes from the non-drive end head of the motor. This end supports the parking brake hub using a woodruff key and a snap ring. There is a bearing between the motor and the parking brake. The parking brake is replaceable.

UL safety rated EE traction motors are available as an option on these forklifts. These motors have covered vent holes and are only a part of the necessary equipment required for the EE safety rating.

Traction motors are long life components and very low maintenance. They have no motor brushes. The motor bearings, rotor, stator and speed sensor are serviceable.

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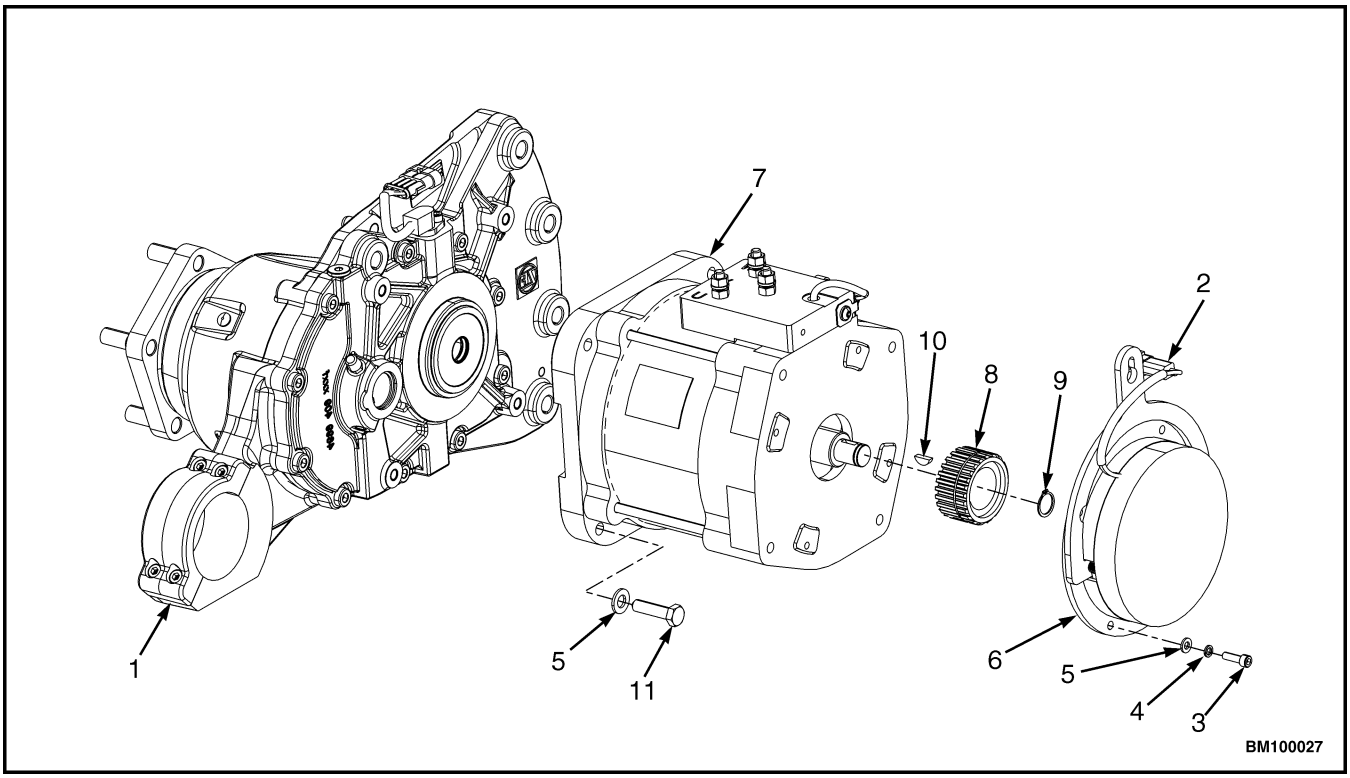
The traction motors vary depending upon the configuration of your forklift. Lift truck model D203 uses a traction motor vertically mounted to the drive unit. The drive unit is refered to as the Master Drive Unit (MDU). For further information on the MDU see MASTER DRIVE UNIT. The model designation K160, A935, A276 and A970 use two traction motors and two motor controllers. A motor is mounted to a drive unit on each side of the vehicle and powers the drive tires. The speed sensor for these motors is physically located on the drive unit housing, not on the motor. See Figure 9025-10-1.



1. TRANSMISSION
2. PARKING BRAKE WIRE HARNESS
3. SOCKET HEAD CAPSCREW
4. LOCKWASHER
5. WASHER
6. PARKING BRAKE
7. TRACTION MOTOR
8. SPLINED HUB
9. SNAP RING
10. WOODRUFF KEY
11. TRACTION MOTOR MOUNTING CAPSCREW

Figure 9025-10-1. Transaxle Assembly J1.5-2.0XNT (J30-J40XNT) (K160) J1.6-2.0XN (A935)

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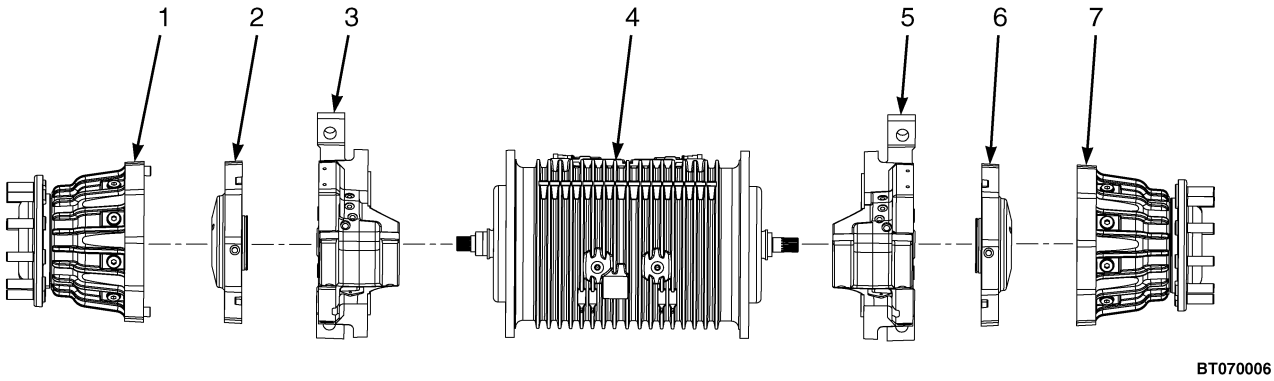

1. RIGHT SIDE TRANSMISSION OUTPUT
2. RIGHT SIDE GEARBOX
3. RIGHT COVER HOUSING
4. TRACTION MOTORS
5. LEFT COVER HOUSING
6. LEFT SIDE GEARBOX
7. LEFT SIDE TRANSMISSION OUTPUT

Figure 9025-10-2. Transaxle Assembly J4.0-5.0XN (A970)

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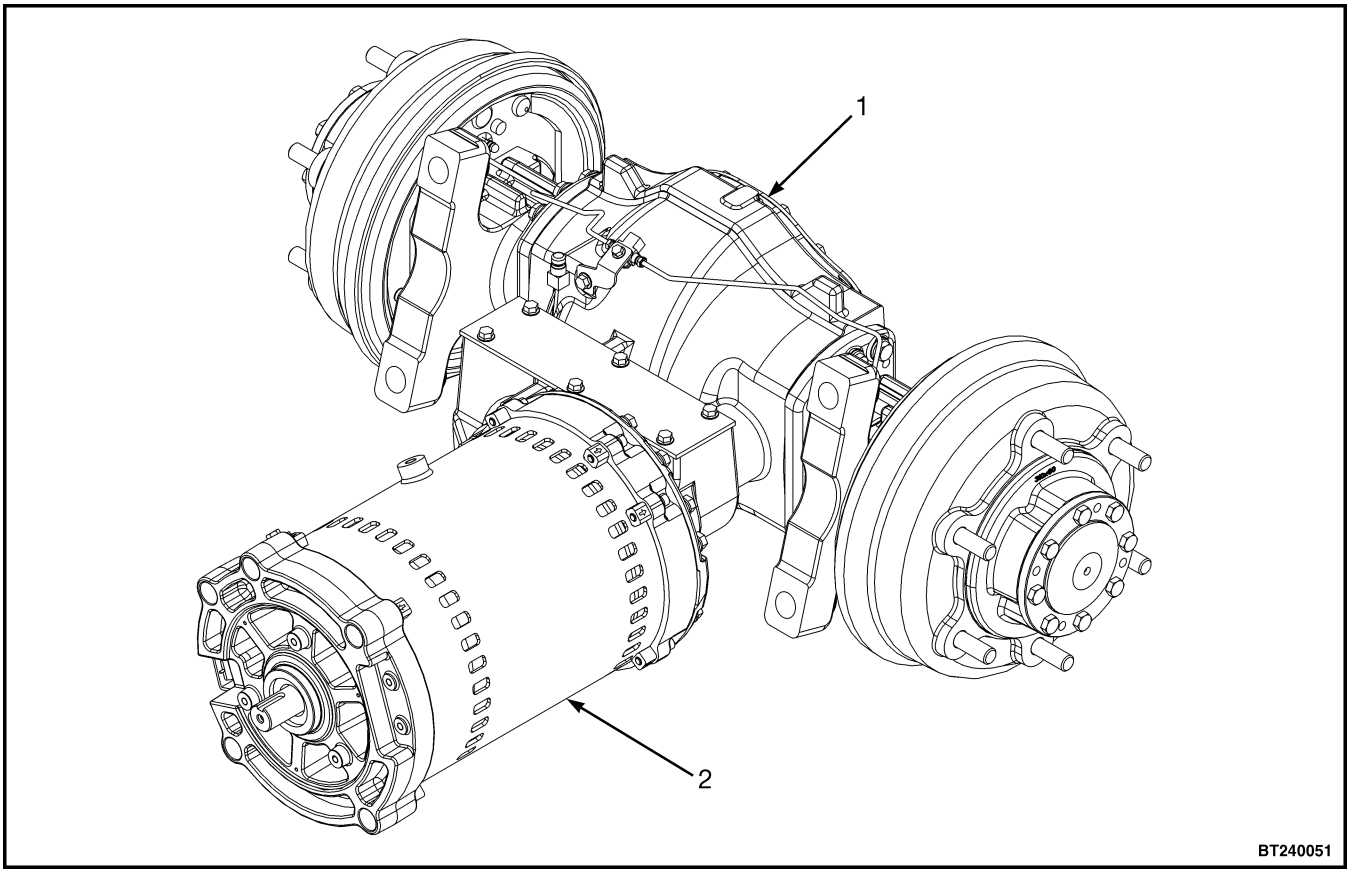
The model designation A268, A269 and A099 uses only one traction motor and one traction controller. It is mounted perpendicular to the drive axle. The speed sensor for this motor is located on the motor itself. See Figure 9025-10-3.



1. TRANSMISSION
2. TRACTION MOTOR

Figure 9025-10-3. Transmission Mounting for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

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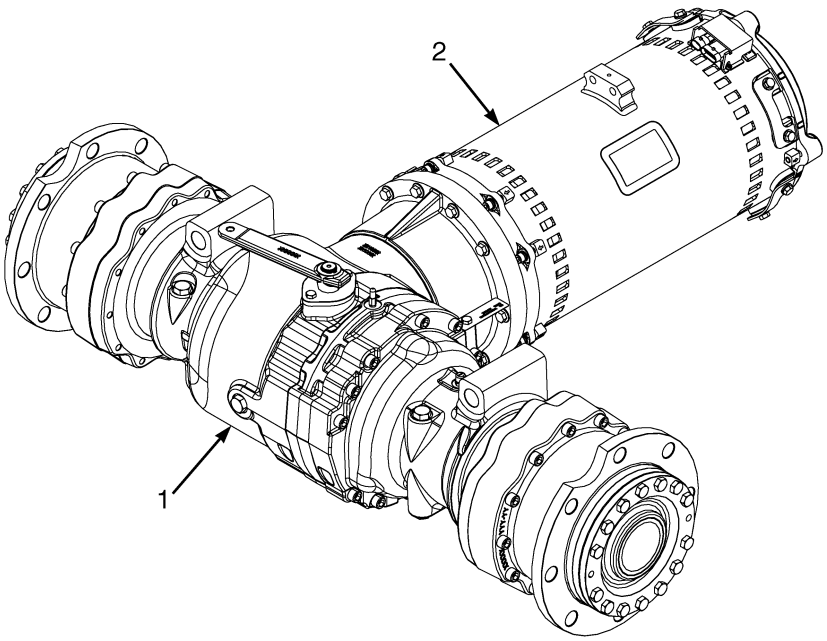

1. DRIVE AXLE
2. TRACTION MOTOR

Figure 9025-10-4. Transmission Mounting for Lift Truck Models E4.0-5.5XN (E80-120XN) (A099)

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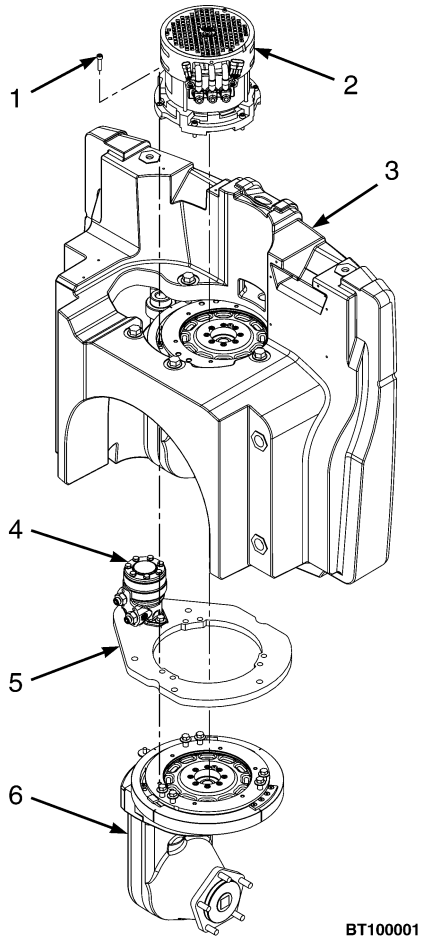
MASTER DRIVE UNIT

The heart of the traction system is the master drive unit (MDU). A stationary traction motor eliminates the power cables from the traction motor to the traction controller from rotating or flexing. The MDU features an integrated pinion with a splined motor to MDU coupling. The support bearings and pinion are integral to the MDU eliminating the potential of damaging the gears when assembling the motor to the MDU. By integrating the pinion, the gear mesh can be better controlled resulting in a quieter MDU. The splined coupling allows for quick removal and installation of the traction motor.



1. CAPSCREW
2. TRACTION MOTOR
3. COUNTERWEIGHT
4. STEER MOTOR
5. PLATE
6. MASTER DRIVE UNIT

Figure 9025-10-5. Master Drive Unit

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Group 30

Observed Symptoms

Poor Tractive Performance

POSSIBLE CAUSE

A. INCORRECT SPEED LIMIT SET.
B. SPEED LIMITING ENABLED.
C. FAILED CHECKLIST ITEM.
D. INCORRECT STEER POSITION SENSOR CALIBRATION.
E. INCORRECT MOTOR CONTROLLER SETTINGS IN CONFIGURATION DATA FILE (CDF).
F. E-BOOST ACTIVE.
G. MOTOR PHASE SHORTED TO FRAME.
H. INCORRECT MOTOR INSTALLED.

CAUSE A - INCORRECT SPEED LIMIT SET.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of the lift truck can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust speed limit setting on Display Panel. If problem still present go to Cause B.

CAUSE B - SPEED LIMITING ENABLED.

PROCEDURE OR ACTION:

1. Verify optional speed limiting is correctly set on Display Panel. See the appropriate **User Interface, Service Technician** SRM . If problem is still present, go to Cause C.

CAUSE C - FAILED CHECKLIST ITEM.

PROCEDURE OR ACTION:

1. Review checklist history and run check as required. Lift truck will not operate correctly until all checklist item requirements have been satisfied.
   Have all checklist requirements been satisfied?
   YES: Go to Cause D.
   NO: Perform necessary actions to fulfill checklist requirements. If checklist requirements have been satisfied and the problem is still present, go to Cause D.

CAUSE D - INCORRECT STEER POSITION SENSOR CALIBRATION.

PROCEDURE OR ACTION:

1. Rerun calibration procedure on the steering position sensor. Refer to the appropriate **Calibration** SRM .
   Did re-calibrating steering position sensor resolve issue?
   YES: Problem resolved. Resume operation.
   NO: Go to Cause E.

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CAUSE E - INCORRECT MOTOR CONTROLLER SETTINGS IN CONFIGURATION DATA FILE (CDF).

PROCEDURE OR ACTION:

1. Go to Hypass Online and download a new CDF from the software options.
2. Install new CDF into lift truck's controller and test drive lift truck.
   Is problem still present?
   YES: Go to Cause F.
   NO: Issue resolved. Resume operation.

CAUSE F - E-BOOST ACTIVE.

PROCEDURE OR ACTION:

1. Make sure the service brakes are not locked up or dragging. See the appropriate **Brake System** SRM . Use the Display Panel to verify e-Boost is not interfering with the traction motor. If e-Boost is active, deactivate it.
   Is the problem still present?
   YES: Go to Cause G.
   NO: Issue resolved. Resume operation.

CAUSE G - MOTOR PHASE SHORTED TO FRAME.

PROCEDURE OR ACTION:

1. Turn lift truck power **OFF**.
2. Disconnect battery.
3. Disconnect power cables to tractions motor.
4. Change DMM to ohms scale. Verify zero reading.
5. Measure continuity between each power terminal of the traction motor and ground.
   Is resistance low or close to zero ohms?
   YES: Replace traction motor with new traction motor.
   NO: Go to Cause H.

CAUSE H - INCORRECT MOTOR INSTALLED.

PROCEDURE OR ACTION:

1. Check that the part number of traction motor is the correct part number for the lift truck. If the part number is not correct, use the correct traction motor.

END SYMPTOM

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SECTION 9030
ELECTRICAL SYSTEM

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Group 03

General Maintenance and Diagnostic Data

Troubleshooting Guidelines and Procedures

TROUBLESHOOTING GUIDELINES

The troubleshooting procedures that will be encountered in this manual require that the individual be familiar with certain policies, requirements, and instructions before starting any of the procedures. These are included to assure the safety of the technician performing the tasks, simplify the procedures, and prevent damage to the machine and supporting equipment.

WARNING

All safety precautions for working on and around powered vehicles must be observed and maintained. (Refer to Operating or Repair Manual.)

1. Initial conditions will be with the vehicle power OFF and park brake set, unless directed otherwise.

2. The Diagnostic Trouble Code (DTC) Chart includes:
   - Diagnostic Trouble Code
   - A brief description of the fault/symptom
   - Page number of applicable Troubleshooting Procedures

   This number is the number displayed in the Liquid Crystal Display (LCD) section of the Display Panel (DP). In addition to active faults that will be displayed on the LCD, the system is capable of displaying fault history data that is stored in the VSM and other controller units, if equipped.
   - VSM Fault Log
   - Traction Controller 1 and 2 Fault Log
   - HYDR PUMP Controller Fault Log
   - LIGHT Controller Fault Log
   - MLM Fault Log
   - IMPACT Fault Log
   - DISPLAY Fault Log

   These fault history logs are accessible to service level technicians. See Troubleshooting Procedures for directions on how to access fault history logs.

3. Abbreviations and Acronyms will be defined when first used in a procedure. They are also listed and defined in Abbreviations and Acronyms that accompanies this document.

4. Most procedures will require the use of a Digital MultiMeter (DMM) and associated probes. The service technician should be familiar with the operation, range scales, polarity selection, and measurement techniques.

   a. Unless otherwise directed, the **RED** probe of the DMM will always be connected to the point indicated as **(+)** and the **BLACK** probe will always be connected to the point indicated as **(-)**.

   b. When performing a continuity check, all signal circuits should be equal or less than 0.5 ohms. At the start of troubleshooting procedures, verify that the DMM will display 0 ohms when the resistance scale is selected and the probes are shorted together. If the DMM display indicates a value less than 1 ohm and that value is consistently repeated, it may be considered as the zero value. Resistance readings during testing will require correction by this small value. If the DMM display is not correct or is greater than 1 ohm, have the meter calibrated/serviced.

   c. In some improved DMMs, when the test probes are shorted together, a momentary push-button switch will re-zero the meter scale and maintain that zero position as a reference until the meter is turned off. If this feature is available, be sure to re-zero each time meter power is cycled.

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d. Probing the back of connectors for obtaining in-line voltage measurements requires a special probe extension for the meter probes. Failure to use this tool can result in damage to the integrity of the connector seal and may cause a failure in the harness/connector assembly. See **Wire Harness Repair** 2200SRM1128.

5. Most electrical problems will be harness related:

- Connectors not fully engaged and locked
- Connector pins not fully inserted
- Circuit repairs incorrectly wired at connectors
- Damaged connector pins

6. Major component service tips:

a. Vehicle System Manager (VSM):

- Connectors are keyed and color coded
- Non-serviceable part
- Last replaceable item in troubleshooting procedures
- Do not transfer VSMs or Display Panel from other trucks
- Always confirm VSM/Display Panel and lift truck serial numbers match before doing any servicing

7. When troubleshooting electrical/electronic faults and symptoms:

a. Verify that the connector is properly engaged and that connector security clips, tabs, and other locking devices are properly attached.

b. Visually examine the connectors and harness termination points for “pushed” or “recessed” pins or sockets.

c. The Electric Truck Battery Negative and Positive are isolated from the Vehicle Frame. Unless directed in a Procedure, no measurements will be made using the vehicle frame as an electrical path.

d. Before opening any connector or removing any wires from their termination point, disconnect the circuits from the battery as directed in the procedure. Trucks are equipped with a Emergency Disconnect Switch. Pushing the emergency disconnect switch in until it clicks, disconnects the power supply to the lift truck.

NOTE: The Electrical System Schematic referenced in this manual will be supplied in Diagrams. Verify that this data is current and the revisions are up to date before making any changes or alterations to the truck wiring.

Prior to making any corrections or changes to the wiring, verify that the wire number and color coincide with the information on the referenced schematics, wiring diagrams, or special instructions, if any.

NOTE: There may be customer options and equipment installed on the lift trucks by third-party services that do not comply with the standard wiring specifications and standards. Suppliers are encouraged to follow these standards for circuits when possible.

8. The chassis wiring used in these vehicles conforms to the electrical circuit identification standard ES-1359 and in addition to surface marked ID circuit numbers, generally utilizes the colors that are indicated below.

a. Red = Battery level power circuits

b. Black = Heavy current grounds

c. Green = Signal Grounds

d. White = Other circuits

e. Twisted Pair (preferred CAN option)

- Yellow = CANbus Hi
- Green = CANbus Lo

f. Twisted Pair (non-preferred CAN option)

- White = CAN-Hi
- White = CAN-Lo

g. Orange = 5 volt

h. Pink = 12 volt

9. Connectors used on schematics and reference drawings are identified as follows: See Figure 9030-03-1 in this section.

a. **CPSXXX** -- **Connector Plug Socket (CPS)**, with **XXX** being the identity number.

b. **CRPXXX** -- **Connector Receptacle Pin (CRP)**, with **XXX** being the identity number.

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10. At the completion of a Troubleshooting Procedure, verify the following:

a. All components removed for replacement, test or access purposes have been correctly reinstalled.

b. All electrical connections are restored.

c. If operational test or checkout is to be performed, make sure operating area is free of personnel, obstructions, and ground hazards.

d. Vehicle is in proper location and configuration for safe operation.

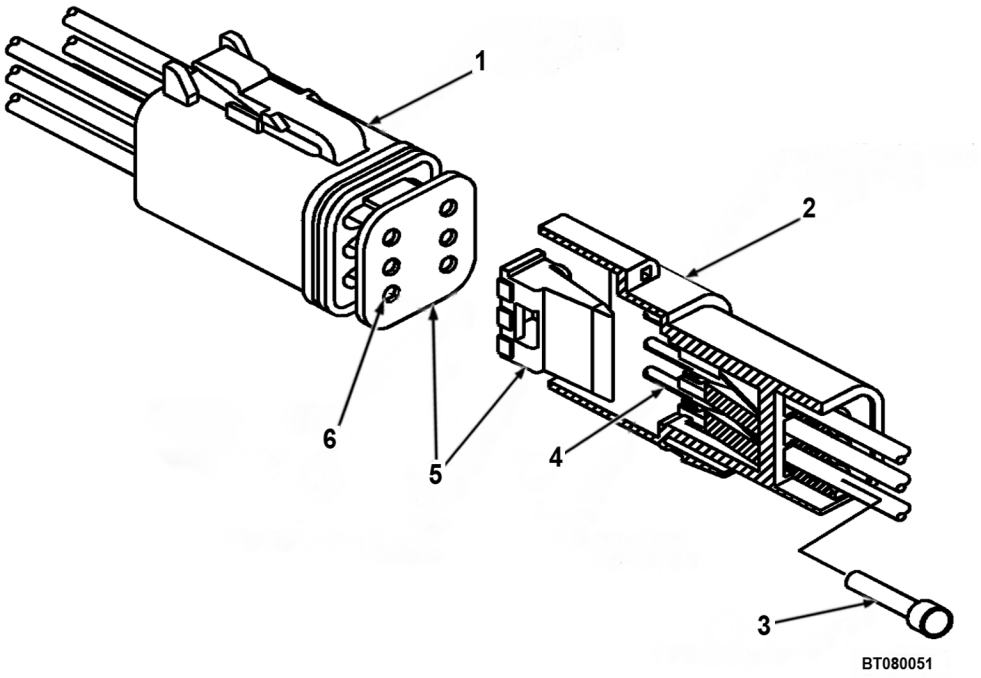
e. Support equipment and tools are removed and properly stored.

f. If operation is complete and the lift truck is to be stored or shut down, verify:

(1) Mast/Carriage/Forks are properly positioned.

(2) By pushing the emergency disconnect switch down until it clicks, disconnects the power supply to the lift truck.

(3) Cab (if equipped) is closed and secured.



1. PLUG TYPE CONNECTOR BODY
2. RECEPTACLE TYPE CONNECTOR BODY
3. CAVITY PLUG
4. PIN-TYPE TERMINAL
5. SECONDARY LOCK
6. SOCKET TYPE TERMINAL

Figure 9030-03-1. Typical DT Series Connector

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TROUBLESHOOTING PROCEDURES

This section describes the general process of identification, location, structure, and performance of the troubleshooting procedures that are included in this manual.

Troubleshooting Procedures, Identification

The various procedures are identified by the fault characteristic.

Troubleshooting Procedures, Location

Once a DTC number has been displayed, indicating a fault has been detected, the operator/service technician can review the DTC chart in this section to determine where the appropriate troubleshooting procedure is located.

The reported DTCs are listed in numerical order, along with the DTC title description of the detected fault. DTCs are also stored in the Fault Logs, where a history of repeat failures is maintained, until cleared by an authorized service technician.

When working from an Integrated Electronic Technical Manual (IETM) format, clicking on the DTC index number, or the page in the Table of Contents, will link you to the applicable procedure in section 9030-20. If working from a hardcopy (paper) manual, this capability is not available.

NOTE: Access to the following Fault Log menus requires Service password.

NOTE: The only Fault Logs available for display are those for the controllers installed in your lift truck, as defined in the VSM's Configuration Data File (CDF)

Access to Fault History Codes — Fault Logs store a history of DTCs within a specific controller file. These fault logs are accessible through the Display Panel main menu. At the Display Panel menu enter the supervisor password, scroll to Diagnostics, **ENTER**, and scroll to appropriate fault log. See Display Menu Flowchart.

Troubleshooting Procedures, Structure

The structure or makeup of the troubleshooting procedures is generally the same for all entries. The procedures are graphical in nature with some text explanation below the relevant graphic. In the text explanation symbols are used wherever possible. See Icon Glossary for definitions.

Minor differences in the beginning of a procedure are determined by whether the procedure has:

- A single fault code with a single schematic diagram
- A single fault code with multiple schematic diagrams
  In this instance, the technician will have to select the appropriate schematic based on the DTC and the lift truck type/configuration.
- Multiple fault codes with a single or multiple schematic diagram(s)
- A single fault code with no schematic diagrams, used when only the operational check and replacement procedures are employed in the procedure.

Troubleshooting procedures include several elements.

- **DTC** number(s) which this procedure applies to.
- **DTC** Identification e.g. Seat Sensor.
- **CHECK** List - Determines if the Fault is still active and helps identify the Possible Cause.
- **POSSIBLE CAUSES**
- **MAIN SCHEMATIC**
- **OPERATIONAL CHECKS**

NOTE: If key icon remains illuminated after software is installed, shut key **OFF**. Wait 30 seconds for power cycling then turn key **ON**. Key icon should not stay lit.

- Verify the DTC is still a valid fault. If the DTC is cleared during the power cycling, it may not have been a hard failure and if it does not reoccur on the display, there is no method of identifying or troubleshooting the problem.
  If this situation occurs randomly or reoccurs frequently with the same DTC, access and review the fault history log for that group to determine the frequency of failure and the last reported time it occurred. This information can be helpful in isolating intermittent problems when known conditions under which it occurred can be repeated.

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- The operational check will also direct the technician to the proper cause in the procedure, based on truck/system configuration, other symptoms, and advise the user if any special conditions are required (i.e. Operate the truck until it has reached normal temperature, recharge the battery before proceeding etc.).
- The operational check is also performed to verify that the problem has been corrected and that the components and devices have been restored to an operating condition.

The next item that appears in the procedure is the **CAUSE A**. This introduces the troubleshooter to the first sequence of tests or measurements to follow. Continuing through the procedure in the step-by-step directions will lead the user to:

- Additional possible causes
- Replacement/repair instructions
- Correction of the fault
- Operational check of the repaired/replaced device

It must be noted that Service Manual factory directions discourage probing of the connectors using any type of wire or pin and that resistance or continuity measurements of these connections should only be done with the appropriate service tool and breakout connectors.

Following through the procedure, the next items are the **DIAGRAMS** that support the troubleshooting and provide relevant data for wiring, connectors, power, signal and other reference data. These will enable the troubleshooter to measure, verify, and make critical decisions leading to the root cause. The diagrams may include:

- A mini-schematic of the suspect circuit
- Wire identification and circuit function
- Connector pin-out locators
- Special reference data for device or component

Troubleshooting Procedures, Performance

It is important to remember the basics of troubleshooting when checking the electronically reported faults. Prior to starting any of the listed procedures, it is recommended that the items listed below be reviewed. These may help to isolate the problem, eliminate some steps or enforce the procedure that has been identified. These items are:

- **LOOK** — Are there any observable symptoms, visual evidence or obvious conditions that could result in, or contribute to, the reported fault.
  Are the displayed Icons due to Interlocks? See **User Interface Supervisor** 2200SRM1335 or **User Interface Service Technician** 2200SRM1336 .
- **LISTEN** — If the lift truck can be operated with the reported problem, are there any unusual noises or vibrations that could result in, or contribute to, the reported fault.
- **TOUCH OR SMELL** — High operating temperatures and excessive wear can sometimes produce an odor or visual evidence that can be linked to other faults or conditions.
- In general, let your senses and your experience assist you in resolving the problem in the most efficient manner. Ask yourself:
  - What is required for this device or operation to function correctly?
  - Where are the devices/parts located?
  - Has this problem been reported before? If so, how frequently? Use the fault history logs to help identify repeated problems. This can be very helpful in analyzing faults of an intermittent nature which may be difficult to duplicate.
  - Has repair work, disassembly or other maintenance work been performed on suspect device or system recently?
- Once these questions have been considered, proceed with the DTC resolution as per the procedure, using any additional information to assist in resolving the discrepancy.

Troubleshooting Procedures, Final

DTCs are stored in the FAULT CODE LOGS, where a history of repeat failures is maintained, until cleared by an authorized service technician. All DTCs are to be cleared prior to operating the lift truck. Fault code logs should only be cleared once the data is recorded by a authorized service technician. See Display Menu Flowchart.

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NOTE: Motor/Motor Controller Fault Logs cannot be cleared. Once the Motor Controller Log is full, DTCs are removed on a First In, First Out (FIFO) basis.

DIAGNOSTIC TROUBLE CODES

The Diagnostic Trouble Codes that appear in the table that follows are those codes that have been stored in the memory of the VSM or in certain cases the Display Panel or other Controllers. They will be displayed via the Display Panel upon detection and will remain in the applicable fault history logs until service intervention clears the logs.

The DTC list is comprised of the DTC number and a brief description of the fault item.

Diagnostic Trouble Code (DTC) Chart

DTC	DESCRIPTION	PAGE NO.
12332	Data Incorrect	9030-20-108
12545	Battery OORH	9030-20-85
12546	Battery OORL	9030-20-85
12576	Motor Voltage Not OK	9030-20-296
12576	DC Bus Charging Timeout	9030-20-389
12592	Capacitor Charge	9030-20-249
12800	Directional Select A	9030-20-67
12801	Directional Select A	9030-20-71
12802	Direction Select Data Incorrect – Direction Signals Incorrect	9030-20-341
12804	Directional Select B	9030-20-67
12805	Directional Select B	9030-20-71
12806	Direction Select – Data Incorrect 2 + Direction Devices Installed	9030-20-349
12807	Direction Select Data Incorrect - No DCS Source	9030-20-353
12808	Accelerator Pedal Position A	9030-20-11
12809	Accelerator Pedal Position A	9030-20-15
12810	Accelerator Pedal Position B	9030-20-11
12811	Accelerator Pedal Position B	9030-20-15
12812	Accelerator Pedal Position A to B	9030-20-20
12813	Foot Brake Position Rationality	9030-20-552
12816	Seat Sensor	9030-20-76
12817	DC Bus Hi – Software Detected	9030-20-389
12818	DC Bus Hi – Hardware Detected	9030-20-389
12819	Seat Sensor	9030-20-80
12820	Steering Wheel Position	9030-20-25
12821	Steering Wheel Position	9030-20-30
12824	Steering Axle Position	9030-20-25
12825	Steering Axle Position	9030-20-30
12831	Park Brake Position	9030-20-62
12832	Park Brake Position	9030-20-57
12833	DC Bus Low – Hardware/Software	9030-20-389
12834	Aux Driver Short to Bat (-) Brake Coil Open Circuit	9030-20-279
12835	Aux Driver Open Circuit Excess Current	9030-20-279
12836	Service Brake Pressure	9030-20-1
12836	Brake Pedal Sensor A OORL	9030-20-552
12837	Service Brake Pressure	9030-20-6
12837	Brake Pedal Sensor A OORH	9030-20-552
12840	Mast Tilt Position	9030-20-57
12841	Mast Tilt Position	9030-20-62
12844	Load Weigh Pressure	9030-20-1
12845	Load Weigh Pressure	9030-20-6

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Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
12852	Hydraulic Temperature	9030-20-39
12853	Hydraulic Temperature	9030-20-43
12856	Manual Hyd 1	9030-20-99
12857	Manual Hyd 1	9030-20-103
12860	Manual Hyd 2	9030-20-99
12861	Manual Hyd 2	9030-20-103
12864	Manual Hyd 3	9030-20-99
12865	Manual Hyd 3	9030-20-103
12868	Manual Hyd 4	9030-20-99
12869	Manual Hyd 4	9030-20-103
12872	Hydraulic Fluid Level	9030-20-48
12873	Hydraulic Fluid Level	9030-20-53
12876	Brake Pedal Sensor B OORL	9030-20-552
12877	Brake Pedal Sensor B OORH	9030-20-552
12928	Display Temperature Sensor (Freezer Option Only)	9030-20-221
12929	Display Temperature Sensor (Freezer Option Only)	9030-20-221
12934	Display Internal LCD Backlight	9030-20-188
12935	Display Internal LCD Backlight	9030-20-188
12936	Display Internal LCD Heater	9030-20-188
12937	Display Internal LCD Heater	9030-20-188
12938	Display Buzzer Output	9030-20-221
12939	Display Buzzer Output	9030-20-221
12940	Display Keyswitch Output	9030-20-195
12941	Display Keyswitch Output	9030-20-195
13056	5V OORL	9030-20-92
13057	5V OORH	9030-20-92
13058	5V Internal Supply Out of Range	9030-20-505
13060	VSM 12V OORL	9030-20-179
13061	VSM 12V OORH	9030-20-179
13070	Keyswitch Data Incorrect	9030-20-195
13104	Sensor Ground Current OORH	9030-20-506
13312	Lift	9030-20-118
13316	Lower	9030-20-118
13320	Tilt Forward	9030-20-118
13324	Tilt Back	9030-20-118
13328	Aux 1A	9030-20-118
13332	Aux 1B	9030-20-118
13336	Aux 2A	9030-20-118
13340	Aux 2B	9030-20-118
13344	Synch Steering Coil Open Circuit	9030-20-420
13352	Diverter Valve	9030-20-232
13356	Hyd Enable	9030-20-232
13360	Acc 1 Relay	9030-20-232
13364	Acc 2 Relay	9030-20-232
13368	Motion Relay	9030-20-232
13372	Reverse Relay	9030-20-232
13376	Spare 1 Relay	9030-20-232
13380	Brake Light Relay Short to B(-) or Open	9030-20-232
13384	Main Contactor	9030-20-232
13388	2nd Contactor	9030-20-232

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Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
16912	Motor Temperature High	9030-20-361
16912	Motor Temperature OORH	9030-20-518
16913	Motor Temperature Sensor Open Circuit	9030-20-510
16914	Motor Temperature Sensor Short Circuit	9030-20-514
17168	Controller/Heatsink Temperature High	9030-20-361
20753	15 Volt Supply Low Voltage	9030-20-383
20755	5 Volt Supply Low/High Voltage	9030-20-383
21008	Current Sensor Offset Calibration Error	9030-20-373
21520	Aux Driver Current High	9030-20-406
21521	Fan Driver Current OORH	9030-20-524
21522	Automatic Park Brake Driver Current OORH	9030-20-529
21569	Contactor Open	9030-20-238
21570	Contactor Closed	9030-20-238
21760	VSM BOOT_BLOCK Checksum failure	9030-20-207
21761	CDF_Checksum_failure	9030-20-207
21762	VSM APPLICATION_SOFTWARE Checksum failure/Error	9030-20-207
21764	VSM EEPROM Checksum failure/Error	9030-20-207
21766	VSM EEPROM Cell failure Write Error	9030-20-207
21776	Internal Error - Hardware	9030-20-527
21792	VSM Serial Number Error	9030-20-207
21830	MLM EEPROM Write Error	9030-20-170
21834	MLM Sensor 1 Out of Range	9030-20-170
21835	MLM Sensor 2 Out of Range	9030-20-170
21836	MLM Sensor 3 Out of Range	9030-20-170
21837	MLM Sensor 4 Out of Range	9030-20-170
22032	Display EEPROM Checksum Error	9030-20-188
22033	Display Cell Write Error	9030-20-188
22528	Display Button *	9030-20-188
22529	Display Button #	9030-20-188
22530	Display \ Arrow	9030-20-188
22531	Display] Arrow	9030-20-188
22532	Display Button 1	9030-20-188
22533	Display Button 2	9030-20-188
22534	Display Button 3	9030-20-188
22535	Display Button 4	9030-20-188
22536	Display Button 5	9030-20-188
22537	Display Button 6	9030-20-188
22538	Display Button 7	9030-20-188
22539	Display Button 8	9030-20-188
22540	Display Button 9	9030-20-188
22541	Display Button 0	9030-20-188
25104	Sensor Fault	9030-20-267
25105	Temperature Sensor Failure	9030-20-361
25106	Park Brake Solenoid and Fan Driver Current High	9030-20-406
25344	MLM Checksum Error	9030-20-170
29216	Speed Sensor High Current	9030-20-531
29217	Speed Sensor Not Connected	9030-20-533
29232	Sensor Supply Reference voltage Out of Range	9030-20-528
29233	Sensor Supply Circuit Out of Range	9030-20-535
29456	Sensor Fault	9030-20-256

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Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
29456	Sensor Fault	9030-20-267
29536	Loss of Speed Sensor Channel A	9030-20-537
29552	Loss of Speed Sensor Channel B	9030-20-539
33024	CAN Communication Failure	9030-20-332
33025	VSM to Display	9030-20-123
33025	VSM to Display	9030-20-137
33025	VSM to Display	9030-20-155
33026	VSM to Traction 1 (Right)	9030-20-123
33026	VSM to Traction 1 (Right)	9030-20-137
33026	VSM to Traction 1 (Right)	9030-20-155
33027	VSM to Traction 2 (Left)	9030-20-123
33027	VSM to Traction 2 (Left)	9030-20-137
33027	VSM to Traction 2 (Left)	9030-20-155
33029	VSM to Pump	9030-20-123
33029	VSM to Pump	9030-20-137
33029	VSM to Pump	9030-20-155
33034	VSM to MLM (DCS)	9030-20-123
33034	VSM to MLM (DCS)	9030-20-137
33034	VSM to MLM (DCS)	9030-20-155
33035	VSM to Impact	9030-20-123
33035	VSM to Impact	9030-20-137
33035	VSM to Impact	9030-20-155
33036	VSM to CAN Reserved 1	9030-20-123
33036	VSM to CAN Reserved 1	9030-20-137
33036	VSM to CAN Reserved 1	9030-20-155
33037	VSM to CAN Reserved 2	9030-20-123
33037	VSM to CAN Reserved 2	9030-20-137
33037	VSM to CAN Reserved 2	9030-20-155
33038	VSM to CAN Reserved 3	9030-20-123
33038	VSM to CAN Reserved 3	9030-20-137
33038	VSM to CAN Reserved 3	9030-20-155
33040	Various CAN Errors	9030-20-556
33050	E-Steer CAN Communications Failure Right	9030-20-500
33051	E-Steer CAN Communications Failure Left	9030-20-500
33056	Display Internal CAN Failure	9030-20-188
33057	Display to VSM	9030-20-123
33057	Display to VSM	9030-20-137
33057	Display to VSM	9030-20-155
33057	Display Communications Error with VSM	9030-20-188
4096	Hydraulic Calibration Required	9030-20-379
4098	Steer Axle Calibration	9030-20-35
4112	Incorrect Lever 1 Installed	9030-20-176
4113	Incorrect Lever 2 Installed	9030-20-176
4114	Incorrect Lever 3 Installed	9030-20-176
4115	Incorrect Lever 4 Installed	9030-20-176
4116	Incorrect Lever 5 Installed	9030-20-176
4117	FOC Configuration Mismatch	9030-20-554
65280	Controller Failure	9030-20-306
65288	Loss of Communication Between the Primary and Secondary Controller	9030-20-424
65293	EEPROM Checksum Failure	9030-20-425

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Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
65296	Motor U-W Phase Voltage Measurement Fault	9030-20-429
65297	Motor U-V Phase Voltage Measurement Fault	9030-20-431
65299	Controller Logic Failure	9030-20-213
65312	Motor Phase Voltage Out of Range	9030-20-435
65333	Standby Current Too High	9030-20-437
65333	Standby Current High	9030-20-548
65340	DC Bus Capacitor Charge Timeout	9030-20-438
65341	Controller Temperature Above Limit	9030-20-441
65341	Controller Internal Temperature OORH	9030-20-522
65341	Controller Internal Temperature OORL	9030-20-523
65345	Motor Temperature Above Limit	9030-20-442
65346	Battery Low	9030-20-541
65350	Controller Internal Error	9030-20-445
65350	Motor Phase W Current OORL	9030-20-461
65351	Motor Phase V Current OORL	9030-20-463
65352	Motor W-V Phase Voltage Measurement Fault	9030-20-433
65353	Motor Phase U Current OORL	9030-20-465
65378	Steering Wheel Position Error	9030-20-473
65481	Wrong Slave Version	9030-20-547
65486	Initial VMN High	9030-20-548
65487	Controller Internal Error	9030-20-446
65488	Controller Internal Error	9030-20-447
65489	Controller Internal Error	9030-20-460
65490	Primary and Secondary Controller Version Mismatch	9030-20-448
65491	TFD Current within Range but Lower than Expected	9030-20-475
65492	Controller Internal Error	9030-20-449
65493	Default Parameter Restore	9030-20-450
65494	Rapid Change in Steering Wheel Position	9030-20-469
65495	Controller Internal Error	9030-20-451
65496	Controller Internal Error	9030-20-452
65496	TFD Resistance Out of Range	9030-20-477
65498	Controller Software Mismatch	9030-20-459
65500	Steering Motor Locked	9030-20-483
65501	Controller Internal Error	9030-20-453
65503	Rapid Change in Steer Axle Position	9030-20-495
65504	Waiting for Node	9030-20-550
65505	Controller Internal Error	9030-20-454
65508	Steer Axle Position Mismatch	9030-20-487
65513	Power MOS Shorted	9030-20-288
65515	TFD Short to battery Negative	9030-20-479
65516	TFD Stand-by Current OORH	9030-20-481
65517	Controller Internal Error	9030-20-455
65519	Controller Mismatch	9030-20-547
65521	Steer Axle Slow Response	9030-20-485
65522	Parameter Transfer	9030-20-547
65524	Primary and Secondary Parameter Mismatch	9030-20-499
65525	Controller Internal Error	9030-20-456
65527	No CAN Communication	9030-20-324
65527	Loss of CAN Communication	9030-20-500
65528	Steer Wheel Sensor Output Mismatch	9030-20-471

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Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
65530	Controller Internal Error	9030-20-457
65531	Controller Initialization Test Failed	9030-20-467
65532	Steer Axle Sensor Output Mismatch	9030-20-491
65533	Controller Internal Error	9030-20-458
8704	Display Internal LCD Backlight	9030-20-188
8705	Display Internal LCD Heater	9030-20-188
8786	Brake Coil Shorted	9030-20-279
8960	Lift	9030-20-113
8964	Lower	9030-20-113
8968	Tilt Forward	9030-20-113
8972	Tilt Back	9030-20-113
8976	AC Current – Over Current	9030-20-313
8978	Aux 1A	9030-20-113
8980	Aux 1B	9030-20-113
8984	Aux 2A	9030-20-113
8988	Aux 2B	9030-20-113
8992	Synchronous Steering Coil Current	9030-20-418
9000	Diverter Valve	9030-20-227
9004	E Hyd Enable	9030-20-227
9008	Clamp Solenoid (Optional)	9030-20-227
9012	Acc 2 Relay	9030-20-227
9012	ACC 2 Current OORH	9030-20-422
9016	Forward Relay	9030-20-227
9020	Reverse Relay	9030-20-227
9024	AC Current – Short Circuit	9030-20-313
9026	Spare 1 Relay	9030-20-227
9028	Spare 2 Relay	9030-20-227
9032	Main Contactor	9030-20-227
9036	2nd Contactor	9030-20-227
9040	Display Buzzer Output	9030-20-221
9041	Display Keyswitch Output	9030-20-195
9045	Internal Error - Software	9030-20-504
95360	Forw + Back	9030-20-543
95520	Key Switch Voltage OORL	9030-20-426
None	No Display/No Truck Operation	9030-30-1
None	Motor Controller Fan Failure	9030-30-8
None	Motor/Motor Controller Temperature Sensor Failure	9030-30-21

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Wiring Reference Data

NOTE: When troubleshooting the electrical wiring harness for your lift truck, the wire connectors may be different but the pin numbers for the connectors are the same between the different connectors.

Function/Circuit Identification — A standard numbering and color-coding system is used in the lift truck wiring. This system will simplify repairs. The Electrical Circuit Identification Specification is ES-1359. The ID data is described in Table 9030-03-1.

Each circuit Function ID has a number from 1 through 999, as indicated in the Table 9030-03-1.

- A circuit labeled with a single numerical Function ID shall be electrically equivalent throughout the harness (physically connected through splices or connectors).
- Wires which are connected only through an internal connection in a controller shall have separate Function ID numbers.
- Wire Function ID numbers will be stamped at 50mm intervals along the wire length.
- The Function IDs are assigned into groups as shown in the table. Unless noted otherwise, specific functions are to be preassigned to unique Function IDs.

If a circuit function does not meet one of the preassigned numbers, and its function is unique within the truck series and option, then a number from the “Non-Standard Functions” range may be used.

Table 9030-03-1. Circuit Group Identification

Function/Group	Number Range
Grounds (IDs not preassigned within this range)	101-149
Current sense ground	150-199
Switched B+ (IDs not preassigned within this range)	200-239
Fused B+ (IDs not preassigned within this range)	240-249
Regulated Power 5V (IDs not preassigned within this range)	250-279
Regulated Power 12V	280-299
Analog Inputs – hydraulics / mast	300-319
Analog Inputs – chassis	320-339
Analog Inputs – powertrain	340-399
Analog Inputs – CAB / OHG	400-419
Reserved for additional analog inputs	420-499
Digital inputs – hydraulics / mast	500-509
Digital inputs – chassis	510-539
Digital inputs – powertrain	540-559
Digital inputs – CAB / OHG	560-569
Encoder inputs	570-599
Reserved for additional digital inputs	600-699
Digital outputs – hydraulics / mast	700-719
Digital outputs – chassis	720-749
Digital outputs – powertrain	750-779

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Table 9030-03-1. Circuit Group Identification (Continued)

Function/Group	Number Range
Digital outputs – CAB /OHG	780-799
PWM outputs – hydraulics / mast	800-829
PWM outputs – chassis	830-839
PWM outputs – powertrain	840-889
PWM outputs – CAB / OHG	890-899
Communications (eg., CANbus)	900-909
Non-Standard functions	910-999

Wiring Color Codes — The colors used to identify the lift truck wiring, in addition to the surface marked circuit ID data, are identified in Table 9030-03-2. Many Diagrams and Schematics in this book can be viewed and printed in color. If not printed or viewed in color refer to the electrical circuit identification located on schematic circuits. When viewing a color version of the diagrams and schematics, the white chassis wires are seen as yellow. Other wires are shown in colors similar to actual colors, i.e., tan shows as yellow. Use circuit identification for true wire color. MONOTROL® , wiring to sensors and other applications vary with respect to wire colors.

Table 9030-03-2. Hyster Wiring Color Codes

Color	Use/Function
Red	Battery-level power circuits
Black	Heavy current grounds
Green	Signal grounds
White	Other circuits
Twisted Pair (Yellow/Green) Yellow Green	Preferred CAN Option CAN-Hi CAN-Lo
Twisted Pair (Yellow/Green) White White	Non-Preferred CAN Option CAN-Hi CAN-Lo

Symbol Definitions

Type "S", Identifies information for UL Safety rated trucks.

Arrow Symbols, Go to specified page of schematic. Page number is located in the “hexagon symbol” on schematic.

---x, Go to specified sheet of diagram. Sheet number is located in lower right corner of figure.

Circuit Segment Suffix Letter — A circuit ID has a segment suffix letter as required (splices or passing through a connector). Each circuit ID is unique and each circuit ID has a suffix. The circuit connects to all other wires in the vehicle with the same circuit ID number. For example, 42-A will be connected to 42-B, 42-J, etc. Function ID numbers appear with suffix letters, the base number is not used by itself. For example, when labeling a circuit #42, start with “42-A” rather than “42”. Suffix letters should be assigned from “A” to “Z” (but “Q” and “V” are not used). Additional branches beyond “Z” to be assigned as “AA”, AB”, etc. If a Suffix is used, the parts of the circuit identification number will be separated by dashes. For example:

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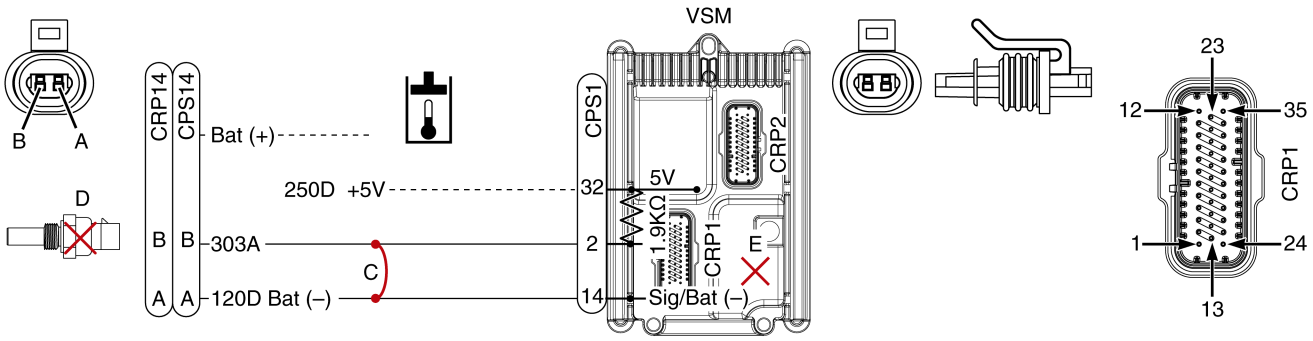
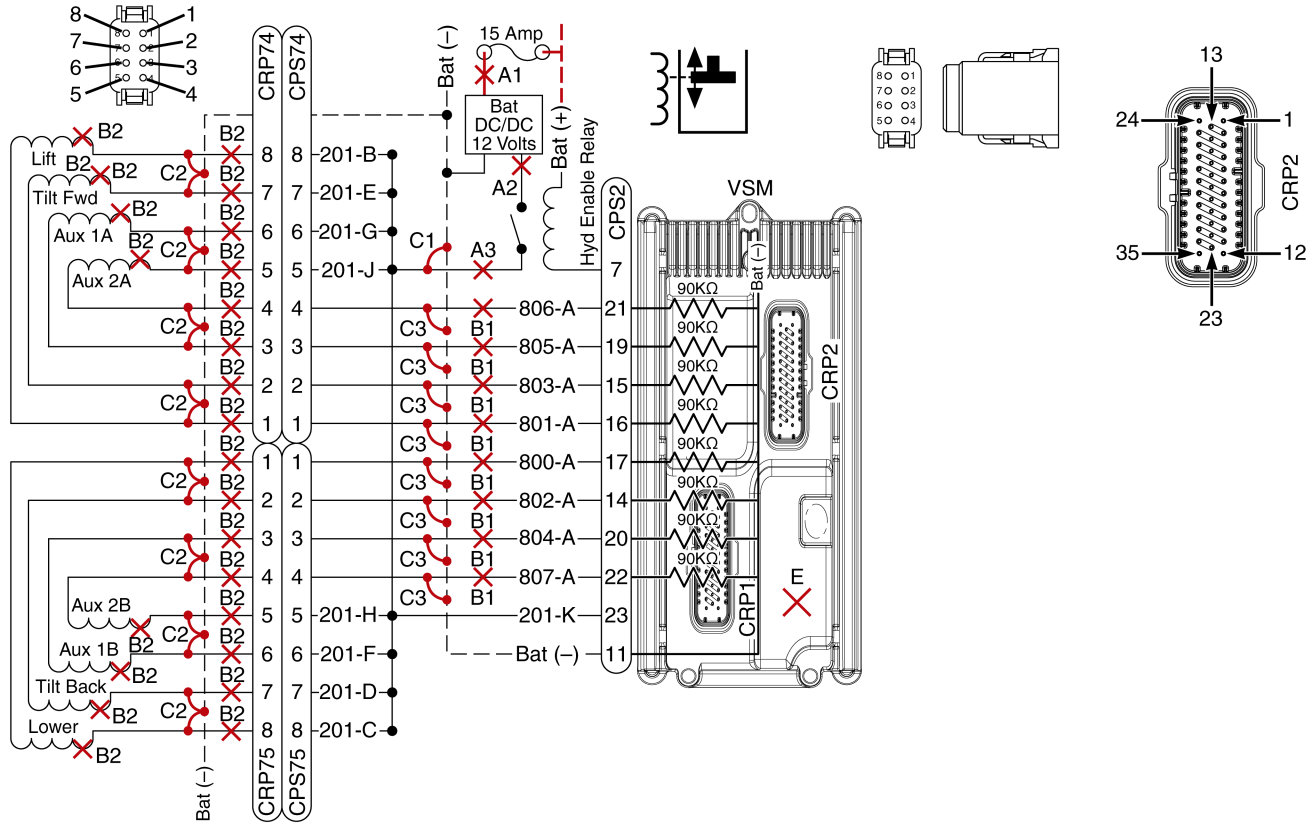


WIRE # 751 (RED), SEGMENTED, SUFFIX LETTERS A, O, P
WIRE # 870 (WHITE), NON-SEGMENTED, SUFFIX LETTER A

WIRE #S 383, 384 (WHITE), NON-SEGMENTED, TWISTED PAIR, SUFFIX LETTER A (SHOWN WITH SHIELD THAT TERMINATES AT PIN B2)

Figure 9030-03-2. Single Wiring Sample Circuit



WIRE # 751 (RED), SEGMENTED, SUFFIX LETTERS A, O, P
WIRE # 870, 871 (WHITE), NON-SEGMENTED, SUFFIX LETTER A

WIRE #S 383, 384, 387, AND 388 (WHITE), NON-SEGMENTED, TWISTED PAIR, SUFFIX LETTER A (SHOWN WITH SHIELD THAT TERMINATES AT PIN B2)

Figure 9030-03-3. Dual Wiring Sample Circuit

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Harness Assembly Data

This section depicts the lift truck harness assemblies with their respective connector identifications. The harnesses are arranged as follows:

- Wire Harness – Auxiliary Key Switch Figure 9030-03-4
- Wire Harness Steering Figure 9030-03-5
- Display Wire Harness Standard Figure 9030-03-6
- Display Wire Harness Freezer Figure 9030-03-7
- Wire Harness Main Electro – Hydraulic Figure 9030-03-8
- Wire Harness Main Manual – Hydraulic Figure 9030-03-9
- Wire Harness Front Switch Figure 9030-03-10
- Wire Harness Back Up Alarm Strobe w/o Conv.Figure 9030-03-11
- Wire Harness Lights LH - OHG Figure 9030-03-12
- Wire Harness Manual Hydraulics Figure 9030-03-13
- Wire Harness Display Freezer Figure 9030-03-14
- Wire Harness Turn Signal Figure 9030-03-15
- Wire Harness Synchro Steer Figure 9030-03-16
- Wire Harness Park Brake Figure 9030-03-17
- Wire Harness LH OHG w/Turn Signals Figure 9030-03-18
- Wire Harness Steering Column Figure 9030-03-19
- Wire Harness Lights w/OHG - RH Figure 9030-03-20
- Wire Harness Lights Chassis Main Figure 9030-03-21
- Wire Harness Seat E-Hydraulic Figure 9030-03-22
- Wire Harness Seat Manual-Hydraulic Figure 9030-03-23
- Wire Harness Main w/Manual – Hydraulic Figure 9030-03-24
- Wire Harness Main w/E – Hydraulic Figure 9030-03-25

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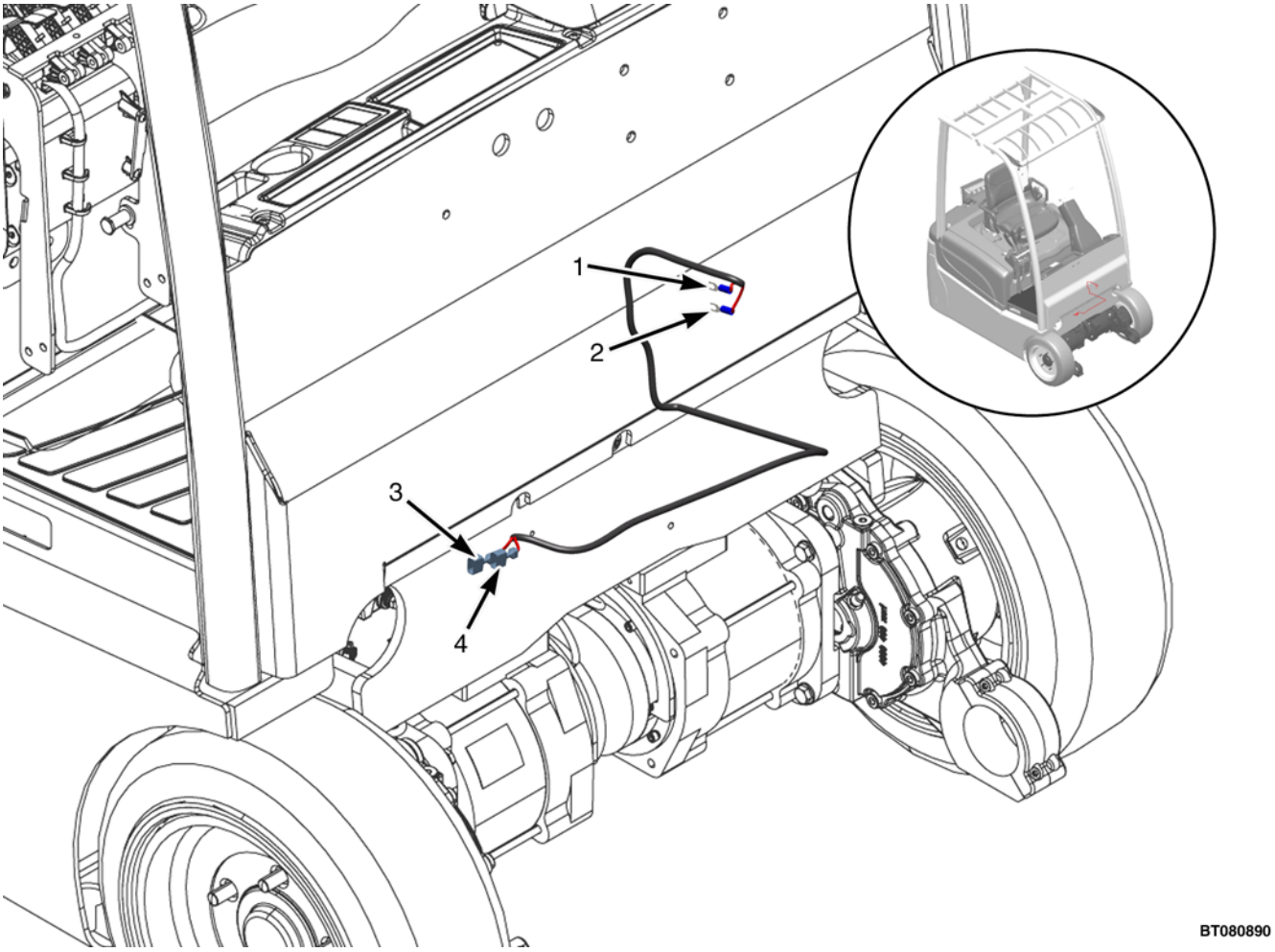

1. T115 FUSE BLOCK
2. T116 FUSE BLOCK
3. T114 KEY SWITCH
4. T113 KEY SWITCH

Figure 9030-03-4. J1.5-2.0XNT (J30-40XNT) (K160) ; Wire Harness – Auxiliary Key Switch

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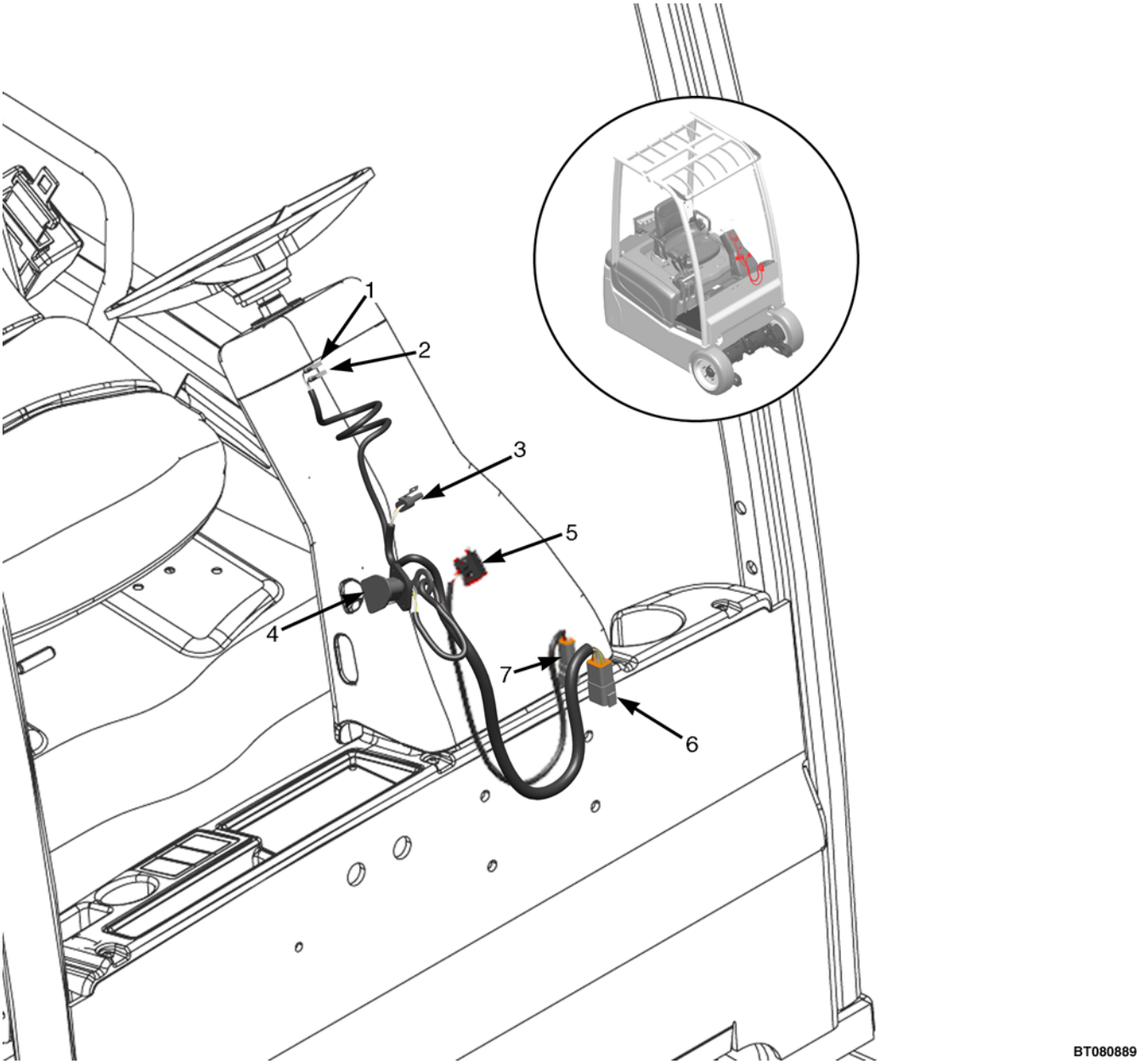

1. TF15 HORN SWITCH NO
2. TF14 HORN SWITCH C
3. CPS78 STEERING WHEEL POSITION SENSOR
4. CPS28 DIAGNOSTIC CONNECTION
5. CPS128 STEER MAKE-UP VALVE
6. CRP132 MAIN HARNESS
7. CRP133 MAIN HARNESS

Figure 9030-03-5. J1.5-2.0XNT (J30-40XNT) (K160) ; Wire Harness Steering

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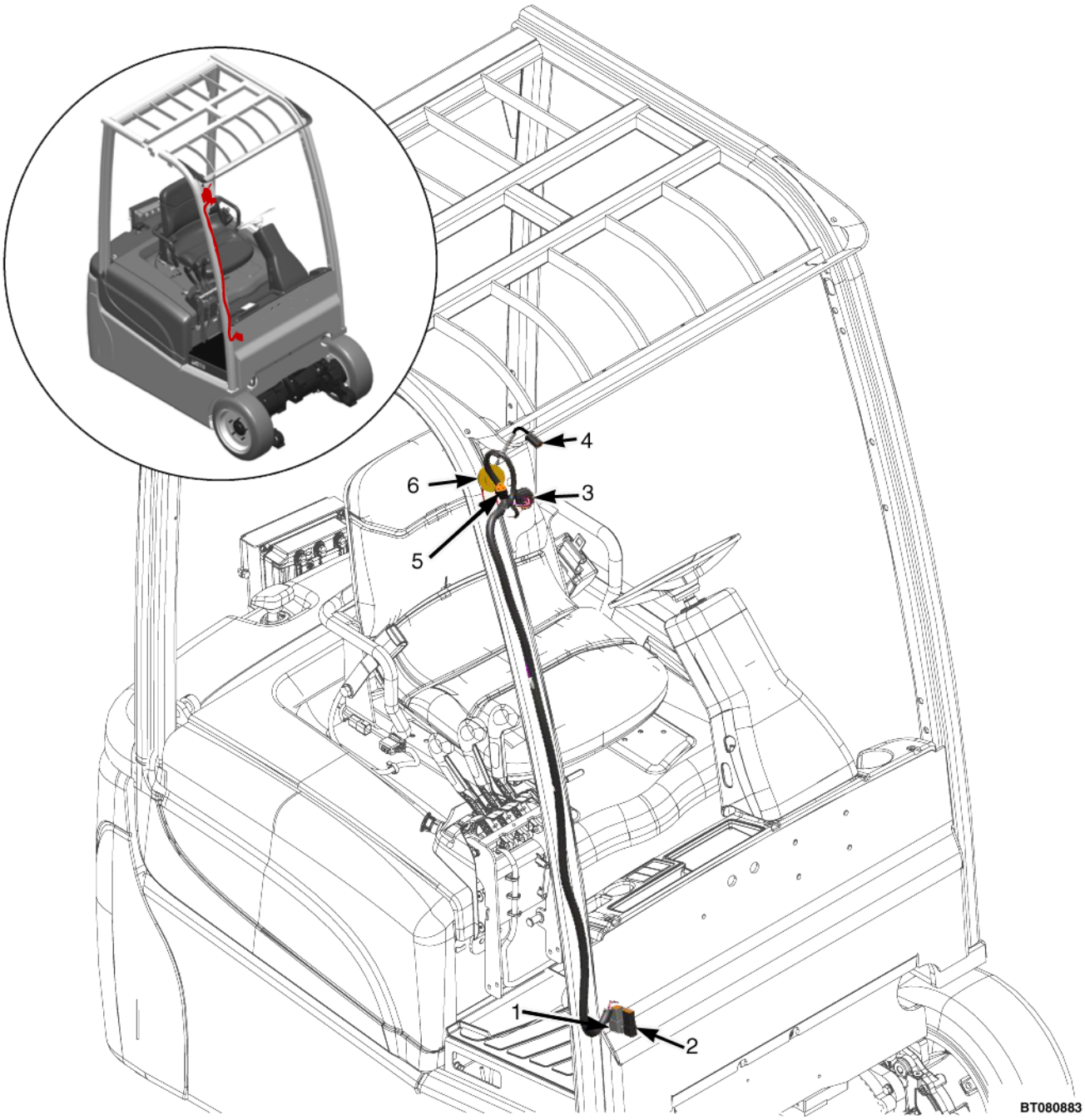
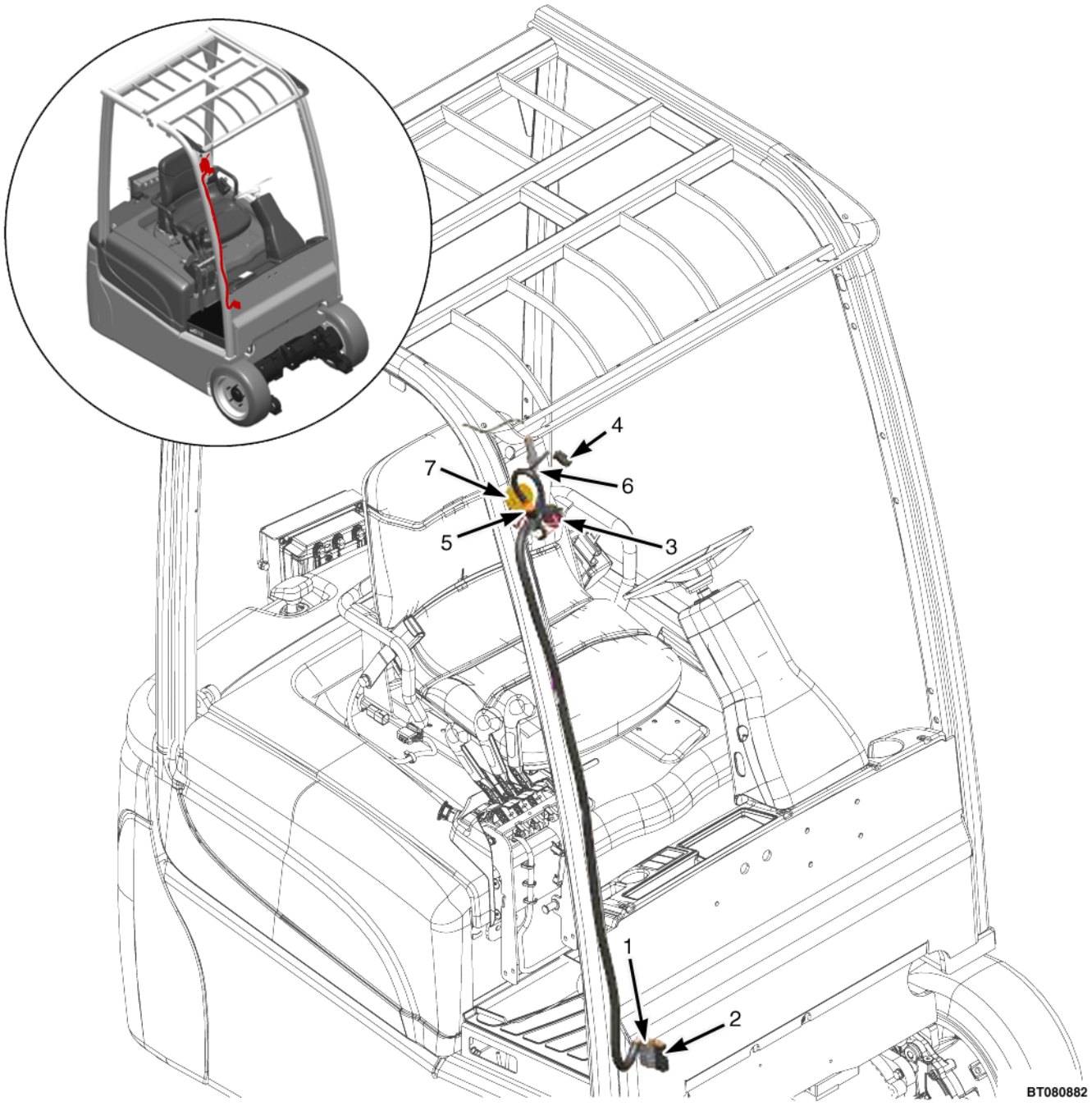


1. CRP135 MAIN HARNESS
2. CRP180 MAIN HARNESS
3. CPS20 DISPLAY
4. CPS103 RIGHT FRONT WORK LIGHT
5. CPS166 RIGHT FRONT MARKER LIGHT
6. BUZZER

Figure 9030-03-6. J1.5-2.0XNT (J30-40XNT) (K160) ; Display Wire Harness Standard

https://truckmanualshub.com/



1. CRP135 MAIN HARNESS
2. CRP180 MAIN HARNESS
3. CPS20 DISPLAY
4. CPS103 RIGHT FRONT WORK LIGHT
5. CPS166 RIGHT FRONT MARKER LIGHT
6. CPS165 TEMPERATURE SENSOR
7. BUZZER

Figure 9030-03-7. J1.5-2.0XNT (J30-40XNT) (K160) ; Display Wire Harness Freezer

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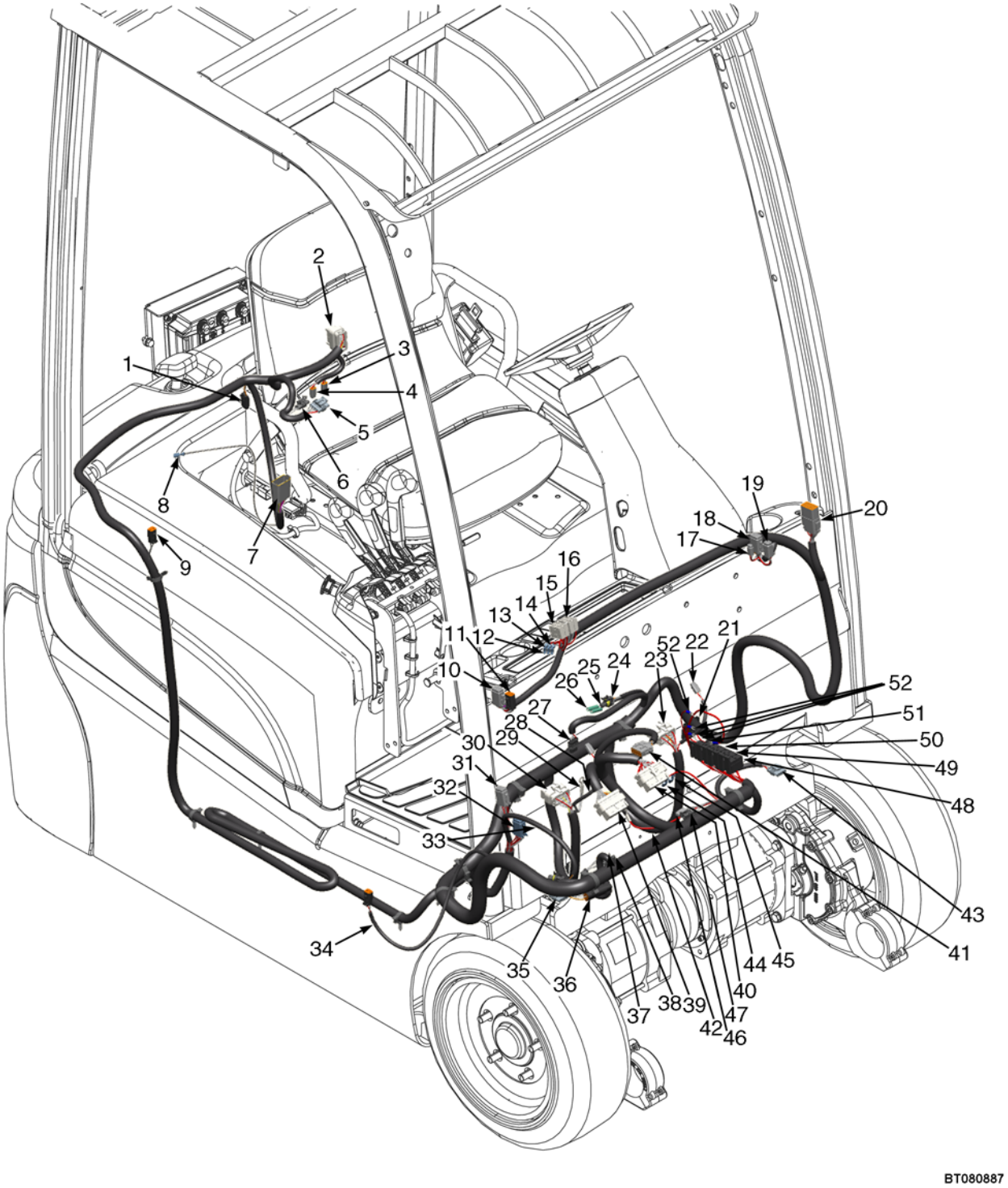

Figure 9030-03-8. J1.5-2.0XNT (J30-40XNT) (K160) ; Wire Harness Main Electro – Hydraulic

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Legend for Figure 9030-03-8

1. CPS31A STEER AXLE HARNESS
2. CPS5 PUMP CONTROLLER
3. CPS95B HYDRAULIC COOLING FAN
4. CPS95A HYDRAULIC CONTROLLER COOLING FAN
5. CPS146 MOTOR SPEED SENSOR
6. CPS61 MOTOR TEMPERATURE SENSOR
7. CRP52-55 MLM SEAT HARNESS
8. TF67 ESD HYDRAULIC TANK
9. CPS114 OHG HORN SWITCH
10. CPS135 DISPLAY HARNESS
11. CPS180 DISPLAY LIGHT HARNESS
12. TF72 FLASHER −
13. TF71 FLASHER +
14. TF70 FLASHER L
15. CRP206 RR WORK LIGHT SWITCH
16. CRP205 NO MARK LIGHT SWITCH
17. CPS133 STEER MAKE UP VALVE
18. CPS132 STEER HARNESS
19. CPS134 TURN SIGNAL SWITCH
20. CPS138 LIGHT OPTION HARNESS
21. CPS90 DC-DC CONVERTER
22. CPS157 LEFT CONTROL COOLING FAN
23. CPS4 LEFT TRACTION MOTOR CONTROLLER
24. CPS11 SERV. BRAKE SENSOR
25. TBF3 BRAKE FLUID LEVEL SENSOR
26. TBF4 BRAKE FLUID LEVEL SENSOR
27. CPS151 HORN ASM
28. CPS156 RIGHT CONTROL COOLING FAN
29. TR65 B-CONT.
30. CPS3 RIGHT TRACTION MOTOR CONTROL-LER
31. CPS74 E HYDRAULIC VALVE UPPER COILS
32. CPS75 E HYDRAULIC VALVE LOWER COILS
33. CPS10 LIFT PRESSURE SENSOR
34. CPS102 BATTERY GATE MAGNETIC SWITCH
35. CPS153 RIGHT TRACTION MOTOR SPEED SENSOR
36. CRP8 TILT POSITION SENSOR
37. CPS24 RIGHT ELECTRIC BRAKE
38. CPS155 RIGHT TRACTION MOTOR TEMPERA-TURE SENSOR
39. CPS1 VSM
40. CPS2 VSM
41. CPS272 ACCELERATOR JUMPER
42. TR3 MN CONTACT BATTERY +
43. CPS152 LEFT TRACTION SPEED SENSOR
44. TF11 MN CONTROLLER COIL
45. TF10 MN CONTROLLER COIL
46. CPS26 LEFT ELECTRIC BRAKE
47. CPS154 LEFT TRACTION MOTOR SENSOR
48. CRS110 BRAKE LIGHT RELAY
49. CRS209 E HYDRAULIC EN-RELAY
50. CRS210 BACK UP LIGHT RELAY
51. CRS208 KEY SWITCH RELAY
52. FUSES

https://truckmanualshub.com/

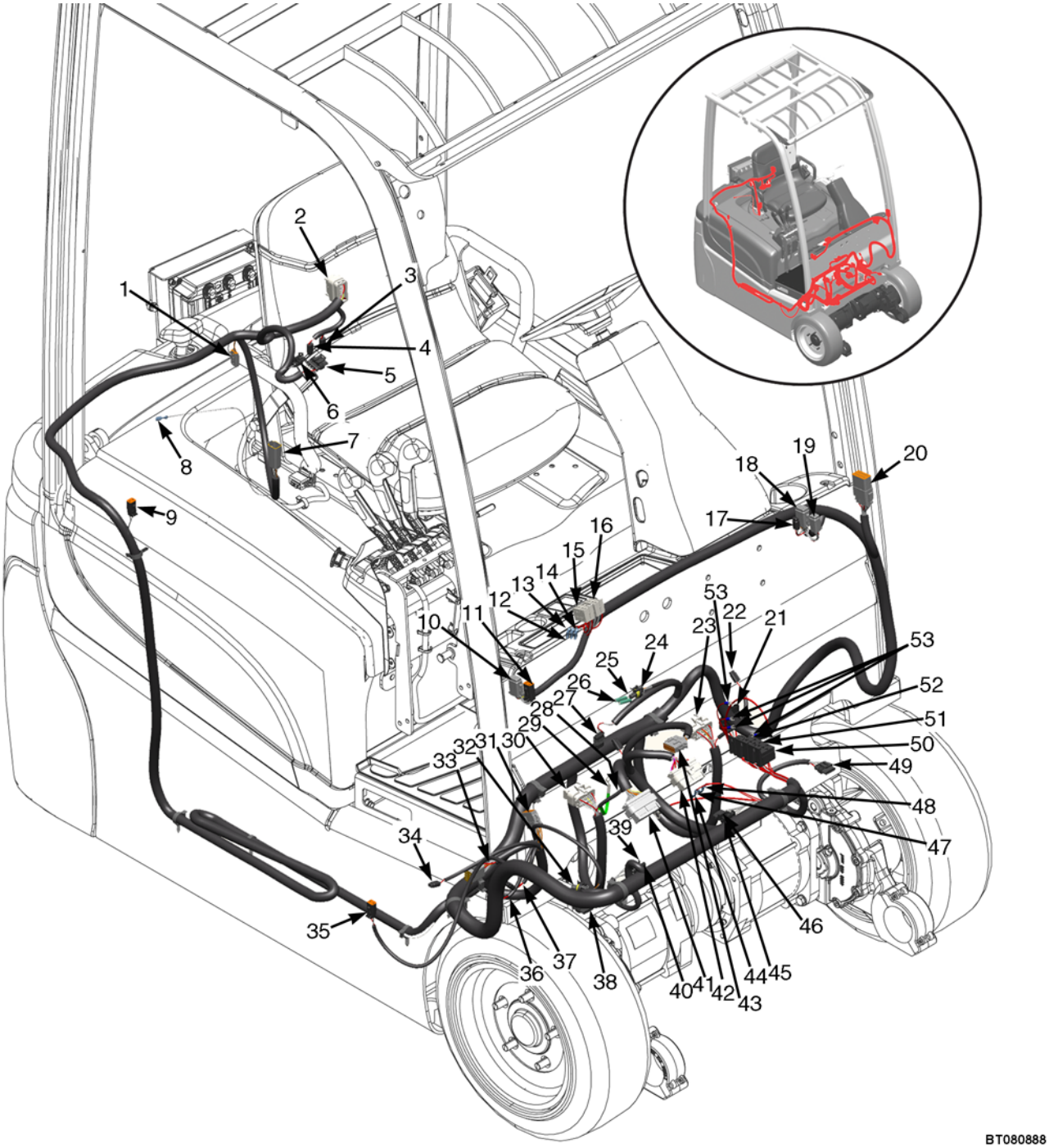

Figure 9030-03-9. J1.5-2.0XNT (J30-40XNT) (K160) ; Wire Harness Main Manual – Hydraulic

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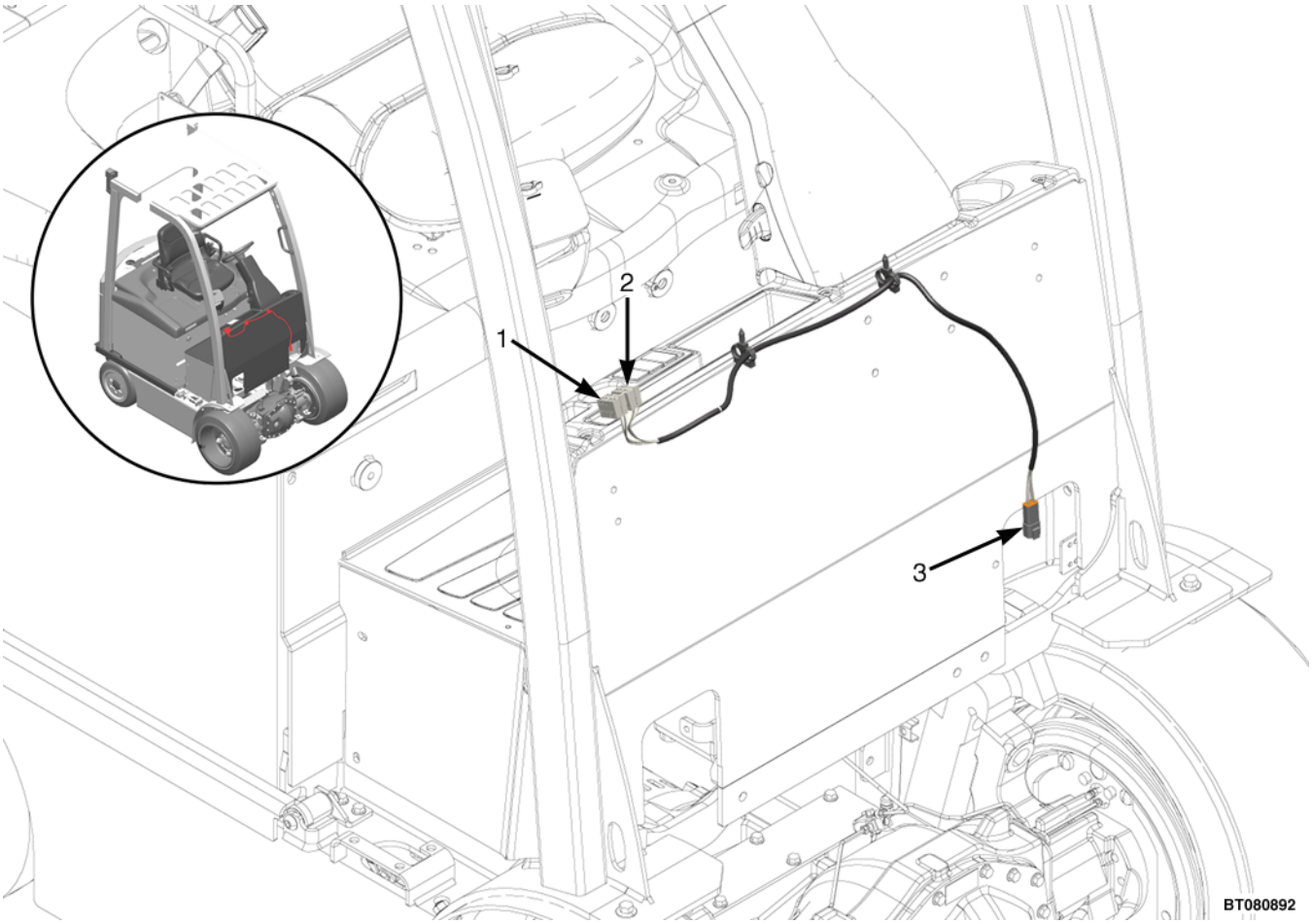
Legend for Figure 9030-03-9

1. CPS31A STEER AXLE HARNESS
2. CPS5 PUMP CONTROLLER
3. CPS95B HYDRAULIC COOLING FAN
4. CPS95A HYDRAULIC CONTROLLER COOLING FAN
5. CPS146 MOTOR SPEED SENSOR
6. CPS61 MOTOR TEMPERATURE SENSOR
7. CRP52-55 MLM SEAT HARNESS
8. TF67 ESD HYDRAULIC TANK
9. CPS114 OHG HORN SWITCH
10. CPS135 DISPLAY HARNESS
11. CPS180 DISPLAY LIGHT HARNESS
12. TF72 FLASHER (-)
13. TF71 FLASHER (+)
14. TF70 FLASHER (L)
15. CRP206 RR WORK LIGHT SWITCH
16. CRP205 NO MARK LIGHT SWITCH
17. CPS133 STEER MAKE UP VALVE
18. CPS132 STEER HARNESS
19. CPS134 TURN SIGNAL SWITCH
20. CPS138 LIGHT OPTION HARNESS
21. CPS90 DC-DC CONVERTER
22. CPS157 LEFT CONTROL COOLING FAN
23. CPS4 LEFT TRACTION MOTOR CONTROLLER
24. CPS11 SERV. BRAKE SENSOR
25. TBF3 BRAKE FLUID LEVEL SENSOR
26. TBF4 BRAKE FLUID LEVEL SENSOR
27. CPS151 HORN ASM
28. CPS156 RIGHT CONTROL COOLING FAN
29. TR65 B-CONT.
30. CPS3 RIGHT TRACTION MOTOR CONTROLLER
31. CPS162 MANUAL HYDRAULIC SPOOL POSITION SENSOR
32. CPS10 LIFT PRESSURE SENSOR
33. CPS192 TO MAN. HYDRAULIC
34. CPS190B CLAMP INTERLOCK COIL
35. CPS102 BATTERY GATE MAGNETIC SWITCH
36. CPS160B SPOOL INTERLOCK SOLENOID 2
37. CPS160A SPOOL INTERLOCK SOLENOID 1
38. CPS153 RIGHT TRACTION MOTOR SPEED SENSOR
39. CPS155 RIGHT TRACTION MOTOR TEMPERATURE SENSOR
40. CPS24 RIGHT ELECTRIC BRAKE
41. CPS1 VSM
42. CPS2 VSM
43. CPS272 ACCELERATOR JUMPER
44. TR3 MN CONTACT BATTERY +
45. CPS154 LEFT TRACTION MOTOR SENSOR
46. CPS26 LEFT ELECTRIC BRAKE
47. TF11 MN CONTROLLER COIL
48. TF10 MN CONTROLLER COIL
49. CPS152 LEFT TRACTION SPEED SENSOR
50. CRS110 BRAKE LIGHT RELAY
51. CRS210 BACK UP LIGHT RELAY
52. CRS208 KEY SWITCH RELAY
53. FUSES

https://truckmanualshub.com/



1. CRP206 REAR WORK LIGHT
2. CRP205 FRONT WORK LIGHT/TAIL LIGHT
3. CRP211 HARNESS-LIGHT CHASSIS MAIN

Figure 9030-03-10. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness – Front Switch

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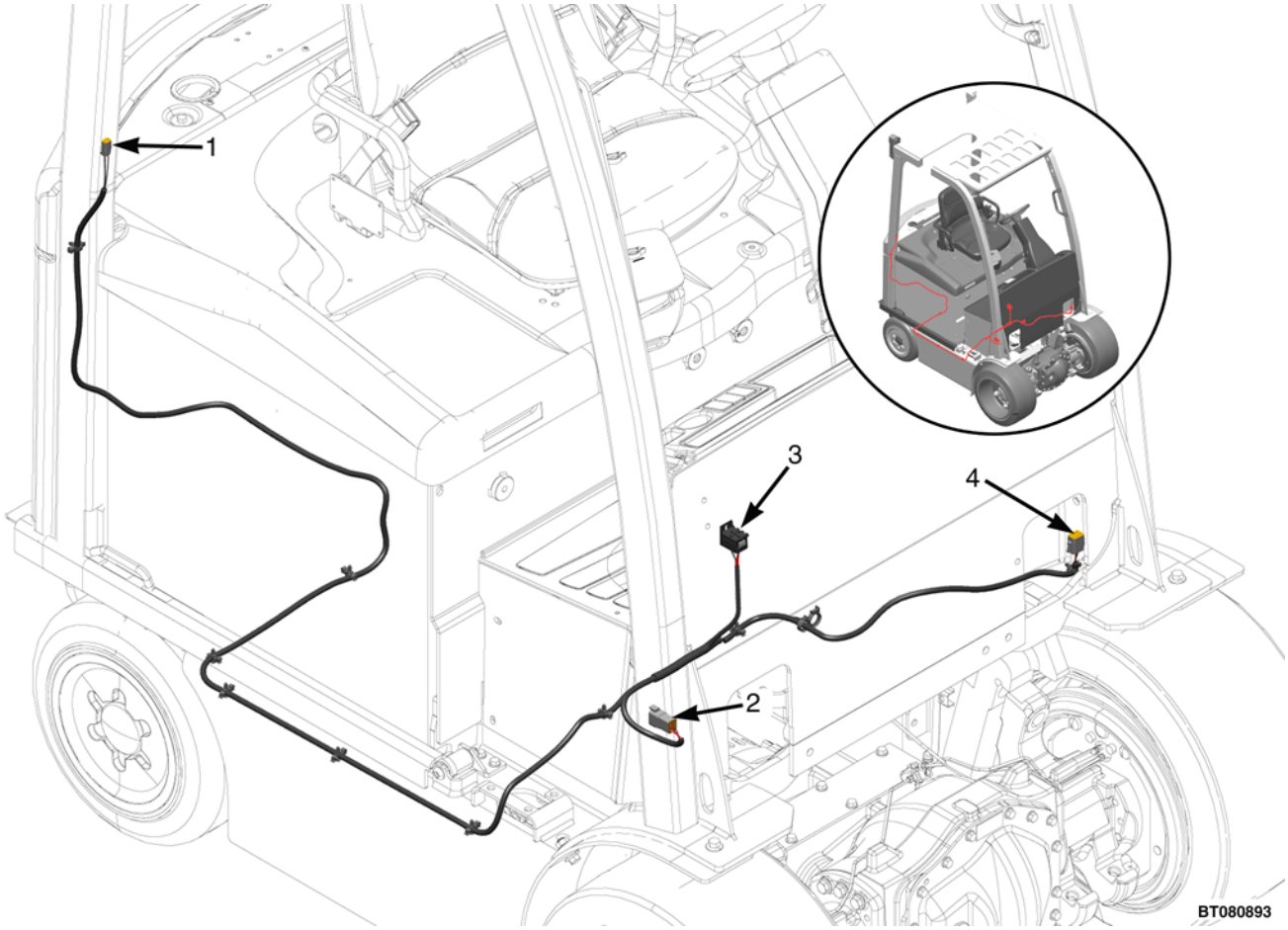

1. CRP112 BACK UP ALARM
2. CRP137 MAIN HARNESS
3. CRP210 REVERSE RELAY
4. CRP138 LIGHT OPTION HARNESS

Figure 9030-03-11. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness – Back Up Alarm Strobe w/o Conv.

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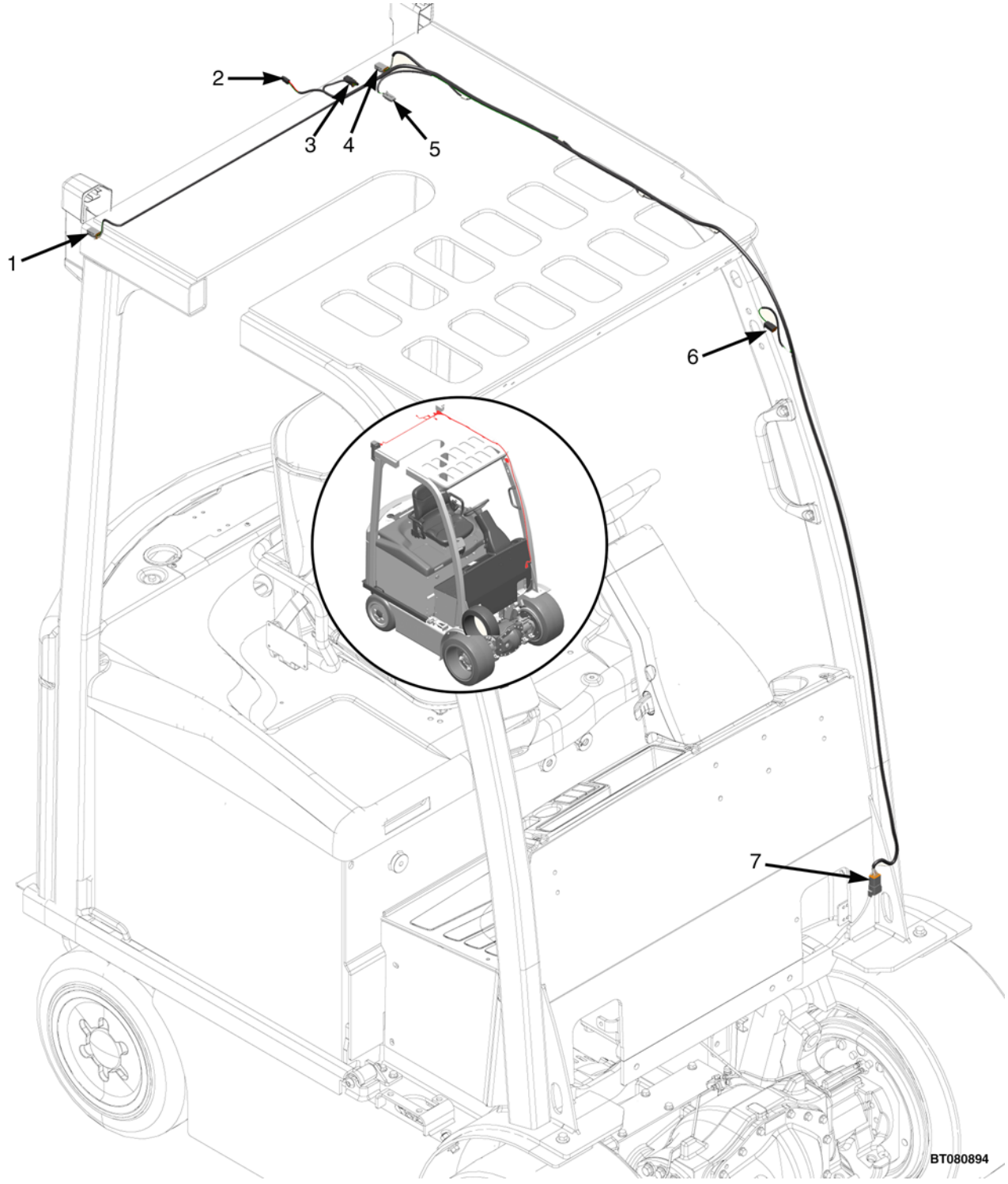

1. CPS106 TAIL LIGHT RH
2. CPS87 STROBE LIGHT
3. CPS116 REAR WORK LIGHT
4. CPS105 TAIL LIGHT LH
5. CPS107 DOME LIGHT W/SWITCH
6. CPS104 WORK LIGHT FRONT LH
7. CRP138 MAIN LIGHT HARNESS

Figure 9030-03-12. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Lights LH - OHG

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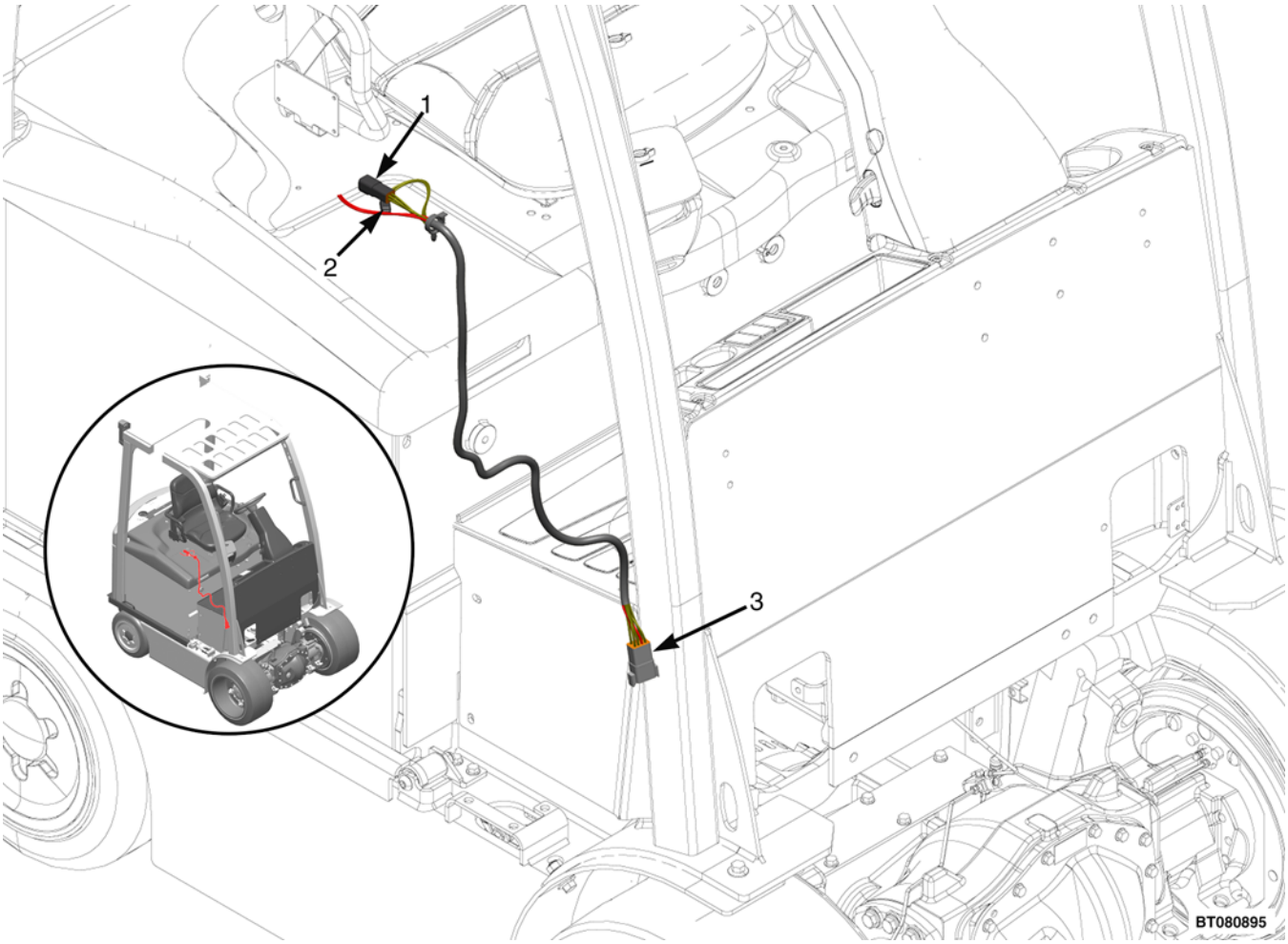

1. CRP64 FWD/REV SWITCH
2. CRS196 CLAMP COIL SWITCH
3. CRP129 TO MAIN HARNESS

Figure 9030-03-13. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Manual Hydraulics

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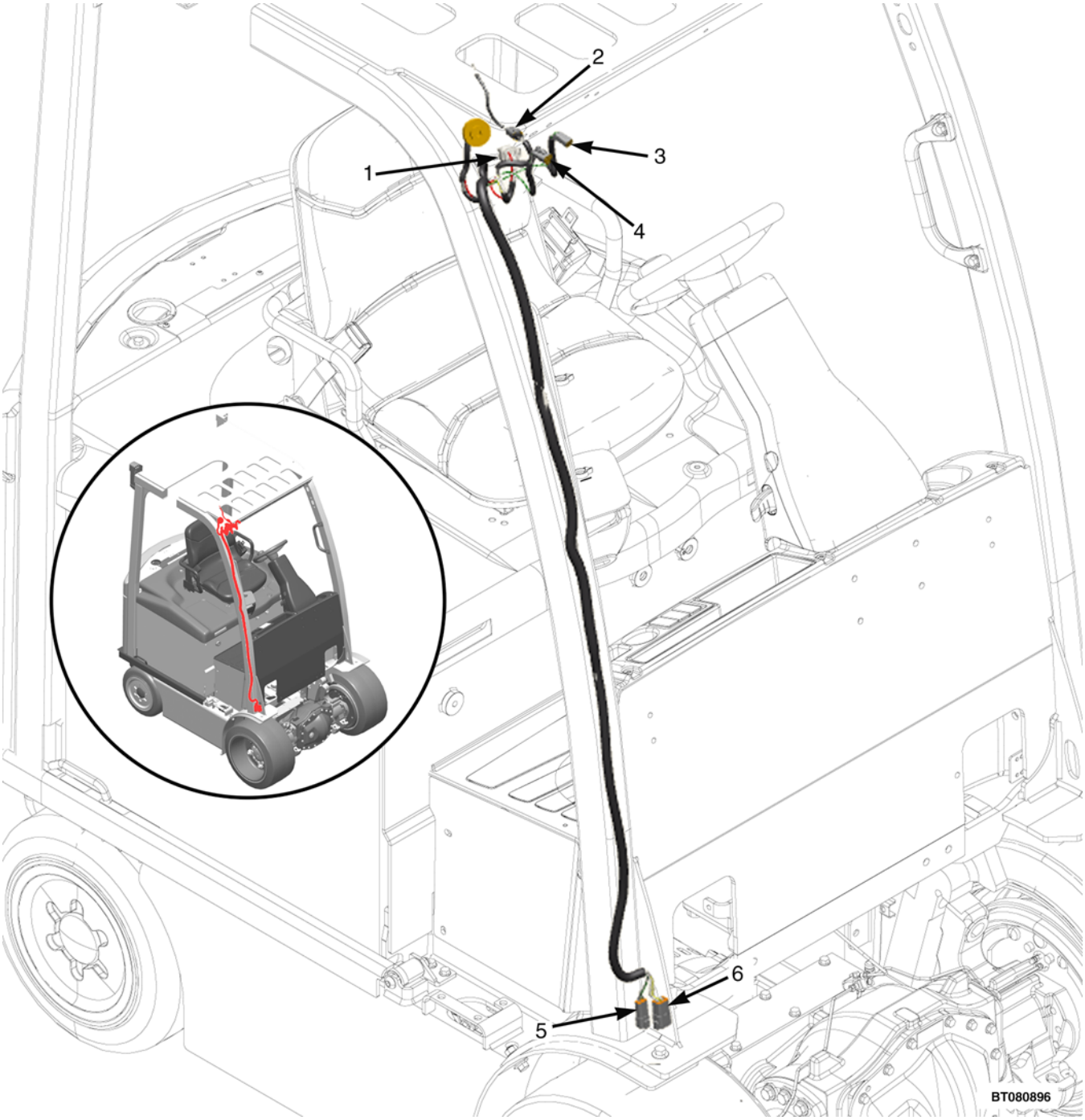
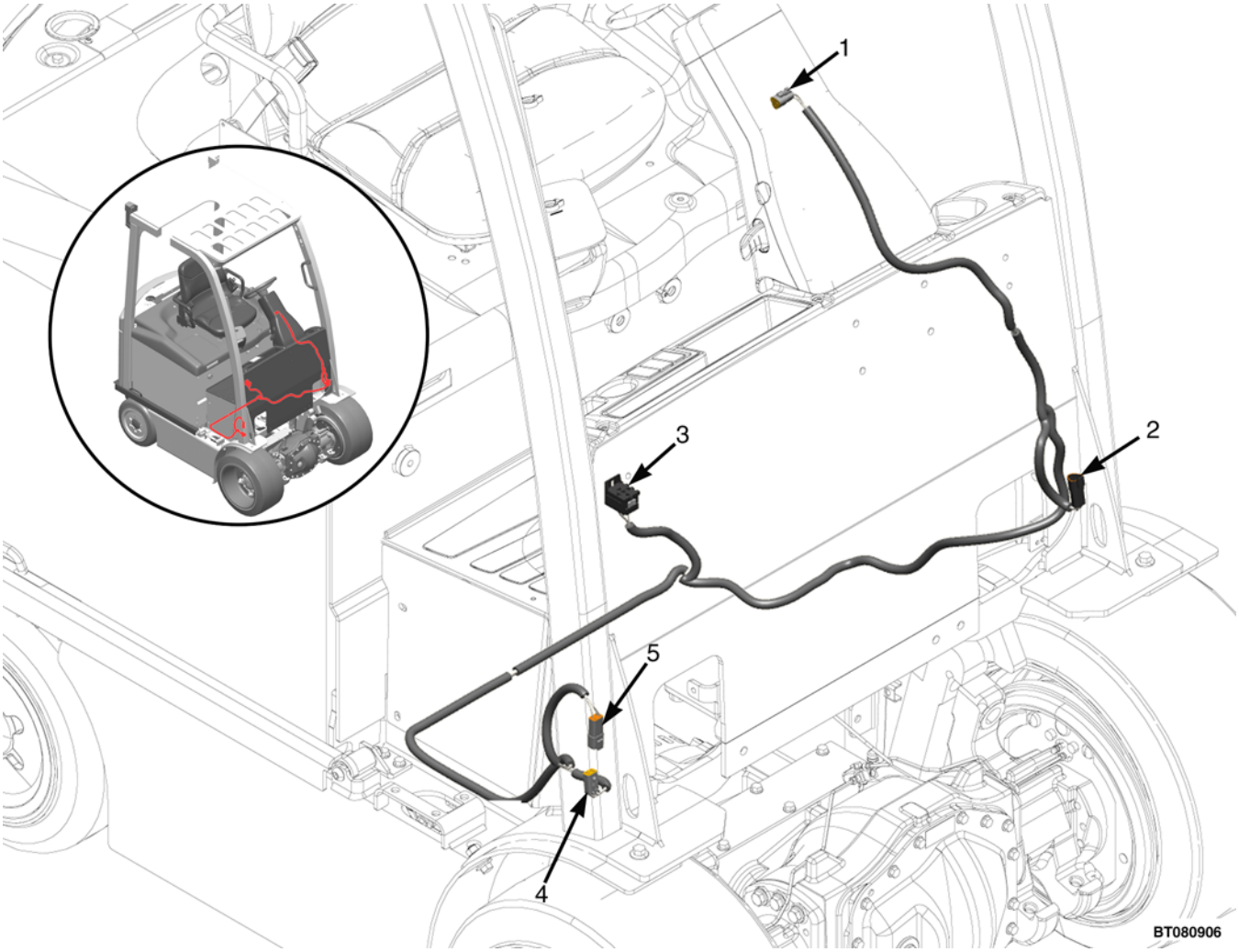


1. CPS20 DISPLAY W/KEY SWITCH
2. CPS21 WIRE HARNESS TEMPERATURE SENSOR
3. CPS103 RH FRONT WORK LIGHT
4. CPS166 FRONT MARKER RH
5. CRP180 MAIN LIGHTS HARNESS
6. CRP135 MAIN HARNESS

Figure 9030-03-14. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Display Freezer

https://truckmanualshub.com/



1. CPS35 TO TURN SIGNAL SWITCH HARNESS
2. CRP131 WIRE HARNESS LH -OHG W/TURN SIGNALS
3. CRS220 FLASHER
4. CPS180A TO DISPLAY FREEZER HARNESS
5. CRP180A TO LIGHT MAIN HARNESS

Figure 9030-03-15. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Turn Wire Harness Signal

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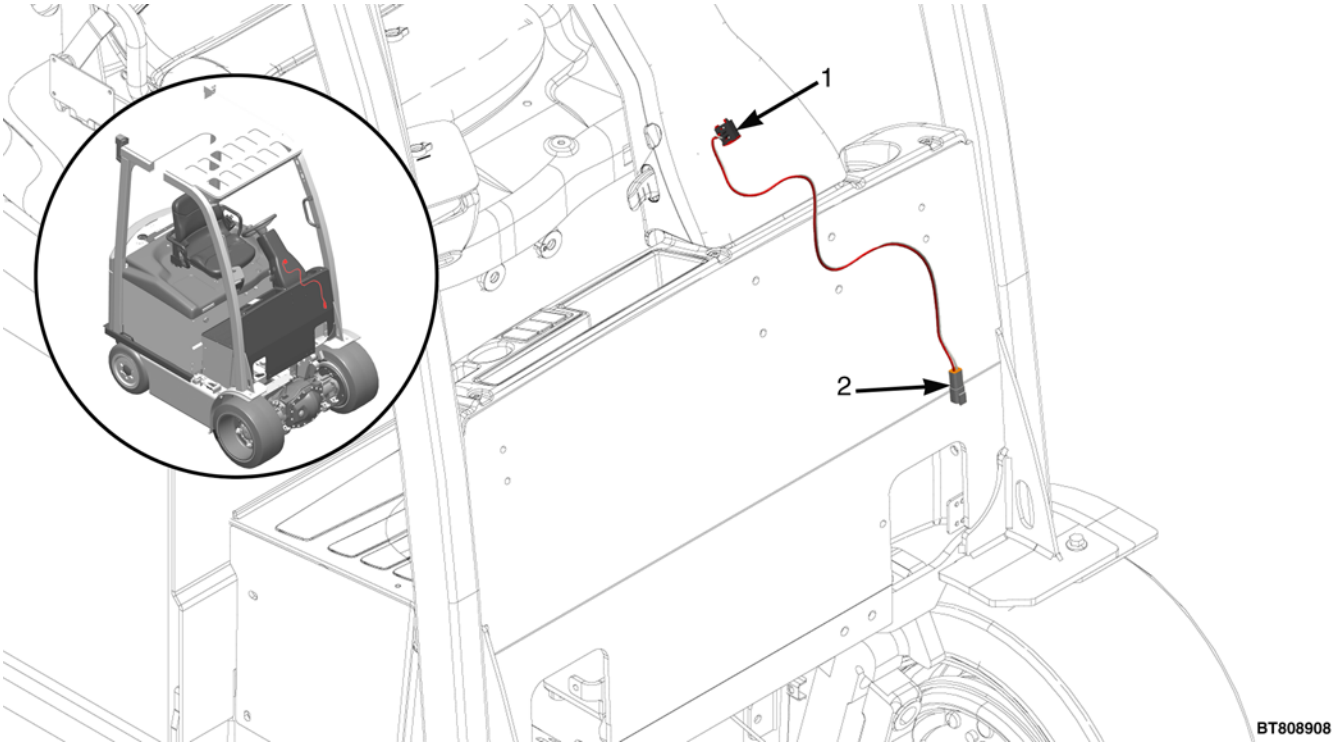
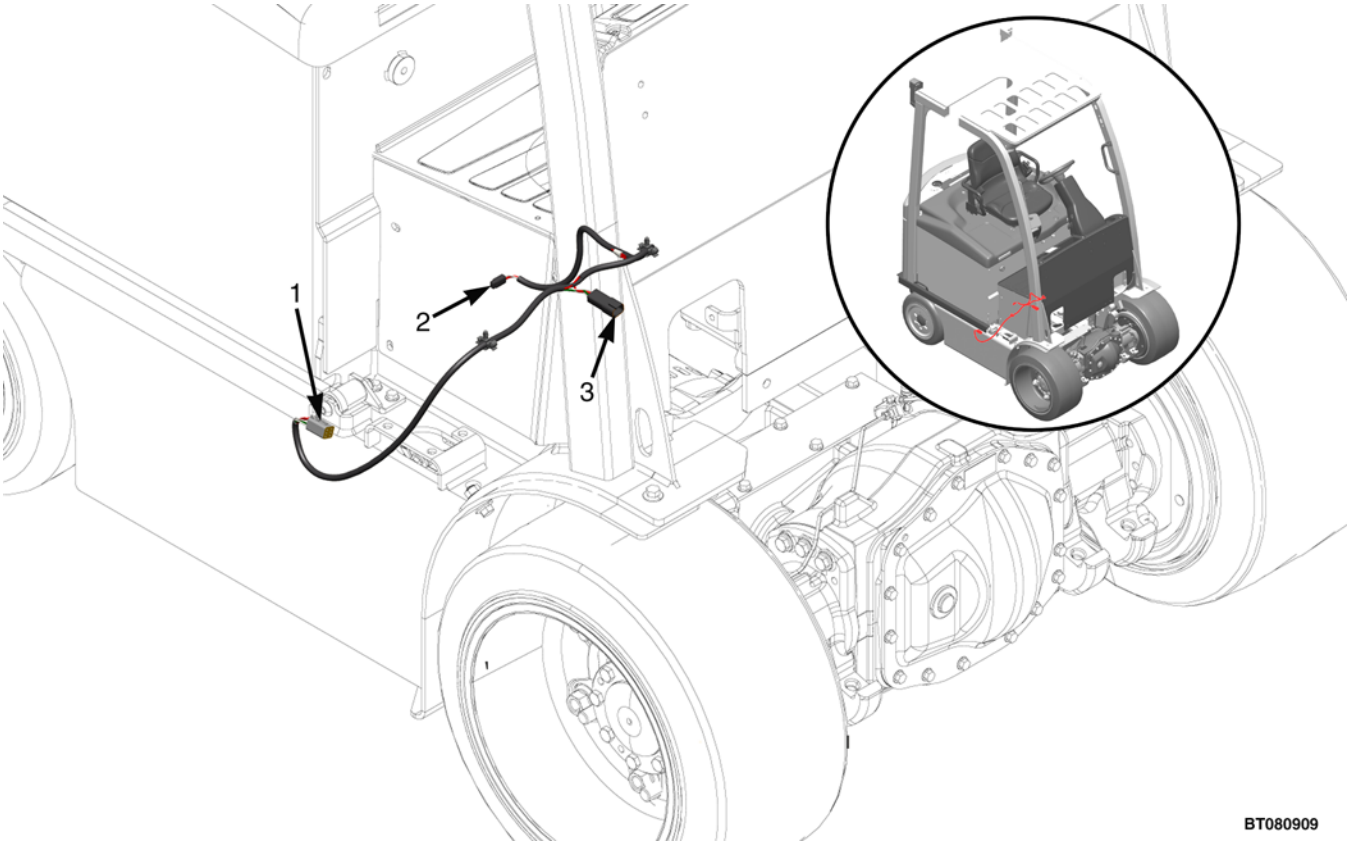


1. CPS128 STEER MAKEUP VALVE
2. CRP133 MAIN HARNESS

Figure 9030-03-16. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Synchro Steer

https://truckmanualshub.com/



1. CPS16 PARK BRAKE MODULE
2. CRS17 PARK BRAKE SOLENOID
3. CRP15 MAIN HARNESS

Figure 9030-03-17. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Park Brake

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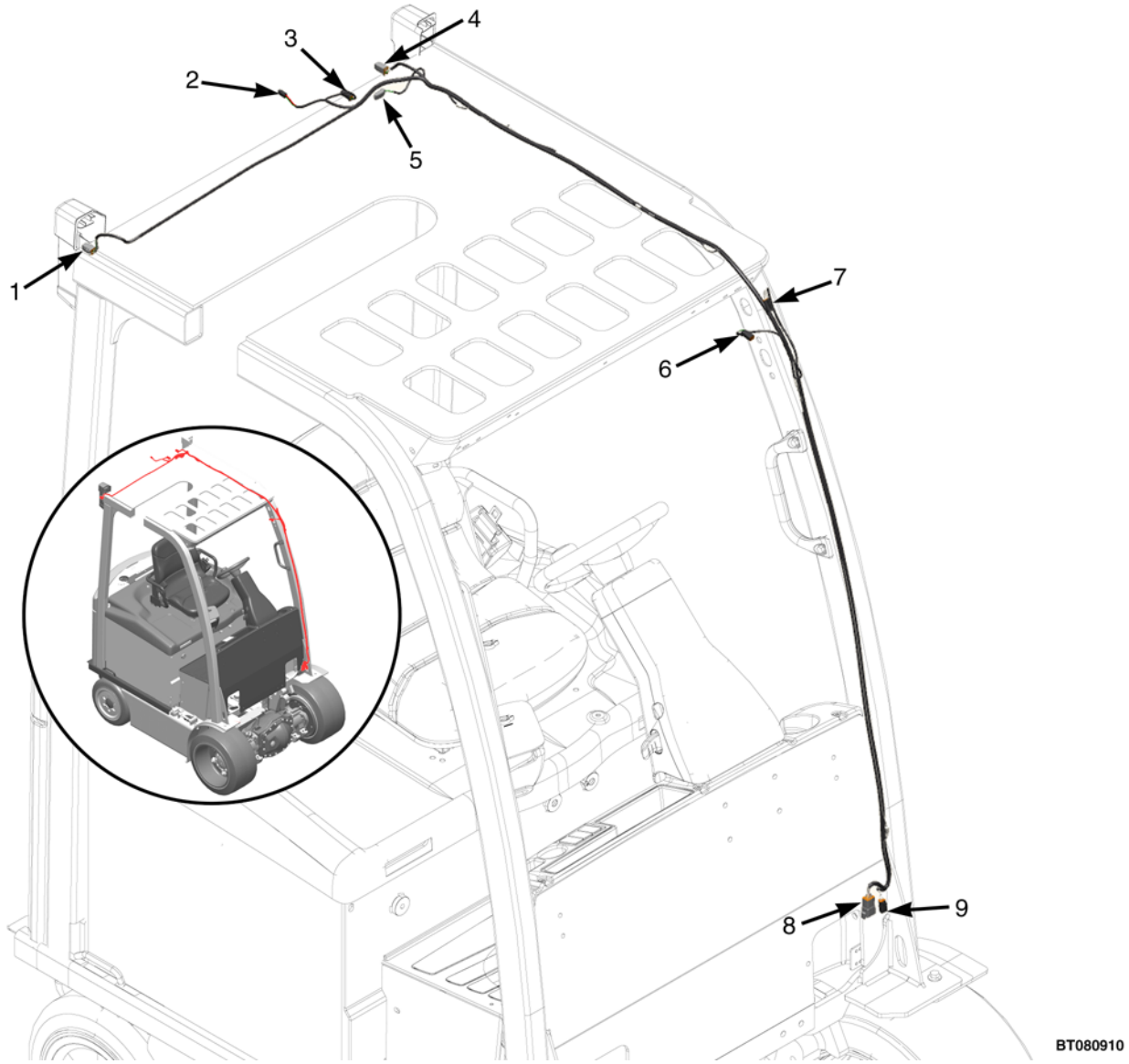

1. CPS106 TAIL LIGHT RH
2. CPS87 STROBE LIGHT
3. CPS116 REAR WORK LIGHT
4. CPS105 TAIL LIGHT LH
5. CPS107 DOME LIGHT
6. CPS104 WORK LIGHT FRONT LH
7. CRP34 LH FRONT MARKER
8. CRP138 MAIN LIGHT HARNESS
9. CPS131 TO TURN SIGNAL HARNESS

Figure 9030-03-18. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness - LH OHG w/ Turn Signals

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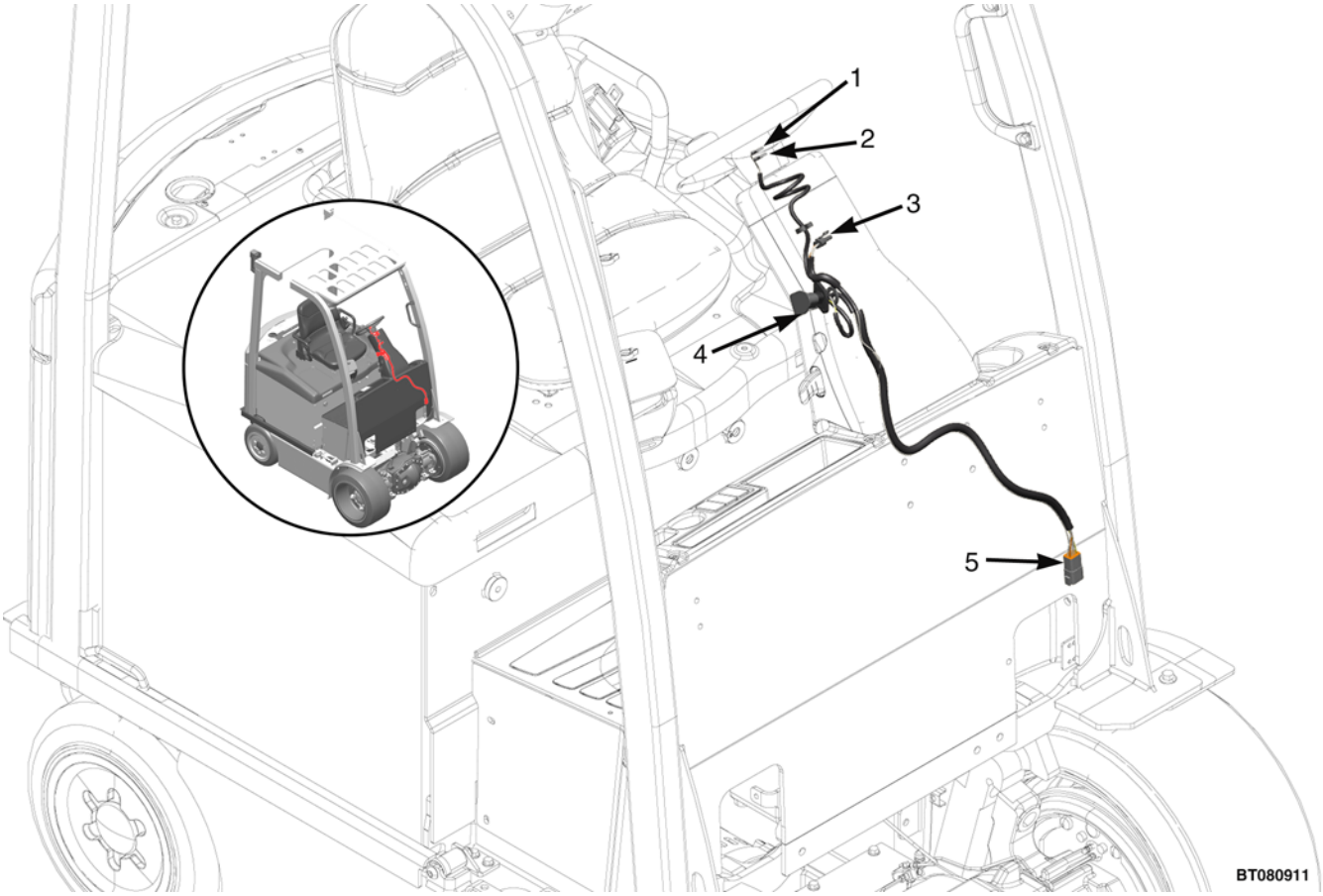

1. TF15 HORN SWITCH NO
2. TF14 HORN SWITCH C
3. CPS78 STEER WHEEL POSITION SENSOR
4. CPS28 DIAGNOSTIC CONNECTOR
5. CRP132 MAIN HARNESS

Figure 9030-03-19. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Steering Column

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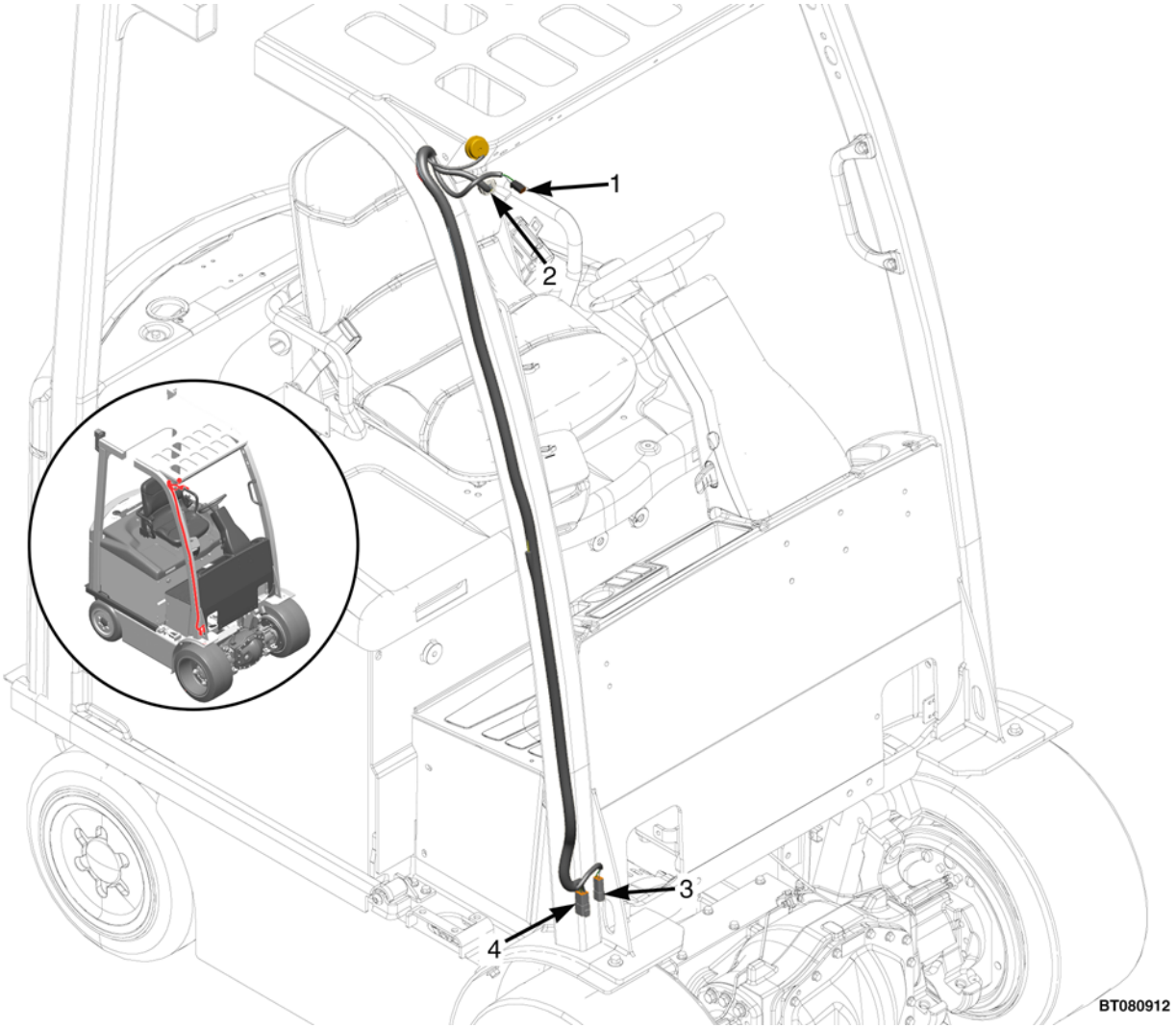
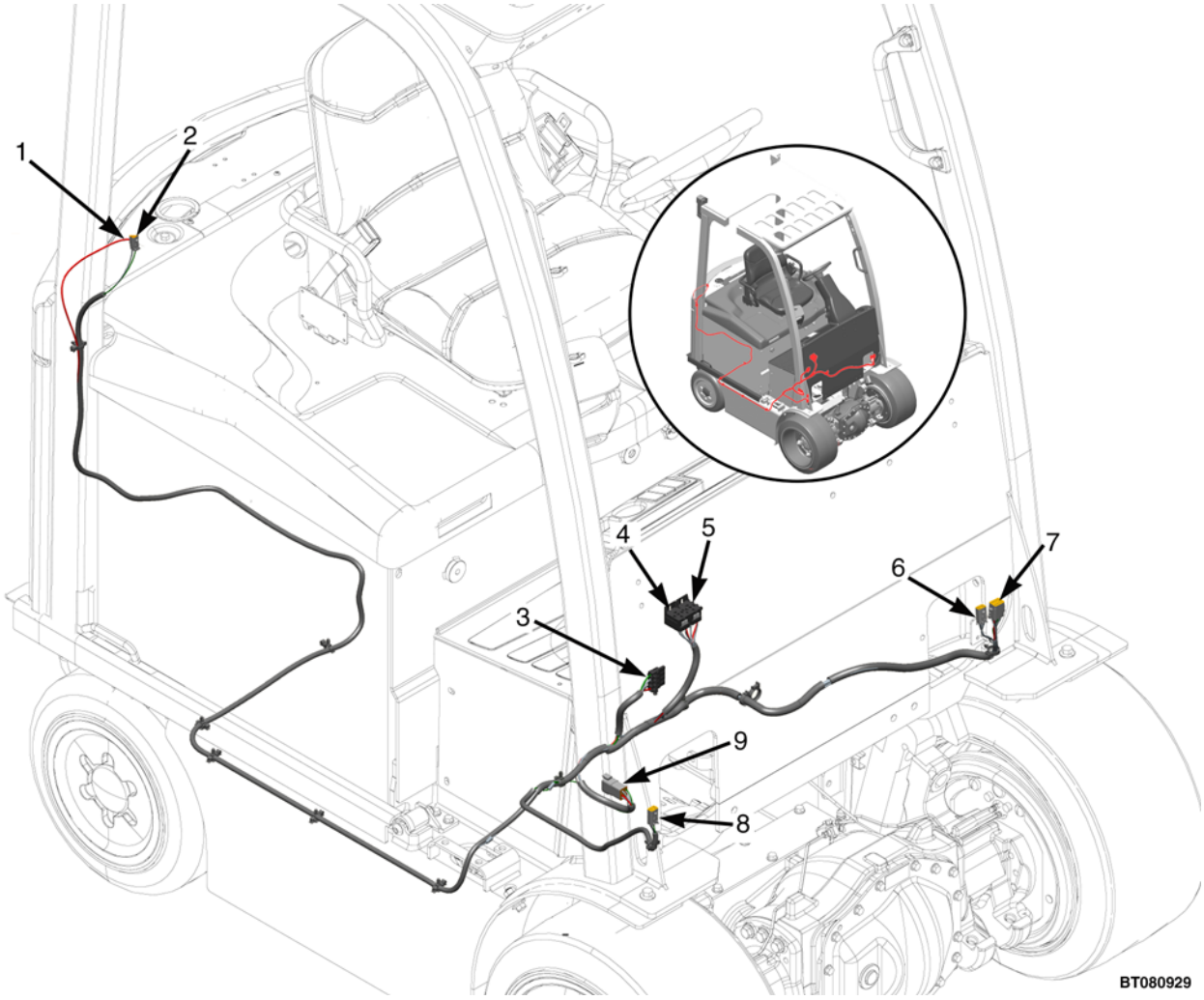


1. CPS103 WORK LIGHT FRONT RH
2. CPS20 DISPLAY W/KEY SWITCH
3. CRP135 DISPLAY HARNESS
4. CRP180 DISPLAY LIGHT HARNESS

Figure 9030-03-20. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Lights w/OHG - RH

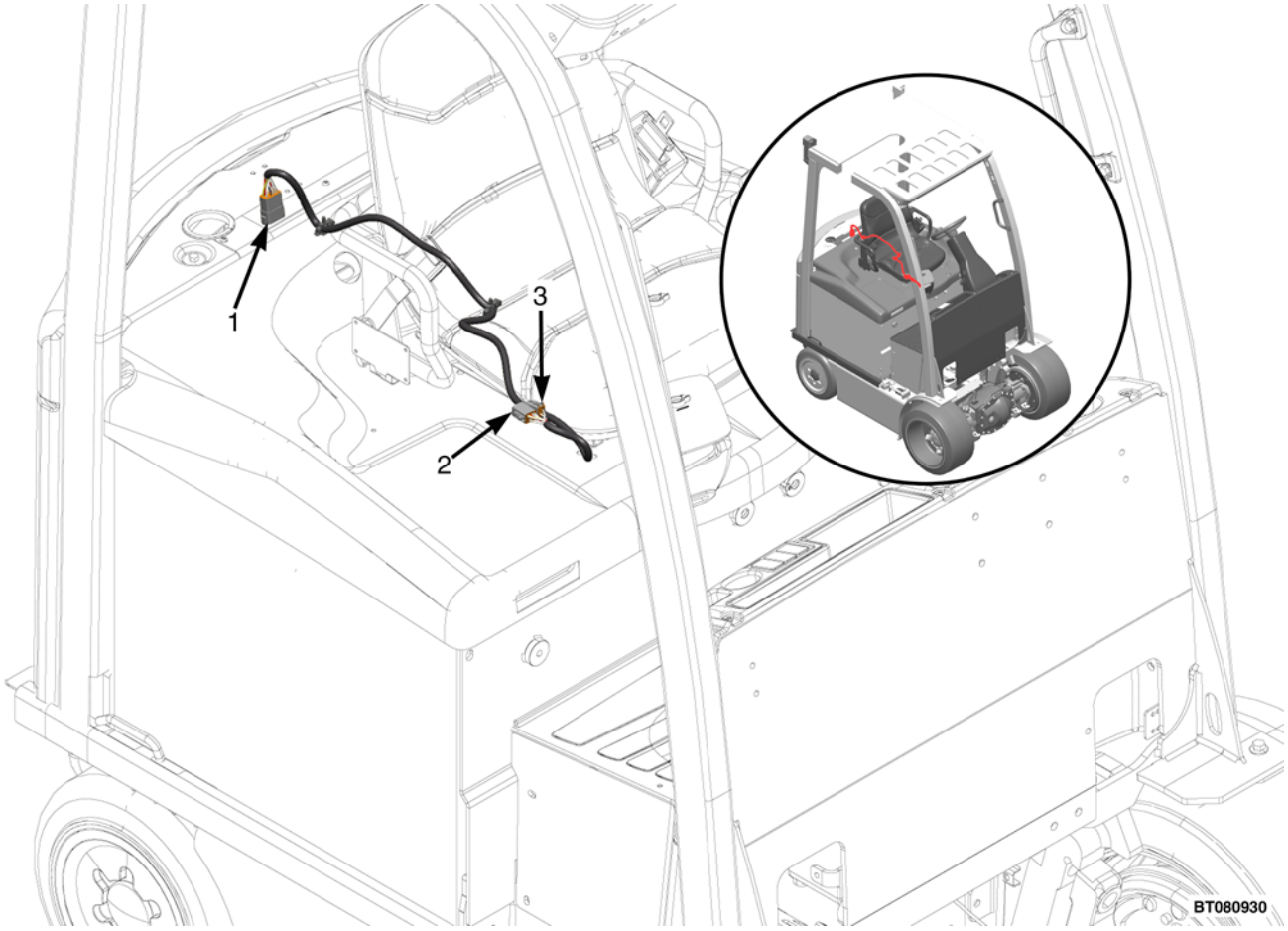
https://truckmanualshub.com/



1. TFK80 FUSE 2
2. CPS112 BACK UP ALARM
3. CPS90 DC - DC CONVERTER
4. CRS210 BRAKE LIGHT RELAY
5. CRS110 REVERSE RELAY
6. CPS138 WIRE HARNESS LIGHTS LH - OHG
7. CPS211 HARNESS LIGHT SWITCH
8. CPS180 DISPLAY LIGHT HARNESS
9. CRP137 MAIN HARNESS

Figure 9030-03-21. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Lights Chassis Main

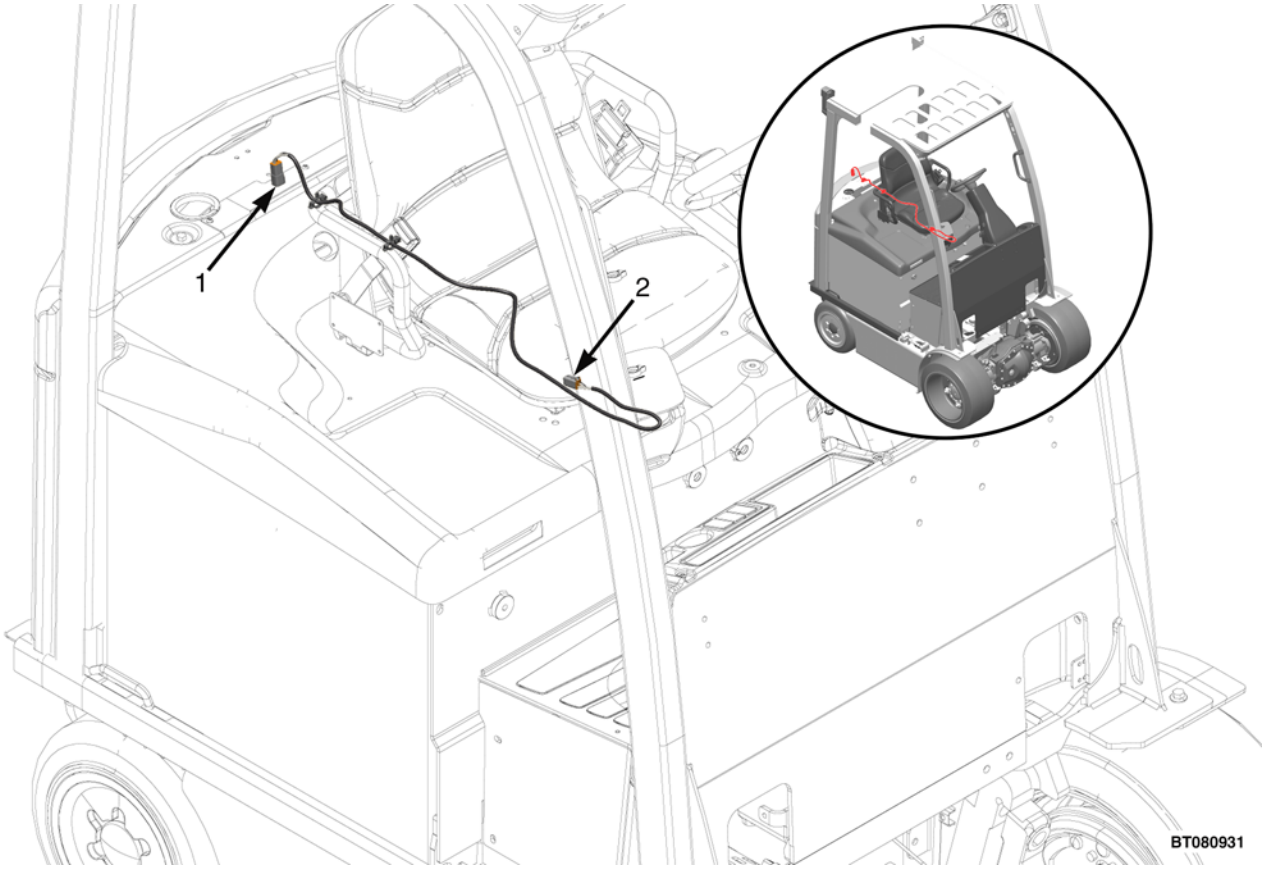
https://truckmanualshub.com/



1. CRP54 MAIN HARNESS
2. CPS52 MLM SEAT HARNESS
3. CPS55 SEAT SENSOR

Figure 9030-03-22. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Seat E-Hydraulic

https://truckmanualshub.com/



1. CRP54 MAIN HARNESS
2. CRP55 SEAT HARNESS

Figure 9030-03-23. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Seat Manual-Hydraulic

https://truckmanualshub.com/

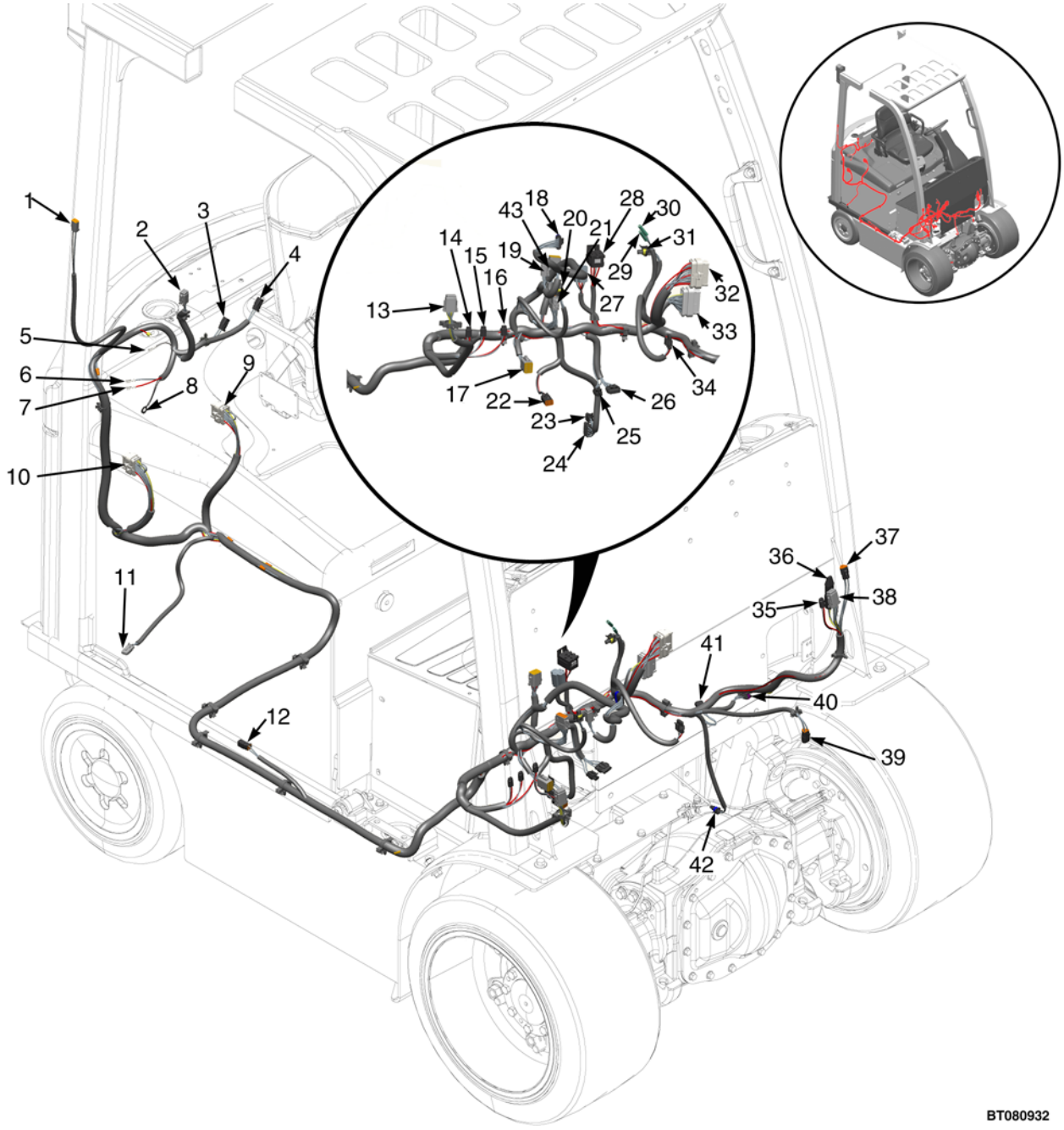


Figure 9030-03-24. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Main w/ Manual – Hydraulic

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Legend for Figure 9030-03-24

1. CPS114 OHG HORN SWITCH
2. CPS54 SEAT HARNESS
3. CPS157 CONTROLLER FAN
4. CPS95 CONTROLLER FAN
5. TFK78 FUI
6. TF10 MAIN CONNECTOR COIL
7. TF11 MAIN CONNECTOR COIL
8. TR65 NEGATIVE TERMINAL TRACTION CONTROLLER
9. CPS5 PUMP CONTROLLER
10. CPS3 TRACTION MOTOR CONTROLLER
11. CPS31 STEER AXLE SENSOR
12. CPS102 BATTERY GATE MAGNETIC SWITCH
13. CPS135 DISPLAY HARNESS
14. CPS191 CLAMP COIL
15. CPS161 MANUAL HYDRAULIC COIL
16. CPS160 MANUAL HYDRAULIC COIL
17. CPS137 LIGHT OPTION HARNESS
18. CPS29 ACCELERATOR PEDAL POSITION SENSOR
19. CPS65 DIRECTION SELECT SENSOR
20. CPS10 LIFT PRESSURE
21. CPS162 MANUAL HYDRAULIC SPOOL POSITION SENSOR
22. CPS15 PARK BRAKE
23. CPS154 TRACTION MOTOR TEMPERATURE SENSOR
24. CPS152 TRACTION MOTOR SPEED SENSOR
25. CPS61 PUMP MOTOR TEMPERATURE SENSOR
26. CPS146 PUMP MOTOR SPEED SENSOR
27. CRS212 SYNC. STEER VALVE RELAY
28. CRS208 KEY SWITCH RELAY
29. TF04 BRAKE FLUID LEVEL
30. TF03 BRAKE FLUID LEVEL
31. CPS11 SERVICE BRAKE PRESSURE SENSOR
32. CPS2 VSM
33. CSP1 VSM
34. CPS151 HORN ASSEMBLY
35. CPS133 SYNC. STEER VALVE HARNESS
36. CPS142 TERMINATION RESISTOR
37. CPS512 PARK BRAKE POSITION
38. CPS132 STEER HARNESS
39. CPS8 TILT POSITION SENSOR
40. CPS70 HYD. OIL LEVEL SENSOR
41. CPS66 HYD. FILTER PRESSURE SWITCH
42. CPS14 HYD. OIL TEMPERATURE SENSOR
43. CPS192 MANUAL HYD. HARNESS

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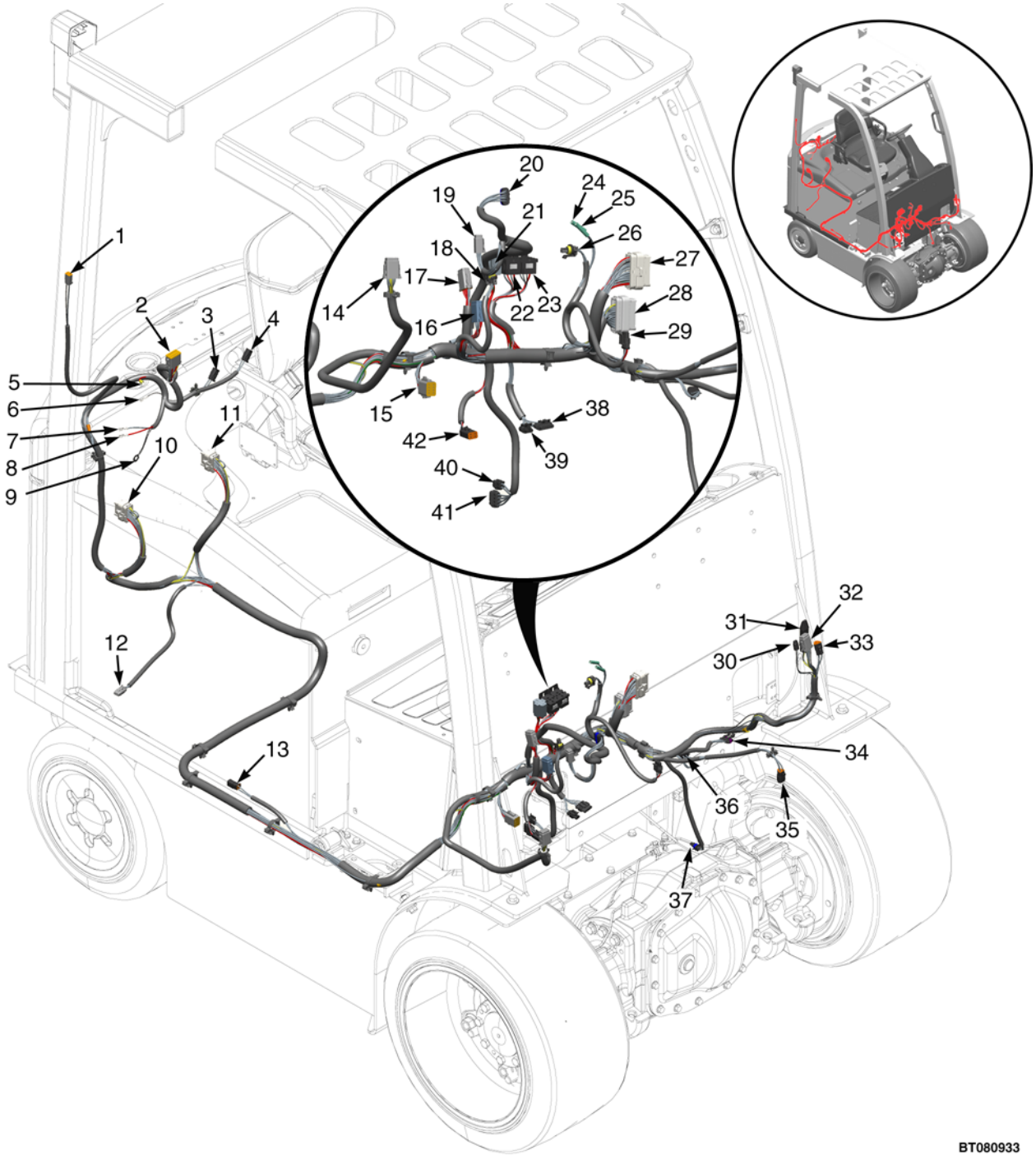

Figure 9030-03-25. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Main w/E – Hydraulic

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Legend for Figure 9030-03-25

1. CPS114 OHG HORN SWITCH
2. CPS54 SEAT HARNESS
3. CPS157 CONTROLLER FAN
4. CPS95 CONTROLLER FAN
5. TFK78 FUI
6. TFK67 ESD TRUCK FRAME
7. TF10 MAIN CONNECTOR COIL
8. TF11 MAIN CONNECTOR COIL
9. TR65 NEGATIVE TERMINAL TRACTION CONTROLLER
10. CPS3 TRACTION MOTOR CONTROLLER
11. CPS5 PUMP CONTROLLER
12. CPS31 STEER AXLE SENSOR
13. CPS102 BATTERY GATE MAGNETIC SWITCH
14. CPS135 DISPLAY HARNESS
15. CPS137 LIGHT OPTION HARNESS
16. CPS75 E-HYDRAULIC LOWER COIL
17. CPS74 E-HYDRAULIC UPPER COIL
18. CPS10 LIFT PRESSURE
19. CPS65 DIRECTION SELECT SENSOR
20. CPS29 ACCELERATOR PEDAL POSITION SENSOR
21. CRS208 KEY SWITCH RELAY
22. CRS212 SYNC. STEER VALVE RELAY
23. CRS209 E-HYDRAULIC ENABLE RELAY
24. TF03 BRAKE FLUID LEVEL
25. TF04 BRAKE FLUID LEVEL
26. CPS11 SERVICE BRAKE PRESSURE SENSOR
27. CPS2 VSM
28. CSP1 VSM
29. CPS151 HORN ASSEMBLY
30. CPS133 SYNC. STEER VALVE HARNESS
31. CPS142 TERMINATION RESISTOR
32. CPS132 STEER HARNESS
33. CPS512 PARK BRAKE POSITION
34. CPS70 HYD. OIL LEVEL SENSOR
35. CPS8 TILT POSITION SENSOR
36. CPS66 HYD. FILTER PRESSURE SWITCH
37. CPS14 HYD. OIL TEMPERATURE SENSOR
38. CPS146 PUMP MOTOR SPEED SENSOR
39. CPS61 PUMP MOTOR TEMPERATURE SENSOR
40. CPS152 TRACTION MOTOR SPEED SENSOR
41. CPS154 TRACTION MOTOR TEMPERATURE SENSOR
42. CPS15 PARK BRAKE

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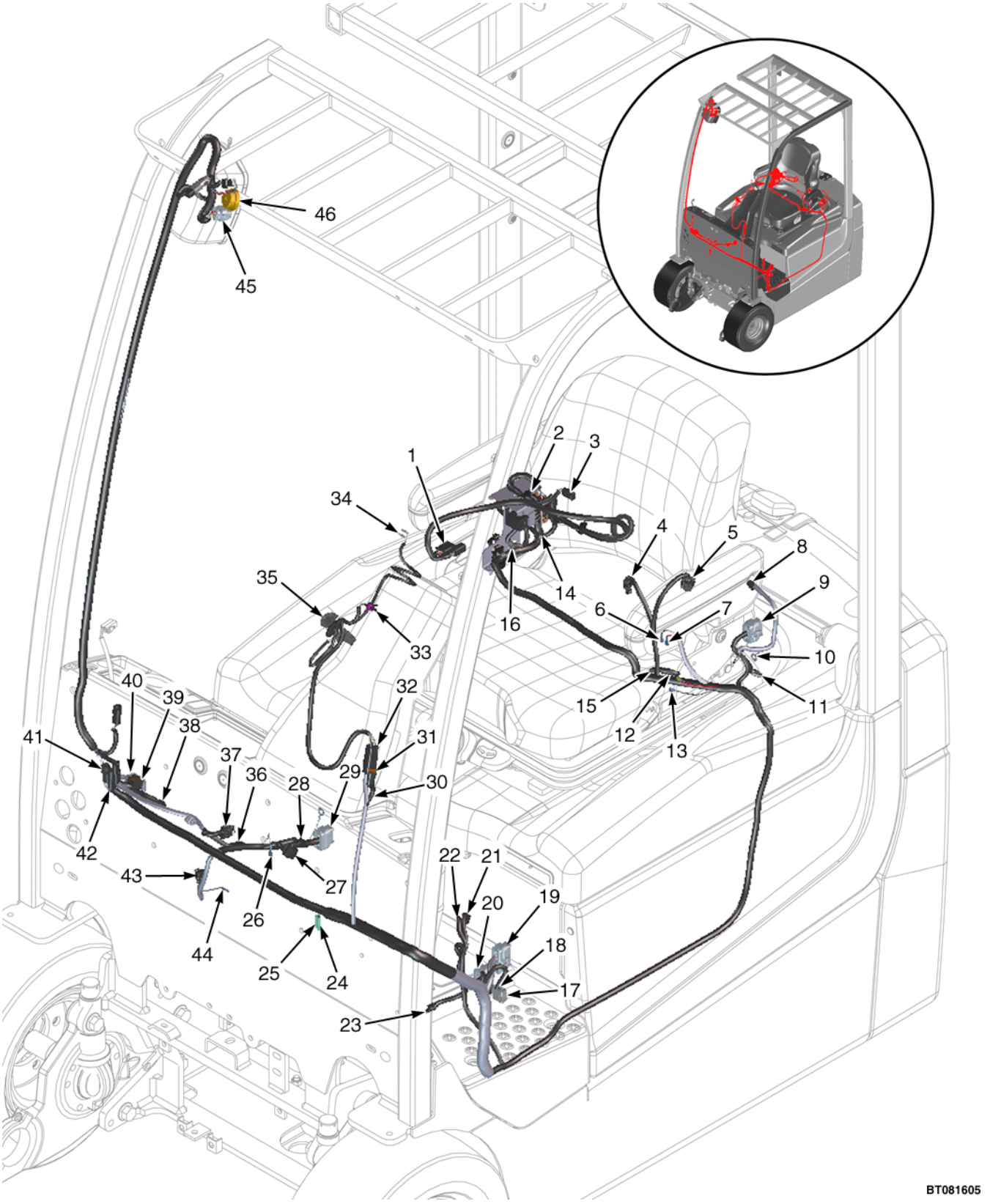

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1. CPS114 OHG HORN SWITCH
2. CRP54 PREMIUM SEAT HORN SWITCH
3. CRP57 SEAT BELT SWITCH HARNESS
4. CPS154 TRACTION MOTOR TEMPERATURE SENSOR
5. CPS152 TRACTION MOTOR SPEED SENSOR
6. TF11 MAIN CONTACTOR COIL
7. TF10 MAIN CONTACTOR COIL
8. CPS94 TRACTION CONTROLLER FAN
9. CPS3 TRACTION CONTROLLER
10. B(-) STUD TRACTION CONTROLLER
11. CPS87 STROBE CONNECTOR
12. TS65 FRAME GROUND B(-)
13. TFK78 FUSE FU1
14. CRS208 KEY SWITCH RELAY
15. CPS31 STEER AXLE POSITION SENSOR
16. CRS210 REVERSE RELAY
17. CPS6 VSM CONNECTOR
18. CPS7 VSM CONNECTOR
19. CPS1 VSM CONNECTOR
20. CPS2 VSM CONNECTOR
21. CPS96 PUMP CONTROLLER FAN
22. CPS95 PUMP CONTROLLER FAN
23. CPS14 HYDRAULIC OIL TEMPERATURE SENSOR
24. TF04 BRAKE FLUID LEVEL
25. TF03 BRAKE FLUID LEVEL
26. TS67 B(-) PUMP MOTOR
27. CPS146 PUMP MOTOR SOLENOID
28. CPS61 PUMP MOTOR TEMPERATURE SENSOR
29. CPS5 PUMP CONTROLLER
30. CRP12 PARK BRAKE SWITCH CONNECTOR
31. CPS12 PARK BRAKE SWITCH CONNECTOR
32. CRP132 STEER HARNESS CONNECTOR
33. CPS78 STEER WHEEL POSITION SENSOR
34. TF15 / TF14 HORN SWITCH
35. CPS28 DIAGNOSTIC CONNECTOR
36. CPS29 ACC PEDAL POSITION SENSOR
37. CPS65 DIRECTION SELECTOR SENSOR
38. CPS160-161 HYDRAULIC COIL CONNECTORS
39. CPS162 HYDRAULIC SPOOL SENSOR
40. CPS192 MANUAL LEVER HARNESS
41. CRP135 DISPLAY HARNESS
42. CRP136 SIG. DISPLAY HARNESS
43. CPS151 HORN CONNECTOR
44. B(-) HORN GND
45. CPS20 DISPLAY CONNECTOR
46. KEY SWITCH

Figure 9030-03-26. A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203] Main Harness Assembly

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Group 10

Principles of Operation

Electrical System

GENERAL DESCRIPTION

The major components in the electrical system are shown in Figure 9030-10-27, Figure 9030-10-28, Figure 9030-10-29, Figure 9030-10-30, and Figure 9030-10-32.

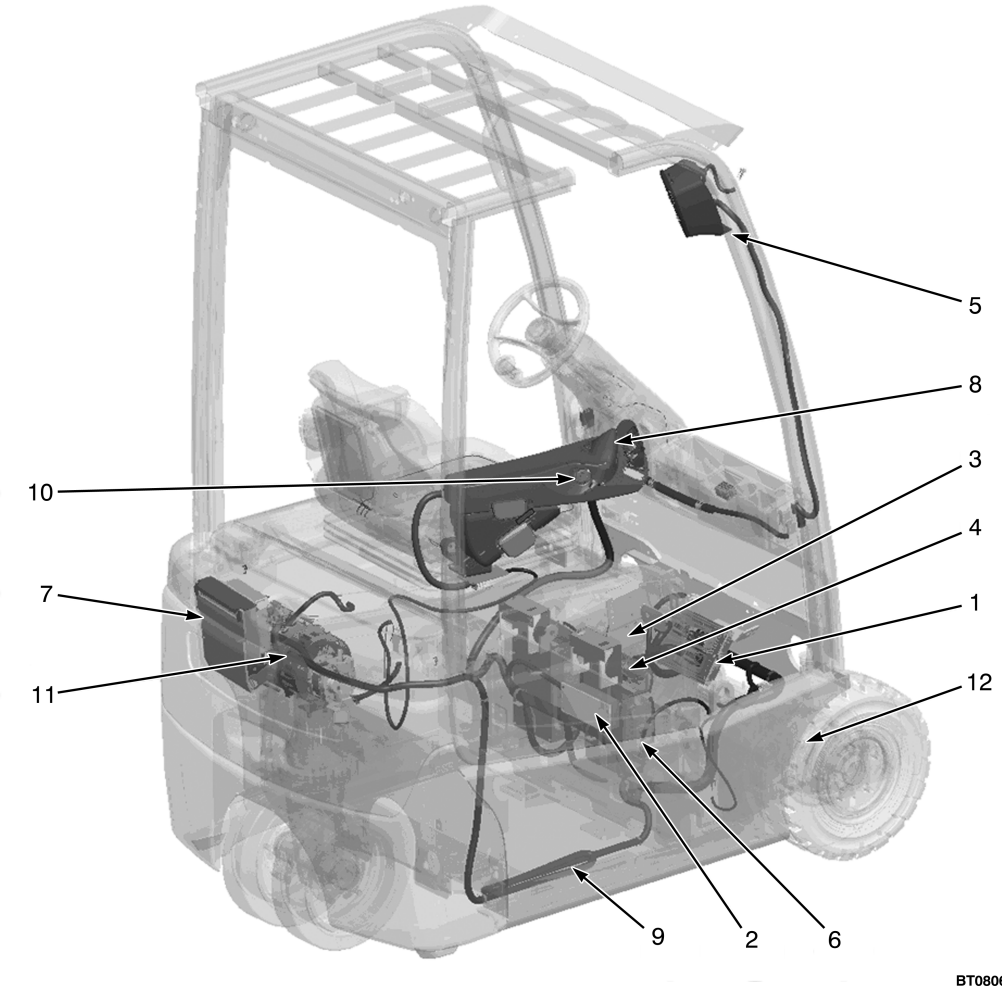

Figure 9030-10-27. J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

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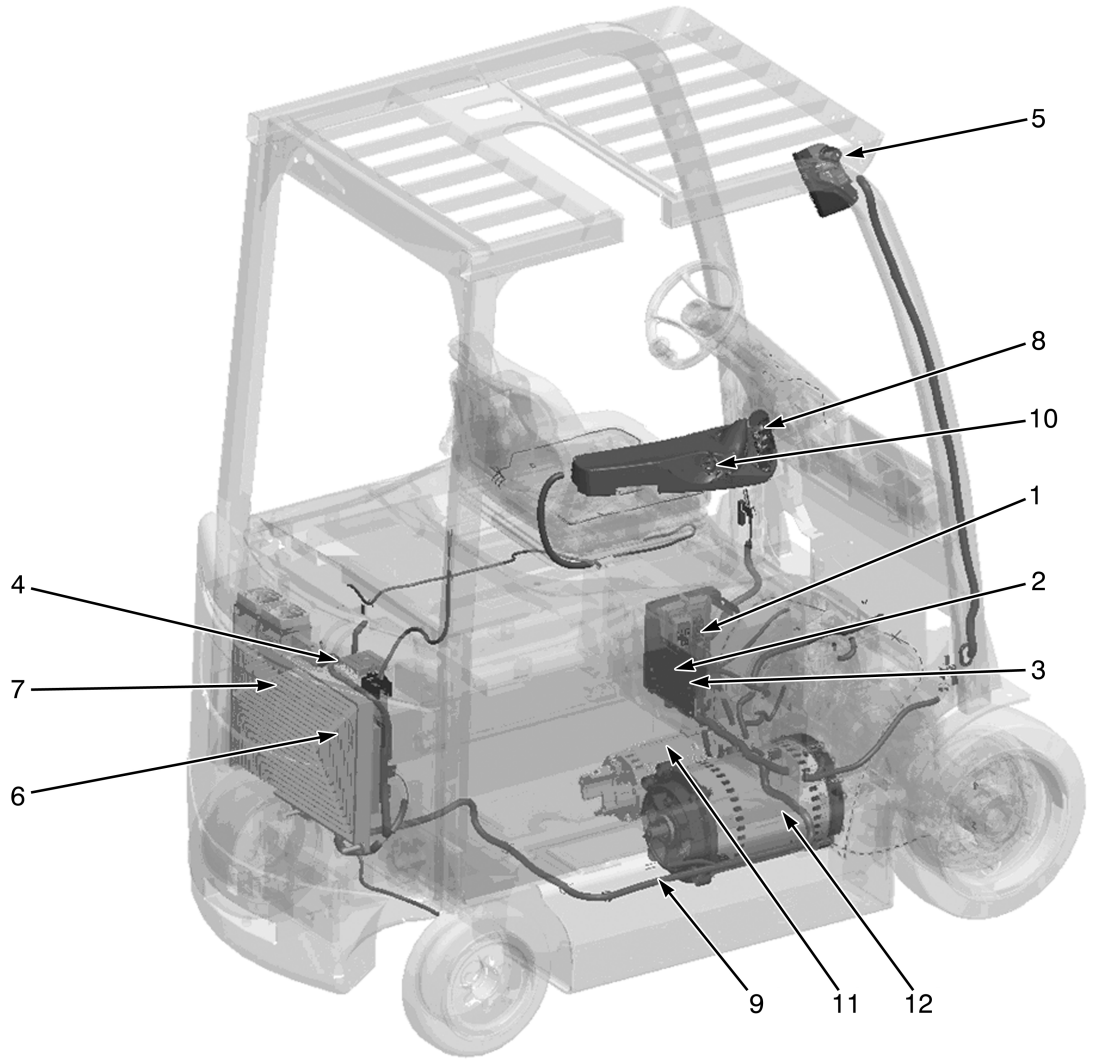
Legend for Figure 9030-10-27

NOTE: J1.5-2.0XNT (J30-40XNT) (K160) IS SHOWN AND THE J1.6-2.0XN (J30-40XN) (A935) IS SIMILAR.

1. VSM
2. DC/DC CONVERTER
3. RELAYS
4. MAIN CONTACTOR AND FUSES
5. DISPLAY
6. TRACTION MOTOR CONTROLLER
7. PUMP MOTOR CONTROLLER
8. MINI-LEVER MODULE (MLM)
9. MAIN CHASSIS HARNESS
10. EMERGENCY STOP
11. PUMP MOTOR
12. TRACTION MOTOR



1. VSM
2. DC/DC CONVERTER
3. RELAYS
4. MAIN CONTACTOR AND FUSES
5. DISPLAY
6. TRACTION MOTOR CONTROLLER
7. PUMP MOTOR CONTROLLER
8. MINI-LEVER MODULE (MLM)
9. MAIN CHASSIS HARNESS
10. EMERGENCY STOP
11. PUMP MOTOR
12. TRACTION MOTOR

Figure 9030-10-28. E2.2-3.5XN (E45-70XN) (A268)

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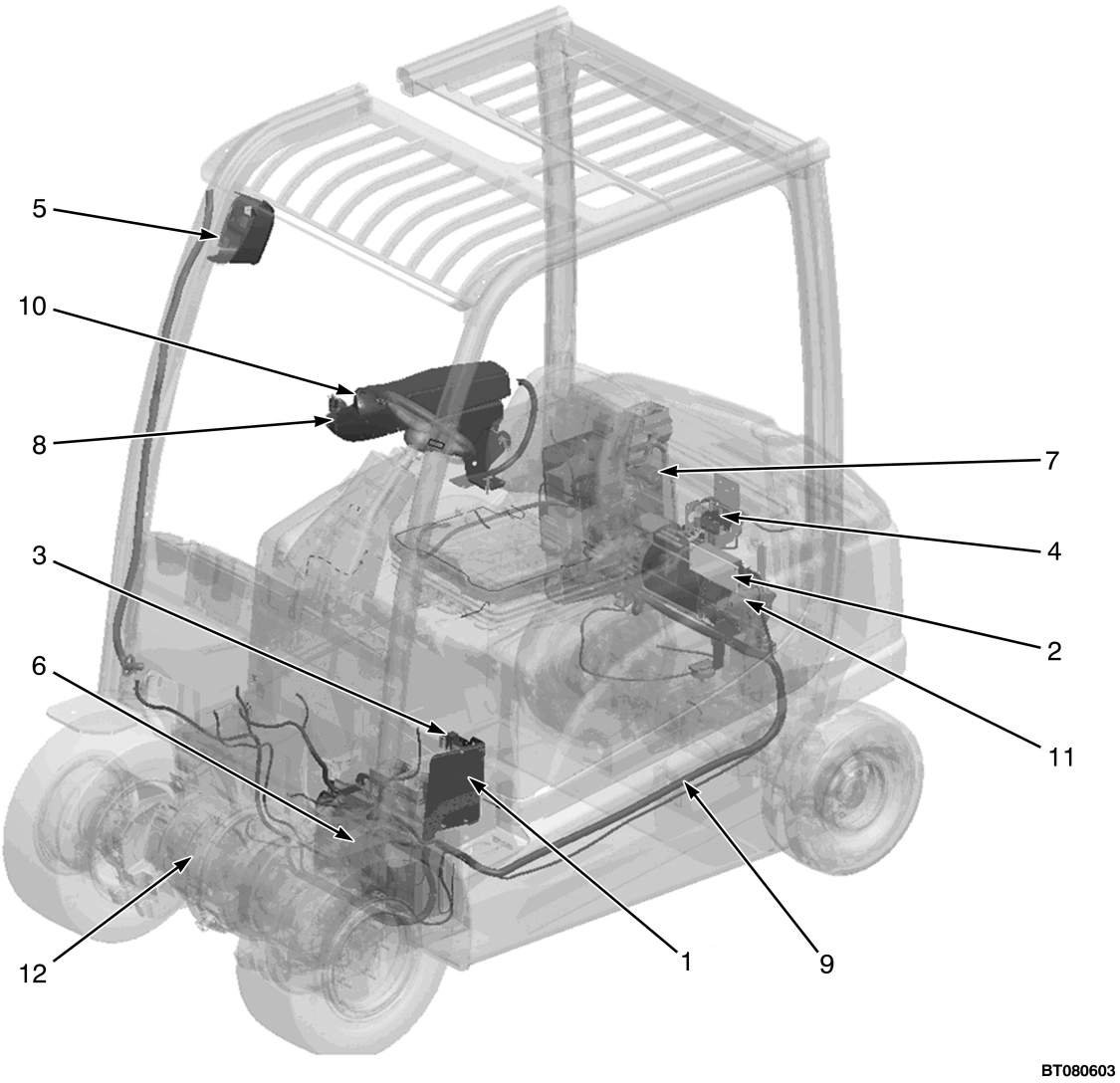

NOTE: J2.2-3.5XN (J45-70XN) (A276) SHOWN. J4.0-5.0XN (J80-100 XN) (A970) IS SIMILAR.

1. VSM
2. DC/DC CONVERTER
3. RELAYS
4. MAIN CONTACTOR AND FUSES
5. DISPLAY
6. TRACTION MOTOR CONTROLLERS
7. PUMP MOTOR CONTROLLER
8. MINI-LEVER MODULE (MLM)
9. MAIN CHASSIS HARNESS
10. EMERGENCY STOP
11. PUMP MOTOR
12. TRACTION MOTORS

Figure 9030-10-29. J2.2-3.5XN (J40-70XN) (A276) and J4.0-5.0XN (J80-100 XN) (A970)

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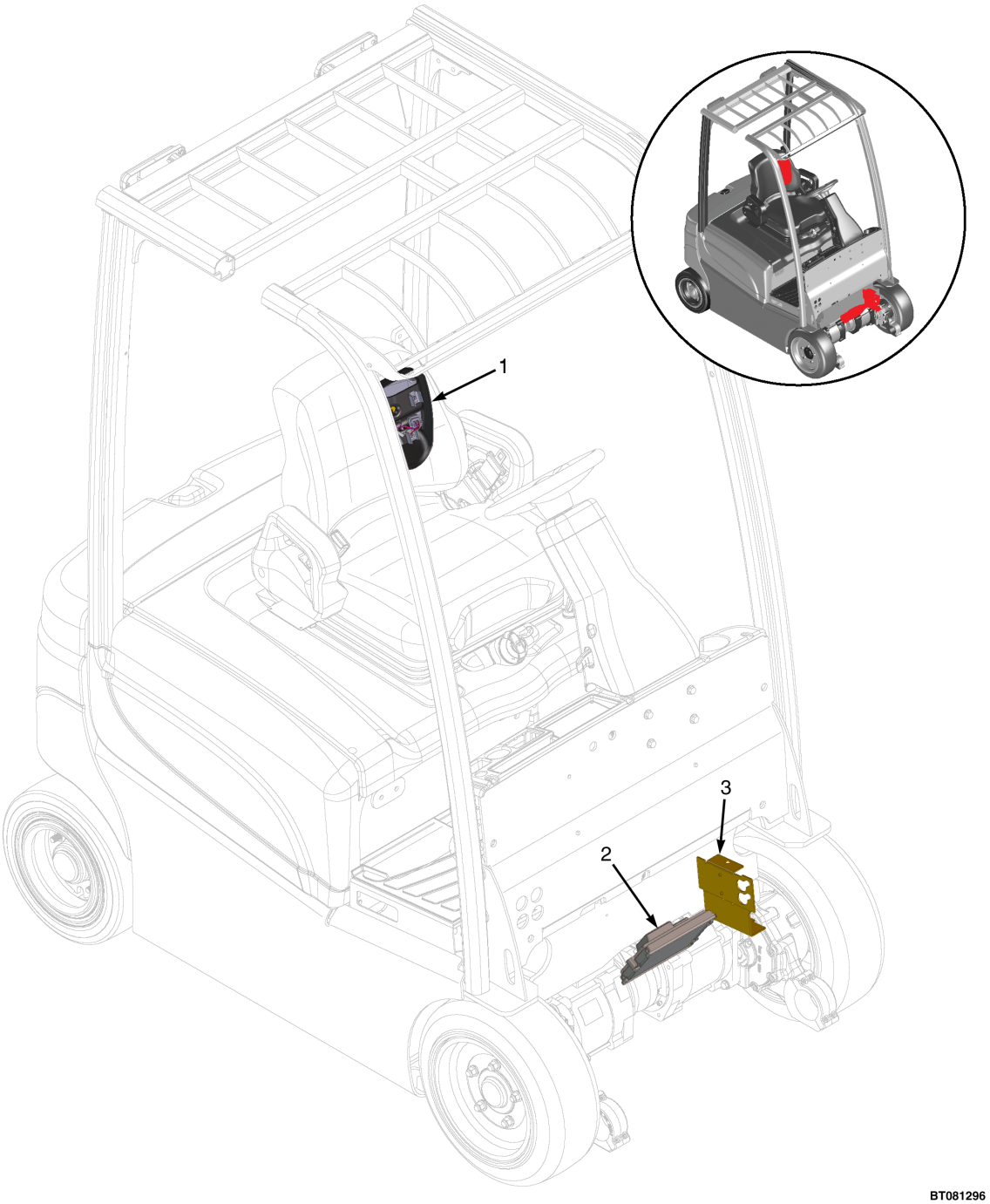

NOTE: J1.6-2.0XN (J30-40XN) (A935) IS SHOWN AND J1.5-2.0XNT (J30-40XNT) (K160) IS SIMILAR.

1. DISPLAY
2. VSM
3. FUSE PANEL

Figure 9030-10-30. J1.6-2.0XN (J30-40XN) (A935) and J1.5-2.0XNT (J30-40XNT) (K160)

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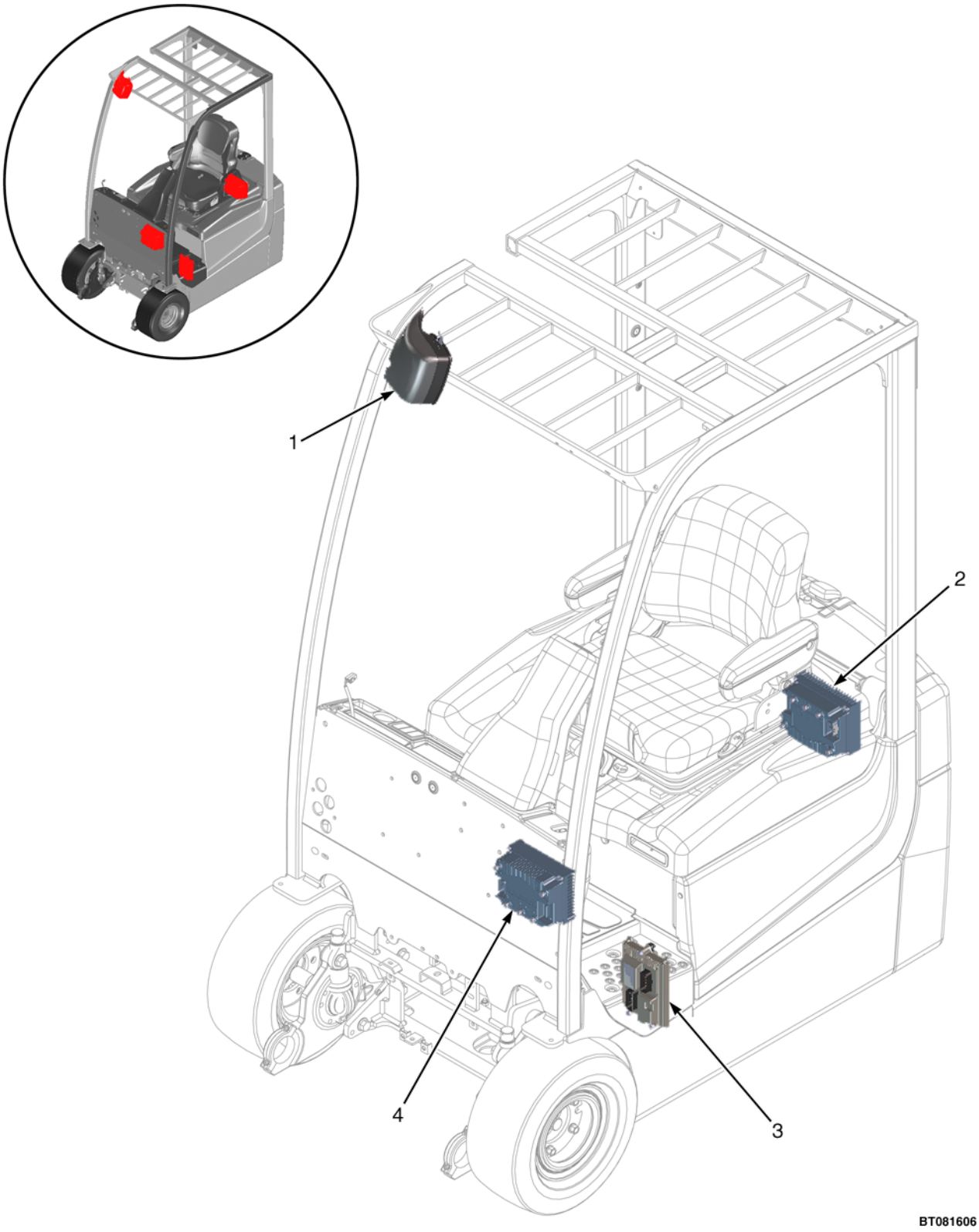

1. DISPLAY
2. TRACTION CONTROLLER
3. VSM
4. PUMP CONTROLLER

Figure 9030-10-31. A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203] Controller Locations

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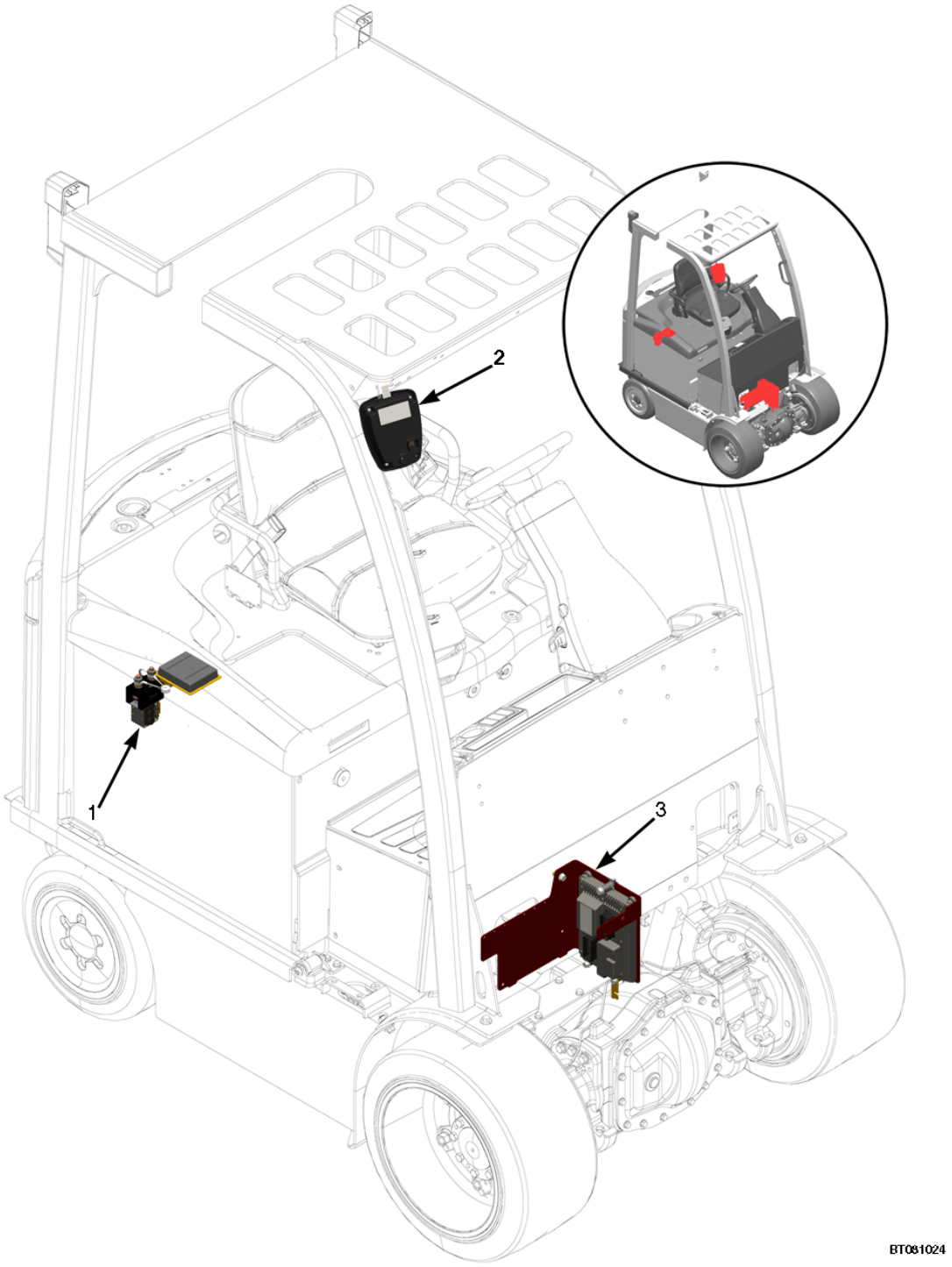

1. CONTACTOR AND FUSE PANEL
2. DISPLAY
3. VSM

Figure 9030-10-32. E2.2-3.5XN (E45-70XN) (A268)

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The truck's electrical system directly controls and monitors every electrical component in the truck. See Figure 9030-10-33 which shows the interconnection between various components in the system.

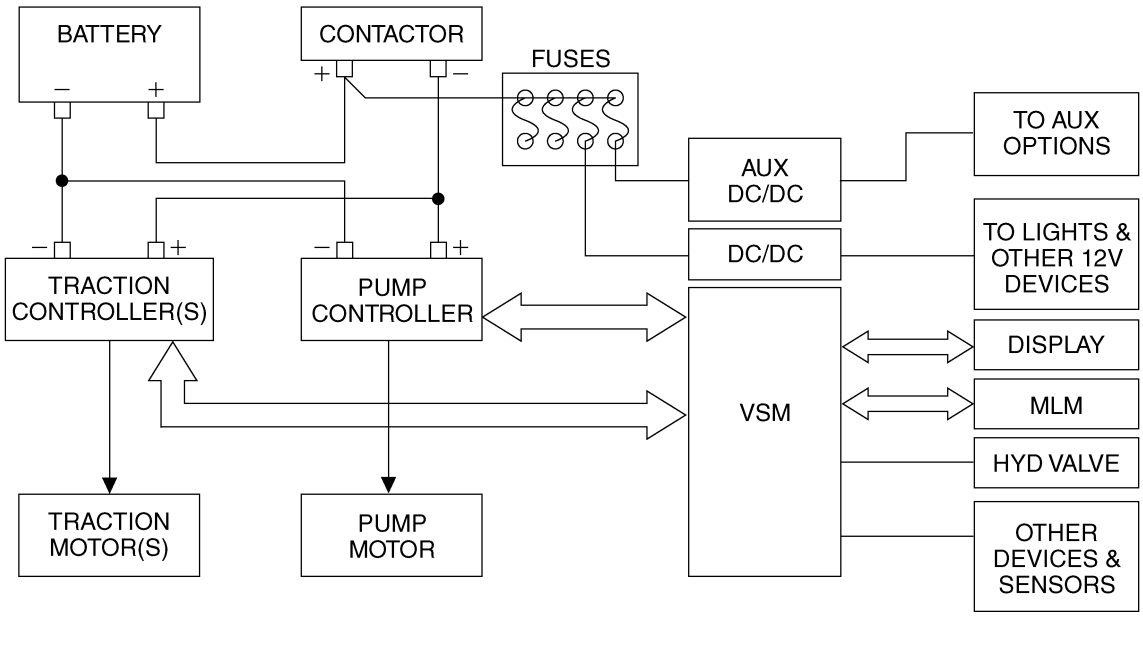

Figure 9030-10-33. System Block Diagram

The lift truck contains components as listed below; Component location on truck may vary with the different platforms.

Battery

- Deep-cycle, multi-cell, lead acid battery.
- Voltage ranges 24/36/48/72/80 volts with different Ah ratings based on customer applications.
- The battery is located below the hood in the battery compartment area.

Contactor

The contactors used are single pole single throw normally open contactors. The contactors are available in UL-E and UL-EE options.

Fuses

- The main fuses are 15 Amp fast acting ceramic tubes with nickel plated brass end cap construction.
- The contactor and fuses are assembled together on a single bracket.
- Other fuses are located adjacent to the devices they are protecting.

Relays

The relays used are 12V and 24V having high contact rating, high temperature and quick connect design. Following are the relays provided in the truck:

- Standard Relays:
  - Key Switch Relay (12V)
  - E-Hyd Enable Relay (24V) (Only on E-Hydraulic Trucks)
- Optional Relays:
  - Reverse Relay (24V)
  - Brake Light Relay (24V)
  - Flasher (Turn Signal Option) Relay (12V)

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Wire Harnesses

Fundamental to the operation of the truck, the wire harnesses have been designed to ensure trouble free, reliable electrical operation, and ease of service. This has been achieved through the following:

- Harness retention clips and brackets used for consistent routing and clean appearance.
- Constructed with ultrasonically welded splices and protective conduit.
- High quality sealed connectors with locks are used instead of spade type connectors and unsealed connections wherever possible.
- Standardized wire colors and circuit identification.

DC/DC Converter

The DC/DC converter is connected permanently to the batteries of the lift truck.

The DC/DC converter regulated voltage outputs. The DC/DC converter helps provide unmatched levels of efficiency with thermal protection for lights, horns, wipers, communication equipment, and charging auxiliary batteries.

Operator Interface

Display

The display panel is located on the upper portion of the right front overhead guard leg. It is the main operator interface providing operator input through the push buttons and outputs to the operator through messages and warning icons. It also provides onboard diagnostics and setup to a qualified technician through password protection. See Figure 9030-10-34. There are two display options available Standard Temperature and Freezer (Arctic) Temperature. Keyed and Keyless Power on is also an option.

Controllers

Vehicle System Manager (VSM)

The Vehicle System Manager (VSM) is a microprocessor powered controller which controls and monitors directly or indirectly every electrical device on the truck. The VSM power inputs are protected for overvoltage, reverse polarity, electrostatic discharge and short to battery.

VSM outputs are protected for short to battery, short to ground, electro static discharge and transients. There are two versions of the VSM. One is for Manual Hydraulics, and one is for the E-Hydraulics configuration. See Figure 9030-10-35.

Figure 9030-10-34. Display

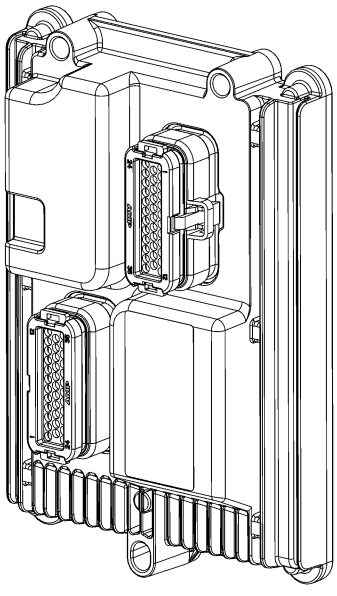

Figure 9030-10-35. Vehicle System Manager (VSM)

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Motor Controllers

Motor controllers are used to provide Traction and Pump motors with power and control signals. Traction and Pump motors are controlled individually by separate controllers. These controllers are linked to VSM via CANbus which provides control signals to controllers. See Figure 9030-10-36 or Figure 9030-10-37.

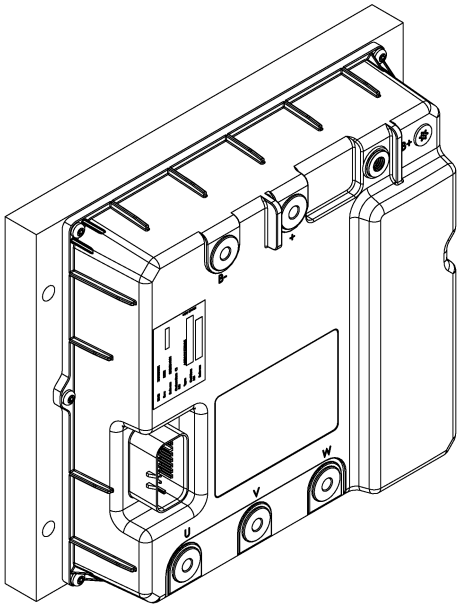

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Figure 9030-10-36. Motor Controller for Four Wheel Applications

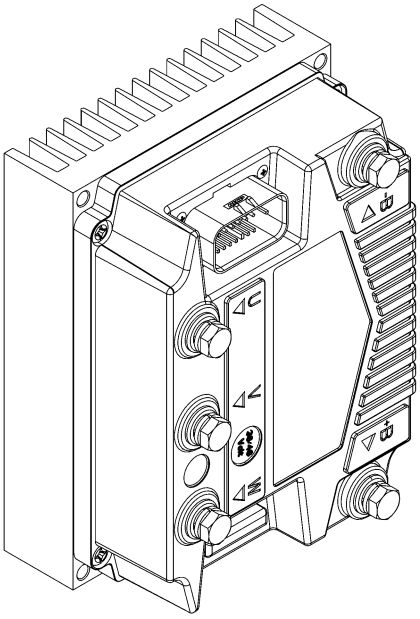

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Figure 9030-10-37. Motor Controller for Three Wheel Applications

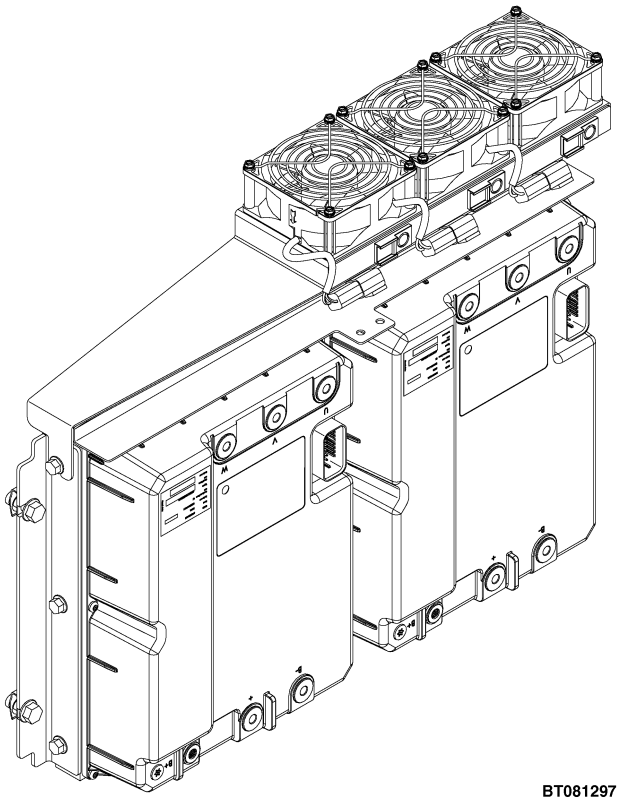

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Figure 9030-10-38. Motor Controllers with Integrated Heat Sink

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E-Hydraulics Mini Levers Module (MLM)

The electro hydraulic systems for all electric rider forklift trucks include a mini-lever module (MLM). The MLM consists of analog (levers) and digital (switch) inputs that command various hydraulic and truck functions. The hydraulic functions which are controlled by the MLM are lift/lower, tilt and up to three auxiliary functions. Auxiliary functions are used for operating "forklift attachments" such as a sideshift, rotator, clamp, push/pull, etc. See E-Hydraulic System Interface.

The truck utilizes CANopen communications, CAN 2.0B hardware, to link the control system components. Multiple packets of information can be sent on this bus, an operation commonly known as Multiplexing. See Figure 9030-10-39 which shows components connected through CANbus.

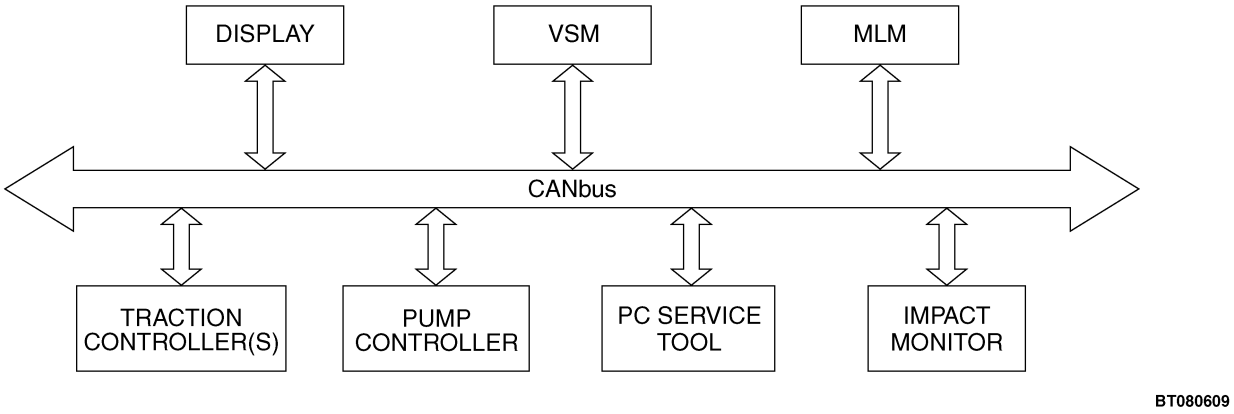

Figure 9030-10-39. CAN Network Diagram

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The CANbus consists of a twisted pair of wires. Each of the twisted wires is uniquely color-coded.

Yellow = CAN Hi

Green = CAN Lo

Typical characteristics of data on the CANbus are:

- Each wire broadcasts a mirror image of the other to insure signal integrity.
- Each CAN connected device receives and broadcasts messages.
- The message data, if viewed with an oscilloscope, would look like the signal trace shown in Figure 9030-10-40.

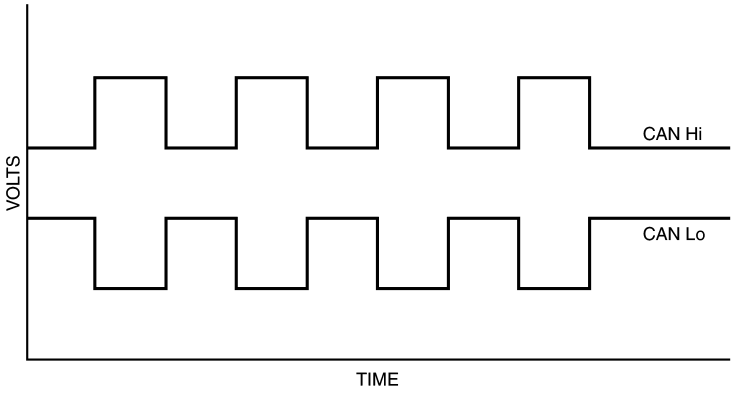


Figure 9030-10-40. Typical CAN Signals

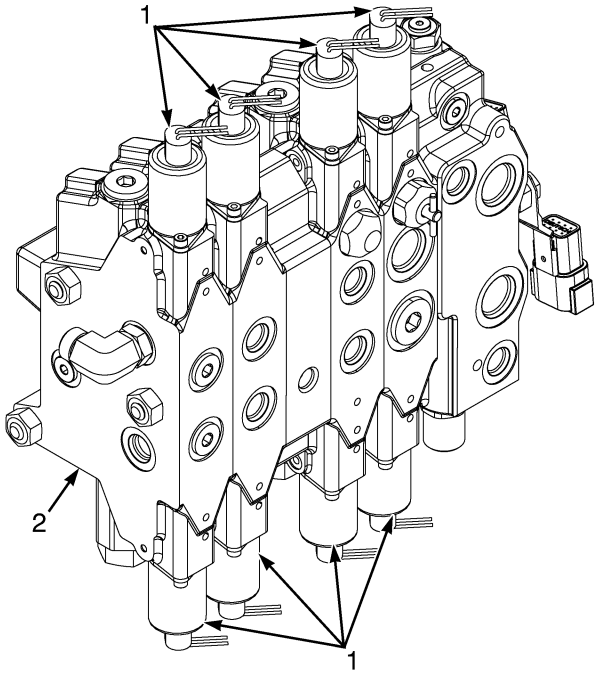
System Controlled Outputs

The various controllers provide electrical outputs to various devices to control variable functions; some of them are described below.

Valve Coils

There are two different valve options available E-Hydraulic and Manual.

- E-Hydraulic valve spool displacement is accomplished by applying an electrical signal to a solenoid located on either end of the valve section. These solenoids receive Pulse Width Modulated (PWM) signals from the VSM which provide proportional control of the spool. See Figure 9030-10-41.



1. E-HYDRAULIC SOLENOIDS
2. E-HYDRAULIC VALVE

Figure 9030-10-41. E-Hydraulic Valve

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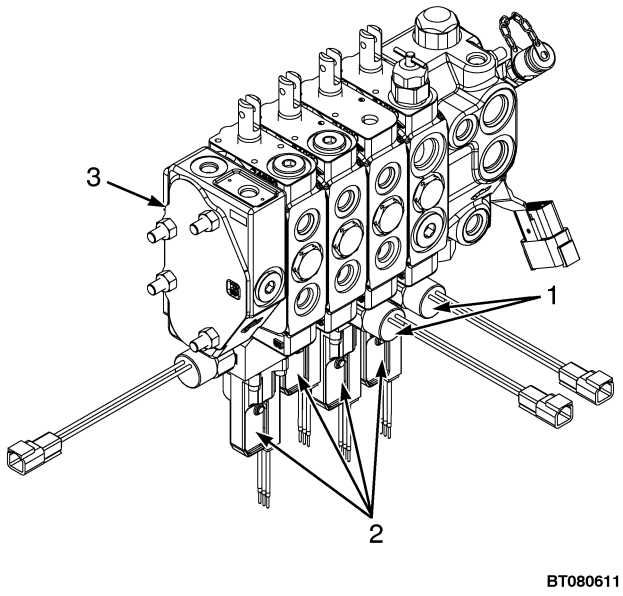
- In Manual valves the spool displacement is accomplished by manual levers. The position sensors provided on the valve monitors the position of the valve spool and produce a variable output signal relative to how far the spool has traveled from its neutral position. The output signal from the sensor is used by the VSM to vary the hydraulic pump flow. The manual valve is provided with Operator presence solenoids (OPS) which allows valve operation only if operator is present on the seat. See Figure 9030-10-42.



1. OPS LOCKOUT SOLENOIDS
2. SPOOL POSITION SENSORS
3. MANUAL HYDRAULIC VALVE

Figure 9030-10-42. Manual Hydraulic Valve

Lights and Backup Alarm

The work lights are 35/55 watt halogen lights. A premium LED 37 or 55 watt work light package is also offered. Tail lights, front-marker and strobe lights are all LED lights and are used in both the incandescent and LED work light options.

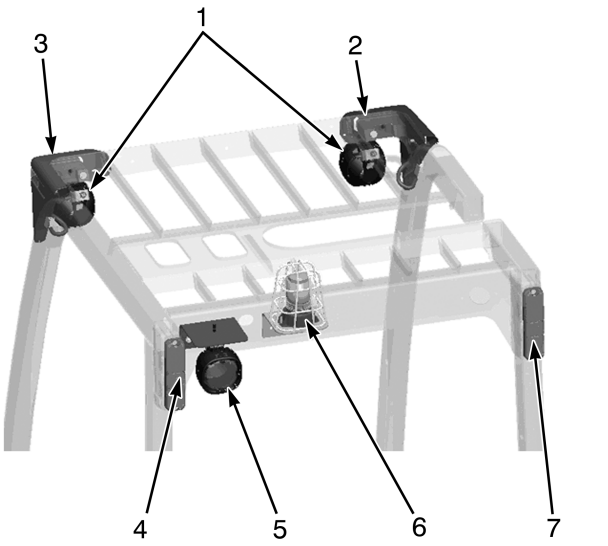
Depending on your lift truck and further information pertaining to lights and schematics, see **Diagrams** 8000SRM1341 or **Diagrams** 8000SRM1384.

See Figure 9030-10-43, which shows general locations of different lights used. They may vary depending upon your lift truck.

Cab options

Some of the lift trucks are equipped with following options:

- Washer/ Front-Rear Wipers
- Cab Heater
- Dome Light



1. FRONT WORK LIGHTS
2. RH FRONT MARKER LIGHTS
3. LH FRONT MARKER LIGHTS
4. LH TAIL LIGHT
5. REAR WORK LIGHT
6. STROBE LIGHT
7. RH TAIL LIGHT

Figure 9030-10-43. Light Location

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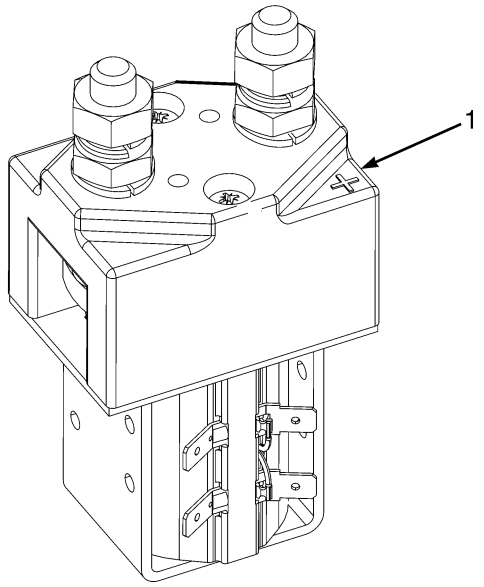
PRINCIPLES OF OPERATION, COMPONENTS

Power Distribution

Contactor

The Contactor is an electrically controlled switch used to supply main power to the lift truck's motion system. It consists of a set of high current contacts to carry battery power. These contacts are closed by an electromagnetic coil which when energized by the control system sends battery power to the motor controllers and other battery operated devices.

One of the main terminals of the contactor is connected to battery power and the other terminal is connected to the motor controllers. In order for the coil to operate there are certain interlock conditions which need to be fulfilled. Once all conditions are met the VSM provides a signal to the coil. When the operator turns on the Key or Keyless Power to ON (both are located on display), the key switch relay is energized on and the main contactor coil is energized closing its contacts. See Figure 9030-10-44.



1. CONTACTOR

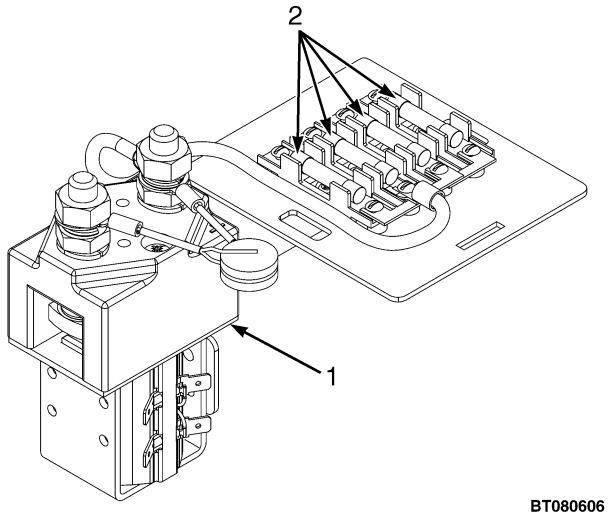
Figure 9030-10-44. Contactor (EE Type Shown)

Positive Temperature Coefficient (PTC)

The PTC thermistor ensures that the motor controller drive capacitors are charged when the battery is connected and prior to the contactor being operated. This prevents damage to the contactor contacts due to large capacitive inrush currents.

Fuses

The fuses used are 15 Amp fuses. They are typically used to connect the Emergency Disconnect Switch circuits, Primary DC/DC converter and Auxiliary DC/DC converter to battery power. One 5 Amp fuse is used for the Key Switch and E-Stop. See Figure 9030-10-45. See Figure 9030-10-46.



1. CONTACTOR
2. FUSES

Figure 9030-10-45. Fuse and Contactor Assembly

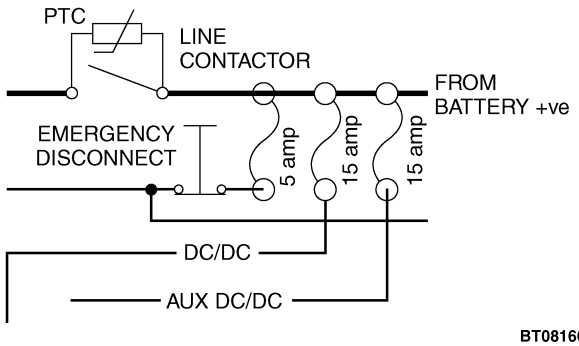


Figure 9030-10-46. Power Circuit Diagram

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Relays

Key Switch Relay: Upon turning on the key or keyless switch located on Display panel, key switch relay gets energized and provides power to components to which it is connected. See Figure 9030-10-47.

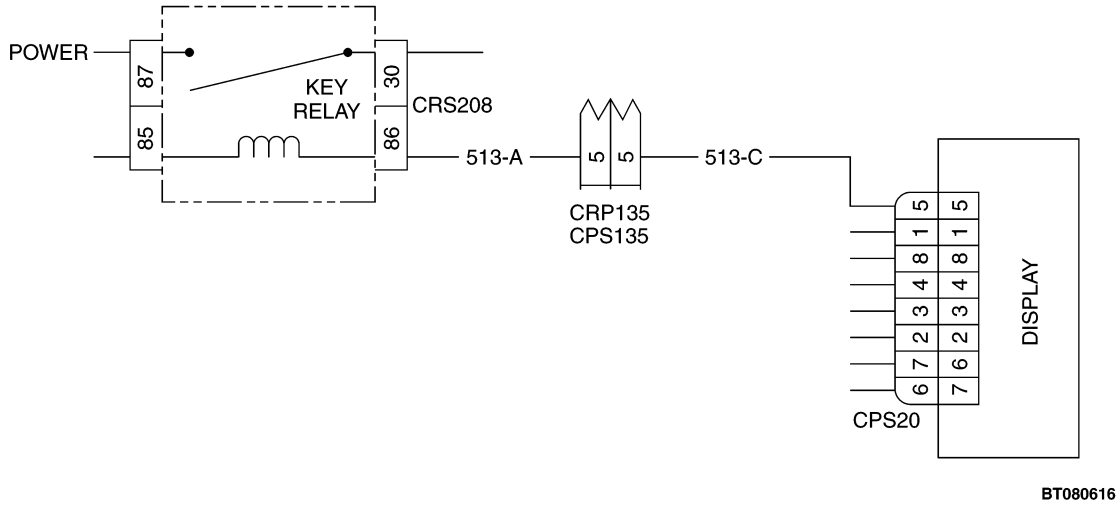

Figure 9030-10-47. Key Switch Relay Diagram

E-Hydraulic Enable Relay: This relay is available on lift trucks with E-Hydraulic option and is controlled by the VSM and gets activated whenever operators send input to VSM via E-Hydraulic input device. It provides 12V power to E-Hyd coils. See Figure 9030-10-48.

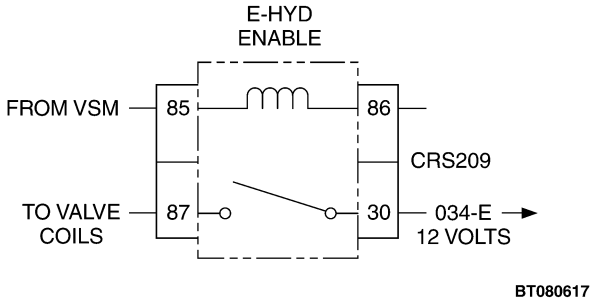

Figure 9030-10-48. E-Hyd Enable Relay Circuit

Backup Light Relay (Optional): This device is controlled by the VSM and gets activated after detecting the selection of reverse direction. See Figure 9030-10-49.

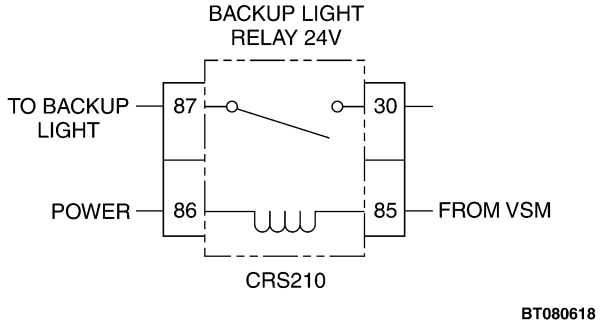

Figure 9030-10-49. Backup Light Relay Circuit

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Brake Light Relay (Optional): This is controlled by the VSM and gets activated after brake is applied. See Figure 9030-10-50.

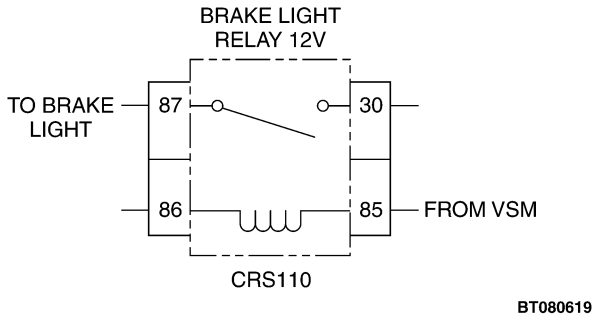

Figure 9030-10-50. Brake Light Relay Circuit

Motion Relay (Optional): This relay is activated via the user interface with supervisor password and energizes whenever lift truck is operational in any direction that is selected.

Operator Interface

Display

The display is the most important operator interface in the lift truck. The display is protected for reverse voltage up to -16 volts, short to 16 volts and battery negative, transients, ESD up to 8,000 volts and electromagnetic interference (EMI) up to 100 volts/meter. The display gets 12V power from VSM; also it is linked to VSM via CANbus. The Display has two controlled outputs: the Buzzer and the Key Switch Relay. The following Figure 9030-10-51 shows how display is connected into the system.

Upon turning on the Key or Keyless switch which is located on display, the key switch relay gets energized and in turn provides power to following components:

- Main Contactor Coil
- Supplementary Contactor Coil (if equipped)
- Traction Controller
- Pump Controller
- Park Brake Controller (if equipped)
- Park Brake Solenoid (if equipped)
- Manual Hydraulic Clamp Coil (if equipped)
- Manual Hydraulic Interlock/E-Hydraulic Enable Relay
- 5th Function Hydraulic Diverter Valve (if equipped)
- Reverse/Backup Light Relay (if equipped)
- Brake Light Relay (if equipped)
- Accessory Relays (if equipped)

After the key is switched on the display screen turns on all pixels and blackens the screen for ½ second. After performing the screen check the system will transition to one of the following screens:

- The Password screen if the Operator Passwords are enabled
- If Operator Passwords are not enabled then the system transitions to the Operator Checklist Screen if the Operator Checklist function is enabled and the system was not powered off through the auto-power down feature.
- If the Operator Checklist function is not enabled (or the system was last powered off through the auto-power off function) and the Operator Passwords function is not enabled then the system transitions to the Operating Screen.

The operating Screen displays several warning and information icons, these include:

- Performance Mode
- Seat Belt Warning
- Low Brake Fluid Warning
- Thermal Management
- Service Due (Optional)
- Direction/Park Brake Indicator
- Steer Angle (Optional)
- Time of Day
- Battery Charge
- Diagnostic Trouble Codes

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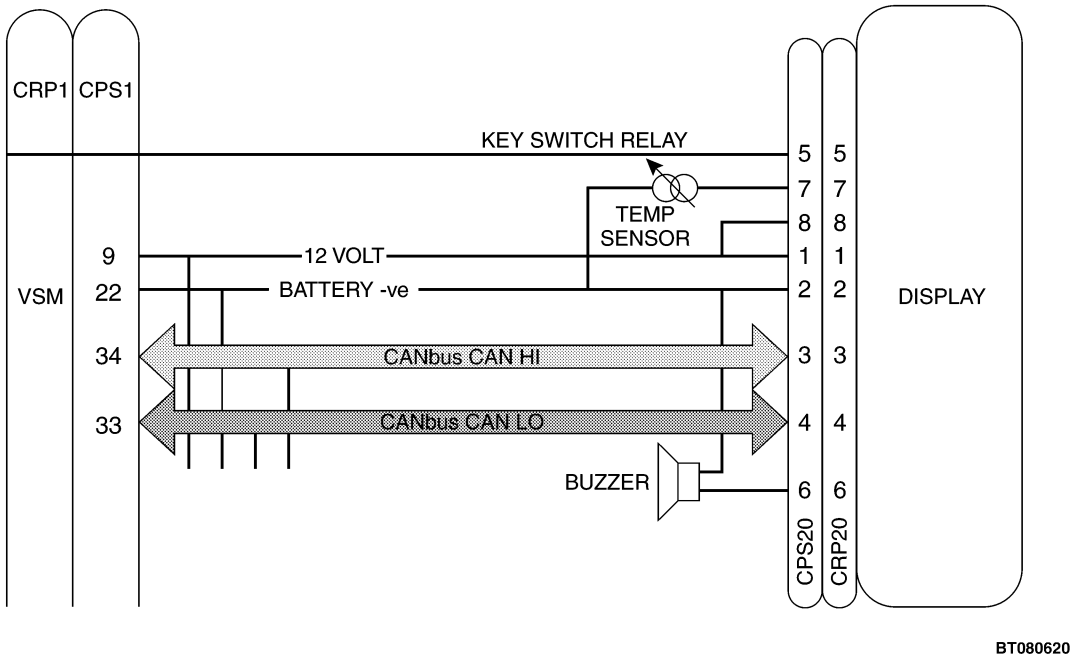


Figure 9030-10-51. Display CAN Connections

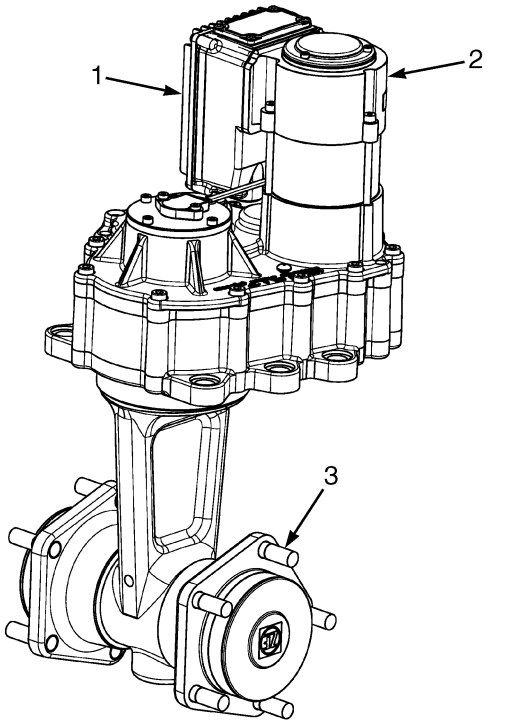
E-Steer

Description

There is no mechanical linkage or hydraulic hose between the steering wheel and the steer axle of the E-Steer system. A sensor driven by the steering wheel communicates operator input to the steer motor controller. The steer motor drives the steer axle in the direction and to the position commanded by the steer motor controller. Actual steer axle position feedback is input to the steer motor controller from the steer axle position sensor mounted on the steer motor. The E-Steer system uses this sensor to calibrate steer axle center point.

Steer Controller and Motor

The steer axle in the E-Steer system is driven by an AC induction motor coupled to the steer axle gearbox. The steer motor controller is mounted directly to the motor. The steer motor controller communicates to the VSM on the CANbus network..



1. STEER CONTROLLER
2. STEER MOTOR
3. STEER AXLE

Figure 9030-10-52. Steer Axle Assembly

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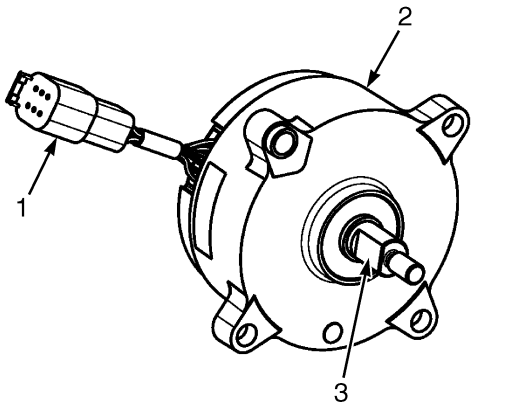
Position Sensor

The steer axle position sensor sends steer axle position feedback to the E-Steer motor controller. The steer axle position sensor is mounted on the steer motor.

TFD (Tactile Feedback Device)

The TFD steering unit provides bearing support, steering position sensing, communication, and variable resistive steering torque. The TFD, located below the steering wheel, senses operation by a hall-effect steering sensor and transmits the steering position to the steer controller. The steer controller uses proximity sensor input to determine the preferred steering response.

The operator will experience torque feedback in response to steering input. The TFD will simulate steer resistance by energizing a magnetically responsive material against a fixed stator. This material is a magneto rheological fluid, or MR fluid, providing a smooth and quiet steering feel.



1. TFD COIL CONNECTOR
2. TFD (TACTILE FEEDBACK DEVICE)
3. INPUT SHAFT

Figure 9030-10-53. TFD Assembly

Controllers

Vehicle System Manager (VSM):

1. The VSM is the Master Controller of the truck. It receives input from:
   - The Operator (Via Display)
   - Sensors
   - Controlled Devices
2. This allows the VSM to analyze, and determine the controls of most of the lift trucks electrically controlled functions. The VSM is also programmed to detect truck malfunctions and provide feedback to the operator and service technician in the form of:
   - Display Messages
   - Display Warning Icons
   - Audible Warnings
   - A Change in truck operations (Decelerate, Shutdown)
3. The VSM can be viewed as a box containing multiple inputs and outputs, see Table 9030-10-3.
4. Inputs are connected to:
   - Sensors
   - Switches
   - Control lines from other devices
   - Voltage supplies
5. Outputs are connected to:
   - Contactor
   - Relays
   - E-Hyd Valve coils
   - Lights
   - Solenoids
6. The VSM communicates to multiple devices over CAN:
   - Motor Controllers
   - Display
   - MLM
   - Impact Sensor
   - PCST

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Table 9030-10-3. VSM Connection

CPS1			CPS2		
Pin #	**Circuit Description**	**Signal**	**Pin #**	**Circuit Description**	**Signal**
1	Foot brake pressure	AI	1	Brake Light Relay	PWM
2	Hydraulic Temperature	AI	2	Battery -	P
3	Brake Fluid Level	AI	3		
4	Lift Pressure	AI	4	Aux 3 (Fifth Function) Diverter	PWM
5	Hydraulic Oil Level	AI	5	Manual Hydraulic Clamp	PWM
6	Manual Hydraulic #3	AI	6	Manual RTST Valve	PWM
7	Manual Hydraulic #1	AI	7	Hydraulic Enable	PWM
8	Steering Wheel Position	AI	8	Reverse Relay	PWM
9	12V Supply	LP	9	Motion Relay	PWM
10			10	Main Contactor	PWM
11			11	Battery - (if equipped) **E-Hydraulic Only**	P
12			12	Keyswitch Input	DI-H
13	Accelerator Pedal Pos A	AI	13	Synchronous Steering (if equipped) **E-Hydraulic Only**	PWM-C
14	Analog Return	LP	14	Tilt B (if equipped) **E-Hydraulic Only**	PWM-C
15	Tilt Position	AI	15	Tilt A (if equipped) **E-Hydraulic Only**	PWM-C
16	Steer Axle Position	AI	16	Lift (if equipped) **E-Hydraulic Only**	PWM-C
17	Analog Return	LP	17	Lower (if equipped) **E-Hydraulic Only**	PWM-C
18	Operator Presence Switch	AI	18		
19	Direction Select 2	AI	19	Aux 1A (if equipped) **E-Hydraulic Only**	PWM-C
20	Analog Return	LP	20	Aux 1B (if equipped) **E-Hydraulic Only**	PWM-C
21			21	Aux 2A (if equipped) **E-Hydraulic Only**	PWM-C
22	12V Return	LP	22	Aux 2B (if equipped) **E-Hydraulic Only**	PWM-C
23	Manual RTST Override Input	DI-L	23	E-Hydraulic Flyback (if equipped) **E-Hydraulic Only**	F
24	Park Brake Position	AI	24	Keyswitch Flyback	F

DI-L = Digital Input (Switch to B-); DI-H = Digital Input (Switch to B=); P= Power; PWM = Pulse Width Modulated Output; PWM-C = Pulse Width Modulated Output with Current Feedback; AI = Analog Input; QI = Quadrature Input; CAN = CAN Bus; F = Flyback; LP = Low Voltage Power

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Table 9030-10-3. VSM Connection (Continued)

CPS1			CPS2		
Pin #	**Circuit Description**	**Signal**	**Pin #**	**Circuit Description**	**Signal**
25	Lift Height Position	AI	25		
26	Manual Hydraulic #4	AI	26	Battery Gate	DI-L
27			27	Hydraulic Filter	DI-L
28	Manual Hydraulic #2	AI	28	Seatbelt Switch	DI-L
29	Direction Select 1	AI	29	Hydraulic Brake Pressure Switch	DI-L
30	Accelerator Pedal Pos B	AI	30	Traction/Hydraulic Enable	DI-L
31	5V Supply	LP	31	Speed Limit Override	DI-L
32	5V Supply	LP	32	Manual Hydraulic Clamp Switch	DI-L
33	CAN Low	CAN	33	Supplementary Contactor	PWM
34	CAN High	CAN	34	Switch Return	LP
35			35	Battery +	P

DI-L = Digital Input (Switch to B-); DI-H = Digital Input (Switch to B=); P= Power; PWM = Pulse Width Modulated Output; PWM-C = Pulse Width Modulated Output with Current Feedback; AI = Analog Input; QI = Quadrature Input; CAN = CAN Bus; F = Flyback; LP = Low Voltage Power

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Motor Controller

The traction and Hydraulic pump motor controllers have been separated and provide power and control signals to their respective motors.

Traction Motor Controller: Each traction motor is controlled by a separate controller which gets its power from the battery and provides power and control signals to the motor. The controller is also connected by CANbus to VSM which monitors various operating parameters of the motor. Both speed and winding temperature are monitored and adjusted to provide optimum performance.

The accelerator pedal, directional switch, and brake pressure sensor signals to the VSM which are sent by CAN to the motor controllers to provide speed, and directional control. In addition to this motor winding temperature and speed are inputs to the controllers. The diagram below shows interconnection between a traction motor and its controller. See Figure 9030-10-54.

Hydraulic Pump Motor Controller: This motor is controlled by a separate controller, which gets its power from the battery and provides power and control signals to the hydraulic pump motor. In addition to the controller the VSM oversees motor configuration and monitoring responsibilities to ensure the motor runs within given operating parameters. Both speed and winding temperature are monitored and adjusted to provide optimum performance. The following diagram shows interconnection between pump motor and its controller.

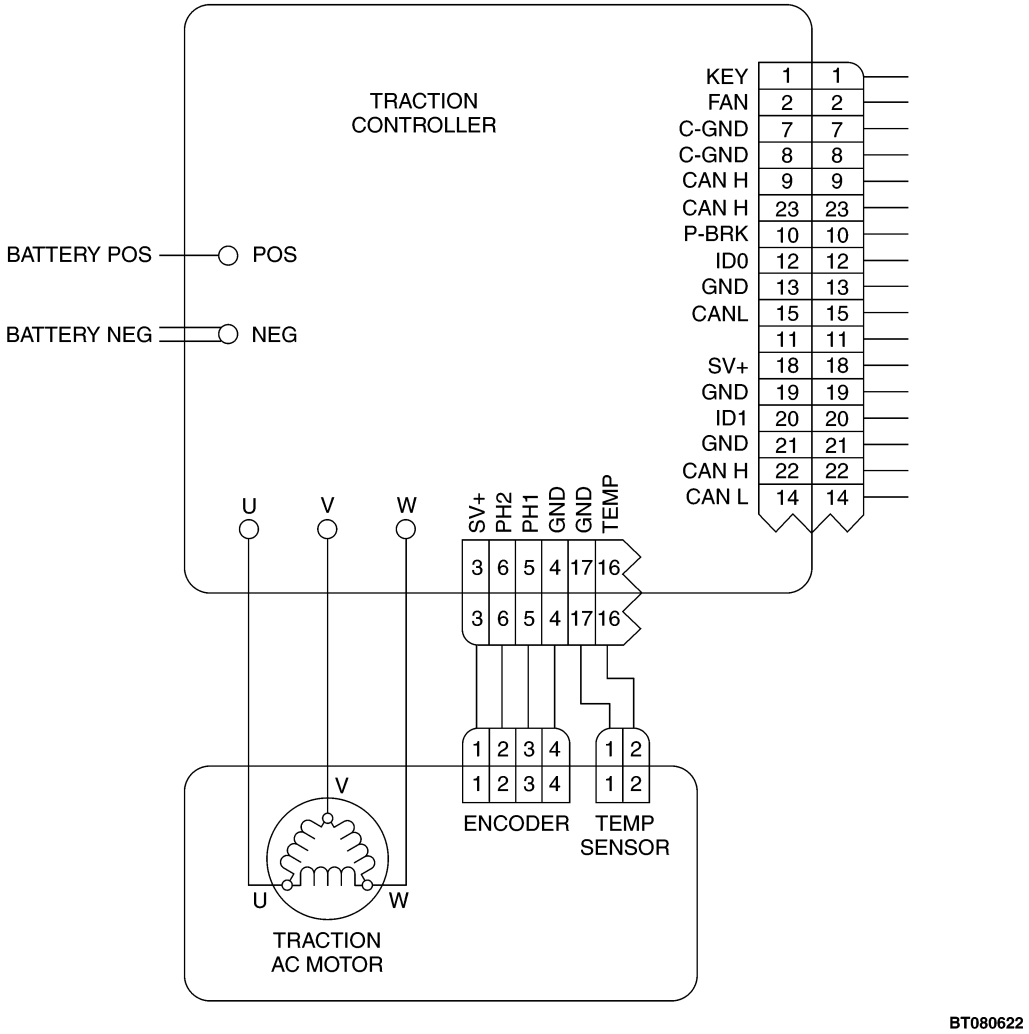

Figure 9030-10-54. Traction Motor and Controller Connections

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Inputs from the hydraulic control valves go to the VSM which then communicate what required flow is needed to meet the requested function. This is communicated over the CAN to the controller to provide the needed motor speed for a given hydraulic flow. The diagram below shows interconnection between pump motor and its controller. See Figure 9030-10-55.

E-Hydraulics Mini Levers Module (MLM)

The E-Hydraulic mini lever module is a controller assembly that includes operator input levers and button(s).

These levers and buttons provide analog and digital inputs to the E-Hydraulic input device. The E-Hydraulic input device then formats the information into a predefined protocol and broadcasts the operator inputs to the VSM via the CANbus. Inputs from the hydraulic control valves go to the VSM which communicate what required flow is needed to meet the requested function. This is communicated over the CANbus to the pump controller to provide the needed pump motor speed.

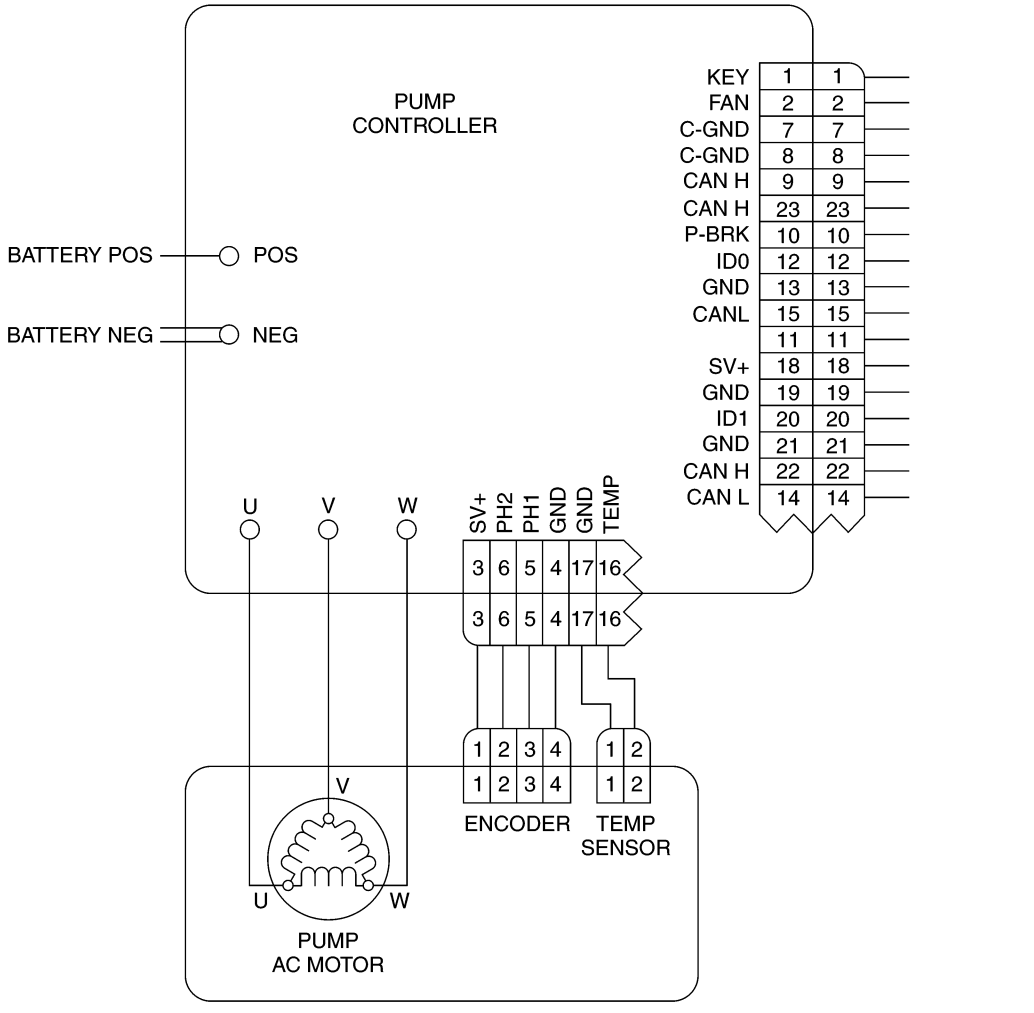

Figure 9030-10-55. Hydraulic Pump Motor and Controller Connections

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PRINCIPLES OF OPERATION, SYSTEM

Battery (Plug-In)

The power is supplied to the system after connecting the battery. The following components are connected to the battery voltage

- The primary and auxiliary DC/DC converter which in turn provides 12V power to components to which they are connected
- The VSM which in turn provides 12V power to display and E-Hydraulics Mini Levers Module (MLM)
- Various relays and contactor
- The motor controllers are only connected to the battery after the key is turned on. The system is powered to an non-operational state until the operator turns on the key.

Key ON and Operation

When the key or keyless switch is turned **ON**, the display wakes up and initiates the power up sequence, as mentioned in Operator Interface. The VSM is programmed and wired to detect certain conditions before allowing the vehicle to be started.

1. Interlocks:
    - Operator presence in the seat
    - Accelerator pedal in released position
    - All hydraulic controls must be in neutral state
    - Battery gate switch closed (If applicable)
    - No other operational faults
2. Upon satisfying above mentioned parameters the following events take place:
    - Contactor closes and provides power to the system
    - Motor controllers become operational
    - Hydraulic system becomes operational and begin to give hydraulic steering flow

Sensors

The sensors are divided into 5 functional groups. Most are supplied from a VSM 5 volt sources. The exception is the ultrasonic hydraulic level sensor which operates on 12 volts. If a sensor signal falls below or exceeds programmed values, a failure condition or a warning will be given to the operator.

The functional groups are:

1. Speed (Hall Sensor Technology):
    - Pump motor
    - Traction motor
2. Pressure :
    - Service Brake Pressure
    - Mast Pressure
3. Position - Rotary and Linear:
    - Park brake
    - Accelerator Pedal Position
    - Operator presence
    - Return To Set Tilt (Tilt Position)
    - Mast height (Optional)
    - Manual hydraulic spool position
    - Steer wheel
    - Steer axle (Optional)
    - Direction control selector
4. Temperature:
    - Traction motor
    - Pump motor
    - Hydraulic oil (Optional)
    - Display temperature (Optional)
5. Level/Miscellaneous:
    - Hydraulic filter (Optional)
    - Hydraulic oil level
    - Impact sensor

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These functional groups have common signal output characteristics:

1. Speed (4-wire devices):
    - Operating voltage = 12 Volts
    - Variable frequency (Zero to Max speed)
2. Pressure and Position (3-wire devices):
    - Operating voltage = 5 Volts
    - Variable output voltage, 0.5 volts to 4.5 volts, Zero to Full scale
3. Temperature (2-wire device):
    - Operating voltage = 5 Volts
    - Variable resistance, NTC (Increase in temperature results in decrease of resistance)
4. Level/Miscellaneous:
    - Ultrasonic
    - Reed Switch

Sensor Operation Technology

1. Hall Effect (Position): This technology uses a sensor that can detect the strength of a magnetic field or in case of rotation, the angle of the magnetic field in relative to the sensor. Moving the magnet closer or further away from the sensor varies the output voltage. For rotation the output varies based on magnetic field angle.
2. Hall Effect (Speed): This uses the same principle as described in the position sensor but uses the presence and absence of gear teeth to change the strength of the magnetic field. This causes a variable voltage that is used to operate a transistor switch output providing a pulse train that is proportional to speed.
3. Pressure: These devices use a strain gauge or capacitive sense element that generates a microvolt signal which is proportional to the pressure applied. This signal is amplified to provide an output voltage that varies between 0.5 and 4.5 Vdc in proportion to pressure changing from zero to maximum. The output is the same irrespective of the different application pressure ranges of the sensors.
4. Temperature: These devices have the same Negative Temperature Coefficient (NTC) Thermistor element in different packages. Heating of this element changes the element resistance. Higher temperature = Lower Resistance. These sensors are connected in series with a pull up resistor connected to 5 volts. The other end of the sensor is connected to Battery negative, effectively forming a variable voltage divider that the VSM can read and then interpret as a temperature reading.
5. Ultrasonic: This device uses ultrasonic waves which radiate out until they hit an object and return. The time of the cycle determines the distance and/or level. See **Diagrams** 8000SRM1528.

Switches

The switches are used for following applications:

- Hydraulic filter pressure
- Battery gate
- Clamp solenoid

Depending on your lift truck and further information pertaining to switches and schematics, see **Diagrams** 8000SRM1341 or **Diagrams** 8000SRM1384.

Outputs

Relays

1. ON/OFF Operation

2. Programmed for a specific maximum current

3. The following faults are detectable
    - Short to Battery
    - Short to Ground
    - Open circuit

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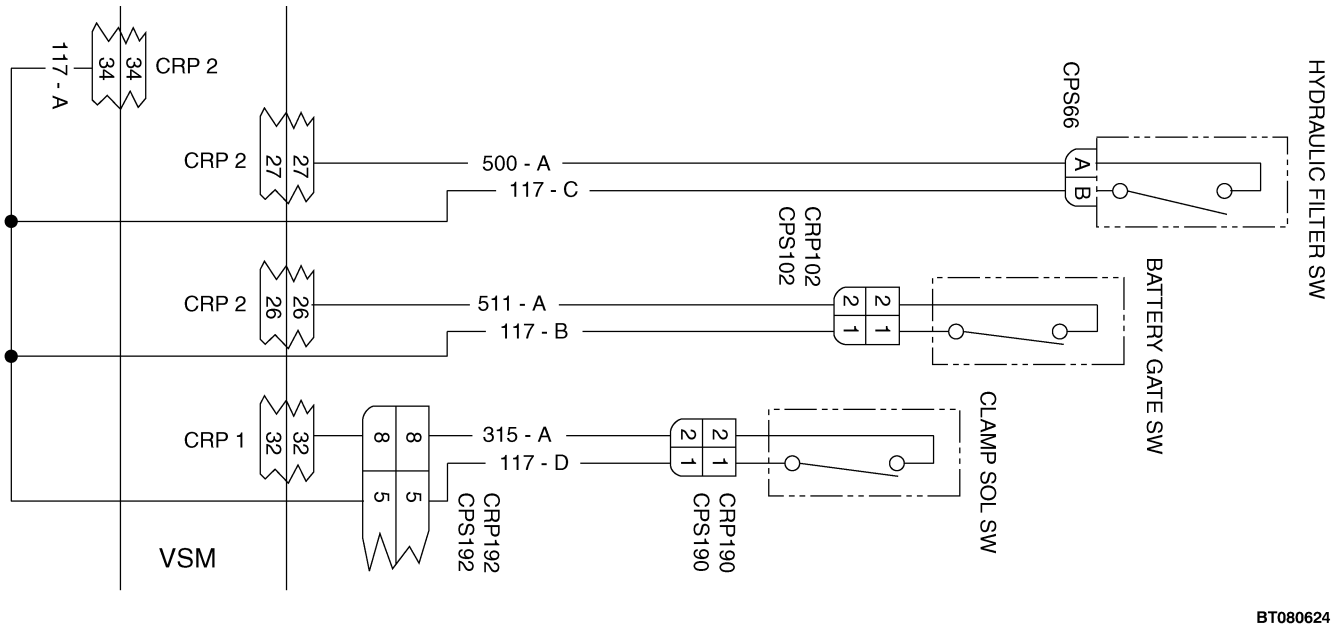

Figure 9030-10-56. Switch Connections

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Table 9030-10-4. Motor Temperature Sensor

(°C)	(°F)	Nominal Resistance (?)
-40	-40	359
-30	-22	391
-20	-4	424
-10	14	460
0	32	498
10	50	538
20	68	581
30	86	626
40	104	672
50	122	722
60	140	773
70	158	826
80	176	882
90	194	940
100	212	1000
110	230	1062
120	248	1127
130	266	1194
140	284	1262
150	302	1334
160	320	1407
170	338	1482
180	356	1560
190	374	1640
200	392	1722
NOTE: Measured resistance should be within ±5% of specified Nominal Resistance (?)		

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E-Hydraulic Valve

1. Valve coil is controlled in following manner

a. Pulse Width Modulated (PWM) signal controls the valve opening, and therefore flow. (Higher duty cycle results in higher fluid flow).

b. Each E-Hydraulics valve is independently controlled and current monitored

c. The following faults are detectable:

- Short to Battery
- Short to Ground
- Open circuit
- Current above or below normal

2. Hydraulics operation is also disabled for the following conditions:

a. Operator presence in seat is not detected

b. Circuit Failures in Valve Wiring/ Connectors/ Valve coils and Valve coil drivers. See Figure 9030-10-57.

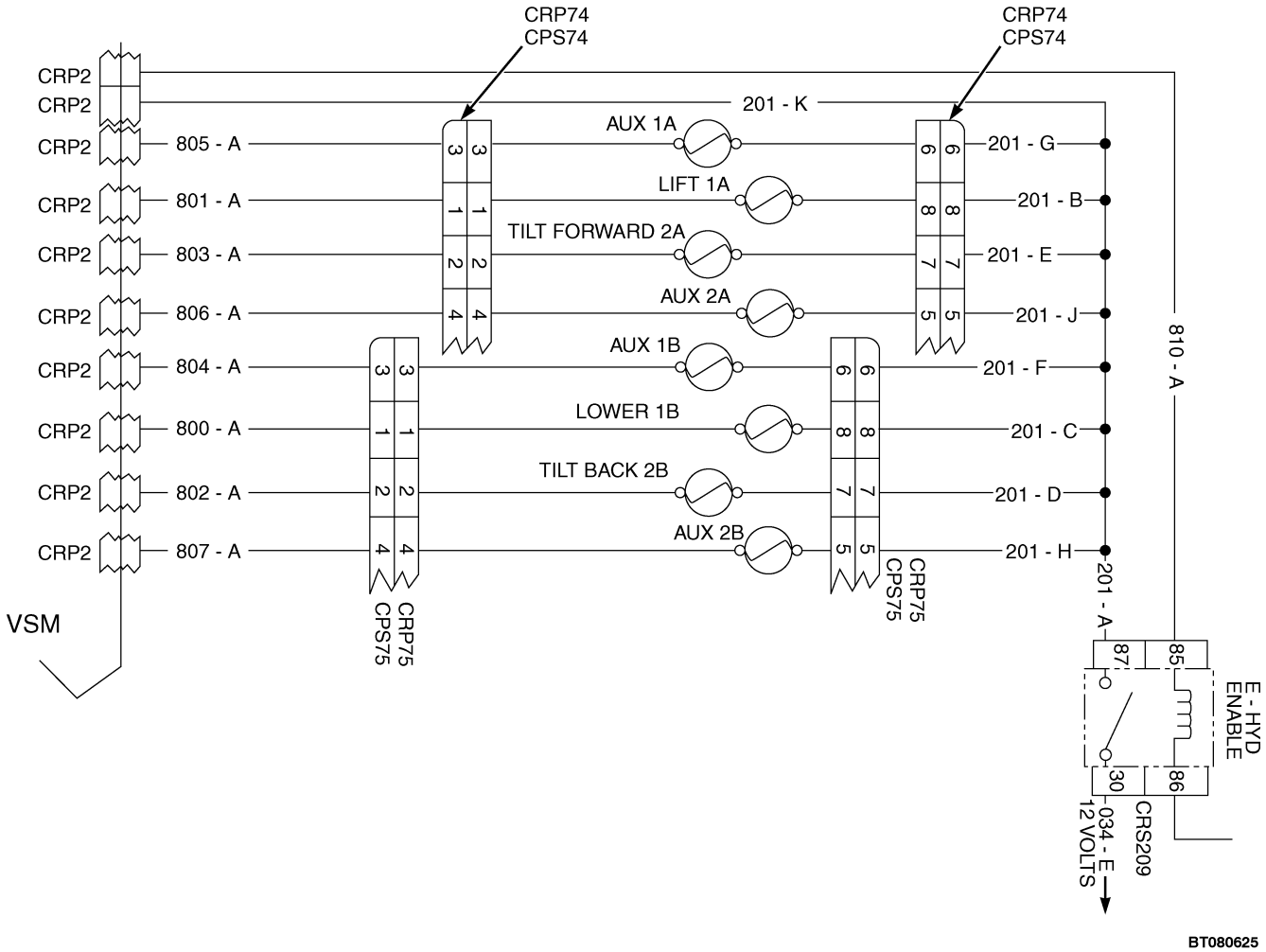

Figure 9030-10-57. Hydraulic Valve Coil Diagram

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Cab Devices

All CAB devices are operated from unswitched or switched battery circuits using the device's own ON/OFF switches

- Front/Rear Wiper
- Washer
- Cab light
- Cab Heater

Lights and Backup Alarm

1. Tail Light/Front Work Lights

a. The Tail light/front work lights can be turned ON or OFF by using a switch which is located on Dash panel. See Figure 9030-10-58.

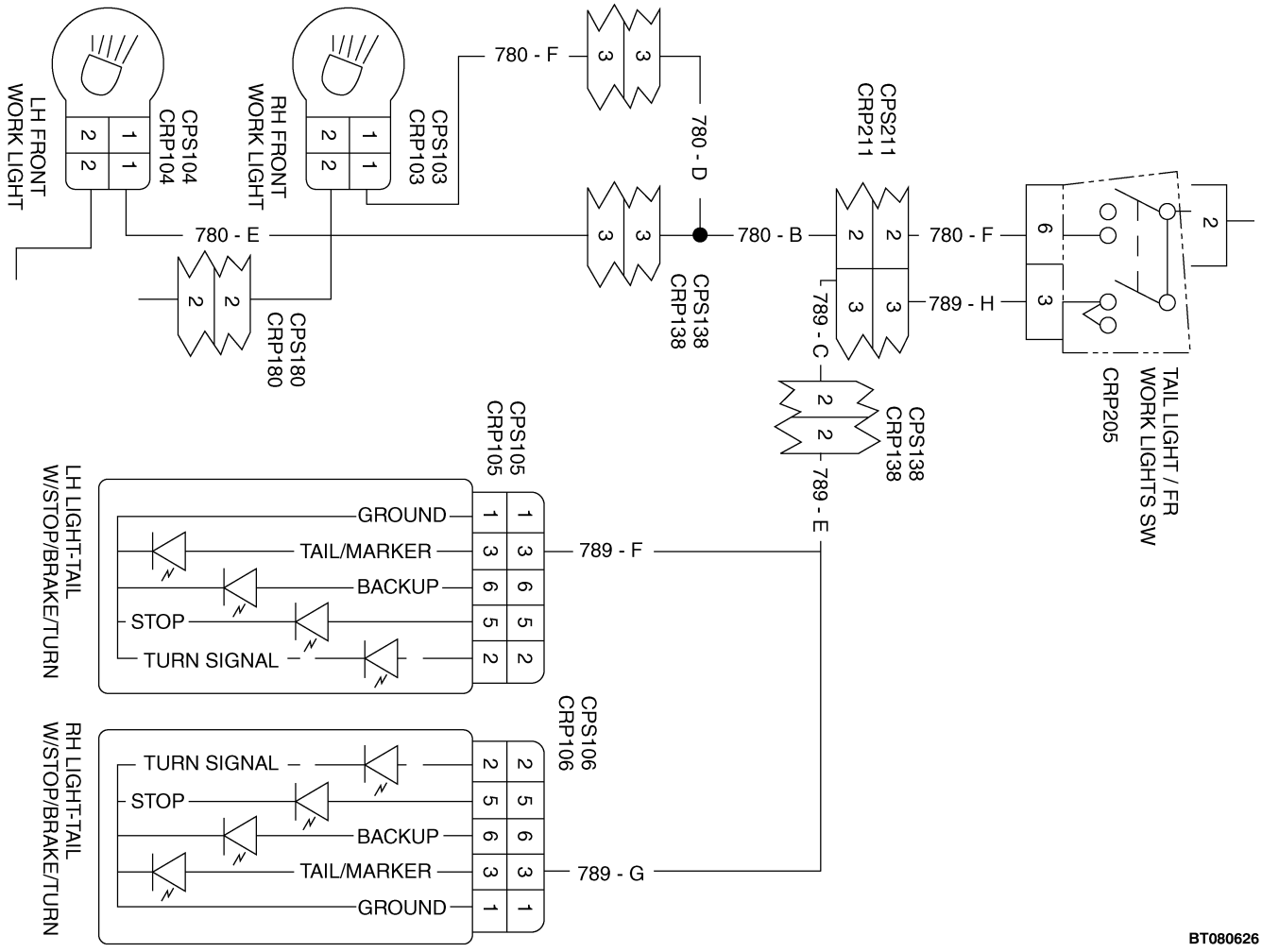

Figure 9030-10-58. Work/Marker Lights Diagram

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2. Rear Work Lights

a. The rear work lights can be turned ON or OFF by using switch which is located on Dash panel or automatically controlled by the reverse relay. See Figure 9030-10-59.

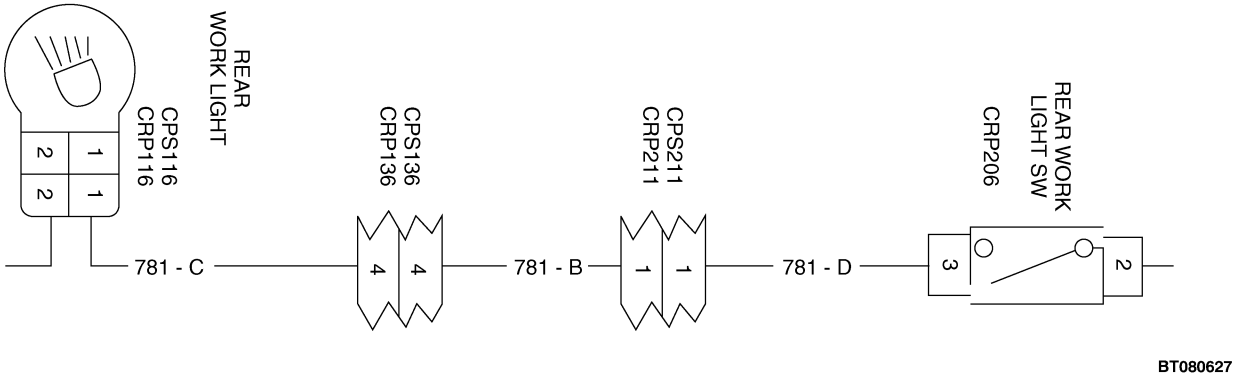

Figure 9030-10-59. Rear Work Lights Diagram

3. Strobe Light

a. The Strobe light becomes operational whenever key switch relay is turned on. See Figure 9030-10-60.

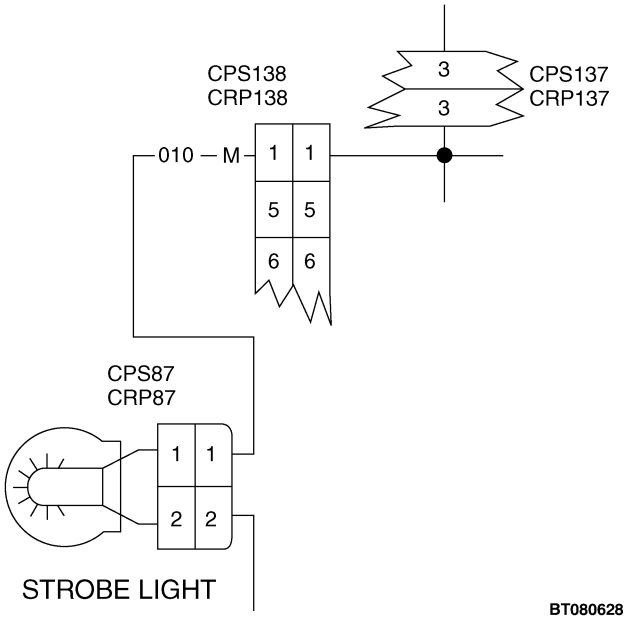

Figure 9030-10-60. Strobe Light Diagram

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4. Backup Light and Alarm

a. The Backup light and Alarm are controlled by the VSM detecting the selection of reverse direction. The circuit is designed to allow a customer to connect their desired audible warning device. See Figure 9030-10-61.

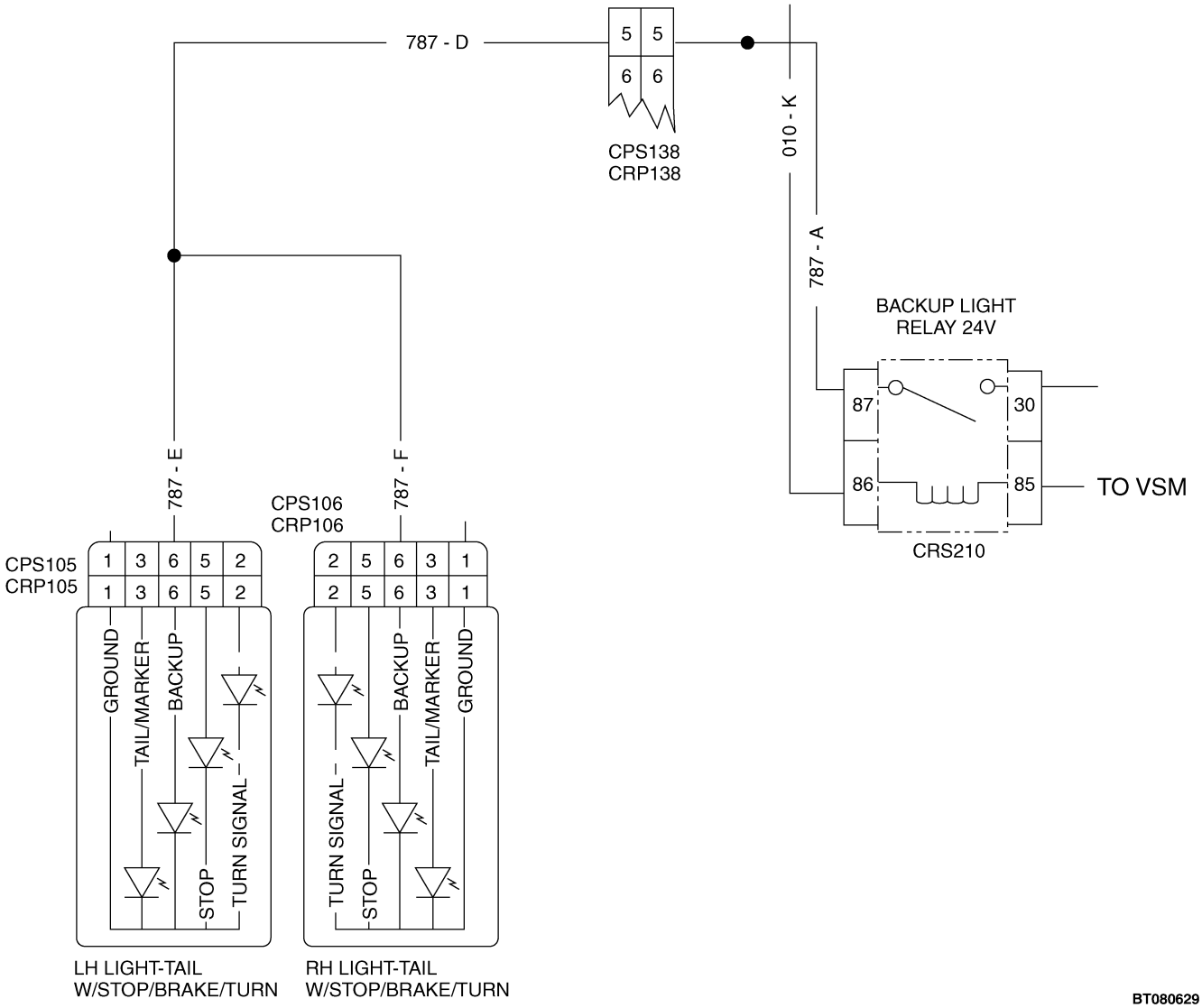

Figure 9030-10-61. Backup Light Diagram

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5. Brake Light

a. This light is controlled by the VSM detecting the pressure in the brake pressure sensor when the brake is applied. See Figure 9030-10-62.

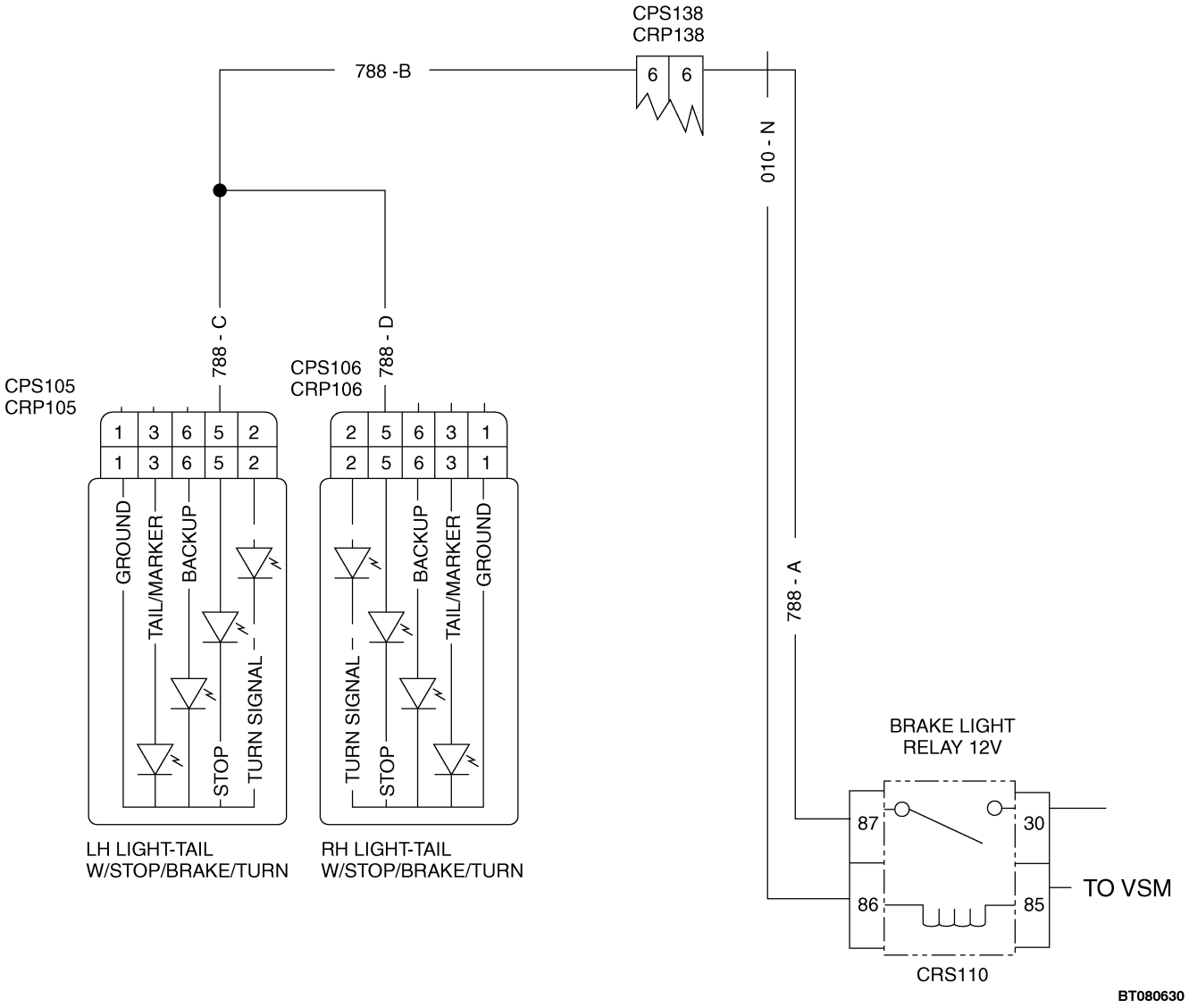

Figure 9030-10-62. Brake Light Diagram

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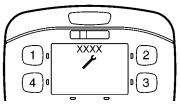
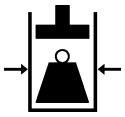
Group 20

Diagnostic Trouble Codes

Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL)

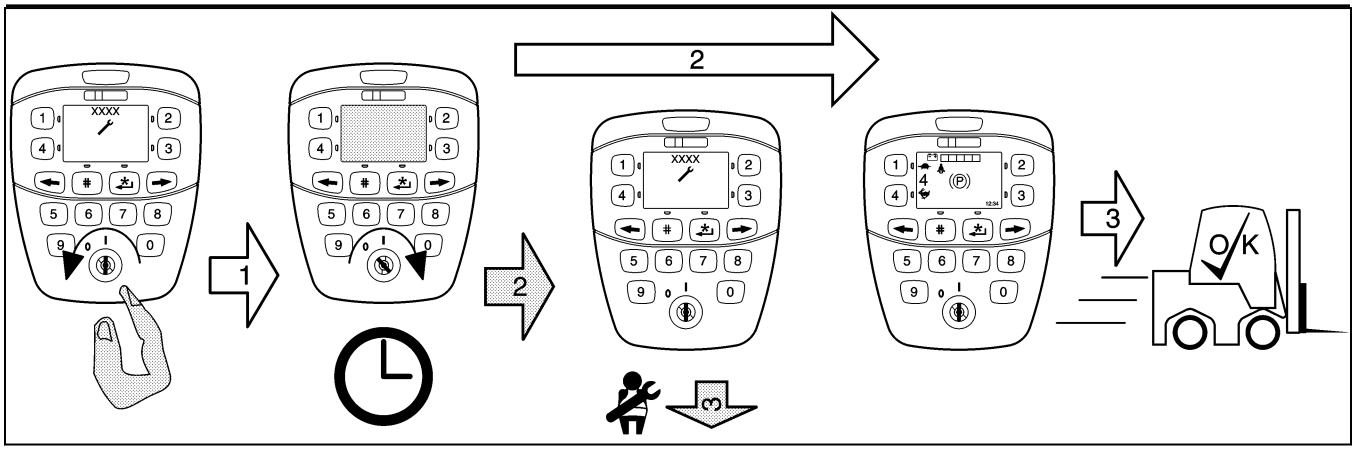


Fault Codes



DTC 12844 Load Weigh Pressure

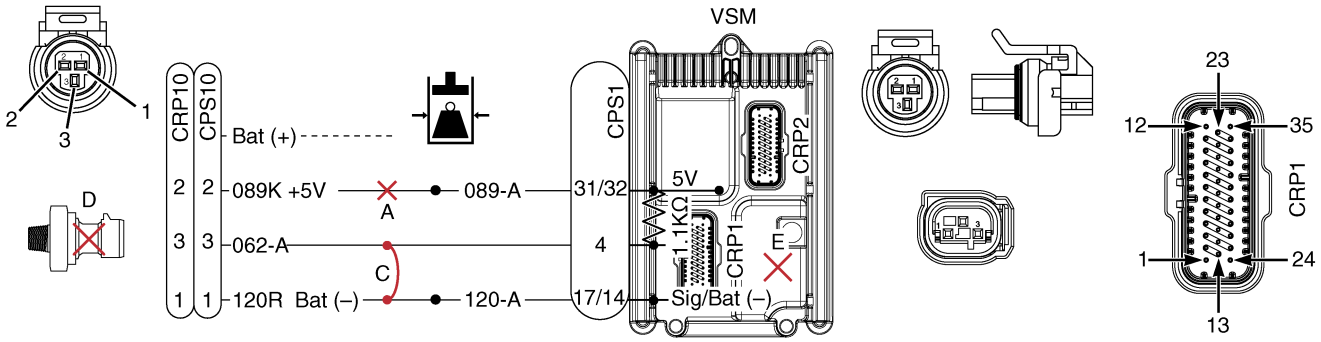
DTC 12836 Service Brake Pressure



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

LOAD WEIGH PRESSURE CAUSES A B C D E > ?



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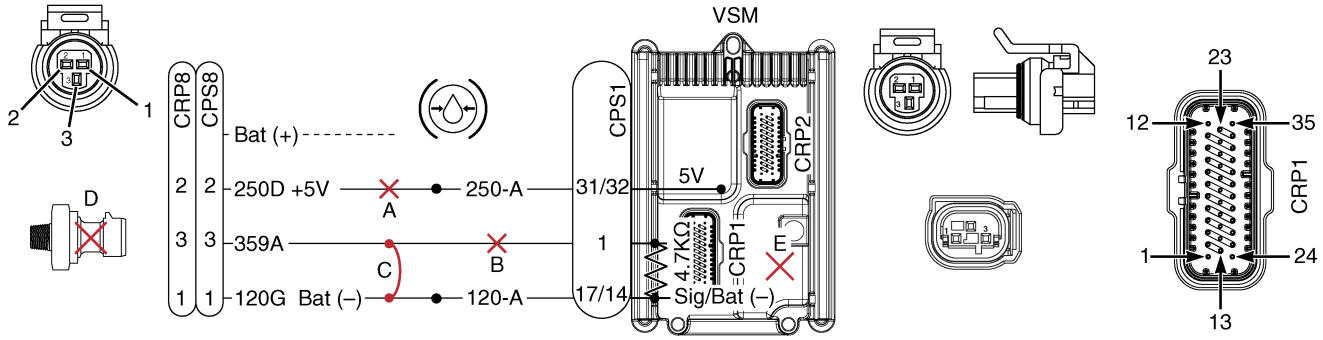
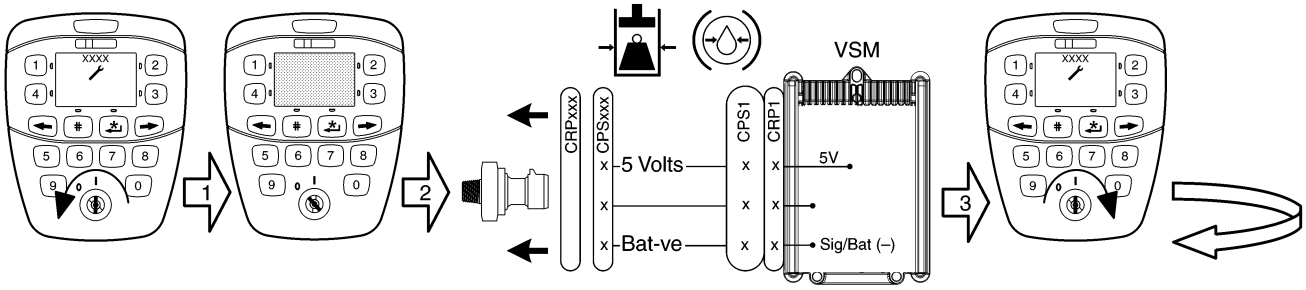
Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL) (Cont)

SERVICE BRAKE PRESSURE CAUSES A B C D E > ?



CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ ?

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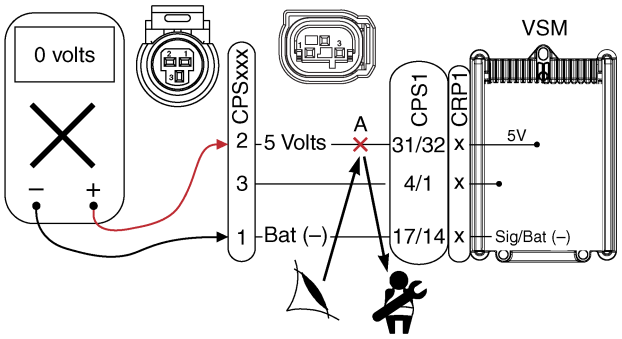
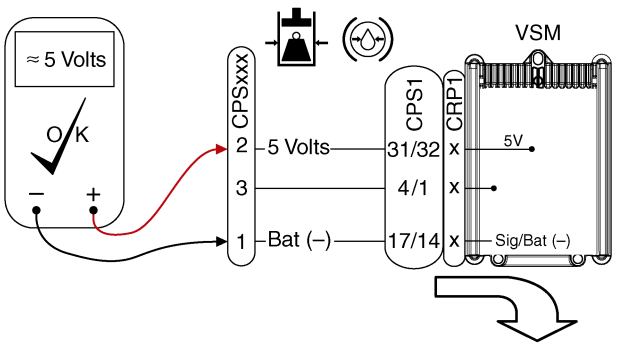
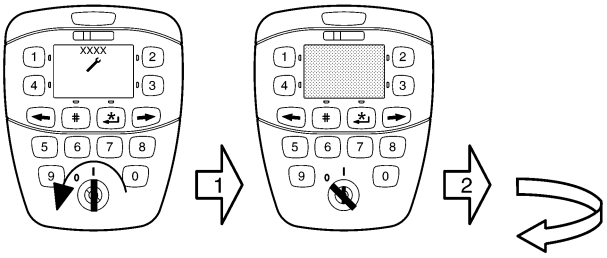
Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL) (Cont)

CAUSE A1 CHECK VOLTAGE



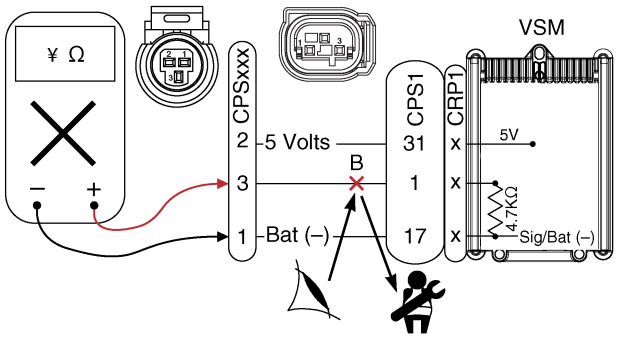


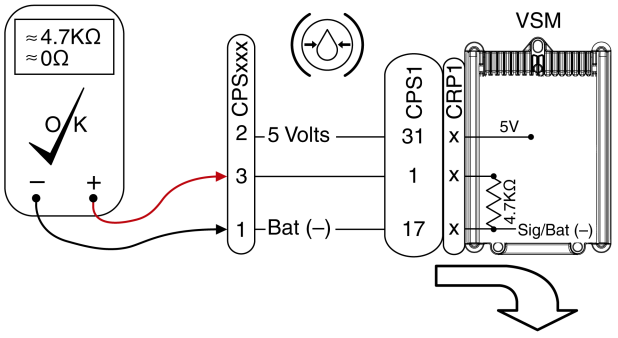
0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts =	**OK** For Service Brake Pressure, go to Component Operational Check.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		For Load Weigh Pressure, go to Component Operational Check.



Power **OFF**→ ?

CAUSE B CHECK RESISTANCE - Ω - OHMS





8 ? = Open circuit→ Find↑ **OPEN** circuit	˜ 4.7K? =	**OK** Go to Component Operational Check.
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? =	?

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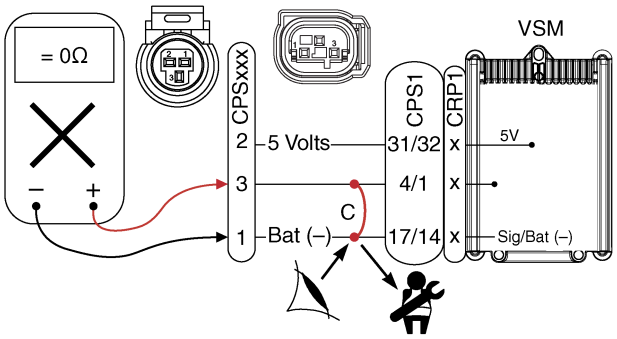
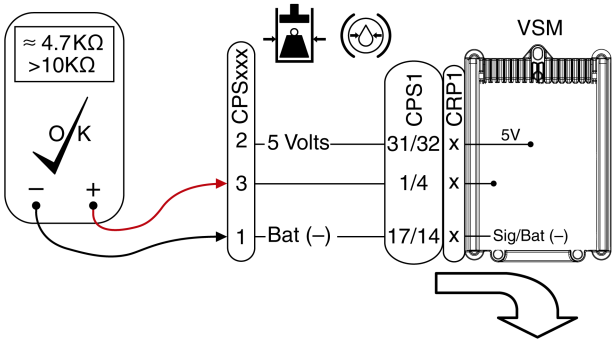
Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL) (Cont)

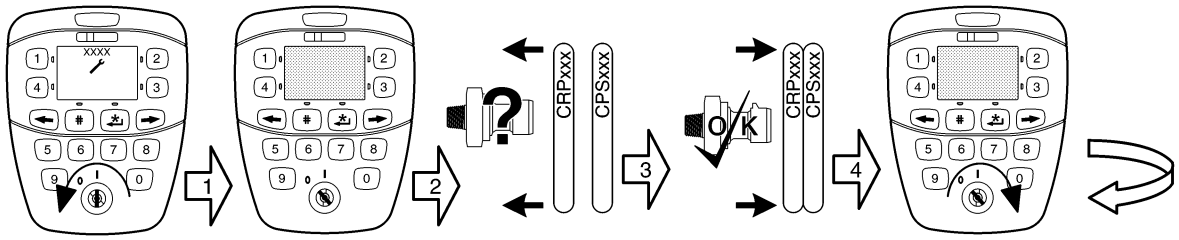
CAUSE C **CHECK RESISTANCE - Ω - OHMS**



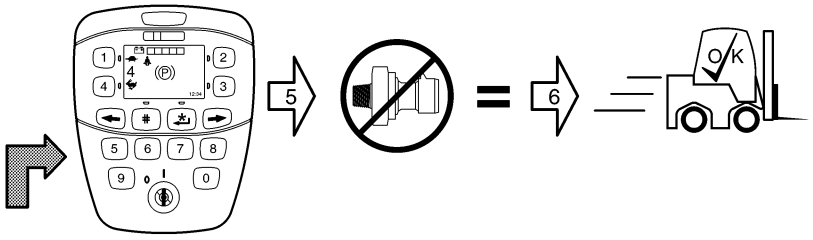


= 0 ? = Short circuit→ Find↑ **Short** circuit	˜ 4.7K? = **OK** For Service Brake Pressure, ?
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	> 10K? = **OK** For Load Weigh Pressure, ?

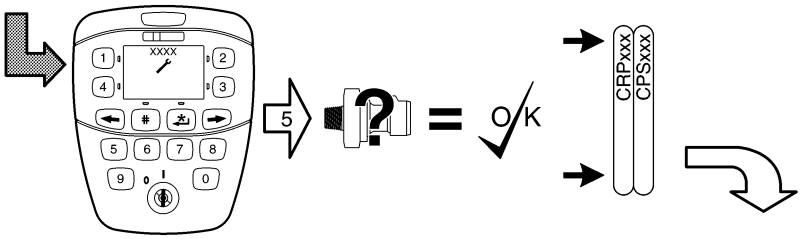
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ ?



? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ ?

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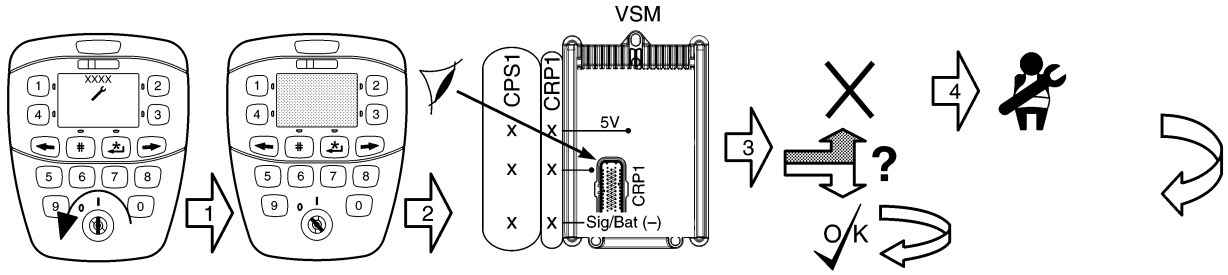
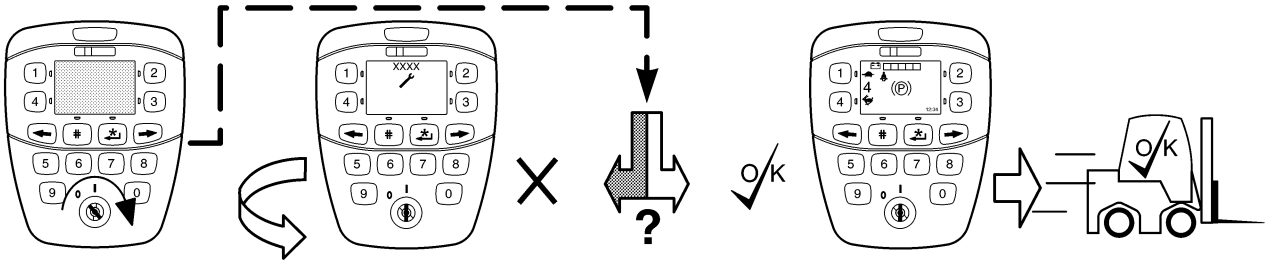
Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ ?

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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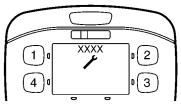
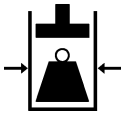
Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH)

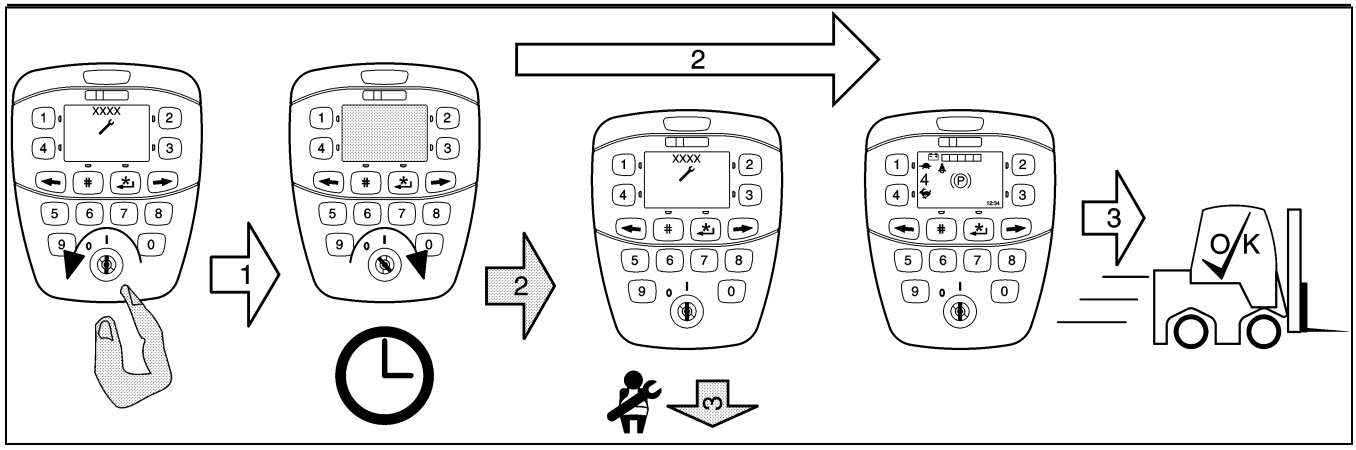


Fault Codes



DTC 12845 Load Weigh Pressure

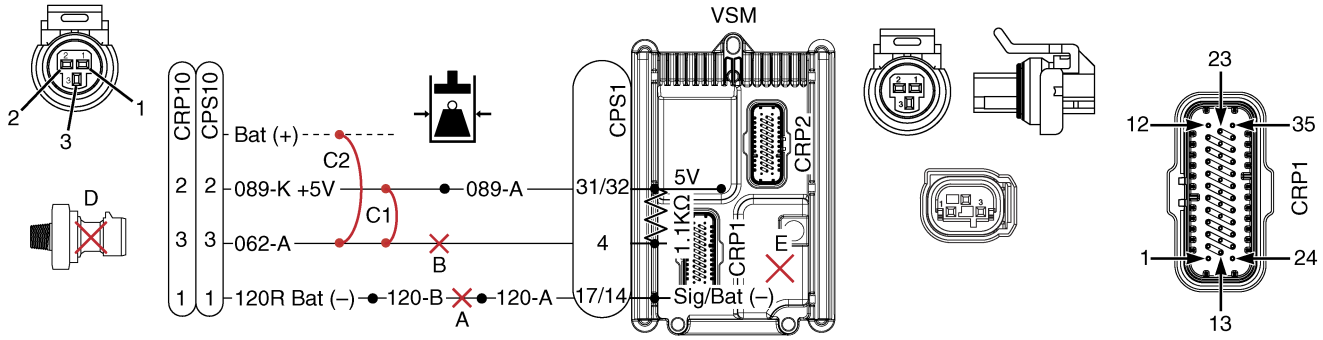
DTC 12837 Service Brake Pressure



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

LOAD WEIGH PRESSURE CAUSES A B C C1 C2 D E > ?



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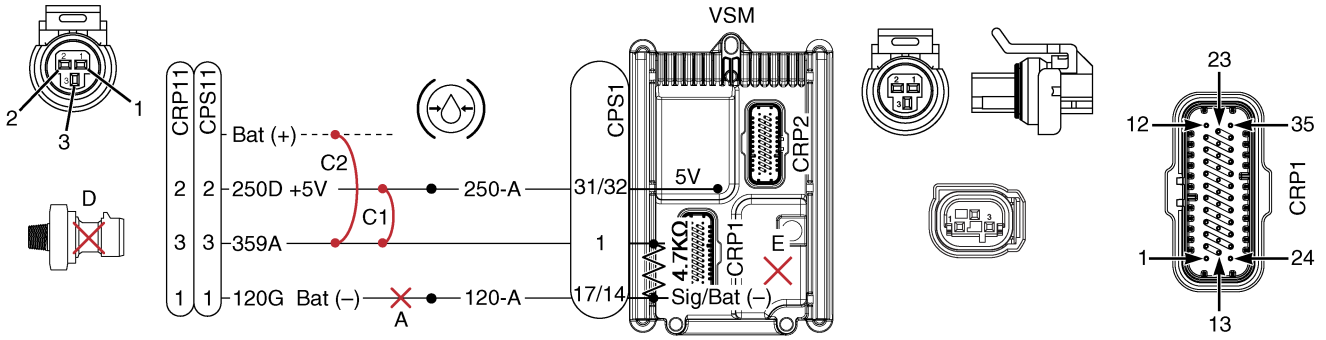
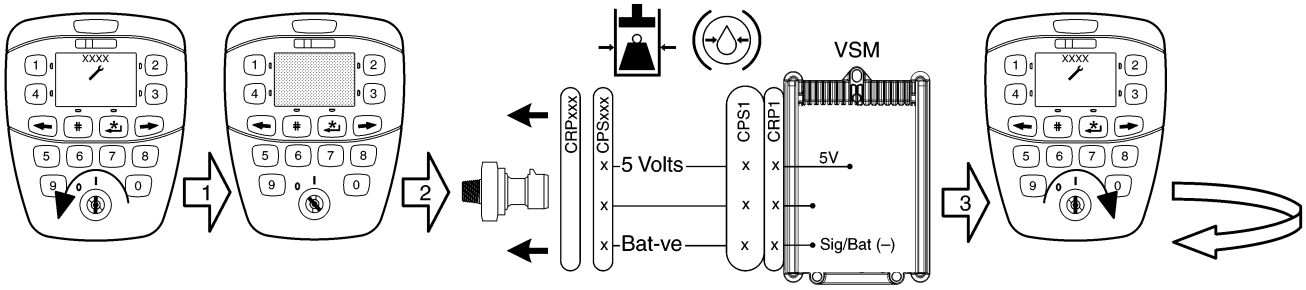
Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH) (Cont)

SERVICE BRAKE PRESSURE CAUSES A B C C1 C2 D E > ?

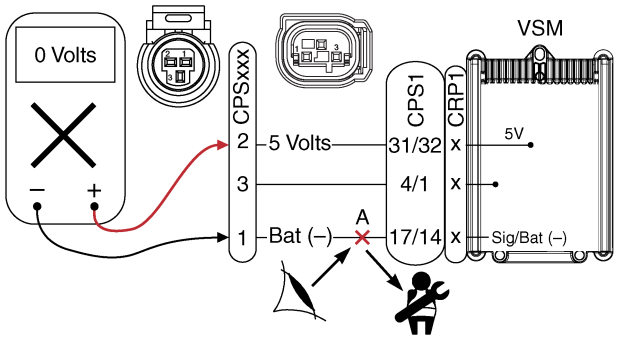


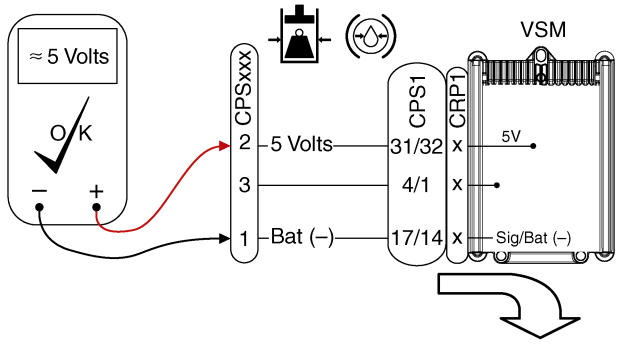
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ ?

CAUSE A1 CHECK VOLTAGE





0 Volts = Open circuit→ Find↑ **OPEN** circuit.	~ 5 Volts =	**OK** For Load Weigh Pressure, go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		For Service Brake Pressure, go to Component Operational Check

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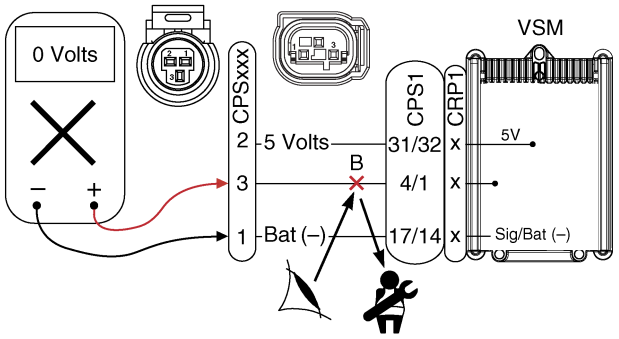
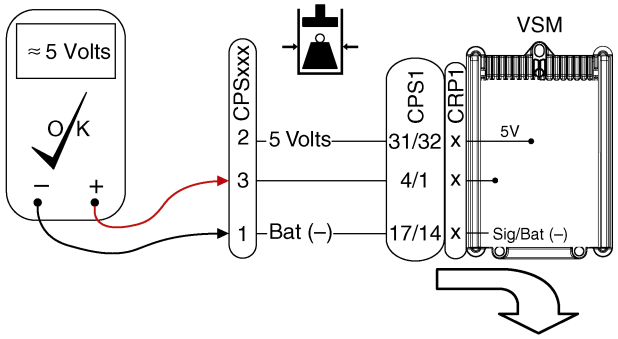
Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH) (Cont)

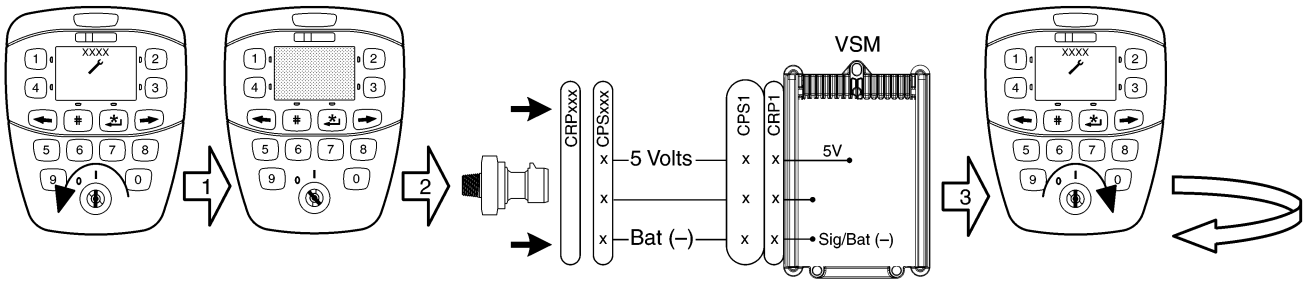
CAUSE B — CHECK VOLTAGE





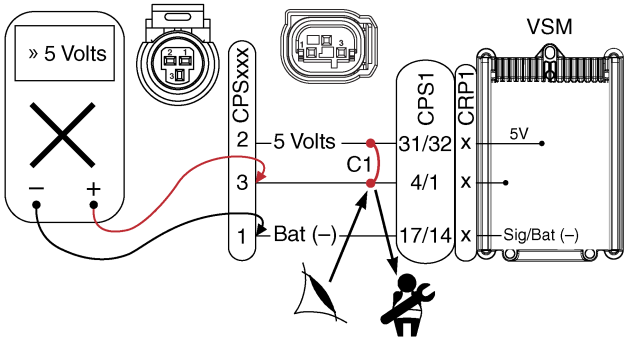
0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

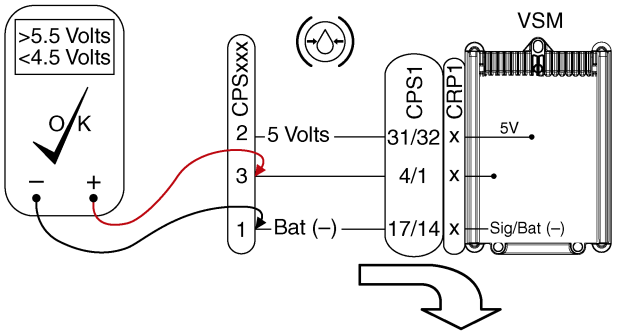
CAUSE C



Power **OFF**→ Reconnect sensor→ Power **ON**→ ?

CAUSE C1 — CHECK VOLTAGE





˜ 5 Volts = Short circuit→ Find↑ **Short** circuit.	> 5.5 volts Go to Cause C2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts OK = Go to Component Operational Check

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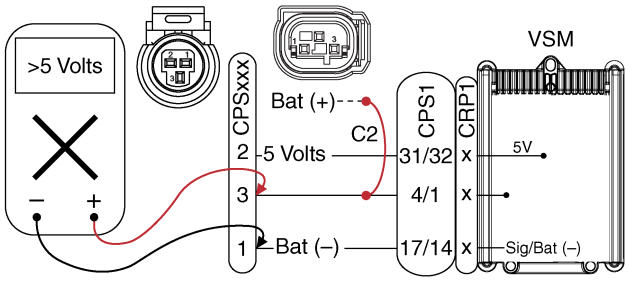
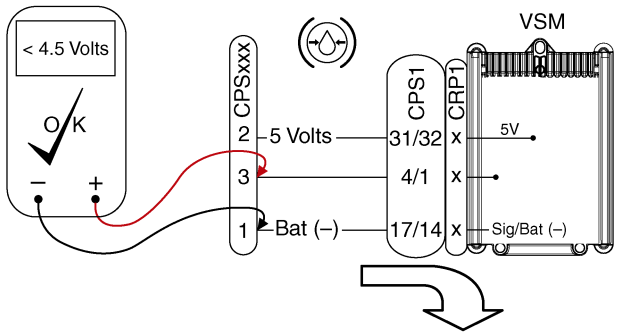
Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH) (Cont)

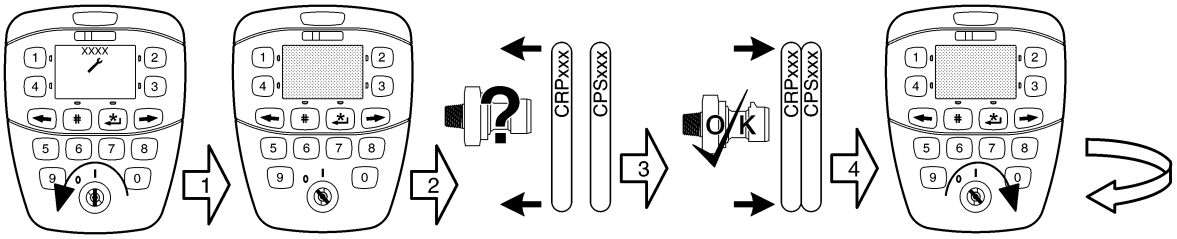
CAUSE C2 CHECK VOLTAGE



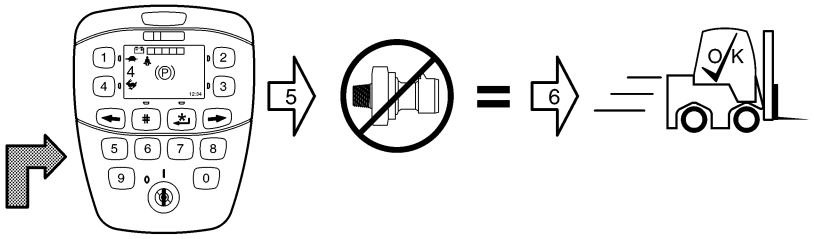


> 5.5 volts = Short circuit→ Find↑ **Short** circuit to another voltage source.	< 4.5 volts =	**OK** Go to Component Operational Check.
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

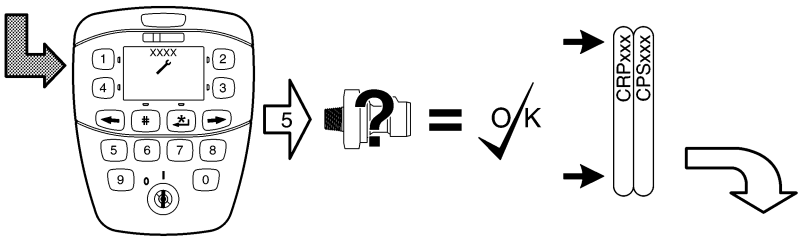
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ ?



? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

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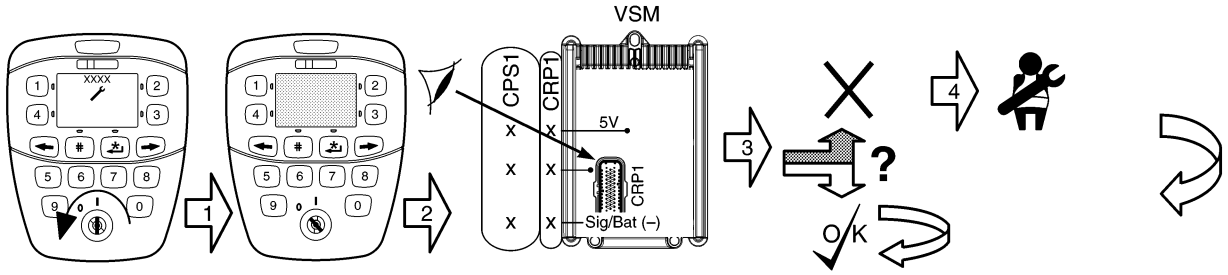
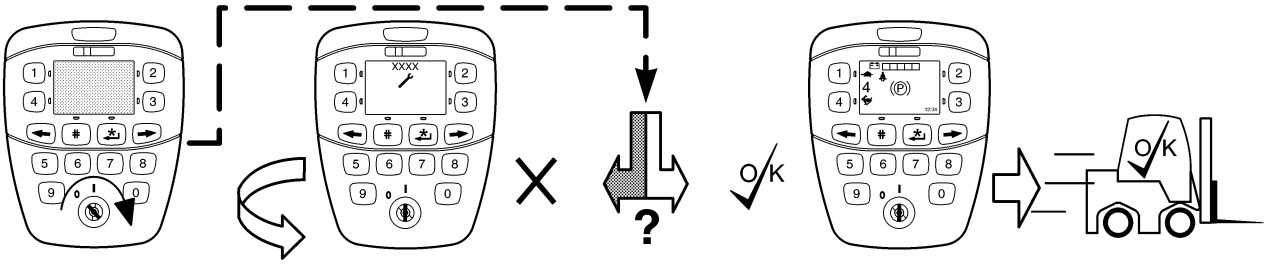
Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH) (Cont)

CAUSE E



Power **OFF**→ | Inspect VSM Connections→ | Go to Cause E1. | Not OK Correct/ Repair→ Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ | **NO** → Go to VSM Controller Check | Is fault DTC gone? | Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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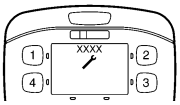
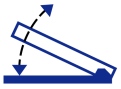
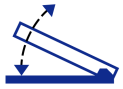
Accelerator Pedal Position A/B Out of Range Low (OORL)



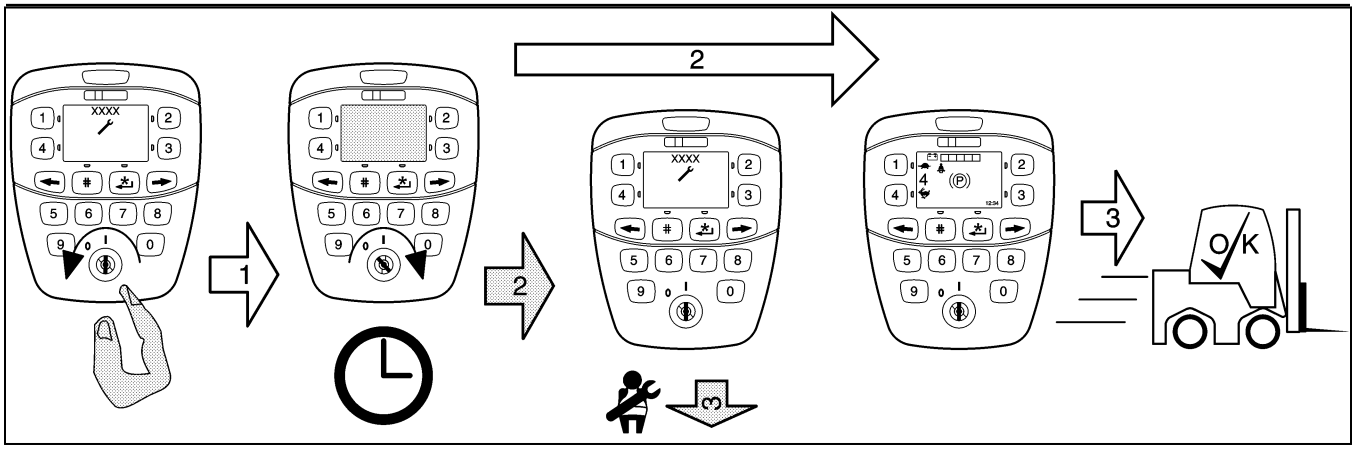
Fault Codes



DTC 12808
Accelerator Pedal Position A



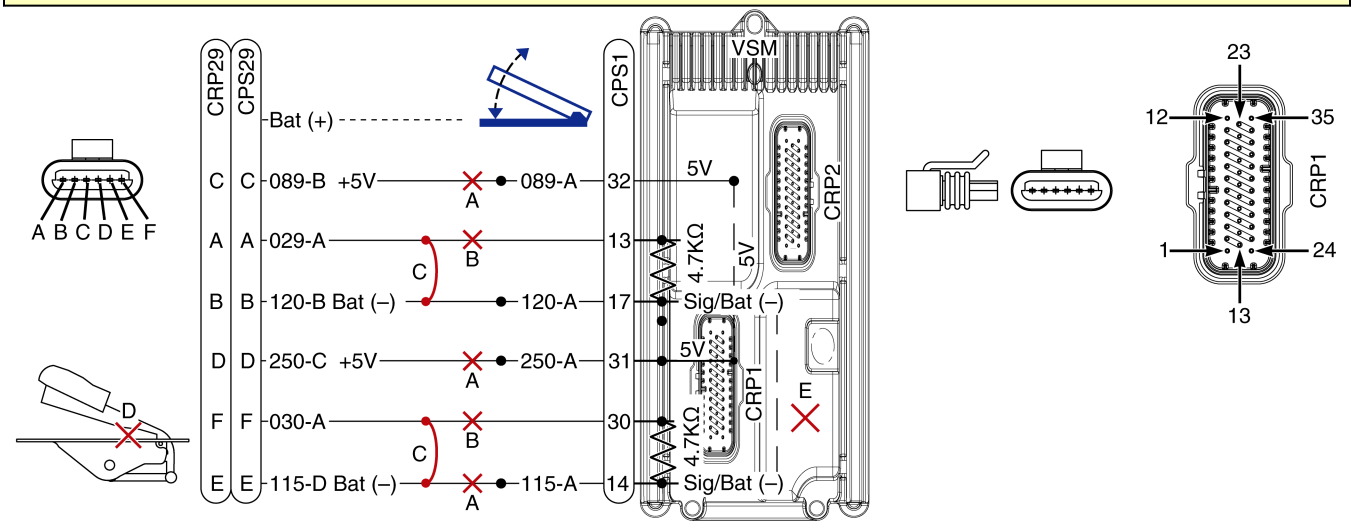
DTC 12810
Accelerator Pedal Position B



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

ACCELERATOR PEDAL POSITION A/B CAUSES A B C D E > ?



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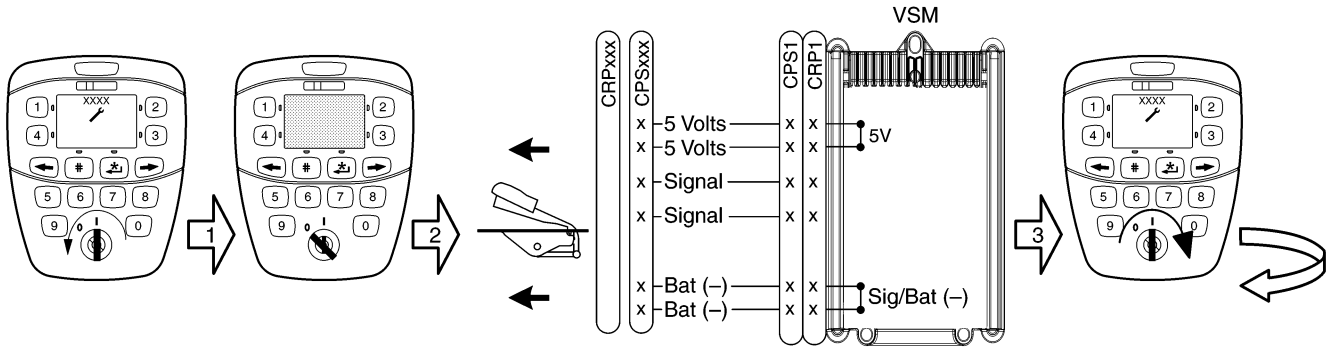
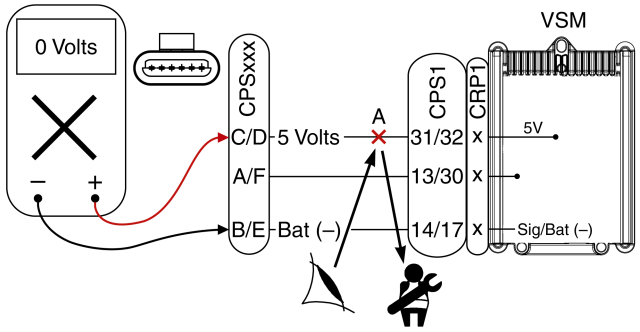
Accelerator Pedal Position A/B Out of Range Low (OORL) (Cont)

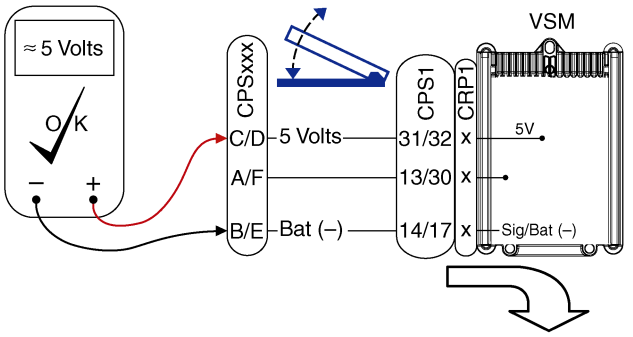
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ ?

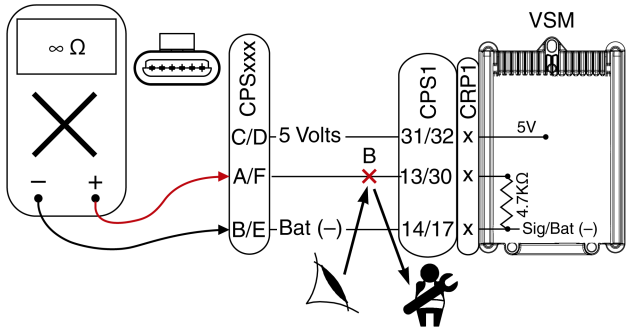
CAUSE A1 CHECK VOLTAGE

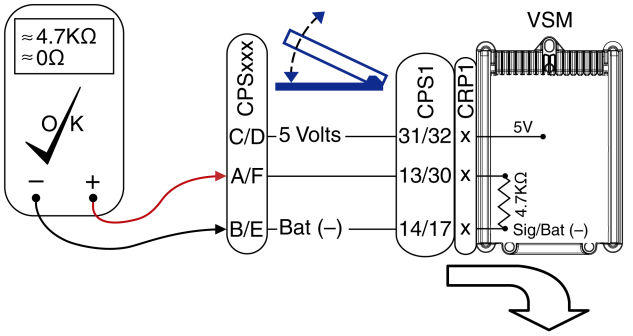




0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B CHECK RESISTANCE - Ω - OHMS





8 ? = Open circuit→ Find↑ **OPEN** circuit	˜ 4.7K? = **OK** Go to Component Operational Check
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? = Go to Component Operational Check

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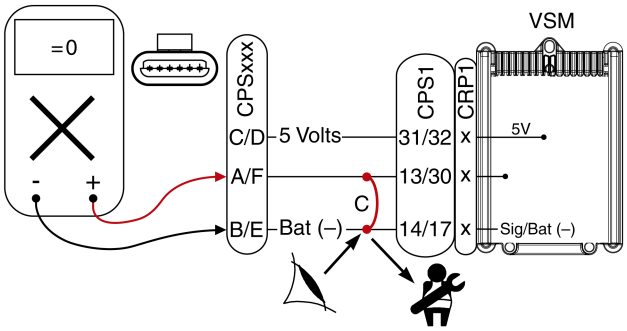
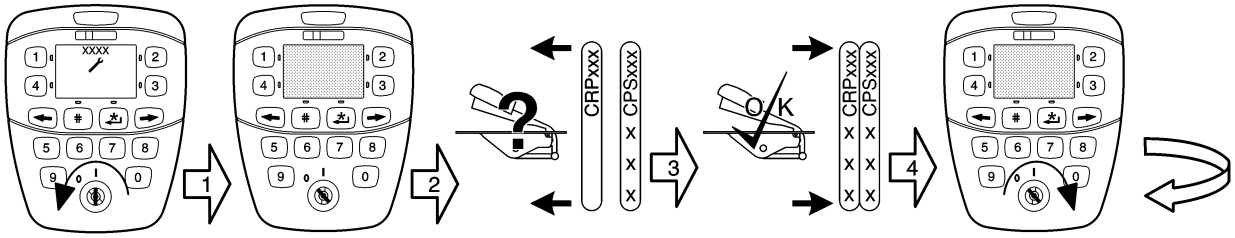
Accelerator Pedal Position A/B Out of Range Low (OORL) (Cont)

CAUSE C **CHECK RESISTANCE - Ω - OHMS**

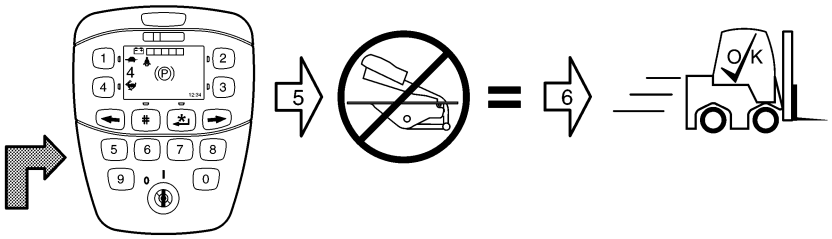


0 ? = Short circuit→ Find↑ **Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

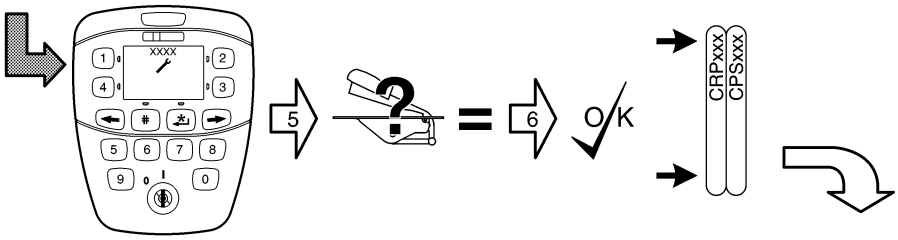
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ ?



? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

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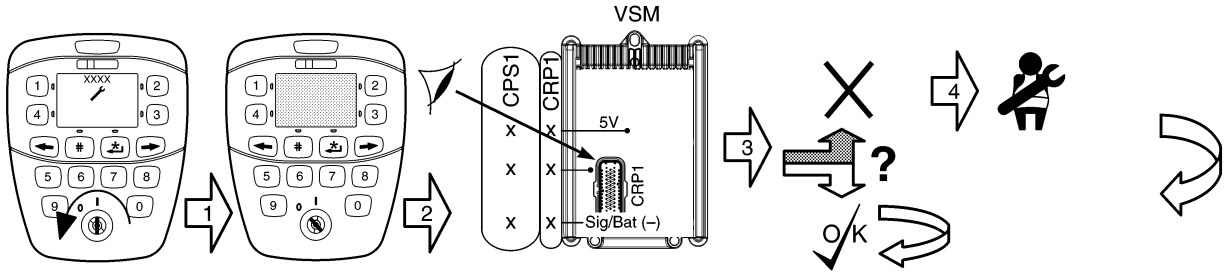
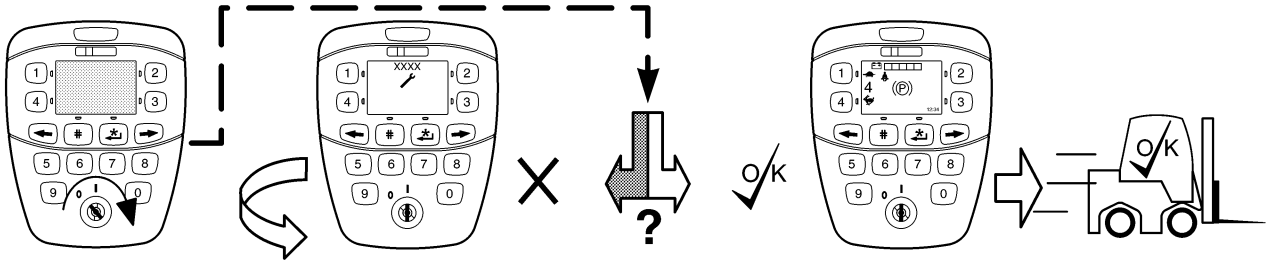
Accelerator Pedal Position A/B Out of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→ | Inspect VSM Connections→ | OK - Go to Cause E1. | Not OK →Correct/Repair Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ | **NO** → Go to VSM Controller Check | Is fault DTC gone? | Fault corrected→ Continue operation.

NO ← **YES** →

END FAULT

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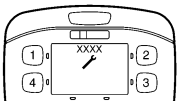
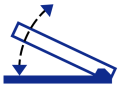
Accelerator Pedal Position A/B Out of Range High (OORH)

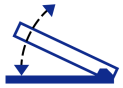


Fault Codes



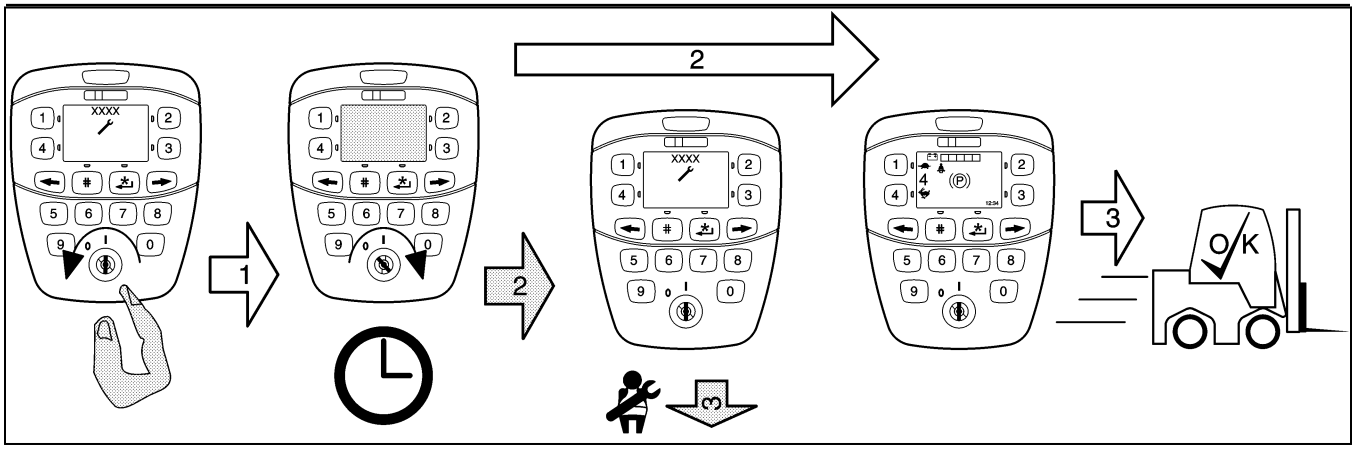
DTC 12809
Accelerator Pedal

Position A



DTC 12811
Accelerator Pedal

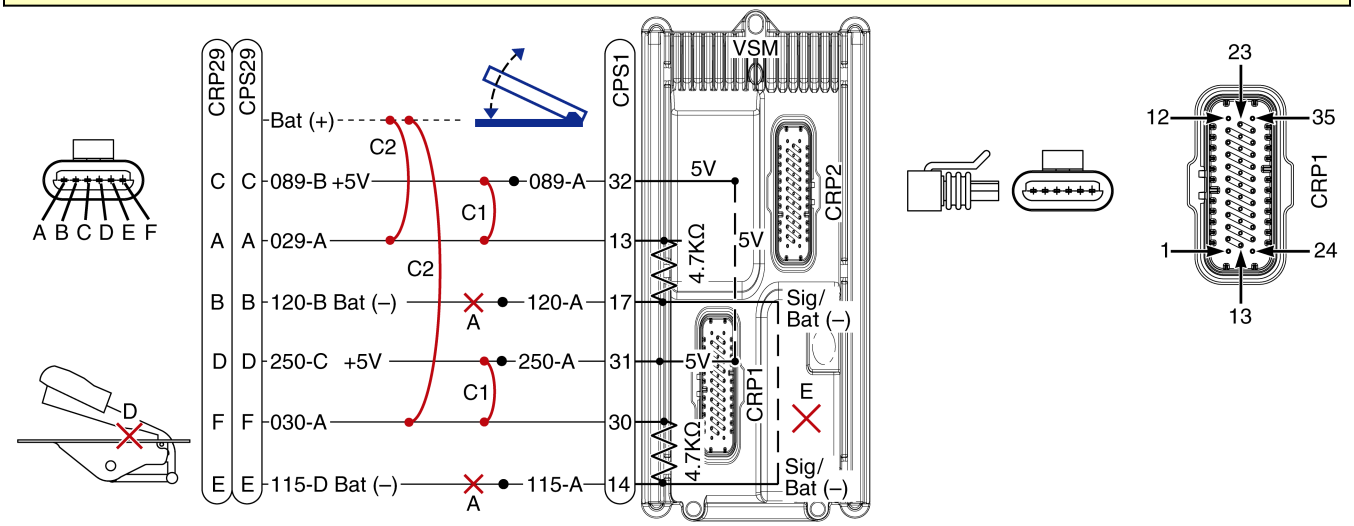
Position B



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

ACCELERATOR PEDAL POSITION A/B CAUSES A B C C1 C2 D E > ?



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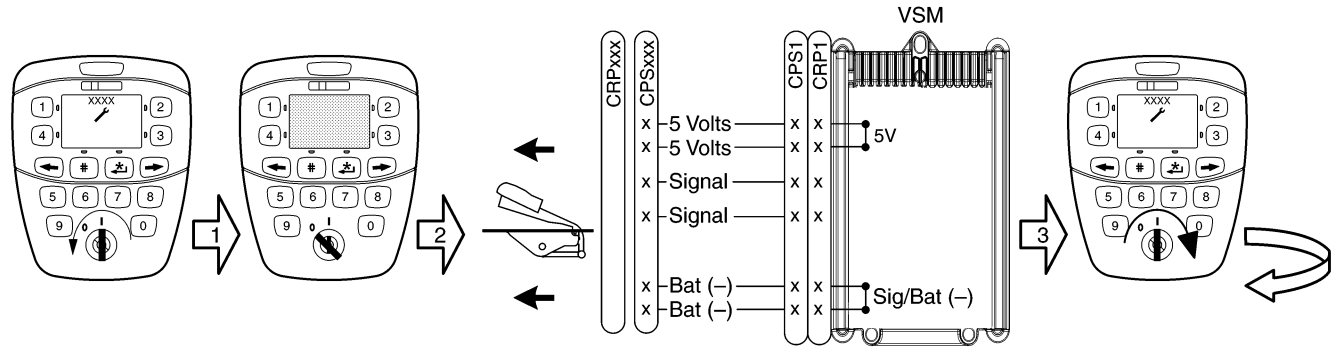
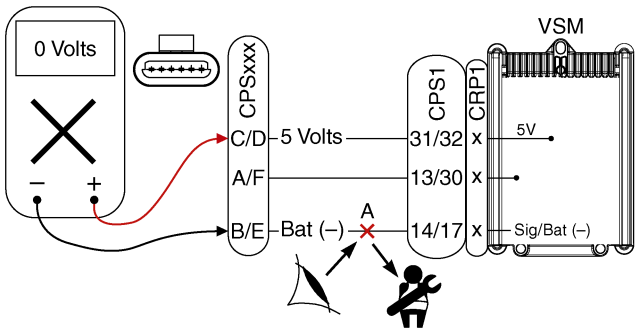
Accelerator Pedal Position A/B Out of Range High (OORH) (Cont)

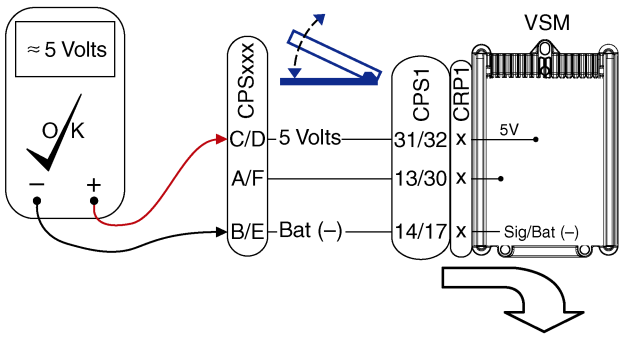
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ ?

CAUSE A1 CHECK VOLTAGE



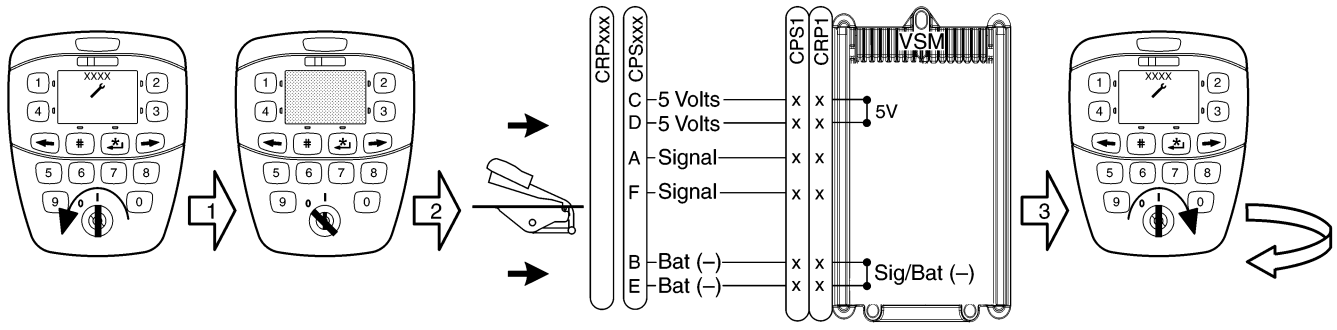


0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B

Not Applicable

CAUSE C



Power **OFF**→ Reconnect sensor→ Power **ON**→ ?

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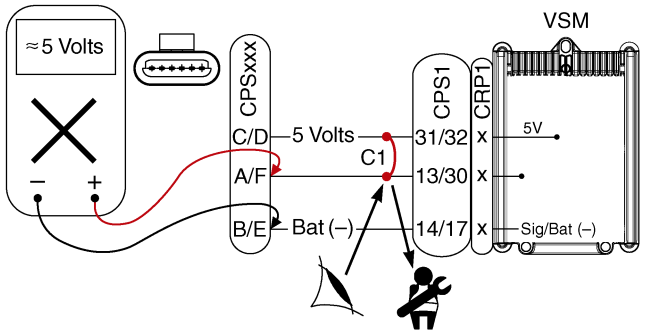
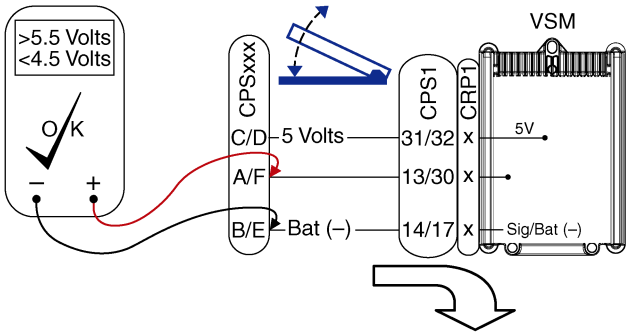
Accelerator Pedal Position A/B Out of Range High (OORH) (Cont)

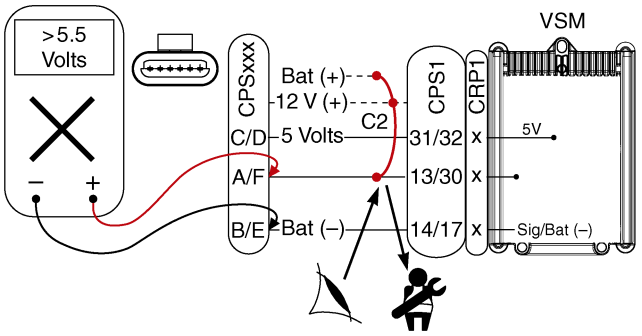
CAUSE C1 CHECK VOLTAGE

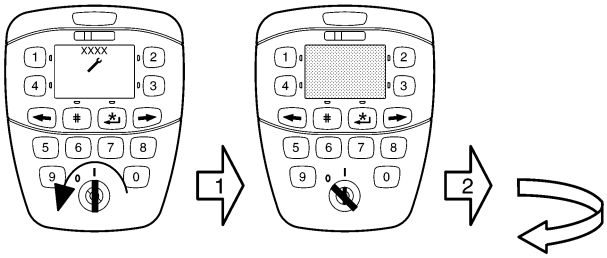




˜ 5 Volts = Short circuit→ Find↑ **Short** circuit.	> 5.5 volts **OK**	Go to Cause C2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts =	Go to Component Operational Check

CAUSE C2 SWITCHED VOLTAGES





> 5.5 Volts = Short circuit→ Find↑ **Short** circuit.	Power **OFF** ?
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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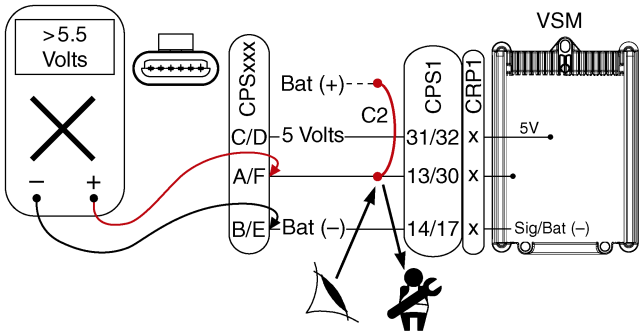
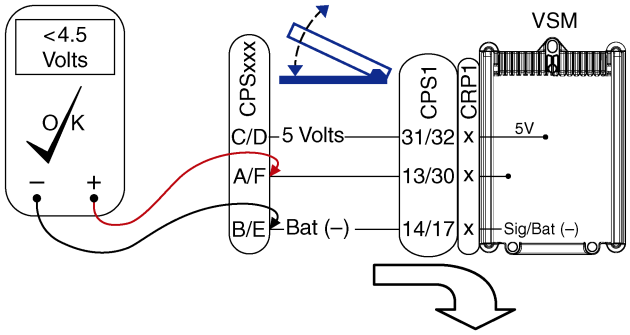
Accelerator Pedal Position A/B Out of Range High (OORH) (Cont)

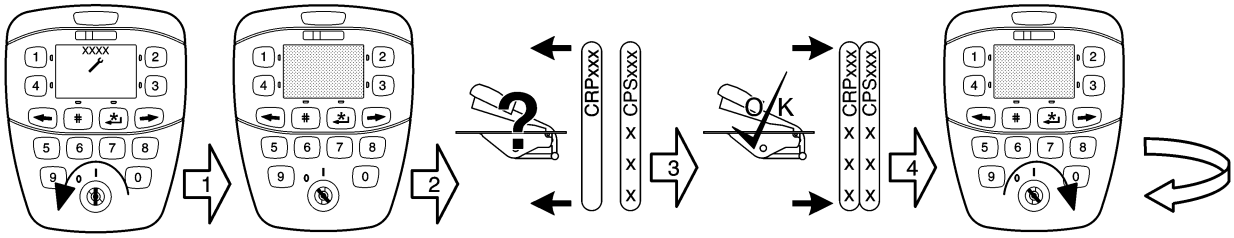
CAUSE C3 UNSWITCHED VOLTAGES



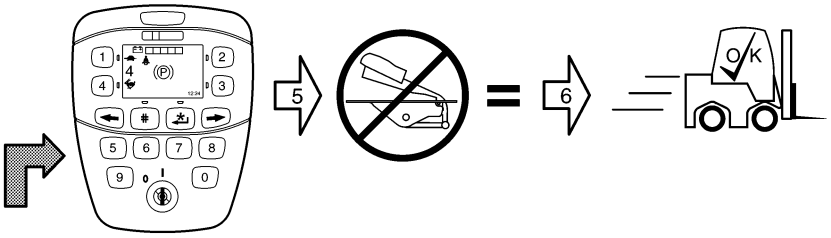


> 5.5 Volts = Short circuit→ Find↑ **Short** circuit.	< 4.5 volts = **OK** Go to Component Operational Check
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

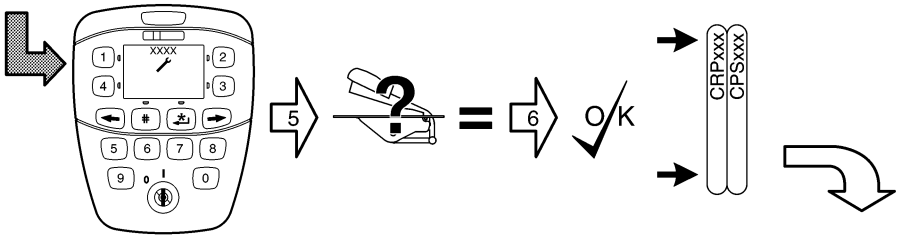
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ ?



? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

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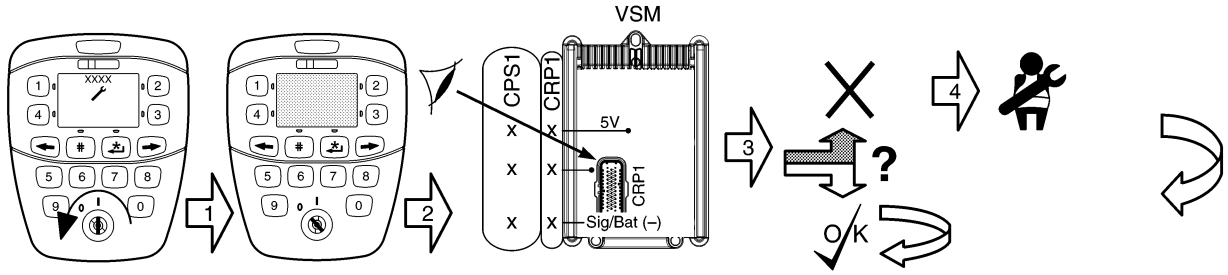
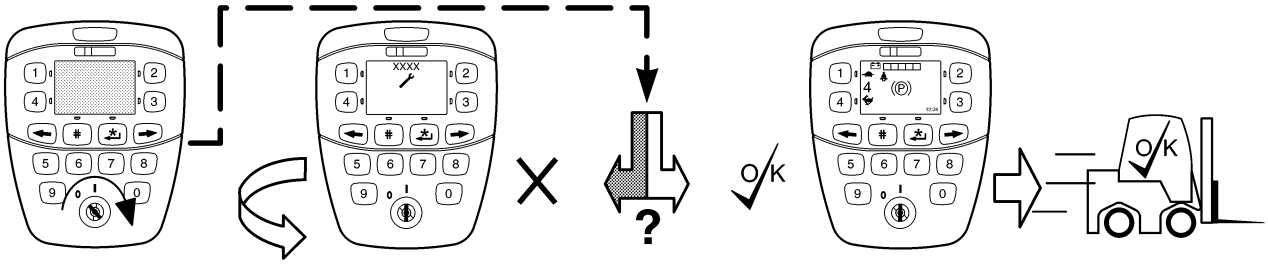
Accelerator Pedal Position A/B Out of Range High (OORH) (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK - Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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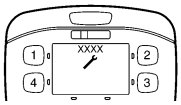
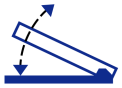
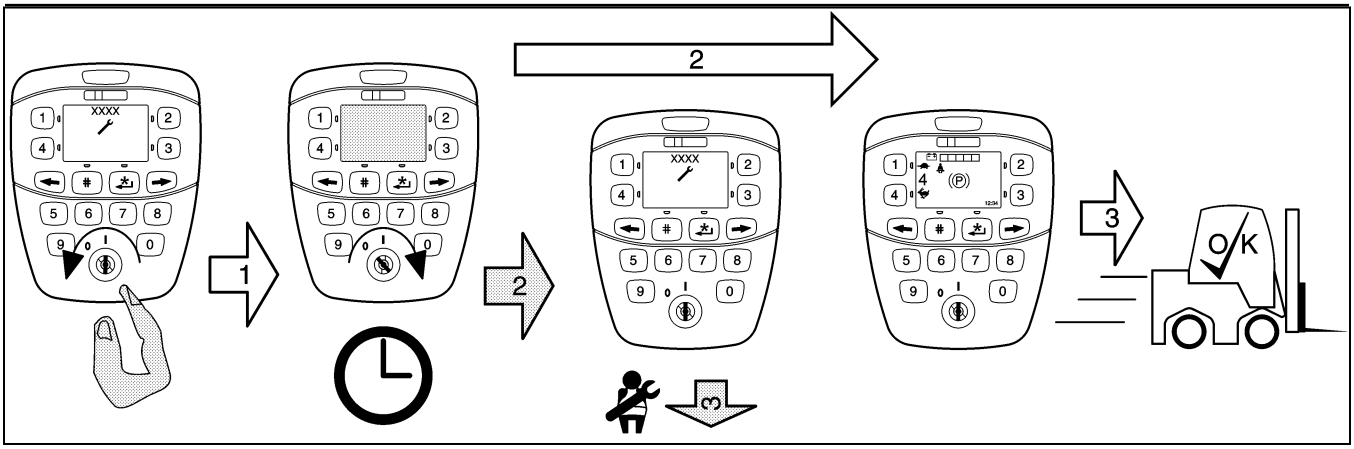
Accelerator Pedal Position A/B Data Incorrect



Fault Codes



DTC 12812
Accelerator Pedal Position A to B



Power **OFF**→

Wait **30 seconds**→

Power **ON**→

Fault remains. Service required. Go to Component Operational Check.

No fault→

Resume operation

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Accelerator Pedal Position A/B Data Incorrect (Cont)

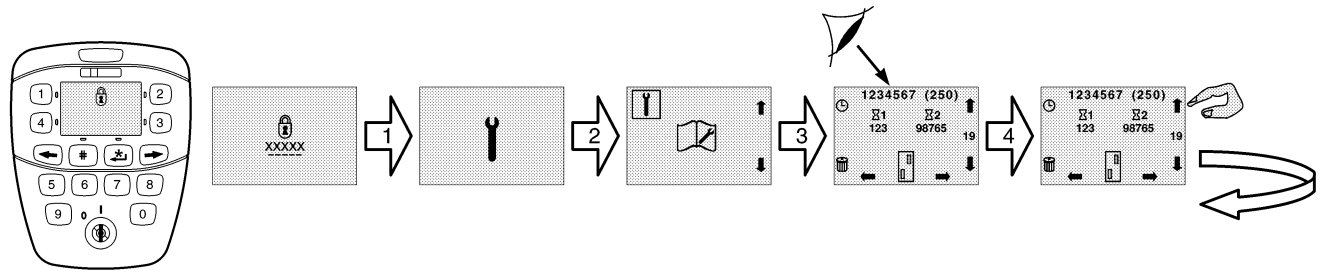
QUICK CHECK X Open Circuit/Fail) = Short Circuit

Check 1 FAULT LOG CODE Review - Go to Display Menu

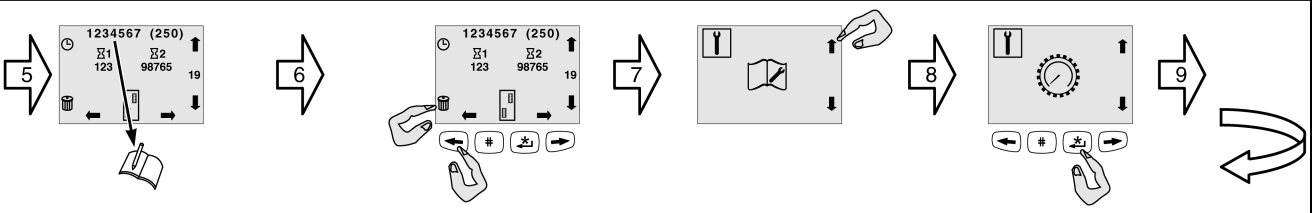
Note: DTC 12812 can be caused by the same conditions that caused DTCs 12808 to 12811

Check VSM Fault Logs→ Go to Check 1↑ Are these codes present?↓

YES→ See Accelerator Pedal Position A/B Out of Range Low (OORL) or Accelerator Pedal Position A/B Out of Range High (OORH)	NO→ Go to Check 1↑

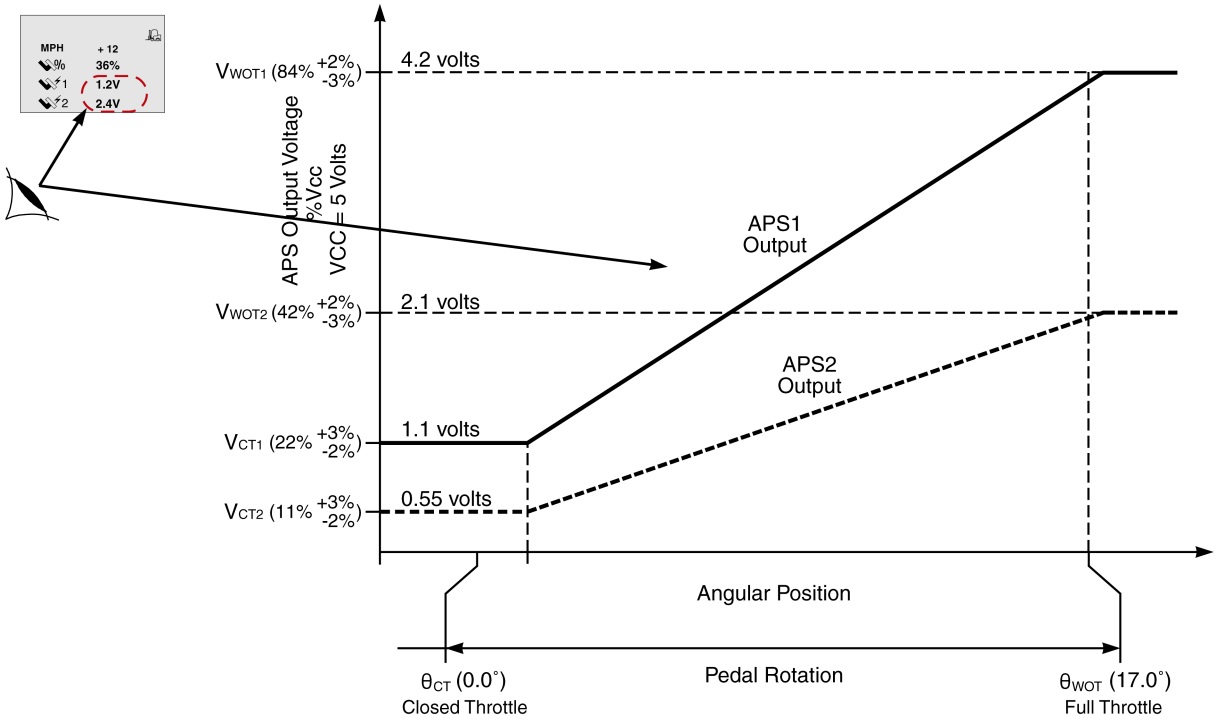


Enter Service Password→ Diagnostic→ FAULT LOGs→ VSM/MLM Fault Logs→ View all VSM/MLM DTCs→ ?



All VSM/MLM DTCs	Erase all VSM/MLM DTCs→ ☜ Exit Fault Log→ ↑ ↓ Speedometer ☞*

Check 2



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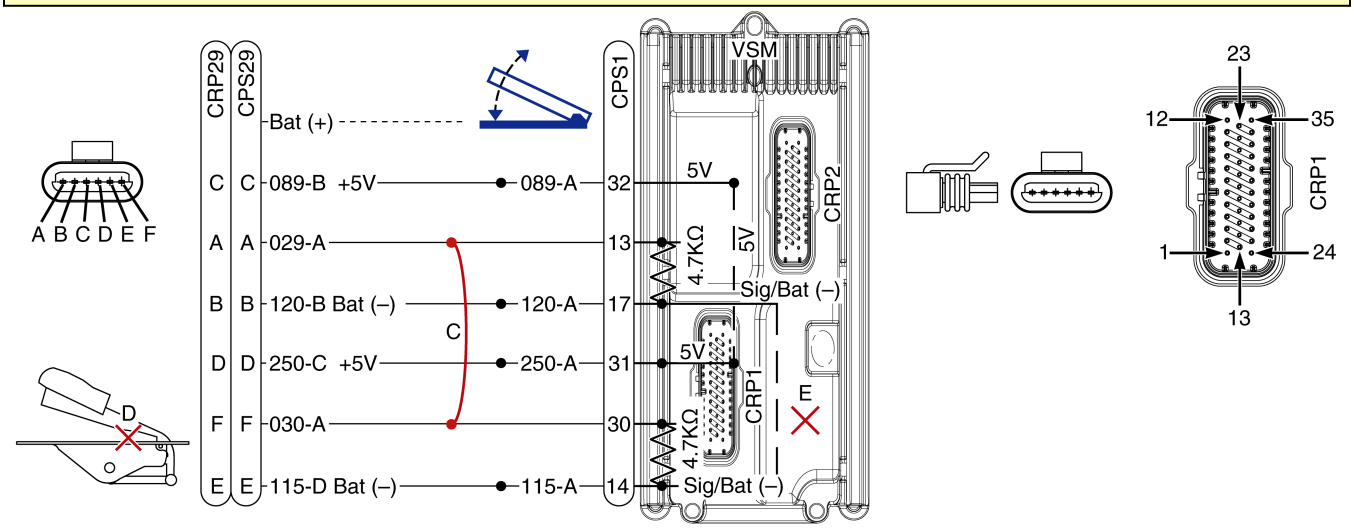
Accelerator Pedal Position A/B Data Incorrect (Cont)

Does Sensor APS2 Volts = Sensor APS1 Volts = DTC 12812?
YES → Component Operational Check NO→ Resume Operation
Does (Sensor APS2 Volts x 2) - Sensor APS1 Volts = > 0.60 volts for more than 2 seconds = DTC 12812?
YES→ Component Operational Check NO→ Resume Operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

ACCELERATOR PEDAL POSITION A/B CAUSES A B C D E > ?



CAUSE A

Not Applicable

CAUSE B

Not Applicable

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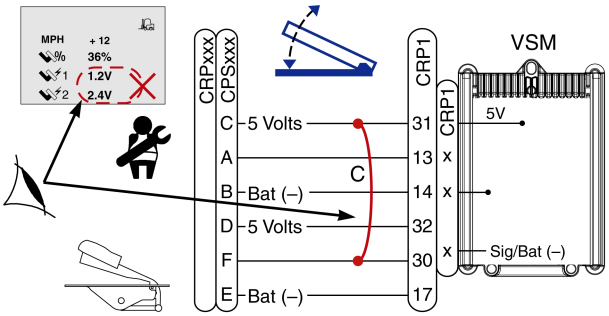
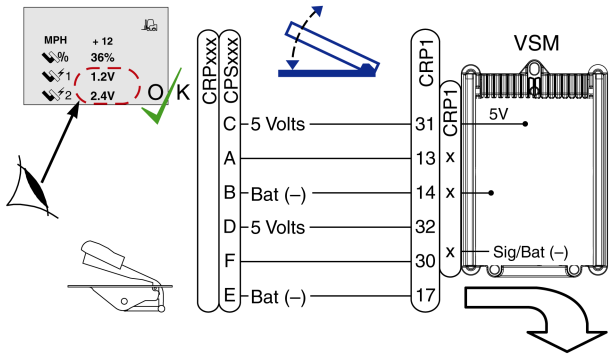
Accelerator Pedal Position A/B Data Incorrect (Cont)

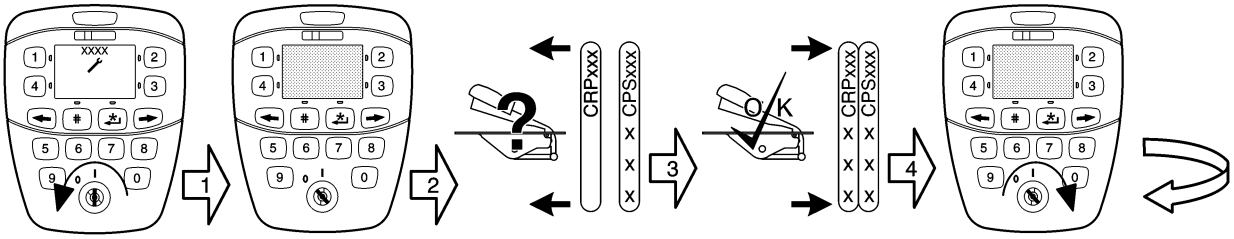
CAUSE C



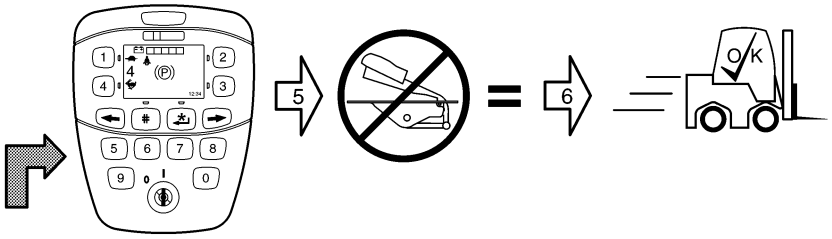


If 2 = 1 = Short circuit→ Find↑ **Short** circuit	If 2 = (2x1) = OK→ Component Operational Check ↓
Find/Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	
Reconnect→ Use Display Diagnostics to validate→ Test OK→ YES→ Resume Operation NO→ Component Operational Check ↓	

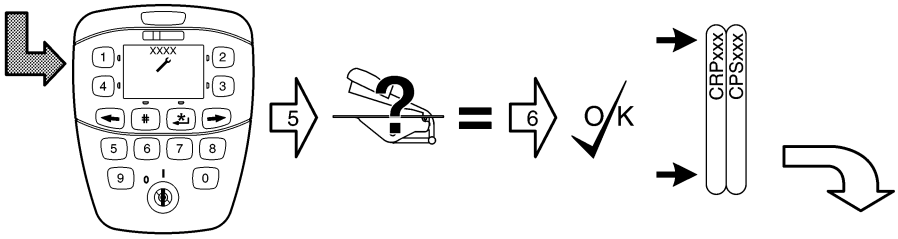
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ ?



? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

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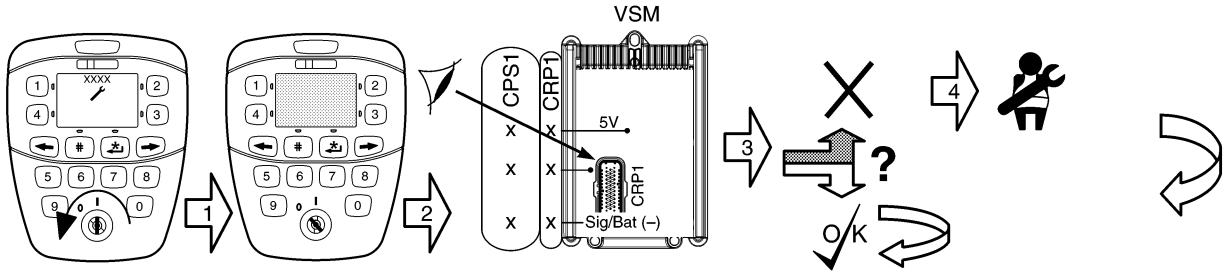
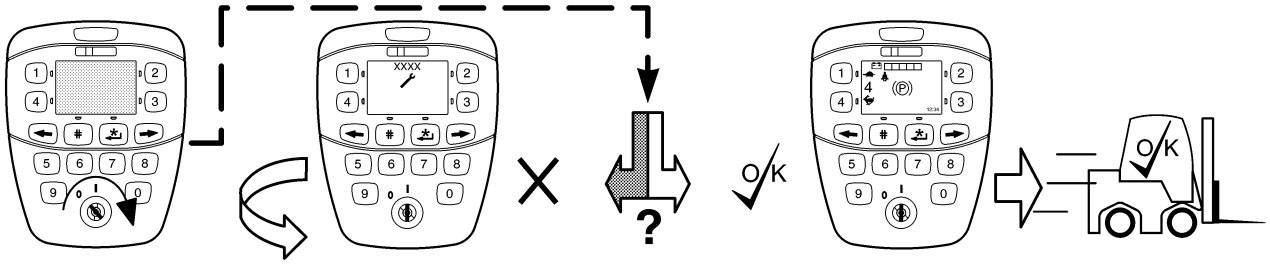
Accelerator Pedal Position A/B Data Incorrect (Cont)

CAUSE E



Power **OFF**→ | Inspect VSM Connections→ | OK - Go to Cause E1. | Not OK →Correct/Repair Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ | **NO** → Go to VSM Controller Check | Is fault DTC gone? | Fault corrected→ Continue operation.

NO ← **YES** →

END FAULT

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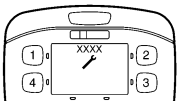
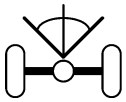
Steering Wheel/Steering Axle Position Sensor Out of Range Low (OORL)

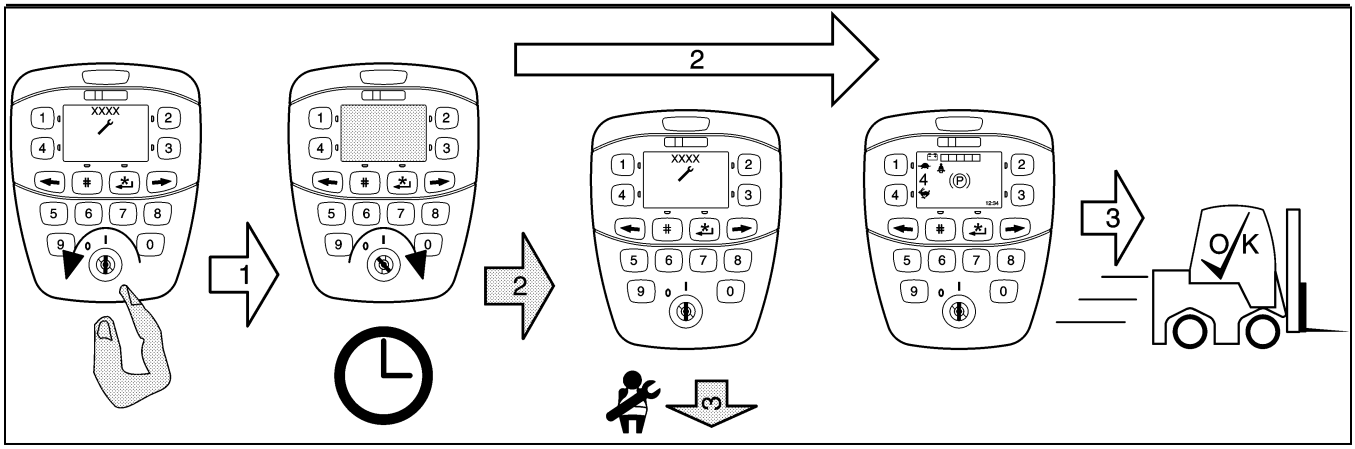


Fault Codes

DTC 12820 Steering Wheel Position



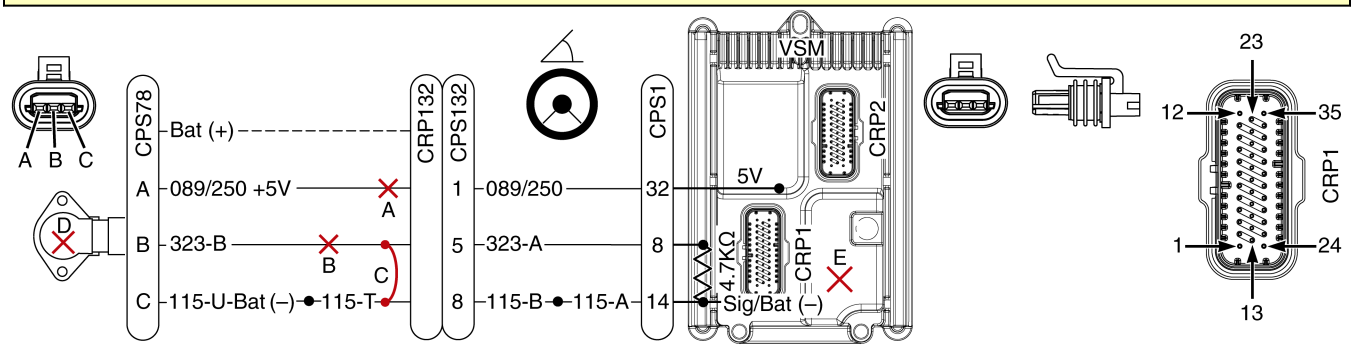
DTC 12824 Steering Axle Position



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

STEERING WHEEL POSITION CAUSES A B C D E > ?



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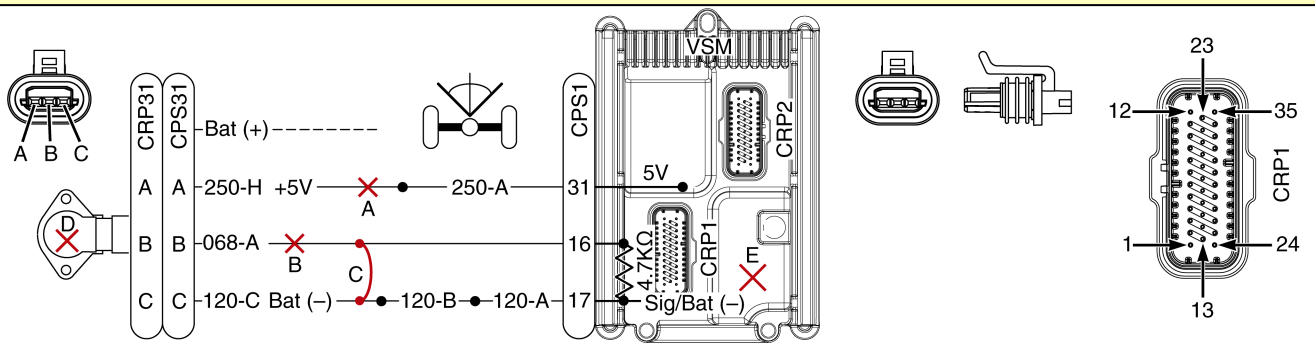
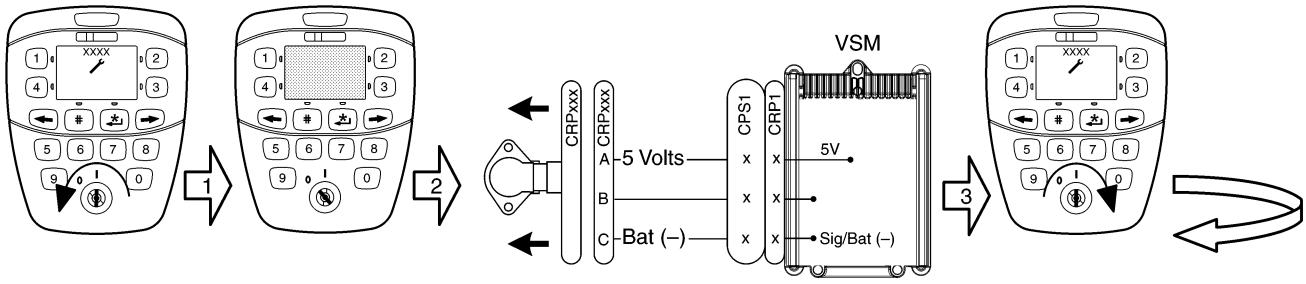
Steering Wheel/Steering Axle Position Sensor Out of Range Low (OORL) (Cont)

STEERING AXLE POSITION CAUSES A B C D E > ?

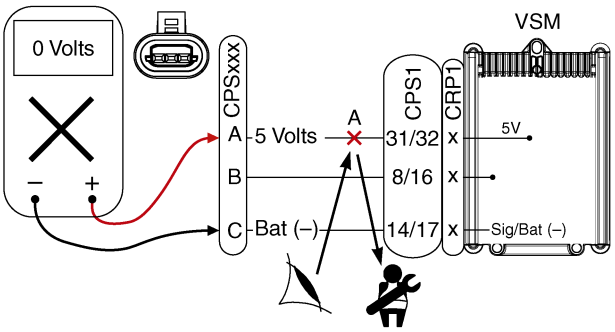


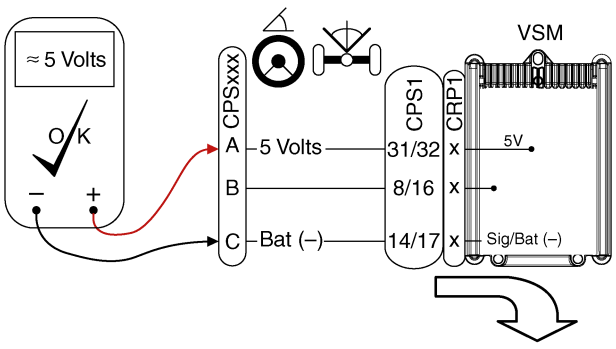
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ ?

CAUSE A1 CHECK VOLTAGE





0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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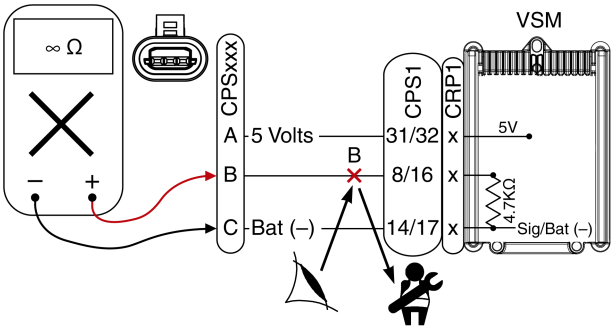
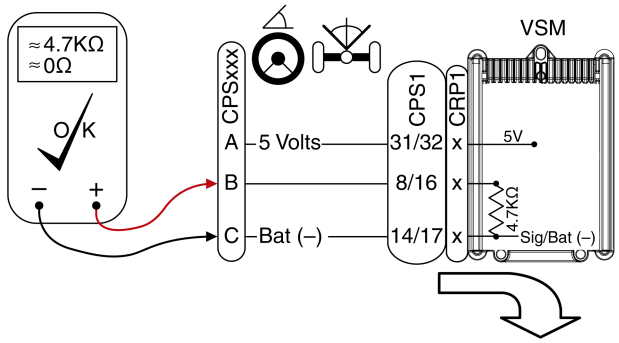
Steering Wheel/Steering Axle Position Sensor Out of Range Low (OORL) (Cont)

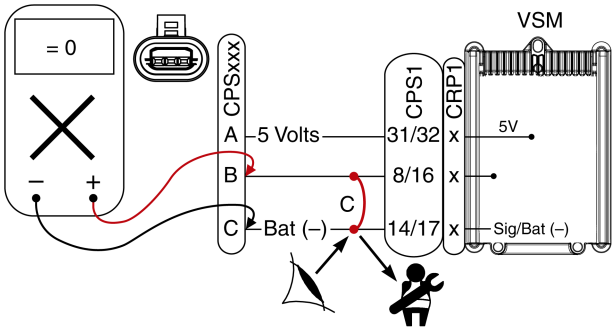
CAUSE B CHECK RESISTANCE - Ω - OHMS





8 ? = Open circuit→ Find↑ **OPEN** circuit	˜ 4.7K? =	**OK** Go to Component Operational Check
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? =	Go to Component Operational Check

CAUSE C CHECK RESISTANCE - Ω - OHMS



0 ? = Short circuit→ Find↑ **Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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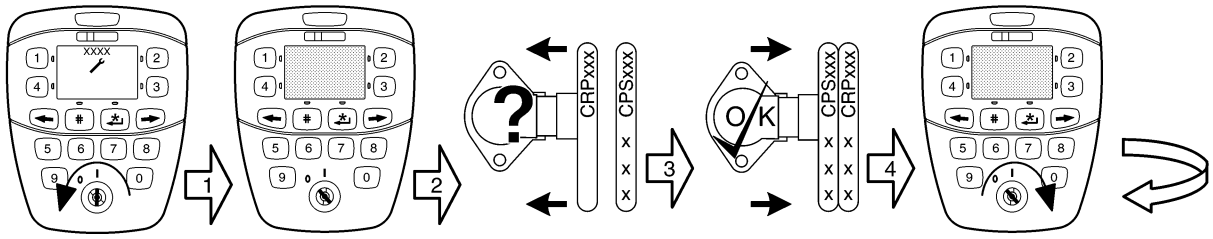
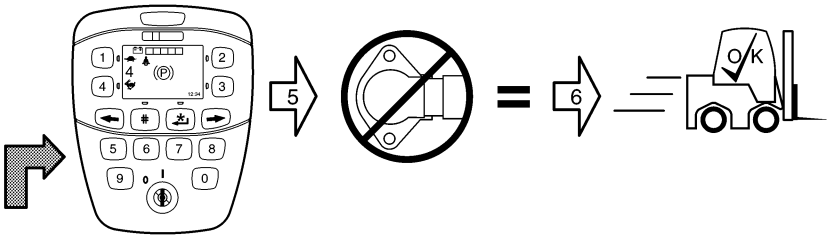
Steering Wheel/Steering Axle Position Sensor Out of Range Low (OORL) (Cont)

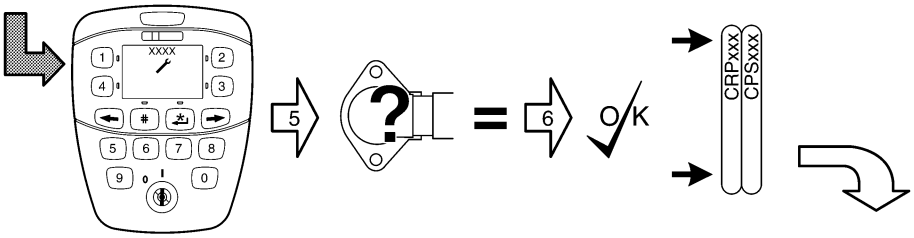
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ ?

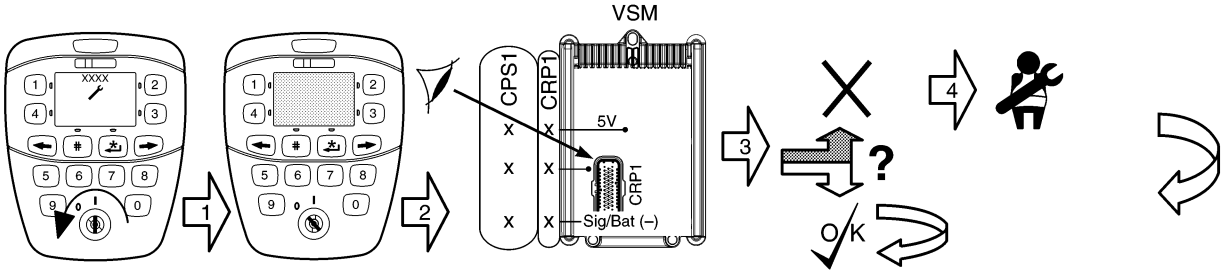


? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK - Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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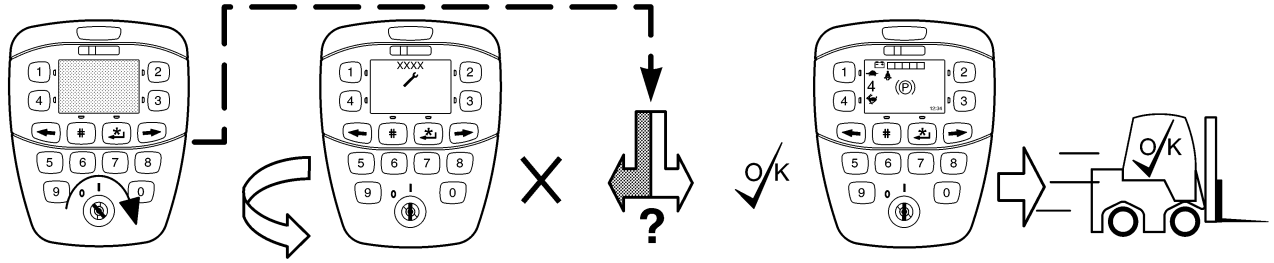
Steering Wheel/Steering Axle Position Sensor Out of Range Low (OORL) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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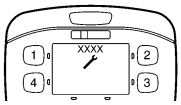
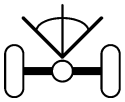
Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH)

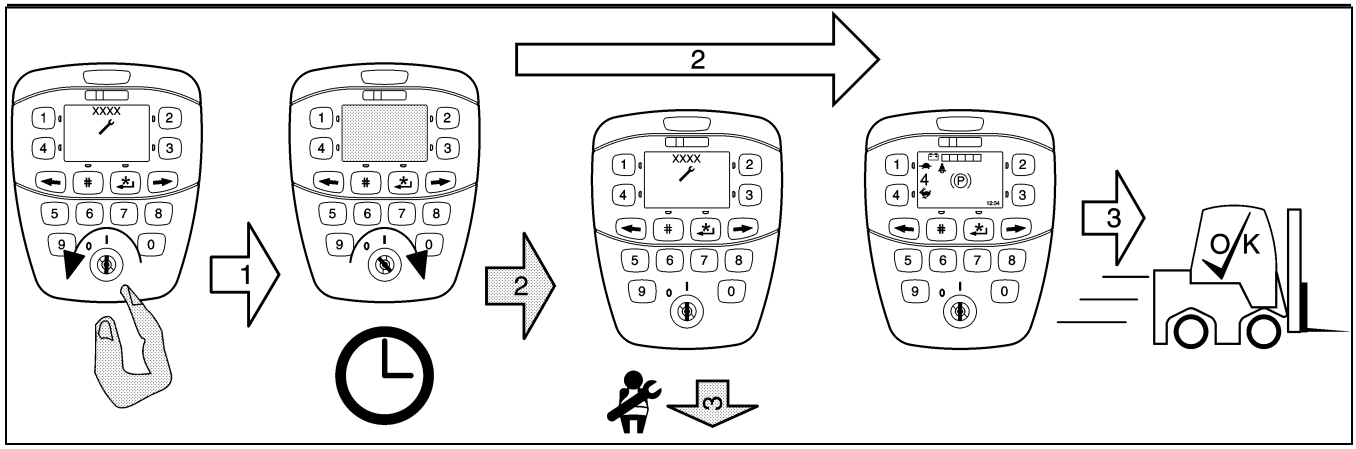


Fault Codes

DTC 12821 Steering Wheel Position



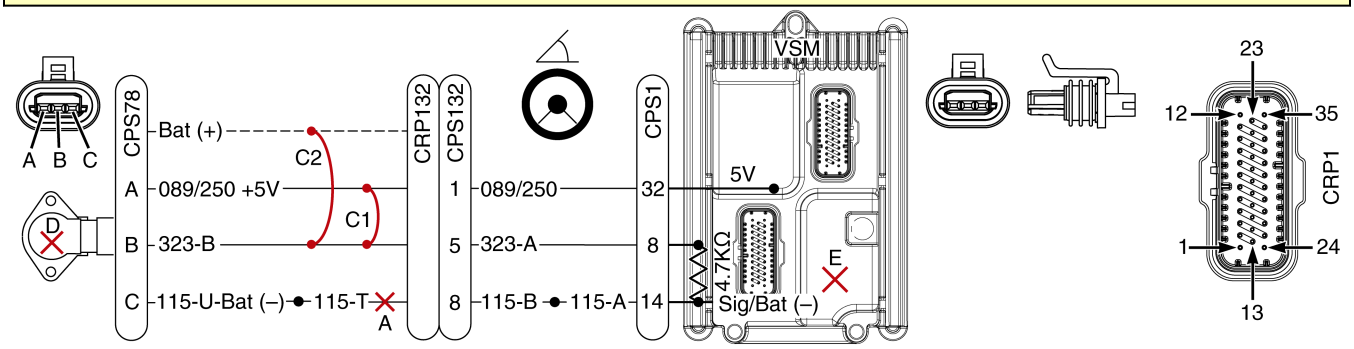
DTC 12825 Steering Axle Position



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

STEERING WHEEL POSITION CAUSES A B C C1 C2 D E > ?



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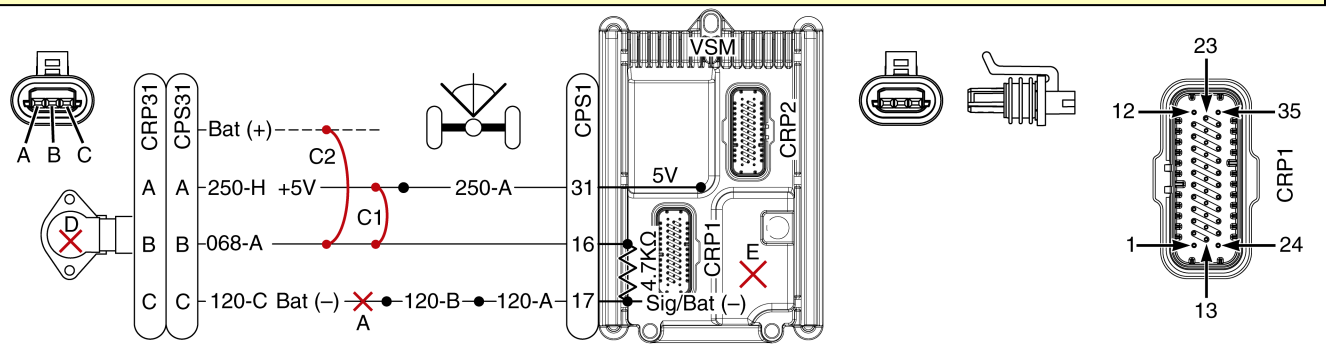
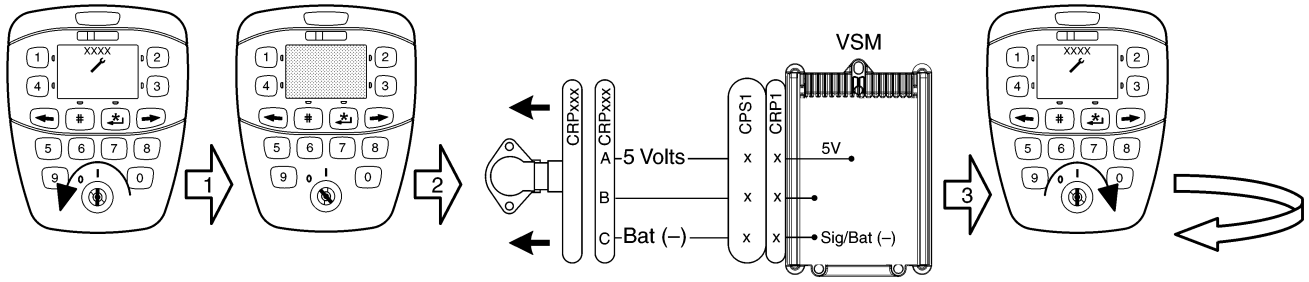
Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH) (Cont)

STEERING AXLE POSITION CAUSES A B C C1 C2 D E > ?

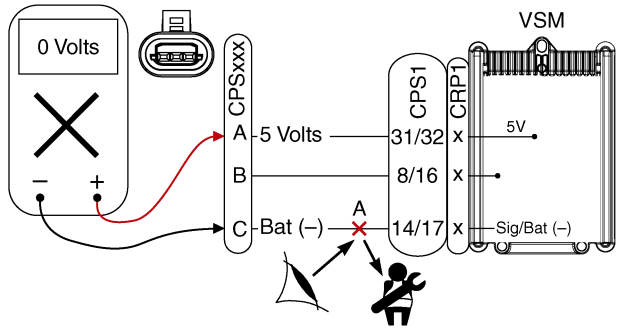


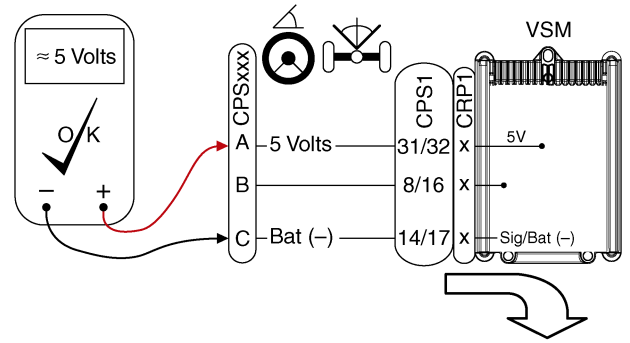
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

CAUSE A1 CHECK VOLTAGE





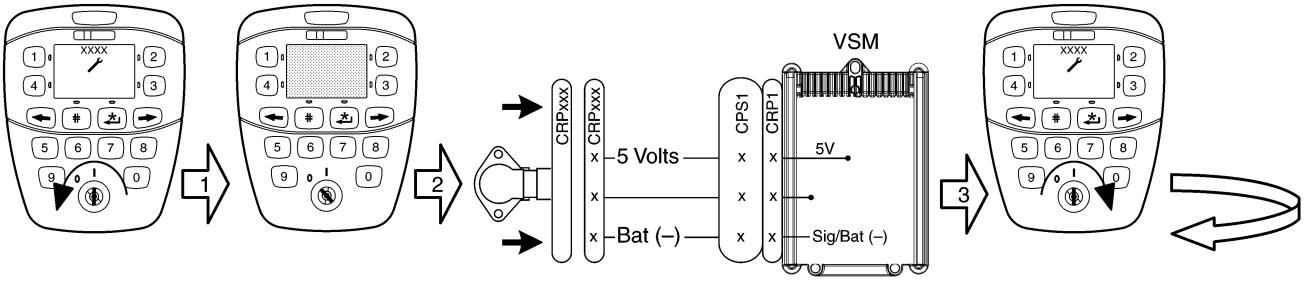
0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B

Not Applicable

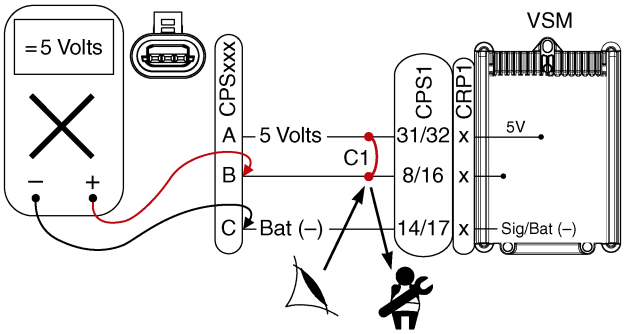
Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH) (Cont)

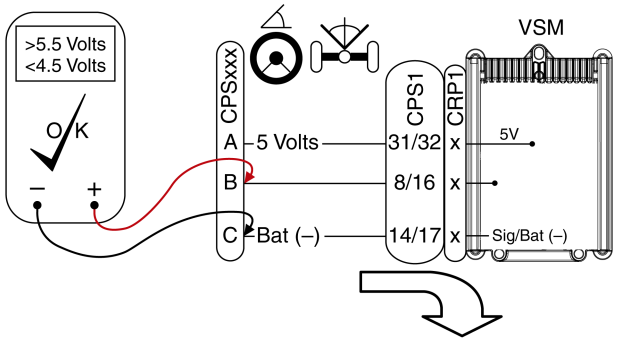
CAUSE C



Power **OFF**→ Reconnect sensor→ Power **ON**→ Go to next step.

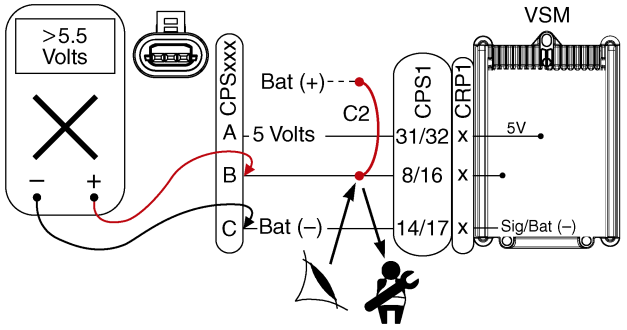
CAUSE C1 CHECK VOLTAGE

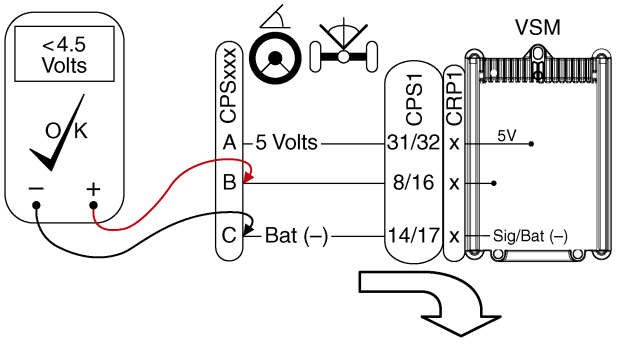




= 5 Volts = Short circuit→ Find↑ **Short** circuit.	> 5.5 volts, Go to Cause C2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts OK = Go to Component Operational Check

CAUSE C2 CHECK VOLTAGE





> 5.5 volts = Open circuit→ Find↑ **OPEN** circuit.	< 4.5 Volts OK = Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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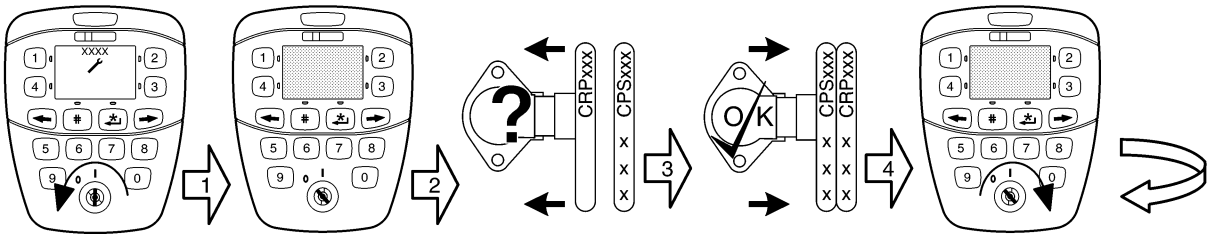
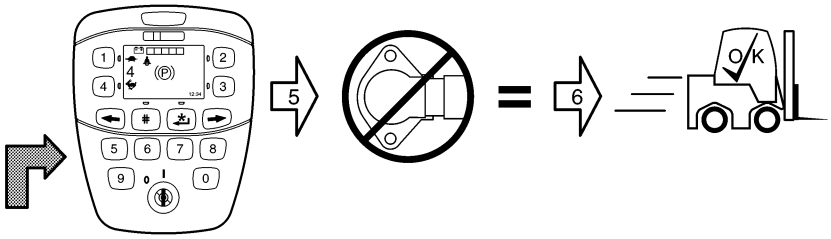
Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH) (Cont)

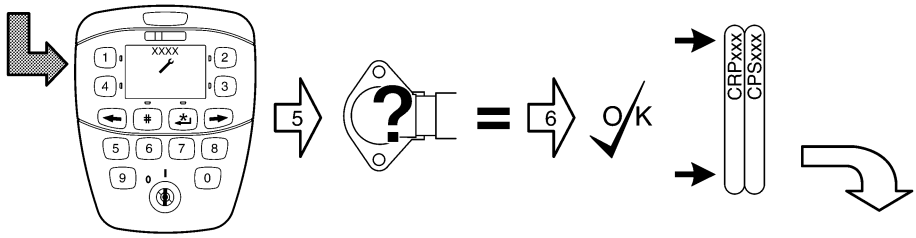
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ Go to next step.

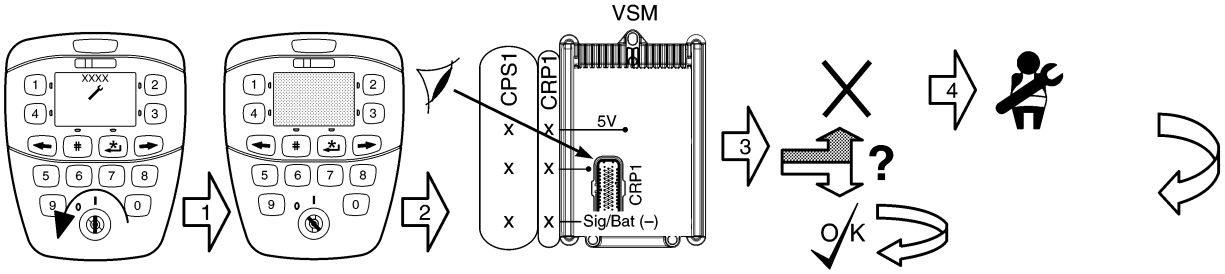


? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK - Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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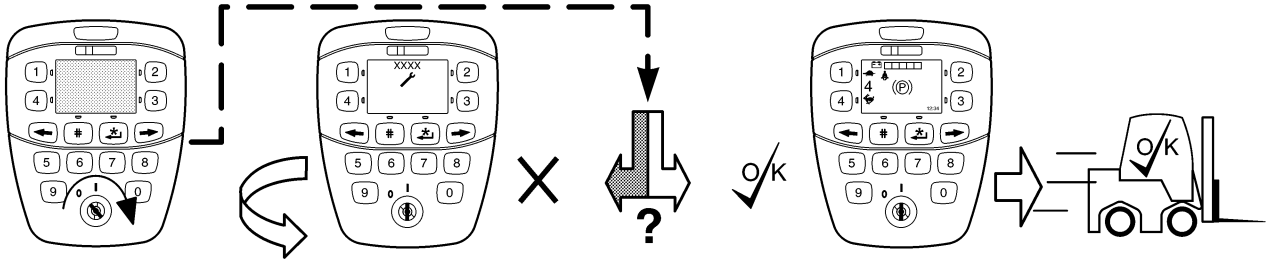
Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO ← **YES** →

Fault corrected→ Continue operation.

END FAULT

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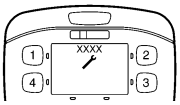
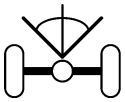
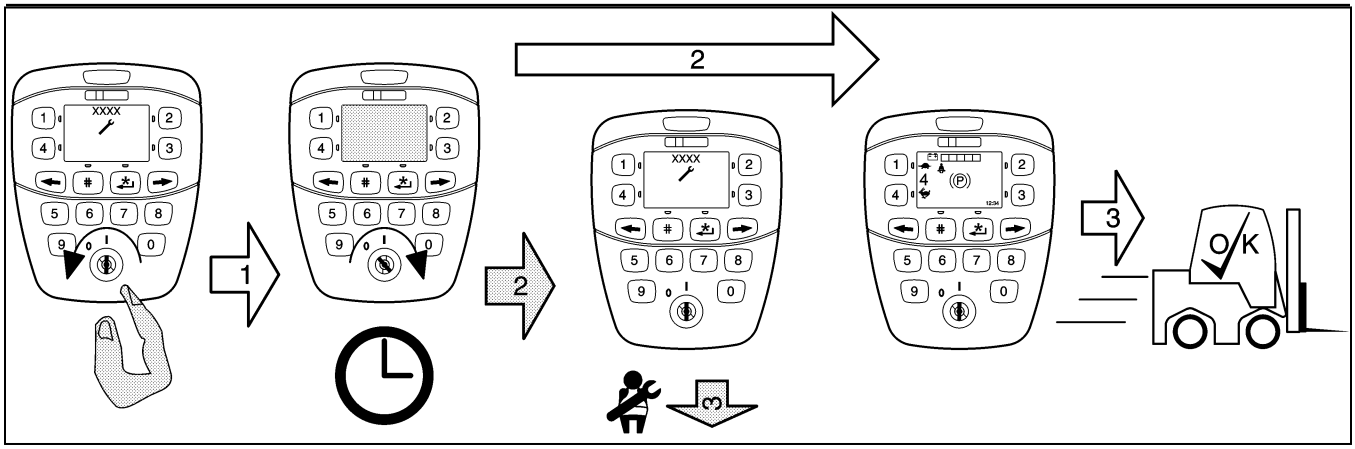
Steer Axle Calibration Required



Fault Codes

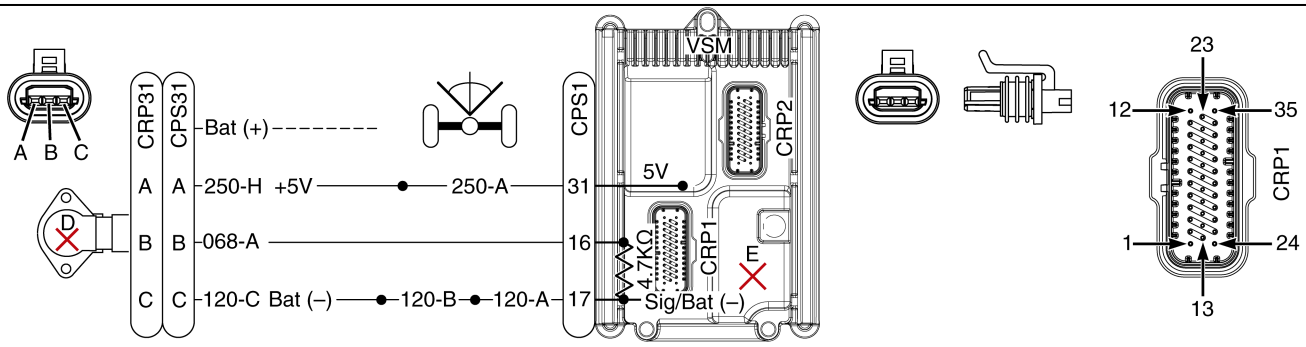


DTC 4098
Steer Axle Calibration



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit
STEERING AXLE CALIBRATION CAUSES A B C D E > ?
Faulty Steer System/Faulty Sensor/New Sensor Installed
VSM



CAUSE A
Not Applicable
CAUSE B
Not Applicable

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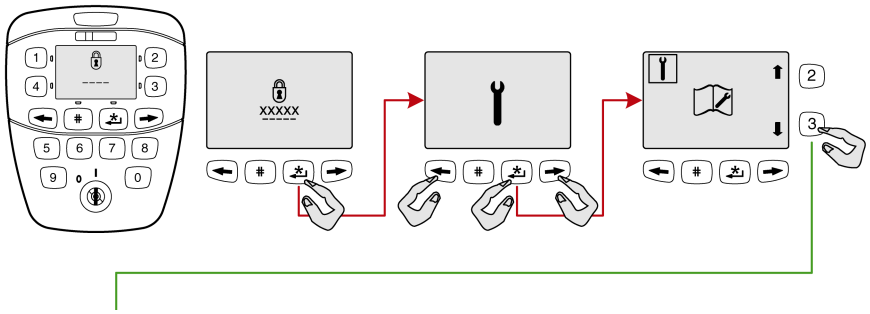
Steer Axle Calibration Required (Cont)

CAUSE C

Not Applicable

CAUSE D

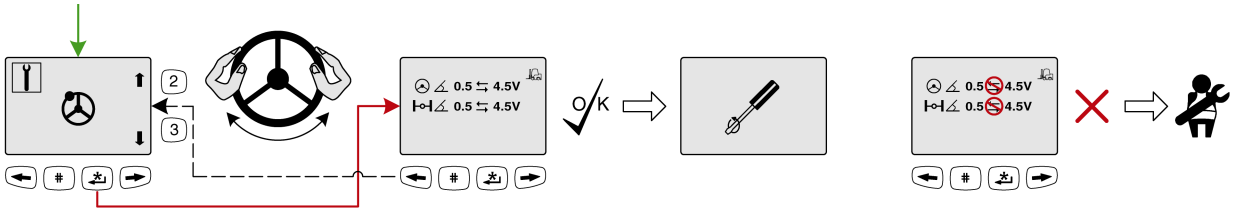
Calibration Process--Go to Display Menu



Enter SERVICE Password→ ☞* DDiagnostics→ ☞* ESteering Sensor

CAUSE D1

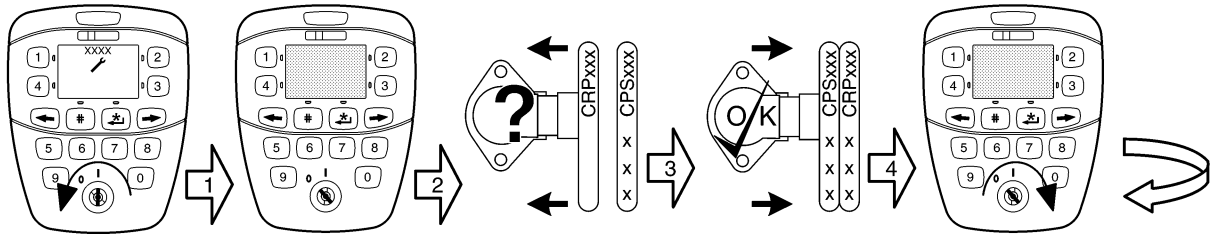
Steering Sensor Values



1. ☞*→Rotate steering wheel #Values vary>0.5V <4.5V = v→Proceed with Calibration→Cause D3↓
2. ☞*→Rotate steering wheel #Values =the same = X=Steer Mechanism/Faulty Sensor→Go to 3↓
3. Check Steer Mechanism Operation→Mechanism v→Cause D2↓Mechanism XGo to 4↓
4. See **Steering System** 1600SRM1331/**Steering System** 1600SRM1363 repair.

CAUSE D2

Steer Sensor(s) Replacement



1. Power **OFF**→Disconnect sensor **Do not discard**.→Install new sensor→Power **ON**→Go to 2↓
2. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

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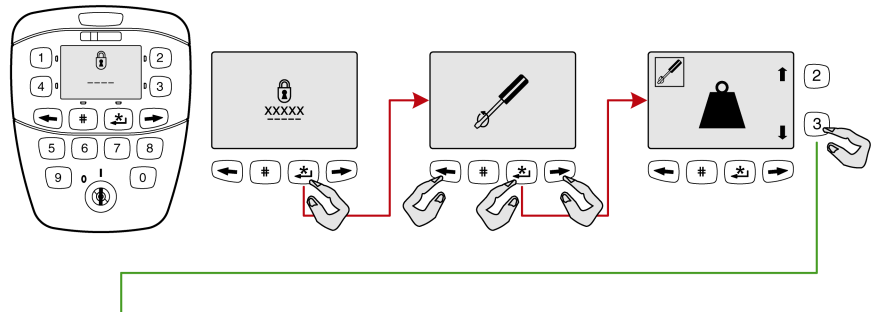
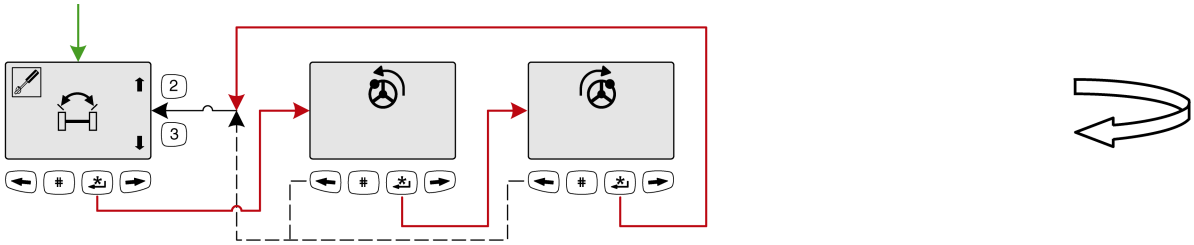
Steer Axle Calibration Required (Cont)

CAUSE D3

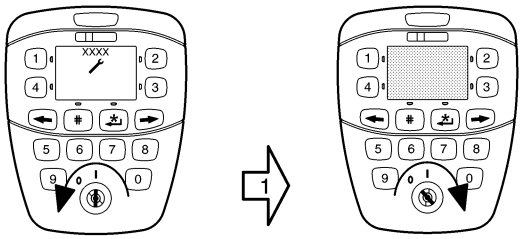


Enter SERVICE Password→ ☞* DCalibration→ ☞* ESteering Axle



☞* Rotate Fully CCW ☞* Rotate Fully CW ☞* Cause D4 ↓

CAUSE D4



Power **OFF**→ Power **ON**→ Cause D5 ↓

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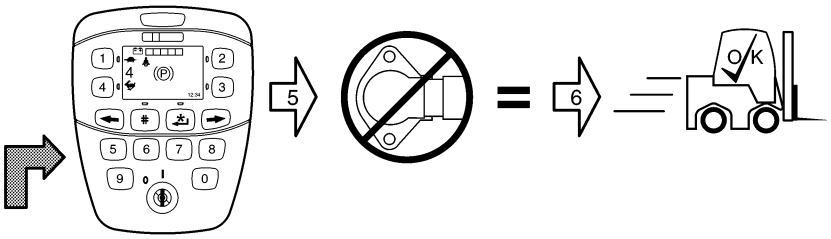
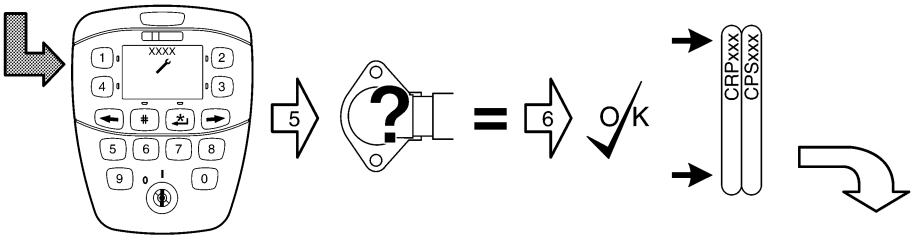
Steer Axle Calibration Required (Cont)

CAUSE D5

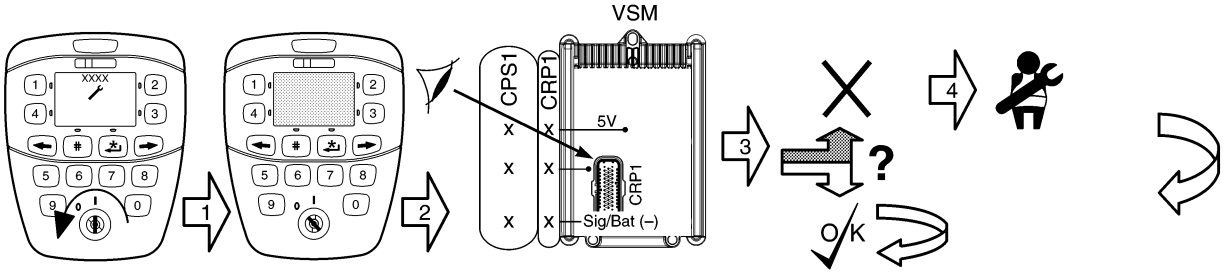


? Fault DTC gone→ Old sensor faulty→ Resume operation



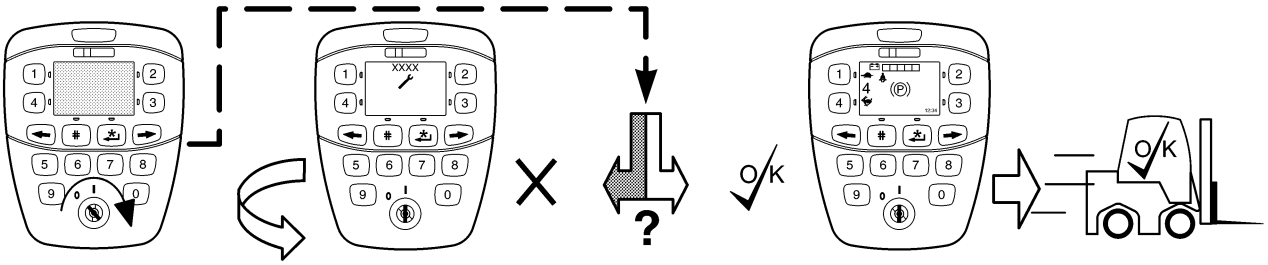
Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK - Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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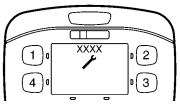
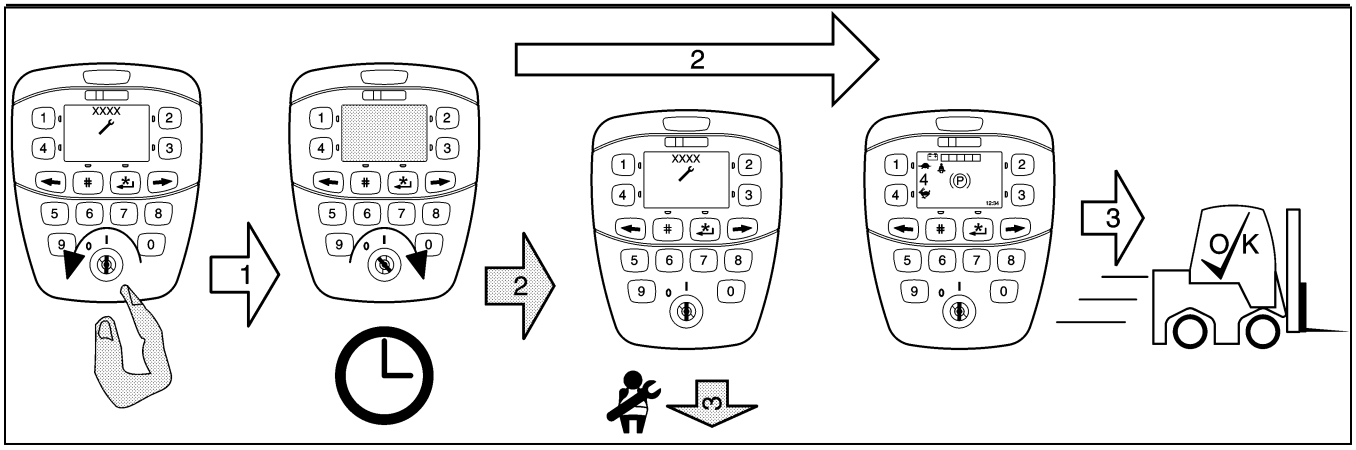
Hydraulic Temperature Sensor Out of Range High (OORL)



Fault Codes

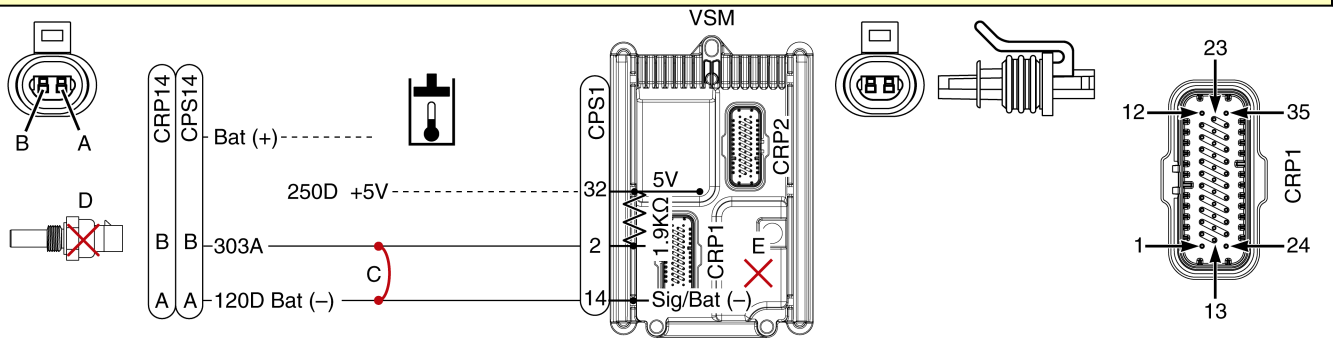
DTC 12852 Hydraulic Temperature



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

HYDRAULIC TEMPERATURE CAUSES A B C D E > ?



CAUSE A

Not Applicable

CAUSE B

Not Applicable

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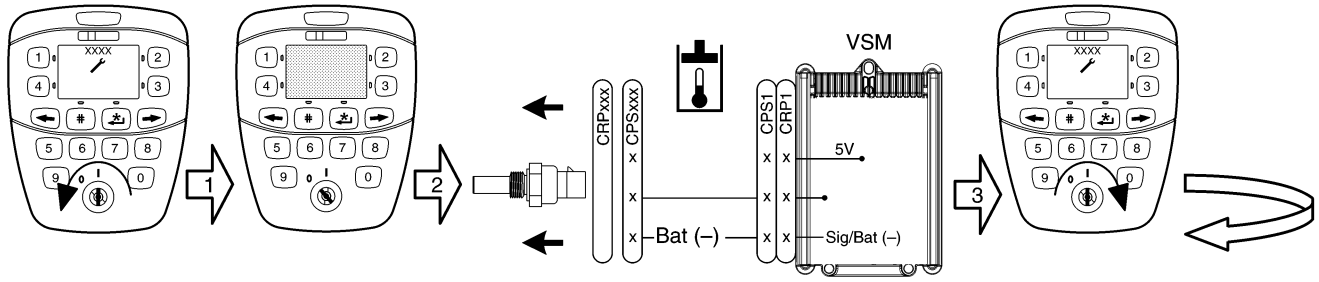
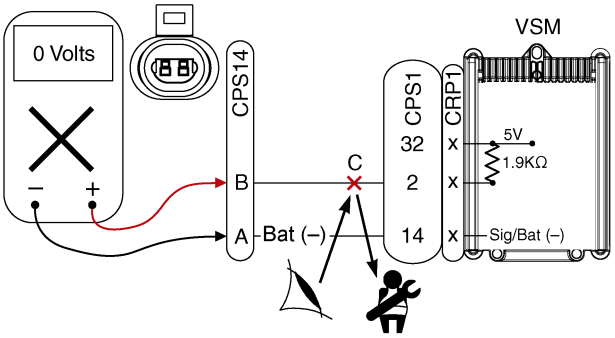
Hydraulic Temperature Sensor Out of Range High (OORL) (Cont)

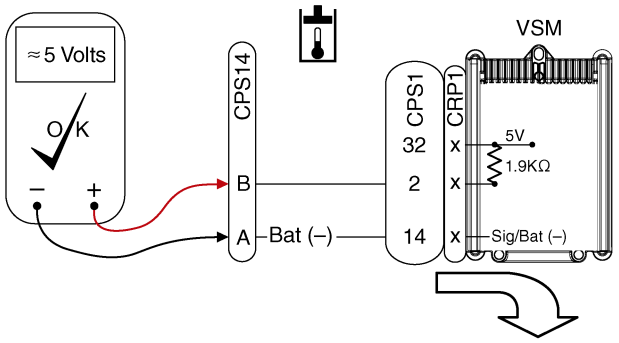
CAUSE C



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

CAUSE C1 CHECK VOLTAGE





0 Volts = Short circuit→ Find↑ **Short** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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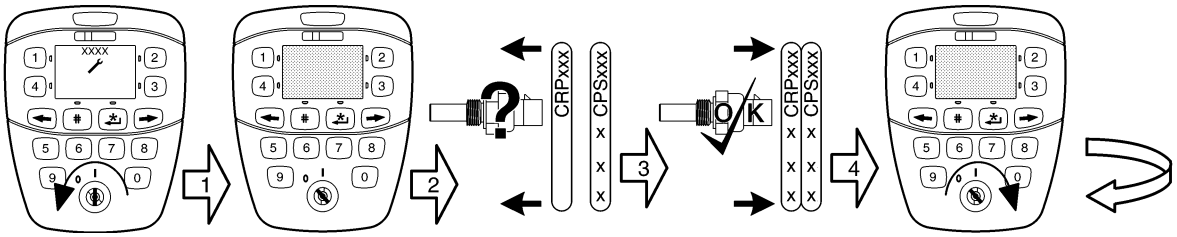
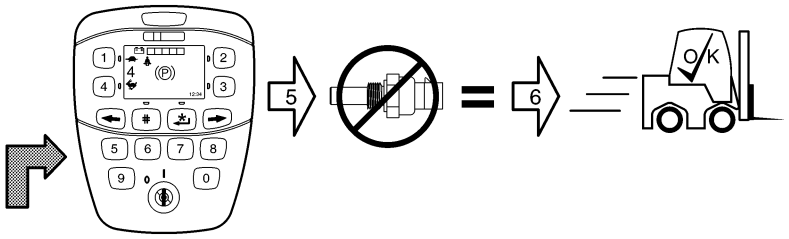
Hydraulic Temperature Sensor Out of Range High (OORL) (Cont)

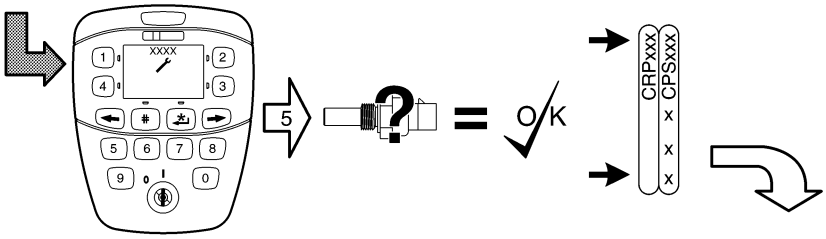
CAUSE D



Power **OFF**→ | Disconnect sensor.→ Install new sensor.→ **Do not discard** | Power **ON**→ | Go to next step.

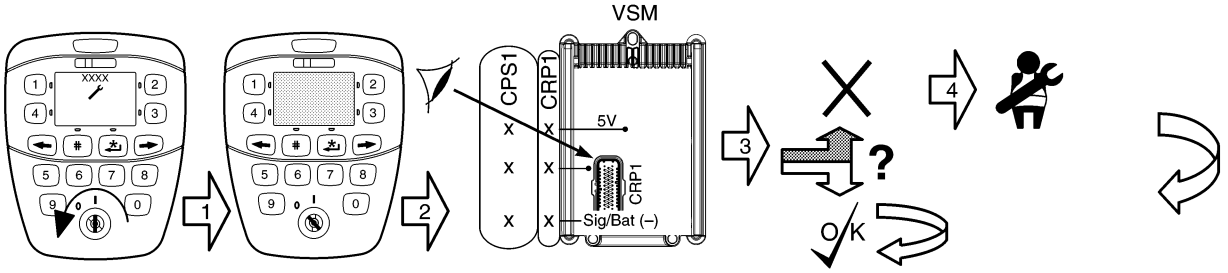


? Fault DTC gone→ | Old sensor faulty→ | Resume operation



Fault DTC present→ | Old sensor OK/Reinstall old sensor→ | Go to Component Operational Check.

CAUSE E



Power **OFF**→ | Inspect VSM Connections→ | Go to Cause E1. | Not OK Correct/Repair→ Go to Cause E1.

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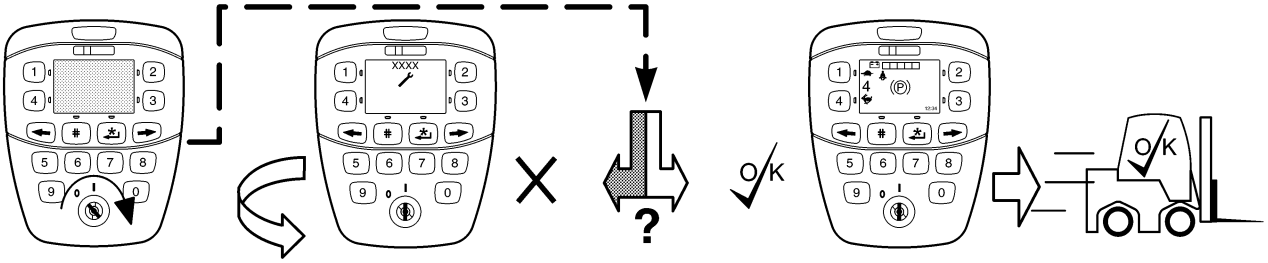
Hydraulic Temperature Sensor Out of Range High (OORL) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO ← **YES** →

Fault corrected→ Continue operation.

END FAULT

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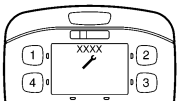
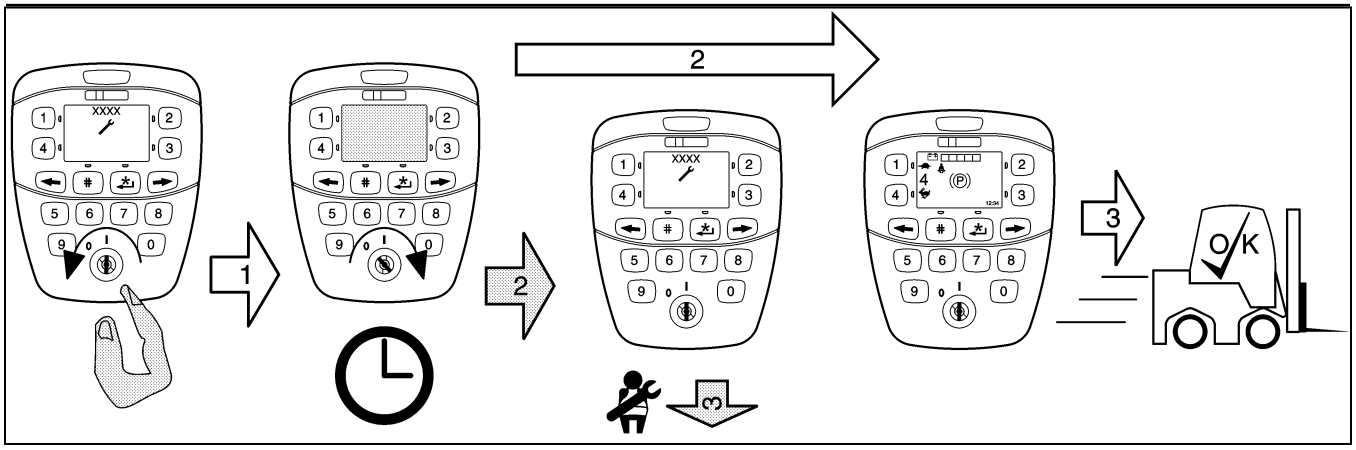
Hydraulic Temperature Sensor Out of Range High (OORH)



Fault Codes

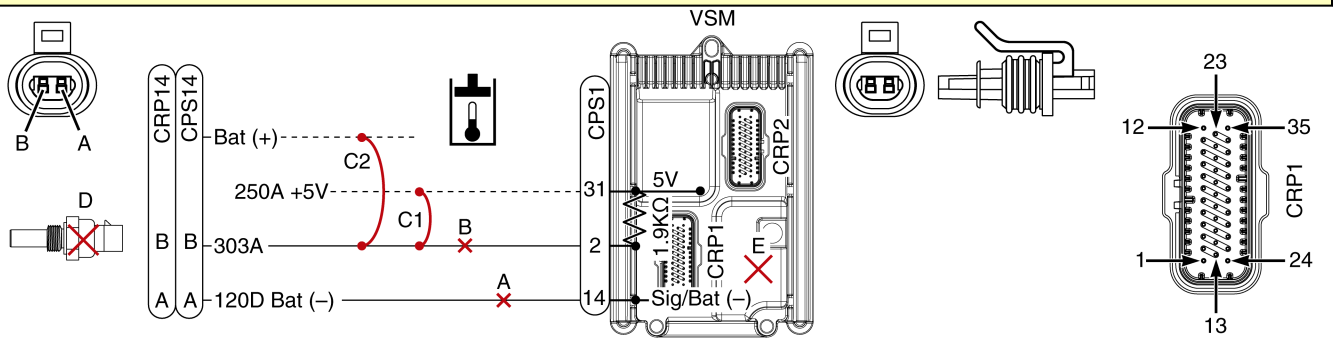
DTC 12853 Hydraulic Temperature



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

HYDRAULIC TEMPERATURE CAUSES A B C C1 C2 D E > ?



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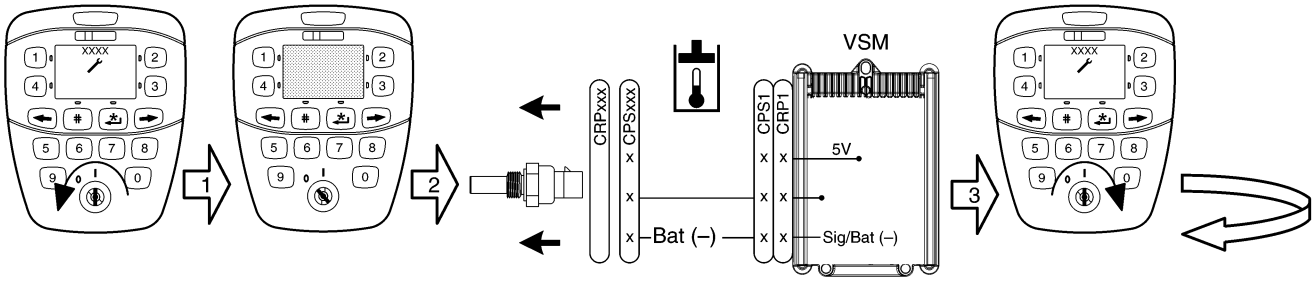
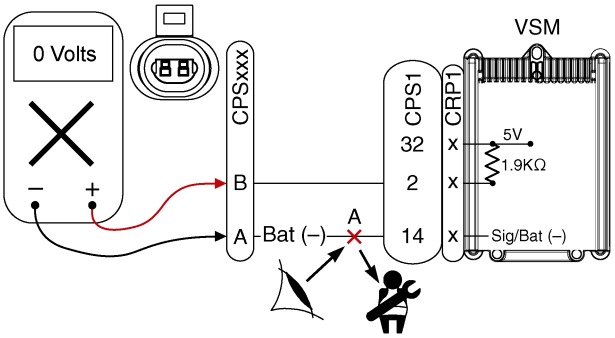
Hydraulic Temperature Sensor Out of Range High (OORH) (Cont)

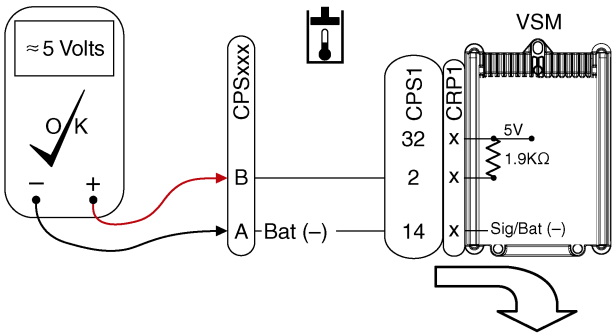
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

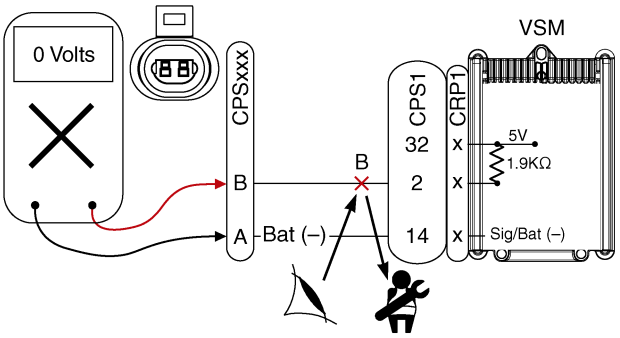
CAUSE A1 CHECK VOLTAGE

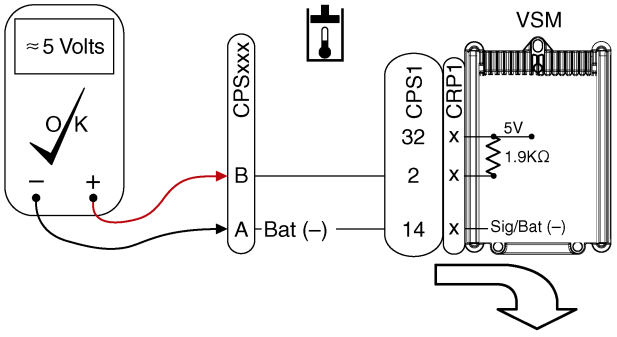




0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B CHECK VOLTAGE





0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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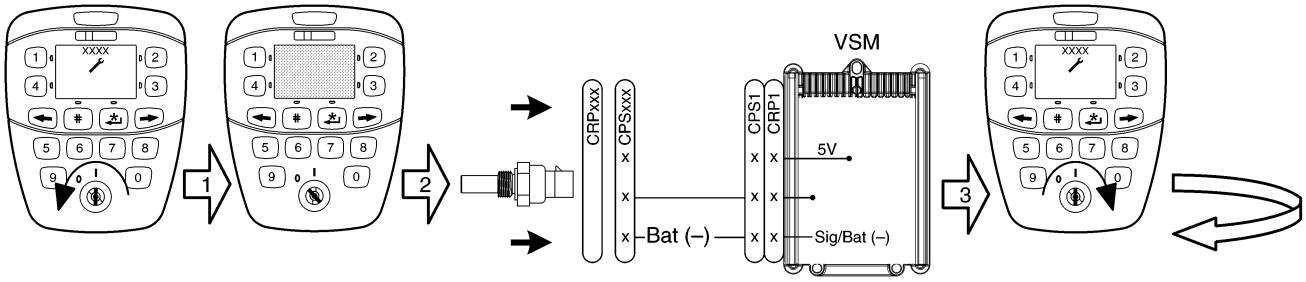
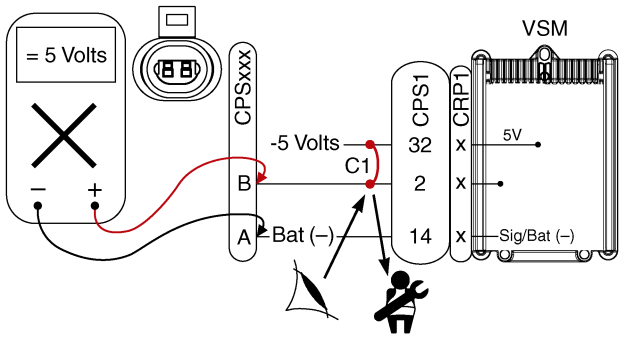
Hydraulic Temperature Sensor Out of Range High (OORH) (Cont)

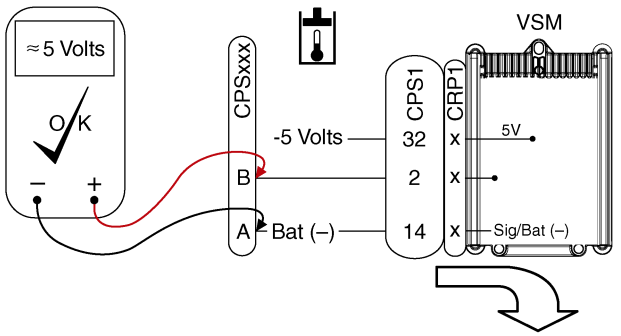
CAUSE C



Power **OFF**→ Reconnect sensor→ Power **ON**→ Go to next step.

CAUSE C1 CHECK VOLTAGE

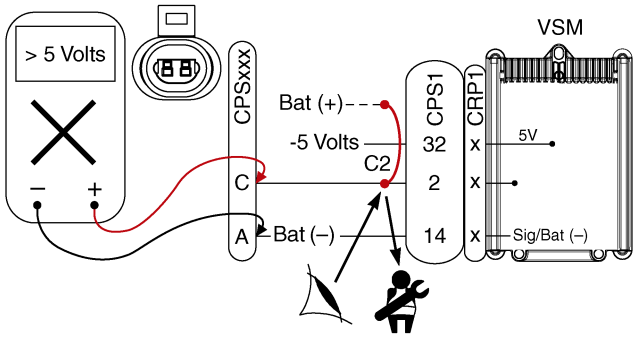


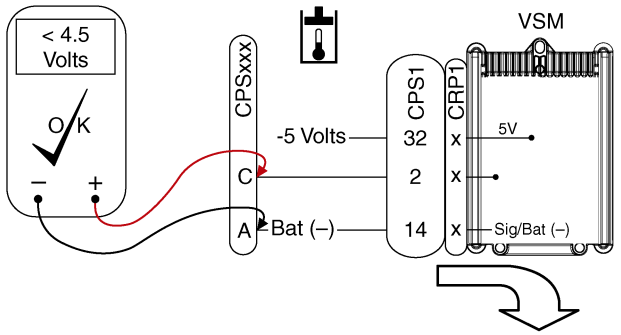


= 5 Volts = Short circuit→ Find↑ **Short** circuit.	> 5.5 volts	Go to Cause C2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts = **OK**	Go to Component Operational Check

CAUSE C2 CHECK VOLTAGE

Switched and Unswitched





> 5.5 volts = Short circuit→ Find↑ **Short** circuit to another voltage source.	< 4.5 volts = **OK**	Go to Component Operational Check.
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

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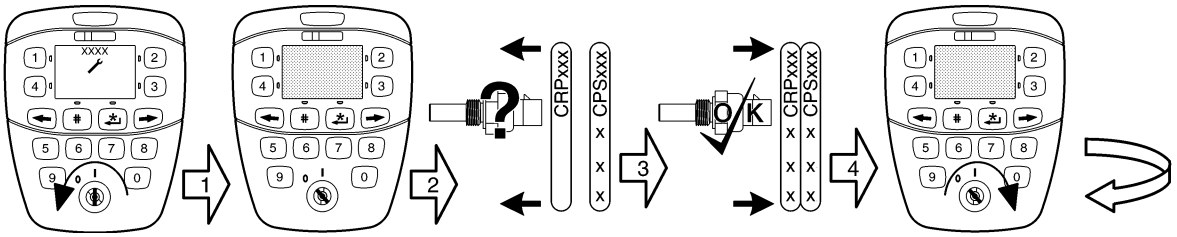
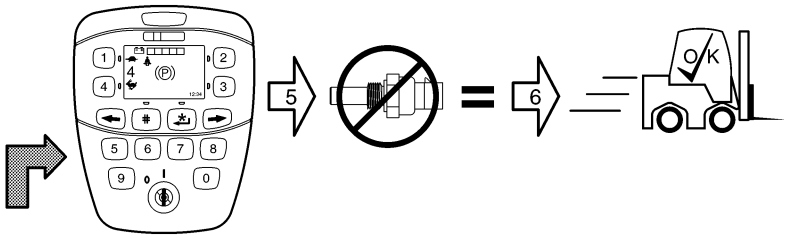
Hydraulic Temperature Sensor Out of Range High (OORH) (Cont)

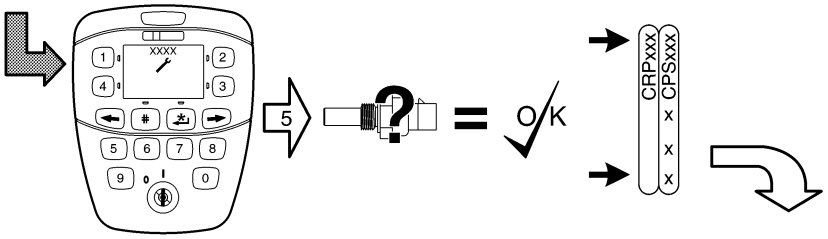
CAUSE D



Power **OFF**→ | Disconnect sensor.→ Install new sensor.→ **Do not discard** | Power **ON**→ | Go to next step.

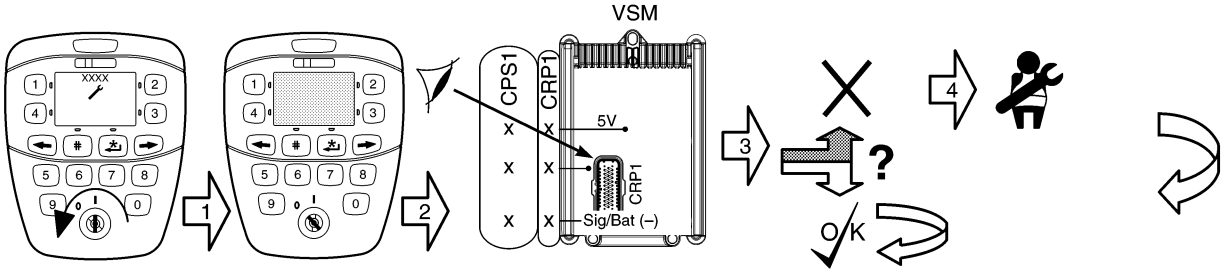


? Fault DTC gone→ | Old sensor faulty→ | Resume operation



Fault DTC present→ | Old sensor OK/Reinstall old sensor→ | Go to Component Operational Check.

CAUSE E



Power **OFF**→ | Inspect VSM Connections→ | Go to Cause E1. | Not OK Correct/ Repair→ Go to Cause E1.

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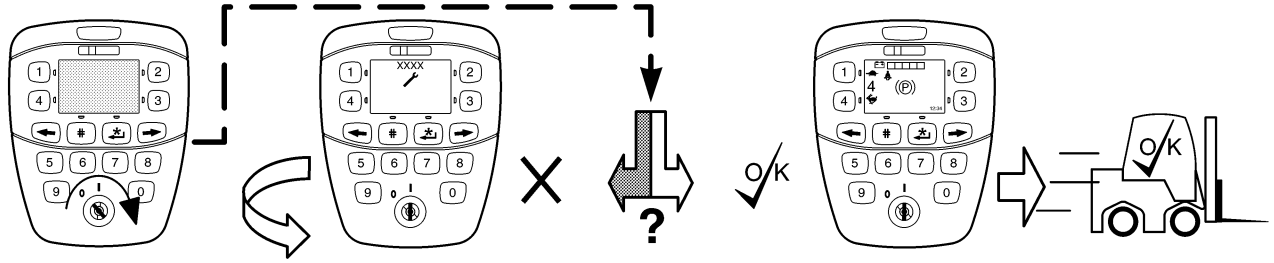
Hydraulic Temperature Sensor Out of Range High (OORH) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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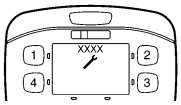
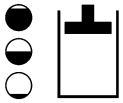
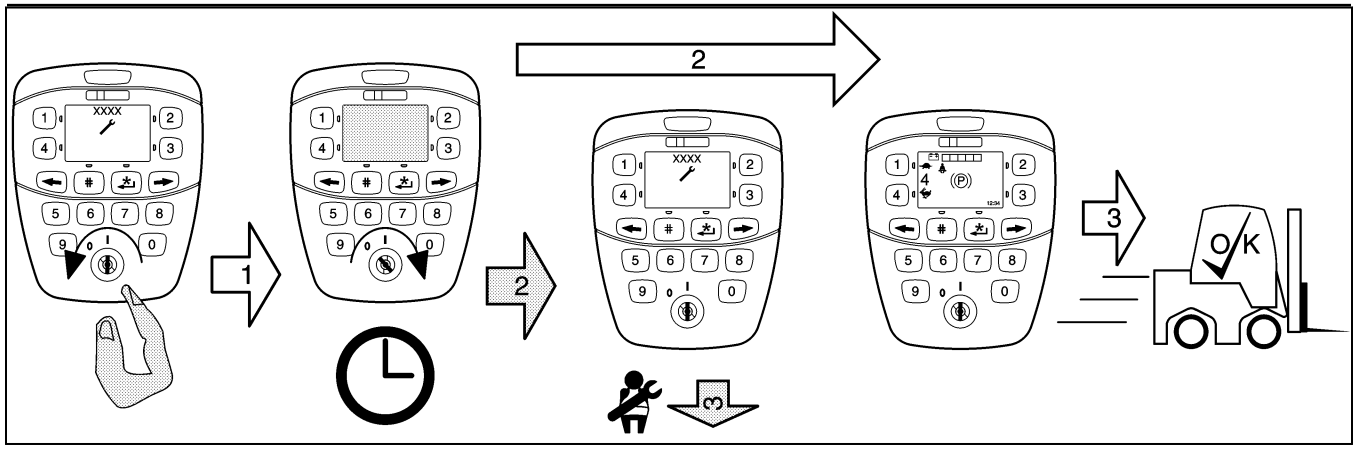
Hydraulic Fluid Level Sensor Out Of Range Low (OORL)



Fault Codes



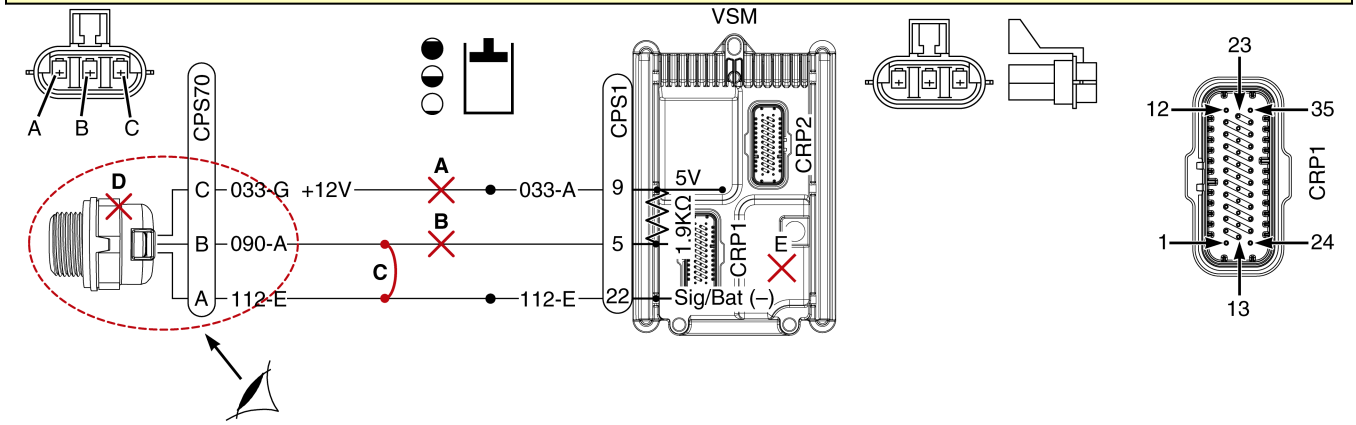
DTC 12872
Hydraulic Fluid Level



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

HYDRAULIC FLUID LEVEL CAUSES A B C D E > ?



NOTE: If the CDF setting is for a sensor but the sensor is not connected, then a DTC code will be displayed.
Check that the sensor is present and the harness connection is OK.

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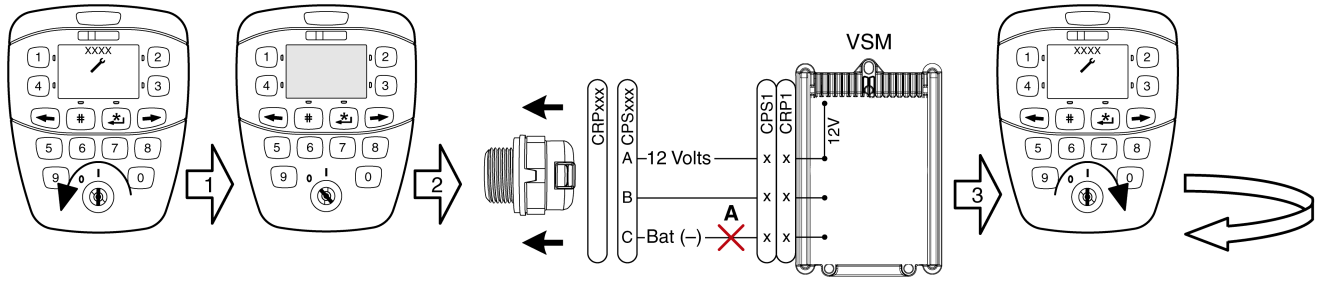
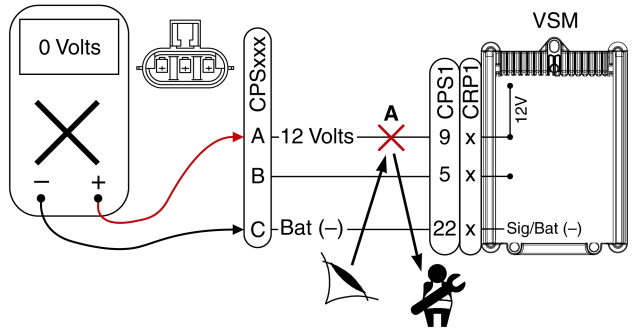
Hydraulic Fluid Level Sensor Out Of Range Low (OORL) (Cont)

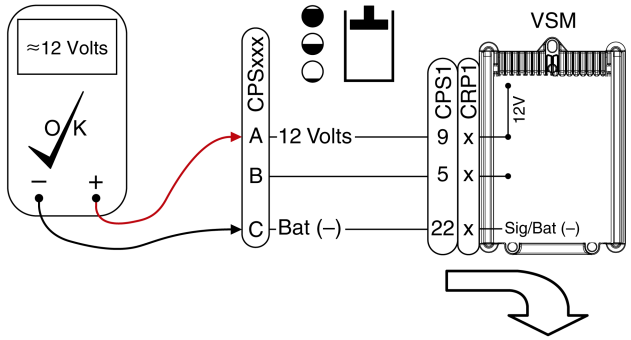
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

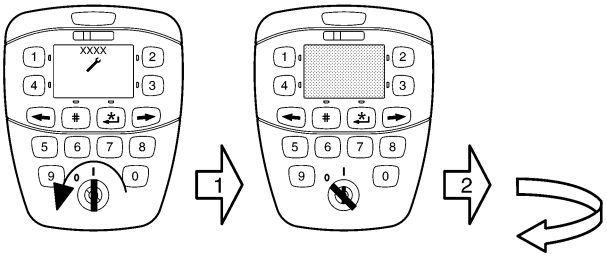
CAUSE A1 CHECK VOLTAGE





0 Volts = Open circuit→ Find↑ **Open** circuit.	˜ 12Volts = **OK** → Go to Component Operational Check↓
Repair Open Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

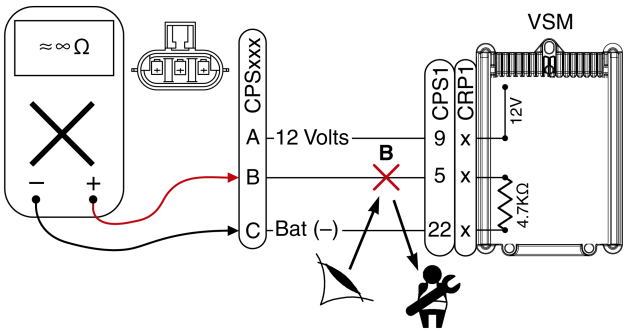
CAUSE B

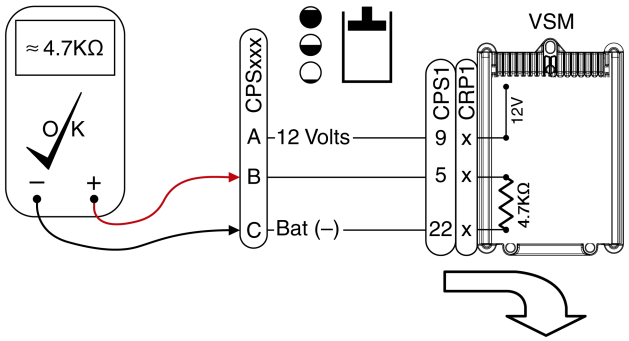


Power **OFF**→ ?

Hydraulic Fluid Level Sensor Out Of Range Low (OORL) (Cont)

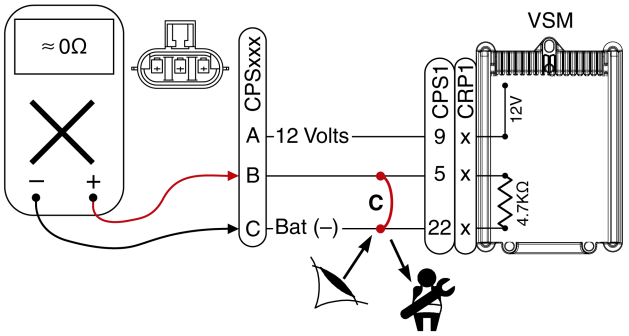
CAUSE B1 CHECK RESISTANCE - Ω - OHMS

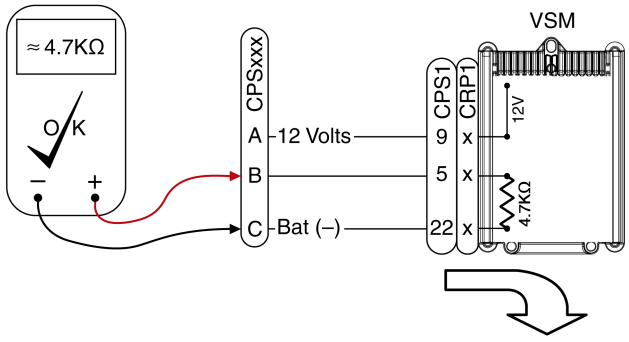




1. 8 ? = Open circuit→Find↑**OPEN** circuit→Go to 3↓	˜ 4.7K? = **OK** Go to Component Operational Check.↓
2. 0? = Short circuit→Go to Component Operational Check↓	
3. Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.Go to 4↓	
4. Repair 🛠→Retest→Cause C1↓	

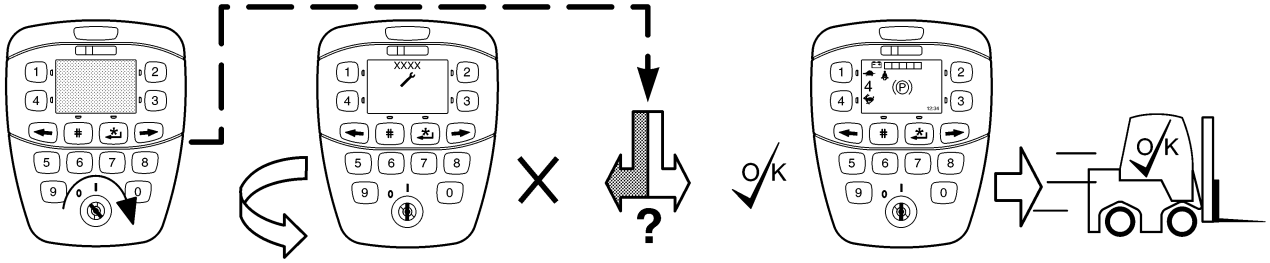
CAUSE C CHECK RESISTANCE - Ω - OHMS





1. 0? = Short circuit→Find↑**Short** circuitGo to 2↓	˜ 4.7K? = **OK** Go to Component Operational Check.↓
2. Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.Go to 3↓	
3. Repair 🛠→Retest→Cause C1↓	

CAUSE C1



Retest - Power **ON**→ **NO** → Go to Component Operational Check

Is fault DTC gone?

NO ← **YES** →

Fault corrected→ Continue operation.

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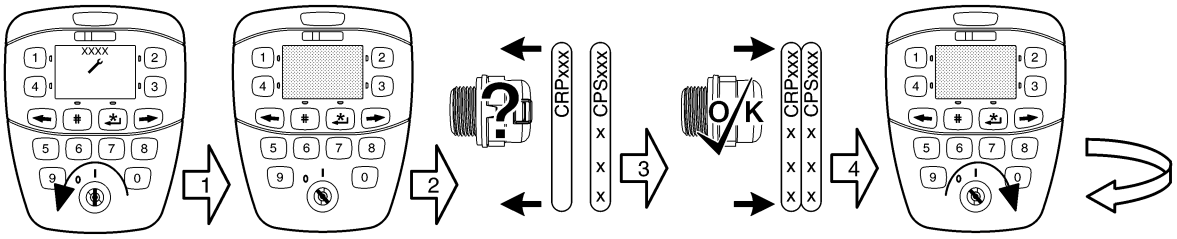
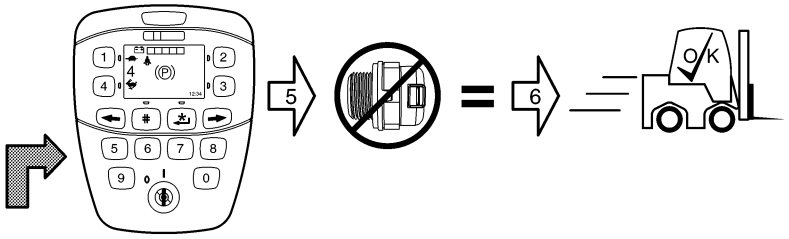
Hydraulic Fluid Level Sensor Out Of Range Low (OORL) (Cont)

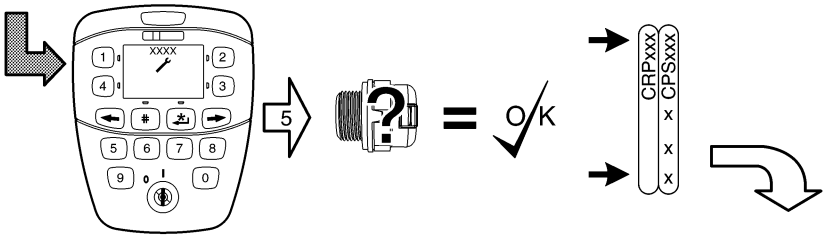
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ Go to next step.

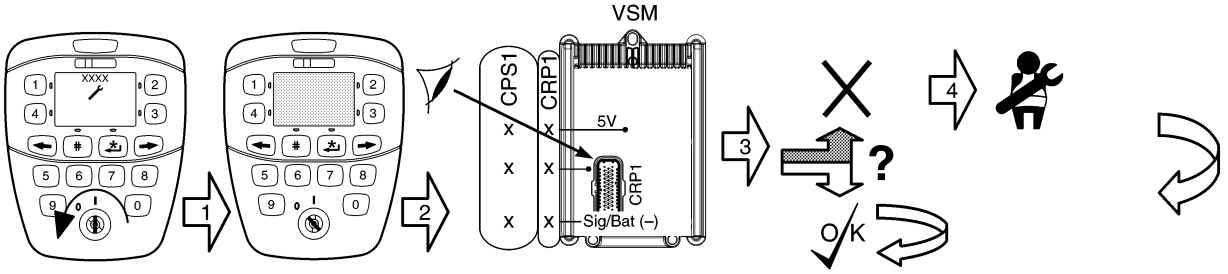


? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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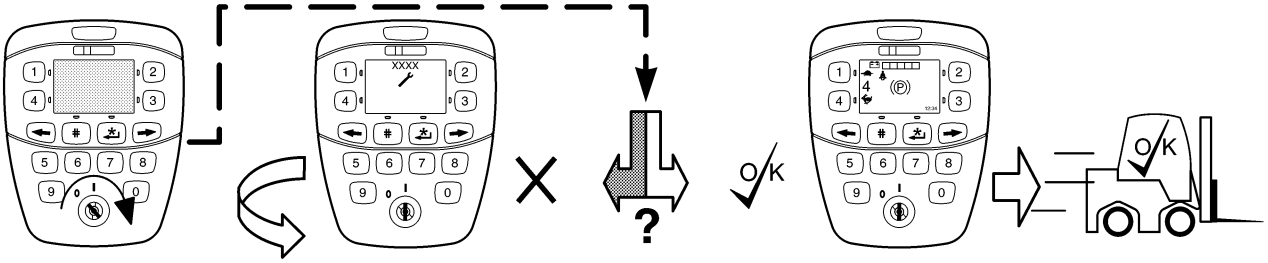
Hydraulic Fluid Level Sensor Out Of Range Low (OORL) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

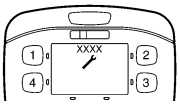
NO ← **YES** →

Fault corrected→ Continue operation.

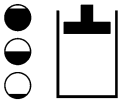
END FAULT

https://truckmanualshub.com/

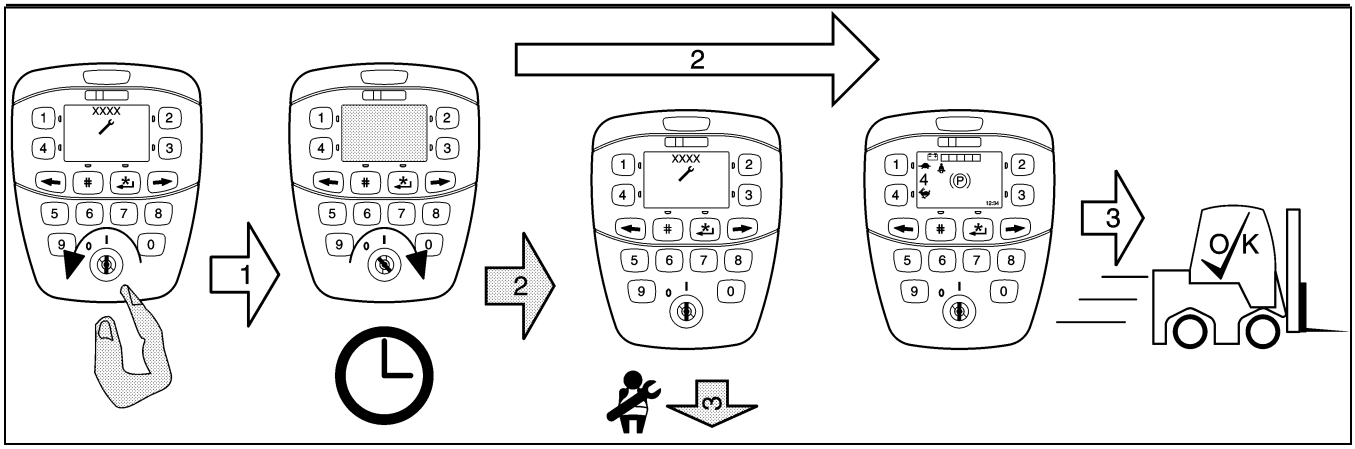
Hydraulic Fluid Level Sensor Out Of Range High (OORH)



Fault Codes



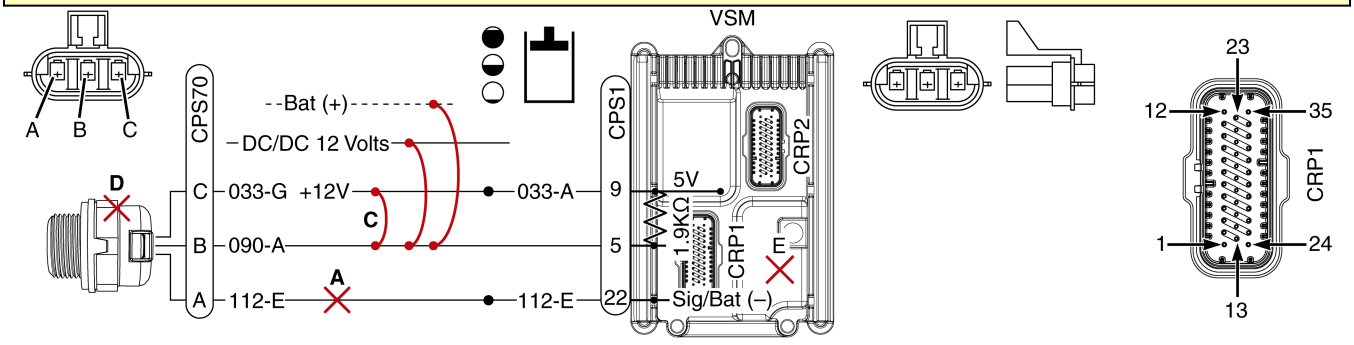
DTC 12873
Hydraulic Fluid Level



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

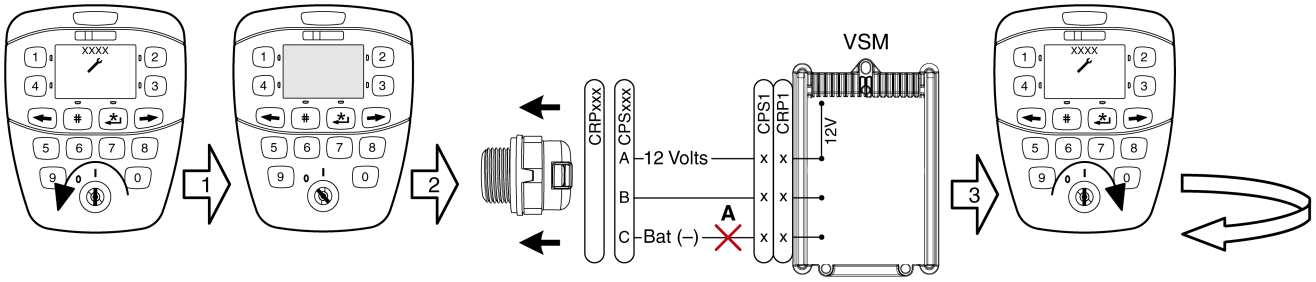
HYDRAULIC TEMPERATURE CAUSES A B C D E > ?



https://truckmanualshub.com/

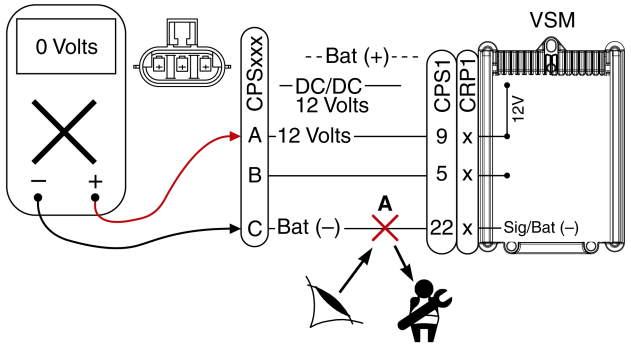
Hydraulic Fluid Level Sensor Out Of Range High (OORH) (Cont)

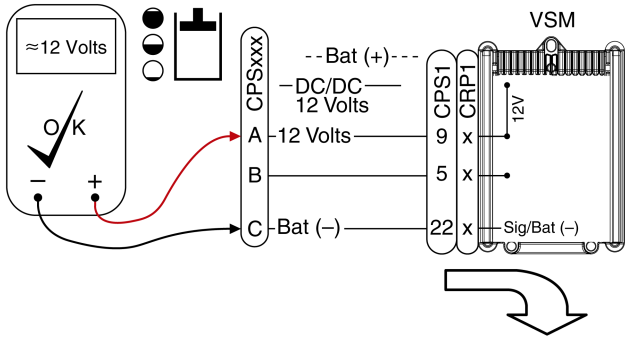
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to A1.↓

CAUSE A1 CHECK VOLTAGE



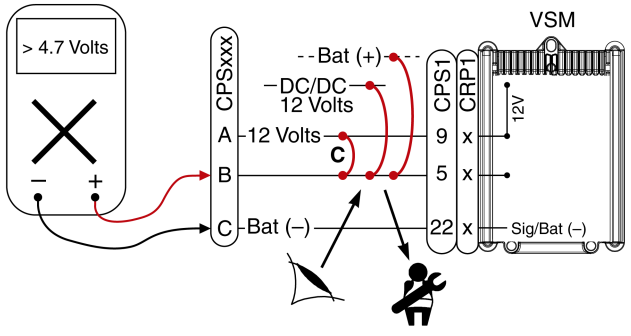


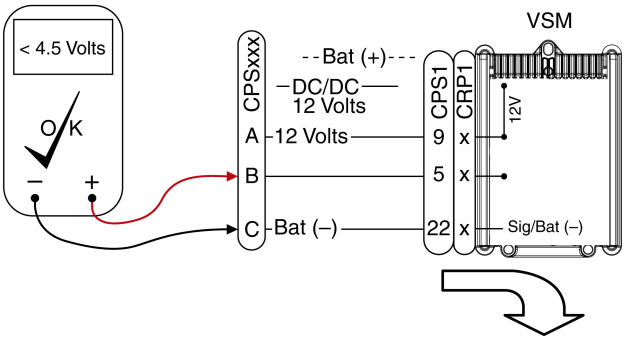
0 Volts = Open circuit→ Find↑ **OPEN** circuit.	~ 12 Volts =	**OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

CAUSE B

Not Applicable

CAUSE C





> 4.7 Volts = Short circuit→ Find↑ **Short** circuit.	< /= 4.5 Volts =	**OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

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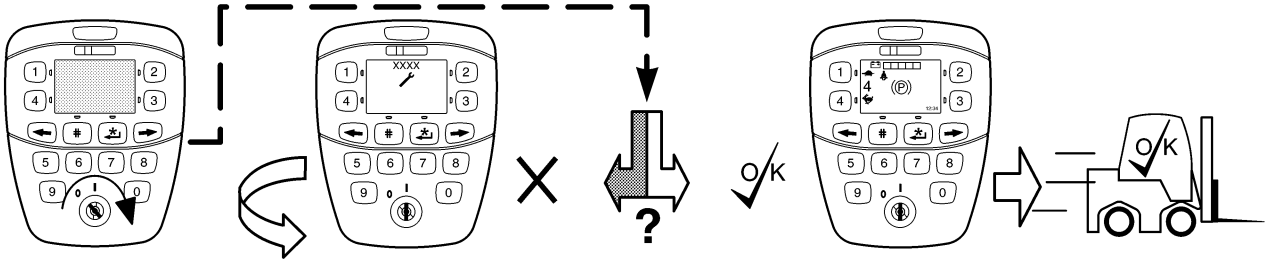
Hydraulic Fluid Level Sensor Out Of Range High (OORH) (Cont)

CAUSE C1



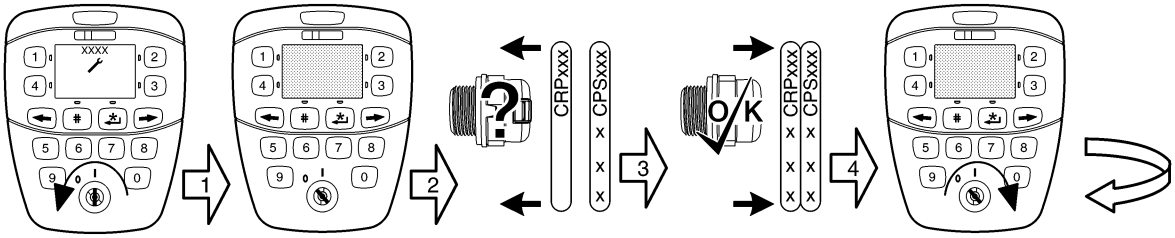
Retest - Power **ON**→ **NO** → Go to Component Operational Check

Is fault DTC gone?

NO ← **YES** →

Fault corrected→ Continue operation.

CAUSE D

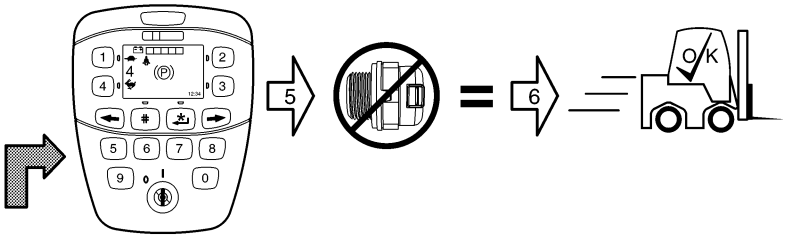


Power **OFF**→

Disconnect sensor.→ Install new sensor.→
Do not discard

Power **ON**→

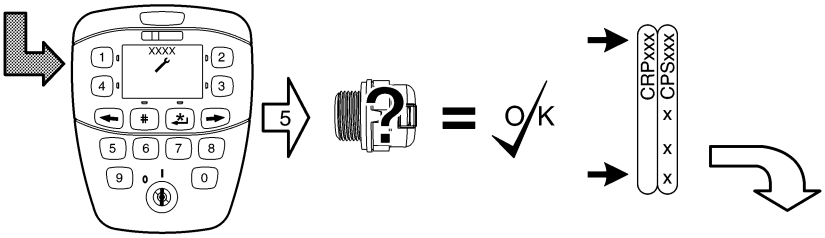
Go to next step.↓



? Fault DTC gone→

Old sensor faulty→

Resume operation



Fault DTC present→

Old sensor OK/Reinstall old sensor→

Go to Component Operational Check.

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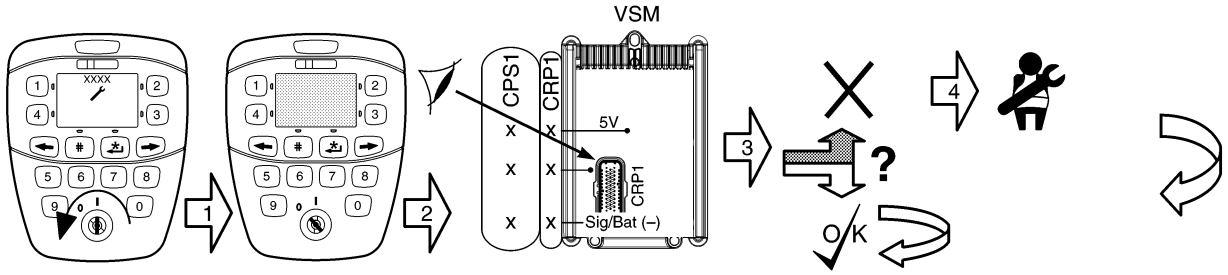
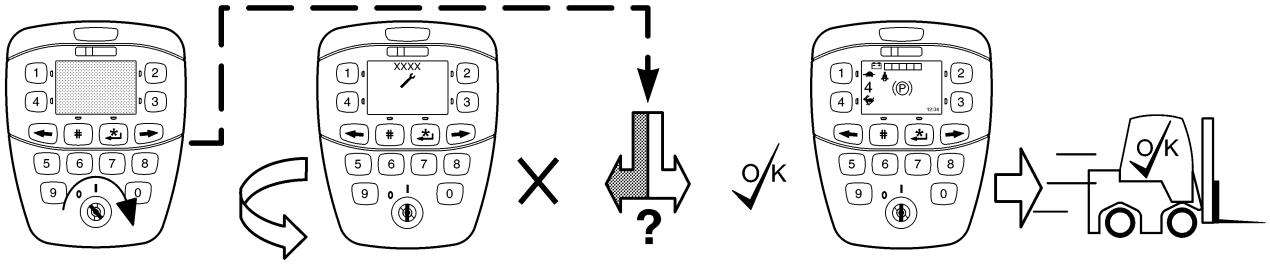
Hydraulic Fluid Level Sensor Out Of Range High (OORH) (Cont)

CAUSE E



Power **OFF**→ | Inspect VSM Connections→ | Go to Cause E1. | Not OK Correct/ Repair→ Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ | **NO** → Go to VSM Controller Check | Is fault DTC gone? | Fault corrected→ Continue operation.

NO ← **YES** →

END FAULT

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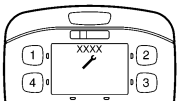
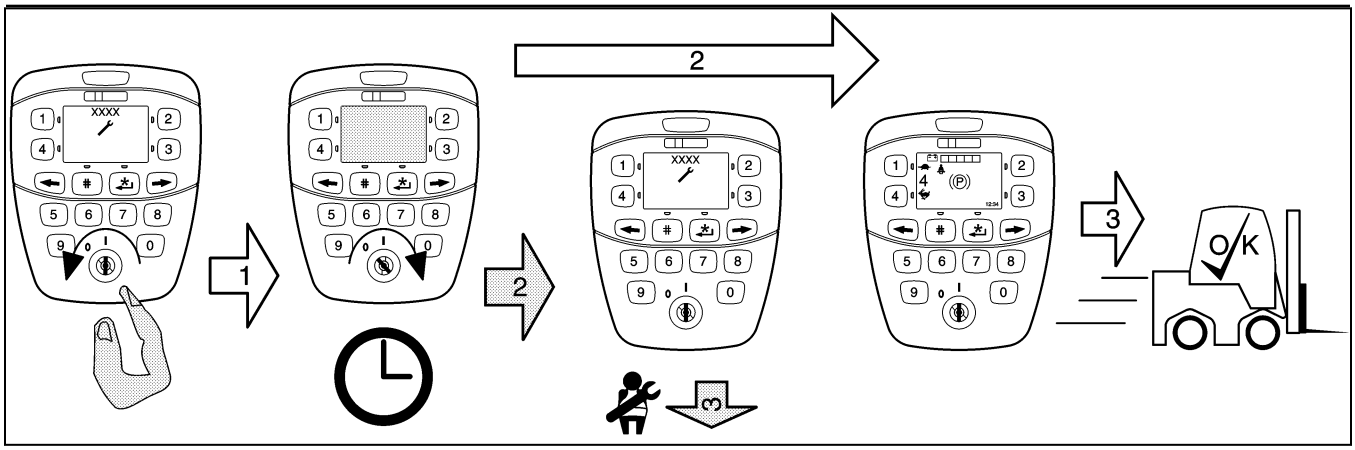
Park Brake/Mast Tilt Position Sensor Out of Range Low (OORL)



Fault Codes

DTC 12832
Park Brake Position

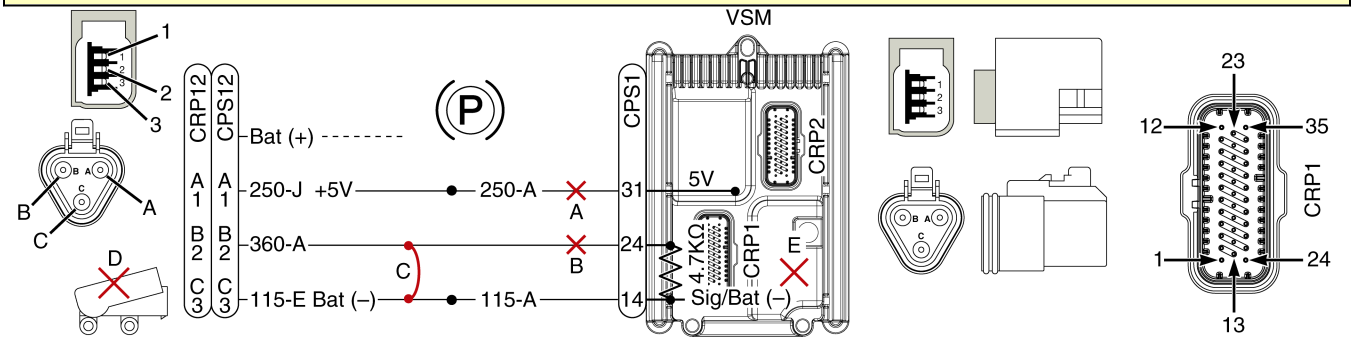
DTC 12840
Mast Tilt Position



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

PARK BRAKE POSITION CAUSES A B C D E > ?



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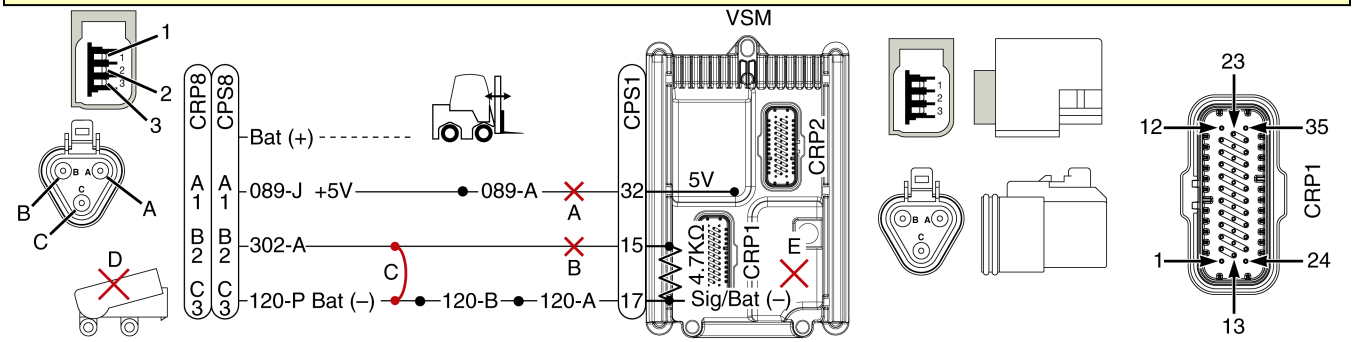
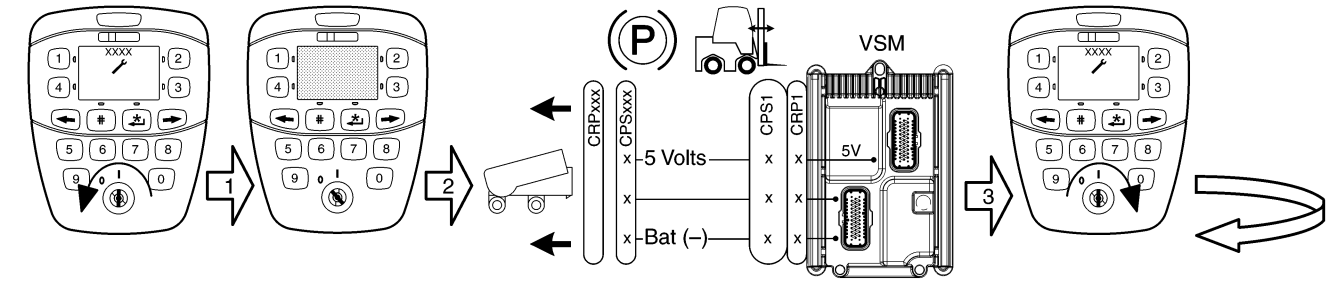
Park Brake/Mast Tilt Position Sensor Out of Range Low (OORL) (Cont)

MAST TILT POSITION CAUSES A B C D E > ?

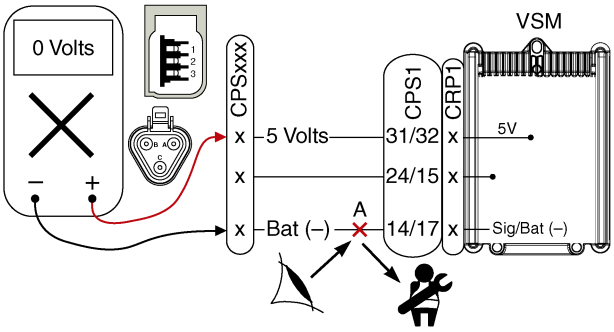


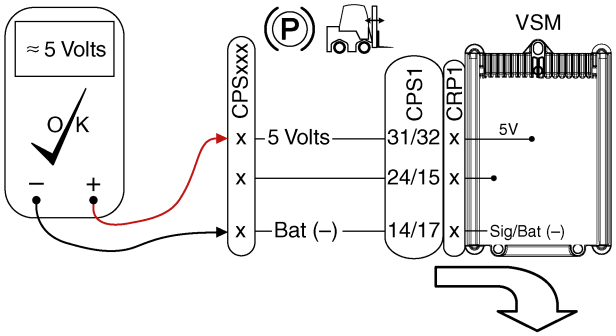
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

CAUSE A1 CHECK VOLTAGE





0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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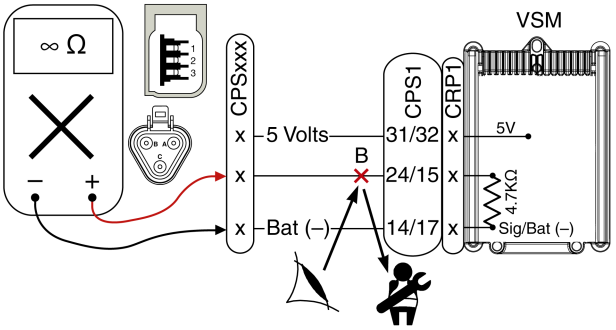
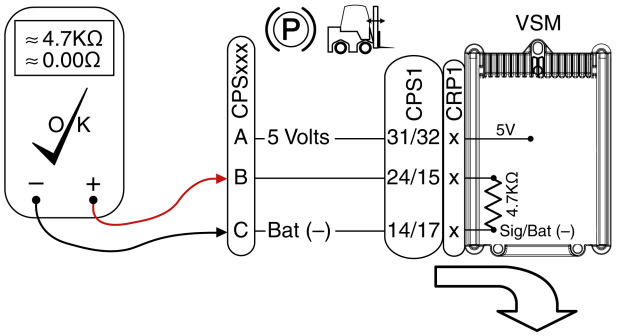
Park Brake/Mast Tilt Position Sensor Out of Range Low (OORL) (Cont)

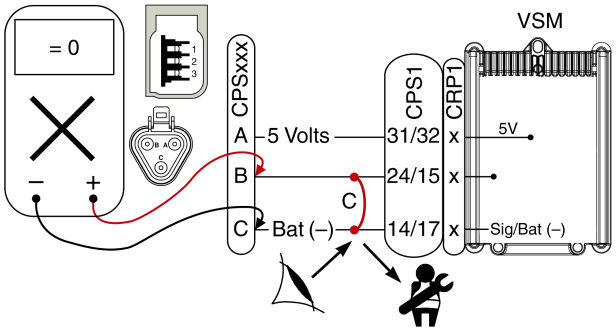
CAUSE B CHECK RESISTANCE - Ω - OHMS





8 ? = Open circuit→ Find↑ **OPEN** circuit	˜ 4.7K? = **OK** Go to Component Operational Check
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? = Go to Component Operational Check

CAUSE C CHECK RESISTANCE - Ω - OHMS



0 ? = Short circuit→ Find↑ **Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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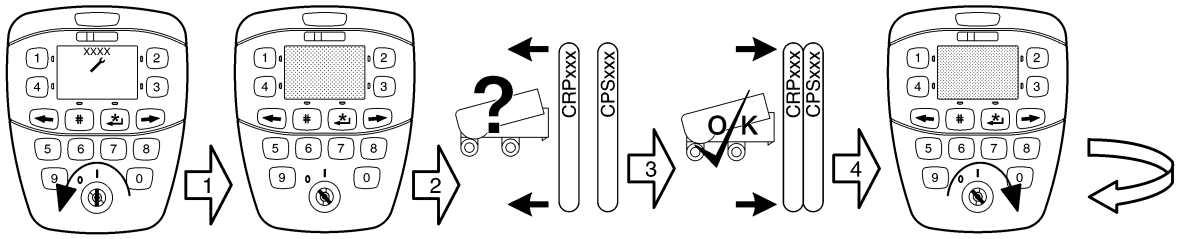
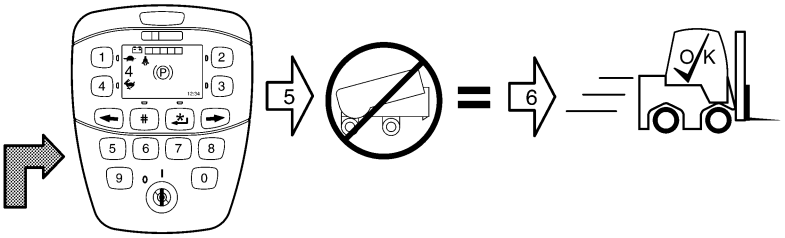
Park Brake/Mast Tilt Position Sensor Out of Range Low (OORL) (Cont)

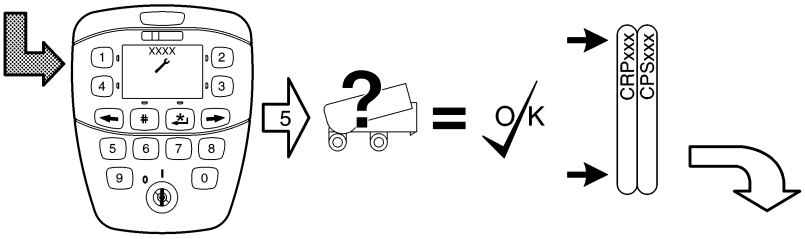
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ Go to next step.

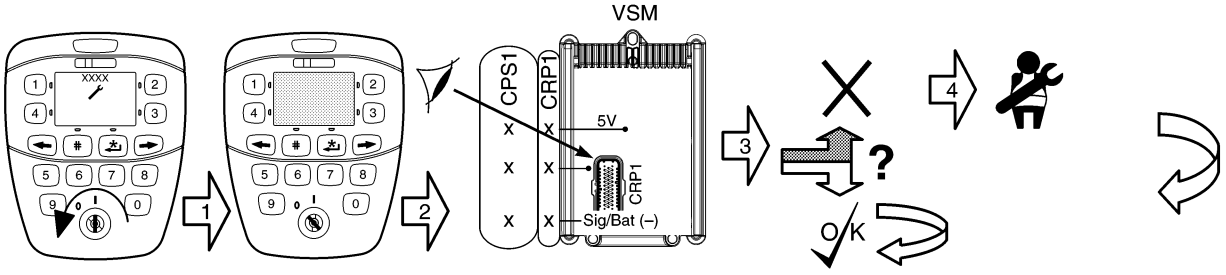


? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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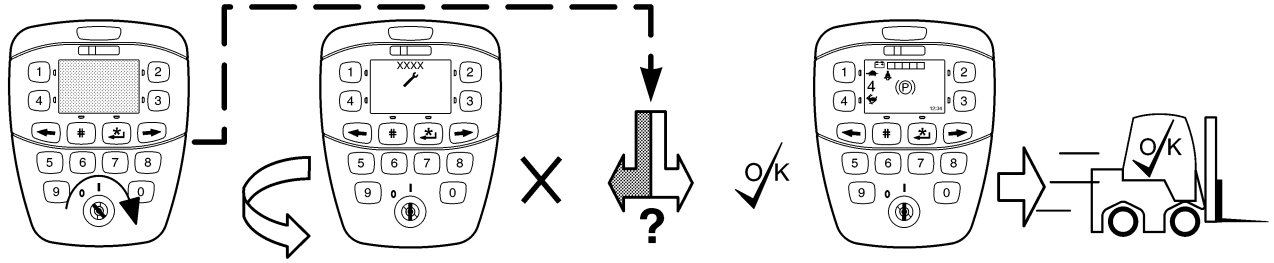
Park Brake/Mast Tilt Position Sensor Out of Range Low (OORL) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO ← YES →

Fault corrected→ Continue operation.

END FAULT

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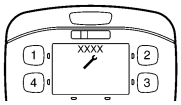
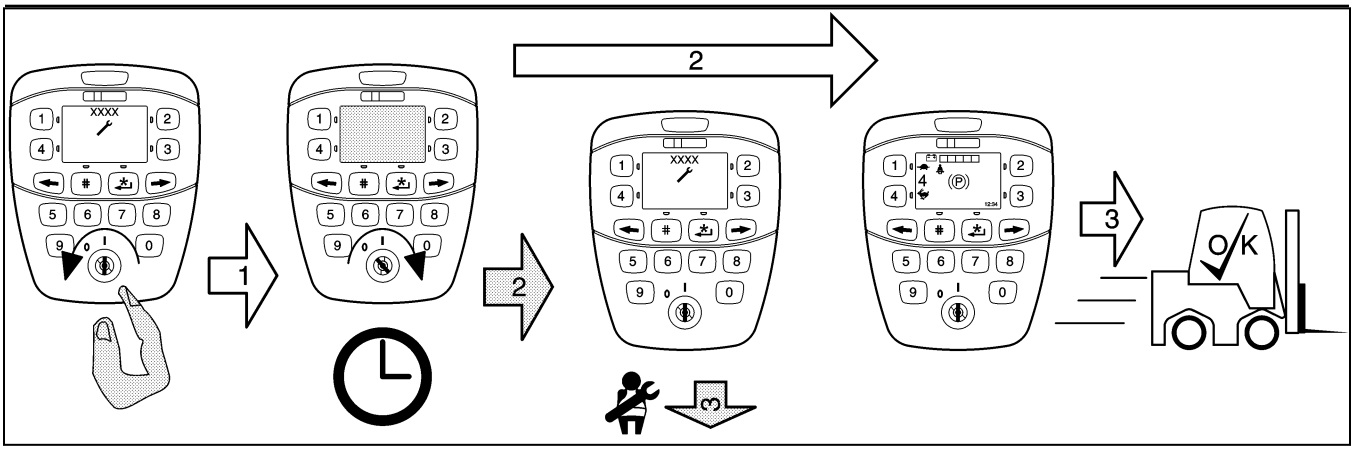
Park Brake/Mast Tilt Position Sensor Out of Range High (OORH)



Fault Codes

DTC 12831
Park Brake Position

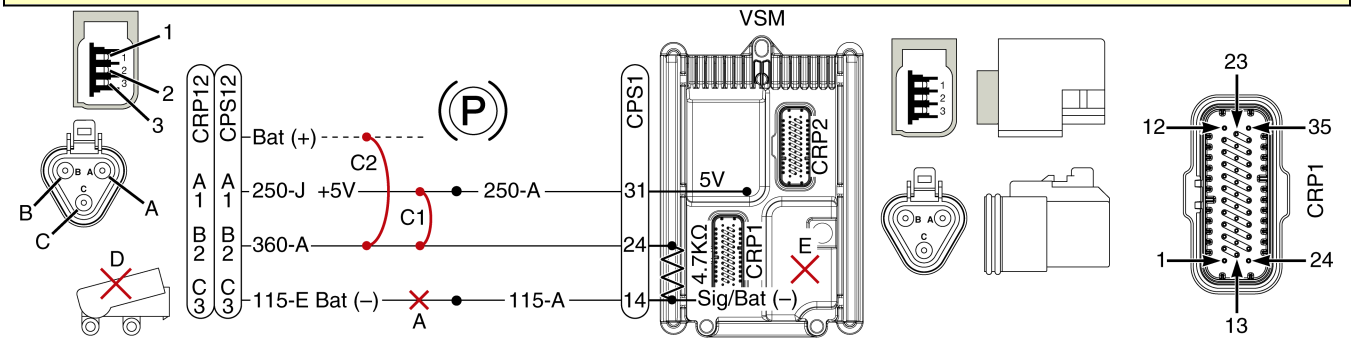
DTC 12841
Mast Tilt Position



Power **OFF**→ Wait **30 seconds**→ Power **ON**→ Fault remains. Service required. Go to Component Operational Check. No fault→ Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

PARK BRAKE POSITION CAUSES A B C D E > ?



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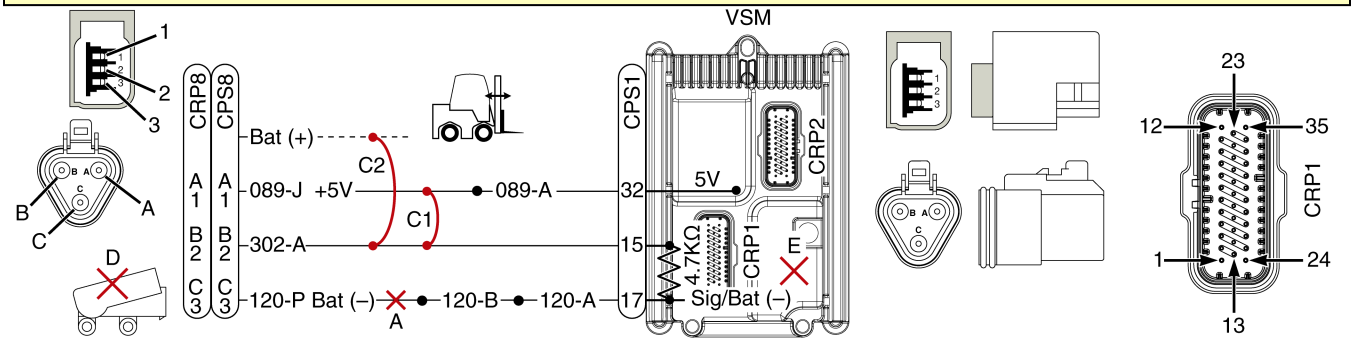
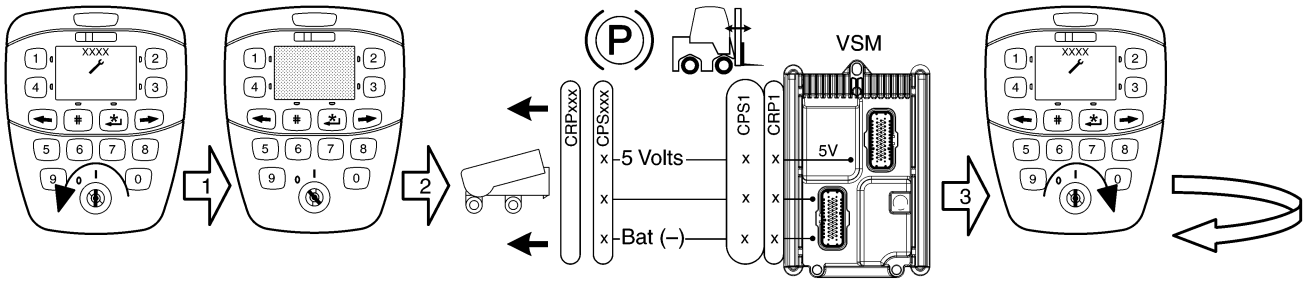
Park Brake/Mast Tilt Position Sensor Out of Range High (OORH) (Cont)

MAST TILT POSITION CAUSES A B C D E > ?

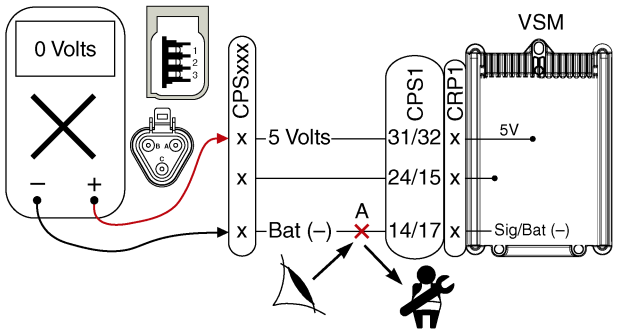


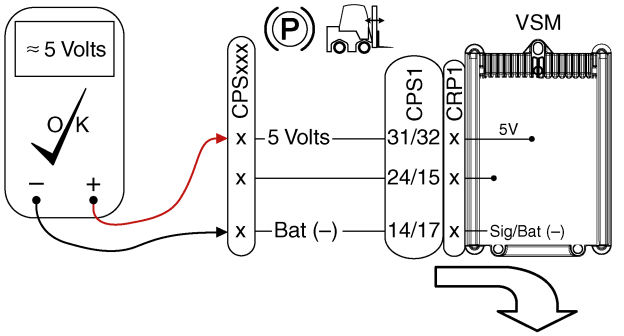
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

CAUSE A1 CHECK VOLTAGE





0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B

Not Applicable

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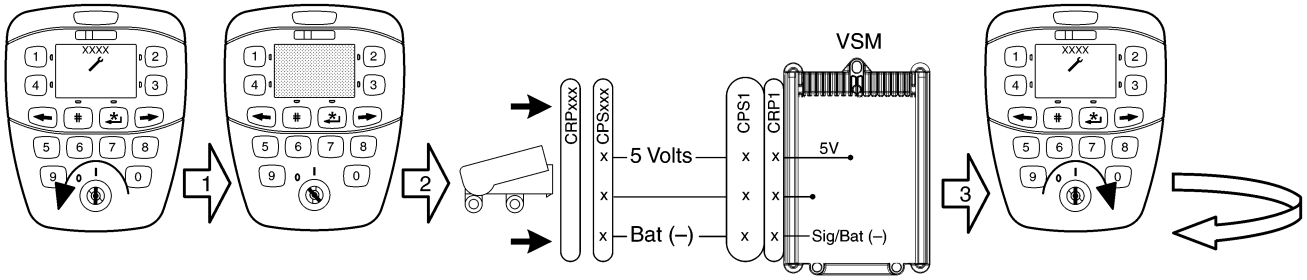
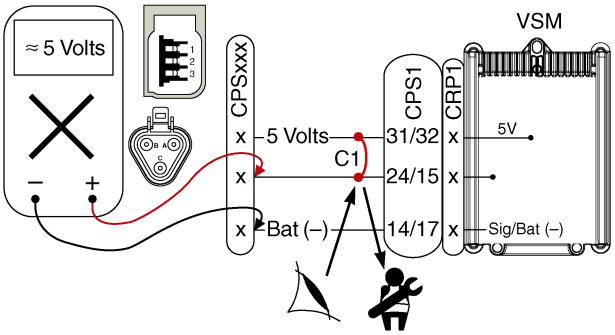
Park Brake/Mast Tilt Position Sensor Out of Range High (OORH) (Cont)

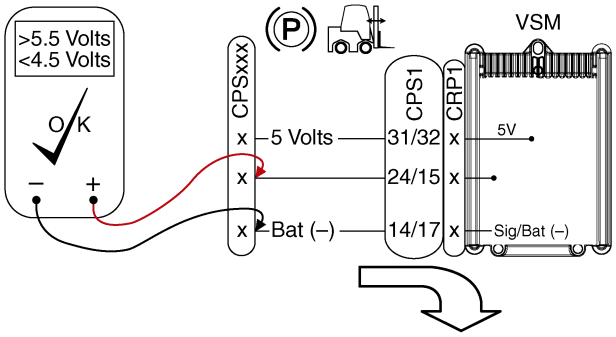
CAUSE C



Power **OFF**→ Reconnect sensor→ Power **ON**→ Go to next step.

CAUSE C1 CHECK VOLTAGE

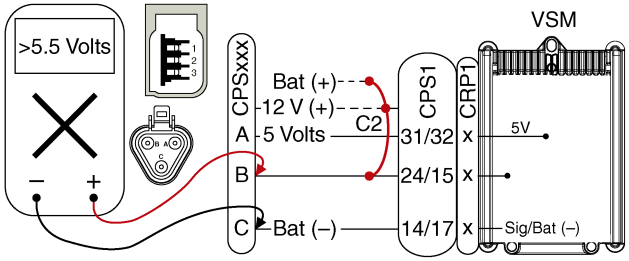


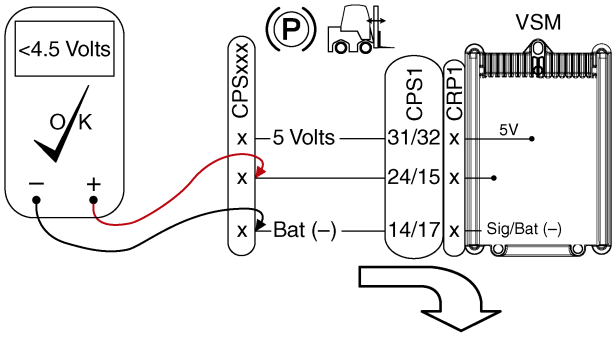


5 Volts = Short circuit→ Find↑ **Short** circuit.	> 5.5 volts	Go to Cause C2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts = **OK**	Go to Component Operational Check

CAUSE C2 CHECK VOLTAGE

Switch and Unswitched





> 5.5 volts = Short circuit→ Find↑ **Short** circuit to another voltage source.	< 4.5 volts = **OK**	Go to Component Operational Check.
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

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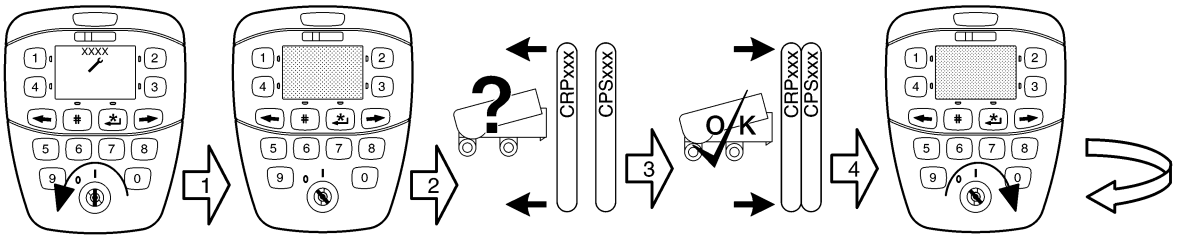
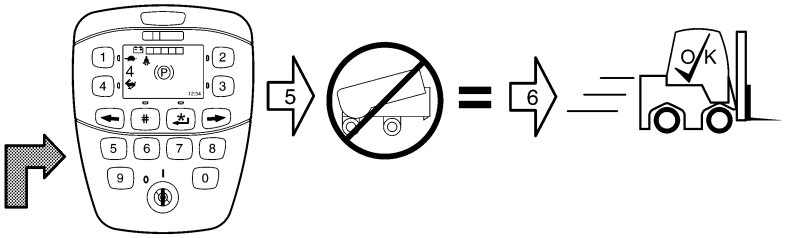
Park Brake/Mast Tilt Position Sensor Out of Range High (OORH) (Cont)

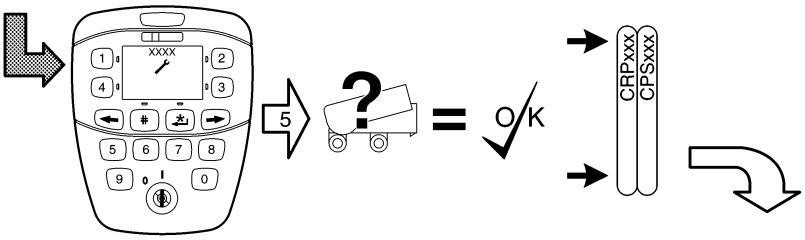
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ Go to next step.

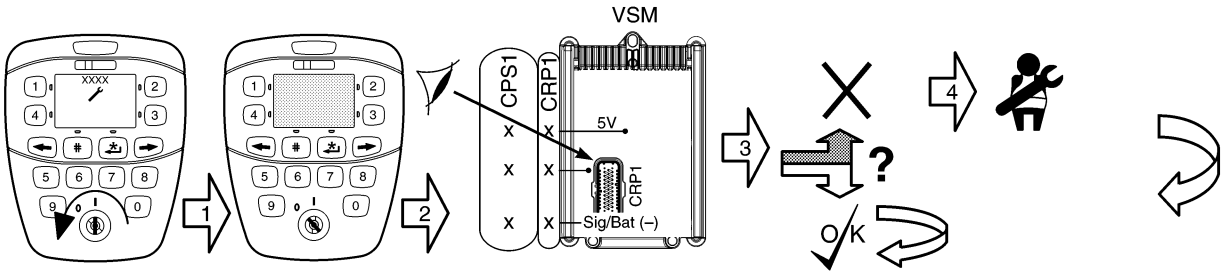


? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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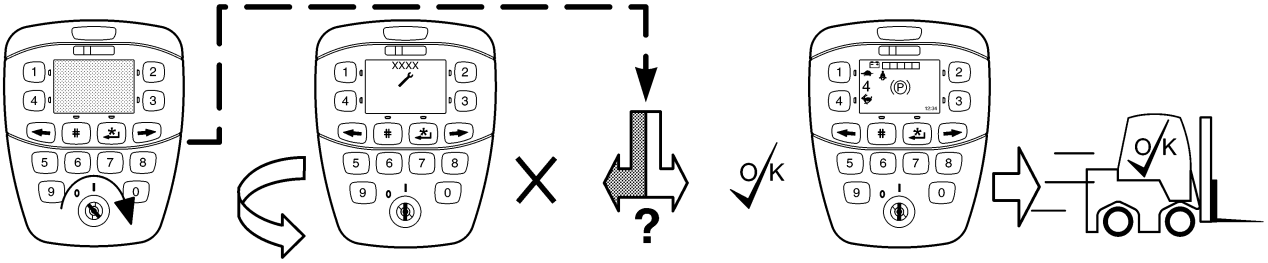
Park Brake/Mast Tilt Position Sensor Out of Range High (OORH) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO ← **YES** →

Fault corrected→ Continue operation.

END FAULT

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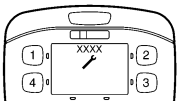
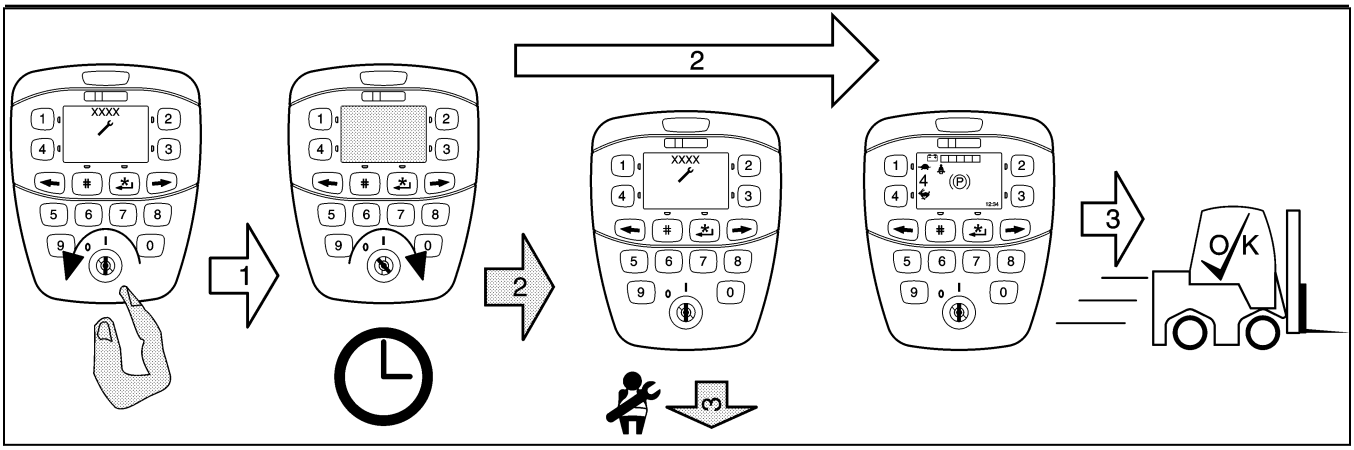
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL)



Fault Codes

DTC 12800
Directional Select A

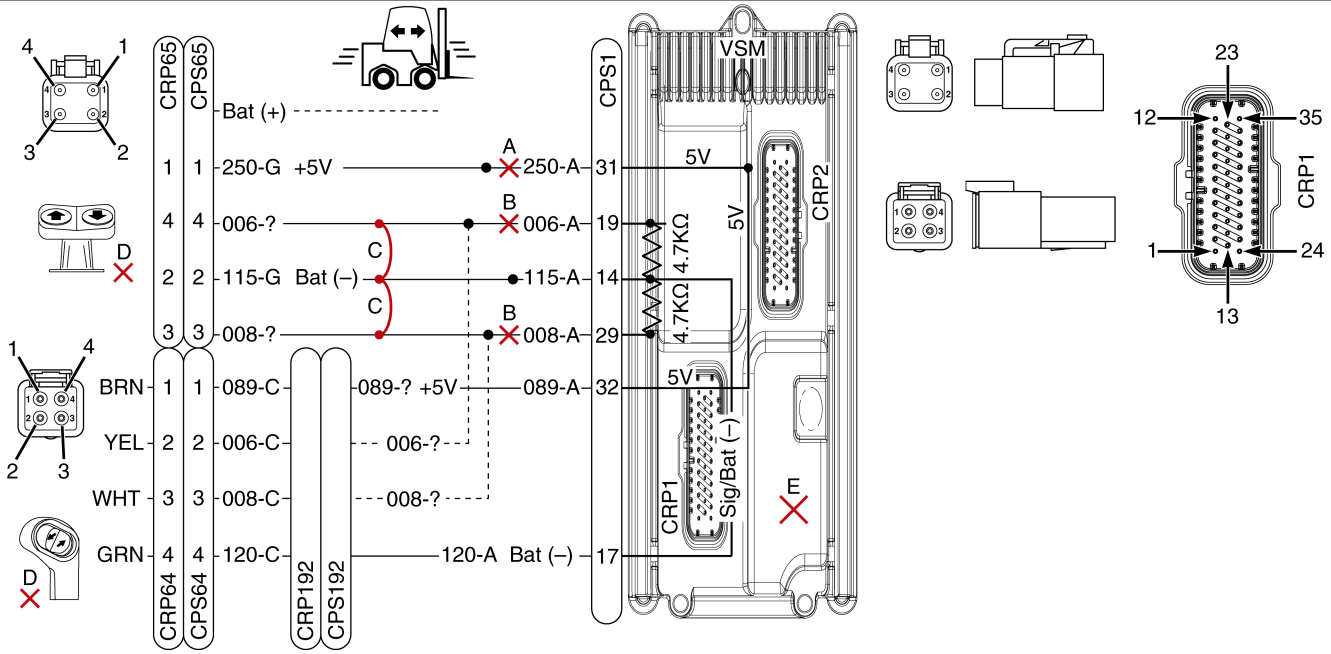
DTC 12804
Directional Select B



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

DIRECTIONAL SELECT A/B CAUSES A B C D E > ?



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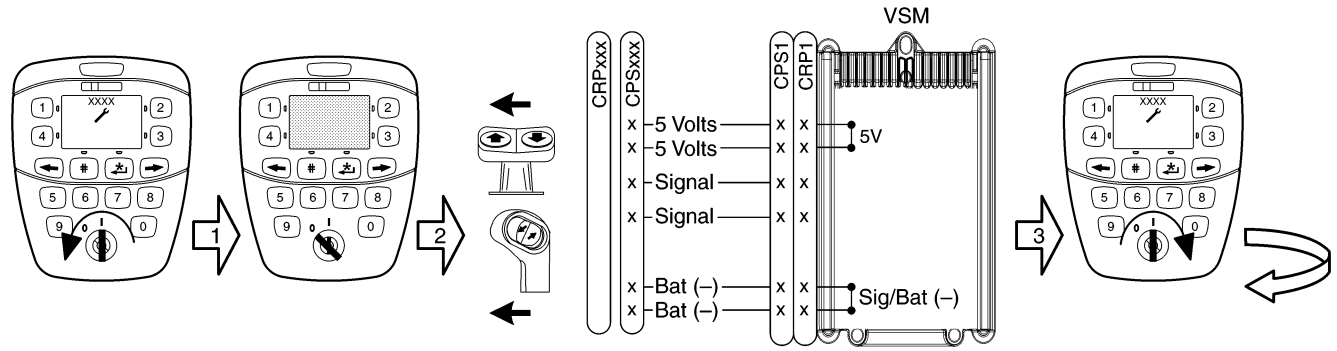
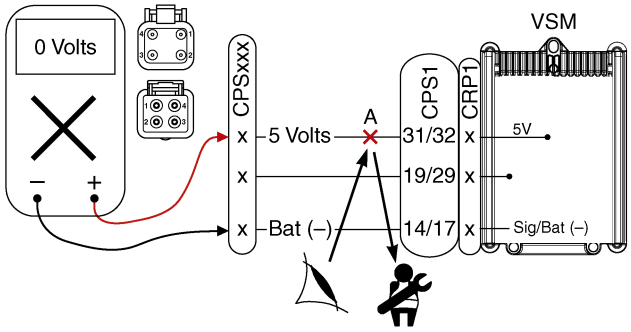
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL) (Cont)

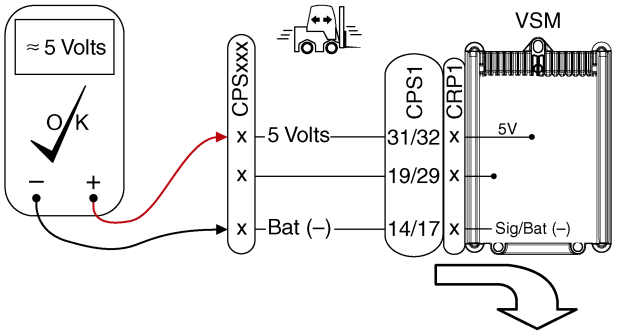
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

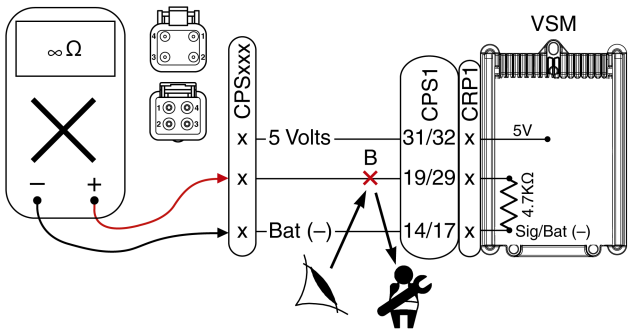
CAUSE A1 CHECK VOLTAGE

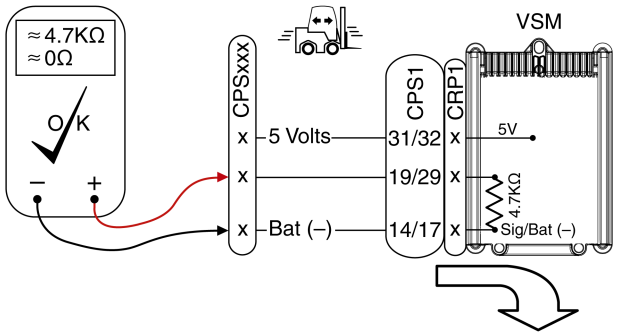




0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B CHECK RESISTANCE - Ω - OHMS





8 ? = Open circuit→ Find↑ **OPEN** circuit	˜ 4.7K? = **OK** Go to Component Operational Check
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0? = Go to Component Operational Check

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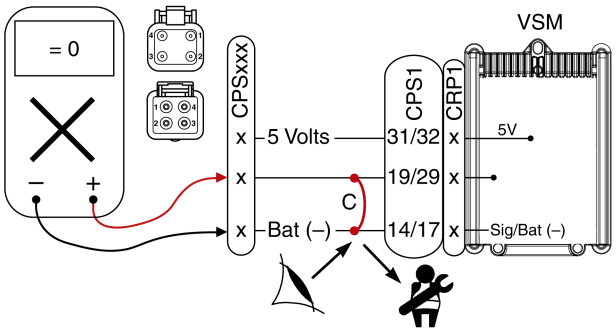
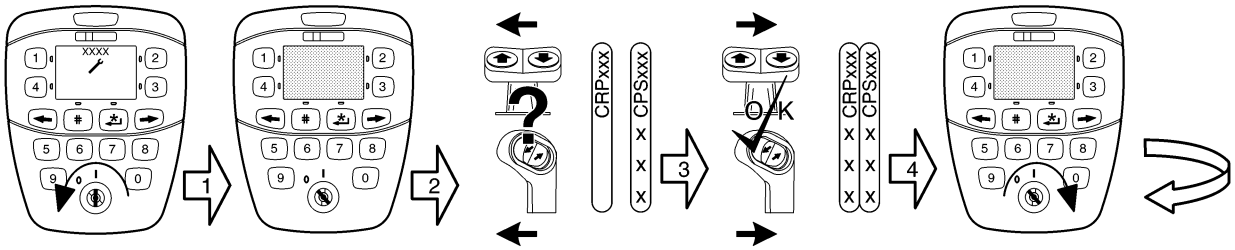
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL) (Cont)

CAUSE C **CHECK VOLTAGE**

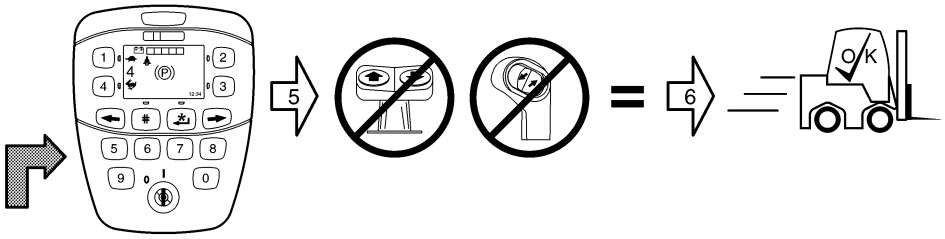


0 ? = Short circuit→ Find↑ **Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

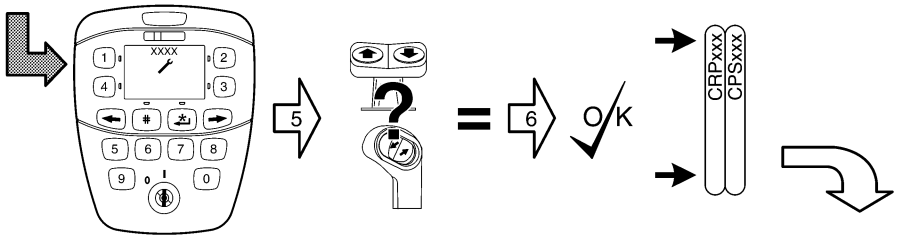
CAUSE D



Power **OFF**→ Disconnect Pedal or Hyd Lever.→ Install new component.→ **Do not discard** Power **ON**→ Go to next step.



? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

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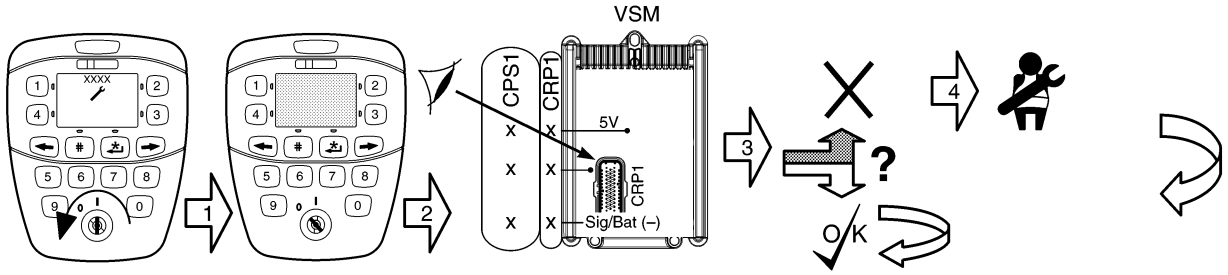
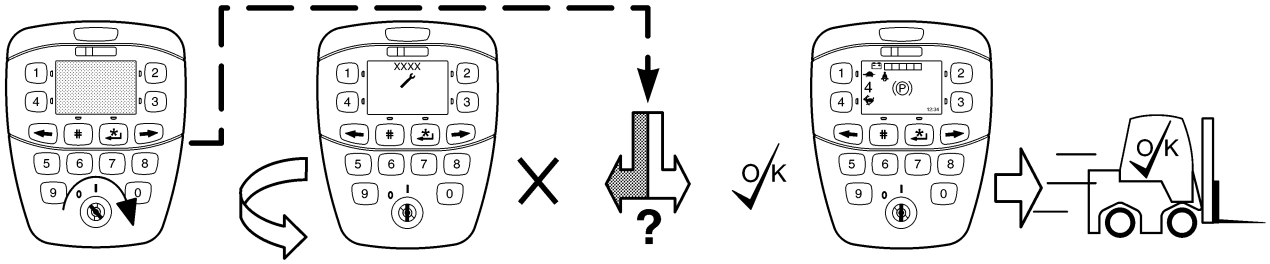
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK - Go to Cause E1. Not OK →Correct/Repair Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO ← **YES** →

END FAULT

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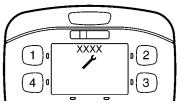
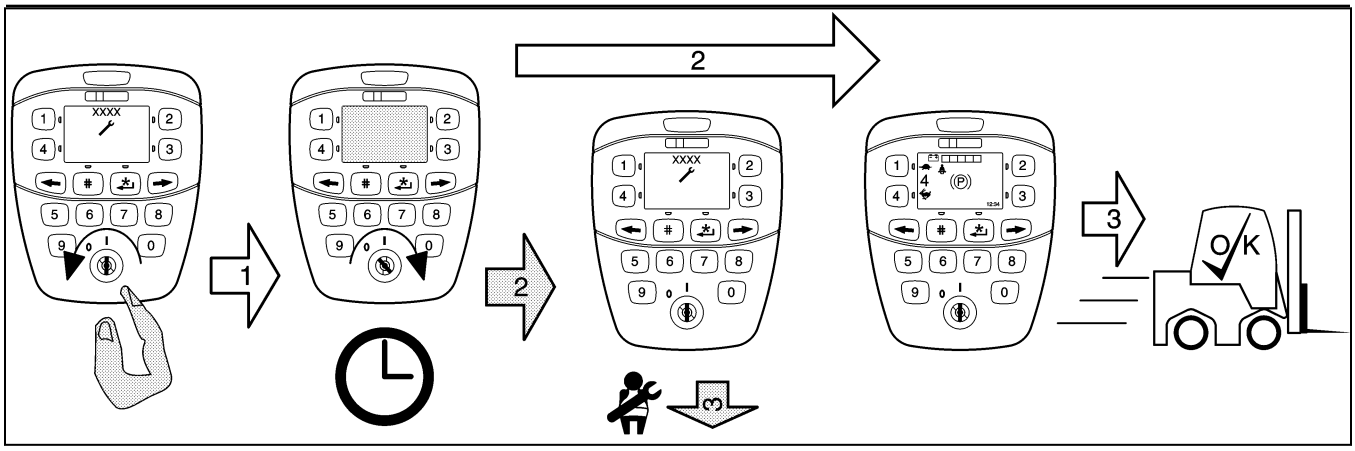
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH)



Fault Codes

DTC 12801
Directional Select A

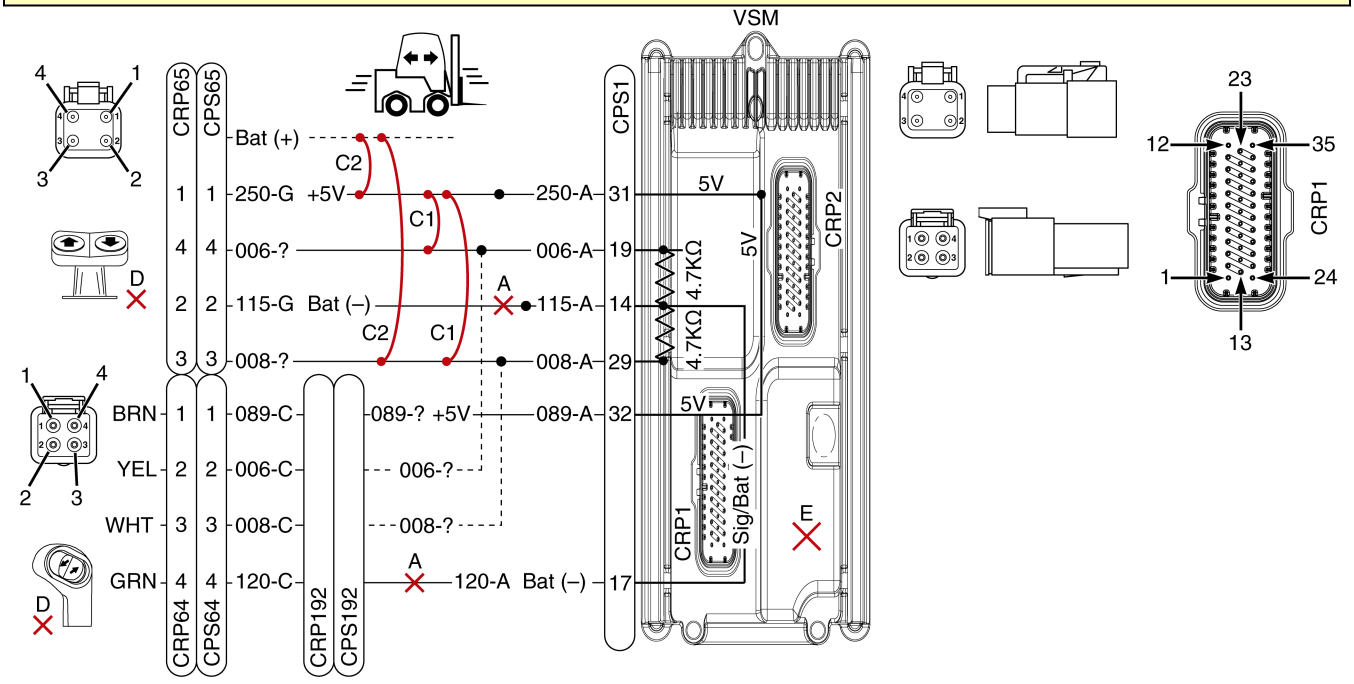
DTC 12805
Directional Select B



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

DIRECTIONAL SELECT A/B CAUSES A B C C1 C2 D E > ?



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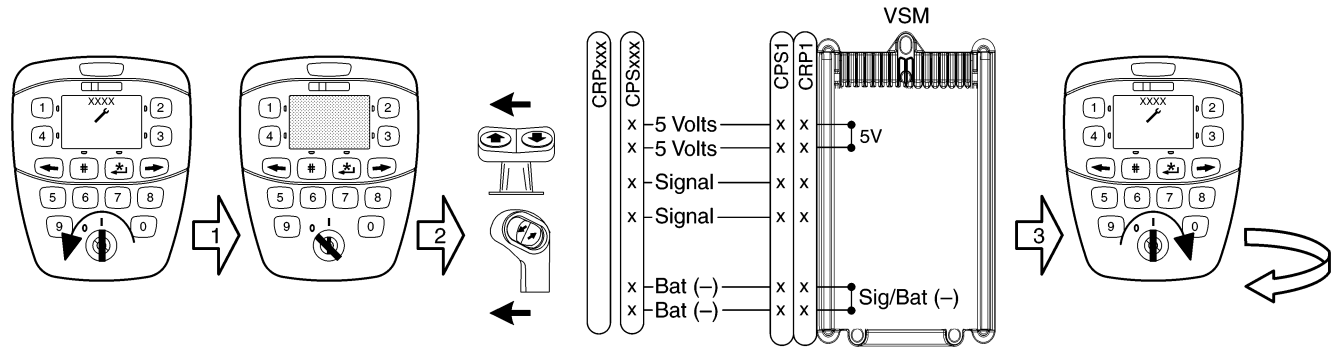
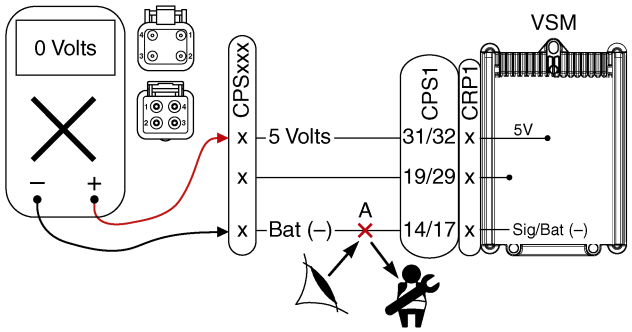
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH) (Cont)

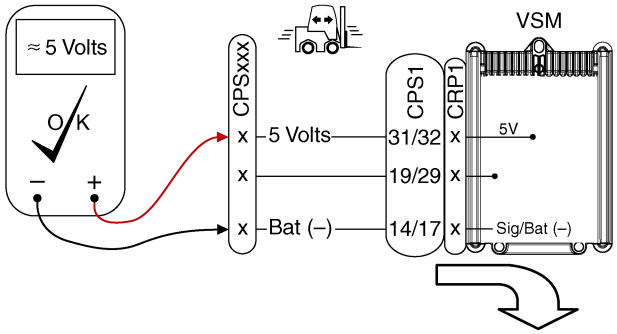
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ ?

CAUSE A1 CHECK VOLTAGE



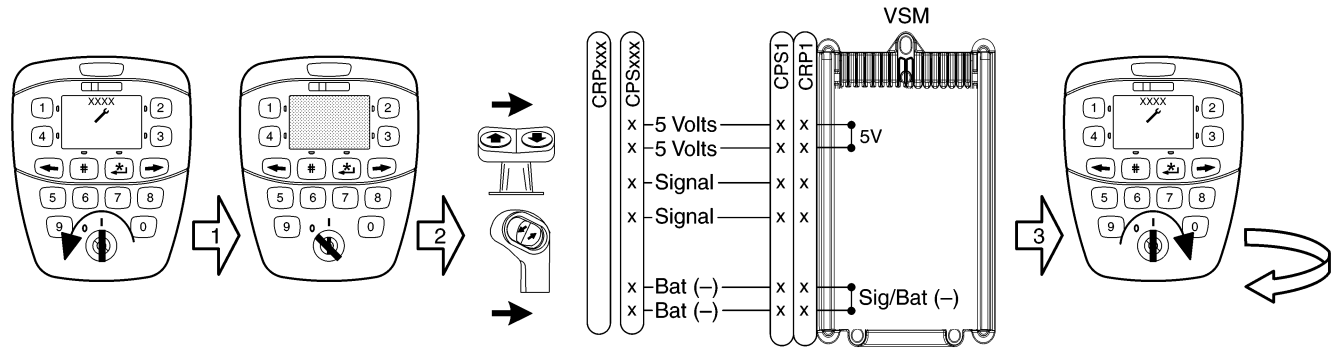


0 Volts = Open circuit→ Find↑ **OPEN** circuit.	~ 5 Volts = **OK** Go to Component Operational Check.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B

Not Applicable

CAUSE C



Power **OFF**→ Reconnect sensor→ Power **ON**→ ?

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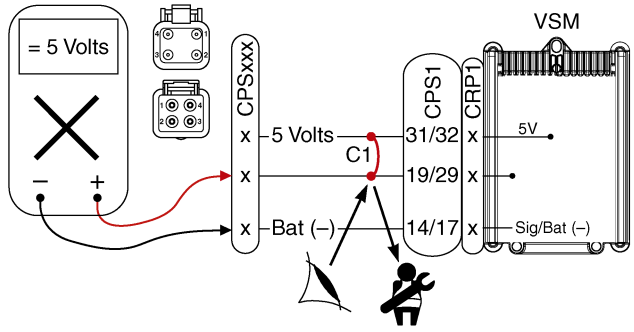
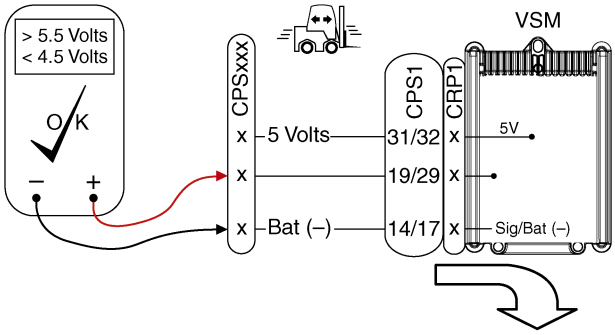
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH) (Cont)

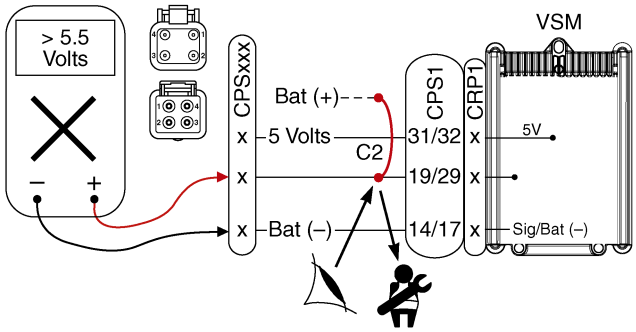
CAUSE C1 CHECK VOLTAGE

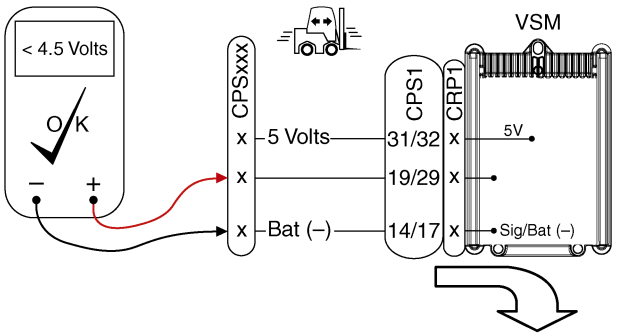




5 Volts = Short circuit→ Find↑ **Short** circuit.	> 5.5 Volts Go to Cause C2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts = **OK** Go to Component Operational Check

CAUSE C2 CHECK VOLTAGE





> 5.5 Volts = Short circuit→ Find↑ **Short** circuit to another voltage source.	< 4.5 volts = **OK** Go to Component Operational Check.
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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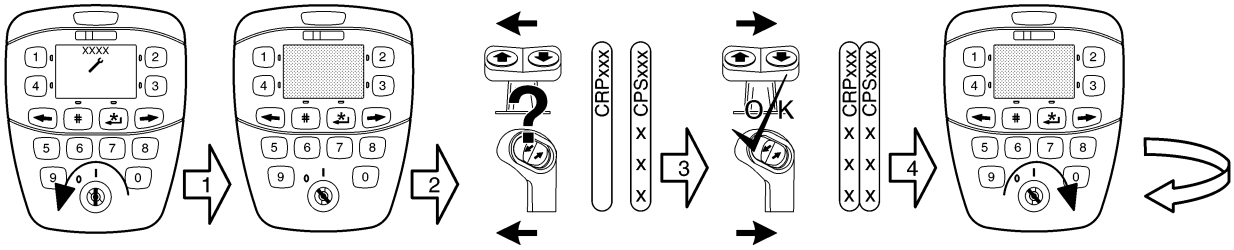
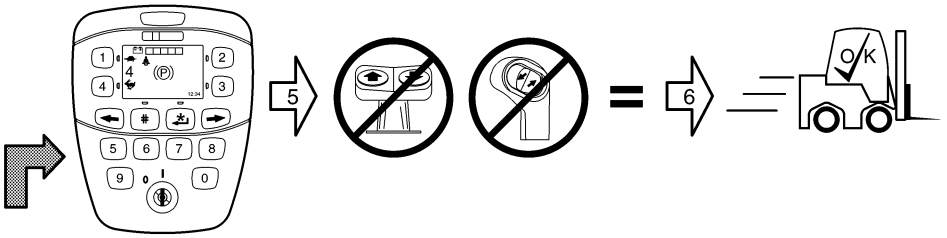
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH) (Cont)

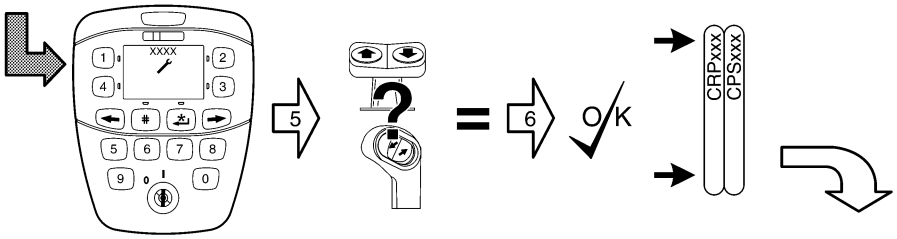
CAUSE D



Power **OFF**→ Disconnect Pedal or Hyd Lever.→ Install new component.→ **Do not discard** Power **ON**→ Go to next step.

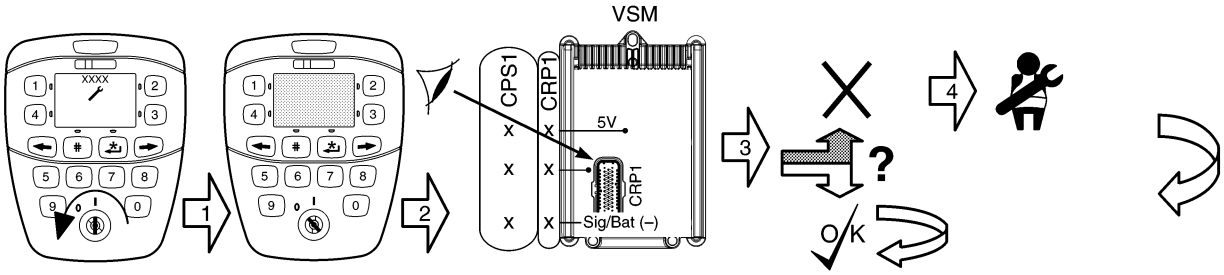


? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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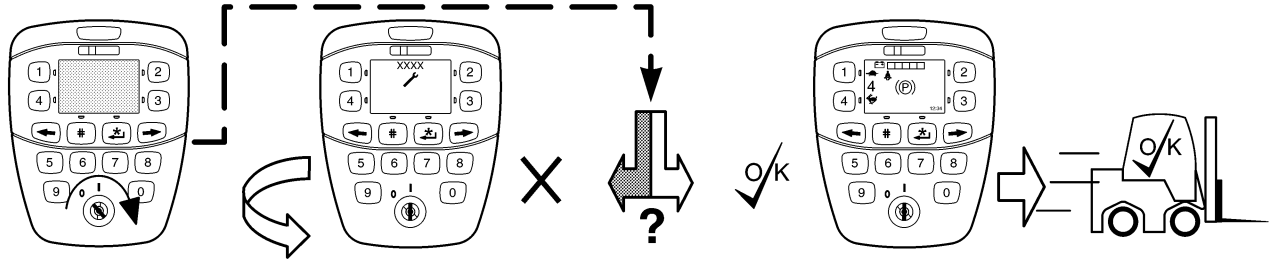
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO ← YES →

Fault corrected→ Continue operation.

END FAULT

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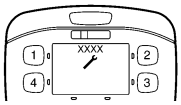
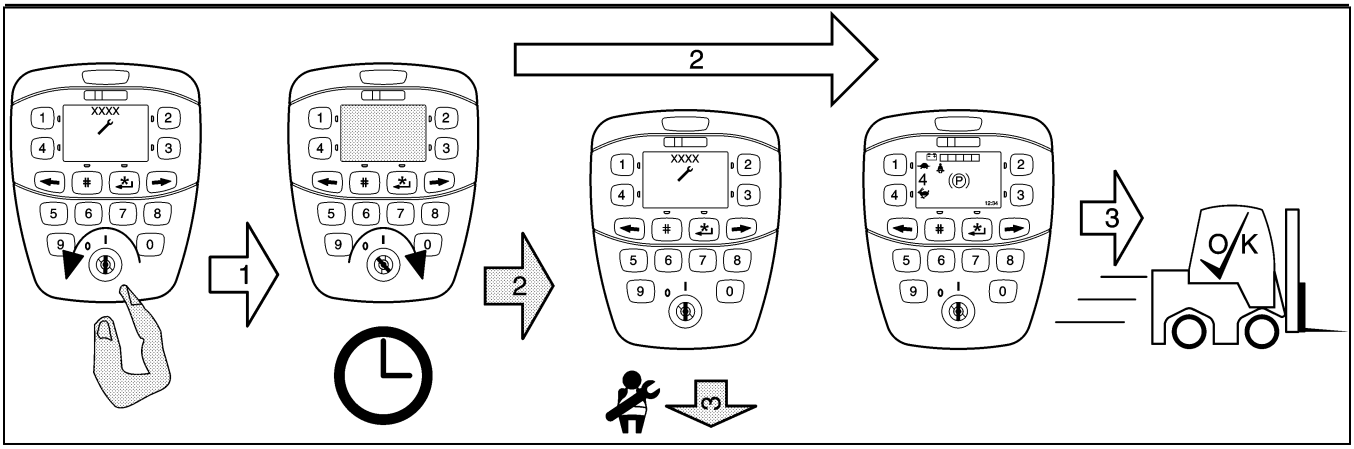
Seat Sensor Out of Range Low (OORL)



Fault Codes

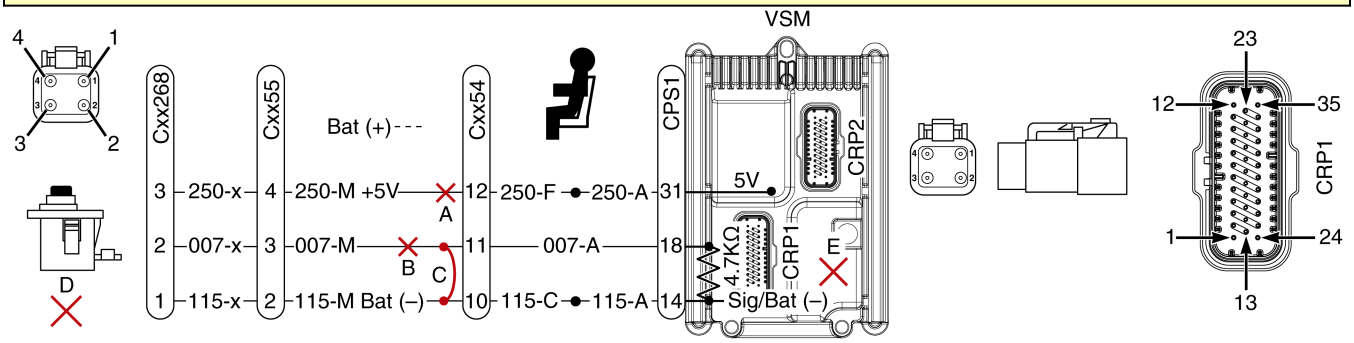
DTC 12816
Seat Sensor



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

SEAT SENSOR CAUSES A B C D E > ?



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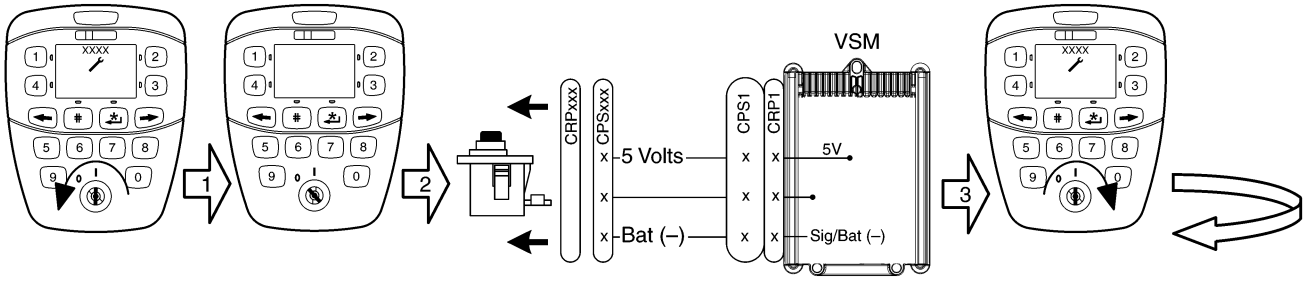
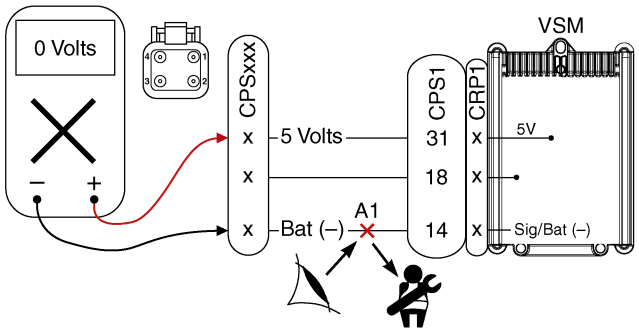
Seat Sensor Out of Range Low (OORL) (Cont)

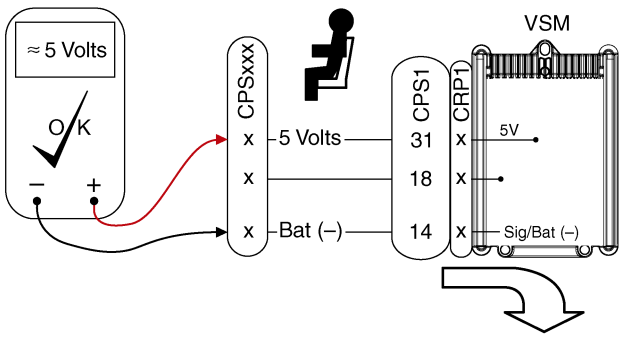
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

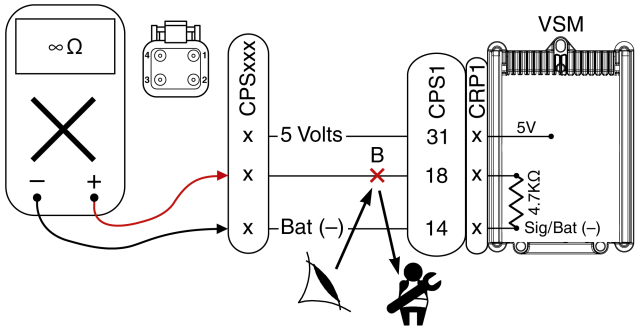
CAUSE A1 CHECK VOLTAGE

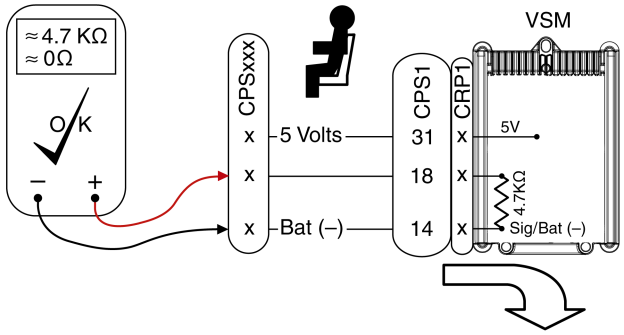




0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts =	**OK** For Service Brake Pressure, go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		For Load Weigh Pressure, go to Component Operational Check

CAUSE B CHECK RESISTANCE - Ω - OHMS





8 ? = Open circuit→ Find↑ **OPEN** circuit	˜ 4.7K? =	**OK** Go to Component Operational Check
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? =	Go to Component Operational Check

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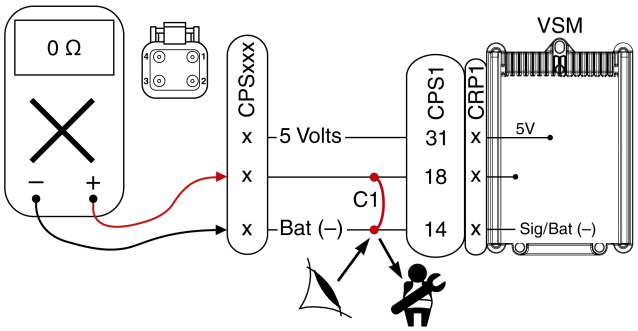
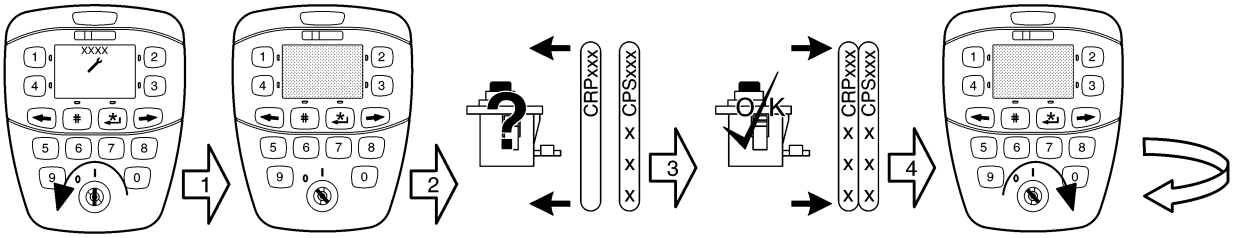
Seat Sensor Out of Range Low (OORL) (Cont)

CAUSE C **CHECK RESISTANCE - Ω - OHMS**

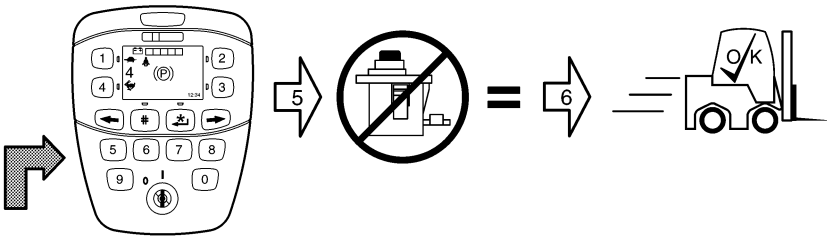


0 ? = Short circuit→ Find↑ **Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

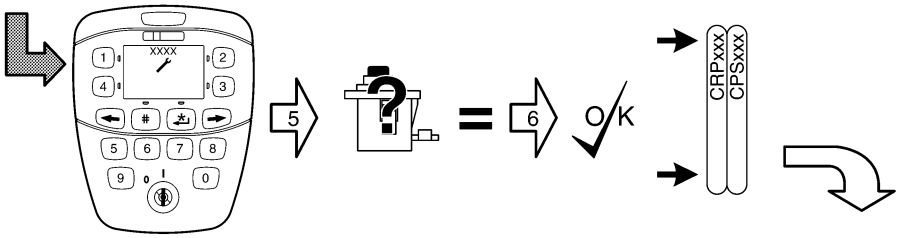
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ Go to next step.



? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

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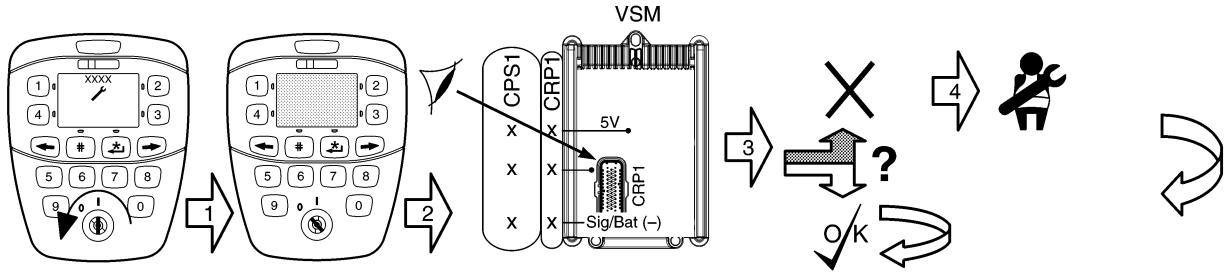
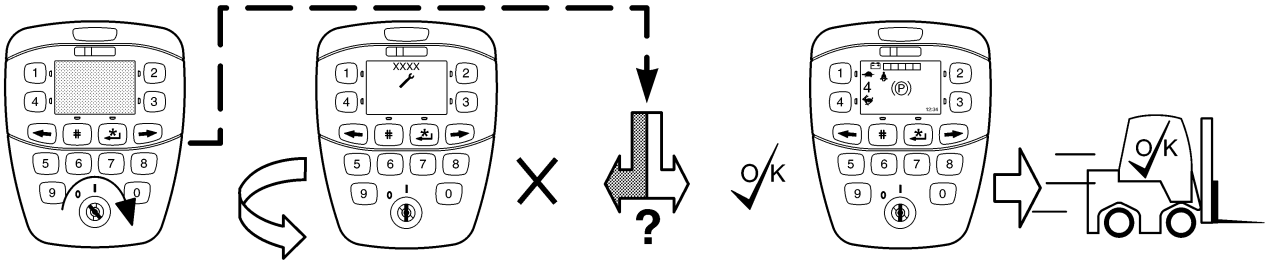
Seat Sensor Out of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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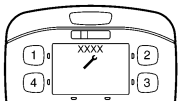
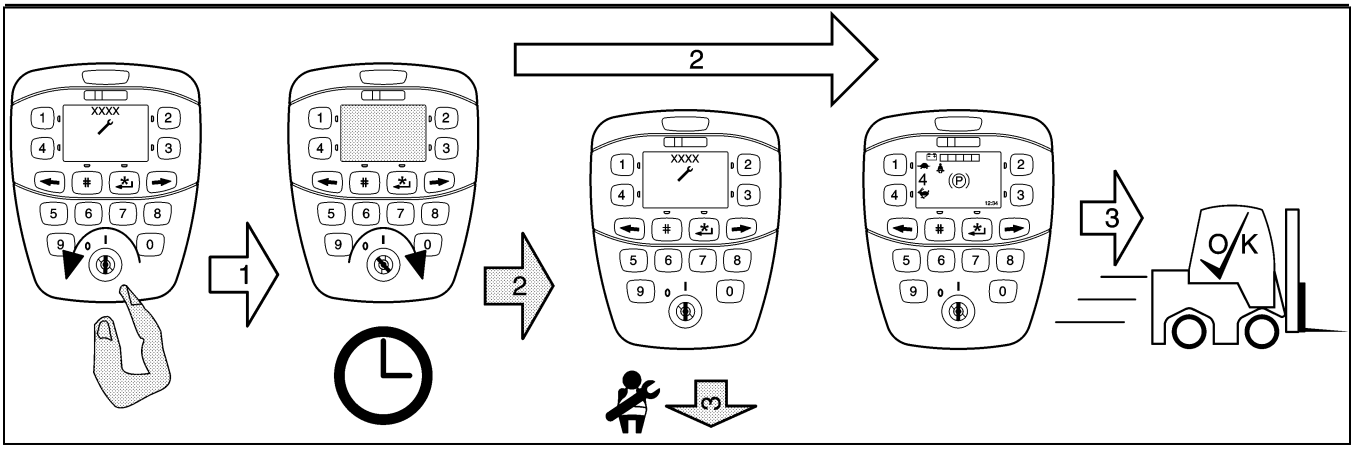
Seat Sensor Out of Range High (OORH)



Fault Codes

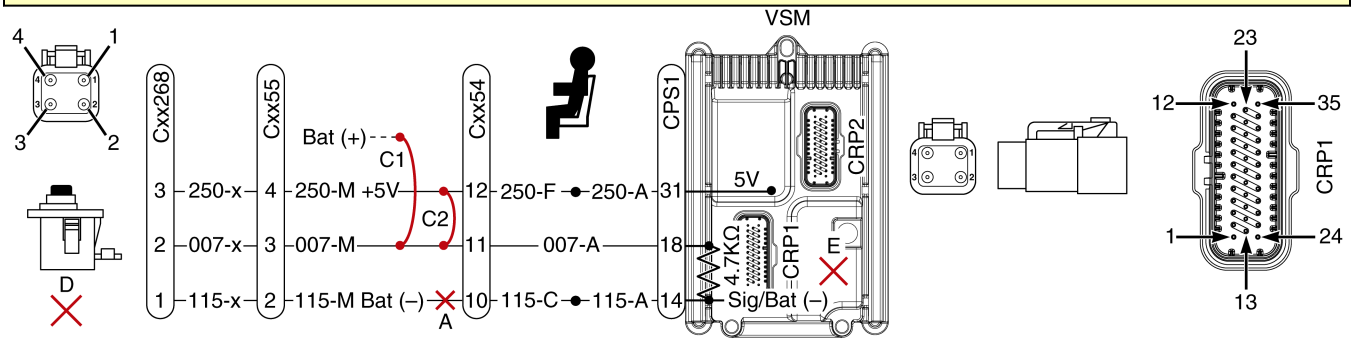
DTC 12819
Seat Sensor



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

LOAD WEIGH PRESSURE CAUSES A B C C1 C2 D E > ?



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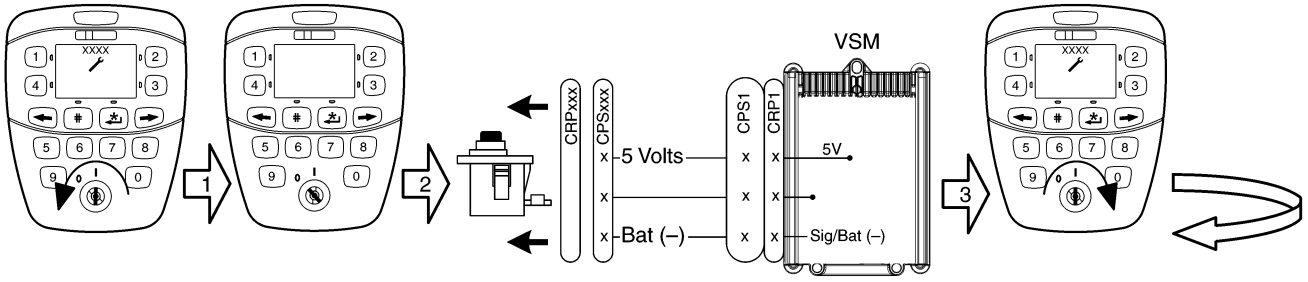
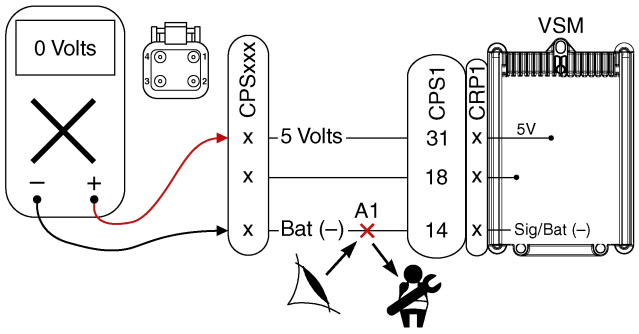
Seat Sensor Out of Range High (OORH) (Cont)

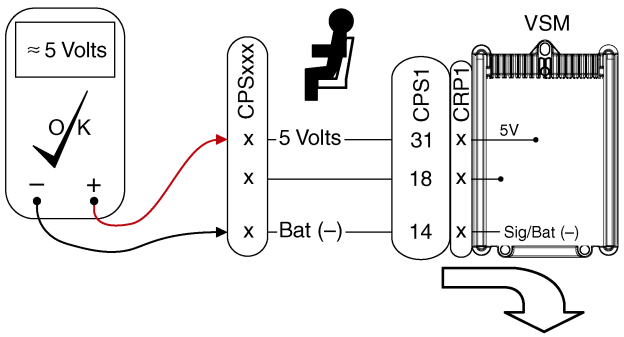
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

CAUSE A1 CHECK VOLTAGE



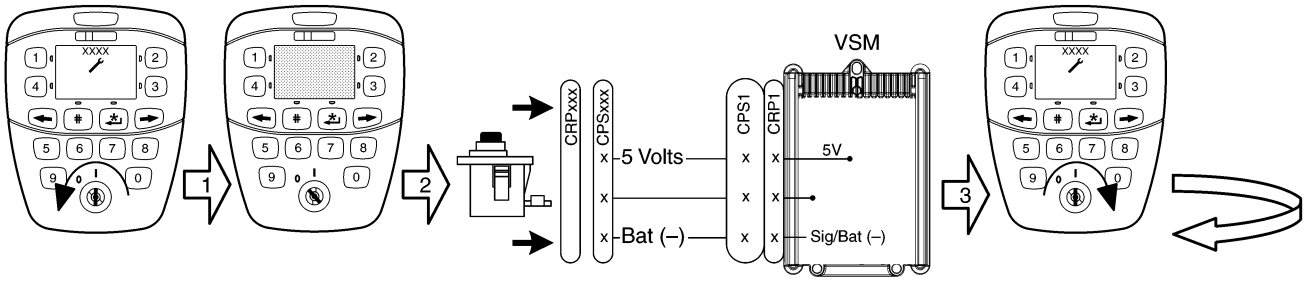


0 Volts = Open circuit→ Find↑ **OPEN** circuit.	~ 5 Volts = **OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B

Not Applicable

CAUSE C



Power **OFF**→ Reconnect sensor→ Power **ON**→ Go to next step.

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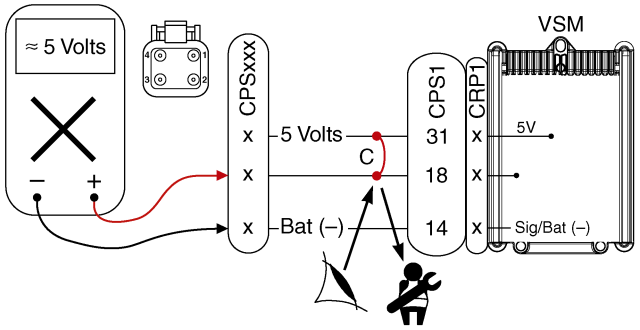
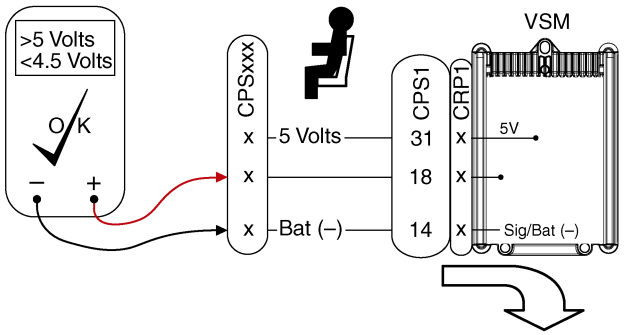
Seat Sensor Out of Range High (OORH) (Cont)

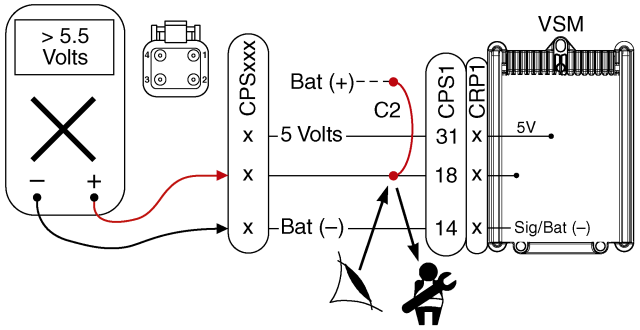
CAUSE C1 CHECK VOLTAGE

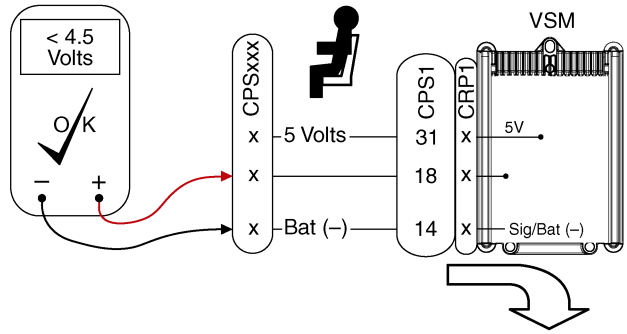




5 Volts = Short circuit→ Find↑ **Short** circuit.	> 5.5 volts = **OK** Go to Cause C2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts = Go to Component Operational Check

CAUSE C2 CHECK VOLTAGE





> 5.5 volts = Short circuit→ Find↑ **Short** circuit to another voltage source.	< 4.5 volts = **OK** Go to Component Operational Check
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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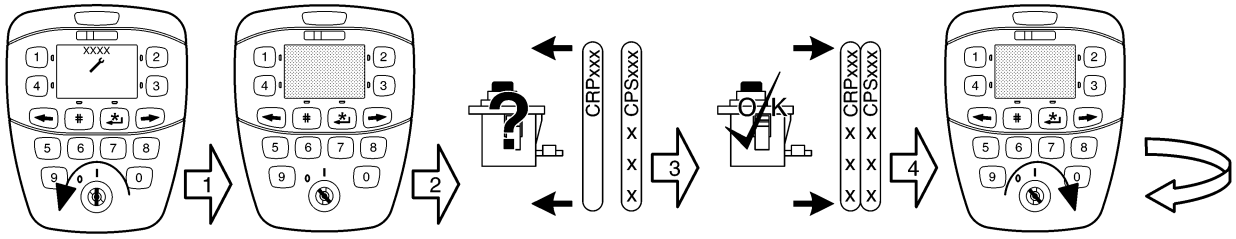
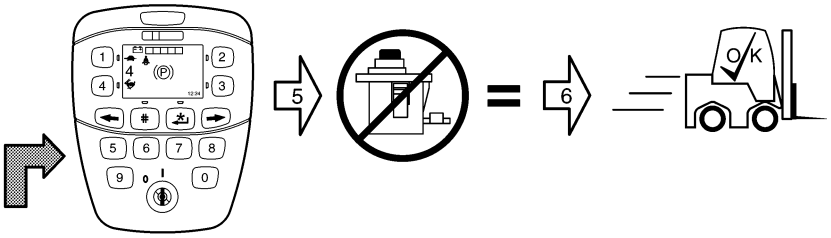
Seat Sensor Out of Range High (OORH) (Cont)

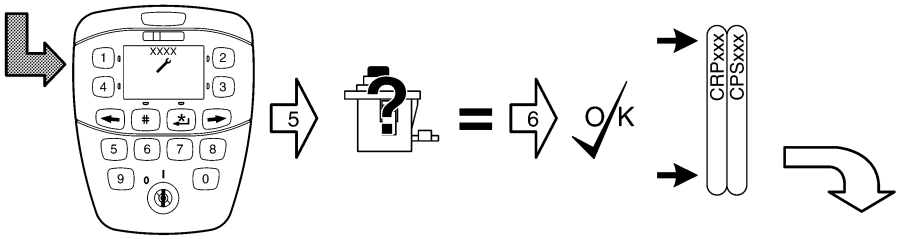
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ Go to next step.

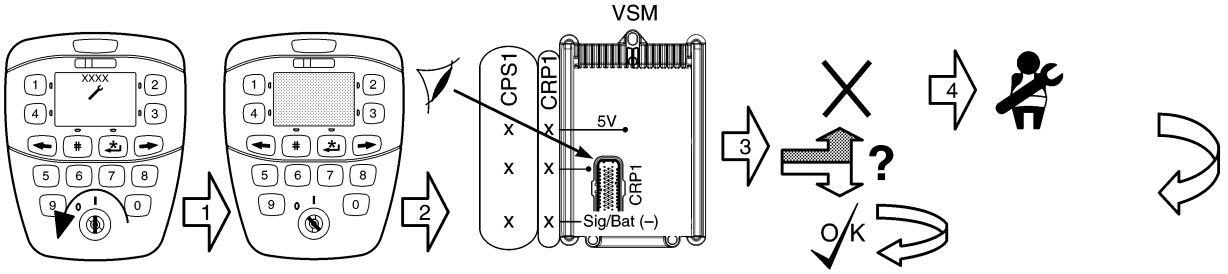


? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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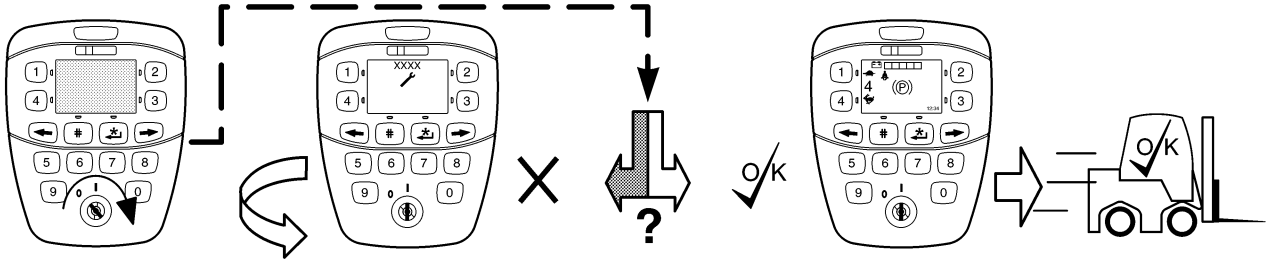
Seat Sensor Out of Range High (OORH) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

Fault corrected→ Continue operation.

NO ← **YES** →

END FAULT

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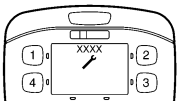
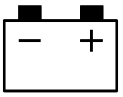
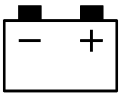
Battery OORH/OORL



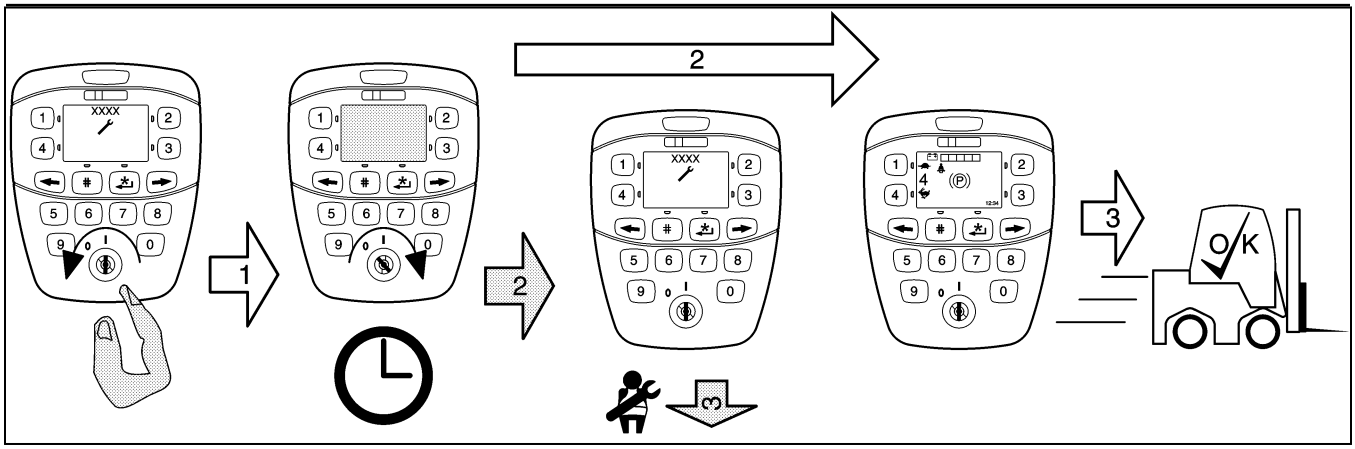
Fault Codes



DTC 12545
Battery OORH



DTC 12546
Battery OORL



Power **OFF**→

Wait **30 seconds**→

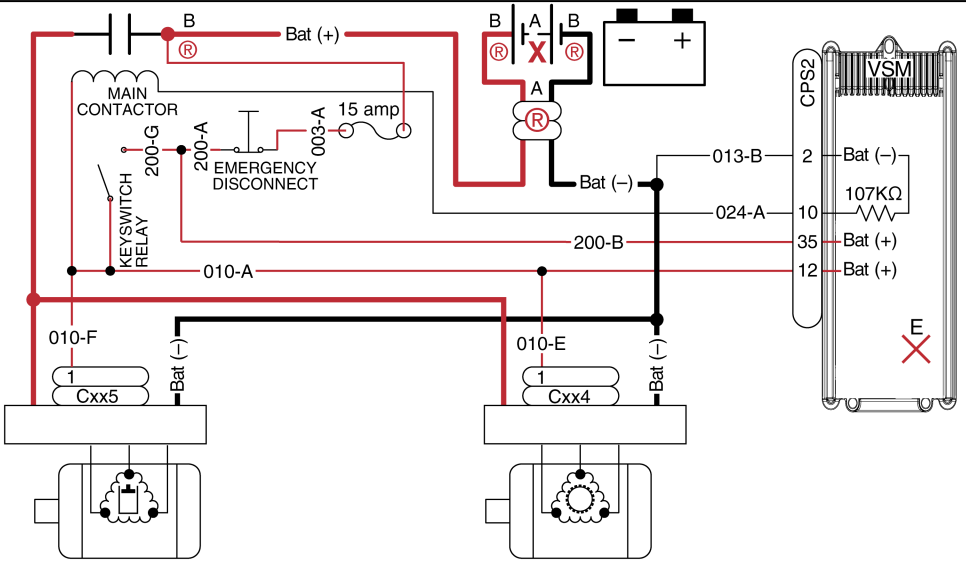
Power **ON**→

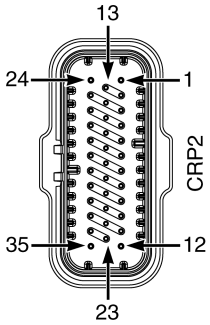
Fault remains. Service required. Go to Component Operational Check.

No fault→

Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit
CBB 4 WHEEL CAUSES A B C D E > ?
Possible Causes (OORL) Wrong Battery/Discharged Battery/Faulty Battery/ ® = High Resistance
Possible Causes (OORH) Wrong Battery Installed/ ® = High Resistance





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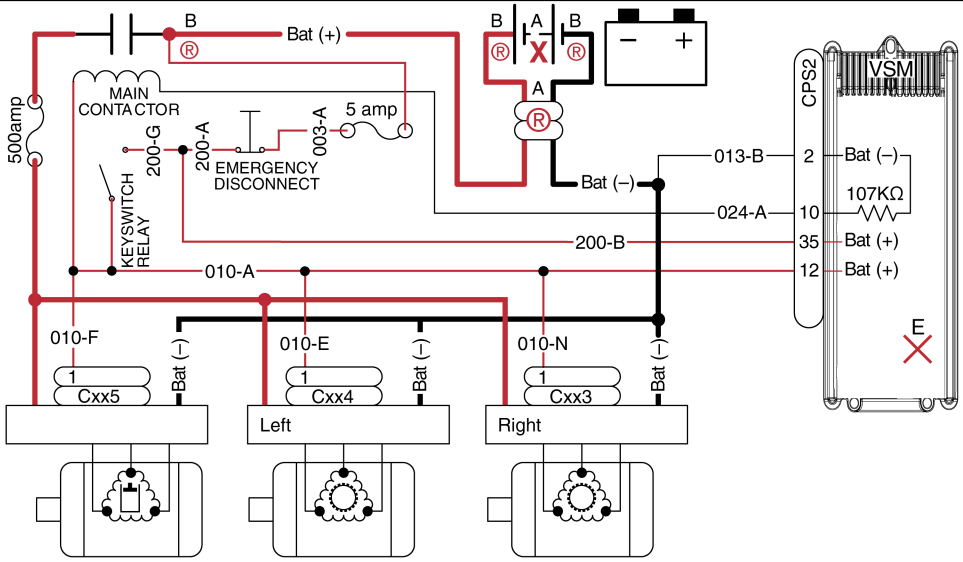
Battery OORH/OORL (Cont)

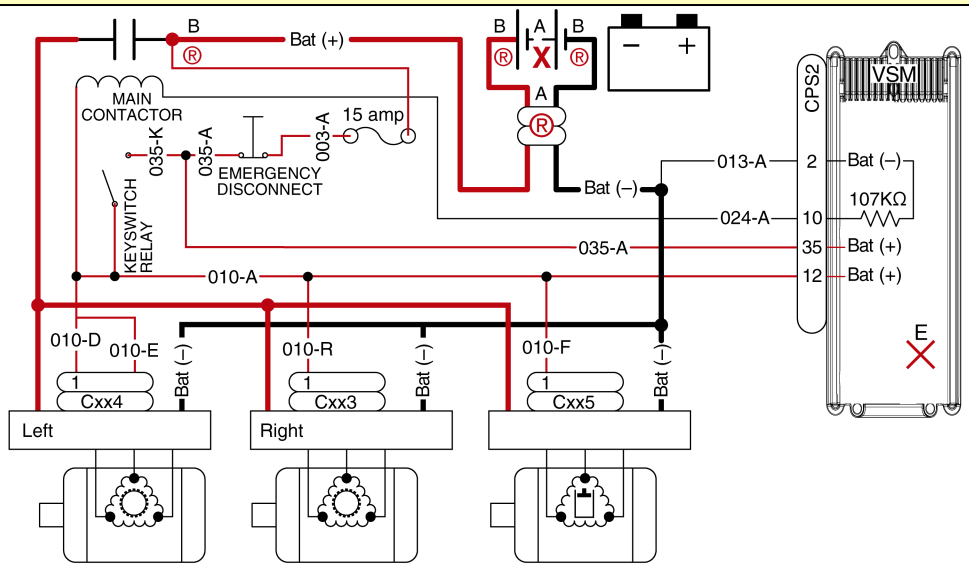
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

A935 K160 HIGH RESISTANCE CONNECTIONS CAUSES A B C D E > ?



POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

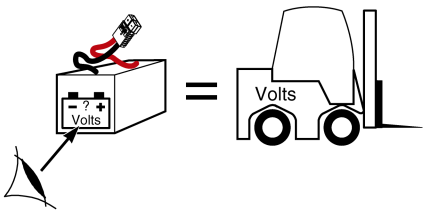
CBB 3 WHEEL HIGH RESISTANCE CONNECTIONS CAUSES A B C D E > ?

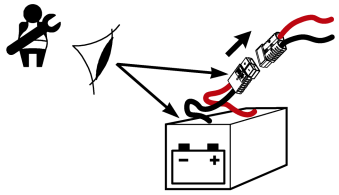


Battery OORH/OORL (Cont)

CAUSE A

Battery OORH/OORL





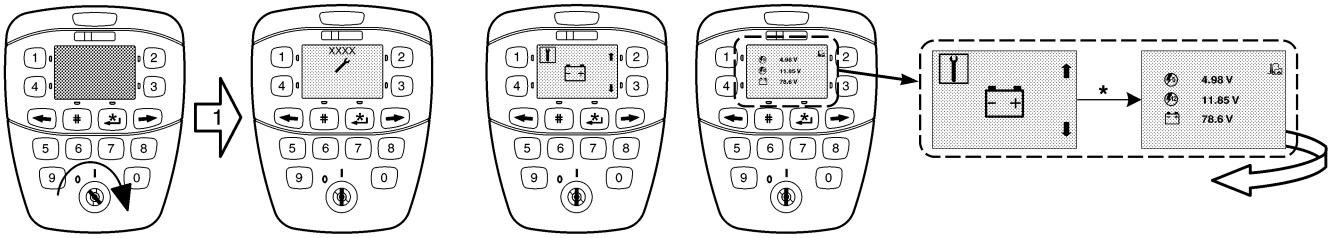
Check that correct voltage battery is installed →

Perform battery maintenance, see **Operating Manual**→

?

STEP A1

OORH/OORL



Power **ON**→

Go to Diagnostic→

See Display Menu Flowchart

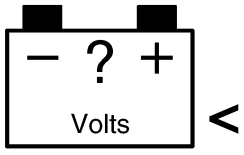
Battery/Supply→ View Battery Value

?

STEP A2

Battery OORL

NOTE: OOR Code is set if OOR condition is present for longer than 1 second.



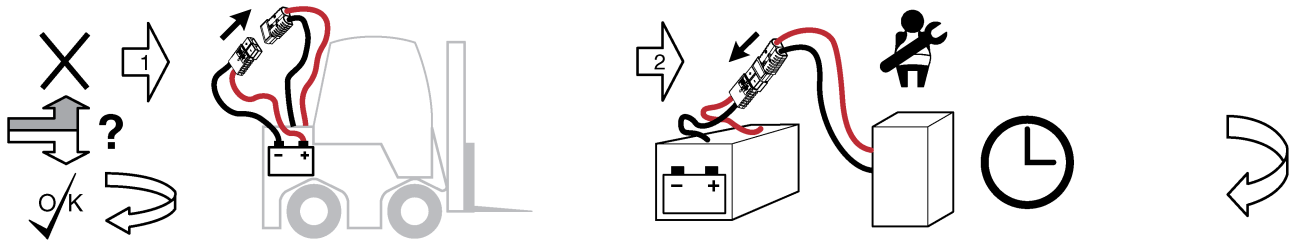
<

Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜< OORL	18	24	36	40
˜ OORH	48.6	57.6	97.2	108

Is battery voltage ˜ < OORL value for correct battery→ ?

STEP A3

Battery OORL



NO (v)→ ?

YES (X) Recharge battery→

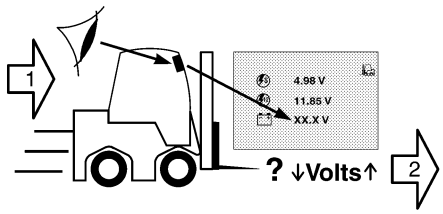
See **Operating Manual** for charge time

?

Battery OORH/OORL (Cont)

STEP A4

Battery OORL/OORH



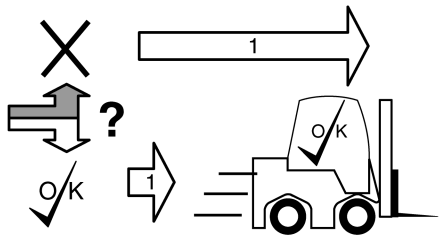
Battery Voltage				
Nominal	36	48	72	80
Fully Charged	40	53	79	88
˜< OORL	18	24	36	40
˜> OORH	48.6	57.6	97.2	108

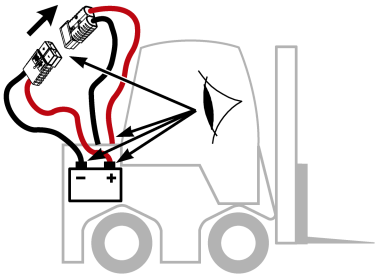
Operate truck→ All functions

Monitor battery voltage→ Is battery voltage going?↓ < OORL or ↑ > OORH value for correct battery→ ?

STEP A5

Battery OORH/OORL





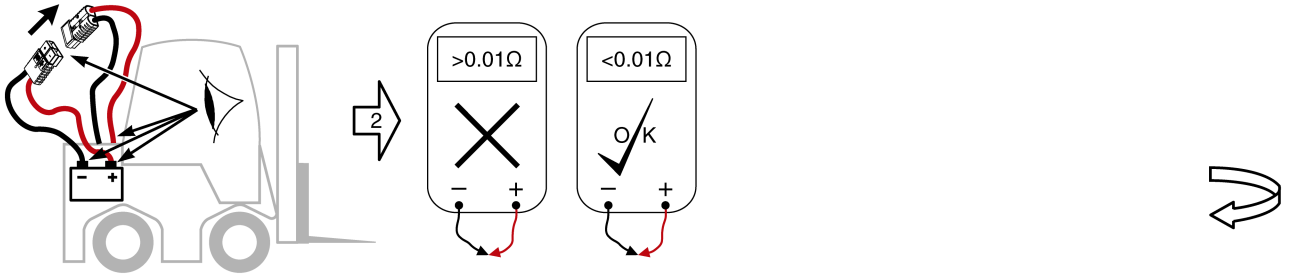
YES (X) Inspect All Battery Connections for Corrosion/ High Resistance→ ?

NO (v) → Go to Step B4

CAUSE B

NOTE: High Resistance in Wiring and Connections will cause **High Voltage** drops (OORL) when subjected to **High Current** Draw

NOTE: High Resistance in Wiring and Connections will cause **High Voltage** peaks (OORH) when subjected to **High Current** Regen



Disconnect battery→ Set meter to lowest ? scale→ Check lead resistance < 0.01? ?

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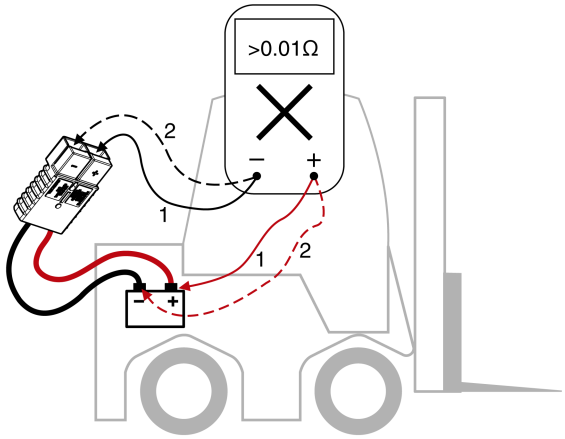
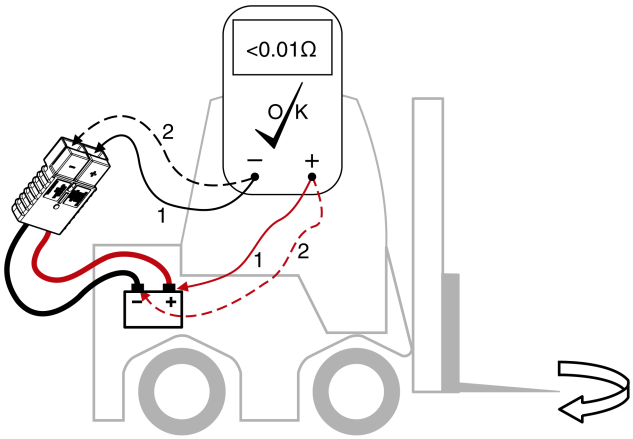
Battery OORH/OORL (Cont)

STEP B1 CHECK RESISTANCE - Ω - OHMS

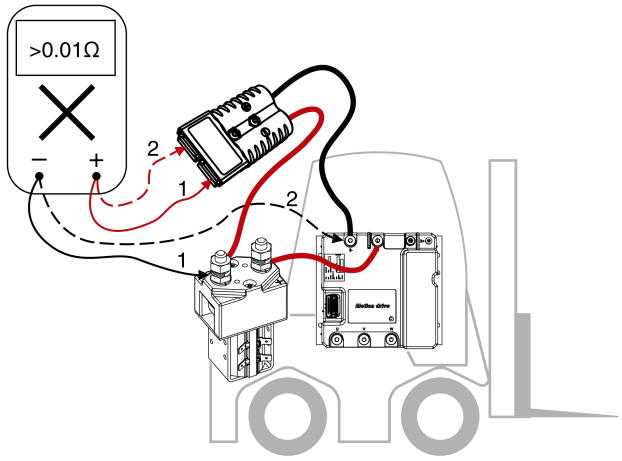
Battery OORH/OORL

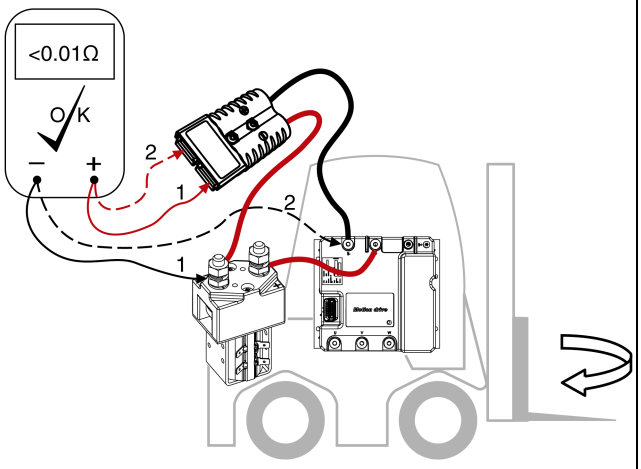




Check resistance between the Battery (+) and (-) terminals and the Battery Connector (+) and (-) Terminals	
1. > 0.01? Replace battery leads/connector terminal↓	
2. > 0.01? Replace battery leads/connector terminal→	< 0.01? Connection OK→ ?

STEP B2





Check Resistance between the Bat (+) Connector and the Contactor Stud/Bat (-) Connector and Bat (-) to System	
1. > 0.01? →Replace battery leads/connector terminal↓	
2. > 0.01? →Replace battery leads/connector terminal→	< 0.01? → Connection OK ?

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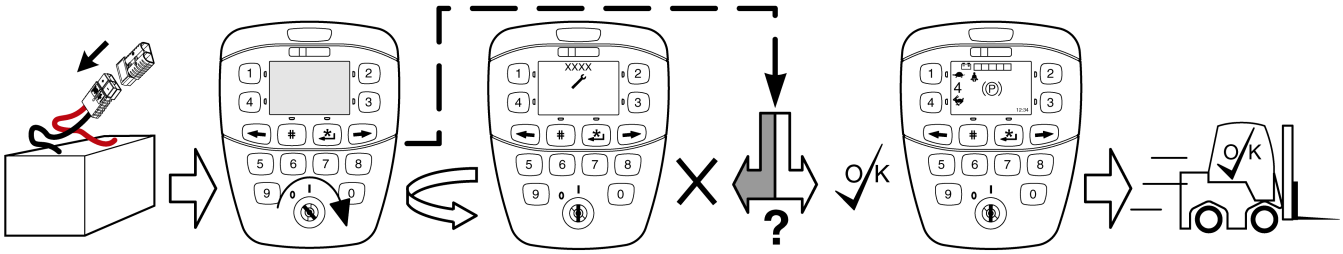
Battery OORH/OORL (Cont)

STEP B3

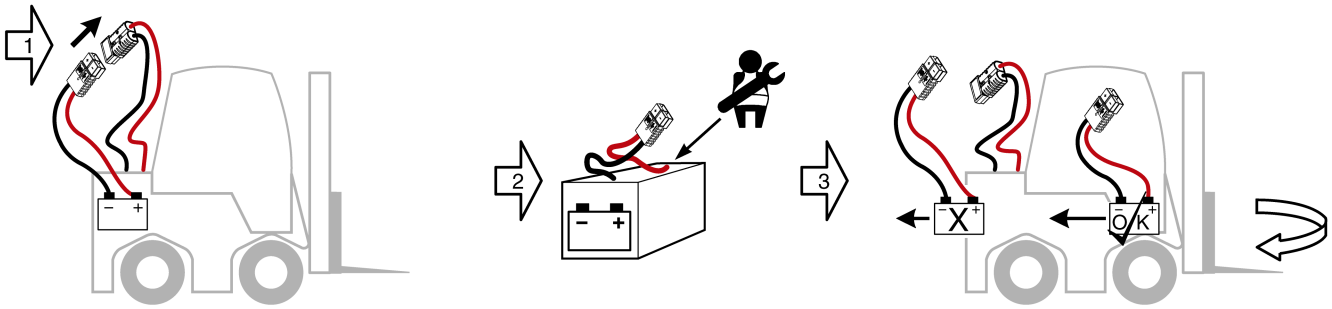
Battery OORH/OORL



Reconnect battery | Retest Power **ON** | **NO** → ? | Is DTC gone? **NO YES** → | Fault Corrected→ | Continue operation

STEP B4

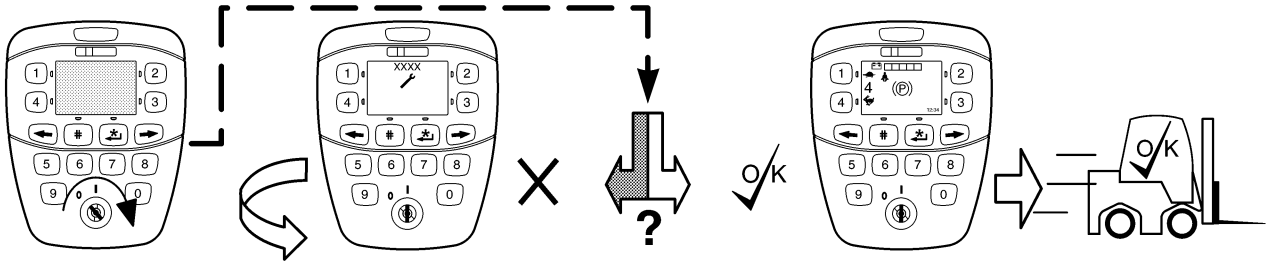
Battery OORH/OORL



Possible Battery Cell Failure→ Perform Battery Cell Test→ See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

If a cell failure is detected replace Battery→ ?

STEP B5



Retest Power **ON** | **NO** → ? | Is DTC gone? **NO YES** → | Fault Corrected→ | Continue operation

CAUSE C

Not Applicable

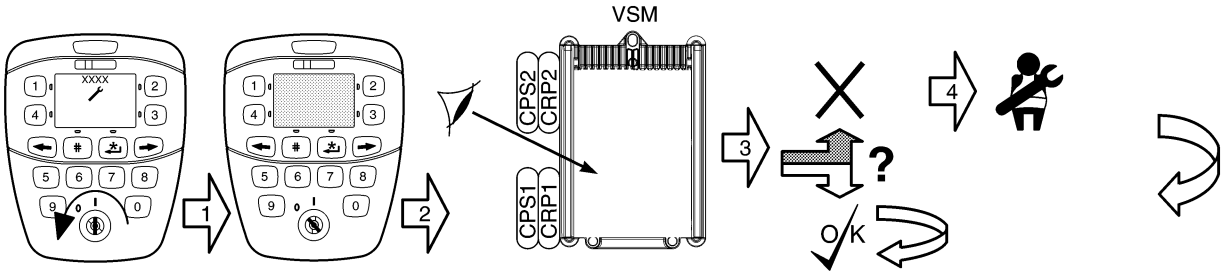
CAUSE D

Not Applicable

https://truckmanualshub.com/

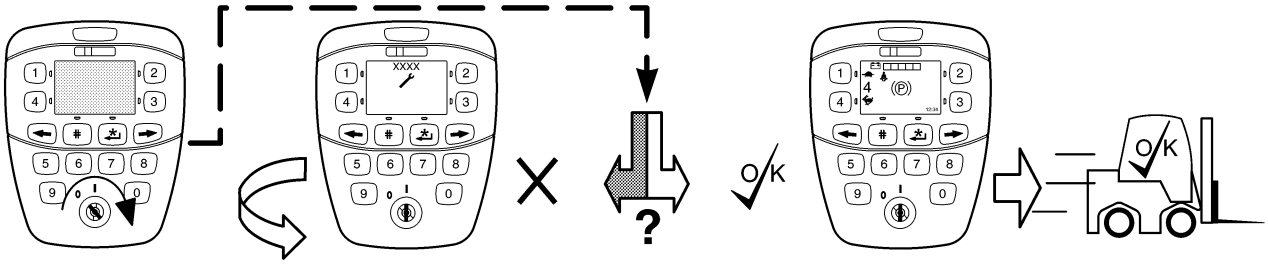
Battery OORH/OORL (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1 Not OK Correct/Repair→ Go to Cause E1

CAUSE E1



Retest - Power **ON**→ **NO** → Is DTC gone? Fault corrected→ Continue operation.

Go to VSM Controller Check **NO YES**

END FAULT

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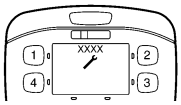
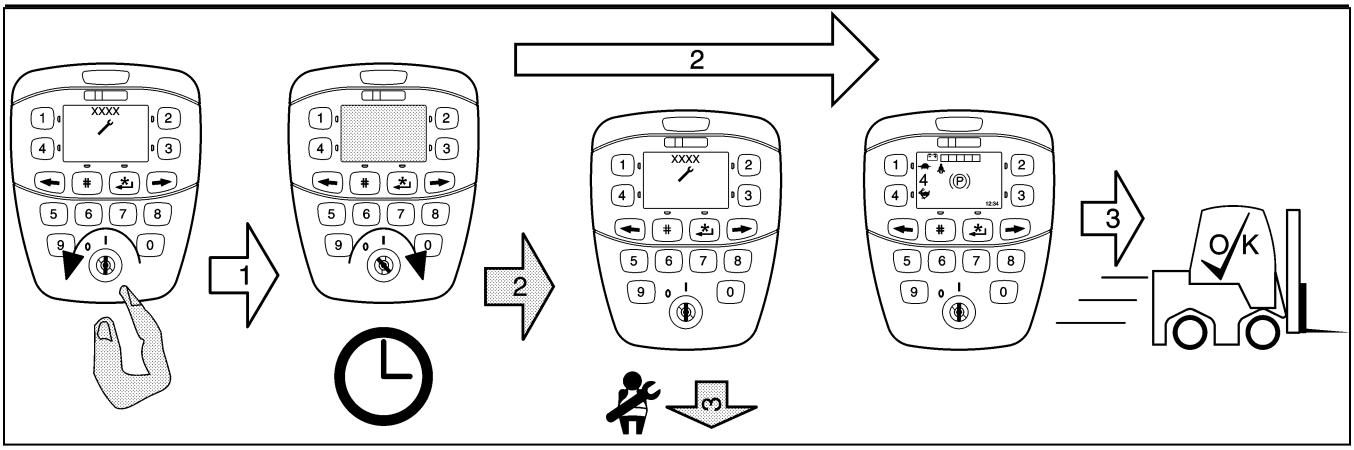
VSM 5 Volt Supply (OORL) (OORH)



DTC 13056 DTC 13057
5V OORL 5V OORH

Fault Codes



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

WARNING

Any VSM 5 volt powered Device will be damaged by a Short to Battery (+) condition and possibly by a Short to 12 volts (+).

WARNING

All VSM 5 volt powered devices will need to be checked for correct operation and probably replaced.

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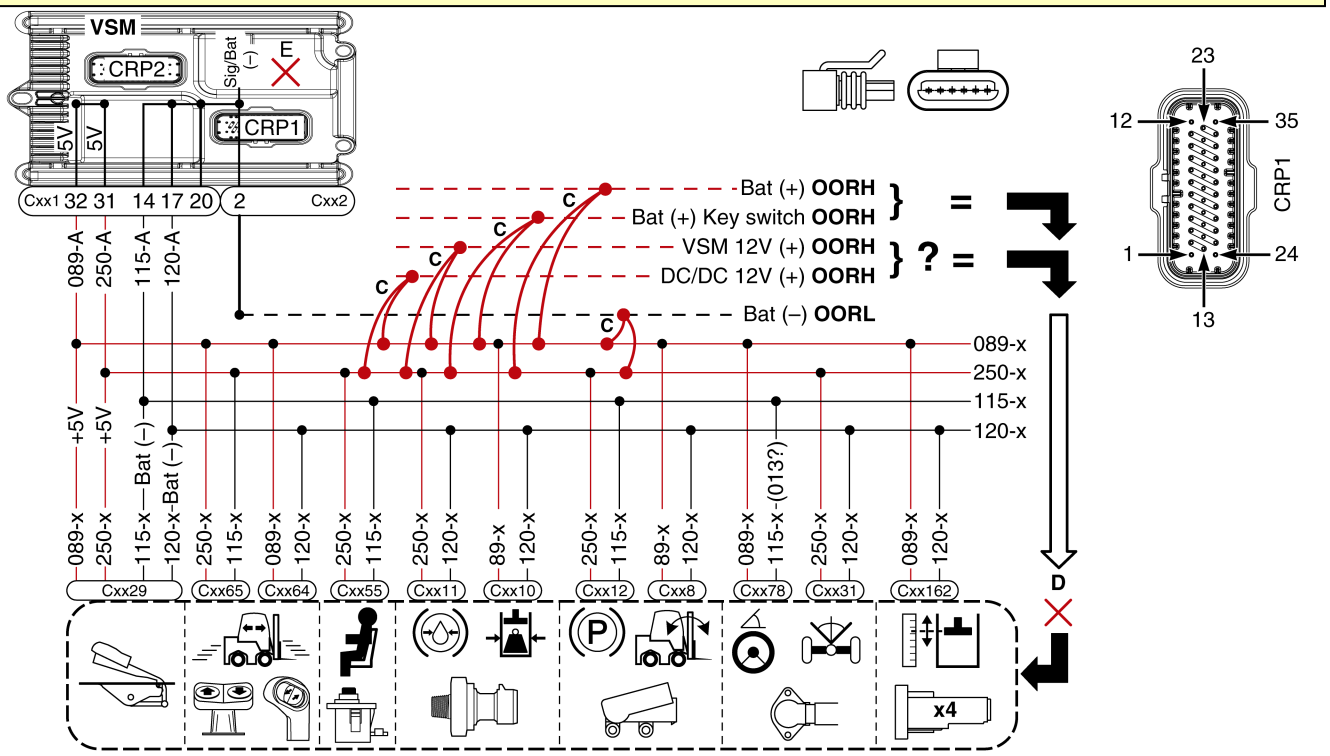
VSM 5 Volt Supply (OORL) (OORH) (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

DBB/CBB 4 WHEEL 5 VOLT SUPPLY CAUSES A B C D E > ?



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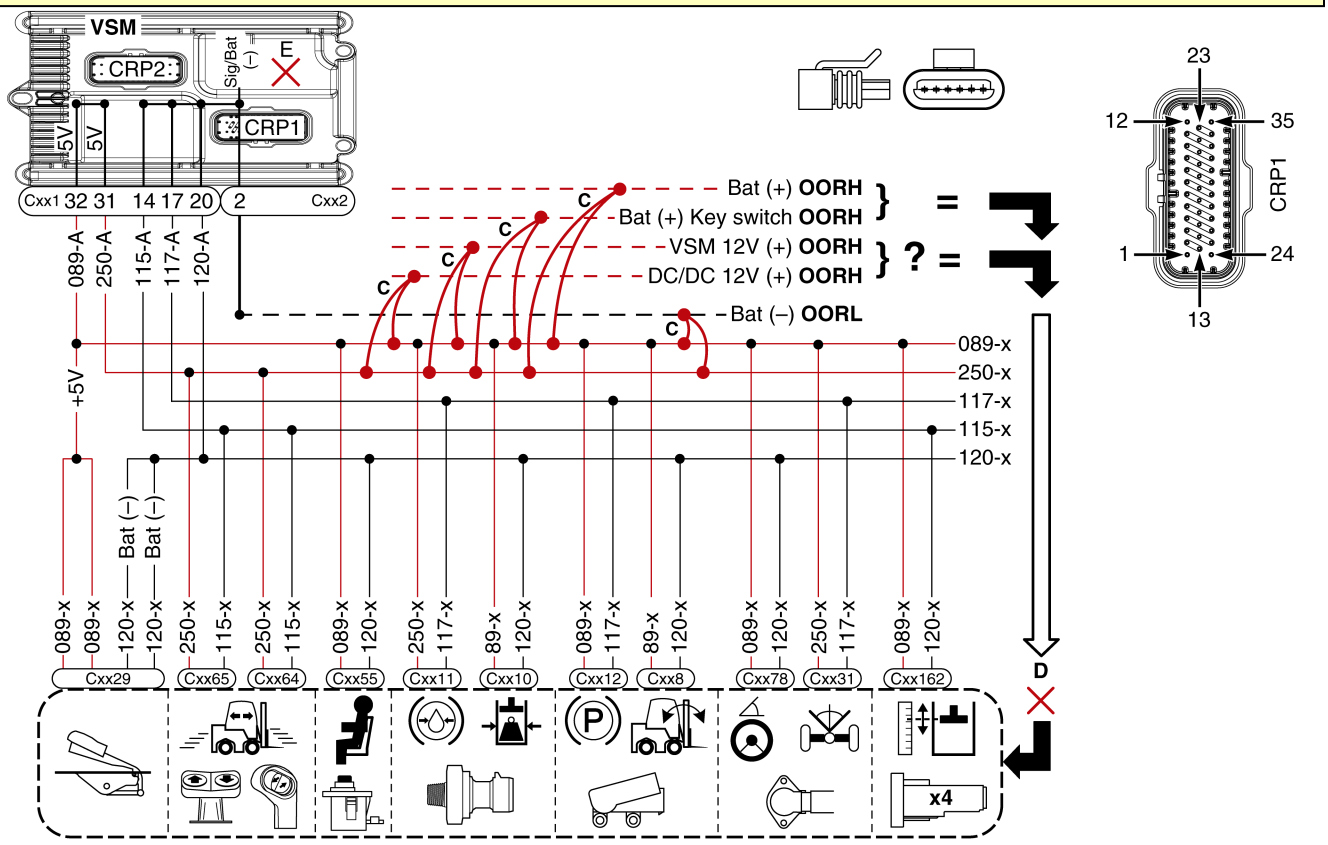
VSM 5 Volt Supply (OORL) (OORH) (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

CBB 3 WHEEL 5 VOLT SUPPLY CAUSES A B C D E > ?



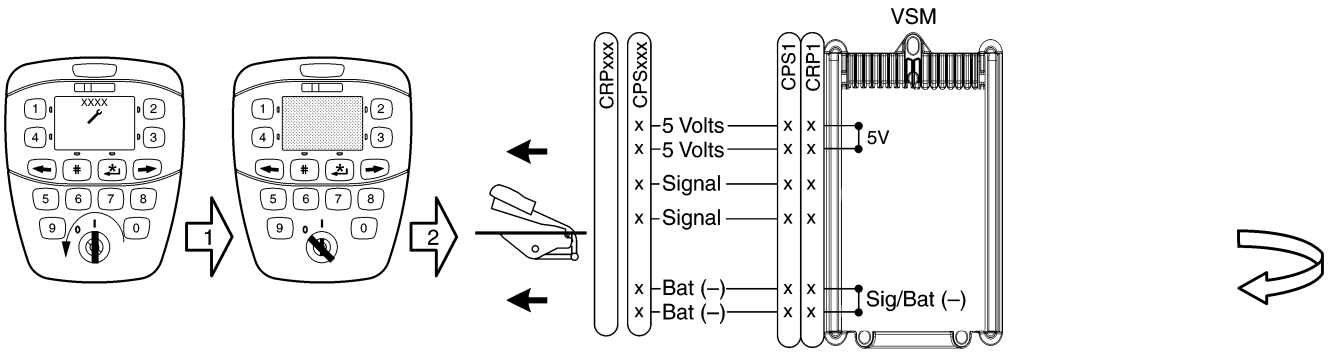
CAUSE A

Not Applicable

CAUSE B

Not Applicable

CAUSE C



Power **OFF**→

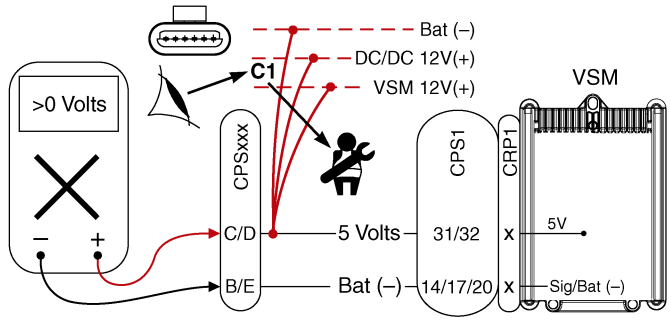
Disconnect Accelerator Pedal sensor→

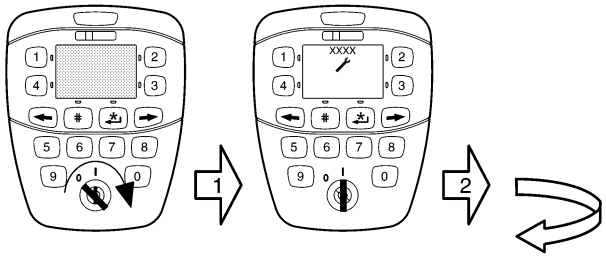
Go to Cause C1

VSM 5 Volt Supply (OORL) (OORH) (Cont)

CAUSE C1 UNSWITCHED VOLTAGES

5 Volt OORH





˜ 0 Volts = OK → Go to Cause C2→

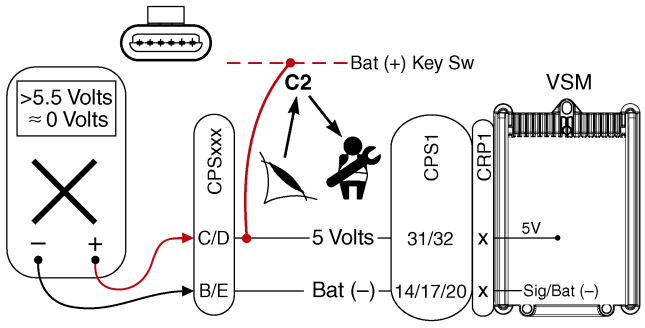
Power **ON**→ Go to Cause C2

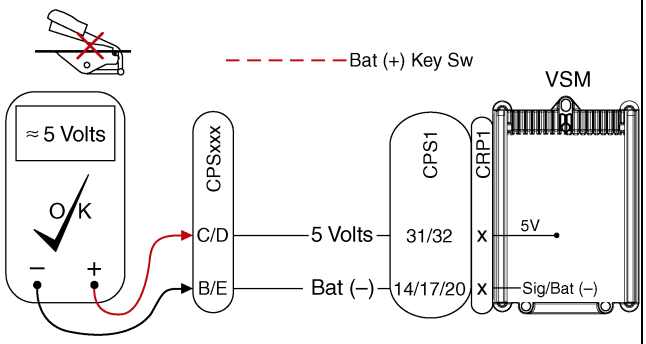
> 0 Volts = Short Circuit→ Bat (+) or 12v (+) Find ↑ Short circuit.

Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369. Check all 5 volt devices → Go to Component Operational Check

CAUSE C2 SWITCHED VOLTAGES

5 Volt OORH





˜ 0 Volts = Short to bat (-) → Go to Cause C3→

˜ 5 Volts = Faulty Accelerator Pedal → Go Component Operational Check↓

> 5.5 Volts = Short Circuit→ Bat (+) or 12v (+) Find ↑ Short circuit↓

Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369. Check all 5 volt devices → Go to Component Operational Check

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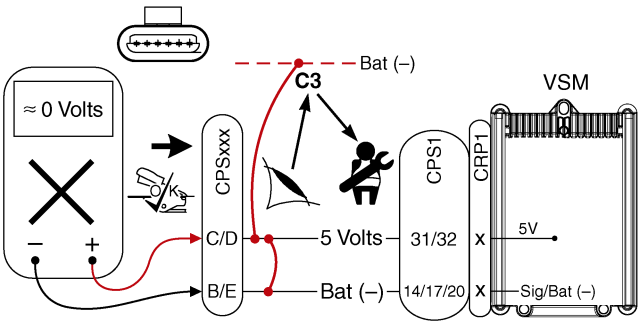
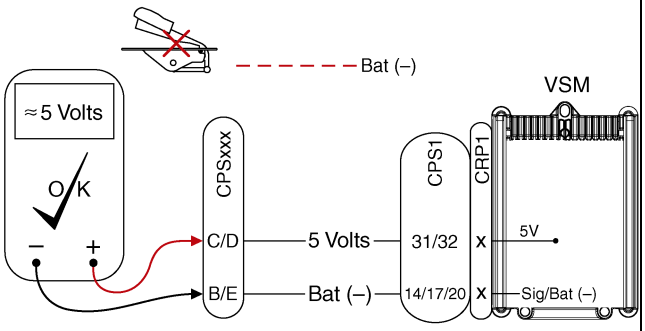
VSM 5 Volt Supply (OORL) (Cont)

CAUSE C3

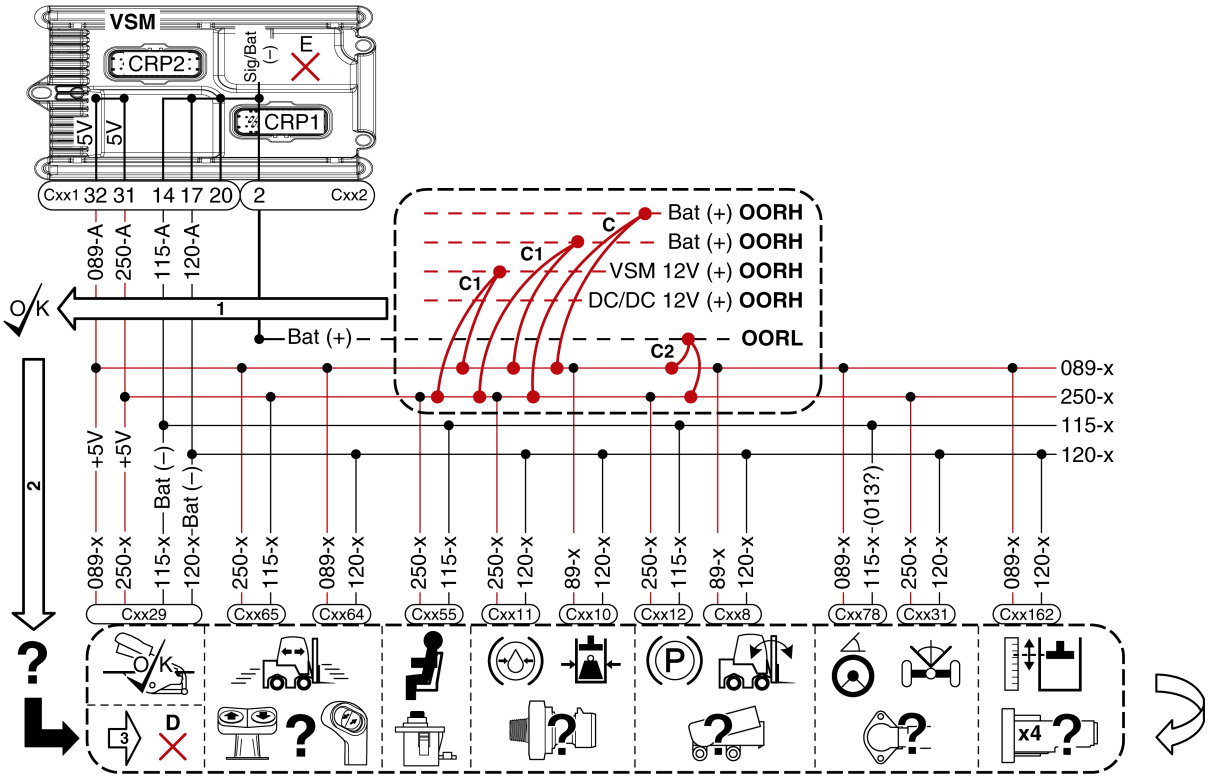
5 Volt OORL





˜ 0 Volts = Short circuit → Bat (-) → Find ↑ Short circuit	˜ 5 Volts = Faulty Accelerator Pedal → Replace – Go Component Operational Check↓
Repair Short circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.→ Check all 5 volt devices →	Go Component Operational Check↓
Reconnect Accelerator Pedal→	Go Component Operational Check↓

CAUSE D



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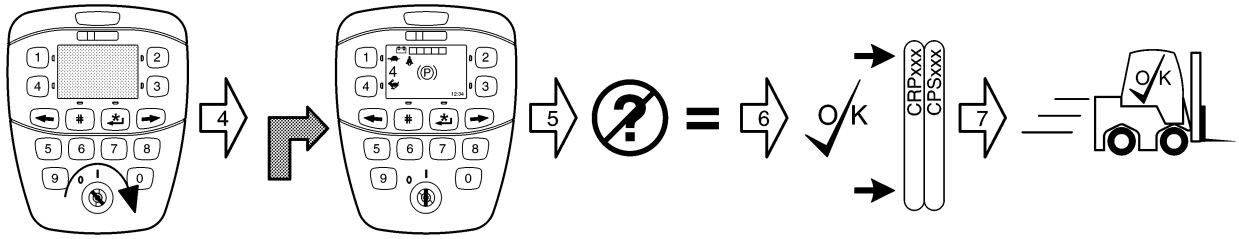
VSM 5 Volt Supply (OORL) (OORH) (Cont)

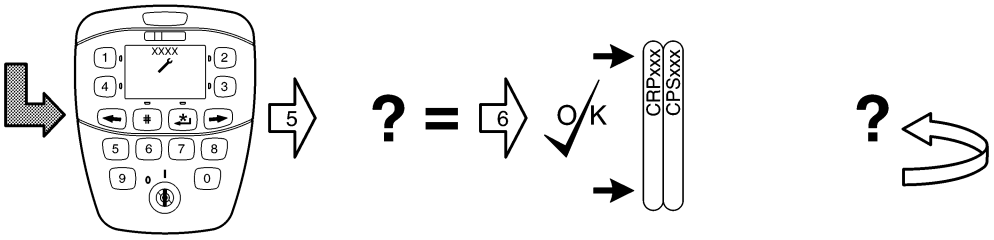
CAUSE D1

Power **OFF**→ Disconnect next 5 volt Sensor→ **Do Not Discard** Go to Cause D2.

CAUSE D2

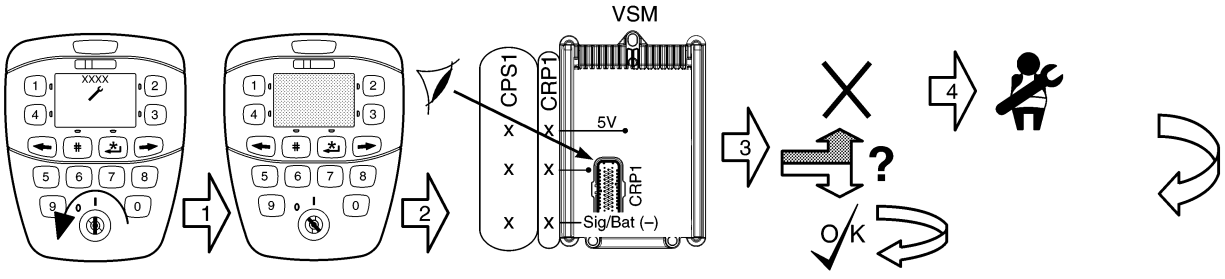


? Power **ON**→ 5 Volt Fault DTC gone→ Old sensor faulty→ Install New sensor→ Resume operation



Original Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Next Sensor. Repeat Component Operational Check
All Sensors tested OK.
Go to Component Operational Check

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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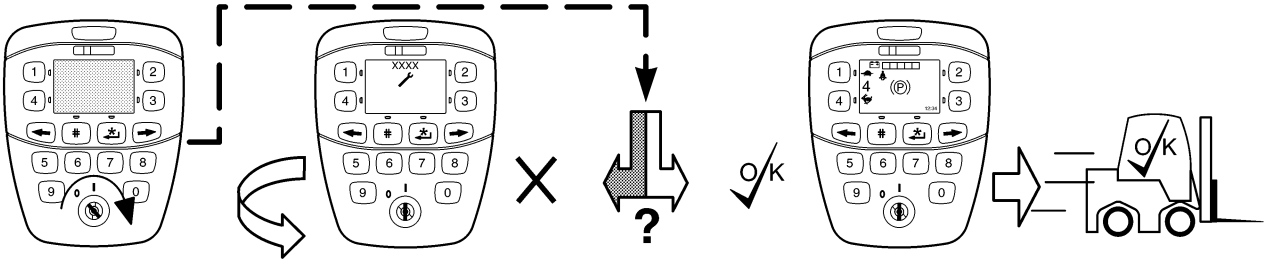
VSM 5 Volt Supply (OORL) (OORH) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO ← **YES** →

Fault corrected→ Continue operation.

END FAULT

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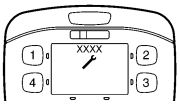
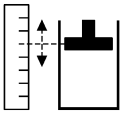
Manual Hydraulic Position Sensors Out Of Range Low (OORL)



Fault Codes

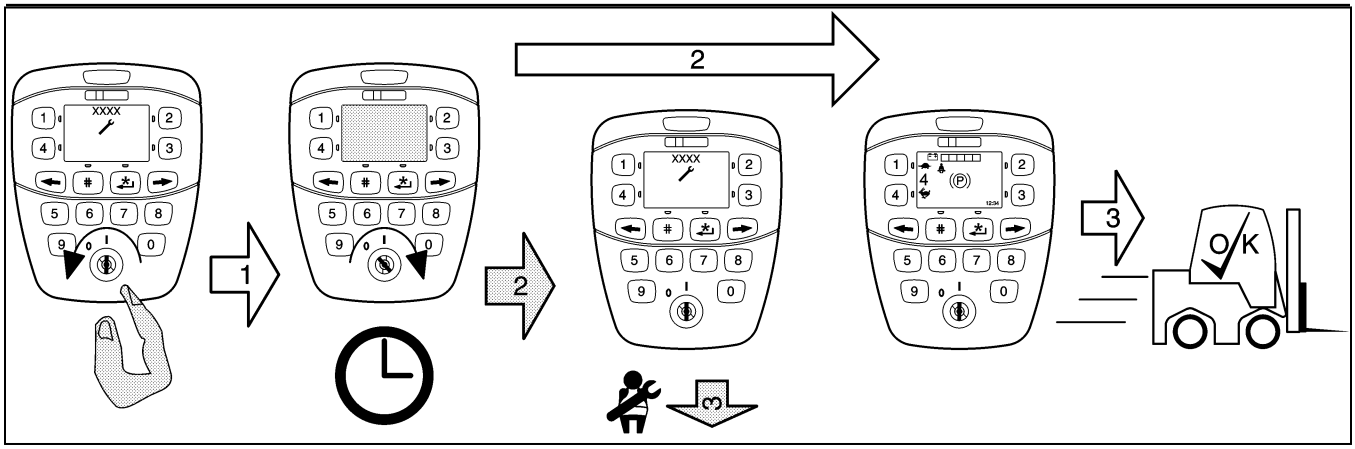


DTC 12856
Manual Hyd 1

DTC 12860
Manual Hyd 2

DTC 12864
Manual Hyd 3

DTC 12868
Manual Hyd 4



Power **OFF**→

Wait **30 seconds**→

Power **ON**→

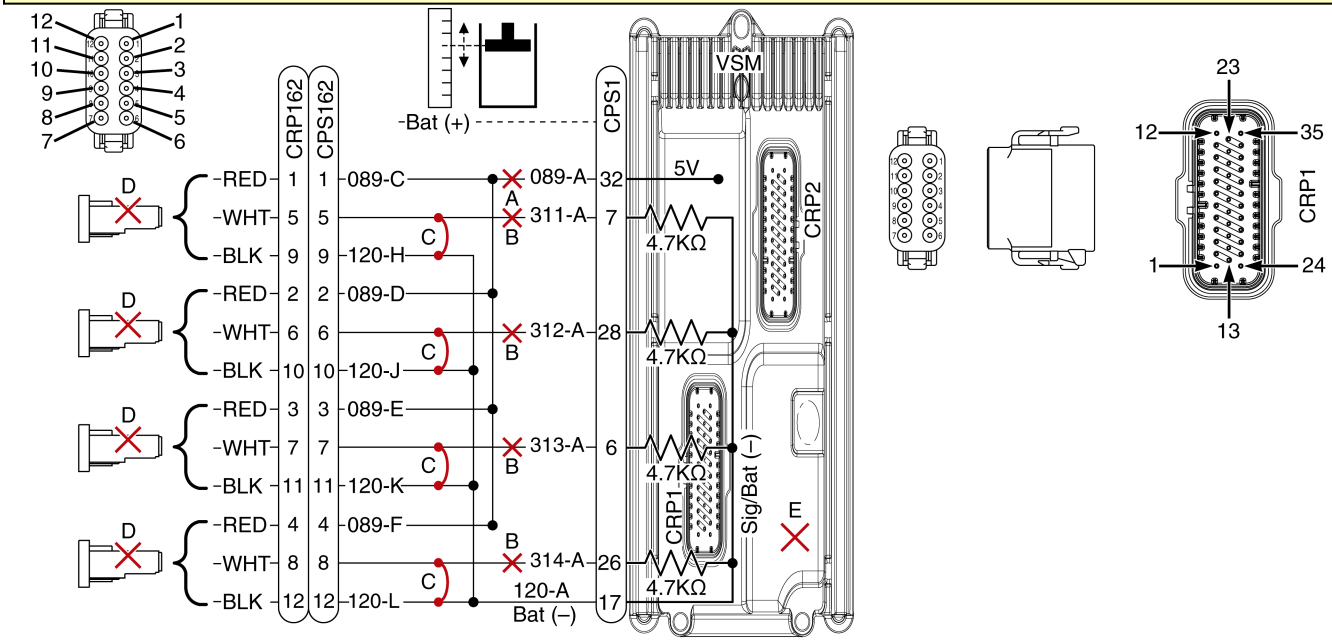
Fault remains. Service required. Go to Component Operational Check.

No fault→

Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

MANUAL HYDRAULIC POSITION SENSOR CAUSES A B C D E > ?



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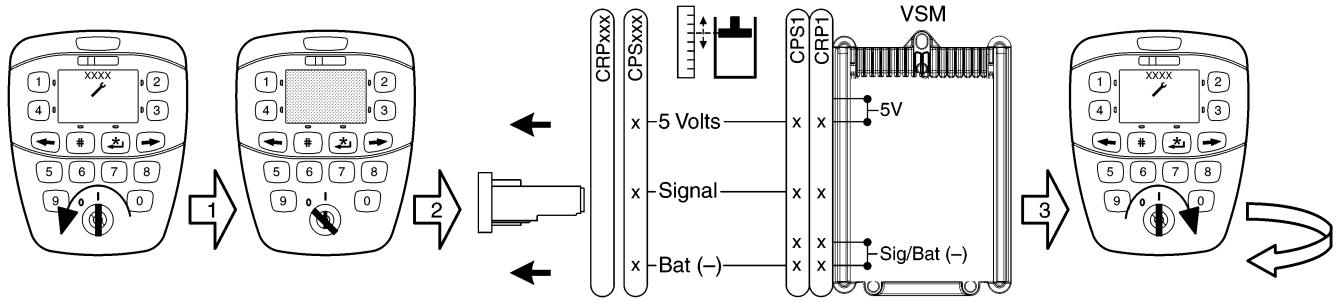
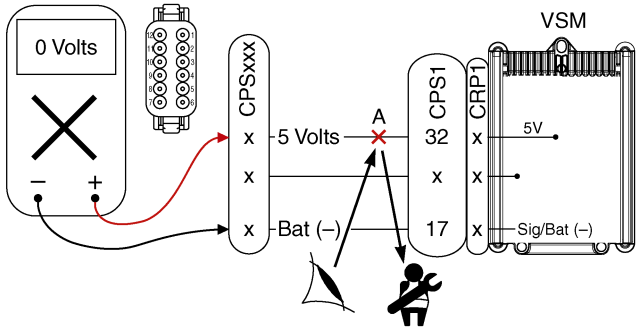
Manual Hydraulic Position Sensors Out Of Range Low (OORL) (Cont)

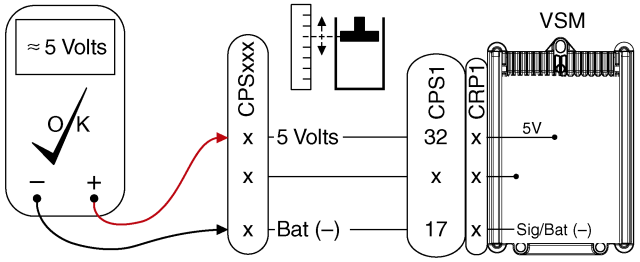
CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

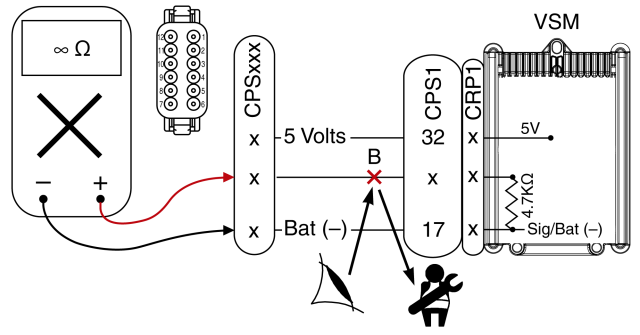
CAUSE A1 CHECK VOLTAGE

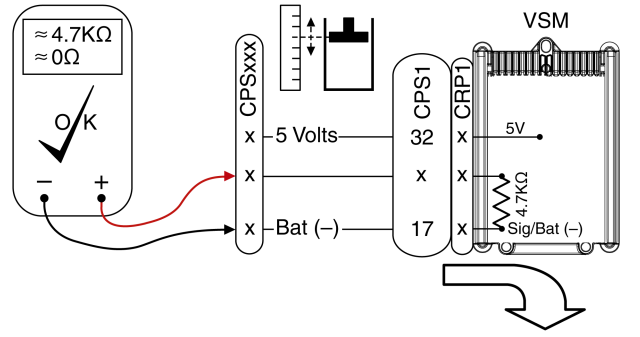




0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B CHECK RESISTANCE - Ω - OHMS





8 ? = Open circuit→ Find↑ **OPEN** circuit	˜ 4.7K? = **OK** Go to Component Operational Check
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? = Go to Component Operational Check

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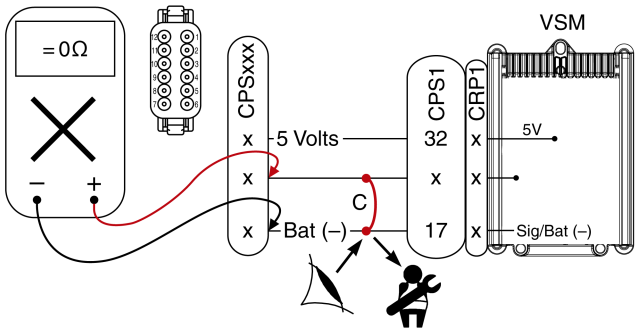
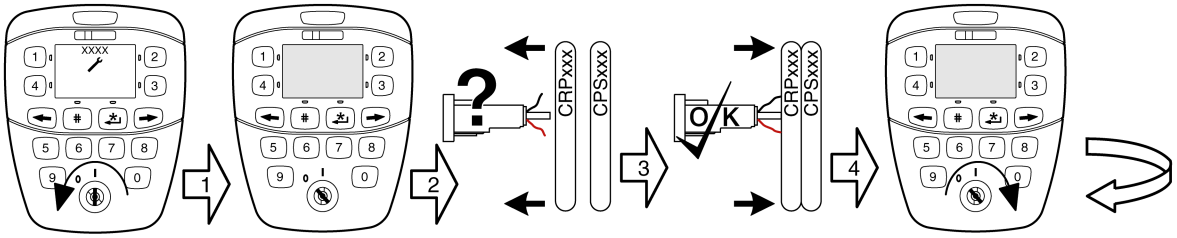
Manual Hydraulic Position Sensors Out Of Range Low (OORL) (Cont)

CAUSE C

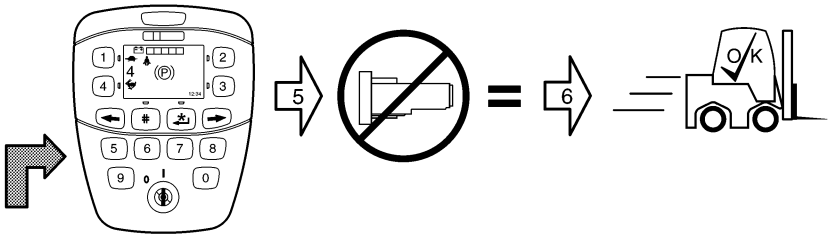


0 ? = Short circuit→ Find↑ **Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

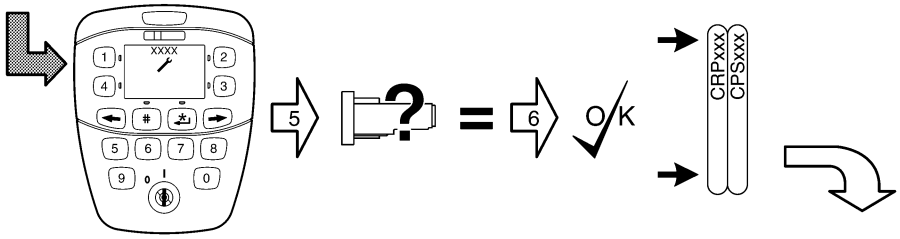
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ Go to next step.



? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

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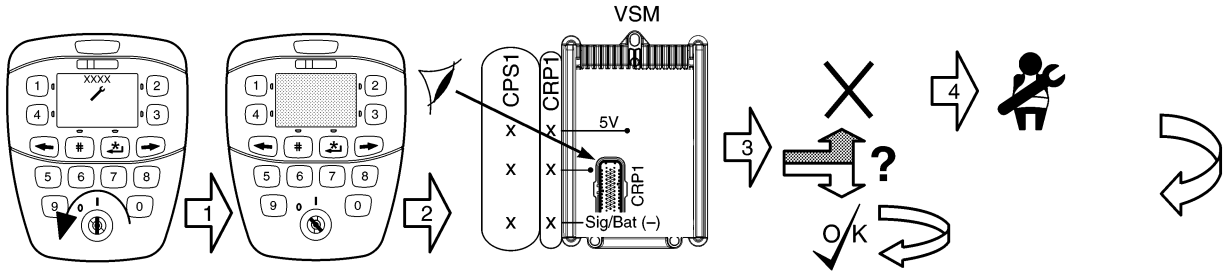
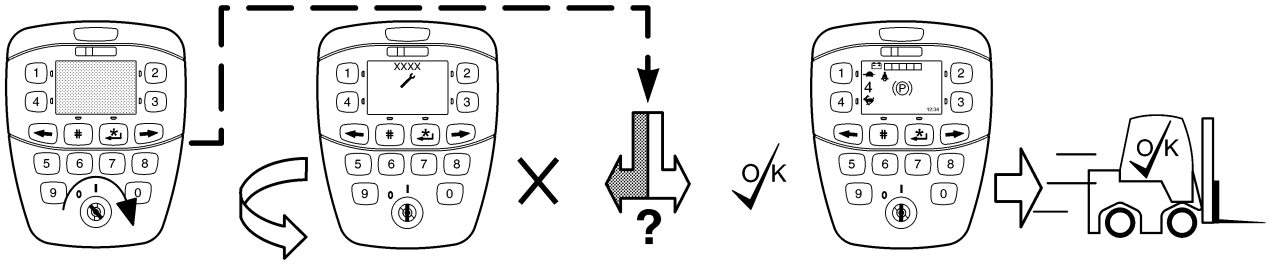
Manual Hydraulic Position Sensors Out Of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK - Go to Cause E1. Not OK →Correct/Repair Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO ← **YES** →

END FAULT

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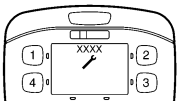
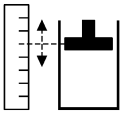
Manual Hydraulic Position Sensor Out Of Range High (OORH)



Fault Codes

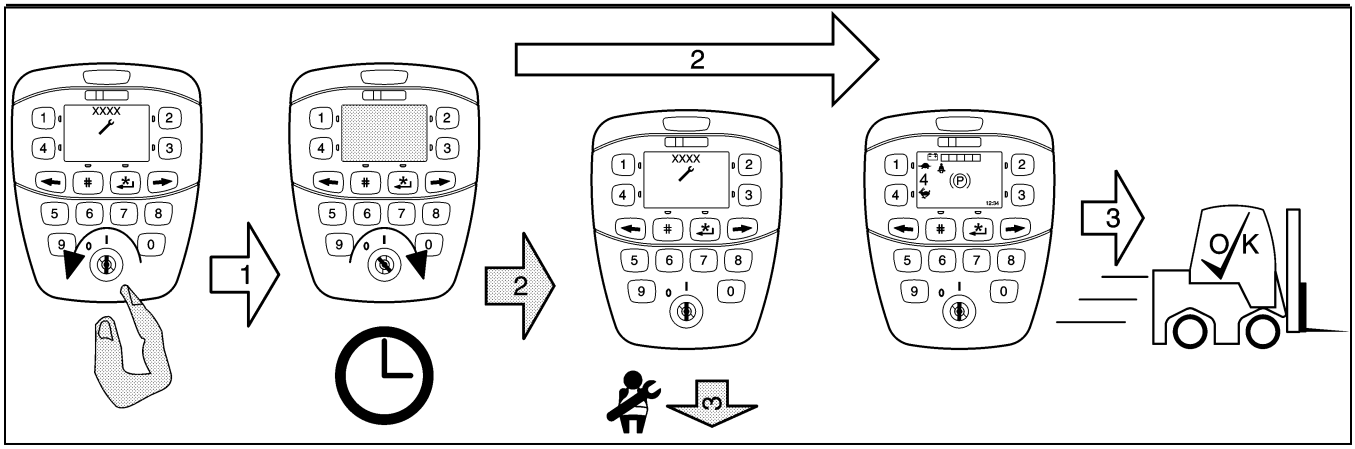


DTC 12857
Manual Hyd 1

DTC 12861
Manual Hyd 2

DTC 12865
Manual Hyd 3

DTC 12869
Manual Hyd 4



Power **OFF**→

Wait **30 seconds**→

Power **ON**→

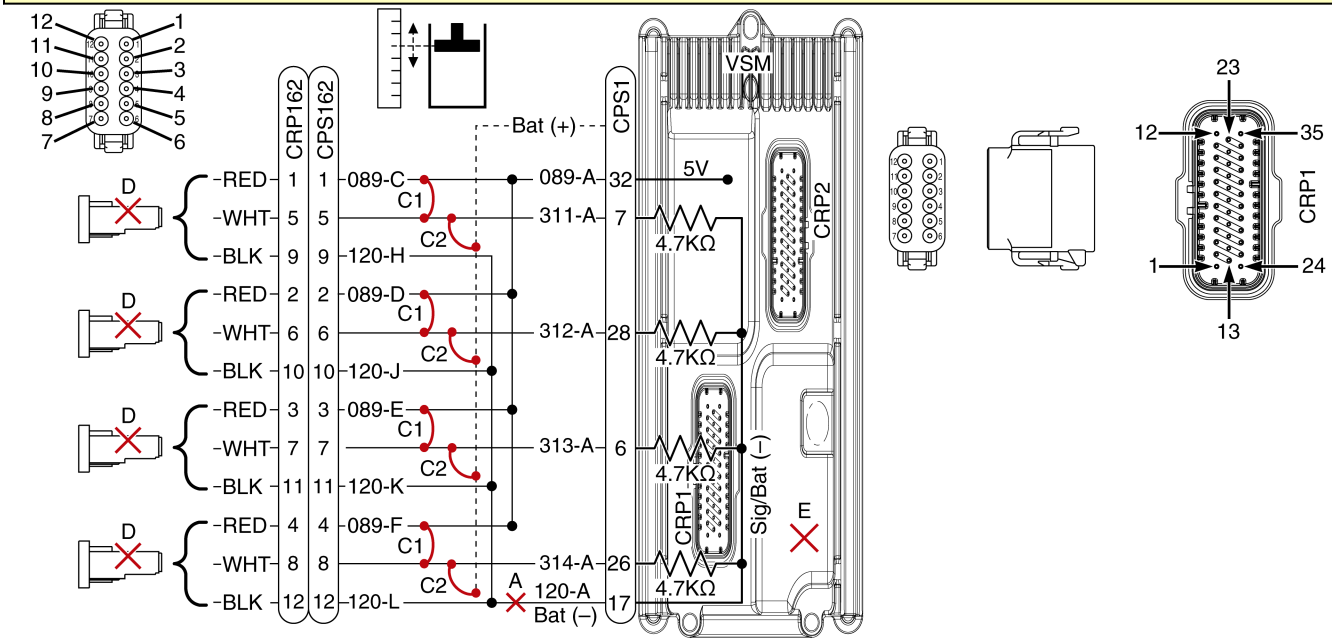
Fault remains. Service required. Go to Component Operational Check.

No fault→

Resume operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

ACCELERATOR PEDAL POSITION A/B CAUSES A B C C1 C2 D E > ?



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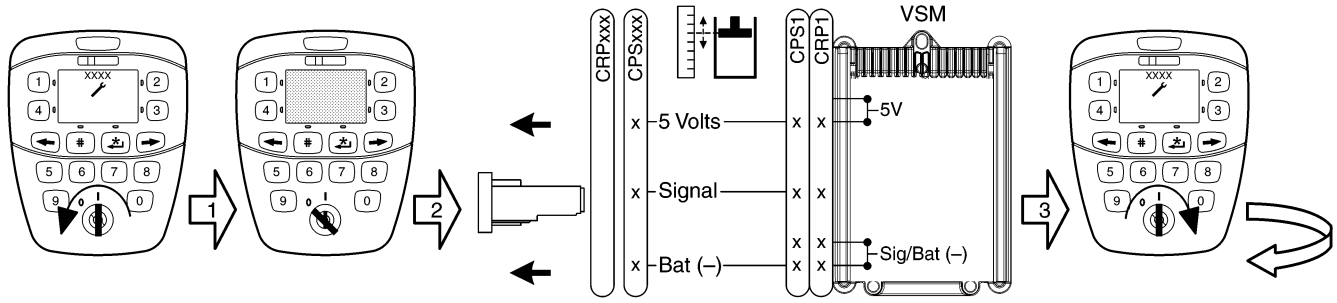
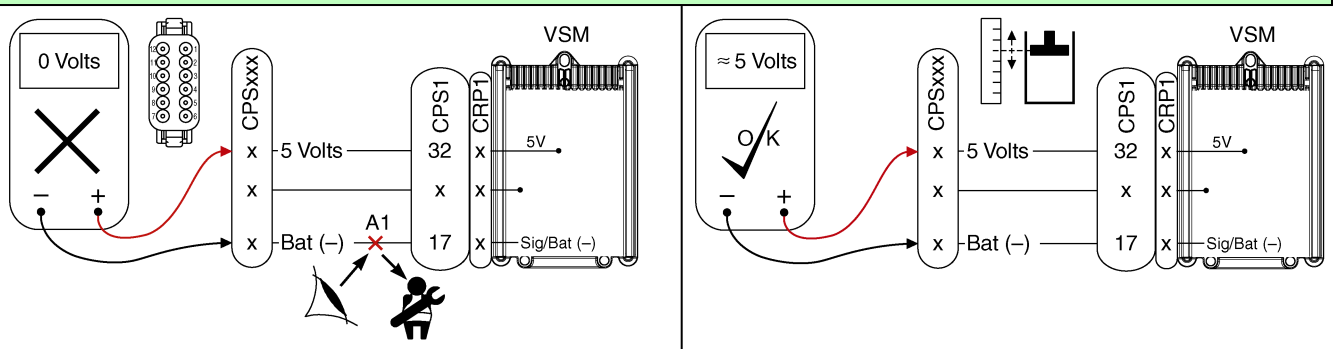
Manual Hydraulic Position Sensor Out Of Range High (OORH) (Cont)

CAUSE A



Power **OFF**→ Disconnect sensor→ Power **ON**→ Go to next step.

CAUSE A1 CHECK VOLTAGE

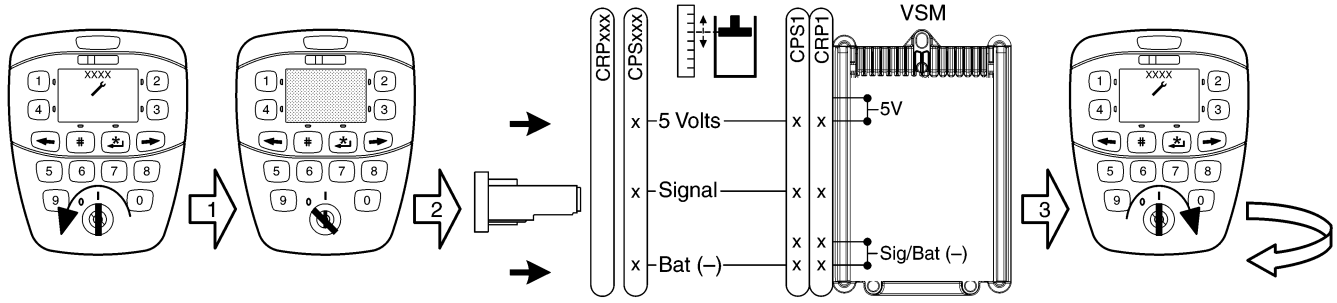


0 Volts = Open circuit→ Find↑ **OPEN** circuit.	˜ 5 Volts = **OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE B

Not Applicable

CAUSE C

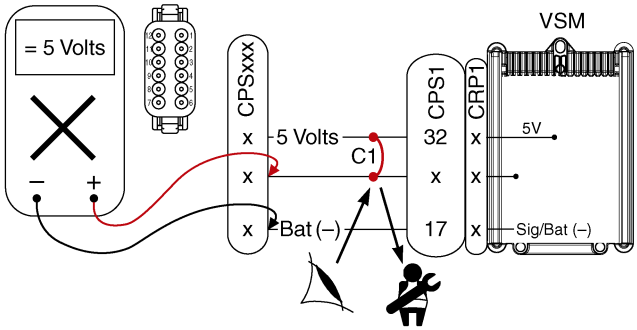


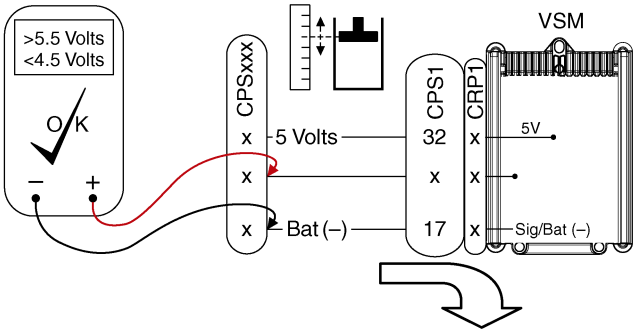
Power **OFF**→ Reconnect sensor→ Power **ON**→ Go to next step.

https://truckmanualshub.com/

Manual Hydraulic Position Sensor Out Of Range High (OORH) (Cont)

CAUSE C1 CHECK VOLTAGE

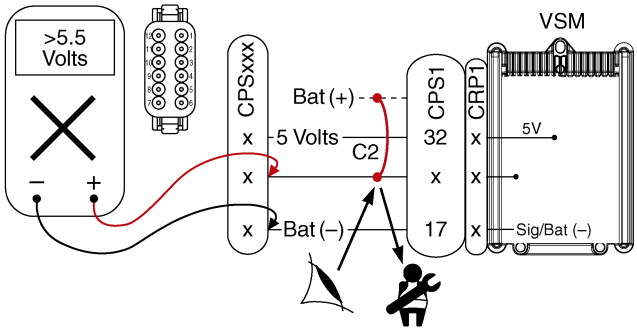


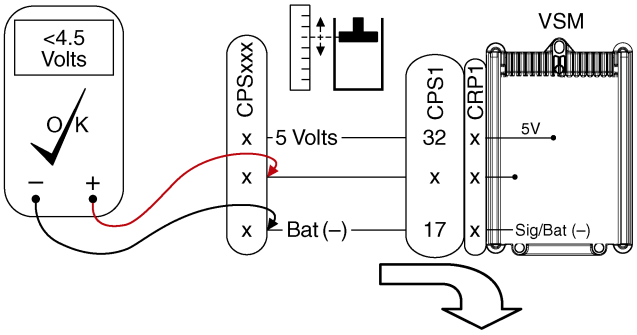


5 Volts = Short circuit→ Find↑ **Short** circuit.	> 5.5 Volts	Go to Cause C2.
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts = **OK**	Go to Component Operational Check.

CAUSE C2 CHECK VOLTAGE

Switched and Unswitched





> 5.5 Volts = Short circuit→ Find↑ **Short** circuit to another voltage source.	< 4.5 volts = **OK**	Go to Component Operational Check.
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

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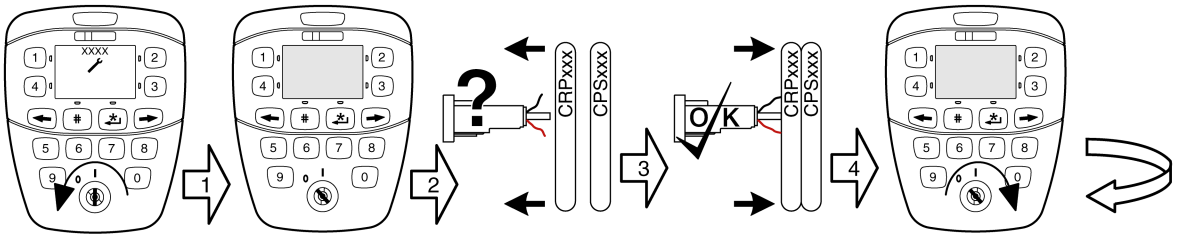
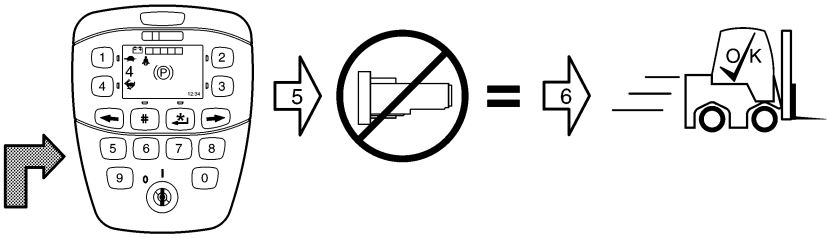
Manual Hydraulic Position Sensor Out Of Range High (OORH) (Cont)

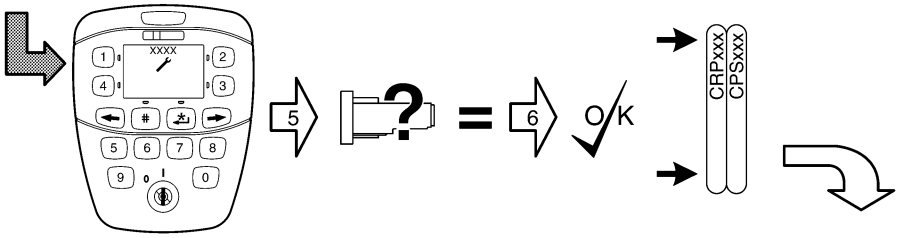
CAUSE D



Power **OFF**→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ Go to next step.

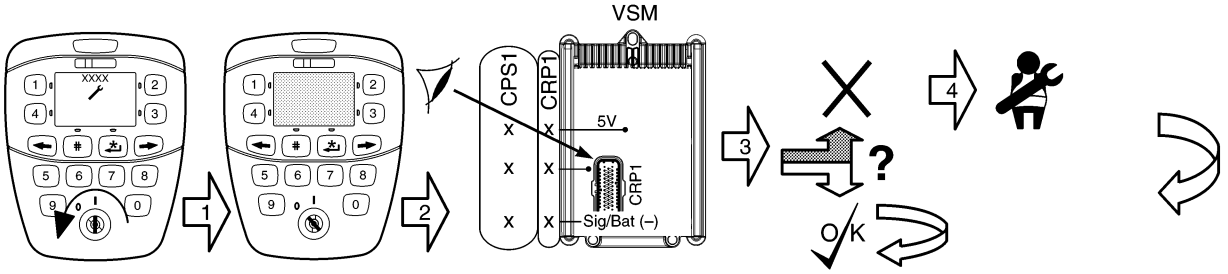


? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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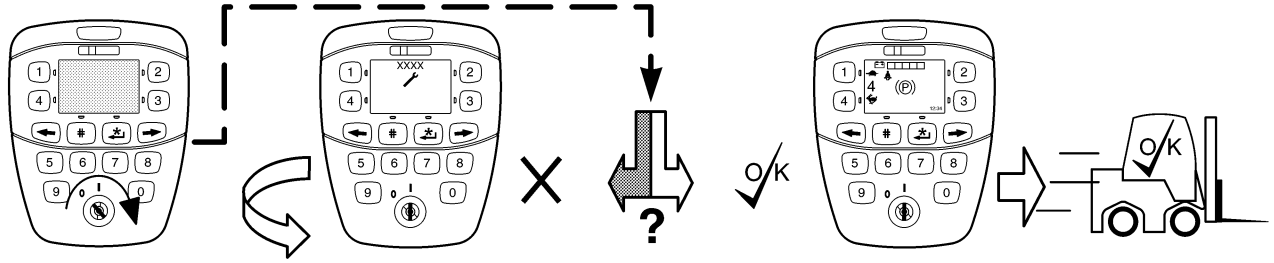
Manual Hydraulic Position Sensor Out Of Range High (OORH) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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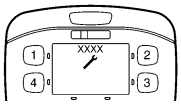
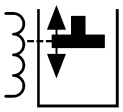
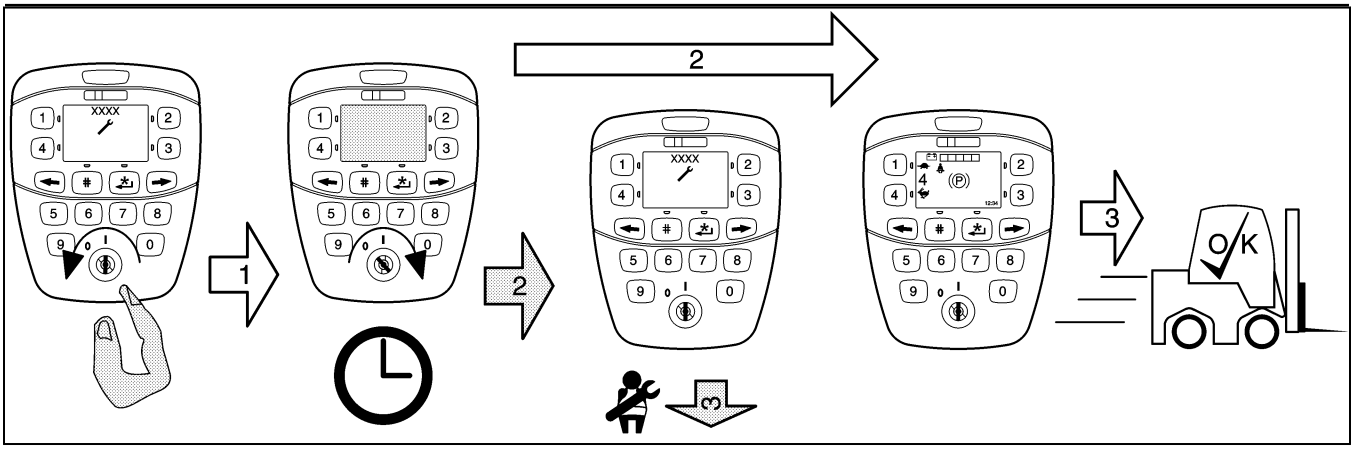
E-Hydraulic Enable System Data Incorrect



Fault Codes



DTC 12332
Data Incorrect



Power **OFF**→

Wait **30 seconds**→

Power **ON**→

Fault remains. Service required. Go to Component Operational Check.

No fault→

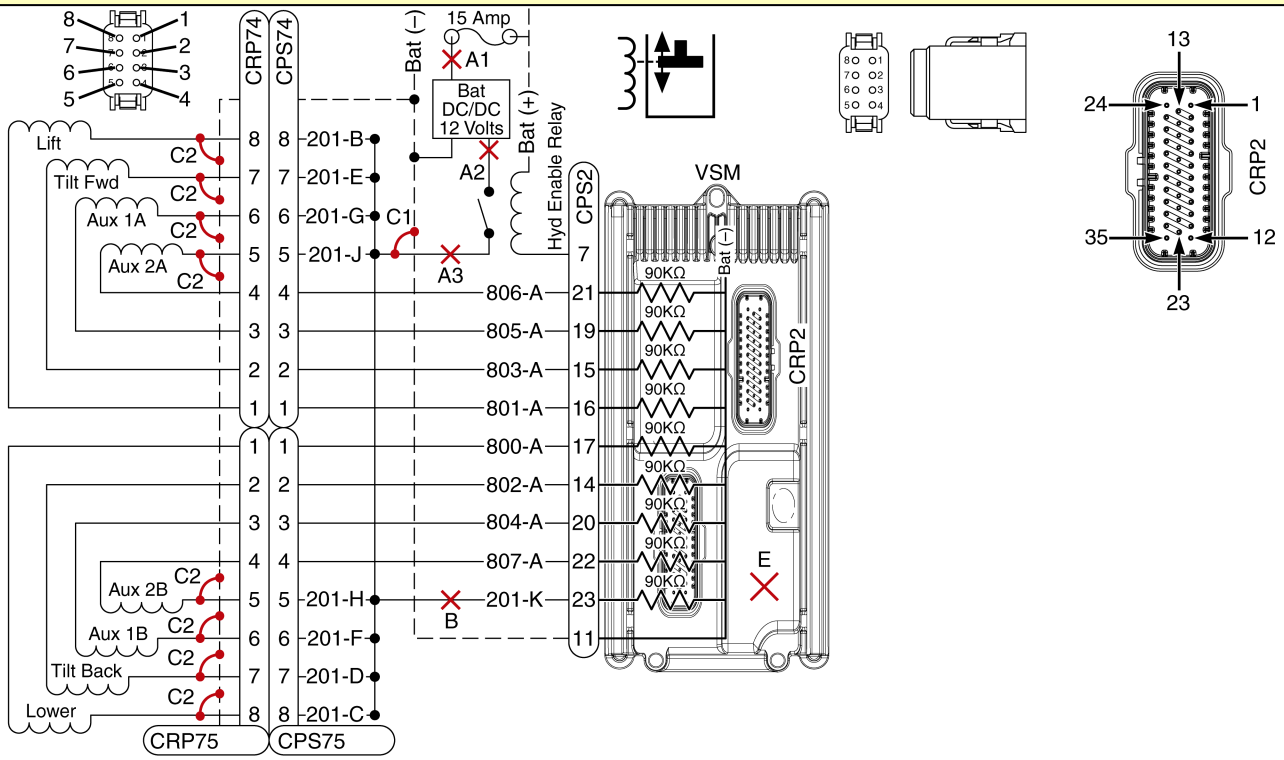
Resume operation

https://truckmanualshub.com/

E-Hydraulic Enable System Data Incorrect (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

E-HYDRAULIC ENABLE SYSTEM DATA INCORRECT CAUSES A A1 A2 A3 B B1 C C1 C2 D E > ?

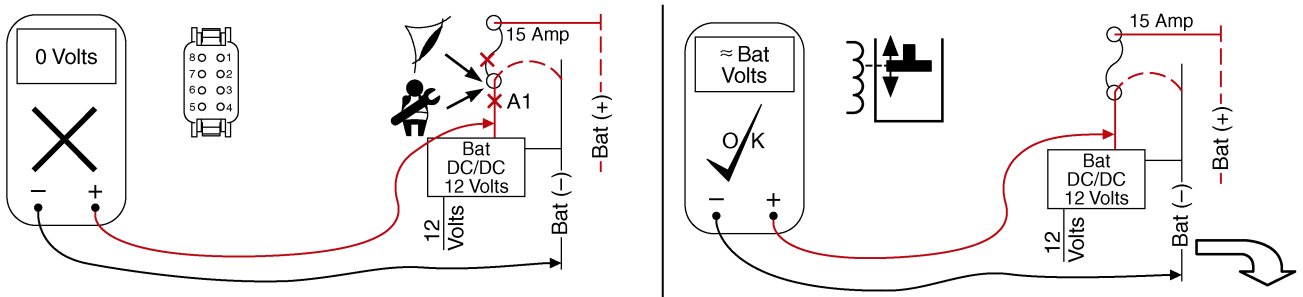


CAUSE A

Not Applicable

CAUSE A1 CHECK VOLTAGE

NOTE: Locate DC/DC Convertor - Check DC/DC Voltage Input

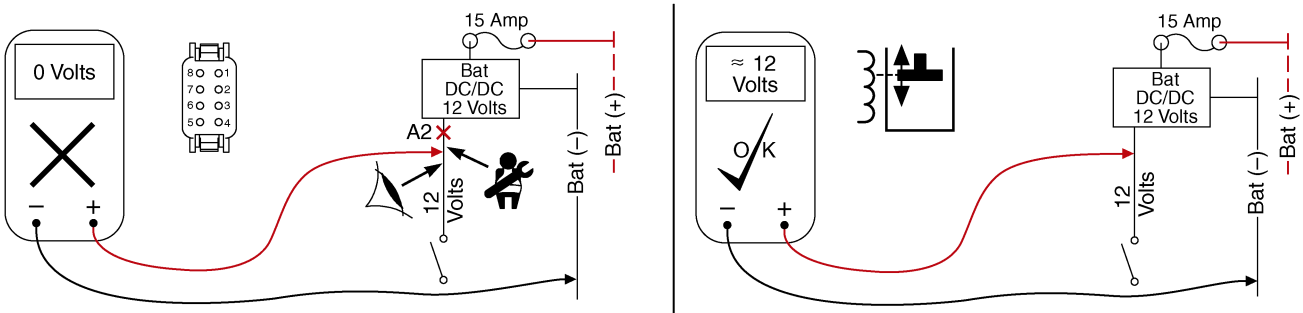


0 Volts = Open circuit/Blown fuse↑ →	~ Bat Volts **OK** Go to Cause A2 =
Find **OPEN** circuit or **SHORT** circuit that blew the fuse.	
Repair OPEN Circuit/SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

E-Hydraulic Enable System Data Incorrect (Cont)

CAUSE A2 CHECK VOLTAGE

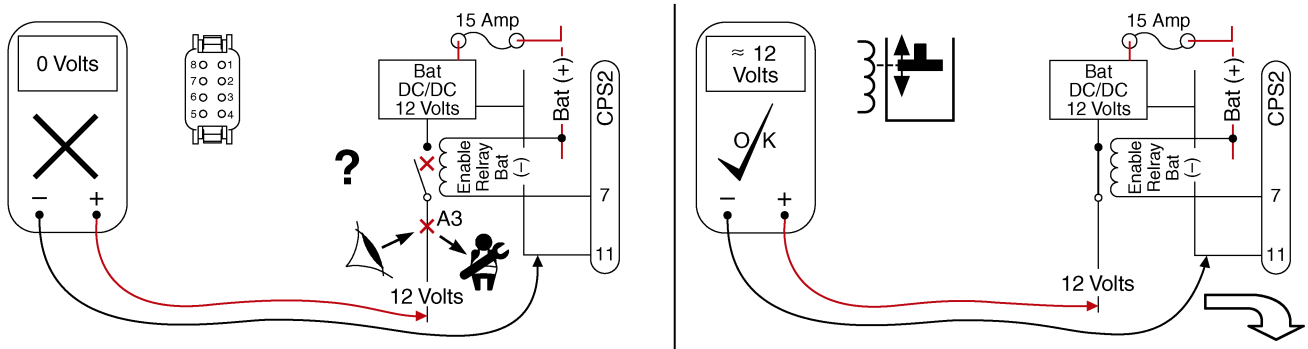
NOTE: Check DC/DC Voltage Output



0 Volts = Open circuit/DC/DC failure↑ → Find **OPEN** circuit.	˜ 12 Volts = **OK** Go to Cause A3
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	
No wiring **OPEN** circuit.→ Replace **DC/DC convertor**.	

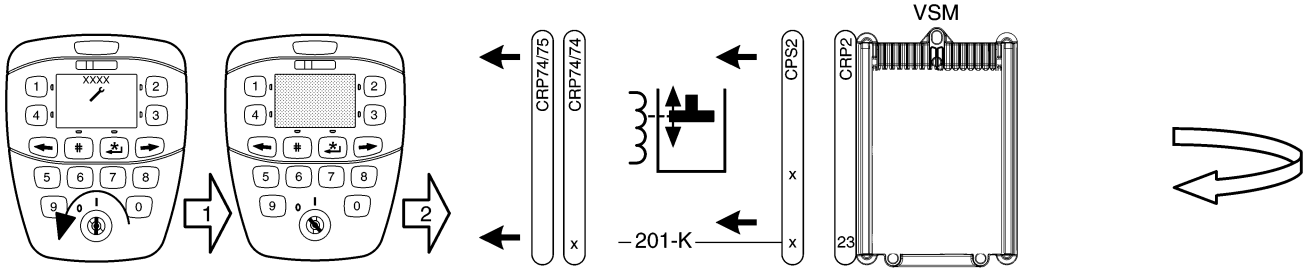
CAUSE A3 CHECK VOLTAGE

NOTE: Occupy Seat - Operate any Hyd Function - Check Voltage out on Enable Relay



0 Volts = Open circuit/Relay Contacts↑ → Find **OPEN** circuit.	˜ 12 Volts = **OK** Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	
No Wiring OPEN Circuit.→ Replace **Enable Relay**.	

CAUSE B



Power **OFF**→ Disconnect Coil Connector→ Disconnect VSM Connector CPS2→ Go to next step.

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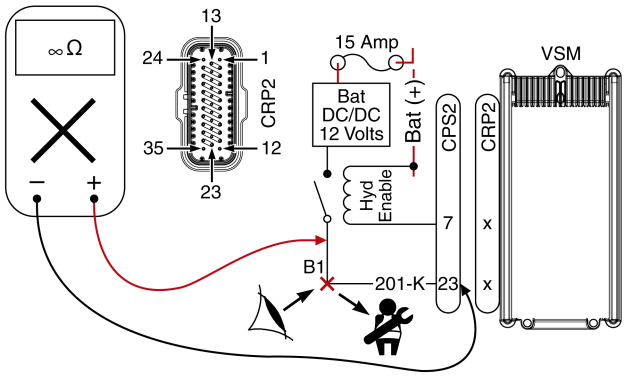
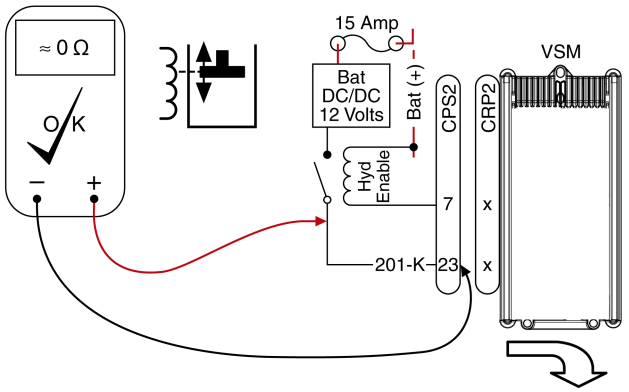
E-Hydraulic Enable System Data Incorrect (Cont)

CAUSE B1 CHECK RESISTANCE - Ω - OHMS



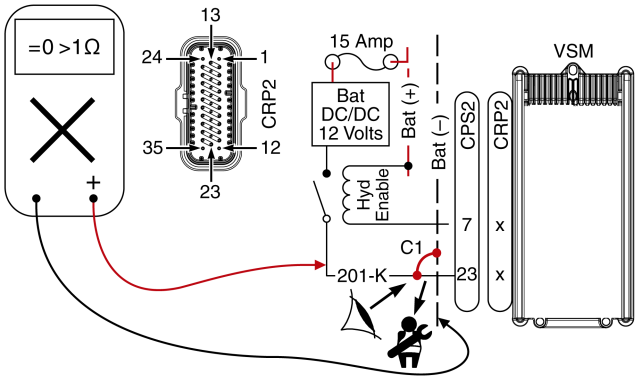


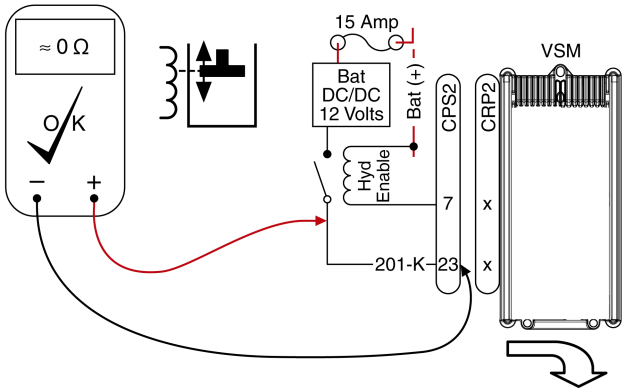
8 ? = Open circuit→ Find↑ **OPEN** circuit.→	˜ 0 ? = **OK** Go to Cause C1
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE C

Not Applicable

CAUSE C1 CHECK RESISTANCE - Ω - OHMS

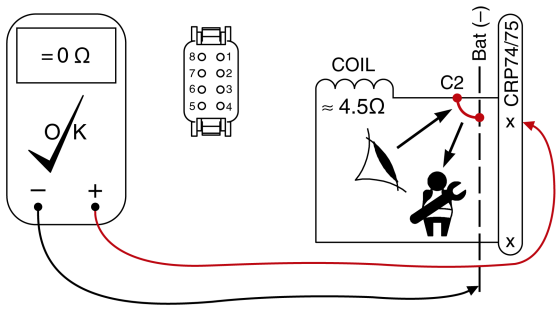


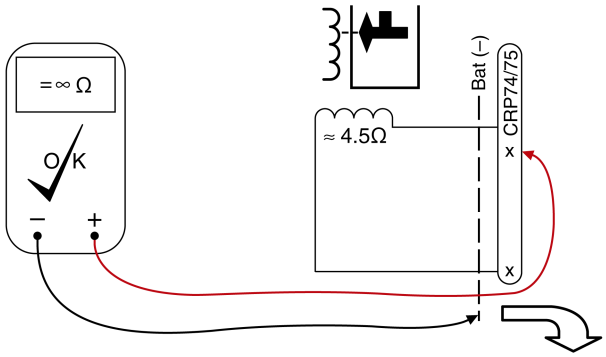


0 ? to 1 ? = Short circuit→ Find↑ **Short** circuit.→	> 1 ? = **OK** Reconnect all connections, go to Component Operational Check
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

E-Hydraulic Enable System Data Incorrect (Cont)

CAUSE C2 CHECK RESISTANCE - Ω - OHMS



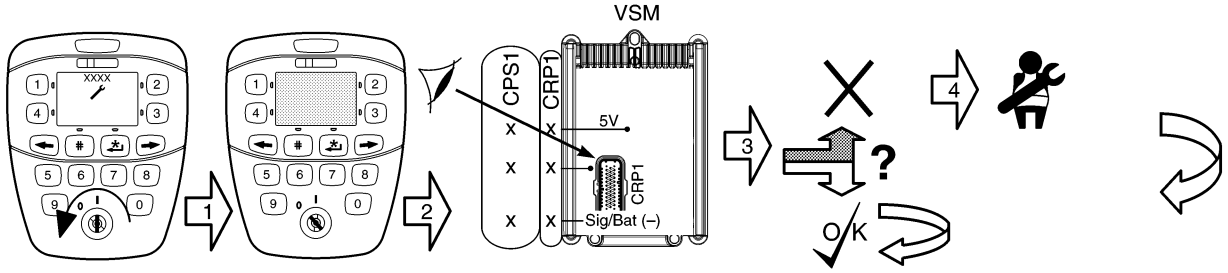


0 ? = Short circuit→ Find↑ **Short** circuit.→	8 ? = **OK** Reconnect all connections, go to Component Operational Check
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE D

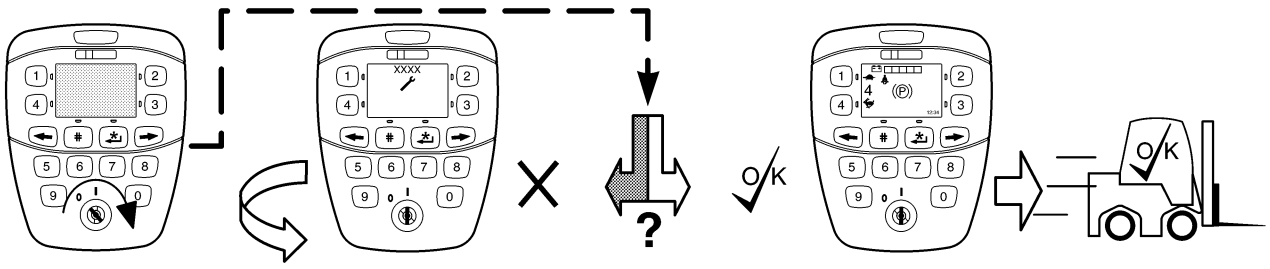
Not Applicable

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO ← **YES** →

END FAULT

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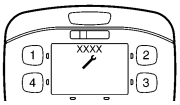
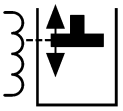
E-Hydraulic Coils Short To Battery Positive (STBP)



Fault Codes



DTC 8960
Lift

DTC 8964
Lower

DTC 8968
Tilt Forward

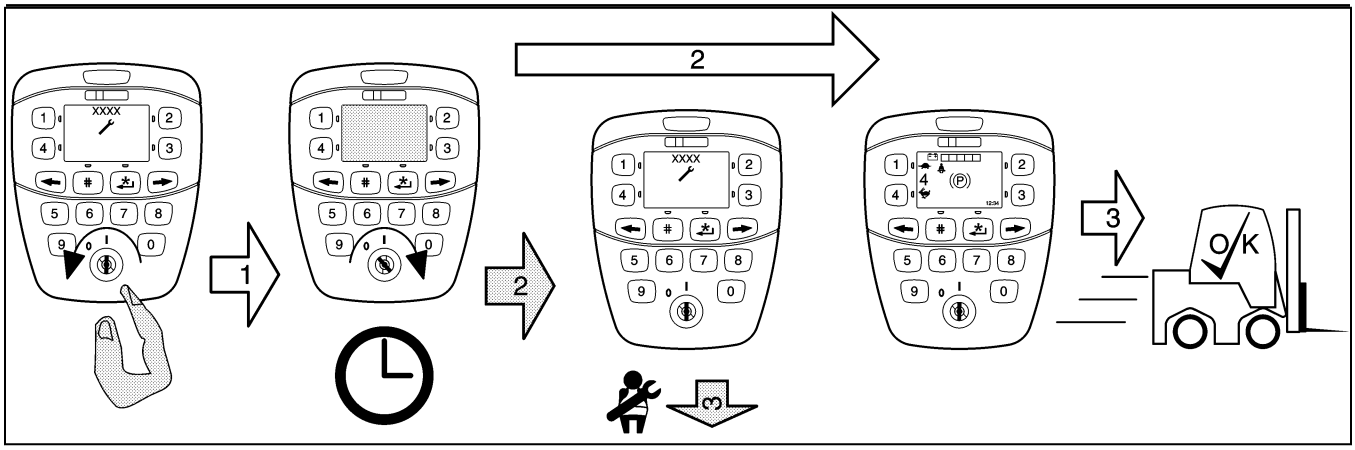
DTC 8972
Tilt Back

DTC 8978
Aux 1A

DTC 8980
Aux 1B

DTC 8984
Aux 2A

DTC 8988
Aux 2B



Power **OFF**→

Wait **30 seconds**→

Power **ON**→

Fault remains. Service required. Go to Component Operational Check.

No fault→

Resume operation

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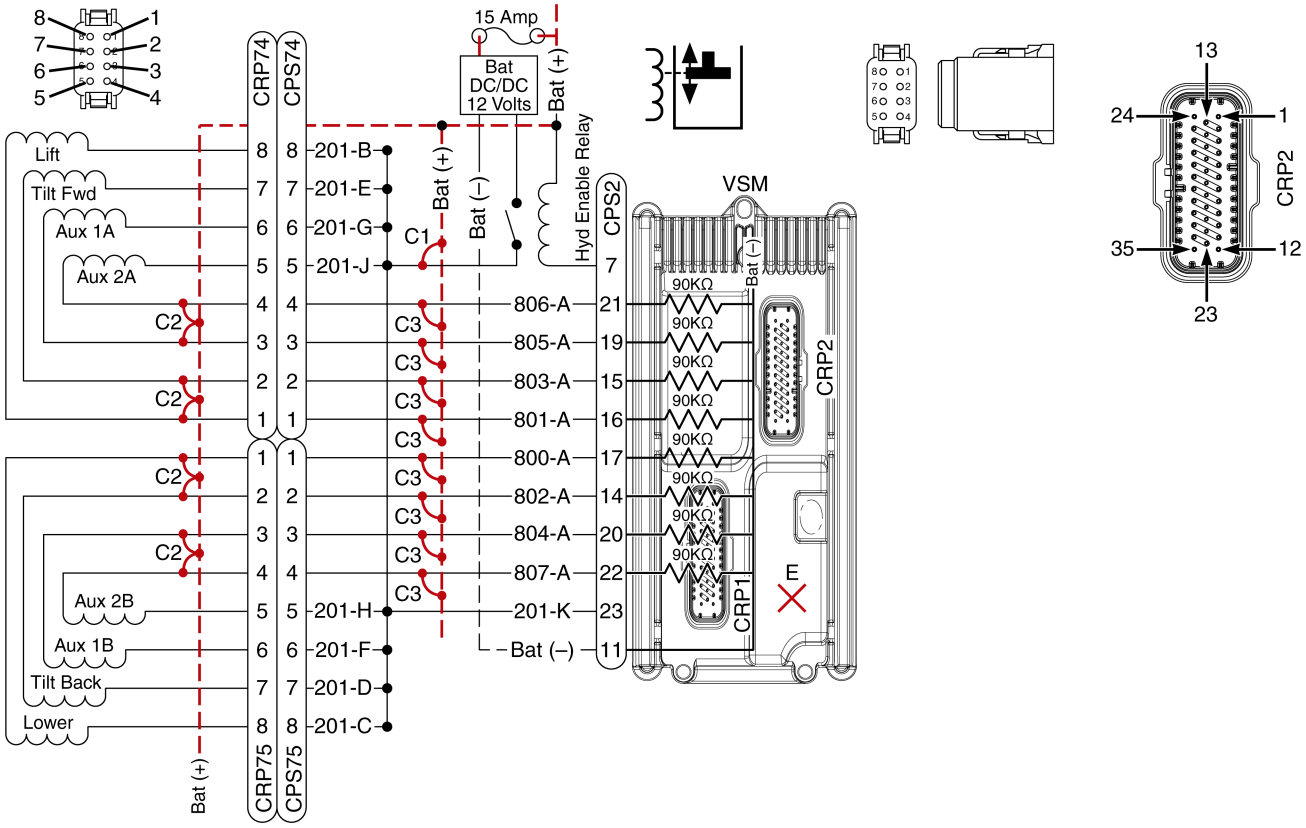
E-Hydraulic Coils Short To Battery Positive (STBP) (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

E-HYDRAULIC ENABLE SYSTEM DATA INCORRECT CAUSES A B C C1 C2 C3 C4 C5 C6 D E > ?



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E-Hydraulic Coils Short To Battery Positive (STBP) (Cont)

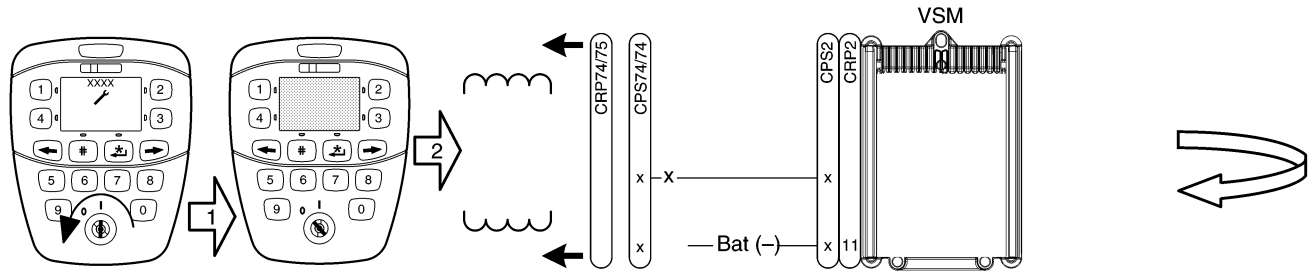
CAUSE A

Not Applicable

CAUSE B

Not Applicable

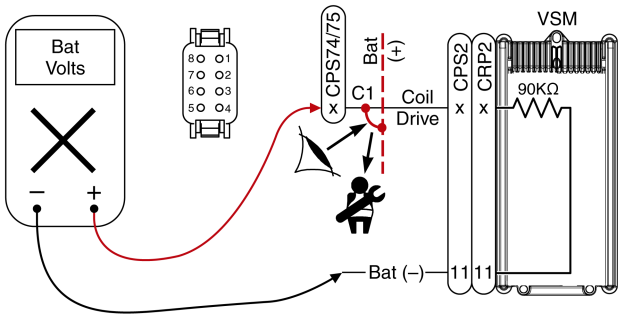
CAUSE C

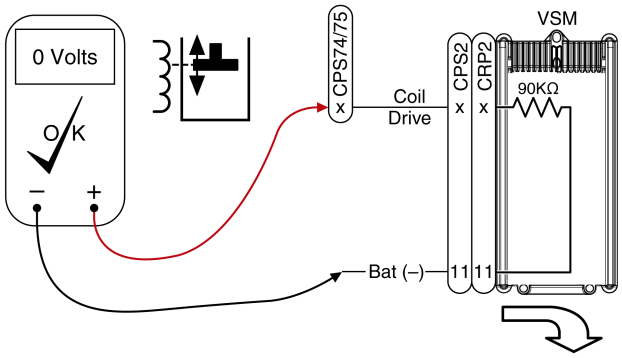


Power **OFF**→ Disconnect coil connectors→ Go to next step.

CAUSE C1 UNSWITCHED VOLTAGES

NOTE: Coil Driver Short to Unswitched Battery

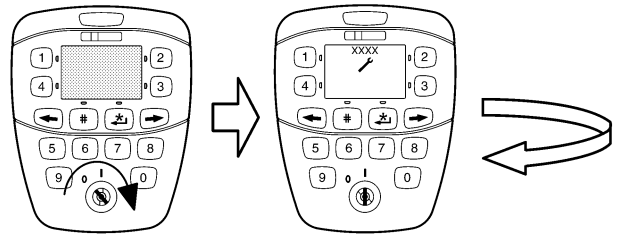




Bat Volts = Short circuit→ Find↑ **SHORT** circuit.→	~ 0 Volts = **OK** Go to Cause C2
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE C2 SWITCHED VOLTAGES

NOTE: Coil Driver Short to Switched Battery

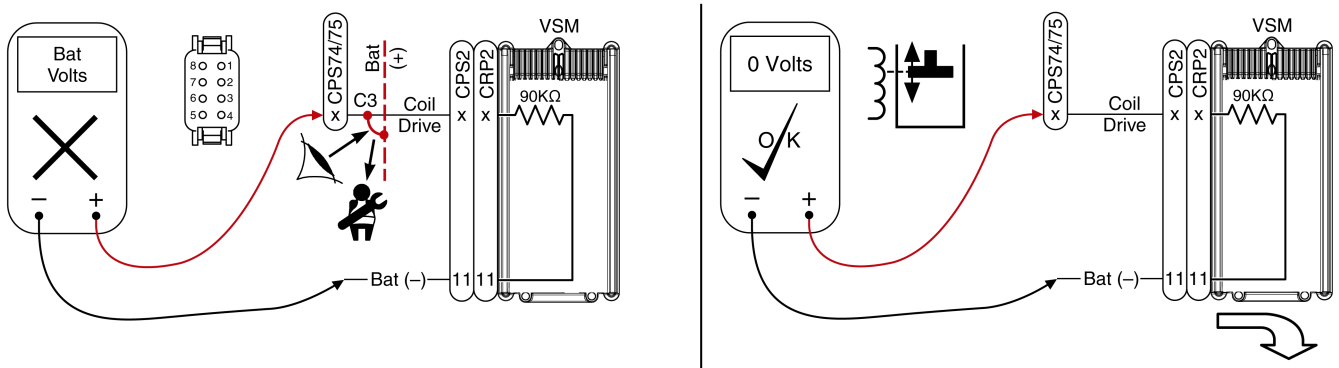


Power **ON**→ Go to next step.

E-Hydraulic Coils Short To Battery Positive (STBP) (Cont)

CAUSE C3 SWITCHED VOLTAGES

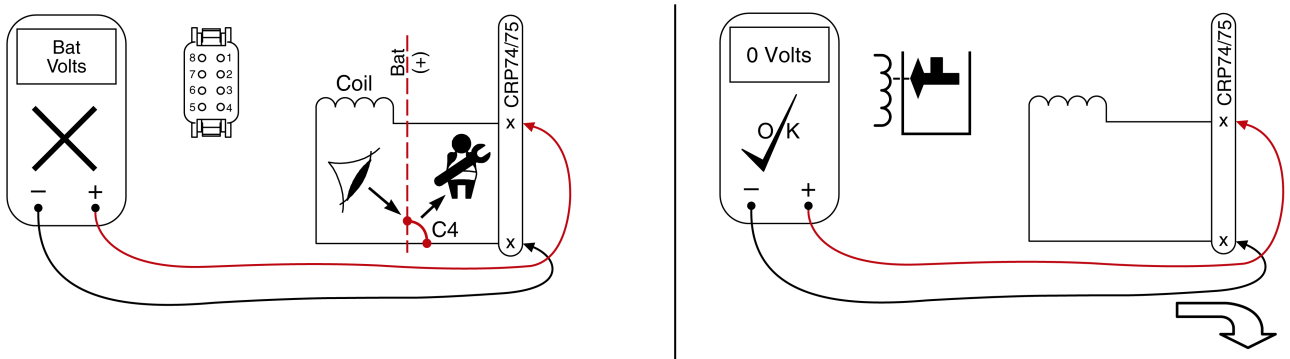
NOTE: Coil Driver Short to Switched Battery



Bat Volts = Short circuit→ Find↑ **SHORT** circuit →	˜ 0 Volts = **OK** Go to Cause C4
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE C4 SWITCHED VOLTAGES

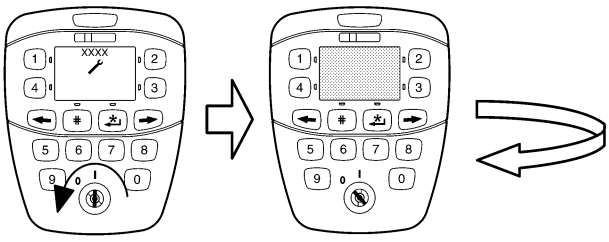
NOTE: Short to Switched Battery



Bat Volts = Short circuit→ Find↑ **SHORT** circuit →	˜ 0 Volts = **OK** Go to Cause C5
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE C5 UNSWITCHED VOLTAGES

NOTE: Short to Unswitched Battery



Power **OFF**→ ?

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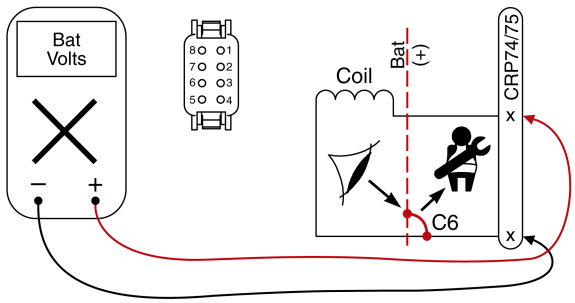
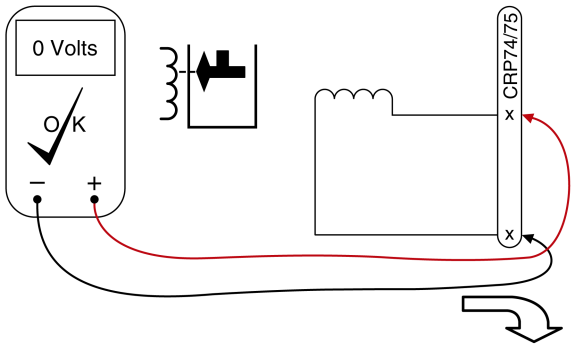
E-Hydraulic Coils Short To Battery Positive (STBP) (Cont)

CAUSE C6 UNSWITCHED VOLTAGES

NOTE: Short to Unswitched Battery



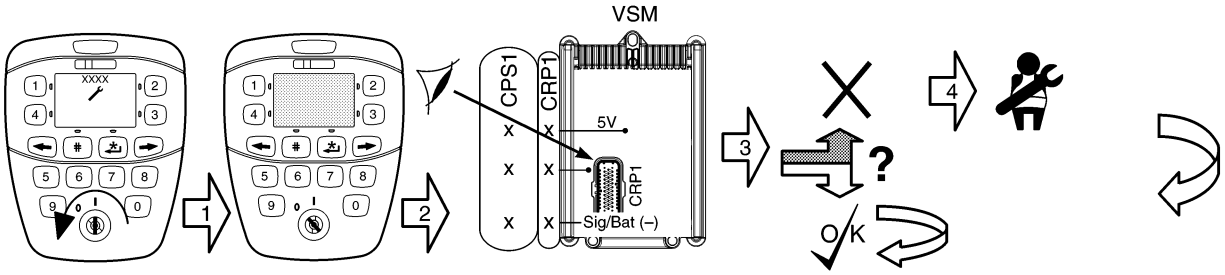


Bat Volts = Short circuit→ Find↑ **SHORT** circuit →	~ 0 Volts = **OK** Go to Component Operational Check
Repair Open Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE D

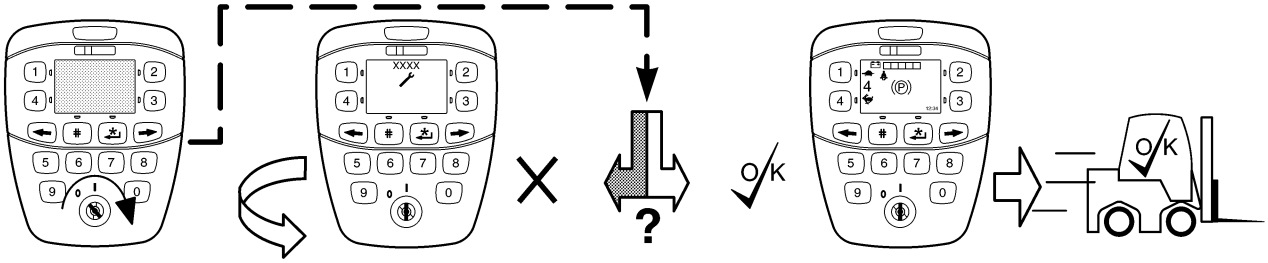
Not Applicable

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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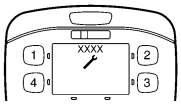
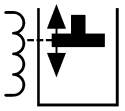
E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC)



Fault Codes



DTC 13312
Lift

DTC 13316
Lower

DTC 13320
Tilt Forward

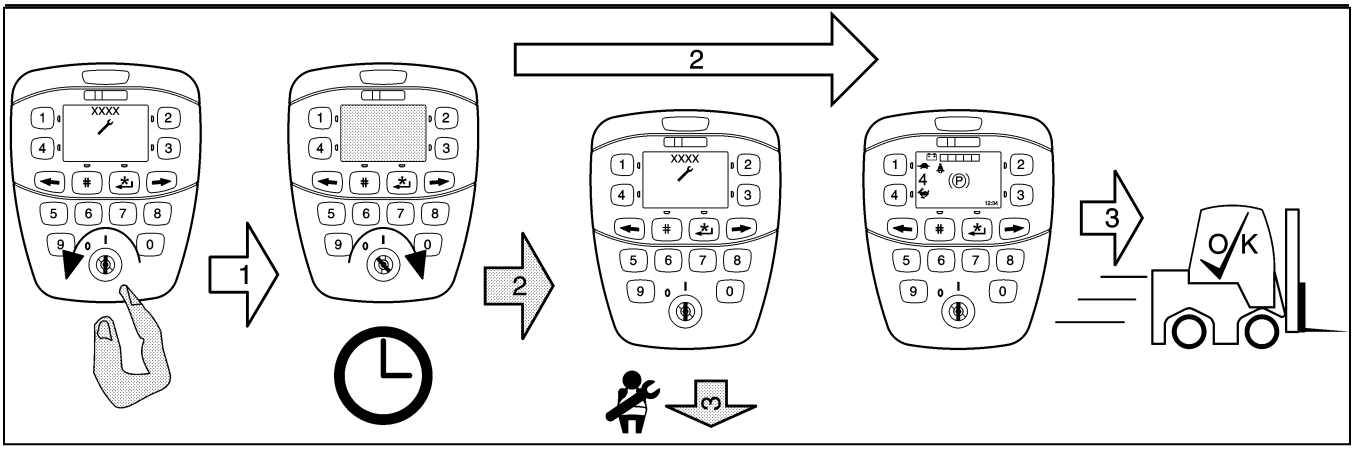
DTC 13324
Tilt Back

DTC 13328
Aux 1A

DTC 13332
Aux 1B

DTC 13336
Aux 2A

DTC 13340
Aux 2B



Power **OFF**→

Wait **30 seconds**→

Power **ON**→

Fault remains. Service required. Go to Component Operational Check.

No fault→

Resume operation

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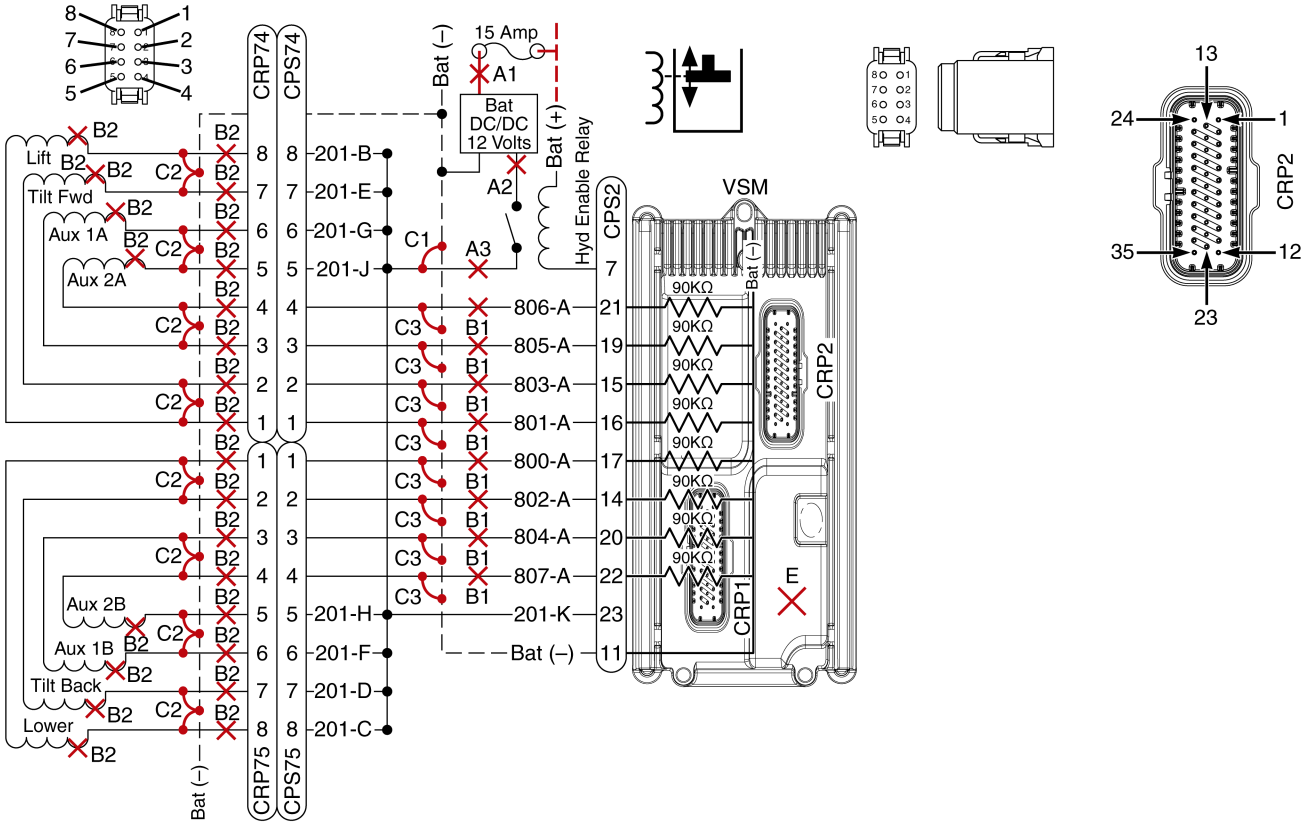
E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC) (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

E-HYDRAULIC COILS (STBN)/(OC) CAUSES A B C E > ?

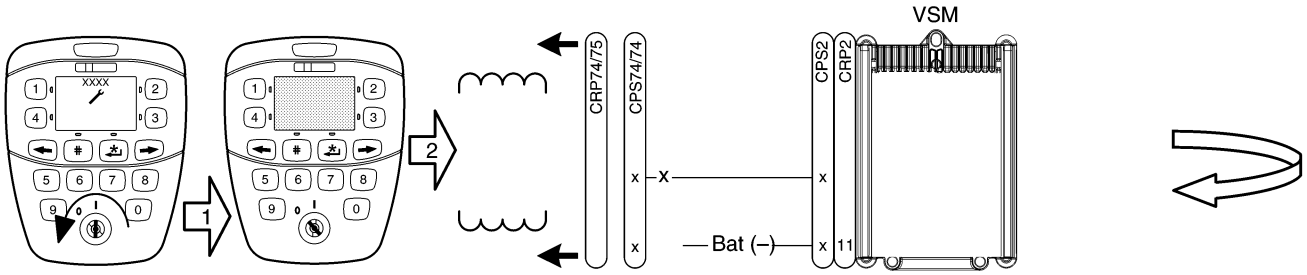


E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC) (Cont)

CAUSE A

For causes A1, A2, and A3, go to DTC 12332 in E-Hydraulic Enable System Data Incorrect.

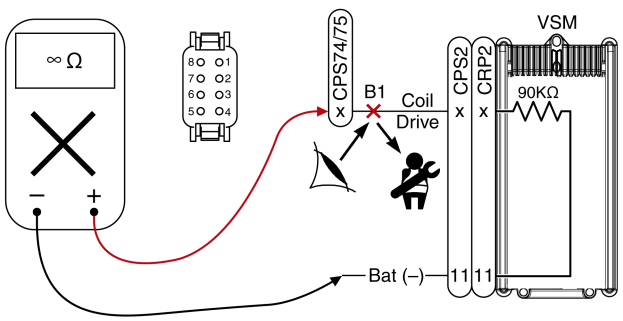
CAUSE B

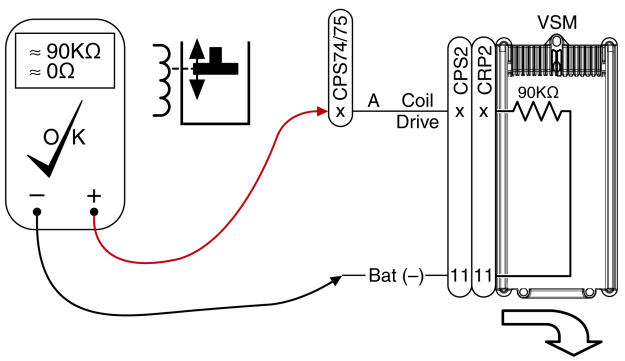


Power **OFF**→ Disconnect coil connectors→ Go to next step.

CAUSE B1 CHECK RESISTANCE - Ω - OHMS

NOTE: Open Circuit - Coil Connector To VSM





8Ω = Open circuit→ Find↑ **OPEN** circuit→	~ 90kΩ =	**OK** Go to Cause B2
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	~ 0Ω =	Go to Cause C3

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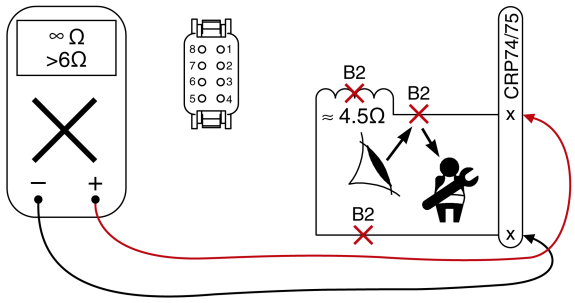
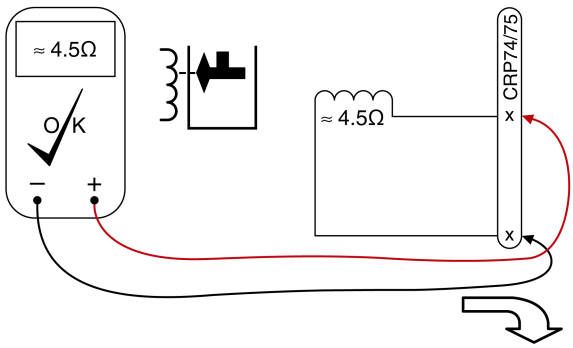
E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC) (Cont)

CAUSE B2 **CHECK RESISTANCE - Ω - OHMS**

NOTE: Open Circuit - Coil Connections To Coil





8Ω = Open circuit→ Find↑ **OPEN** circuit→	˜4.5Ω ± 1.5Ω = **OK** Go to Cause C2
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	
> 6Ω < 3Ω = Faulty Coil→ Replace**Coil**→ Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE C

Go to Cause C1

CAUSE C1 **CHECK RESISTANCE - Ω - OHMS**

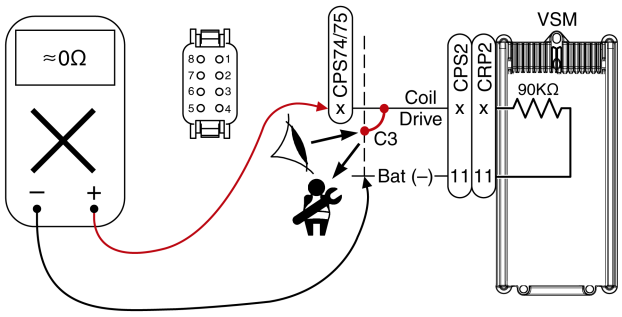
For DC/DC volt Short to Battery, go to DTC 12332 in E-Hydraulic Enable System Data Incorrect.

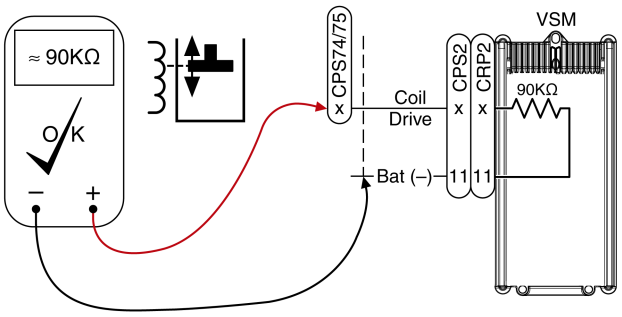
CAUSE C2 **CHECK RESISTANCE - Ω - OHMS**

For DC/DC volt Short to Battery, go to DTC 12332 in E-Hydraulic Enable System Data Incorrect.

CAUSE C3 **CHECK RESISTANCE - Ω - OHMS**

NOTE: Short to Bat (-) Coil Driver Connectional





0 Ω = Short circuit→ Find↑ **Short** circuit→	˜ 90kΩ = **OK** Go to Component Operational Check
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE D

Not Applicable

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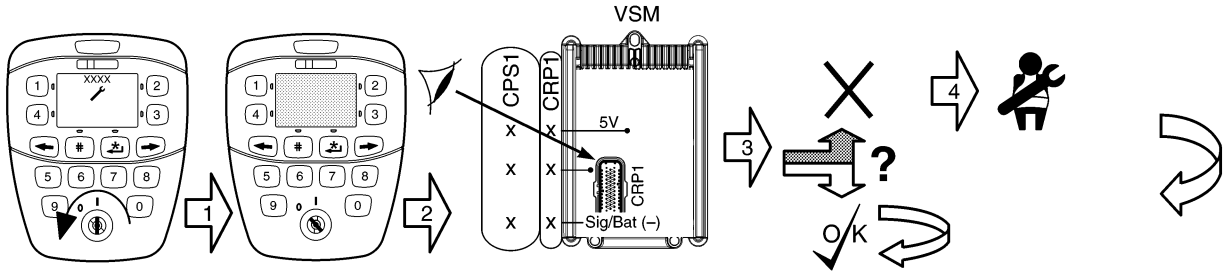
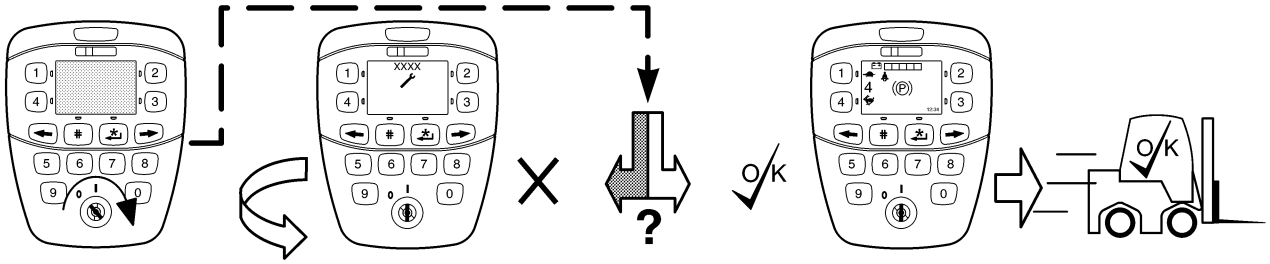
E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC) (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO ← **YES** →

END FAULT

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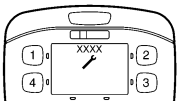
A935 – K160 CAN Communication Failure



Fault Codes

DTC 33025
VSM to Display

DTC 33026
VSM to Traction 1 (Right)

DTC 33027
VSM to Traction 2 (Left)

DTC 33029
VSM to Pump

DTC 33034
VSM to MLM (DCS)

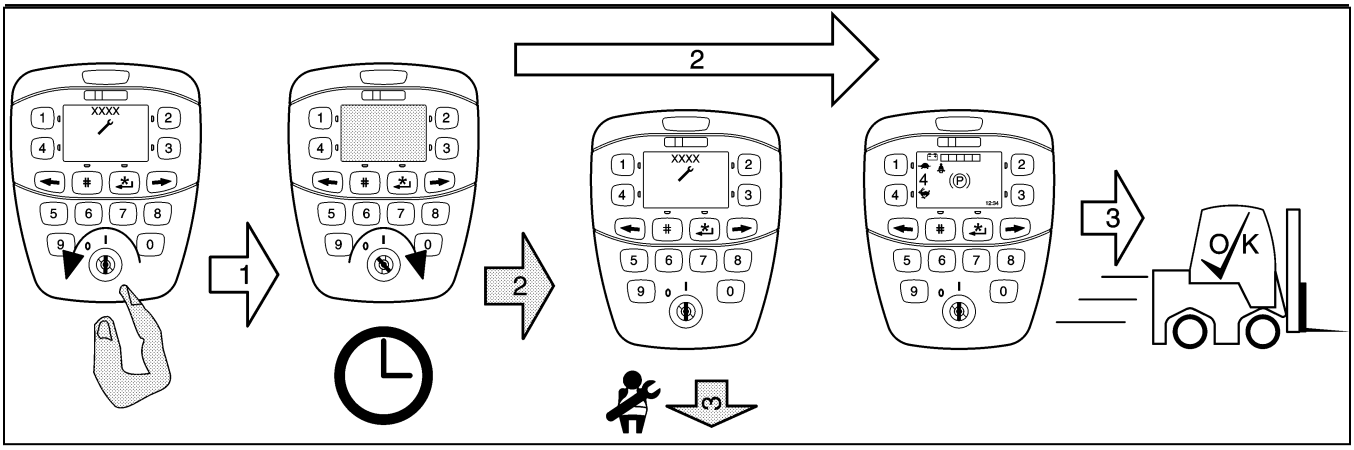
DTC 33035
VSM to Impact

DTC 33036
VSM to CAN Reserved 1

DTC 33037
VSM to CAN Reserved 2

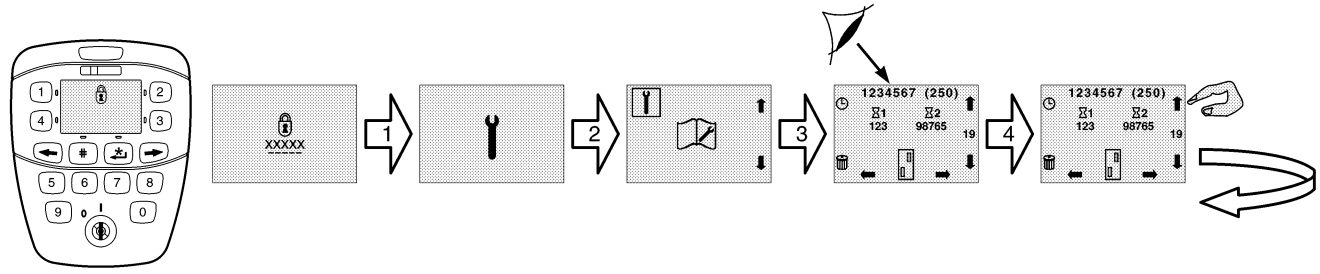
DTC 33038
VSM to CAN Reserved 3

DTC 33057
Display to VSM

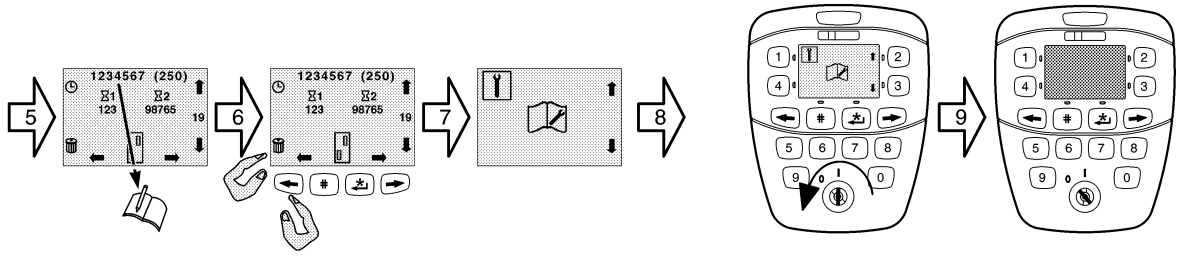


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Quick Check.	No fault→ Resume Operation

FAULT LOG DTC Review – Go to Display Menu



Enter SERVICE Password→	Diagnostics→	Fault Logs→	VSM Fault Logs→	View all VSM DTCs→ ?



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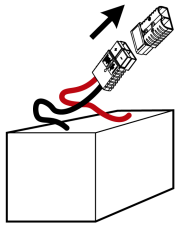
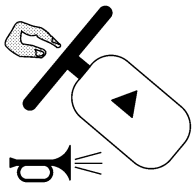
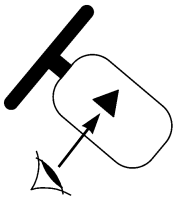
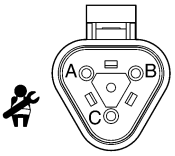
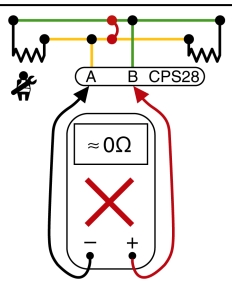
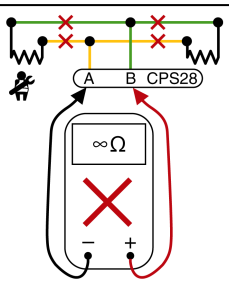
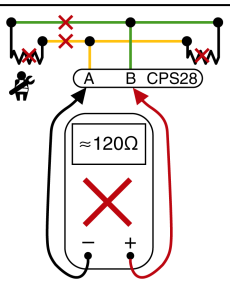
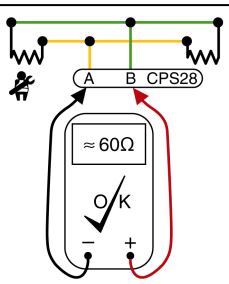
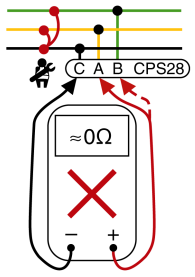
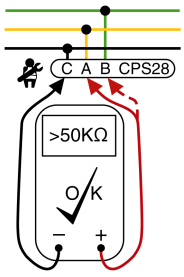
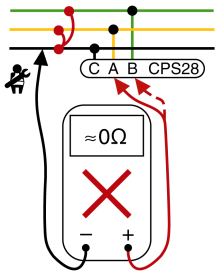
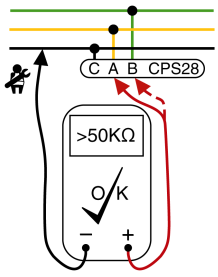
A935 – K160 CAN Communication Failure (Cont)

📄✍ all VSM DTCs	Multiple VSM DTCs→ Erase VSM DTCs→ Exit Fault Log→ Power **OFF**→ **Quick Check** ↓
Single DTC→ Specific Device Fault Log→	📄✍ Device DTCs→ Erase Device DTCs↓
Emergency Stop Switch→ **OFF** → Wait 30 seconds→ **ON** → ?↓ Recheck Single Device Fault Logs↓	
DTCs Present→ 📄✍ DTCs→ Power **OFF**→ Go to Single Device TSP↓	DTCs Gone→ Resume Operation

QUICK CHECK X Open Circuit/Fail) = Short Circuit

			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Locate Diagnostic Connector CPS 28	Service Connection
			
Short Circuit CAN Hi/CAN Lo Go to Step C1, All CAN Device DTCs	Open Circuit CAN Hi/CAN Lo Go to Component Operational Check, Multiple CAN Device DTCs	Open Circuit CAN Hi/ CAN Lo Termination Resistor Go to Component Operational Check, Intermittent DTCs	Circuit OK Go to Step A2, Single CAN Device DTC
			

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A935 – K160 CAN Communication Failure (Cont)			
CAN Hi Short Circuit Bat (-) Go to Step C2, All CAN Device DTCs CAN Lo STB (-), No DTC Go to Step C2, No DTC	CANbus Circuit OK Go to Step A2, Single CAN Device DTC	CAN Hi Short Circuit Bat (+) All CAN Device DTCs Go to Step C3, CAN Hi Short to 12/5 (+) No DTC CAN Lo Short Circuit Bat (+) All CAN Device DTCs Go to Step C3,	CANbus Circuit OK Go to Step A2, Single CAN Device DTC
SINGLE DEVICE DTC→ Fault is isolated to a SINGLE CANbus Connected Device and its Supply Connections			
MULTIPLE DEVICE DTCs → Faults that affect some but not all CANbus Devices→ Typically Open Circuits			
ALL DEVICE DTCs→ Faults that affect all of the CANbus connected devices→ Typically Short Circuits			

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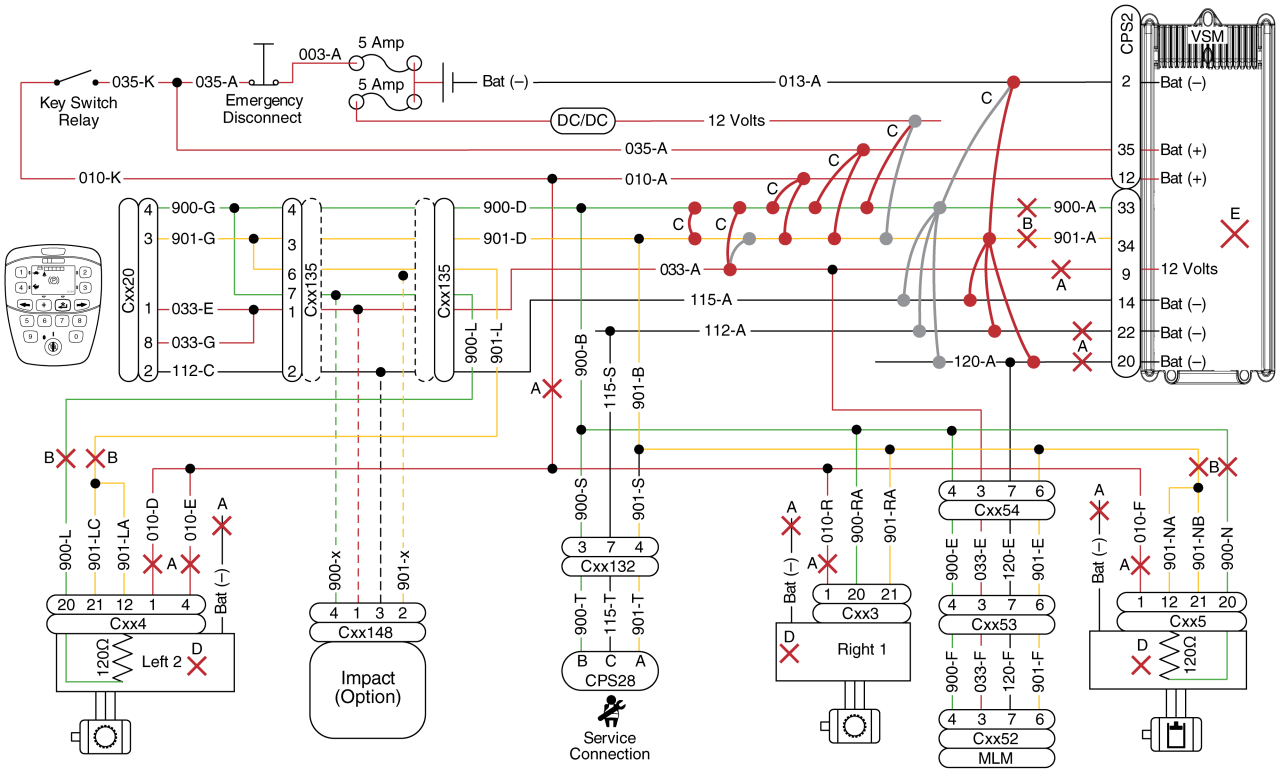
A935 – K160 CAN Communication Failure (Cont)
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC
CAUSES A B C D E > ?

Table 9030-20-5. Main Schematic

Open Circuit – Termination Resistor/CAN Hi/CAN Lo/Key Switch Supply/Device Supply/ CAUSES A, B
CAN Short to – Bat (-)/12volt Bat (+)/Shorted CAN Hi to CAN Lo/Device Failure CAUSES C, D, E



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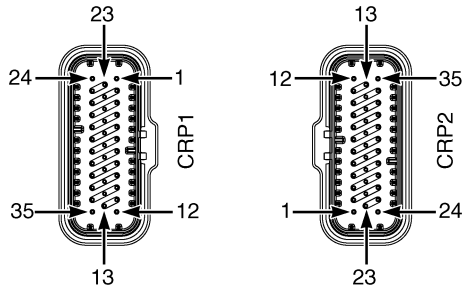
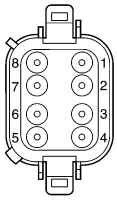
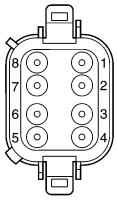
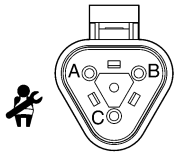
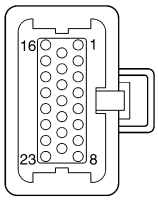
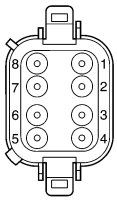
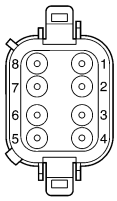
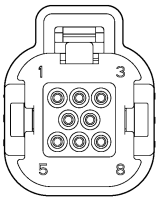
A935 – K160 CAN Communication Failure (Cont)

CONNECTORS

Table 9030-20-6. Device Connectors

			
VSM Cxx 1 and Cxx 2	Main Seat Cxx 52 and 54	Impact Device Cxx 148	Service Connector Cxx 28
			
Traction/Pump Controller Cxx 3, 4, and 5	MLM Cxx 52	Display Harness Cxx 135	Display Cxx 20

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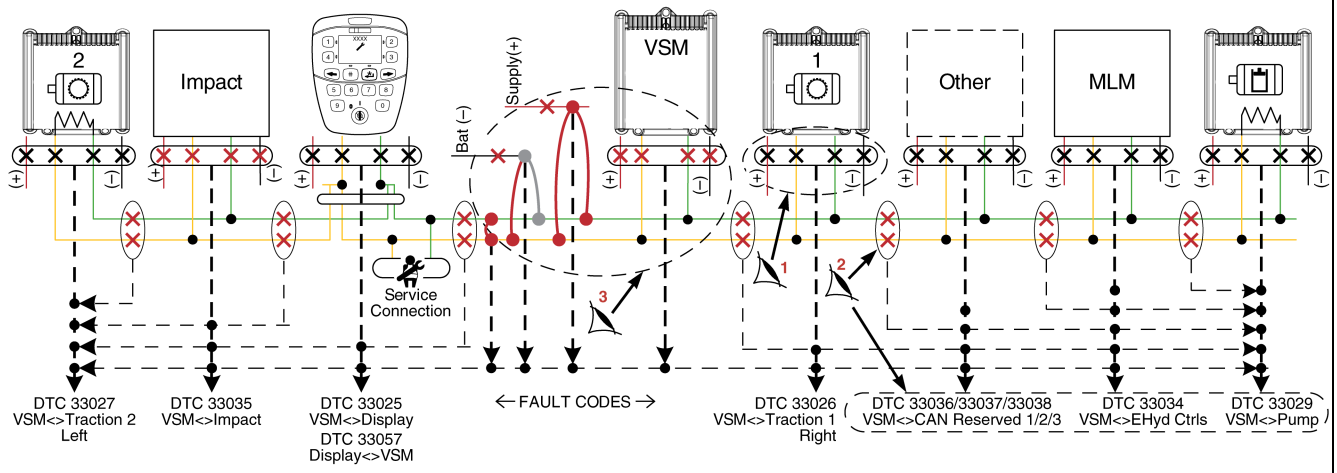
A935 – K160 CAN Communication Failure (Cont)

CAUSE A

CAN Hi/CAN Lo Single Device DTC (Black X) vs Multiple DTCs (Red X)



1, 2, and 3 are examples of possible Causes

1. Single DTC→Indicated Device Connections/Device Fail→Step A1

1. Single DTC above →Open Circuit on Device Supply (+) or Bat (-) or Open Circuit on Sub Circuit Wiring→Step A3

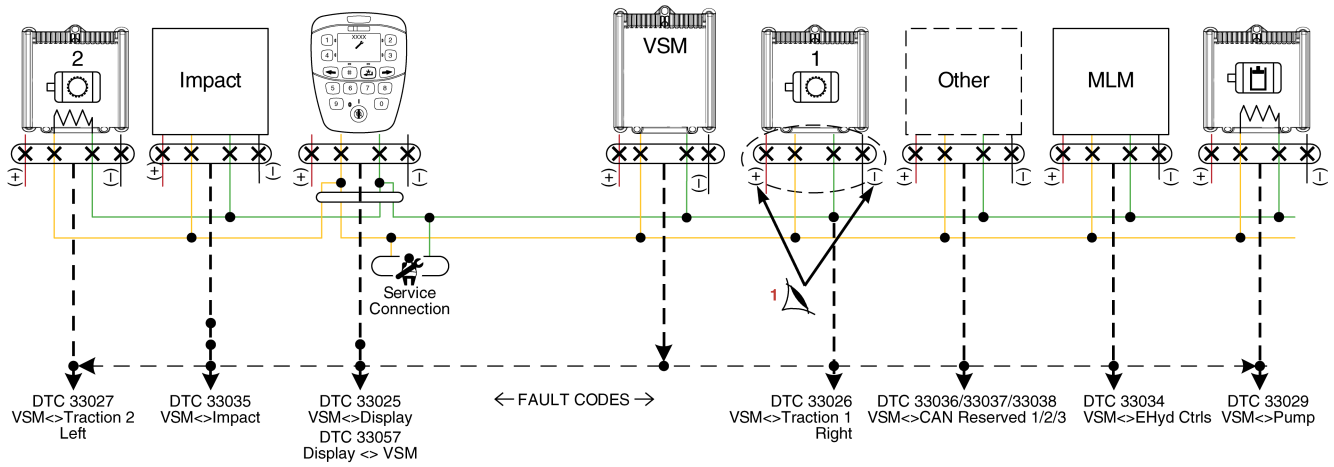
2. Multiple DTCs→Fault Log→DTC/Device closest to VSM↑→= Open circuit between DTC Device and VSM→Step B3

3. All DTCs above→Open Circuit on Device Supply (+) Bat (-)→= Supply Failure/Open Circuit Main Supply Circuit→Step A3

3. All DTCs above→Open/Short Circuit on VSM CANbus→= Open Circuit→Step B3 – Short Circuit→Component Operational Check

STEP A1

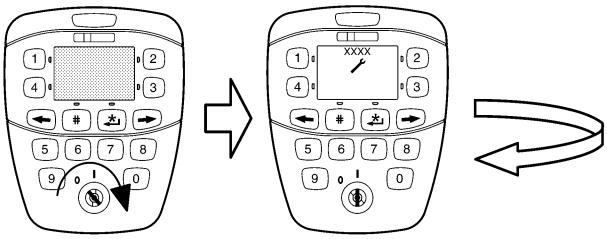
CAN Hi/ CAN Lo Single Device DTC - Locate Device



1. Example Only→ Single DTC→ Indicated Device Connections/Device Fail→ of Step A2

A935 – K160 CAN Communication Failure (Cont)

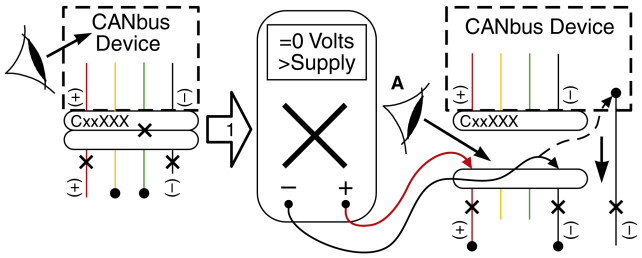
STEP A2

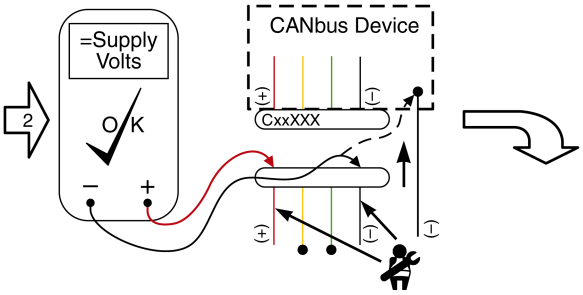


Power **ON**→ Step A3

STEP A3

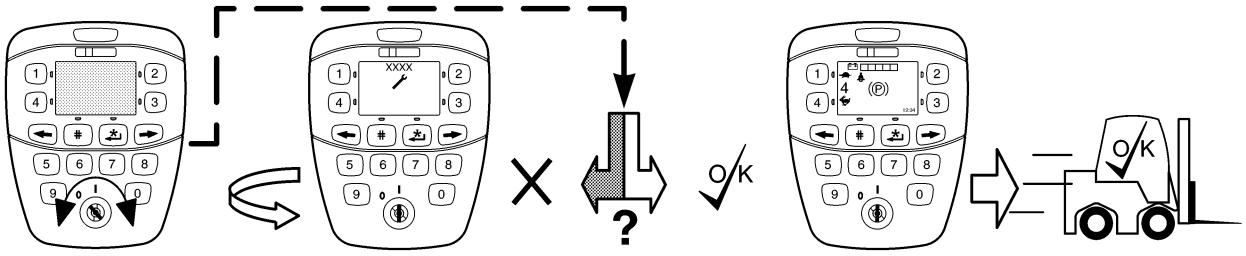
Single Device DTC Open Circuit Supply Voltage





1. Locate Device→Check connection→Not OK, Go to 4↓	1. Connection OK→Go to 2↓
2. = 0 Volts = Open Circuit Supply/(+) or (-) →Go to 4↓	2. =Supply Volts = OK→Step B1↓
3. > Supply Volts →Check for Shorts to a higher supply source→Repair→Component Operational Check as CAN Device may be damaged	
4. Reference **Main Schematic** - Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck Voltage↑→Step A4↓	

STEP A4



Retest - Power **OFF** Power **ON**

NO → Component Operational Check

Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation

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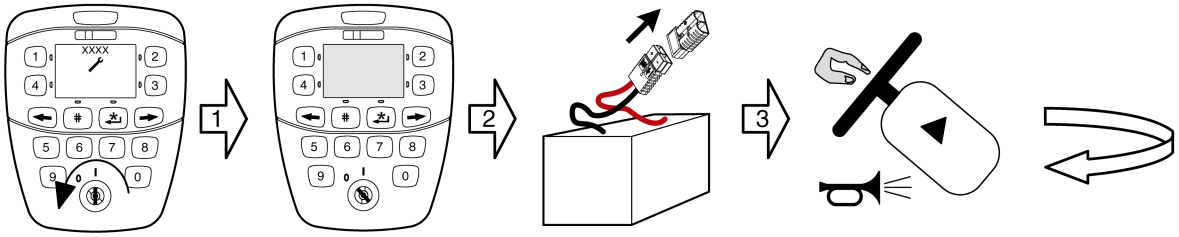
A935 – K160 CAN Communication Failure (Cont)

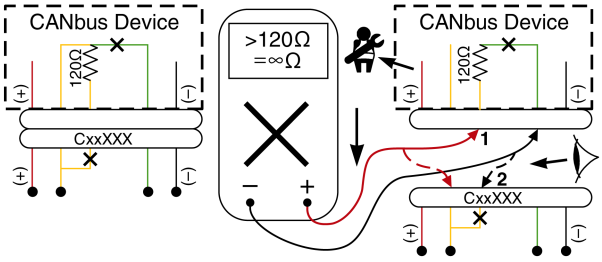
CAUSE B

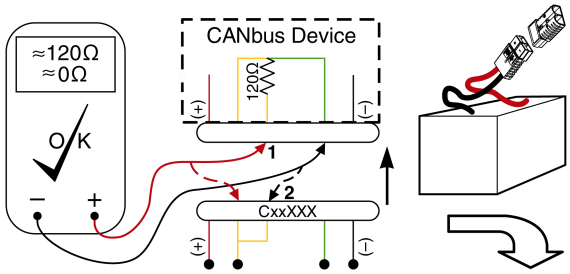


Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. Go to Step B1

STEP B1

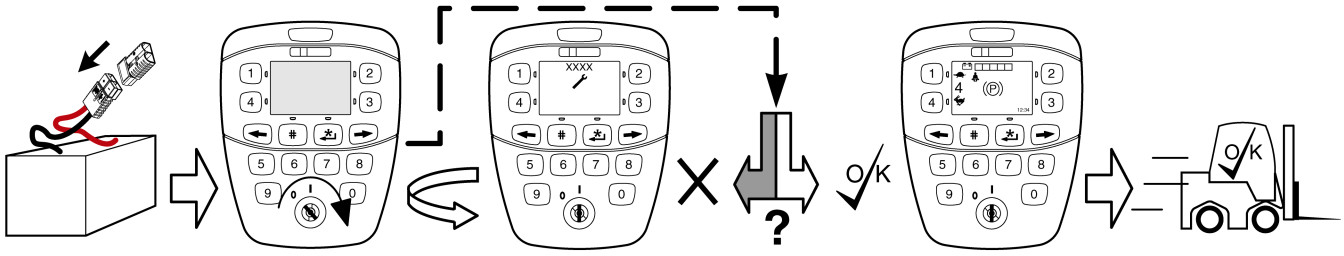
Single Device DTC Open Circuit CAN Hi or CAN Lo





Locate Device→ Check Connection→ Not OK, Go to 4↓	Connections OK→ Reconnect→ Go to Step B2
Device with Termination Resistor→ Locate and Disconnect ↓	See **Device Connectors**
1. > 120? = Open Circuit Termination Resistor →Go to 3↓	1. ˜ 120? = OK Go to 2 ↓
2. = 8? = Open Circuit →Go to 4↓	2. ˜ 0? = OK Go to 3 ↓
3. **Replace Device**→Component Operational Check↓	
4. Find/Repair Open Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck?↑→Reconnect→Step B2↓	

STEP B2



Reconnect Battery Retest - Power **ON** **NO** → Step B3, Is fault DTC gone?

NO YES

Fault corrected→ Continue operation

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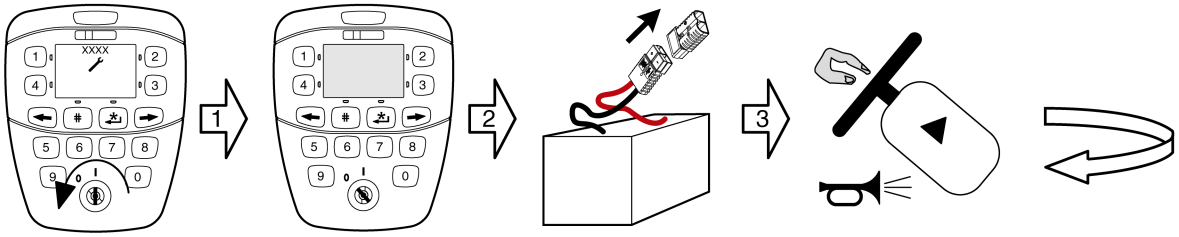
A935 – K160 CAN Communication Failure (Cont)

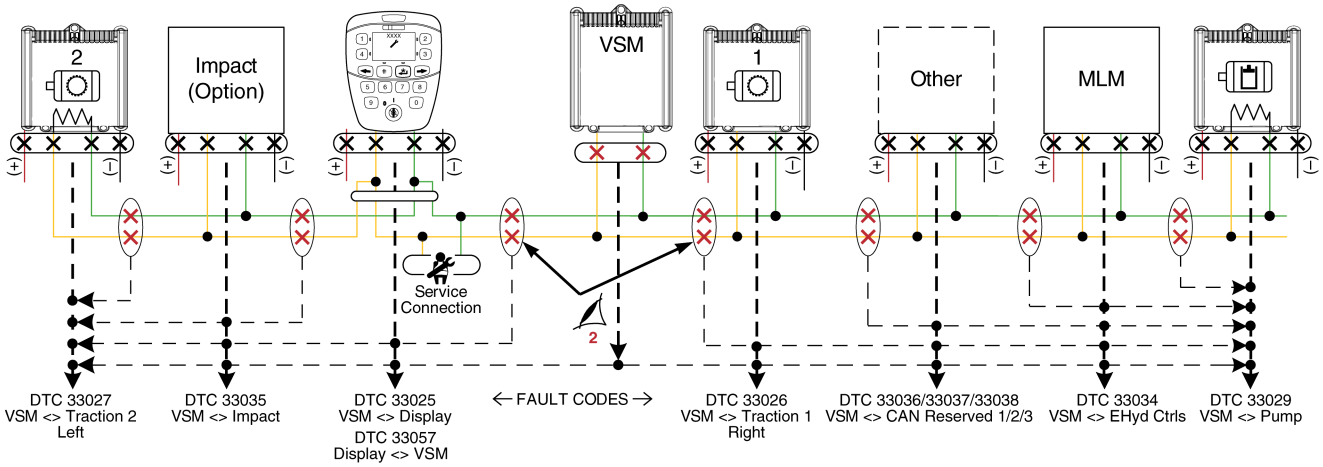
STEP B3



Power **OFF**→ | Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. | Go to Step B4

STEP B4

Multi CAN Device DTCs Display > Open Circuit CAN Hi to CAN Lo



Example Only→ Multiple DTCs→ Fault Log→ DTC/Device closest to VSM

Open circuit is between DTC Device and VSM→ , Step B5↓

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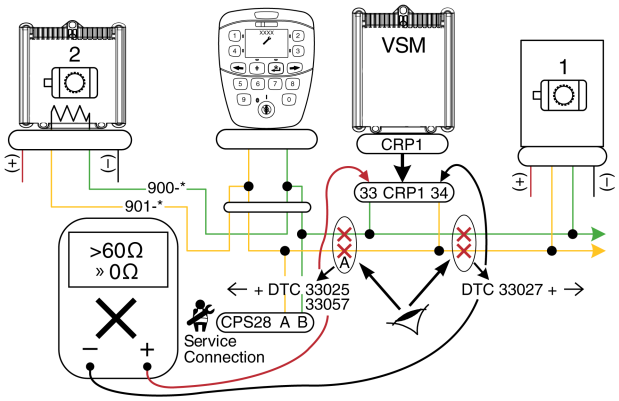
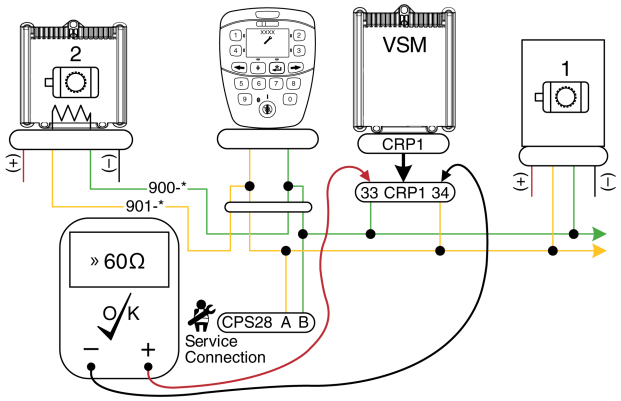
A935 – K160 CAN Communication Failure (Cont)

STEP B5

Multi Device DTCs Open Circuit CAN Hi or CAN Lo

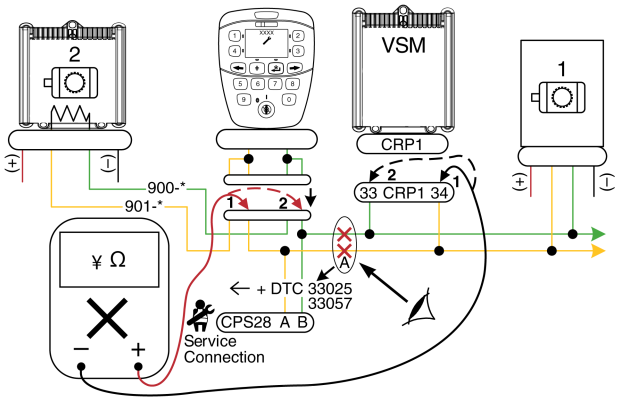


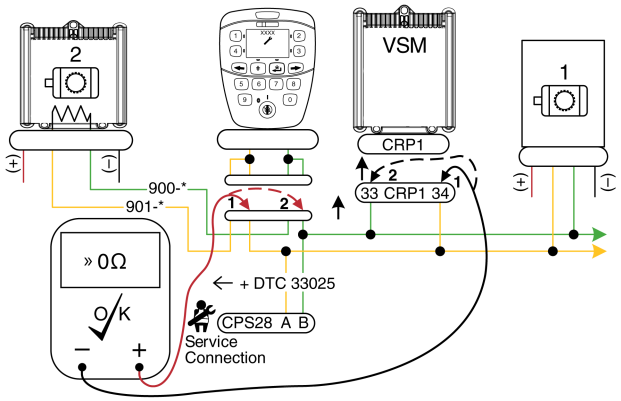


The above is an Example Only

Disconnect VSM CPS1→ Measure ?	See **Device Connectors**
> 60? to 8? = CAN Hi/Lo Open Circuit Step B6↓	˜ 0? → Component Operational Check ↓ ˜ 60? = OK→ Component Operational Check ↓

STEP B6





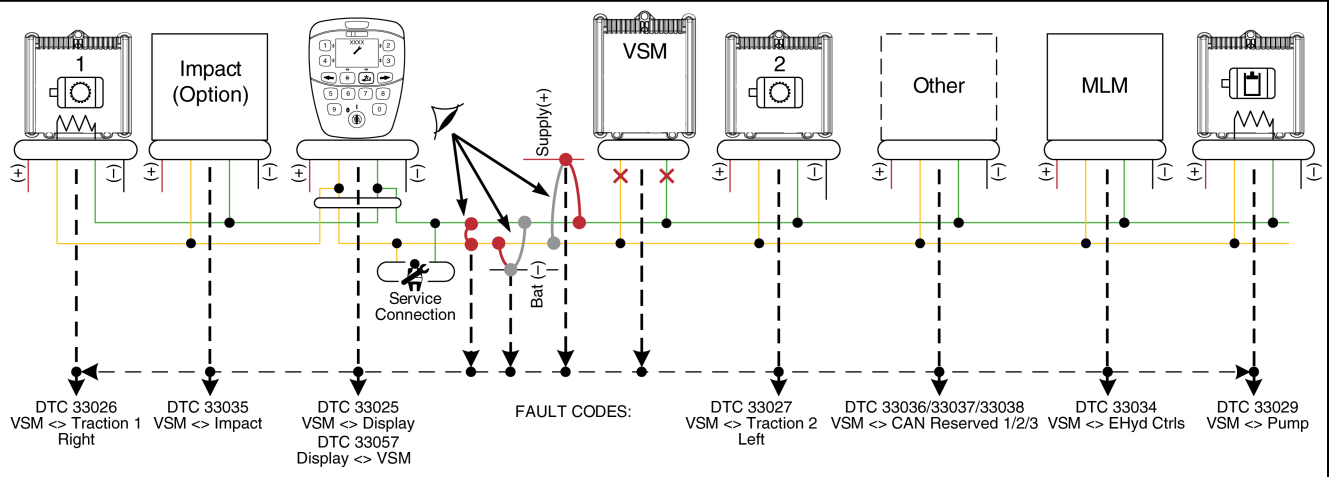
The above is an Example Only

Locate Device to Right or Left of Indicated Open Circuit→	Disconnect → See **Device Connectors**↓
1. 8? = CAN Hi Open Circuit→Go to 3↓	1. ˜ 0? = OK →Component Operational Check↓
2. 8? = CAN Lo Open Circuit→Go to 3↓	2. ˜ 0? = OK →Component Operational Check↓
3. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369Recheck ?→Reconnect→Retest→Component Operational Check↓	

A935 – K160 CAN Communication Failure (Cont)

CAUSE C

All CAN Device DTCs Displayed > CAN Hi/CAN Lo Short Circuit together/Supply (+) or (-)



All DTCs→ Open Circuit to VSM → Step B5 ↑

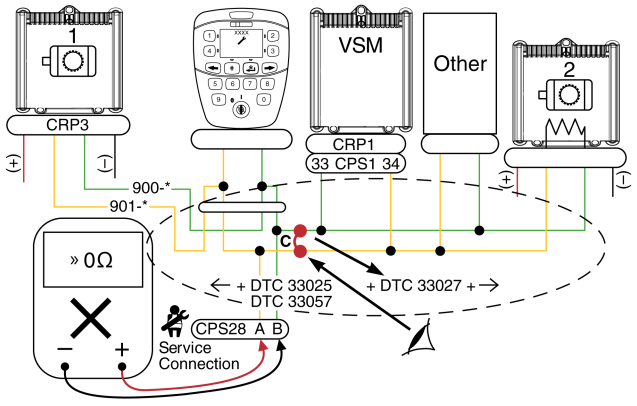
All DTCs→ Short Circuit CAN Hi to CAN Lo → Step C1 ↓

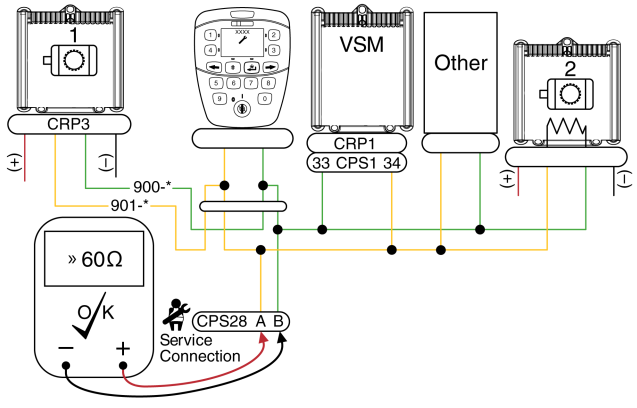
All DTCs→ Short Circuit CAN Hi to (-) Supply Sources → Step C2 ↓ No DTCs→ Short Circuit CAN Lo to (–-) Supply Sources

All DTCs→ Short Circuit CAN Lo to (+) Supply Sources→ Step C3 ↓ No DTCs→ Short Circuit CAN Hi to (+) Supplies (5, 12 volt)

STEP C1

All Device DTCs Short Circuit CAN Hi to CAN Lo





Locate Service Connection → Measure ?	See **Device Connectors**↓
1. = 0? CAN Hi/Lo Short Circuit→Go to 2↓	1. ˜ 60? = OK →Step C2↓
2. Inspect Accessible Harness Areas for Insulation Damage then Inaccessible Harness Areas. Focus on Bend Edges and Pinch Points, Go to 3↓	
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→Step C5↓	

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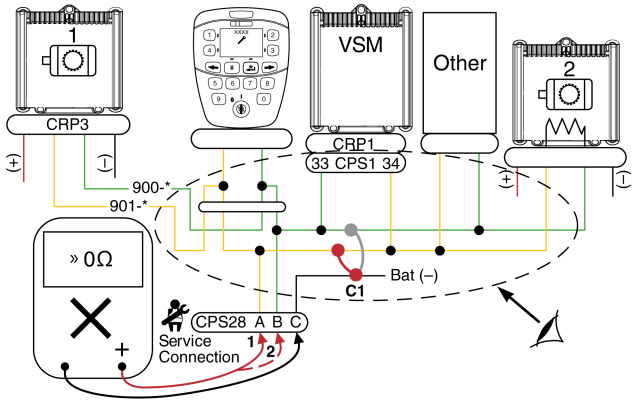
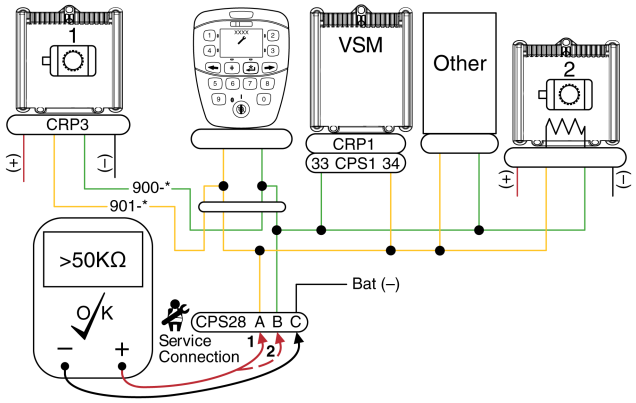
A935 – K160 CAN Communication Failure (Cont)

STEP C2

All Device DTCs Short Circuit CAN Hi to Bat (-) CAN Lo to Bat (-) will not Produce a DTC



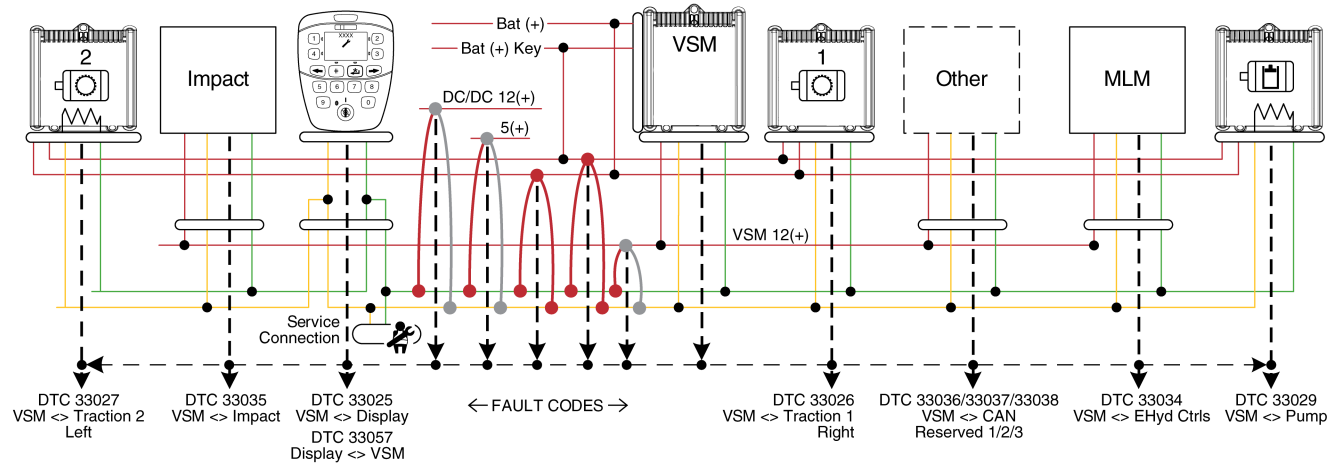


1. 0? = CAN Hi Short Circuit. Go to 3↓	1. > 50K? = OK, Go to 3↓
2. 0? = CAN Lo Short Circuit. Go to 3↓	2. > 50K? = OK, Go to 3 ↓

3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest, →Step C5

STEP C3

Multiple CAN Device DTCs Displayed > (+) Supply Short Circuit to CAN Hi or CAN Lo



All DTCs→ Short Circuit CAN Lo to (+) Supply Sources.

All DTCs→ Short Circuit CAN Hi to (+) Supply Sources. No DTCs for a Short to (+)12 Volts or (+) 5 Volts

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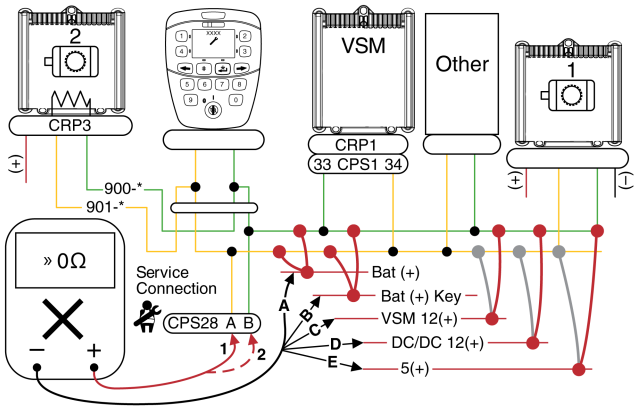
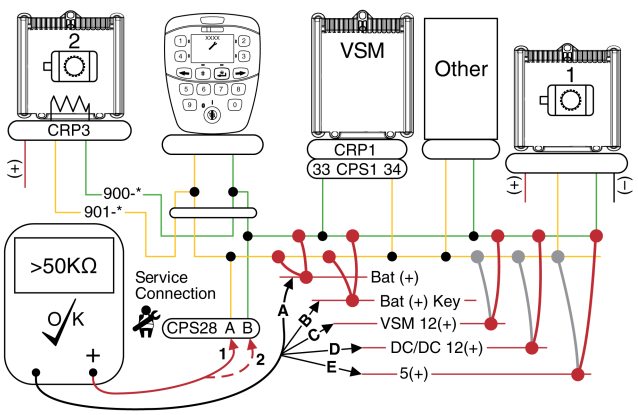
A935 – K160 CAN Communication Failure (Cont)

STEP C4

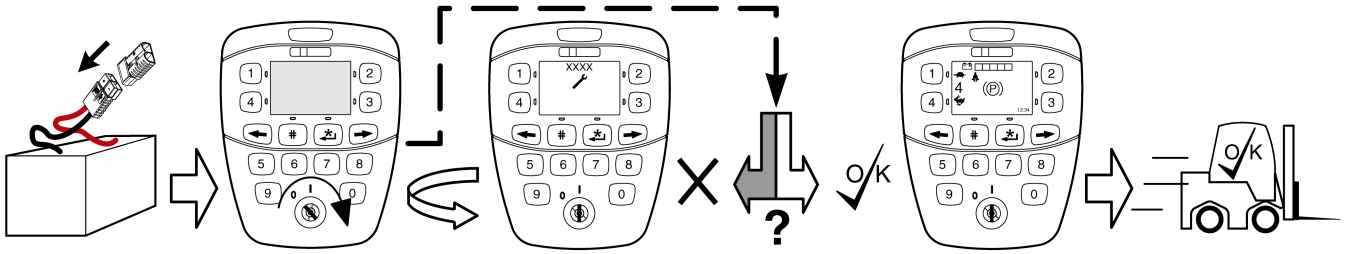
All Device DTCs Short Circuit Supply (+) to CAN Hi or CAN Lo





1. A, B, C, D, and E = 0? = CAN Hi Short Circuit, Go to 3↓	1. A, B, C, D, and E > 50K? = OK→, Step C5↓
2. A, B, C, D, and E = 0? = CAN Lo Short Circuit, Go to 3↓	2. A, B, C, D, and E > 50K? =OK→Step C5↓
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→Step C5↓	

STEP C5



Reconnect Battery

Retest - Power **ON**

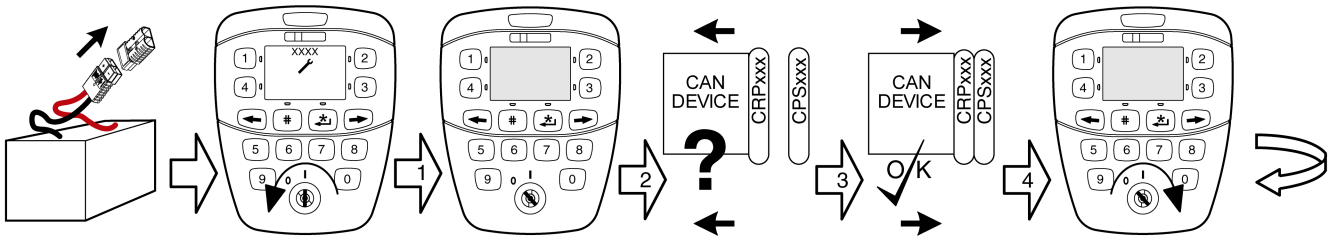
NO → Go to Component Operational Check

Is fault DTC gone?

NO YES

Fault corrected→ Continue operation

CAUSE D



Disconnect Battery To Replace Motor Controller

Power **OFF**

Disconnect CAN Device→

Do Not Discard

Install New CAN Device

Power **ON**→ Go to Step D1

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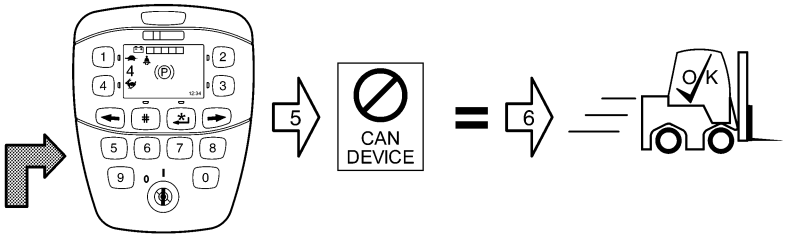
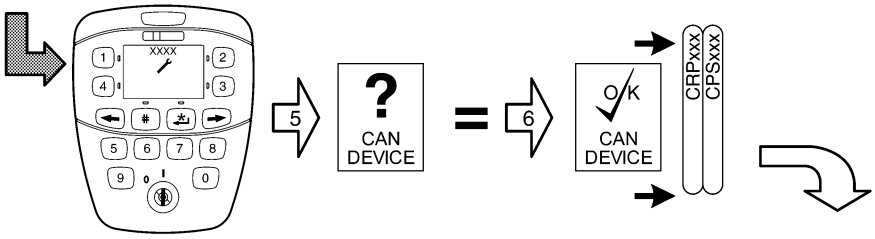
A935 – K160 CAN Communication Failure (Cont)

STEP D1

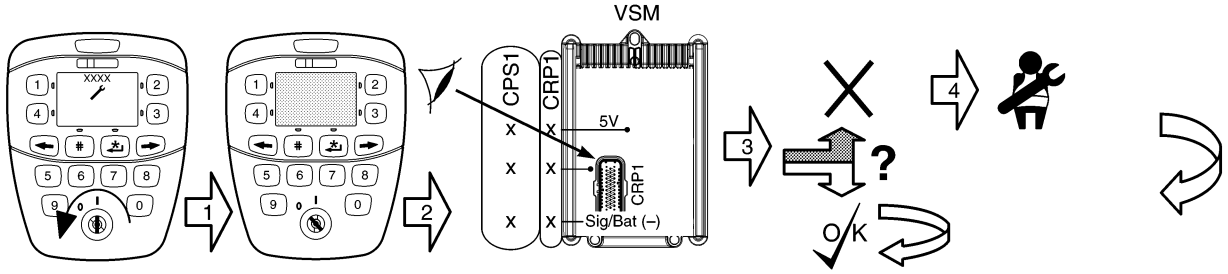


? Fault DTC gone→ Old device faulty→ Resume operation



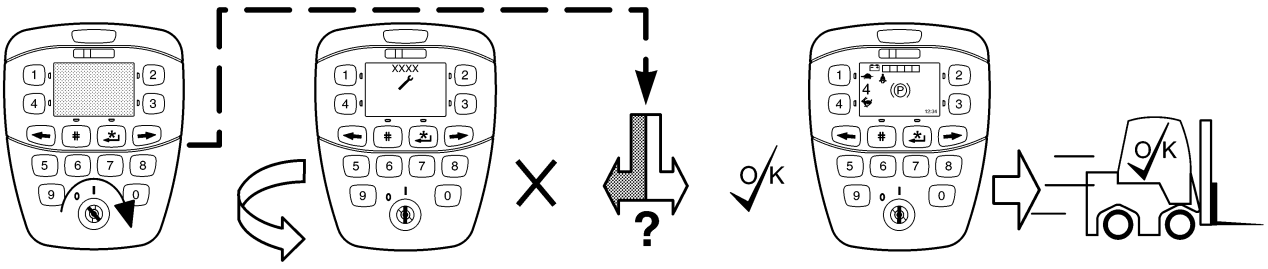
Fault DTC present→ Old Device OK/Reinstall Old Device→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Step E1 Not OK Correct/Repair→ Go to Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation

NO YES

END FAULT

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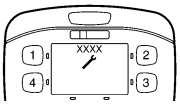
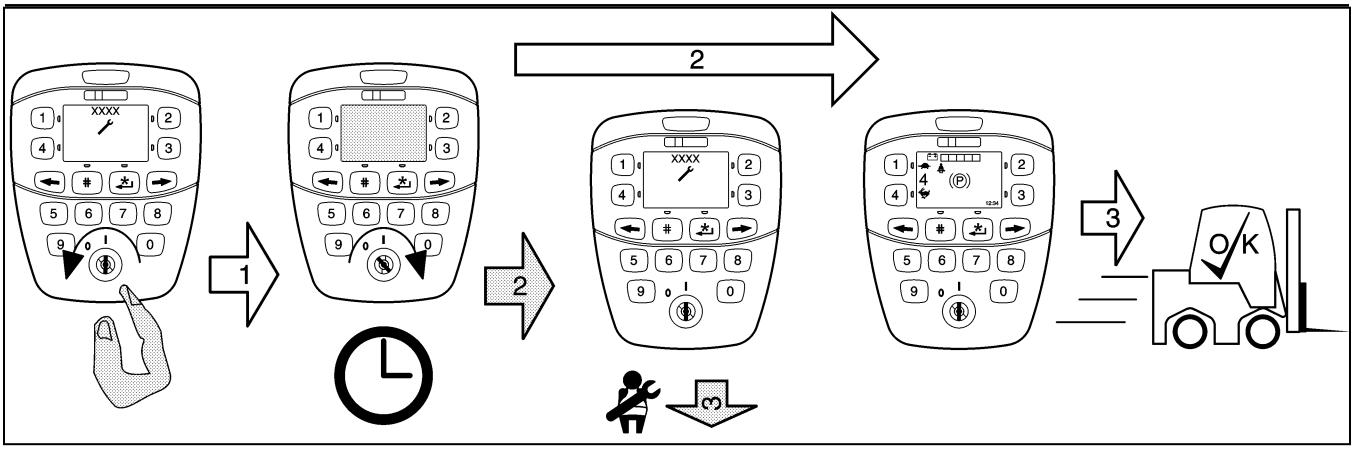
CBB 4 Wheel CAN Communication



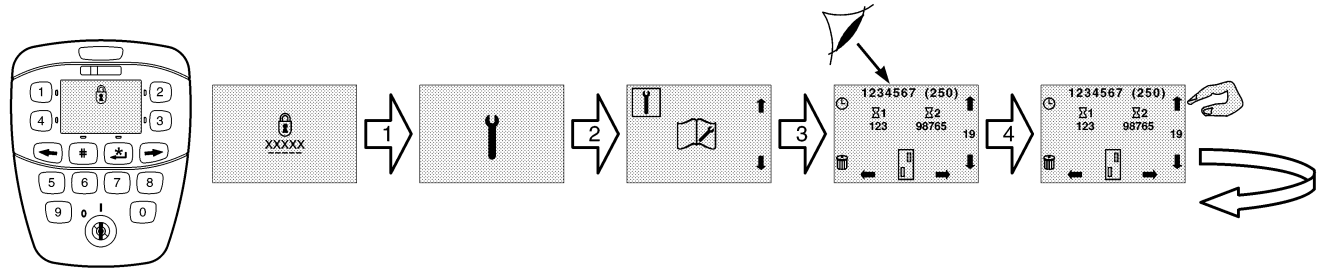
Fault Codes

DTC 33025 **VSM to Display**	**DTC 33026** **VSM to Traction 1 (Right)**	**DTC 33027** **VSM to Traction 2 (Left)**	**DTC 33029** **VSM to Pump**
DTC 33034 **VSM to MLM (DCS)**	**DTC 33035** **VSM to Impact**	**DTC 33036** **VSM to CAN Reserved 1**	**DTC 33037** **VSM to CAN Reserved 2**
DTC 33038 **VSM to CAN Reserved 3**			**DTC 33057** **Display to VSM**

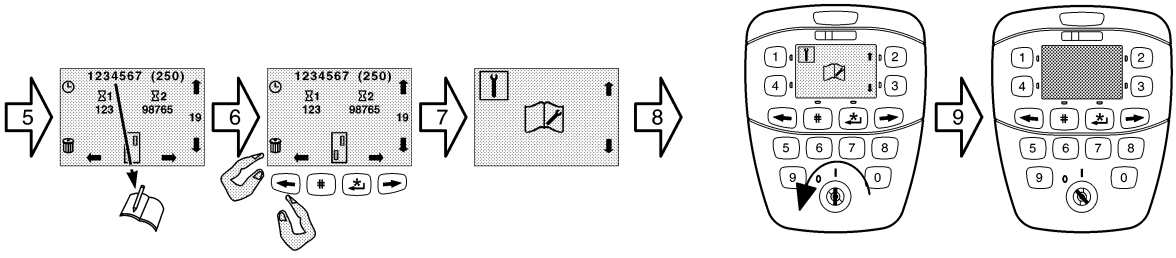


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Quick Check.	No fault→ Resume Operation

FAULT LOG DTC Review – Go to Display Menu



Enter SERVICE Password→	Diagnostics→	Fault Logs→	VSM Fault Logs→	View all VSM DTCs→ ?



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CBB 4 Wheel CAN Communication (Cont)		
📄✍ all VSM DTCs	Multiple VSM DTCs→ Erase VSM DTCs→ Exit Fault Log→ Power **OFF**→ **Quick Check** ↓	
Single DTC→ Specific Device Fault Log→	📄✍ Device DTCs→	Erase Device DTCs↓
Emergency Stop Switch→ **OFF** → Wait 30 seconds→ **ON** → ?↓ Recheck Single Device Fault Logs↓		
DTCs Present→ 📄✍ DTCs→ Power **OFF**→ Go to Single Device TSP↓		DTCs Gone→ Resume Operation

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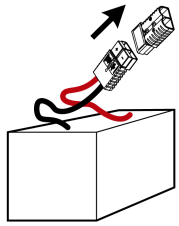
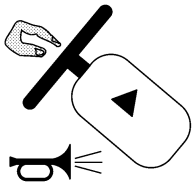
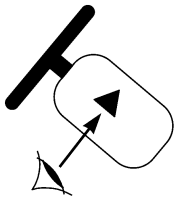
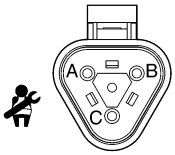
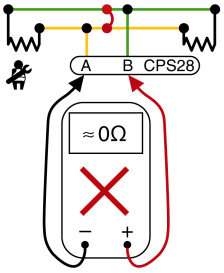
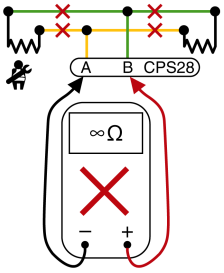
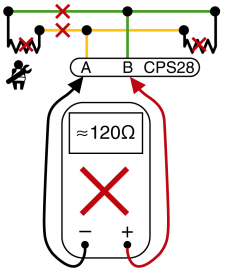
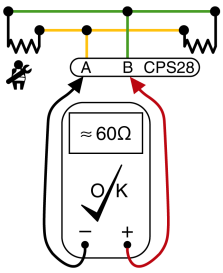
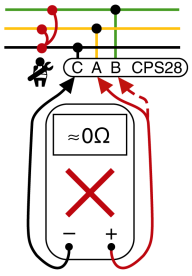
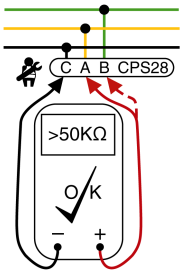
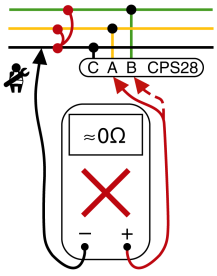
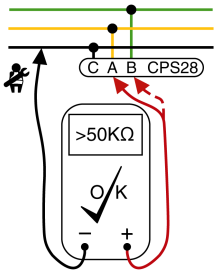
CBB 4 Wheel CAN Communication (Cont)

QUICK CHECK X Open Circuit/Fail) = Short Circuit

			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Locate Diagnostic Connector CPS 28	Service Connection
			
Short Circuit CAN Hi/CAN Lo Go to Step C1, All CAN Device DTCs	Open Circuit CAN Hi/CAN Lo Go to Component Operational Check, Multiple CAN Device DTCs	Open Circuit CAN Hi/ CAN Lo Termination Resistor Go to Component Operational Check, Intermittent DTCs	Circuit OK Go to Step A2, Single CAN Device DTC
			

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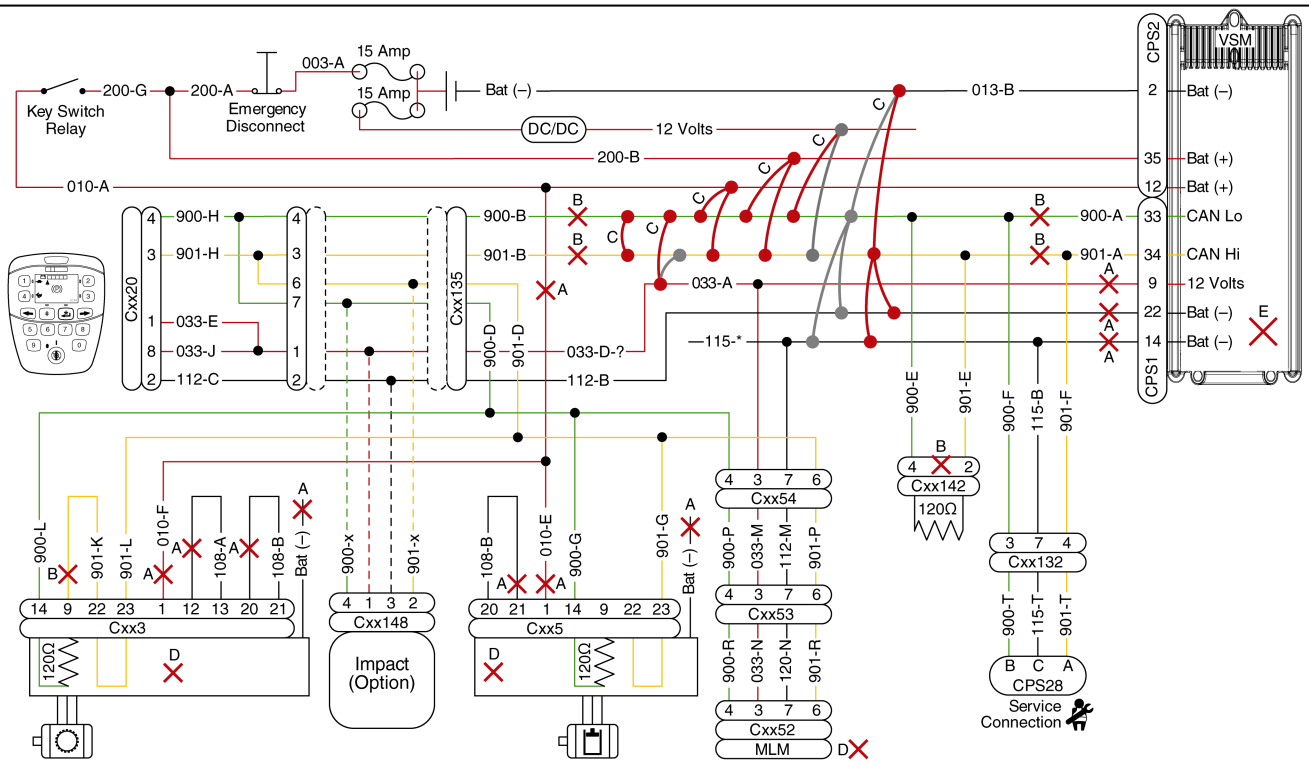
CBB 4 Wheel CAN Communication (Cont)			
CAN Hi Short Circuit Bat (-) Go to Step C2, All CAN Device DTCs CAN Lo STB (-), No DTC Go to Step C2, No DTC	CANbus Circuit OK Go to Step A2, Single CAN Device DTC	CAN Hi Short Circuit Bat (+) All CAN Device DTCs Go to Step C3, CAN Hi Short to 12/5 (+) No DTC CAN Lo Short Circuit Bat (+) All CAN Device DTCs Go to Step C3,	CANbus Circuit OK Go to Step A2, Single CAN Device DTC
SINGLE DEVICE DTC→ Fault is isolated to a SINGLE CANbus Connected Device and its Supply Connections			
MULTIPLE DEVICE DTCs → Faults that affect some but not all CANbus Devices→ Typically Open Circuits			
ALL DEVICE DTCs→ Faults that affect all of the CANbus connected devices→ Typically Short Circuits			

CBB 4 Wheel CAN Communication (Cont)
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC
CAUSES A B C D E > ?

Table 9030-20-7. Main Schematic

Open Circuit – Termination Resistor/CAN Hi/CAN Lo/Key Switch Supply/Device Supply/ CAUSES A, B
CAN Short to > Bat (-)/12volt Bat (+)/Shorted CAN Hi to CAN Lo/Device Failure CAUSES C, D, E >?



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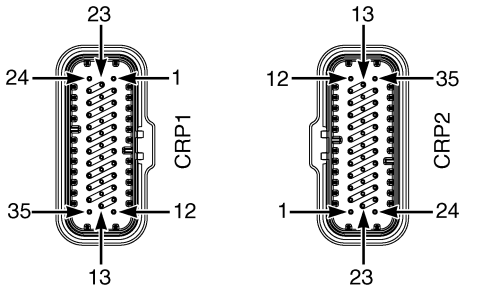
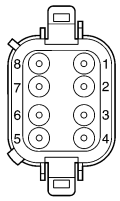
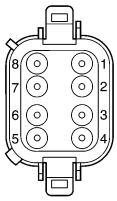
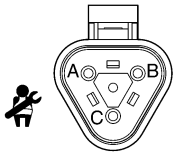
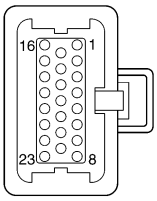
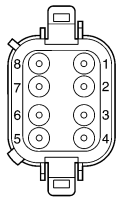
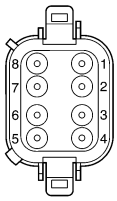
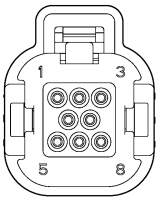
CBB 4 Wheel CAN Communication (Cont)

CONNECTORS

Table 9030-20-8. Device Connectors

			
VSM Cxx 1 and Cxx 2	Main Seat Cxx 52 and 54	Impact Device Cxx 148	Service Connector Cxx 28
			
Traction/Pump Controller Cxx 3, 4, and 5	MLM Cxx 52	Display Harness Cxx 135	Display Cxx 20

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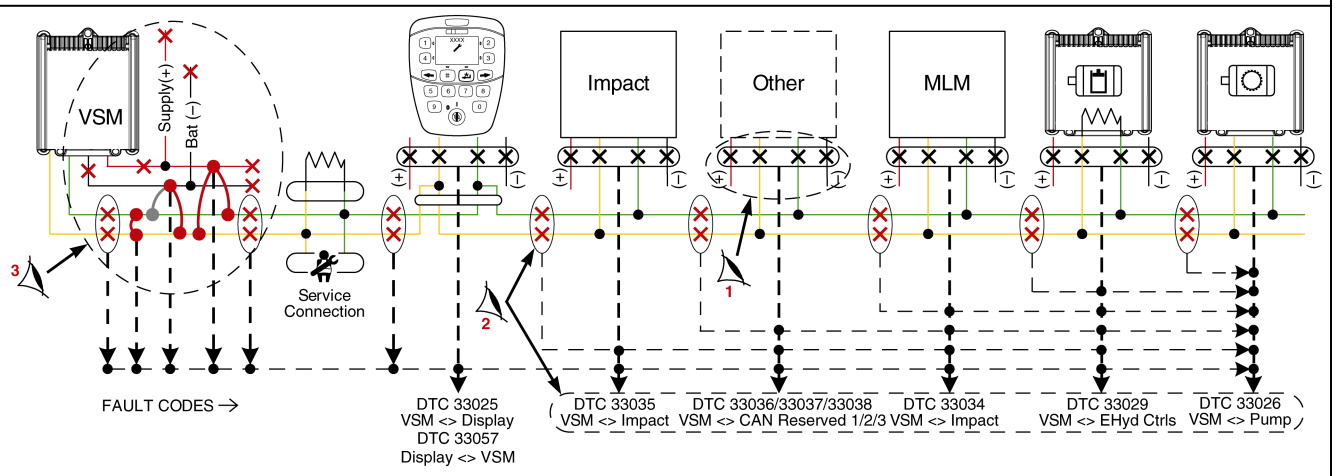
CBB 4 Wheel CAN Communication (Cont)

CAUSE A

CAN Hi/CAN Lo Single Device DTC (Black X) vs Multiple DTCs (Red X)



1, 2, and 3 are examples of possible Causes

1. Single DTC→Indicated Device Connections/Device Fail→Step A1

1. Single DTC above →Open Circuit on Device Supply (+) or Bat (-) or Open Circuit on Sub Circuit Wiring→Step A3

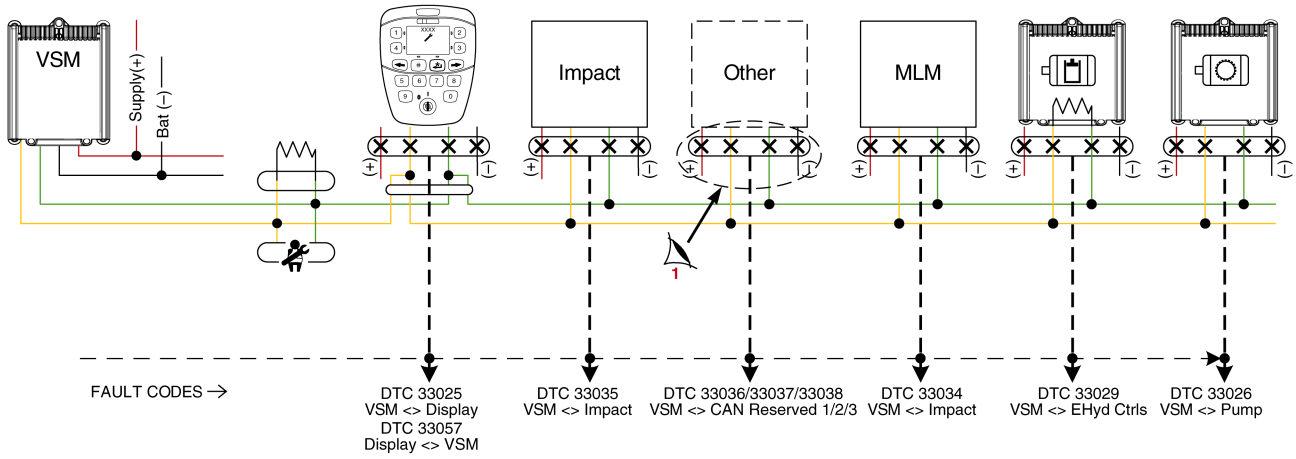
2. Multiple DTCs→Fault Log→DTC/Device closest to VSM↑→= Open circuit between DTC Device and VSM→Step B3

3. All DTCs above→Open Circuit on Device Supply (+) Bat (-)→= Supply Failure/Open Circuit Main Supply Circuit→Step A3

3. All DTCs above→Open/Short Circuit on VSM CANbus→= Open Circuit→Step B3 – Short Circuit→Component Operational Check

STEP A1

CAN Hi/ CAN Lo Single Device DTC - Locate Device



1. Example Only→Single DTC→Indicated Device Connections/Device Fail→Step A2↓

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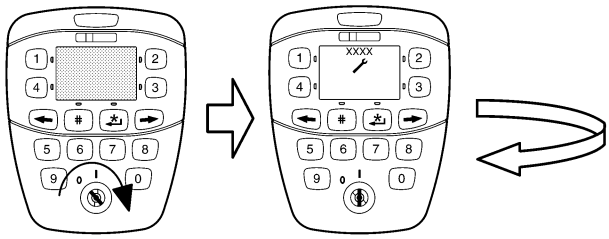
CBB 4 Wheel CAN Communication (Cont)

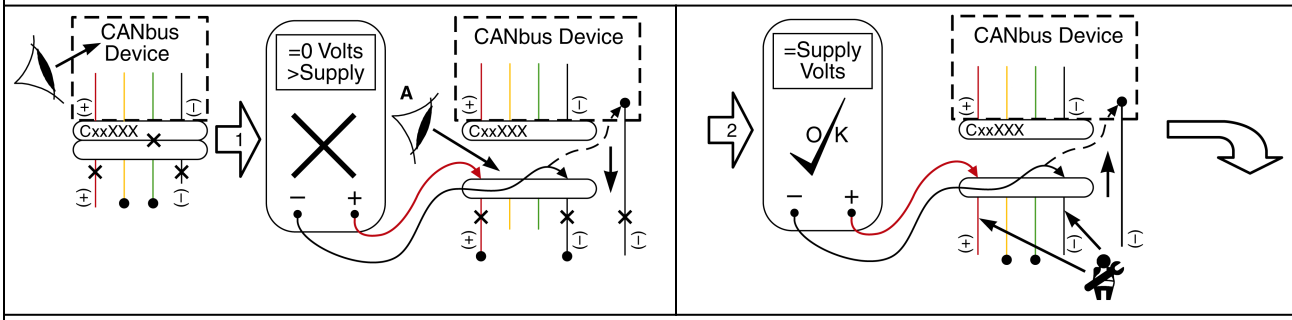
STEP A2



Power **ON**→ Step A3

STEP A3

Single Device DTC Open Circuit Supply Voltage



NOTE: Motor Controllers Require Battery Removal. Only do this if either or both Motor Controller DTCs as Displayed

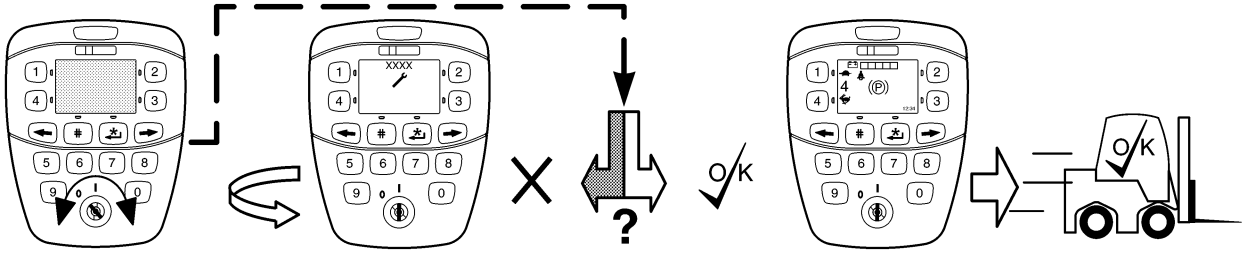
NOTE: If Fault Log shows Multiple DTCs = Possible Open Circuit Supply (+) (-) other than at the Device

1. Locate Device→Check connection→Not OK, Go to 4↓	1. Connection OK→Go to 2↓
2. = 0 Volts = Open Circuit Supply/(+) or (-) →Go to 4↓	2. =Supply Volts = OK→Step B1↓

3. > Supply Volts →Check for Shorts to a higher supply source→Repair→Component Operational Check as CAN Device may be damaged

4. Reference **Main Schematic** - Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck Voltage↑→Step A4↓

STEP A4



Retest - Power **OFF** Power **ON**

NO → Component Operational Check

Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation

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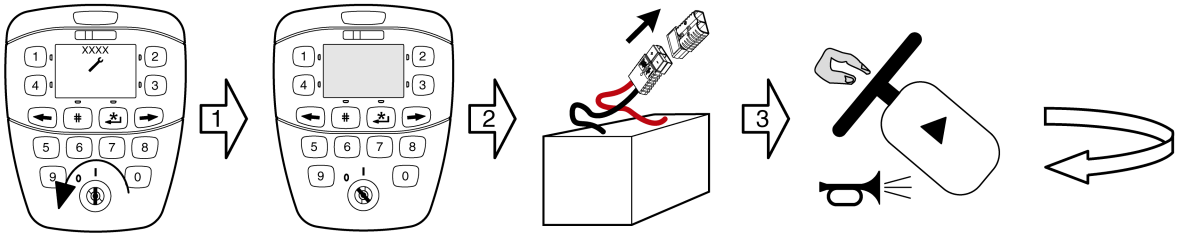
CBB 4 Wheel CAN Communication (Cont)

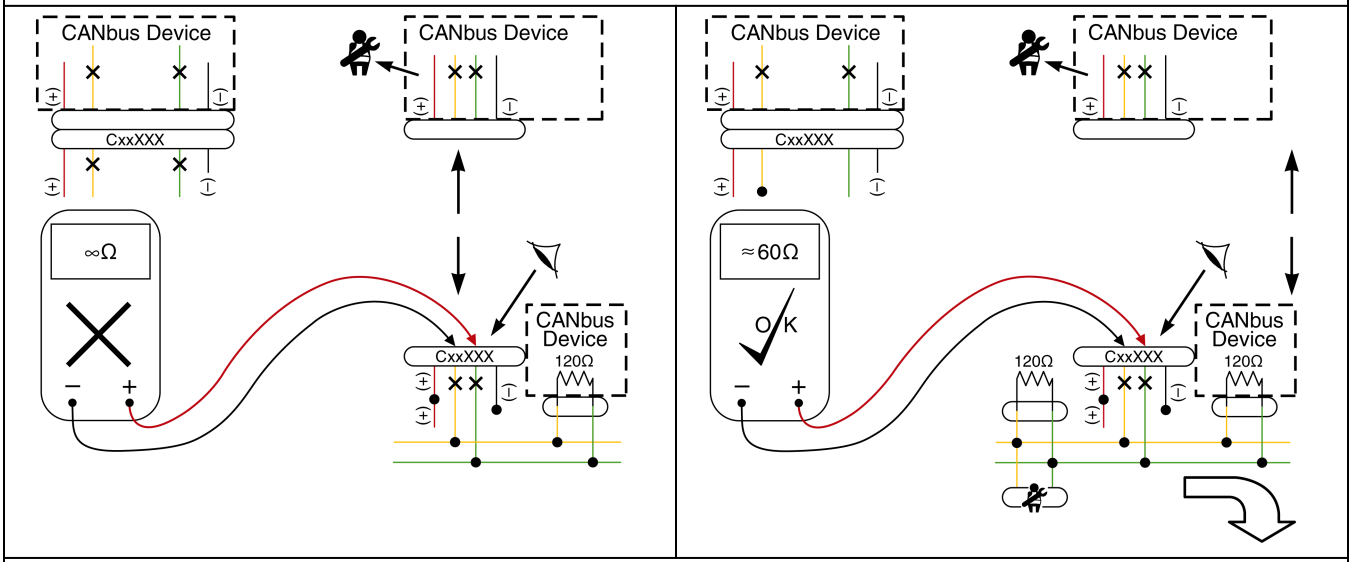
CAUSE B



Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. Go to Step B1

STEP B1

Single Device DTC Open Circuit CAN Hi or CAN Lo – Motor Devices, See Step B2.



Locate Device→ Disconnect→ Check Connection→ Measure ? → Go to 1↓

1. 8? = Open Circuit CAN Device to Harness→Go to 2↓	1. ˜ 60? = OK →**CAN Device Faulty**Go to Component Operational Check↓
2. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 3↓	
3. Recheck ?↑→Reconnect→Step B2↓	

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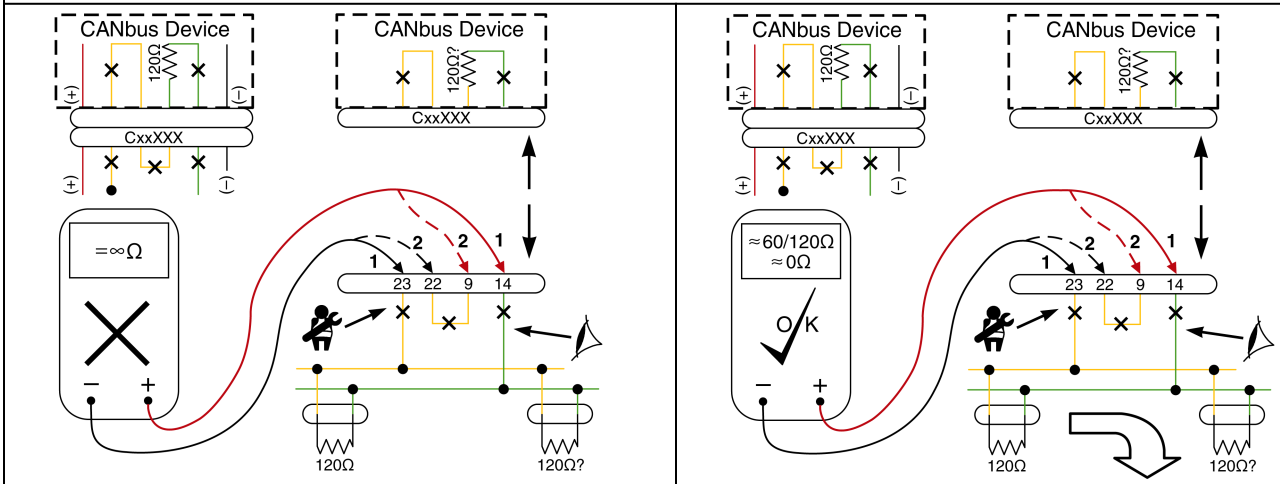
CBB 4 Wheel CAN Communication (Cont)

STEP B2

Single Device DTC Open Circuit CAN Hi or CAN Lo – Motor Device with Termination Resistor shown



Locate Device→ Disconnect→ Check Connection→ Measure ? → Go to 1↓	
1. 8? = Open Circuit CAN Device to Harness→Go to 3↓	1. ˜ 60?/120? = OK →**CAN Device Faulty**Go to Component Operational Check↓
2. 8? = Open Circuit →Go to 3↓	2. ˜ 0? = OK Reconnect Device →Go to 3↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓	
4. Recheck ?↑→Reconnect→Step B2↓	

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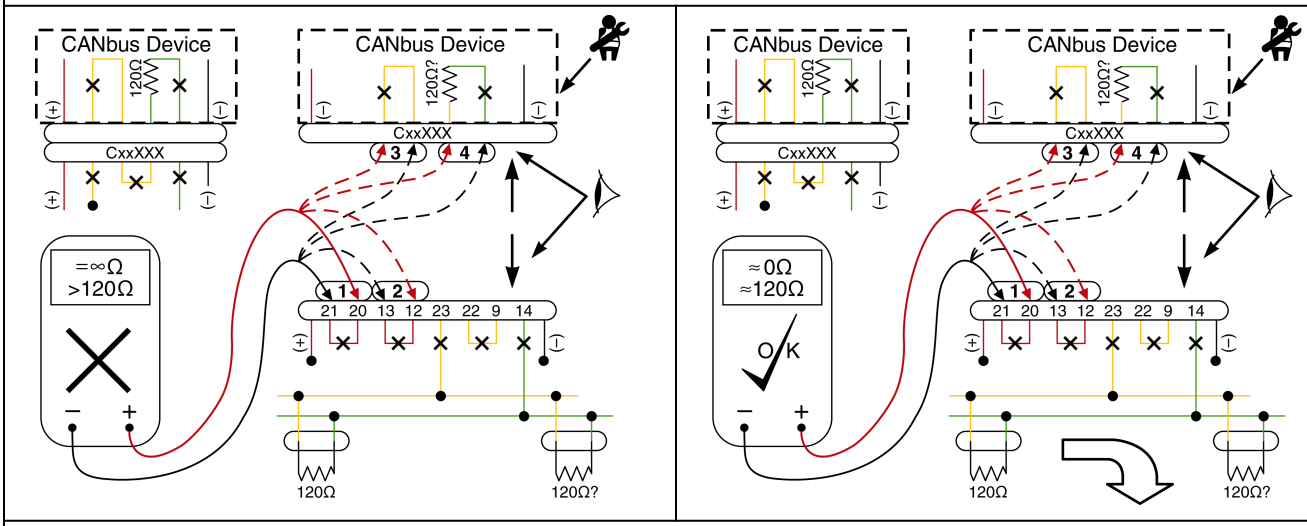
CBB 4 Wheel CAN Communication (Cont)

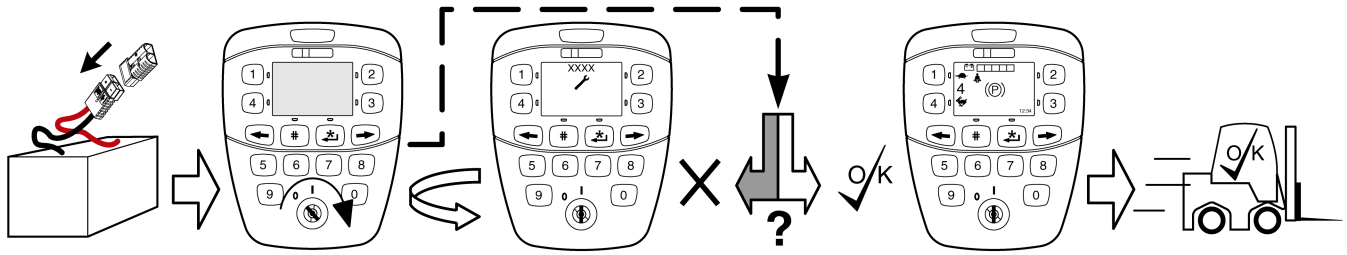
STEP B3

Single Device DTC Open Circuit CAN Hi or CAN Lo – Motor Device with Termination Resistor shown



Locate Device→ Disconnect→ Check Connection→ Measure ? → Go to 1↓	
1. 8? = Open Circuit Motor Controller Loop(s)→Go to 5↓	1. ˜ 0? = OK →Go to 3↓
2. 8? = Open Circuit Motor Controller Loop(s)→Go to 5↓	2. ˜ 0? = OK →Go to 3↓
3. 8? = Open Circuit →Go to Component Operational Check↓	3. ˜ 0? = OK Reconnect Device →Go to 4↓
4. > 120? = Open Circuit Termination Resistor→Go to Component Operational Check↓	4. ˜ 120? = OK Reconnect Device →Go to Step B4↓
5. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 6↓	
6. Recheck ?↑→Reconnect→Step B4↓	

STEP B4



Reconnect Battery — Retest - Power **ON** — **NO** → ? — Is fault DTC gone? **NO YES** — Fault corrected→ Continue operation

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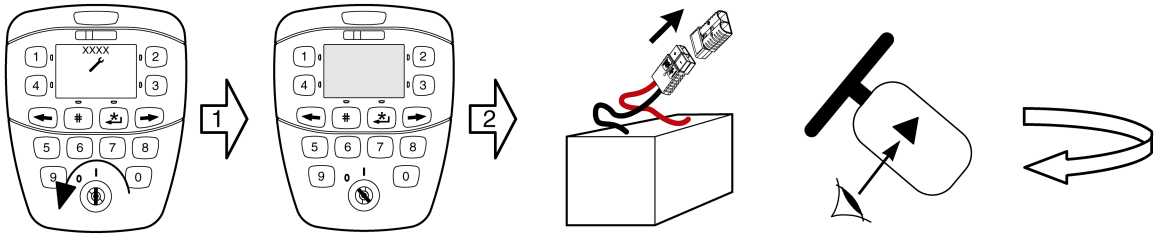
CBB 4 Wheel CAN Communication (Cont)

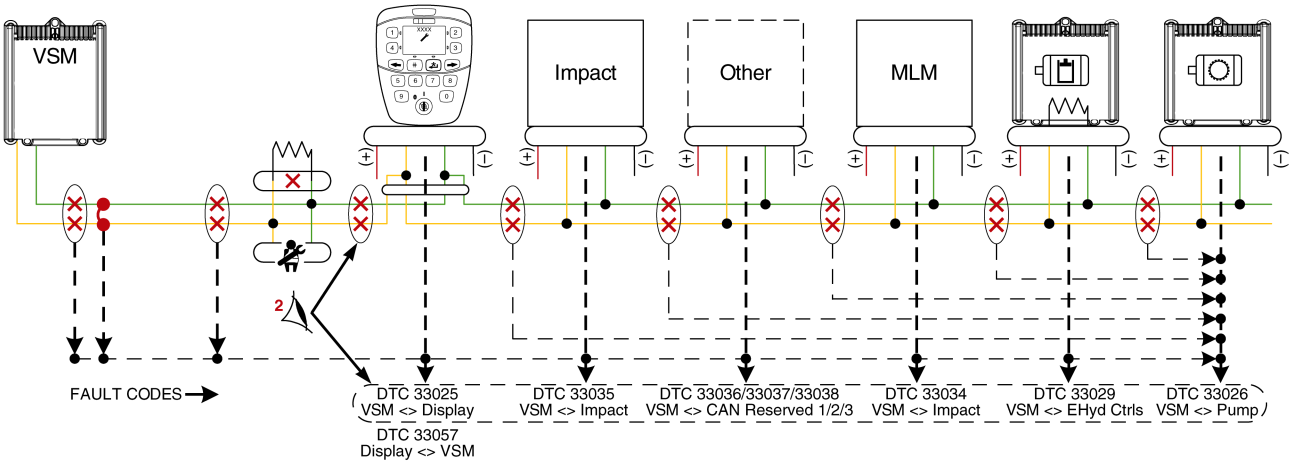
STEP B5



Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. Go to Step B4

STEP B6

Multi CAN Device DTCs Display > Open Circuit CAN Hi to CAN Lo



Example Only→ Multiple DTCs→ Fault Log→ DTC/Device closet to VSM

Open circuit is between DTC Device and VSM→ Step B5 ↓

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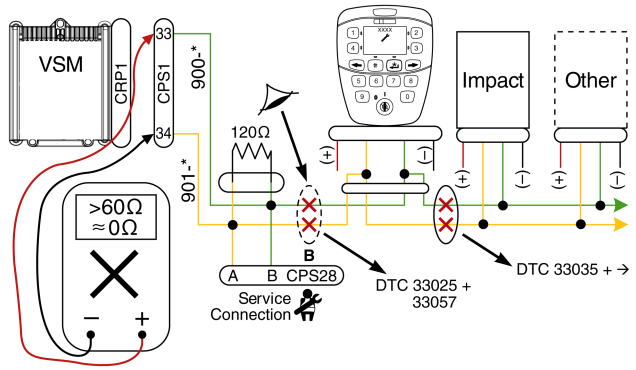
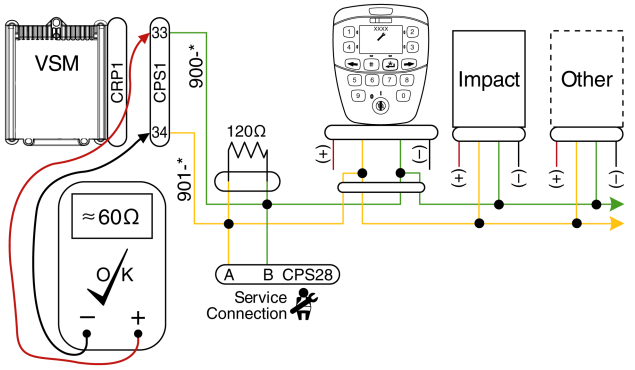
CBB 4 Wheel CAN Communication (Cont)

STEP B7

Multi Device DTCs Open Circuit CAN Hi or CAN Lo

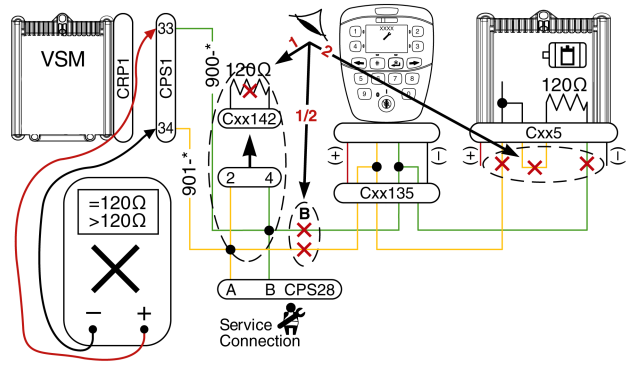


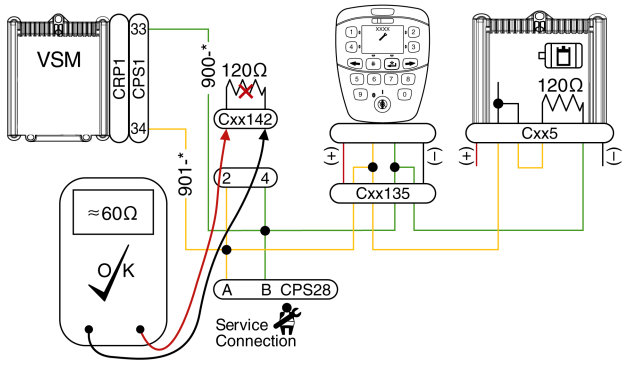


The above is an Example Only

Disconnect VSM CPS1→ Measure ?	See **Device Connectors**
> 60? to 8? = Termination Resistor/CAN Hi/Lo Open Circuit Step B6↓	˜ 60? = OK→ Component Operational Check ↓
> 60? to 8? = Termination Resistor/CAN Hi/Lo Open Circuit Step B6↓ ˜ 0?→ Component Operational Check ↓	

STEP B8





Disconnect Termination Resistor Connector Cxx 42

1. = 120? = Faulty Connections/Wiring/ to Termination Resistor or Faulty Termination Resistor→Go to 3↓

2. >120? = Faulty Connections/Wiring/ Pump Controller→Step B7↓

3. Measure Termination Resistor ?

4. >120? = Faulty Resistor→Replace→Recon-nect→Retest ?→	4. = 120?→Step B7↓

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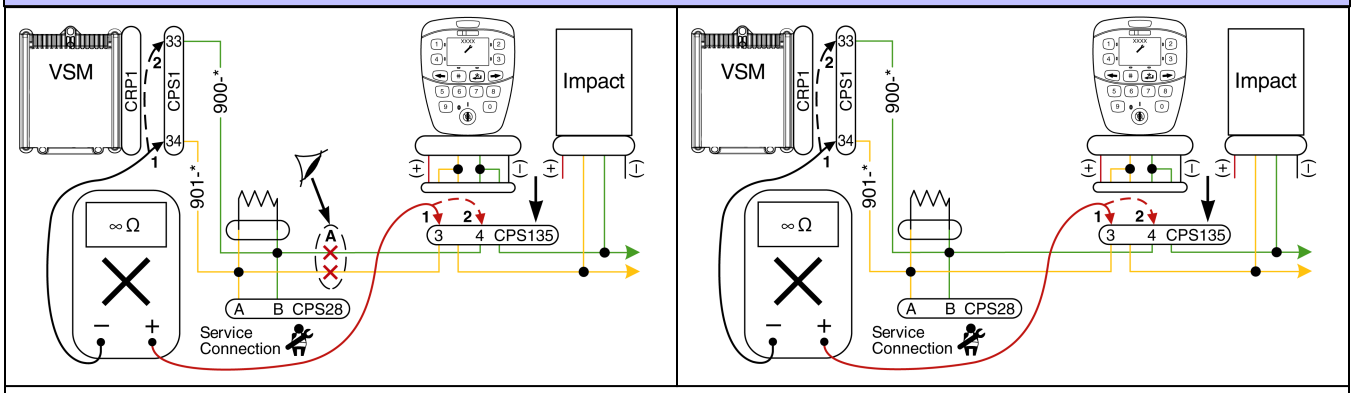
CBB 4 Wheel CAN Communication (Cont)

STEP B9

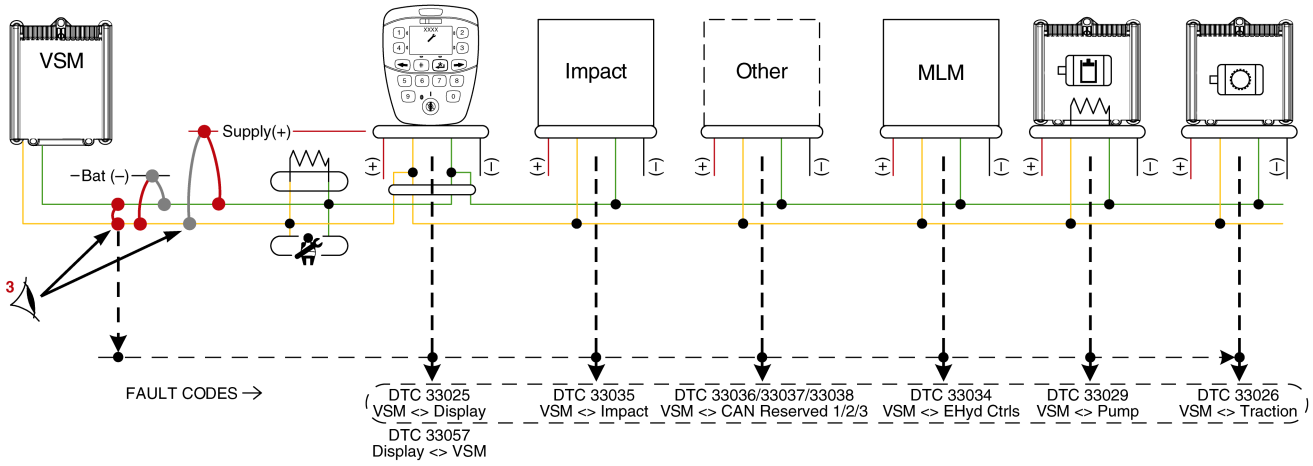


The above is an Example Only

Locate Device to Right or Left of Indicated Open Circuit→	Disconnect → See **Device Connectors**↓
1. 8? = CAN Hi Open Circuit→Go to 3↓	1. ˜ 0? = OK →Component Operational Check↓
2. 8? = CAN Lo Open Circuit→Go to 3↓	2. ˜ 0? = OK →Component Operational Check↓
3. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369Recheck ?→Reconnect→Retest→Component Operational Check↓	

CAUSE C

All CAN Device DTCs Displayed > CAN Hi/CAN Lo Short Circuit together/Supply (+) or (-)



All DTCs→ Open Circuit to VSM → Step B5 ↑

All DTCs→ Short Circuit CAN Hi to CAN Lo → Step C1 ↓

All DTCs→ Short Circuit CAN Hi to (-) Supply Sources → Step C2 ↓ No DTCs→ Short Circuit CAN Lo to (–-) Supply Sources

All DTCs→ Short Circuit CAN Lo to (+) Supply Sources→ Step C3 ↓ No DTCs→ Short Circuit CAN Hi to (+) Supplies (5, 12 volt)

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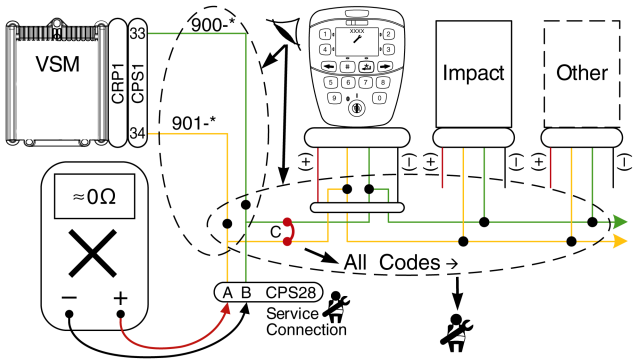
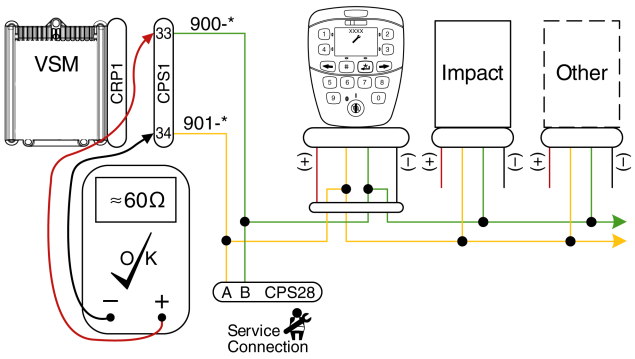
CBB 4 Wheel CAN Communication (Cont)

STEP C1

All Device DTCs Short Circuit CAN Hi to CAN Lo

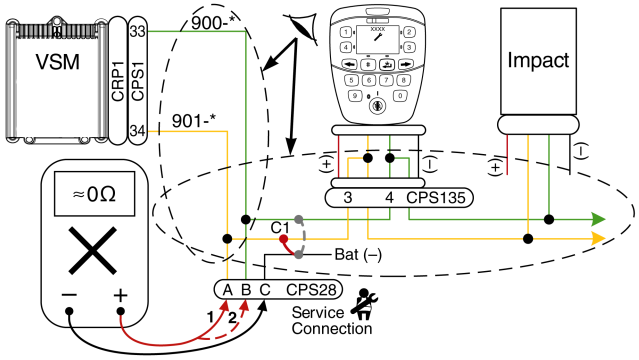


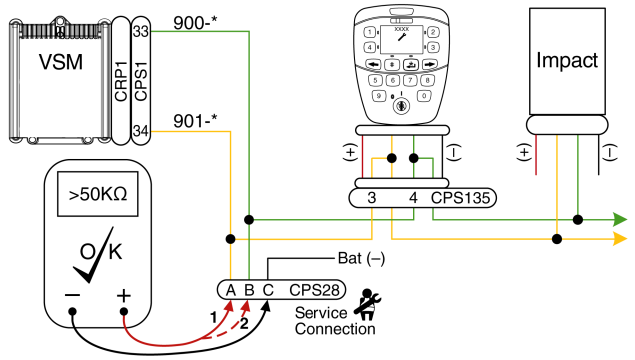


Locate Service Connection → Measure ?	See **Device Connectors**↓
1. = 0? CAN Hi/Lo Short Circuit→Go to 2↓	1. ˜ 60? = OK →Step C2↓
2. Inspect Accessible Harness Areas for Insulation Damage then Inaccessible Harness Areas. Focus on Bend Edges and Pinch Points, Go to 3↓	
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→Step C5↓	

STEP C2

All Device DTCs Short Circuit CAN Hi to Bat (-) CAN Lo to Bat (-) will not Produce a DTC





1. 0? = CAN Hi Short Circuit. Go to 3↓	1. > 50K? = OK, Go to 3↓
2. 0? = CAN Lo Short Circuit. Go to 3↓	2. > 50K? = OK, Go to 3 ↓
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest, →Step C5	

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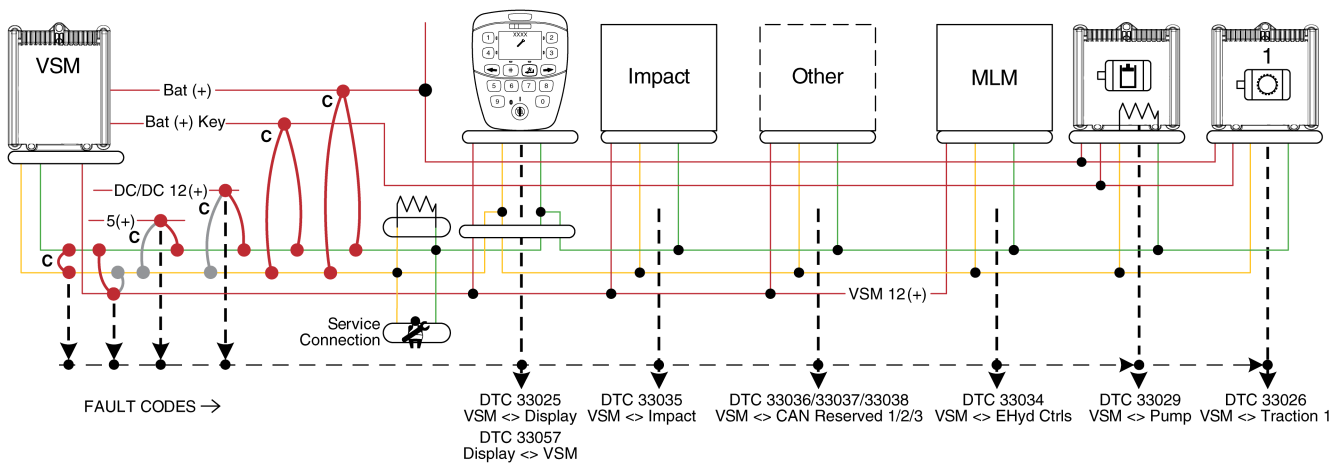
CBB 4 Wheel CAN Communication (Cont)

STEP C3

Multiple CAN Device DTCs Displayed > (+) Supply Short Circuit to CAN Hi or CAN Lo

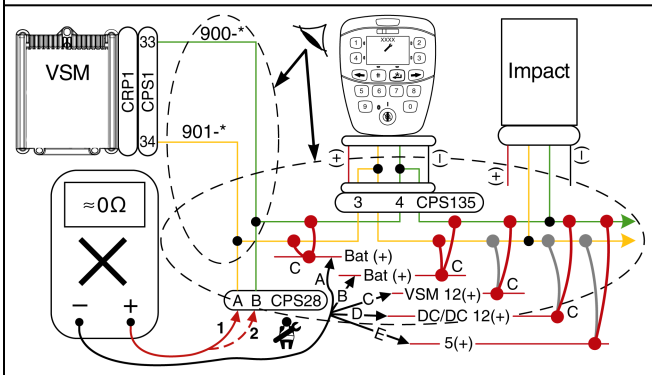


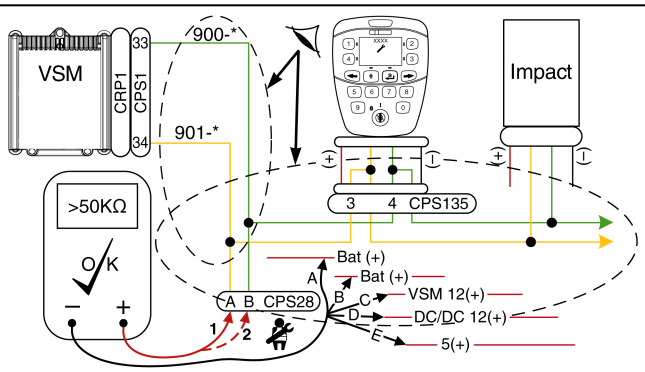
All DTCs→ Short Circuit CAN Lo to (+) Supply Sources.

All DTCs→ Short Circuit CAN Hi to (+) Supply Sources. No DTCs for a Short to (+)12 Volts or (+) 5 Volts

STEP C4

All Device DTCs Short Circuit Supply (+) to CAN Hi or CAN Lo

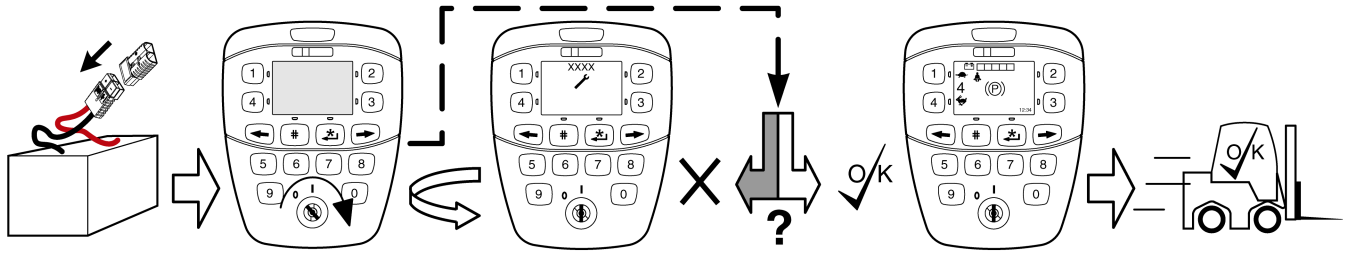




1. A, B, C, D, and E = 0? = CAN Hi Short Circuit, Go to 3↓	1. A, B, C, D, and E > 50K? = OK→, Step C5↓
2. A, B, C, D, and E = 0? = CAN Lo Short Circuit, Go to 3↓	2. A, B, C, D, and E > 50K? =OK→Step C5↓
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→Step C5↓	

CBB 4 Wheel CAN Communication (Cont)

STEP C5



Reconnect Battery

Retest - Power **ON**

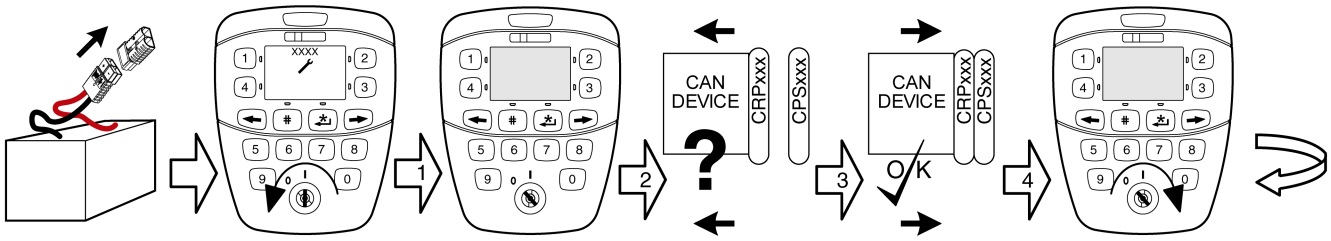
NO → Go to Component Operational Check

Is fault DTC gone?

NO YES

Fault corrected→ Continue operation

CAUSE D



Disconnect Battery To Replace Motor Controller

Power **OFF**

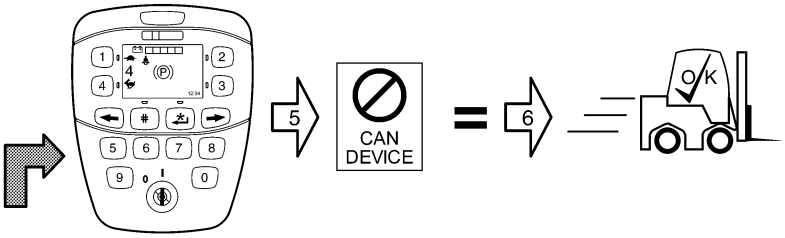
Disconnect CAN Device→

Do Not Discard

Install New CAN Device

Power **ON**→ Go to Step D1

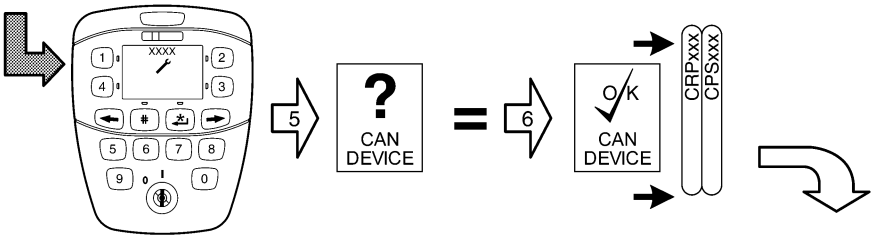
STEP D1



? Fault DTC gone→

Old device faulty→

Resume operation



Fault DTC present→

Old Device OK/Reinstall Old Device→

Go to Component Operational Check.

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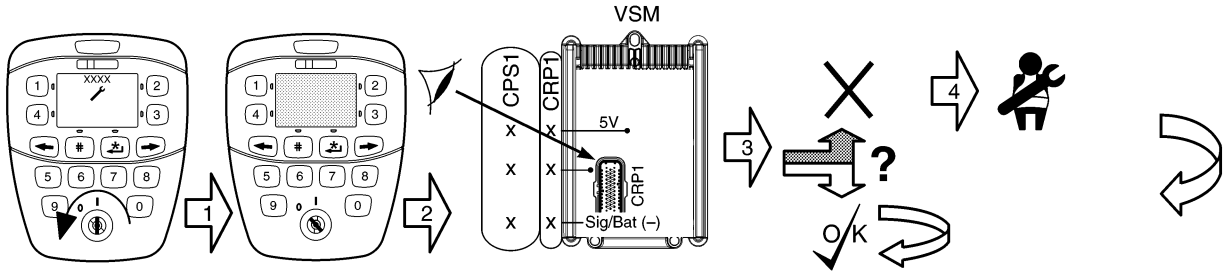
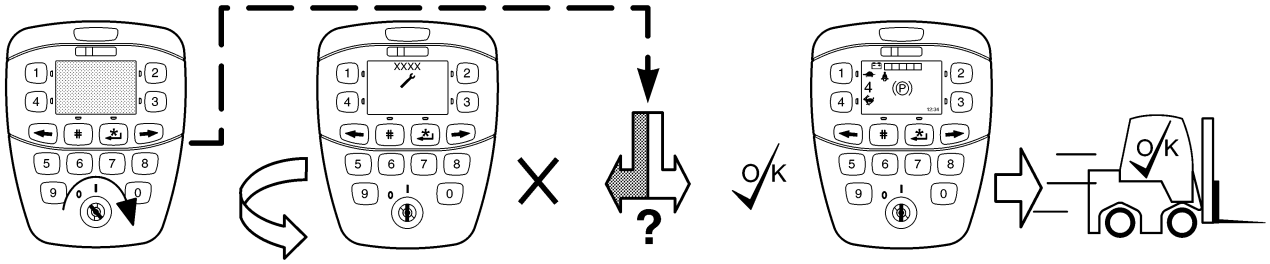
CBB 4 Wheel CAN Communication (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Step E1 Not OK Correct/Repair→ Go to Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation

NO YES

END FAULT

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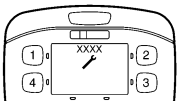
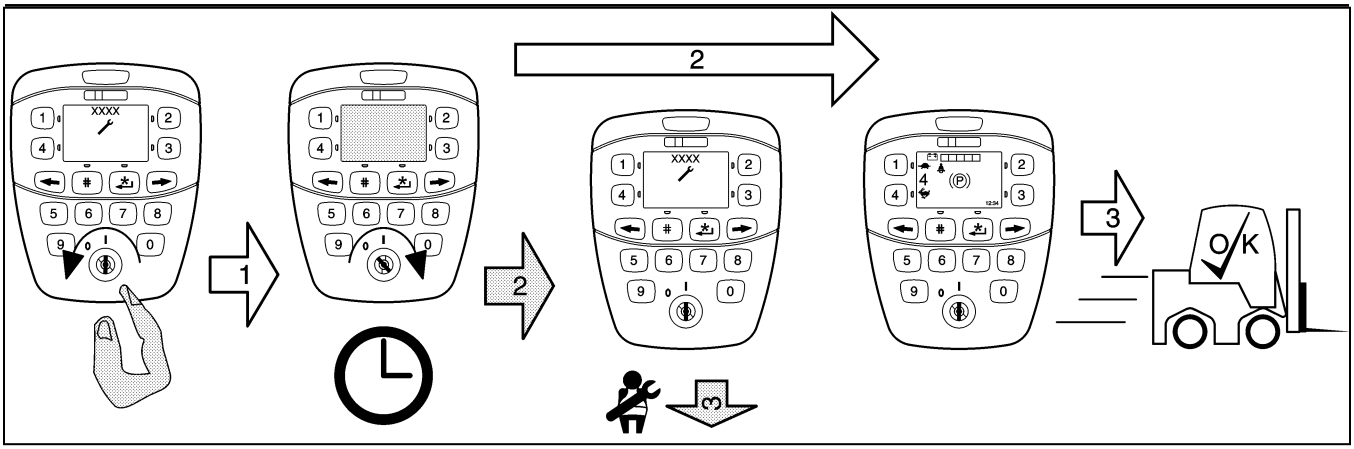
DBB 4 Wheel CAN Communication



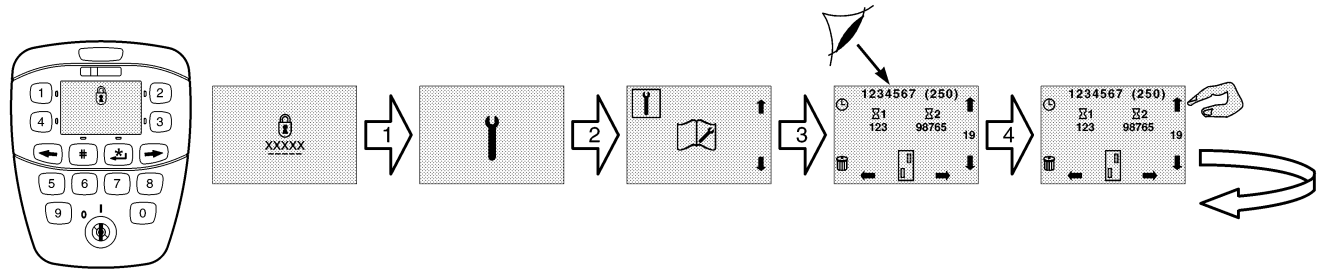
Fault Codes

DTC 33025 **VSM to Display**	**DTC 33026** **VSM to Traction 1 (Right)**	**DTC 33027** **VSM to Traction 2 (Left)**	**DTC 33029** **VSM to Pump**
DTC 33034 **VSM to MLM (DCS)**	**DTC 33035** **VSM to Impact**	**DTC 33036** **VSM to CAN Reserved 1**	**DTC 33037** **VSM to CAN Reserved 2**
DTC 33038 **VSM to CAN Reserved 3**			**DTC 33057** **Display to VSM**

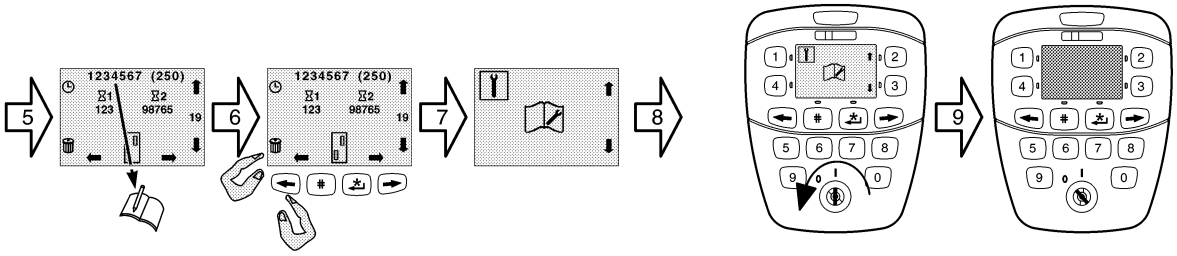


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Quick Check.	No fault→ Resume Operation

FAULT LOG DTC Review – Go to Display Menu



Enter SERVICE Password→	Diagnostics→	Fault Logs→	VSM Fault Logs→	View all VSM DTCs→ ?



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DBB 4 Wheel CAN Communication (Cont)	
📝 all VSM DTCs	Multiple VSM DTCs→ Erase VSM DTCs→ Exit Fault Log→ Power **OFF**→ **Quick Check** ↓
Single DTC→ Specific Device Fault Log→	📝 Device DTCs→ Erase Device DTCs↓
Emergency Stop Switch→ **OFF** → Wait 30 seconds→ **ON** → ? Recheck Single Device Fault Logs↓	
DTCs Present→ 📝 DTCs→ Power **OFF**→ Go to Single Device TSP↓	DTCs Gone→ Resume Operation

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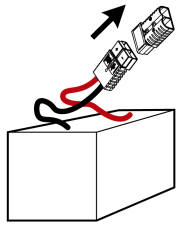
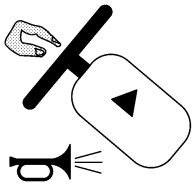
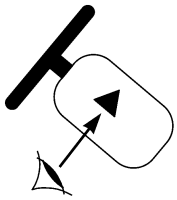
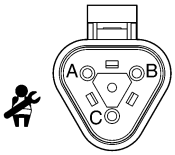
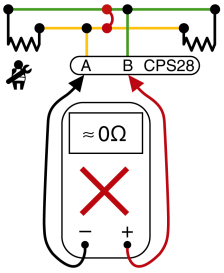
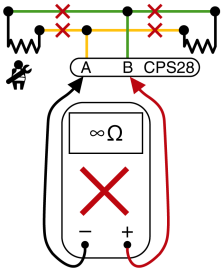
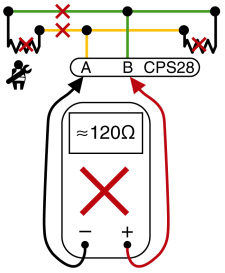
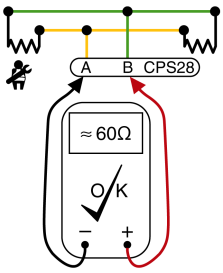
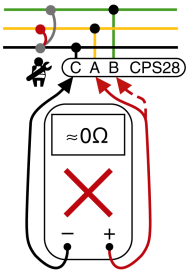
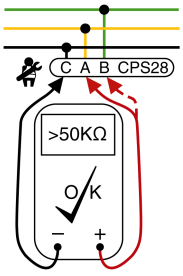
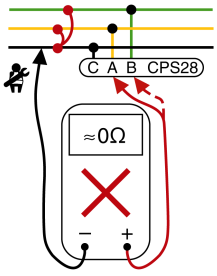
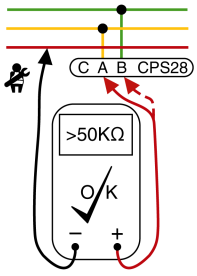
DBB 4 Wheel CAN Communication (Cont)

QUICK CHECK X Open Circuit/Fail) = Short Circuit

			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Locate Diagnostic Connector CPS 28	Service Connection
			
Short Circuit CAN Hi/CAN Lo Go to Step C1, All CAN Device DTCs	Open Circuit CAN Hi/CAN Lo Go to Component Operational Check, Multiple CAN Device DTCs	Open Circuit CAN Hi/ CAN Lo Termination Resistor Go to Component Operational Check, Intermittent DTCs	Circuit OK Go to Step A2, Single CAN Device DTC
			

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DBB 4 Wheel CAN Communication (Cont)			
CAN Hi Short Circuit Bat (-) Go to Step C2, All CAN Device DTCs CAN Lo STB (-), No DTC Go to Step C2, No DTC	CANbus Circuit OK Go to Step A2, Single CAN Device DTC	CAN Hi Short Circuit Bat (+) All CAN Device DTCs Go to Step C3, CAN Hi Short to 12/5 (+) No DTC CAN Lo Short Circuit Bat (+) All CAN Device DTCs Go to Step C3,	CANbus Circuit OK Go to Step A2, Single CAN Device DTC
SINGLE DEVICE DTC→ Fault is isolated to a SINGLE CANbus Connected Device and its Supply Connections			
MULTIPLE DEVICE DTCs → Faults that affect some but not all CANbus Devices→ Typically Open Circuits			
ALL DEVICE DTCs→ Faults that affect all of the CANbus connected devices→ Typically Short Circuits			

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DBB 4 Wheel CAN Communication (Cont)

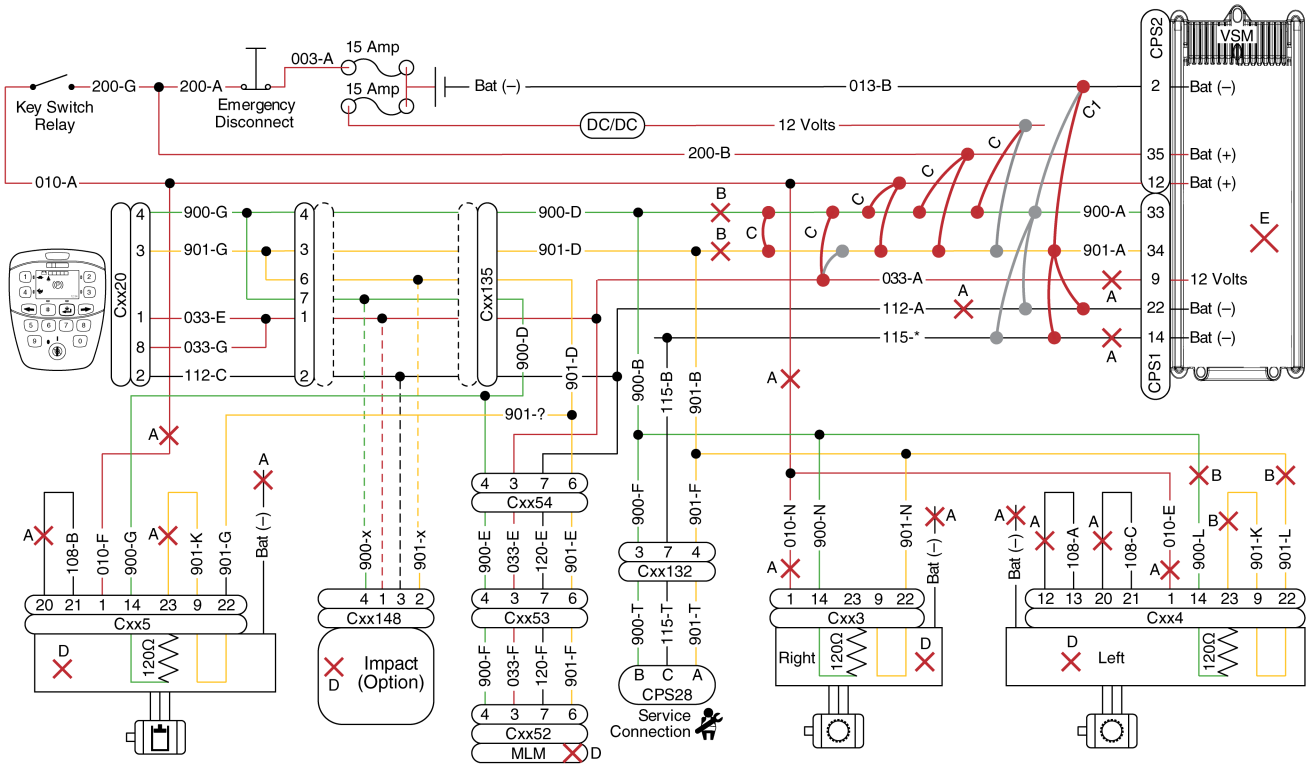
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

CAUSES A B C D E > ?

Table 9030-20-9. Main Schematic

Open Circuit – Termination Resistor/CAN Hi/CAN Lo/Key Switch Supply/Device Supply/ CAUSES A, B

CAN Short to – Bat (-)/12volt Bat (+)/Shorted CAN Hi to CAN Lo/Device Failure CAUSES C, D, E



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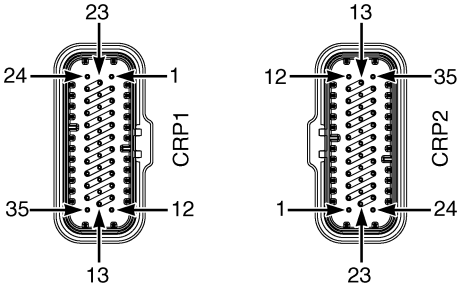
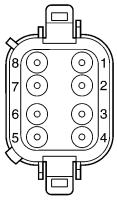
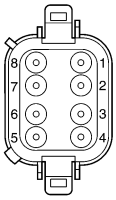
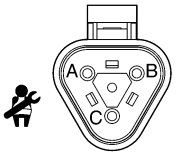
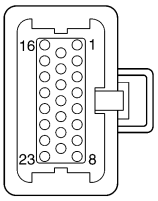
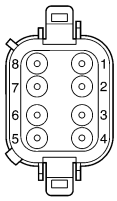
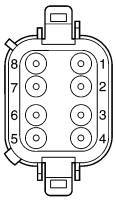
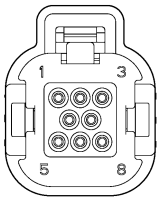
DBB 4 Wheel CAN Communication (Cont)

CONNECTORS

Table 9030-20-10. Device Connectors

			
VSM Cxx 1 and Cxx 2	Main Seat Cxx 52 and 54	Impact Device Cxx 148	Service Connector Cxx 28
			
Traction/Pump Controller Cxx 3, 4, and 5	MLM Cxx 52	Display Harness Cxx 135	Display Cxx 20

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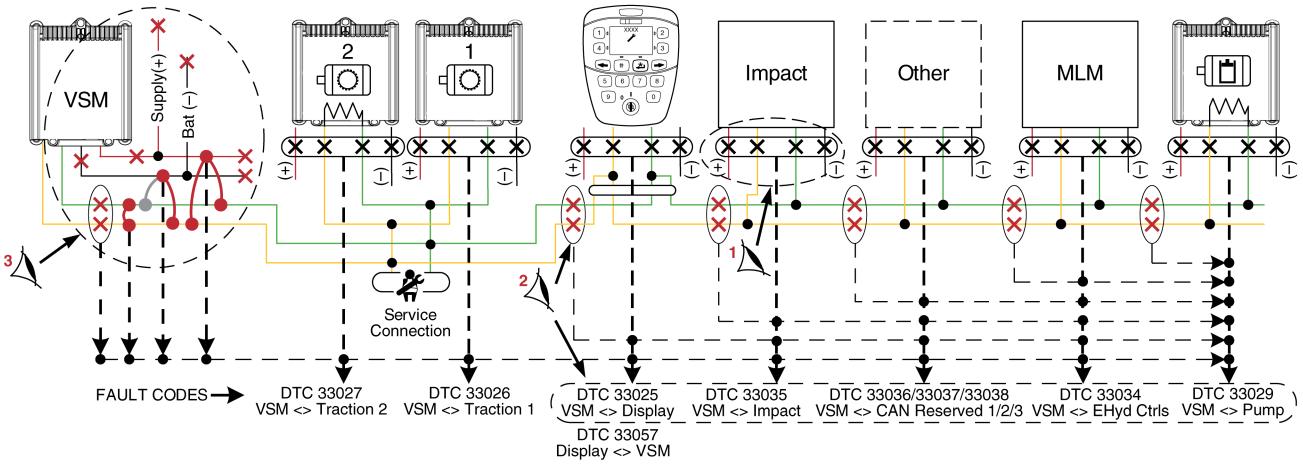
DBB 4 Wheel CAN Communication (Cont)

CAUSE A

CAN Hi/CAN Lo Single Device DTC (Black X) vs Multiple DTCs (Red X)



1, 2, and 3 are examples of possible Causes

1. Single DTC→Indicated Device Connections/Device Fail→Step A1

1. Single DTC above →Open Circuit on Device Supply (+) or Bat (-) or Open Circuit on Sub Circuit Wiring→Step A3

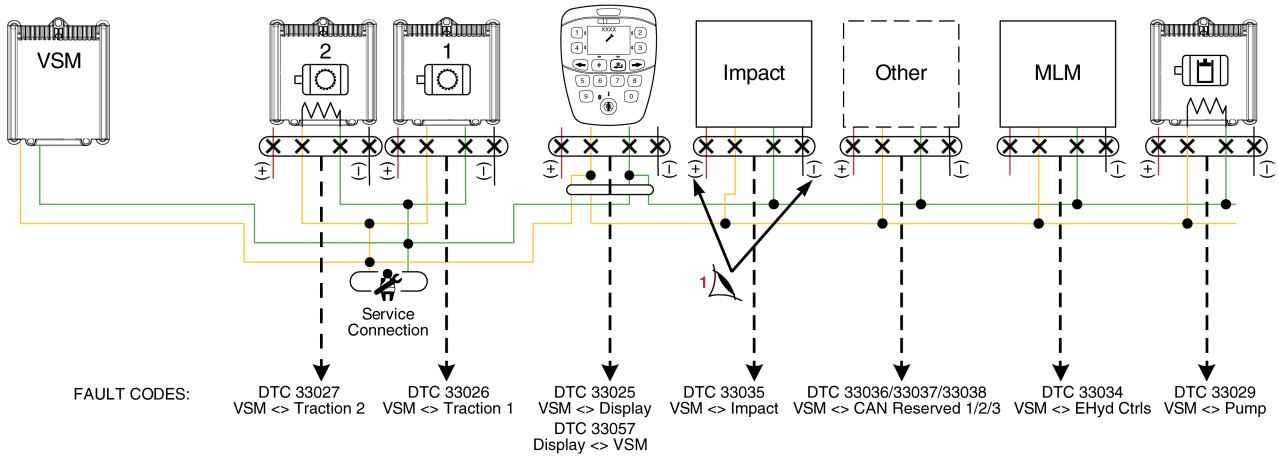
2. Multiple DTCs→Fault Log→DTC/Device closest to VSM↑→= Open circuit between DTC Device and VSM→Step B3

3. All DTCs above→Open Circuit on Device Supply (+) Bat (-)→= Supply Failure/Open Circuit Main Supply Circuit→Step A3

3. All DTCs above→Open/Short Circuit on VSM CANbus→= Open Circuit→Step B3 – Short Circuit→Component Operational Check

STEP A1

CAN Hi/ CAN Lo Single Device DTC - Locate Device



1. Example Only→Single DTC→Indicated Device Connections/Device Fail→?

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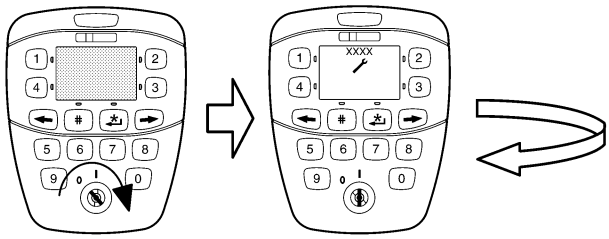
DBB 4 Wheel CAN Communication (Cont)

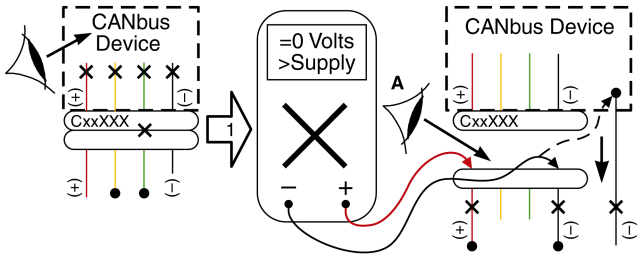
STEP A2

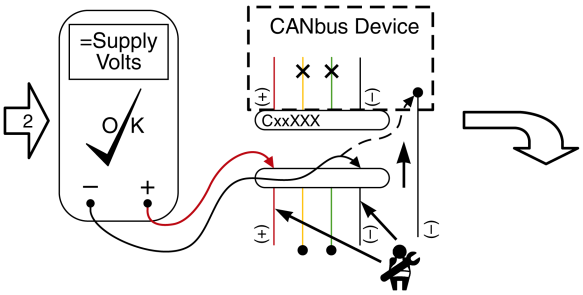


Power **ON**→ ?

STEP A3

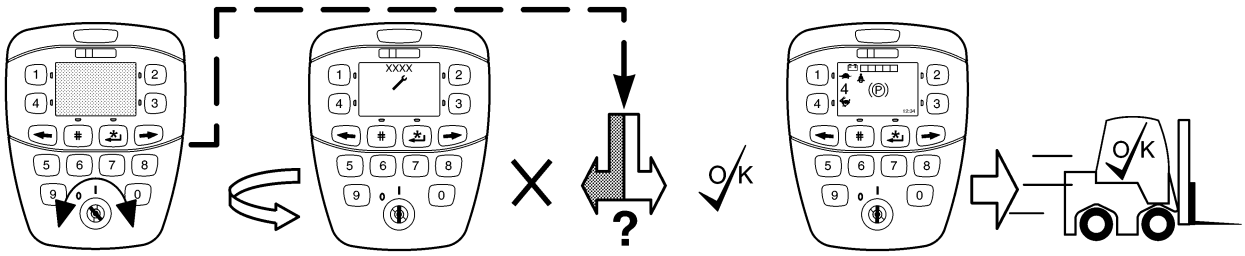
Single Device DTC Open Circuit Supply Voltage





1. Locate Device→Check connection→Not OK, Go to 4↓	1. Connection OK→Go to 2↓
2. = 0 Volts = Open Circuit Supply/(+) or (-) →Go to 4↓	2. =Supply Volts = OK→Step B1↓
3. > Supply Volts →Check for Shorts to a higher supply source→Repair→Component Operational Check as CAN Device may be damaged	
4. Reference **Main Schematic** - Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck Voltage↑→Step A4↓	

STEP A4



Retest - Power **OFF**
Power **ON**

NO → ?

Is fault DTC gone?

NO YES

Fault corrected→ Continue operation

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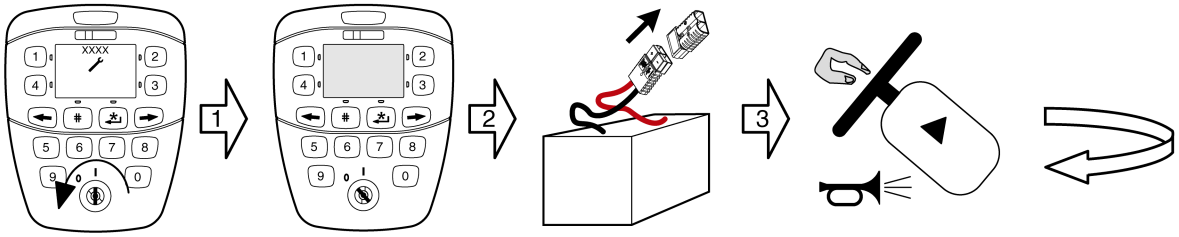
DBB 4 Wheel CAN Communication (Cont)

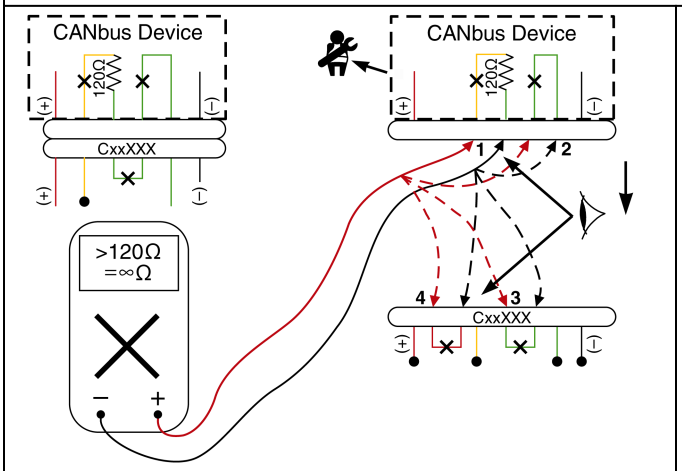
CAUSE B

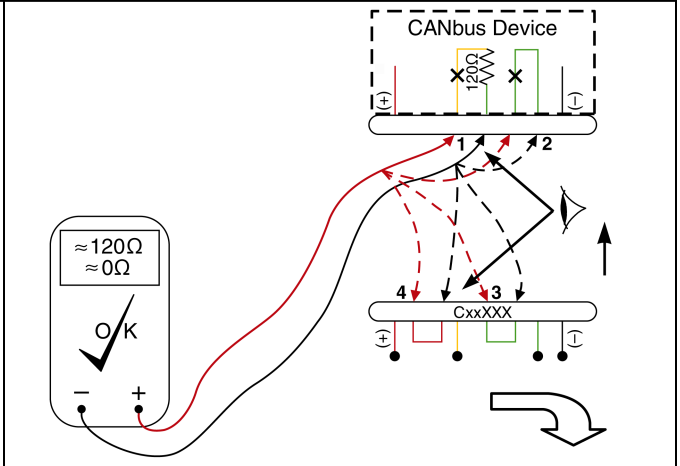


Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. ?

STEP B1

Single Device DTC Open Circuit CAN Hi or CAN Lo





Locate Device→ Check Connection→ Not OK, Go to 6↓	Connections OK→ Reconnect→ Go to Step B2
Device with Termination Resistor→ Locate and Disconnect ↓	See **Device Connectors**
1. > 120? = Open Circuit Termination Resistor →Go to 5↓	1. ˜ 120? = OK Go to 2 ↓
2. = 8? = Open Circuit →Go to 5↓	2. ˜ 0? = OK Go to 3 ↓
3. = 8? = Open Circuit →Go to 6↓	3. ˜ 0? = OK Reconnect Device↓
4. Motor Controller ID Loop(s) = 8? = Open Circuit→Go to 6↓	4. Reference **Main Schematic** ˜ 0? = OK Reconnect Device ↓
5. **Replace Device**→Component Operational Check↓	
6. Find/Repair Open Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck?↑→Reconnect→?	

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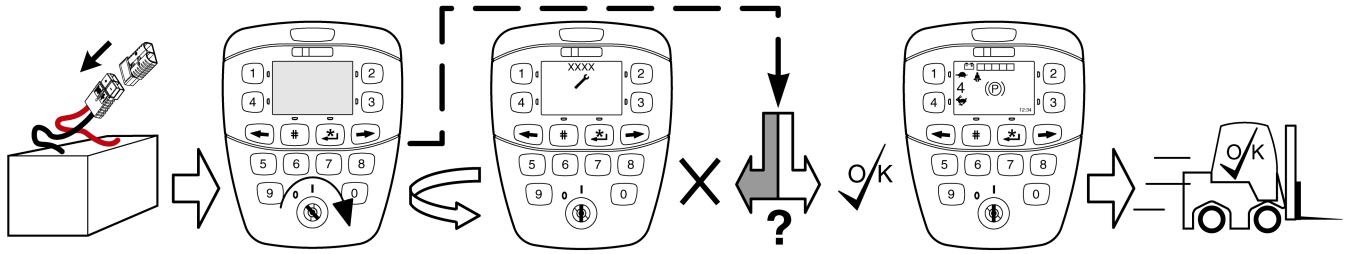
DBB 4 Wheel CAN Communication (Cont)

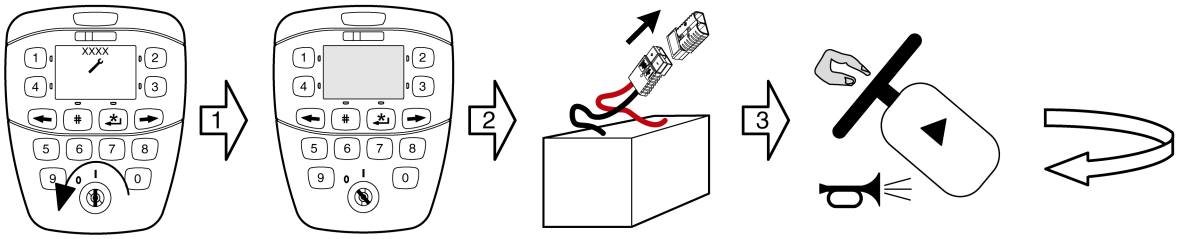
STEP B2



Reconnect Battery | Retest - Power **ON** | **NO** → ? | Is fault DTC gone? | Fault corrected→ Continue operation

NO YES

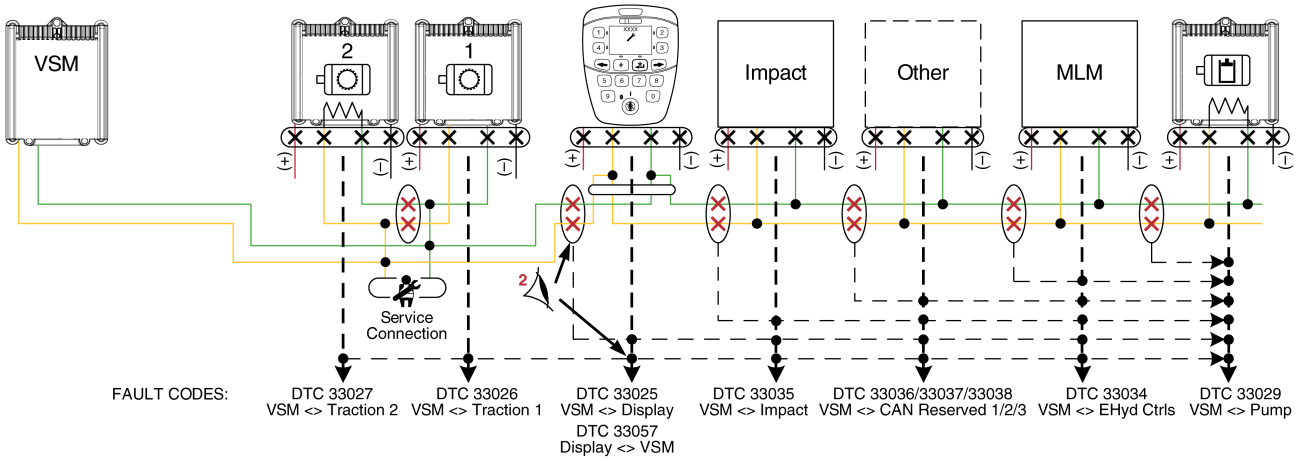
STEP B3



Power **OFF**→ | Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. | ?

STEP B4

Multi CAN Device DTCs Display > Open Circuit CAN Hi to CAN Lo



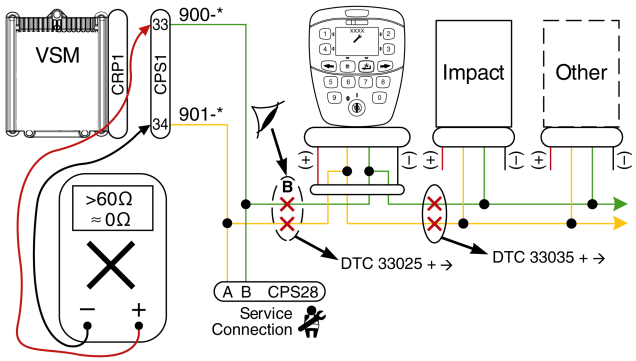
Example Only→ Multiple DTCs→ Fault Log→ DTC/Device closet to VSM

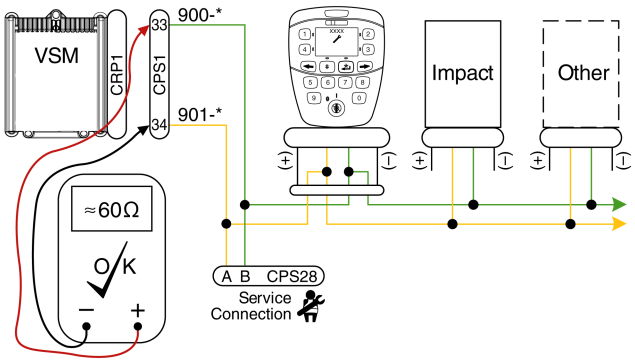
Open circuit is between DTC Device and VSM→ ?

DBB 4 Wheel CAN Communication (Cont)

STEP B5

Multi Device DTCs Open Circuit CAN Hi or CAN Lo

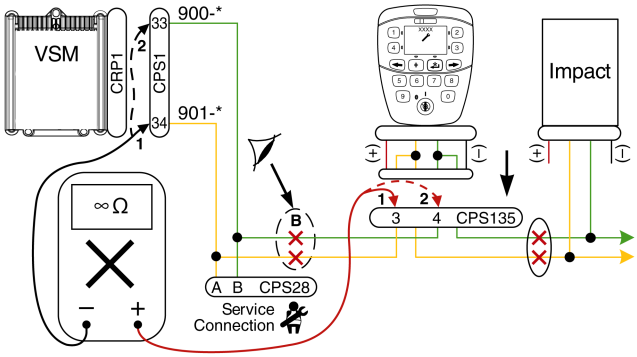


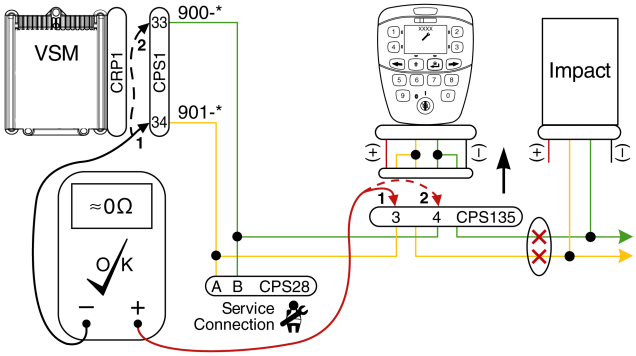


The above is an Example Only

Disconnect VSM CPS1→ Measure ?	See **Device Connectors**
> 60? to 8? = CAN Hi/Lo Open Circuit ?	˜ 0? = → Component Operational Check ↓ ˜ 60? = OK→ Component Operational Check ↓

STEP B6





The above is an Example Only

Locate Device to right or Left of Indicated Open Circuit

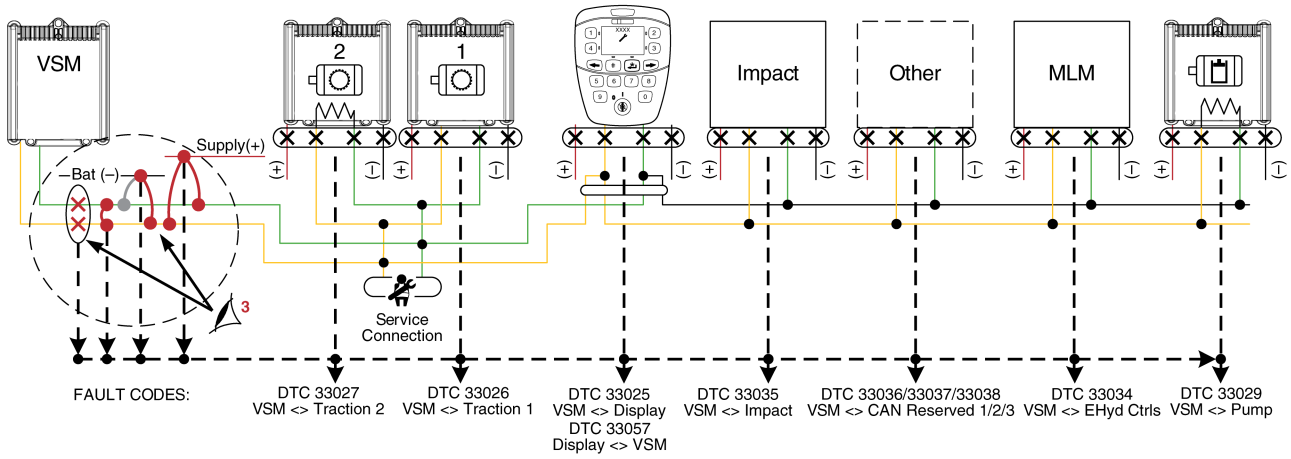
1. 8? = CAN Hi Open Circuit→Go to 3↓	1. ˜0? = OKComponent Operational Check↓
2. 8? = CAN Hi Open Circuit→Go to 3↓	2. ˜0? = OKComponent Operational Check↓

4. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-check?→→Reconnect→Retest→?

DBB 4 Wheel CAN Communication (Cont)

CAUSE C

All CAN Device DTCs Displayed > CAN Hi/CAN Lo Short Circuit together/Supply (+) or (-)



All DTCs→ Open Circuit to VSM → Step B5 ↑

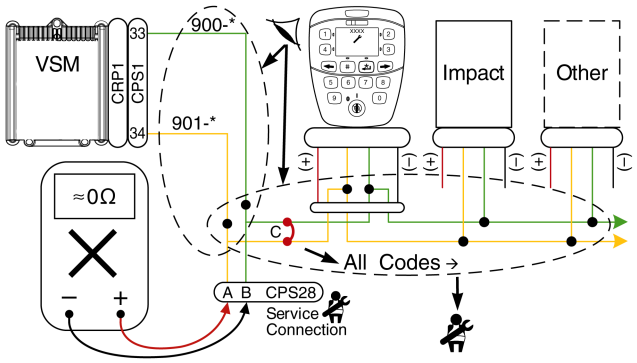
All DTCs→ Short Circuit CAN Hi to CAN Lo → Step C1 ↓

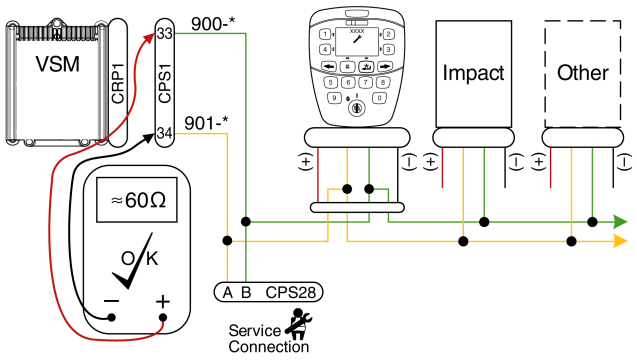
All DTCs→ Short Circuit CAN Hi to (-) Supply Sources → Step C2 ↓ No DTCs→ Short Circuit CAN Lo to (–) Supply Sources

All DTCs→ Short Circuit CAN Lo to (+) Supply Sources→ Step C3 ↓ No DTCs→ Short Circuit CAN Hi to (+) Supplies (5, 12 volt)

STEP C1

All Device DTCs Short Circuit CAN Hi to CAN Lo





Locate Service Connection → Measure ?	See **Device Connectors**↓
1. = 0? CAN Hi/Lo Short Circuit→Go to 2↓	1. ˜ 60? = OK →Step C2↓
2. Inspect easily Accessible Harness Areas for Insulation Damage then Inaccessible Harness Areas. Focus on Bend Edges and Pinch Points, ?	
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→?	

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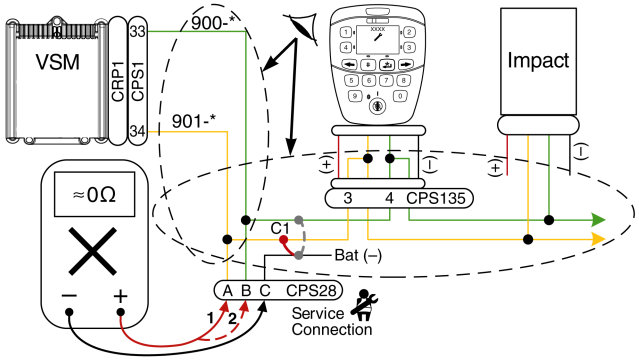
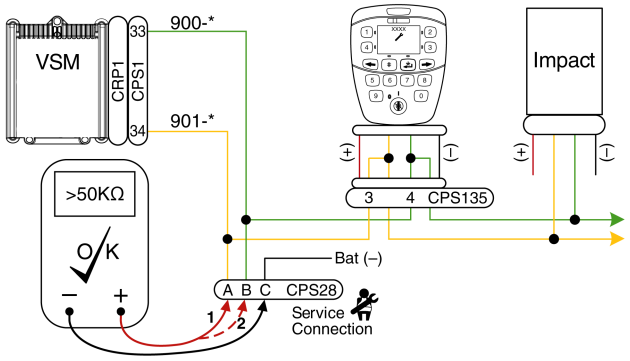
DBB 4 Wheel CAN Communication (Cont)

STEP C2

All Device DTCs Short Circuit CAN Hi to Bat (-) CAN Lo to Bat (-) will not Produce a DTC



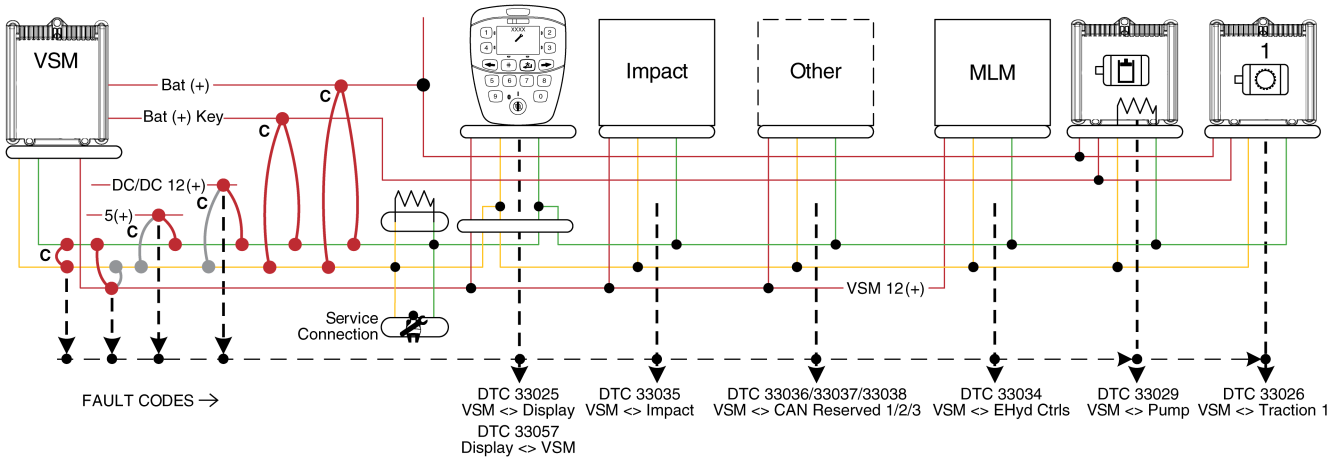


1. 0? = CAN Hi Short Circuit. Go to 3↓	1. > 50K? = OK, Go to 3↓
2. 0? = CAN Lo Short Circuit. Go to 3↓	2. > 50K? = OK, Go to 3 ↓

3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest, →Step C5

STEP C3

Multiple CAN Device DTCs Displayed > (+) Supply Short Circuit to CAN Hi or CAN Lo



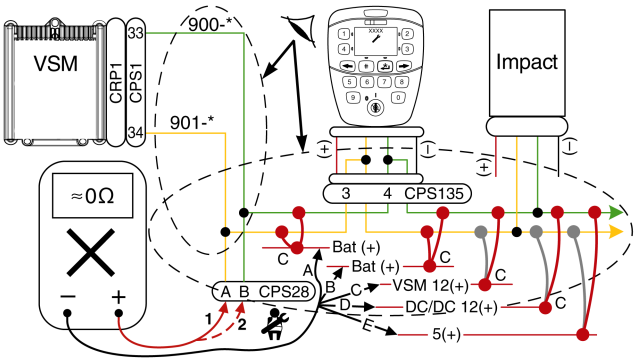
All DTCs→ Short Circuit CAN Lo to (+) Supply Sources.

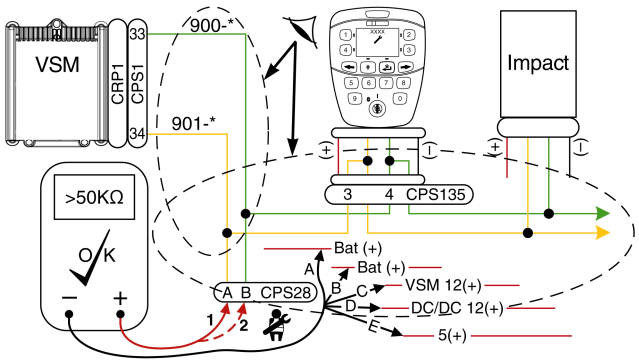
All DTCs→ Short Circuit CAN Hi to (+) Supply Sources. No DTCs for a Short to (+)12 Volts or (+) 5 Volts

DBB 4 Wheel CAN Communication (Cont)

STEP C4

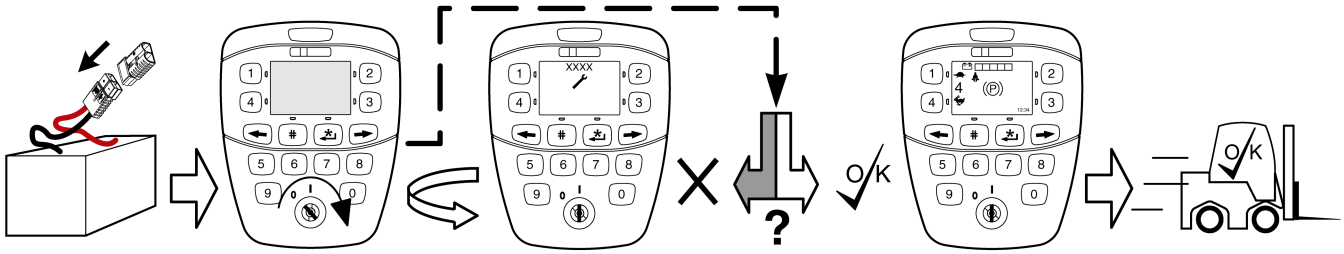
All Device DTCs Short Circuit Supply (+) to CAN Hi or CAN Lo





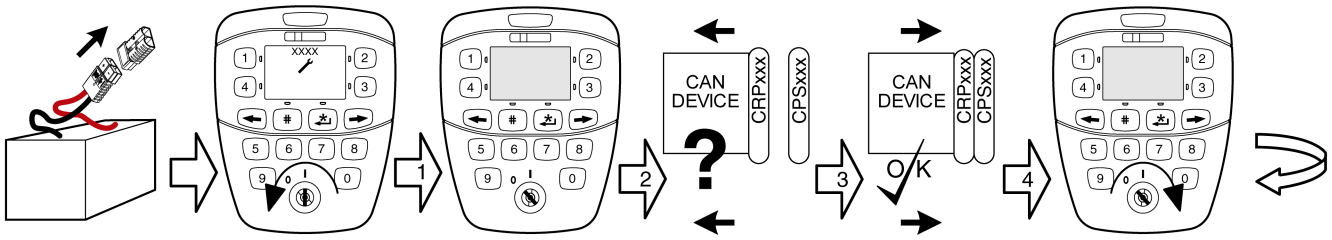
1. A, B, C, D, and E = 0? = CAN Hi Short Circuit, Go to 3↓	1. A, B, C, D, and E > 50K? = OK→?
2. A, B, C, D, and E = 0? = CAN Lo Short Circuit, Go to 3↓	2. A, B, C, D, and E > 50K? =OK→?
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→?	

STEP C5



Reconnect Battery — Retest - Power **ON** — **NO** → Go to ? — Is DTC gone? **NO YES** → — Fault corrected→ Continue operation

CAUSE D



Disconnect Battery To Replace **Motor Controller** — Power **OFF** — Disconnect CAN Device→ Do Not Discard — Install New CAN Device — Power **ON**→ ?

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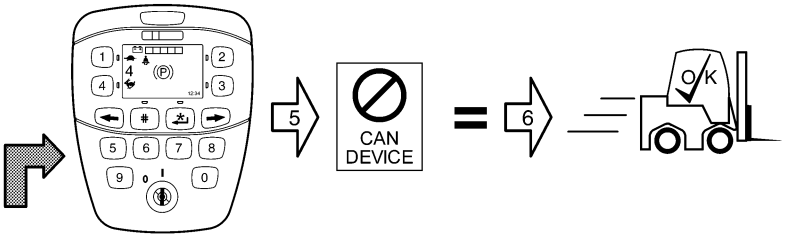
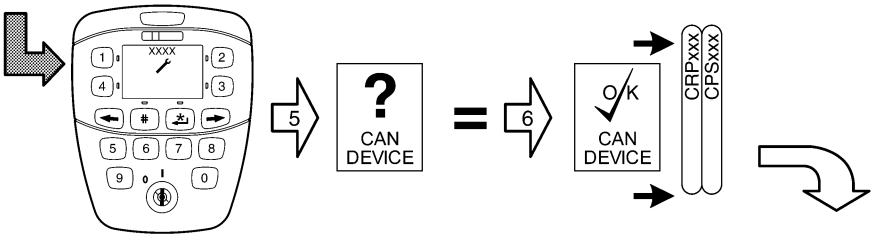
DBB 4 Wheel CAN Communication (Cont)

STEP D1

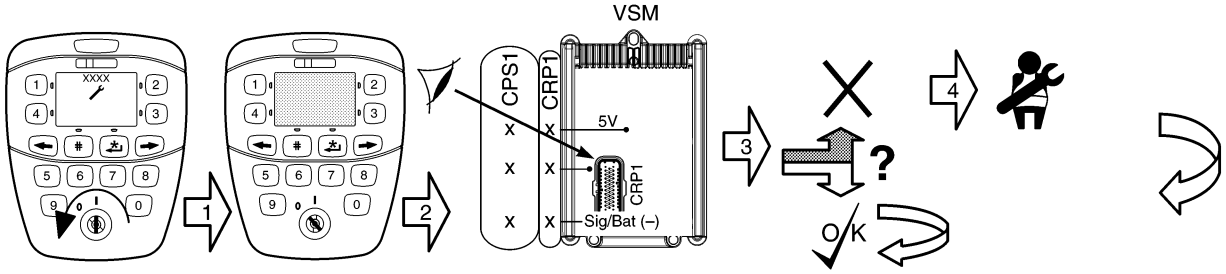


? Fault DTC gone→ Old device faulty→ Resume operation



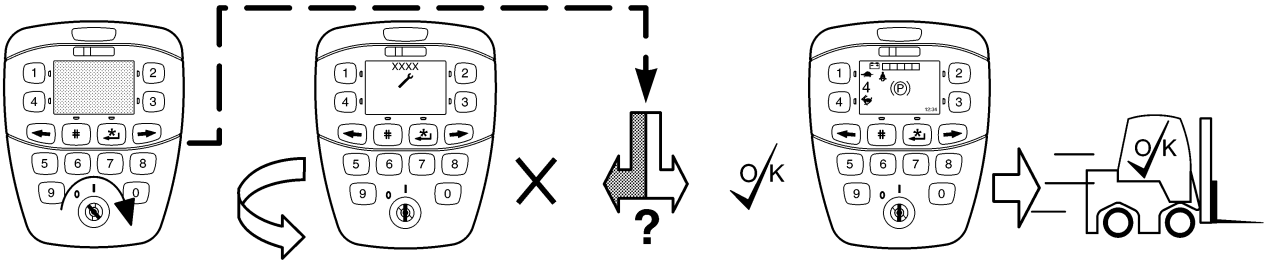
Fault DTC present→ Old Device OK/Reinstall Old Device→ ?

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Step E1 Not OK Correct/Repair→ Go to Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation

NO YES ← →

END FAULT

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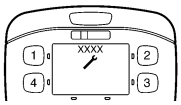
MLM Failure



Fault Codes

DTC 21830
MLM EEPROM Write Error

DTC 21834
MLM Sensor 1 Out of Range

DTC 21835
MLM Sensor 2 Out of Range

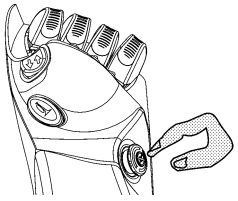
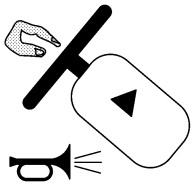
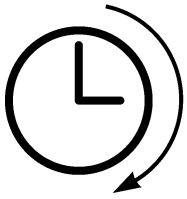
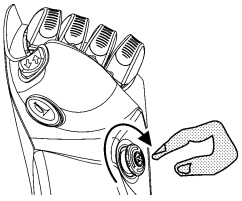
DTC 21836
MLM Sensor 3 Out of Range

DTC 21837
MLM Sensor 4 Out of Range

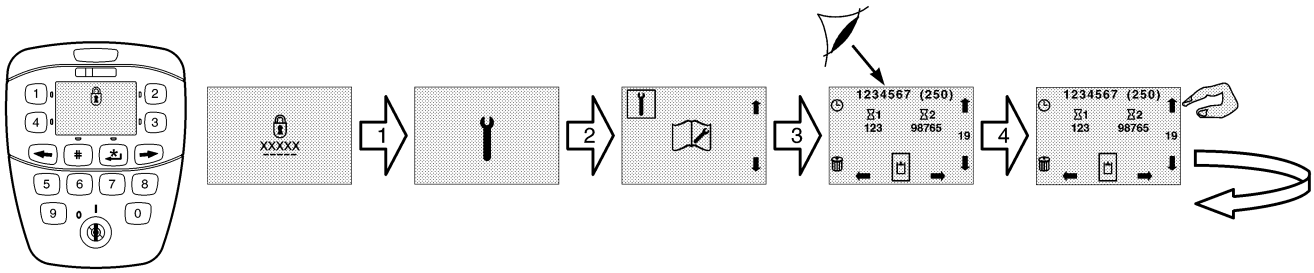
DTC 25344
MLM Checksum Error

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**			
DTC 21834	MLM Sensor 1 Out of Range		→ Component Operational Check ↓
DTC 21835	MLM Sensor 2 Out of Range		→ Component Operational Check ↓
DTC 21836	MLM Sensor 3 Out of Range		→ Component Operational Check ↓
DTC 21837	MLM Sensor 4 Out of Range		→ Component Operational Check ↓
DTC 25344	MLM Checksum Error	DTC 33034 Display	→ Component Operational Check ↓
DTC 21830	MLM EEPROM Write Error	DTC 33034 Display	→ Component Operational Check ↓

Check 1

			
Push in Emergency Stop	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Release Emergency Stop

FAULT LOG CODE Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ VSM/MLM Fault Logs→ View all VSM/MLM DTCs→ ?

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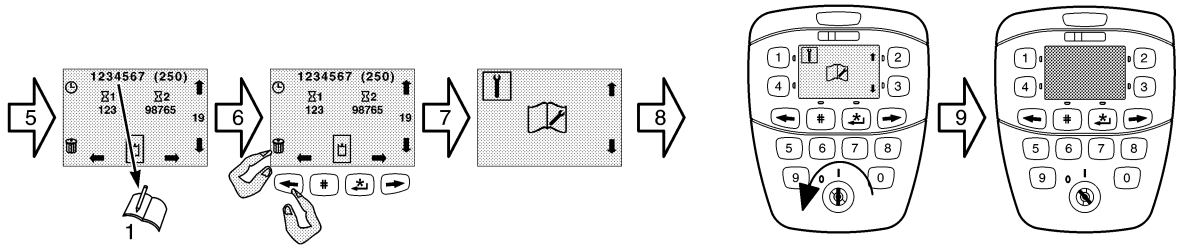
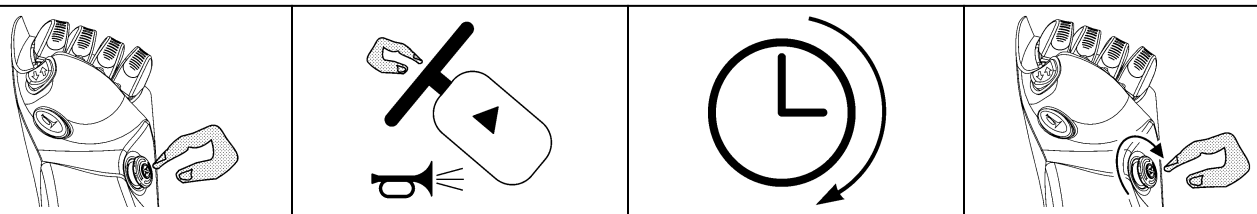
MLM Failure (Cont)

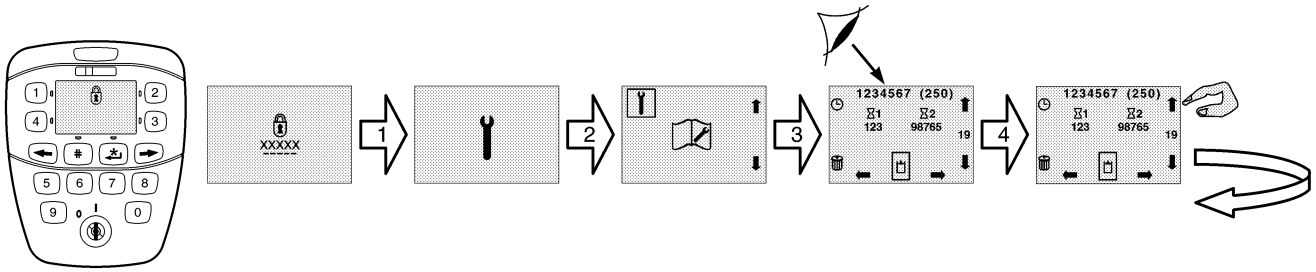


All VSM/MLM DTCs	Erase all VSM/MLM DTCs→ Exit Fault Log	Power OFF↓

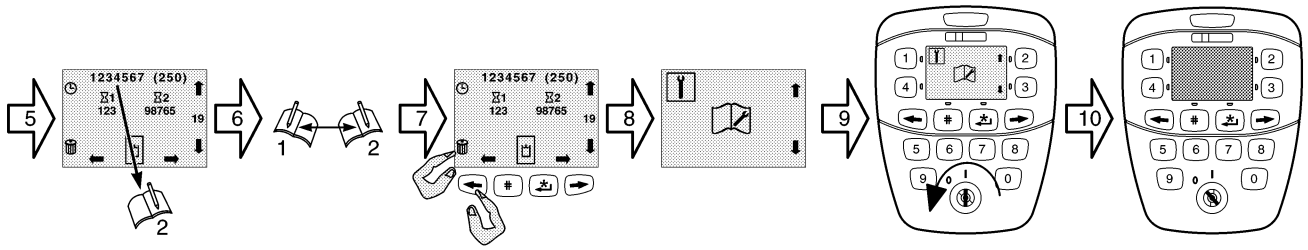
Check 2



Push in Emergency Stop	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Release Emergency Stop



Enter Service Password→ Diagnostic→ FAULT LOGs→ VSM/MLM Fault Logs→ View all VSM/MLM DTCs→ ?



VSM/MLM DTCs→ Compare VSM/MLM DTCs Check 1 & 2→ Erase all VSM/MLM DTCs→ Exit Fault Log↓

MLM 21834, 21835, 21836, & 21837→	Power OFF→ Component Operational Check

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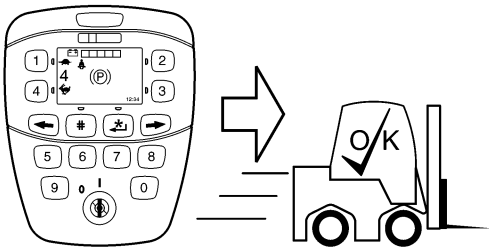
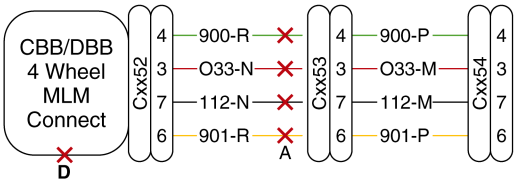
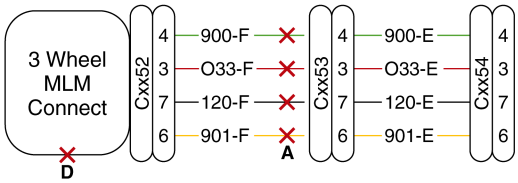
MLM Failure (Cont)	
33034 VSM DTC Only→	Power OFF→ Component Operational Check
No DTCs→ ?	
	
No Fault→ Resume Operation	

CAUSE A

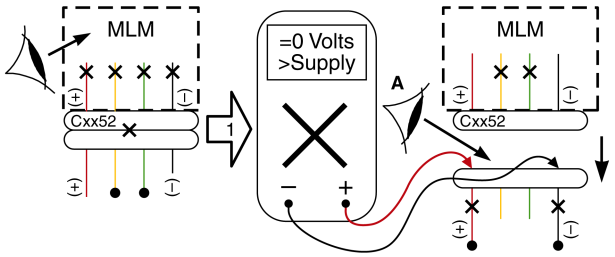
Table 9030-20-11. Main Schematic

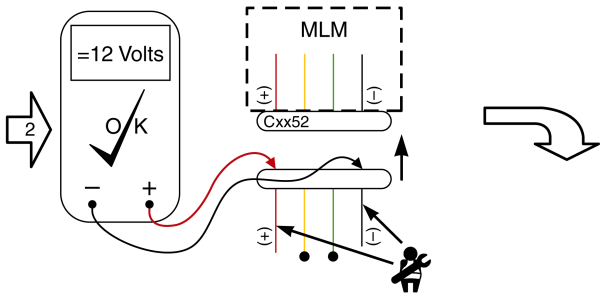




STEP A1

MLM Open Circuit Supply Voltage





1. Locate Device→Check Connections→Not OK Go to 4↓	1. Connections OK→Go to 2↓
2. =0 Volts = Open Circuit→Supply/(+) or (-)→Go to 4↓	2. = Supply Volts= OK→Step A2↓
3. > Supply Volts→Check for Shorts to a Higher Supply Source→Repair→Component Operational Check as MLM may be damaged.	
4. Reference Table 9030-20-11→ - Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ReCheck Voltage↑	

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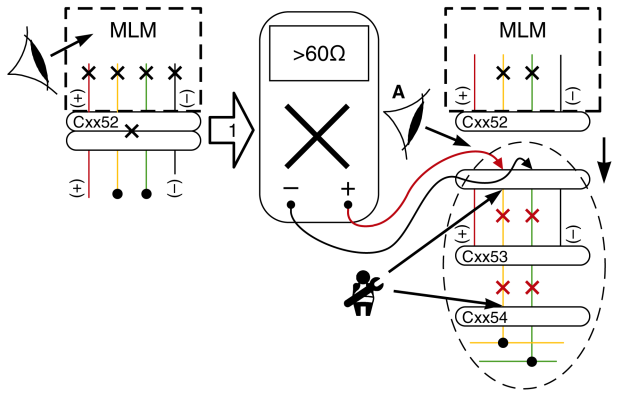
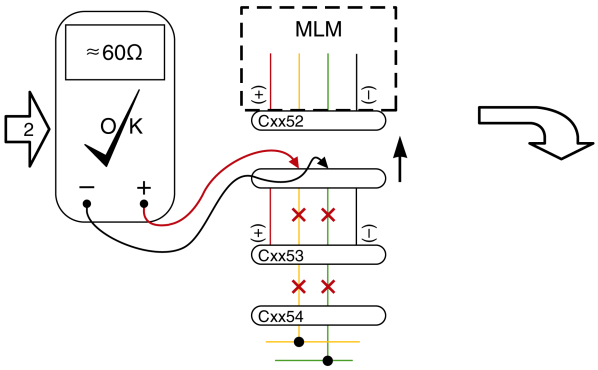
MLM Failure (Cont)

STEP A2

MLM Open Circuit CAN Hi/CAN Lo





1. Locate Device→Check Connections→Not OK Go to 4↓

1. Connections OK→Go to 2↓

2. > 60? = Open Circuit→CAN Hi/CAN Lo→Go to 4↓

2. CAN Hi/CAN Lo Connections = OK→Component Operational Check↓

3. Reference Table 9030-20-11→ - Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓

4. ReCheck ?↑→Repeat Check 2↑?

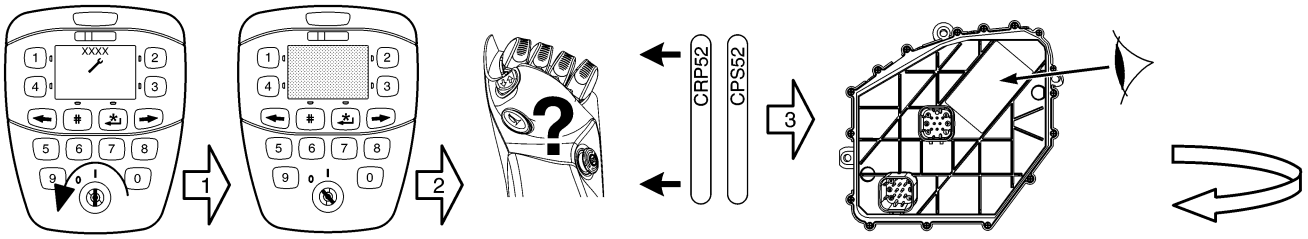
CAUSE B

Not Applicable

CAUSE C

Not Applicable

CAUSE D



Power **OFF**→ Remove and Replace MLM PCB Cassette Assembly→ See **Electrical System** 2200SRM1337/ **Electrical System** 2200SRM1369↓

Check Replacement MLM 🖫 Version→ See Label Information→ Step D2 ↓

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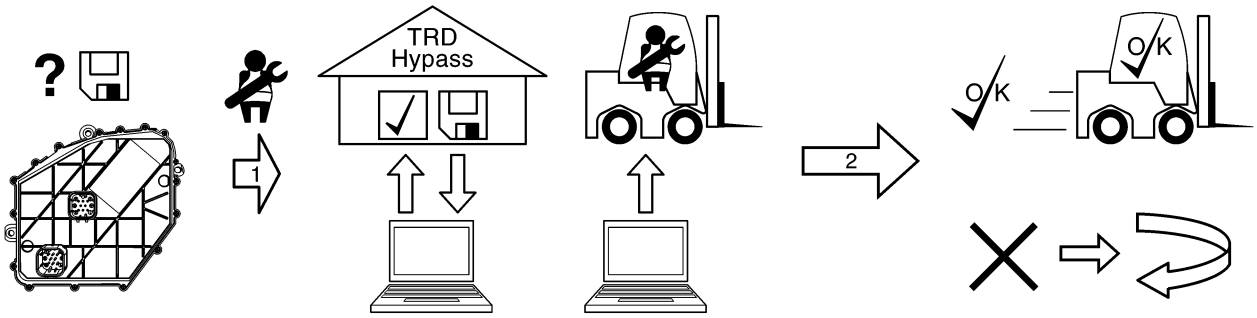
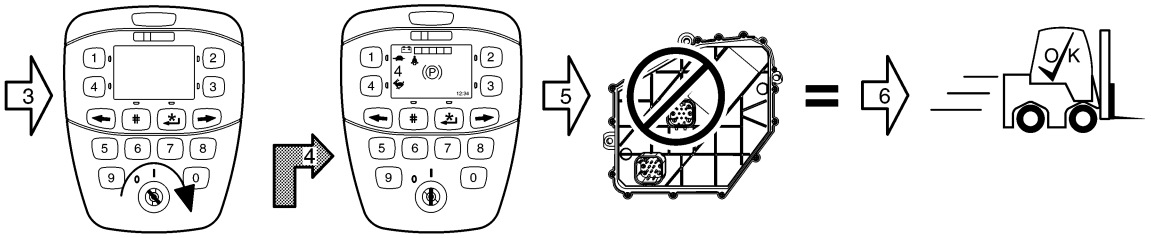
MLM Failure (Cont)

STEP D1

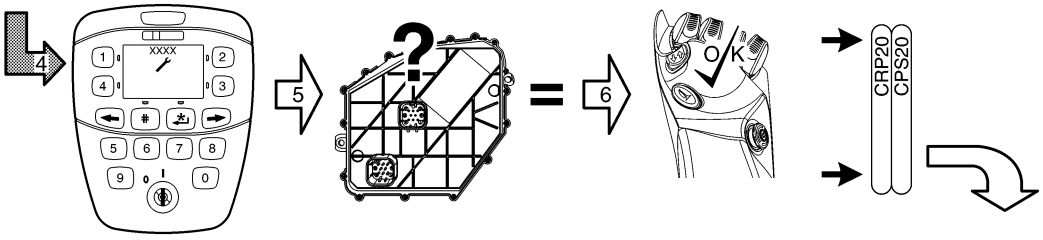


1. Go to TRD/ Hypass Online /Software.?? Is Replacement Cassette Software Version the Latest Version
2. **NO**→Download the latest Application 🖫→Install on truck→See 4↓→Step D2↓
3. **YES**→Test New Installation→Step D2↓
4. **WARNING:** Keyswitch must be **OFF** during reprogramming

STEP D2

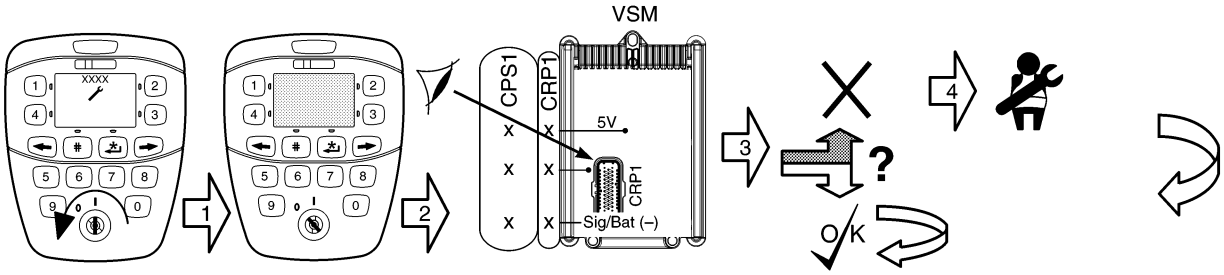


Power **ON**→ **?** DTCs gone→ Original MLM Cassette faulty→ Resume operation



DTCs Still Present→ Original MLM Cassette OK/Reinstall Original Cassette→ ?

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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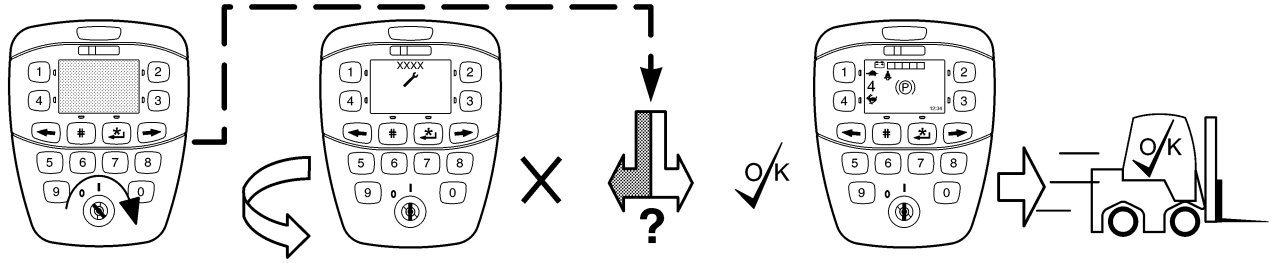
MLM Failure (Cont)

STEP E1



Retest - Power **ON**→

NO → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation.

END FAULT

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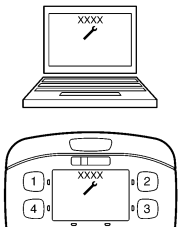
MLM Incorrect Lever Installed



Fault Codes

DTC 4112 Incorrect Lever 1 Installed

DTC 4113 Incorrect Lever 2 Installed

DTC 4114 Incorrect Lever 3 Installed

DTC 4115 Incorrect Lever 4 Installed

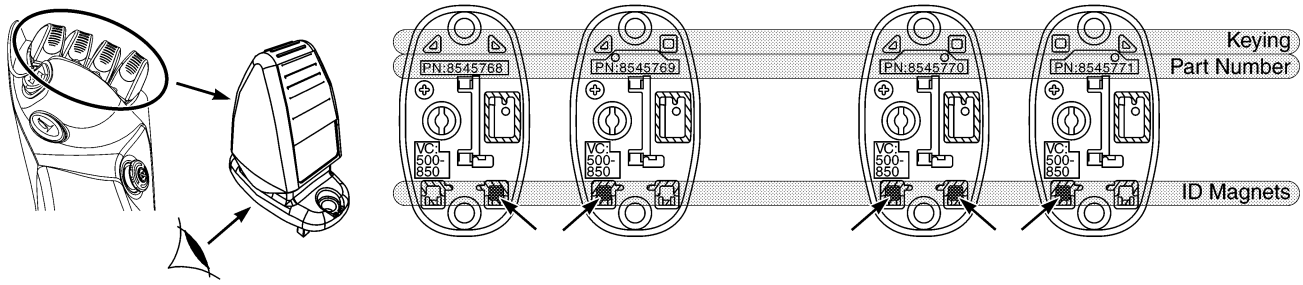
DTC 4116 Incorrect Lever 5 Installed

QUICK CHECK X Open Circuit/Fail) = Short Circuit

Check 1

Is Truck Lever Hardware Configuration Correct With Software Configuration?

Standard↓ Dual Function↓ Clamp↓ Monentary↓ (RTST)



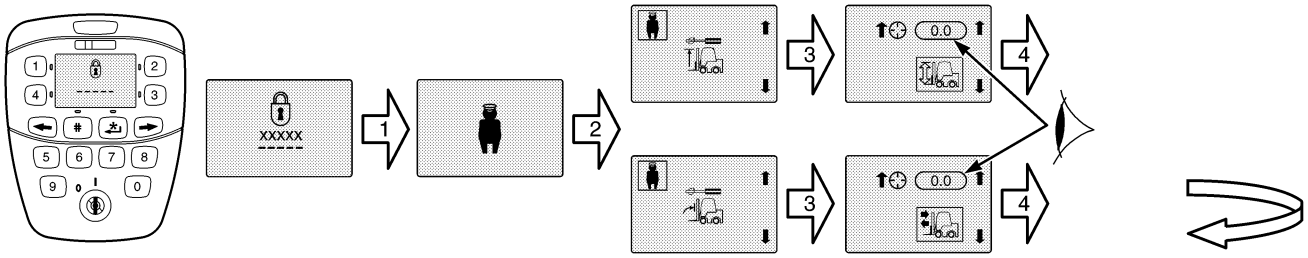
Remove Lever(s)→ Check Base Information

If Incorrect Install Correct Lever(s)

Check 2

?DTC for Lever 1 or Lever 2→ Truck Setup→ Review RTST Setup Procedures

Standard Lever Installation→ Timer should be set to zero?



Enter Service Password→ Truck Setup→ RTST→ ? Timer Value = 0 for Standard Levers→ **NO** ↓

→ Reset Timer to Zero→ See Display Menu Flowchart for next step

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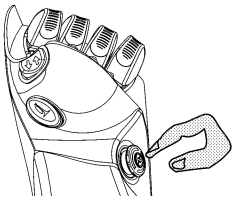
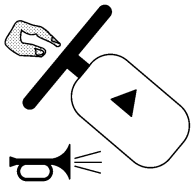
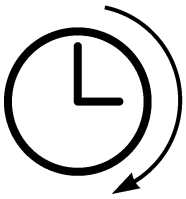
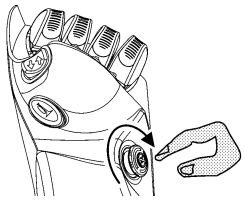
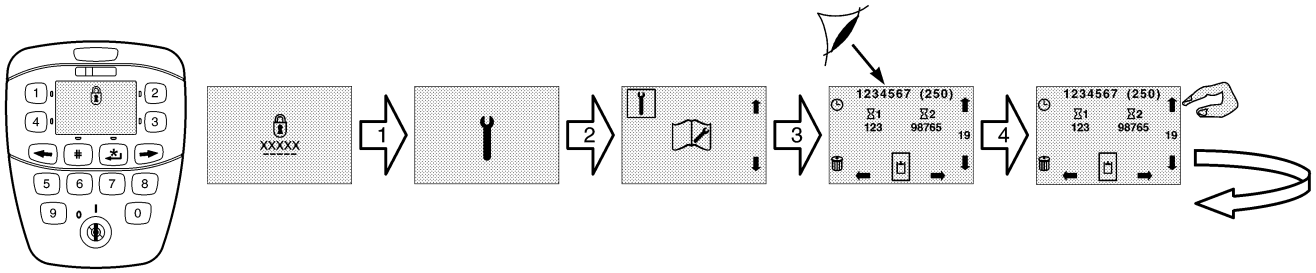
MLM Incorrect Lever Installed (Cont)

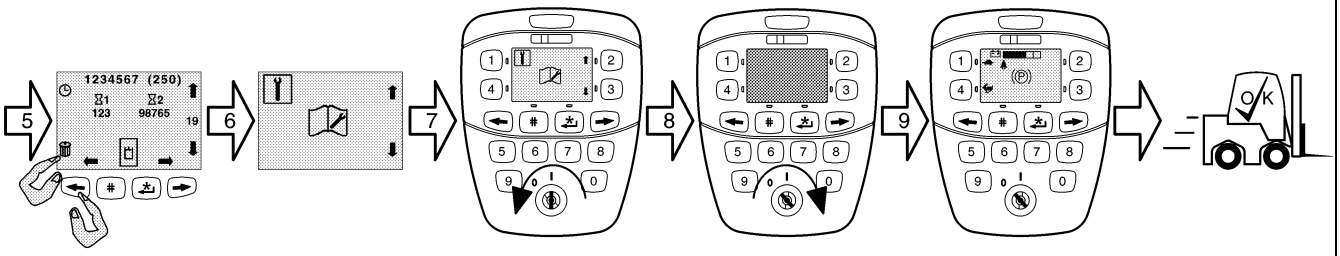
Check 3

			
Push in Emergency Stop	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Release Emergency Stop

DTC FAULT LOG CODE Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ VSM/MLM Fault Logs→ View all VSM/MLM DTCs→ ?



Erase all VSM/MLM DTCs→ Exit Fault Log→ Power OFF/Power ON→ No DTCs→ Resume Operation

Same DTCs Return→ Configuration File Incorrect→ Go to Component Operational Check

CAUSE A

Not Applicable

CAUSE B

Not Applicable

CAUSE C

Not Applicable

CAUSE D

Not Applicable

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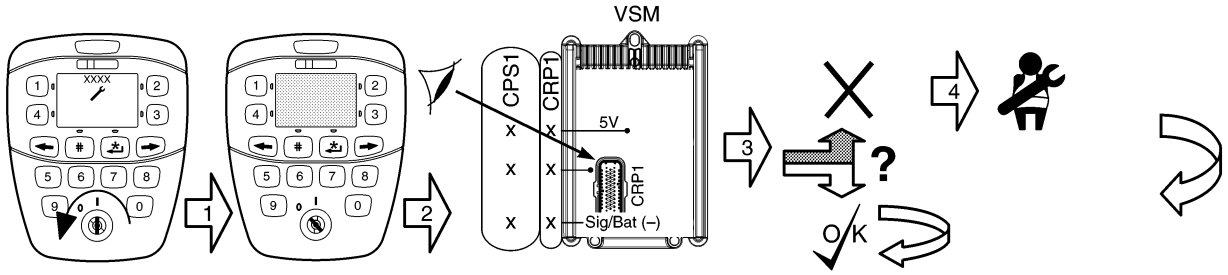
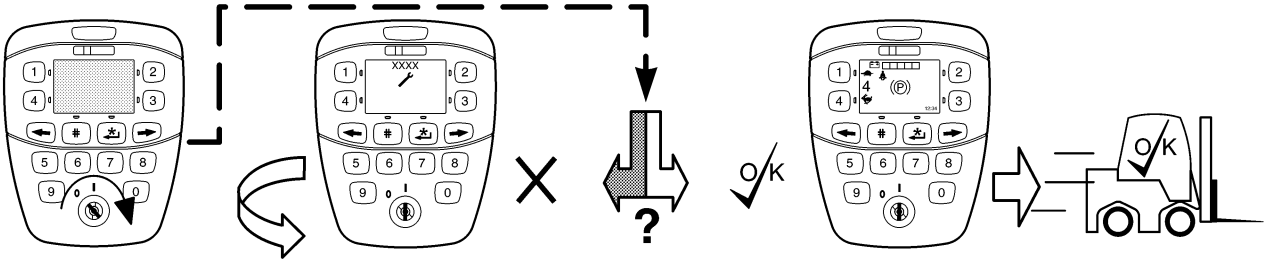
MLM Incorrect Lever Installed (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

END FAULT

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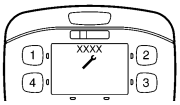
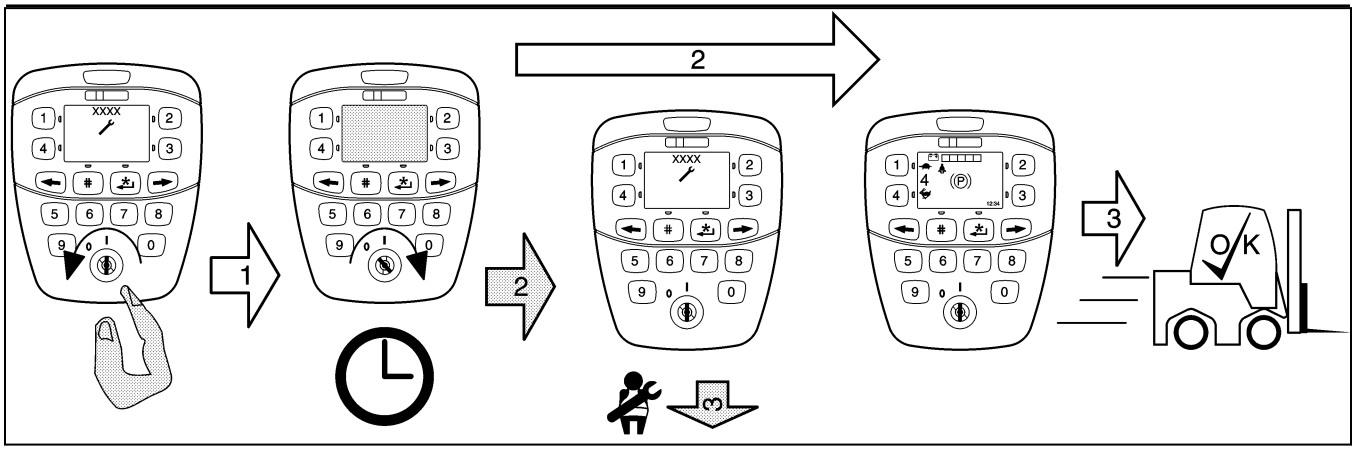
VSM 12 Volts Supply OORL/OORH



DTC 13060 **VSM 12V OORL**

DTC 13061 **VSM 12V OORH**

Fault Codes



Power **OFF**→

Wait **30 seconds**→

Power **ON**→

Fault remains. Service required. Go to Component Operational Check.

No fault→

Resume operation

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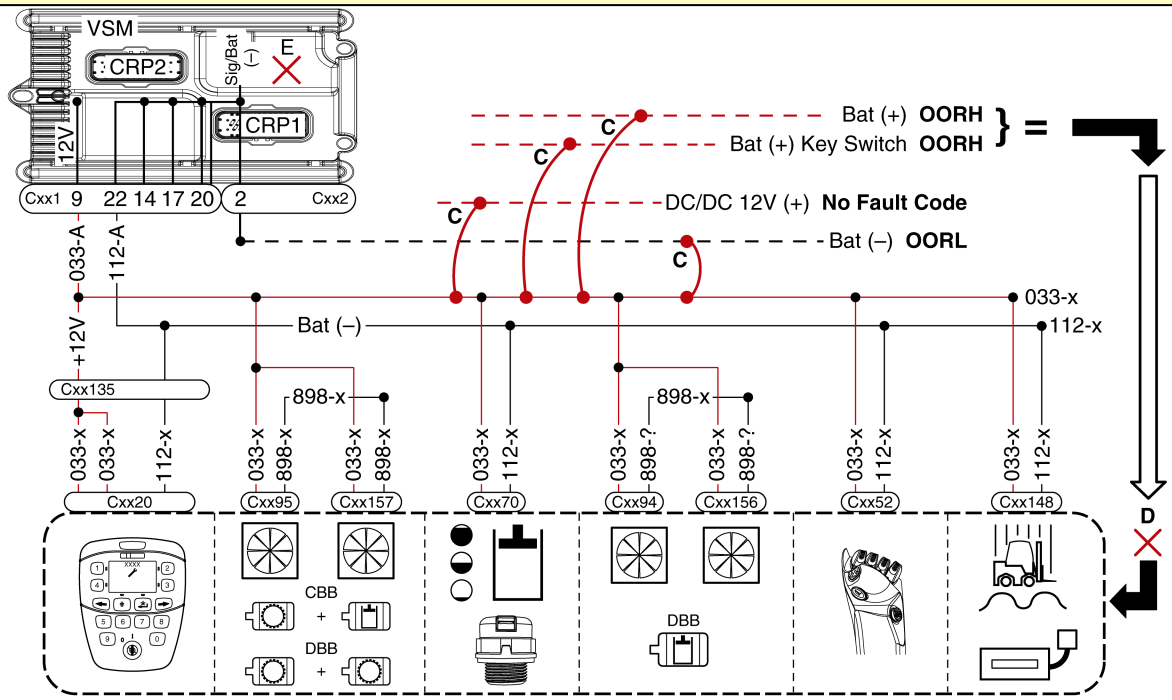
VSM 12 Volts Supply OORL/OORH (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

DBB/CBB 4 WHEEL VSM 12 VOLT SUPPLY CAUSES A B C D E > ?



The addition of Non Approved 12 Volt Devices other than those listed on the schematics may cause an OORL condition

WARNING

No Display Fault Code will be visible for a Short To Battery(+) [STB(+)] OORH condition as the Display will be Inoperative

For a STB (+) Fault Codes will only be visible on the PC Service Tool

Any VSM 12 volt powered Device that is turned on, will be damaged by a STB(+) condition, except for the Display

All VSM 12 volt powered devices will need to be checked for correct operation and probably replaced

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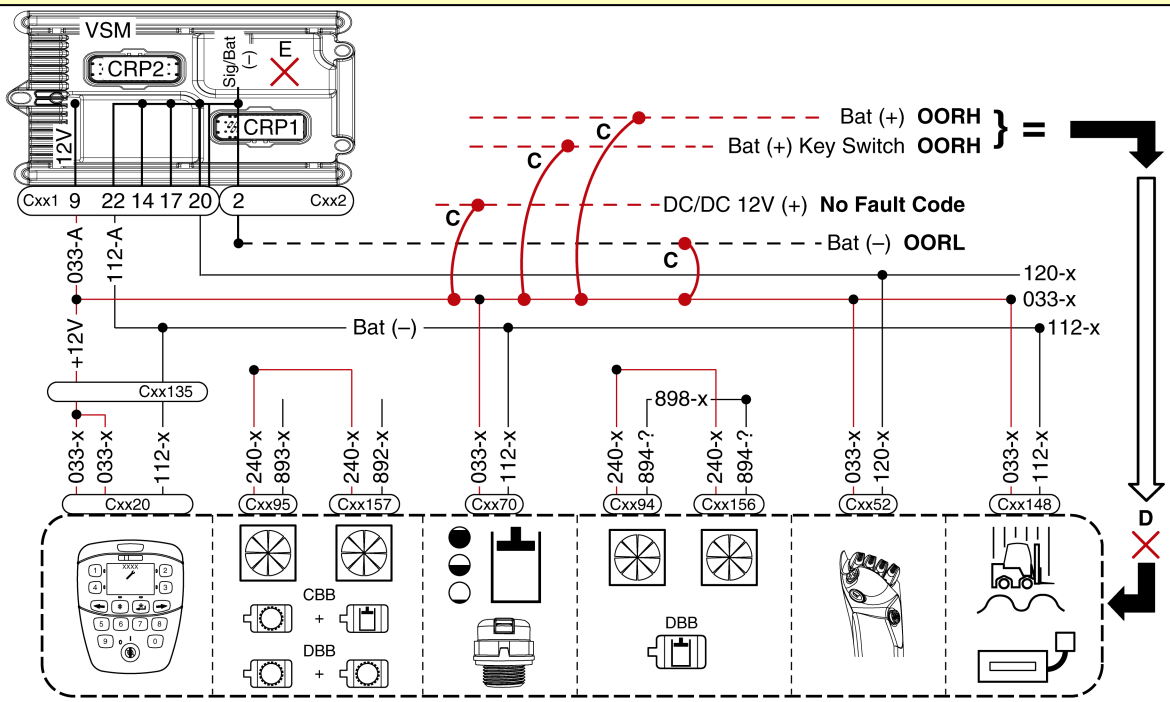
VSM 12 Volts Supply OORL/OORH (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

CBB 3 WHEEL VSM 12 VOLT SUPPLY CAUSES A B C D E > ?



WARNING

No Display Fault Code will be visible for a Short To Battery(+) [STB(+)] OORH condition as the Display will be Inoperative

For a STB (+) Fault Codes will only be visible on the PC Service Tool

Any VSM 12 volt powered Device that is turned on, will be damaged by a STB(+) condition, except for the Display

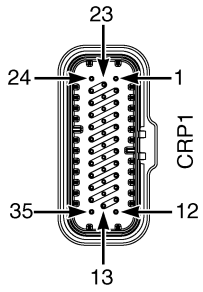
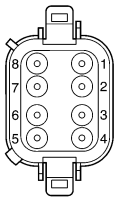
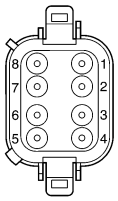
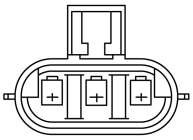
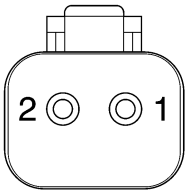
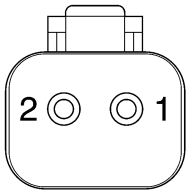
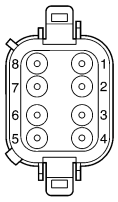
All VSM 12 volt powered devices will need to be checked for correct operation and probably replaced

A Breakout Connection for Cxx 135 is recommended for this TSP. See Table 9030-20-12 for Connector location

VSM 12 Volts Supply OORL/OORH (Cont)

CONNECTORS

Table 9030-20-12. Device Connectors

			
VSM Cxx 1 & 2		Display Cxx 20 &135	MLM Cxx 52
			
Hydraulic Level Cxx 70	Cxx 94 & 156	Cxx 95 & 157	Impact Device Cxx 148

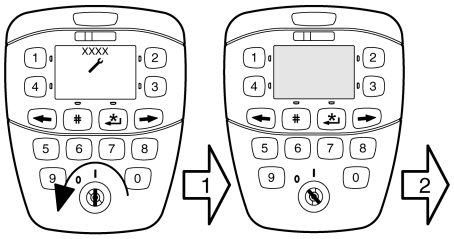
CAUSE A

Not Applicable

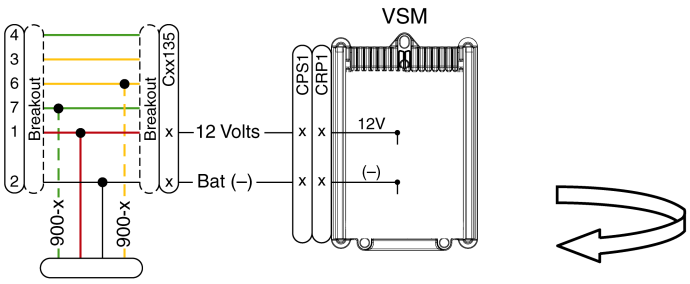
CAUSE B

Not Applicable

CAUSE C



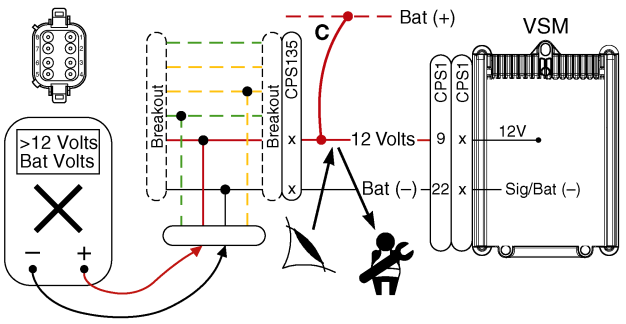
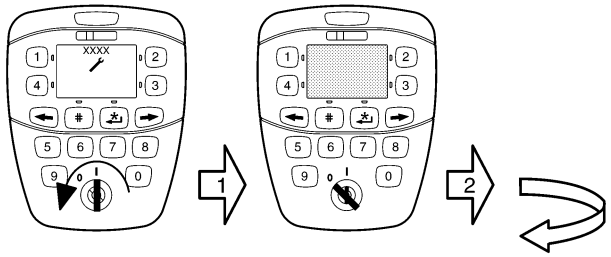
Power **OFF**→

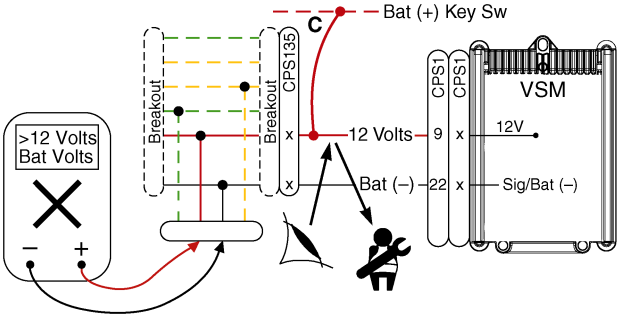
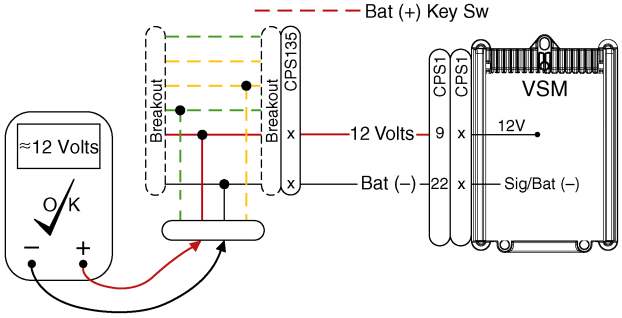


Disconnect Connector Cxx 135 and Install Breakout→

Go to Step C1

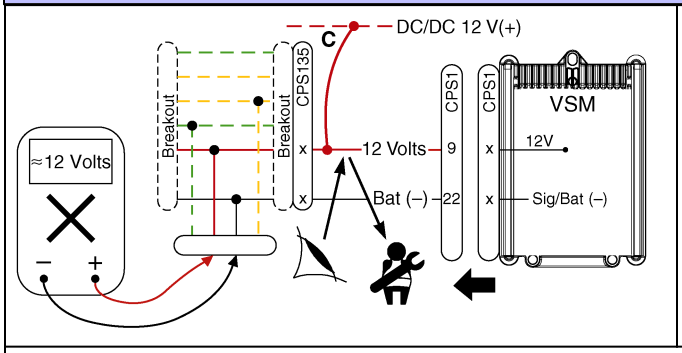
VSM 12 Volts Supply OORL/OORH (Cont)

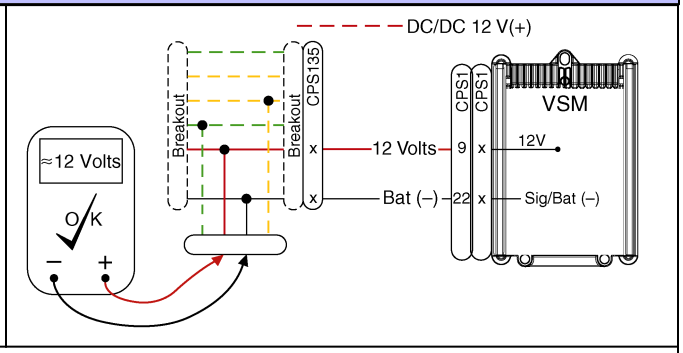
STEP C1	UNSWITCHED VOLTAGES
	
1. ˜ 0 Volts→Step C4↓	
2. ˜ 12 Volts→	Power **ON**→ Go to 2↓
3. ˜ Bat Volts = Short Circuit to Unswitched Bat (+)→Go to 4↓	
4. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck Voltage↑→Reconnect Go to 5↓	
5. Check correct operation of all 12 volt Devices except Display→Component Operational Check↓	

STEP C2	SWITCHED VOLTAGES
	
1. ˜ 12 Volts→	˜ 12 Volts → Step C3, Component Operational Check↓
2. ˜ Bat Volts = Short Circuit to Switch Bat (+)→Go to 3↓	
3. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck Voltage↑→Reconnect Go to 4↓	
4. Check correct operation of all 12 volt Devices except Display→Component Operational Check↓	

VSM 12 Volts Supply OORL/OORH (Cont)

STEP C3





1. Disconnect VSM CPS1

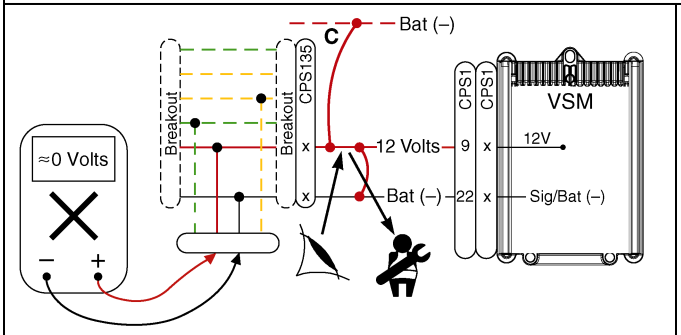
2. ˜ 12 Volts = Short Circuit→DC/DC 12 Volts (+), Go to 3↓

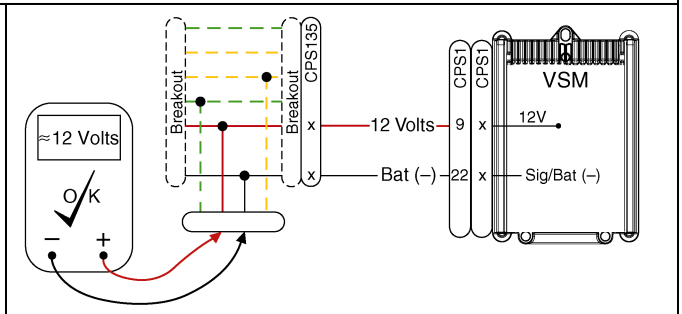
3. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck Voltage↑Fault Remains →Reconnect→Go to 4↓

Check correct operation of all 12 volt Devices except Display→ Component Operational Check ↓

STEP C4

OORL





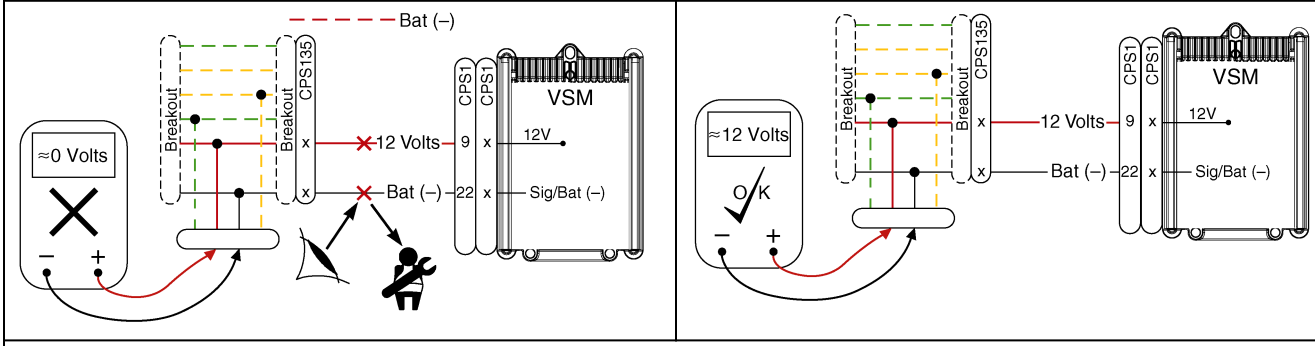
1. ˜ 0 Volts = Short Circuit→Bat (-)→Find/Repair Short Circuit→Go to 2↓

2. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck Voltage↑Fault Remains →Reconnect Cxx 135 →Component Operational Check↓

VSM 12 Volts Supply OORL/OORH (Cont)

STEP C5

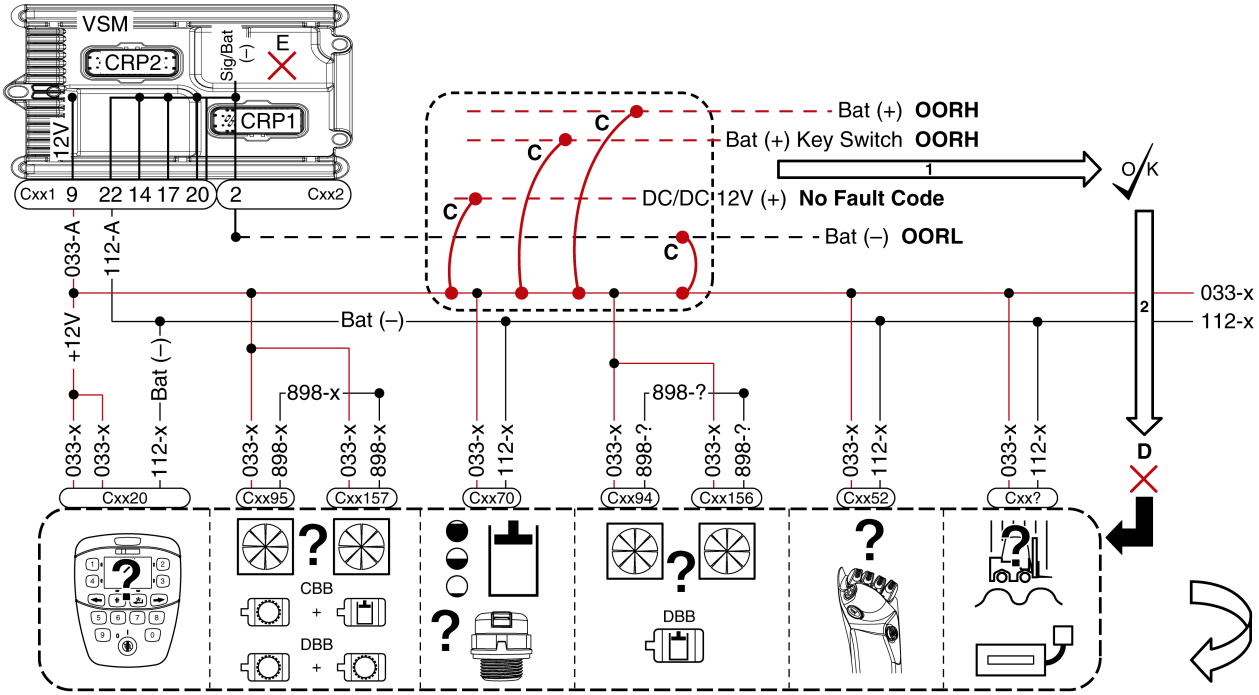
OORL – No 12 volt Device Operation→No Fault Code



1. ˜ 0 Volts = No 12 volt Device operation→This will not Cause a Fault Code

2. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→
ReCheck Voltage↑Fault Remains →Reconnect Cxx 135 →Component Operational Check↓

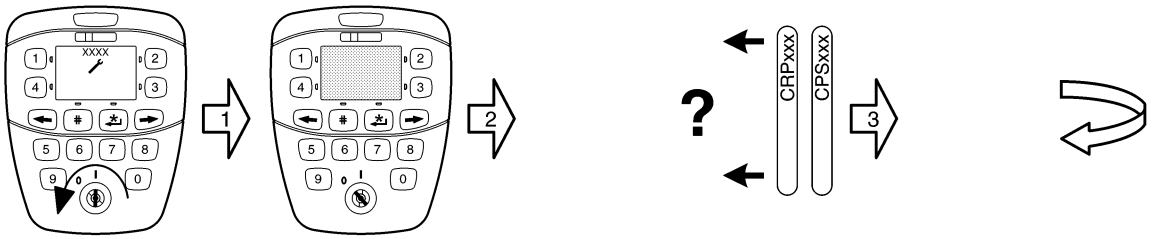
CAUSE D



1. Shorted Devices that are switched on by a control device will not cause a problem until operated by the control device. E,g.. Motor Controller Fans
2. 3 Wheel Fans are not supplied with 12 volts
3. Only approved 12 volt devices are allowed to be connected to this supply

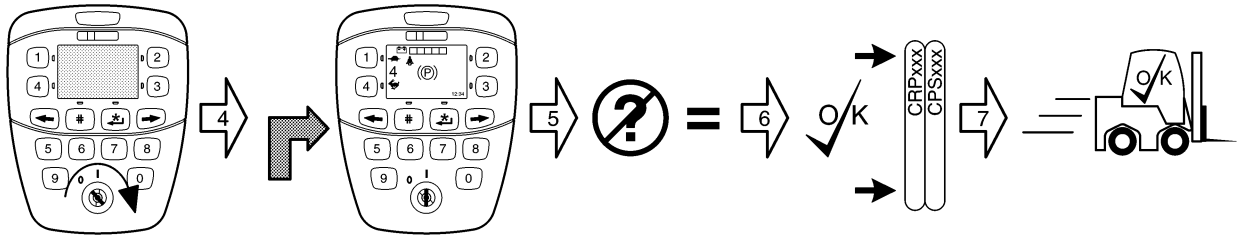
VSM 12 Volts Supply OORL/OORH (Cont)

STEP D1

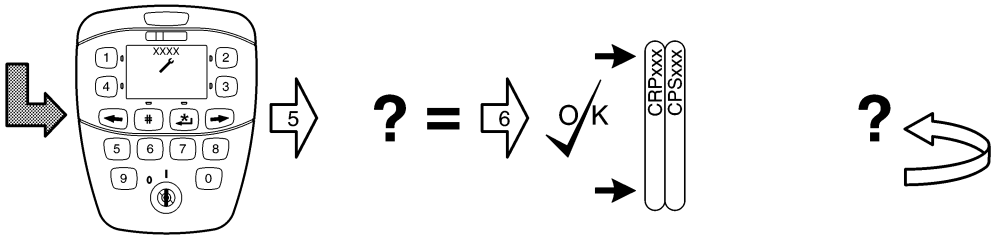


Power **OFF**→ Disconnect 12 volt Device→ **Do Not Discard** Go to Step D2, Component Operational Check

STEP D2



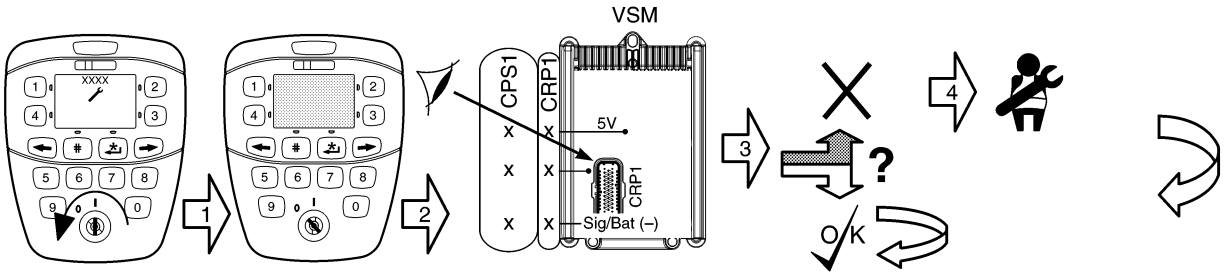
? 12 Volt Fault DTC gone→ Old device faulty→ Old device faulty→Install New Device Resume operation



Original Fault DTC present→ Old Device OK/Reinstall Old Device→ Go to Next Device, Repeat Component Operational Check

All Devices Tested OK, go to Component Operational Check

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Step E1. Not OK Correct/Repair→ Go to Step E1.

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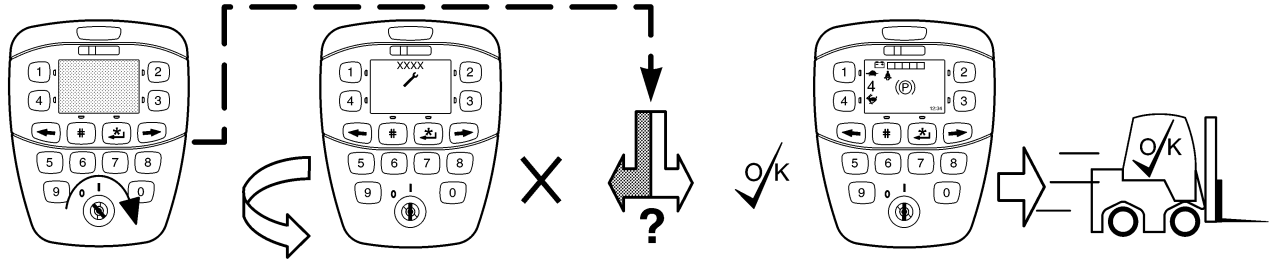
VSM 12 Volts Supply OORL/OORH (Cont)

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

Fault corrected→ Continue operation.

NO ← YES →

END FAULT

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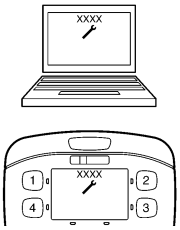
Display Internal Failure



Fault Codes

DTC 22032 Display EEPROM Checksum Error	**DTC 22033 Display Cell Write Error**	**DTC 33056 Display Internal CAN Failure**	**DTC 33057 Display Communi-cations Error with VSM**
DTC 8704 Display Internal LCD Backlight	**DTC 12934 Display Internal LCD Backlight**	**DTC 12935 Display Internal LCD Backlight**	**DTC 8705 Display Internal LCD Heater**
DTC 12936 Display Internal LCD Heater	**DTC 12937 Display Internal LCD Heater**	**DTC 22528 Display Button ***	**DTC 22529 Display Button #**
DTC 22530 Display \ Arrow	**DTC 22531 Display] Arrow**	**DTC 22532 Display Button 1**	**DTC 22533 Display Button 2**
DTC 22534 Display Button 3	**DTC 22535 Display Button 4**	**DTC 22536 Display Button 5**	**DTC 22537 Display Button 6**
DTC 22538 Display Button 7	**DTC 22539 Display Button 8**	**DTC 22540 Display Button 9**	**DTC 22541 Display Button 0**

FAULT LOG CODE Review - Go To Display Review

QUICK CHECK X Open Circuit/Fail) = Short Circuit

Table 9030-20-13. Display Internal Failure Fault DTCs

DTC 22032	Display EEPROM Checksum Error		→ Component Operational Check ↓
DTC 22033	Display Cell Write Error		→ Component Operational Check ↓
DTC 33056	Display Internal CAN Failure		→ Component Operational Check ↓
DTC 33057	Display Communications Error with VSM	→ See CAN Communication TSPs	
DTC 8704	Display Internal LCD Backlight	STB (-)/Current OORH	→ Component Operational Check ↓
DTC 12934	Display Internal LCD Backlight	STB (+)	→ Component Operational Check ↓
DTC 12935	Display Internal LCD Backlight	Open Circuit	→ Component Operational Check ↓
DTC 8705	Display Internal LCD Heater	STB (-)/Current OORH	→ Component Operational Check ↓

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Display Internal Failure (Cont)

Table 9030-20-13. Display Internal Failure Fault DTCs (Continued)

DTC 12936	Display Internal LCD Heater	STB (+)	→ Component Operational Check ↓
DTC 12937	Display Internal LCD Heater	Open Circuit	→ Component Operational Check ↓
DTC 22528	Display Button *	Button Stuck	→ Component Operational Check ↓
DTC 22529	Display Button #	Button Stuck	→ Component Operational Check ↓
DTC 22530	Display \Arrow	Button Stuck	→ Component Operational Check ↓
DTC 22531	Display] Arrow	Button Stuck	→ Component Operational Check ↓
DTC 22532	Display Button 1	Button Stuck	→ Component Operational Check ↓
DTC 22533	Display Button 2	Button Stuck	→ Component Operational Check ↓
DTC 22534	Display Button 3	Button Stuck	→ Component Operational Check ↓
DTC 22535	Display Button 4	Button Stuck	→ Component Operational Check ↓
DTC 22536	Display Button 5	Button Stuck	→ Component Operational Check ↓
DTC 22537	Display Button 6	DTC 33034 Display	→ Component Operational Check ↓
DTC 22538	Display Button 7	Button Stuck	→ Component Operational Check ↓
DTC 22539	Display Button 8	Button Stuck	→ Component Operational Check ↓
DTC 22540	Display Button 9	Button Stuck	→ Component Operational Check ↓
DTC 22541	Display Button 0	Button Stuck	→ Component Operational Check ↓
Note: No Display Visible→ Use PC Service Tool→			Component Operational Check ↓
Note: No DTC on PC Service Tool→ Possible Key Switch Failure→			Component Operational Check ↓

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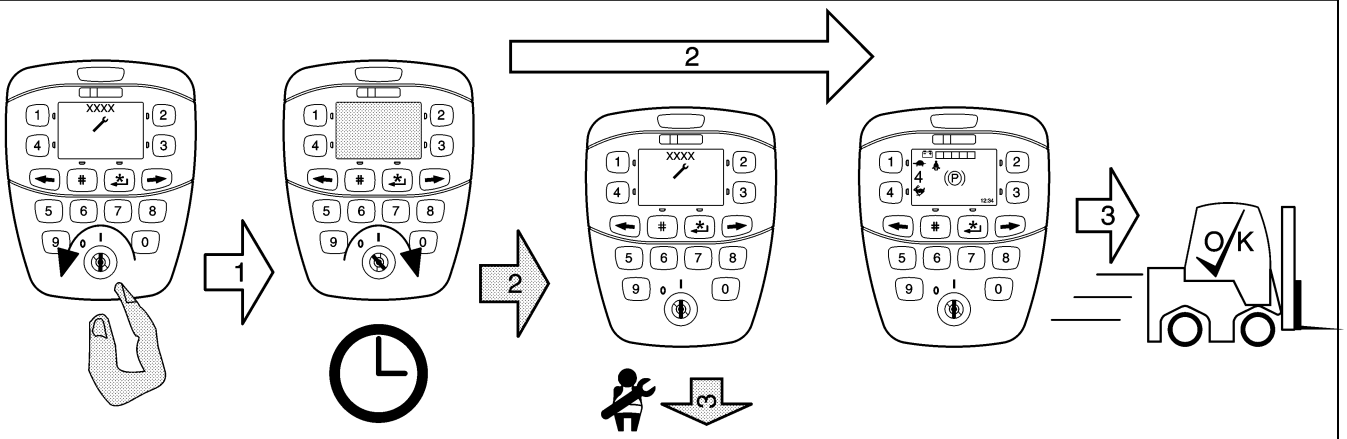
Display Internal Failure (Cont)

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains Service required Go to Check 2↓	No fault→ Resume operation

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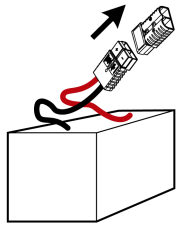
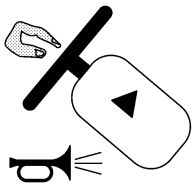
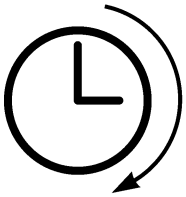
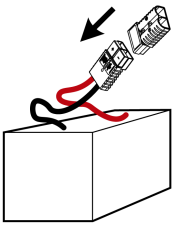
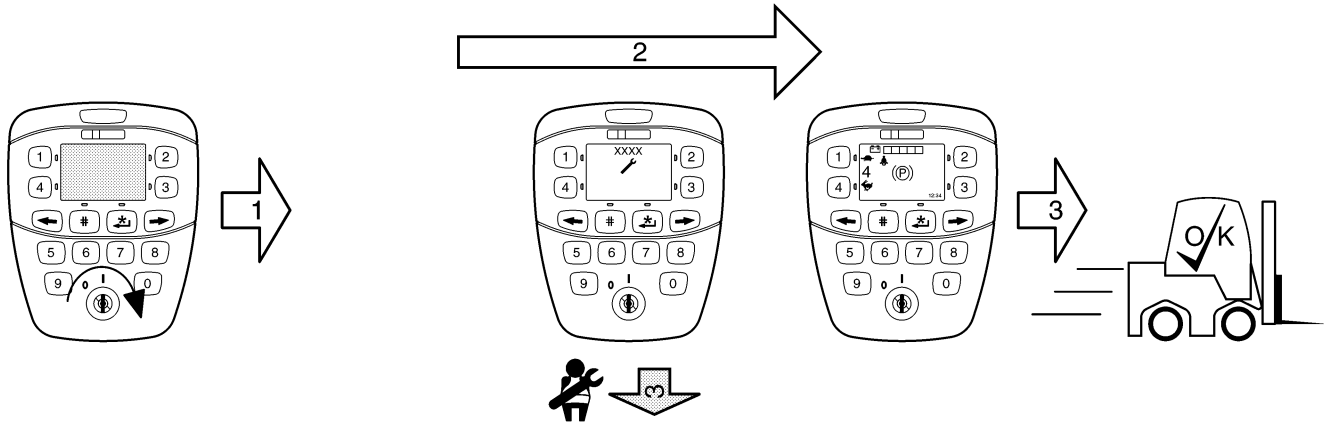
Display Internal Failure (Cont)

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 2

			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery



Power **ON**→ Fault Remains Service Required→ No Fault→ Resume Operation

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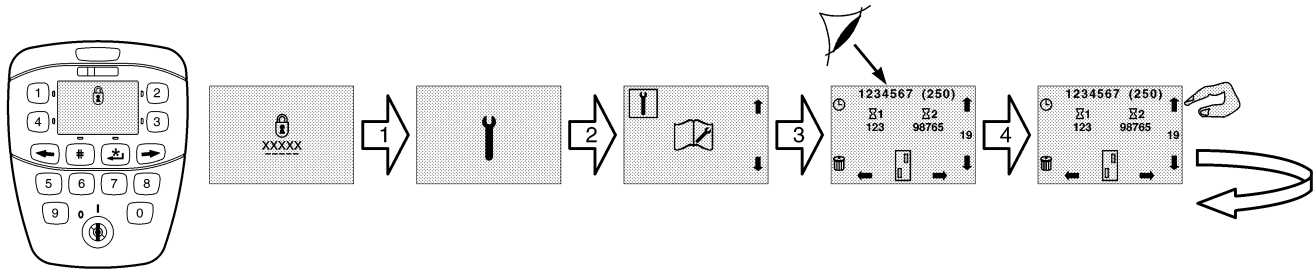
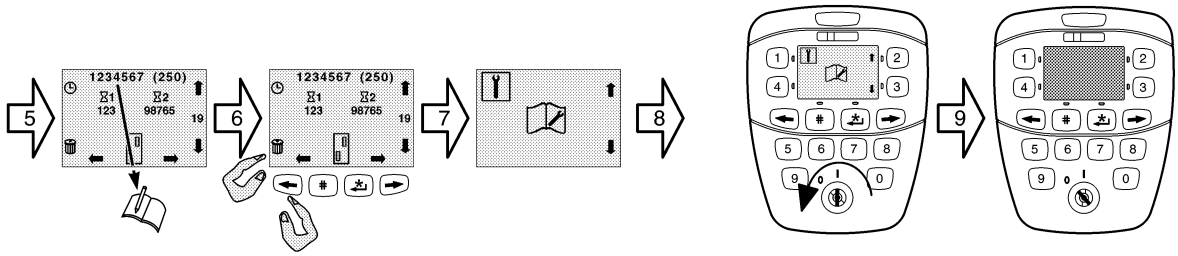
Display Internal Failure (Cont)

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 3



Enter SERVICE Password→	Diagnostics→	FAULT LOGs→	Display FAULT LOGs→	View all Display DTCs→ ?



all Display DTCs→	Erase all Display DTCs→ Exit Fault Log	Power **OFF**→ Component Operational Check

CAUSE A

Not Applicable

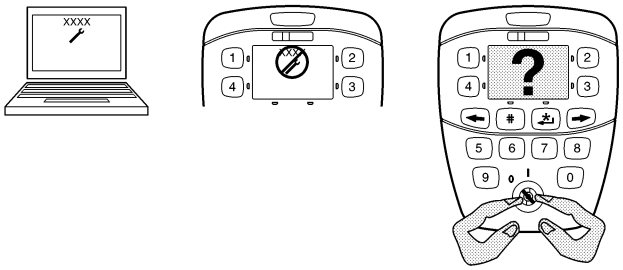
CAUSE B

Not Applicable

CAUSE C

Not Applicable

CAUSE D



1. No Display/No PC DTCs→Possible Keyswitch Failure↓
2. Keyswitch Mechanical Operation Indicates Binding/No Turn↓
3. YES→Replace Keyswitch Barrel↓NO→Step D1↓
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

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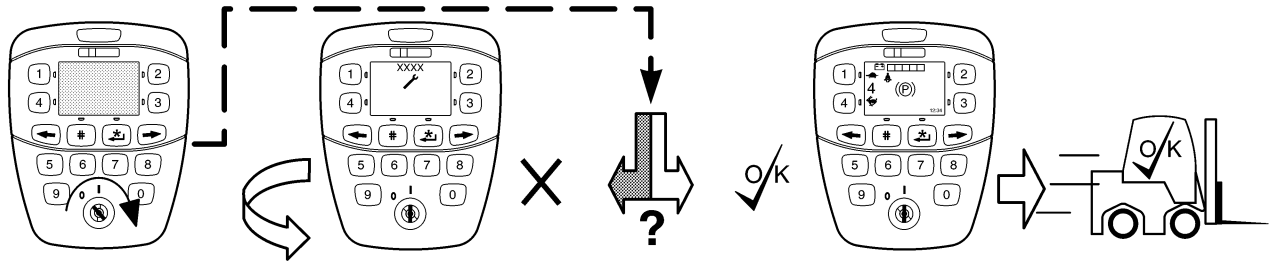
Display Internal Failure (Cont)

STEP D1



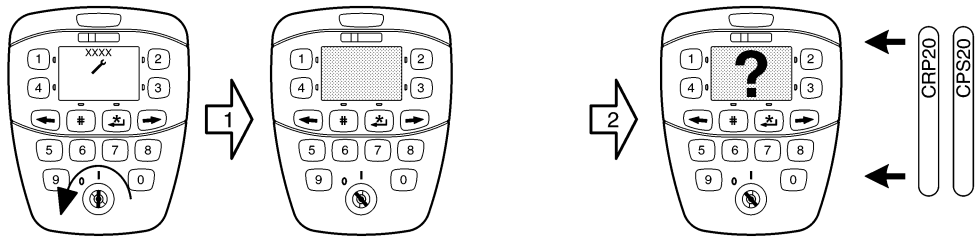
Retest - Power **ON**→ **NO** → Step D2

Does Display Turn On? Fault corrected→ Continue operation.

Is DTC gone?

NO YES ← →

STEP D2



Power **OFF**→	Disconnect Display→ Do not Discard→	Step D3 ↓

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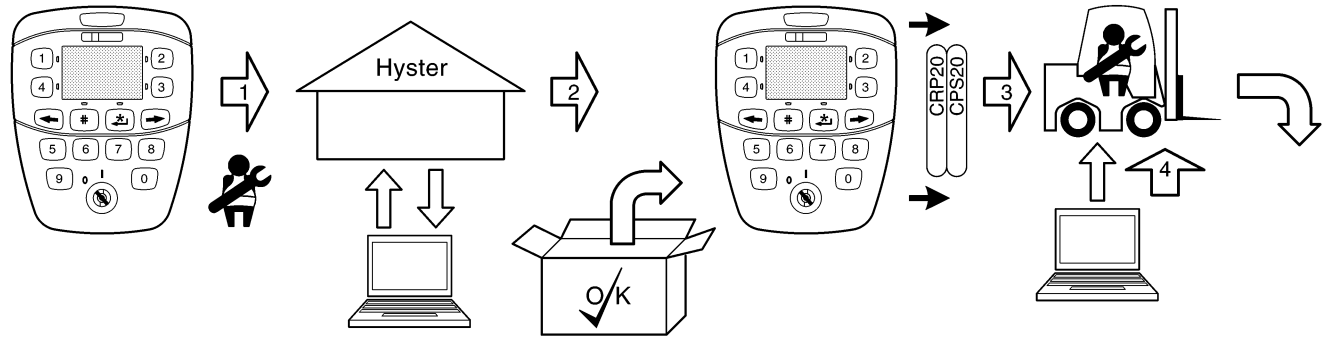
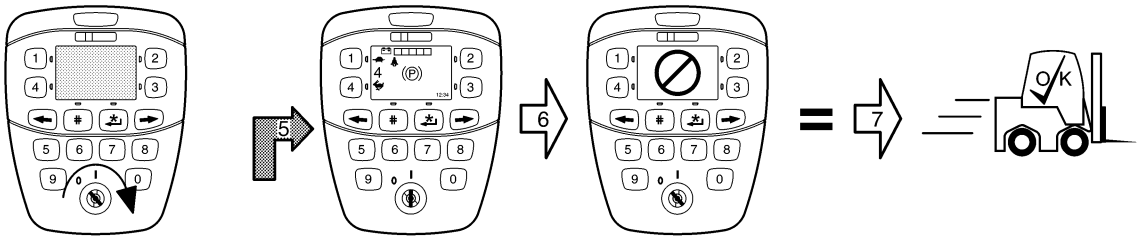
Display Internal Failure (Cont)

STEP D3



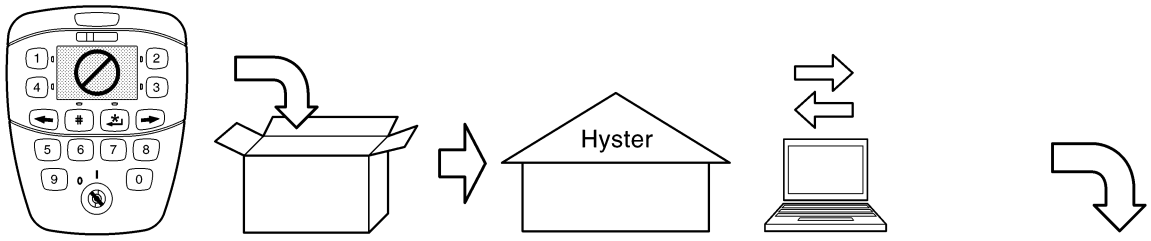
1. Download the latest **Display Application** Version→Install NEW Display→Install NEW Application →Go to 2↓

2. See **Hypass Online**, Software Resources for your truck, (Installing Display Application Software)↓



Power **ON**→ **?**	DTC Gone→	Original Display Faulty→	Resume Operation

New DTC Present→	DTC TSP↓



Return Faulty Display→ Dealer→ Factory→ Failure Analysis→ ?? Reprogramming

END FAULT

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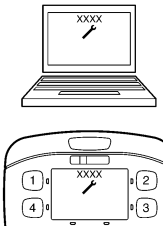
Display Failure – Keyswitch Relay Output

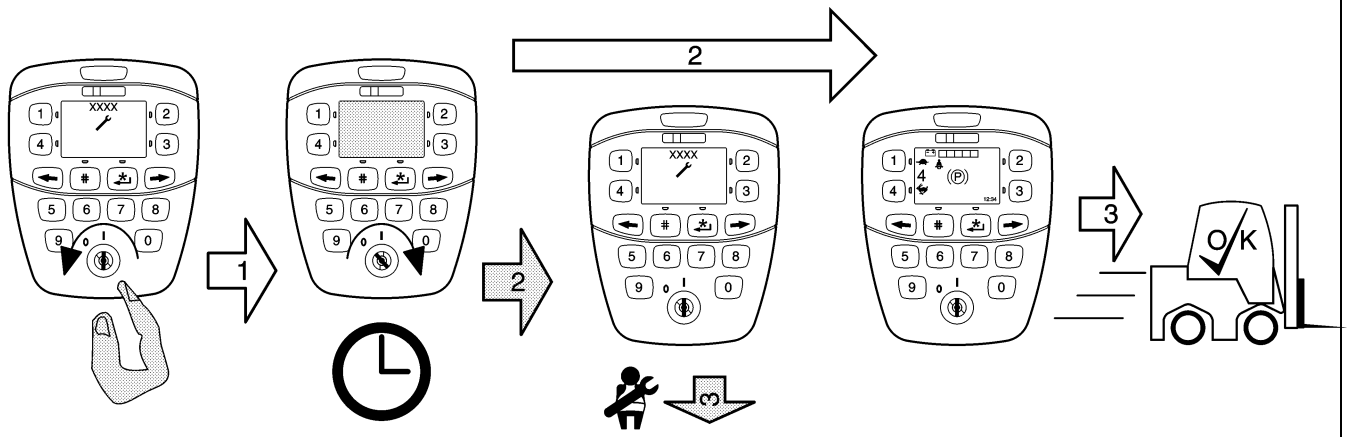


Fault Codes

DTC 9041	DTC 12940	DTC 12941	DTC 13070
Display Keyswitch Output	Display Keyswitch Output	Display Keyswitch Output	Keyswitch Data Incorrect

FAULT LOG CODE Review - Go To Display Review			
QUICK CHECK X Open Circuit/Fail) = Short Circuit			
DTC 9041	Display Keyswitch Output	STB (-)/Current OORH	→ Component Operational Check ↓
DTC 12940	Display Keyswitch Output	STB (+)	→ Component Operational Check ↓
DTC 12941	Display Keyswitch Output	Open Circuit	→ Component Operational Check ↓
DTC 13070	Display Keyswitch Data Incorrect	STB (+)	→ Component Operational Check ↓
Note: No Display Visible→ Use PC Service Tool→			Component Operational Check ↓
Note: No DTC on PC Service Tool→ Possible Key Switch Failure→			Component Operational Check ↓
QUICK CHECK X = Open Circuit/Fail) = Short Circuit			

Check 1



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains Service required Go to Check 2↓	No fault→ Resume operation

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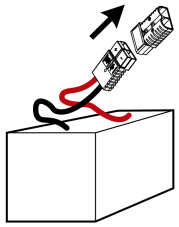
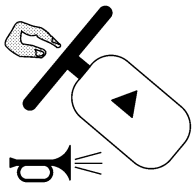
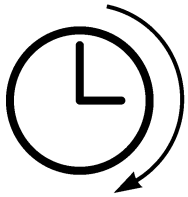
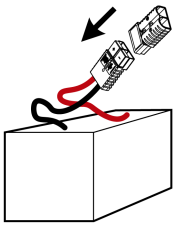
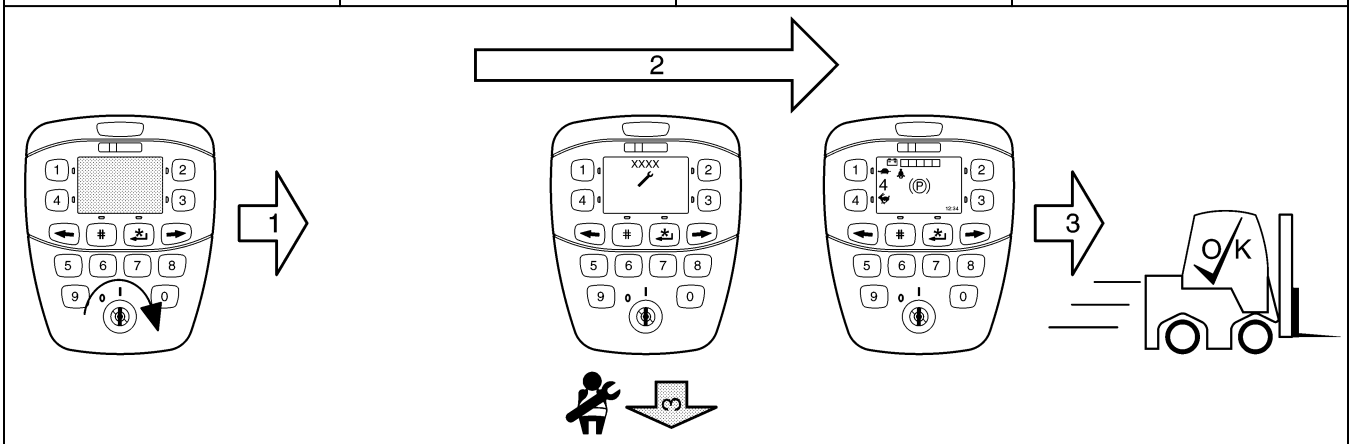
Display Failure – Keyswitch Relay Output (Cont)

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 2

			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery



Power **ON**→	Fault Remains Service Required→	No Fault→ Resume Operation

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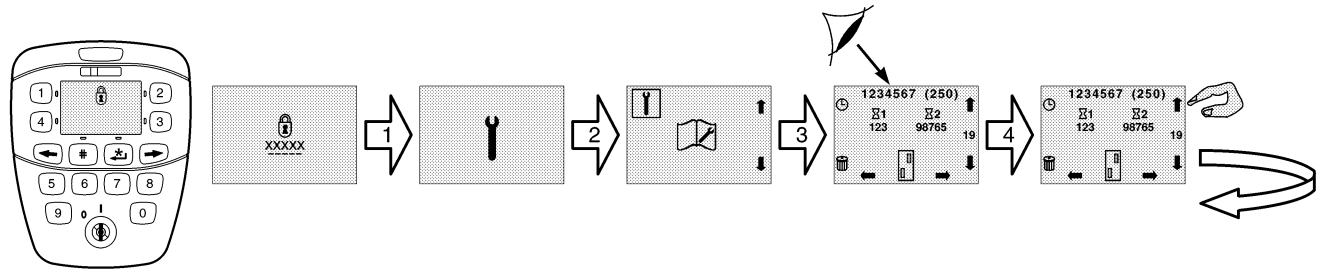
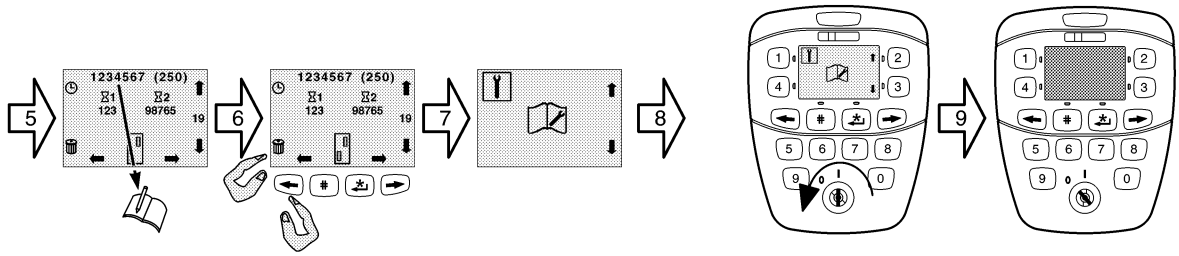
Display Failure – Keyswitch Relay Output (Cont)

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 3



Enter SERVICE Password→	Diagnostics→	FAULT LOGs→	Display FAULT LOGs→	View all Display DTCs→ ?



✍ all Display DTCs→	Erase all Display DTCs→ Exit Fault Log	Power **OFF**→ Component Operational Check

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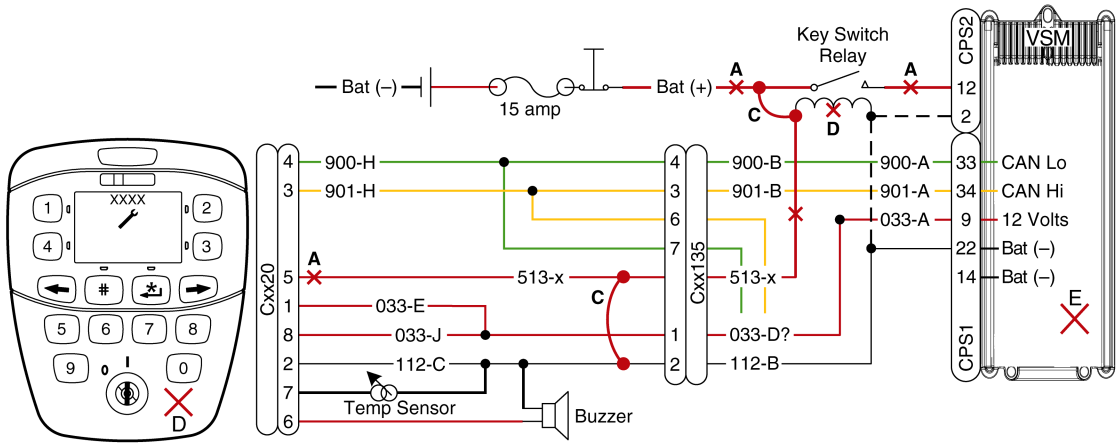
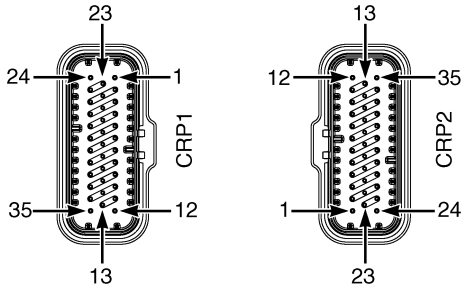
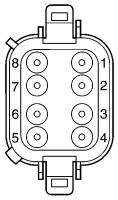
Display Failure – Keyswitch Relay Output (Cont)

CONNECTORS

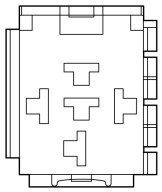




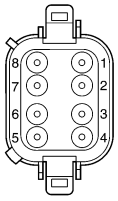
VSM Cxx 1 and Cxx 2



Display Cxx 20



Key Switch Relay Connector Cxx 208

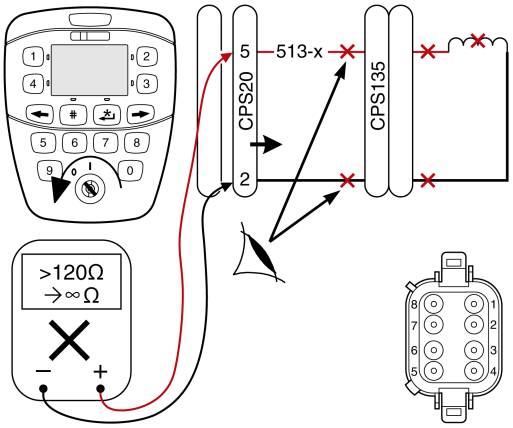


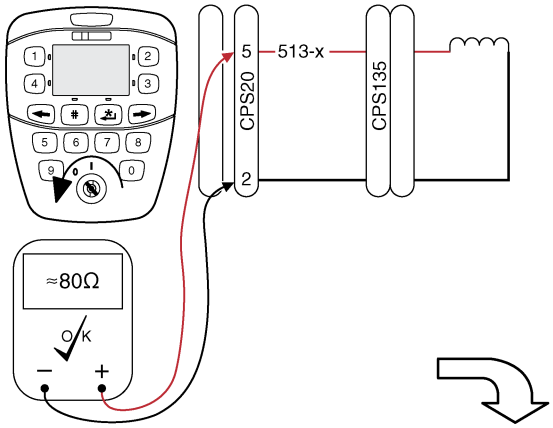
Display Cxx 135

Display Failure – Keyswitch Relay Output (Cont)

CAUSE A

DTC 12941 Key Switch Relay OC

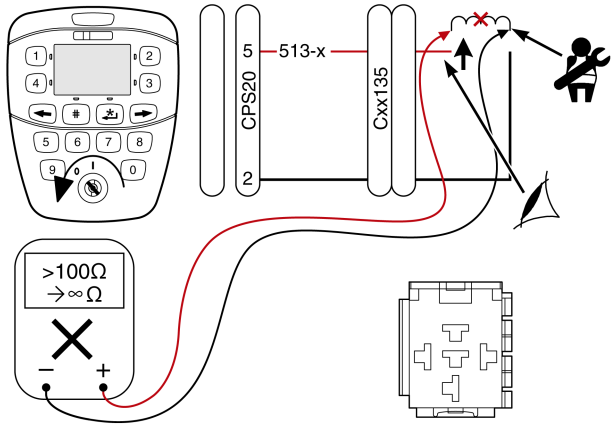


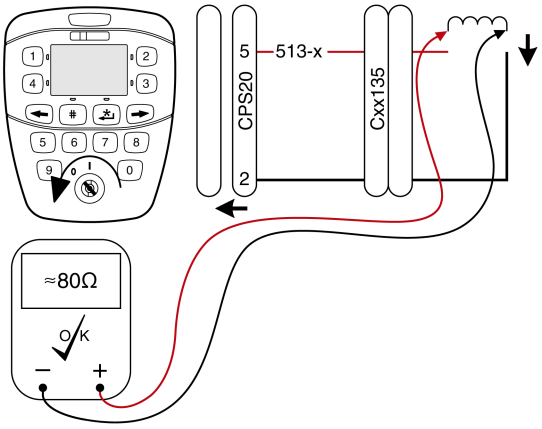


Remove Display and Disconnect Display Connector→ Measure ?→ Go to 1↓

1. > 100? to 8? = High Resistance/Open Circuit→Go to Step A2↓	1. ˜80? = OK→Step A5↓
2. < ˜60? to 0? = Short Circuit→Component Operational Check↓	2. ˜80? = OK→Step A5↓

STEP A1





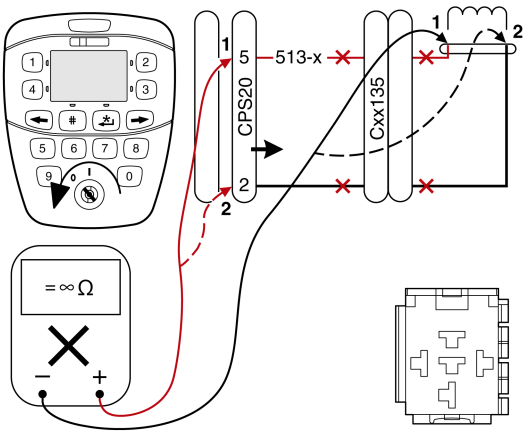
Remove 12 Volt Relay→ Measure ?→ Go to 1↓

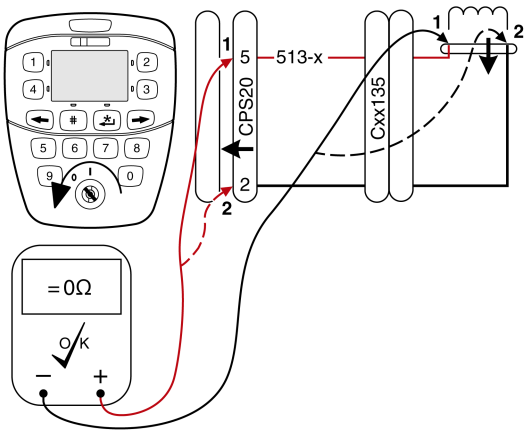
1. > 100? to 8? = High Resistance/Open Circuit→Go to 3↓	1. ˜80? = OK→Step A3↓
2. < ˜60? to 0? = Short Circuit→Go to 3↓	2. ˜80? = OK→Step A3↓

3. Relay Coil OPEN/SHORT Circuit→Replace Relay→ReCheck ?↑Step A1→Reconnect Display→Step A4↓

Display Failure – Keyswitch Relay Output (Cont)

STEP A2



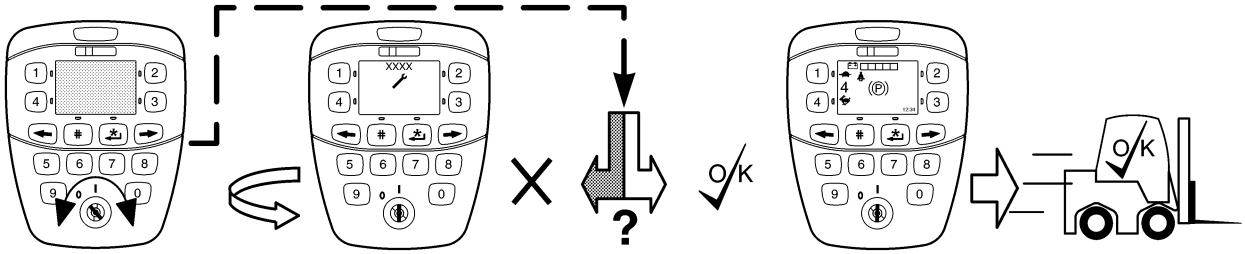


Measure ?→ Go to 1↓

1. 8? = High Resistance/Open Circuit→Go to 2↓	1. ˜0? = OK→Step A4↓

2. Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check ?↑Step A1→Reconnect→Step A4↓

STEP A3



Retest - Power **OFF** Power **ON**

NO → Step A4

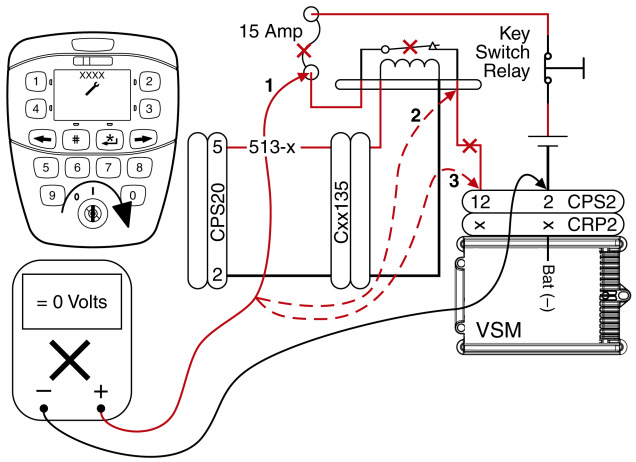
Is fault DTC gone?

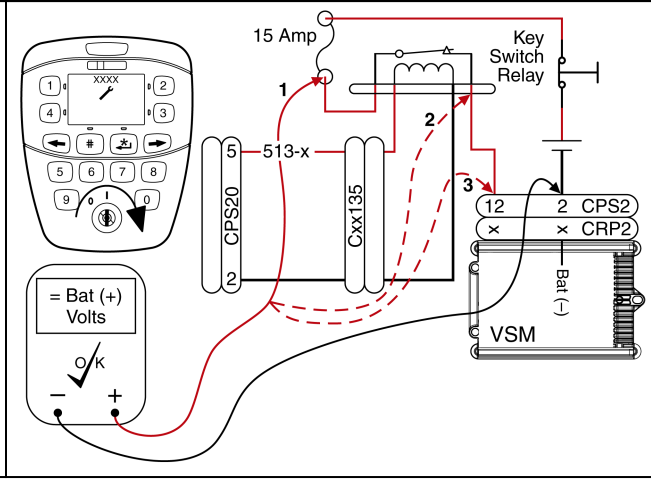
NO YES

Fault corrected→ Continue operation

Display Failure – Keyswitch Relay Output (Cont)

STEP A4





CAUTION

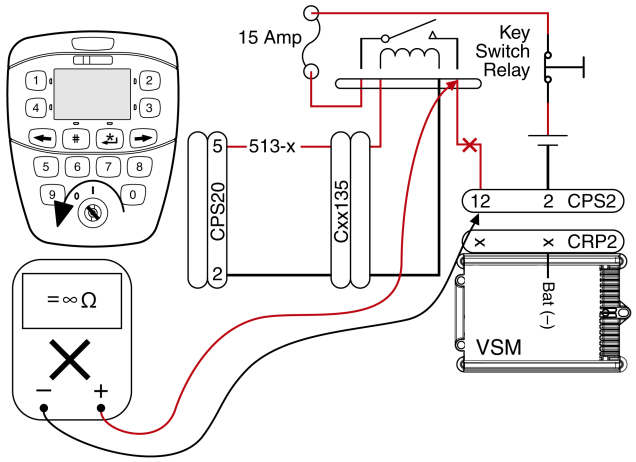
Do not backprobe VSM connector if Breakout Connectors are available. See Step A6 for Alternative to 3.

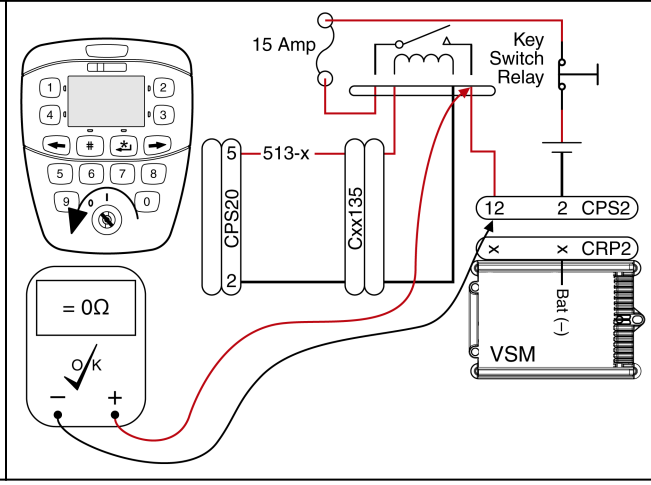
1. Turn Key Switch **ON**→Measure Volts at 1, 2, and 3→Go to 2↓

2. 0 Volts→Open Circuit Fuse/Wiring/Relay Contacts→Go to 3↓	2. ˜ Bat (+) Volts = OK→Step A6↓

3. Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check Volts↑Step A5→Reconnect→Step A6↓

STEP A5





Turn Key Switch **OFF**→ Disconnect Relay and VSM CPS 2→ Measure ?→ Go to 1↓

1. = 8?→Open Circuit Wiring→Go to 2↓	1. ˜ 0? = OK→Step A6↓

2. Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check ?↑Step A1→Reconnect→Step A6↓

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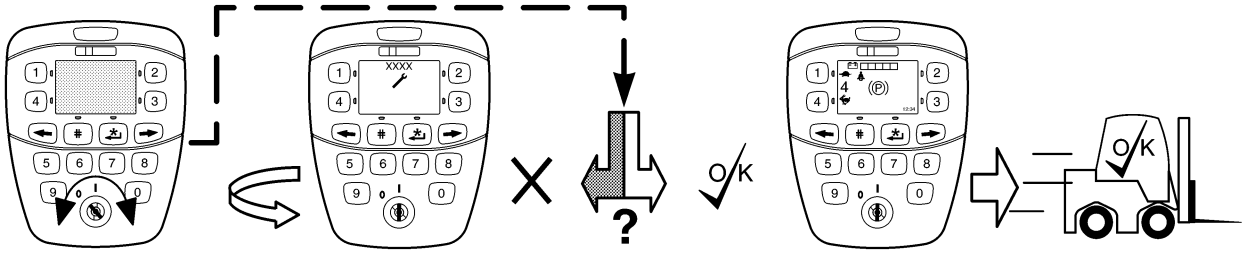
Display Failure – Keyswitch Relay Output (Cont)

STEP A6



Retest - Power **OFF** Power **ON**

NO → Component Operational Check

Is fault DTC gone?

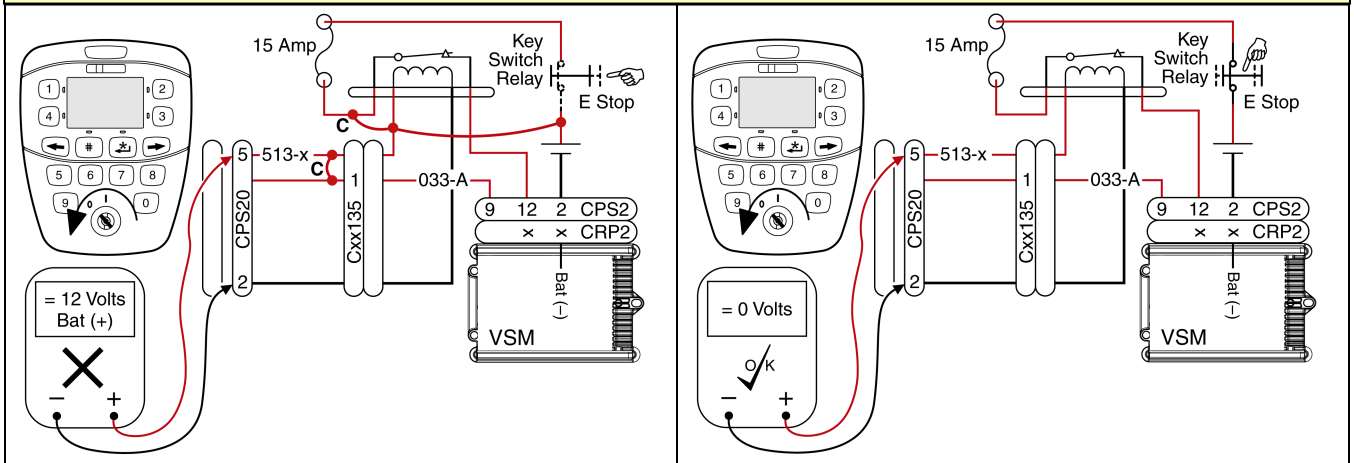
Fault corrected→ Continue operation

NO YES →

CAUSE B

Not Applicable

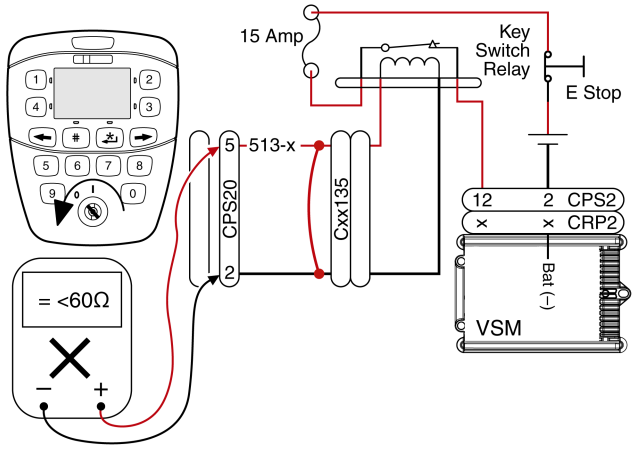
CAUSE C

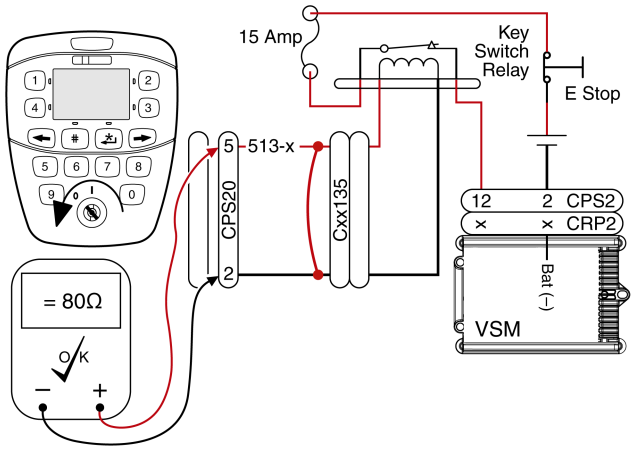


1. Turn Key Switch **OFF**→Push Emergency Stop→Remove Display and Disconnect→Measure Volts→Go to 2↓	
2. ˜ Bat (+) Volts = Short to Unswitched Bat (+) →Go to 6↓	2. 0 Volts = OK→Go to 3↓
3. Release Emergency Stop→Go to 4↓	
4. ˜ 12 Volts = Short to VSM 12 Volt Supply→Go to 6↓	4. 0 Volts = OK→Step C1↓
5. ˜ Bat (+) Volts = Short to Switched Bat (+) →Go to 6↓	
6. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check Volts↑→Reconnect→↓	

Display Failure – Keyswitch Relay Output (Cont)

STEP C1



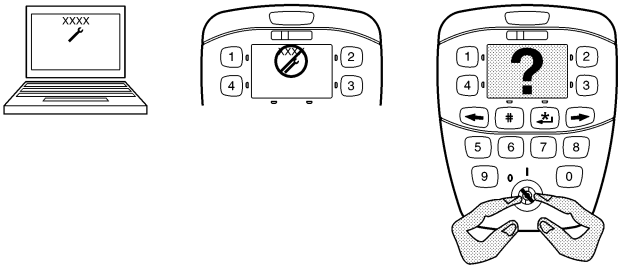


1. Turn Key Switch **OFF**→Measure ?→Go to 2↓

2. < ˜60? = Short Circuit →Go to 3↓	2. ˜ 80? = OK→Component Operational Check↓

3. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check ?↑→Reconnect→Component Operational Check↓

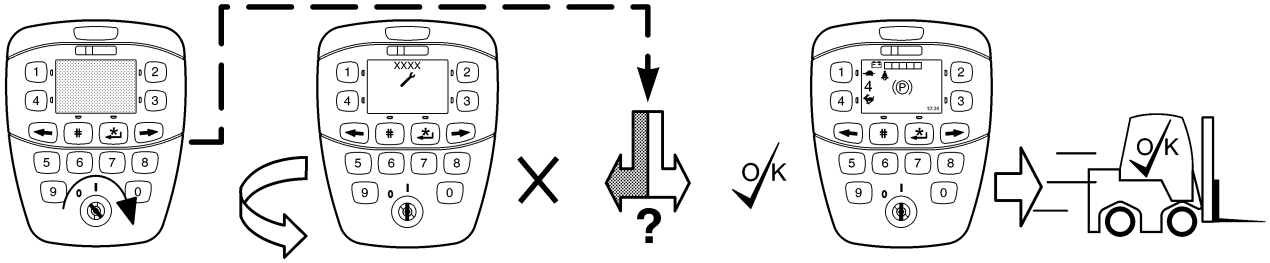
CAUSE D



1. No Display/No PC DTCs→Possible Keyswitch Failure↓
2. Keyswitch Mechanical Operation Indicates Binding/No Turn↓
3. YES→Replace Keyswitch Barrel↓NO→Step D1↓
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Display Failure – Keyswitch Relay Output (Cont)

STEP D1



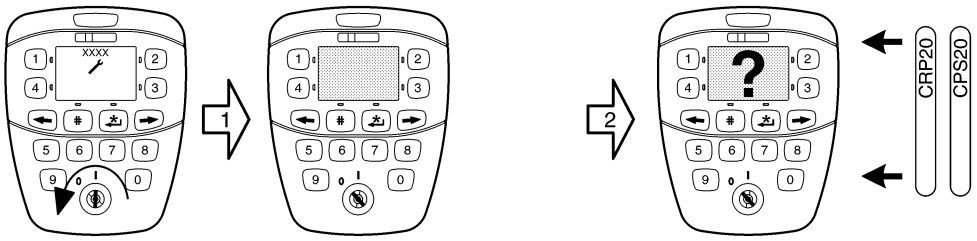
Retest - Power **ON**→ **NO** → Step D2

Does Display Turn On? Fault corrected→ Continue operation.

Is DTC gone?

NO YES ← →

STEP D2



Power **OFF**→	Disconnect Display→ Do not Discard→	Step D3 ↓

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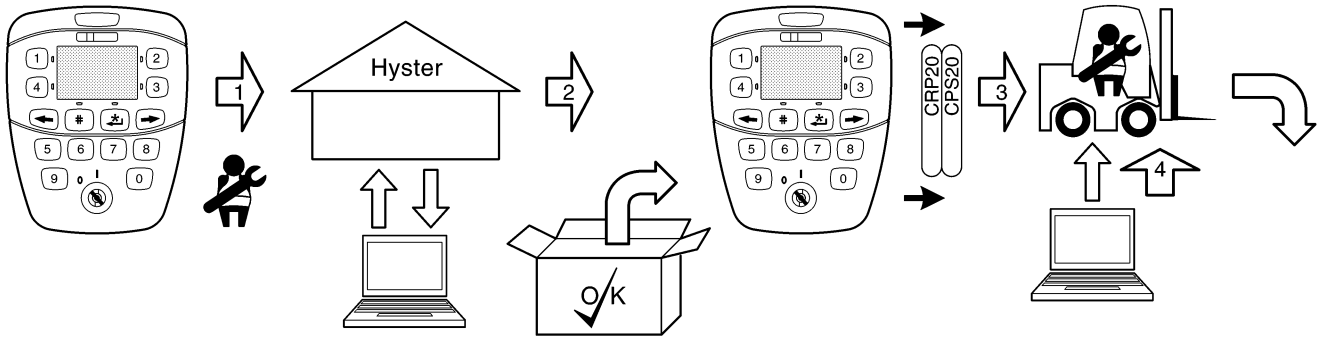
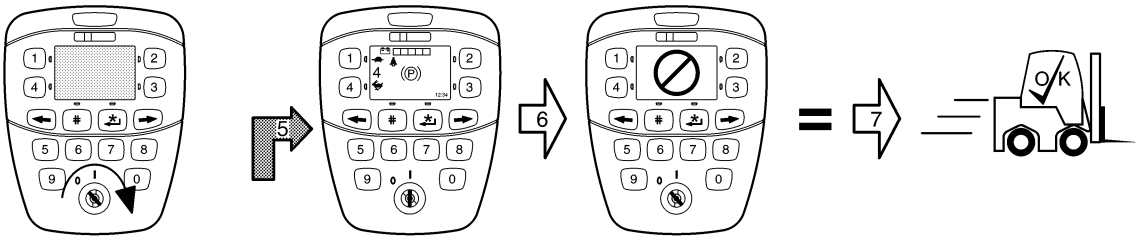
Display Failure – Keyswitch Relay Output (Cont)

STEP D3



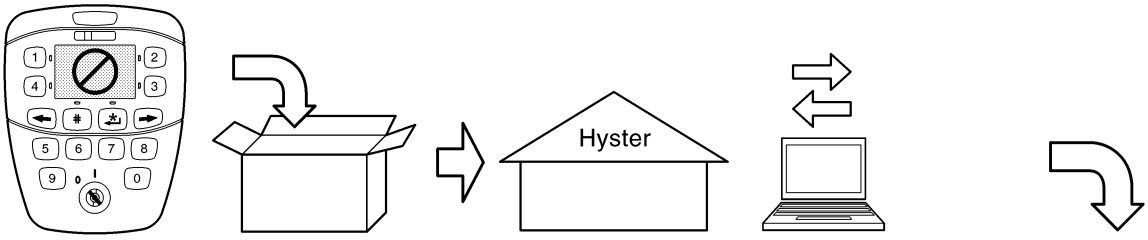
1. Download the latest **Display Application** Version→Install NEW Display→Install NEW Application →Go to 2↓

2. See **Hypass Online**, Software Resources for your truck, (Installing Display Application Software)↓



Power **ON**→ **?**	DTC Gone→	Original Display Faulty→	Resume Operation

New DTC Present→	DTC TSP↓



Return Faulty Display→ Dealer→ Factory→ Failure Analysis→ ?? Reprogramming

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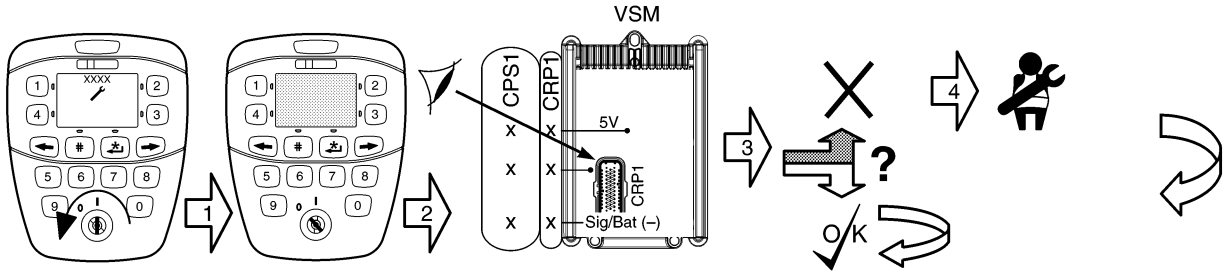
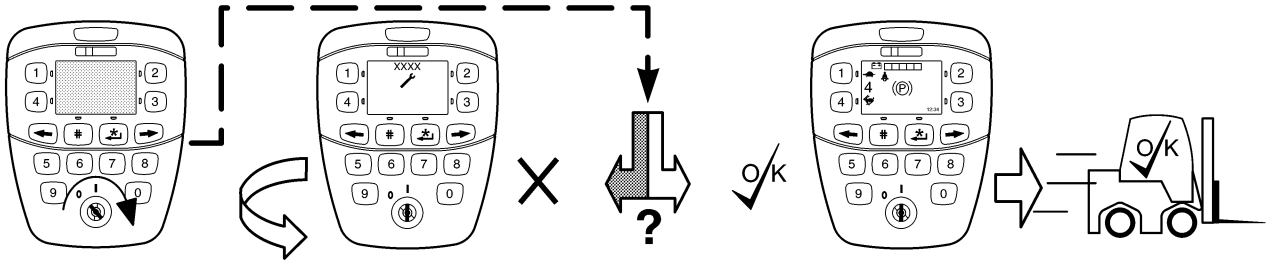
Display Failure – Keyswitch Relay Output (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Step E1. Not OK Correct/Repair→ Go to Step E1.

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is DTC gone? Fault corrected→ Continue operation.

NO YES ← →

END FAULT

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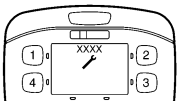
VSM Controller Check



Fault Codes

DTC 21760
VSM BOOT_BLOCK

Checksum failure

DTC 21761
CDF_Check-sum_failure

DTC 21762
VSM APPLICA-TION_SOFT-WARE Checksum failure/Error

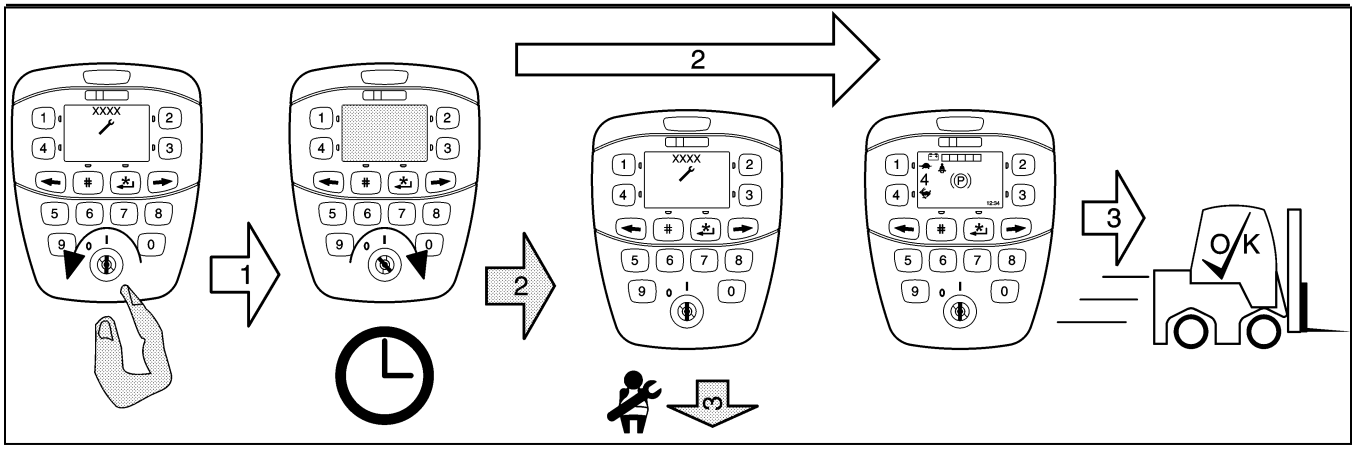
DTC 21764
VSM EEPROM Checksum

failure/Error

DTC 21766
VSM EEPROM Cell fail-ure

Write Error

DTC 21792
VSM Serial Num-ber Error



Power **OFF**→ | Wait **30 sec-onds**→ | Power **ON**→ | Fault remains. Service required. Go to Quick Check. | No fault→ | Resume operation

QUICK CHECK X Open Circuit/Fail) = Short Circuit

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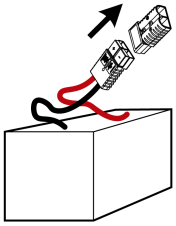
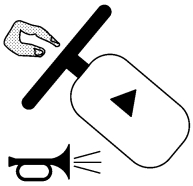
VSM Controller Check (Cont)

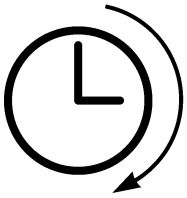
Check 1



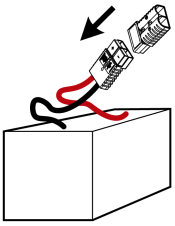
Disconnect Battery



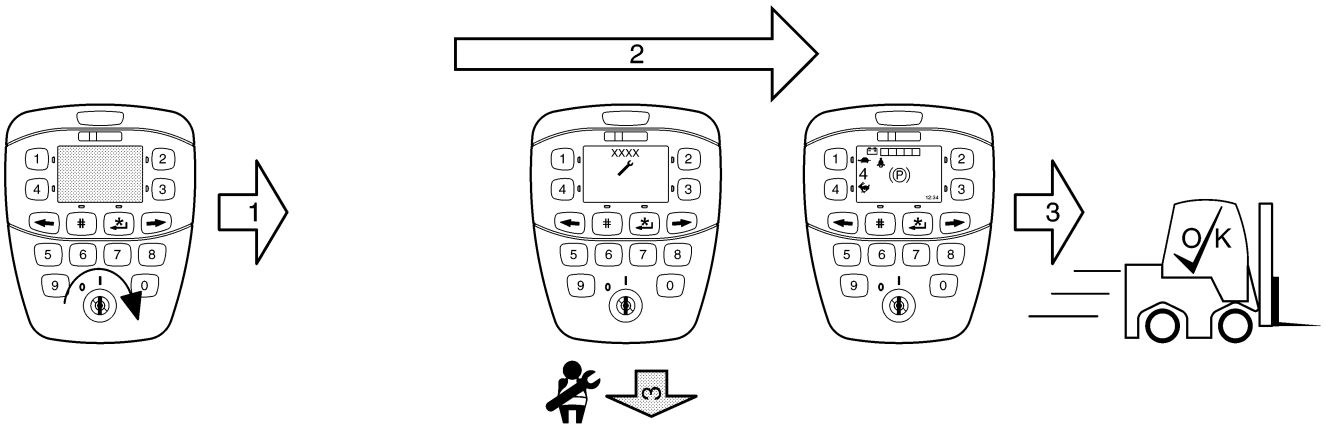
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.



Wait 30 seconds

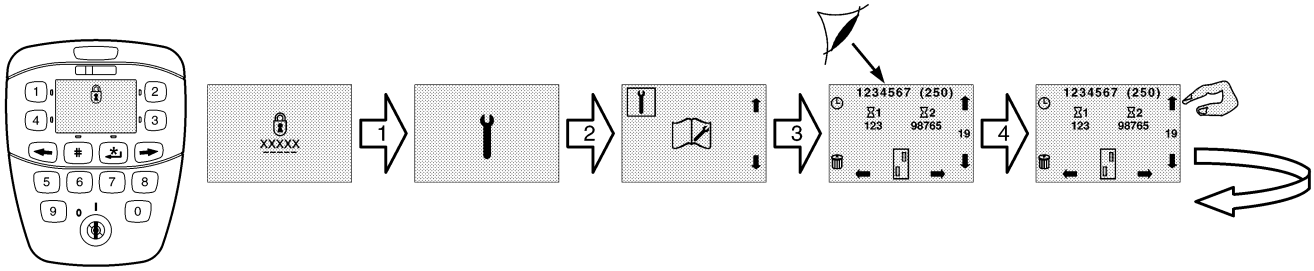


Reconnect Battery



Power **ON**→	Fault remains, Service required→ Go to Check 2↓	No fault→ Resume operation

Check 2



Enter Service Password→ Diagnostic→ FAULT LOGs→	VSM Fault Logs View all VSM DTCs→ Go to next step↓

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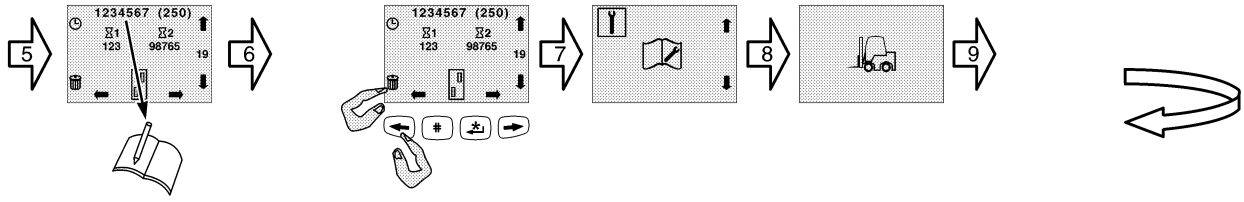
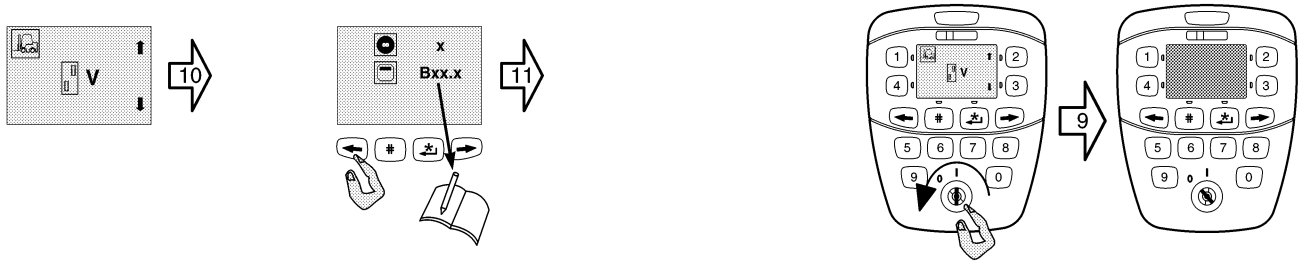
VSM Controller Check (Cont)



☰✍ all VSM DTCs	Erase all VSM DTCs→ ☜Exit Fault Log→	Truck Status



VSM Versions→	☰✍ Hardware/Software Versions→ ☜Exit Versions	Power **OFF**→ Go to Next Step↓

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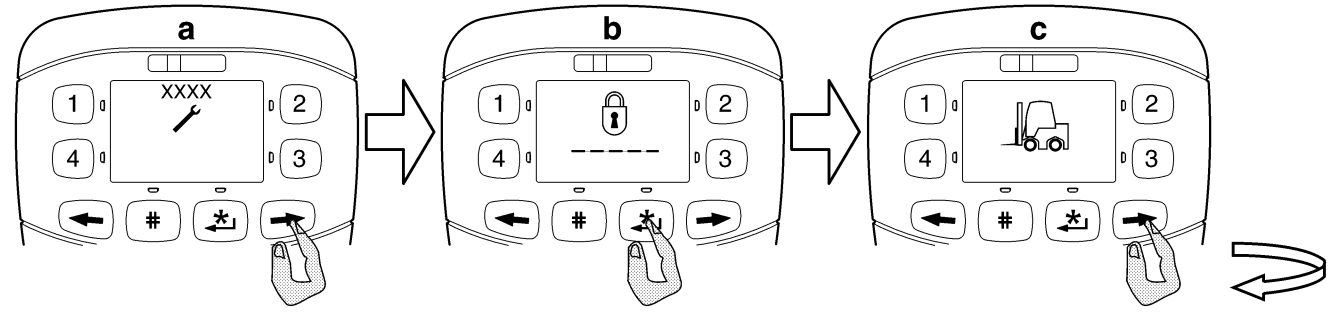
VSM Controller Check (Cont)

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

DTCs 21792→ Step 1 VSM has been installed from another truck
DTCs 21792→ Step 1 Display has been installed from another truck
DTCs 21761→ Step 3, Step 1→ Reprogram CDF
DTCs 21762→ Step 4, Step 1→ Reprogram Application Software
DTCs 21760, 21764, 21766→ Step 4, Step 1→ Factory Issued VSM Required

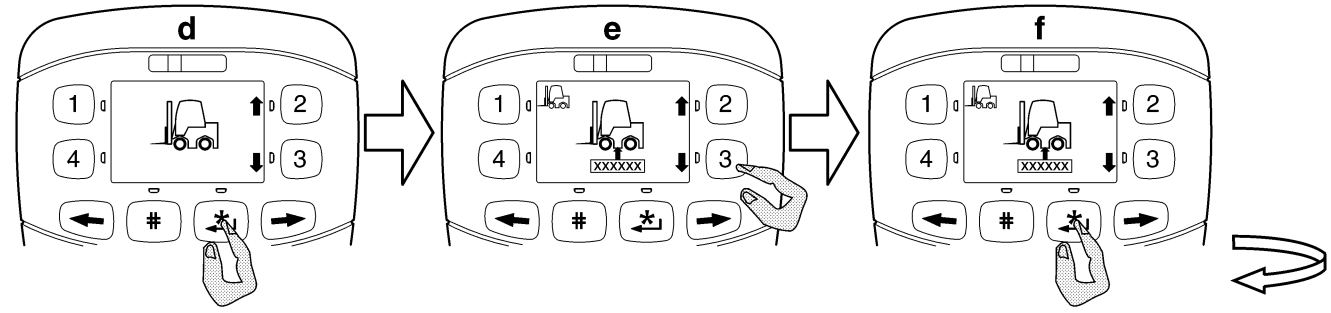
STEP 1



Scroll to Password symbol→

Enter 5 Digit Password → Press *→

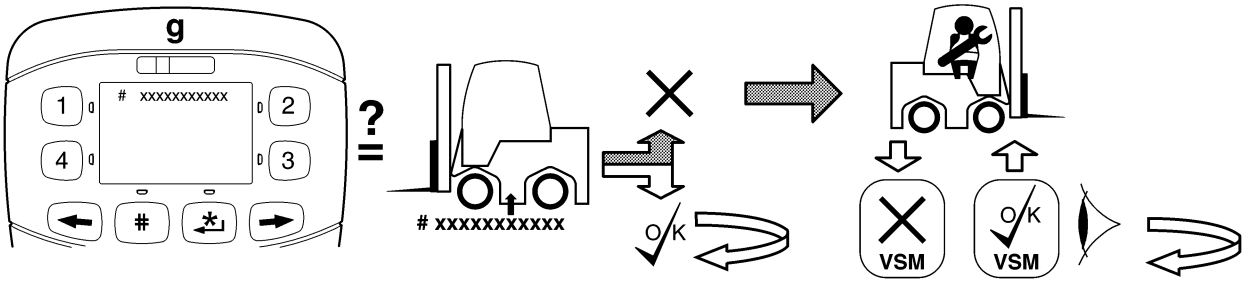
Scroll to Truck Symbol. Press *→



Press *→

Scroll to Truck Serial #→

Press *→



? Displayed Serial Number = the Truck Serial Number?→

YES → Step 2 ↓

NO → Find/Replace with Correct VSM. See **Electrical System** 2200SRM1337/ **Electrical System** 2200SRM1369. Repair Complete.→ Step 2 ↓

? Displayed Serial Number for VSM and Display are BLANK?→

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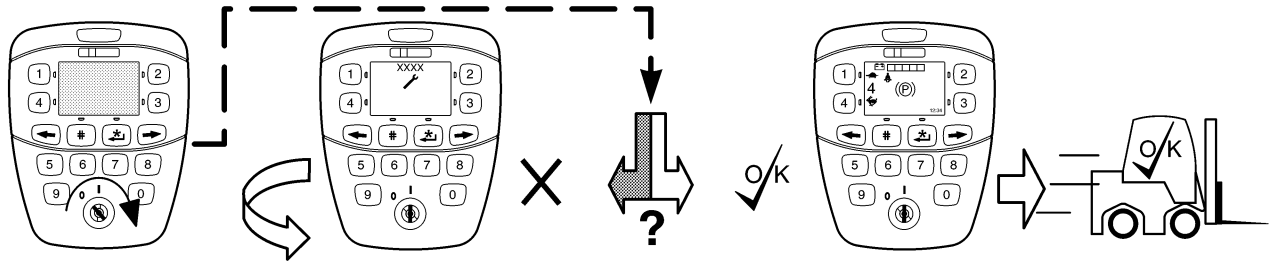
VSM Controller Check (Cont)

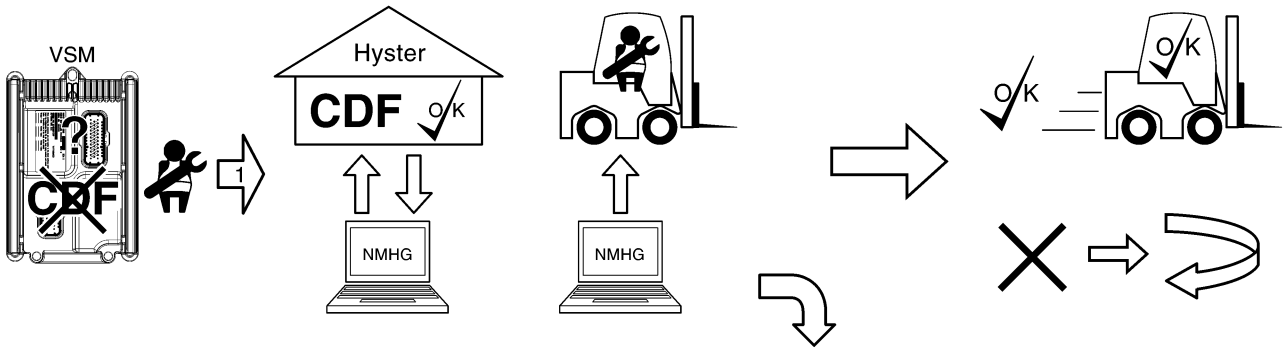
STEP 2



Retest - Power **ON**→ **NO** → Go to Step 3. Is fault DTC gone? Fault corrected→ Continue operation.

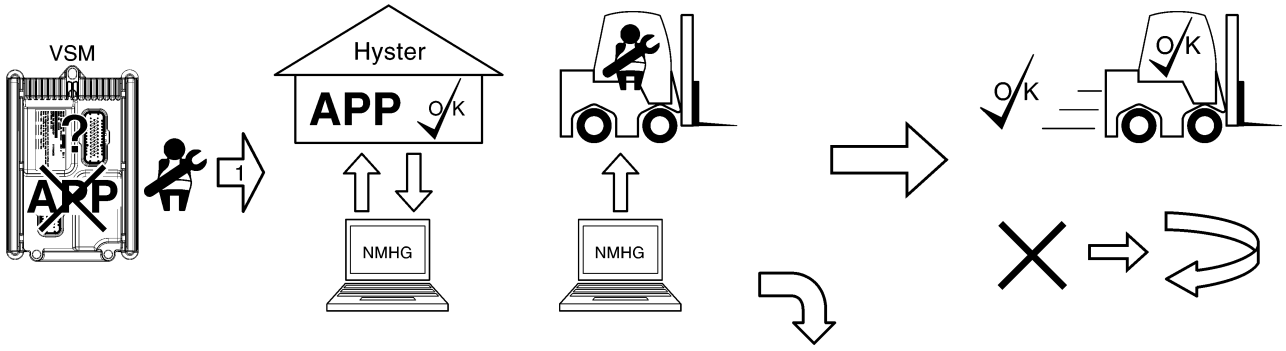
NO YES ← →

STEP 3



1. DTC 21761↓
2. Go to Hypass Online→Software→Download new CDF→Install on Truck→Go to 3↓
3. Test→Step 6↓→OK→Resume Operation – Not OK Step 5↓

STEP 4



1. DTC 21761↓
2. Go to Hypass Online→Software→Download the latest Application Software→Install on Truck→Go to 3↓
3. Test→Step 6↓→OK→Resume Operation – Not OK Step 5↓

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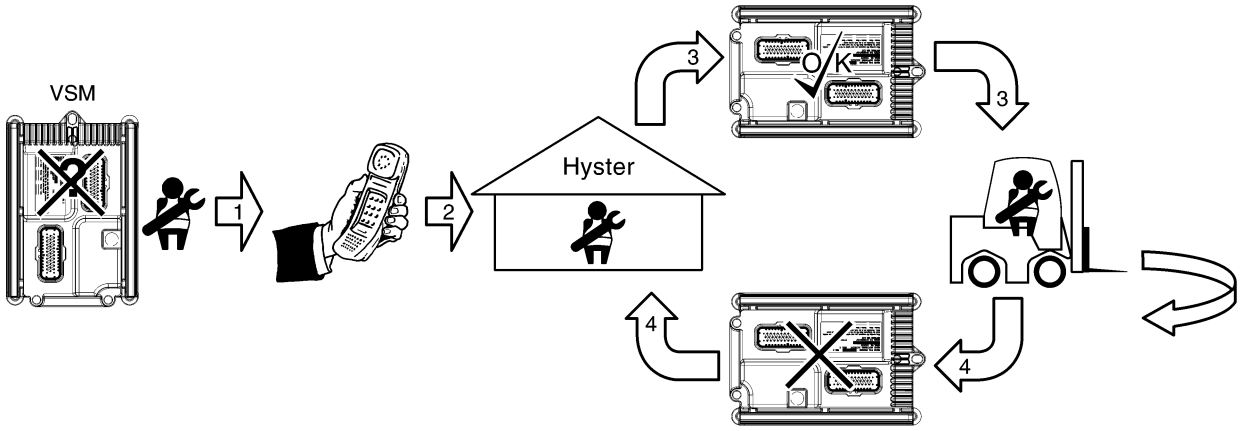
VSM Controller Check (Cont)

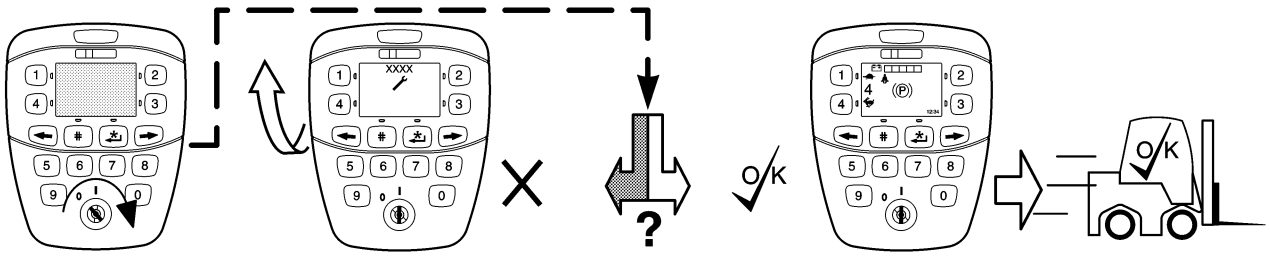
STEP 5



DTCs 21760, 21762, 21764, and 21766→

1. Replacement Approval –**Contact Hyster Resident Service.**
2. Remove and replace faulty VSM with new VSM. See **Electrical System** 2200SRM1337 or **Electrical System** 2200SRM1369.
3. Return faulty VSM to dealer.
4. Retest new installed VSM. Go to Step 6.

STEP 6



Retest - Power **ON**→

NO → Go to Step 3.

Is DTC gone? **NO** ← **YES** →

Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **– Clearing DTCs.**

END FAULT

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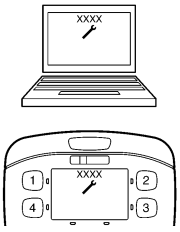
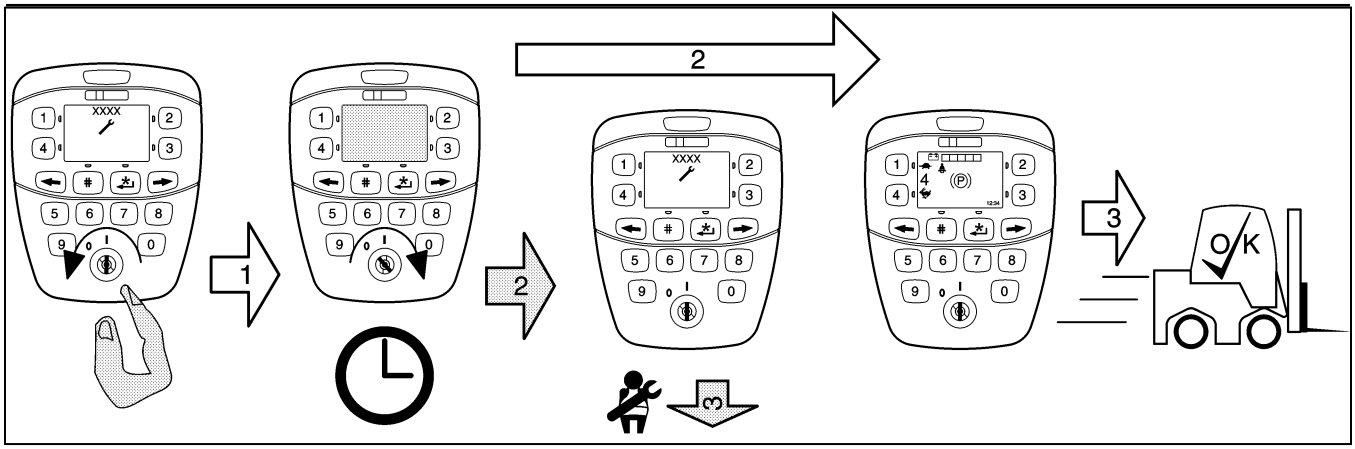
Controller Logic Failure



DTC 65299
Controller Logic Failure

Fault Codes



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

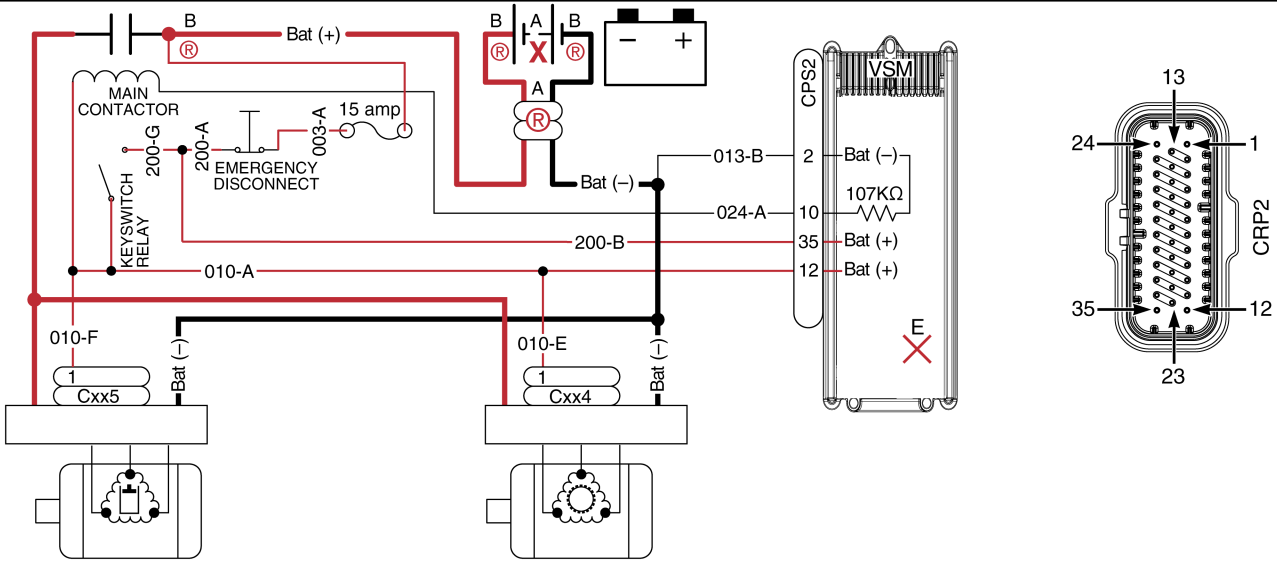
Controller Logic Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

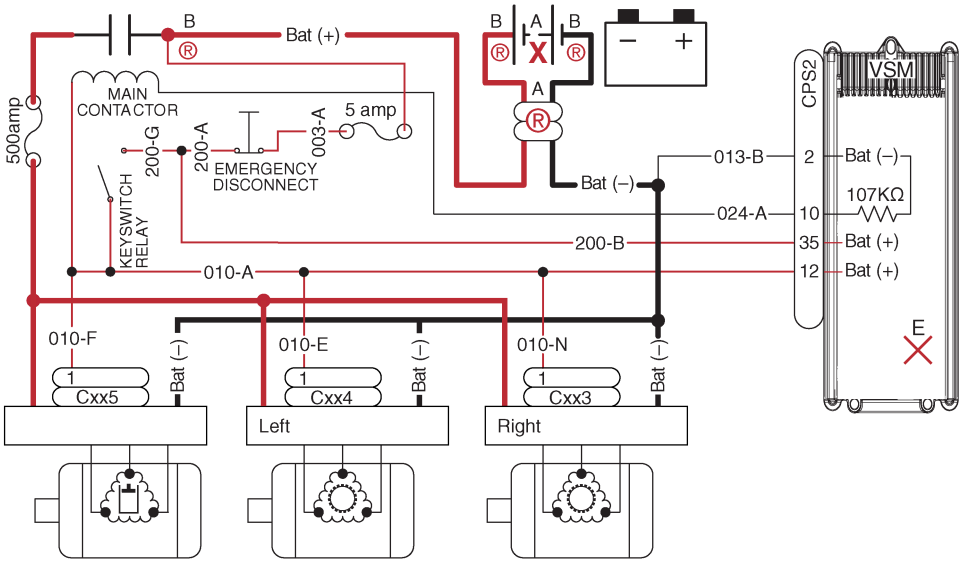
CBB 4 WHEEL CAUSES A B C D E > ?

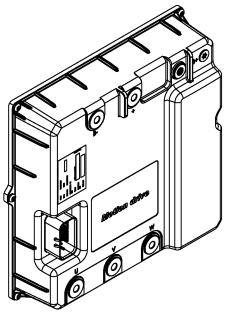
Possible Causes Battery Voltage Below Input Threshold/ ® = High Resistance

Possible Causes Battery Voltage Above Input Threshold/ ® = High Resistance



DBB 4 WHEEL CAUSES A B C D E > ?





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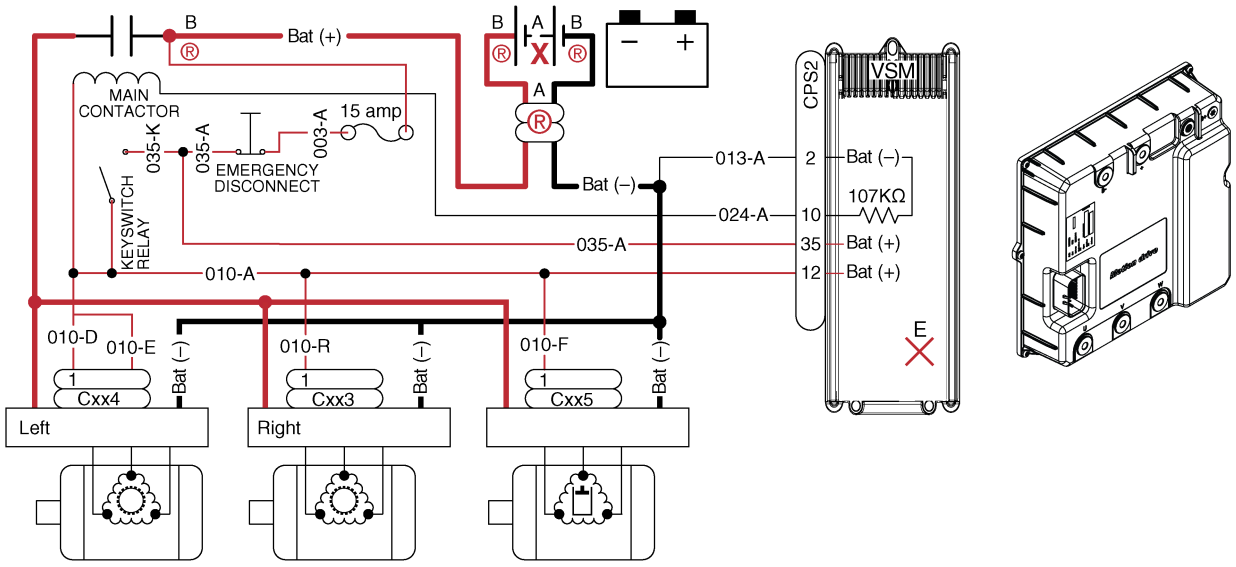
Controller Logic Failure (Cont)

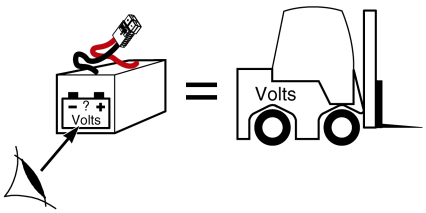
A935 K160 HIGH RESISTANCE CONNECTIONS CAUSES A B C D E > ?

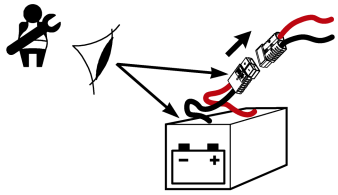


Controller Logic Failure (Cont)

CAUSE A

Controller Detected Voltage OOR



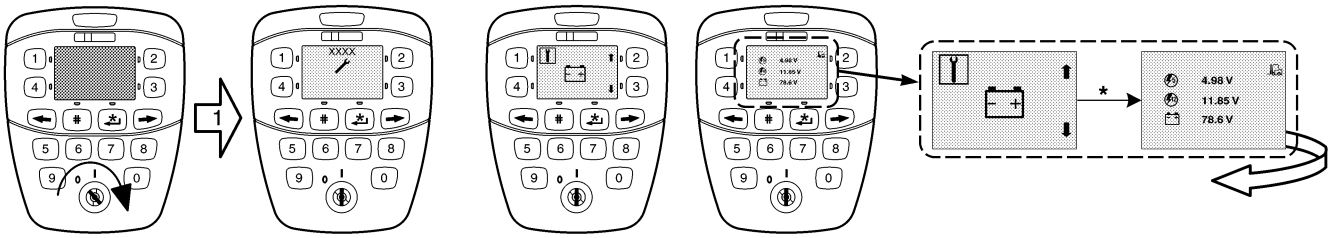


Check that correct voltage battery is installed →

Perform battery maintenance, see **Operating Manual**→

?

STEP A1



Power **ON**→

Go to Diagnostic→

See Display Menu Flowchart

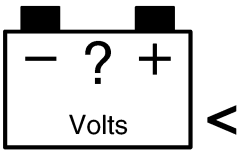
Battery/Supply→ View Battery Value

?

STEP A2

Controller Detected Voltage OOR

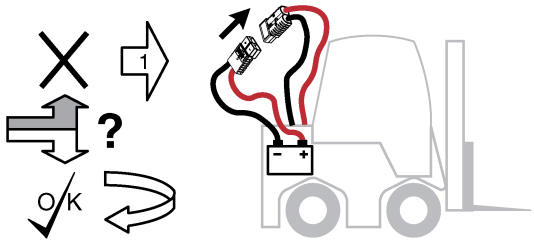
NOTE: OOR Code is set if OOR condition is present for longer than 1 second.

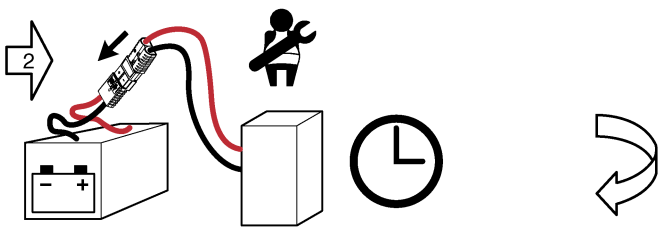


Controller Threshold			
	24v	48v	
< OORL	9	11	
< OORH	45	65	

Is battery voltage ˜ < OORL value for correct battery→ ?

STEP A3





NO (v)→ ?

YES (X) Recharge battery→

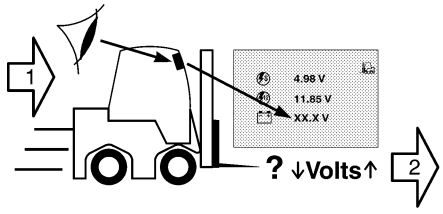
See **Operating Manual** for charge time

?

Controller Logic Failure (Cont)

STEP A4

Battery OORL/OORH

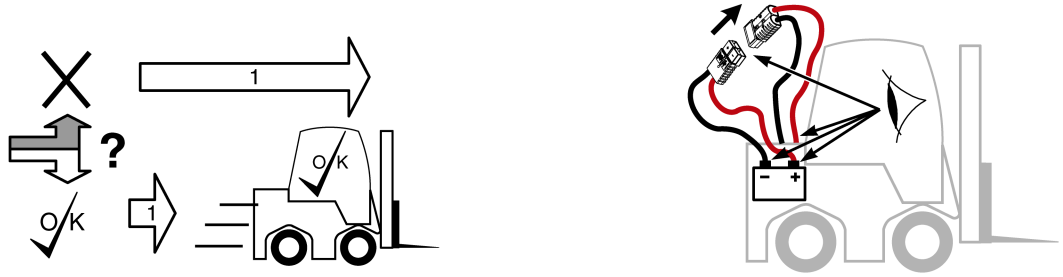


Battery Voltage				
Nominal	36	48	72	80
Fully Charged	40	53	79	88
˜< OORL	18	24	36	40
˜> OORH	48.6	57.6	97.2	108

Operate truck→ All functions

Monitor battery voltage→ Is battery voltage going?↓ < OORL or ↑ > OORH value for correct battery→ ?

STEP A5



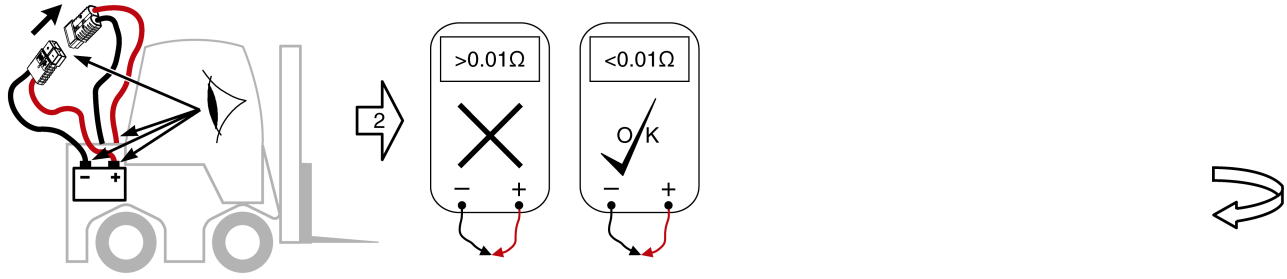
YES (X) Inspect All Battery Connections for Corrosion/ High Resistance→

NO (v) → Go to Step B4

CAUSE B

NOTE: High Resistance in Wiring and Connections will cause **High Voltage** drops (OORL) when subjected to **High Current** Draw

NOTE: High Resistance in Wiring and Connections will cause **High Voltage** peaks (OORH) when subjected to **High Current** Regen



Disconnect battery→ Set meter to lowest ? scale→ Check lead resistance < 0.01? ?

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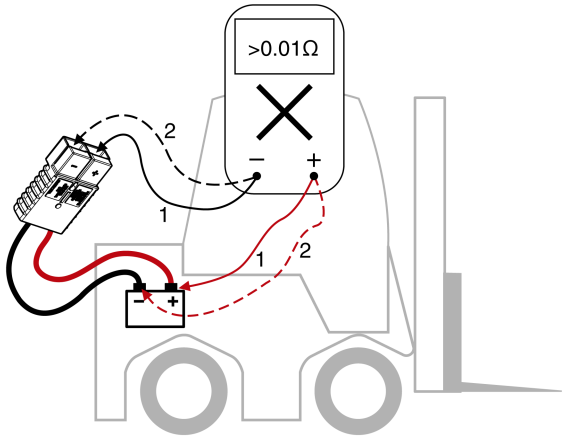
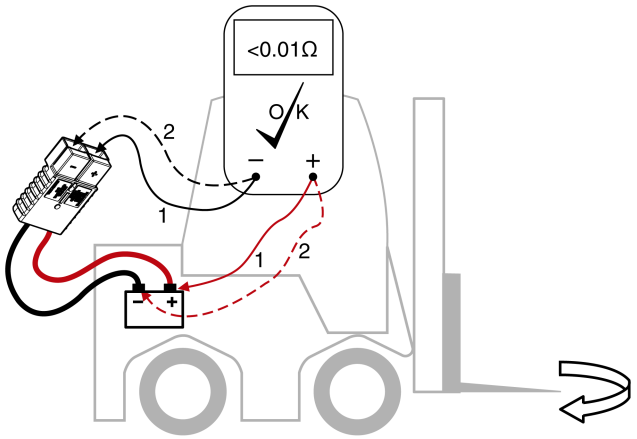
Controller Logic Failure (Cont)

STEP B1 CHECK RESISTANCE - Ω - OHMS

Battery OORH/OORL

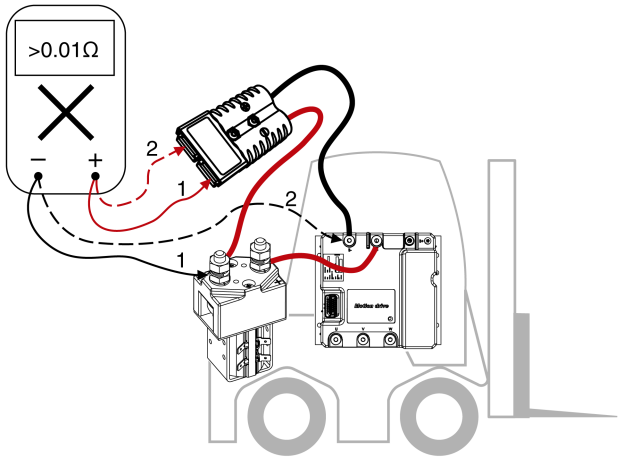


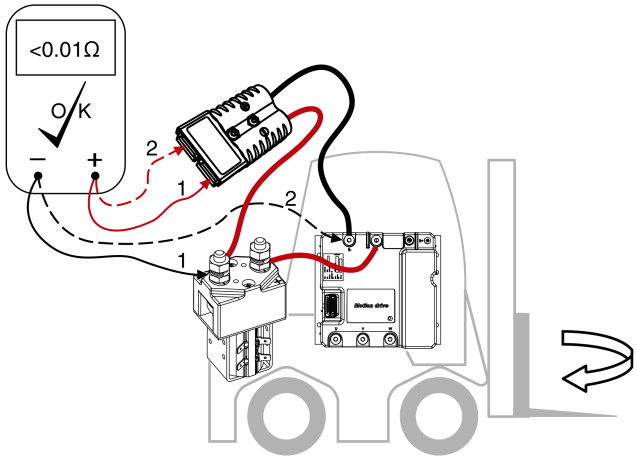


Check resistance between the Battery (+) and (-) terminals and the Battery Connector (+) and (-) Terminals

1. > 0.01? Replace battery leads/connector terminal↓	
2. > 0.01? Replace battery leads/connector terminal→	< 0.01? Connection OK→ ?

STEP B2





Check Resistance between the Bat (+) Connector and the Contactor Stud/Bat (-) Connector and Bat (-) to System

1. > 0.01? →Replace battery leads/connector terminal↓	
2. > 0.01? →Replace battery leads/connector terminal→	< 0.01? → Connection OK ?

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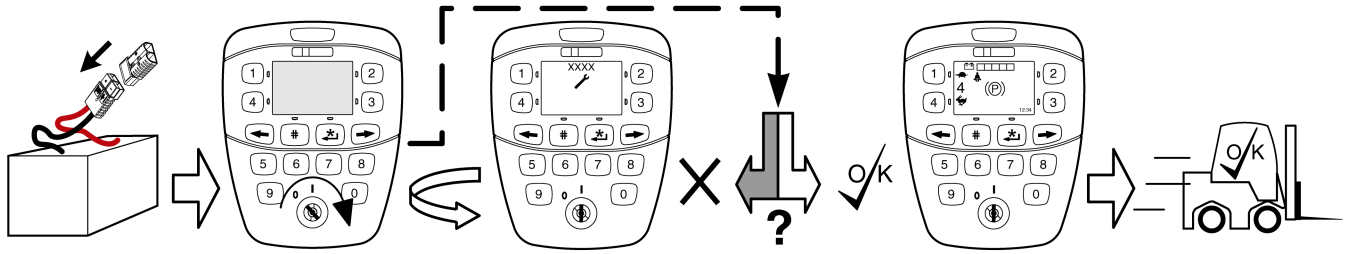
Controller Logic Failure (Cont)

STEP B3

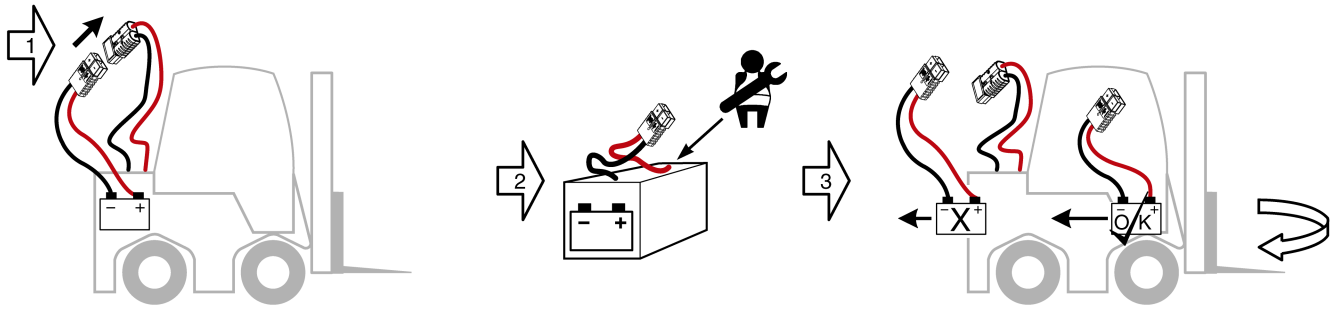
Battery OORH/OORL



Reconnect battery | Retest Power **ON** | **NO** → ? | Is DTC gone? **NO YES** → | Fault Corrected→ | Continue operation

STEP B4

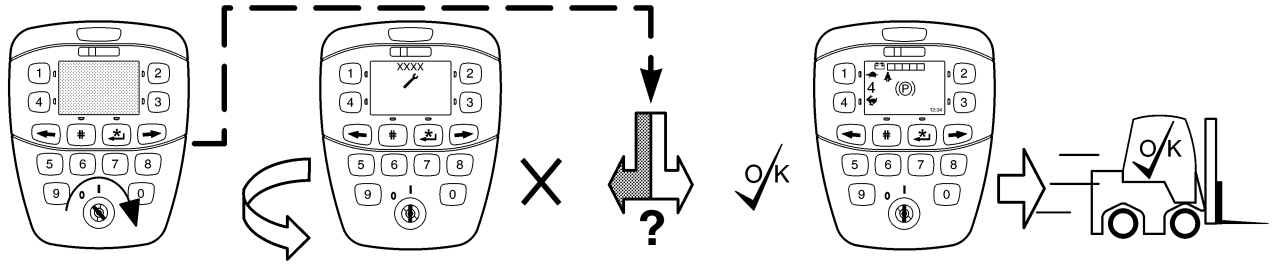
Battery OORH/OORL



Possible Battery Cell Failure→ Perform Battery Cell Test→ See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

If a cell failure is detected replace Battery→ ?

STEP B5



Retest Power **ON** | **NO** → ? | Is DTC gone? **NO YES** → | Fault Corrected→ | Continue operation

CAUSE C

Not Applicable

CAUSE D

Not Applicable

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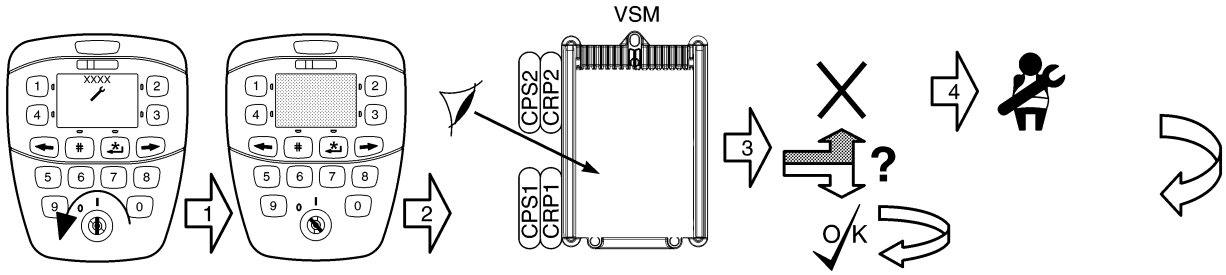
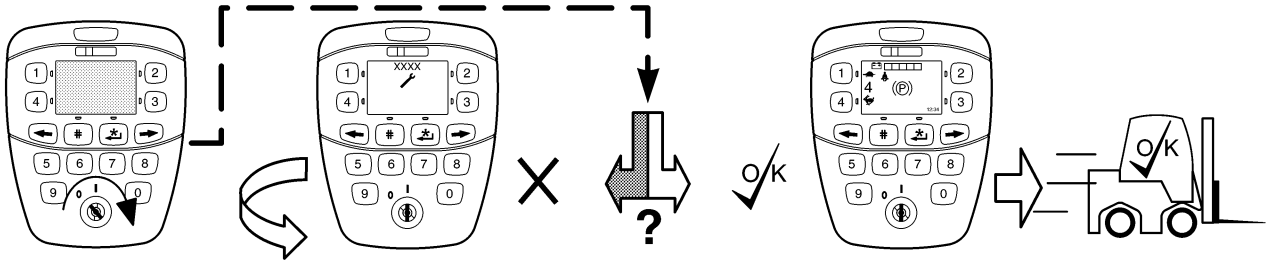
Controller Logic Failure (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1 Not OK Correct/Repair→ Go to Cause E1

CAUSE E1



Retest - Power **ON**→ **NO** → Is DTC gone? Fault corrected→ Continue operation.

Go to VSM Controller Check **NO YES**

END FAULT

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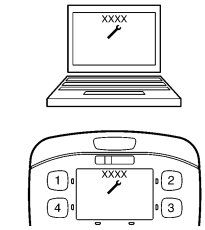
Display Failure – Temperature/Buzzer



Fault Codes

DTC 12928
Display Temperature Sensor (Freezer Option Only)

DTC 12929
Display Temperature Sensor (Freezer Option Only)

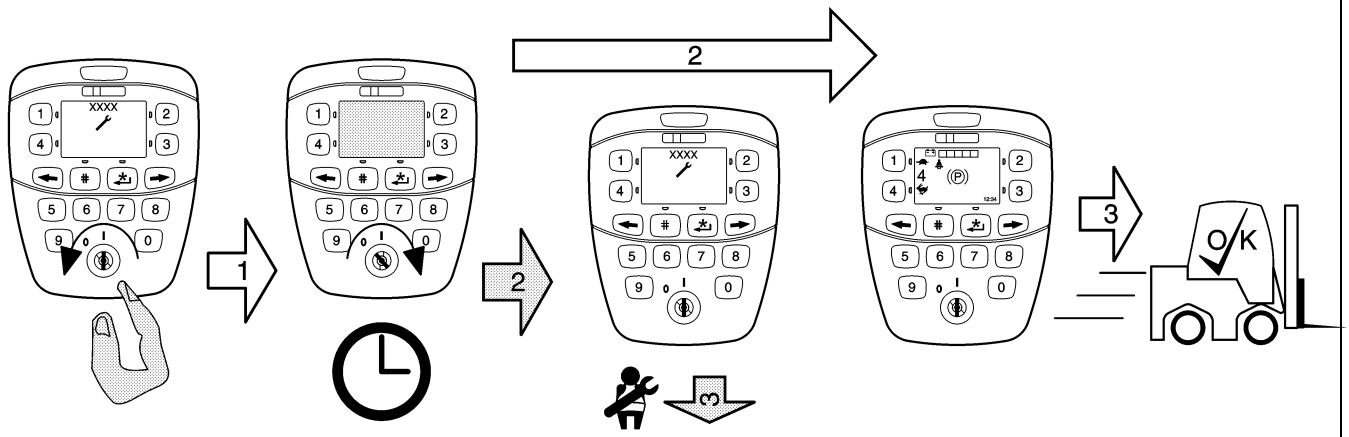
DTC 12939
Display Buzzer Output

DTC 9040
Display Buzzer Output

DTC 12938
Display Buzzer Output

QUICK CHECK X Open Circuit/Fail) = Short Circuit			
DTC 12928	Display Temperature Sensor (Freezer Option Only)	OORL Open Circuit	→ Component Operational Check ↓
DTC 12929	Display Temperature Sensor (Freezer Option Only)	OORH	→ Component Operational Check ↓
DTC 9040	Display Buzzer Output	STB (-)/Current OORH	Code Not Active
DTC 12938	Display Buzzer Output	STB (+)	Code Not Active
DTC 12939	Display Buzzer Output	Open Circuit	Code Not Active
QUICK CHECK X = Open Circuit/Fail) = Short Circuit			

Check 1



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains Service required Go to ↓	No fault→ Resume operation

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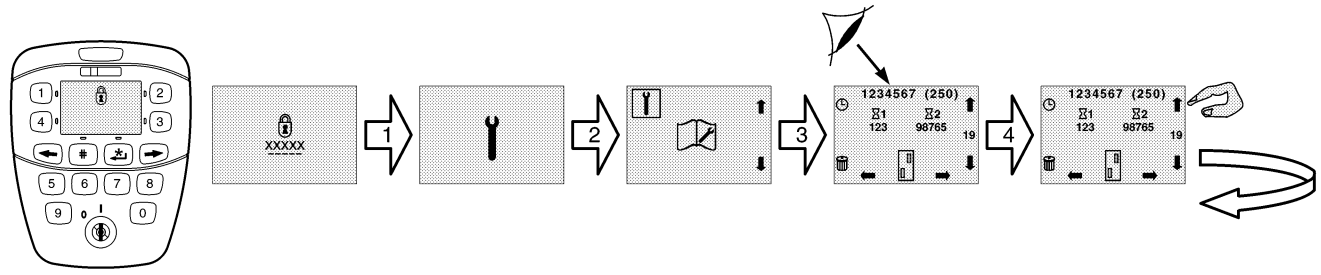
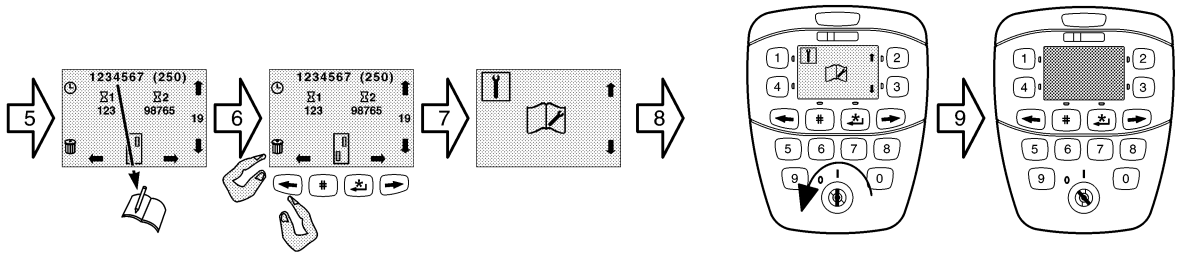
Display Failure – Temperature/Buzzer (Cont)

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

FAULT LOG CODE Review – Go to Display Menu



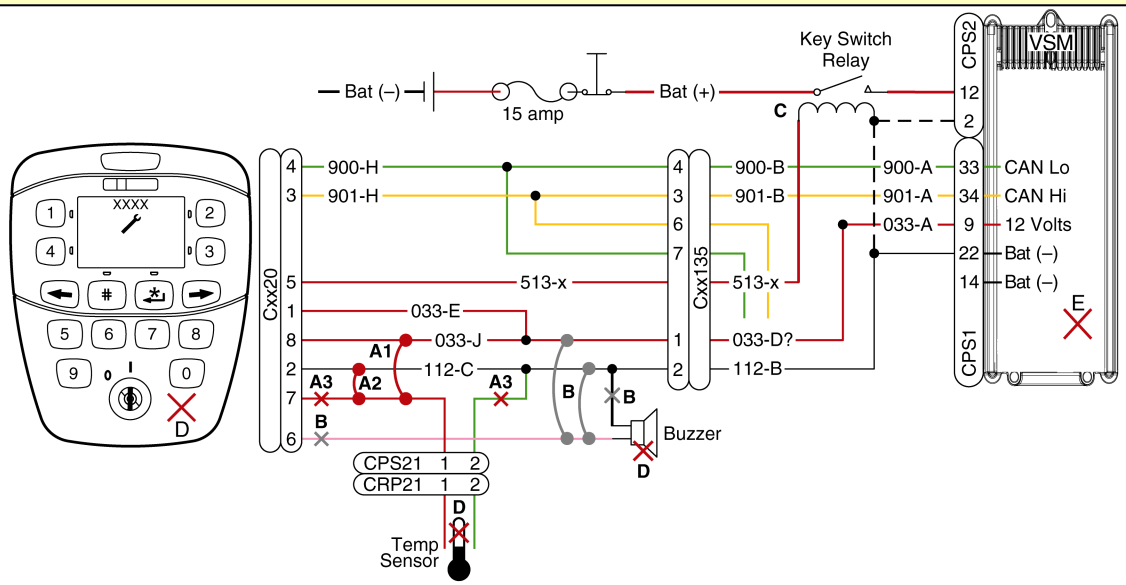
Enter SERVICE Password→	Diagnostics→	FAULT LOGs→	Display FAULT LOGs→	View all Display DTCs→ ?



all Display DTCs→	Erase all Display DTCs→ Exit Fault Log	Power **OFF**→ ?

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

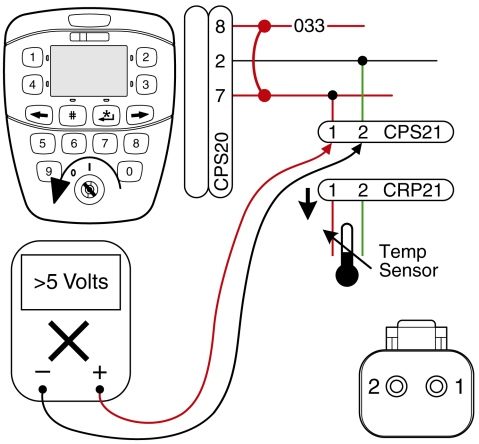
CAUSES A B C D > ?

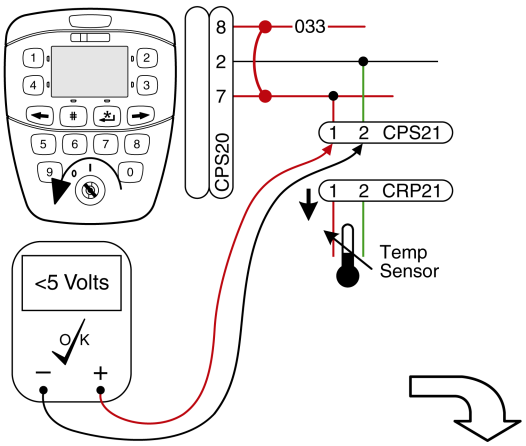


Display Failure – Temperature/Buzzer (Cont)

CAUSE A

DTC 12929 Temperature Sensor OORH





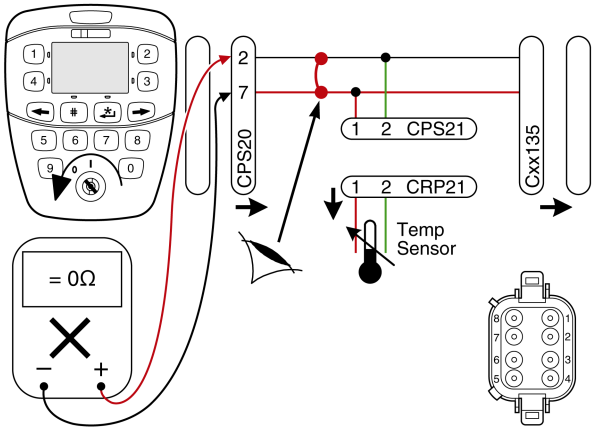
Remove Display and Disconnect Temperature Sensor→ Measure Volts→ Go to 1↓

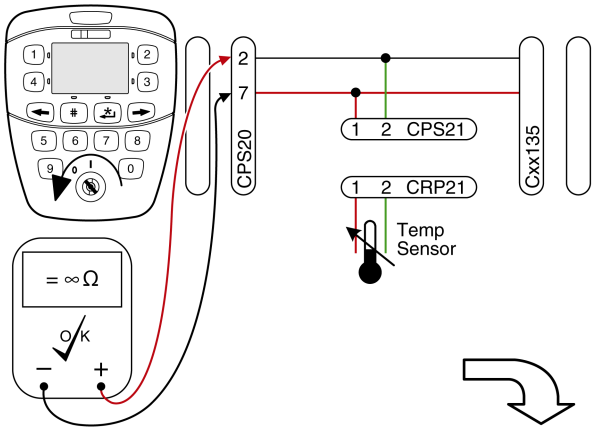
1. > 5 volts = Short to→Go to 2↓	1. < 5 volts = OK→Step A1↓

2. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck ?↑Component Operational Check→Reconnect Display→Step A3↓

STEP A1

DTC 12928 Temperature Sensor STB (-) OORL





Disconnect connector 135→ Measure ?→ Go to 1↓

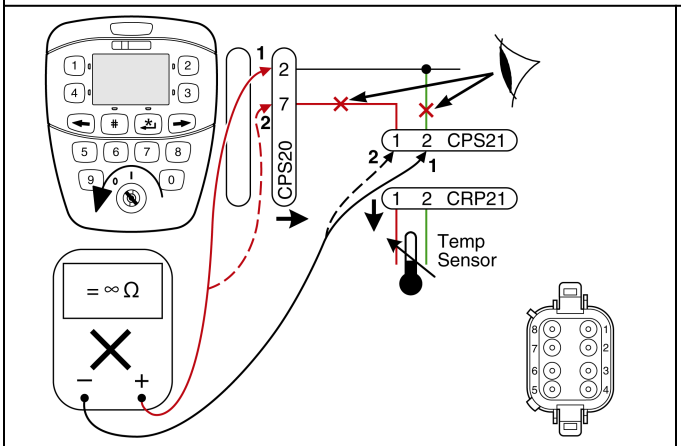
1. ˜0? = Short Circuit to Bat (-)→Go to 2↓	1. =8? = OK→Step A2↓

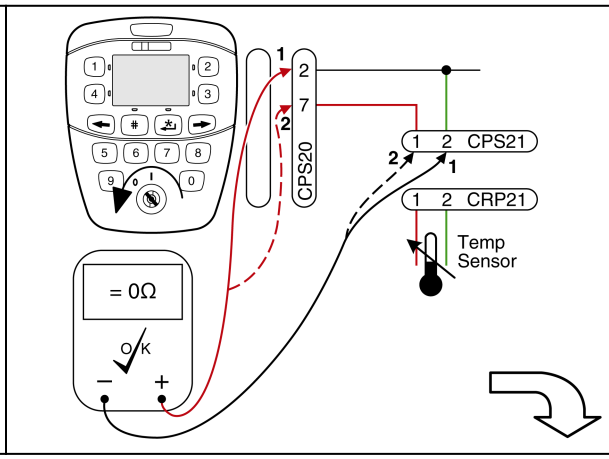
2. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck ?↑Reconnect→Step A3↓

Display Failure – Temperature/Buzzer (Cont)

STEP A2

DTC 12928 Temperature Sensor Open Circuit OORL



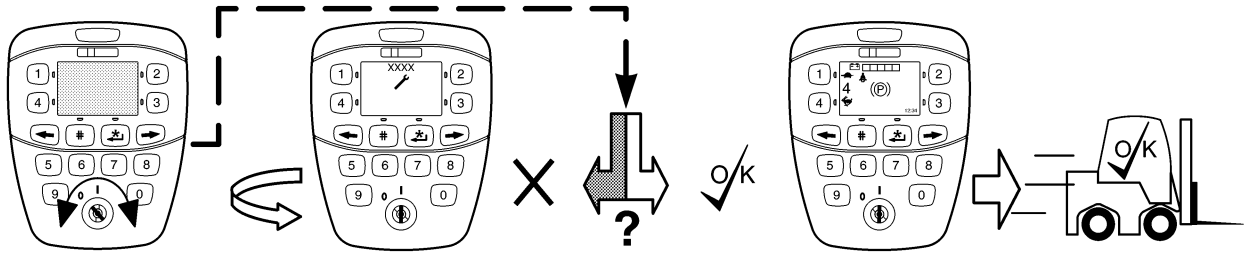


Remove Display and Disconnect Display Connector→ Disconnect Temperature Sensor→ Measure ? at 1 and 2→ Go to 1↓

1. =8? = Open Circuit→Go to 2↓	1. ˜0? = OK→Component Operational Check↓

2. Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck ?↑Component Operational Check→Reconnect →?

STEP A3



Retest - Power **OFF** **NO** → ? Is fault DTC gone? ?
Power **ON**

NO ← **YES** →

CAUSE B

There are no active DTCs displayed for Buzzer Failure. Please refer to the Troubleshooting Electrical Symptoms for Diagnostics.

CAUSE C

Not Applicable

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Display Failure – Temperature/Buzzer (Cont)

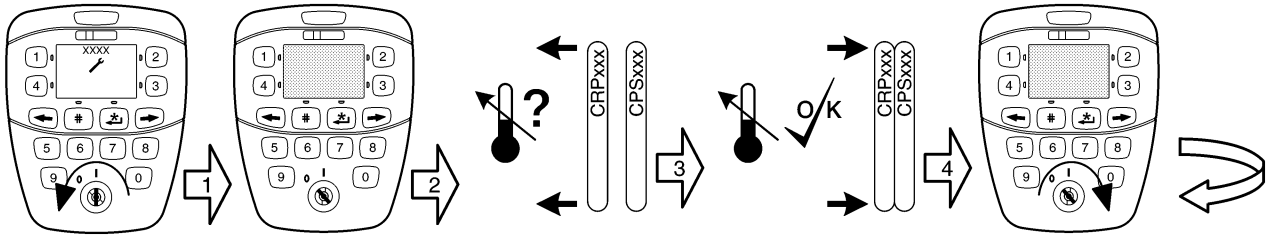
CAUSE D

Device Failure

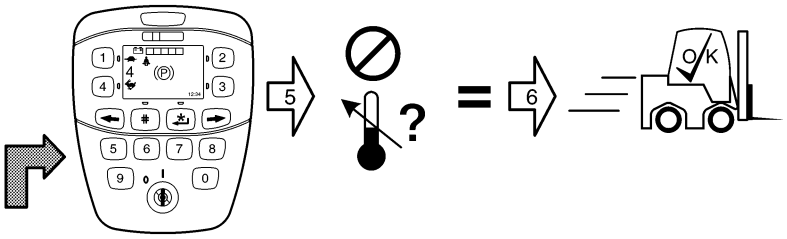
NOTE: The Temperature Sensor is Only used on Freezer configured Displays.

NOTE: The Temperature Sensor is tied to the wiring Harness behind the Display.

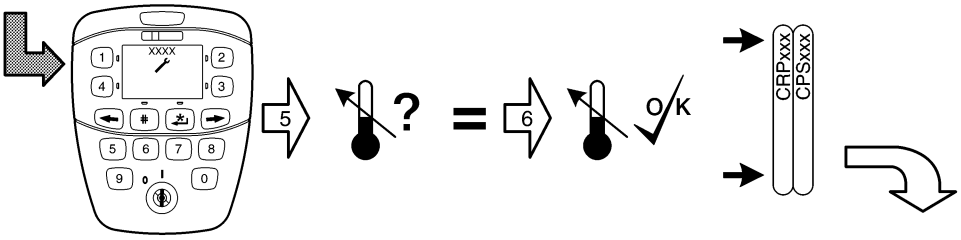
NOTE: The Temperature Sensor is NOT RESISTIVE and cannot be analyzed using a DMM.



Power **OFF**→ Remove Display→ Disconnect sensor.→ Install new sensor.→ **Do not discard** Power **ON**→ ?

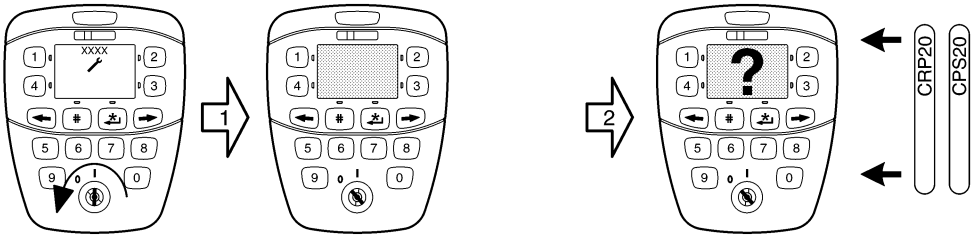


? Fault DTC gone→ Original sensor faulty→ Resume operation



Fault DTC present→ Original sensor OK/Reinstall old sensor→ Go to Step D1.

STEP D1



Power **OFF**→	Disconnect Display→ Do not Discard→	Step D2 ↓

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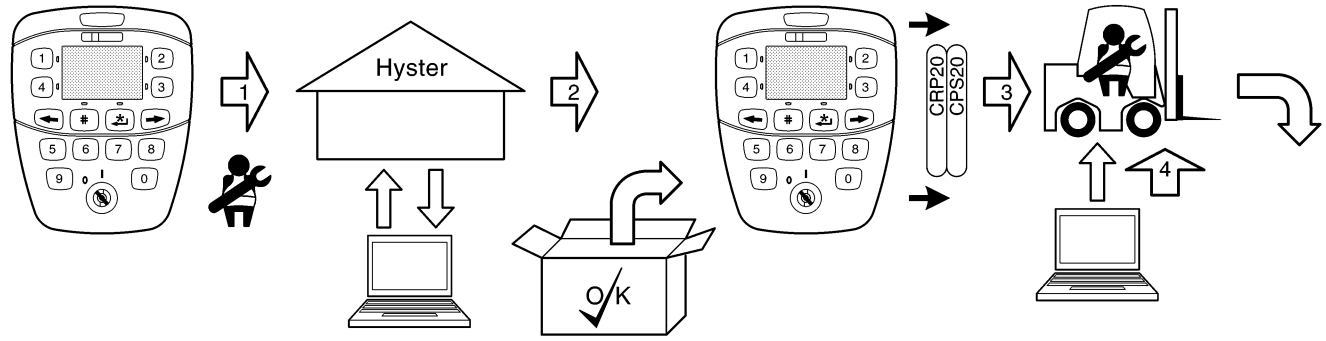
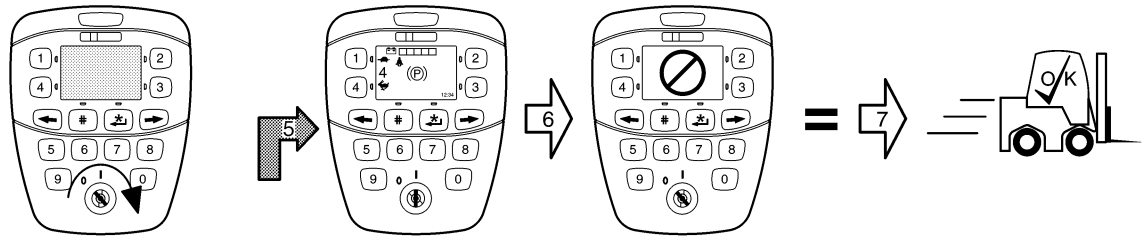
Display Failure – Temperature/Buzzer (Cont)

STEP D2



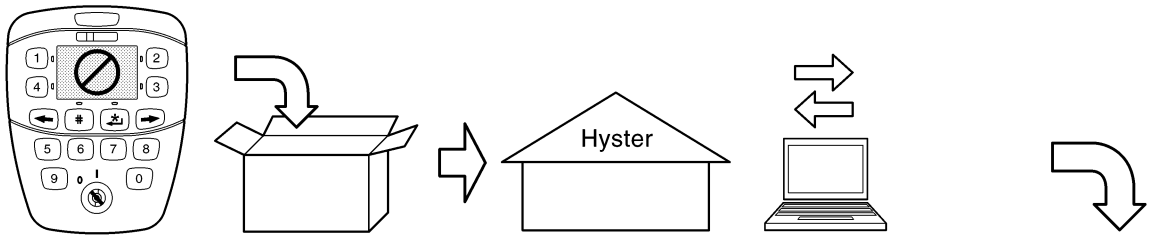
1. Download the latest **Display Application** Version→Install NEW Display→Install NEW Application →Go to 2↓
2. See **Hypass Online**, Software Resources for your truck, (Installing Display Application Software)↓

STEP D3



Power **ON**→ ⇳	DTC Gone→	Original Display Faulty→	Resume Operation

New DTC Present→	DTC TSP↓



Return Faulty Display→ Dealer→ Factory→ Failure Analysis→ ?? Reprogramming

END FAULT

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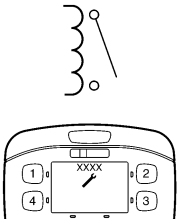
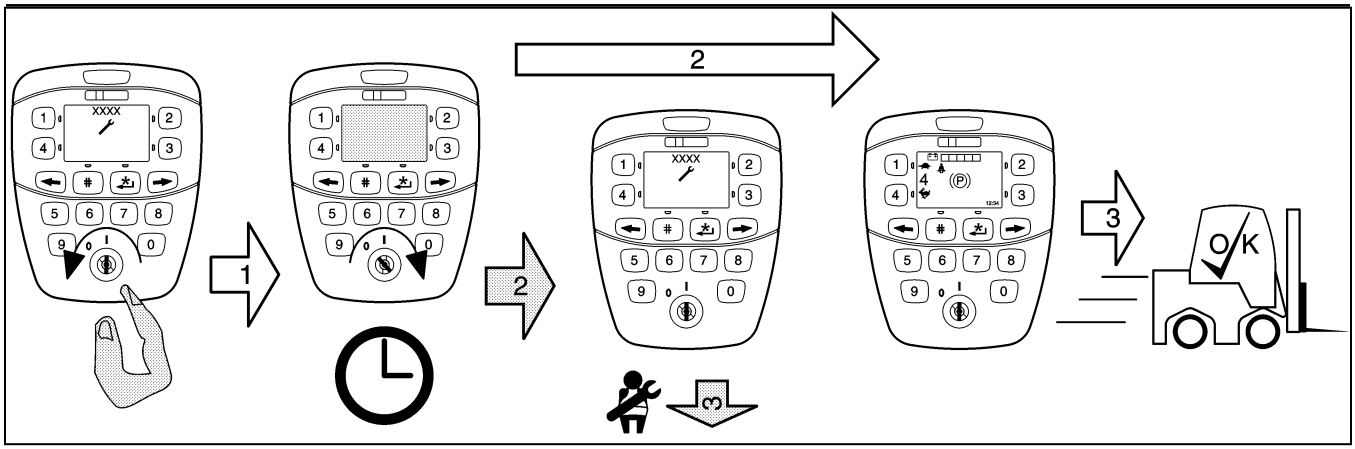
Contactor/Relay/Valve Coil Short to Battery Positive (STBP)



Fault Codes

DTC 9000 **Diverter Valve**	**DTC 9004** **E Hyd Enable**	**DTC 9008** **Clamp Solenoid (Optional)**	**DTC 9012** **Acc 2 Relay**
DTC 9016 **Forward Relay**	**DTC 9020** **Reverse Relay**	**DTC 9026** **Spare 1 Relay**	**DTC 9028** **Spare 2 Relay**
DTC 9032 **Main Contactor**			**DTC 9036** **2nd Contactor**

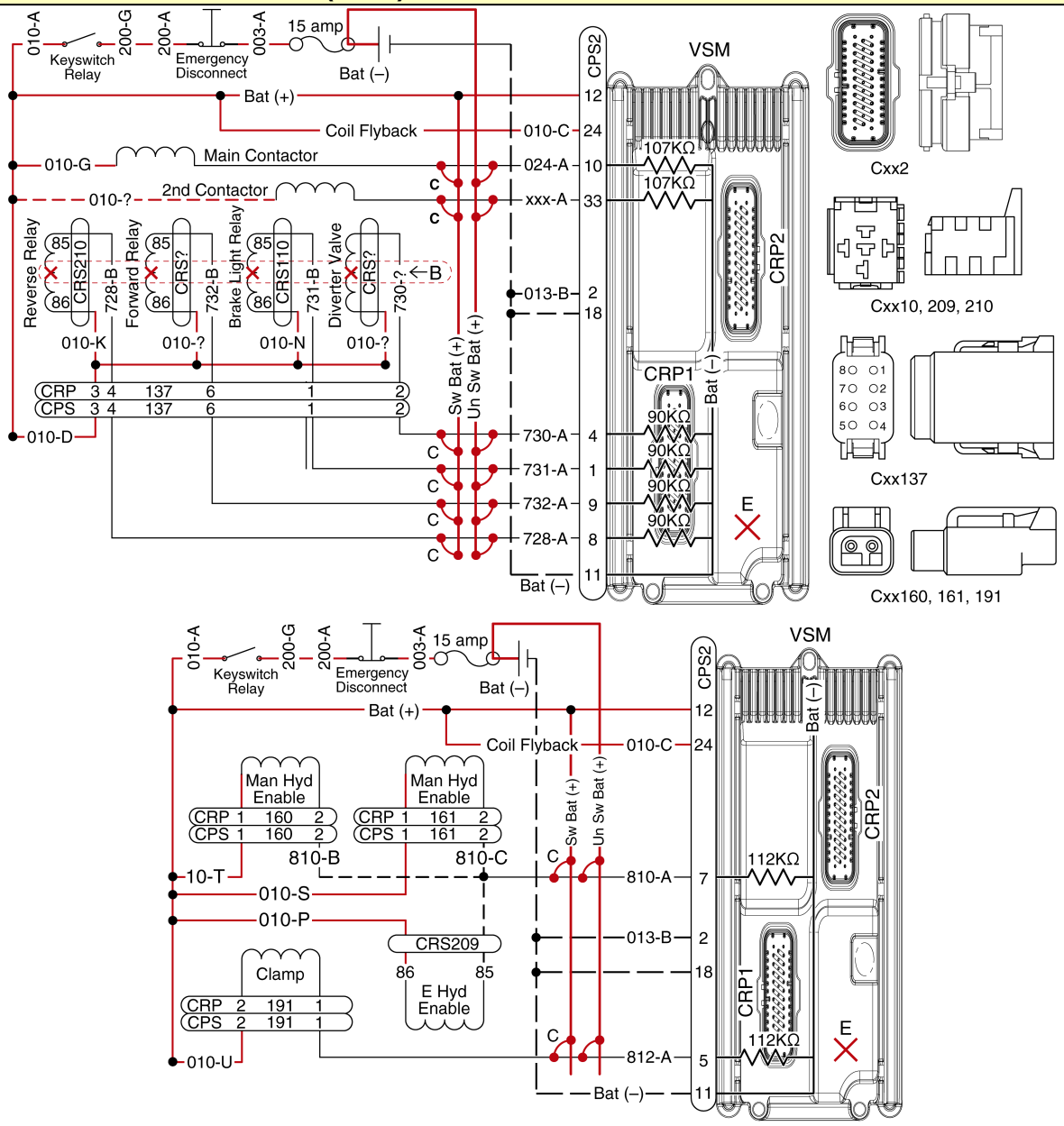


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

Contactor/Relay/Valve Coil Short to Battery Positive (STBP) (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

CONTACTOR/RELAY/VALVE COIL (STBP) CAUSES A B C D E > ?



CAUSE A

Not Applicable

CAUSE B

Not Applicable

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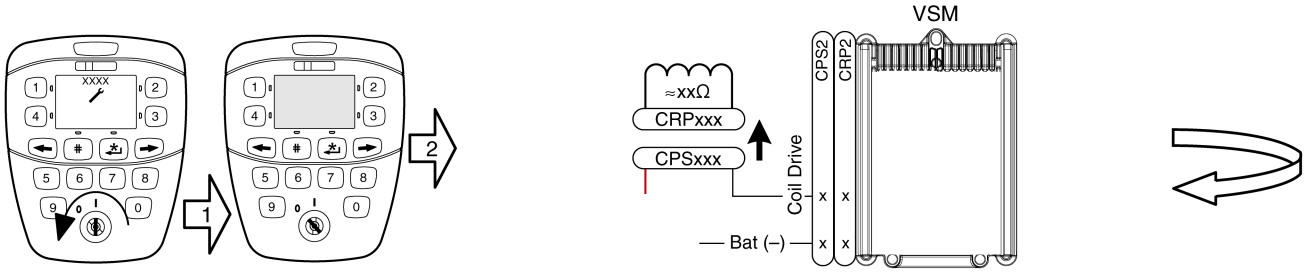
Contactor/Relay/Valve Coil Short to Battery Positive (STBP) (Cont)

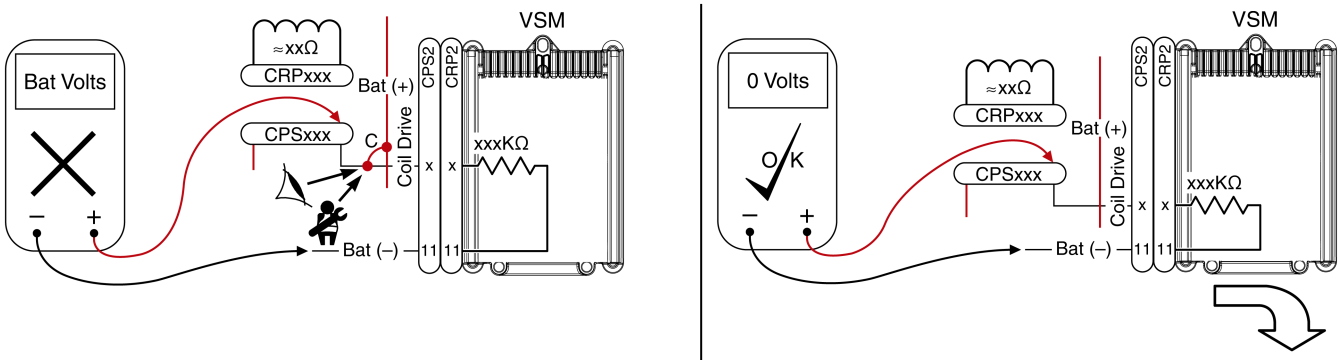
CAUSE C



Power **OFF**→ Unplug/Disconnect Contactor/Relay/Valve Coil Indicated DTC Connection to VSM→ ?

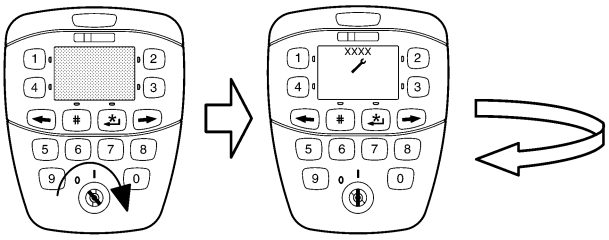
STEP C1 UNSWITCHED VOLTAGES

NOTE: Short Circuit to Unswitched Bat (+) Contactor/Relay/Valve Coil Connection to VSM



Bat Volts = Short circuit→ Find↑ **SHORT** circuit.→	˜ 0 Volts = **OK** ?
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	
See Schematic for Connection information	

STEP C2



Power **ON**→ ?

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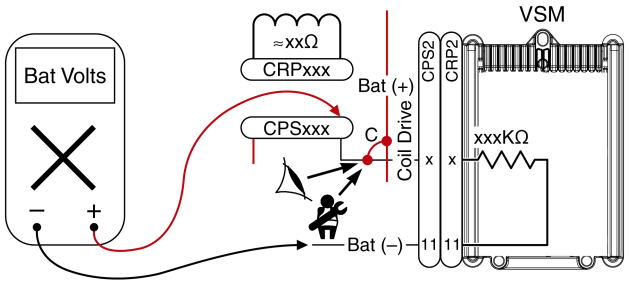
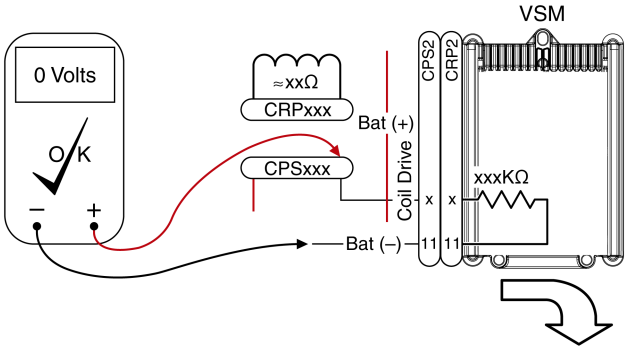
Contactor/Relay/Valve Coil Short to Battery Positive (STBP) (Cont)

STEP C3 SWITCHED VOLTAGES

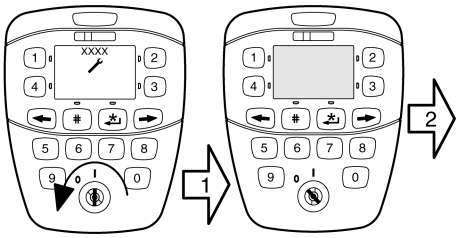
NOTE: Short Circuit to Switched Bat (+) – Contactor/Relay/Valve Coil Connection to VSM

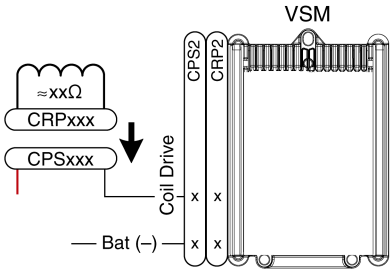




Bat Volts = Short circuit→ Find↑ **SHORT** circuit →	˜ 0 Volts = **OK** ?
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	
See Schematic for Connection information	

STEP C4



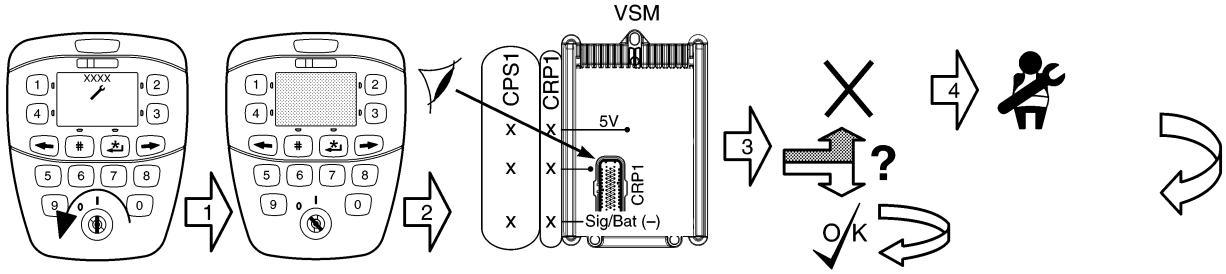


Power **OFF**→ Reconnect Contactor/Relay/Valve Coil Connections to VSM→ ?

CAUSE D

Not Applicable

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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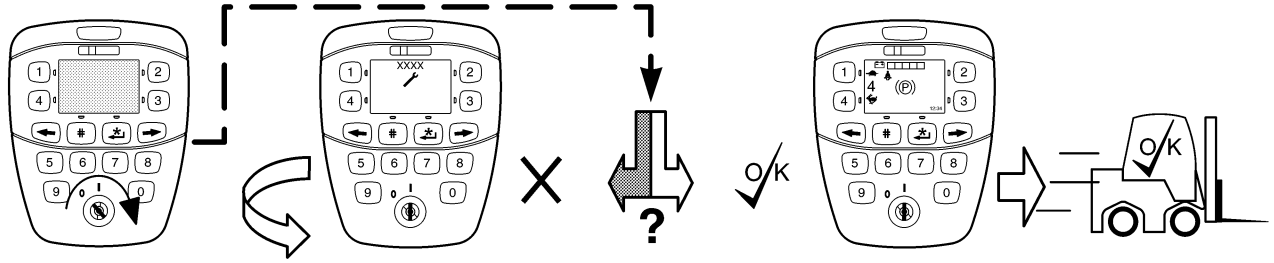
Contactor/Relay/Valve Coil Short to Battery Positive (STBP) (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO ← YES →

Fault corrected→ Continue operation.

END FAULT

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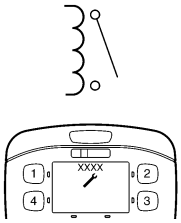
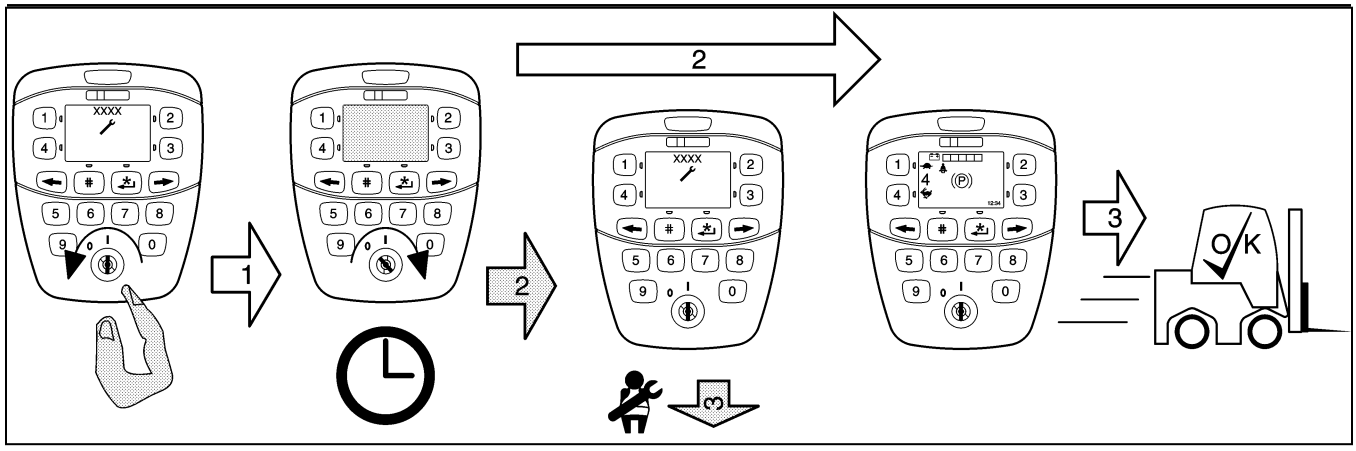
Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC)



Fault Codes

DTC 13352 **Diverter Valve**	**DTC 13356** **Hyd Enable**	**DTC 13360** **Acc 1 Relay**	**DTC 13364** **Acc 2 Relay**
DTC 13368 **Motion Relay**	**DTC 13372** **Reverse Relay**	**DTC 13376** **Spare 1 Relay**	**DTC 13380** **Brake Light Relay Short to B(-) or Open**
DTC 13384 **Main Contactor**			**DTC 13388** **2nd Contactor**

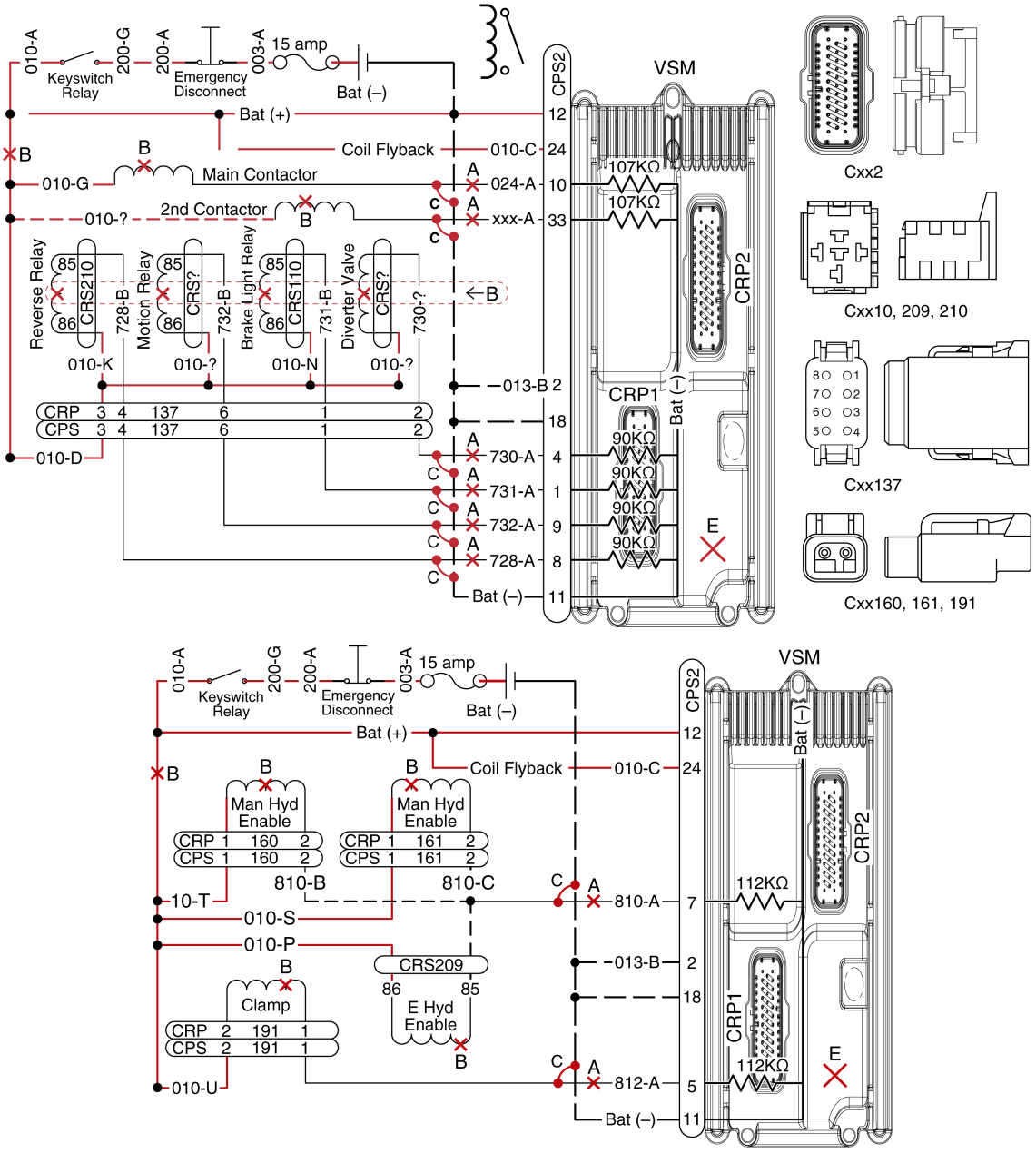


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

CONTACTOR/RELAY/VALVE COILS STBN/(OC) CAUSES A B C D E > ?



Relay/Coil Function	Coil Voltage	Coil Resistance (?)
Key Switch	12	80
Motion Direction	24	320
Reverse Direction	24	320
Brake Light	24	320
Diverter Valve	24	320

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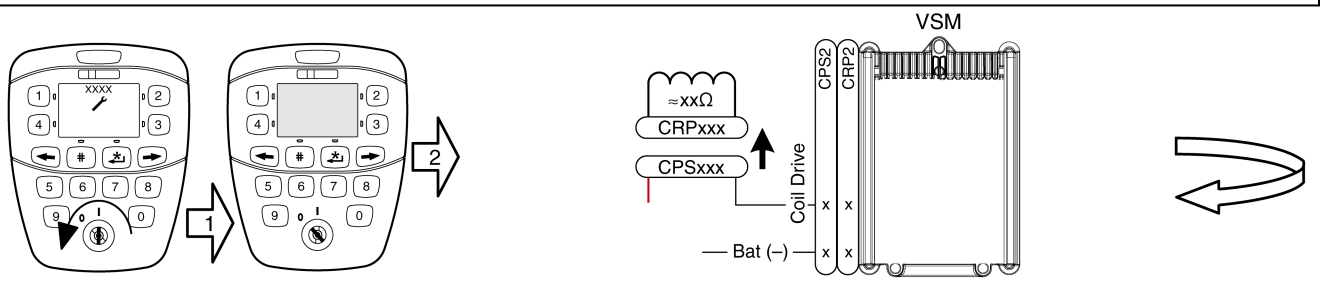
Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)

Relay/Coil Function	Coil Voltage	Coil Resistance (?)
E Hyd Enable	24	320
Man Hyd Enable x 2	24	33
Clamp	24	33

CAUSE A

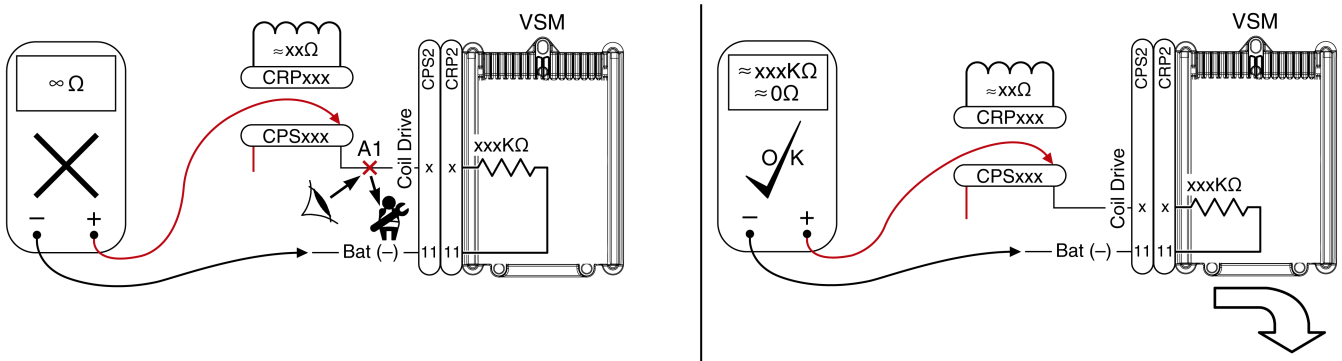
NOTE: Prior to performing any checks, Service Technician should verify to see if the Motion relay option or Diverter valve option is activated. (See Truck Setup Display menu- Motion Alarm/Diverter Valve). If neither device is part of the truck hardware then the function should be TURNED **OFF** to prevent false DTC conditions.



Power **OFF**→ Unplug/Disconnect Contactor/Relay/Valve Coil Indicated DTC Connection to VSM→ ?

STEP A1 **CHECK RESISTANCE - Ω - OHMS**

Open Circuit – Contactor/Relay/Valve Coil Connection to VSM



8 ? = Open Circuit→ Find↑ **Open** circuit→	˜ Function K? = **OK** ?
	˜ 0? Go to Component Operational Check
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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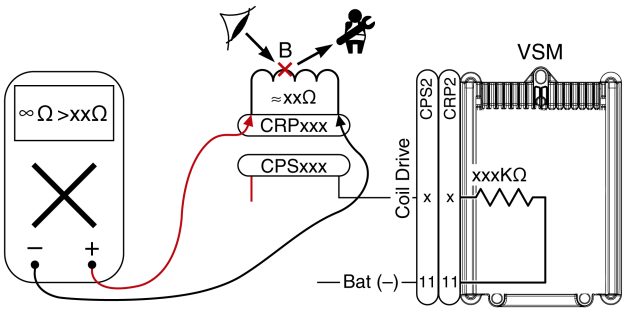
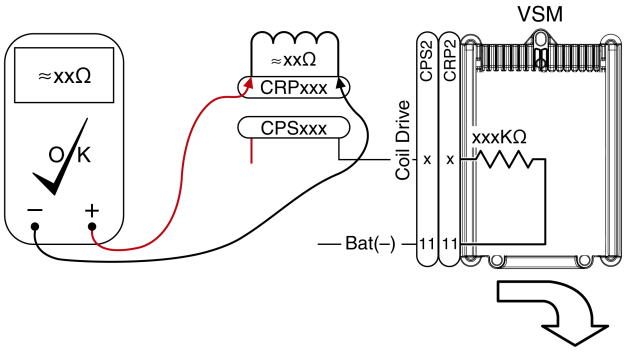
Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)

CAUSE B CHECK RESISTANCE - Ω - OHMS

NOTE: Open Circuit – Contactor/Relay/Valve Coil Connections to Coil

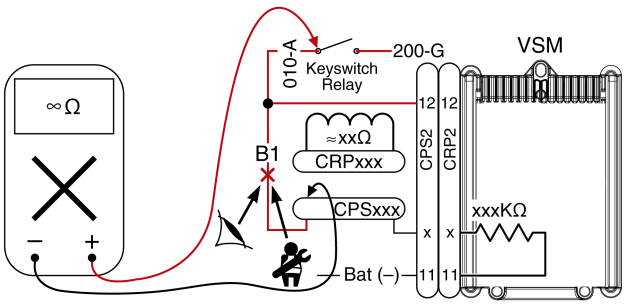


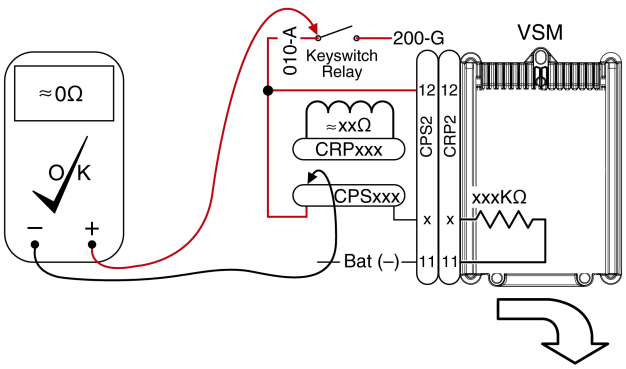


8 ? = Open Circuit→ Find↑ **Open** circuit→	˜ xx? =→ See Schematics =**OK**→ ?
Repair **OPEN** Circuit in wiring or Replace Open Circuit Coil/Relay ↓	
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	
> xx ? = Faulty Coil→ Replace Coil↓	
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

STEP B1 CHECK RESISTANCE - Ω - OHMS

Open Circuit – Bat (+) Connections to Contactor/Relay/Valve Coil





8 ? = Open Circuit→ Find↑ **Open** circuit→	˜ 0? = **OK** Go to Component Operational Check↓
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

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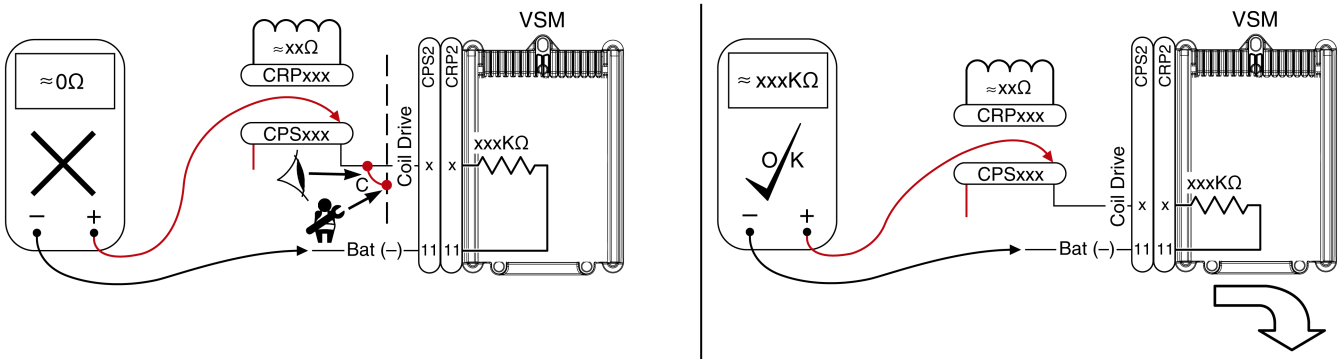
Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)

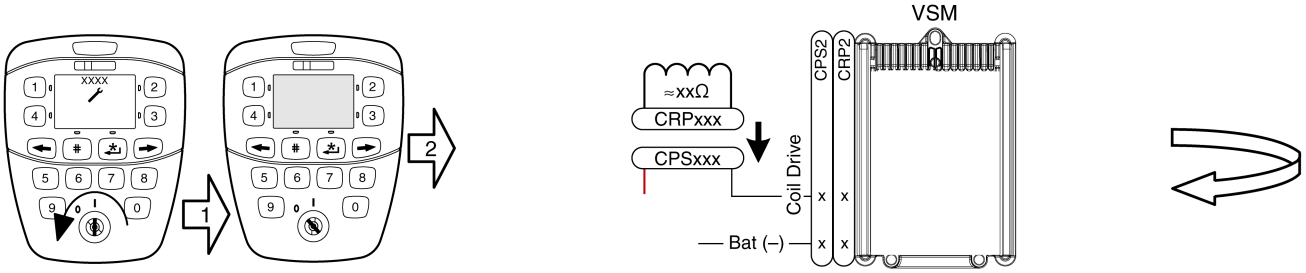
CAUSE C

NOTE: STBN – Contactor/Relay/Valve Coil Connection to VSM



˜ 0 ? = Short Circuit→ Find↑ **Short** circuit→	˜ Function K? = **OK** Go to Component Operational Check↓
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

STEP C1

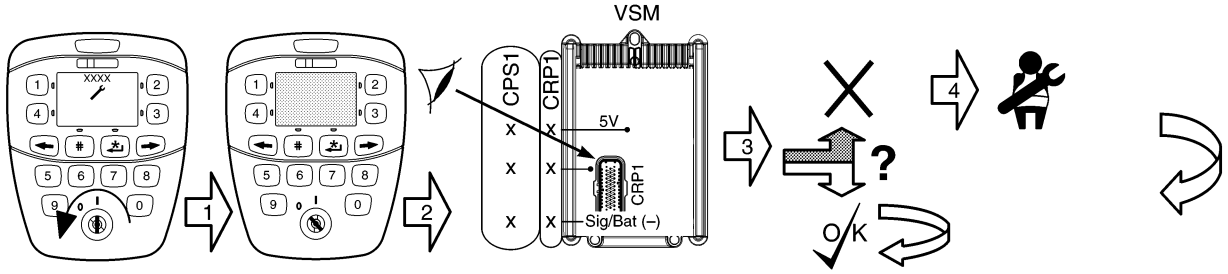


Power **OFF**→ Reconnect Contactor/Relay/Valve Coil Connections to VSM→ ?

CAUSE D

Not Applicable

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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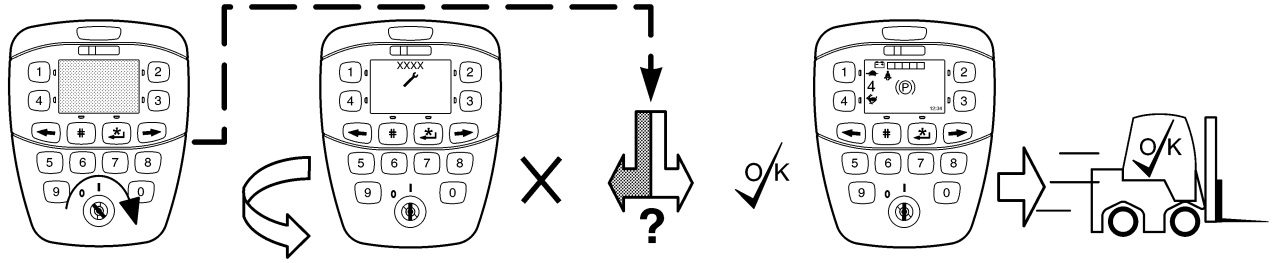
Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)

CAUSE E1



Retest – Power **ON**→ **NO** → Go to VSM Controller Check

Is DTC gone?

NO YES ← →

Fault corrected→ Continue operation.

END FAULT

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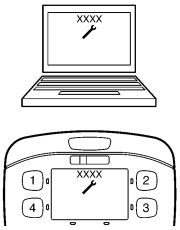
A935 – K160 D203 Motor Controller Contactor Failure



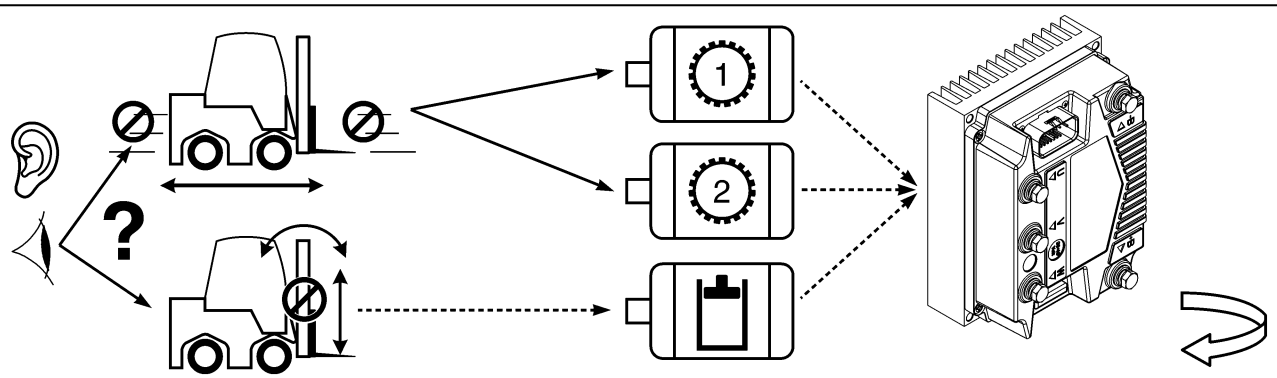
Fault Codes

DTC 21569
Contactor Open

DTC 21570
Contactor Closed

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1



? No Operation?

POSSIBLE CAUSES

DTC 21569 Contactor Open	Low Battery/Open Circuit Connections Go to 1, 2, and 3↓	→ Component Operational Check ↓
DTC 21570 Contactor Closed	Short Circuit Connections Go to 2 and 3↓	→ Component Operational Check ↓
DTC 21569/21570 Contactor Coil	Open/Short Circuit Connections Go to 2 and 3↓	→ Component Operational Check/ Component Operational Check↓

1. Go to Battery OORH/OORL
2. Go to Contactor/Relay/Valve Coil Short to Battery Positive (STBP)
3. Go to Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC)

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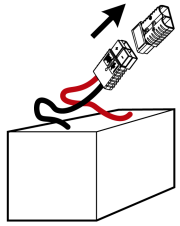
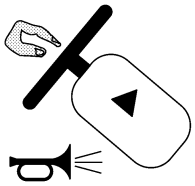
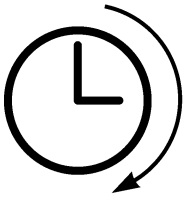
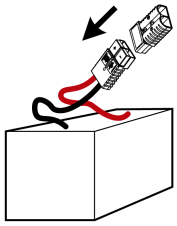
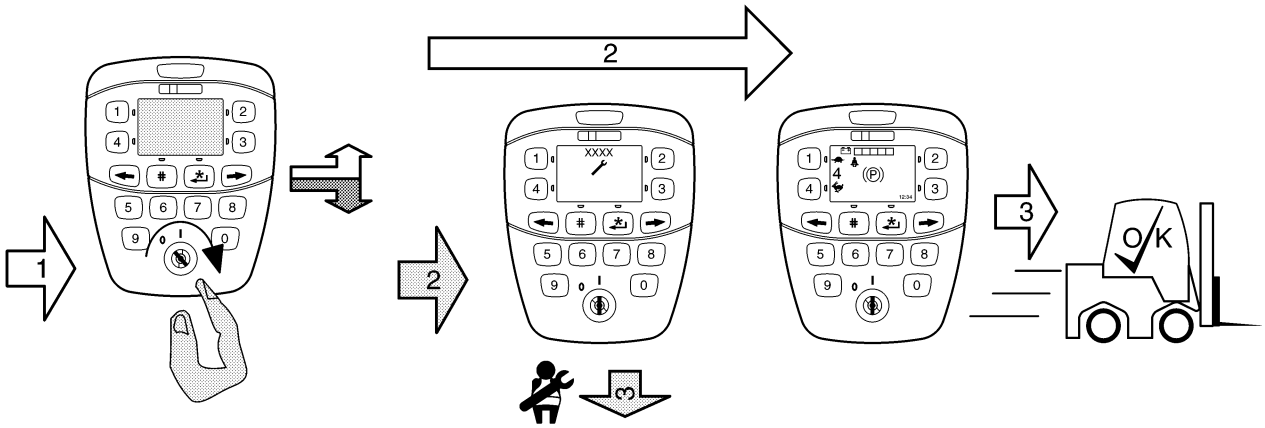
A935 – K160 D203 Motor Controller Contactor Failure (Cont)

Check 2

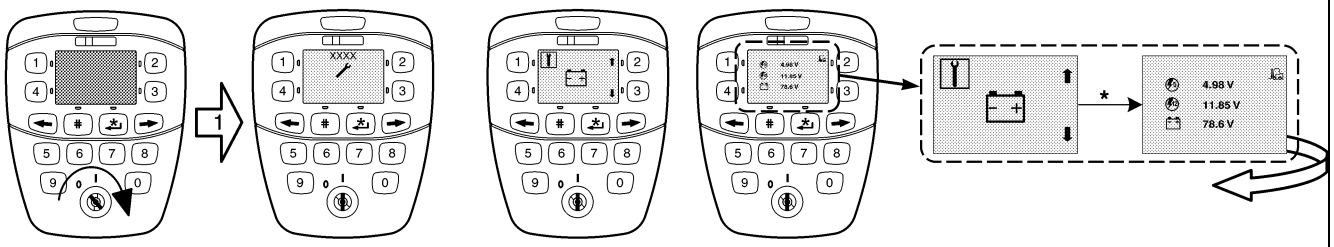
			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery

Check 3



Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

Check 4



Power ON→ Go to Diagnostics→ Battery/Supply→ View Bat Value→ Go to Display Menu Flowchart↓

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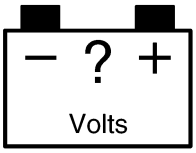
A935 – K160 D203 Motor Controller Contactor Failure (Cont)

Check 5

Battery OORL

NOTE: OOR Code is set if OOR condition is present for longer than 1 second.

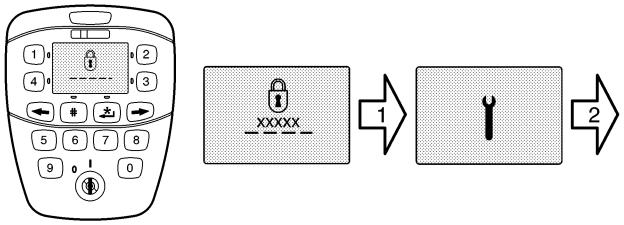


<

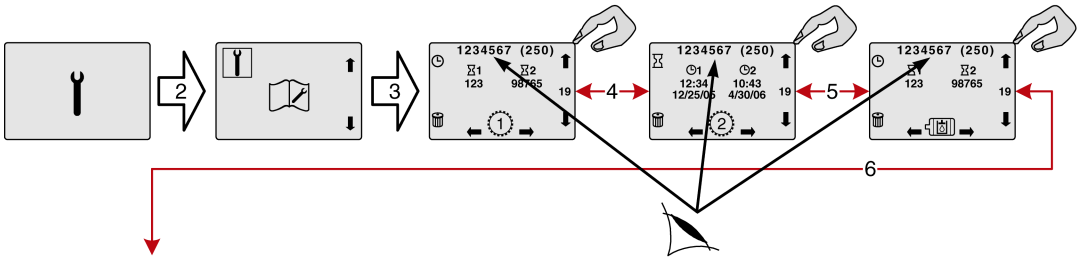
Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜< OORL	18	24	36	40
˜ OORH	48.6	57.6	97.2	108

Is battery voltage ˜ < OORL value for correct battery→ Is Bat Voltage ˜< OORL value for Correct Battery→ YES → Battery OORH/OORL → NO ?

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostics→



Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?

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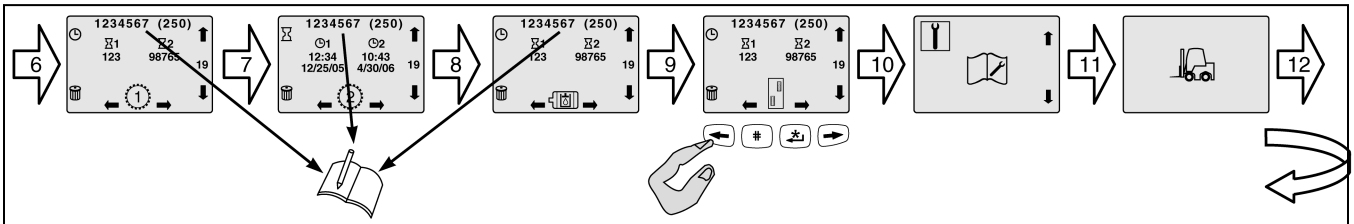
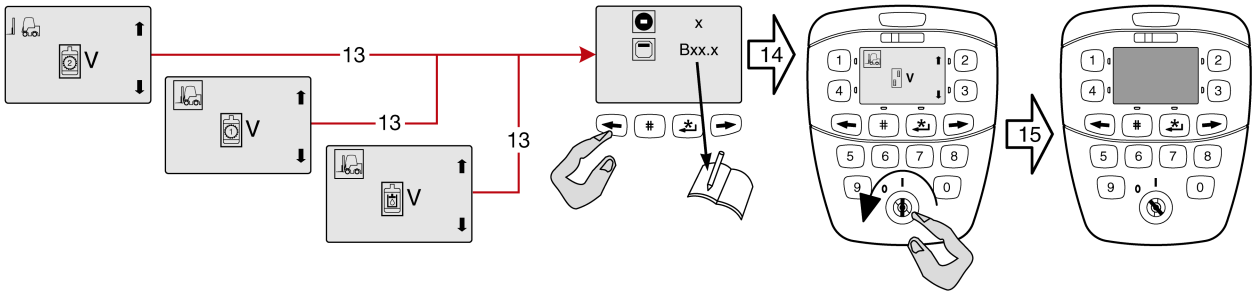
A935 – K160 D203 Motor Controller Contactor Failure (Cont)



all Motor DTCs→ ☜ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ ☜ Exit Versions→ Power **OFF**?

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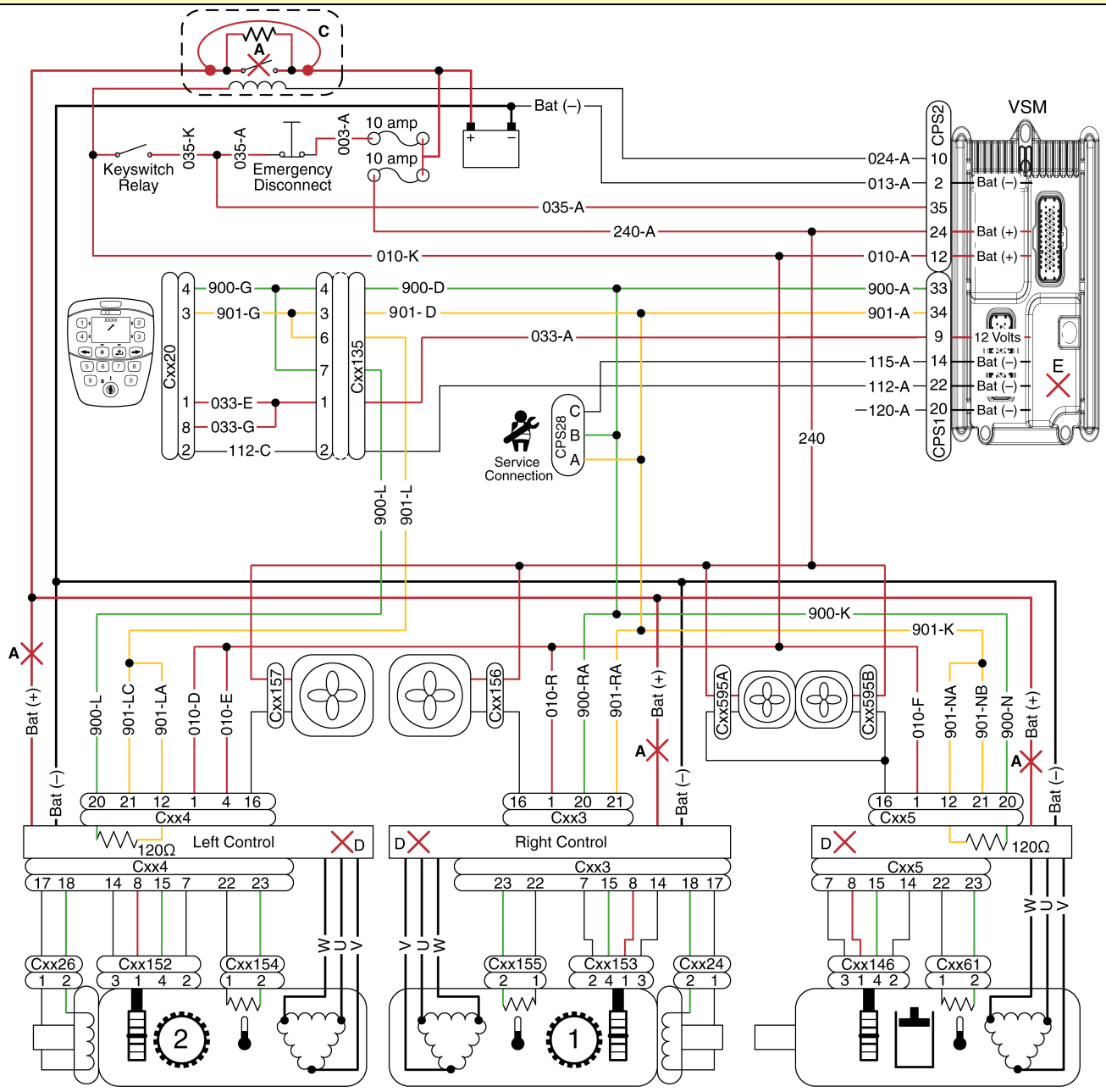
A935 – K160 D203 Motor Controller Contactor Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

MOTOR CONTROLLER CONTACTOR FAILURE CAUSES A B C D E > ?



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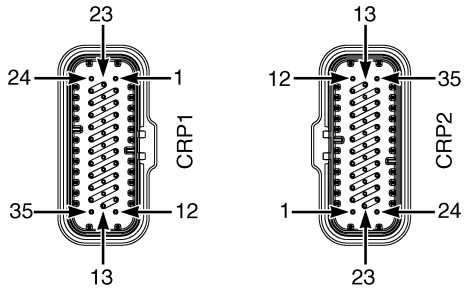
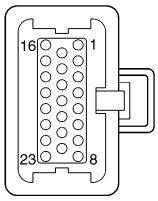
A935 – K160 D203 Motor Controller Contactor Failure (Cont)

CONNECTORS

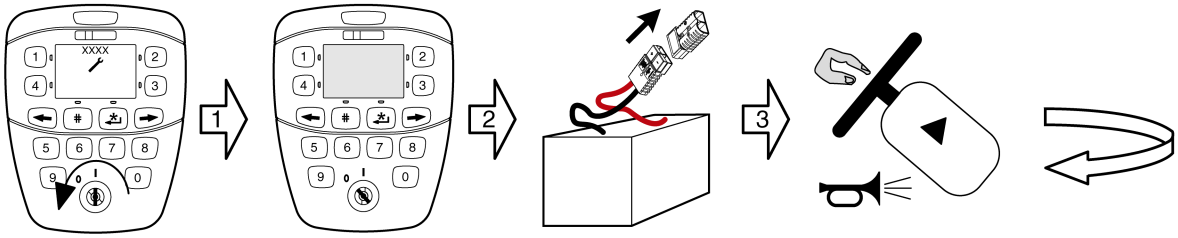


VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

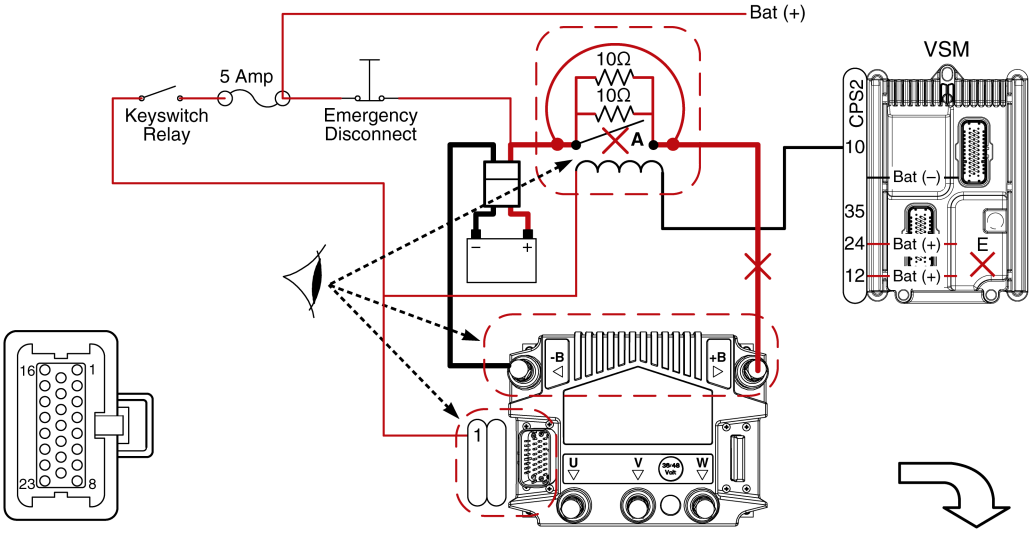
CAUSE A



Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. ?

STEP A1

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections

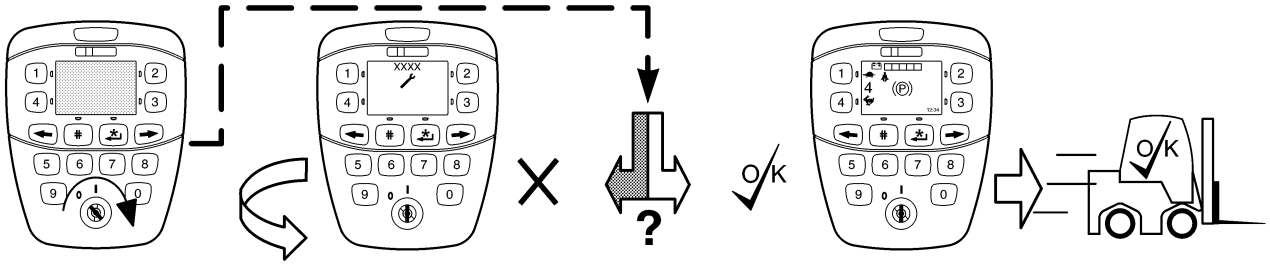


A935 – K160 D203 Motor Controller Contactor Failure (Cont)

STEP A2

1. Inspect Contactor Top and Bottom Contacts for Pitting/Corrosion/Dirt Build-Up→Go to 2↓
2. Replace Contactor if Pitting/Corrosion is Observed→↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓
4. Check all Connections→Reconnect Battery→Step A3↓

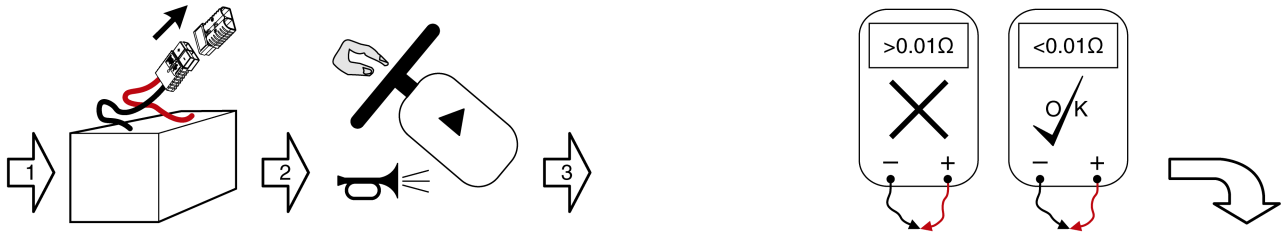
STEP A3



Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

STEP A4 CHECK RESISTANCE - Ω - OHMS



Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→ ?

Set DMM to Lowest ?→ Check Lead Resistance < 0.01?

Note: If the Resistance is > 0.01? then record this as the Zero ? Value→ ↓

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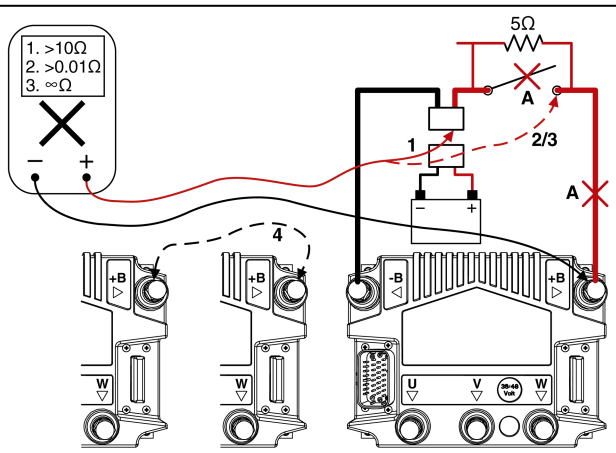
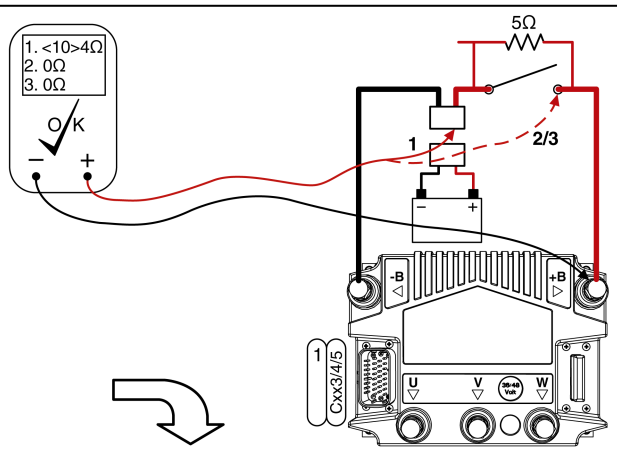
A935 – K160 D203 Motor Controller Contactor Failure (Cont)

STEP A5	**CHECK RESISTANCE - Ω - OHMS**
Contactor Open	
	
1. >10 ? @ 25 °C (77 °F) = Faulty PTC→5↓0 ?→Component Operational Check↓	1. <10 ? >4 ? = OK→Go to 2↓
2. > Zero Value +0.01 = High Resistance→Go to 5↓	2. ˜0 ? = OK→Go to 4↓
3. 8 ? = Open Circuit→Go to 5↓	3. ˜0 ? = OK→Go to 4↓
4. Repeat 2 & 3 on other Motor Controllers↑→Go to 5↓	
5. Find/Repair High Resistance Open Circuit→Go to 7↓	
6. Replace PTC(s)→Go to 7↓	
7. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
8. Recheck ?↑→ Reconnect→Test→Component Operational Check↓	
CAUSE B	
Not Applicable	

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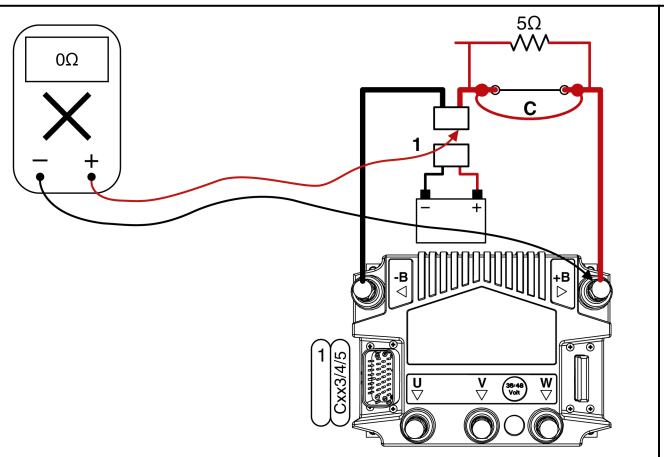
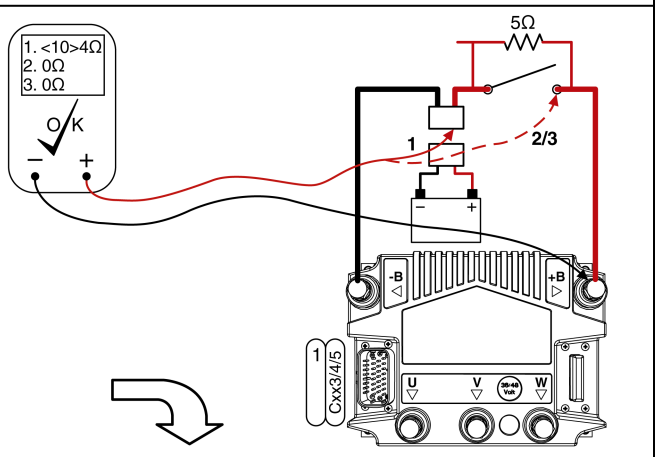
A935 – K160 D203 Motor Controller Contactor Failure (Cont)

CAUSE C

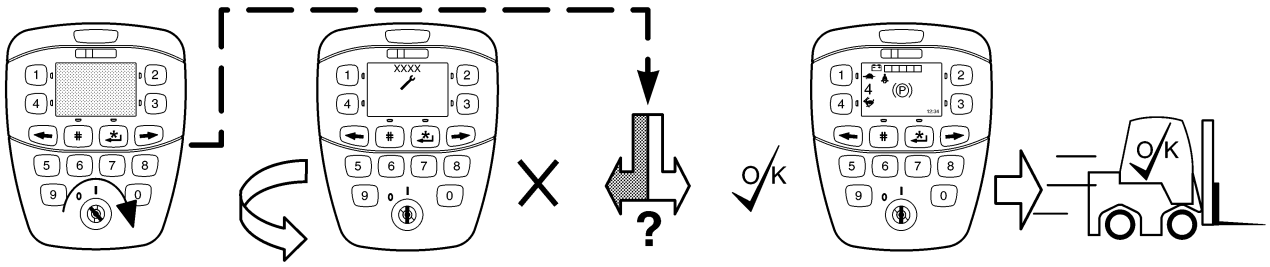
Contactor Closed





1. 0 ? = Shorted PTC/Welded Contacts→Go to 2↓	1. >4 ? <10 ? = OK→Component Operational Check↓
2. Disconnect PTC→Recheck ?↓	
3. 8 ? = Shorted PTC Go to 4↓0 ? = Welded Contacts→Go to 5↓	
4. Replace PTC(s)→Go to 6↓	
5. Replace Contactor→Go to 6↓	
6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
7. Recheck ?↑→ Reconnect→Test↓	

STEP C1



Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

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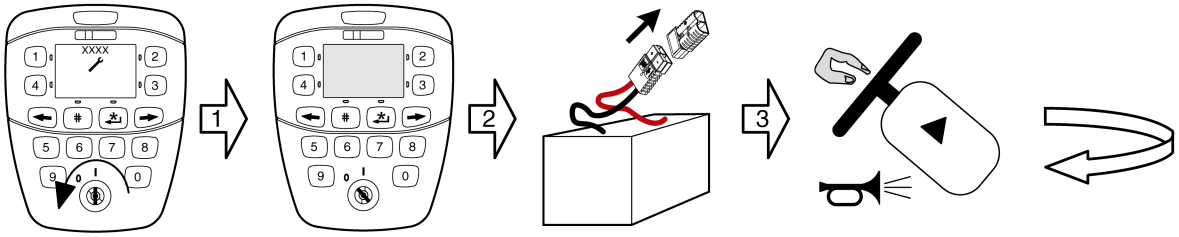
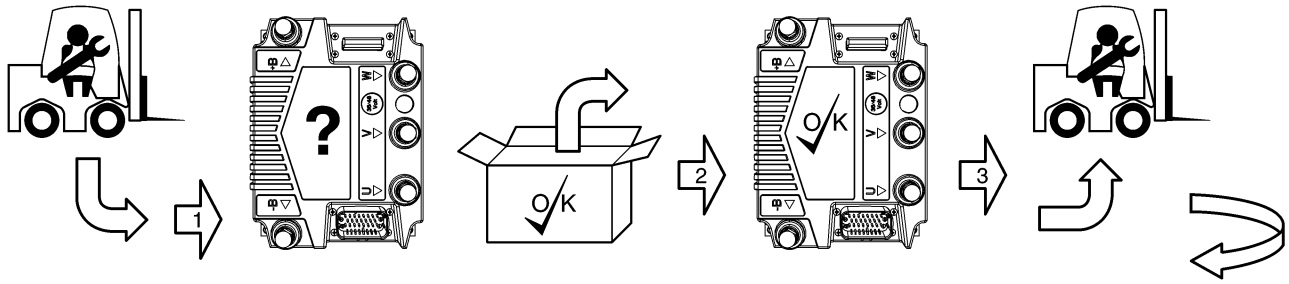
A935 – K160 D203 Motor Controller Contactor Failure (Cont)

CAUSE D



Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. ?

STEP D1

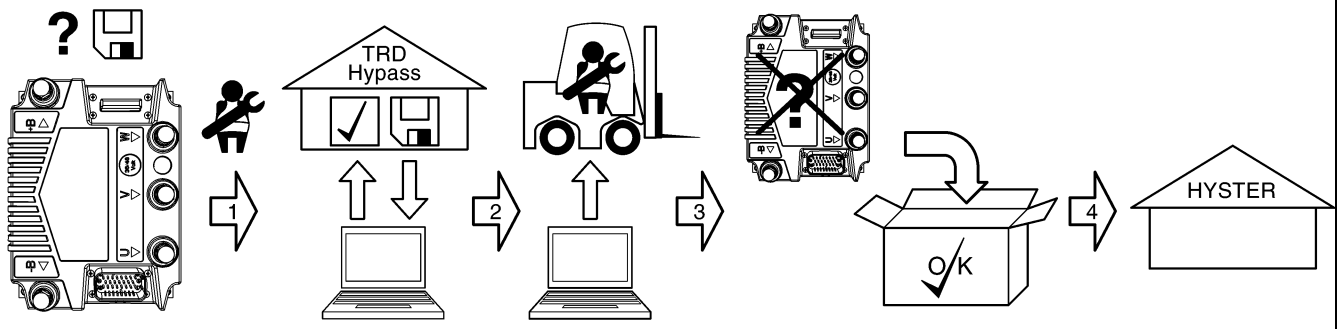


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

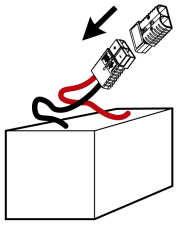
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

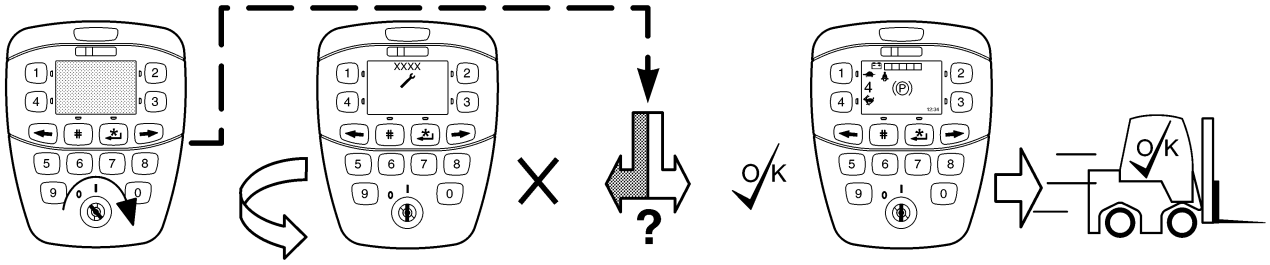
3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 D203 Motor Controller Contactor Failure (Cont)

STEP D3

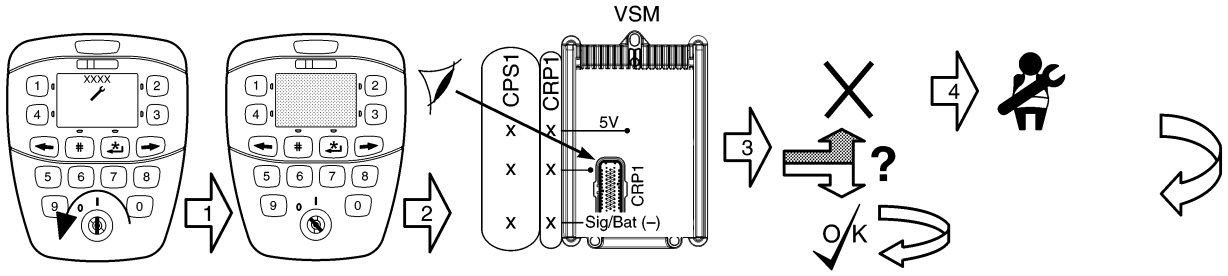




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

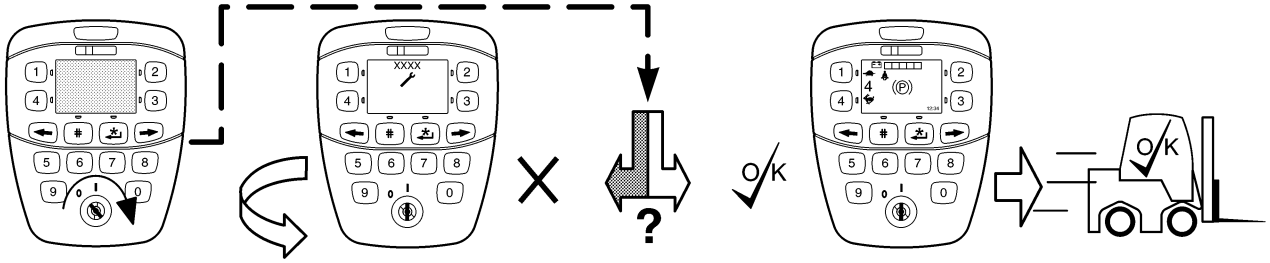
NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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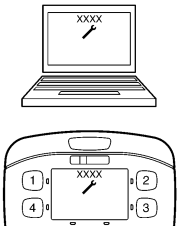
A935 – K160 D203 Motor Controller Capacitor Failure

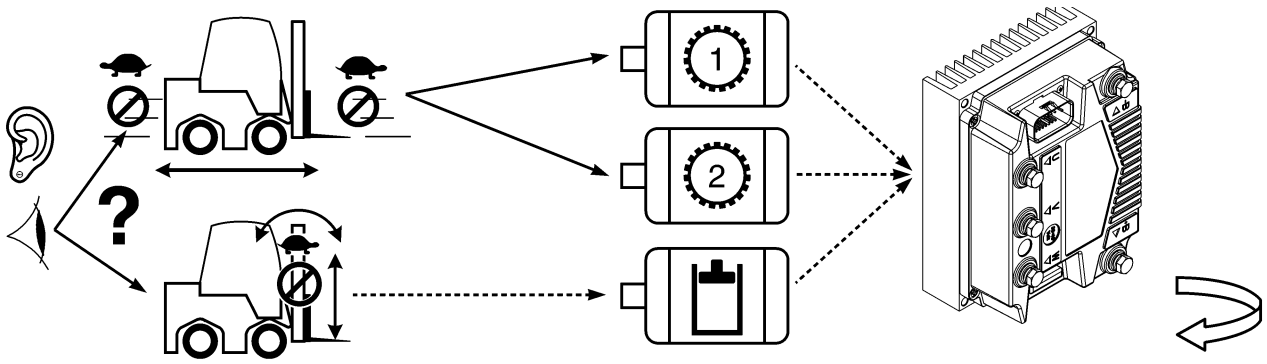


Fault Codes

DTC 12592
Capacitor Charge

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1

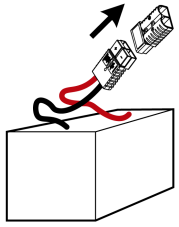
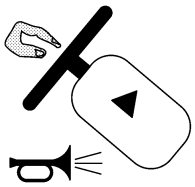
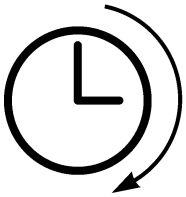
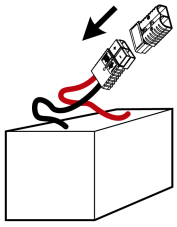


? Function Failure/Reduced Performance/Uncommanded Continuous Operation?

POSSIBLE CAUSES

1. Motor Controller Connections/Wiring High Resistance?→	→ Component Operational Check ↓
2. Motor Controller(s) Failure?→	→ Component Operational Check ↓

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

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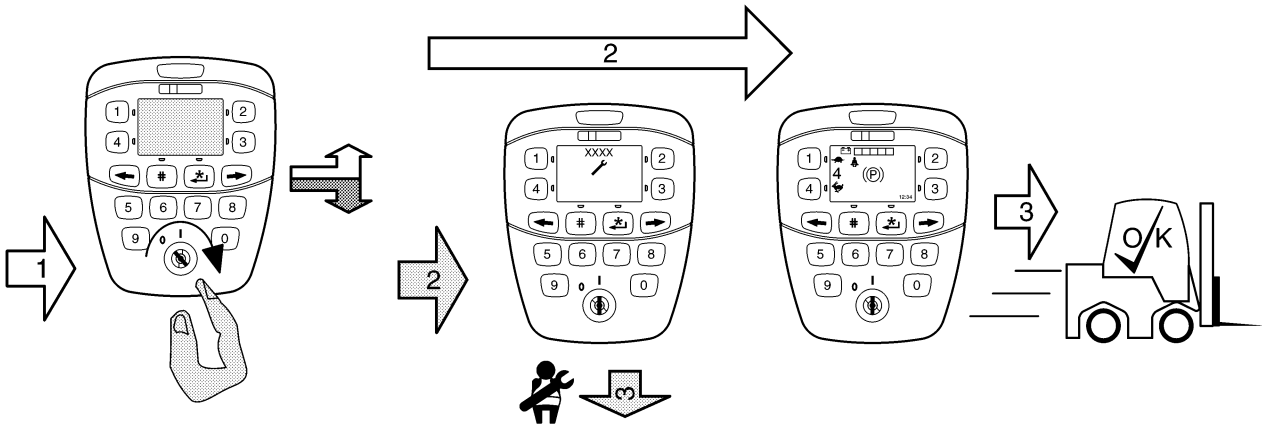
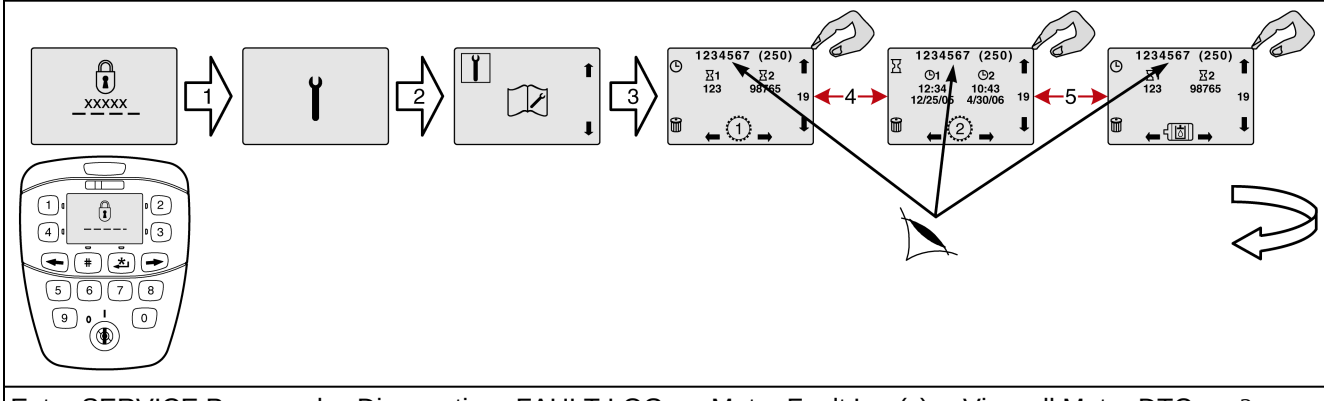
A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

Check 3

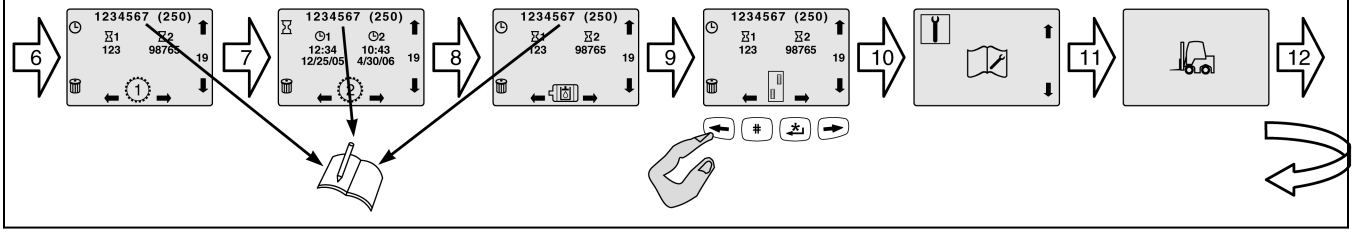


Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

FAULT LOG Review - Go to Display Menu



Enter SERVICE Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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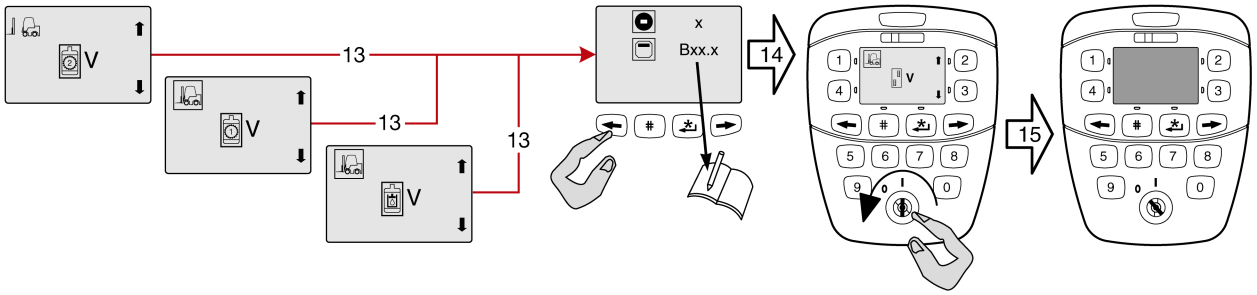
A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

📝 all Motor DTCs→ ☜ Exit Fault Log→ Truck Status ?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection
Motor Versions→ 📝Hardware/Software Versions→ ☜ Exit Versions→ Power **OFF**?

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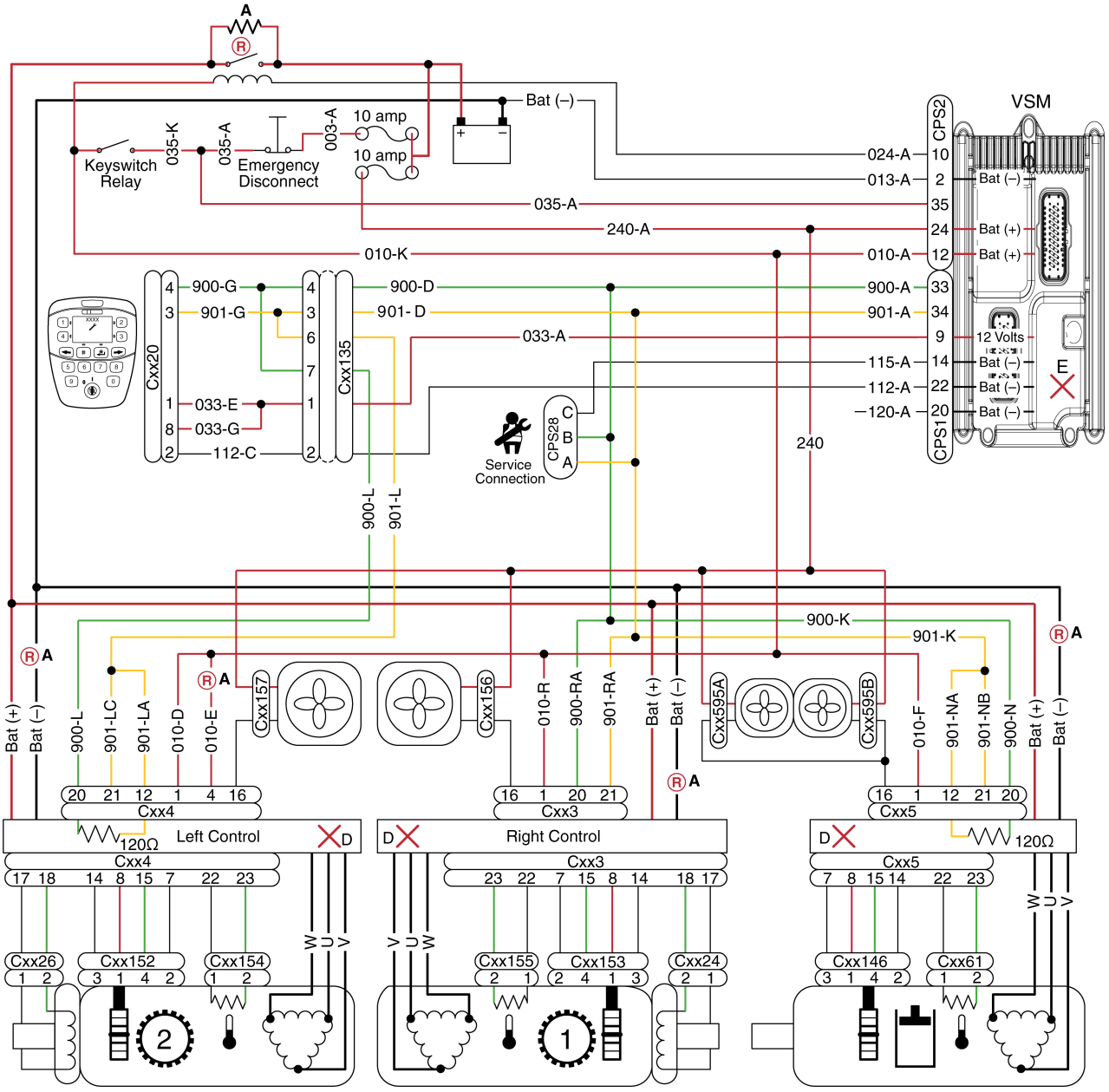
A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

MOTOR CONTROLLER CAPACITOR FAILURE CAUSES A B C D E > ?



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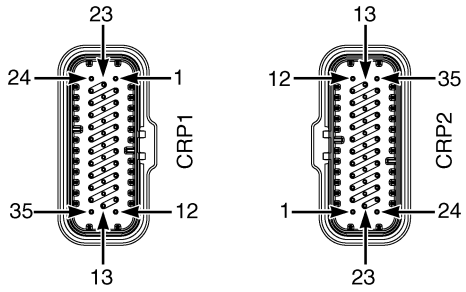
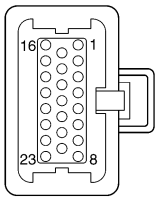
A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

CONNECTORS

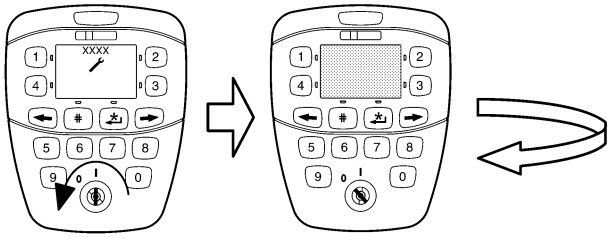


VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

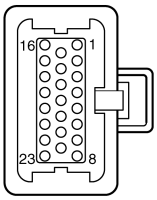
CAUSE A

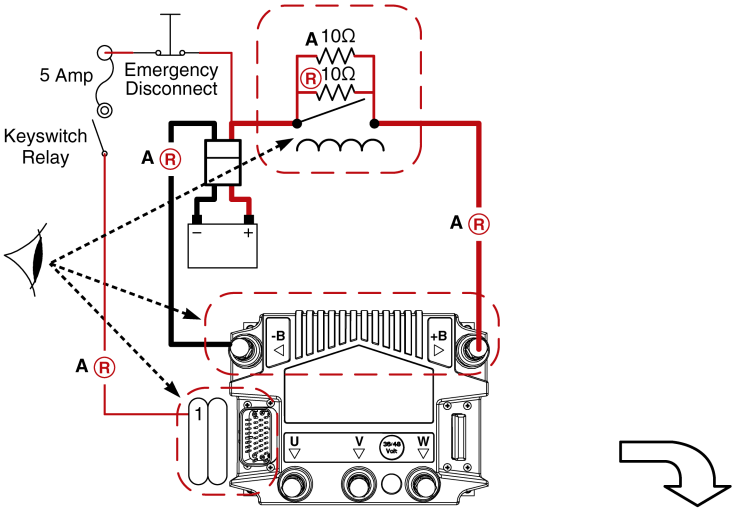


Power **OFF**→ ?

STEP A1

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections See Diagnostic Trouble Codes, Page 9030-20-238





CAUSE B

Not Applicable

CAUSE C

Not Applicable

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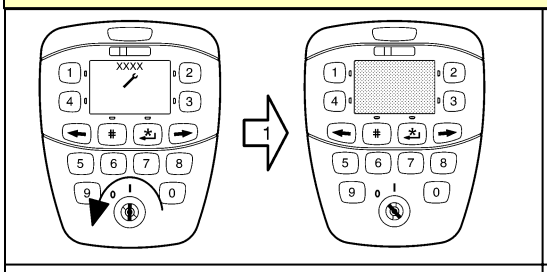
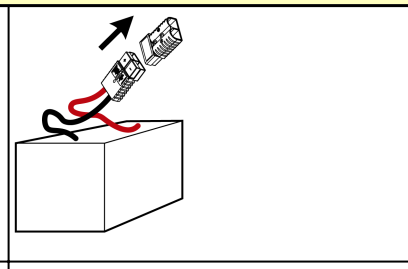
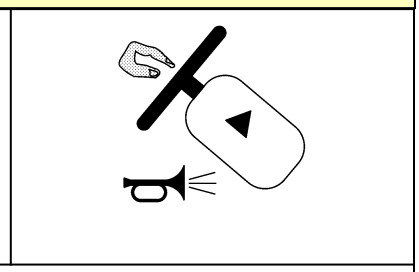
A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

CAUSE D

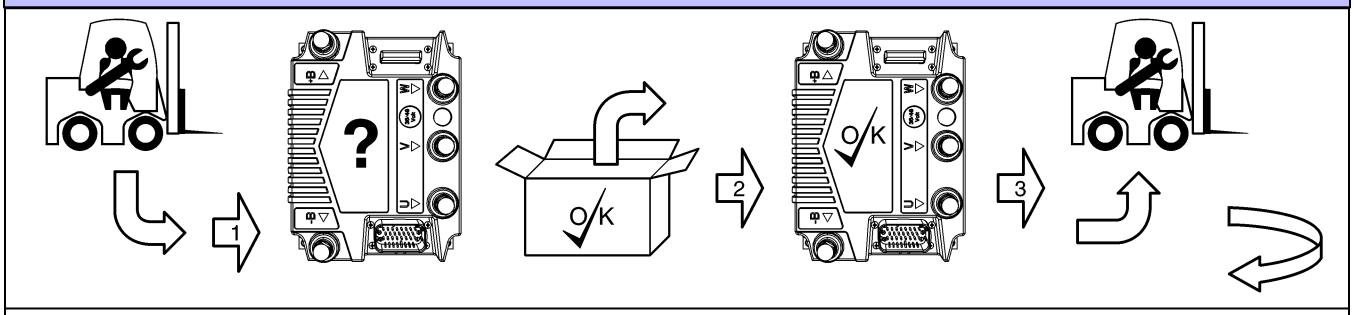






Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1

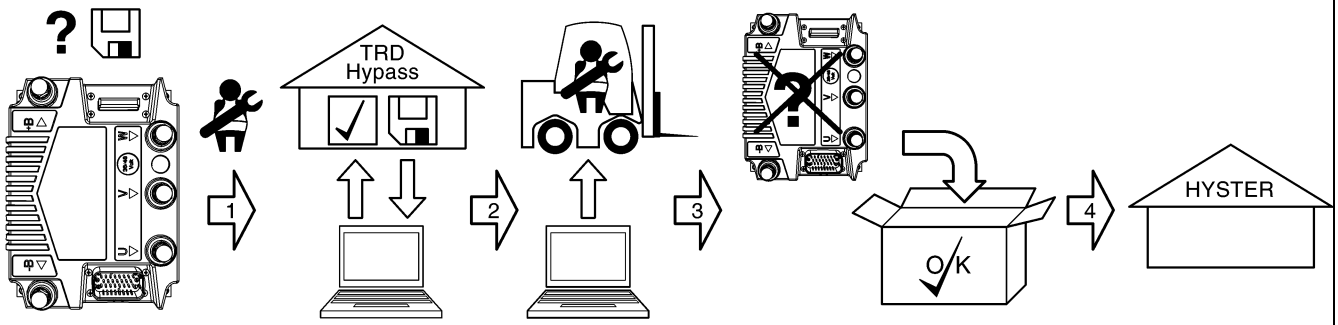


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

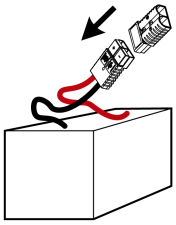
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

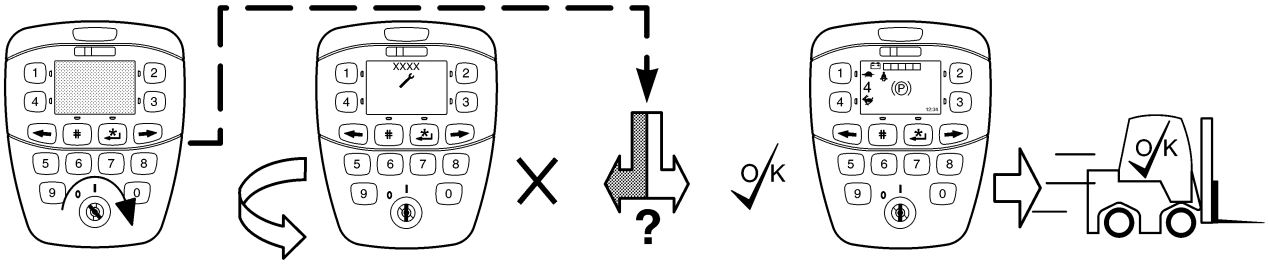
3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

STEP D3

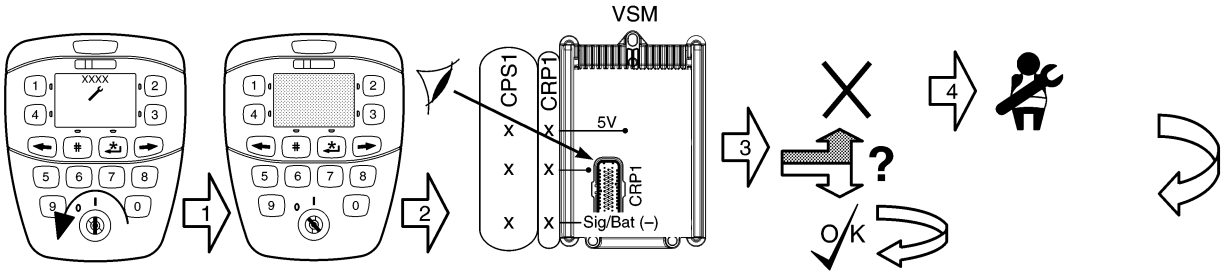




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

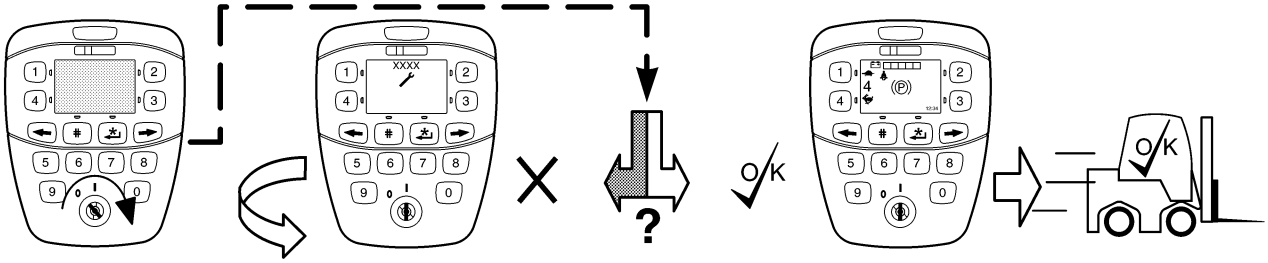
NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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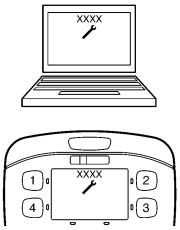
A935 – K160 D203 Motor Speed Sensor Failure

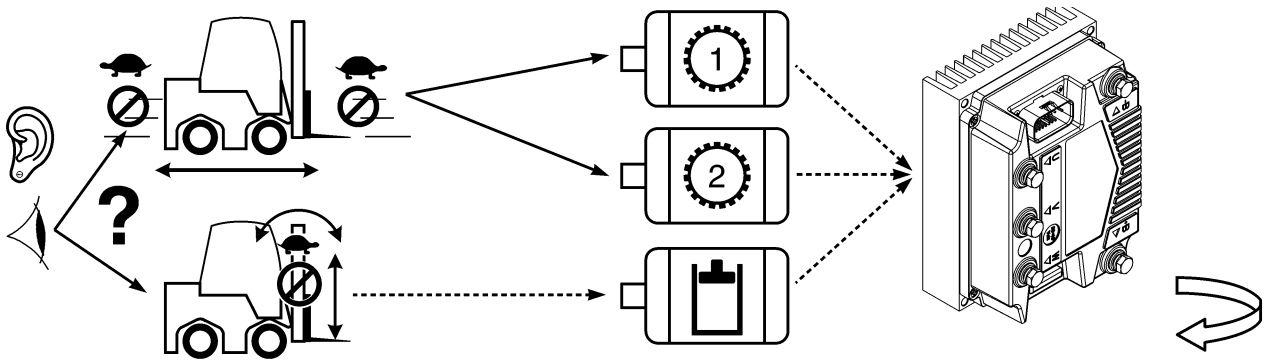


Fault Codes

DTC 29456
Sensor Fault

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1

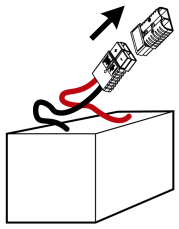
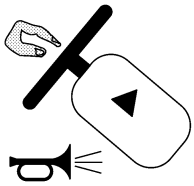
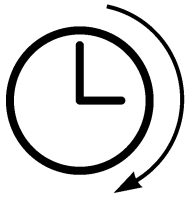
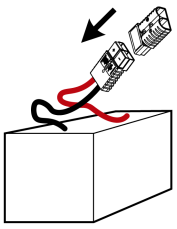


?No Traction/Hydraulic Operation?

POSSIBLE CAUSES

1. Speed Sensor/Motor Controller Connections/Wiring?→
2. Speed Sensor Failure?→
3. Brake Drag and/or Axle Lockup?→Go to Brake and Axle Drag Check, Operational Checkout.↓
4. Motor Controller(s) Failure ?→
5. Motor Failure ?→

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery	

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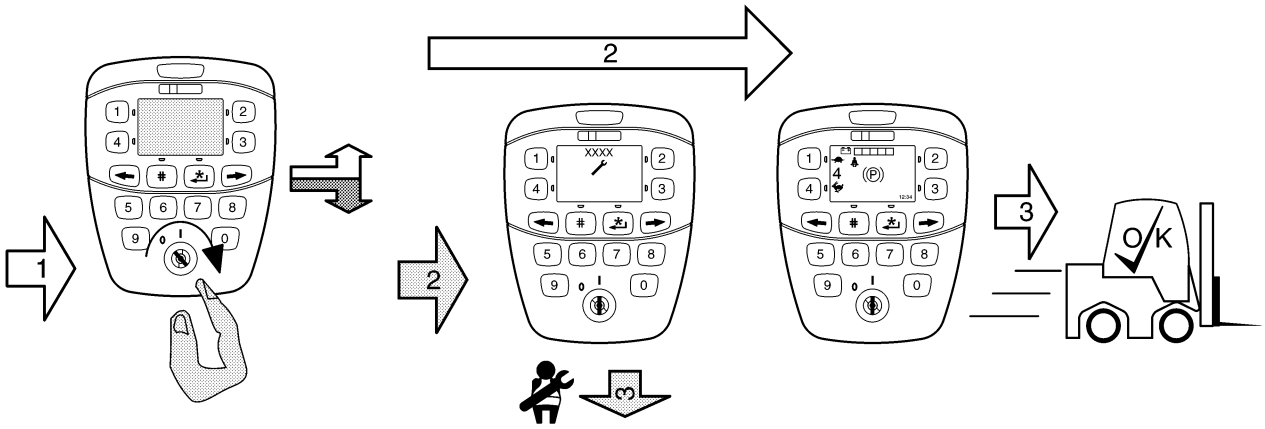
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

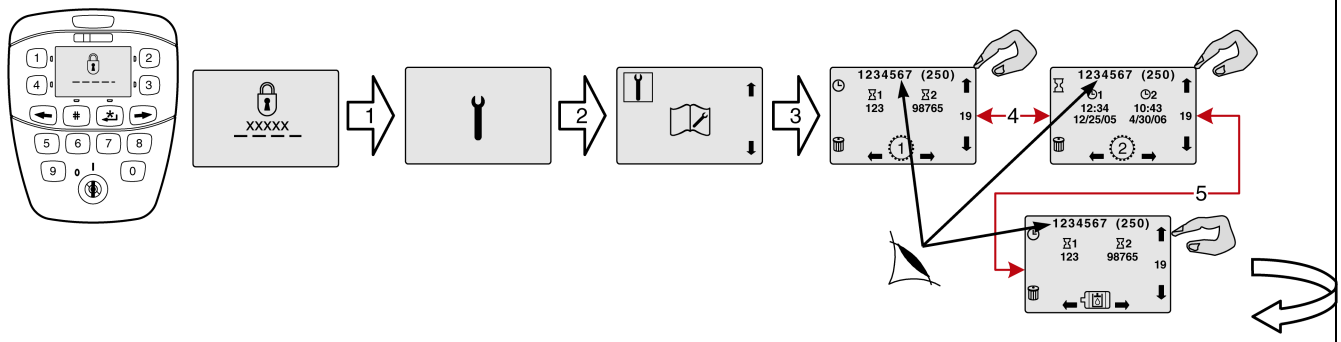
Check 3



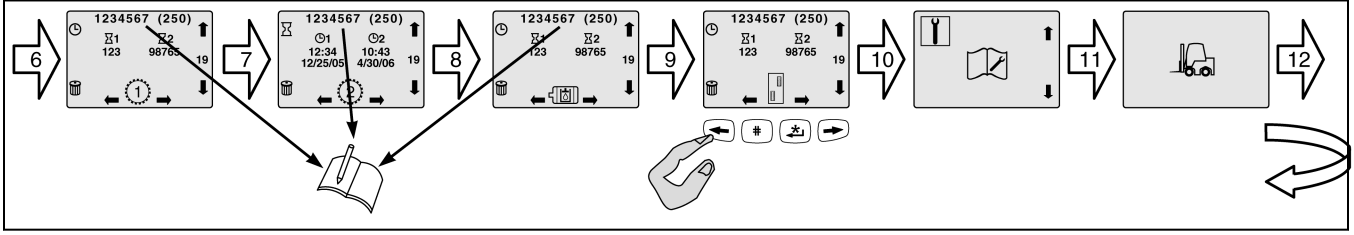
Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

Check 4

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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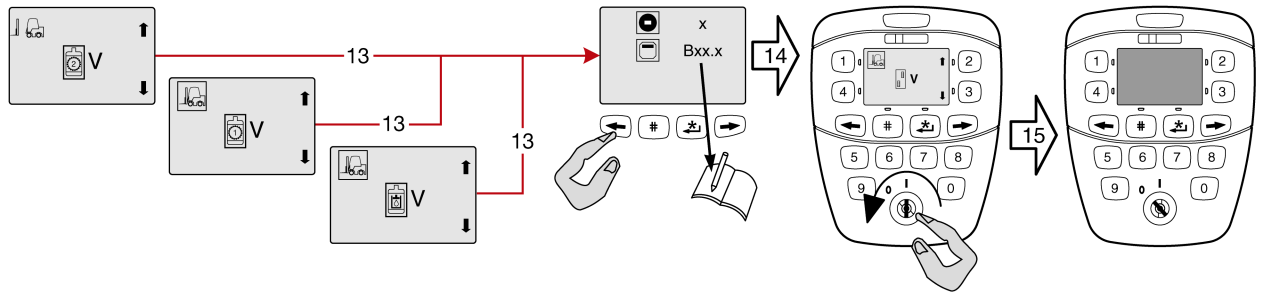
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

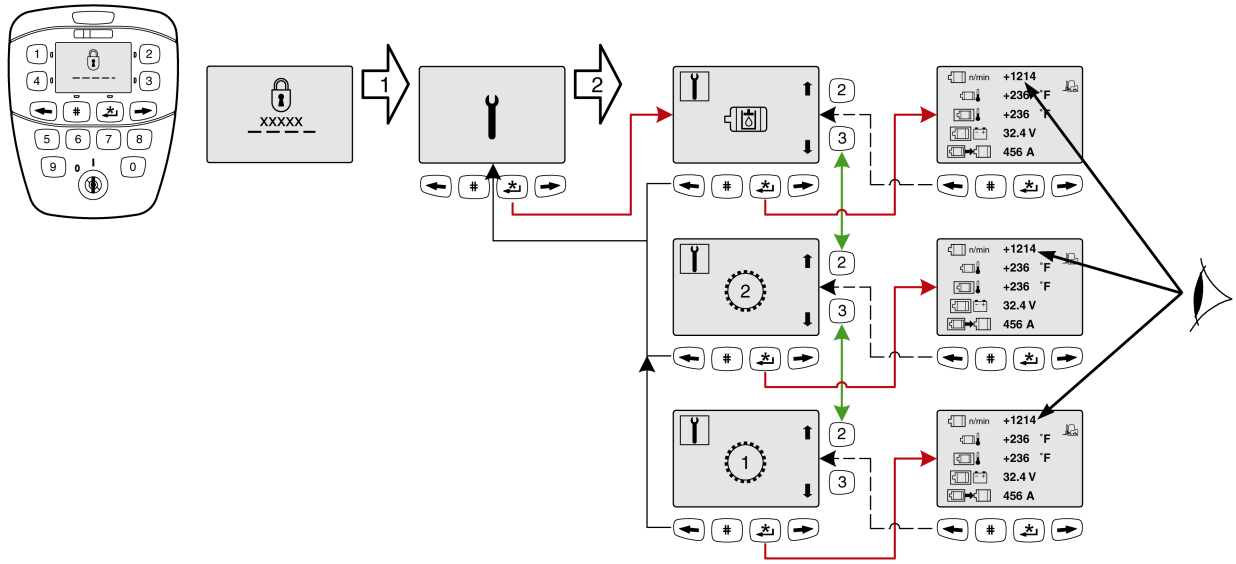
all Motor DTCs→ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ Exit Versions→ Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

Diagnostics Speed Sensor Analysis – Use to Validate Correct Sensor Operation after Repairs

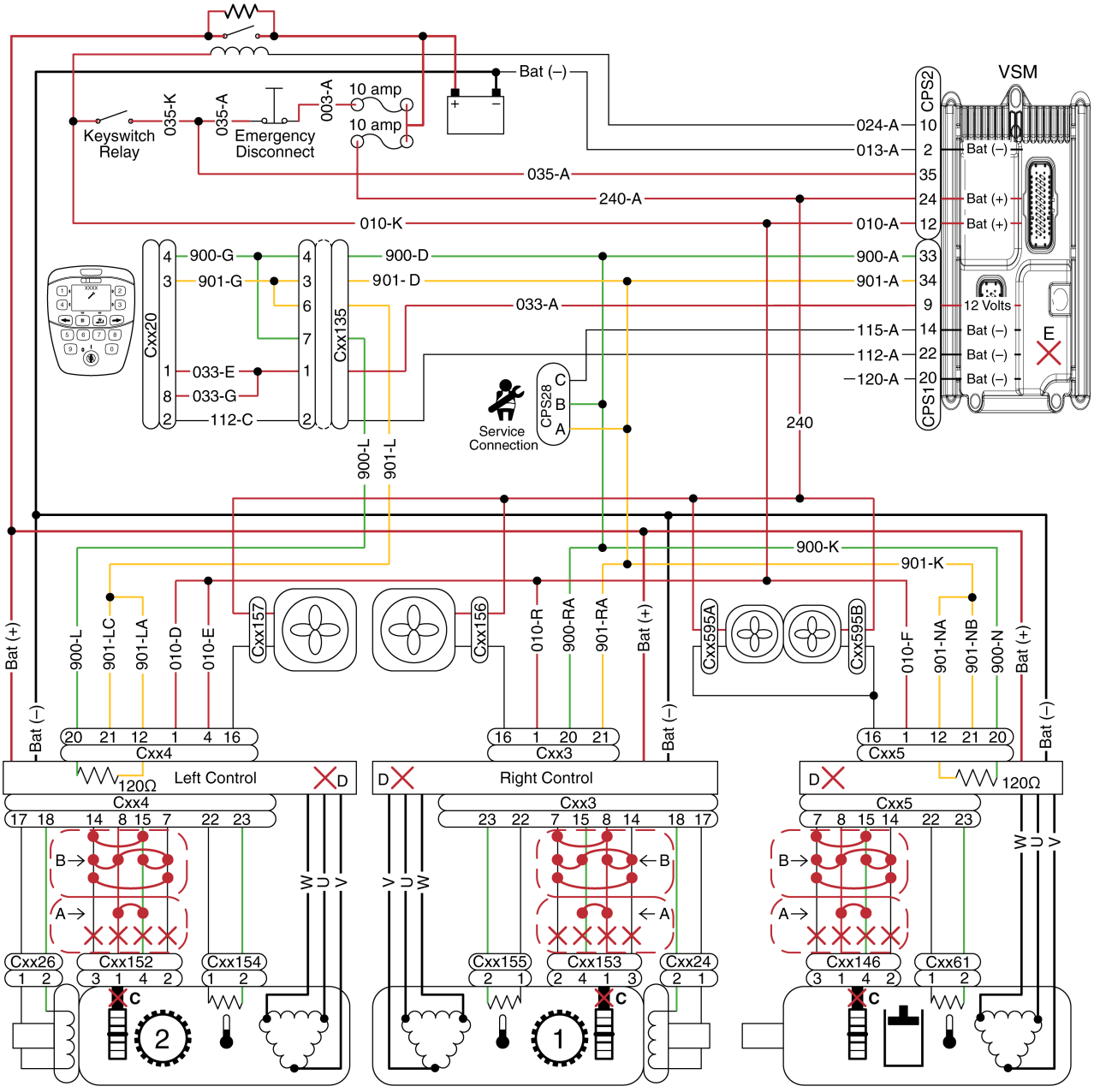


NOTE: If Motor Operation is Disabled then no speed will be displayed

A935 – K160 D203 Motor Speed Sensor Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

WHEEL MOTOR SPEED SENSOR FAILURE CAUSES A B C D E > ?



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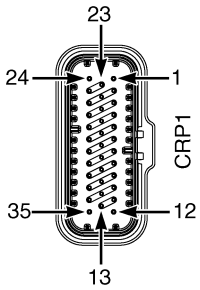
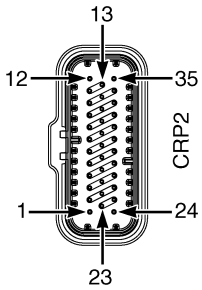
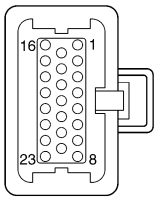
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

CONNECTORS

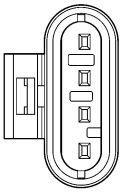




VSM Cxx 1 and Cxx 2

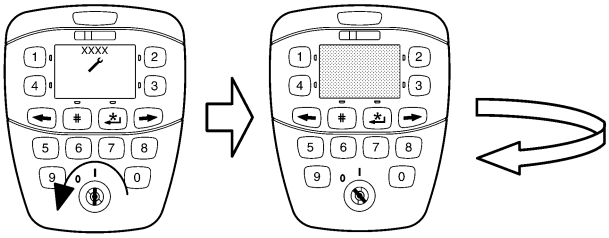


Traction/Pump Controller Cxx 3, 4, and 5



Speed Sensor Motor Connector Cxx 146, 152, and 153

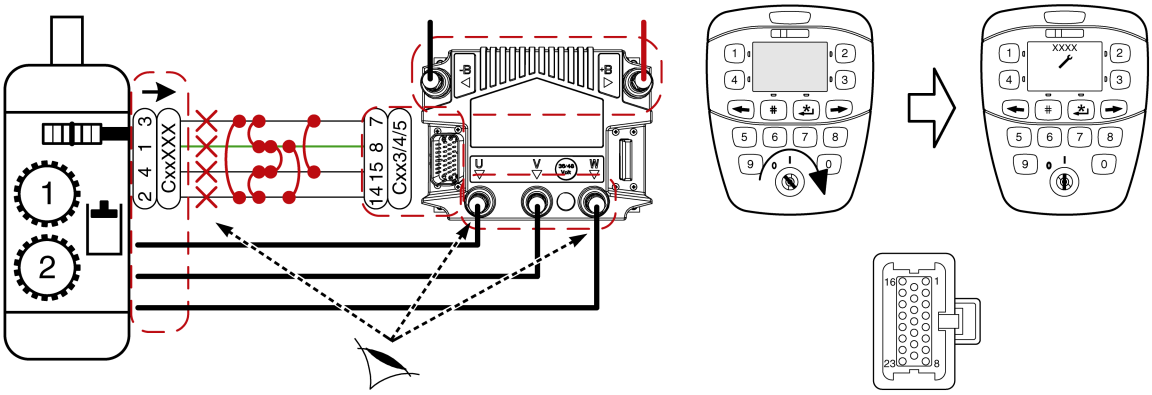
CAUSE A



Power **OFF**→ ?

STEP A1

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections



Disconnect Cxx XXX as indicated from the Fault Logs→ Power **ON**↓

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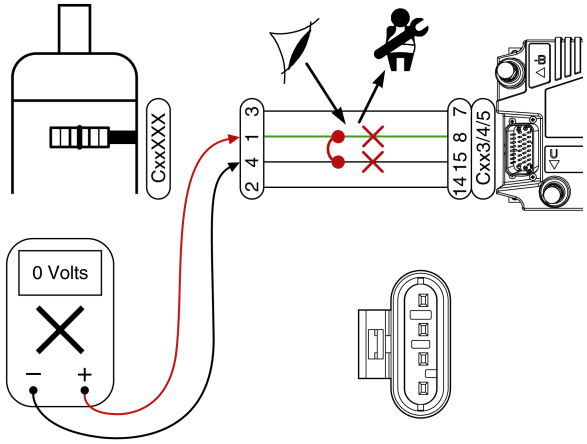
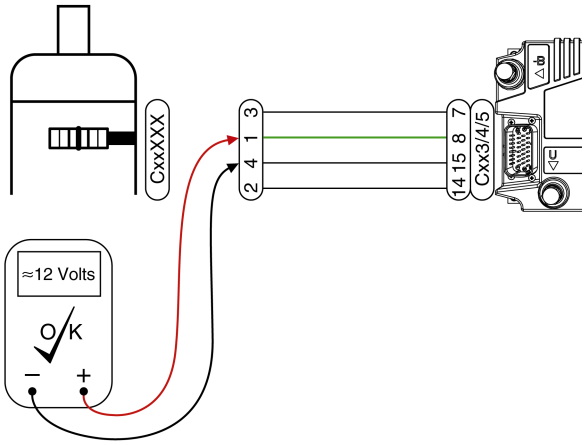
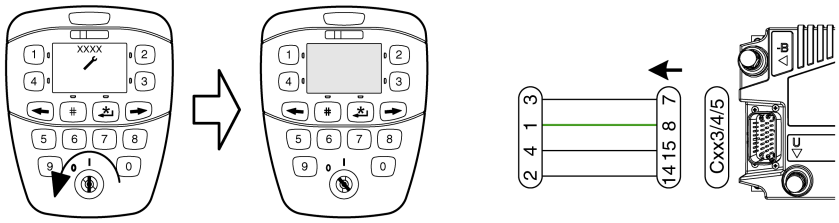
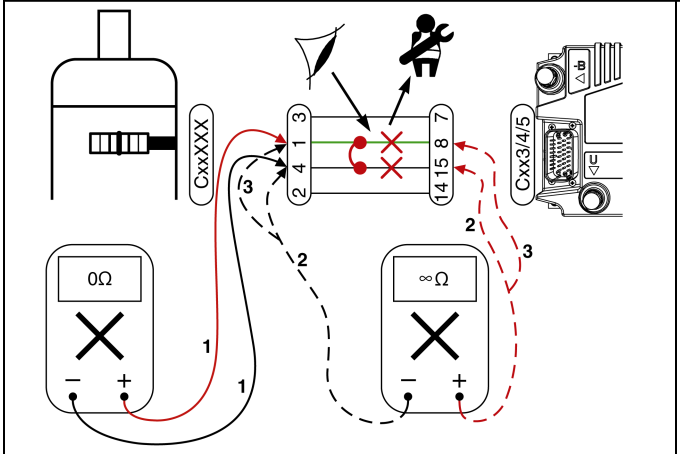
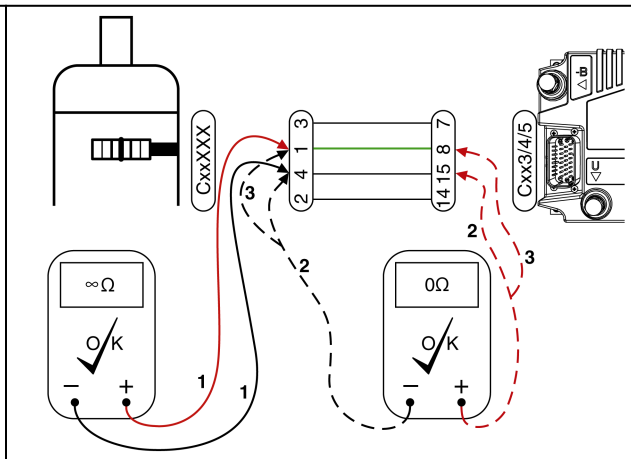
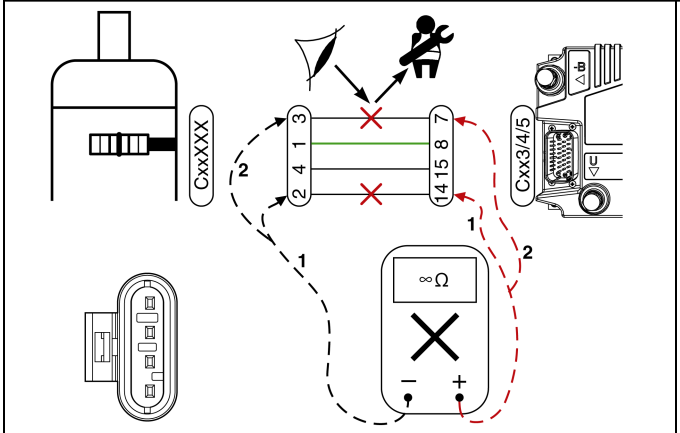
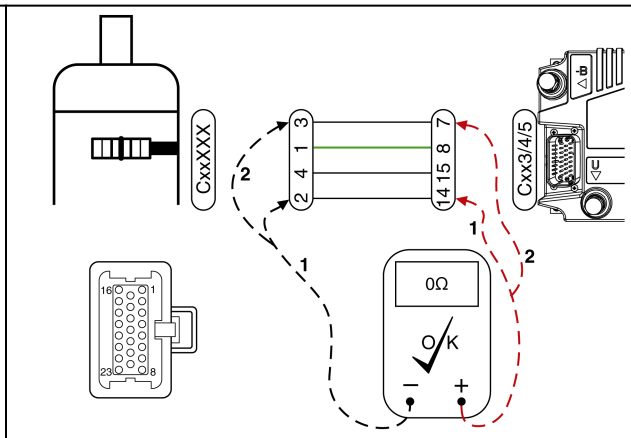
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

STEP A2	CHECK VOLTAGE
Speed Sensor Supply	
	
1. 0 Volts = Open/Short Circuit→Step A3↓	1 ˜ 12 Volts = OK→Step A3↓Step A5↓
2. Bat Volts = Short to Bat (+)→Component Operational Check↓	2. ˜ 12 Volts = OK→Step A3↓Step A5↓

STEP A3	CHECK RESISTANCE - Ω - OHMS
	
Power **OFF**→ Disconnect Cxx 3, 4, or 5 as indicated from the Fault Logs→	

A935 – K160 D203 Motor Speed Sensor Failure (Cont)

STEP A4	CHECK RESISTANCE - Ω - OHMS
Speed Sensor Connections	
	
1. 0? = Short Circuit→Go to 4↓	1 ˜ 8? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 4↓	2. ˜ 0? = OK→Go to 3↓
3. 8? = Open Circuit→Go to 4↓	3. ˜ 0? = OK→Component Operational Check↓
4. Find/Repair Short/Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
5. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume OperationNo→Component Operational Check↓	

STEP A5	CHECK RESISTANCE - Ω - OHMS
Speed Sensor Connections	
	
1. 8? = Open Circuit→Go to 3↓	1. ˜ 0? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 3↓	2. ˜ 0? = OK→Component Operational Check↓
3. Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
4. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume OperationNo→Component Operational Check↓	

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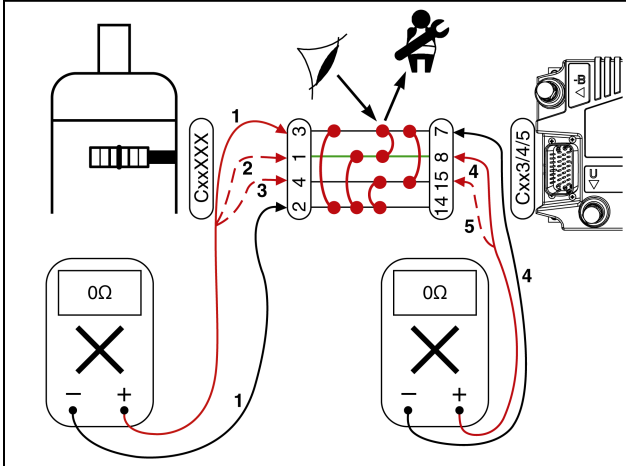
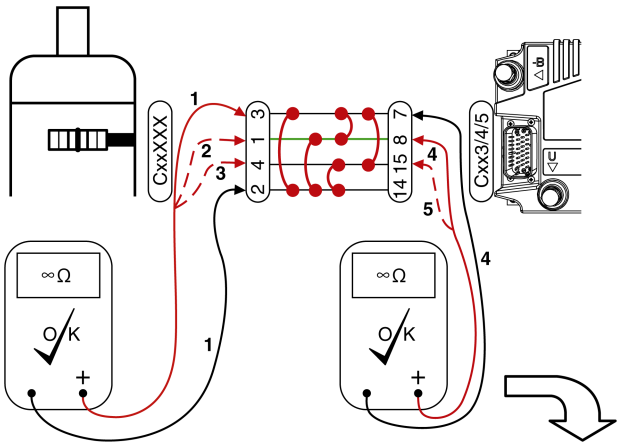
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

CAUSE B **CHECK RESISTANCE - Ω - OHMS**

Speed Sensor Connections

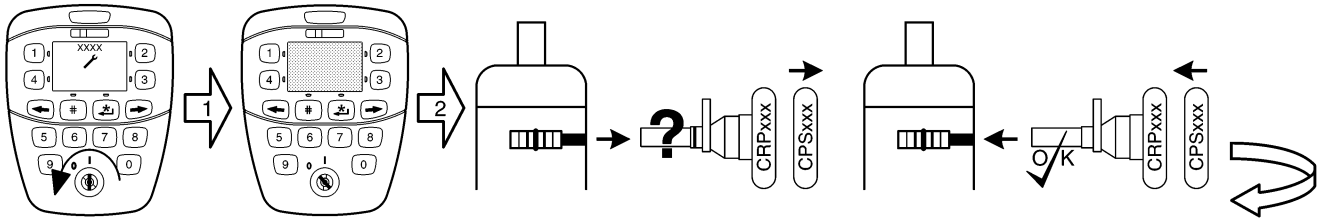




1. 0? = Short Circuit→Go to 6↓	1. ˜ 8? = OK→Go to 2↓
2. 0? = Short Circuit→Go to 6↓	2. ˜ 8? = OK→Go to 3↓
3. 0? = Short Circuit→Go to 6↓	3. ˜ 8? = OK→Go to 4↓
4. 0? = Short Circuit→Go to 6↓	4. ˜ 8? = OK→Go to 5↓
5. 0? = Short Circuit→Go to 6↓	5. ˜ 8? = OK→Component Operational Check↓
6. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓	
7. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume OperationNo→Component Operational Check↓	

CAUSE C **CHECK RESISTANCE - Ω - OHMS**

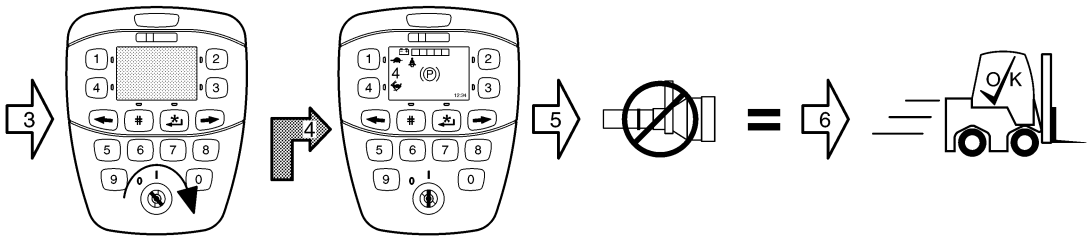
Sensor Failure



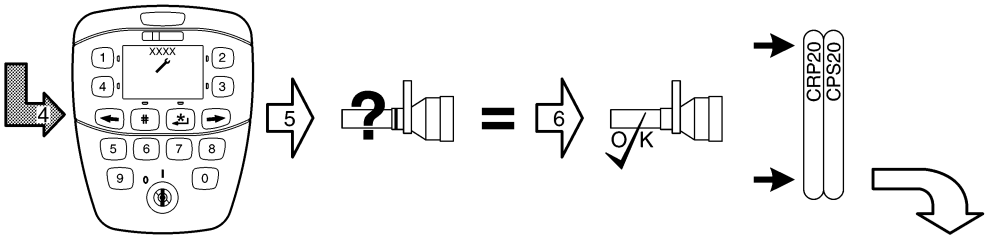
Power **OFF**→	Remove/Replace Motor Speed Sensor↓
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ Step C1 ↓	

A935 – K160 D203 Motor Speed Sensor Failure (Cont)

STEP C1

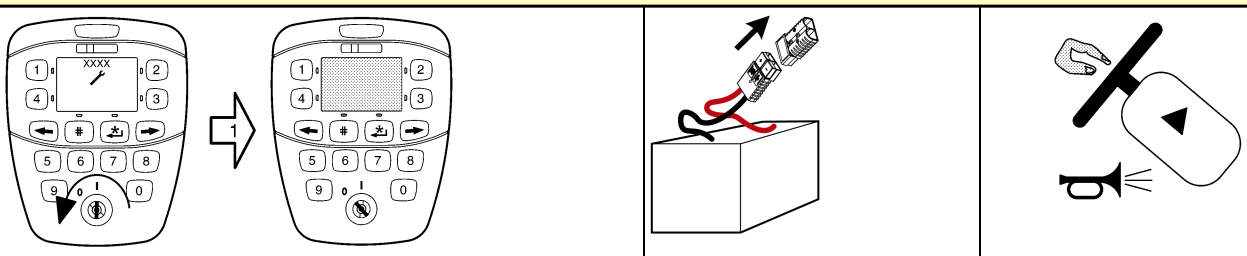


Power **ON**→ ⇳	DTCs Gone→	Original Sensor Faulty→	Resume Operation



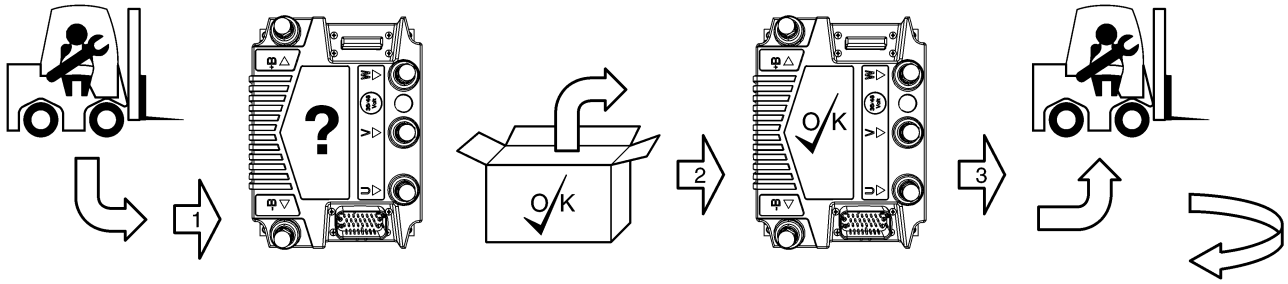
	DTCs Present→	Original Sensor OK/Reinstall Original Sensor→ Component Operational Check ↓

CAUSE D



Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

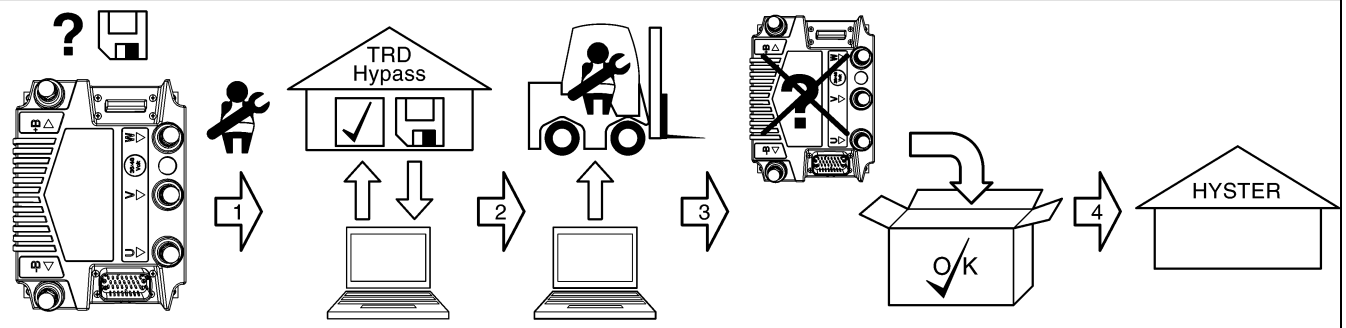
STEP D1



Remove and Replace Faulty Motor Controller↓
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓
Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

A935 – K160 D203 Motor Speed Sensor Failure (Cont)

STEP D2



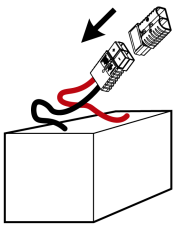
1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

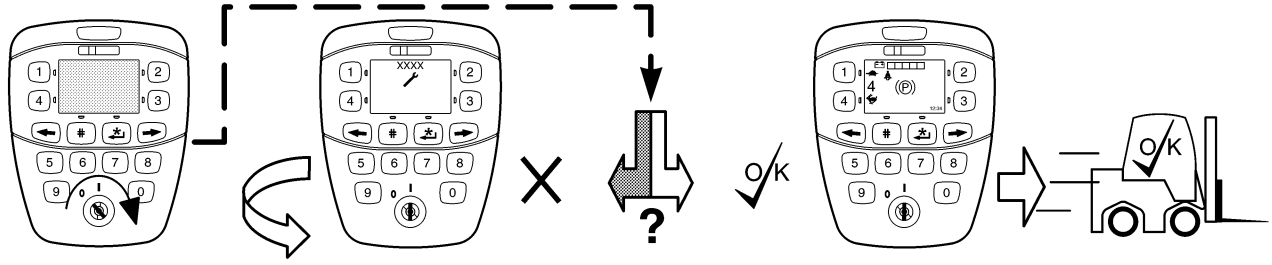
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

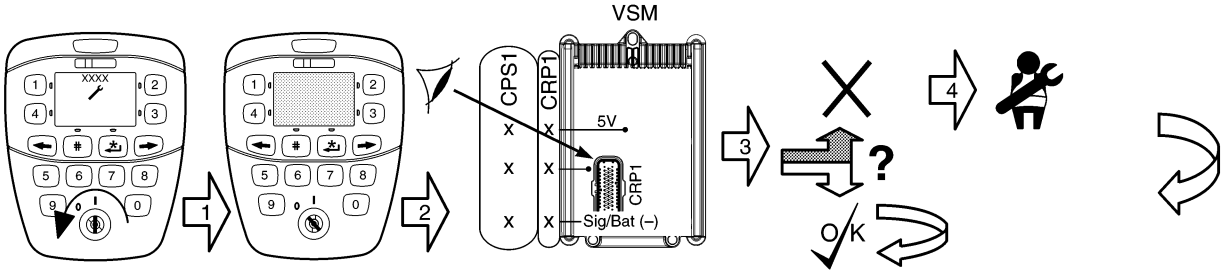




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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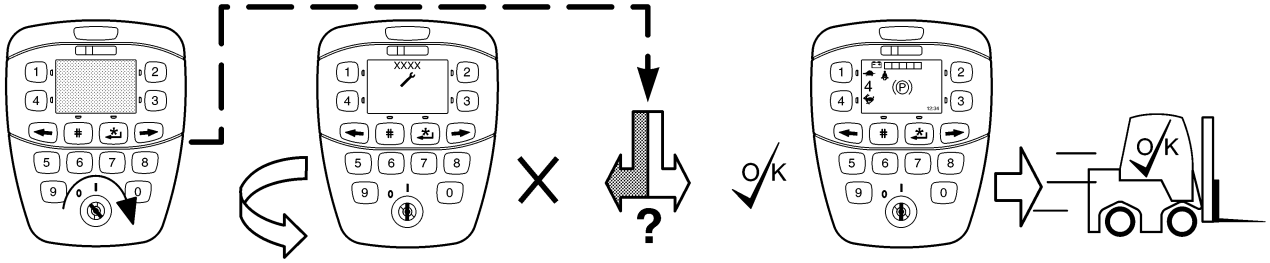
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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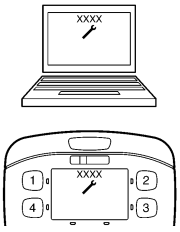
CBB/DBB Motor Speed Sensor Failure



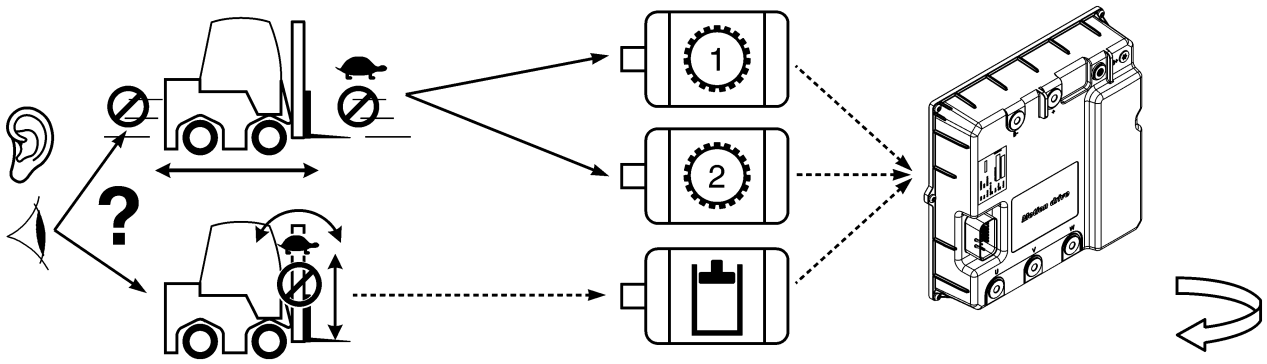
DTC 25104 **Sensor Fault**

DTC 29456 **Sensor Fault**

Fault Codes

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1



?No Traction/Hydraulic Truck Operation?

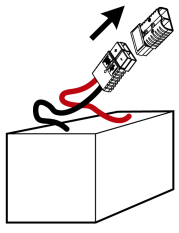
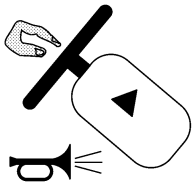
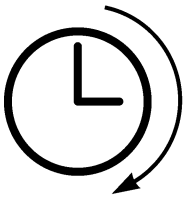
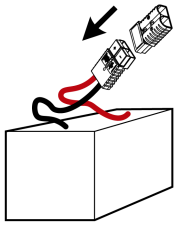
POSSIBLE CAUSES

1. Speed Sensor/Motor Controller Connections/Wiring?→
2. Speed Sensor Failure?→
3. Motor Controller(s) Failure ?→
4. Motor Failure ?→

WARNING

The CBB Truck requires the removal of the battery to access the Controllers and Motors

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

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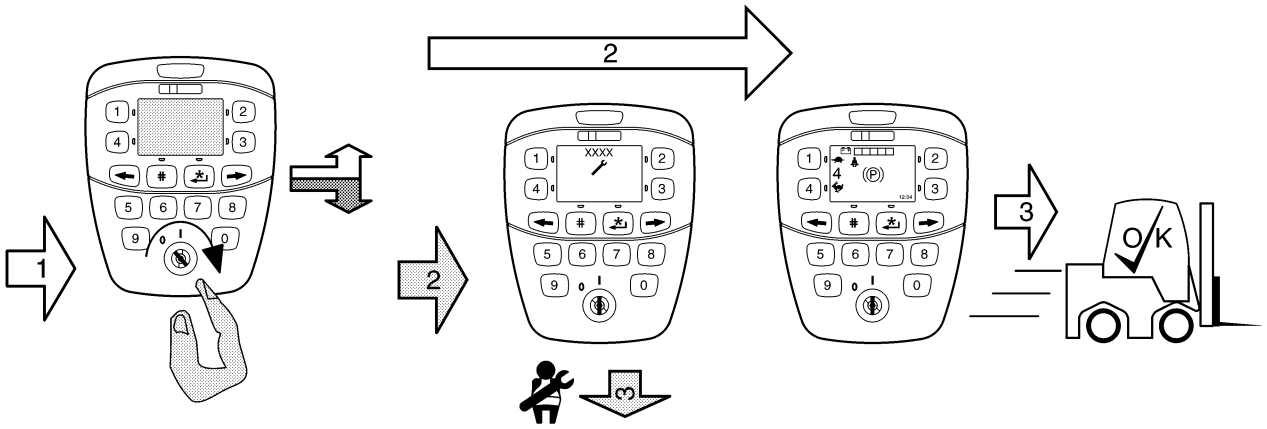
CBB/DBB Motor Speed Sensor Failure (Cont)

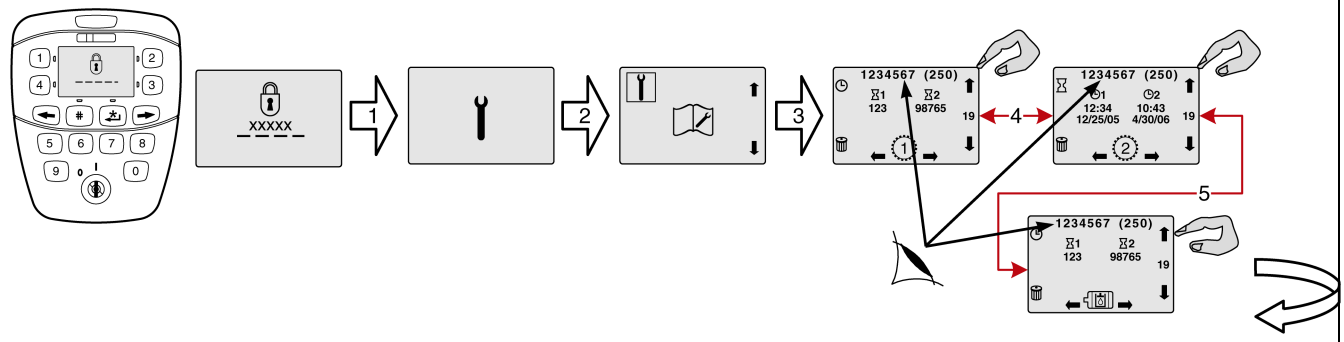
Check 3



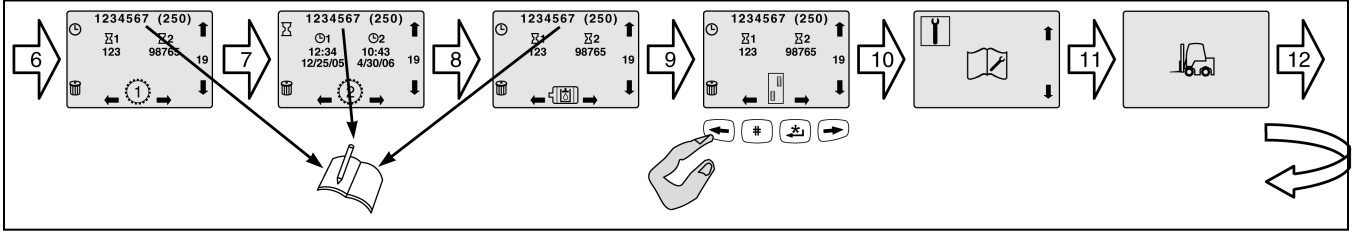
Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

Check 4

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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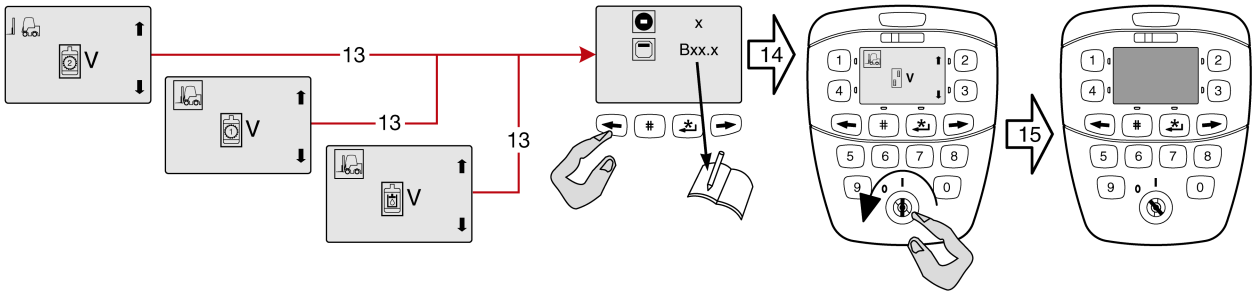
CBB/DBB Motor Speed Sensor Failure (Cont)

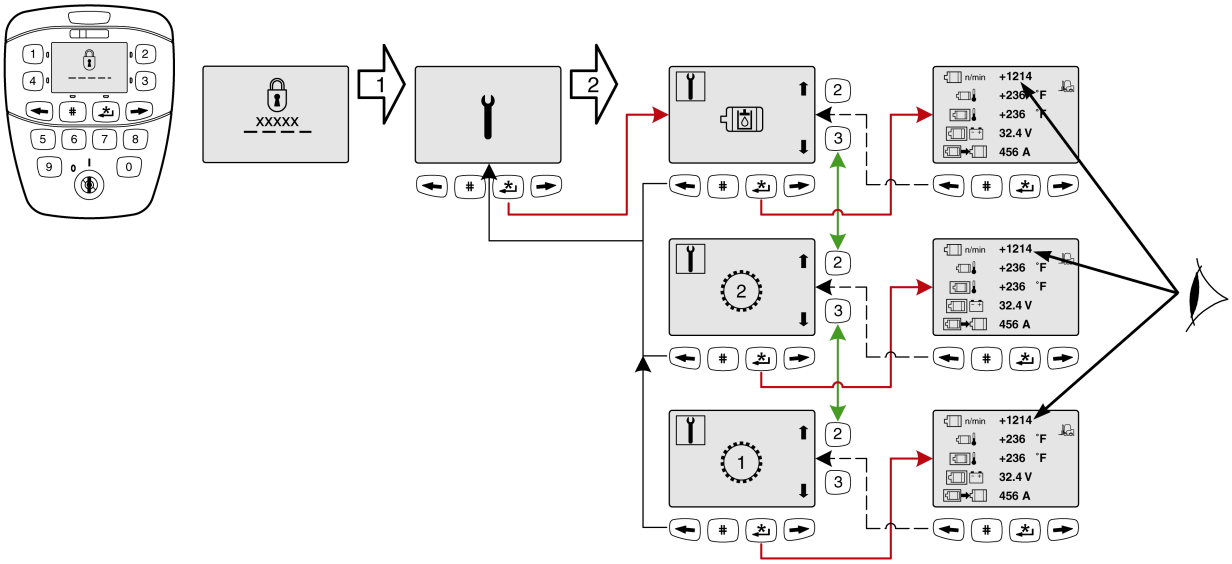
all Motor DTCs→ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ Exit Versions→ Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

Diagnostics Speed Sensor Analysis – Use to Validate Correct Sensor Operation after Repairs



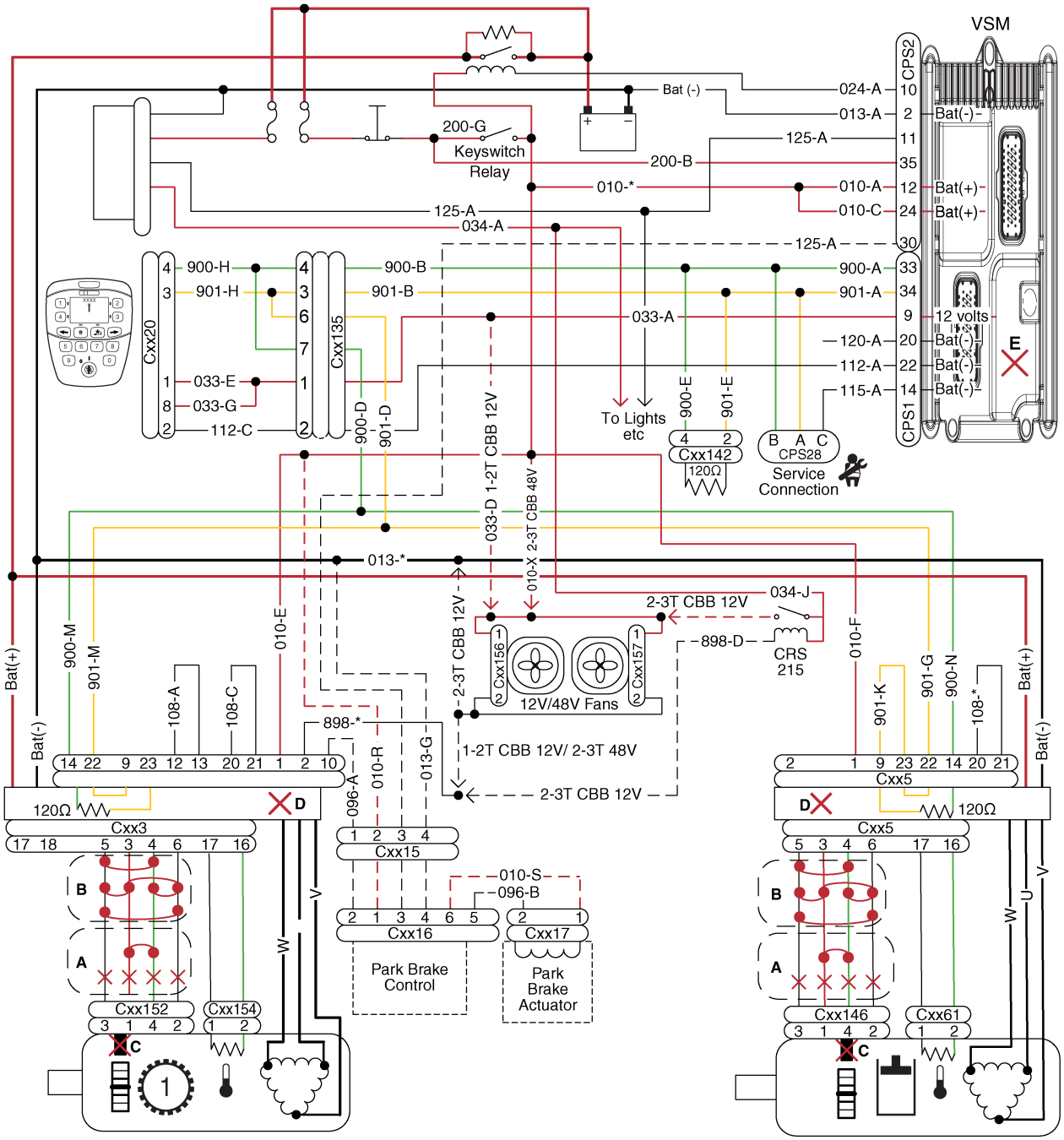
NOTE: If Motor Operation is Disabled then no speed will be displayed

https://truckmanualshub.com/

CBB/DBB Motor Speed Sensor Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

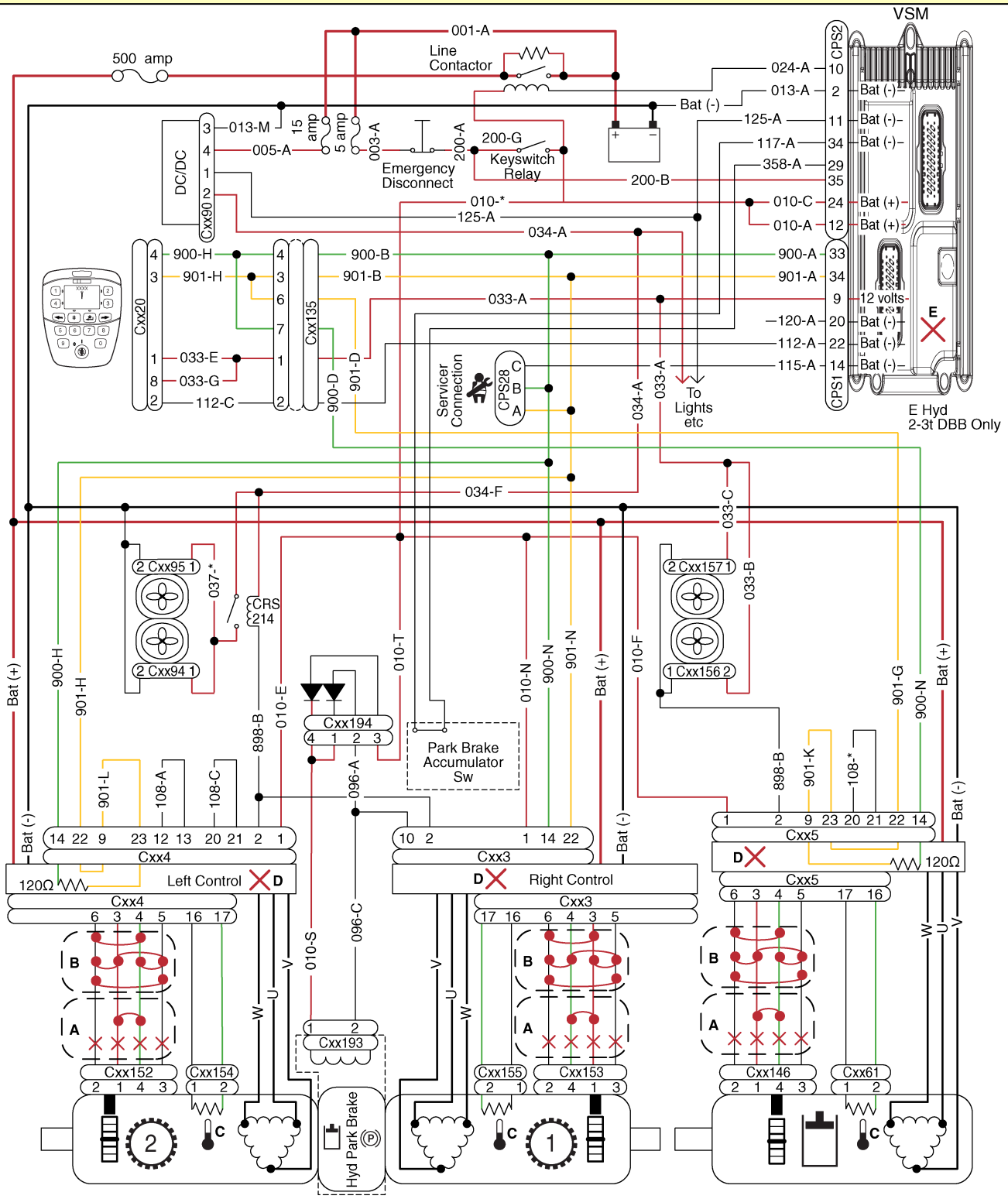
1.5 – 2.0 TON CBB SCHEMATIC CAUSES A B C D E > ?



https://truckmanualshub.com/

CBB/DBB Motor Speed Sensor Failure (Cont)

2.2 – 3.5 TON DBB SCHEMATIC CAUSES A B C D E > ?



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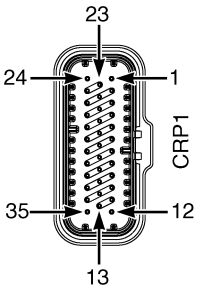
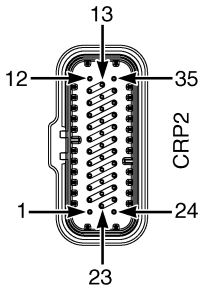
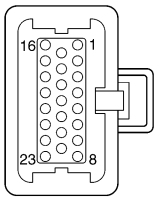
CBB/DBB Motor Speed Sensor Failure (Cont)

CONNECTORS

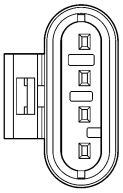




VSM Cxx 1 and Cxx 2

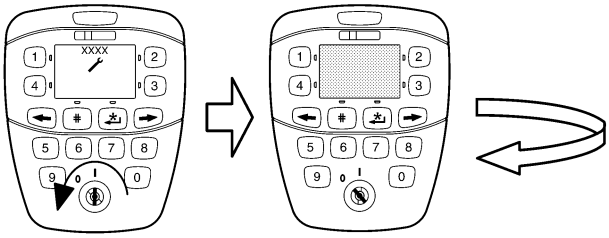


Traction/Pump Controller Cxx 3, 4, and 5



Speed Sensor Motor Connector Cxx 146, 152, and 153

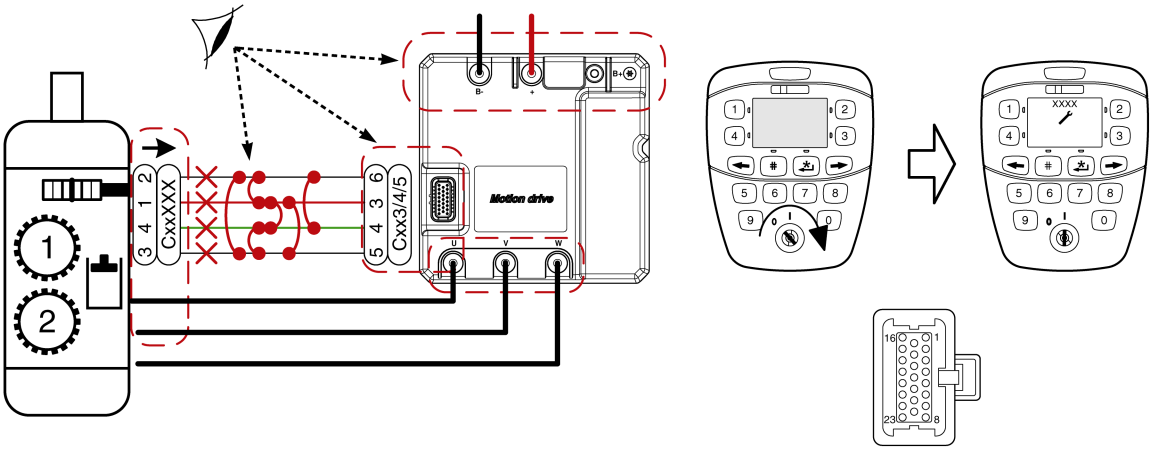
CAUSE A



Power **OFF**→ ?

STEP A1

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections



Disconnect Cxx XXX as indicated from the Fault Logs→ Power **ON**↓

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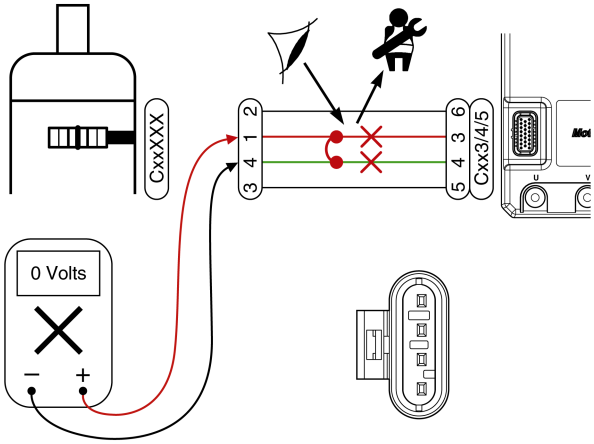
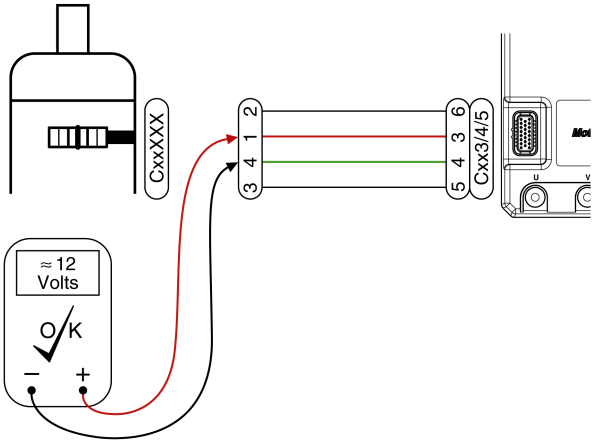
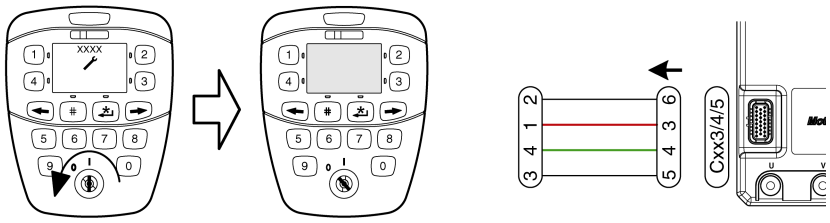
CBB/DBB Motor Speed Sensor Failure (Cont)

STEP A2	**CHECK VOLTAGE**
Speed Sensor Supply	
	
1. 0 Volts = Open/Short Circuit→Step A3↓	1 ˜ 12 Volts = OK→Step A3↓Step A5↓
2. Bat Volts = Short to Bat (+)→Component Operational Check↓	2. ˜ 12 Volts = OK→Step A3↓Step A5↓

STEP A3



Power **OFF**→ Disconnect Cxx 3, 4, or 5 as indicated from the Fault Logs→

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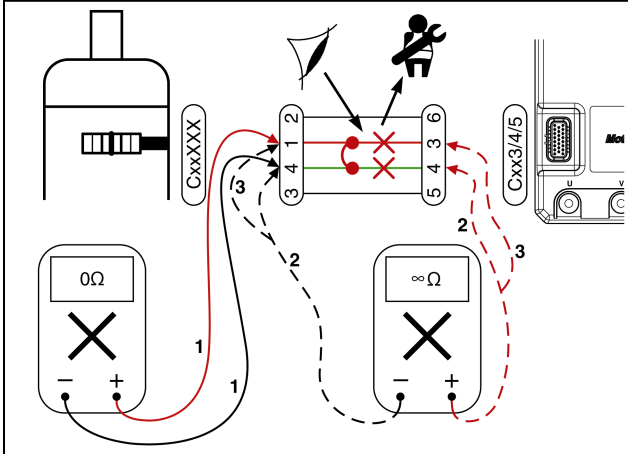
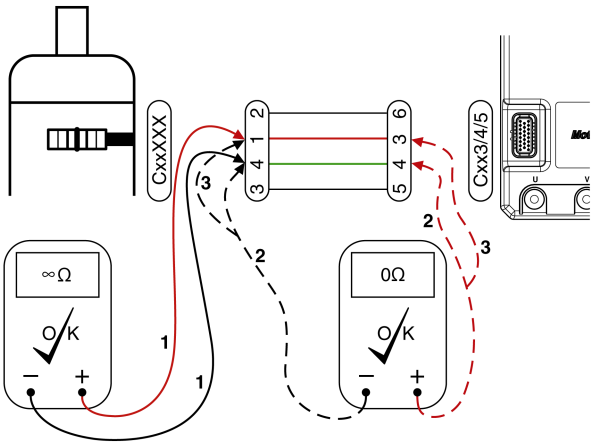
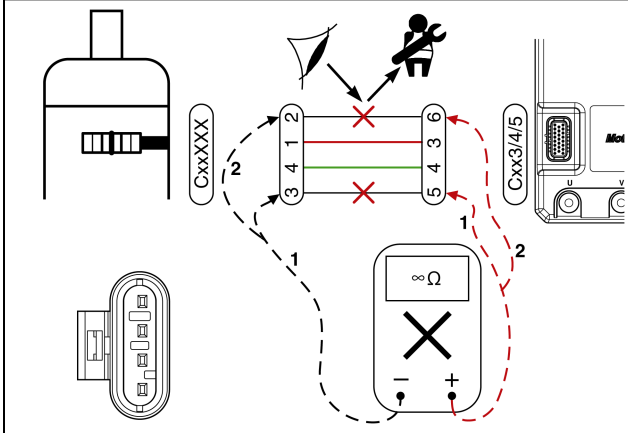
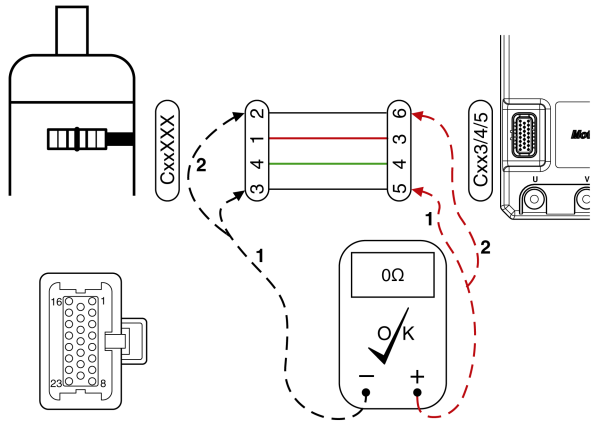
CBB/DBB Motor Speed Sensor Failure (Cont)

STEP A4	**CHECK RESISTANCE - Ω - OHMS**
Speed Sensor Connections	
	
1. 0? = Short Circuit→Go to 4↓	1 ˜ 8? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 4↓	2. ˜ 0? = OK→Go to 3↓
3. 8? = Open Circuit→Go to 4↓	3. ˜ 0? = OK→Component Operational Check↓
4. Find/Repair Short/Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
5. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume Opera-tionNO→Component Operational Check↓	

STEP A5	**CHECK RESISTANCE - Ω - OHMS**
Speed Sensor Connections	
	
1. 8? = Open Circuit→Go to 3↓	1. ˜ 0? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 3↓	2. ˜ 0? = OK→Component Operational Check↓
3. Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
4. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume Opera-tionNO→Component Operational Check↓	

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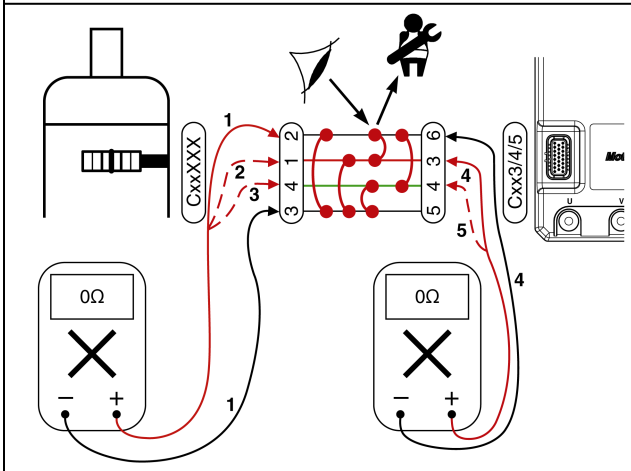
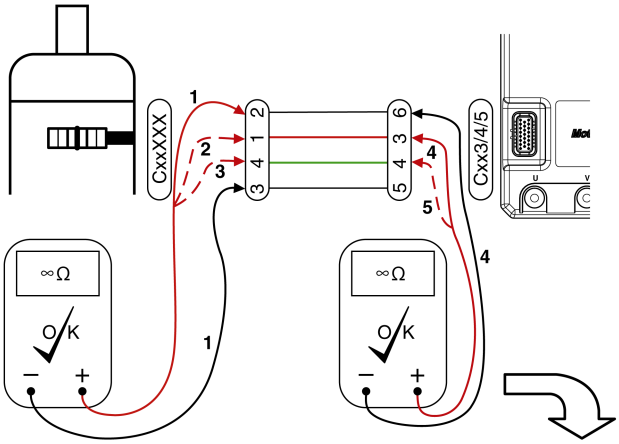
CBB/DBB Motor Speed Sensor Failure (Cont)

CAUSE B **CHECK RESISTANCE - Ω - OHMS**

Speed Sensor Connections

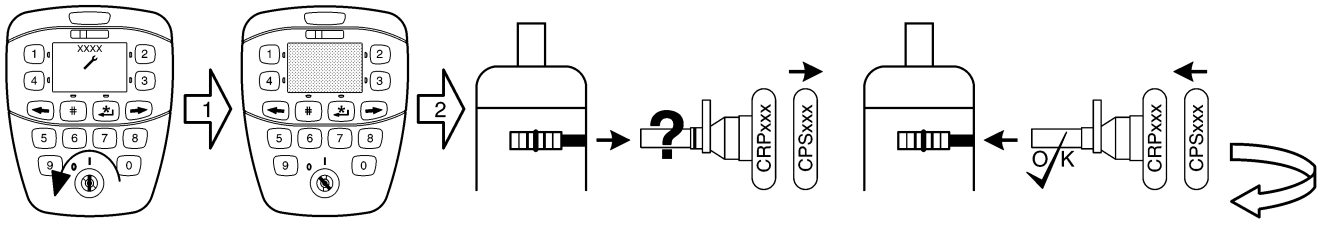




1. 0? = Short Circuit→Go to 6↓	1. ˜ 8? = OK→Go to 2↓
2. 0? = Short Circuit→Go to 6↓	2. ˜ 8? = OK→Go to 3↓
3. 0? = Short Circuit→Go to 6↓	3. ˜ 8? = OK→Go to 4↓
4. 0? = Short Circuit→Go to 6↓	4. ˜ 8? = OK→Go to 5↓
5. 0? = Short Circuit→Go to 6↓	5. ˜ 8? = OK→Component Operational Check↓
6. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓	
7. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume Opera-tionNO→Component Operational Check↓	

CAUSE C **CHECK RESISTANCE - Ω - OHMS**

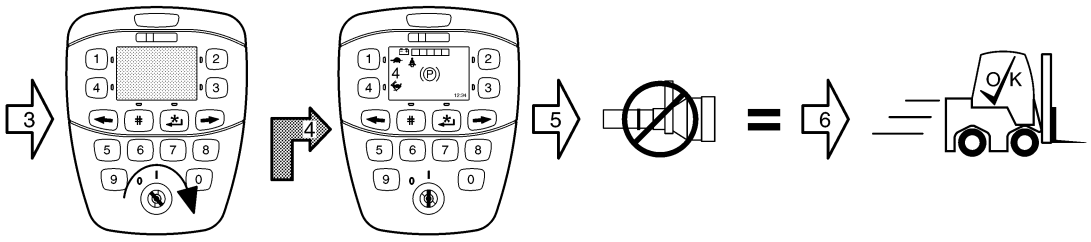
Sensor Failure



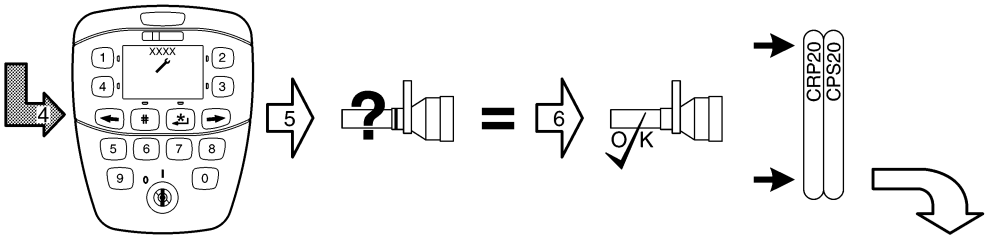
Power **OFF**→	Remove/Replace Motor Speed Sensor↓
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ Step C1 ↓	

CBB/DBB Motor Speed Sensor Failure (Cont)

STEP C1

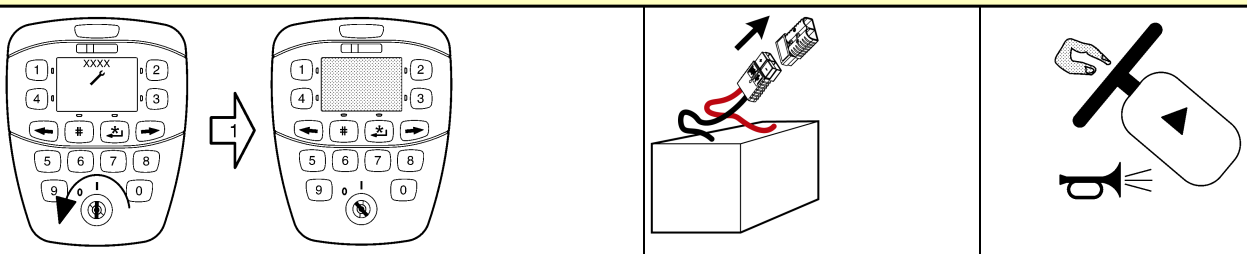


Power **ON**→	DTCs Gone→	Original Sensor Faulty→	Resume Operation



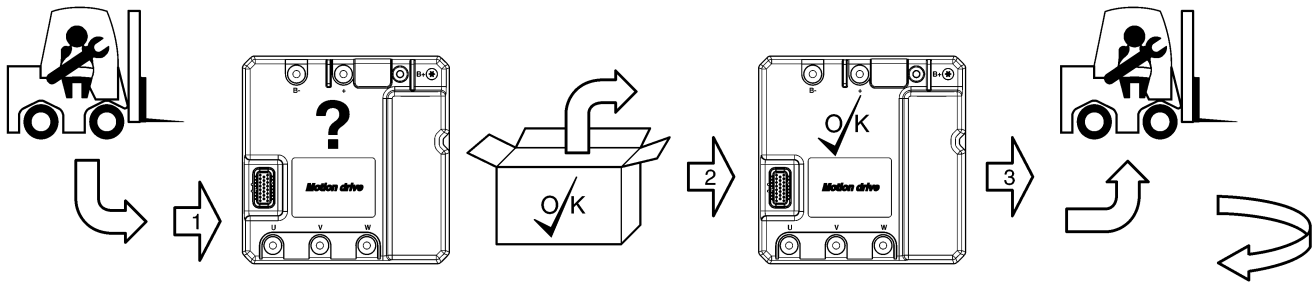
	DTCs Present→	Original Sensor OK/Reinstall Original Sensor→ Component Operational Check ↓

CAUSE D



Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

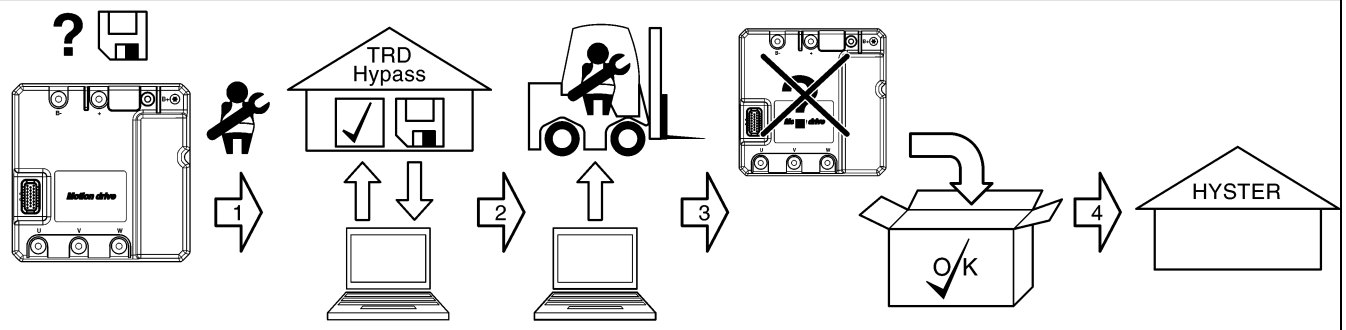
STEP D1



Remove and Replace Faulty Motor Controller↓
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓
Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

CBB/DBB Motor Speed Sensor Failure (Cont)

STEP D2



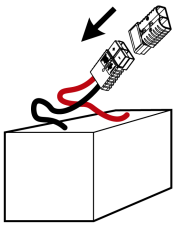
1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

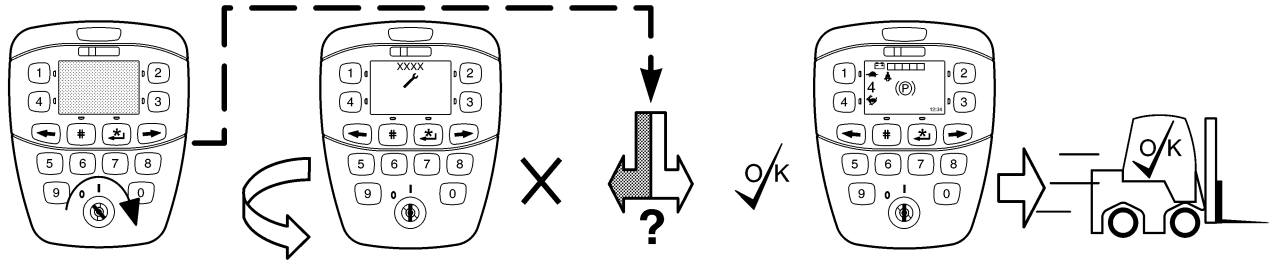
2. **NO**→Download the latest Application →Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

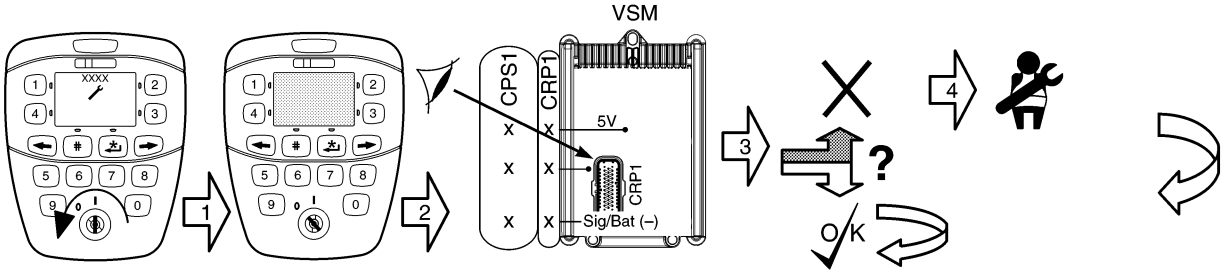




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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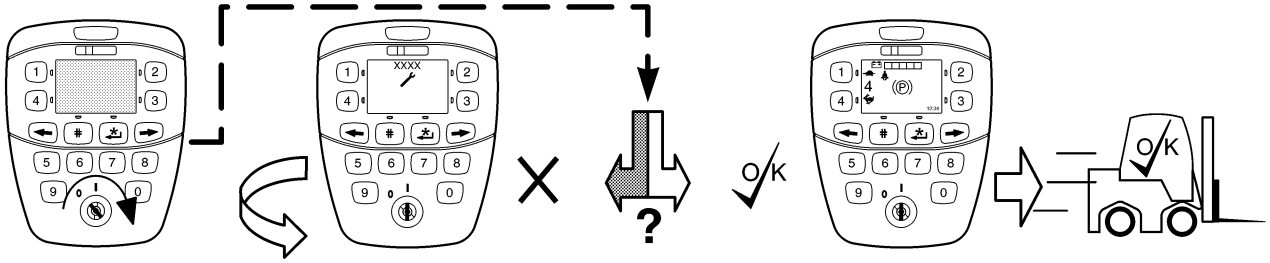
CBB/DBB Motor Speed Sensor Failure (Cont)

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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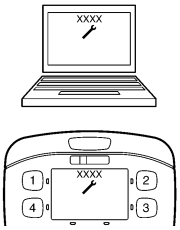
A935 – K160 Motor Auto Brake Failure



Fault Codes

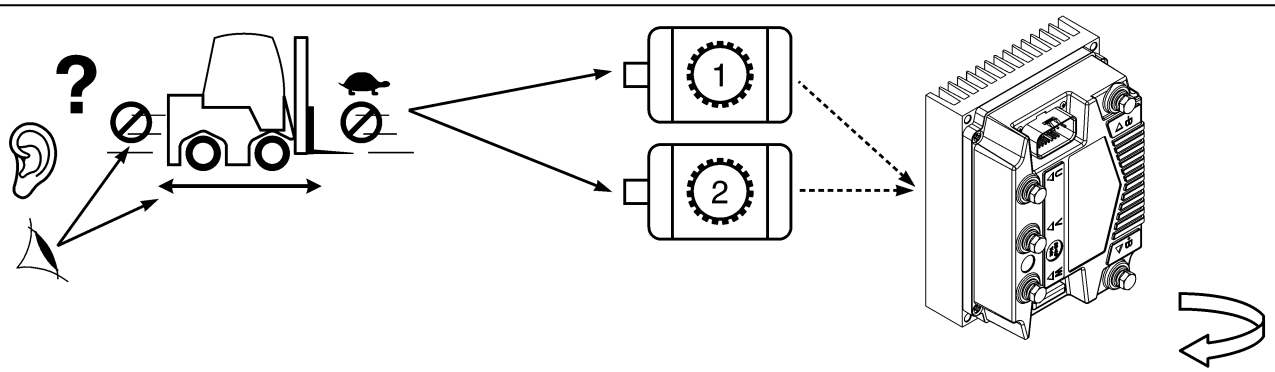
DTC 8786
Brake Coil Shorted

DTC 12834
Aux Driver Short to Bat (-)
Brake Coil Open Circuit

DTC 12835
Aux Driver Open Circuit
Excess Current

QUICK CHECK X Open Circuit/Fail) = Short Circuit

Check 1

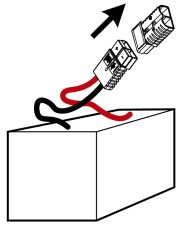
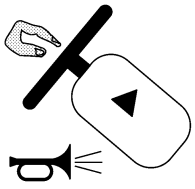
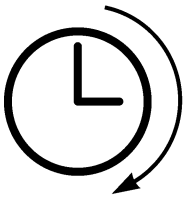
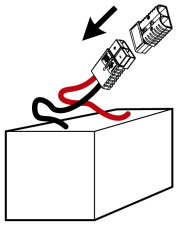


?Brake does not Release when Traction is Commanded?

POSSIBLE CAUSES

DTC 12834	Aux Driver Short to Bat (-) Brake Coil Open Circuit		→ Component Operational Check ↓
DTC 12835	Aux Driver Open Circuit Excess Current	No Current/> 5 amps driver current	→ Component Operational Check ↓
DTC 8786	Brake Coil Shorted	> 5.3 amps driver current	→ Component Operational Check ↓
Motor Controllers Fail-ure?→		Driver Failure	→ Component Operational Check ↓

Check 2

			
Disconnect Battery and Sound Horn to Discharge Ca-pacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

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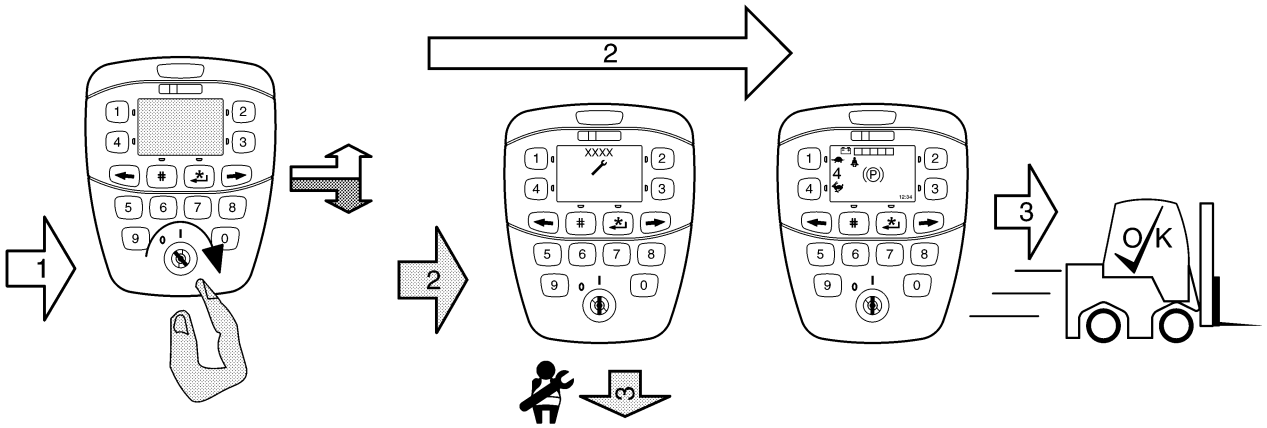
A935 – K160 Motor Auto Brake Failure (Cont)

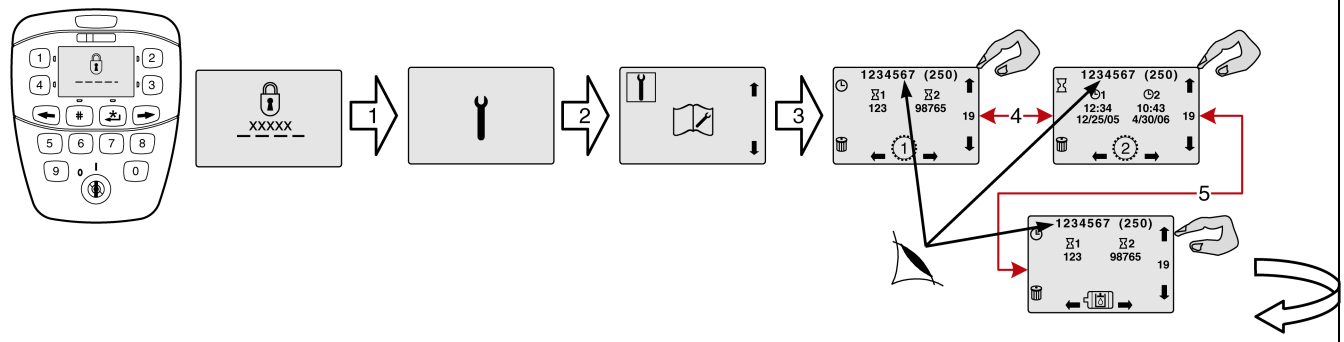
Check 3



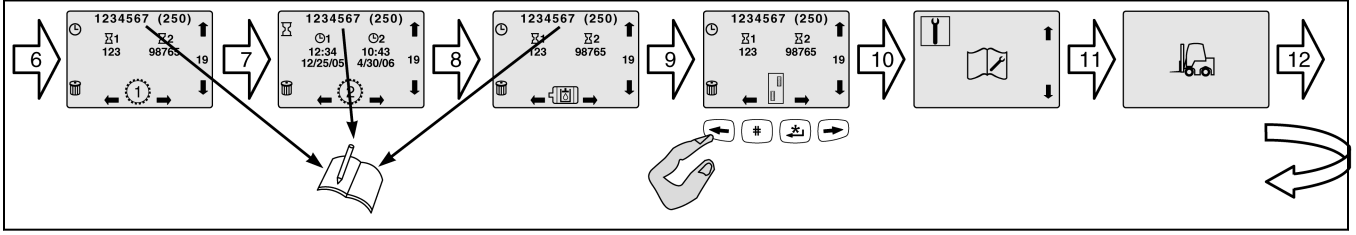
Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

Check 4

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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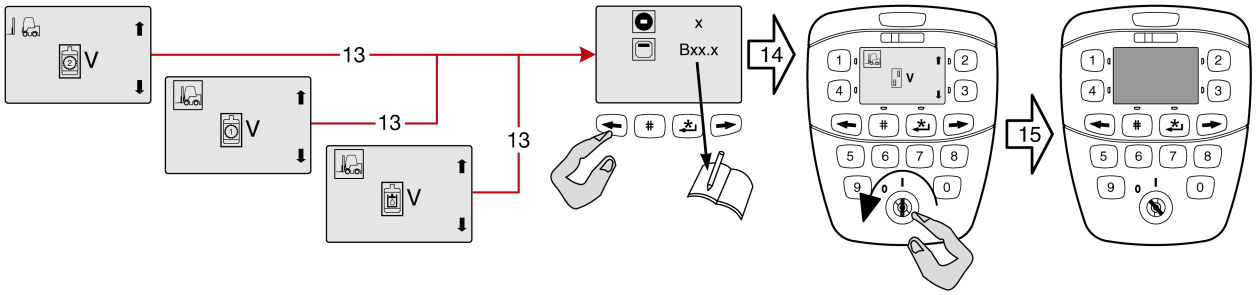
A935 – K160 Motor Auto Brake Failure (Cont)

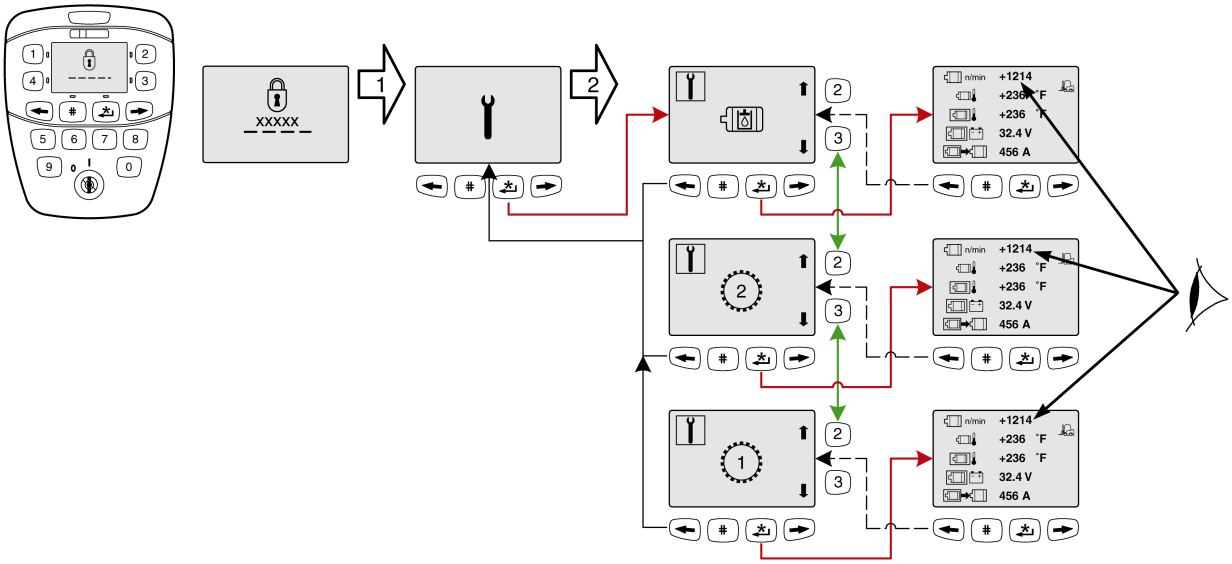
all Motor DTCs→ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ Exit Versions→ Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

Diagnostics Speed Sensor Analysis – Use to Validate Correct Sensor Operation after Repairs



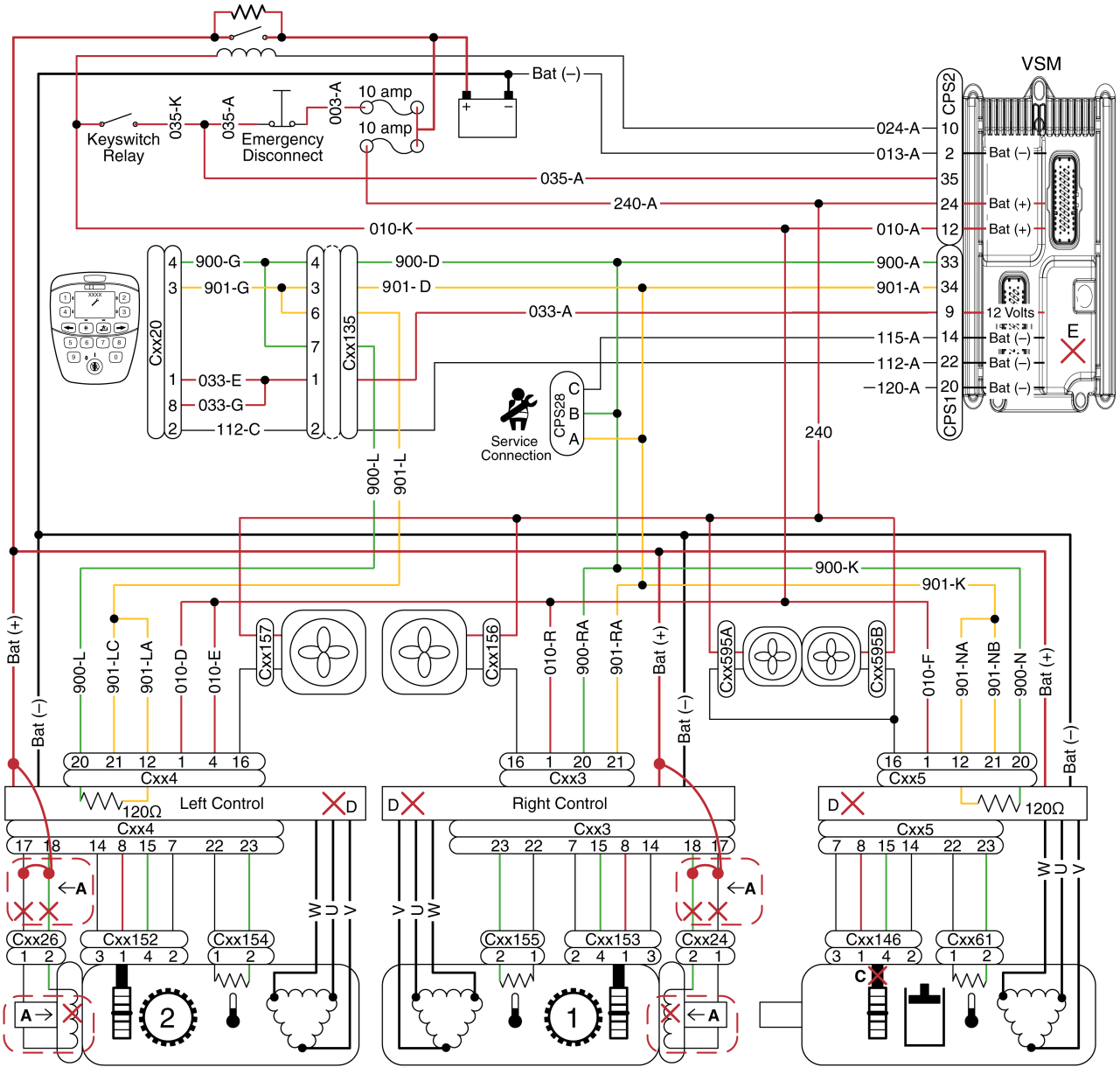
Note: If Motor Operation is Disabled then no speed will be displayed

https://truckmanualshub.com/

A935 – K160 Motor Auto Brake Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

WHEEL MOTOR AUTO BRAKE FAILURE CAUSES A B C D E > ?



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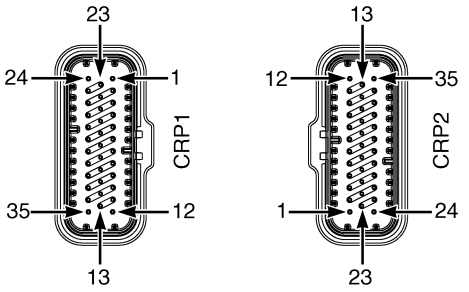
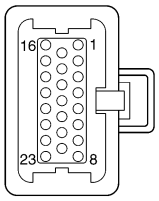
A935 – K160 Motor Auto Brake Failure (Cont)

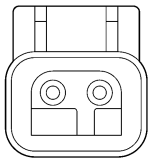
CONNECTORS



VSM Cxx 1 and Cxx 2



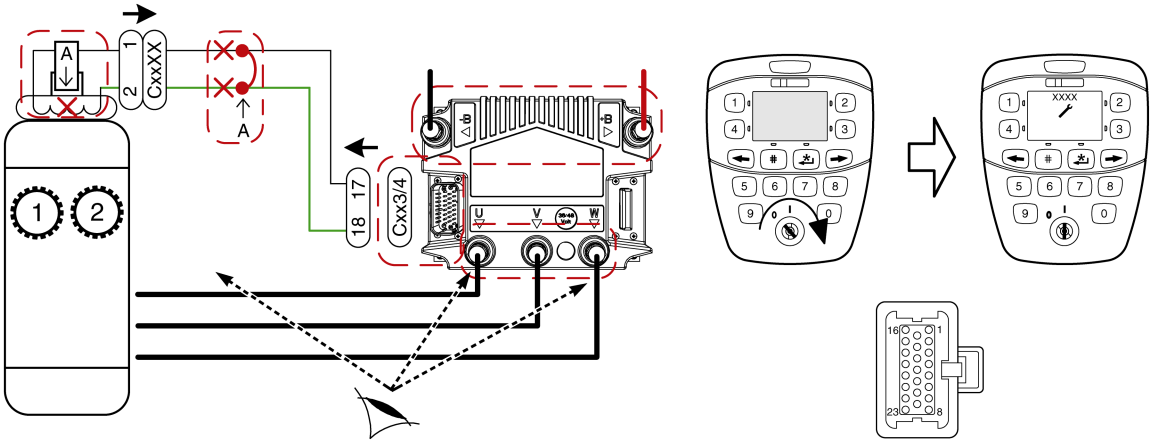
Traction/Pump Controller Cxx 3, 4, and 5



Auto Brake Motor Connectors Cxx 24 and 26

CAUSE A

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections



Disconnect Cxx and Cxx 3 or 4 as indicated from the Fault Logs→ Power **ON**↓

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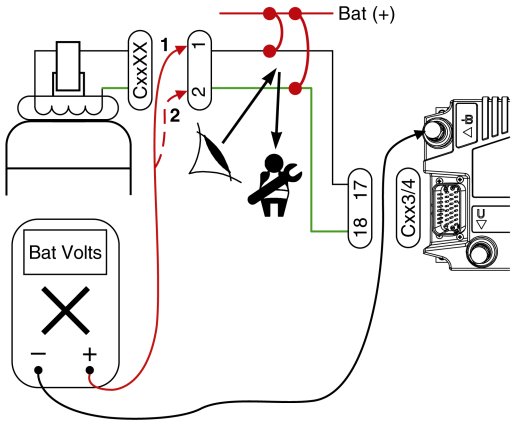
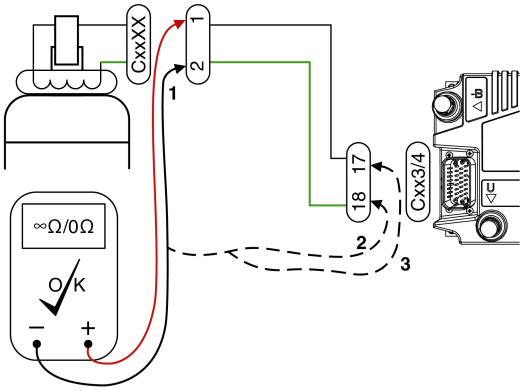
A935 – K160 Motor Auto Brake Failure (Cont)

STEP A1

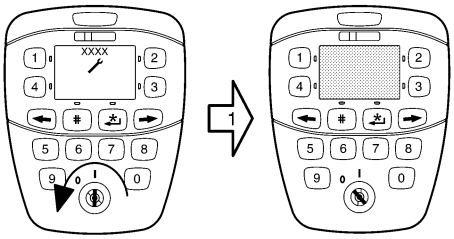
Auto Brake Short Circuit to Bat (+)

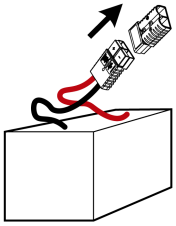


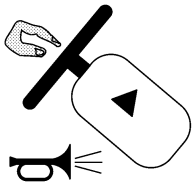


1. Short to Bat (+)→Go to 2↓	1 0 Volts = OK→Go to 2↓
2. Short to Bat (+)→Go to 3↓	2. 0 Volts = OK→Step A2↓
3. Recheck ?↑→ Reconnect→Test→No DTCs→YES→Resume OperationNo→Step A2↓	

STEP A2

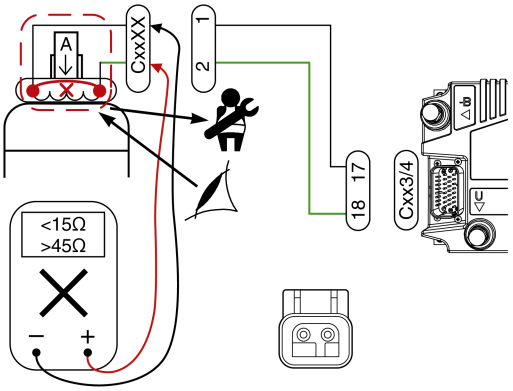
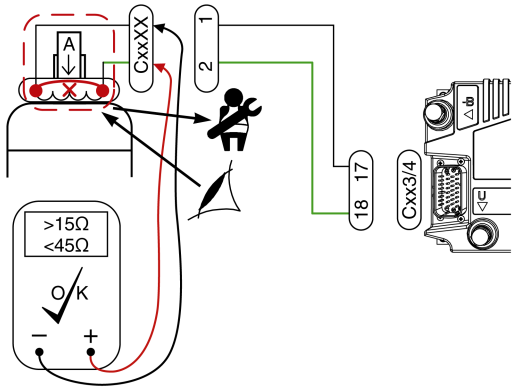


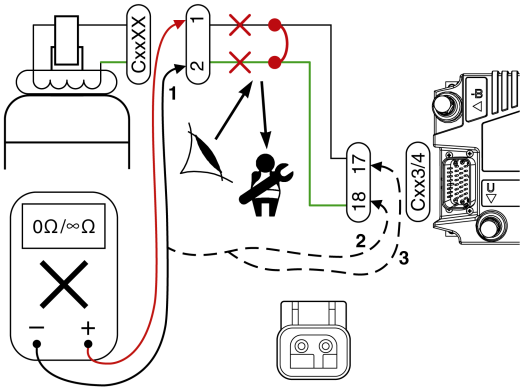
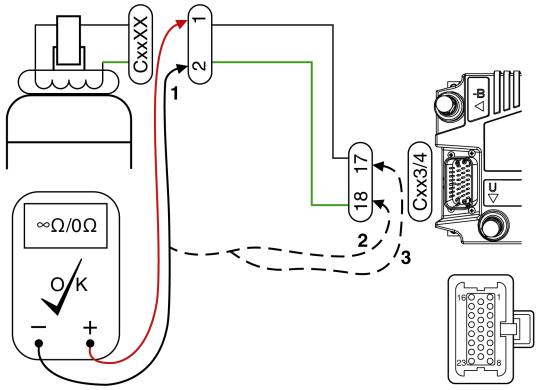




Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

A935 – K160 Motor Auto Brake Failure (Cont)

STEP A3	**CHECK RESISTANCE - Ω - OHMS**
Auto Brake Coil Open/Short Circuit	
	
1. <15 ? > 45 ?= Faulty Coil→Go to 2↓	1 >15 ? < 45 ?= OK Coil→Go to Step A4↓
2. Replace Auto Brake→See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
3. Recheck ?↑→ Reconnect→Test→No DTCs→YES→Resume OperationNo→Step A4↓	

STEP A4	**CHECK RESISTANCE - Ω - OHMS**
Auto Brake Connections Open/Short Circuit	
	
1. 0? = Short Circuit→Go to 4↓	1. ˜ 8? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 4↓	2. ˜ 0? = OK→Go to 3↓
3. 8? = Open Circuit→Go to 4↓	3. ˜ 0? = OK→Component Operational Check↓
4. Find/Repair Short/Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
5. Recheck ?↑→ Reconnect→Test→No DTCs→YES→Resume OperationNo→Component Operational Check↓	
CAUSE B	
Not Applicable	
CAUSE C	
Not Applicable	

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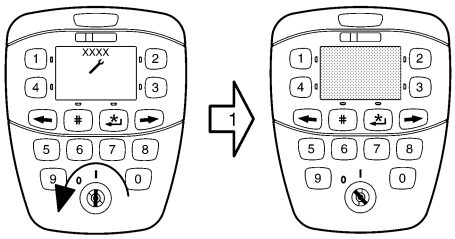
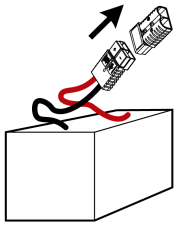
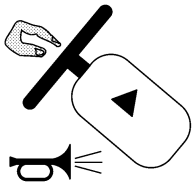
A935 – K160 Motor Auto Brake Failure (Cont)

CAUSE D

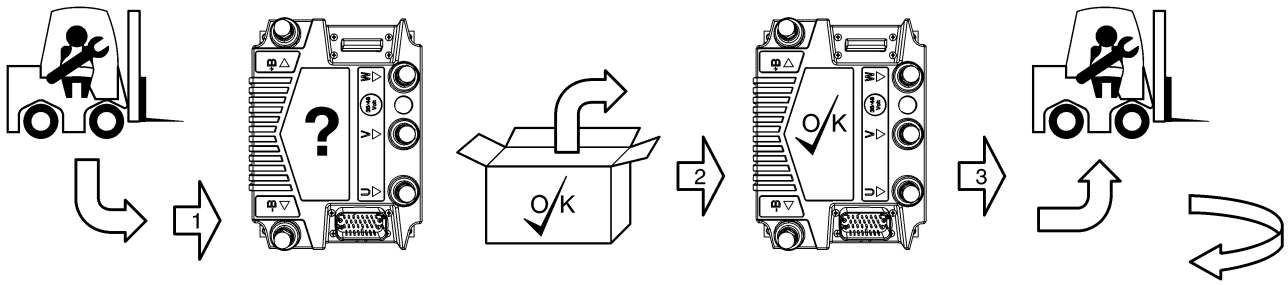






Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1

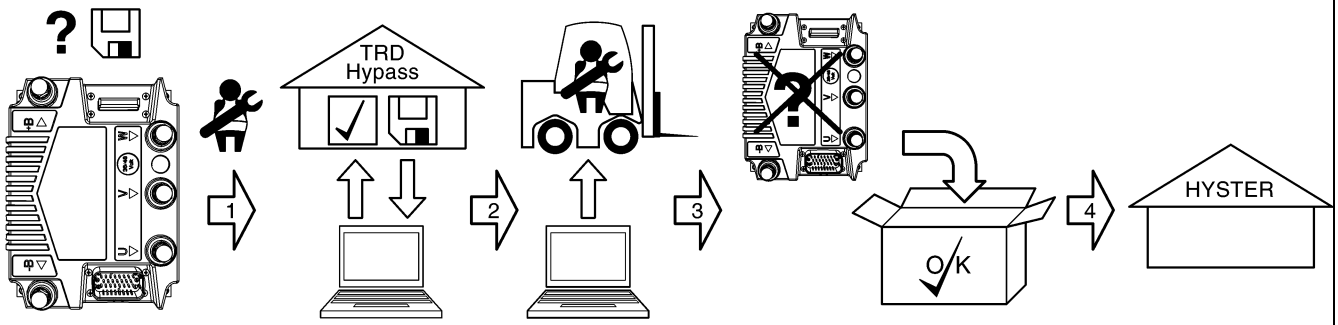


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

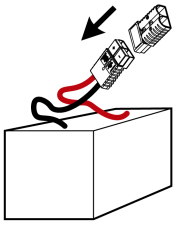
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

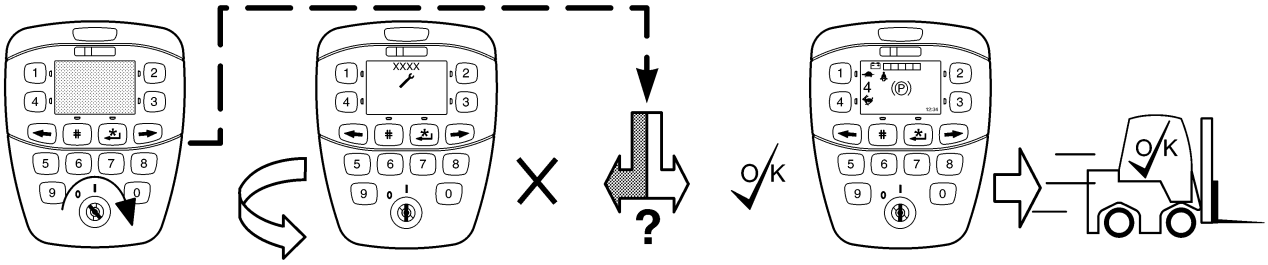
3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Controller→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 Motor Auto Brake Failure (Cont)

STEP D3

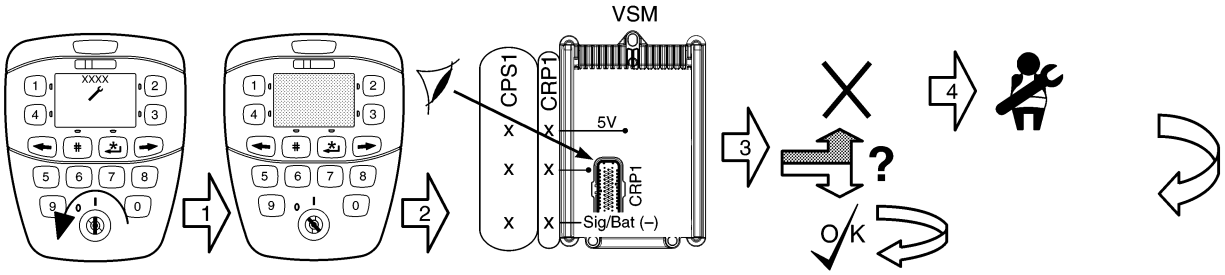




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

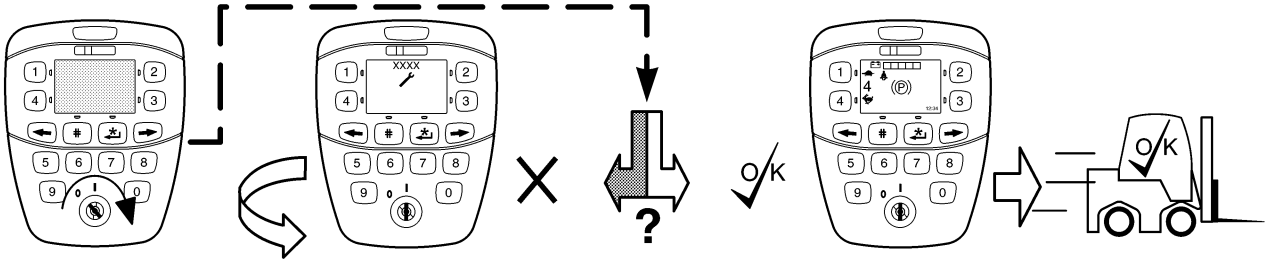
NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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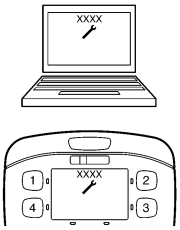
A935 – K160 D203Motor Controller Power Mosfet Failure

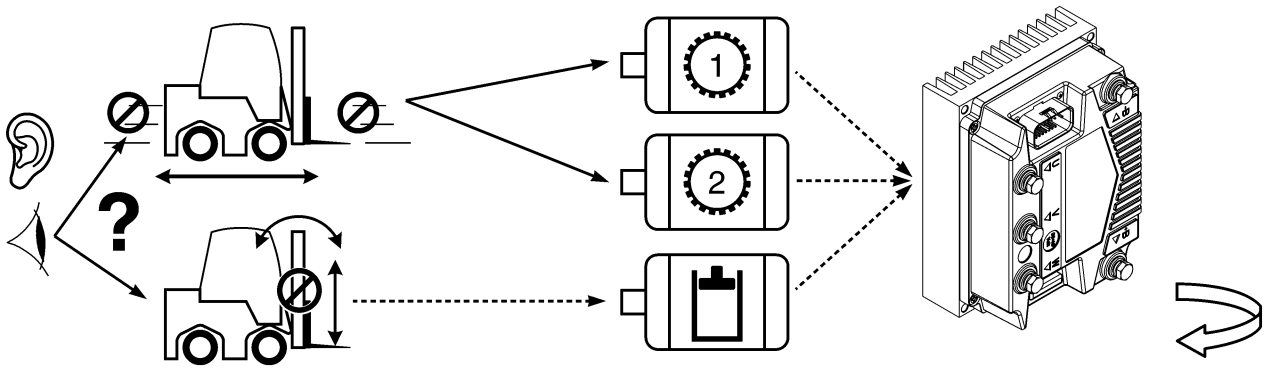


Fault Codes

DTC 65513
Power MOS Shorted

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1

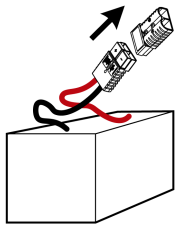
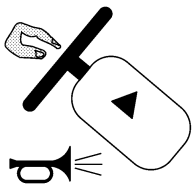
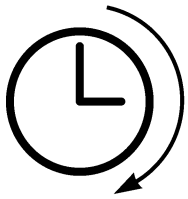
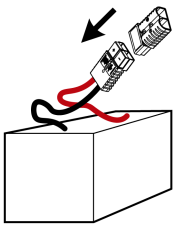


? No Traction/Hydraulics Truck Operation ?

Possible Causes

Motor Controller(s) Failure ?→	→ Component Operational Check ↓

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery	

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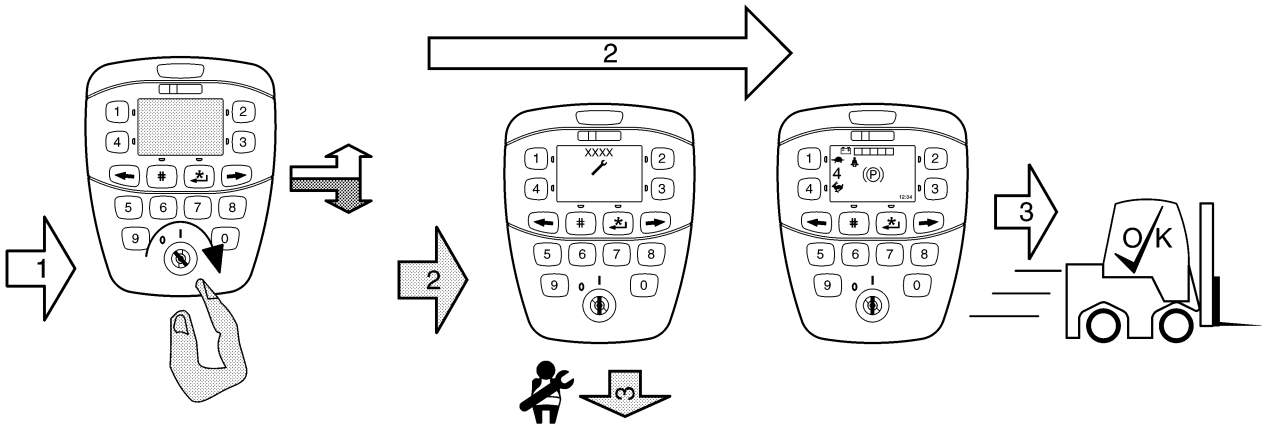
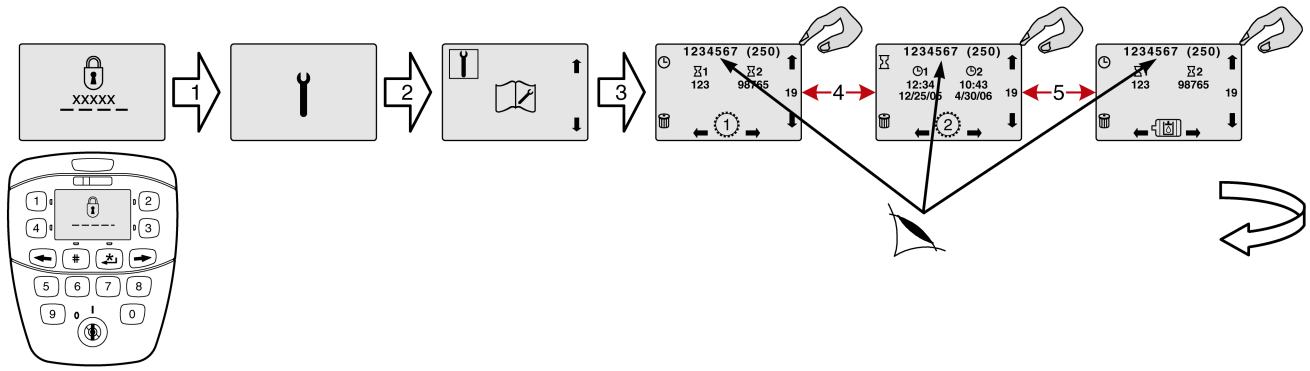
A935 – K160 D203Motor Controller Power Mosfet Failure (Cont)

Check 3



Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

FAULT LOG Review - Go to Display Menu



Enter SERVICE Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?

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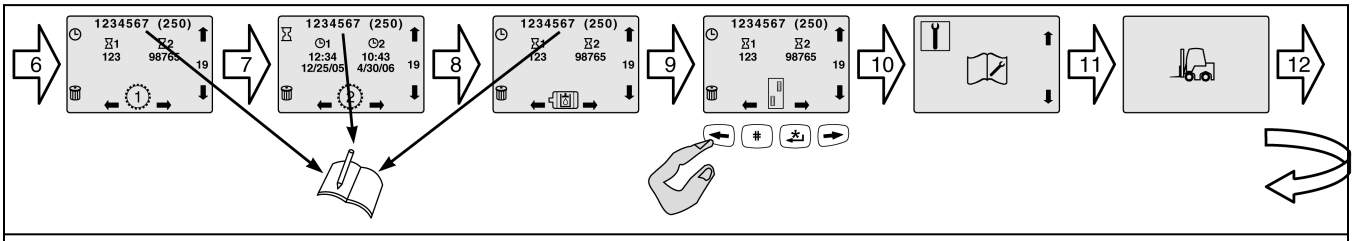
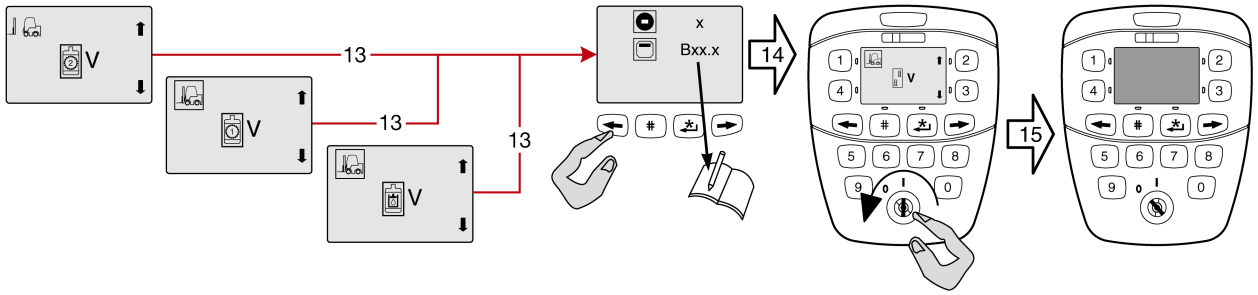
A935 – K160 D203Motor Controller Power Mosfet Failure (Cont)



all Motor DTCs→ ☜ Exit Fault Log→ Truck Status ?

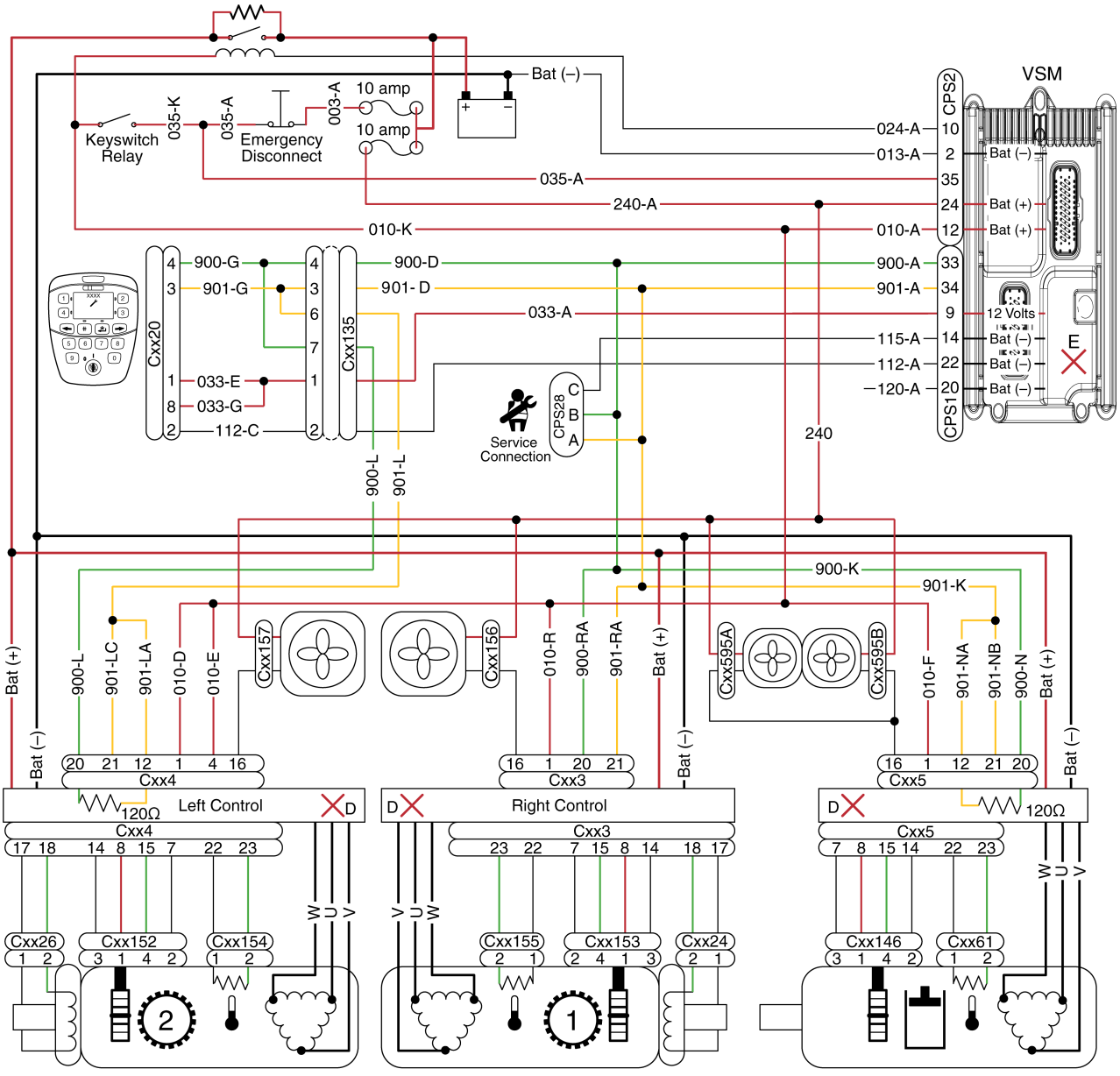


Motor Versions→ Hardware/Software Versions→ ☜ Exit Versions→ Power **OFF**?

A935 – K160 D203Motor Controller Power Mosfet Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

MOTOR CONTROLLER POWER MOSFET FAILURE CAUSES A B C D E > ?



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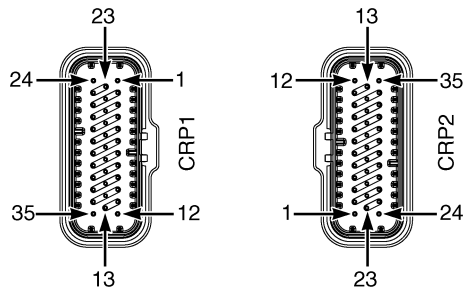
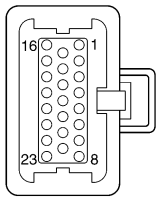
A935 – K160 D203Motor Controller Power Mosfet Failure (Cont)

CONNECTORS



VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

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A935 – K160 D203Motor Controller Power Mosfet Failure (Cont)

CAUSE A

Not Applicable

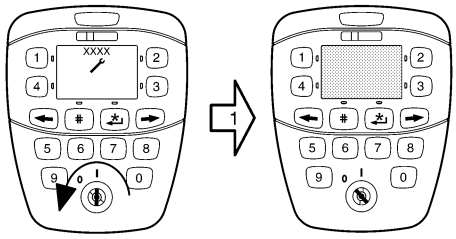
CAUSE B

Not Applicable

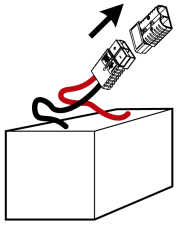
CAUSE C

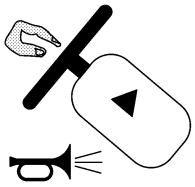
Not Applicable

CAUSE D



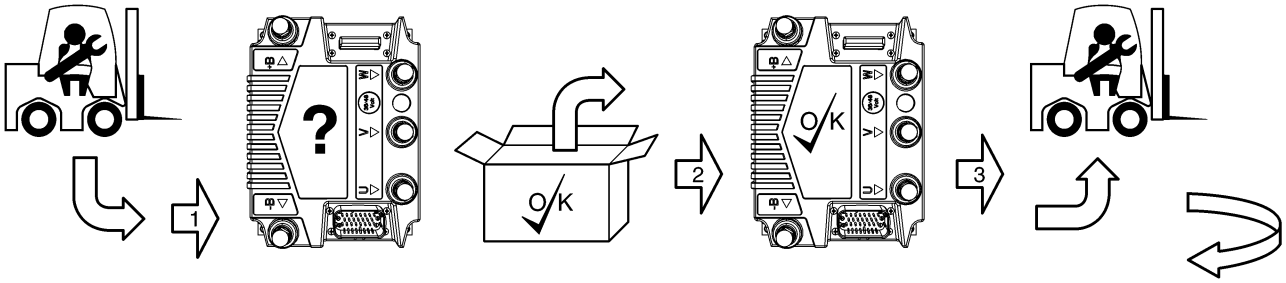
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1



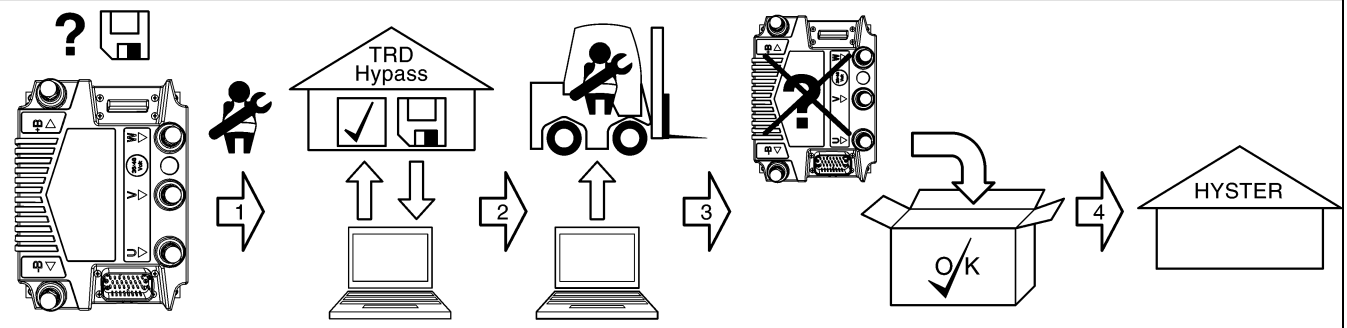
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

A935 – K160 D203Motor Controller Power Mosfet Failure (Cont)

STEP D2



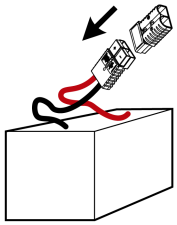
1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

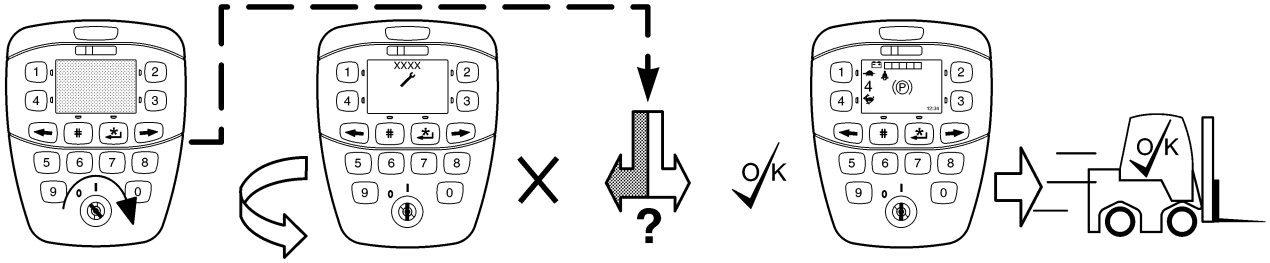
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

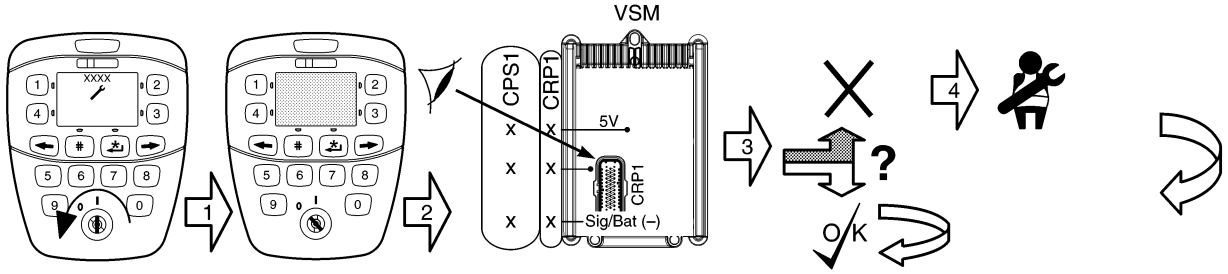




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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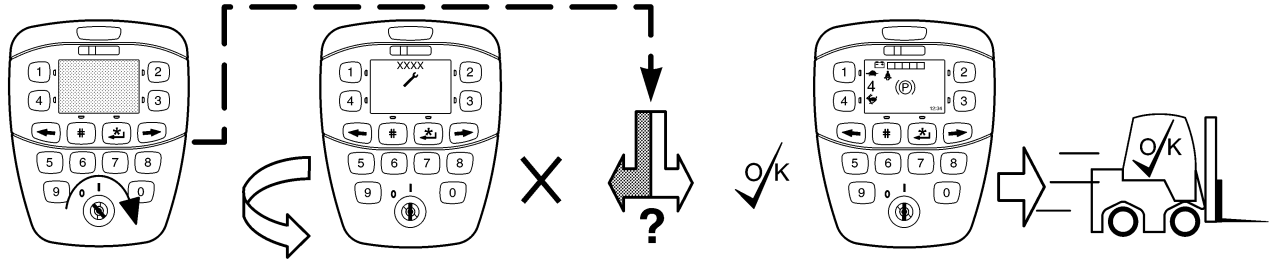
A935 – K160 D203Motor Controller Power Mosfet Failure (Cont)

STEP E1



Retest - Power **ON**→

NO → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

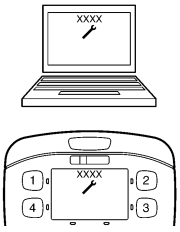
Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

https://truckmanualshub.com/

A935 – K160 D203Motor/Motor Controller Failure

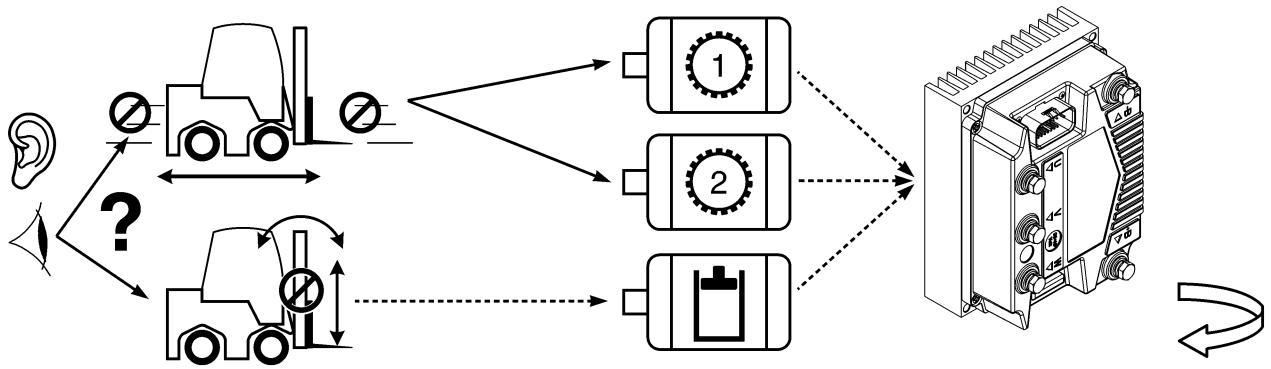


Fault Codes

DTC 12576
Motor Voltage Not OK

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1

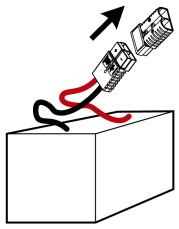
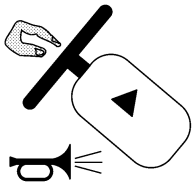
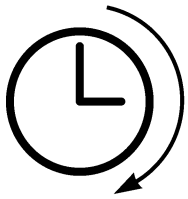
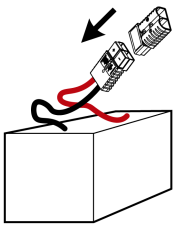


? No Traction/Hydraulic Truck Operation ?

POSSIBLE CAUSES

Motor to Motor Controller Connections/Wiring→ High Resistance?→	→ Component Operational Check ↓
Motor Windings Failure Open Circuit?→	→ Component Operational Check ↓
Motor Windings Short to Frame?→	→ Component Operational Check ↓
Motor Controller(s) Failure?→	→ Component Operational Check ↓

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

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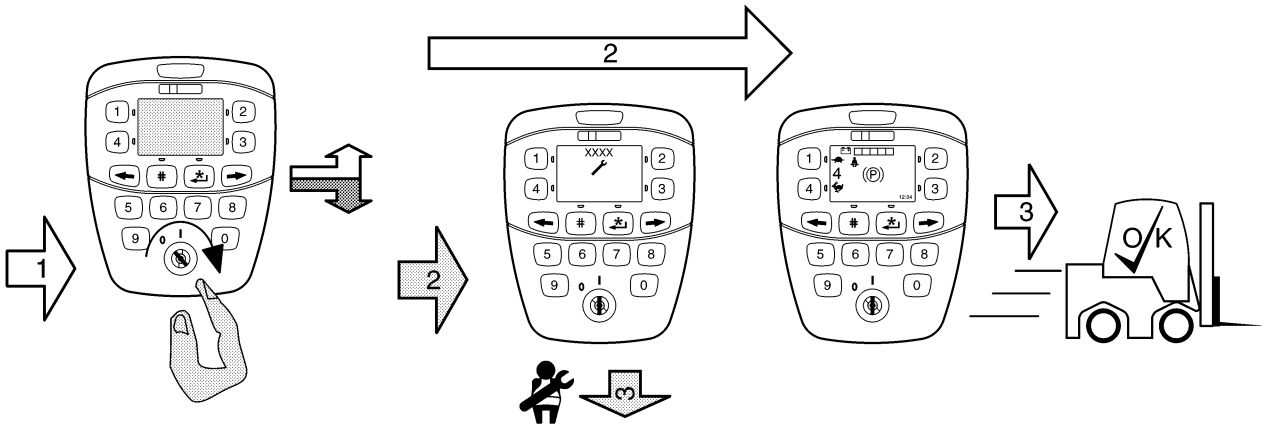
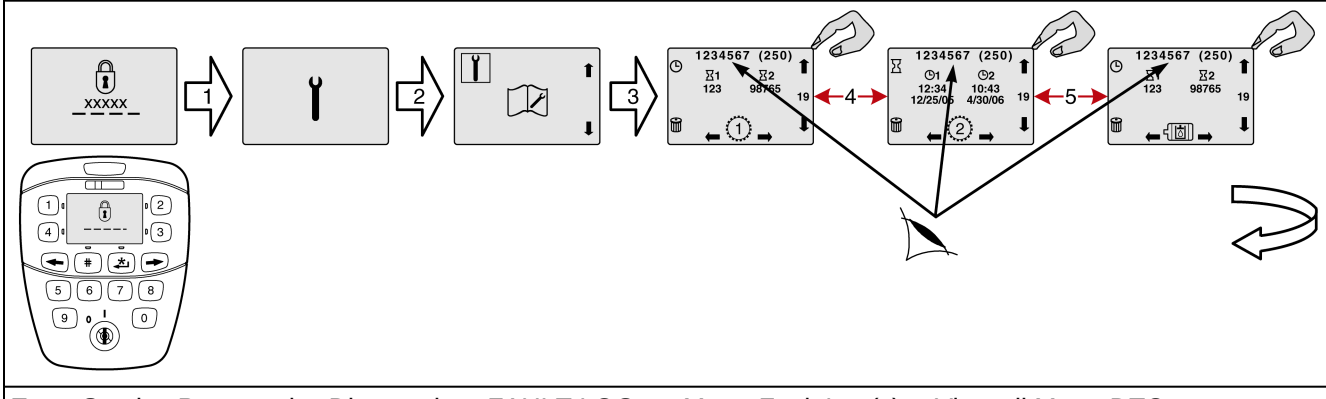
A935 – K160 D203Motor/Motor Controller Failure (Cont)

Check 3

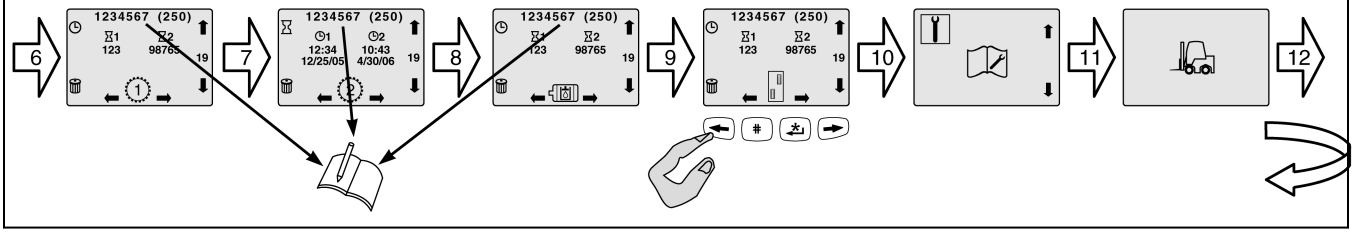


Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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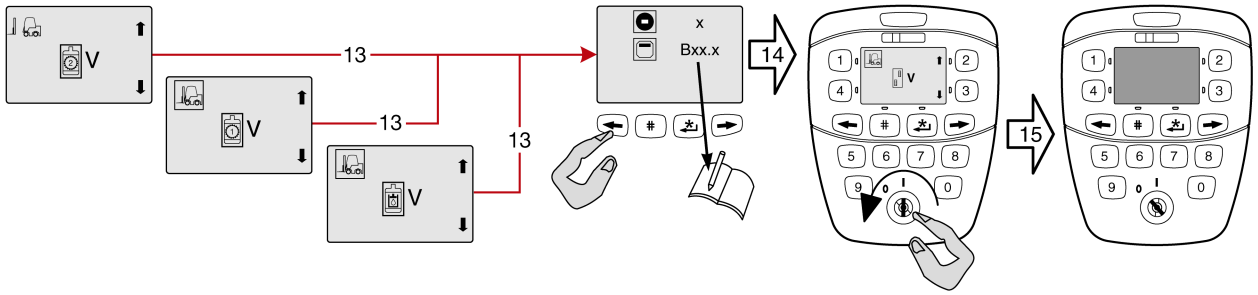
A935 – K160 D203Motor/Motor Controller Failure (Cont)

all Motor DTCs→ ☜ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ ☜ Exit Versions→ Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the Faulty Component/Connection

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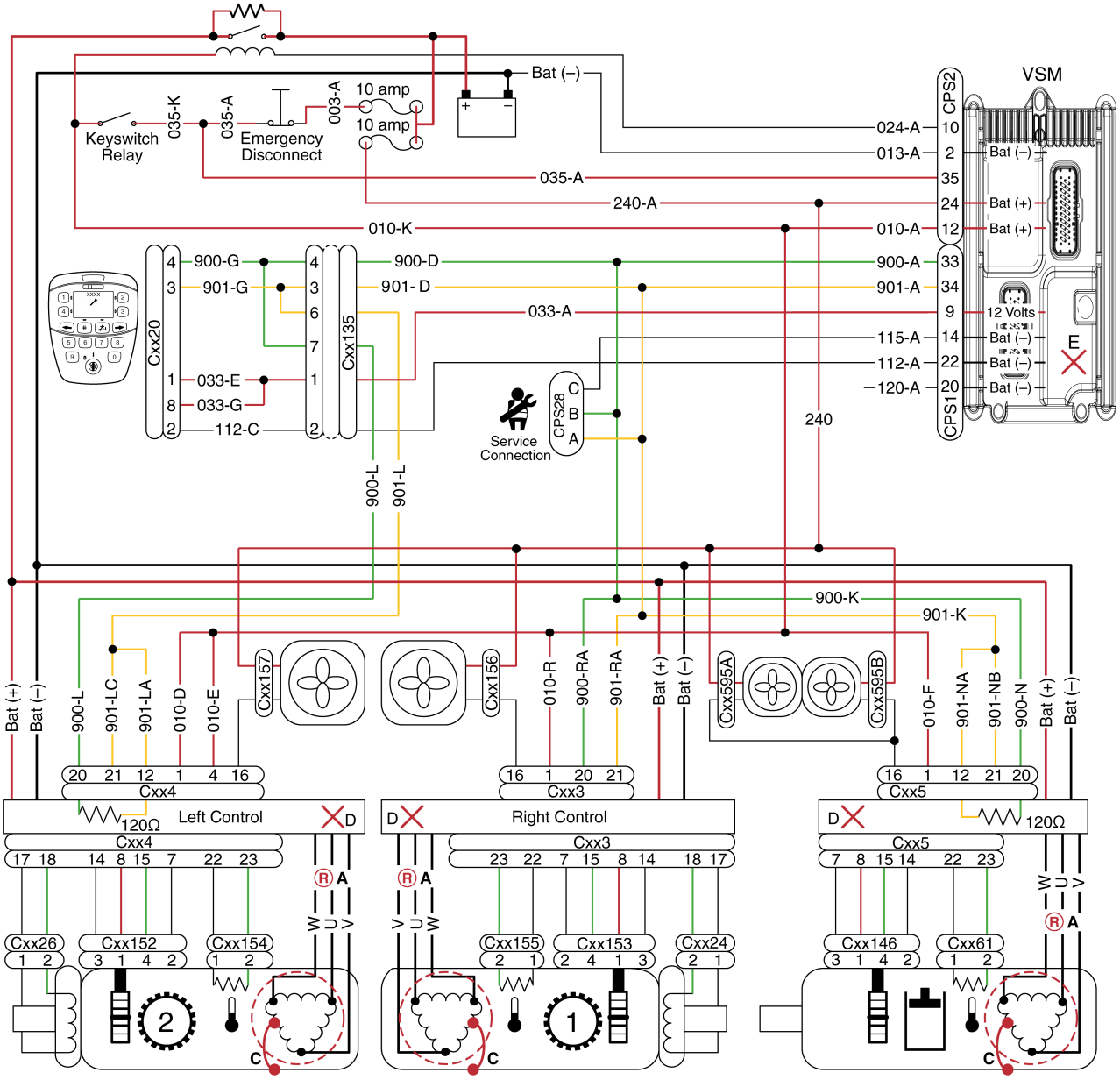
A935 – K160 D203Motor/Motor Controller Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

MOTOR/MOTOR CONTROLLER FAILURE CAUSES A B C D E > ?



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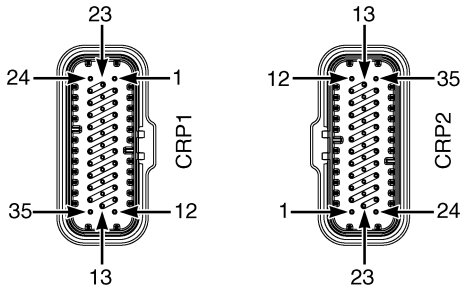
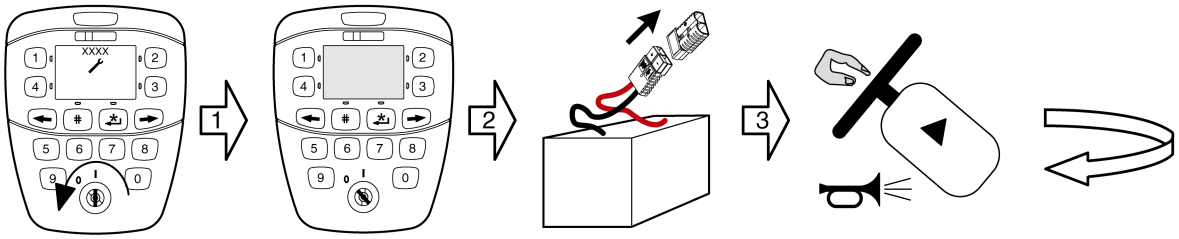
A935 – K160 D203Motor/Motor Controller Failure (Cont)

CONNECTORS



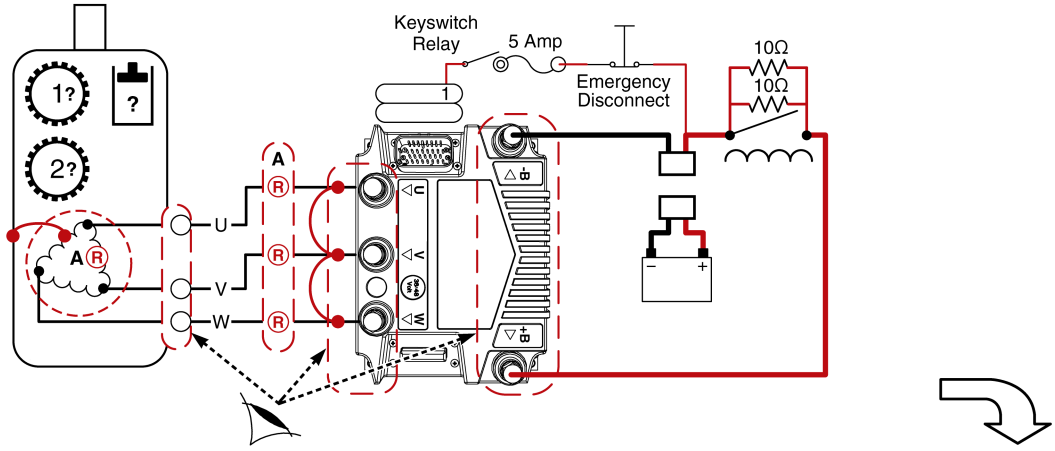
VSM Cxx 1 and Cxx 2

CAUSE A



Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ ?
Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP A1



For any Fault DTC→ Locate Device↓
Inspect ALL Wiring/Connections for Open Circuits/Corrosion/Bridging between adjacent Terminals

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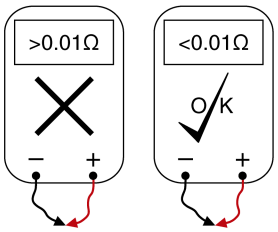
A935 – K160 D203Motor/Motor Controller Failure (Cont)

STEP A2

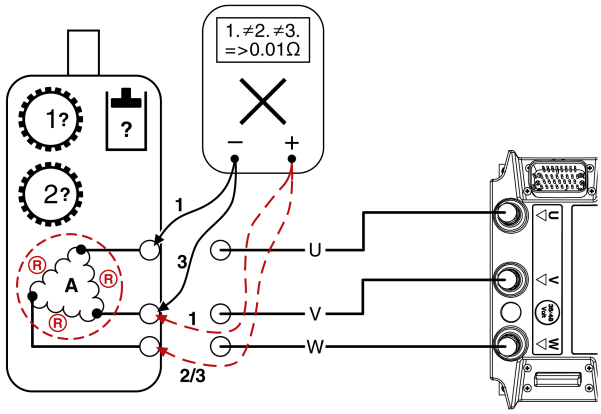


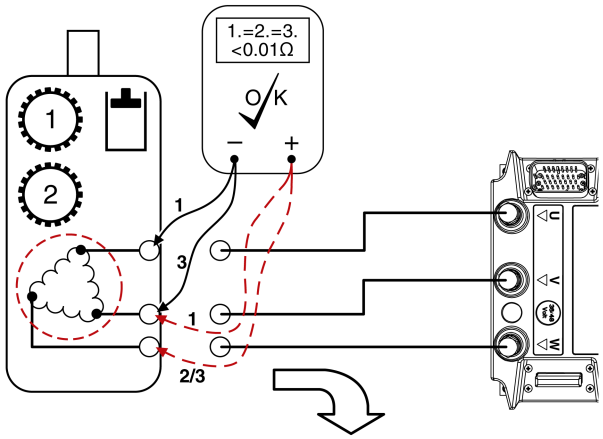
1. Set DMM to Lowest ?→Check Lead Resistance <0.01?

Note: If the Resistance is >0.01? then record this as the Zero ? Value → Step A3 ↓

STEP A3 **CHECK RESISTANCE - Ω - OHMS**

Motor Coils





Disconnect Motor connections W, V, U on Motor System indicated in Fault Log↓

1. Measure ?→Go to 2↓

2. Measure ?→Go to 3↓

3. Measure ?→Go to 4↓

4. 1 ? 2 ? 3 = > 0.01? + Zero Value→Go to 5↓	4. 1 = 2 = 3 < 0.01? + Zero Value→Step A4↓

5. Motor Faulty→Replace MotorGo to 6↓

6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→

7. Recheck ?↑→ Reconnect→Test→?DTCs? YES→Step A4↓ NO→Resume Operation

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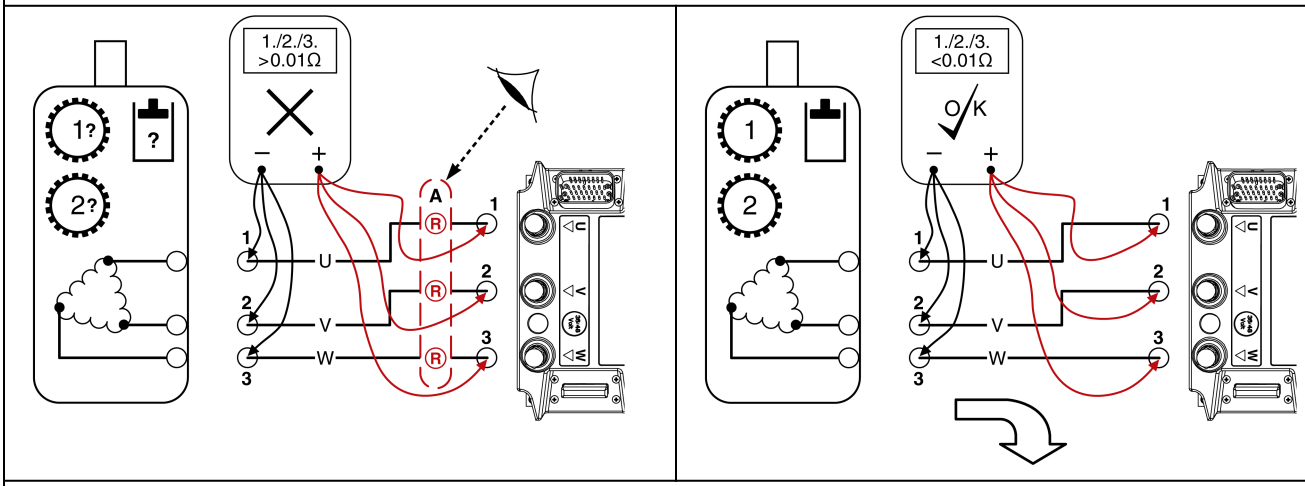
A935 – K160 D203Motor/Motor Controller Failure (Cont)

STEP A4 **CHECK RESISTANCE - Ω - OHMS**

Motor Coils



Disconnect Motor connections W, V, U on Controller↓	
1. Measure ?→Go to 2↓	
2. Measure ?→Go to 3↓	
3. Measure ?→Go to 4↓	
4. 1 ? 2 ? 3 > 0.01? + Zero Value→Go to 5↓	4. 1 = 2 = 3 < 0.01? + Zero Value→Component Operational Check↓
5. Wiring/Connector(s) Faulty→ReplaceGo to 6↓	
6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
7. Recheck ?↑→ Reconnect→Test→?DTCs? YES→Component Operational Check↓ NO→Resume Operation	

CAUSE B

Not Applicable

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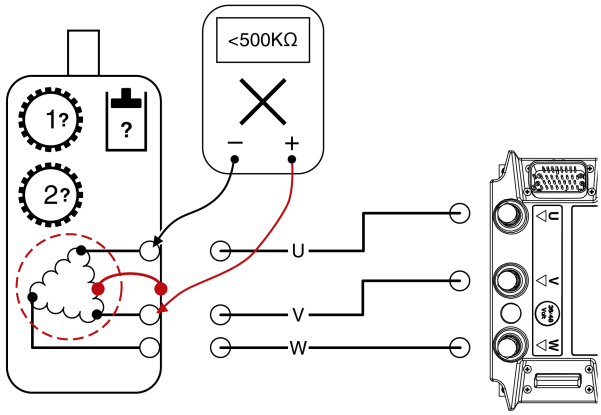
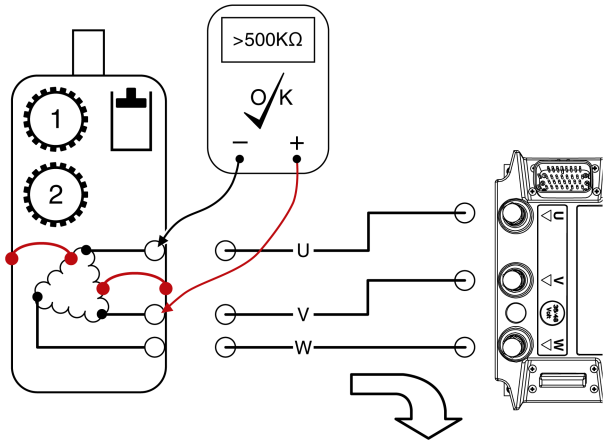
A935 – K160 D203Motor/Motor Controller Failure (Cont)

CAUSE C

Motor Windings to Motor Case





Measure ? between Case and any Motor Terminal

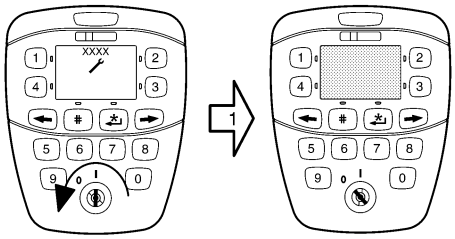
1. < 500K?→Go to 2↓	1. > 500K?→Component Operational Check↓

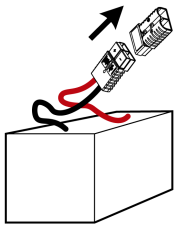
2. Short to Case→Replace Motor→Go to 3↓

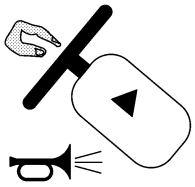
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→

4. Recheck ?↑→ Reconnect→Test→?DTCs? YES→Component Operational Check↓ NO→Resume Operation

CAUSE D

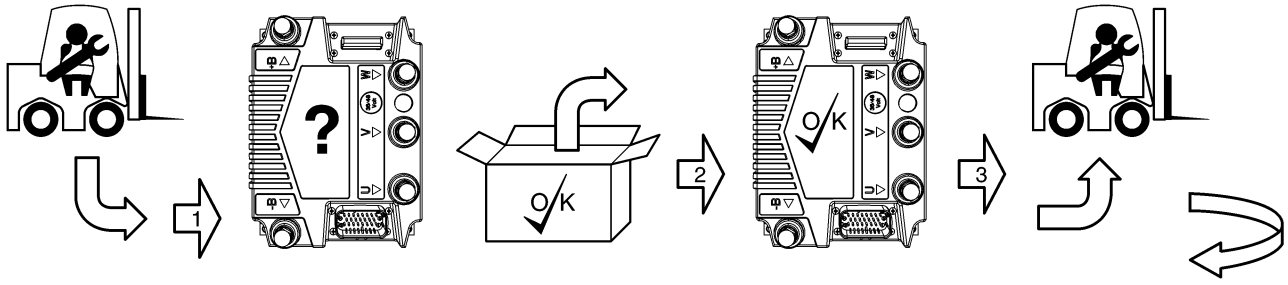






Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1



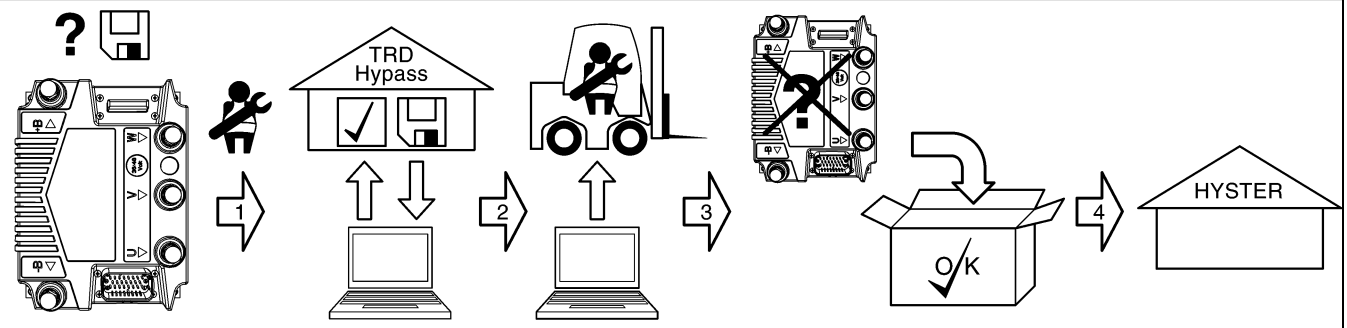
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

A935 – K160 D203Motor/Motor Controller Failure (Cont)

STEP D2



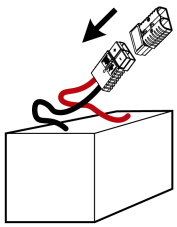
1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

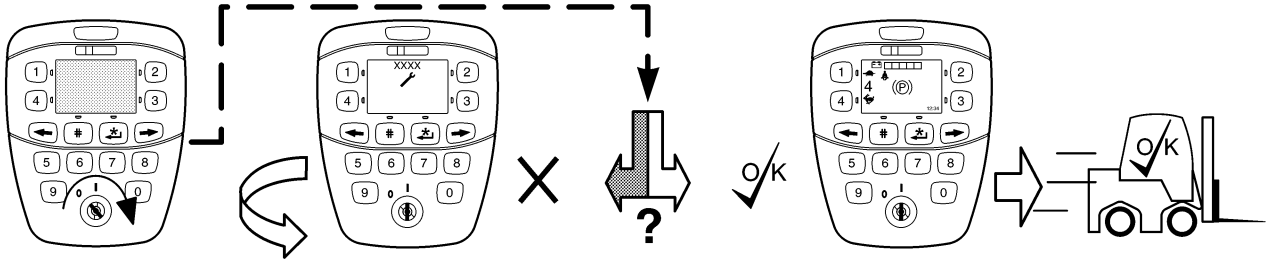
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

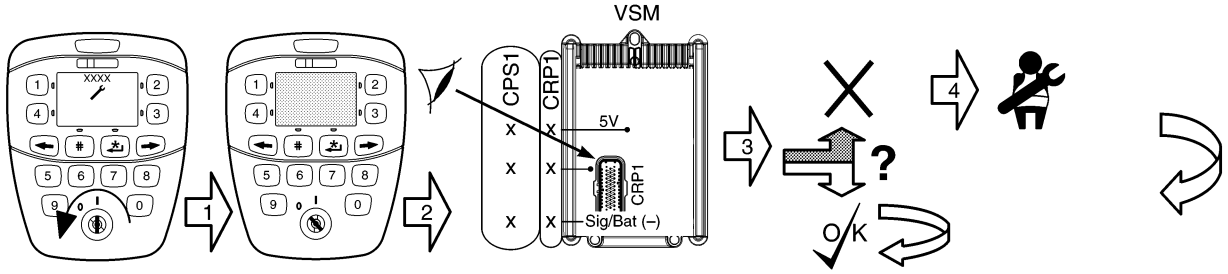




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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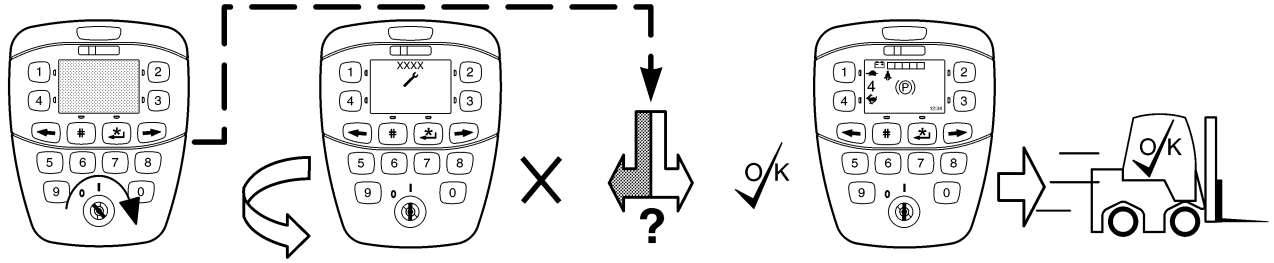
A935 – K160 D203Motor/Motor Controller Failure (Cont)

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

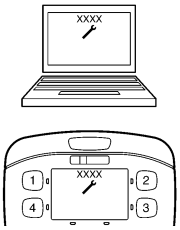
Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

https://truckmanualshub.com/

A935 – K160 D203 Motor Controller Failure

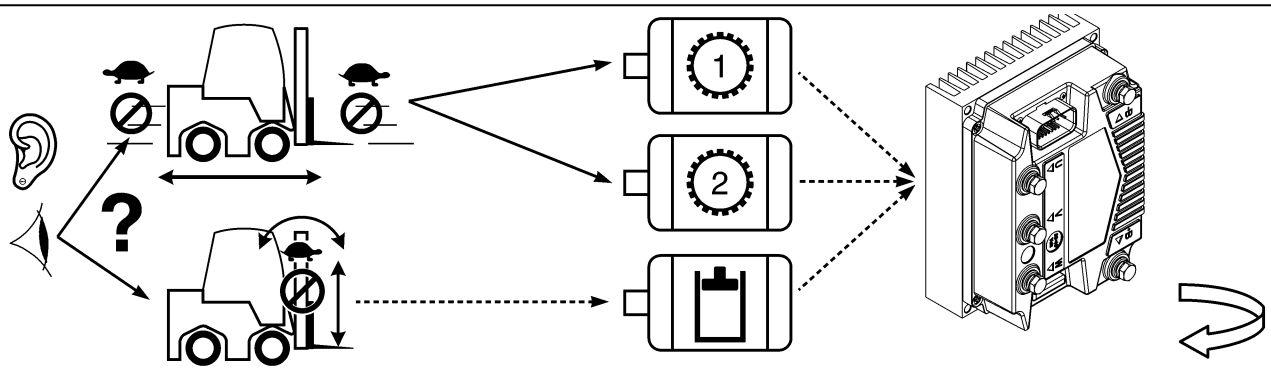


Fault Codes

DTC 65280
Controller Failure

QUICK CHECK **X Open Circuit/Fail)** **= Short Circuit**

Check 1

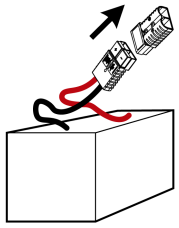
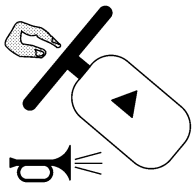
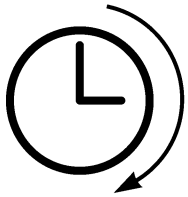
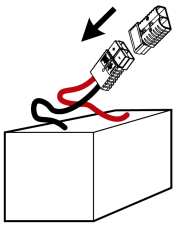


? Function Failure/Reduced Performance/Uncommanded Continuous Operation?

POSSIBLE CAUSES

1. Motor Controller Connections/Wiring High Resistance?→	→ Component Operational Check ↓
2. Motor Controller(s) Failure?→	→ Component Operational Check ↓

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

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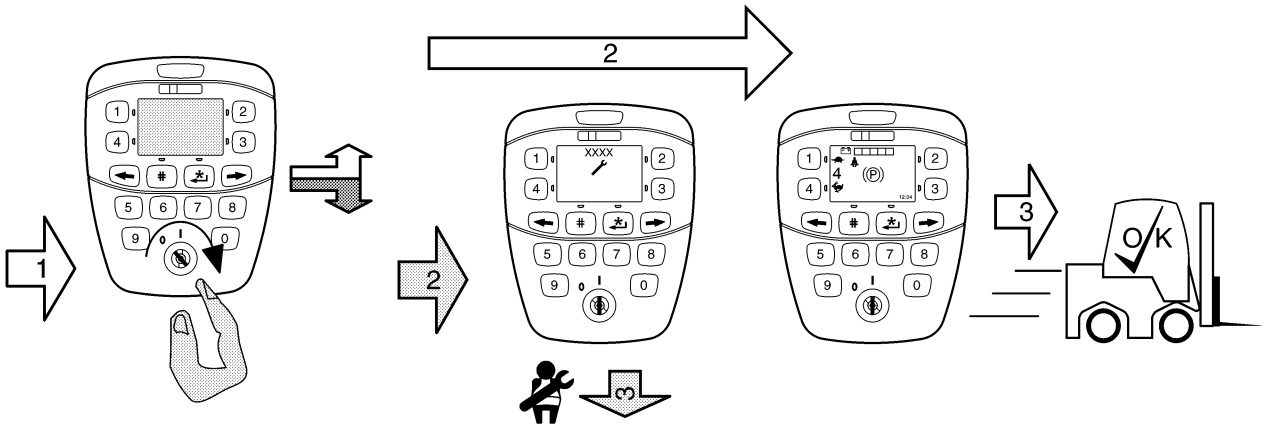
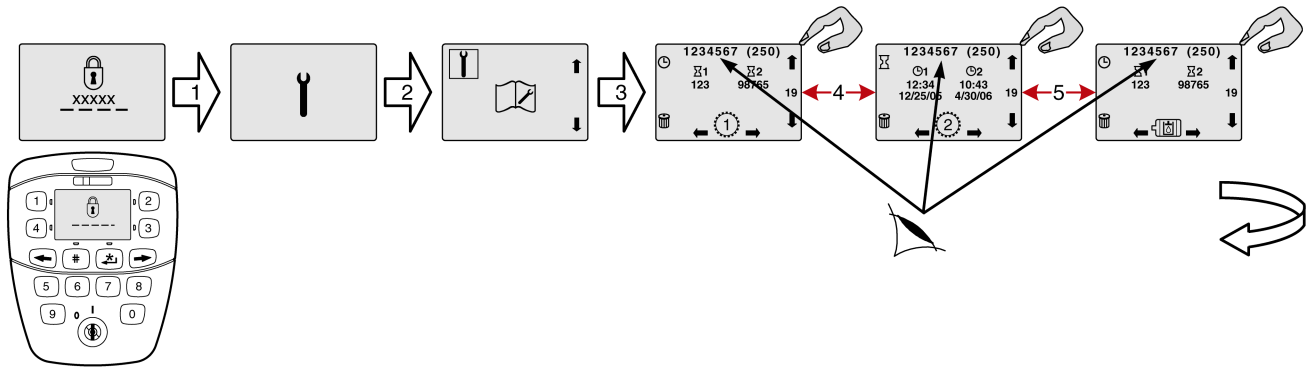
A935 – K160 D203 Motor Controller Failure (Cont)

Check 3

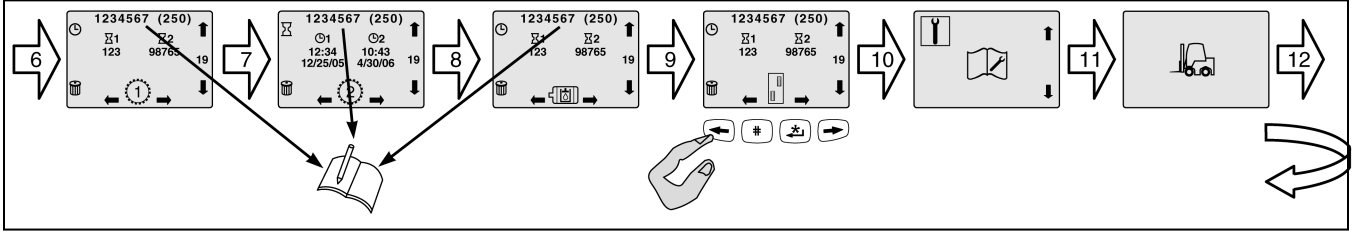


Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

FAULT LOG Review - Go to Display Menu



Enter SERVICE Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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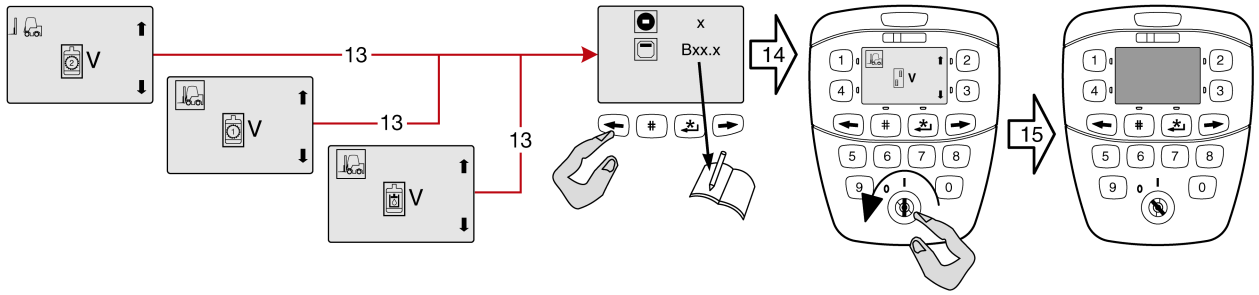
A935 – K160 D203 Motor Controller Failure (Cont)

all Motor DTCs→ ☜ Exit Fault Log→ Truck Status ?



NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

Motor Versions→ Hardware/Software Versions→ ☜ Exit Versions→ Power **OFF**?

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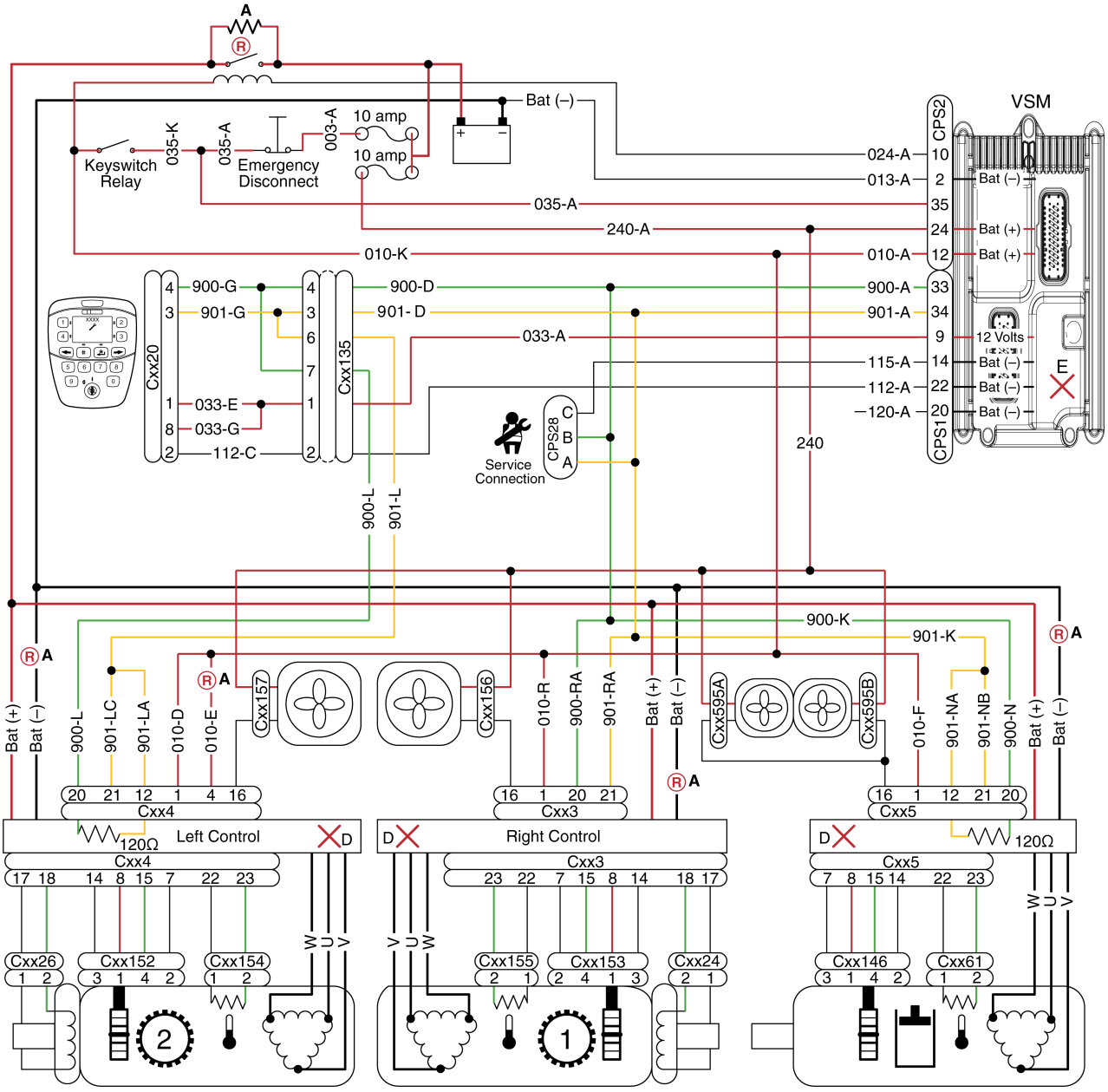
A935 – K160 D203 Motor Controller Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

MOTOR CONTROLLER CAPACITOR FAILURE CAUSES A B C D E > ?



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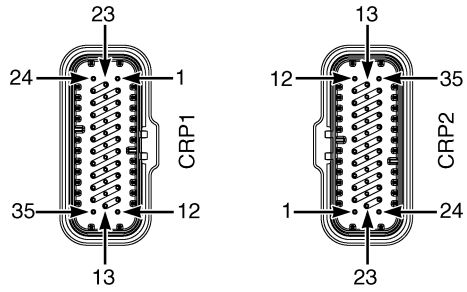
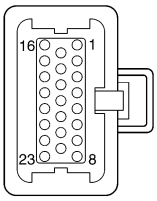
A935 – K160 D203 Motor Controller Failure (Cont)

CONNECTORS

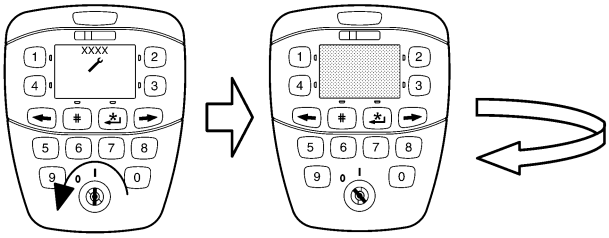


VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

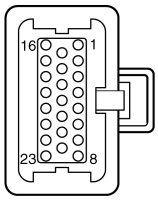
CAUSE A

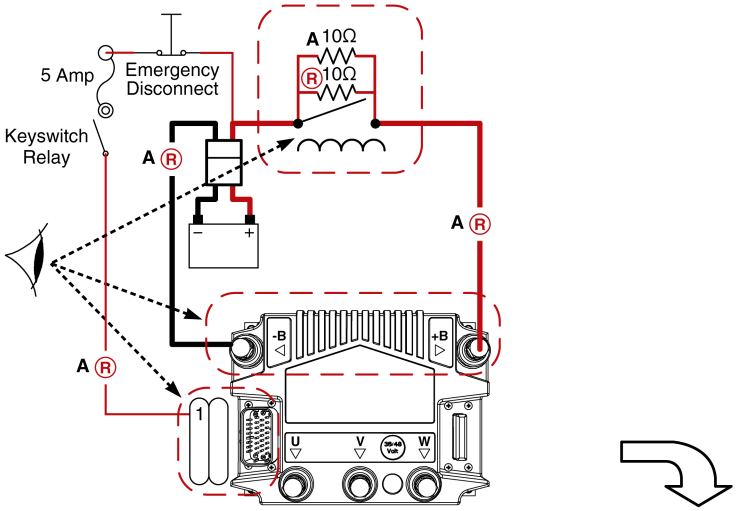


Power **OFF**→ ?

STEP A1

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections See Diagnostic Trouble Codes, Page 9030-20-238





CAUSE B

Not Applicable

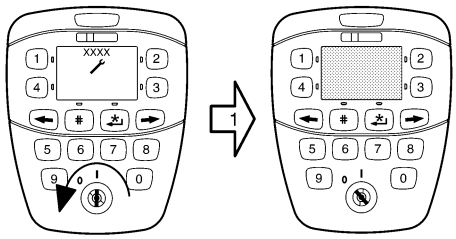
CAUSE C

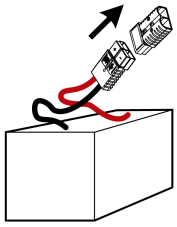
Not Applicable

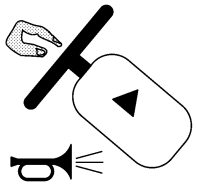
https://truckmanualshub.com/

A935 – K160 D203 Motor Controller Failure (Cont)

CAUSE D



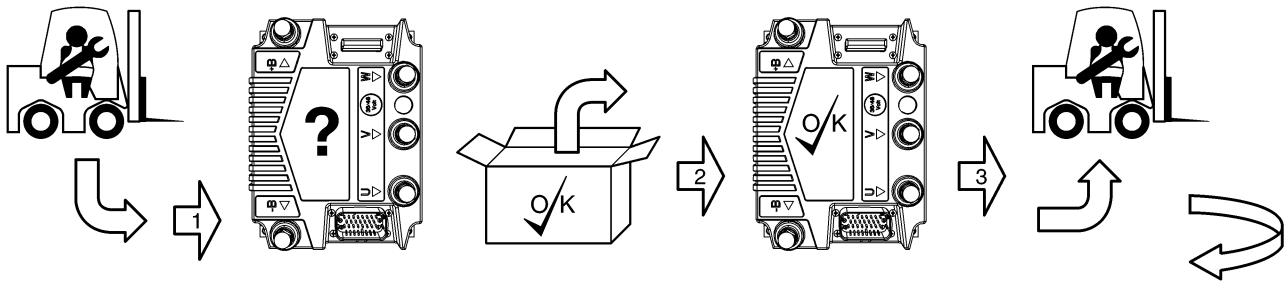




Power **OFF**→

Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1

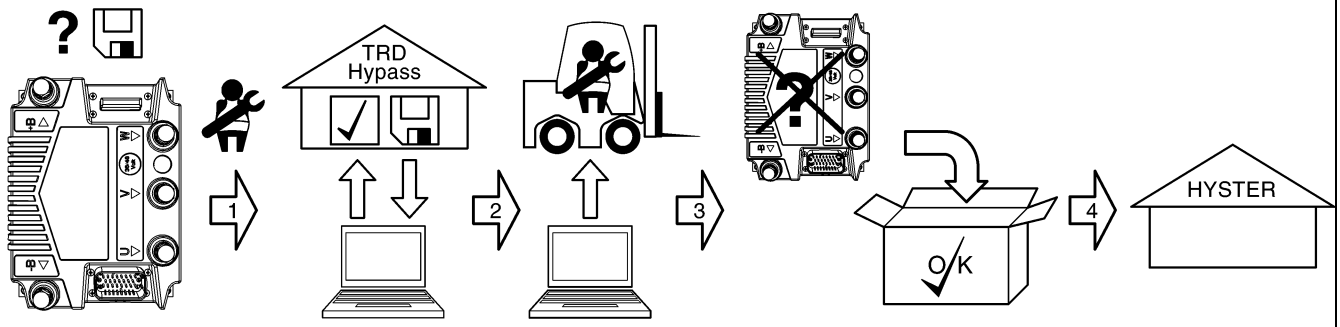


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

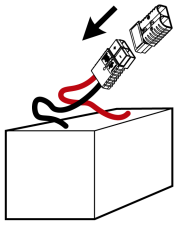
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

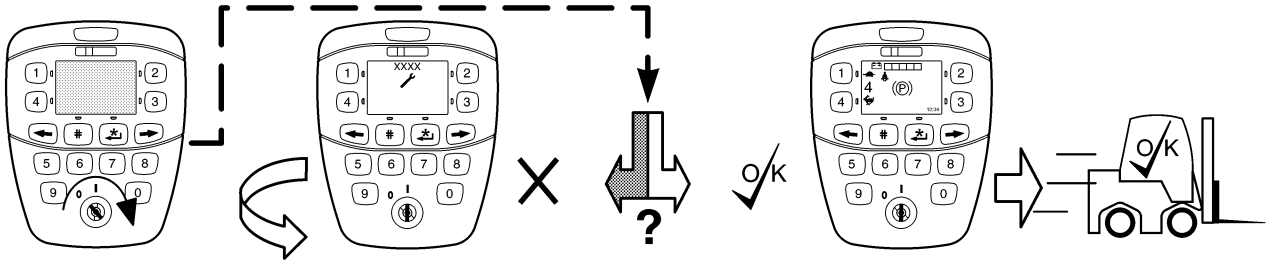
3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 D203 Motor Controller Failure (Cont)

STEP D3

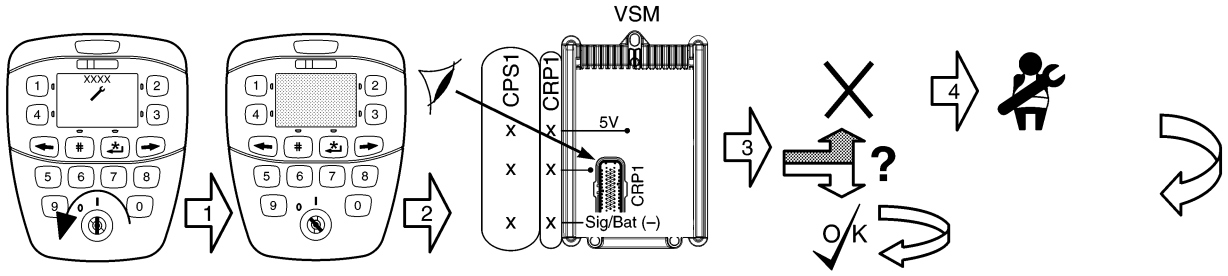




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

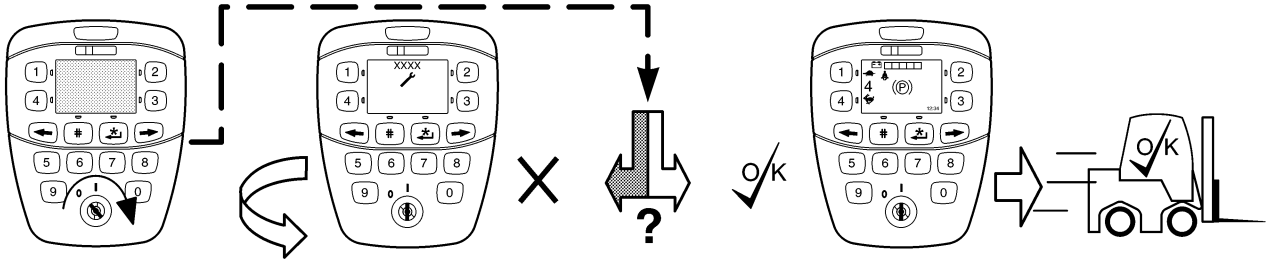
NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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CBB/DBB Motor/Motor Controller Failure

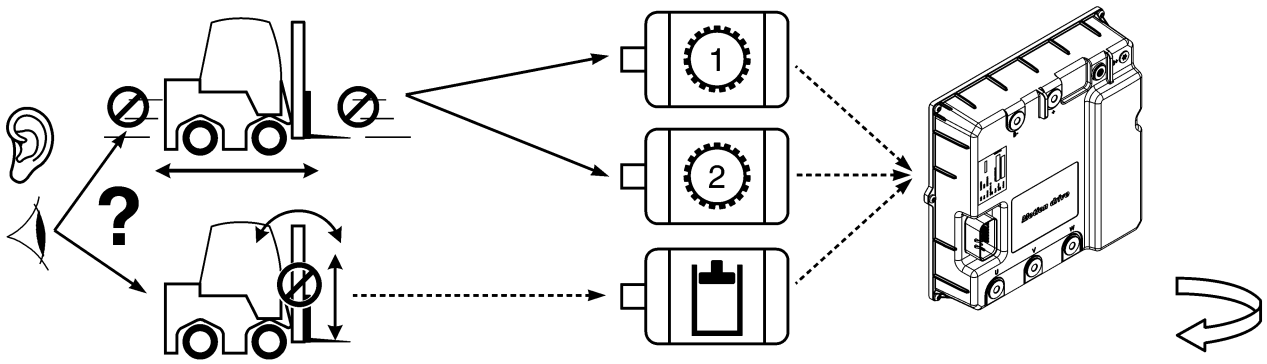
Fault Codes

DTC 8976
AC Current – Over Current

DTC 9024
AC Current – Short Circuit

QUICK CHECK X Open Circuit/Fail) = Short Circuit

Check 1



? No Traction/Hydraulic Truck Operation ?

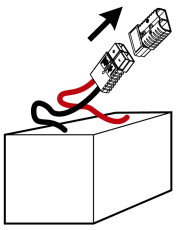
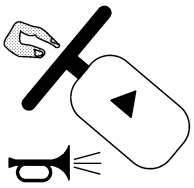
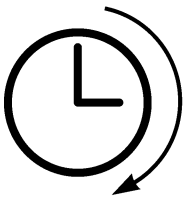
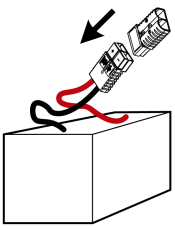
POSSIBLE CAUSES

Motor to Motor Controller Connections/Wiring→ High Resistance?→	→ Component Operational Check ↓
Motor Windings Failure Open Circuit?→	→ Component Operational Check ↓
Motor Windings Short to Frame?→	→ Component Operational Check ↓
Motor Controller(s) Failure?→	→ Component Operational Check ↓

WARNING

The CBB Truck requires the removal of the battery to access the Controllers and Motors

Check 2

			
Disconnect Battery	Sound Horn to Discharge Capacitors	Wait 30 seconds	Reconnect Battery

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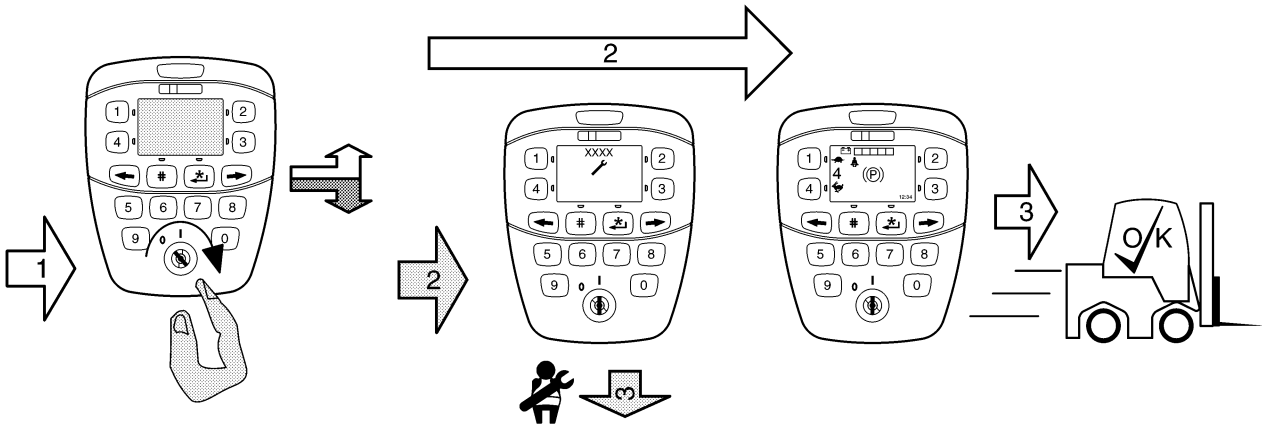
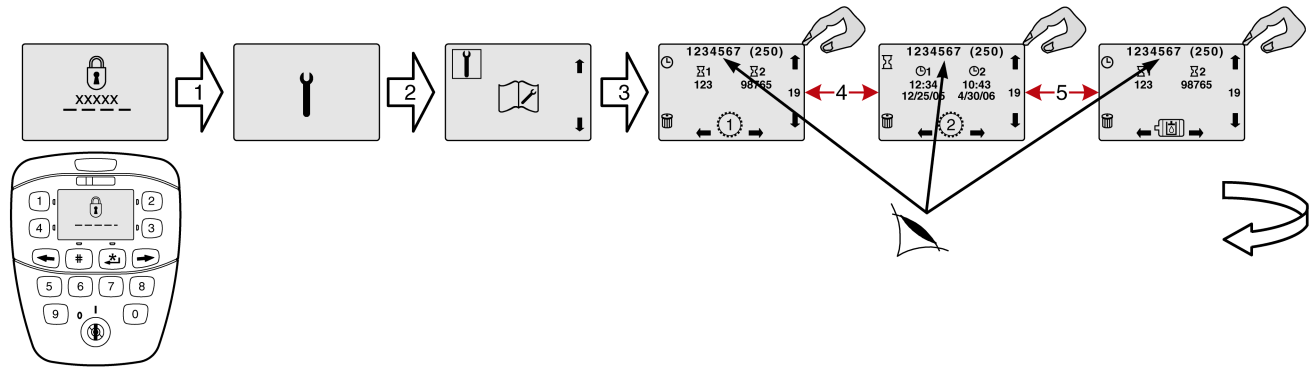
CBB/DBB Motor/Motor Controller Failure (Cont)

Check 3

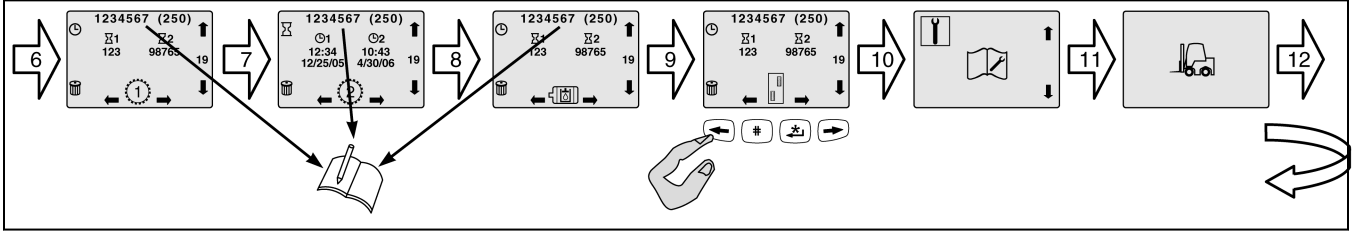


Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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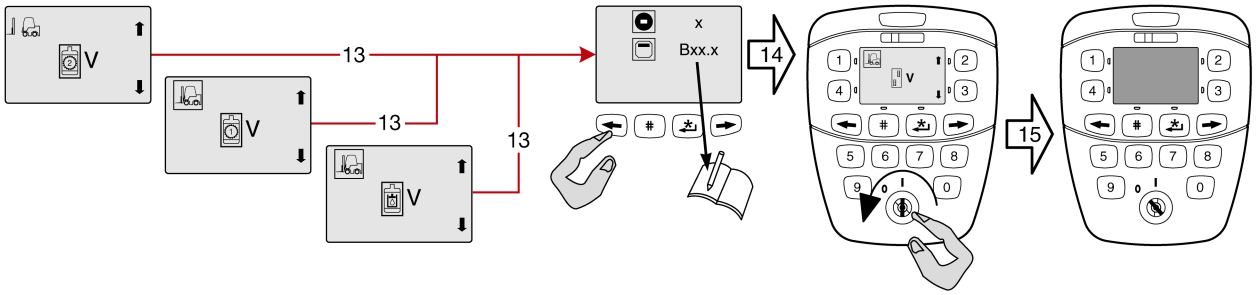
CBB/DBB Motor/Motor Controller Failure (Cont)

all Motor DTCs→ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ Exit Versions→ Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the Faulty Component/Connection

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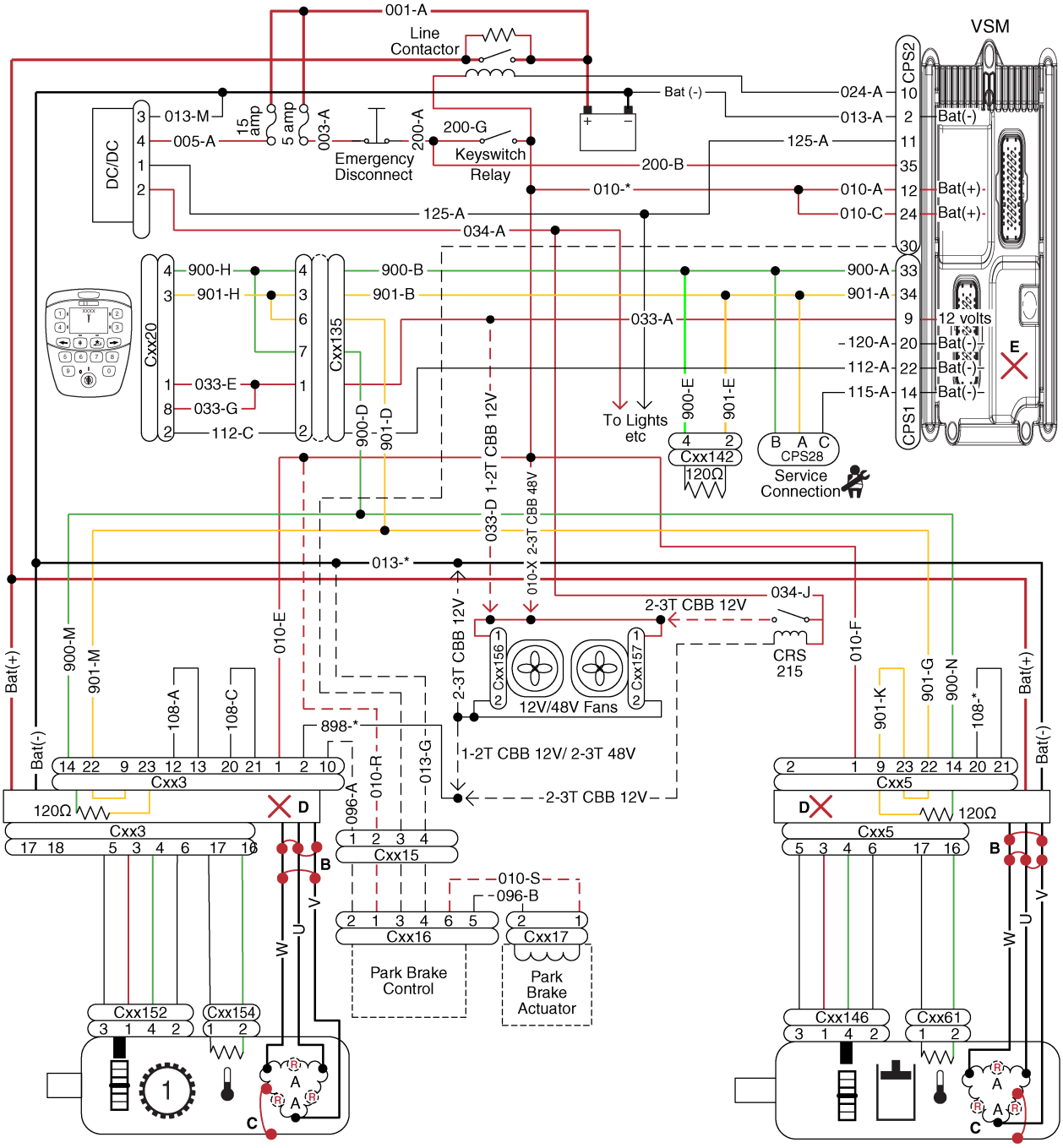
CBB/DBB Motor/Motor Controller Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

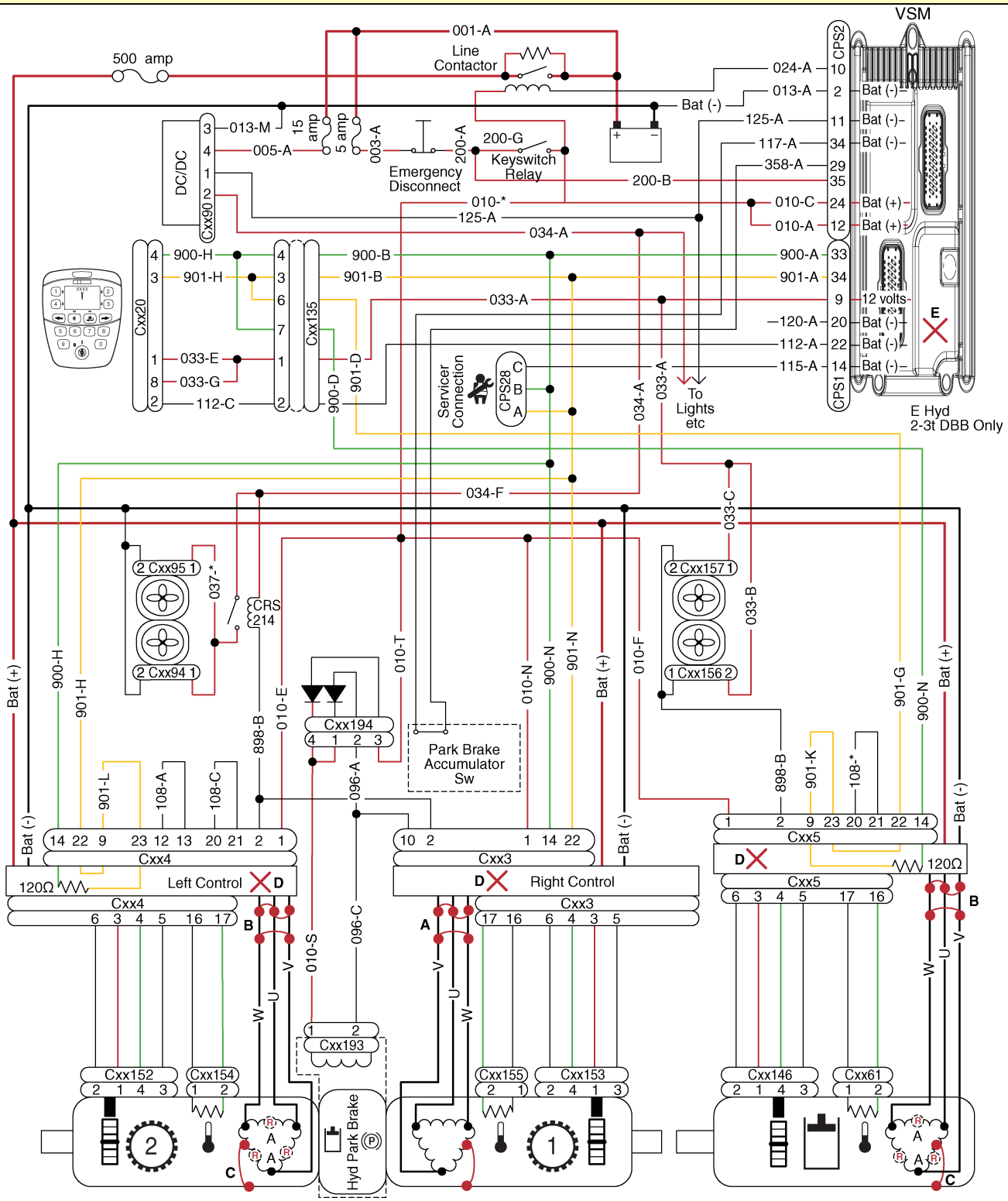
1.5 – 2.0 TON CBB SCHEMATIC CAUSES A B C D E > ?



https://truckmanualshub.com/

CBB/DBB Motor/Motor Controller Failure (Cont)

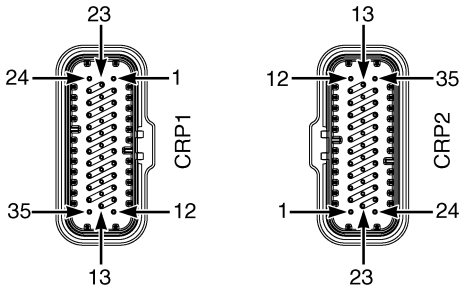
2.2 – 3.0 TON DBB SCHEMATIC CAUSES A B C D E > ?



https://truckmanualshub.com/

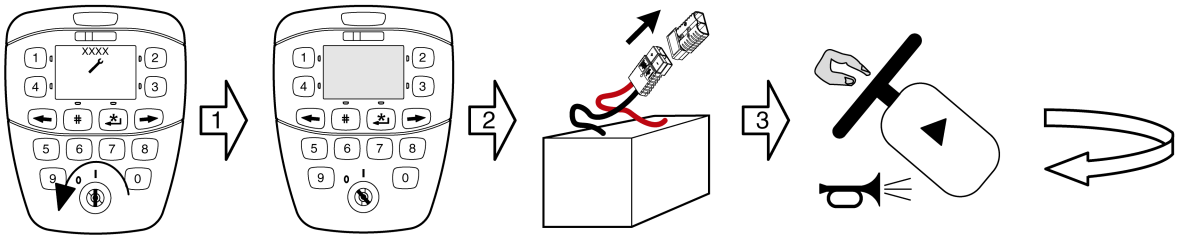
CBB/DBB Motor/Motor Controller Failure (Cont)

CONNECTORS



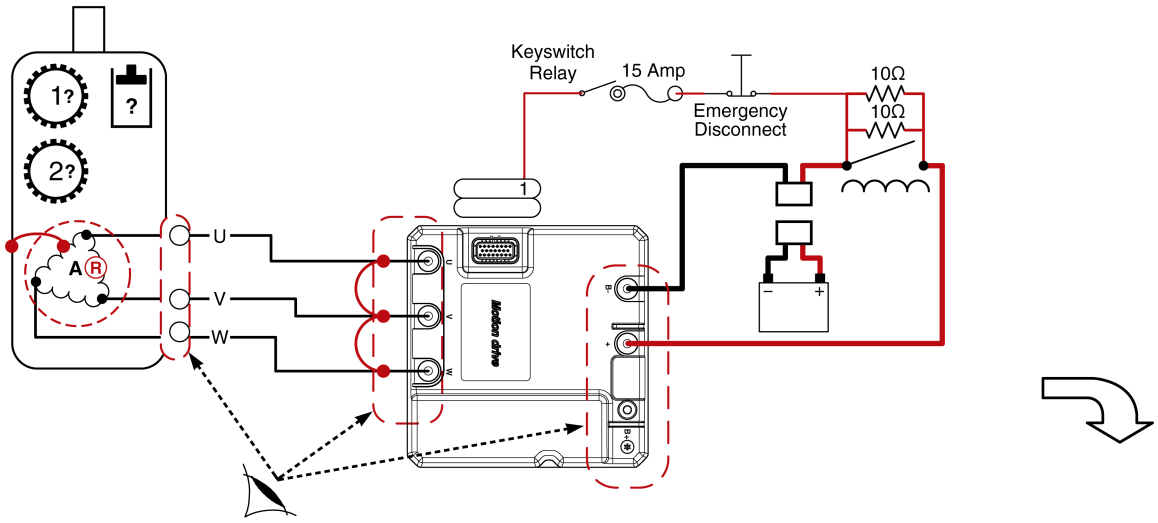
VSM Cxx 1 and Cxx 2

CAUSE A



Power **OFF**→ Disconnect Battery→ Sound Horn to Discharge Capacitors→ ?

STEP A1



For any Fault DTC→ Locate Device↓
Inspect ALL Wiring/Connections for Open Circuits/Corrosion/Bridging between adjacent Terminals

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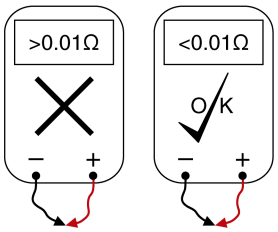
CBB/DBB Motor/Motor Controller Failure (Cont)

STEP A2

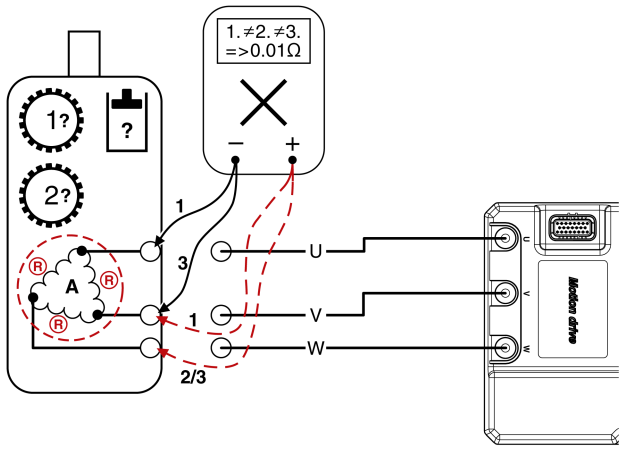


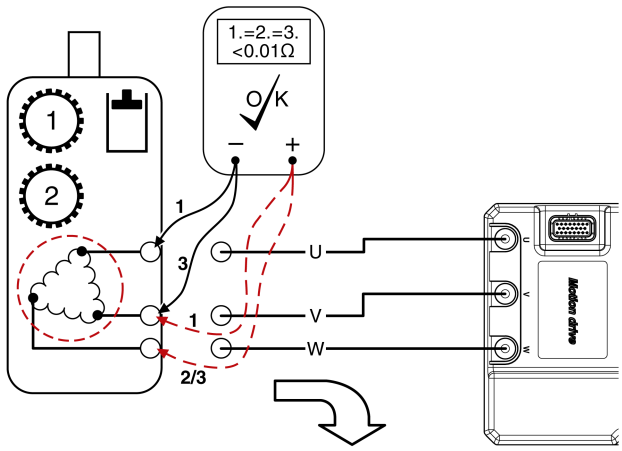
1. Set DMM to Lowest ?→Check Lead Resistance <0.01?

Note: If the Resistance is >0.01? then record this as the Zero ? Value → Step A3 ↓

STEP A3 **CHECK RESISTANCE - Ω - OHMS**

Motor Coils





Disconnect Motor connections W, V, U on Motor System indicated in Fault Log↓

1. Measure ?→Go to 2↓

2. Measure ?→Go to 3↓

3. Measure ?→Go to 4↓

4. 1 ? 2 ? 3 = > 0.01? + Zero Value→Go to 5↓	4. 1 = 2 = 3 < 0.01? + Zero Value→Component Operational Check↓

5. Motor Faulty→Replace MotorGo to 6↓

6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓

7. Recheck ?↑→ Reconnect→Test→?DTCs? YES→Component Operational Check↓ NO→Resume Operation

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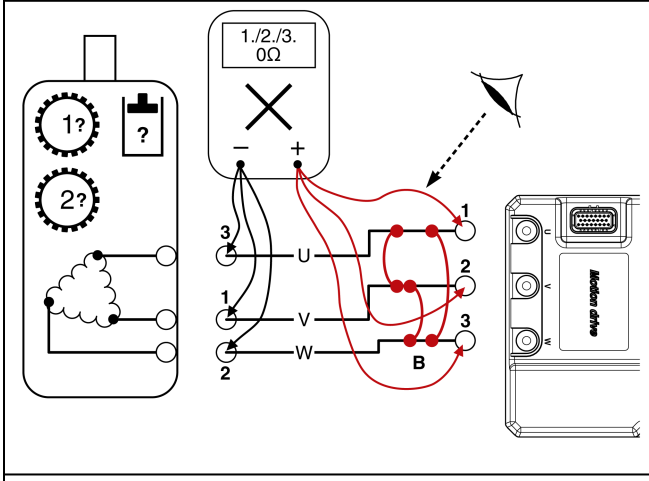
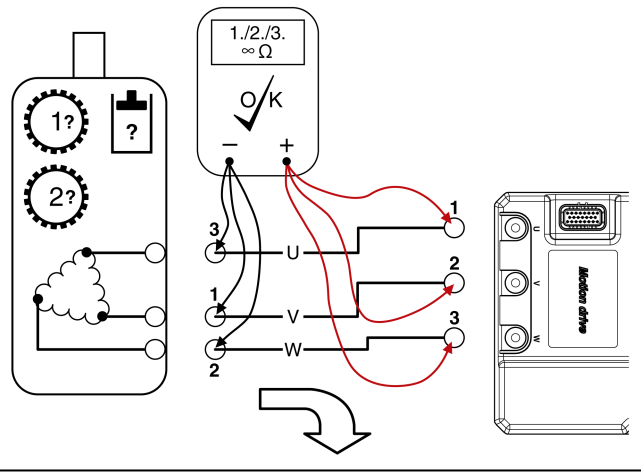
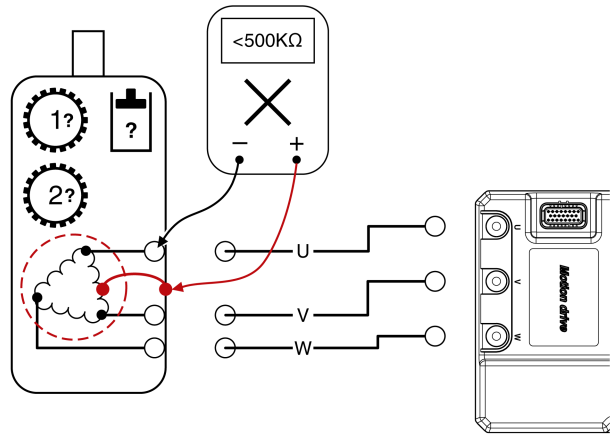
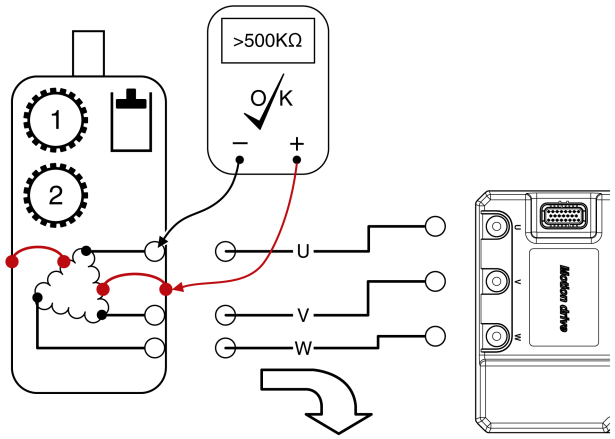
CBB/DBB Motor/Motor Controller Failure (Cont)	
CAUSE B	**CHECK RESISTANCE - Ω - OHMS**
Motor/Controller Connections	
	
Disconnect Motor connections W, V, U on Controller↓	
1. Measure ?→Go to 2↓	
2. Measure ?→Go to 3↓	
3. Measure ?→Go to 4↓	
4. 1./2./3. 0?→Go to 5↓	4. 1./2./3. 8?→Component Operational Check↓
5. Wiring/Connector(s) Faulty→ReplaceGo to 6↓	
6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓	
7. Recheck ?↑→ Reconnect→Test→?DTCs? YES→Component Operational Check↓ NO→Resume Operation	

CBB/DBB Motor/Motor Controller Failure (Cont)

CAUSE C

Motor Windings to Motor Case





Measure ? between Case and any Motor Terminal

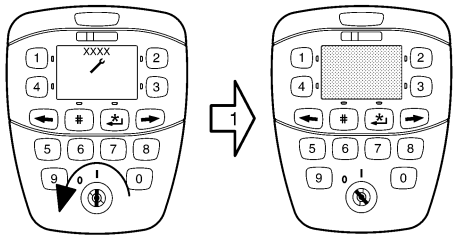
1. < 500K?→Go to 2↓	1. > 500K?→Component Operational Check↓

2. Short to Case→Replace Motor→Go to 3↓

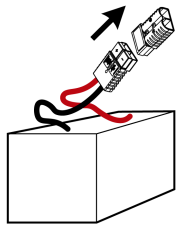
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓

4. Recheck ?↑→ Reconnect→Test→?DTCs? YES→Component Operational Check↓ NO→Resume Operation

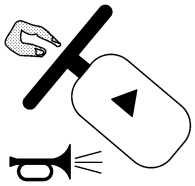
CAUSE D



Power **OFF**→

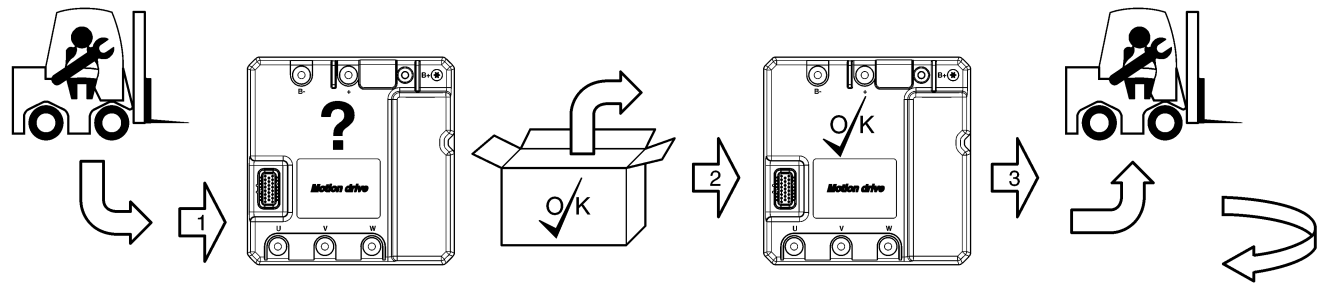


Disconnect Battery



Sound Horn to Discharge Capacitors

STEP D1



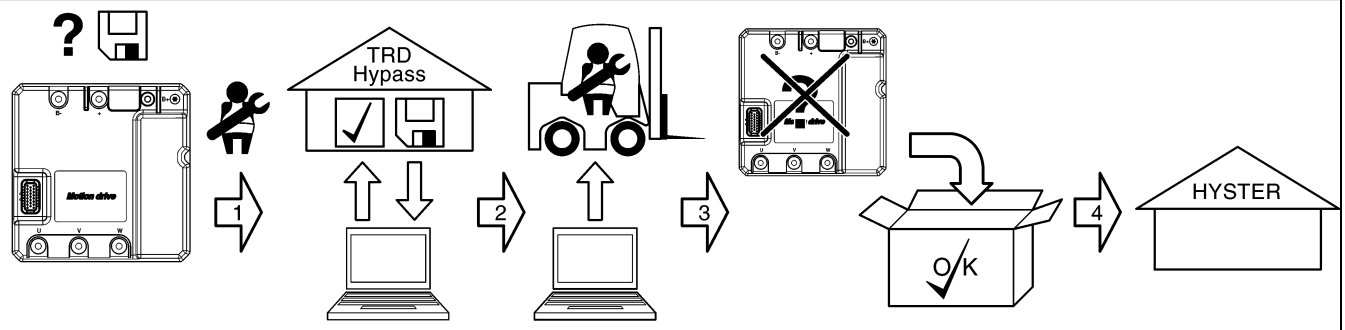
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

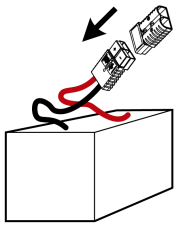
CBB/DBB Motor/Motor Controller Failure (Cont)

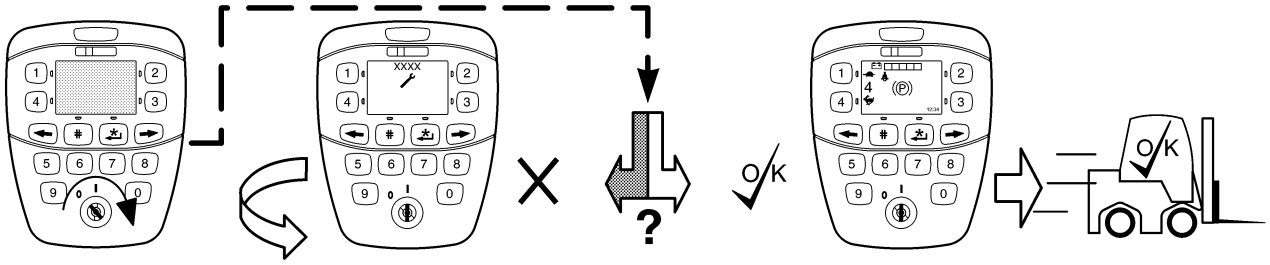
STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??
2. **NO**→Download the latest Application →Install on truck→Step D3↓
3. **YES**→Test New Installation→↓Step D3↓
4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

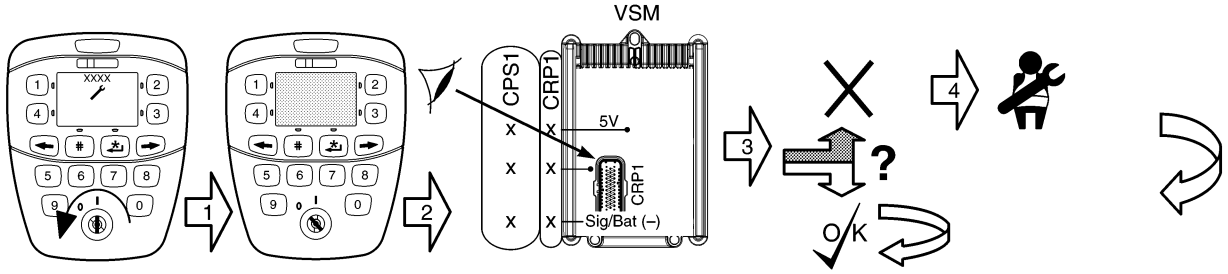




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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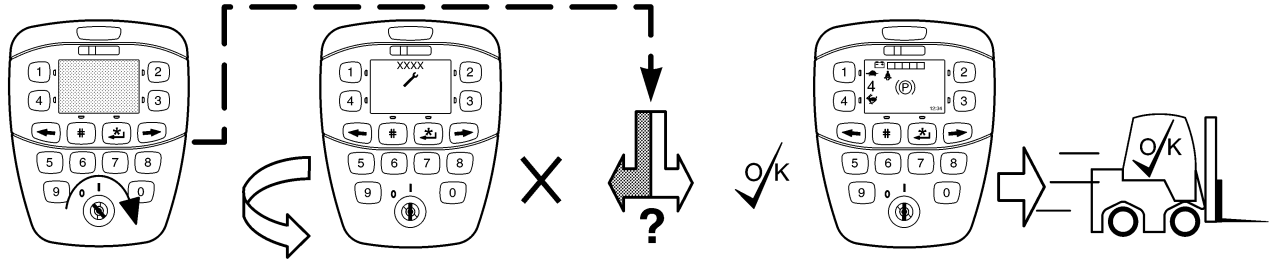
CBB/DBB Motor/Motor Controller Failure (Cont)

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

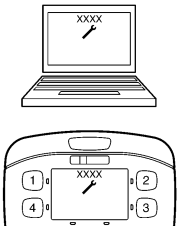
Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

https://truckmanualshub.com/

A935 – K160 D203 Motor Controller CAN Communication Failure

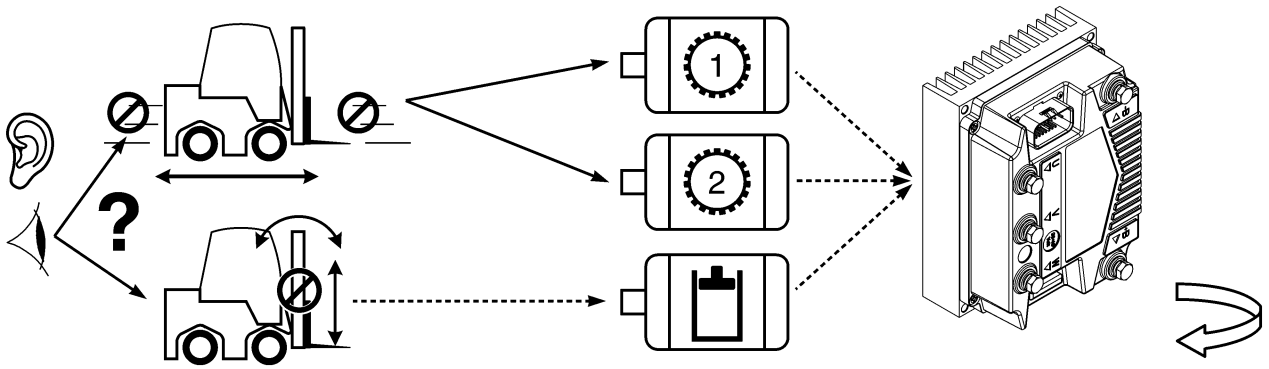


Fault Codes

DTC 65527
No CAN Communication

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1

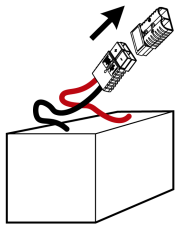
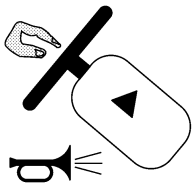
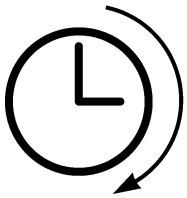
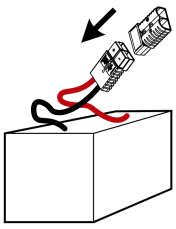


? No Traction/Hydraulic Truck Operation ?

POSSIBLE CAUSES

Motor Controller Connections/Wiring Open/ Short Circuit→	A935 – K160 CAN Communication Failure
Motor Controller(s) Failure?→	→ Component Operational Check ↓

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

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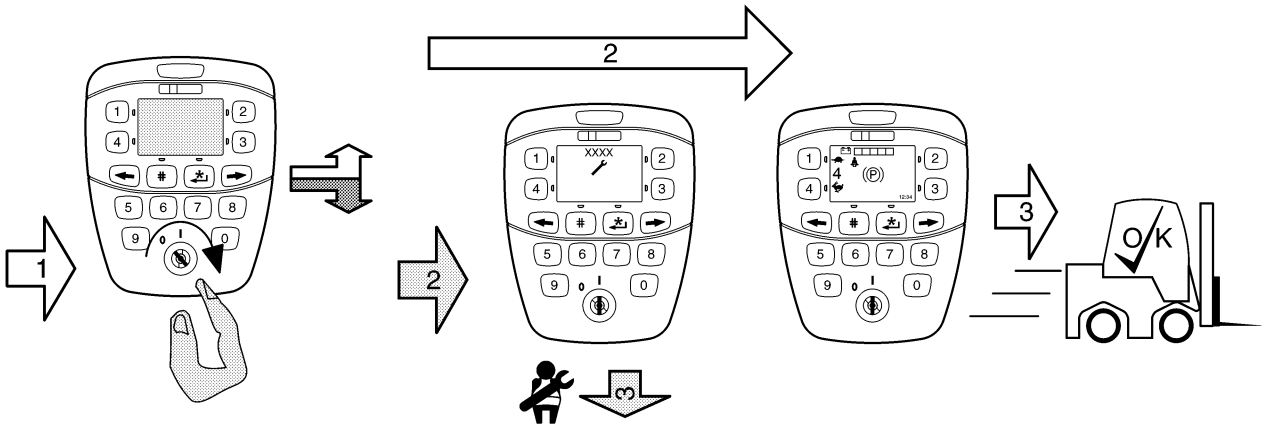
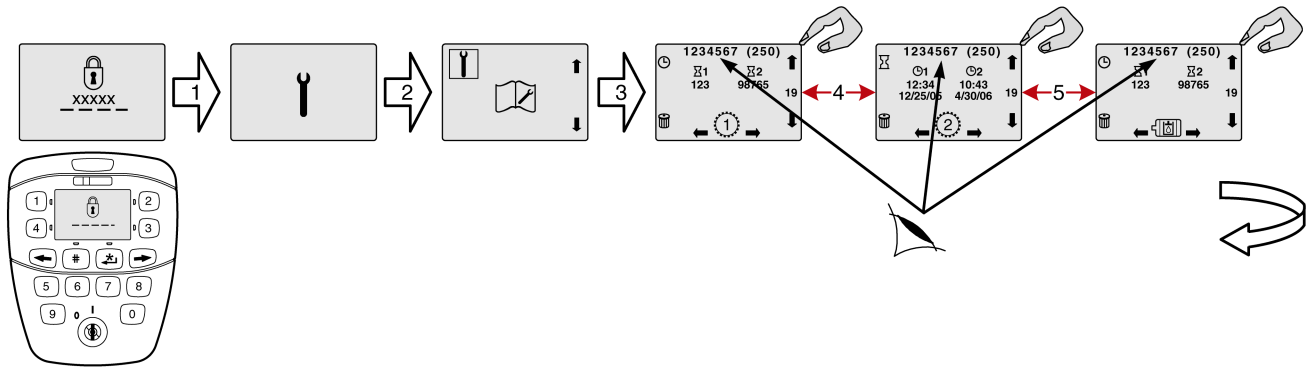
A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

Check 3

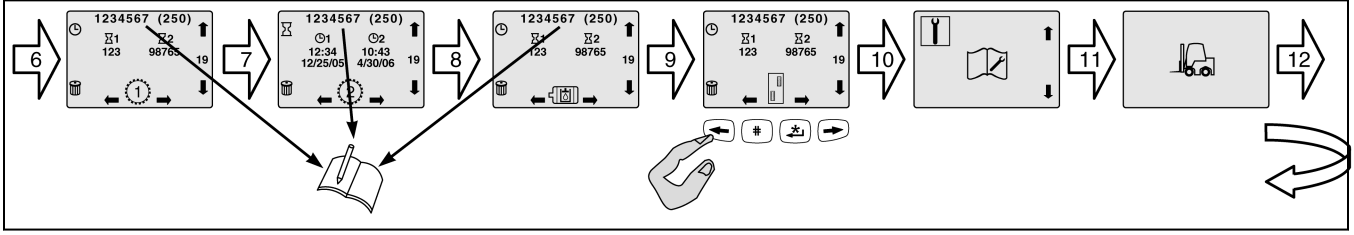


Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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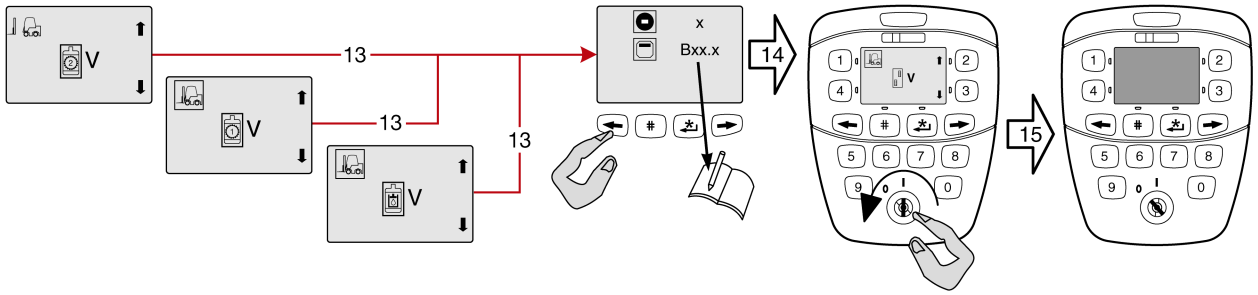
A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

all Motor DTCs→ Exit Fault Log→ Truck Status ?



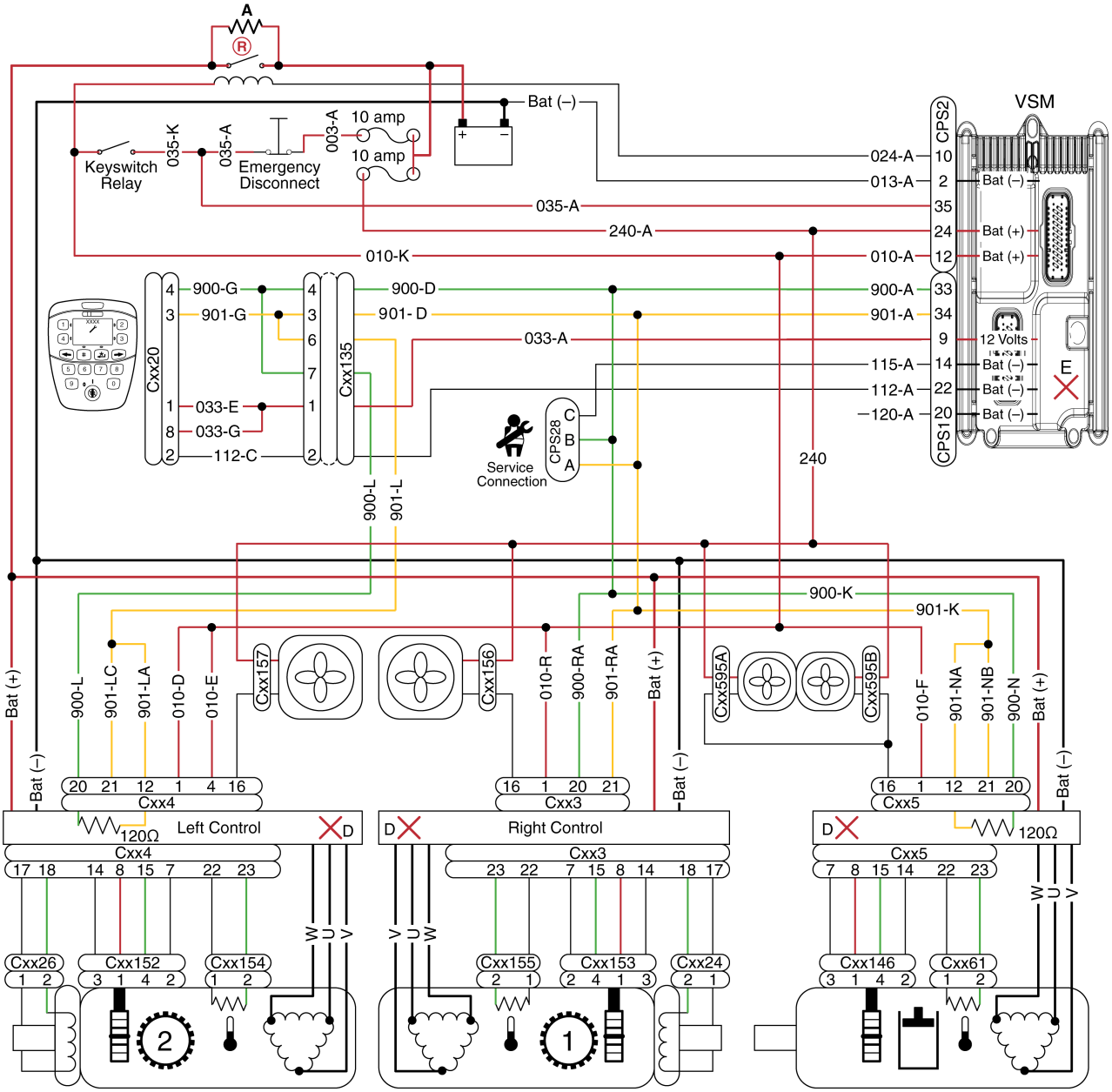
Motor Versions→ Hardware/Software Versions→ Exit Versions→ Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the Faulty Component/Connection

A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

MOTOR CONTROLLER CAN COMMUNICATION FAILURE CAUSES A B C D E > ?



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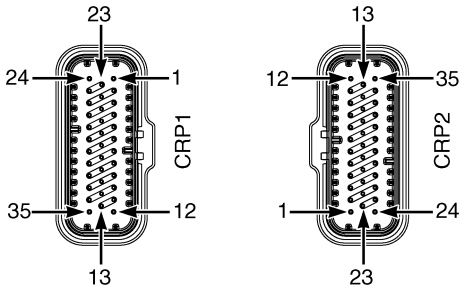
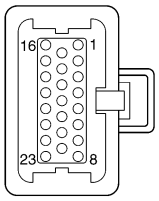
A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

CONNECTORS



VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

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A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

CAUSE A

See A935 – K160 CAN Communication Failure

CAUSE B

Not Applicable

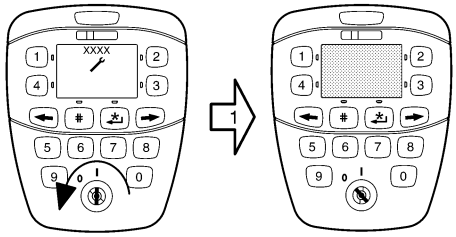
CAUSE C

Not Applicable

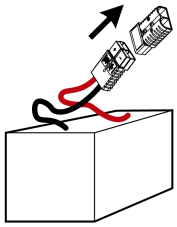
CAUSE D

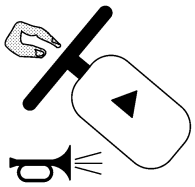
WARNING

Do not do Component Operational Check until Component Operational Check is complete.



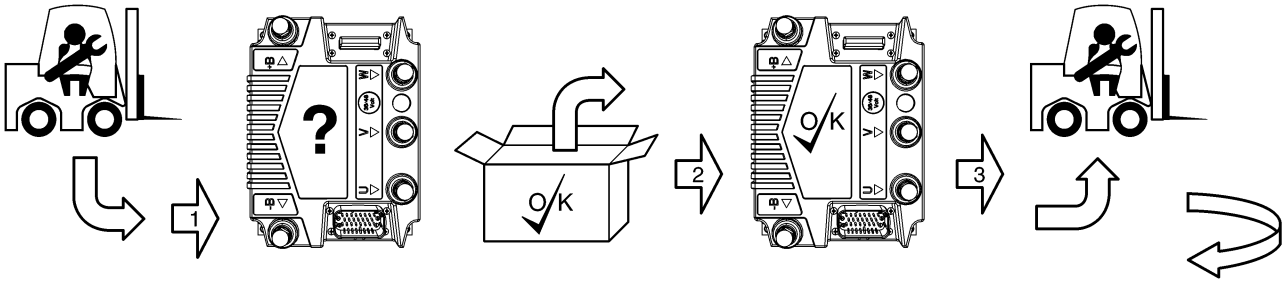
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1



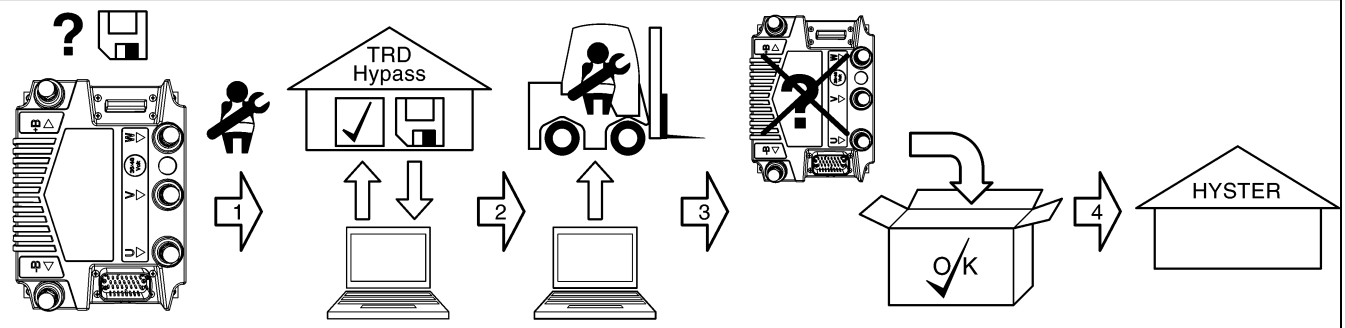
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

STEP D2



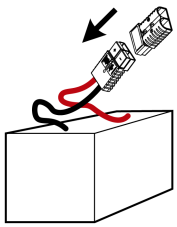
1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

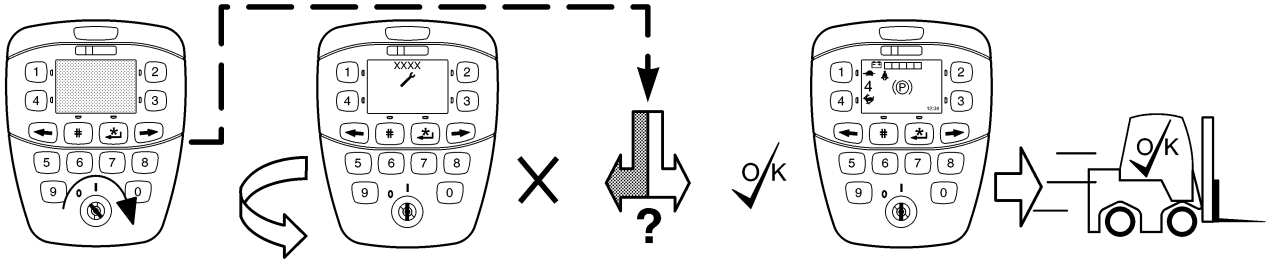
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

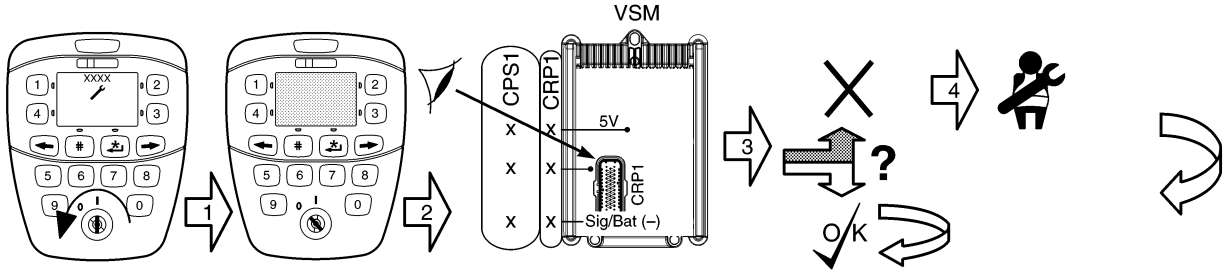




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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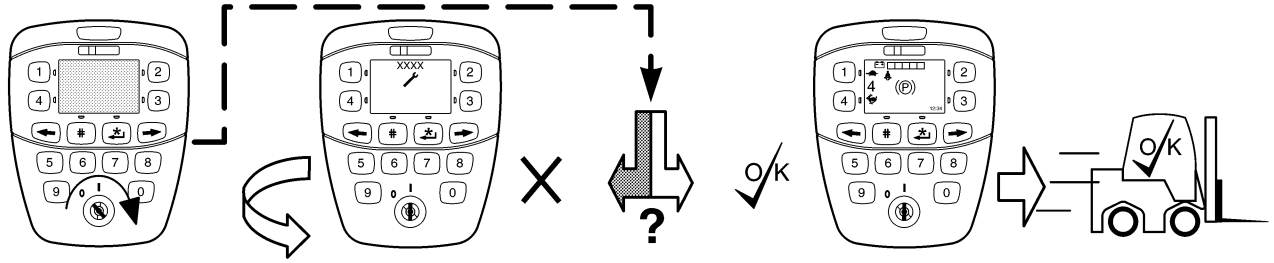
A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

STEP E1



Retest - Power **ON**→

NO → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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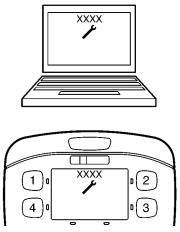
CBB/DBB Motor Controller CAN Communication Failure

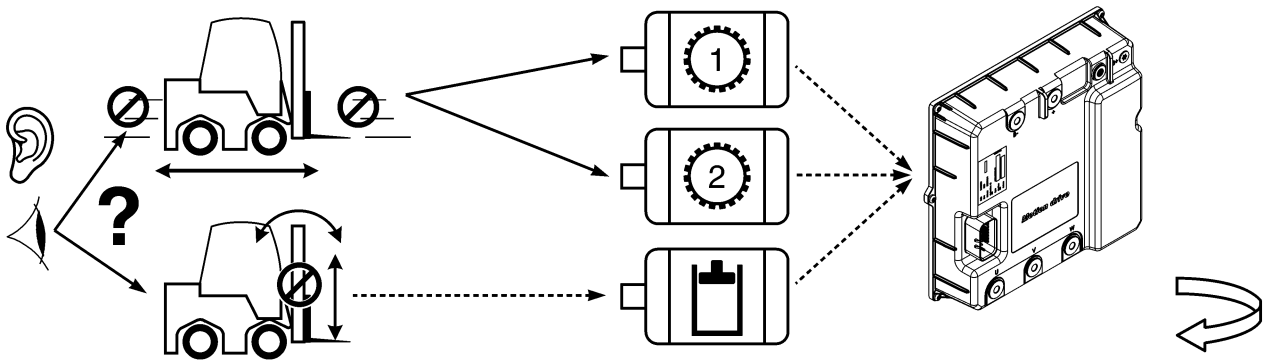


Fault Codes

DTC 33024
CAN Communication Failure

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1



? No Traction/Hydraulic Truck Operation ?

POSSIBLE CAUSES

1. Motor Controller Connections/Wiring – Open/Short Circuit→Go to 1a or 1b↓

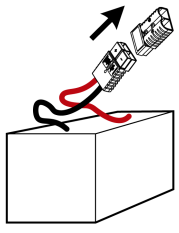
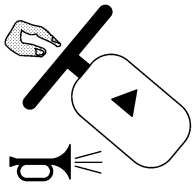
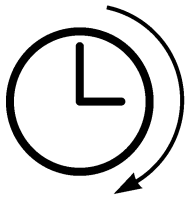
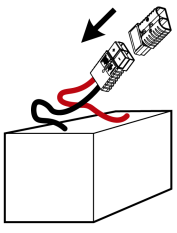
1a. CAN Communication Failure. See CBB 4 Wheel CAN Communication→

1b. CAN Communication Failure. See DBB 4 Wheel CAN Communication→

2. Motor Controller(s) Failure?→Component Operational Check↓

WARNING
The CBB Truck requires the removal of the battery to access the Controllers and Motors

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery	

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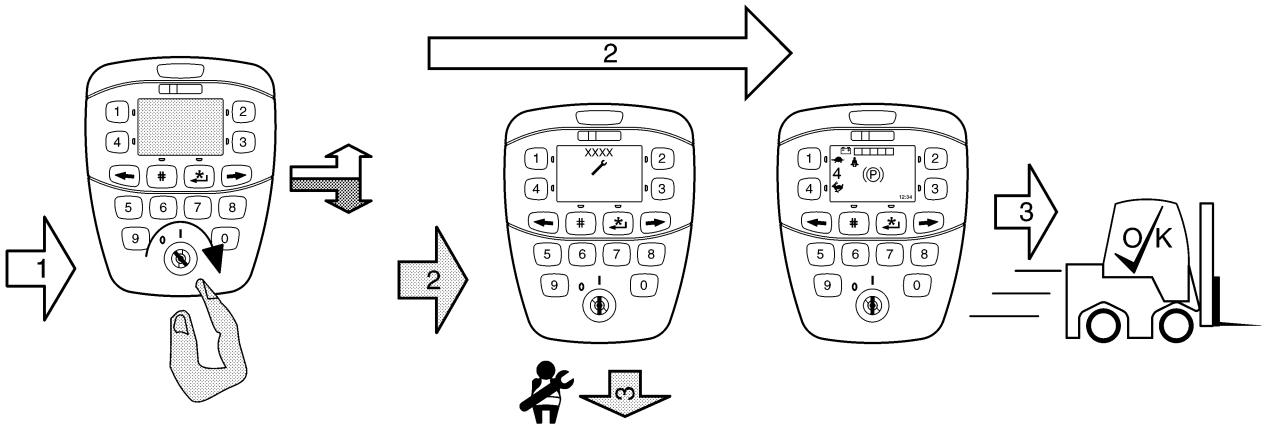
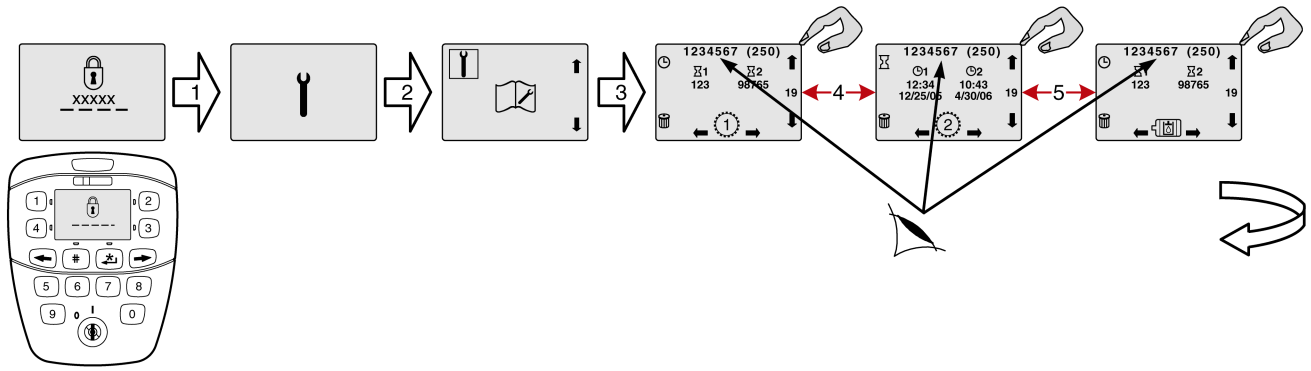
CBB/DBB Motor Controller CAN Communication Failure (Cont)

Check 3

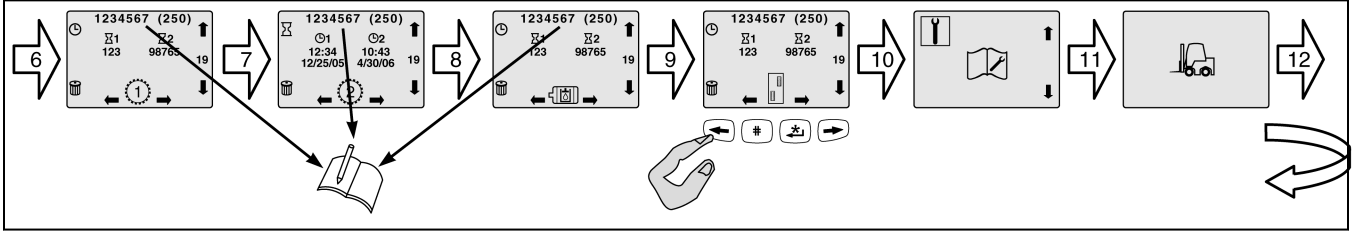


Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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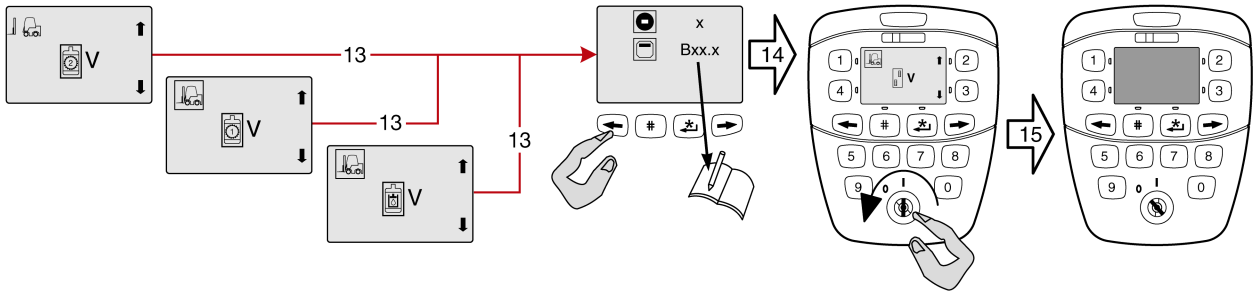
CBB/DBB Motor Controller CAN Communication Failure (Cont)

all Motor DTCs→ Exit Fault Log→ Truck Status ?



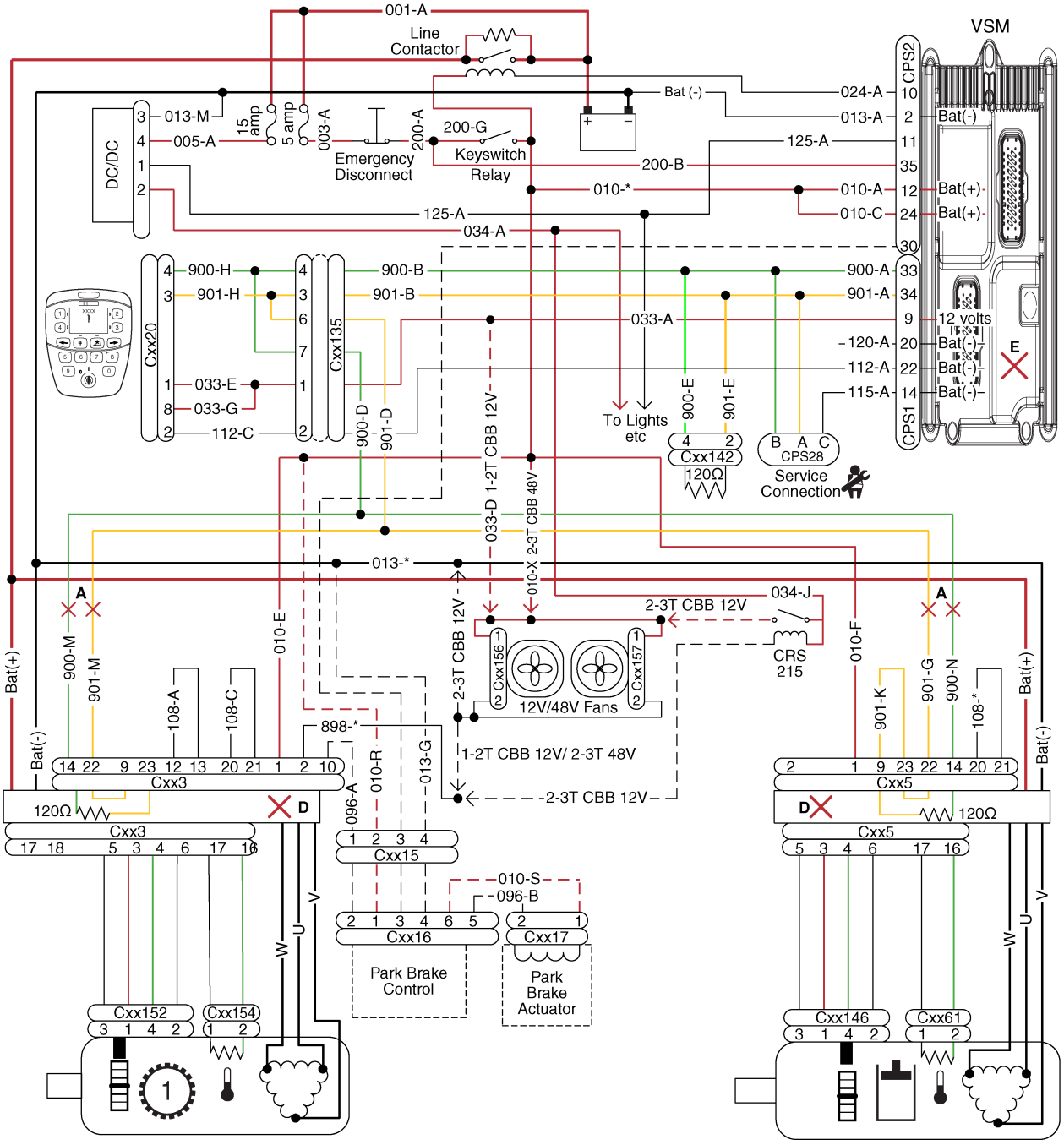
Motor Versions→ Hardware/Software Versions→ Exit Versions→ Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the Faulty Component/Connection

CBB/DBB Motor Controller CAN Communication Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

1.5 – 2.0 CBB SCHEMATIC CAUSES A B C D E > ?



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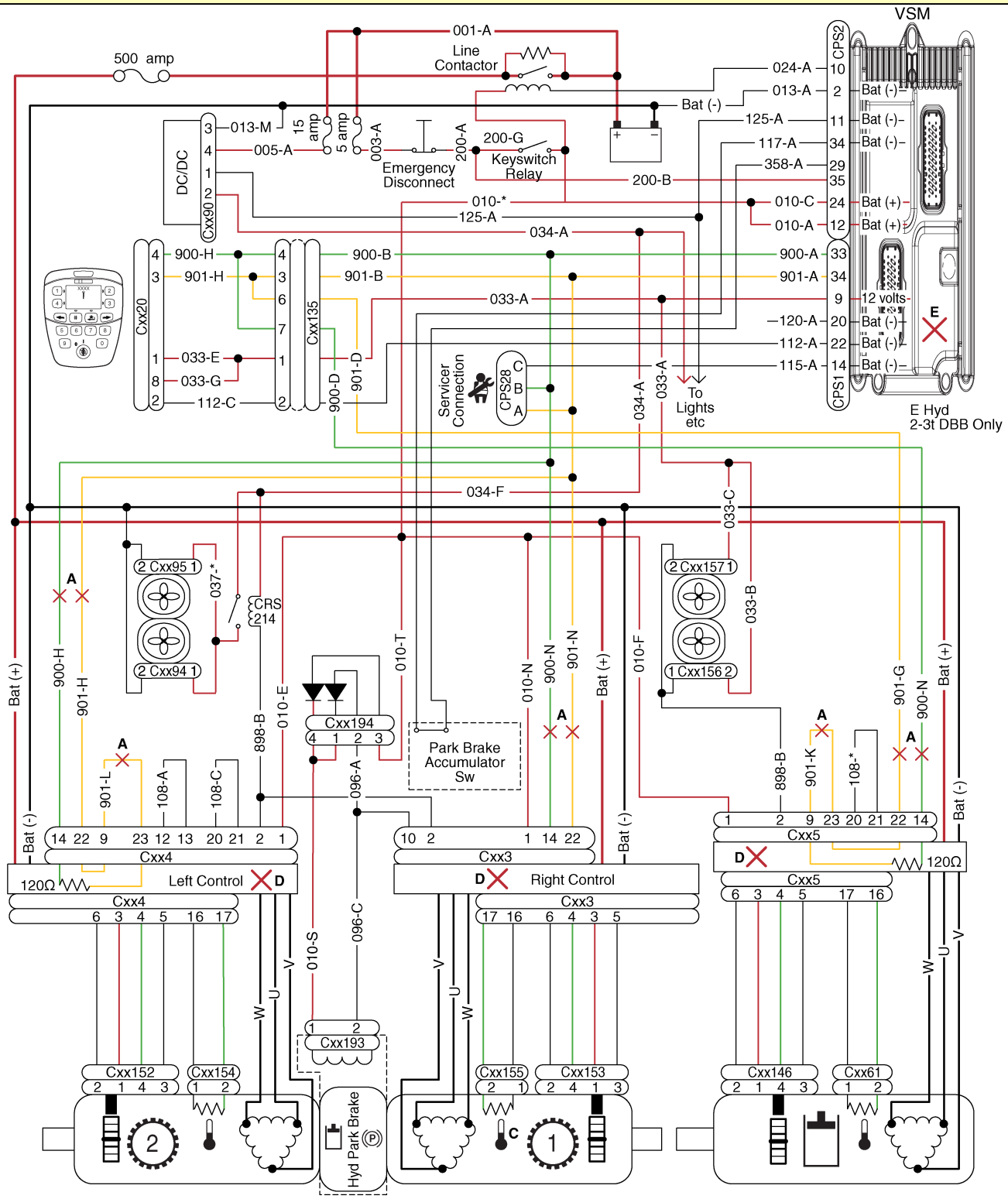
CBB/DBB Motor Controller CAN Communication Failure (Cont)

2.2 – 3.0 DBB SCHEMATIC CAUSES A B C D E > ?



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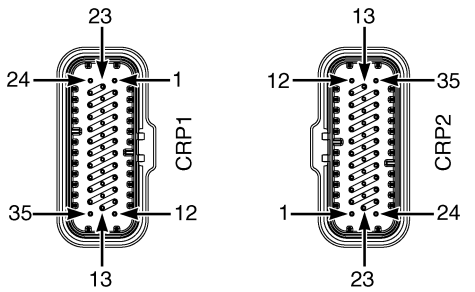
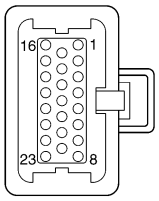
CBB/DBB Motor Controller CAN Communication Failure (Cont)

CONNECTORS



VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

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CBB/DBB Motor Controller CAN Communication Failure (Cont)

CAUSE A

See CBB 4 Wheel CAN Communication or DBB 4 Wheel CAN Communication

CAUSE B

Not Applicable

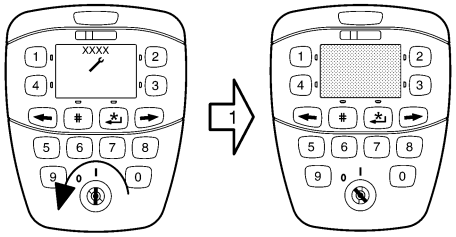
CAUSE C

Not Applicable

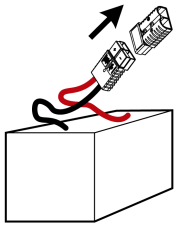
CAUSE D

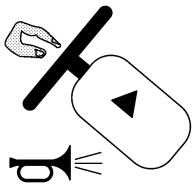
WARNING

Do not do Component Operational Check until Component Operational Check is complete.



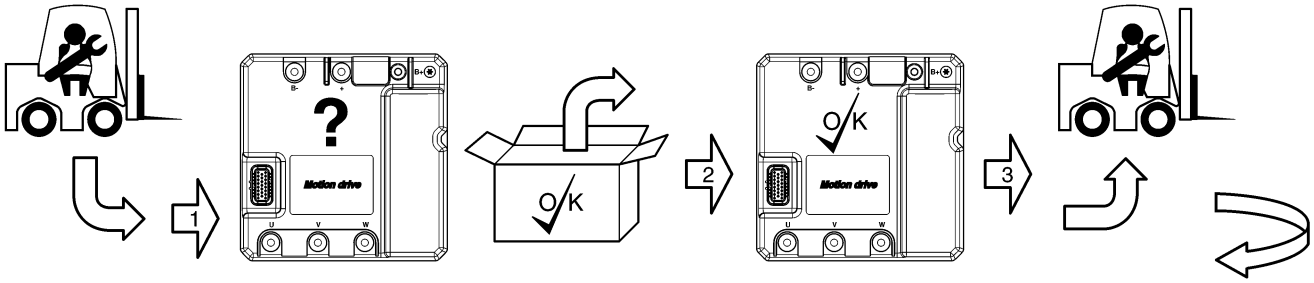
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1



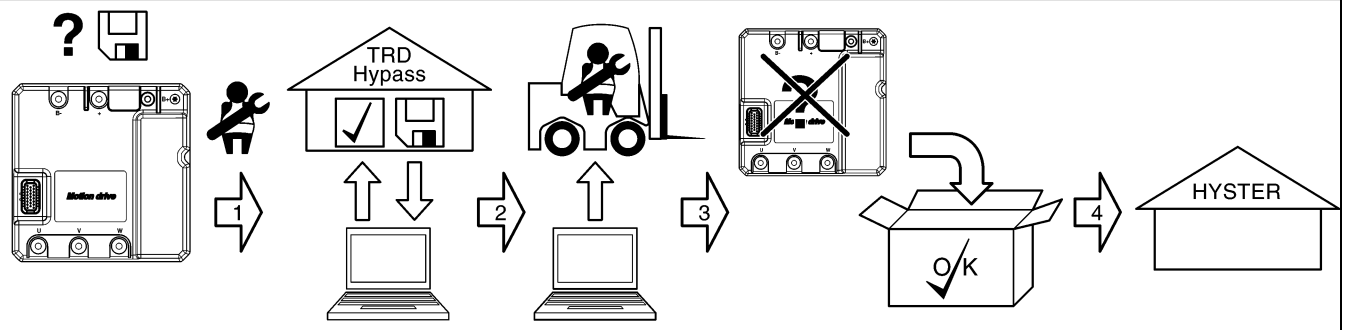
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

CBB/DBB Motor Controller CAN Communication Failure (Cont)

STEP D2



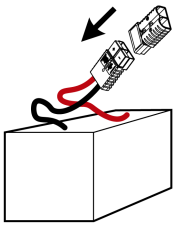
1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

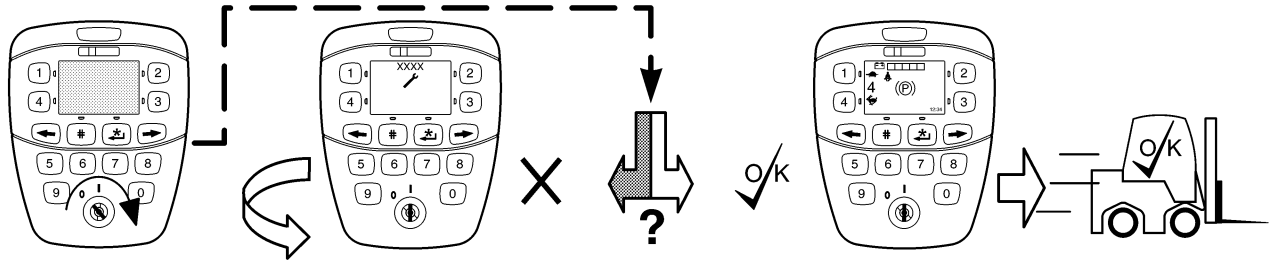
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

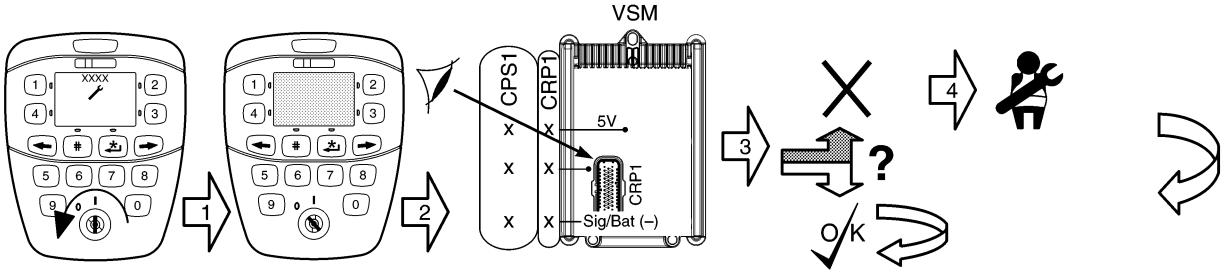




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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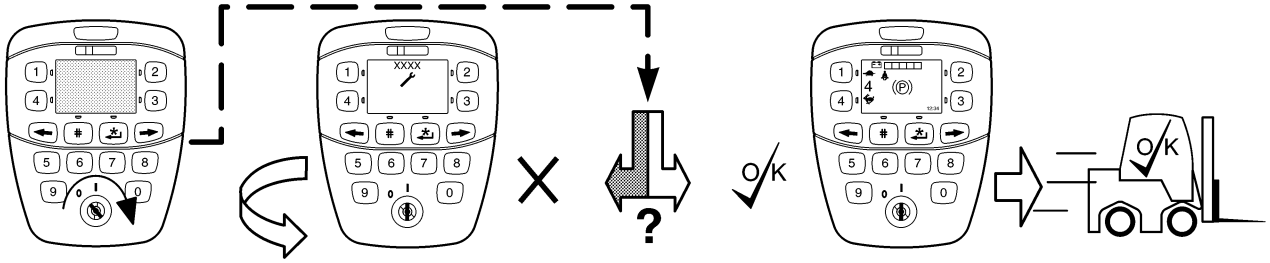
CBB/DBB Motor Controller CAN Communication Failure (Cont)

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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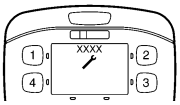
Travel Direction Select Incorrect

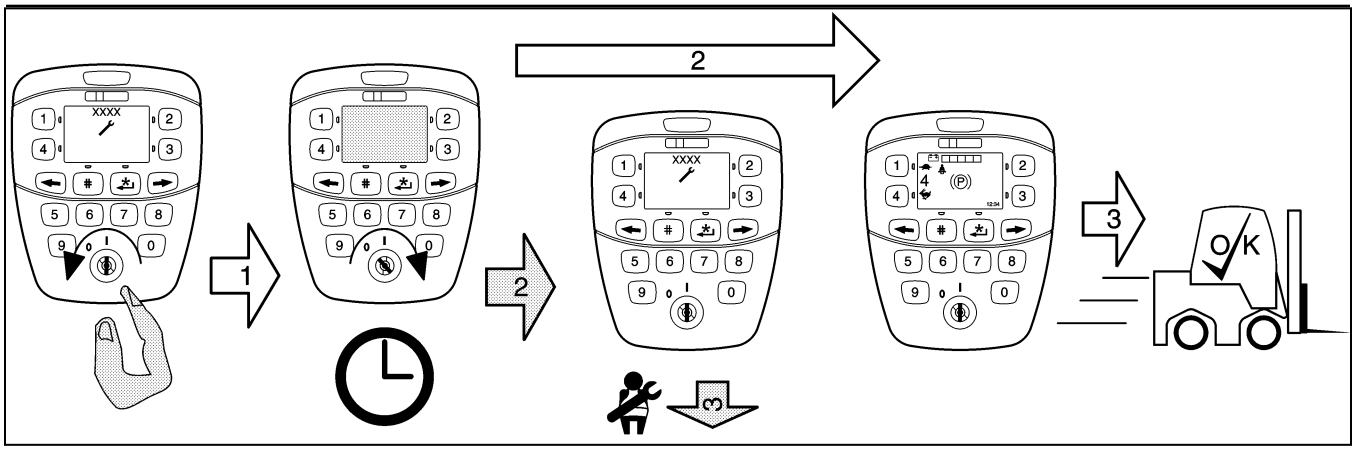


Fault Codes

DTC 12802
Direction Select

Data Incorrect –

Direction Signals Incorrect



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

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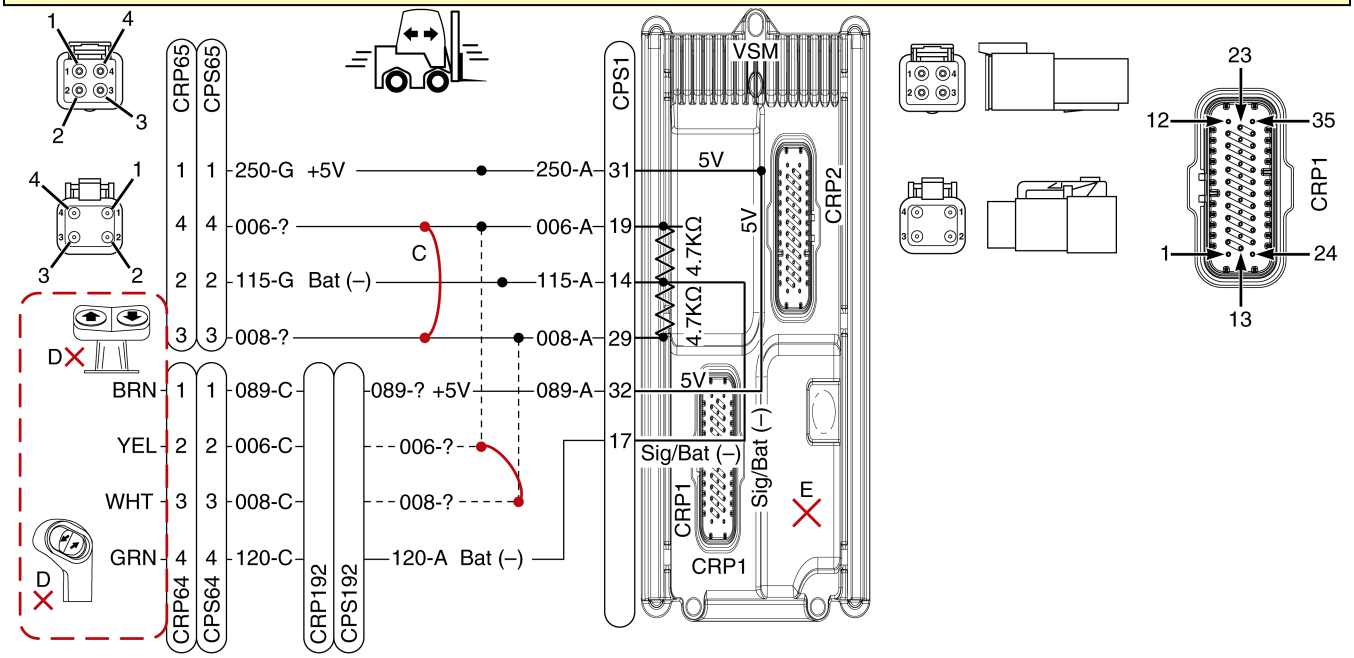
Travel Direction Select Incorrect (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

TRAVEL DIRECTION SELECT INCORRECT CAUSES A B C D E > ?



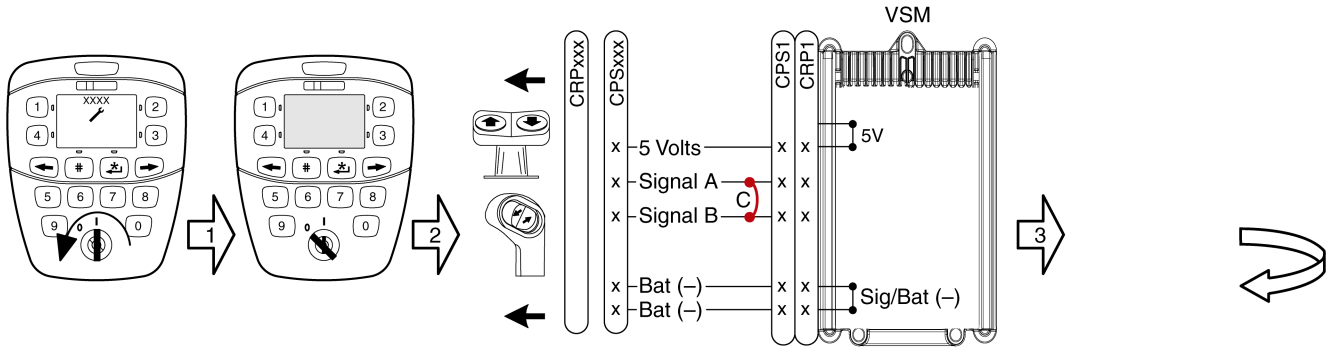
CAUSE A

Not Applicable

CAUSE B

Not Applicable

CAUSE C



Power **OFF**→ Disconnect sensor→ ?

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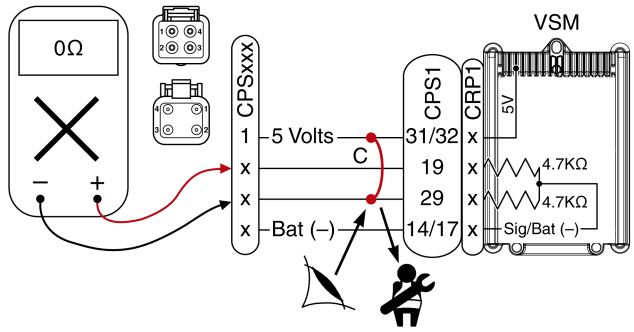
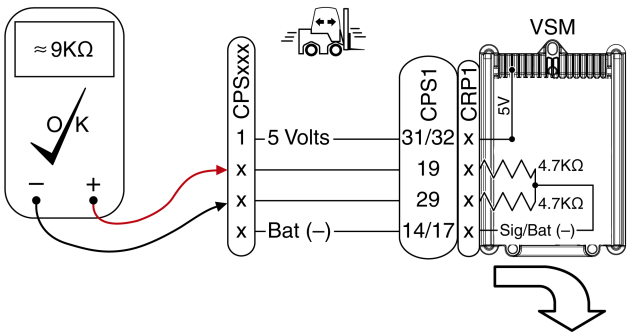
Travel Direction Select Incorrect (Cont)

STEP C1 **CHECK RESISTANCE - Ω - OHMS**





0 ? = Short circuit↑ Find→ **Short** circuit.	˜ 9K? = **OK** Go to Component Operational Check. ?
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.→	
Recheck ?↑ → Reconnect→ Test OK→ YES→ Resume Operation NO→ Component Operational Check ↓	
Recheck ?↑ → Reconnect→ Use Display Diagnostics to validate→ Test OK→ YES→ Resume Operation NO→ Component Operational Check ↓	

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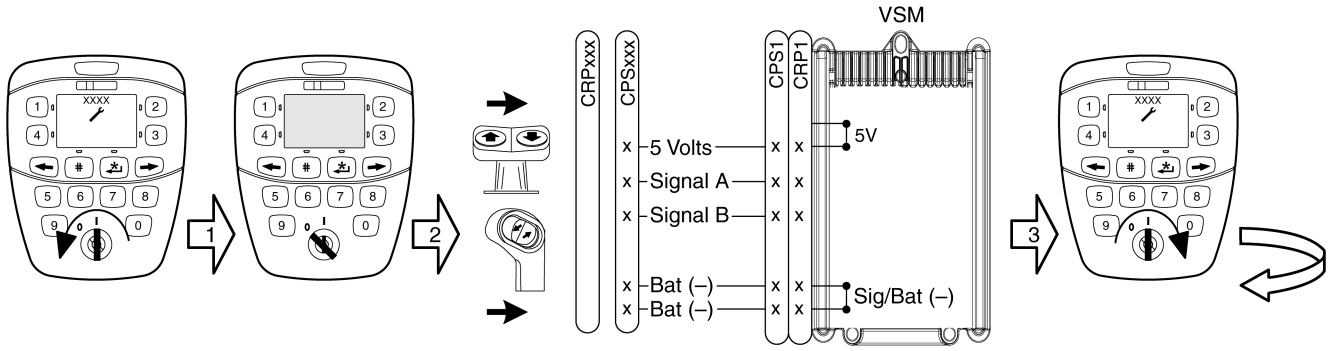
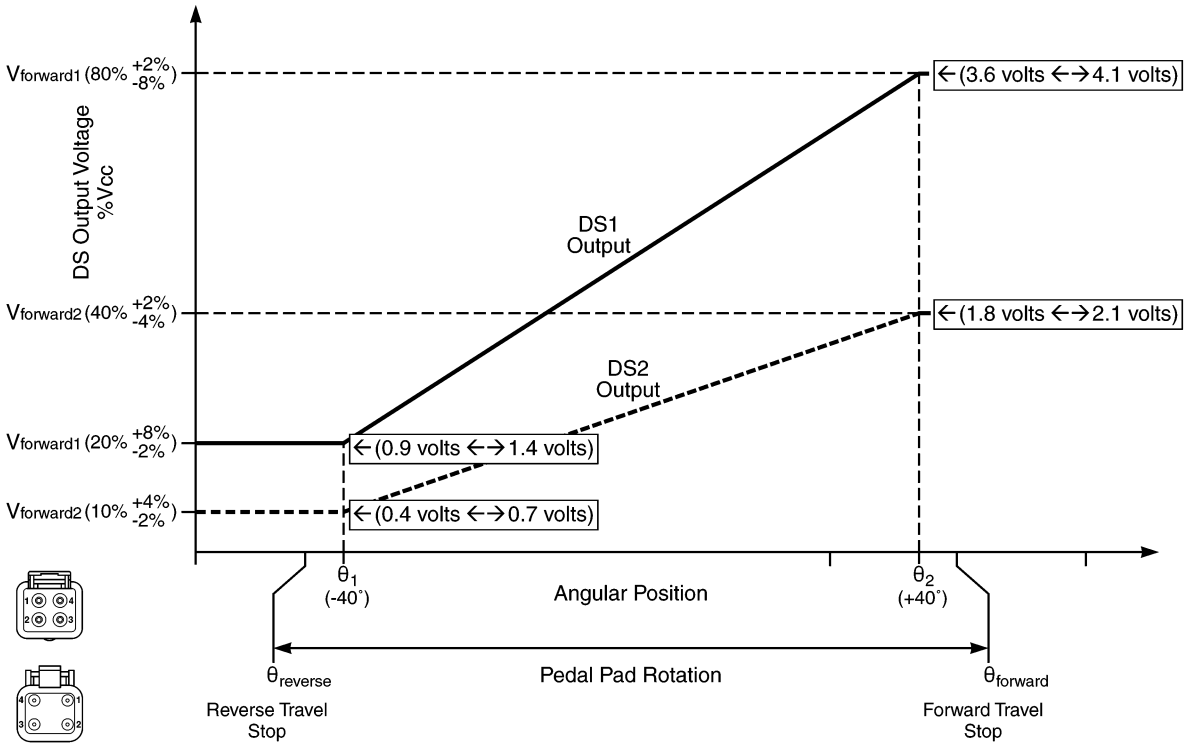
Travel Direction Select Incorrect (Cont)

CAUSE D





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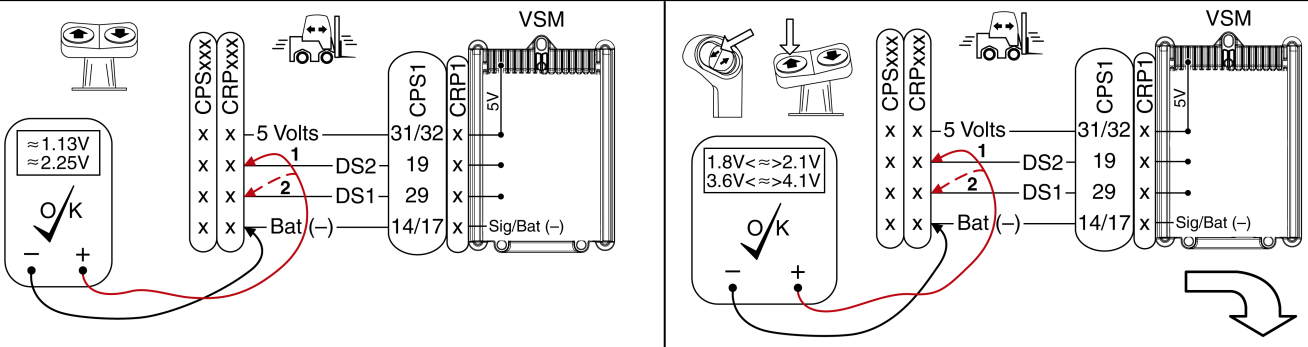
Travel Direction Select Incorrect (Cont)

STEP D1



1. Measure Pedal Neutral Voltage DS2 and DS1
? DS2 (1.13V ± 2%) volts ˜ ½ DS1 (2.25V ± 2%) volts?→ YES→Go to 2 NO →Go to 3↓
2. Select FORWARD Position – Foot DCS or Man Hyd DCS and Measure voltage at points 1 & 2
? DS2 (1.8 ? ?2.1)volts ˜ ½ DS1(3.6 ? ?4.1)volts ?→ YES→Go to Step D2NO →Go to Step D3↓
Note: >4.9 Volts→ Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH)→ **Note:** <0.31 Volts→ Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL)→

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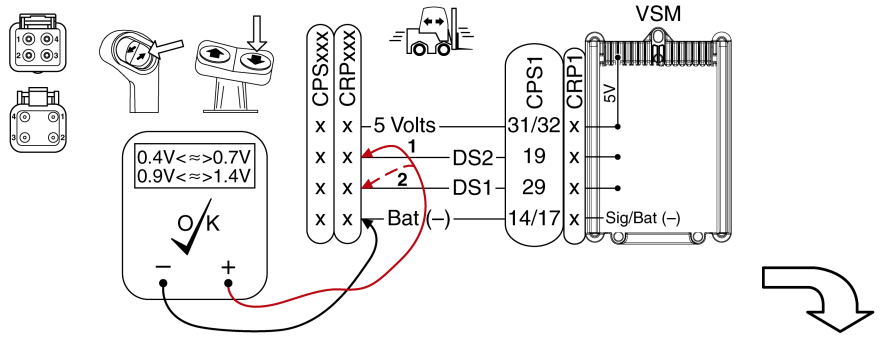
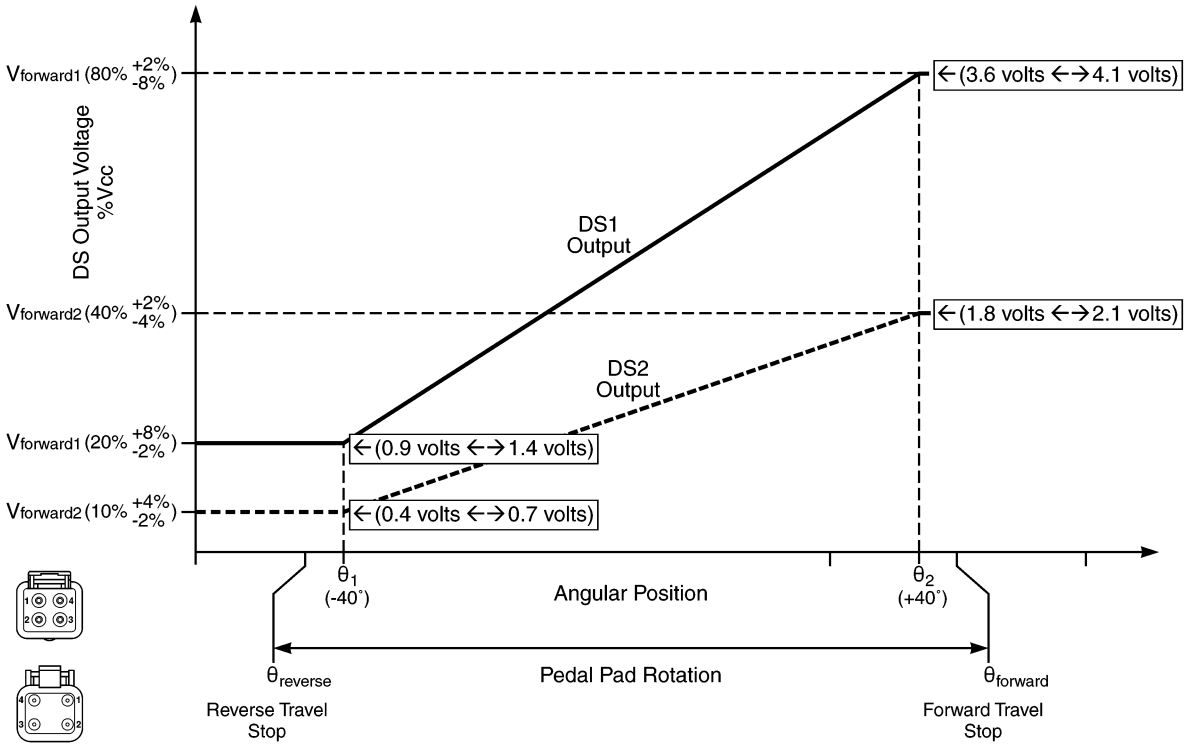
Travel Direction Select Incorrect (Cont)

STEP D2 **CHECK VOLTAGE**



1. Select REVERSE Position – Foot DCS or Man Hyd DCS and Measure voltage at points 1 & 2
2. ? DS2 (0.9 ? ?1.4)volts ˜ ½ DS1(0.4 ? ?0.7)volts ?→YES→Go to Component Operational CheckNO →Go to Step D3↓
Note >4.9 Volts→ Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH)→ Note <0.31 Volts→ Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL)→



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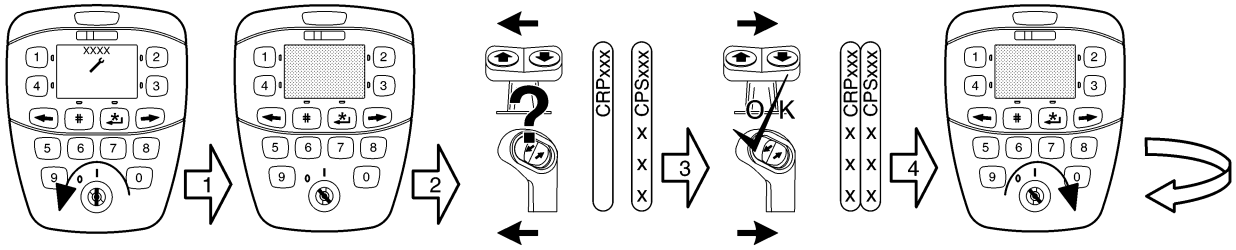
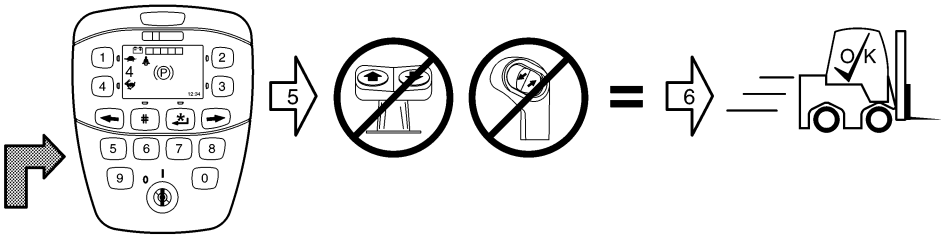
Travel Direction Select Incorrect (Cont)

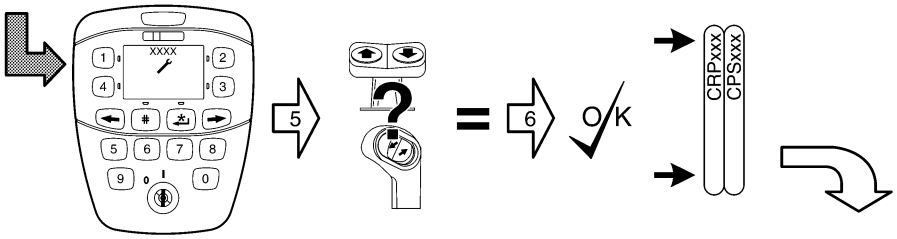
STEP D3 CHECK VOLTAGE



Power **OFF**→ Reconnect sensor→ Power **ON**→ Go to next step.

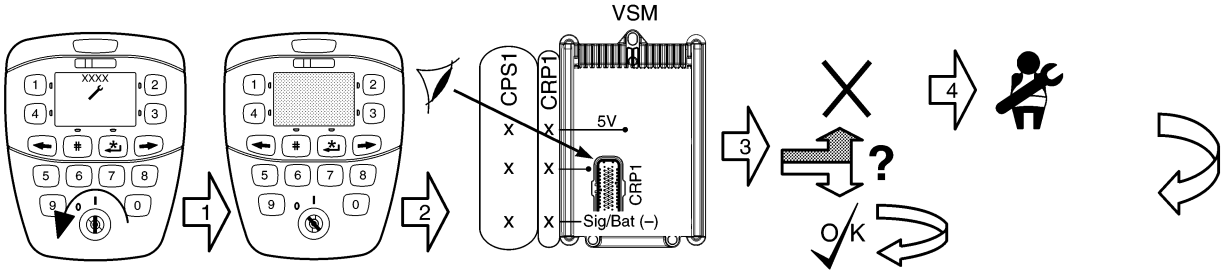


? Fault DTC gone→ Old sensor faulty→ Resume operation



Fault DTC present→ Old sensor OK/Reinstall old sensor→ Go to Component Operational Check.

CAUSE E



Power **OFF**→ Inspect VSM Connections→ Go to Cause E1. Not OK Correct/Repair→ Go to Cause E1.

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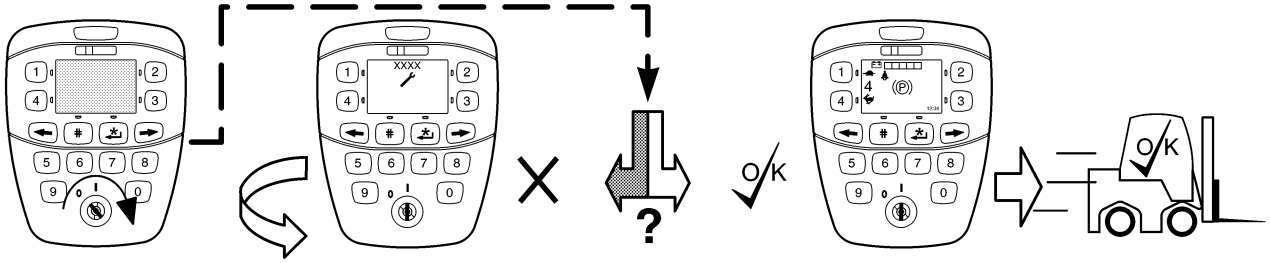
Travel Direction Select Incorrect (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO ← **YES** →

Fault corrected→ Continue operation.

END FAULT

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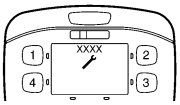
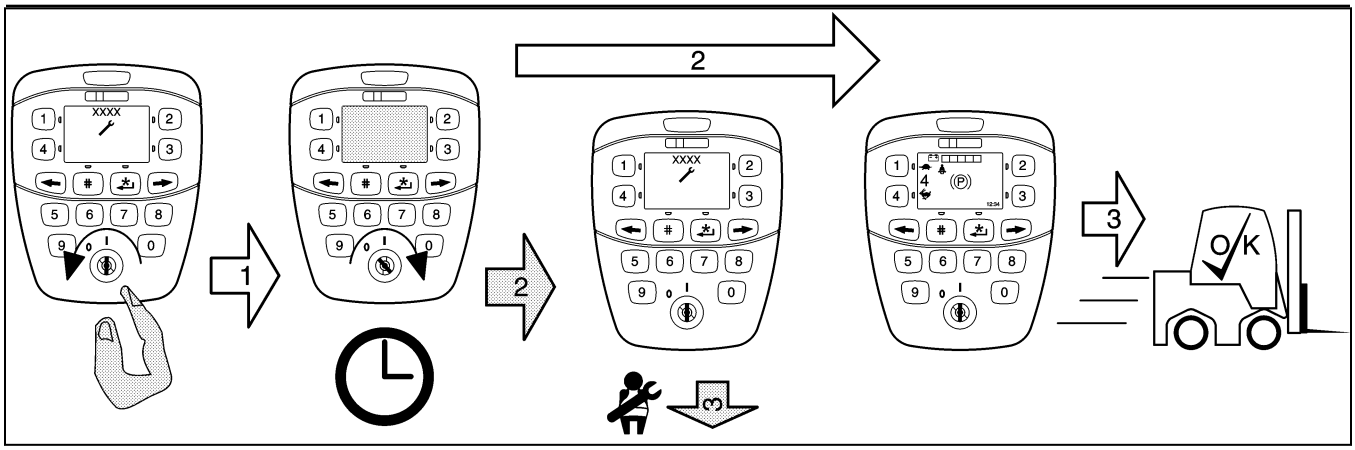
Travel Direction Select Data Incorrect – 2 Sources



Fault Codes

DTC 12806
Direction Select – Data Incorrect

2 + Direction Devices Installed

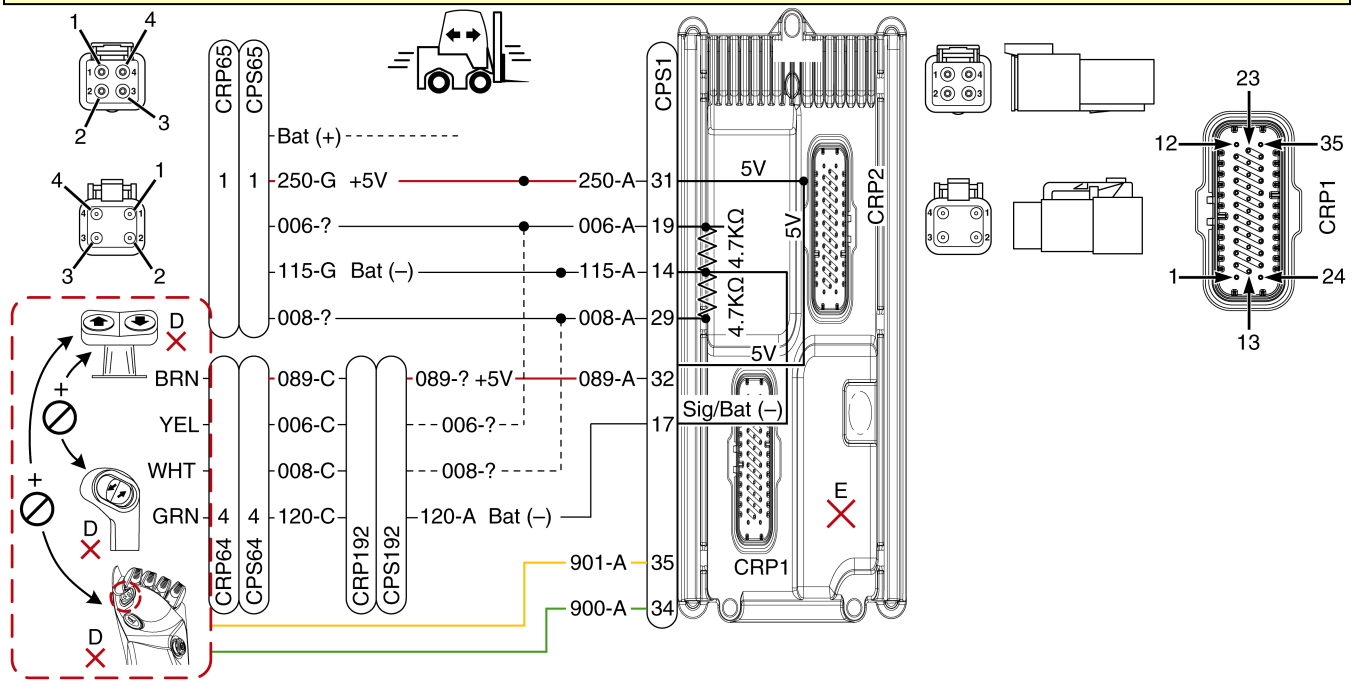


Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

Travel Direction Select Data Incorrect – 2 Sources (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

TRAVEL DIRECTION SELECT DATA INCORRECT CAUSES A B C D E > ?



WARNING

The Fault DTC will be displayed if more than one Direction Control Device is installed.

CAUSE A

Not Applicable

CAUSE B

Not Applicable

CAUSE C

Not Applicable

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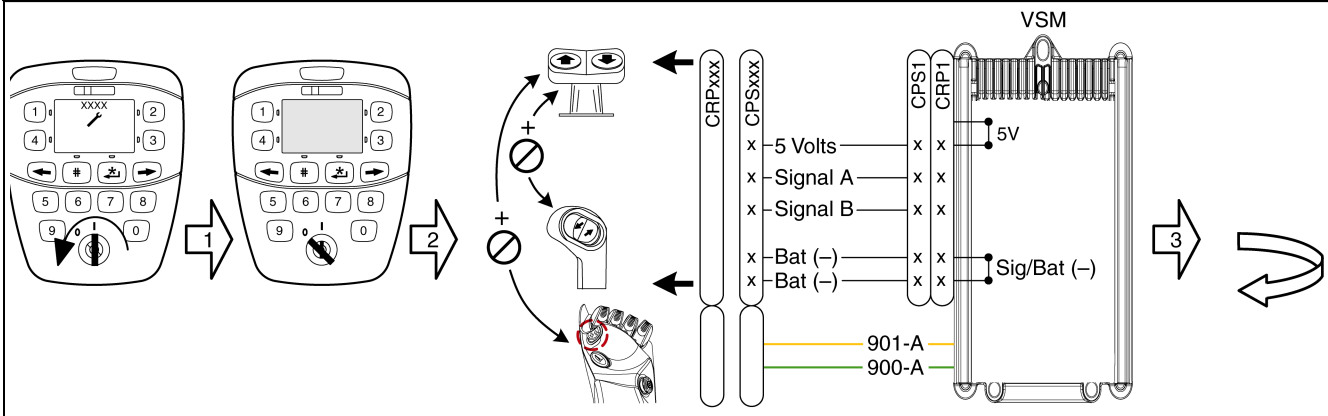
Travel Direction Select Data Incorrect – 2 Sources (Cont)

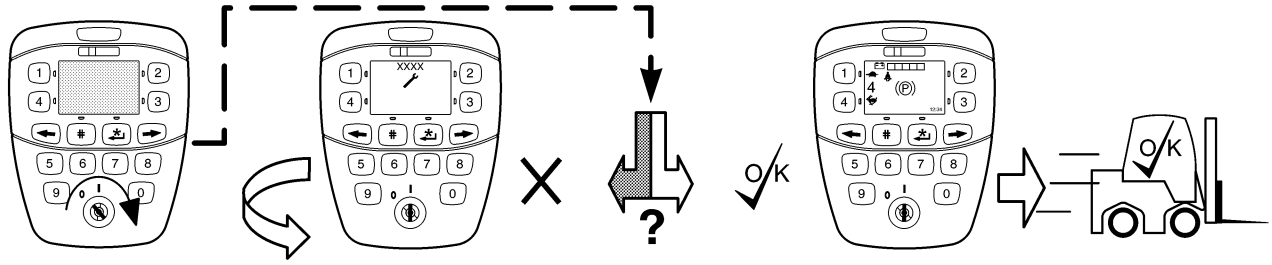
CAUSE D



Power OFF→ Locate and Disconnect Incorrect Direction Selection Device→ Step D1 ?

For MLM see **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→

STEP D1



Retest - Power **ON**→

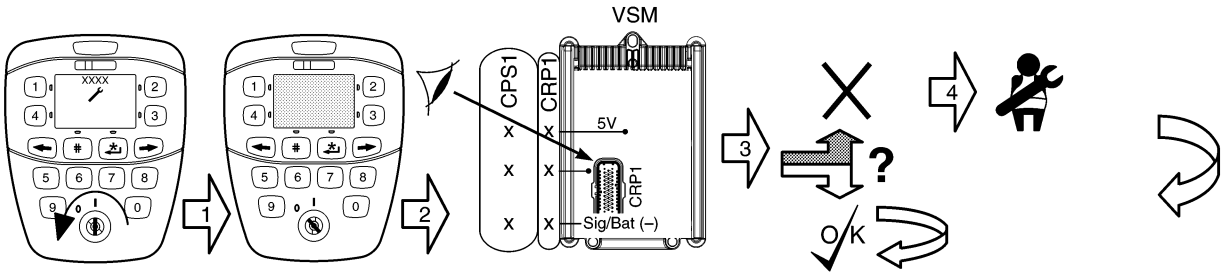
NO → Go to Component Operational Check

Is fault DTC gone?

NO ← **YES** →

Fault corrected→ Continue operation.

CAUSE E



Power **OFF**→

Inspect VSM Connections→

Go to Cause E1.

Not OK Correct/Repair→ Go to Cause E1.

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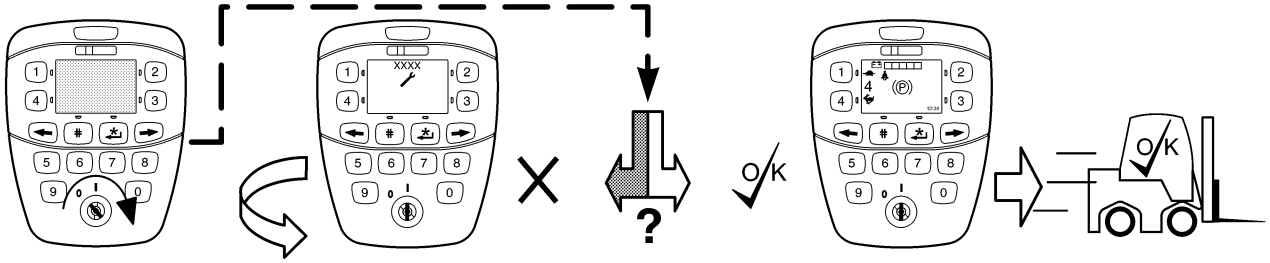
Travel Direction Select Data Incorrect – 2 Sources (Cont)

CAUSE E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO ← **YES** →

Fault corrected→ Continue operation.

END FAULT

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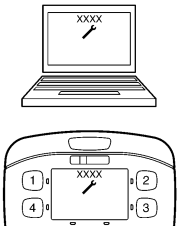
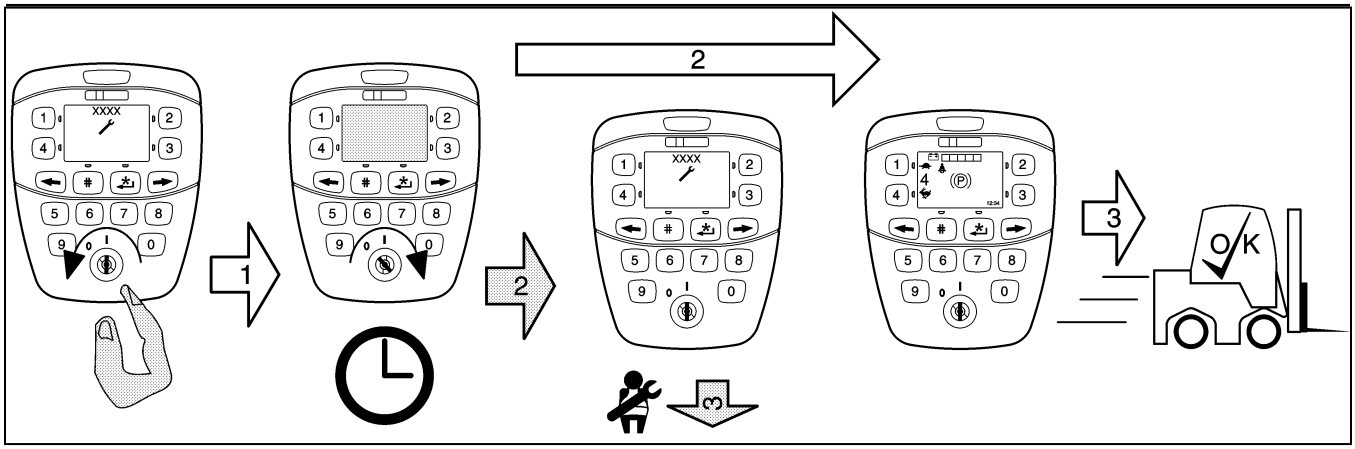
Direction Select Data Incorrect - No DCS Source



Fault Codes

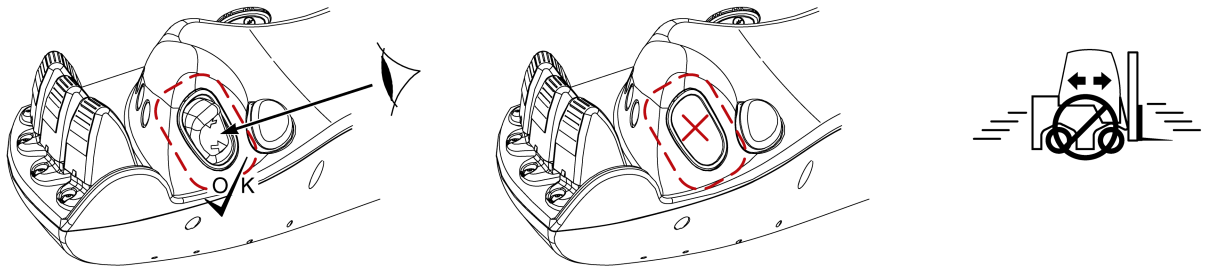
DTC 12807
Direction Select Data Incorrect - No DCS Source



Power **OFF**→ | Wait **30 seconds**→ | Power **ON**→ | Fault remains. Service required. Go to Component Operational Check. | No fault→ | Resume operation

QUICK CHECK X Open Circuit/Fail) = Short Circuit

Check 1



1. Is there any other DCS devices installed except the armrest DCS?
2. YES→Check 2NO→Go to 3↓
3. Is DCS installed on the armrest?YES→Check 2NO→Obtain and Install DCS→Go to 4↓
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓
5. Test new DCS→Function OK/DTC gone→YES→Resume OperationNO→Check 2↓

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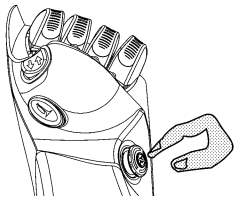
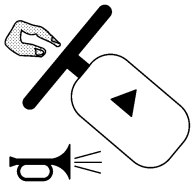
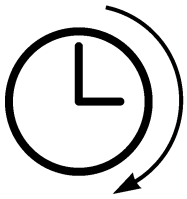
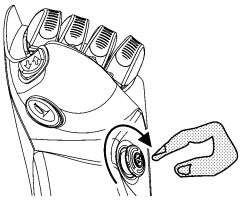
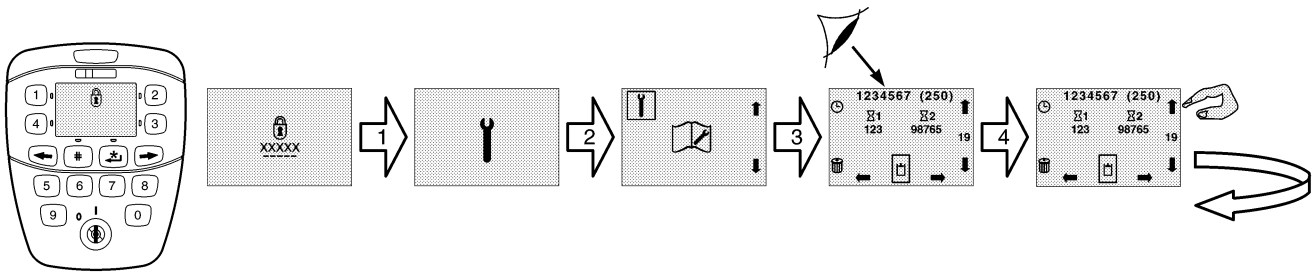
Direction Select Data Incorrect - No DCS Source (Cont)

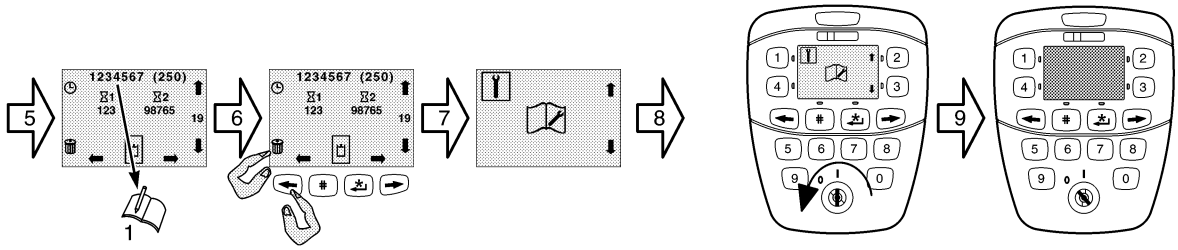
Check 2

			
Push in Emergency Stop	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Release Emergency Stop

FAULT LOG CODE Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ VSM/MLM Fault Logs→ View all VSM/MLM DTCs→ ?



All VSM/MLM DTCs	Erase all VSM/MLM DTCs→ Exit Fault Log	Power OFF↓

NOTE: ?DTC 33034 ?→ A935 – K160 CAN Communication Failure

NOTE: ?DTC 12807 ?→Component Operational Check↓

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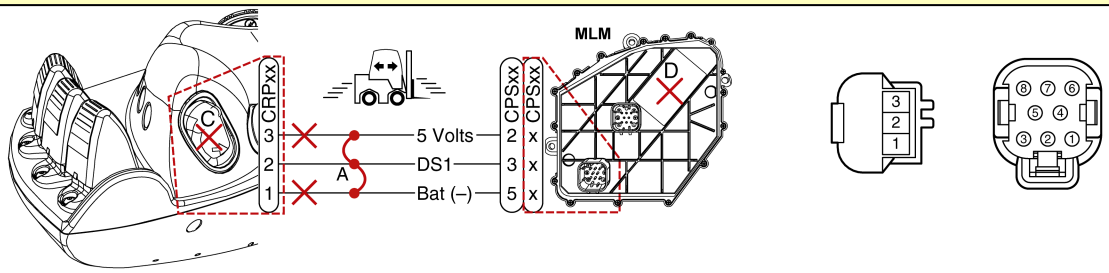
Direction Select Data Incorrect - No DCS Source (Cont)

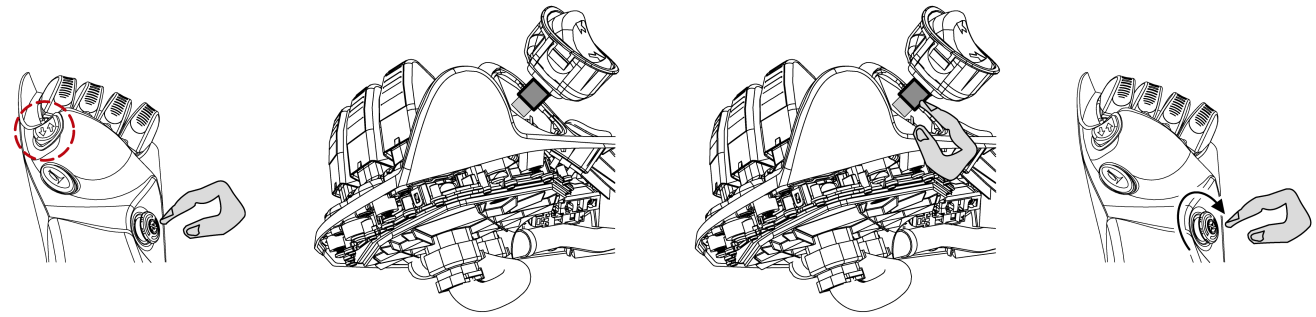
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

DIRECTION SELECT DATA INCORRECT - NO DCS SOURCE CAUSES A B C D E > ?



CAUSE A

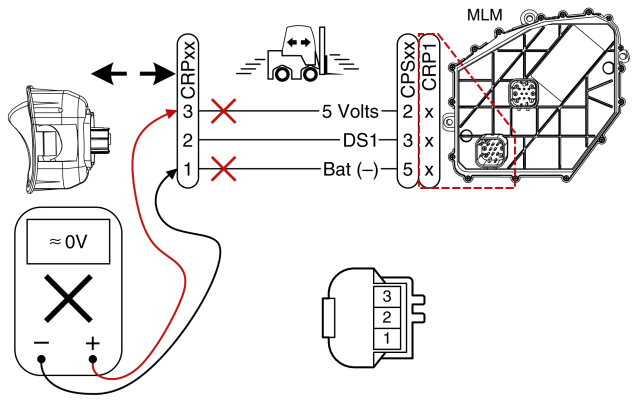
DCS Wiring/Connections



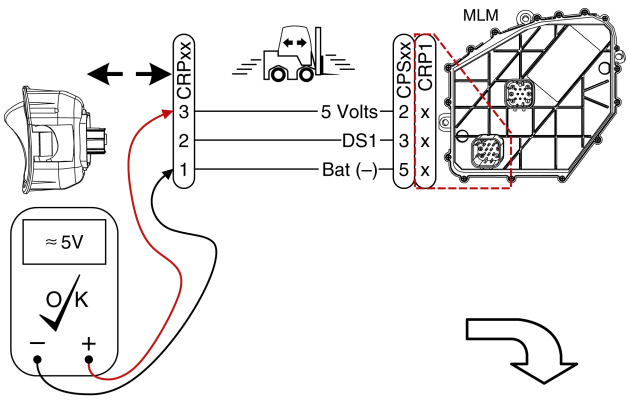
1. Push In Emergency Stop
2. NOTE: Do not remove PCB Cassette to Remove DCS↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓
4. Disconnect DCS from harness
5. Release Emergency Stop

STEP A1 CHECK VOLTAGE

MLM Open Circuit CAN Hi/CAN Lo



1. 0 Volts →Step A2↓



1. ˜ 5 Volts →Step A3↓

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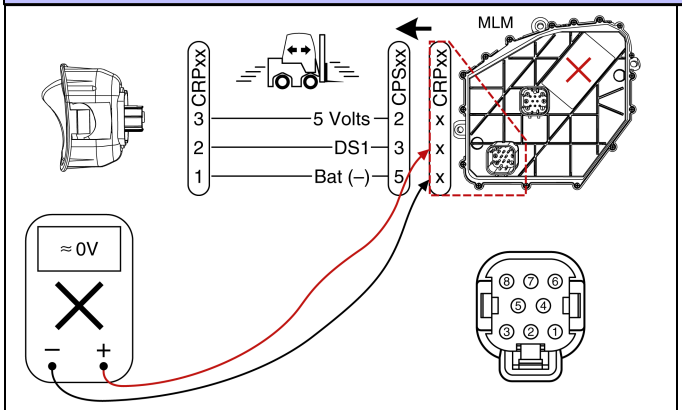
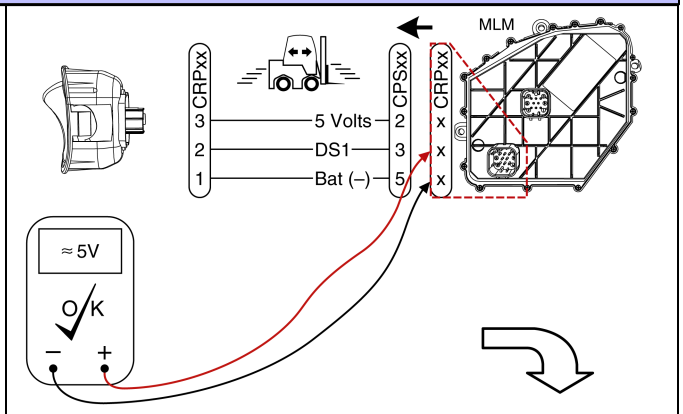
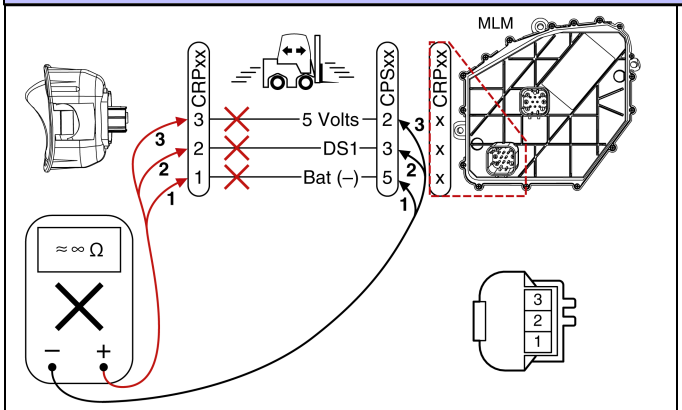
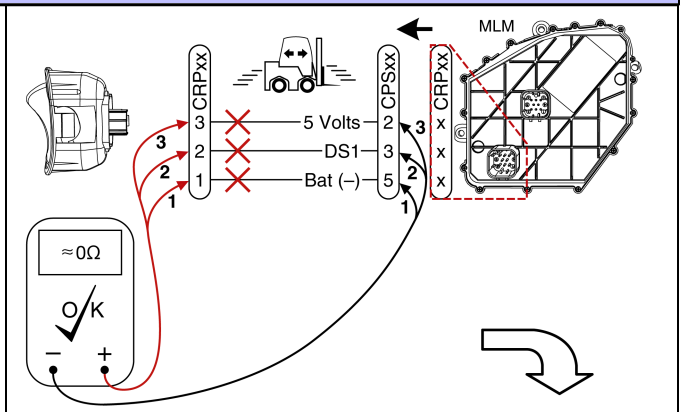
Direction Select Data Incorrect - No DCS Source (Cont)

STEP A2	**CHECK VOLTAGE**
	
1. Disconnect Cassette Connector as Indicated→Measure Volts↓	
2. 0 Volts→Faulty MLM Cassette→Component Operational Check↓	˜ 5 Volts → Step A3 ↓

STEP A3	
	
Disconnect Cassette Connector as Indicated→ Measure ?↓	
1. 8 ?→OPEN Circuit→Go to 4↓	1. 0 ?→Go to 2↓
2. 8 ?→OPEN Circuit→Go to 4↓	2. 0 ?→Go to 3↓
3. 8 ?→OPEN Circuit→Go to 4↓	3. 0 ?→Step A4↓
4. Find/Repair OPEN Circuit→Go to 5↓	
5. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓	
6. Recheck ?↑→ Reconnect→Test OK→No DTCs→YES→Resume OperationNo→Step A4↓	

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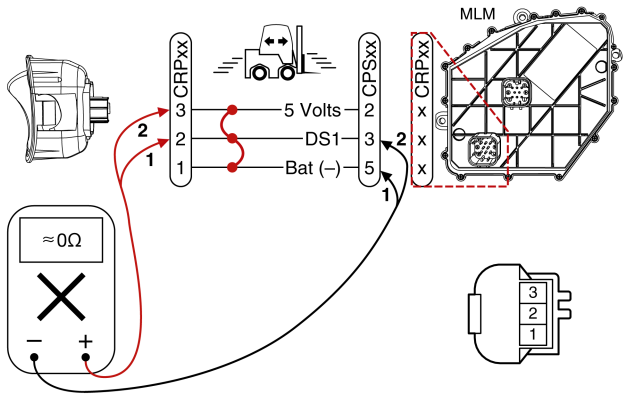
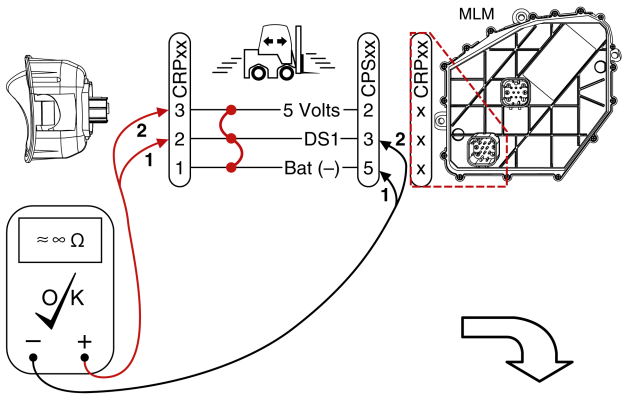
Direction Select Data Incorrect - No DCS Source (Cont)

STEP A4	**CHECK RESISTANCE - Ω - OHMS**
	
1. 0?→Short Circuit→Go to 3↓	1. 8 ?→Go to 2↓
2. 0?→Short Circuit→Go to 3↓	2. 8 ?→Component Operational Check↓
3. Find/Repair Short Circuit→Go to 5↓	
5. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓	
6. Recheck ?↑→ Reconnect→Test OK→No DTCs→YES→Resume OperationNo→Component Operational Check↓	
CAUSE B	
Not Applicable	

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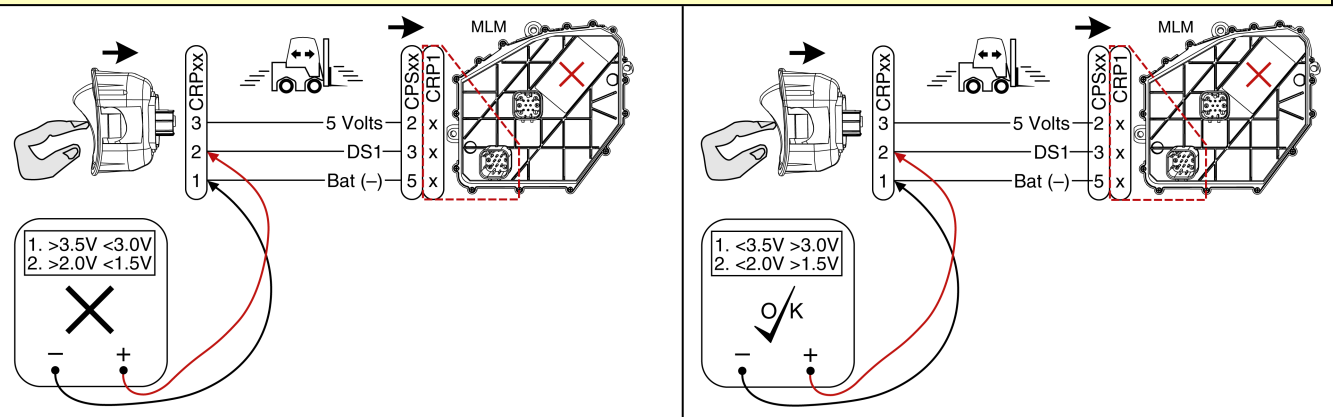
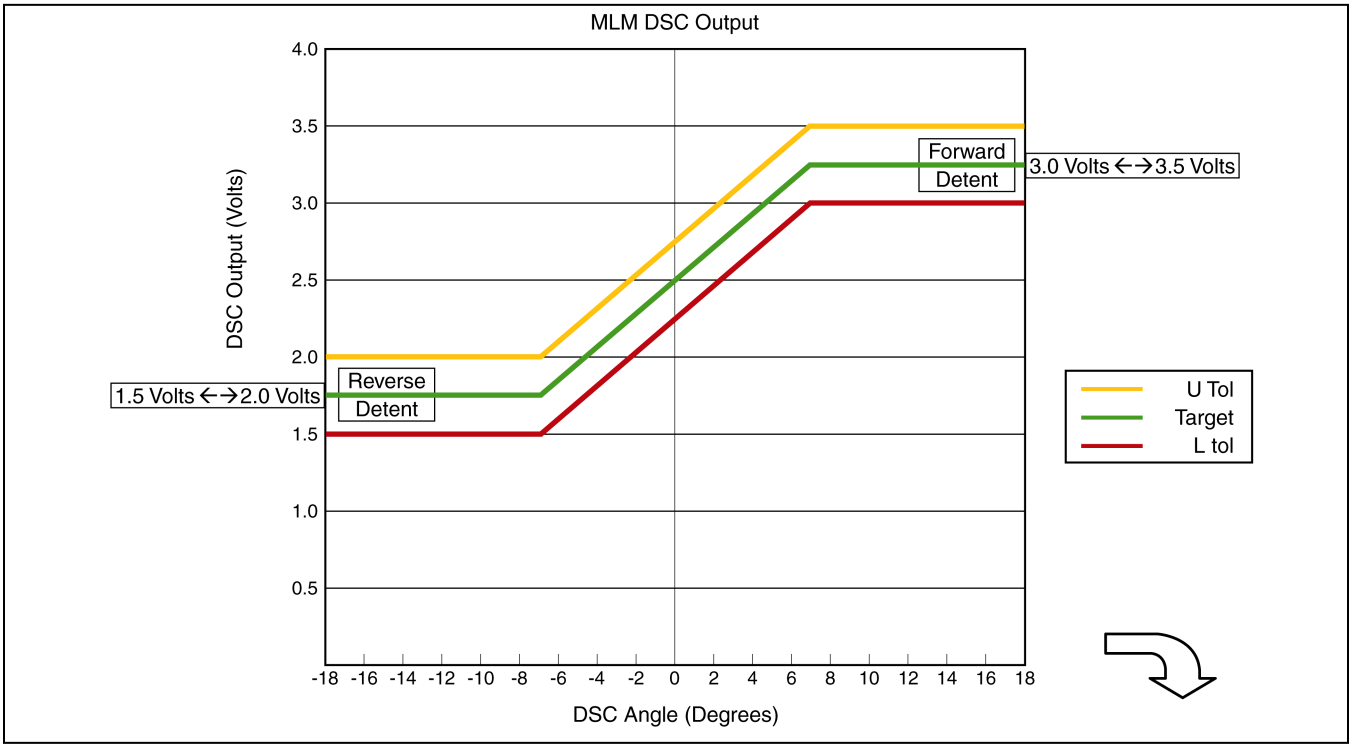
Direction Select Data Incorrect - No DCS Source (Cont)

CAUSE C

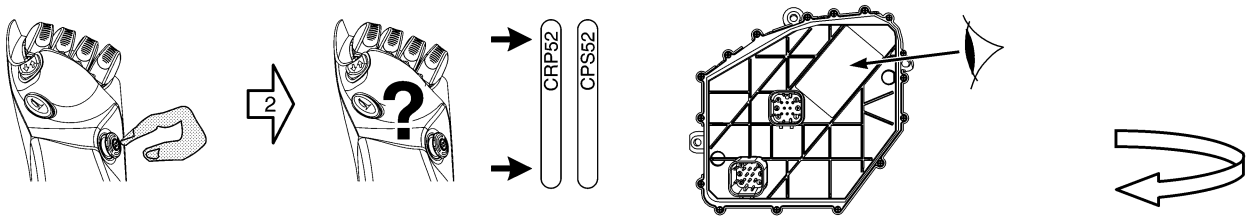


Reconnect Cassette Connector and DCS as Indicated→ Select FOWARD Position→ Measure Volts↓
1. Does FORWARD Voltage DS1 = 3.25V ± 0.25 V?↓
NO: Replace DSC→ See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓
YES: Select REVERSE Position→ Measure Volts→ Does REVERSE Voltage DSC1 = 1.75V ± 0.25 V?↓
NO: Replace DSC→ See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓
YES→ Replace PCB Cassette→ Component Operational Check ↓
Note: >4.9 Volts→ Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH)→ **Note:** <0.31 Volts→ Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL)→



Direction Select Data Incorrect - No DCS Source (Cont)

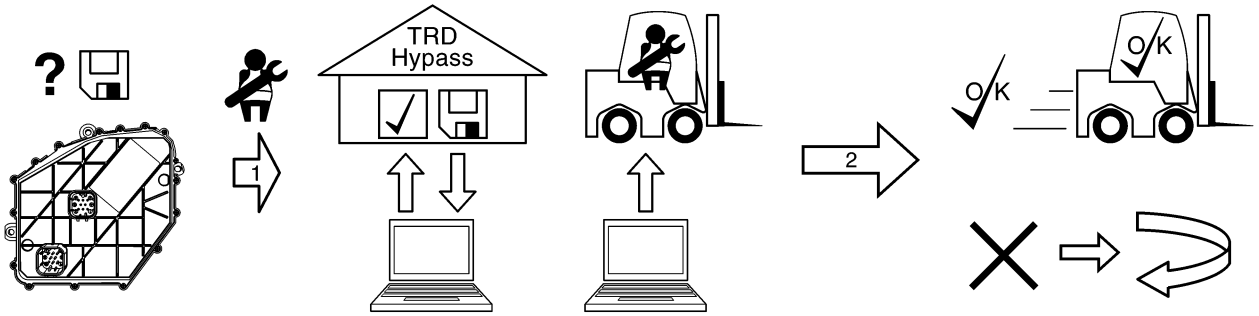
CAUSE D



Power **OFF**→ Remove and Replace MLM PCB Cassette Assembly→ See **Electrical System** 2200SRM1337/ **Electrical System** 2200SRM1369↓

Check Replacement MLM 🖫 Version→ See Label Information→ Step D1 ↓

STEP D1

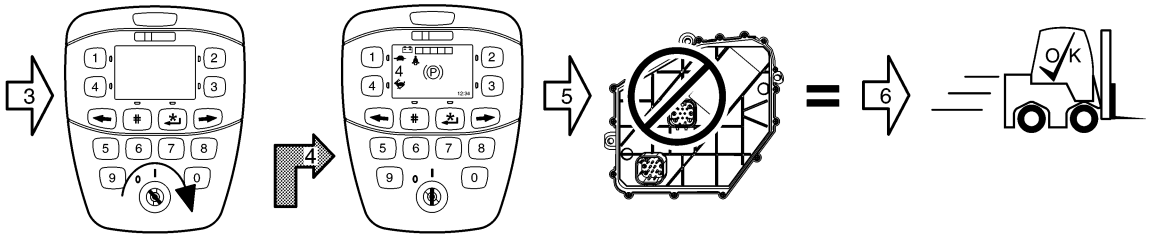


1. Go to TRD/ Hypass Online /Software.?? Is Replacement Cassette Software Version the Latest Version

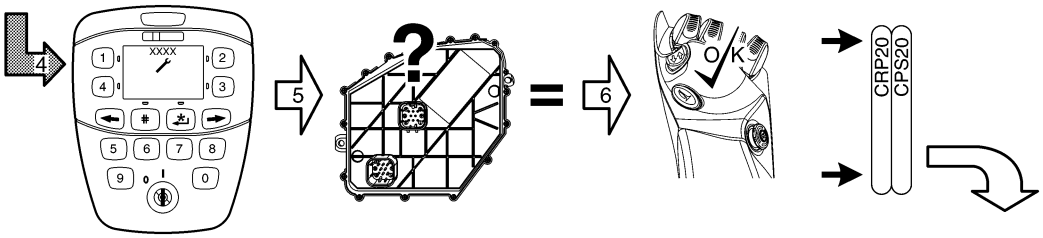
2. **NO**→Download the latest Application 🖫→Install on truck→Step D2↓

3. **YES**→Test New Installation→Step D2↓

STEP D2



Power **ON**→ **?** DTCs gone→ Original MLM Cassette faulty→ Resume operation



DTCs Still Present→ Original MLM Cassette OK/Reinstall Original Cassette→ ?

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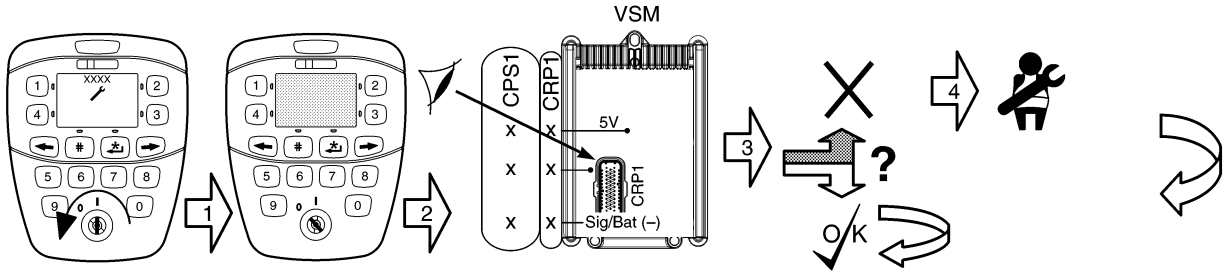
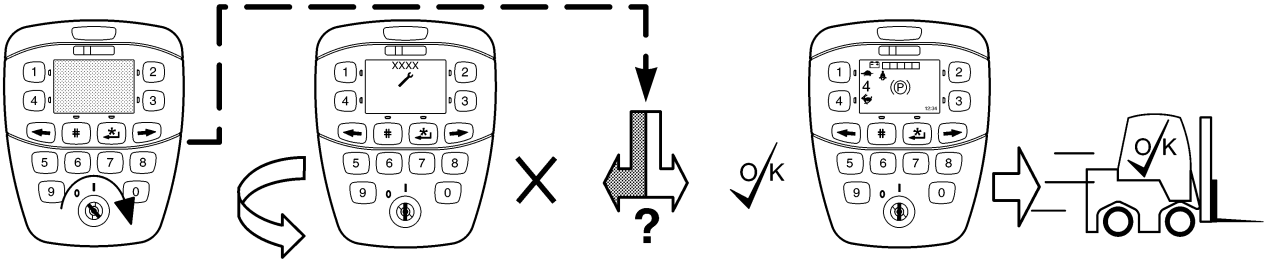
Direction Select Data Incorrect - No DCS Source (Cont)

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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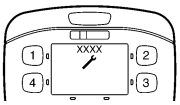
CBB/DBB Motor/Motor Controller Temperature Sensor Failure



Fault Codes

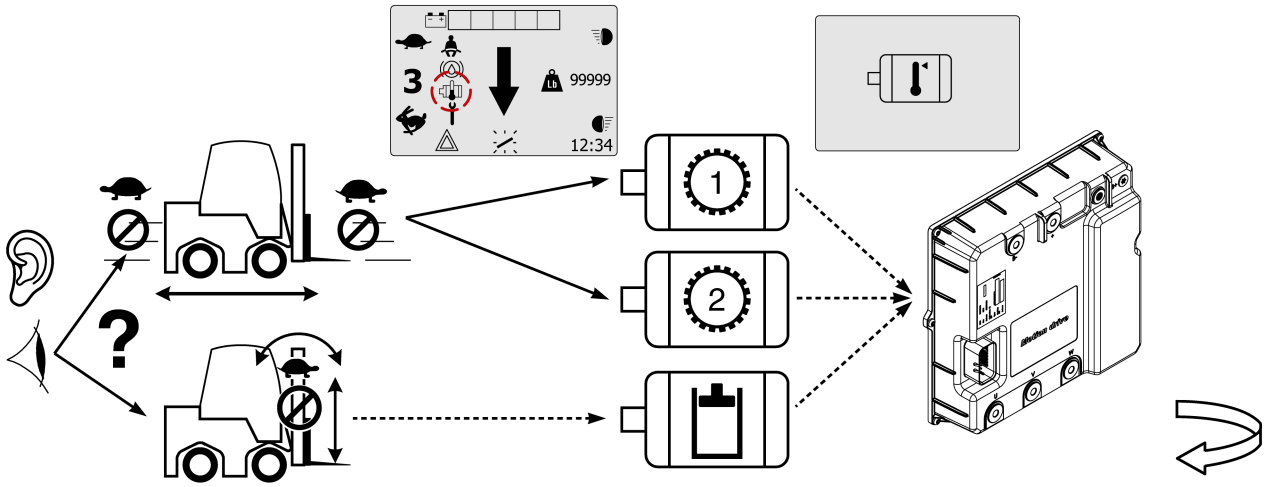
DTC 16912
Motor Temperature High

DTC 17168
Controller/Heatsink Temperature High

DTC 25105
Temperature Sensor Failure

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1



? Over Temperature Icon Displayed at Power ON?

POSSIBLE CAUSES

1. Sensor(s) – Motor/Motor Controller – Connections/Wiring?→	Component Operational Check ↓
2. Sensor(s) Failure?→	Component Operational Check ↓
3. Motor Controller(s) Hardware Failure?→	Component Operational Check ↓

Note: Hydraulic Oil Over Temperature and Sensor Issues see Hydraulic Temperature Sensor Out of Range High (OORL) Hydraulic Temperature Sensor Out of Range High (OORH)

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CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

? Over Temperature Icon Displayed during Operation/Reduced Performance/Function Failure?	
POSSIBLE CAUSES	
1. Motor/Motor Controller/Hydraulic Fluid Overheating?→	Aggressive Operation?→
2. Sensor – Motor/Motor Controller/Hyd Tank – Connections/Wiring?→	Component Operational Check ↓
3. Sensor(s) Failure?→	Component Operational Check ↓
4. Motor Controller(s) Failure ?→	Component Operational Check ↓

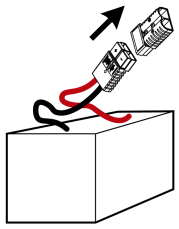
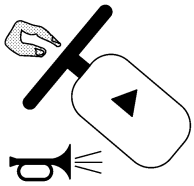
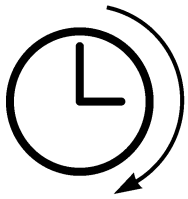
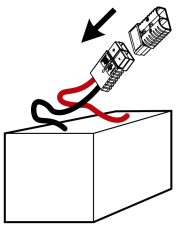
WARNING

The CBB Truck requires the removal of the battery to access the Controllers and Motors

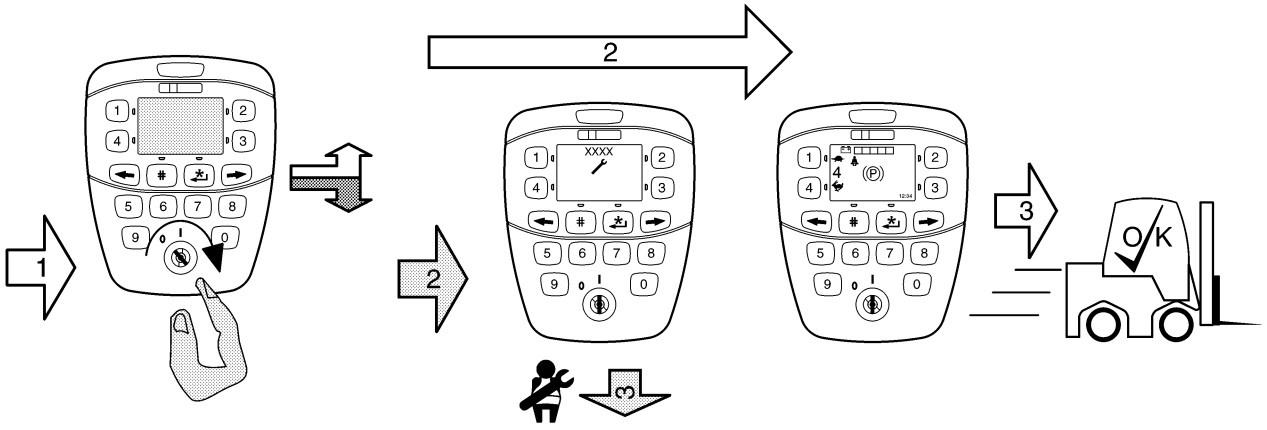
Table 9030-20-14. Motor Controller Temperature and Silicon Temperature Sensor

Note: For further assistance on Motor Controller Temperature and Silicon Temperature Sensor readings, see Table 9030-10-4.

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

Check 3



Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

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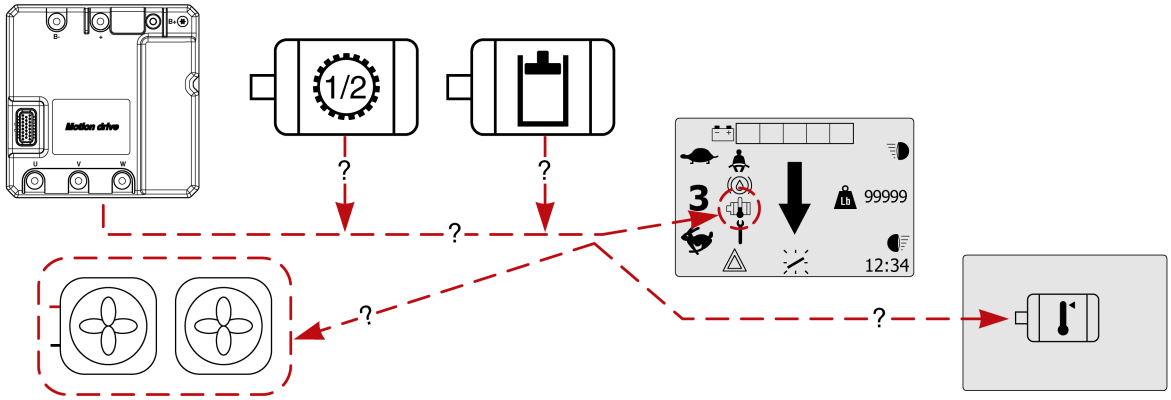
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

Check 4



Reduced Performance→ Check Display Icons?

Motor/Motor Controller Temperature Icon On

1. Check fan operation→Are fans operating?→NO → A935 – K160 D203 Motor Controller Fan FailureYES →2. ?

2. Temp Sensor/Controller to Motor connection→Open Circuit→Component Operational Check↓

3. Use the following steps for viewing Motor Temperature

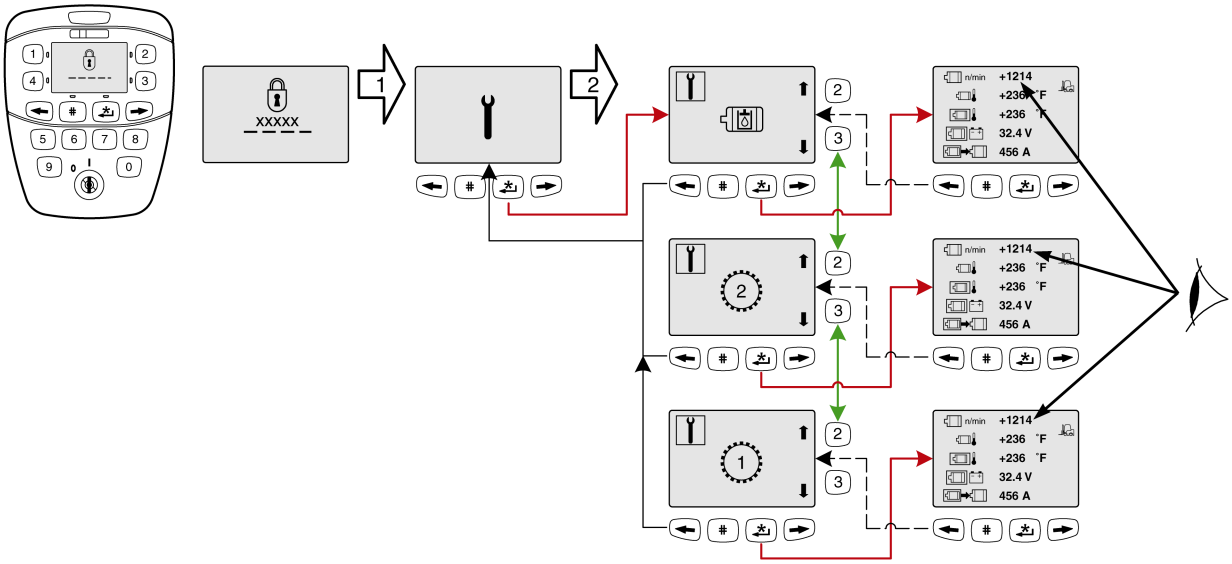
Note: The Motor Temperature ICON will be displayed for any Over Temperature of Traction 1/Traction 2, Pump Motor and their associated Controllers plus Hydraulic Fluid

Note: The Diagnostics Display Menu Flowchart will show which device is overheating See Check 5

Note: The Service Tech may need to operate the truck for an extended time on a 20% grade to have this Over temperature icon(s) display again after it has been first reported

Check 5

Diagnostics Temperature Analysis – Go to Display Menu Flowchart



Enter Service Password→	Diagnostics→	Motor→ Traction1/Traction2/ Pump→	Motor/Control-ler Data

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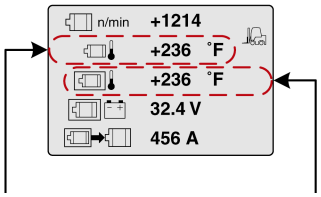
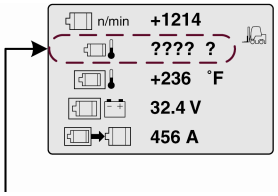
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

Fan(s) Operation Temperature Threshold: Traction = 55°C (131°F) Pump = 65°C (149°F)

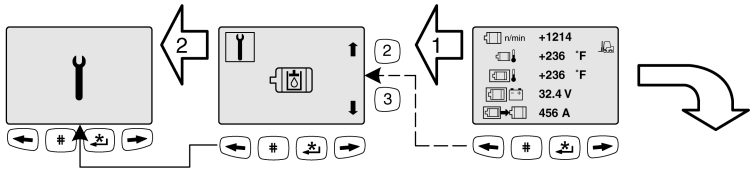
Reduced Performance: Traction = 80°C (176°F) Pump = 80°C (176°F)



Motor		Motor Controller



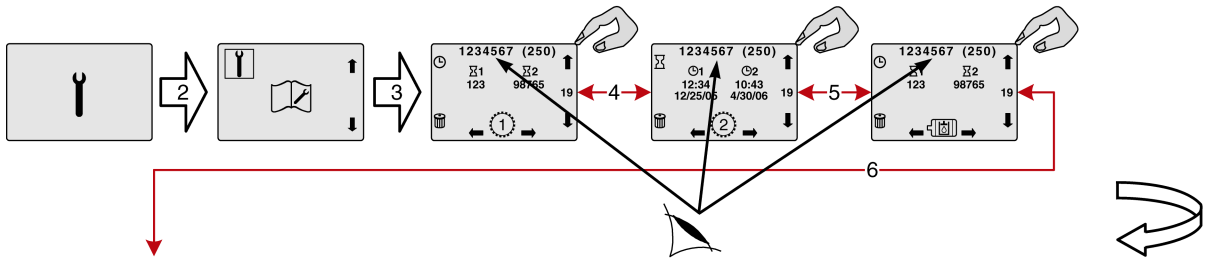
Invalid Temperature Signal (Traction/Pump Motor(s) Only): **Sensor Connections/Sensor Open Circuit**



Return to Diagnostics Menu→ ?

Check 6

Fault Log DTC – Go to Display Menu Flowchart



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?

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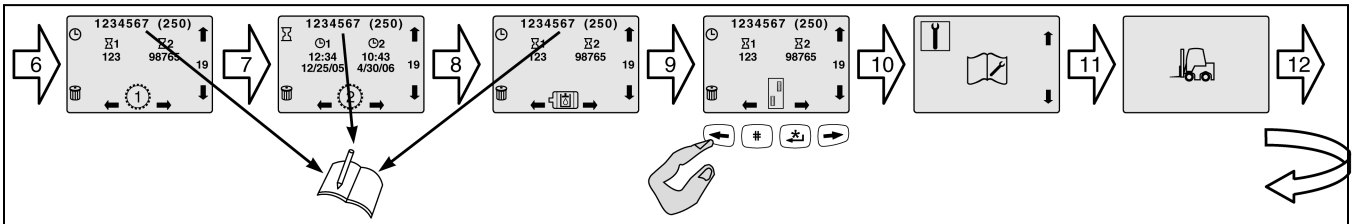
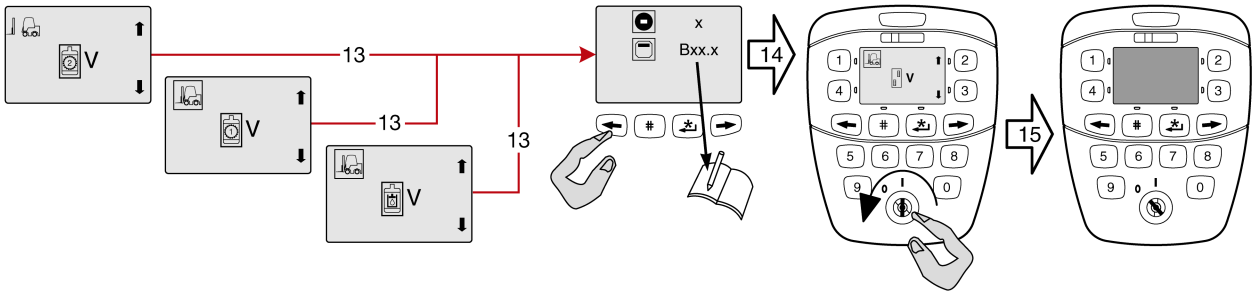
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)



all Motor Codes→ ☜ Exit Fault Log→ Truck Status ?

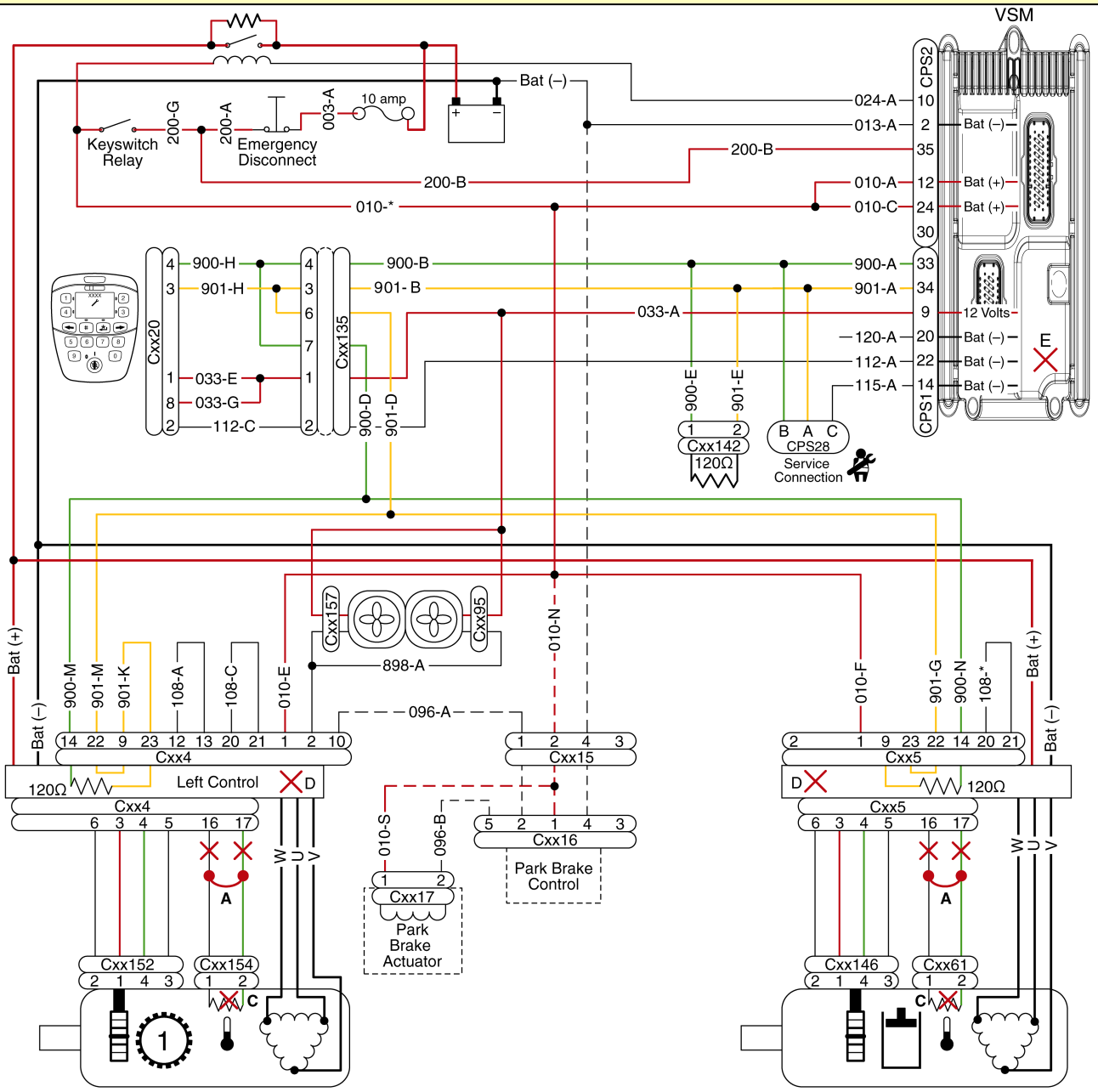


Motor Versions→ Hardware/Software Versions→ ☜ Exit Versions→ Power **OFF**?

CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

CBB SCHEMATIC CAUSES A B C D E > ?



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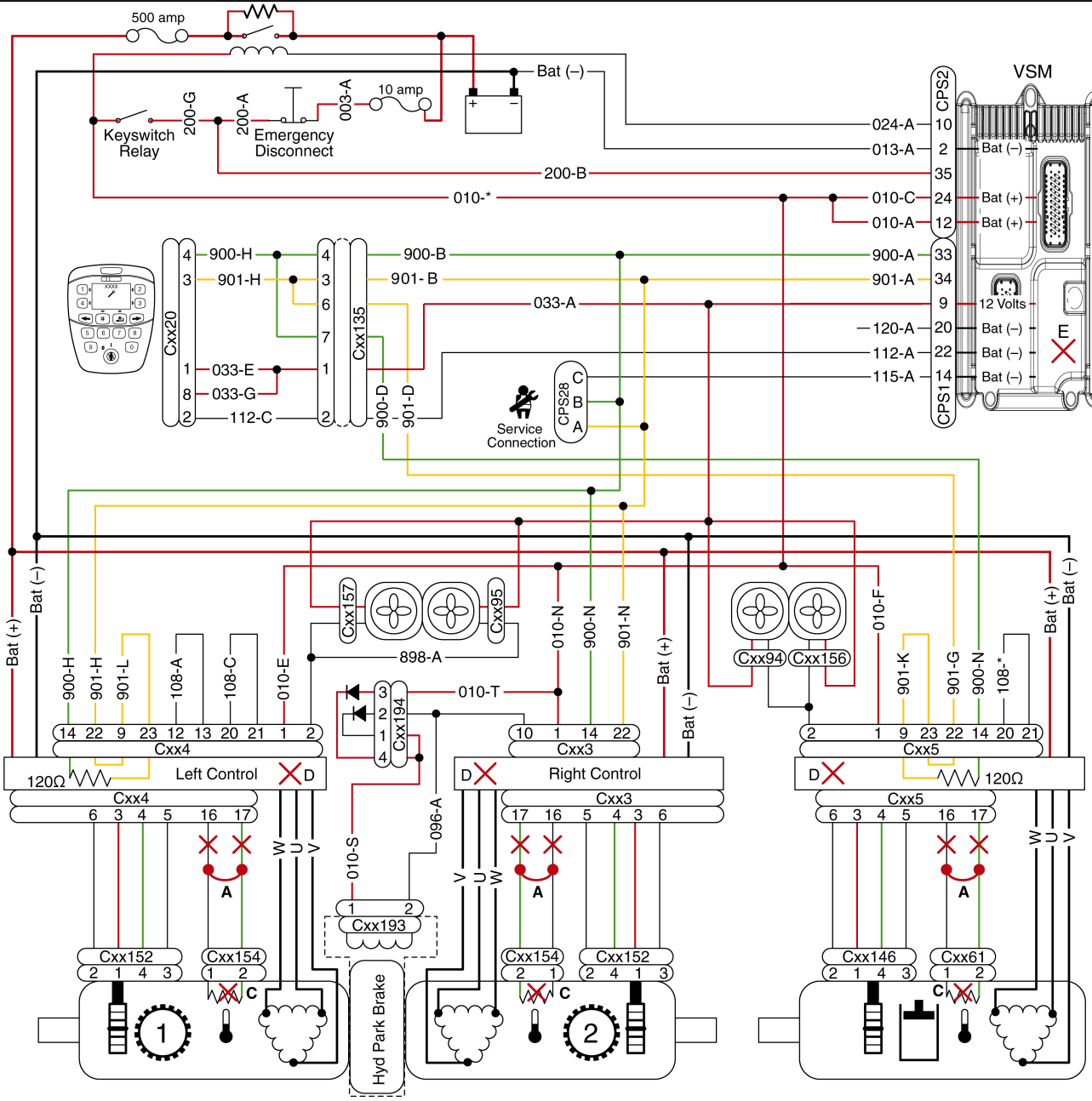
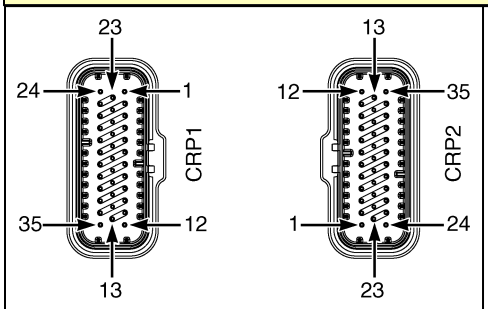
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

DBB SCHEMATIC CAUSES A B C D E > ?

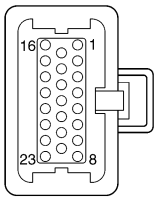


CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

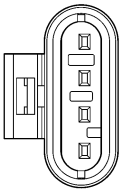
CONNECTORS



VSM Cxx 1 and Cxx 2

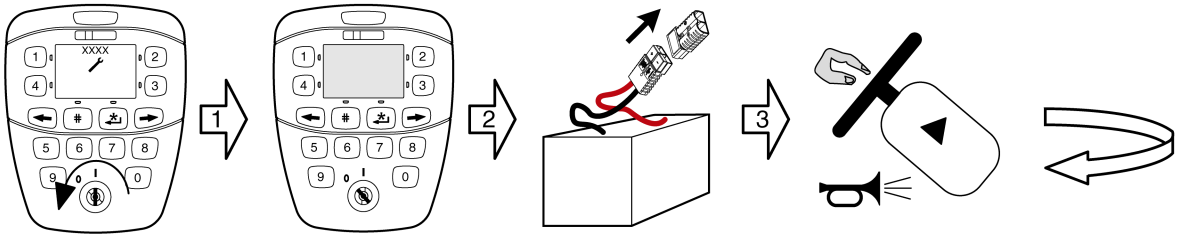


Traction/Pump Controller Cxx 3, 4, and 5



Fan Motor Connector Cxx 146, 154, and 155

CAUSE A



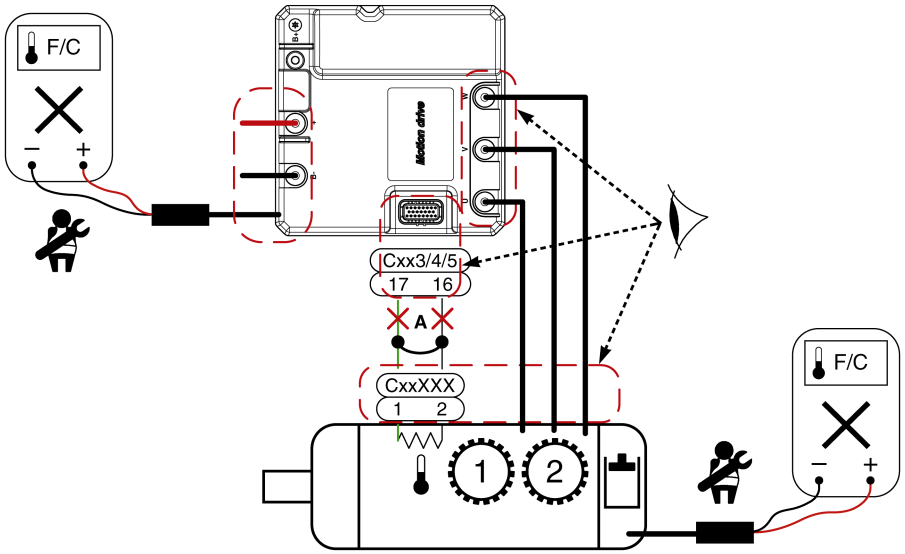
Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

Go to Step A1

STEP A1

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections

A DMM Temperature probe can also be used to determine which device is overheating



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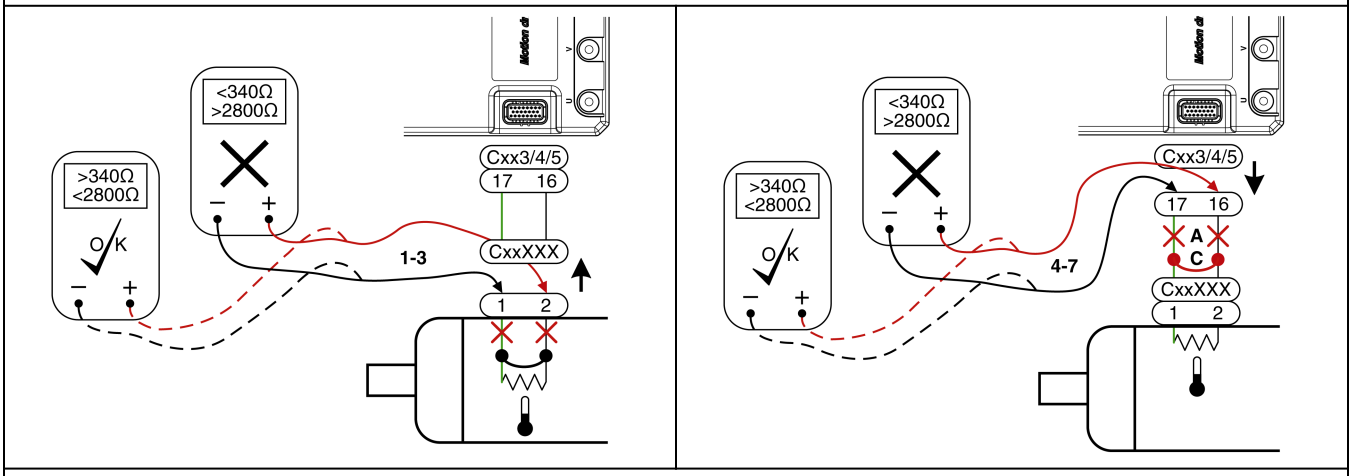
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

STEP A2	CHECK RESISTANCE - Ω - OHMS

Motor Temperature Sensor



1. Disconnect Motor Connector→Measure ? as indicated→

Note: For temperature sensor readings, see Table 9030-10-4.

At xxx deg→ sensor ? ˜ match Temperature Chart 340? @ → -40°C (25°F) to 2791? @ 300°C (572°F) ↓

2. <300? to 0? = Motor Sensor Short Circuit→Go to 8↓

3. >2800? to 8? = Motor Sensor Open Circuit/High Resistance Connection→Go to 8↓

4. Reconnect Motor Connector↓

5. Disconnect Controller Connector→Measure ? as indicated→See Table 9030-10-4.↓

6. <300? to 0? = Short Circuit→Go to 9↓

7. >2800? to 8? = Open Circuit/High Resistance Connection→Go to 9↓

8. **Replace Motor**→Go to 10↓

9. Find/Repair Harness OPEN/SHORT Circuit→Go to 10↓

10. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 11↓

11. Recheck ?↑→ Reconnect→Resume Operation

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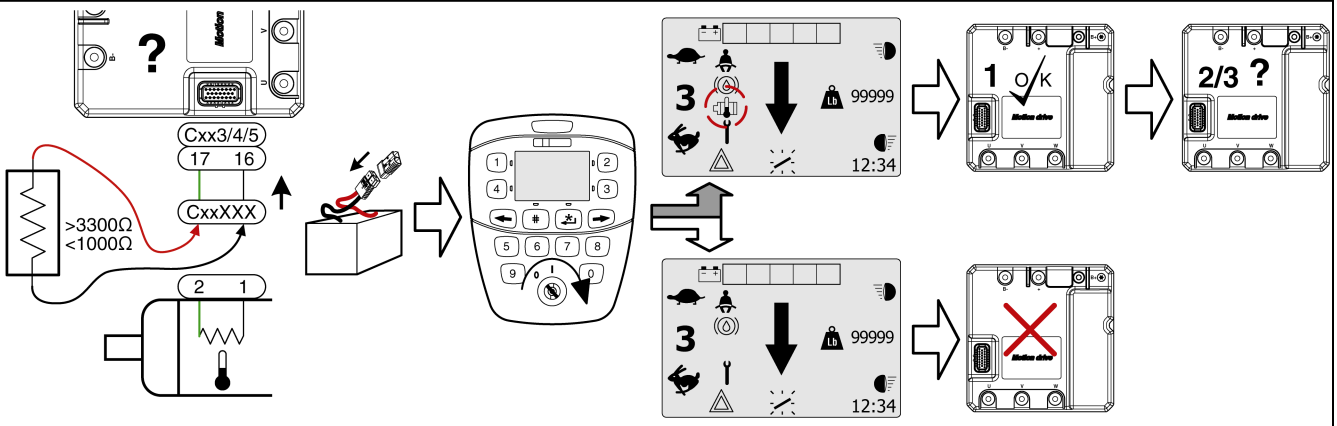
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

STEP A3

Motor Temperature Sensor (Controller Check)



1. Disconnect Motor Temperature Sensor Connector from suspect Controller→
2. Connect a ¼ watt resistor (>3300? to <10,000?) as shown
3. Reconnect Battery and all other Connectors
4. Does Over Temperature ICON Appear?↓
5. YES: Go to 7↓
6. NO: Controller is Faulty→Component Operational Check↓
7. Repeat Resistor Test on other Controllers↓
8. Temperature ICON is Displayed?→YES: Controller tested OK, Go to 9→NO: Controller tested Faulty→Component Operational Check↓
9. Reconnect other Motor Temperature Sensors

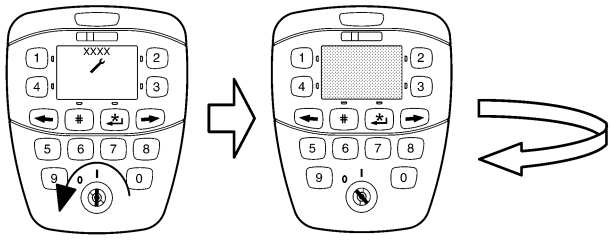
CAUSE B

Not Applicable

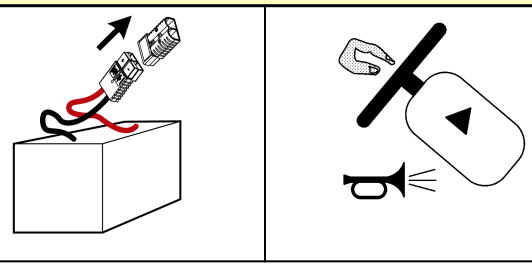
CAUSE C

Not Applicable

CAUSE D



Power **OFF**→



Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

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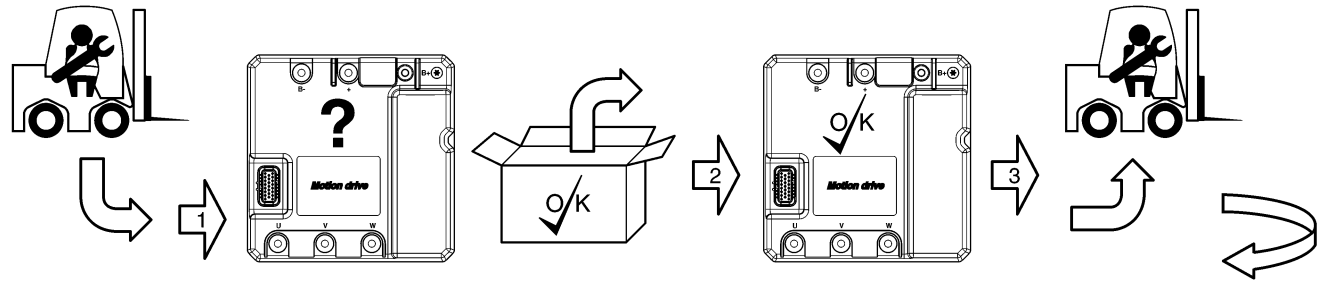
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

STEP D1

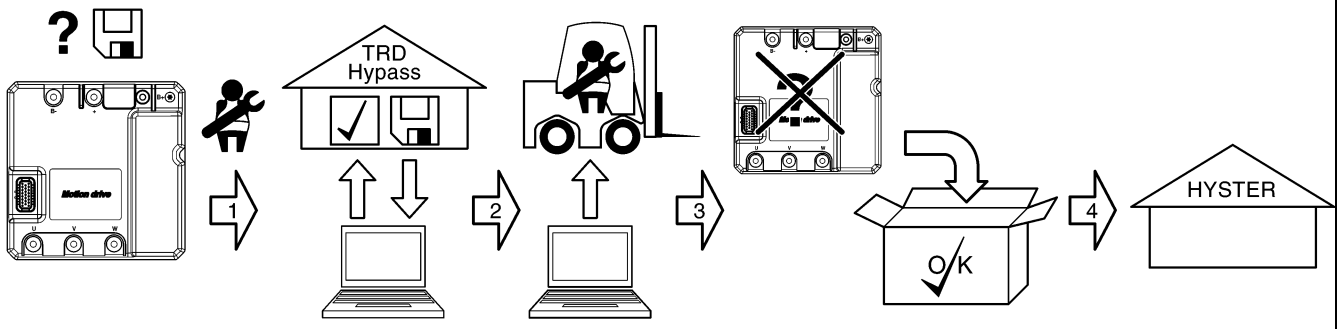


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

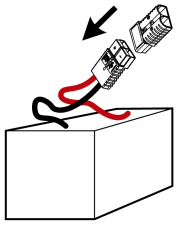
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

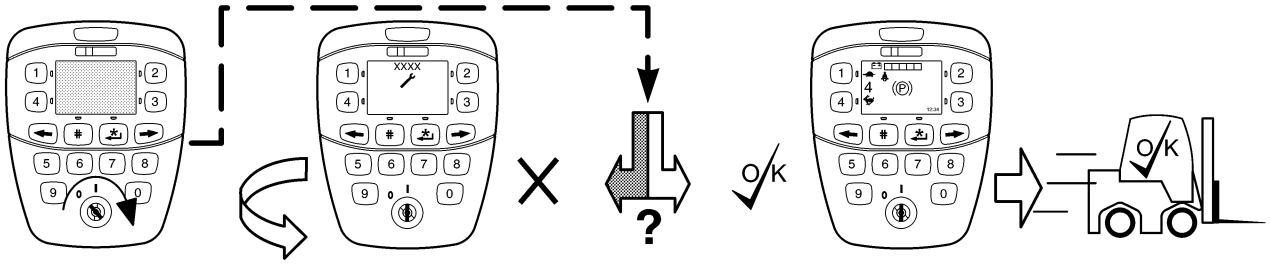
3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

STEP D3

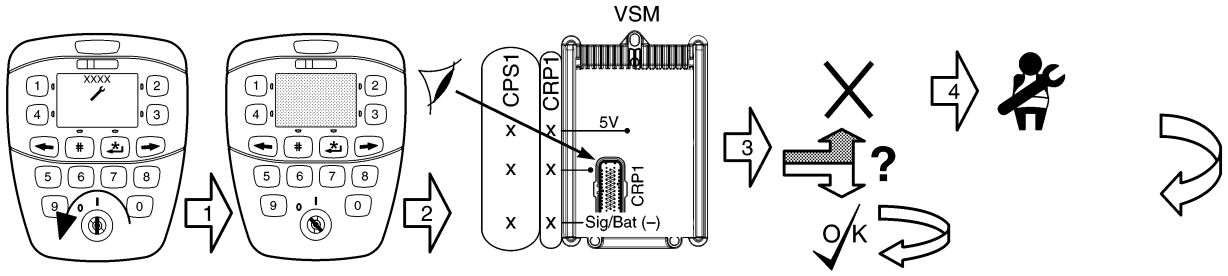




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

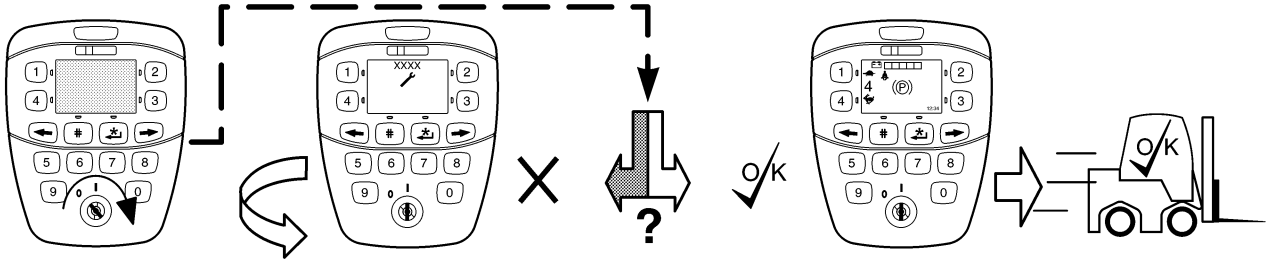
NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

https://truckmanualshub.com/

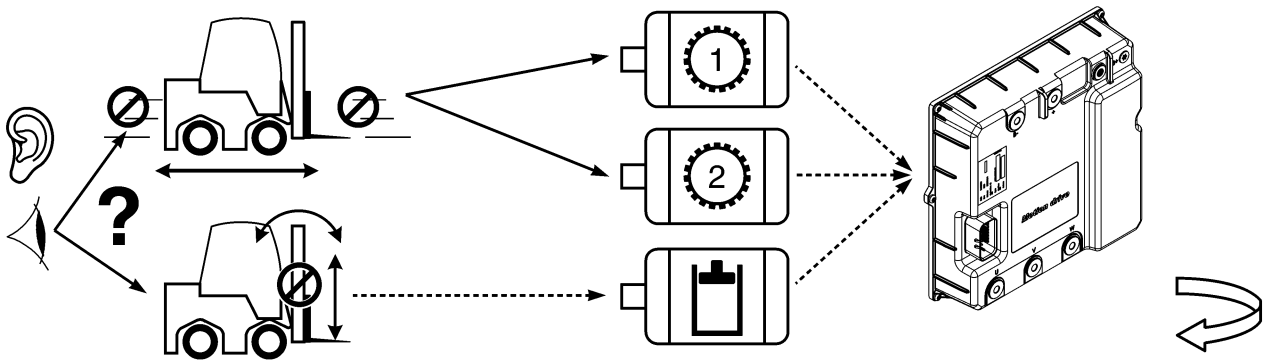
CBB/DBB Motor Controller Current Sensor Failure

DTC 21008
Current Sensor Offset Calibration Error

Fault Codes

QUICK CHECK X Open Circuit/Fail) = Short Circuit

Check 1



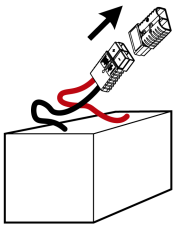
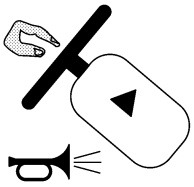
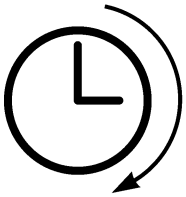
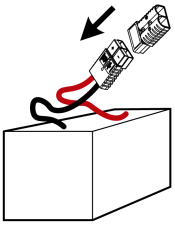
? No Traction/Hydraulics Truck Operation ?

Possible Causes

Motor Controller(s) Failure ?→	→ Component Operational Check ↓

WARNING
The CBB Truck requires the removal of the battery to access the Controllers and Motors

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

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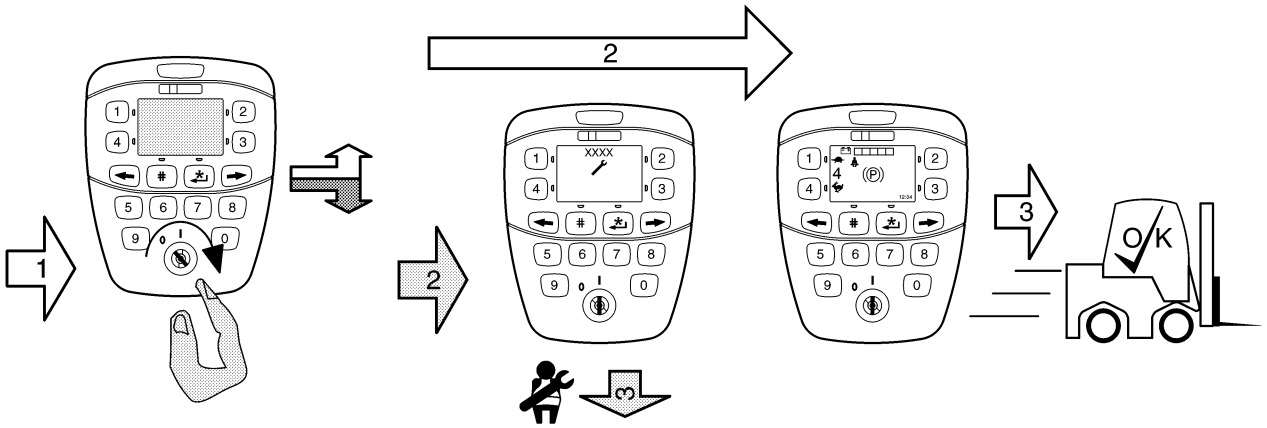
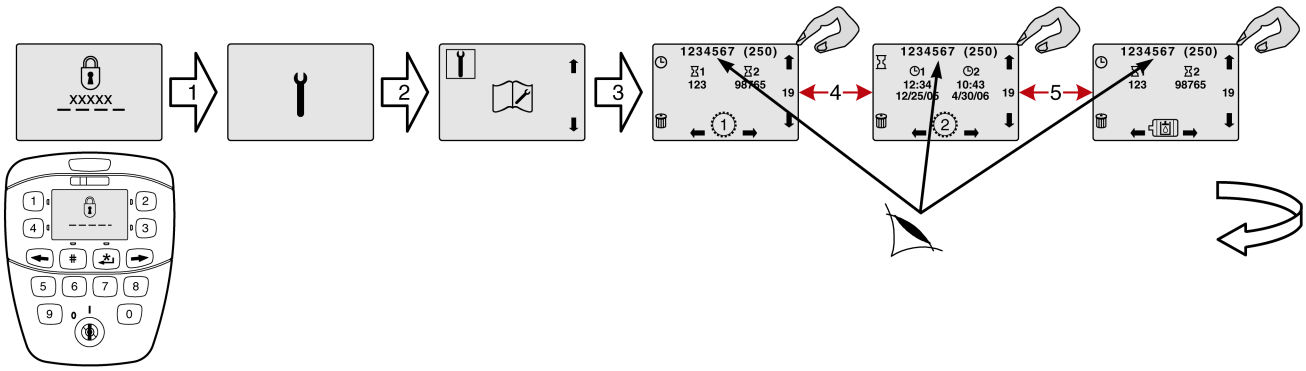
CBB/DBB Motor Controller Current Sensor Failure (Cont)

Check 3



Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

FAULT LOG Review - Go to Display Menu



Enter SERVICE Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?

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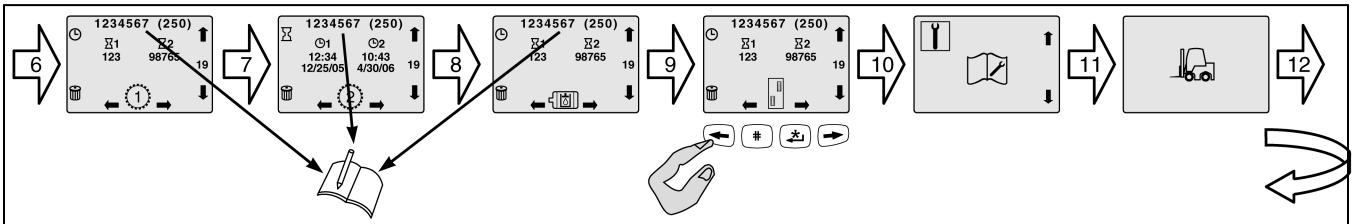
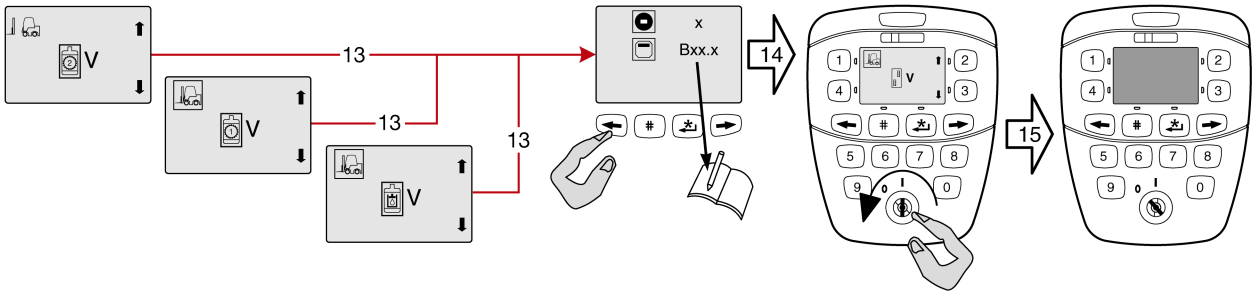
CBB/DBB Motor Controller Current Sensor Failure (Cont)



all Motor DTCs→ ☜ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ ☜ Exit Versions→ Power **OFF**?

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CBB/DBB Motor Controller Current Sensor Failure (Cont)

CAUSE A

Not Applicable

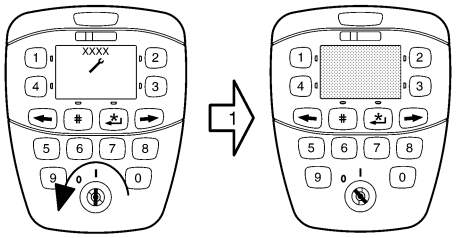
CAUSE B

Not Applicable

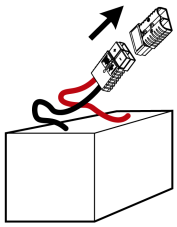
CAUSE C

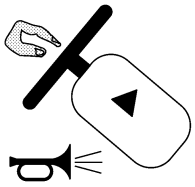
Not Applicable

CAUSE D



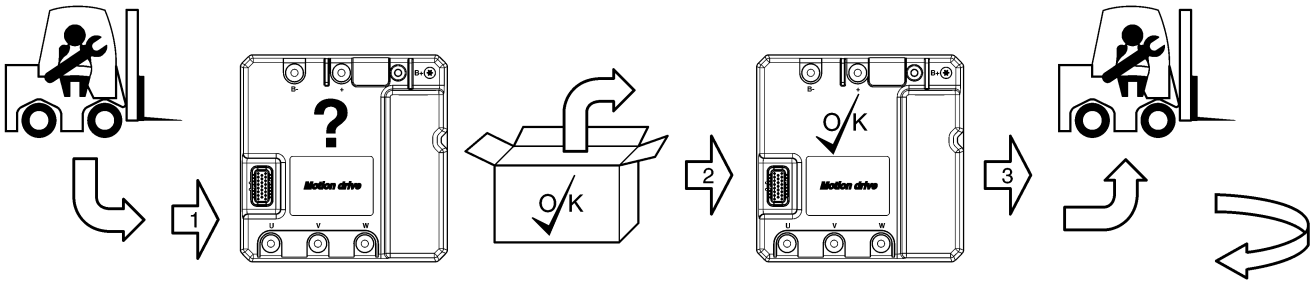
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

STEP D1



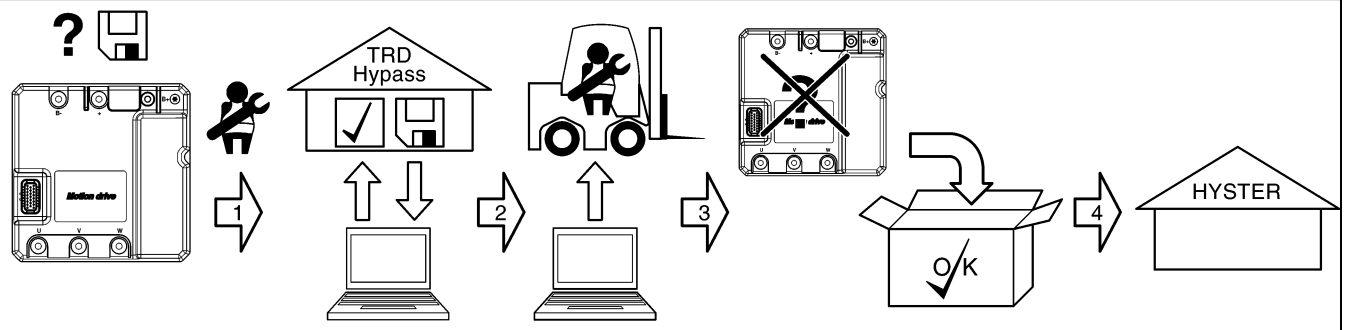
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

CBB/DBB Motor Controller Current Sensor Failure (Cont)

STEP D2



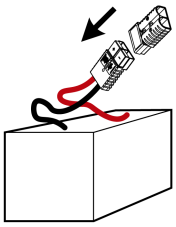
1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

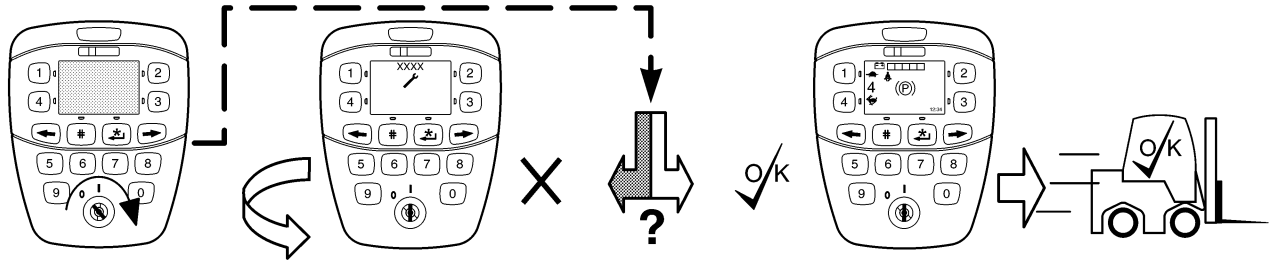
2. **NO**→Download the latest Application →Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

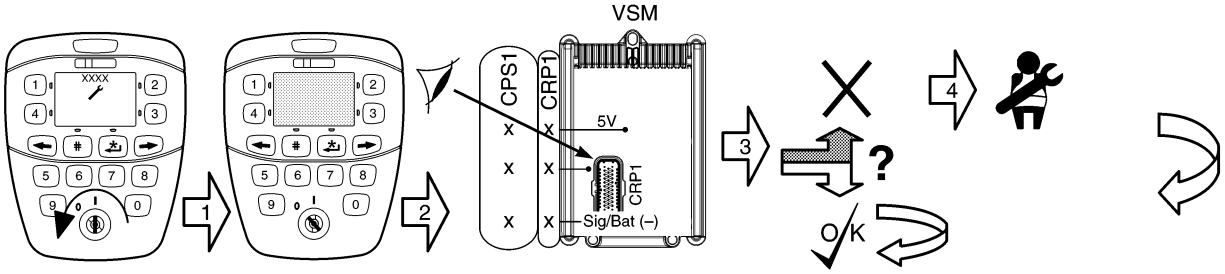




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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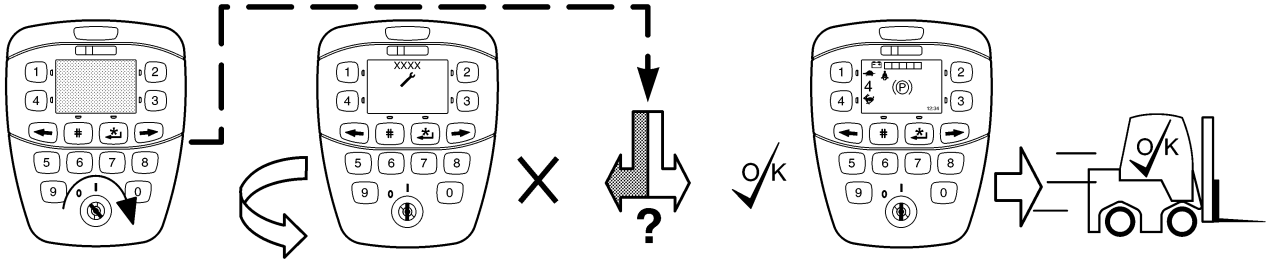
CBB/DBB Motor Controller Current Sensor Failure (Cont)

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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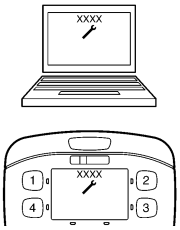
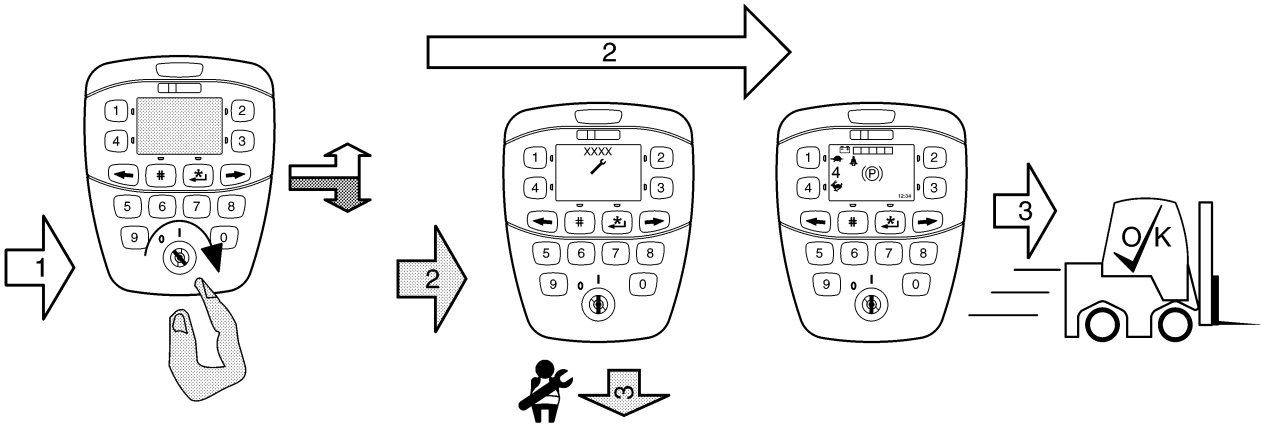
Hydraulic Calibration Required



DTC 4096
Hydraulic Calibration Required

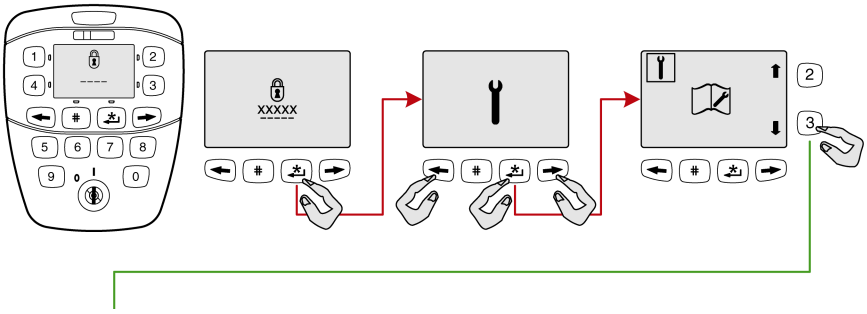
Fault Codes

FAULT LOG CODE Review - Go To Display Review



Power **ON**→ Fault Remains Service Required ? No Fault→ Resume Operation

Calibration Process - Go to Display Menu



Enter Service Pass-word→ ☞*	D Diagnostics → ☞*	E Hydraulic Input ?

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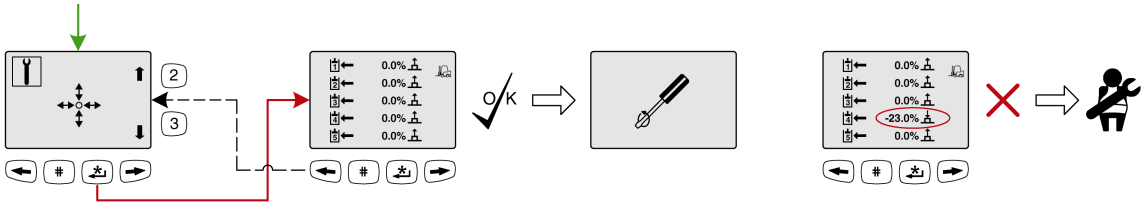
Hydraulic Calibration Required (Cont)

Hydraulic Lever Sensor Input Values

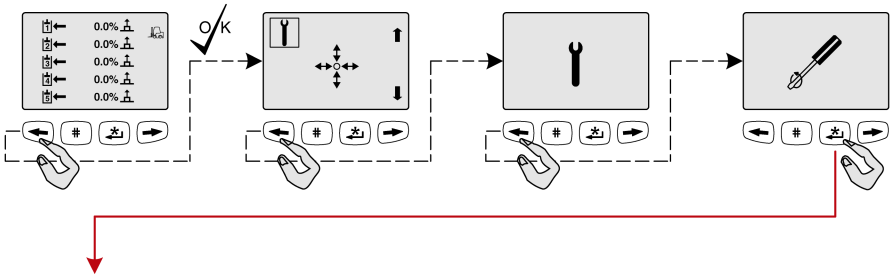


1. ☞*"Hydraulic Levers at Center position# < ± 2.5% = v" Proceed with Calibration ?

2. ☞*"Hydraulic Levers at Center position# > ± 2.5% = X = Faulty Lever Mechanism " Repair, Go to 3?

3. Manual Hydraulics Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

Calibration Process - Go to Display Menu



Calibration Menu

This Hydraulic Calibration Display Menu is viewable to those logged in with a supervisor or service level password.

E-Hydraulics and Manual Hydraulics Threshold Calibration: For Display Menu graphics see following pages.

1. Access Calibration Menu→Press *→Scroll to Hydraulic Calibration→Press*↓

2. Move the lever for function 1 in the A direction until the forks begin to visibly move in the A Direction.Press* The VSM will record the setting and the Display will automatically step to the next Calibration step.E.g. 1A→1B→2A→2B.

Note: Calibration reading outside of the allowable engineering tolerances = X across the graphic. Press any key to return to the A direction graphic for the valve under calibration. Repeat calibration steps.

3. Last Calibration completed.→Display transitions back to the Calibration Maintenance Menu List.

Manual-Hydraulic: For Display Menu graphics see following pages.

1. Access Calibration Menu→Press *→Scroll to Manual Hydraulic Valve→Press*↓

2. Move the Lift Lever first to the end of mechanical travel in one direction and then to the other endPress* Repeat for the other Levers.
When all levers have been calibrated Press the Scroll Left Button to return to the previous Menu.

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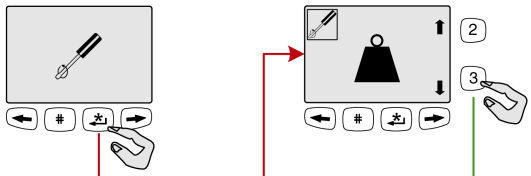
Hydraulic Calibration Required (Cont)

Note: If the calibration reading is outside of the allowable engineering tolerances the Display will display an X' across the graphic.

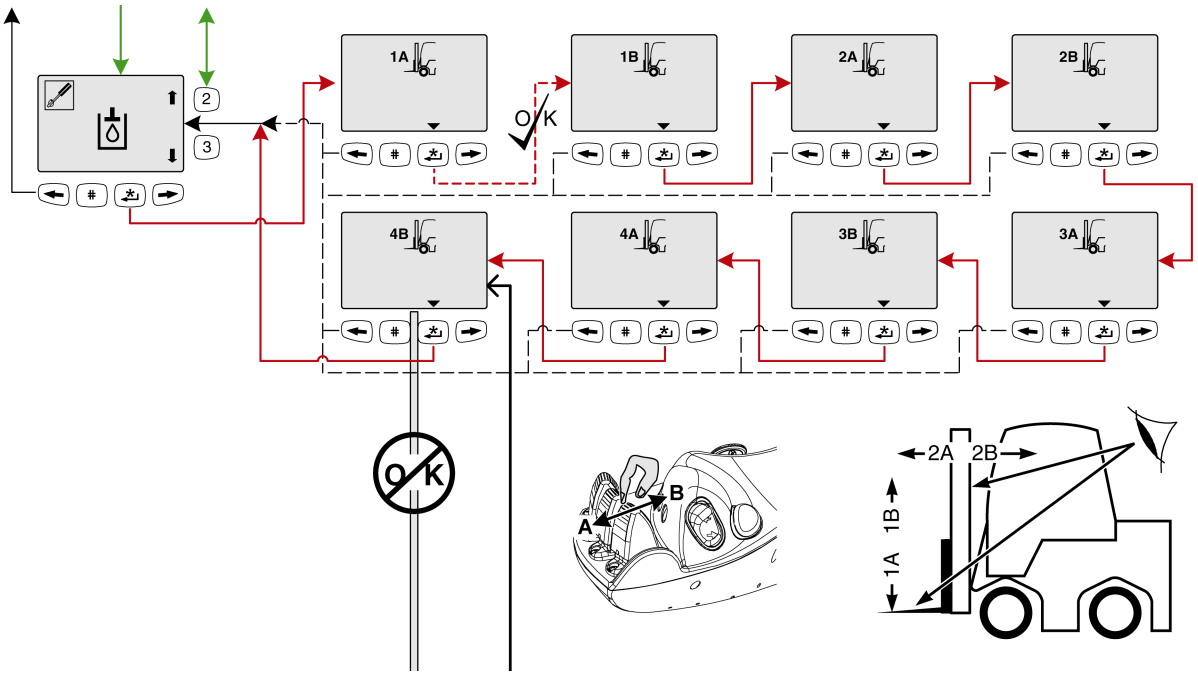
Wait 3 seconds→Press*→Repeat the calibration for this Lever.

Calibration Process - Go to Display Menu



Calibration → ☞* ↓ Hydraulic Valve Threshold

Hydraulic Valve Threshold - Manual and E-Hydraulic



☞*	Operate Indicated Control until Hyd movement is observed ☞*	Repeat for each Function ☞*

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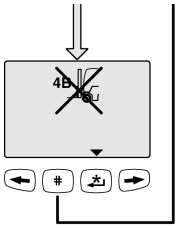
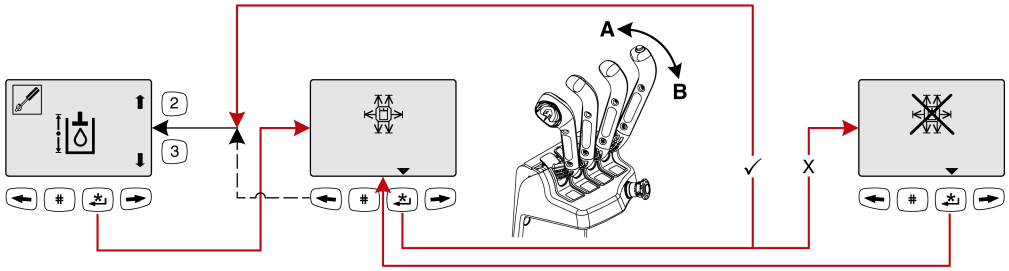
Hydraulic Calibration Required (Cont)



X = Calibration Failure	☞ # to Reset↑	Repeat Calibration
WARNING: X = MLM Lever operated in the wrong direction. Repeat Calibration		

Manual Hydraulic Valve



☞* Lift/LowerG ☞ * v Next Lever G X = Calibration Fail I_touchup FontFamname="Wingdings" 🗁 3 seconds ☞* Repeat Calibration

FAULT DTC LOGS: DTC logs should only be cleared once the data is 📝 by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

CAUSE A

End of Task

END FAULT

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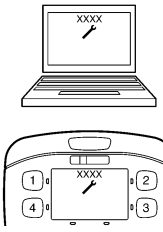
CBB/DBB Motor Controller 15 – 5 Volt Internal Failure



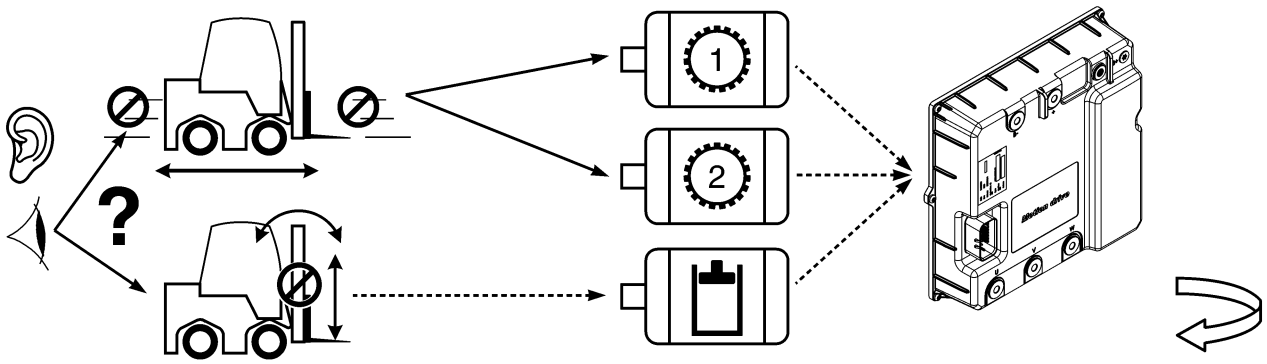
Fault Codes

DTC 20753
15 Volt Supply Low Voltage

DTC 20755
5 Volt Supply Low/High Voltage

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1



? No Traction/Hydraulics Truck Operation ?

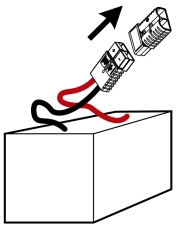
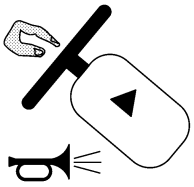
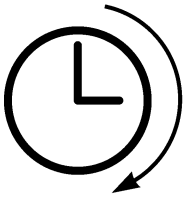
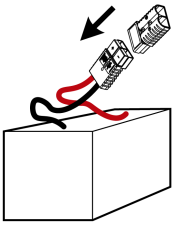
Possible Causes

20753/20755→ Motor Controller(s) Failure ?→	Component Operational Check ↓

WARNING

The CBB Truck requires the removal of the battery to access the Controllers and Motors

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

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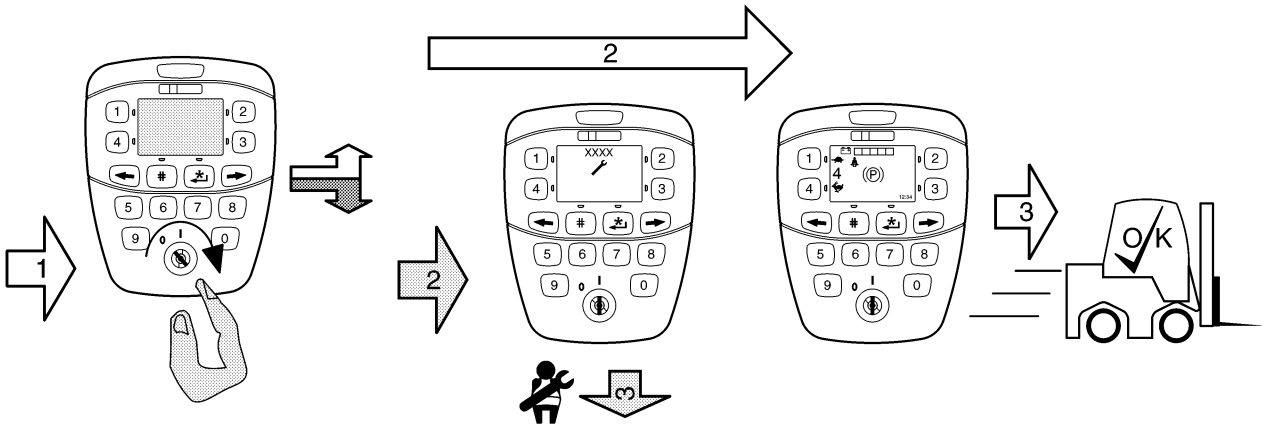
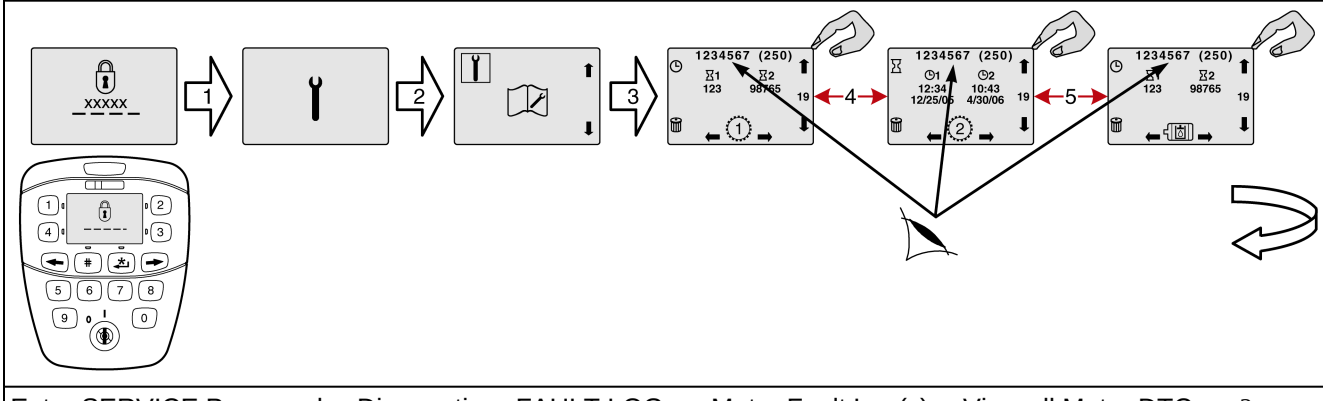
CBB/DBB Motor Controller 15 – 5 Volt Internal Failure (Cont)

Check 3

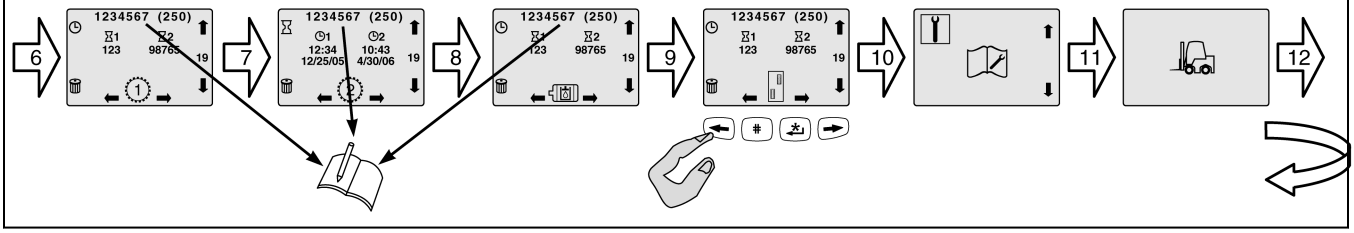


Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

FAULT LOG Review - Go to Display Menu



Enter SERVICE Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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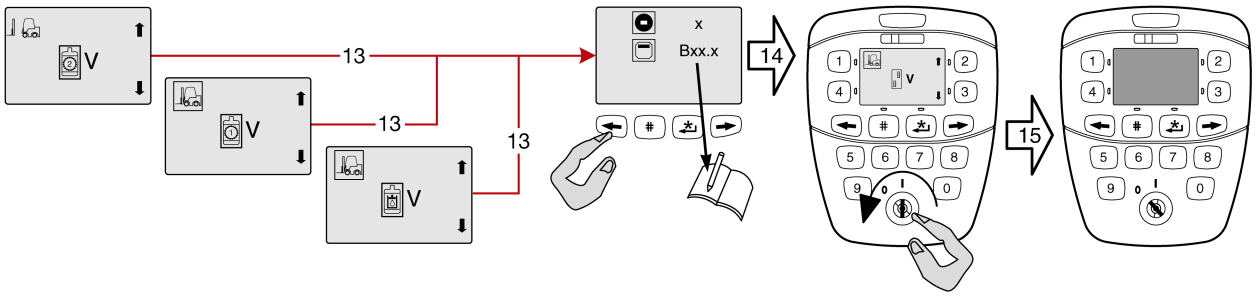
CBB/DBB Motor Controller 15 – 5 Volt Internal Failure (Cont)

all Motor DTCs→ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ Exit Versions→ Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

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CBB/DBB Motor Controller 15 – 5 Volt Internal Failure (Cont)

CAUSE A

Not Applicable

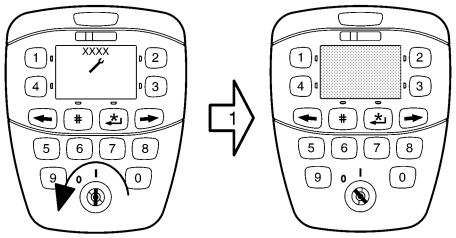
CAUSE B

Not Applicable

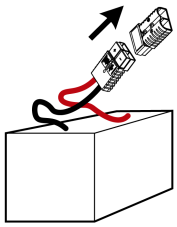
CAUSE C

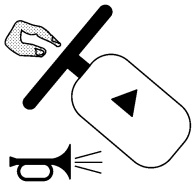
Not Applicable

CAUSE D



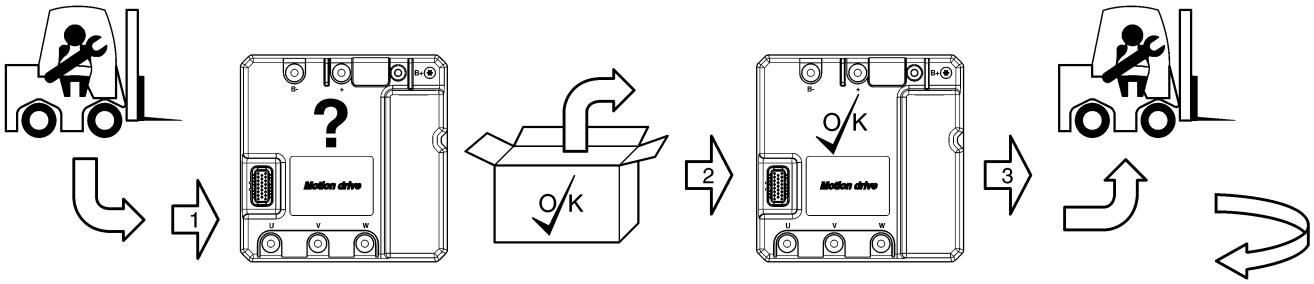
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

STEP D1



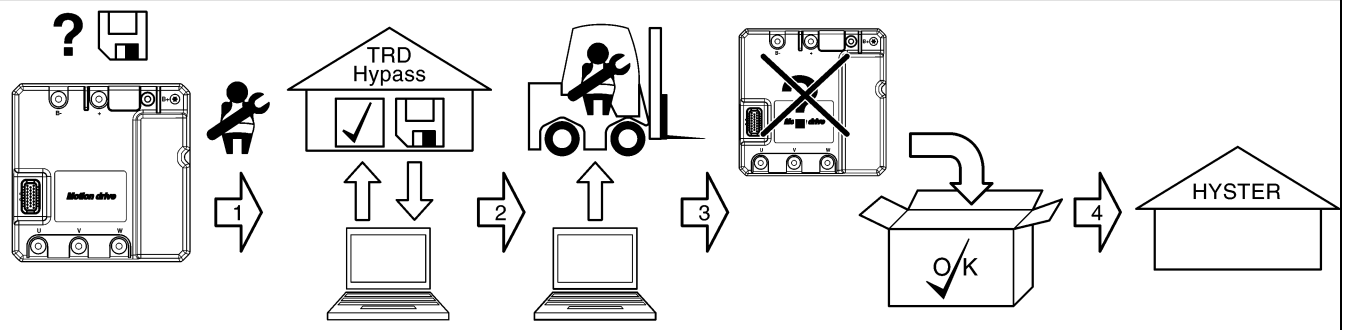
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

CBB/DBB Motor Controller 15 – 5 Volt Internal Failure (Cont)

STEP D2



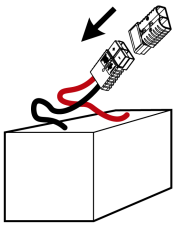
1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

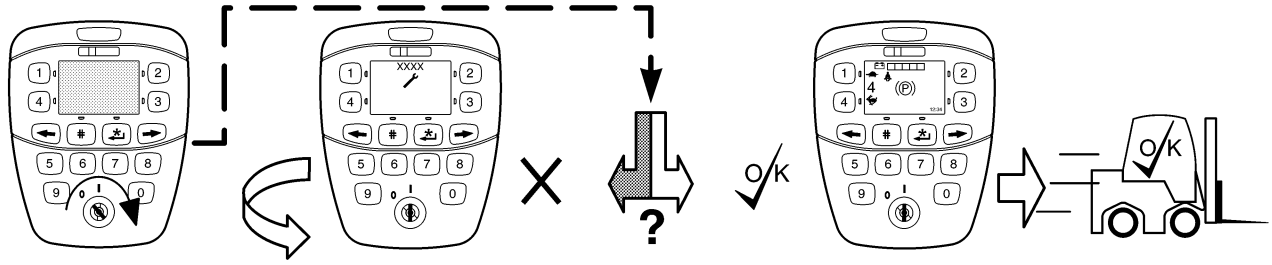
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

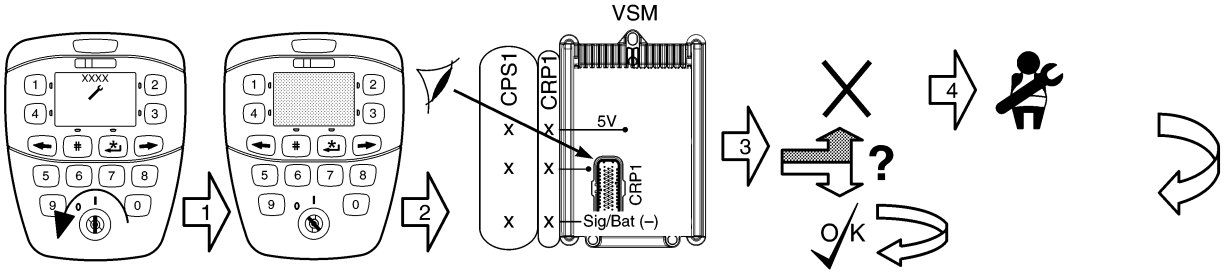




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

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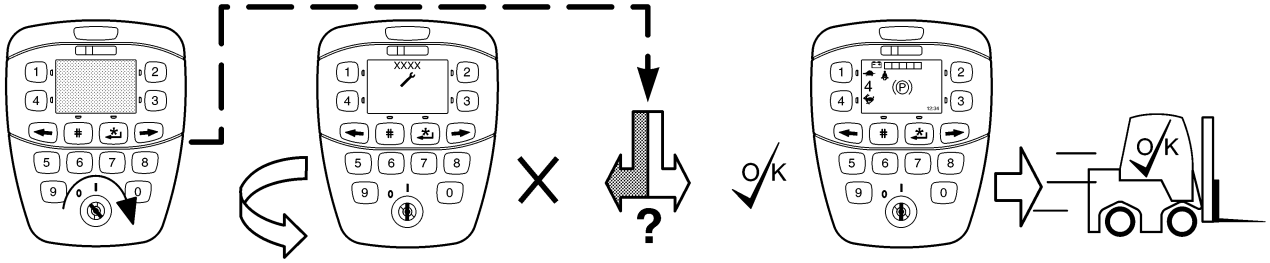
CBB/DBB Motor Controller 15 – 5 Volt Internal Failure (Cont)

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check

Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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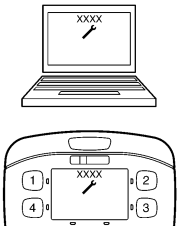
CBB/DBB Motor Controller DC Bus Low/High

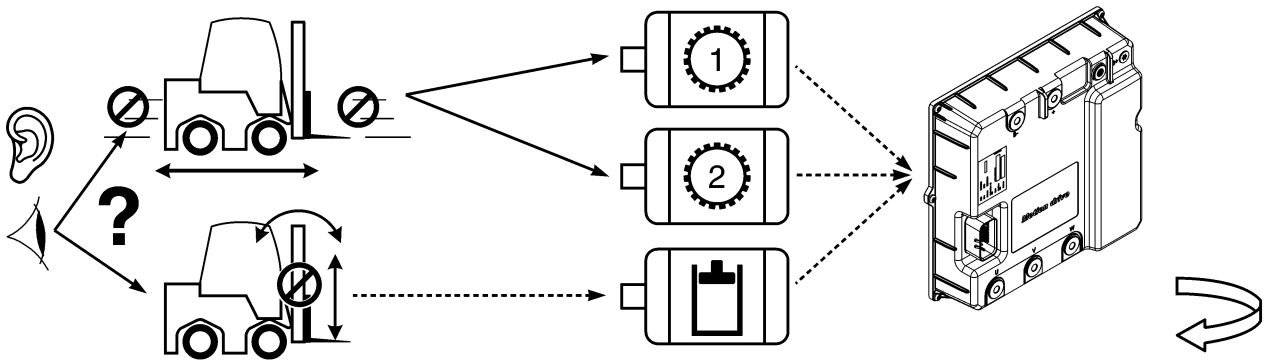


Fault Codes

DTC 12576 DC Bus Charging Timeout	DTC 12817 DC Bus Hi – Software Detected	DTC 12818 DC Bus Hi – Hardware Detected	DTC 12833 DC Bus Low – Hardware/Software

QUICK CHECK X Open Circuit/Fail) = Short Circuit

Check 1



? No Operation ?

POSSIBLE CAUSES

DTC 12576 DC Bus Charging Timeout	Low Battery/High ® Connections→ Go to 1, 2, and 3↓	→ Component Operational Check ↓
DTC 12817 DC Bus Hi – Software Detected	Brake Torque Settings→ Go to 4↓	→ Component Operational Check ↓
DTC 12818 DC Bus Hi – Hardware Detected	High ® Connections→ Go to 3 and 4↓	→ Component Operational Check/ Component Operational Check↓
DTC 12833 DC Bus Low – Hardware/ Software	High ® Connections→ Go to 3↓	Component Operational Check → ↓

1. Go to OORL. See Battery OORH/OORL
2. PTC Failure?→
3. Motor/Motor Controller Battery Connections/Wiring – High ®/Contactor Contacts?→
4. Commanded Braking Torque (Regen) is set too High for Battery Condition

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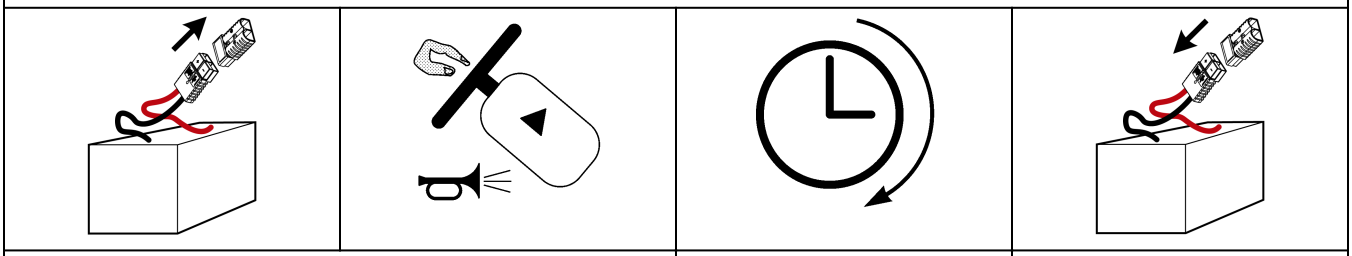
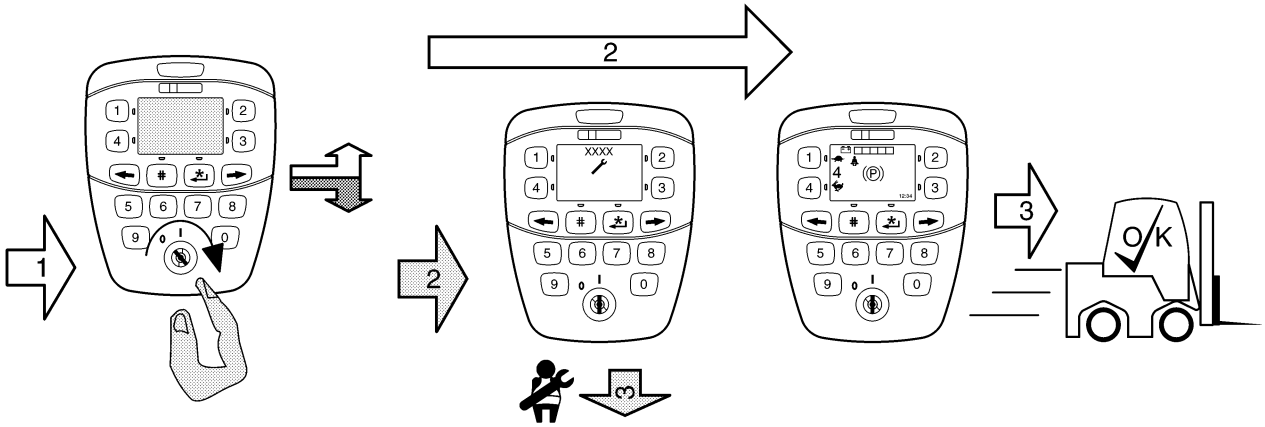
CBB/DBB Motor Controller DC Bus Low/High (Cont)

Check 2



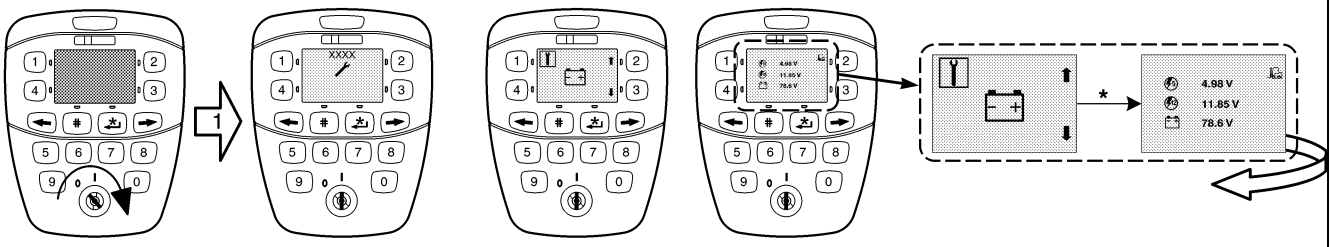
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery

Check 3



Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

Check 4



Power ON→ Go to Diagnostics→ Battery/Supply→ View Bat Value→ Go to Display Menu Flowchart↓

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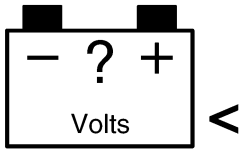
CBB/DBB Motor Controller DC Bus Low/High (Cont)

Check 5

Battery OORL/OORH as measured by the Motor Controllers

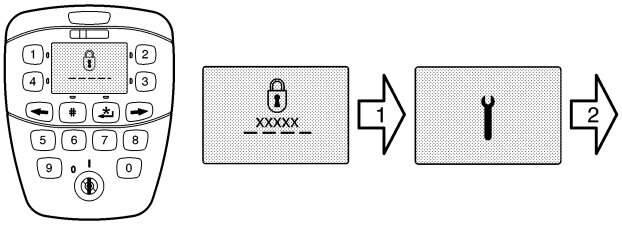
NOTE: OOR fault is set if OOR condition is present for longer than 1 second.
NOTE: Both Motor control and VSM OOR faults may appear due to the different thresholds levels



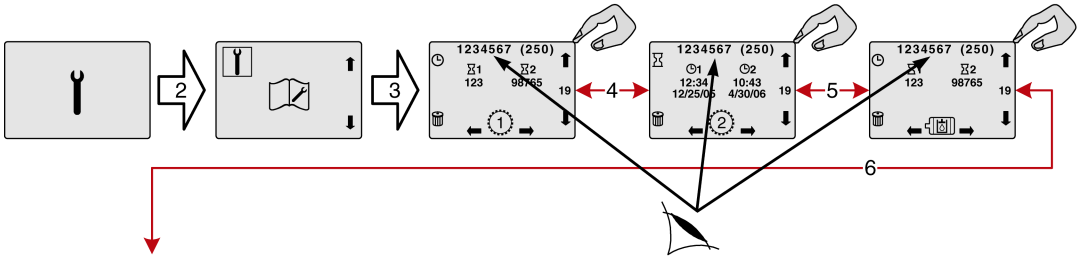
Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜< OORL	23	30	41	48
˜ OORH	50	65	99	110

Is battery voltage ˜ < OORL value for correct battery?↓
YES → Battery OORH/OORL → Return to this Fault after Battery OORH/OORL/Retest is complete.?
NO→ Check 6?

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostics→



Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?

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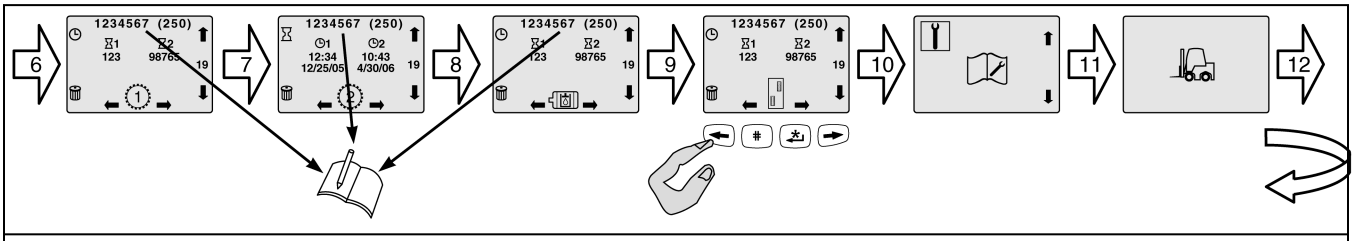
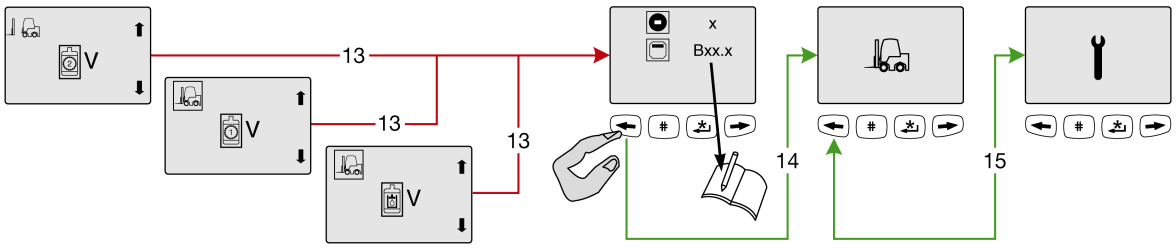
CBB/DBB Motor Controller DC Bus Low/High (Cont)



all Motor DTCs→ ☜ Exit Fault Log→ Truck Status ?



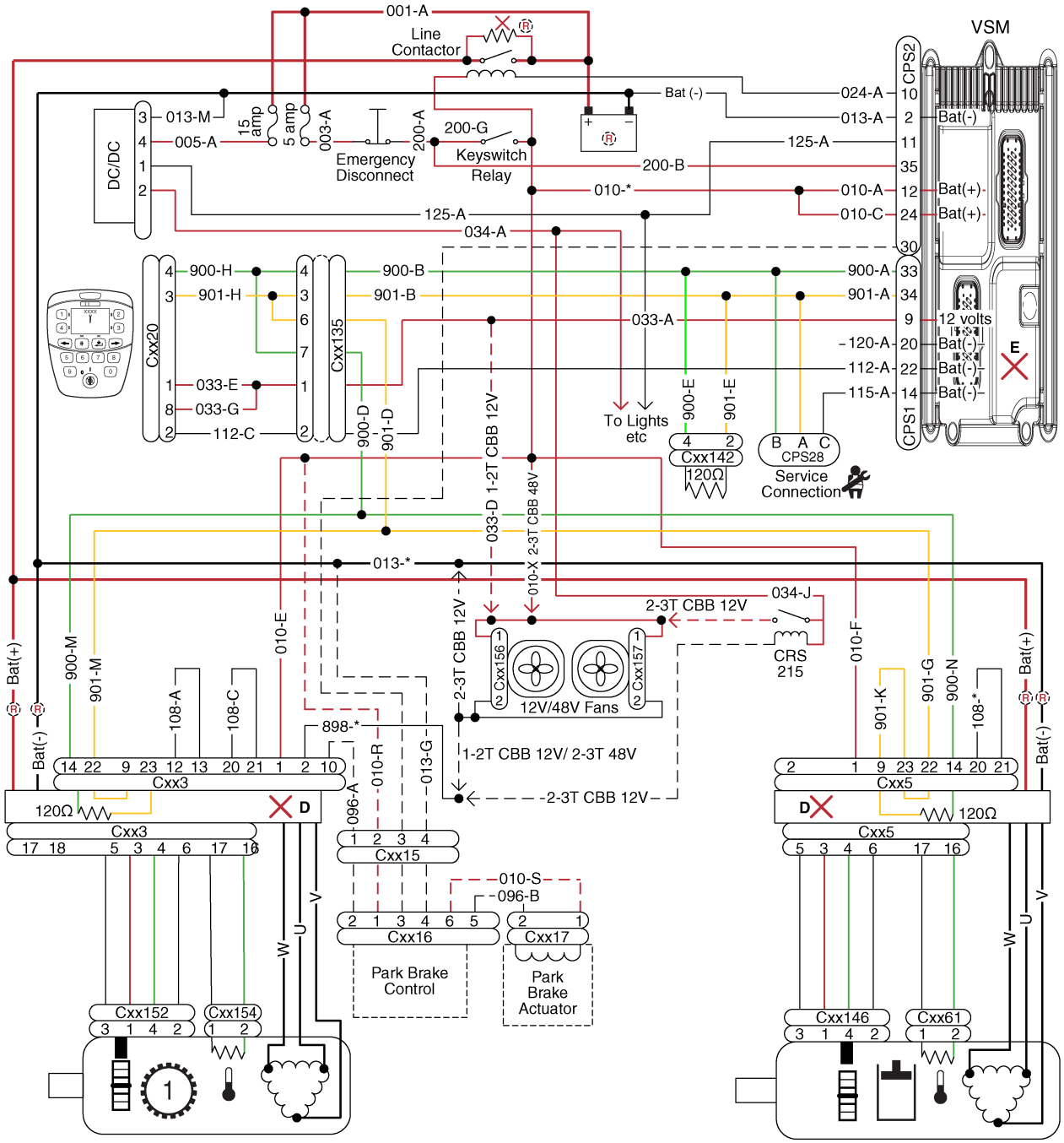
Motor Versions→ Hardware/Software Versions→ ☜ Exit Versions→ Status→ Truck Diagnostics☞*↓

CBB/DBB Motor Controller DC Bus Low/High (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

1.5 – 2.0 CBB SCHEMATIC CAUSES A B C D E > ?

® = High Resistance Connections



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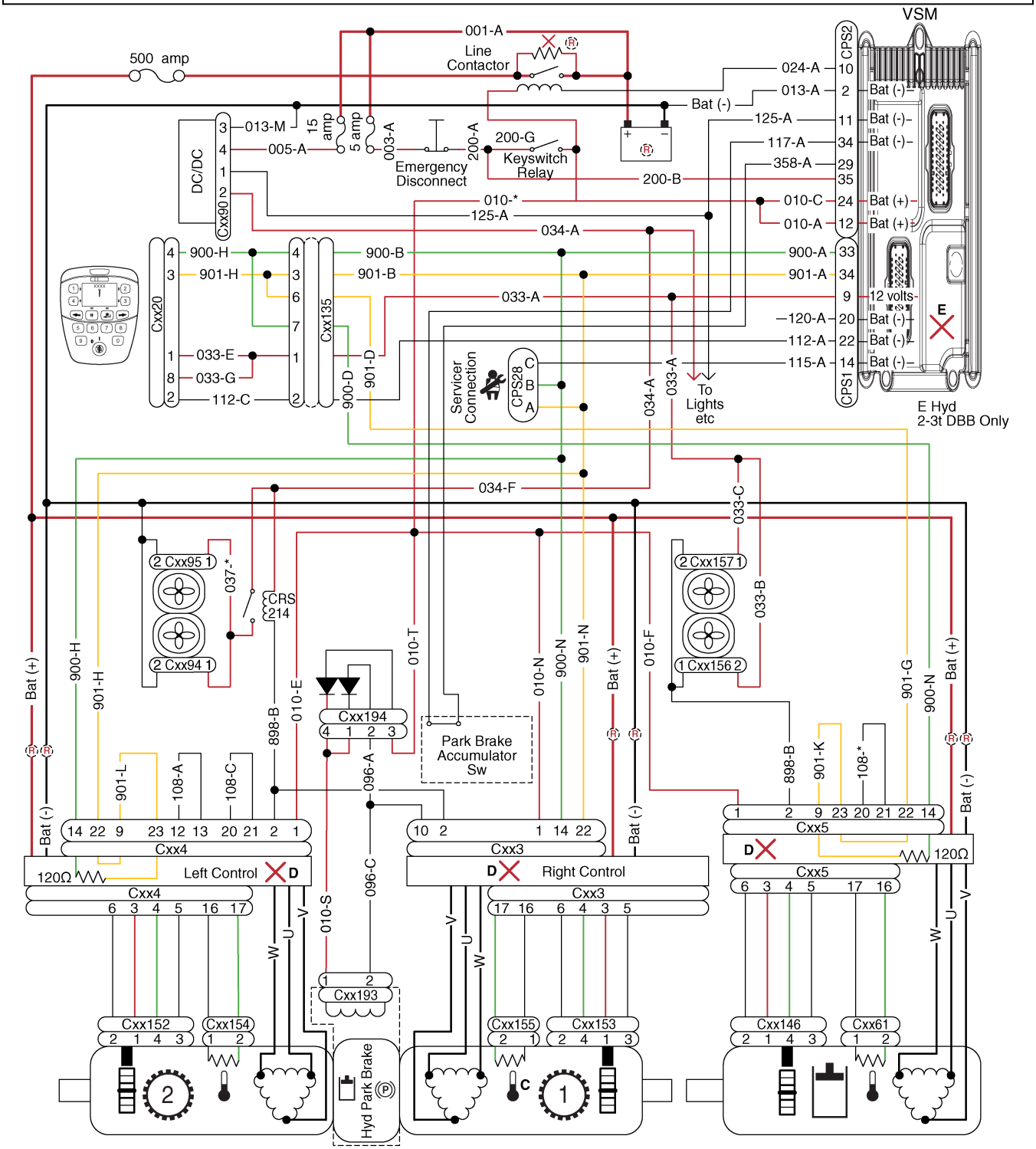
CBB/DBB Motor Controller DC Bus Low/High (Cont)

2.2 – 3.0 DBB SCHEMATIC CAUSES A B C D E > ?

® = High Resistance Connections



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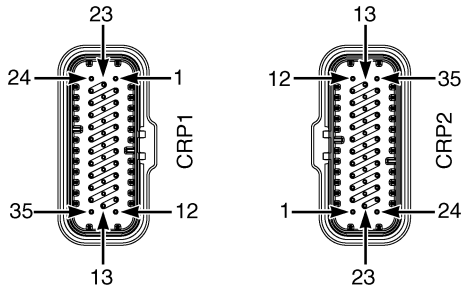
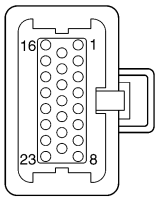
CBB/DBB Motor Controller DC Bus Low/High (Cont)

CONNECTORS

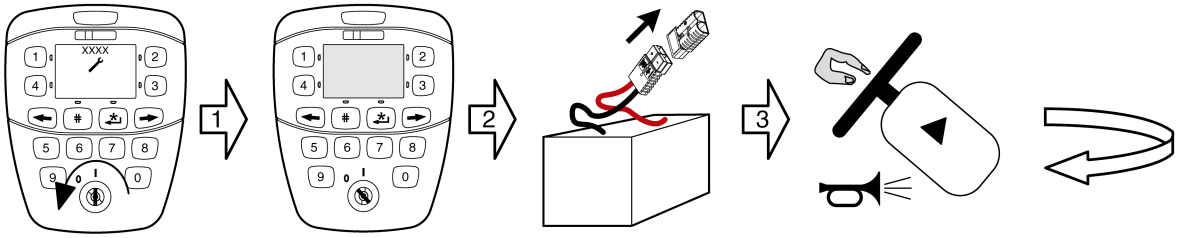


VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

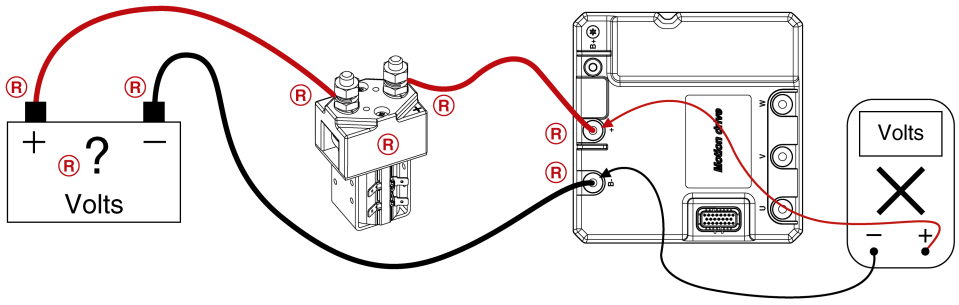
CAUSE A



Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. ?

STEP A1

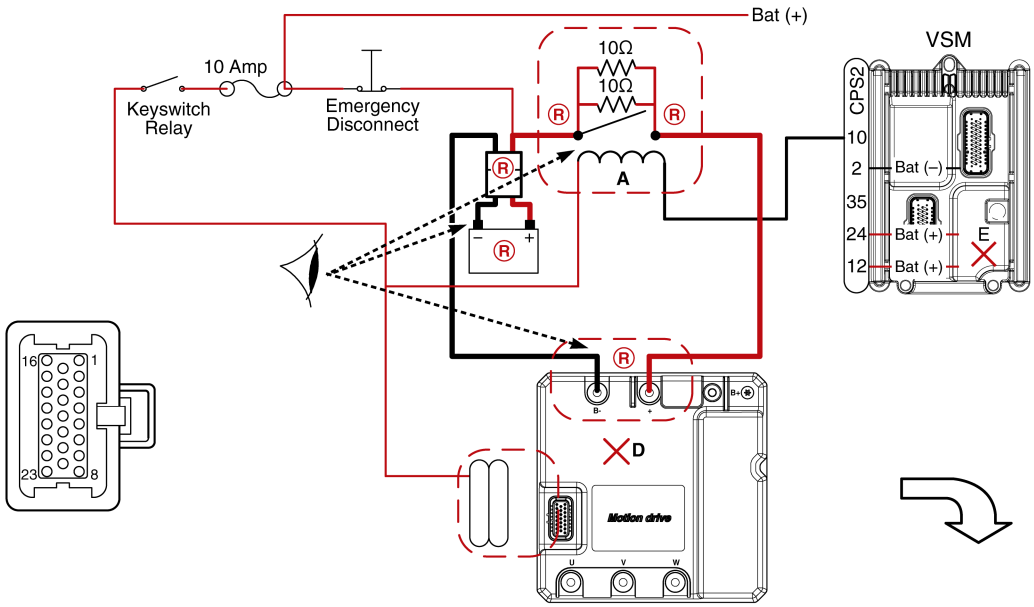
NOTE: ® Battery or Battery to Motor Controller Power Connections→ all DTC Faults are possible
NOTE: High Current drawn from the battery through ® = Voltage drops = OORL
NOTE: High Current sent to the battery through ® = Voltage increases = OORH



CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP A2

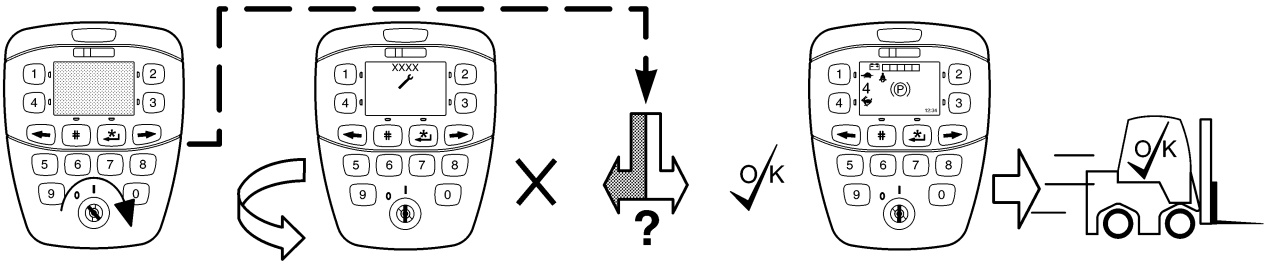
For any Fault DTCs→ Locate Devices→ Inspect ALL Wiring/Connections



STEP A3

1. Inspect Contactor Top and Bottom Contacts for Pitting/Corrosion/Dirt Build-Up→Go to 2↓
2. Replace Contactor if Pitting/Corrosion is Observed/ Clean out any Dirt Build up↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓
4. Check all Connections→Reconnect Battery→Step A4↓

STEP A4



Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

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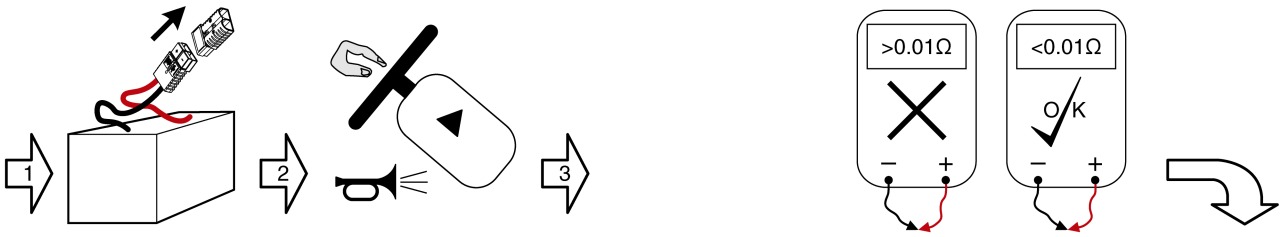
CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP A5



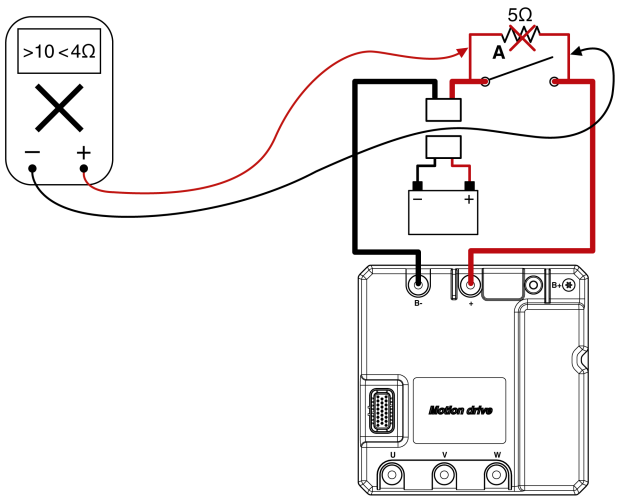
Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.?

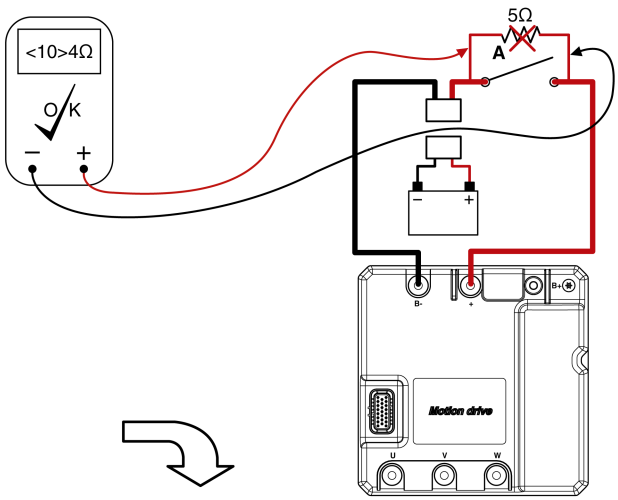
Set DMM to Lowest ? scale→ Check Lead Resistance < 0.01?

Note: If the Resistance is > 0.01? then record this as the Zero ? Value→ Step A6 ↓

STEP A6 CHECK RESISTANCE - Ω - OHMS

PTC Failure





1. >10 ? @ 25 °C (77 °F) = Faulty PTC→Go to 2↓	1. <10 ? >4 ? = OK→Go to 2↓
2. Replace PTC(s)→Go to 3↓	
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓	
4. Recheck ?↑→ Reconnect→Step A7↓	

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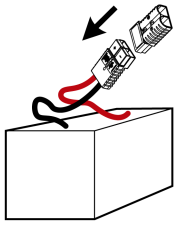
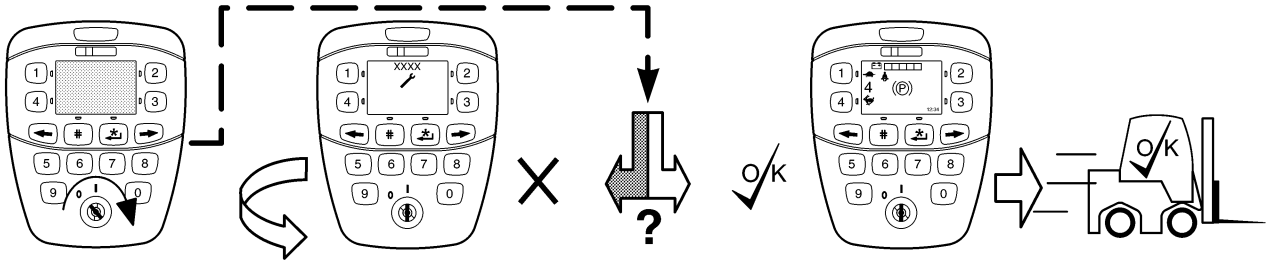
CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP A7

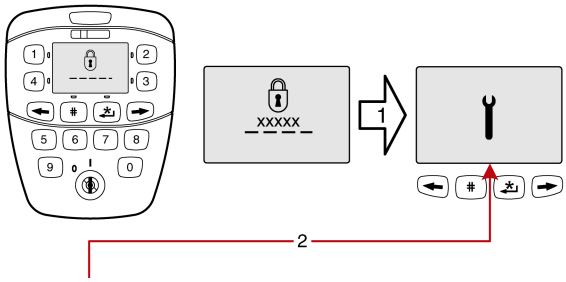




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

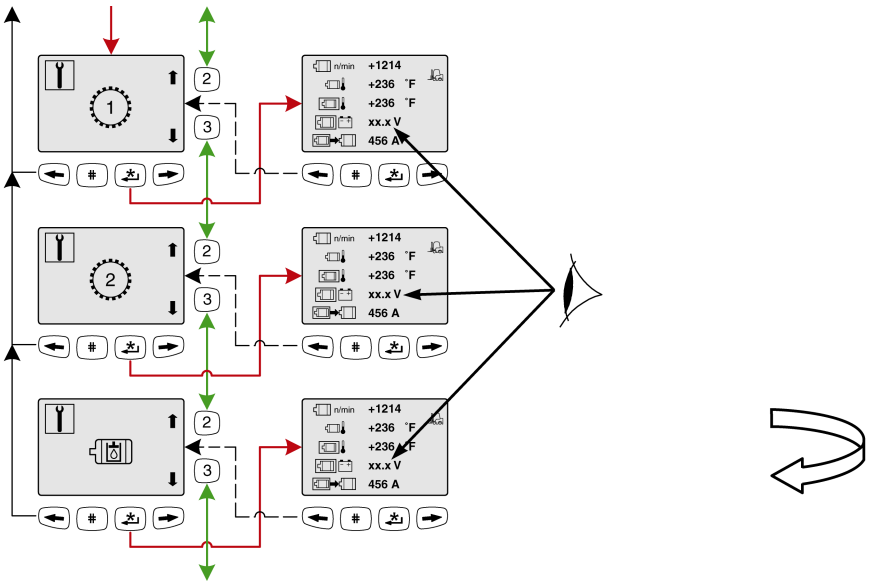
CAUSE B



Enter SERVICE Password→ Diagnostics↓

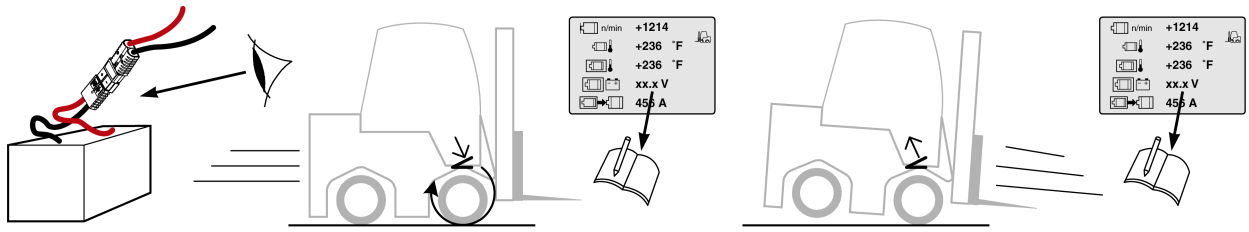
CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP B1



Scroll ↑ ↓ Indicated Motor with Fault DTC ☞*→ View Voltage→ 📋✍ Voltage↓

STEP B2



Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜ < OORL	23	30	41	48
˜ > OORH	50	65	99	110

1. Ensure that the Battery has been fully charged→Check Battery connections are clean and secure.

2 Operate Truck with Maximum Acceleration in Forward Direction→📋✍ Maximum Voltage

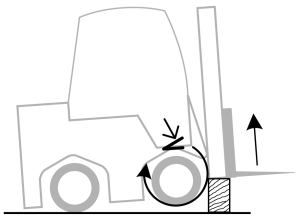
3. Completely release acceleration pedal→Regen Braking Only→📋✍ Maximum Voltage

4. Do Minimum and Maximum Voltages exceed the OORL or OORH thresholds?

5. YES →Step B3NO→Resume Operation

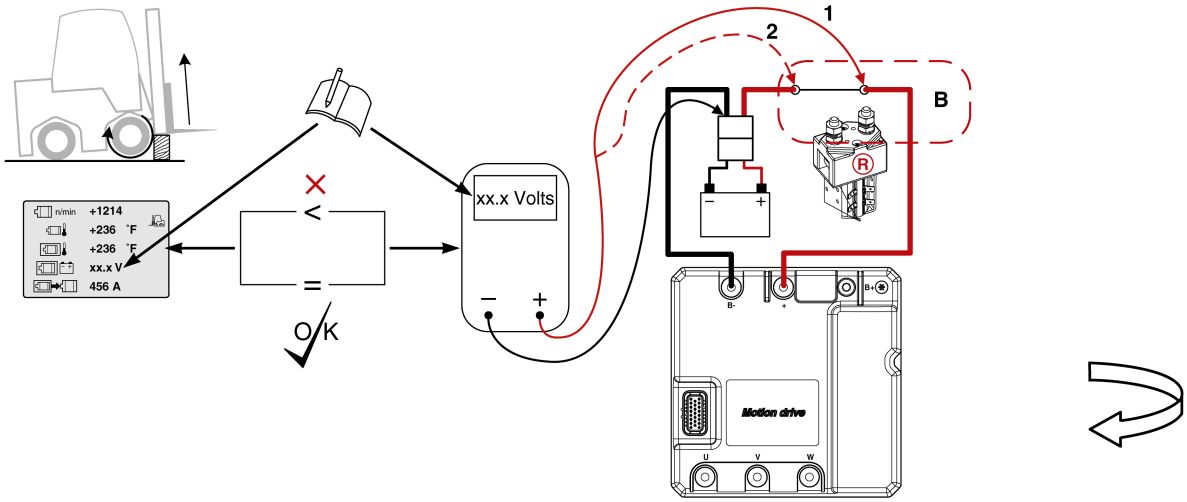
CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP B3



1. Elevate Truck drive wheels.**Use only approved support methodsSee Operating Manual**
2. All Hydraulic Functions need to be free to be operated.

STEP B4 CHECK VOLTAGE



1. Connect DMM→Position 1→Measure Battery Volts at the Contactor terminals→ Value↓
2. Operate Traction and Hoist Hydraulics against Relief Valve→ DMM/Display Volts→Compare→Go to 2a↓

2a. Display Volts < DMM Volts < Controller Minimum?→® Connections→Go to 4↓

2b. Display Volts = DMM Volts > Controller Minimum?→Change DMM to Position 2→Repeat Step2?↑

3. Operate Traction and Hoist Hydraulics against Relief Valve→ DMM/Display Volts→Compare→Go to 3a↓

3a. Display Volts < DMM Volts < Controller Minimum?→® Contactor Contacts→Go to 4↓

3b. Display Volts = DMM Volts > Controller Minimum?→Go to 4?↓

4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 5?↓

5. Recheck Volts↑→Test Truck→
DTC Faults? YES→Step B3↓
NO → Resume Operation→

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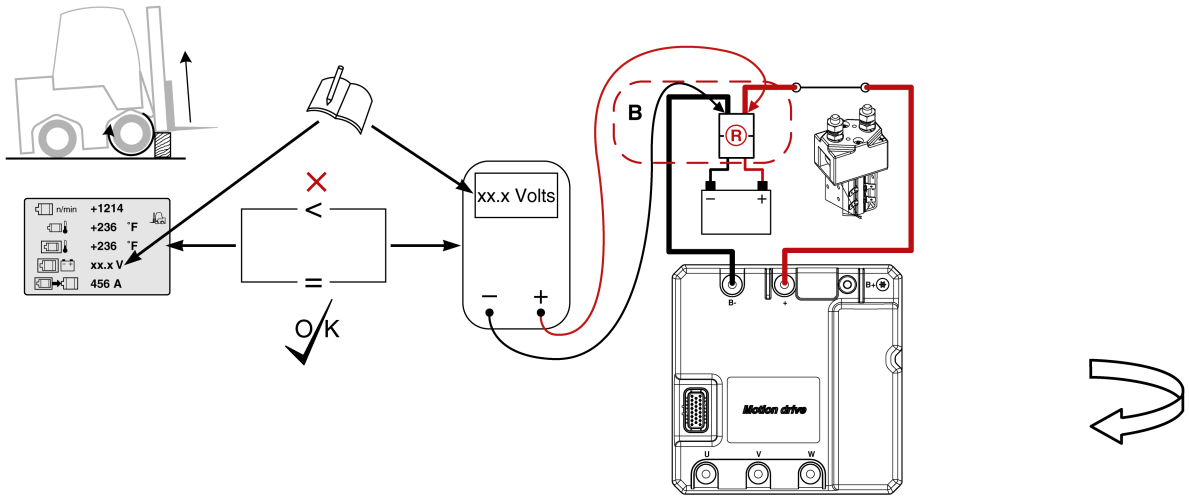
CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP B5 **CHECK VOLTAGE**



1. Connect DMM→Measure Battery Volts at the Connector terminals→ Value↓

2. Operate Traction and Hoist Hydraulics against Relief Valve→ DMM/Display Volts→Compare→Go to 2a↓

2a. Display Volts < DMM Volts < Controller Minimum?→® Connections→Go to 3↓

2b. Display Volts = DMM Volts > Controller Minimum?→Go to 3↓

3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓

4. Recheck Volts↑→Test Truck→
DTC Faults? YES→Step B6↓
NO → Resume Operation→

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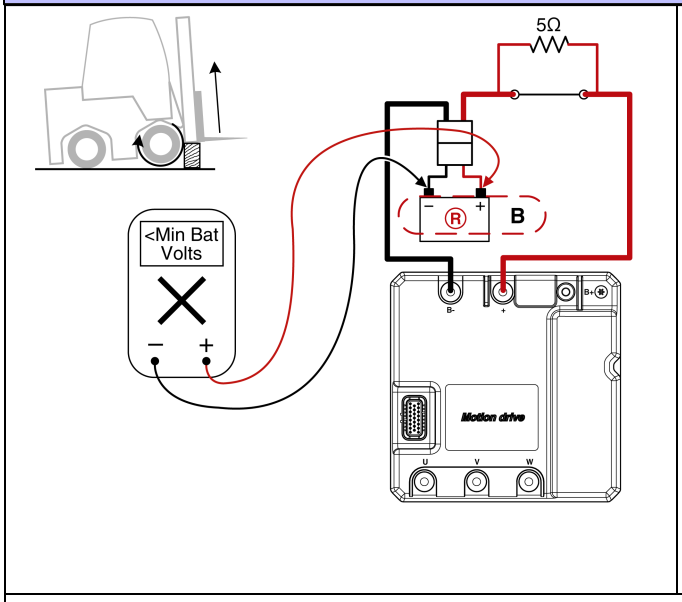
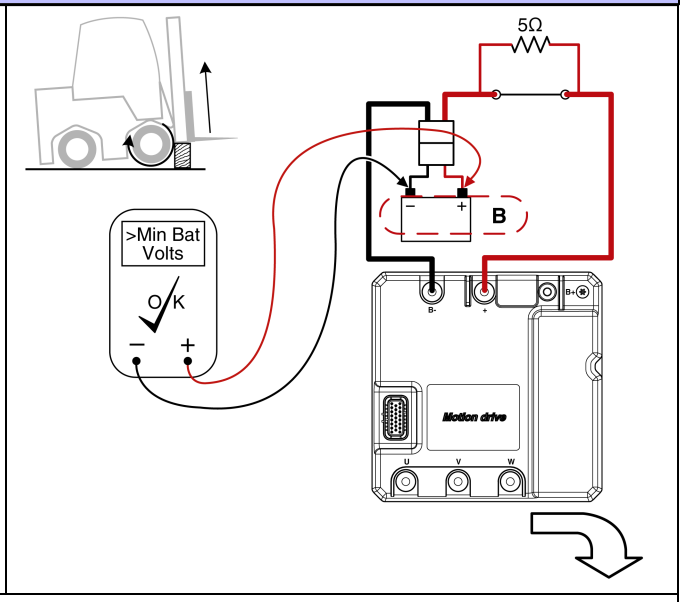
CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP B6 **CHECK VOLTAGE**





1. Connect DMM as shown→Measure Battery Volts at the Battery terminals→ Value↓

2. Operate Truck Traction and Hoist Hydraulics against Relief Valve→ Lowest Battery Voltage→Compare→Go to 3↓

3. Battery Voltage < Controller Minimum?↓

4. YES Battery internal Resistance is too high→Battery Maintenance check/Replace Battery(s)→Go to 6↓

5. NO →Component Operational Check↓

3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓

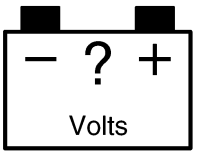
4. Recheck Volts↑→Test Truck→
DTC Faults? YES→Component Operational Check↓
NO → Resume Operation→

CAUSE C

Battery OORL/OORH as measured by the Motor Controllers

NOTE: OOR DTC is set if OOR condition is present for longer than 1 second.

NOTE: Both Motor control and VSM OOR DTCs may appear due to the different thresholds levels



<

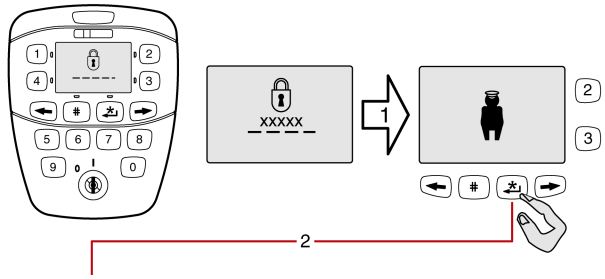
Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜ < OORL	23	30	41	48
˜ > OORH	50	65	99	110

An OORH DTC can occur if the Regen braking setting is too high

CBB/DBB Motor Controller DC Bus Low/High (Cont)

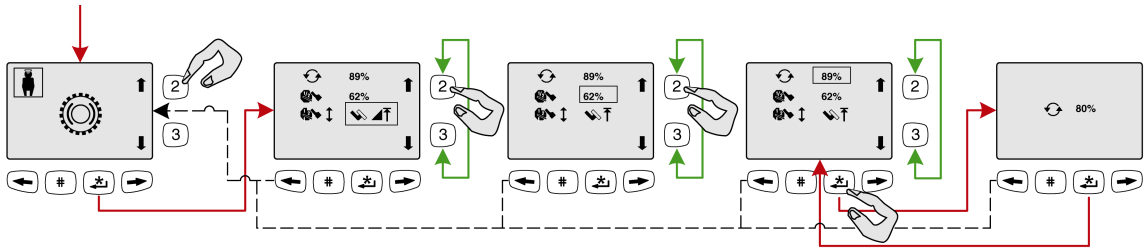
STEP C1

REGEN BRAKE SETTING – must be completed before making adjusted.



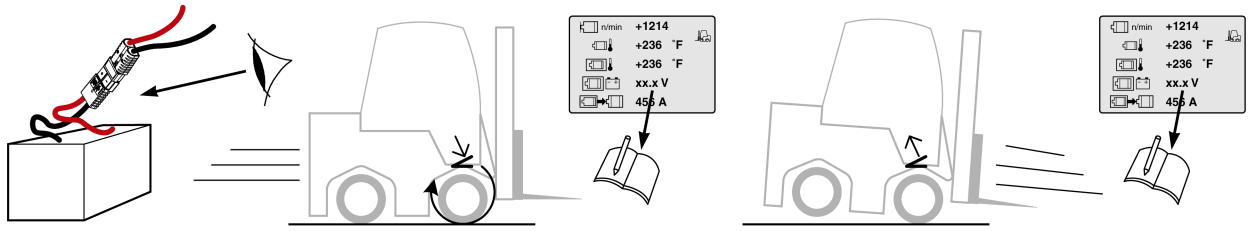
Enter Service Password→ Truck Setup→ ☞*→ Scroll to Braking Setup↑ ↓

Braking Setup



☞*→ Scroll to Regen Function↑ ↓ ☞* To Select→ Enter Lower Value Using Number Buttons ☞*

STEP C2



Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜ < OORL	23	30	41	48
˜ > OORH	50	65	99	110

1. Ensure that the Battery has been fully charged→Check Battery connections are clean and secure.

2 Operate Truck with Maximum Acceleration in Forward Direction→ Maximum Voltage

3. Completely release acceleration pedal→Regen Braking Only→ Maximum Voltage

4. Do Maximum Voltages exceed the OORH thresholds?

5. Yes→Repeat Step C1 until no fault exist.↑NO→Resume Operation

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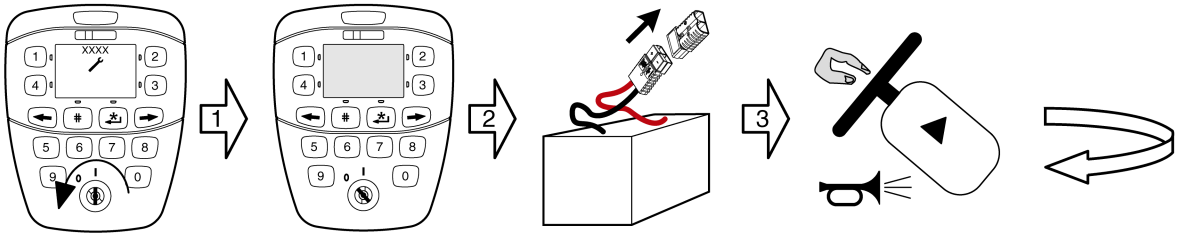
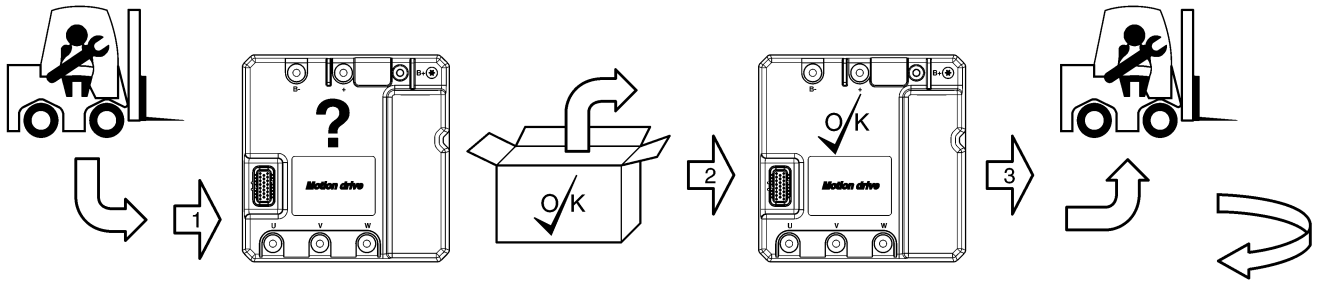
CBB/DBB Motor Controller DC Bus Low/High (Cont)

CAUSE D



Power **OFF**→ Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. ?

STEP D1

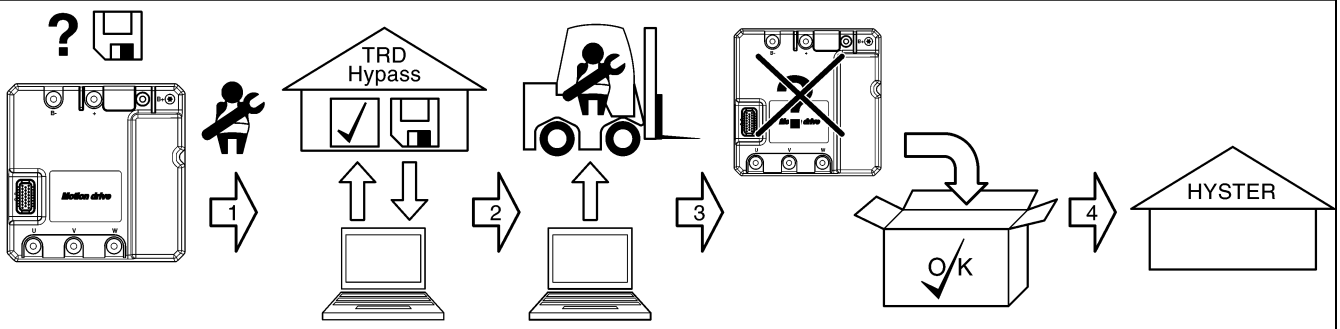


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

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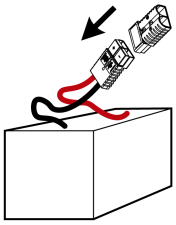
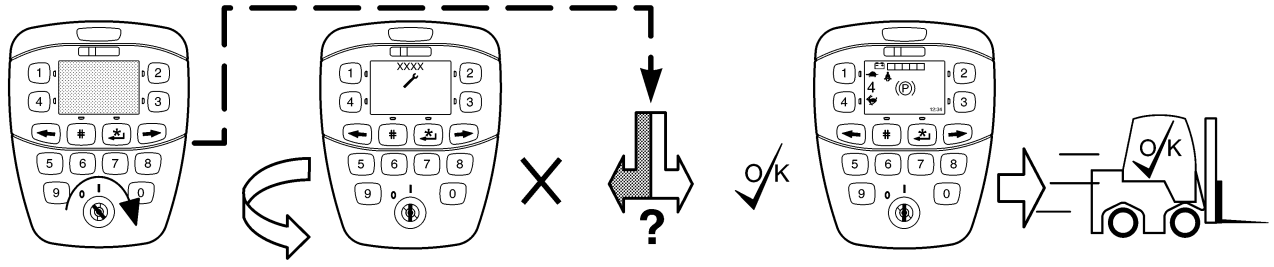
CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP D3

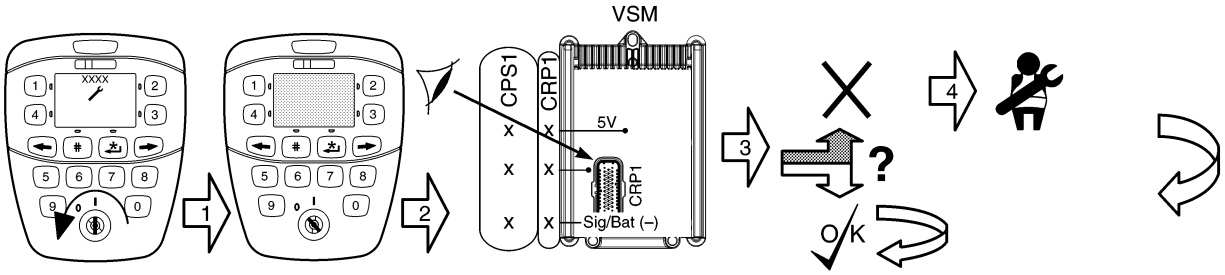




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

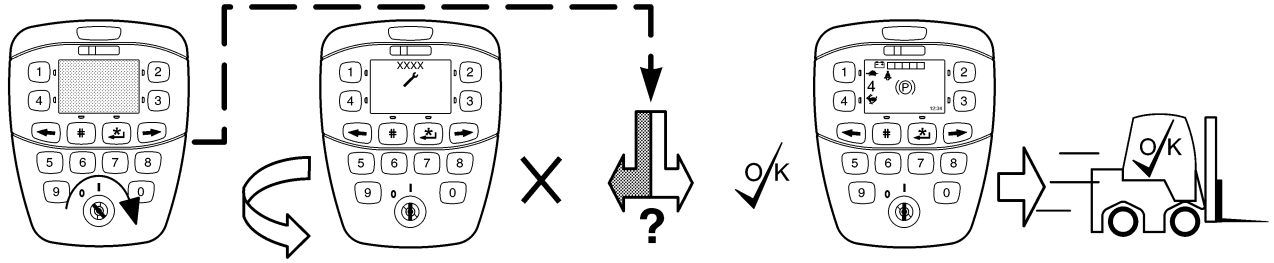
NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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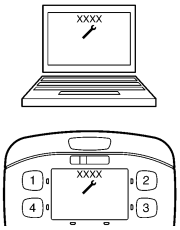
CBB/DBB Traction Controller Driver Current High



Fault Codes

DTC 21520
Aux Driver Current High

DTC 25106
Park Brake Solenoid and Fan Driver Current High

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

It is recommended that the Display or PC Service Tool diagnostics be used as much as possible to determine the potential Motor.

Motor Controller failure before starting as analysis using the CAUSE procedures,

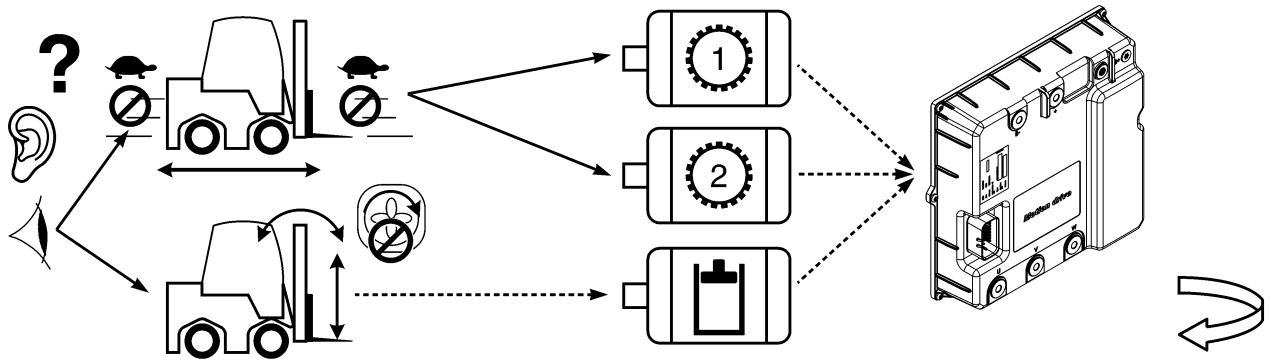
CBB Motor Controller Access requires Battery removal

CBB Auto Brake Access requires Battery removal

DBB Motor Controller Connector Access is very difficult. Use a Break-Out Harness kit

DBB/CBB Motor Controller Component Access requires Battery removal

Check 1



POSSIBLE SYMPTOMS

No/ Reduced Traction - Auto Brake Does not Release/Fan(s) do not Operate at Key **ON**

POSSIBLE CAUSES

DTC 21520	Aux Driver Short to Bat (+)	> 1 amp driver current	→ Component Operational Check ↓
DTC 21520	Brake Coil (DBB)/Fan Short Circuit	> 1 amp driver current	→ Component Operational Check/Component Operational Check↓

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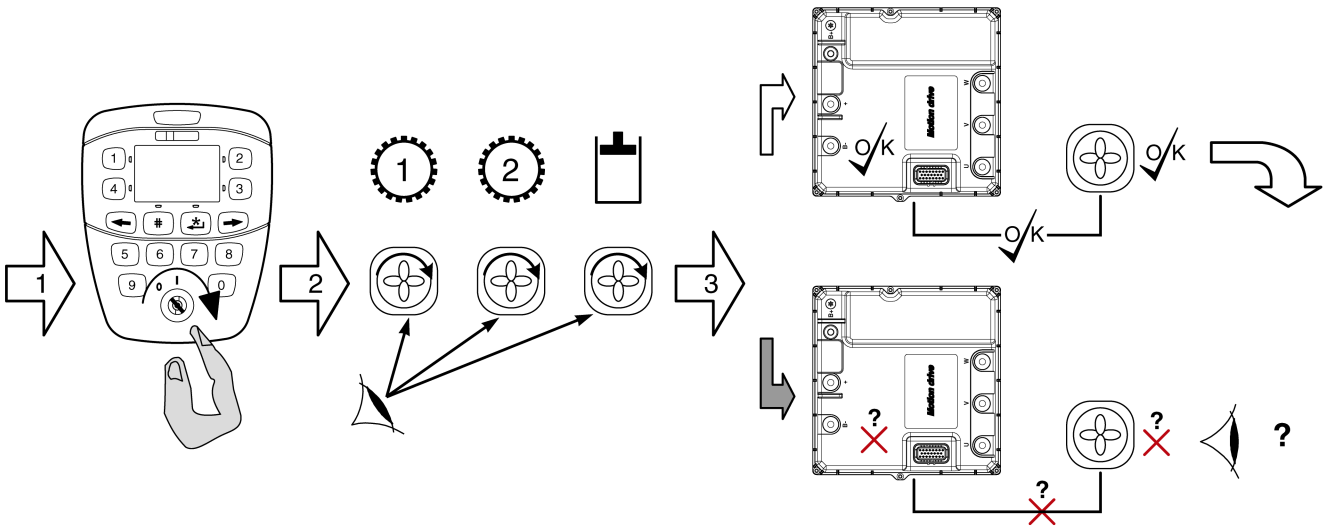
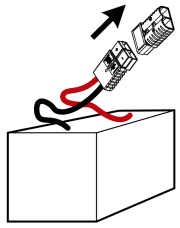
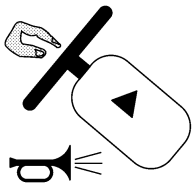
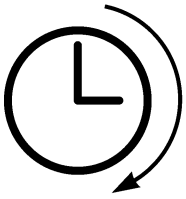
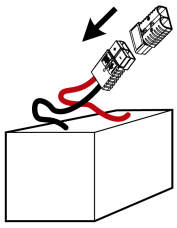
CBB/DBB Traction Controller Driver Current High (Cont)

DTC 25106	Park Brake Coil	> 1 amp driver current	→ Component Operational Check ↓
DTC 25106	Cooling Fan	> 1 amp driver current	→ Component Operational Check ↓
Motor Controller(s) Failure ?→		Driver Failure	→ Component Operational Check ↓
Also see, Observed Symptom - Auto Brake Does not Release/Fan(s) do Not Operate at Key **ON**			
Check 2			
			
Power **ON**→			
YES→ Go to Check 3 → Component Operational Check ↓			
NO→ Observed Symptoms - Fans do Not Operate→ Component Operational Check ↓			
Check 3			
			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

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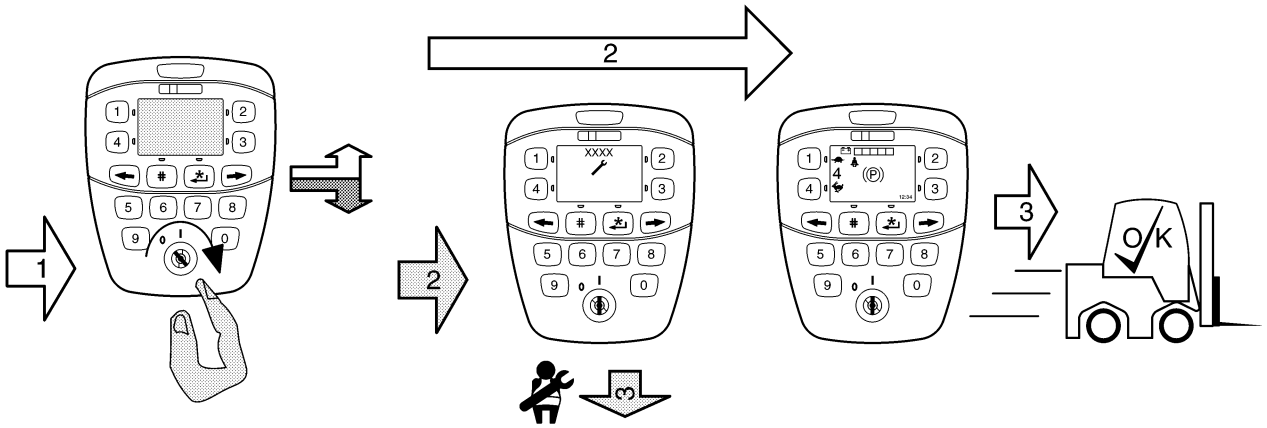
CBB/DBB Traction Controller Driver Current High (Cont)

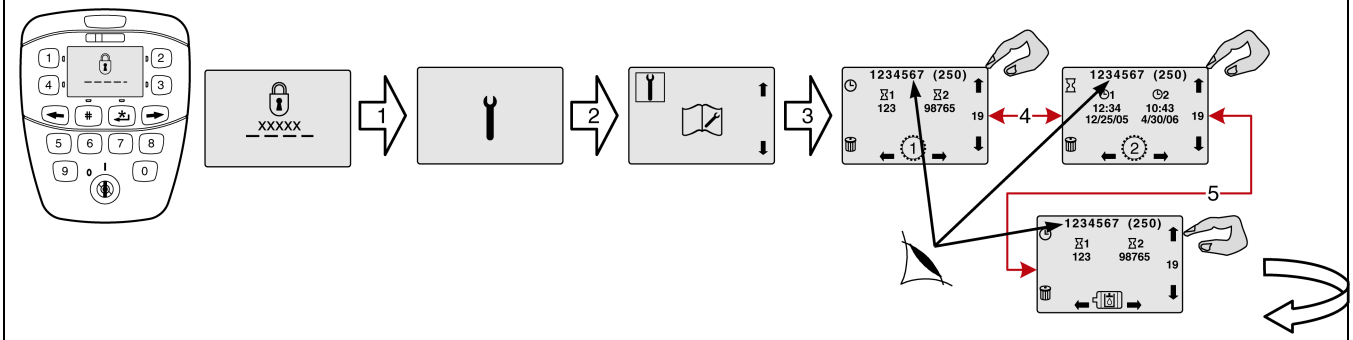
Check 4



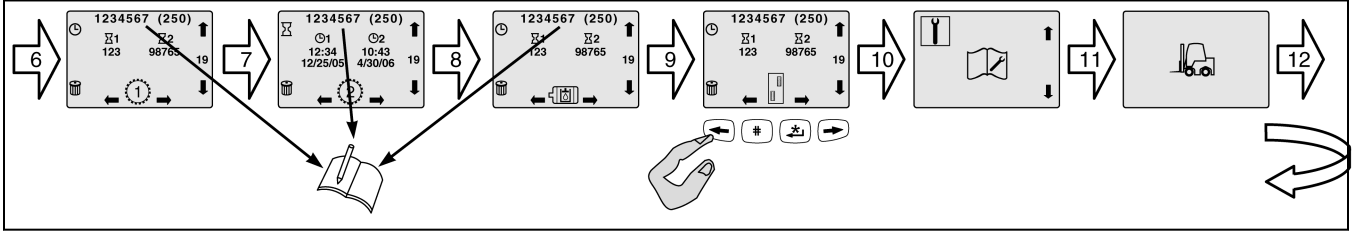
Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

Check 5

FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



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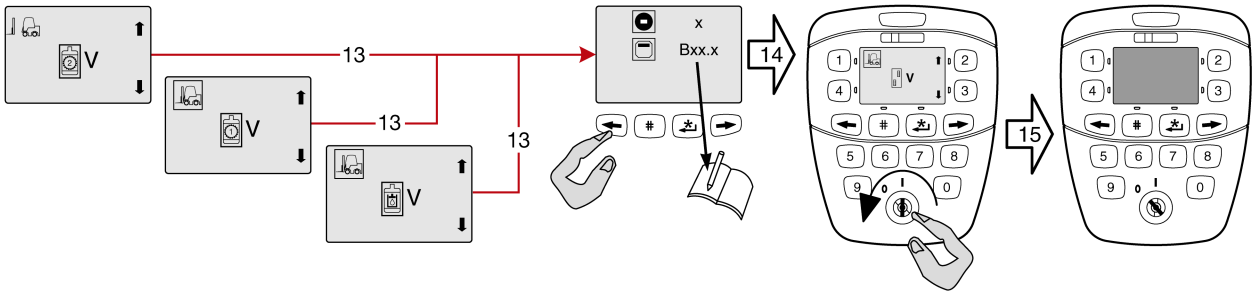
CBB/DBB Traction Controller Driver Current High (Cont)

all Motor DTCs→ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ Exit Versions→ Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

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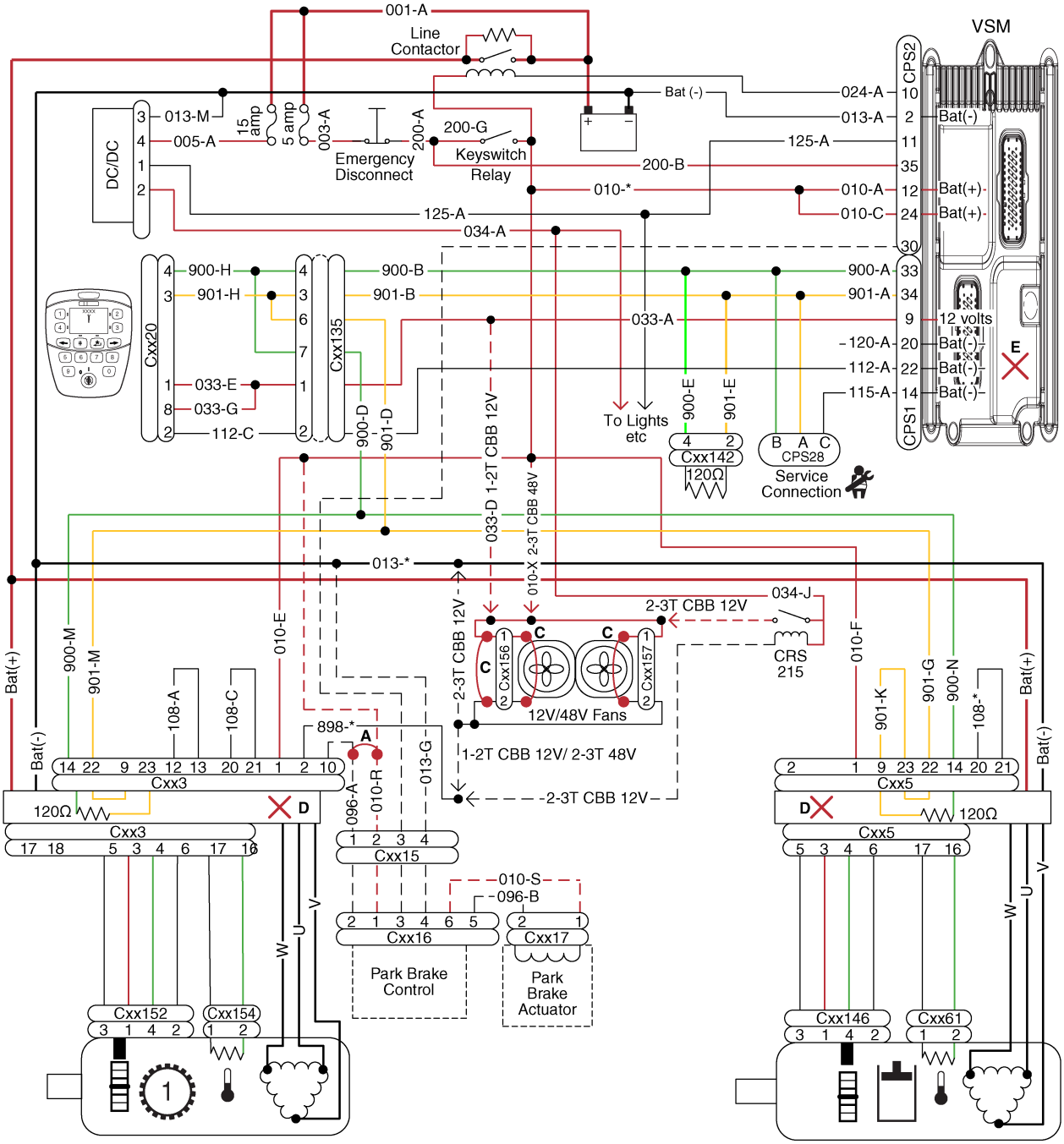
CBB/DBB Traction Controller Driver Current High (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit) = No DTC

1.5 – 2.0 CBB SCHEMATIC CAUSES A B C D E > ?



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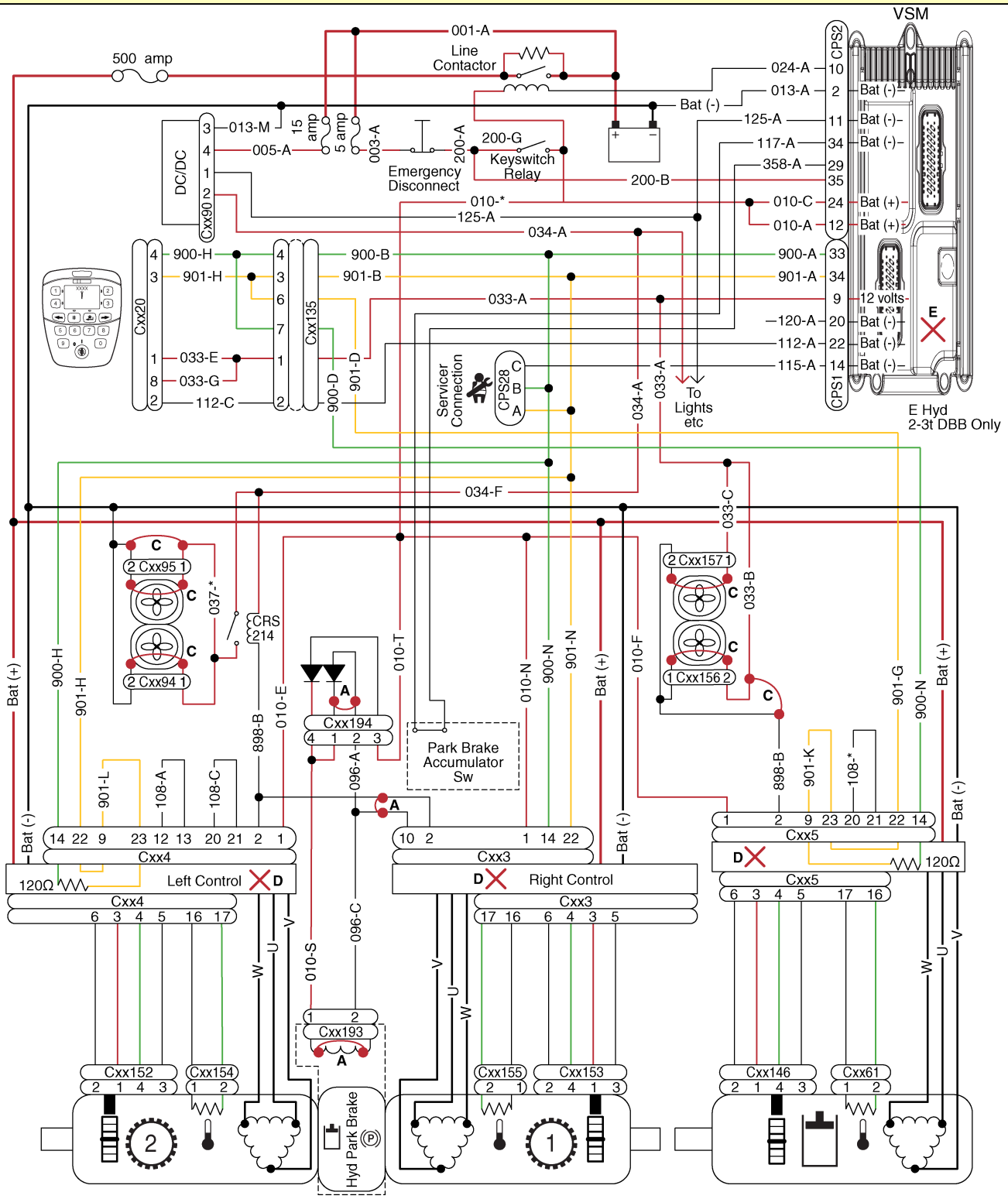
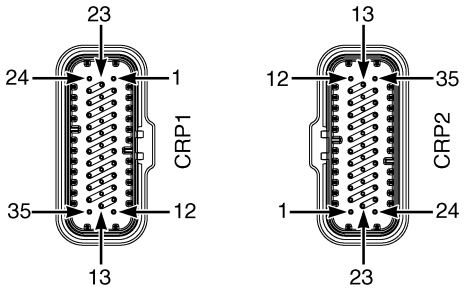
CBB/DBB Traction Controller Driver Current High (Cont)

2.2 – 3.0 DBB SCHEMATIC CAUSES A B C D E > ?

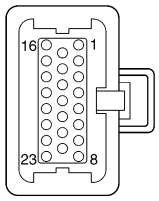


CBB/DBB Traction Controller Driver Current High (Cont)

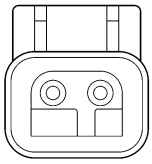
CONNECTORS



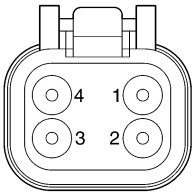
VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5



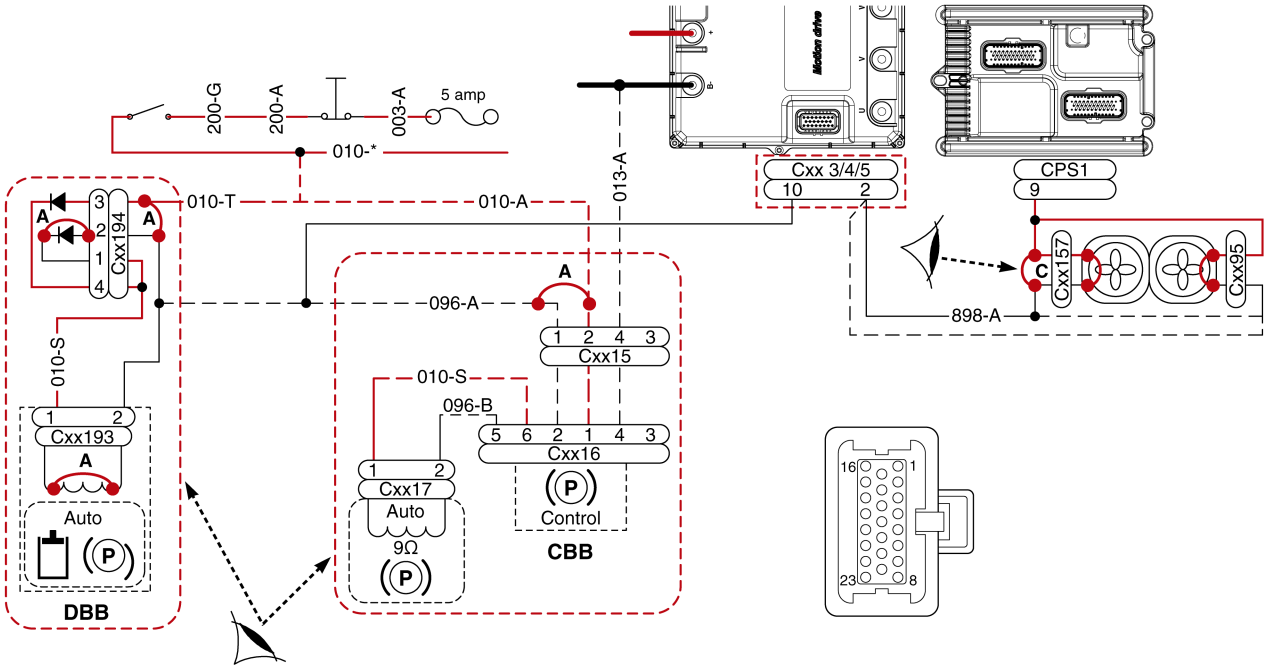
Fan Connector Cxx 94, 95, 156, and 153



Auto Brake Motor Connector Cxx 15, 16, 17, 193, and 194

CAUSE A

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections→



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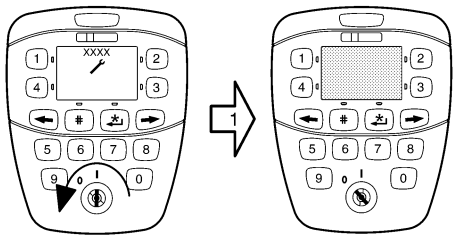
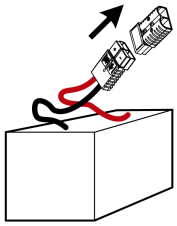
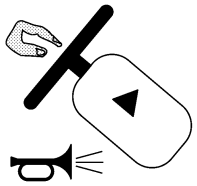
CBB/DBB Traction Controller Driver Current High (Cont)

STEP A1





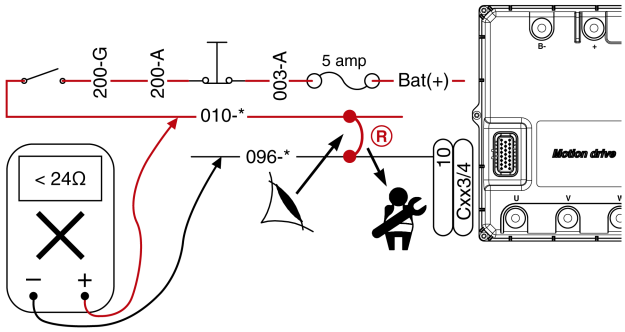


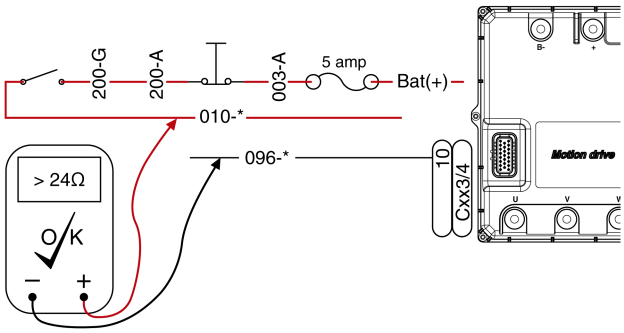
Power **OFF**→

Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

STEP A2 CHECK RESISTANCE - Ω - OHMS

Auto Brake Short Circuit to Bat (+)





1. < 24 ? →Short to Bat (+)→CBB go to 2.↓DBB→Step A3→

1 > 24 ?→OK→Component Operational Check↓

2. Find/Repair Short/Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→

3. Recheck ?↑→ Reconnect→Test OK→YES→Resume OperationNO→Component Operational Check↓

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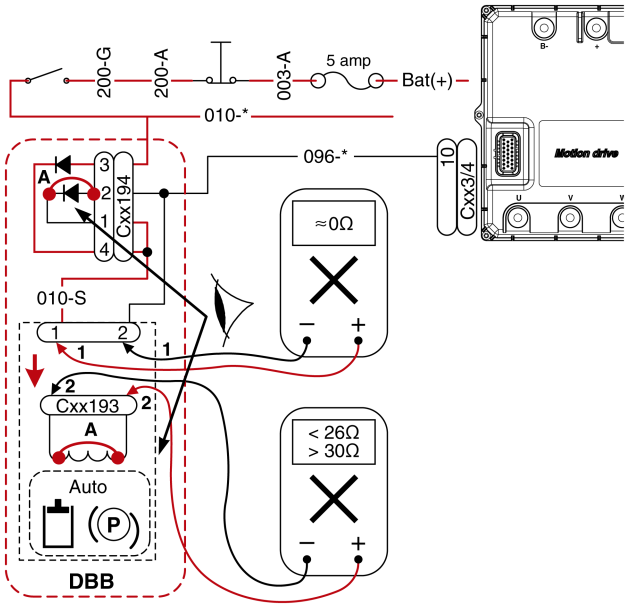
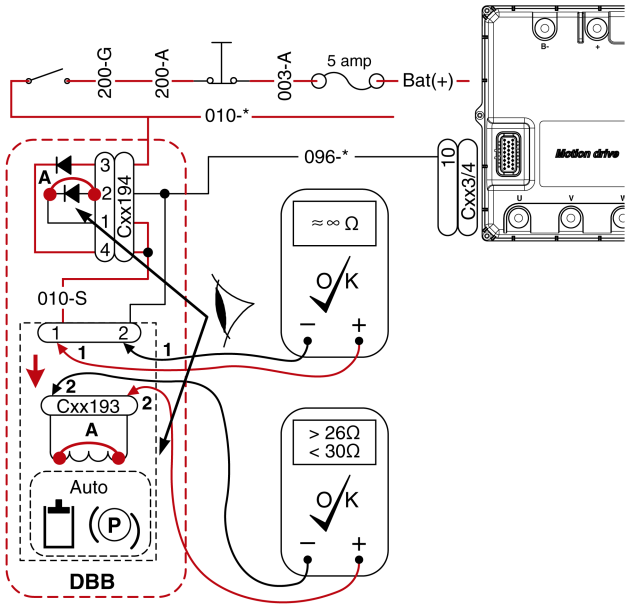
CBB/DBB Traction Controller Driver Current High (Cont)

STEP A3	**CHECK RESISTANCE - Ω - OHMS**
DBB Auto Brake Diode/Coil Short Circuit	
	
Disconnect Coil, Measure ?	
1. 0? = Short Diode→Go to 2↓	1 8? = OK→Go to 2↓
2. < 26? > 30? = Faulty Coil→Go to 4↓	2. > 26? < 30? = OK→Component Operational Check↓
3. Replace Diode Pack. →Go to 5↓	
4. Replace Auto Brake Coil Assy. →Go to 5↓	
5. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 6↓	
5. Recheck ?↑→ Reconnect→Test OK→YES→Resume OperationNO→Component Operational Check↓	
CAUSE B	**CHECK RESISTANCE - Ω - OHMS**
Not Applicable	

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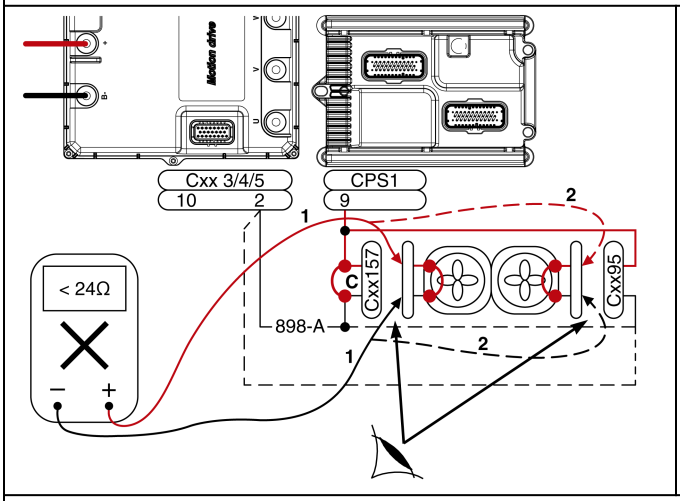
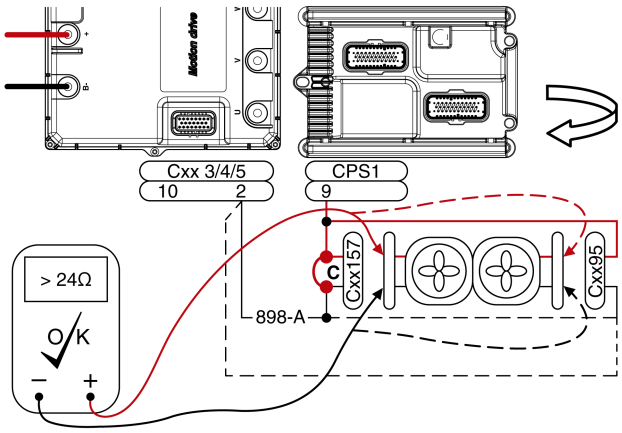
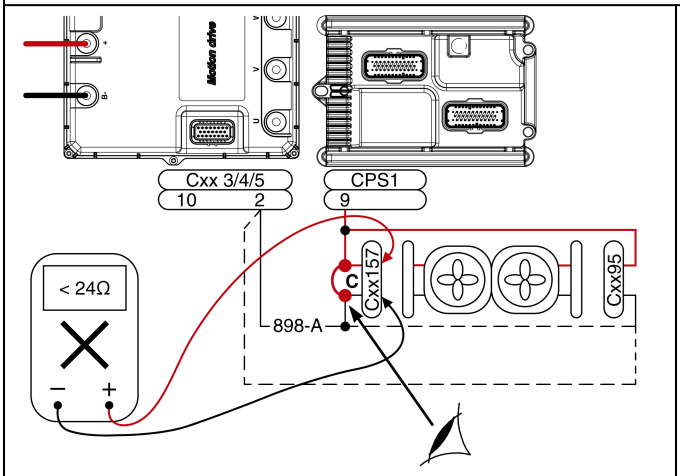
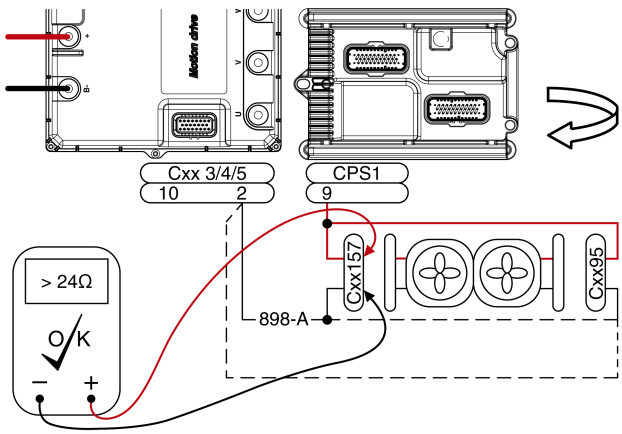
CBB/DBB Traction Controller Driver Current High (Cont)

CAUSE C	**CHECK RESISTANCE - Ω - OHMS**
Fan Short Circuit	
	
Disconnect Fans Measure ?	
1. < 24 ? →Shorted Fan→Go to 2.↓	1. > 24 ?→OK→Go to 2.↓
2. < 24 ? →Shorted Fan→Go to 2.↓	1. > 24 ?→OK→Go to Step C1.↓
2. Replace Fan. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 3↓	
3. Recheck ?↑→ Reconnect→Test OK→YES→Resume OperationNO→Component Operational Check↓	

STEP C1	**CHECK RESISTANCE - Ω - OHMS**
Fan Harness Short Circuit	
	
1. < 24 ? →Shorted Circuit→Go to 3.↓	1. > 24 ?→OK→Go to Component Operational Check.↓
2. Find Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 3↓	
3. Recheck ?↑→ Reconnect→Test OK→YES→Resume OperationNO→Component Operational Check↓	

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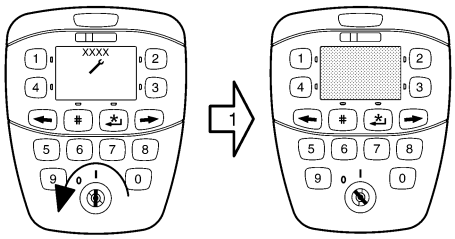
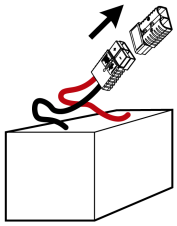
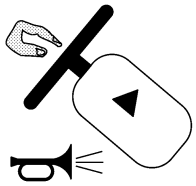
CBB/DBB Traction Controller Driver Current High (Cont)

CAUSE D



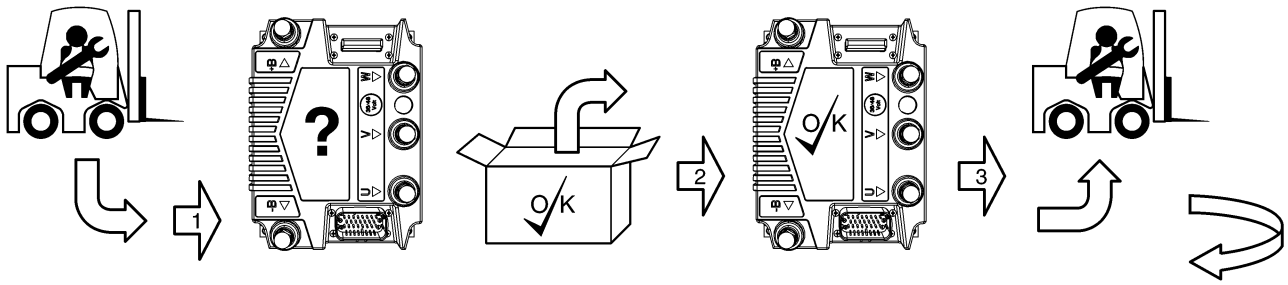




Power **OFF**→

Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

STEP D1

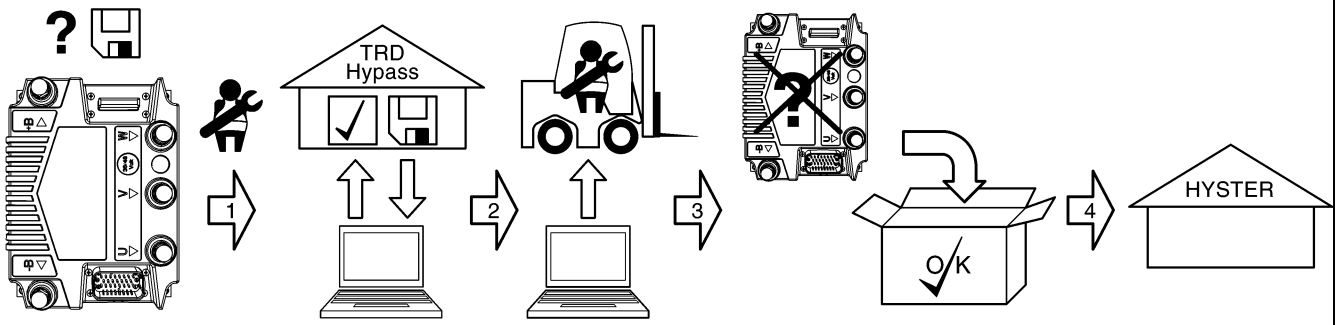


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

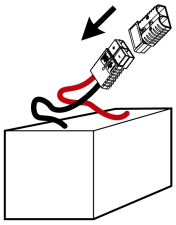
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

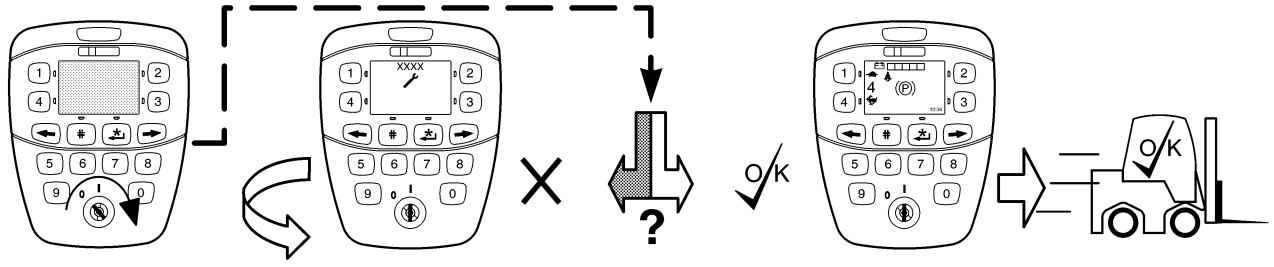
3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

CBB/DBB Traction Controller Driver Current High (Cont)

STEP D3

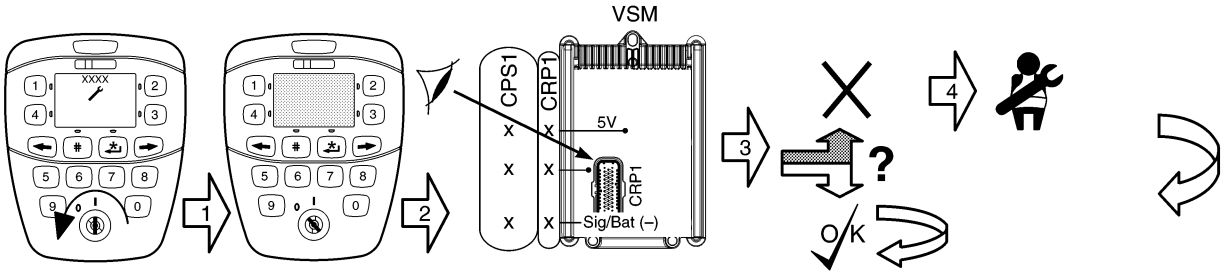




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

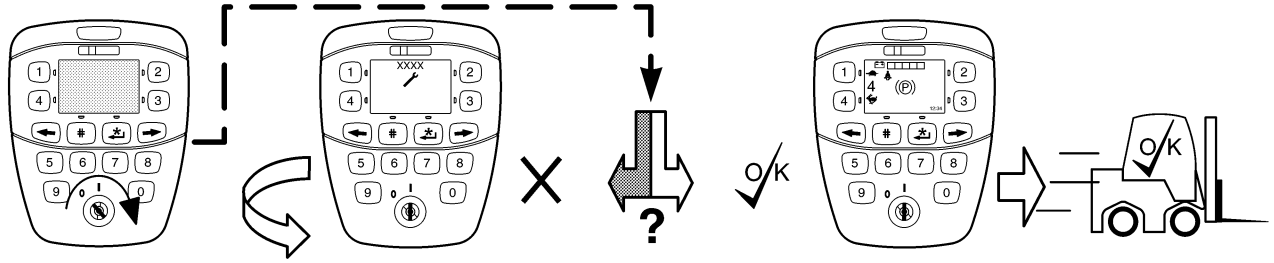
NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

https://truckmanualshub.com/

DTC 8992
Synchronous Steering Coil Current

POSSIBLE CAUSE

A. STEERING COIL WIRING FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEERING COIL WIRING FAULT

PROCEDURE OR ACTION:

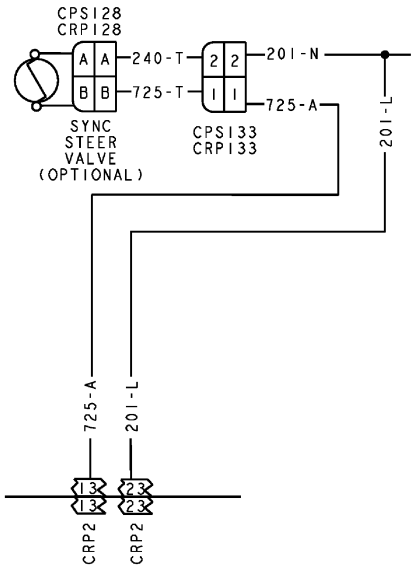
1. Inspect for short to B(+) between coil and VSM.
   Is short to power detected?
   YES: Repair short, clear code and retest system.
   NO: Replace faulty coil.

END POSSIBLE CAUSES

https://truckmanualshub.com/

DTC 8992 (Cont)
Synchronous Steering Coil Current

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 13344
Synch Steering Coil Open Circuit

POSSIBLE CAUSE

A. ACC WIRING FAULT

B. COIL FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - ACC WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect for short to B(+) between coil and VSM.
   Is short to power detected?
   YES: Repair short, clear code and retest system.
   NO: Disconnect battery and proceed to Cause B.

CAUSE B - COIL FAULT

PROCEDURE OR ACTION:

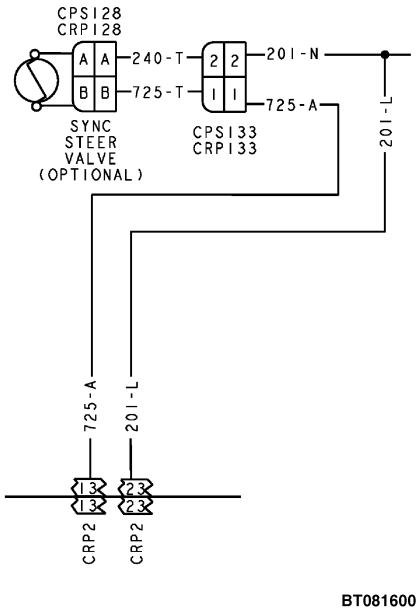
1. Disconnect suspected coil and measure resistance across coil terminals.
   Is resistance between 20 +/- 5 ohms?
   YES: Suspect faulty VSM.
   NO: Replace faulty coil.

END POSSIBLE CAUSES

https://truckmanualshub.com/

DTC 13344 (Cont)
Synch Steering Coil Open Circuit

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 9012
ACC 2 Current OORH

POSSIBLE CAUSE

A. ACC WIRING FAULT

B. COIL FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - ACC WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect for short to B(+) between coil and VSM.
   Is short to power detected?
   YES: Repair short, clear code and retest system.
   NO: Disconnect battery and proceed to Cause B.

CAUSE B - COIL FAULT

PROCEDURE OR ACTION:

1. Disconnect suspected coil and measure resistance across coil terminals.
   Is resistance between 20 +/- 5 ohms?
   YES: Suspect faulty VSM.
   NO: Replace faulty coil.

END POSSIBLE CAUSES

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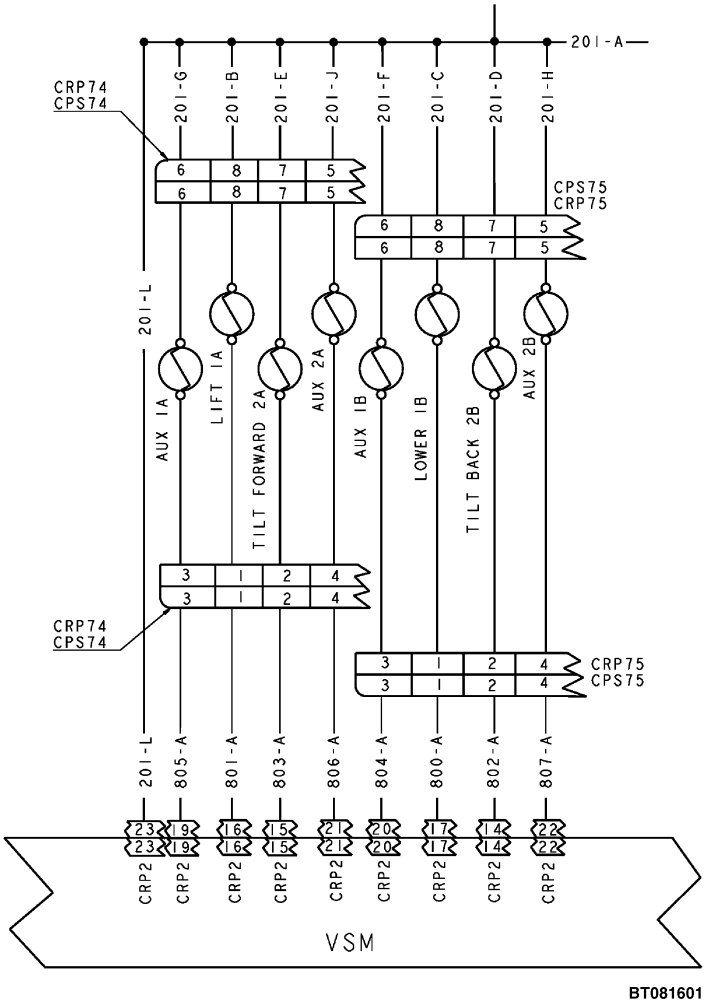
DTC 9012 (Cont)
ACC 2 Current OORH

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65288
Loss of Communication Between the Primary and Secondary Controller

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65293
EEPROM Checksum Failure

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

https://truckmanualshub.com/

DTC 95520
Key Switch Voltage OORL

POSSIBLE CAUSE

A. KEY INPUT WIRING FAULT

B. KEY SWITCH RELAY FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - KEY INPUT WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the steer motor controller connector CPS6 and measure voltage between socket 15 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Cause C.
   NO: Remove key switch relay 1 and proceed to Cause B.

CAUSE B - KEY SWITCH RELAY FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the key switch relay 1, socket 86 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect coil input circuit 513A for open or short. Inspect connector CPS135 for loose, damaged, or corroded terminals. Verify key switch operation by measuring continuity between the display connector CPS20, socket 5 and socket 1 while operating switch.
2. Measure voltage between the key switch relay 1, socket 86 and socket 85.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect relay ground circuit 013K and 013A for open or short. Inspect VSM connector CPS2 for loose, damaged, or corroded terminals.
3. Measure voltage between the key switch relay 1, socket 87 and B(-).

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DTC 95520 (Cont)
Key Switch Voltage OORL

Is voltage 12 ± 1.5 Vdc?
YES: Inspect key voltage input circuit 010A for open, short, or source of excessive resistance.
NO: Inspect relay switch input circuit 200K and 200M for open or short. Inspect connectors CRPS52-55, CRP52 for loose, damaged, or corroded terminals. Verify E-stop switch functionality by measuring continuity while operating switch.

CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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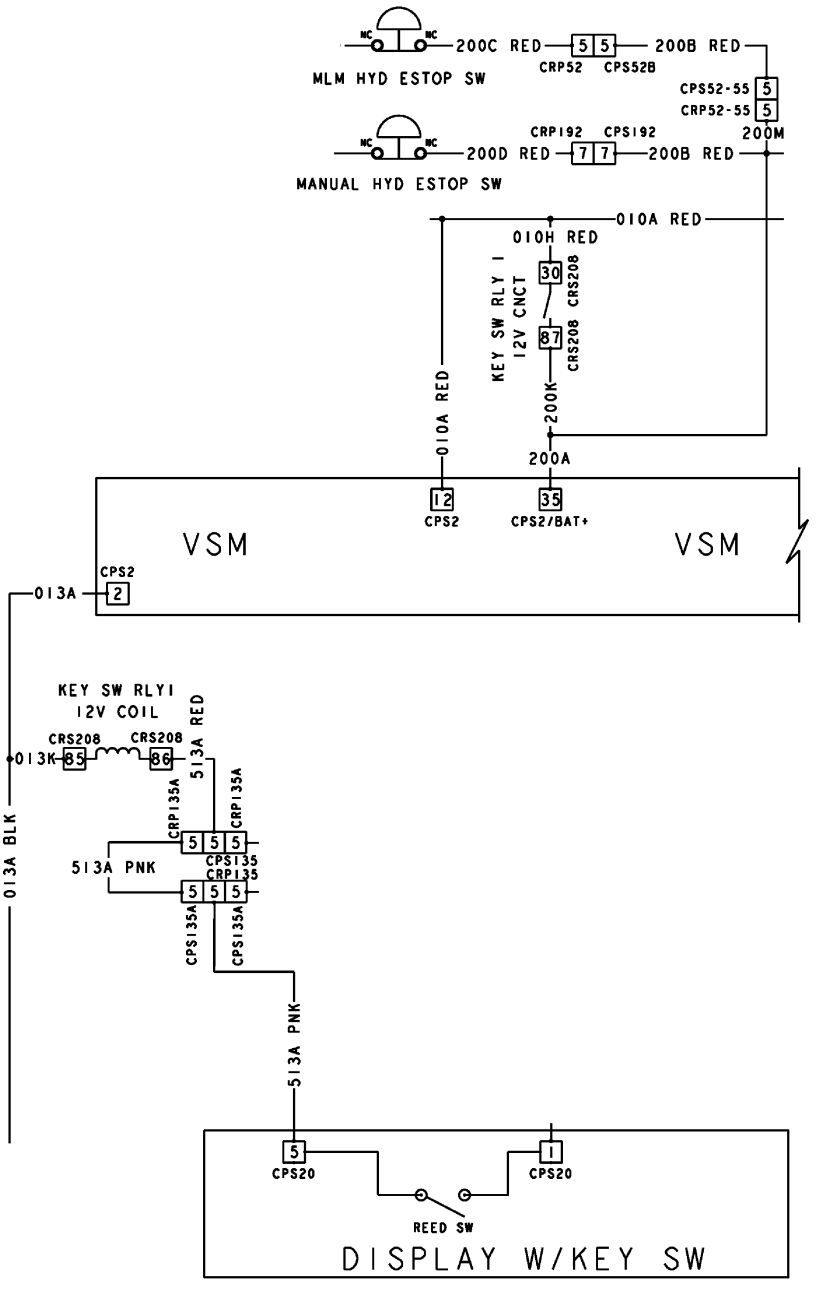
DTC 95520 (Cont)
Key Switch Voltage OORL

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65296
Motor U-W Phase Voltage Measurement Fault

POSSIBLE CAUSE

A. PHASE CABLE FAULT

B. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect individual phase cables from controller and motor. Measure resistance of individual cables.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Cause B.
   NO: Replace faulty phase cable.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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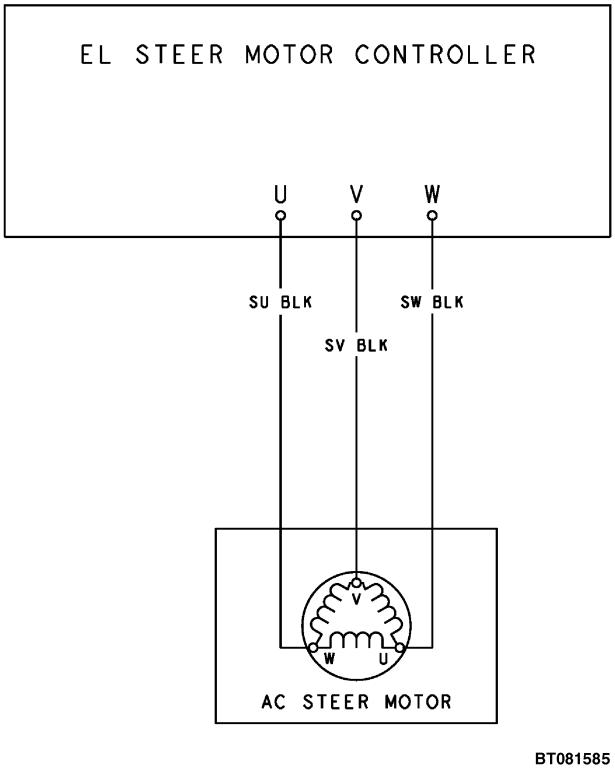
DTC 65296 (Cont)
Motor U-W Phase Voltage Measurement Fault

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65297
Motor U-V Phase Voltage Measurement Fault

POSSIBLE CAUSE

A. PHASE CABLE FAULT

B. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect individual phase cables from controller and motor. Measure resistance of individual cables.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Cause B.
   NO: Replace faulty phase cable.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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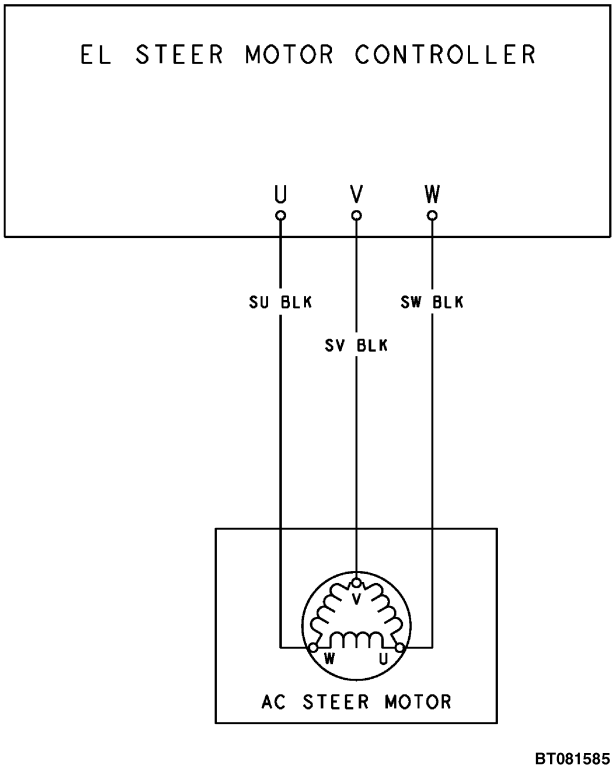
DTC 65297 (Cont)
Motor U-V Phase Voltage Measurement Fault

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65352
Motor W-V Phase Voltage Measurement Fault

POSSIBLE CAUSE

A. PHASE CABLE FAULT

B. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect individual phase cables from controller and motor. Measure resistance of individual cables.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Cause B.
   NO: Replace faulty phase cable.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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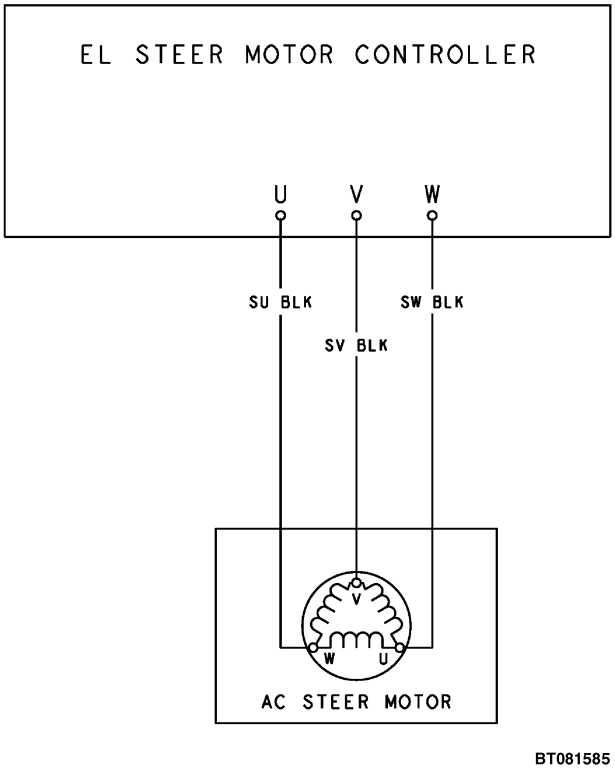
DTC 65352 (Cont)
Motor W-V Phase Voltage Measurement Fault

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65312
Motor Phase Voltage Out of Range

POSSIBLE CAUSE

A. PHASE CABLE FAULT

B. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect individual phase cables from controller and motor. Measure resistance of individual cables.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Cause B.
   NO: Replace faulty phase cable.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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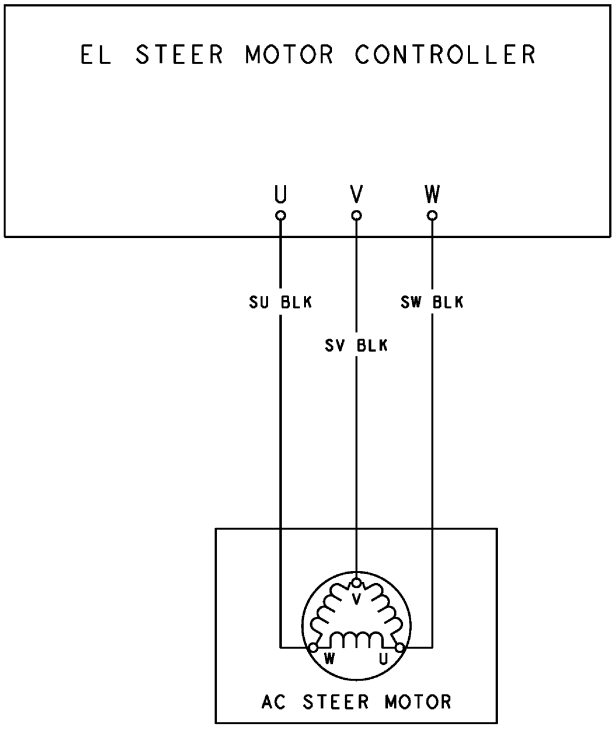
DTC 65312 (Cont)
Motor Phase Voltage Out of Range

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65333
Standby Current Too High

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

https://truckmanualshub.com/

DTC 65340
DC Bus Capacitor Charge Timeout

DC Bus voltage does not rise above 14 volts in 3.2 seconds after key ON

POSSIBLE CAUSE

A. CONTROLLER WIRING FAULT
B. CONTACTOR PTC RESISTOR FAULT
C. FAULTY FUSE
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CONTROLLER WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect power connection at appropriate controller.
   Is connection loose or damaged?
   YES: Repair connection, clear DTC, and retest system.
   NO: If only E-Steer controller is reporting DTC, proceed to Cause D, if more than one controller is reporting fault, proceed to Cause B.

CAUSE B - CONTACTOR PTC RESISTOR FAULT

PROCEDURE OR ACTION:

1. Disconnect PTC resistor and measure resistance.
   Is resistance between 5 +/- 0.5 ohms?
   YES: Proceed to Cause C.
   NO: Replace PTC resistor, clear DTC, and retest system.

CAUSE C - FAULTY FUSE

PROCEDURE OR ACTION:

1. Inspect appropriate fuse:
   - FU1-10A

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DTC 65340 (Cont)
DC Bus Capacitor Charge Timeout

- FU2-10A
- FU3-10A
- FU4-5A

Is fuse blown?
YES: Inspect circuit for source of short and repair if necessary. Replace fuse, clear DTC, and retest system.
NO: Proceed to Cause D.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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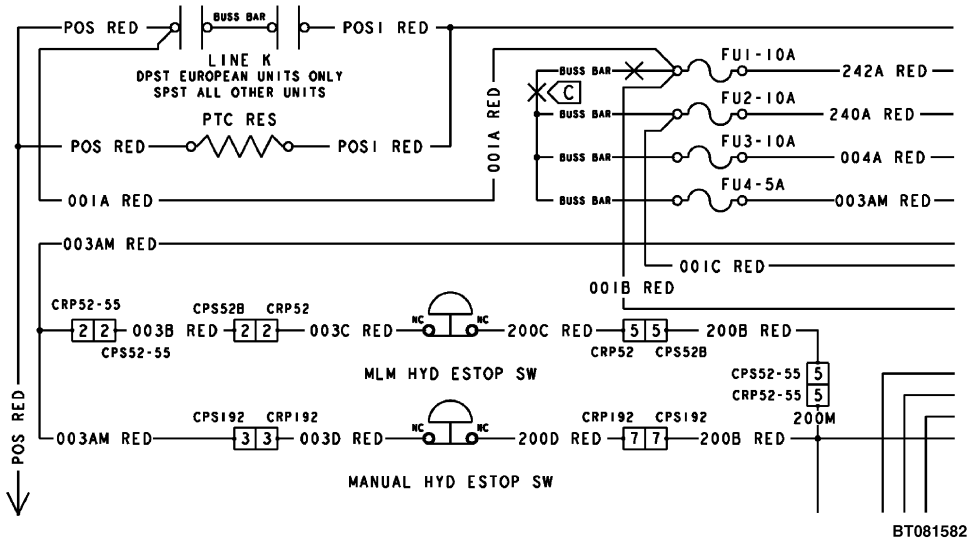
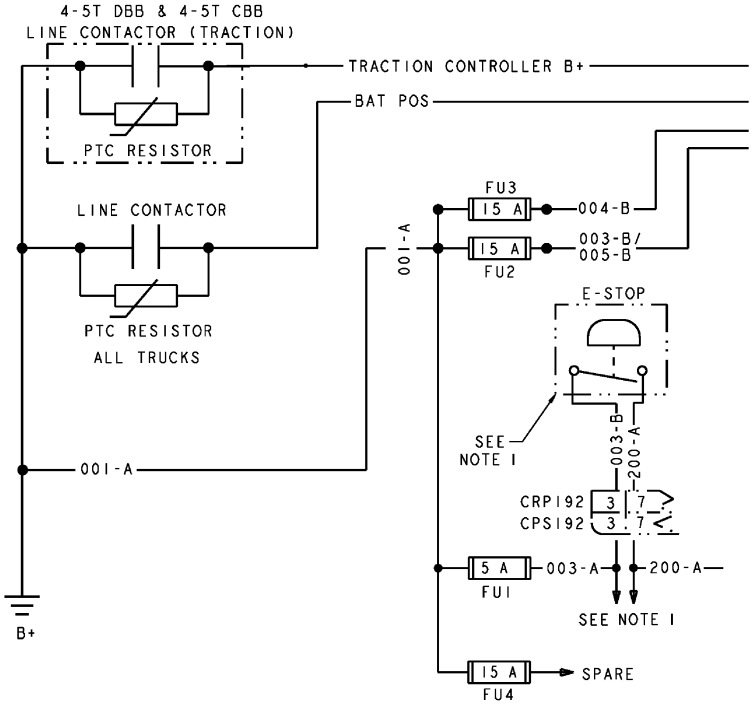
DTC 65340 (Cont)
DC Bus Capacitor Charge Timeout

DIAGRAMS





Troubleshooting Scenes

END FAULT

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DTC 65341
Controller Temperature Above Limit

POSSIBLE CAUSE

A. CONTROLLER OVER TEMP

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CONTROLLER OVER TEMP

PROCEDURE OR ACTION:

1. Verify actual controller or ambient temperatures are above 8080°C (176°F).
   Is controller temperature out of range?
   YES: Allow controller to cool within acceptable temperatures, clear DTC and resume operation.
   NO: Proceed to Cause B.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65345
Motor Temperature Above Limit

Motor temperatures above 120°C (248°F)

POSSIBLE CAUSE

A. MOTOR OVER TEMPERATURE
B. TEMP SENSOR WIRING FAULT
C. TEMP SENSOR FAULT
D. MOTOR FAULT
E. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - MOTOR OVER TEMPERATURE

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify steer motor serial data and then measure actual motor temperatures. Over temp conditions are above 120°C (248°F).
   Is motor temperature out of range?
   YES: Allow motor to cool within acceptable temperatures, clear DTC and resume operation. If motor continues to overheat, proceed to Cause D.
   NO: Disconnect battery and proceed to Cause B.

CAUSE B - TEMP SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect temperature sensor connectors from motor and controller and inspect pins and sockets.
   Is connector damage evident?
   YES: Repair connector, clear DTC and retest system.
   NO: Proceed to .
2. Measure resistance between the following:
   - Controller temp sensor connector, socket 6 and the motor temp sensor connector, socket 1.
   - Controller temp sensor connector, socket 7 and motor temp sensor connector, socket 2.

   Is resistance <1 ohm?

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DTC 65345 (Cont)
Motor Temperature Above Limit

YES: Proceed to Cause C.
NO: Inspect appropriate temp sensor circuit for open or source of excessive resistance.

CAUSE C - TEMP SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the temp sensor connector, pin 1 and pin 2. Refer to temp sensor specification chart.
   Is resistance within specifications?
   YES: Proceed to Cause E.
   NO: Replace faulty temp sensor.

CAUSE D - MOTOR FAULT

PROCEDURE OR ACTION:

1. Replace faulty motor.

CAUSE E - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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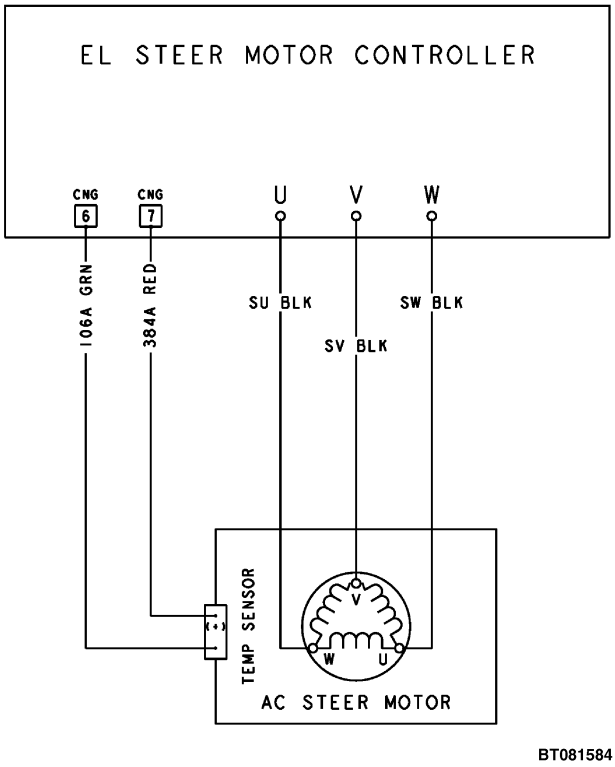
DTC 65345 (Cont)
Motor Temperature Above Limit

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 65350
Controller Internal Error

Hardware circuit limits maximum current.

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65487
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65488
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65490
Primary and Secondary Controller Version Mismatch

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65492
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65493
Default Parameter Restore

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65495
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65496
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65501
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65505
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65517
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65525
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65530
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65533
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65498
Controller Software Mismatch

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65489
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65350
Motor Phase W Current OORL

POSSIBLE CAUSE

A. STEER MOTOR PHASE CABLE FAULT

B. STEER MOTOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to Cause B.
   NO: Repair or replace faulty phase cable.

CAUSE B - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty phase cable.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty phase cable.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383?
   YES: Proceed to Cause C.
   NO: Repair or replace faulty phase cable.

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DTC 65350 (Cont)
Motor Phase W Current OORL

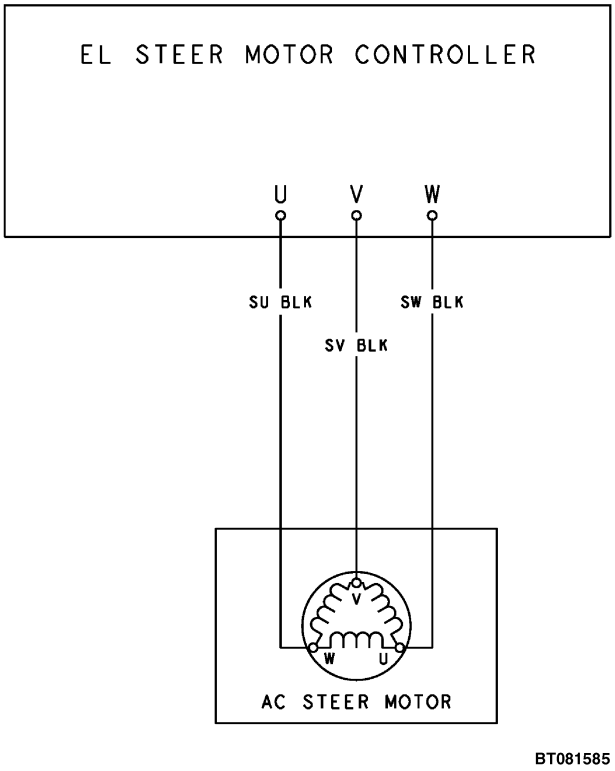
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scene

END FAULT

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DTC 65351
Motor Phase V Current OORL

POSSIBLE CAUSE

A. STEER MOTOR PHASE CABLE FAULT

B. STEER MOTOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to Cause B.
   NO: Repair or replace faulty phase cable.

CAUSE B - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty phase cable.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty phase cable.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383?
   YES: Proceed to Cause C.
   NO: Repair or replace faulty phase cable.

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DTC 65351 (Cont)
Motor Phase V Current OORL

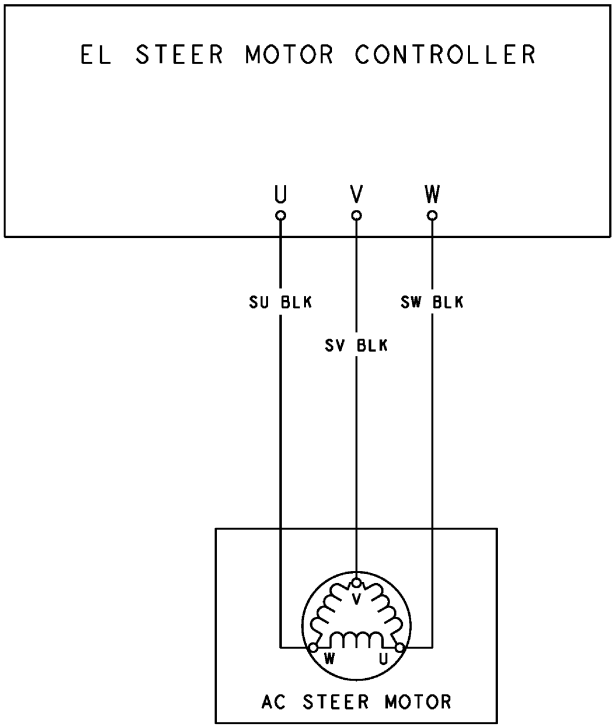
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



BT081585

Troubleshooting Scenes

END FAULT

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DTC 65353
Motor Phase U Current OORL

POSSIBLE CAUSE

A. STEER MOTOR PHASE CABLE FAULT

B. STEER MOTOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to Cause B.
   NO: Repair or replace faulty phase cable.

CAUSE B - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty phase cable.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty phase cable.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383?
   YES: Proceed to Cause C.
   NO: Repair or replace faulty phase cable.

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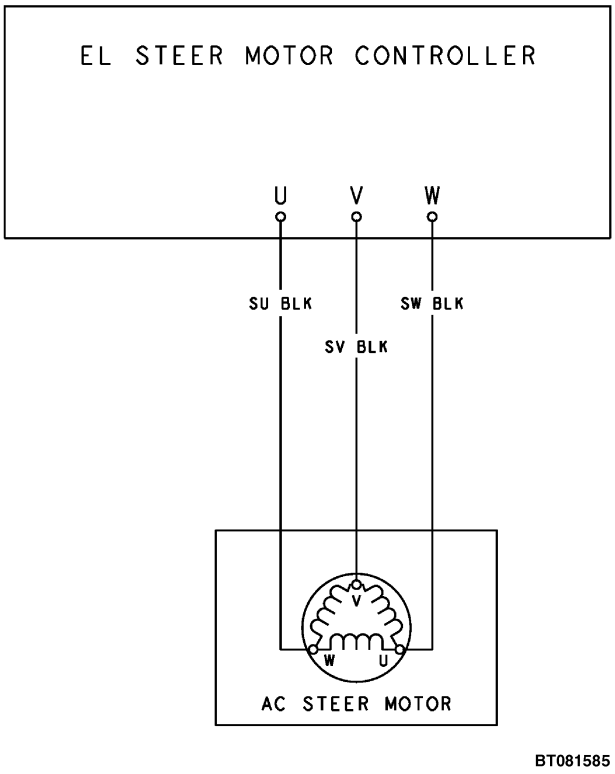
DTC 65353 (Cont)
Motor Phase U Current OORL

CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES



END FAULT

https://truckmanualshub.com/

DTC 65531
Controller Initialization Test Failed

POSSIBLE CAUSE

A. STEER MOTOR PHASE CABLE FAULT

B. STEER MOTOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to Cause B.
   NO: Repair or replace faulty phase cable.

CAUSE B - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty phase cable.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty phase cable.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383?
   YES: Proceed to Cause C.
   NO: Repair or replace faulty phase cable.

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DTC 65531 (Cont)
Controller Initialization Test Failed

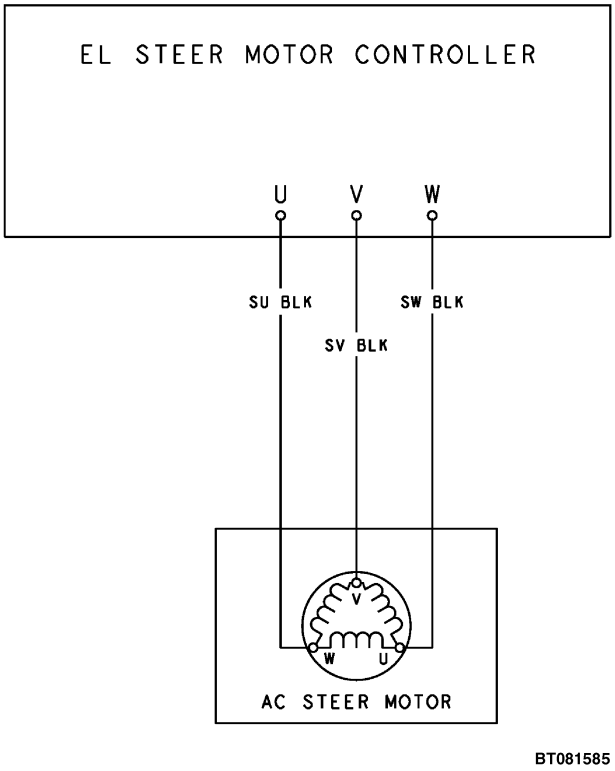
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



BT081585

Troubleshooting Scenes

END FAULT

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DTC 65494
Rapid Change in Steering Wheel Position

POSSIBLE CAUSE

A. STEER SENSOR WIRING FAULT

B. STEER SENSOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect steer sensor connector CPS78 and steer motor controller CPS6. Measure resistance between the following:
   - CPS78, socket 2 and CPS6, socket 19
   - CPS78, socket 3 and CPS6, socket 17
   - CPS78, socket 4 and CPS6, socket 20
   - CPS78, socket 1 and CPS6, socket 21

   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect appropriate circuit for open or source of excessive resistance. Inspect connector CPS132 for damage.

CAUSE B - STEER SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, observe steer sensor output signals.
   Does sensor output signal match Figure 1?
   YES: Proceed to Cause C.
   NO: Replace faulty steer sensor.

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DTC 65494 (Cont)
Rapid Change in Steering Wheel Position

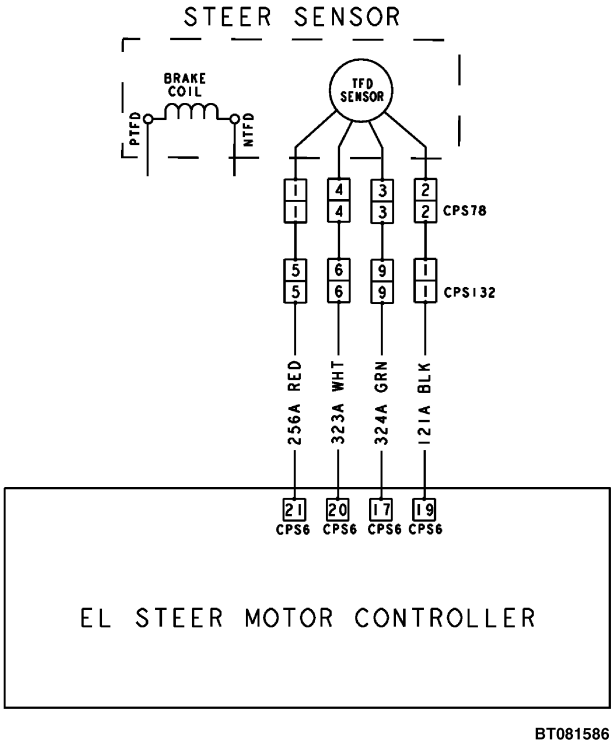
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 65528
Steer Wheel Sensor Output Mismatch

POSSIBLE CAUSE

A. STEER SENSOR WIRING FAULT

B. STEER SENSOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect steer sensor connector CPS78 and steer motor controller CPS6. Measure resistance between the following:
   - CPS78, socket 2 and CPS6, socket 19
   - CPS78, socket 3 and CPS6, socket 17
   - CPS78, socket 4 and CPS6, socket 20
   - CPS78, socket 1 and CPS6, socket 21

   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect appropriate circuit for open or source of excessive resistance. Inspect connector CPS132 for damage.

CAUSE B - STEER SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, observe steer sensor output signals.
   Does sensor output signal match Figure 1?
   YES: Proceed to Cause C.
   NO: Replace faulty steer sensor.

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DTC 65528 (Cont)
Steer Wheel Sensor Output Mismatch

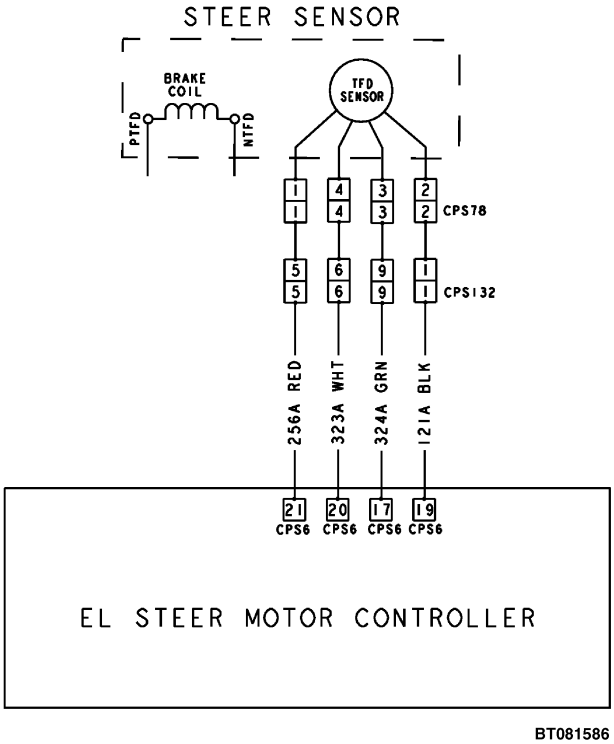
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 65378
Steering Wheel Position Error

POSSIBLE CAUSE

A. STEER SENSOR WIRING FAULT

B. STEER SENSOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect steer sensor connector CPS78 and steer motor controller CPS6. Measure resistance between the following:
   - CPS78, socket 2 and CPS6, socket 19
   - CPS78, socket 3 and CPS6, socket 17
   - CPS78, socket 4 and CPS6, socket 20
   - CPS78, socket 1 and CPS6, socket 21

   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect appropriate circuit for open or source of excessive resistance. Inspect connector CPS132 for damage.

CAUSE B - STEER SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, observe steer sensor output signals.
   Does sensor output signal match Figure 1?
   YES: Proceed to Cause C.
   NO: Replace faulty steer sensor.

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DTC 65378 (Cont)
Steering Wheel Position Error

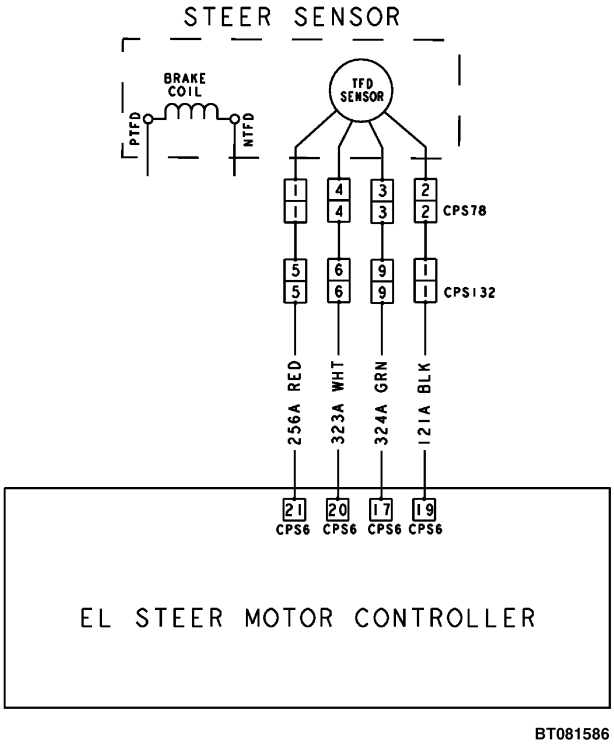
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 65491
TFD Current within Range but Lower than Expected

POSSIBLE CAUSE

A. TFD WIRING FAULT

B. TFD COIL FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - TFD WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect TFD coil connector CPS78 and measure voltage between socket 5 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Disconnect steer controller connector CPS6 and measure resistance between socket 10 and the TFD coil connector CPS78, socket 6.
   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect ground circuit for open or source of excessive resistance.

CAUSE B - TFD COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across TFD coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to Cause C.
   NO: Replace faulty TFD coil.

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DTC 65491 (Cont)
TFD Current within Range but Lower than Expected

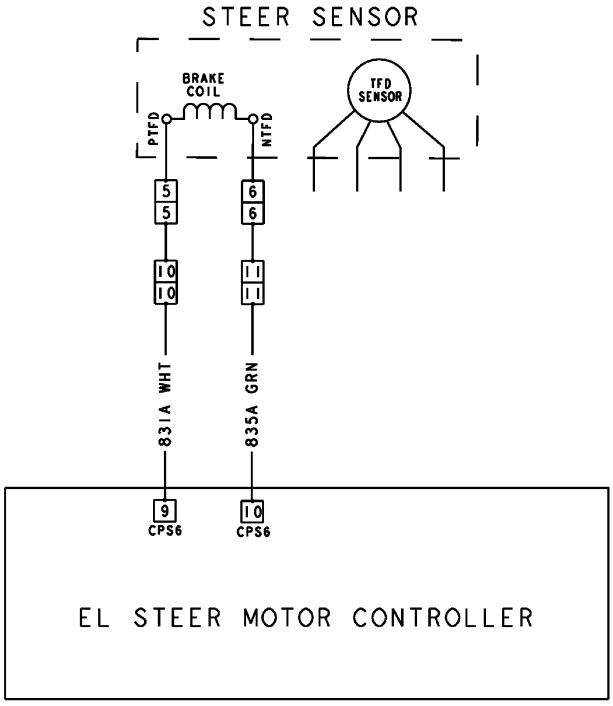
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65496
TFD Resistance Out of Range

POSSIBLE CAUSE

A. TFD WIRING FAULT

B. TFD COIL FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - TFD WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect TFD coil connector CPS78 and measure voltage between socket 5 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Disconnect steer controller connector CPS6 and measure resistance between socket 10 and the TFD coil connector CPS78, socket 6.
   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect ground circuit for open or source of excessive resistance.

CAUSE B - TFD COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across TFD coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to Cause C.
   NO: Replace faulty TFD coil.

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DTC 65496 (Cont)
TFD Resistance Out of Range

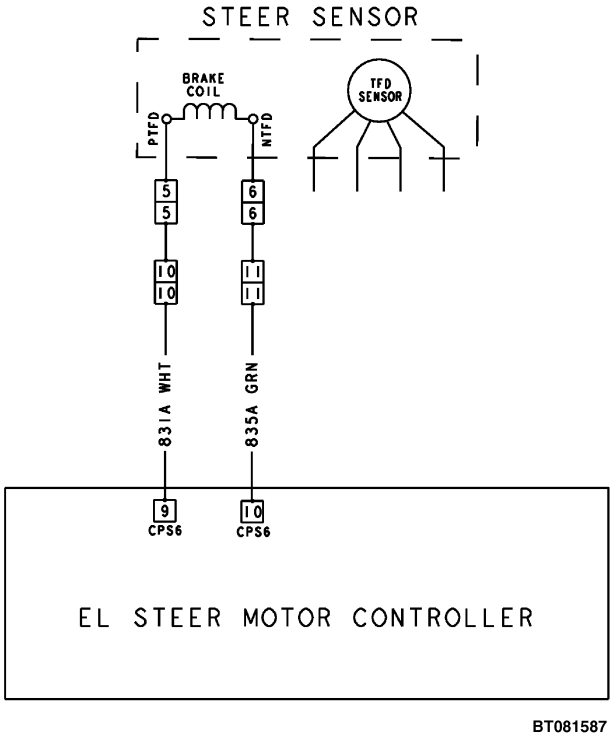
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65515
TFD Short to battery Negative

POSSIBLE CAUSE

A. TFD WIRING FAULT

B. TFD COIL FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - TFD WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect TFD coil connector CPS78 and measure voltage between socket 5 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Disconnect steer controller connector CPS6 and measure resistance between socket 10 and the TFD coil connector CPS78, socket 6.
   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect ground circuit for open or source of excessive resistance.

CAUSE B - TFD COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across TFD coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to Cause C.
   NO: Replace faulty TFD coil.

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DTC 65515 (Cont)
TFD Short to battery Negative

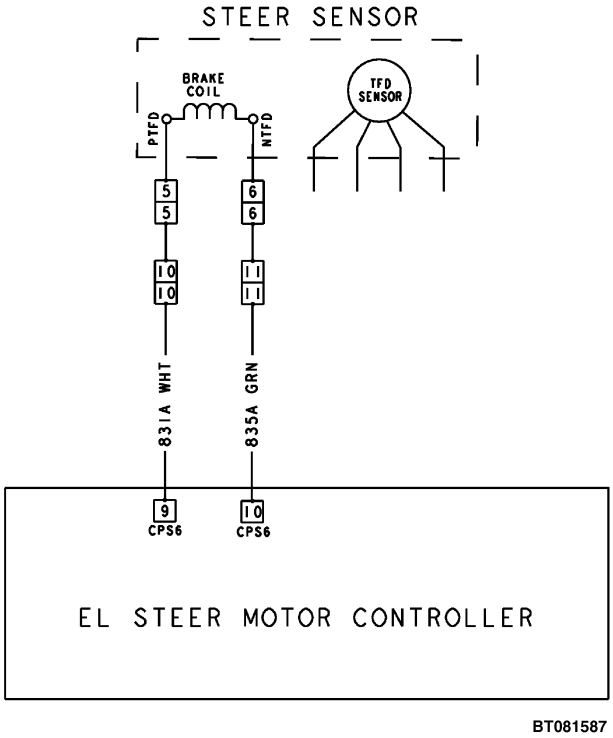
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 65516
TFD Stand-by Current OORH

POSSIBLE CAUSE

A. TFD WIRING FAULT

B. TFD COIL FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - TFD WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect TFD coil connector CPS78 and measure voltage between socket 5 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Disconnect steer controller connector CPS6 and measure resistance between socket 10 and the TFD coil connector CPS78, socket 6.
   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect ground circuit for open or source of excessive resistance.

CAUSE B - TFD COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across TFD coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to Cause C.
   NO: Replace faulty TFD coil.

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DTC 65516 (Cont)
TFD Stand-by Current OORH

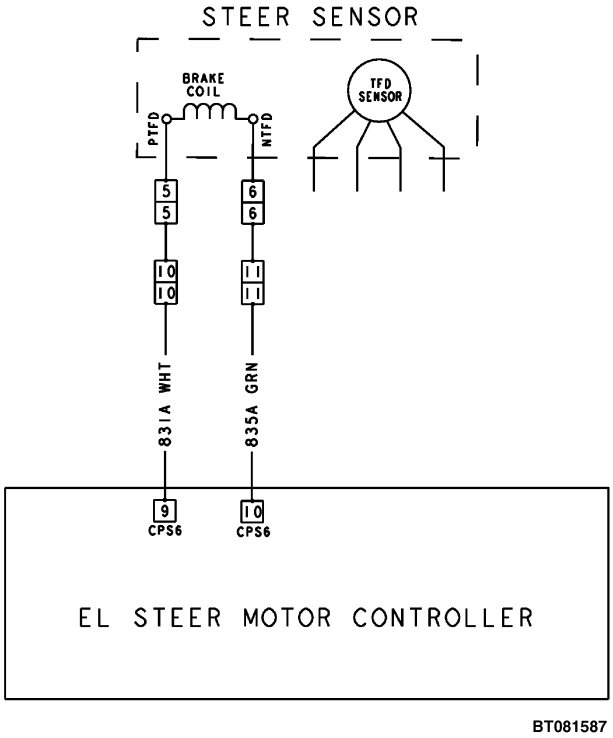
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 65500
Steering Motor Locked

POSSIBLE CAUSE

A. STEERING DAMAGE OR BINDING
B. STEER MOTOR PHASE CABLE FAULT
C. STEER MOTOR FAULT
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEERING DAMAGE OR BINDING

PROCEDURE OR ACTION:

1. Inspect steer wheel for obstruction or damage.
   Is damage present?
   YES: Remove obstruction or repair damage.
   NO: Disconnect battery and proceed to Cause B.

CAUSE B - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to Cause C.
   NO: Repair or replace faulty phase cable.

CAUSE C - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty motor.

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DTC 65500 (Cont)
Steering Motor Locked

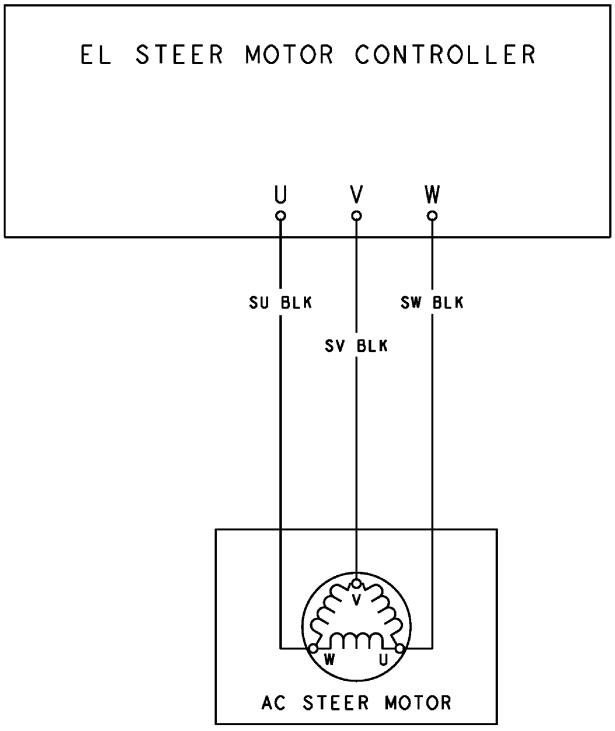
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty motor.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Cause D.
   NO: Repair or replace faulty motor.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES



END FAULT

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DTC 65521
Steer Axle Slow Response

POSSIBLE CAUSE

A. STEERING DAMAGE OR BINDING
B. STEER MOTOR PHASE CABLE FAULT
C. STEER MOTOR FAULT
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEERING DAMAGE OR BINDING

PROCEDURE OR ACTION:

1. Inspect steer wheel for obstruction or damage.
   Is damage present?
   YES: Remove obstruction or repair damage.
   NO: Disconnect battery and proceed to Cause B.

CAUSE B - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to Cause C.
   NO: Repair or replace faulty phase cable.

CAUSE C - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty motor.

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DTC 65521 (Cont)
Steer Axle Slow Response

2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty motor.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Cause D.
   NO: Repair or replace faulty motor.

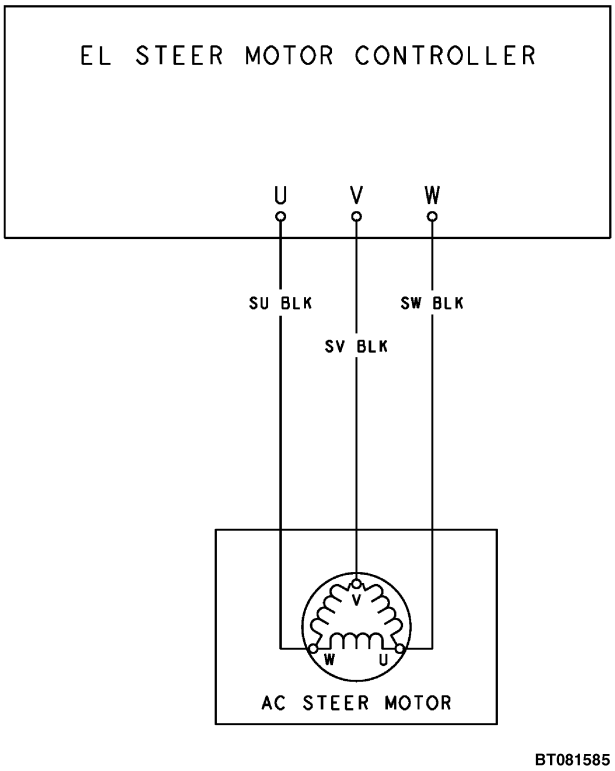
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65508
Steer Axle Position Mismatch

POSSIBLE CAUSE

A. STEER AXLE SENSOR WIRING FAULT
B. STEER AXLE SENSOR FAULT
C. ENCODER FAULT
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER AXLE SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer axle sensor connector CPS31 and measure voltage between socket A and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect supply circuit 089F for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
2. Measure voltage between the steer axle sensor connector CPS31, socket A and socket C.
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect ground circuit 117B for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
3. Disconnect VSM connector CPS1 and measure resistance between socket 16 and the steer axle sensor connector CPS31, socket B.
   Is voltage 5 ± 0.5 Vdc?
   YES: Connect steer axle sensor and proceed to Cause B.
   NO: Inspect input signal circuit 068A for open or source of excessive resistance. Inspect pigtail connector CRP31A, for loose, damaged, or corroded terminals.

CAUSE B - STEER AXLE SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the VSM connector CPS1, socket 16 and B(-).

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DTC 65508 (Cont)
Steer Axle Position Mismatch

Does voltage respond to steer axle sensor movement?
YES: Proceed to Cause C.
NO: Replace faulty steer axle sensor.

CAUSE C - ENCODER FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer encoder connector and measure voltage between encoder 12 volt supply and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A for open or short.
2. Measure voltage between 12 volt supply circuit and ground circuit.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 107A for open or short.
3. Disconnect steer controller connector and measure resistance between the following signal circuits:
   - Steer motor controller, socket 1 and steer encoder, socket A.
   - Steer motor controller, socket 3 and steer encoder, socket B.

   Is resistance <1 ohm?
   YES: Connect the encoder and steer controller connectors and proceed to Step 4.
   NO: Inspect encoder signal circuits for open or source of excessive resistance.
4. Using the PC Service Tool, locate and observe the steer encoder count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to Cause D.
   NO: Replace faulty steer encoder.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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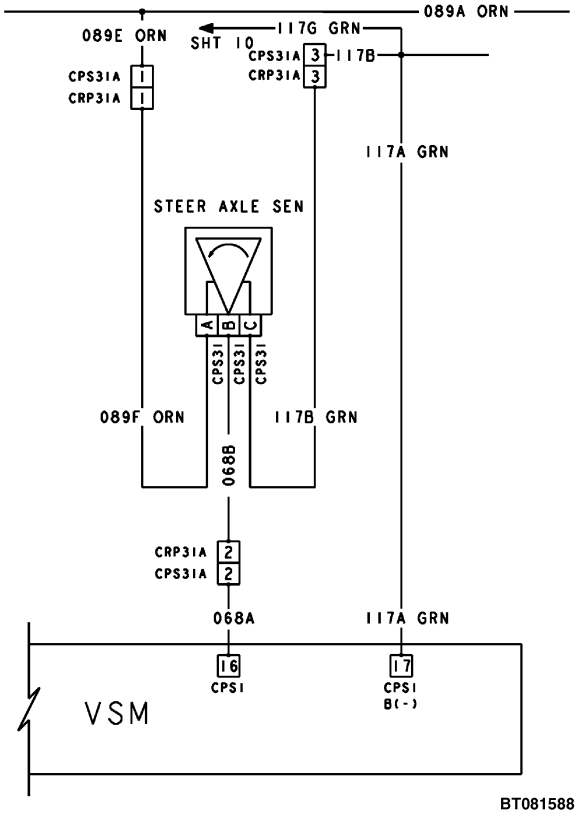
DTC 65508 (Cont)
Steer Axle Position Mismatch

DIAGRAMS



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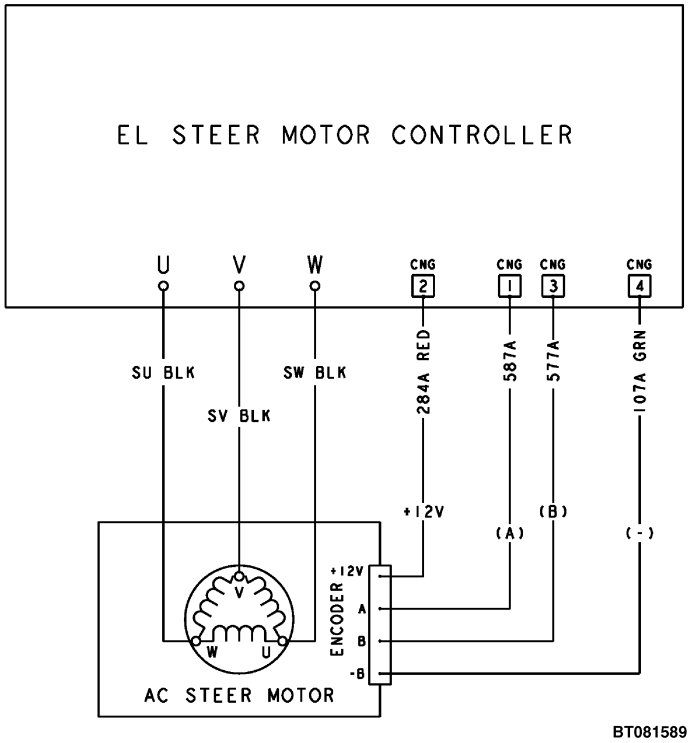
DTC 65508 (Cont)
Steer Axle Position Mismatch



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65532
Steer Axle Sensor Output Mismatch

POSSIBLE CAUSE

A. STEER AXLE SENSOR WIRING FAULT
B. STEER AXLE SENSOR FAULT
C. ENCODER FAULT
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER AXLE SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer axle sensor connector CPS31 and measure voltage between socket A and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect supply circuit 089F for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
2. Measure voltage between the steer axle sensor connector CPS31, socket A and socket C.
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect ground circuit 117B for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
3. Disconnect VSM connector CPS1 and measure resistance between socket 16 and the steer axle sensor connector CPS31, socket B.
   Is voltage 5 ± 0.5 Vdc?
   YES: Connect steer axle sensor and proceed to Cause B.
   NO: Inspect input signal circuit 068A for open or source of excessive resistance. Inspect pigtail connector CRP31A, for loose, damaged, or corroded terminals.

CAUSE B - STEER AXLE SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the VSM connector CPS1, socket 16 and B(-).

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DTC 65532 (Cont)
Steer Axle Sensor Output Mismatch

Does voltage respond to steer axle sensor movement?
YES: Proceed to Cause C.
NO: Replace faulty steer axle sensor.

CAUSE C - ENCODER FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer encoder connector and measure voltage between encoder 12 volt supply and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A for open or short.
2. Measure voltage between 12 volt supply circuit and ground circuit.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 107A for open or short.
3. Disconnect steer controller connector and measure resistance between the following signal circuits:
   - Steer motor controller, socket 1 and steer encoder, socket A.
   - Steer motor controller, socket 3 and steer encoder, socket B.

   Is resistance <1 ohm?
   YES: Connect the encoder and steer controller connectors and proceed to Step 4.
   NO: Inspect encoder signal circuits for open or source of excessive resistance.
4. Using the PC Service Tool, locate and observe the steer encoder count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to Cause D.
   NO: Replace faulty steer encoder.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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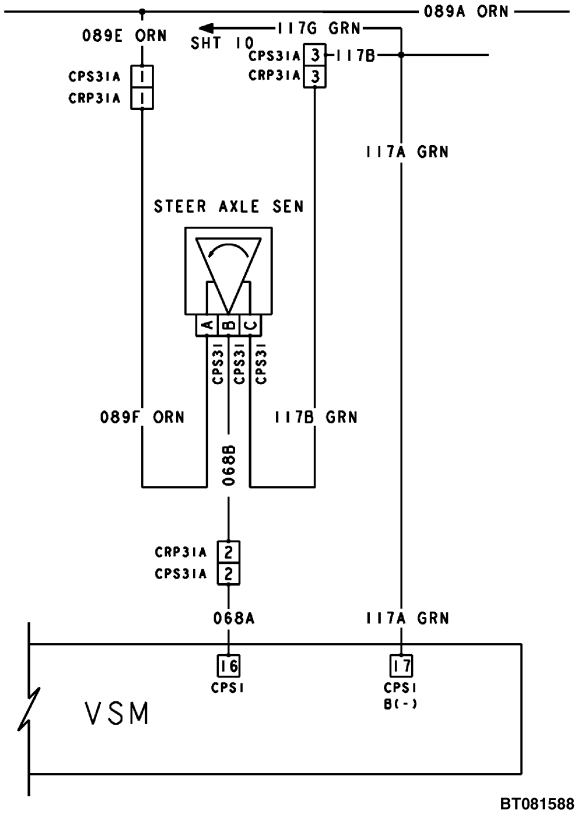
DTC 65532 (Cont)
Steer Axle Sensor Output Mismatch

DIAGRAMS



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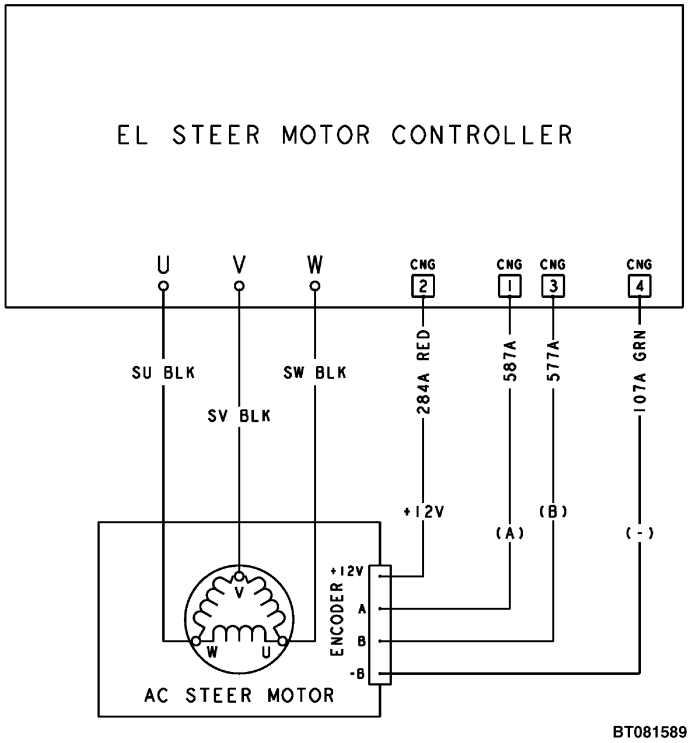
DTC 65532 (Cont)
Steer Axle Sensor Output Mismatch



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 65503
Rapid Change in Steer Axle Position

POSSIBLE CAUSE

A. STEER AXLE SENSOR WIRING FAULT
B. STEER AXLE SENSOR FAULT
C. ENCODER FAULT
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEER AXLE SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer axle sensor connector CPS31 and measure voltage between socket A and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect supply circuit 089F for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
2. Measure voltage between the steer axle sensor connector CPS31, socket A and socket C.
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect ground circuit 117B for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
3. Disconnect VSM connector CPS1 and measure resistance between socket 16 and the steer axle sensor connector CPS31, socket B.
   Is voltage 5 ± 0.5 Vdc?
   YES: Connect steer axle sensor and proceed to Cause B.
   NO: Inspect input signal circuit 068A for open or source of excessive resistance. Inspect pigtail connector CRP31A, for loose, damaged, or corroded terminals.

CAUSE B - STEER AXLE SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the VSM connector CPS1, socket 16 and B(-).

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DTC 65503 (Cont)
Rapid Change in Steer Axle Position

Does voltage respond to steer axle sensor movement?
YES: Proceed to Cause C.
NO: Replace faulty steer axle sensor.

CAUSE C - ENCODER FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer encoder connector and measure voltage between encoder 12 volt supply and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A for open or short.
2. Measure voltage between 12 volt supply circuit and ground circuit.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 107A for open or short.
3. Disconnect steer controller connector and measure resistance between the following signal circuits:
   - Steer motor controller, socket 1 and steer encoder, socket A.
   - Steer motor controller, socket 3 and steer encoder, socket B.

   Is resistance <1 ohm?
   YES: Connect the encoder and steer controller connectors and proceed to Step 4.
   NO: Inspect encoder signal circuits for open or source of excessive resistance.
4. Using the PC Service Tool, locate and observe the steer encoder count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to Cause D.
   NO: Replace faulty steer encoder.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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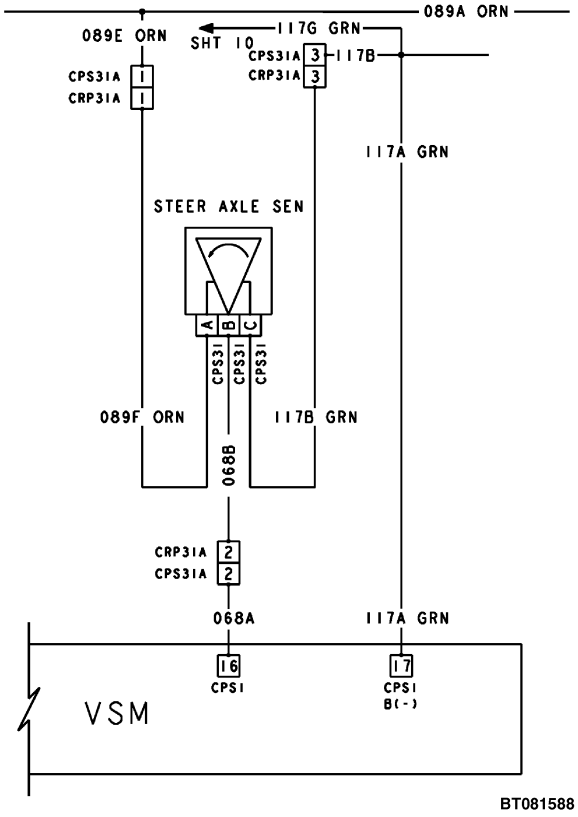
DTC 65503 (Cont)
Rapid Change in Steer Axle Position

DIAGRAMS



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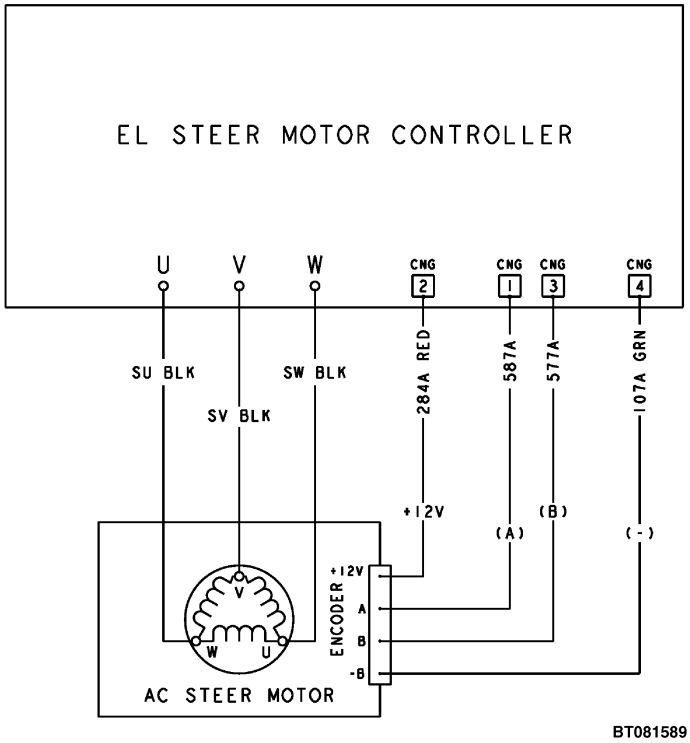
DTC 65503 (Cont)
Rapid Change in Steer Axle Position



Troubleshooting Scenes

END FAULT

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DTC 65524
Primary and Secondary Parameter Mismatch

POSSIBLE CAUSE

A. STEERING WHEEL POSITION CALIBRATION

B. SOFTWARE UPDATE

C. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - STEERING WHEEL POSITION CALIBRATION

PROCEDURE OR ACTION:

1. Perform steer wheel position calibration procedure and retest system.
   Does DTC return after steer wheel has been recalibrated?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause C.
   NO: No further service is required.

CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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CODES

DTC 65527 - Loss of CAN Communication
DTC 33050 - E-Steer CAN Communications Failure Right
DTC 33051 - E-Steer CAN Communications Failure Left

POSSIBLE CAUSE

A. CANBUS FAULT
B. VSM WIRING FAULT
C. CDF VERSION
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CANBUS FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the diagnostic connector CPS28, socket A and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. if voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the diagnostic connector CPS28, socket B and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.
3. Measure resistance between the diagnostic connector CPS28, socket A and socket B.
   Is resistance 60 ± 6 ohms?
   YES: Connect battery and proceed to Cause B.
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damage termination resistor. If resistance is 0 ohms, the CANbus circuit are shorted together.

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(Cont)

CAUSE B - VSM WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the VSM connector CPS2 and measure voltage between socket 35 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 200A and 200M for open or short. Inspect connector CRP52-55 for loose, damaged, or corroded terminals.
2. Measure voltage between socket 35 and the VSM connector CPS2, socket 2.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Cause C.
   NO: Inspect 013-A for open or short.

CAUSE C - CDF VERSION

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify current CDF version.
   Is CDF version current?
   YES: Proceed to Cause D.
   NO: Update CDF and retest system to verify repair.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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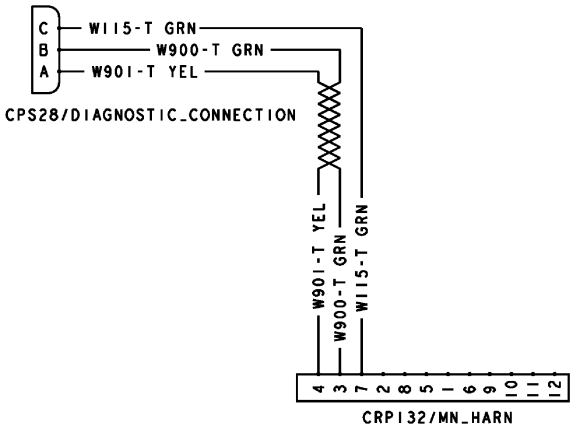
(Cont)

DIAGRAMS



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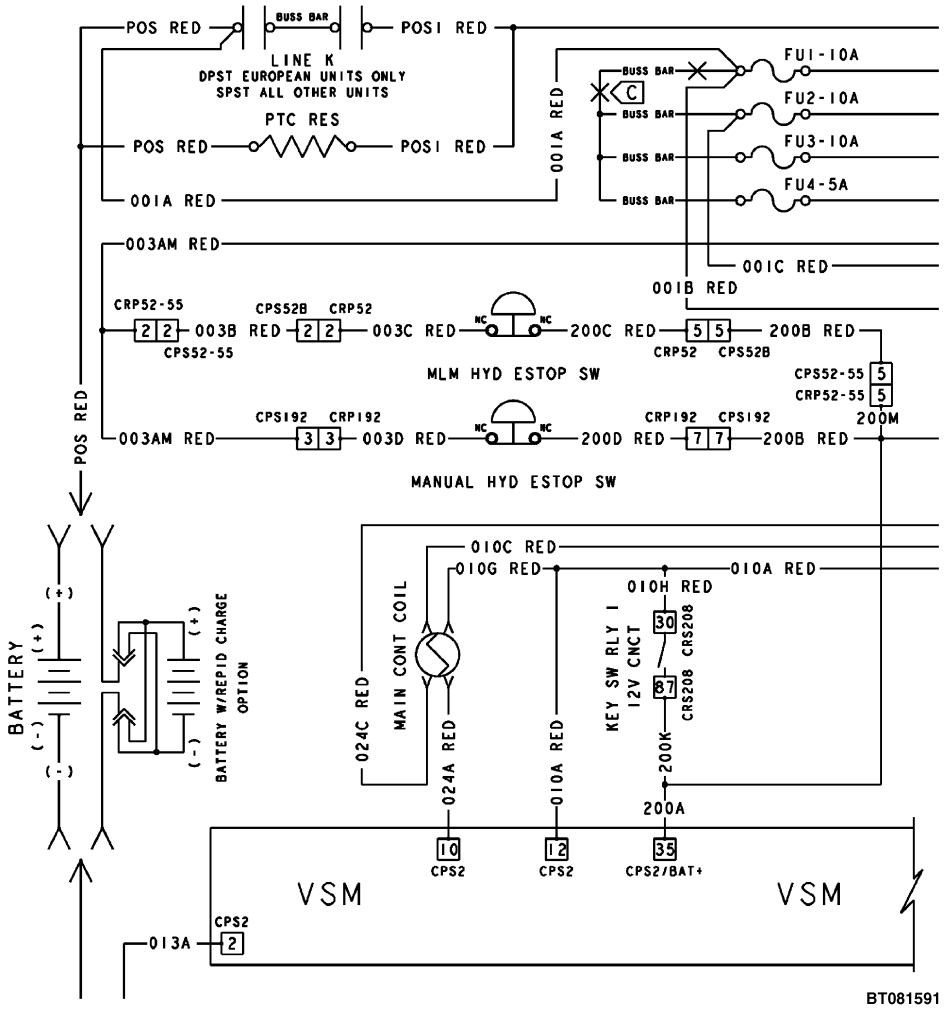

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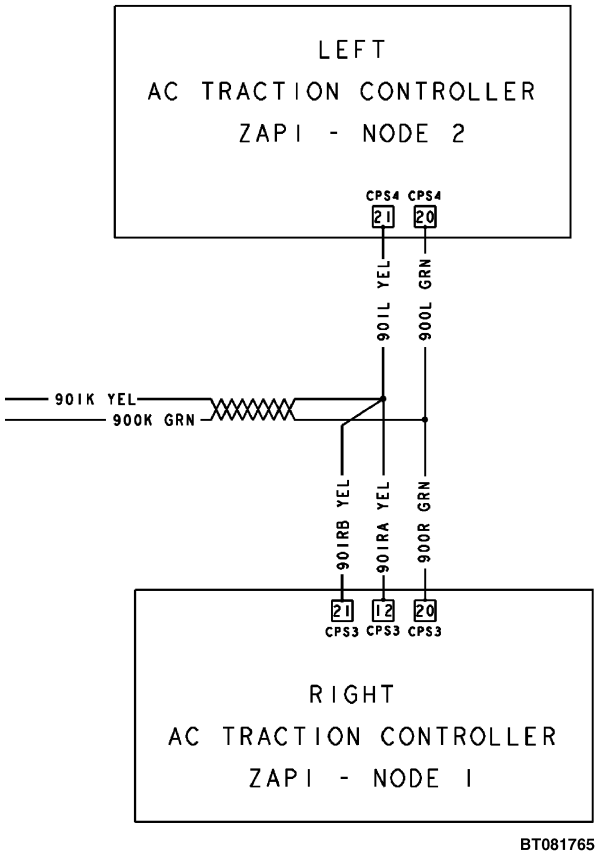

Troubleshooting Scenes

END FAULT

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DTC 9045
Internal Error - Software

POSSIBLE CAUSE

A. SOFTWARE UPDATE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 13058
5V Internal Supply Out of Range

5V supply is outside valid range.

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 13104
Sensor Ground Current OORH

POSSIBLE CAUSE

A. SENSOR WIRING FAULT
B. SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)
C. TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the traction controller connector CPS3 and the temperature or speed sensor connector. Measure resistance between the following:
   - Temperature Sensor - CRS3, socket 17 and connector CRS155, socket 2
   - Speed Sensor - CRS3, socket 4 and connector CRS153, socket 4

   Is resistance <1 ohm?
   YES: Connect traction controller connector CPS3 and proceed to Cause B for speed sensor troubleshooting, or Cause C for temp sensor troubleshooting.
   NO: Inspect the speed sensor ground circuit 103-A or 106-A for open or source of excessive resistance. Inspect temperature sensor circuit 104-A or 107-A for open or source of excessive remittance.

CAUSE B - SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)

PROCEDURE OR ACTION:

1. Measure voltage between the speed sensor connector CRP153, socket 1 and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect the controller connector CPS3 and proceed to Step 2.
   NO: Inspect 5 volt supply circuit 282-A or 284-A for open or short.
2. Measure resistance between the traction controller connector CRS3, socket 6 and the speed sensor connector CRP153, socket 2.
   Is resistance <1 ohm?

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DTC 13104 (Cont)
Sensor Ground Current OORH

YES: Proceed to Step 3.
NO: Inspect circuit 574-A or 278-A for open or source of excessive resistance.

3. Measure resistance between the traction controller connector CRS3, socket 5 and the speed sensor connector CRP153, socket 3.
   Is resistance <1 ohm?
   YES: Replace faulty speed sensor.
   NO: Proceed to Cause D.

CAUSE C - TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)

PROCEDURE OR ACTION:

1. Measure resistance across temper sensor connector CRP155, socket 1 and socket 2.
   Does resistance match temperatures (Refer to table 9030-10-4 for specification)?
   YES: Proceed to Cause D.
   NO: Replace faulty temperature sensor.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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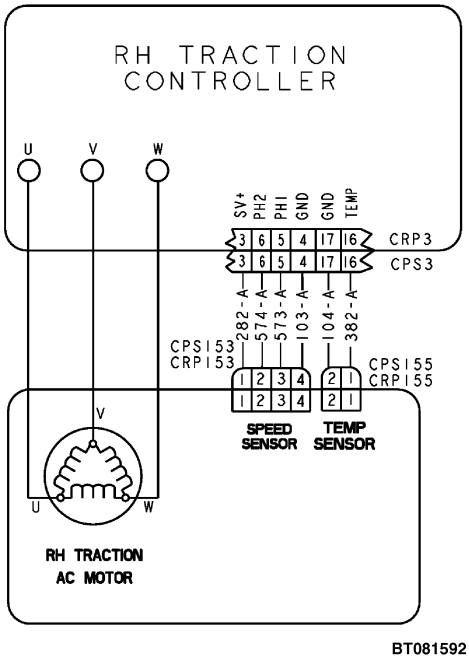
DTC 13104 (Cont)
Sensor Ground Current OORH

DIAGRAMS



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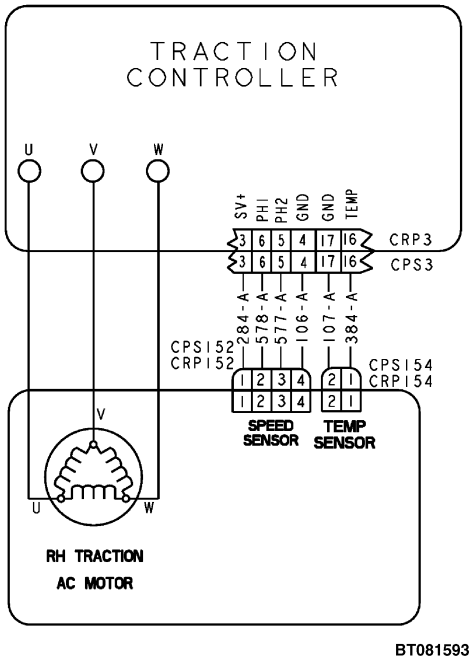

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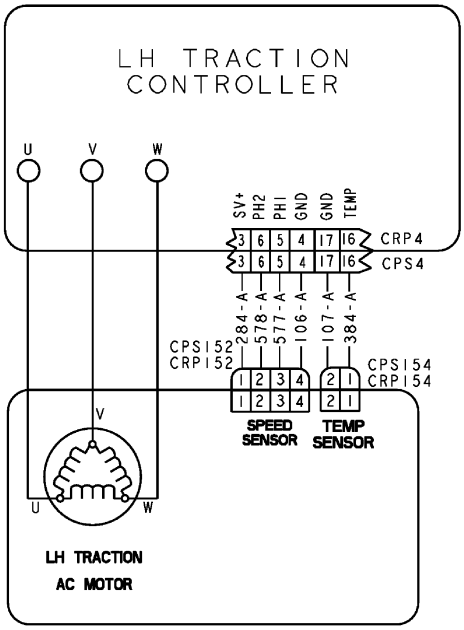
DTC 13104 (Cont)
Sensor Ground Current OORH



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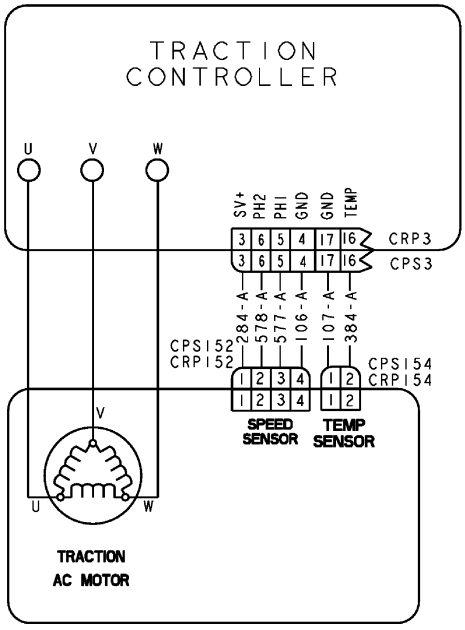

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Troubleshooting Scenes

END FAULT

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DTC 16913
Motor Temperature Sensor Open Circuit

POSSIBLE CAUSE

A. SENSOR WIRING FAULT
B. SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)
C. TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the traction controller connector CPS3 and the temperature or speed sensor connector. Measure resistance between the following:
   - Temperature Sensor - CRS3, socket 17 and connector CRS155, socket 2
   - Speed Sensor - CRS3, socket 4 and connector CRS153, socket 4

   Is resistance <1 ohm?
   YES: Connect traction controller connector CPS3 and proceed to Cause B for speed sensor troubleshooting, or Cause C for temp sensor troubleshooting.
   NO: Inspect the speed sensor ground circuit 103-A or 106-A for open or source of excessive resistance. Inspect temperature sensor circuit 104-A or 107-A for open or source of excessive remittance.

CAUSE B - SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)

PROCEDURE OR ACTION:

1. Measure voltage between the speed sensor connector CRP153, socket 1 and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect the controller connector CPS3 and proceed to Step 2.
   NO: Inspect 5 volt supply circuit 282-A or 284-A for open or short.
2. Measure resistance between the traction controller connector CRS3, socket 6 and the speed sensor connector CRP153, socket 2.
   Is resistance <1 ohm?

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DTC 16913 (Cont)
Motor Temperature Sensor Open Circuit

YES: Proceed to Step 3.
NO: Inspect circuit 574-A or 278-A for open or source of excessive resistance.

3. Measure resistance between the traction controller connector CRS3, socket 5 and the speed sensor connector CRP153, socket 3.
   Is resistance <1 ohm?
   YES: Replace faulty speed sensor.
   NO: Proceed to Cause D.

CAUSE C - TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)

PROCEDURE OR ACTION:

1. Measure resistance across temper sensor connector CRP155, socket 1 and socket 2.
   Does resistance match temperatures (Refer to table 9030-10-4 for specification)?
   YES: Proceed to Cause D.
   NO: Replace faulty temperature sensor.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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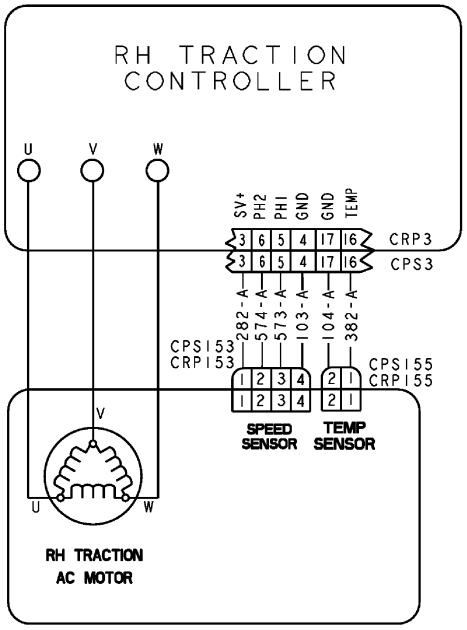
DTC 16913 (Cont)
Motor Temperature Sensor Open Circuit

DIAGRAMS



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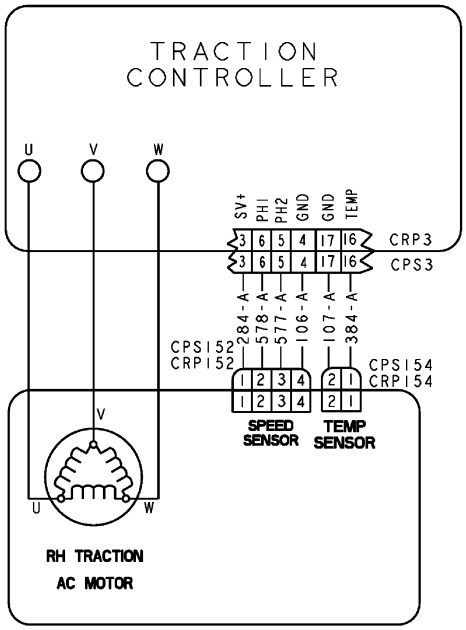

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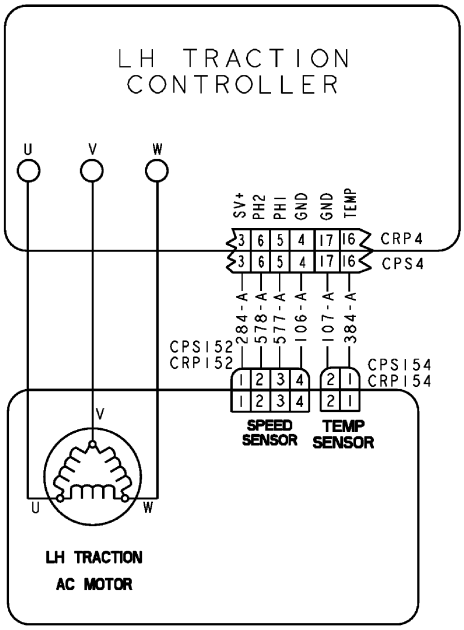
DTC 16913 (Cont)
Motor Temperature Sensor Open Circuit



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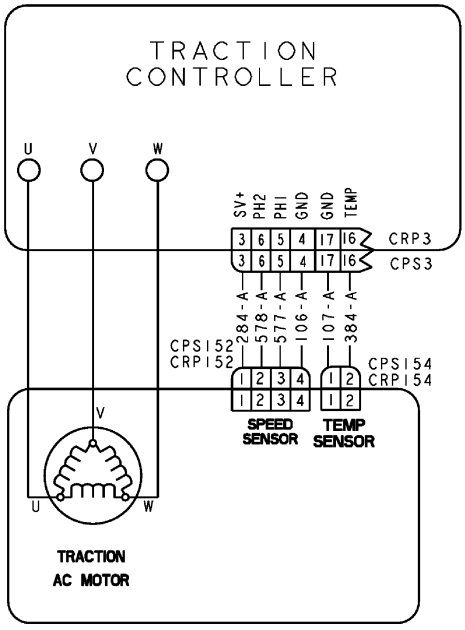

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Troubleshooting Scenes

END FAULT

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DTC 16914
Motor Temperature Sensor Short Circuit

POSSIBLE CAUSE

A. SENSOR WIRING FAULT
B. SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)
C. TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the traction controller connector CPS3 and the temperature or speed sensor connector. Measure resistance between the following:
   - Temperature Sensor - CRS3, socket 17 and connector CRS155, socket 2
   - Speed Sensor - CRS3, socket 4 and connector CRS153, socket 4

   Is resistance <1 ohm?
   YES: Connect traction controller connector CPS3 and proceed to Cause B for speed sensor troubleshooting, or Cause C for temp sensor troubleshooting.
   NO: Inspect the speed sensor ground circuit 103-A or 106-A for open or source of excessive resistance. Inspect temperature sensor circuit 104-A or 107-A for open or source of excessive remittance.

CAUSE B - SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)

PROCEDURE OR ACTION:

1. Measure voltage between the speed sensor connector CRP153, socket 1 and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect the controller connector CPS3 and proceed to Step 2.
   NO: Inspect 5 volt supply circuit 282-A or 284-A for open or short.
2. Measure resistance between the traction controller connector CRS3, socket 6 and the speed sensor connector CRP153, socket 2.
   Is resistance <1 ohm?

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DTC 16914 (Cont)
Motor Temperature Sensor Short Circuit

YES: Proceed to Step 3.
NO: Inspect circuit 574-A or 278-A for open or source of excessive resistance.

3. Measure resistance between the traction controller connector CRS3, socket 5 and the speed sensor connector CRP153, socket 3.
   Is resistance <1 ohm?
   YES: Replace faulty speed sensor.
   NO: Proceed to Cause D.

CAUSE C - TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)

PROCEDURE OR ACTION:

1. Measure resistance across temper sensor connector CRP155, socket 1 and socket 2.
   Does resistance match temperatures (Refer to table 9030-10-4 for specification)?
   YES: Proceed to Cause D.
   NO: Replace faulty temperature sensor.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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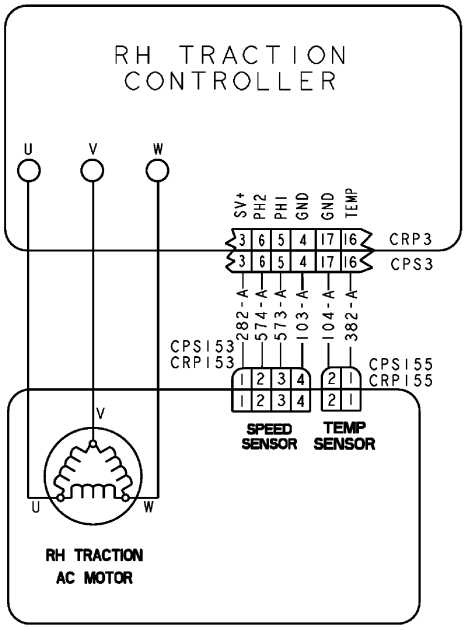
DTC 16914 (Cont)
Motor Temperature Sensor Short Circuit

DIAGRAMS



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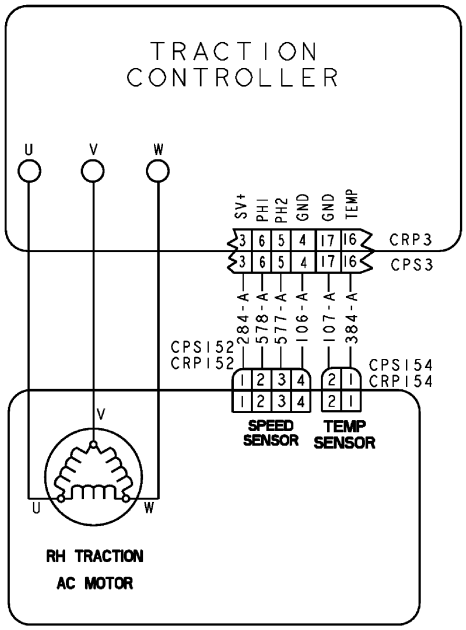

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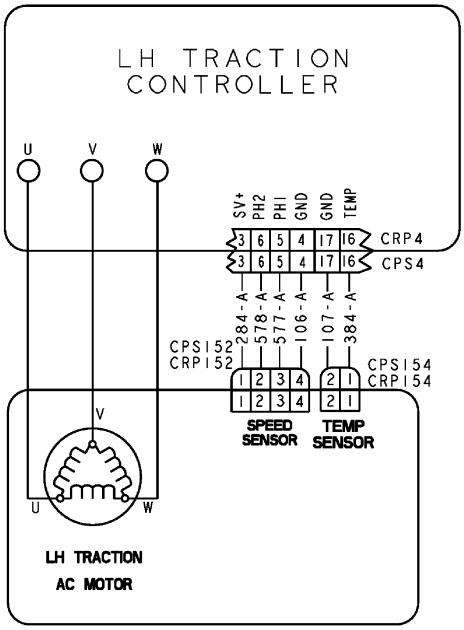
DTC 16914 (Cont)
Motor Temperature Sensor Short Circuit



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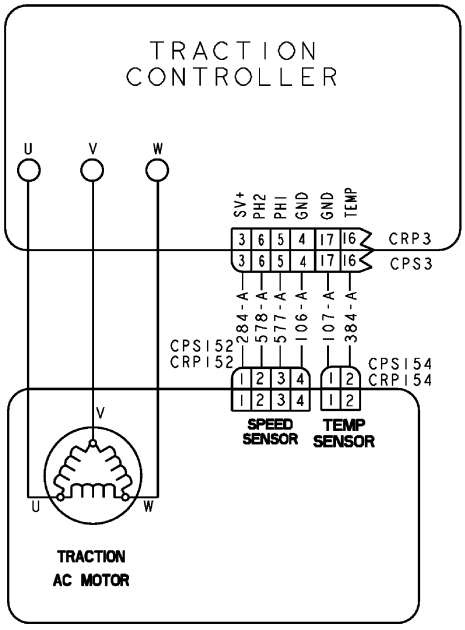

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Troubleshooting Scenes

END FAULT

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DTC 16912
Motor Temperature OORH

POSSIBLE CAUSE

A. MOTOR OVER TEMP
B. TEMP SENSOR WIRING FAULT
C. TEMPERATURE SENSOR FAULT
D. MOTOR FAULT
E. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - MOTOR OVER TEMP

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify steer motor temperature and then measure actual motor temperatures. Over temp conditions are above 120°C (248°F).
   Is motor temperature out of range?
   YES: Allow motor to cool within acceptable temperatures, clear DTC and resume operation. If motor continues to overheat, proceed to Cause D.
   NO: Disconnect battery and proceed Cause B

CAUSE B - TEMP SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect temperature sensor connectors from motor and controller and inspect pins/sockets.
   Is connector damage present?
   YES: Repair connector, clear DTC and retest system.
   NO: Proceed to Step 2.
2. Measure resistance between the following:
   - Controller temp sensor connector, socket 16 and motor temp sensor connector, socket 2.
   - Controller temp sensor connector, socket 17 and motor temp sensor connector, socket 1.

   Is resistance <1 ohm?
   YES: Proceed to Cause E.

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DTC 16912 (Cont)
Motor Temperature OORH

NO: Inspect appropriate temp sensor circuit for open or source of excessive resistance.

CAUSE C - TEMPERATURE SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the temp sensor connector pin 1 and pin 2.
   Does resistance match temperatures (Refer to table 9030-10-4 for specification)?
   YES: Proceed to Cause E.
   NO: Replace faulty temperature sensor.

CAUSE D - MOTOR FAULT

PROCEDURE OR ACTION:

1. Replace faulty motor.

CAUSE E - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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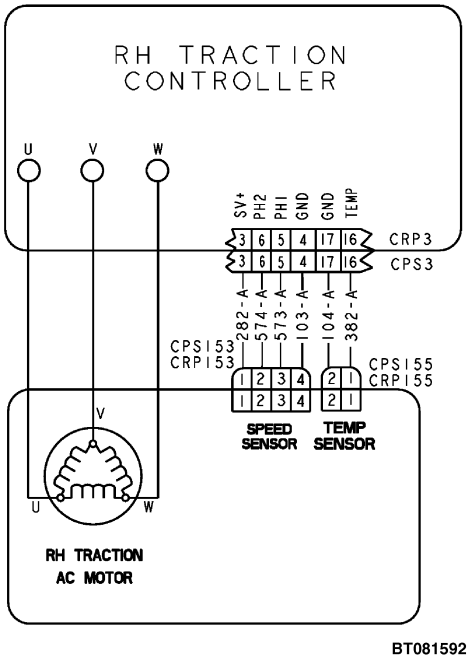
DTC 16912 (Cont)
Motor Temperature OORH

DIAGRAMS



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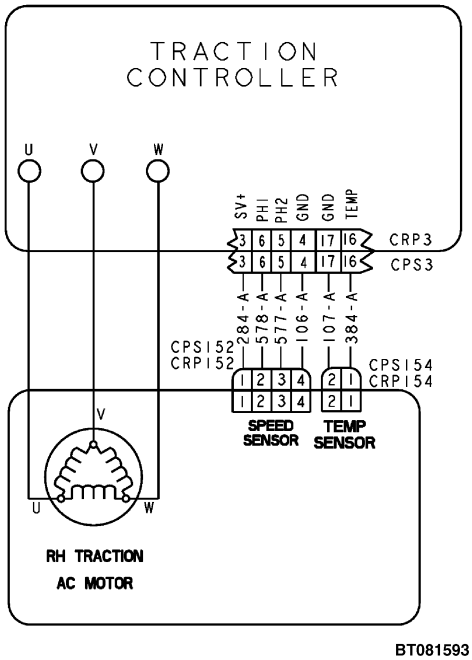

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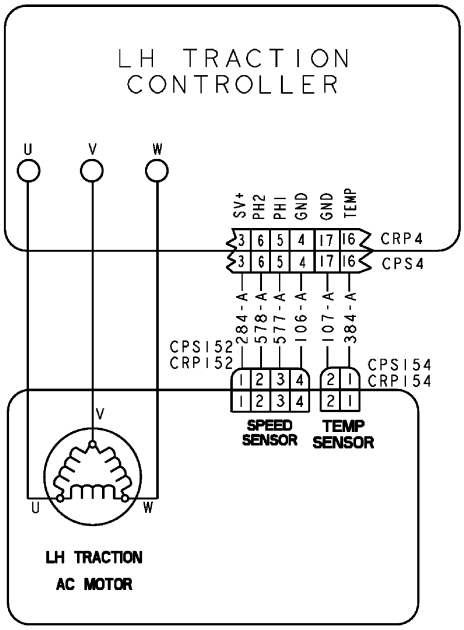
DTC 16912 (Cont)
Motor Temperature OORH



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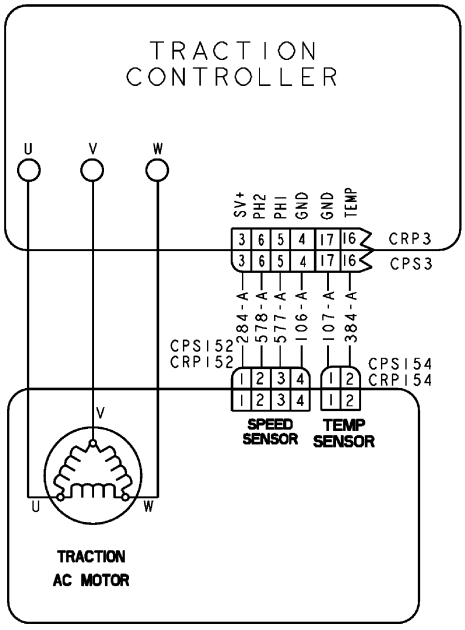

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Troubleshooting Scenes

END FAULT

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DTC 65341
Controller Internal Temperature OORH

Controller temperatures above 80°C (176°F)

POSSIBLE CAUSE

A. CONTROLLER OVER TEMPERATURE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CONTROLLER OVER TEMPERATURE

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify controller temperature and measure actual controller temperature. Over temp conditions are above 80°C (176°F).
   Is controller temperature out of range?
   YES: Allow controller to cool within acceptable temperatures, clear DTC and resume operation.
   NO: Proceed to Cause B.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 65341
Controller Internal Temperature OORL

Controller temperatures below 45°C (113°F)

POSSIBLE CAUSE

A. CONTROLLER BELOW TEMPERATURE

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CONTROLLER BELOW TEMPERATURE

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify controller temperature and measure actual controller temperature. Low temp conditions are below 45°C (113°F).
   Is controller temperature out of range?
   YES: Bring controller temperatures above temperature threshold, clear DTC and resume operation.
   NO: Proceed to Cause B.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 21521
Fan Driver Current OORH

POSSIBLE CAUSE

A. FAN WIRING FAULT
B. FAN RELAY FAULT
C. FAN FAULT
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - FAN WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the appropriate cooling fan connector CRP156A/157A and measure voltage between socket 1 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect appropriate voltage circuit 034-K, 034-H, and 034-J for open or short. If no wiring short is found, proceed to Cause B.
2. Measure voltage between the cooling fan connector CRP126A/127A, socket 1 and socket 2.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Cause B.
   NO: Inspect fan ground circuit 013-X and 13-V for open or short.

CAUSE B - FAN RELAY FAULT

PROCEDURE OR ACTION:

1. Remove fan relay CRS214 and measure voltage between socket 86 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect coil power supply circuit 034-F for open or short.
2. Measure voltage between the fan relay CRS214, socket 30 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.

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DTC 21521 (Cont)
Fan Driver Current OORH

NO: Inspect switch power supply circuit 034-G for open or short.

3. Measure voltage between the fan relay CRS214, socket 30 and socket 85.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 4.
   NO: Inspect ground circuit 898-E for open or short.
4. Using a jumper wire, bypass the fan relay by placing jumper wire between socket 30 and socket 87.
   Does fan operate?
   YES: Replace faulty fan relay.
   NO: Install fan relay and proceed to Cause C.

CAUSE C - FAN FAULT

PROCEDURE OR ACTION:

1. Replace inoperative fan.
   Is cooling fan operational?
   YES: Clear DTC and verify correct operation.
   NO: Proceed to Cause D.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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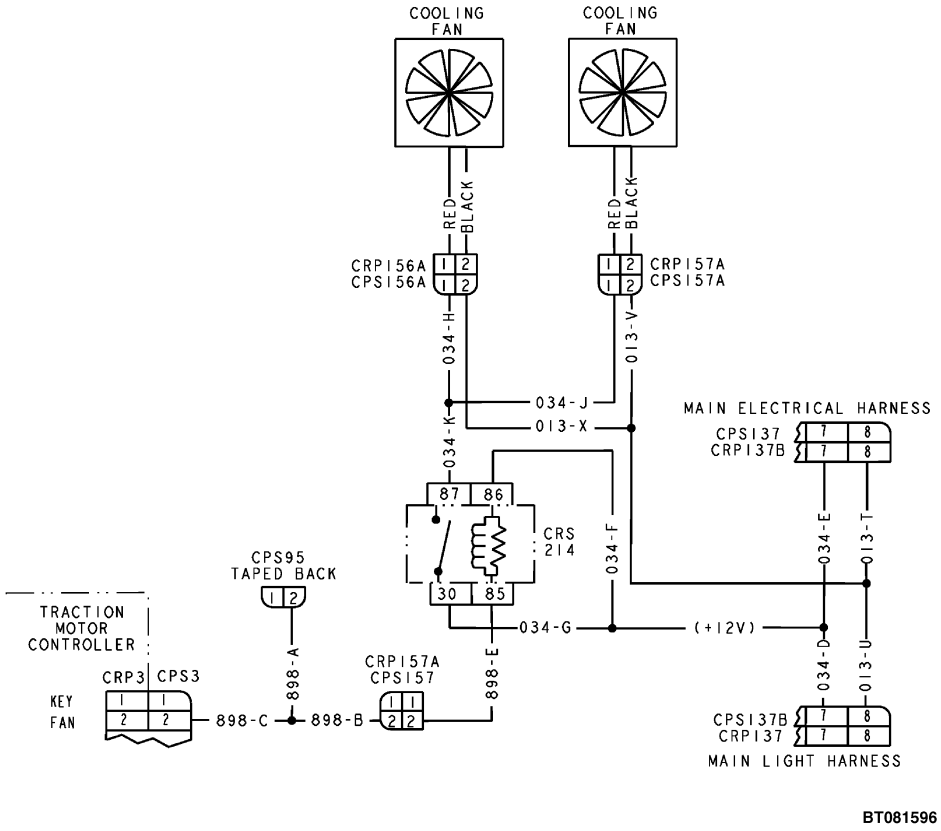
DTC 21521 (Cont)
Fan Driver Current OORH

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 21776
Internal Error - Hardware

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 29232
Sensor Supply Reference voltage Out of Range

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 21522
Automatic Park Brake Driver Current OORH

POSSIBLE CAUSE

A. PARK BRAKE WIRING FAULT

B. PARK BRAKE SOLENOID FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - PARK BRAKE WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the park brake solenoid connector CPS195 and measure voltage between socket 1 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect supply circuit 010-J for open or short.
2. Measure voltage between the park brake solenoid connector CPS195, socket 1 and socket 2.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Cause B.
   NO: Inspect ground circuit 096-C for open or short.

CAUSE B - PARK BRAKE SOLENOID FAULT

PROCEDURE OR ACTION:

1. Measure resistance across the park brake solenoid connector CRP195, pin 1 and pin 2.
   Is resistance XX ohms?
   YES: Proceed to Cause C.
   NO: Replace faulty park brake solenoid.

CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

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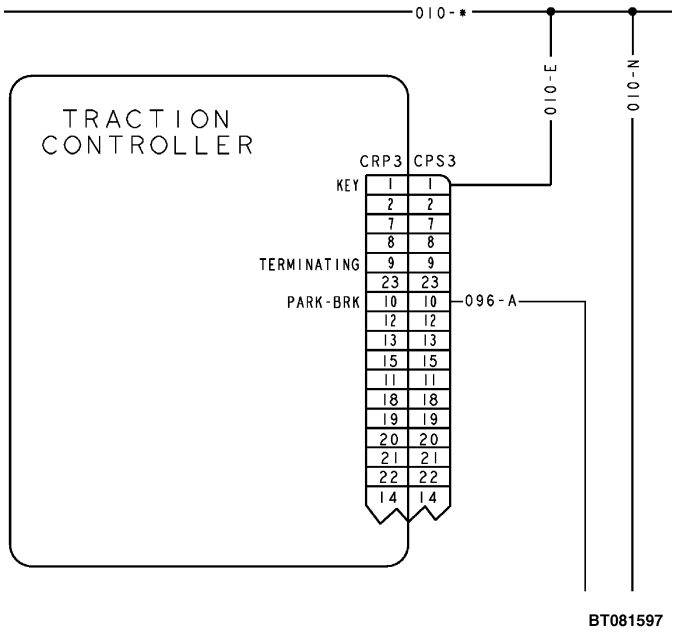
DTC 21522 (Cont)
Automatic Park Brake Driver Current OORH

END POSSIBLE CAUSES



END FAULT

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DTC 29216
Speed Sensor High Current

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT

B. SPEED SENSOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to Cause B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to Cause C.

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DTC 29216 (Cont)
Speed Sensor High Current

NO: Replace faulty speed sensor.

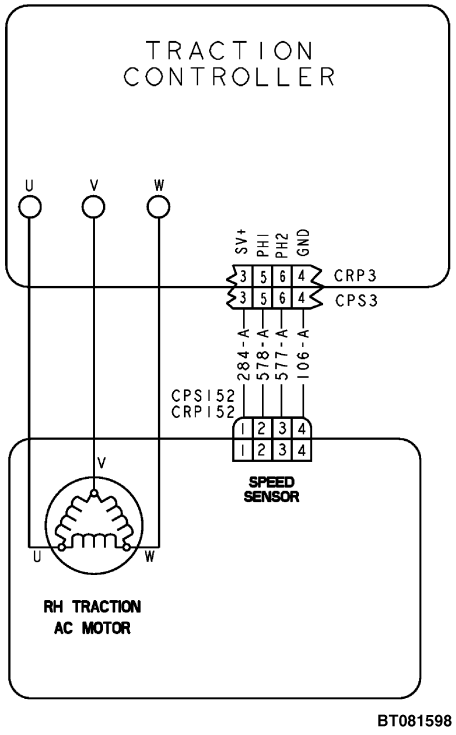
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 29217
Speed Sensor Not Connected

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT

B. SPEED SENSOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to Cause B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to Cause C.

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DTC 29217 (Cont)
Speed Sensor Not Connected

NO: Replace faulty speed sensor.

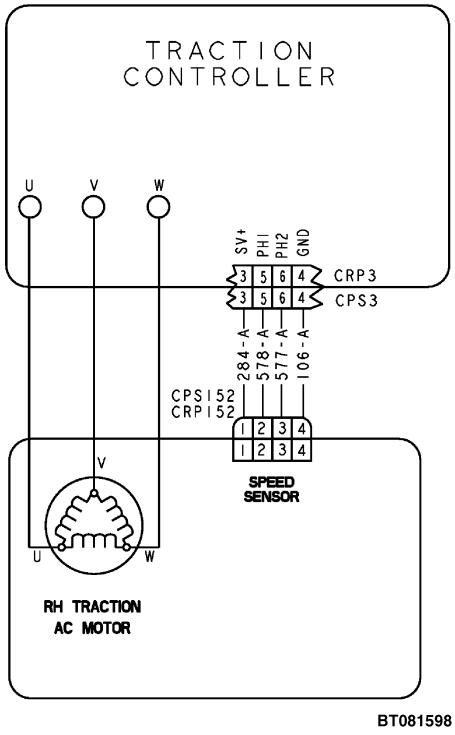
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 29233
Sensor Supply Circuit Out of Range

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT

B. SPEED SENSOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to Cause B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to Cause C.

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DTC 29233 (Cont)
Sensor Supply Circuit Out of Range

NO: Replace faulty speed sensor.

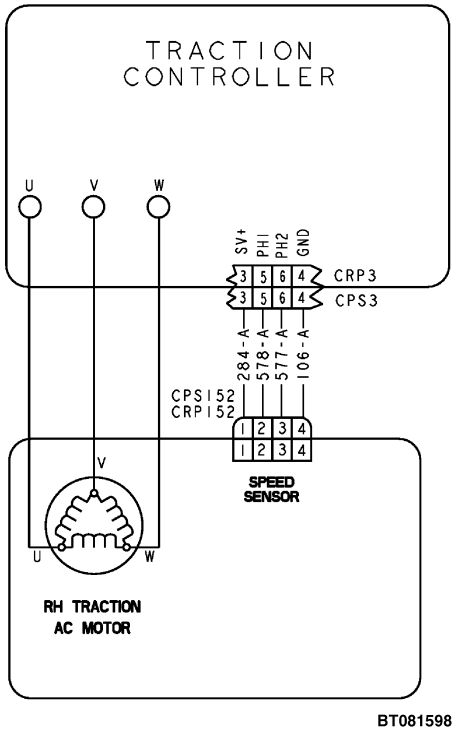
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

https://truckmanualshub.com/

DTC 29536
Loss of Speed Sensor Channel A

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT

B. SPEED SENSOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to Cause B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to Cause C.

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DTC 29536 (Cont)
Loss of Speed Sensor Channel A

NO: Replace faulty speed sensor.

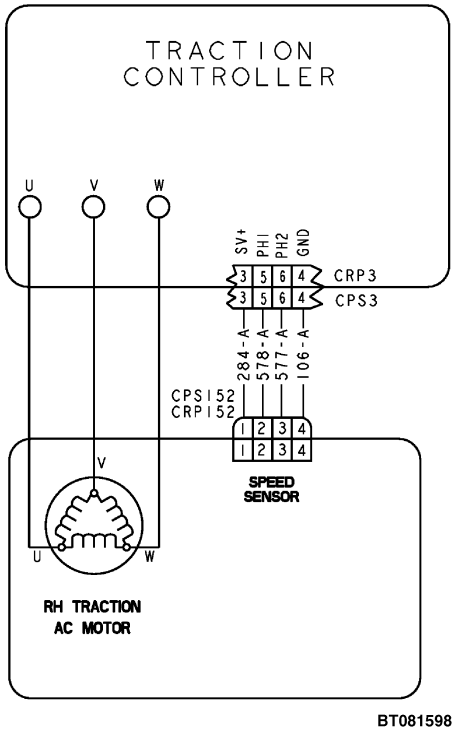
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 29552
Loss of Speed Sensor Channel B

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT

B. SPEED SENSOR FAULT

C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to Cause B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to Cause C.

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DTC 29552 (Cont)
Loss of Speed Sensor Channel B

NO: Replace faulty speed sensor.

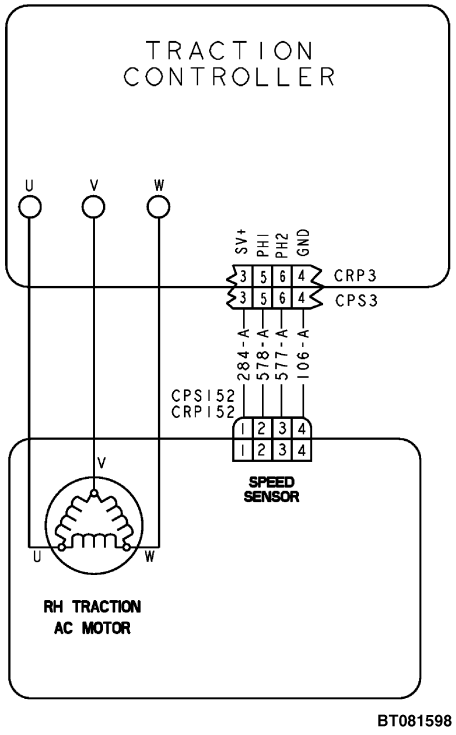
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 65346
Battery Low

POSSIBLE CAUSE

A. KEY INPUT OR BATTERY WIRING FAULT

B. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - KEY INPUT OR BATTERY WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the appropriate traction controller connector CPS3/CPS4. Measure voltage between controller connector CPS3/CPS4, cavity 1 and B(-).
   Is voltage 36 ± 3.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuits 010LB, 010R, and 010A for open or short.

NOTE: Key in ON position.

2. Measure voltage between the appropriate traction controller B(+) terminal and B(-).
   Is voltage 36 ± 3.5 Vdc?
   YES: Proceed to Cause B.
   NO: Suspect faulty battery. Charge and retest system.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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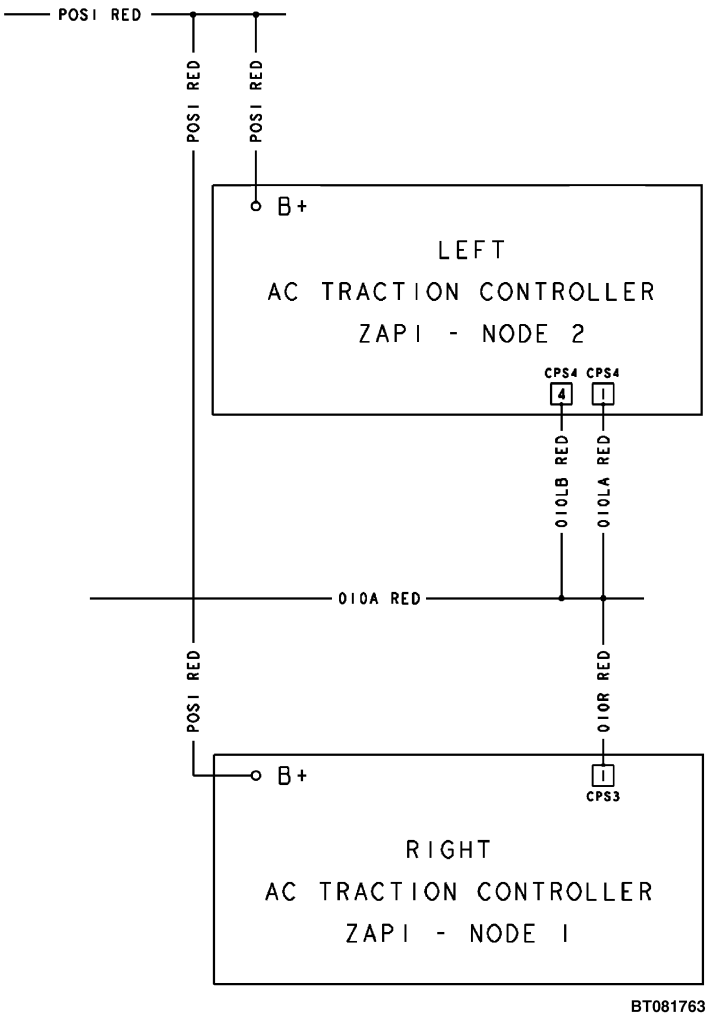
DTC 65346 (Cont)
Battery Low

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 95360
Forw + Back

POSSIBLE CAUSE

A. FWD / REV SELECT SWITCH WIRING FAULT
B. FWD / REV SELECT SWITCH FAULT
C. TRACTION CONTROLLER CANBUS FAULT
D. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - FWD / REV SELECT SWITCH WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the FWD / REV select switch connector CRP64 and measure voltage between cavity 1 (Harness side) and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect 5 volt supply circuit 089(250) or 250B for open or short.

NOTE: Key in ON position.

2. Measure voltage between FWD / REV select switch connector CRP64, cavity 1 and cavity 2 (Harness side).
   Is voltage 5 ± 0.5 Vdc?
   YES: Connect FWD / REV select switch connector CRP64 and proceed to Step 3.
   NO: Inspect ground circuits 120(115) or 115C for open or short.
3. Measure voltage between the FWD / REV select switch connector, cavity 3 and B(-). Place select switch in FWD position.
   Is signal 1 circuit voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 4.
   NO: Inspect signal 1 circuit 008C, 008B, and 006AB for open or short.
4. Measure voltage between the FWD / REV select switch connector, cavity 2 and B(-). Place select switch in REV position.
   Is signal 1 circuit voltage 5 ± 0.5 Vdc?

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DTC 95360 (Cont)
Forw + Back

YES: Proceed to Cause B.
NO: Inspect signal 2 circuit 006A, 006B, and 006AB for open or short.

CAUSE B - FWD / REV SELECT SWITCH FAULT

PROCEDURE OR ACTION:

1. Disconnect FWD / REV select switch connector CRP64 and measure continuity between cavity 1 and cavity 3. Place select switch in FWD position.
   Is continuity present?
   YES: Proceed to Cause D.
   NO: Replace faulty switch.
2. Measure continuity between switch connector CRP64, cavity 1 and cavity 2. Place select switch in REV position.
   Is continuity present?
   YES: Proceed to Cause C.
   NO: Replace faulty switch.

CAUSE C - TRACTION CONTROLLER CANBUS FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the appropriate traction controller connector CPS3/CPS4. Measure voltage between cavity 20 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. If voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the traction controller connector CPS3/CPS4, cavity 21/12 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.
3. Measure resistance between the traction controller connector CPS11, socket A21 and socket A20.
   Is resistance 60 ± 6 ohms?
   YES: Cause D
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

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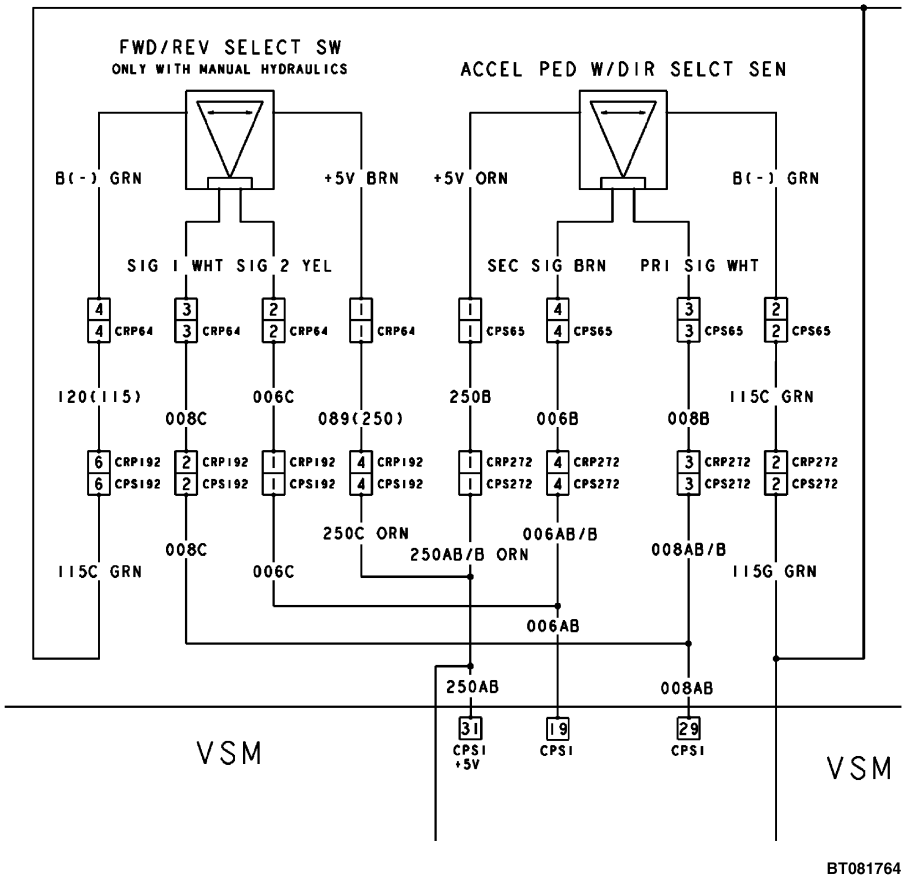
DTC 95360 (Cont)
Forw + Back

DIAGRAMS



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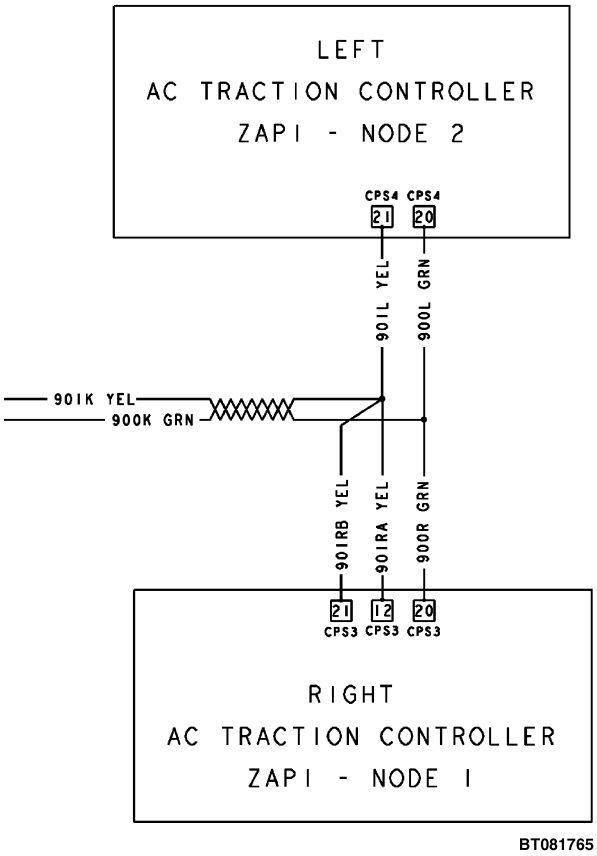
DTC 95360 (Cont)
Forw + Back



Troubleshooting Scenes

END FAULT

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CODES

DTC 65481 - Wrong Slave Version
DTC 65519 - Controller Mismatch
DTC 65522 - Parameter Transfer

POSSIBLE CAUSE

A. SOFTWARE FAULT

B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE FAULT

PROCEDURE OR ACTION:

1. Verify software version in both right and left traction controllers.
   Is software version the same in both controllers?
   YES: Proceed to Cause B.
   NO: Proceed to Step 2.
2. Reprogram controller with correct software version.
   Was reprogram successful?
   YES: Clear DTC and verify repairs.
   NO: Proceed to Cause B.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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CODES

DTC 65486 - Initial VMN High
DTC 65333 - Standby Current High

POSSIBLE CAUSE

A. PHASE CABLE FAULT
B. TRACTION MOTOR FAULT
C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

NOTE: Disconnect battery.

1. Disconnect the traction motor cables from the appropriate traction controller and traction motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to Cause B.
   NO: Repair or replace faulty phase cable.

CAUSE B - TRACTION MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty traction motor.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty traction motor.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383 ohms?

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(Cont)

YES: Proceed to Cause C.
NO: Repair or replace faulty traction motor.

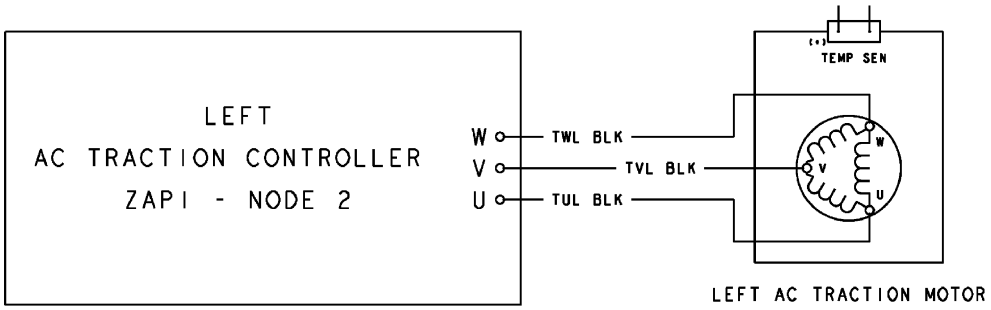
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 65504
Waiting for Node

POSSIBLE CAUSE

A. TRACTION CONTROLLER CANBUS FAULT

B. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - TRACTION CONTROLLER CANBUS FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the appropriate traction controller connector CPS3/CPS4. Measure voltage between cavity 20 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. If voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the traction controller connector CPS3/CPS4, cavity 21/12 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.
3. Measure resistance between the traction controller connector CPS11, socket A21 and socket A20.
   Is resistance 60 ± 6 ohms?
   YES: Cause B
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

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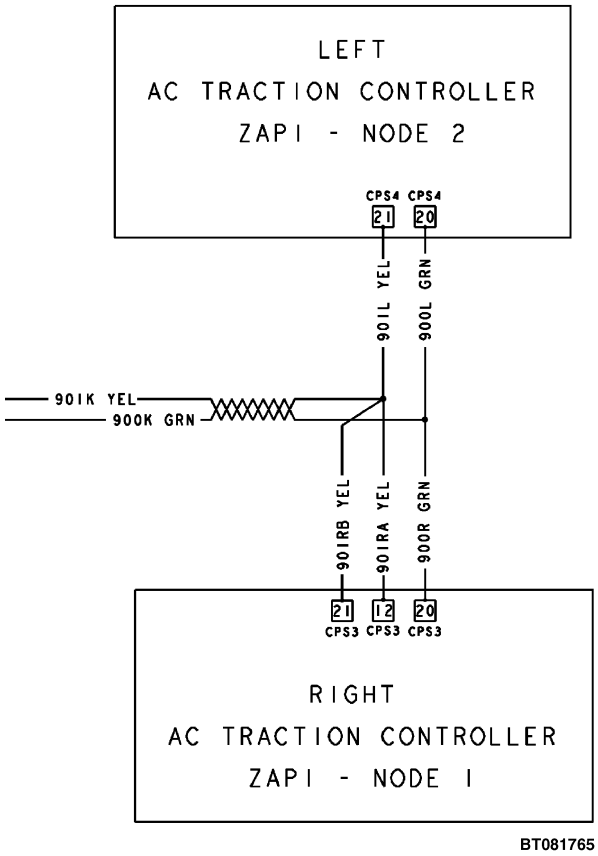
DTC 65504 (Cont)
Waiting for Node

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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CODES

DTC 12836 - Brake Pedal Sensor A OORL
DTC 12837 - Brake Pedal Sensor A OORH
DTC 12876 - Brake Pedal Sensor B OORL
DTC 12877 - Brake Pedal Sensor B OORH
DTC 12813 - Foot Brake Position Rationality

POSSIBLE CAUSE

A. BRAKE PEDAL SENSOR WIRING FAULT
B. BRAKE PEDAL SENSOR SIGNAL FAULT
C. BRAKE PEDAL SENSOR FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - BRAKE PEDAL SENSOR WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect brake pedal sensor connector CPS274, and measure voltage between cavity C/D and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect 5 volt supply circuits 250L and 250AB (Sensor A) / 089F and 089A (Sensor B) for open or short.

NOTE: Key in ON position.

2. Measure voltage between brake pedal sensor connector CPS274, cavity C/D and B/E.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Cause B.
   NO: Inspect ground circuit 120N (Sensor A) / 115N (Sensor B) for open or short.

CAUSE B - BRAKE PEDAL SENSOR SIGNAL FAULT

PROCEDURE OR ACTION:

1. Disconnect VSM connector CPS1. Measure resistance between the following:

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(Cont)

- Brake pedal connector CPS274, cavity A and VSM connector CPS1, cavity 1.
- Brake pedal connector CPS274, cavity F and VSM connector CPS1, cavity 27.

Is resistance <1 ohm?
YES: Proceed to Cause C.
NO: Inspect appropriate brake pedal signal circuit for open, short, or source of excessive resistance.

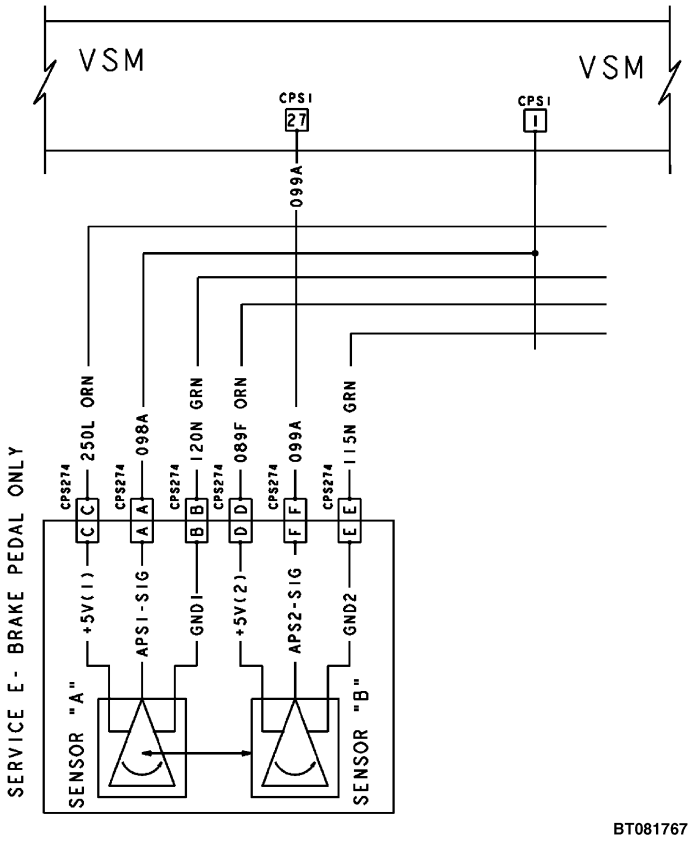
CAUSE C - BRAKE PEDAL SENSOR FAULT

PROCEDURE OR ACTION:

1. Replace faulty brake pedal sensor.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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DTC 4117
FOC Configuration Mismatch

POSSIBLE CAUSE

A. SOFTWARE CONFIGURATION FAULT
B. INCORRECT CDF SETUP
C. BAD SERVICE BRAKE POSITION SENSOR
D. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - SOFTWARE CONFIGURATION FAULT

PROCEDURE OR ACTION:

1. Locate and view traction controller version.
   Does traction 1 controller version match AE2M?
   YES: Proceed to Step 2.
   NO: Proceed to Cause B.
2. Verify controller is configured with electric brake option CDF.
   Is controller equipped with electric brake?
   YES: Proceed to Cause C.
   NO: Proceed to Cause D.

CAUSE B - INCORRECT CDF SETUP

PROCEDURE OR ACTION:

1. Bad CDF, disable electric brake option in CDF.

CAUSE C - BAD SERVICE BRAKE POSITION SENSOR

PROCEDURE OR ACTION:

1. Measure output voltage at brake pedal signal B.
   Is fault 12876 also present with this fault?
   YES: Proceed to Diagnostic Trouble Codes, Page 9030-20-552.
   NO: Proceed to Cause D.

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DTC 4117 (Cont)
FOC Configuration Mismatch

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

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DTC 33040
Various CAN Errors

POSSIBLE CAUSE

A. CANBUS FAULT
B. SOFTWARE UPDATE
C. CONTROLLER FAULT

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to Cause A.

CAUSE A - CANBUS FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the diagnostic connector CPS28, socket A and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. if voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the diagnostic connector CPS28, socket B and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.
3. Measure resistance between the diagnostic connector CPS28, socket A and socket B.
   Is resistance 60 ± 6 ohms?
   YES: Connect battery and proceed to Cause B.
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damage termination resistor. If resistance is 0 ohms, the CANbus circuit are shorted together.

CAUSE B - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to Cause C.

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DTC 33040 (Cont)
Various CAN Errors

NO: No further service required.

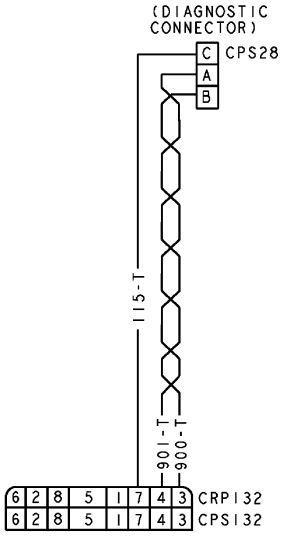
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

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NOTES

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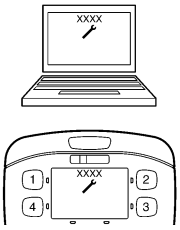
Group 30

Observed Symptoms

No Display/No Truck Operation

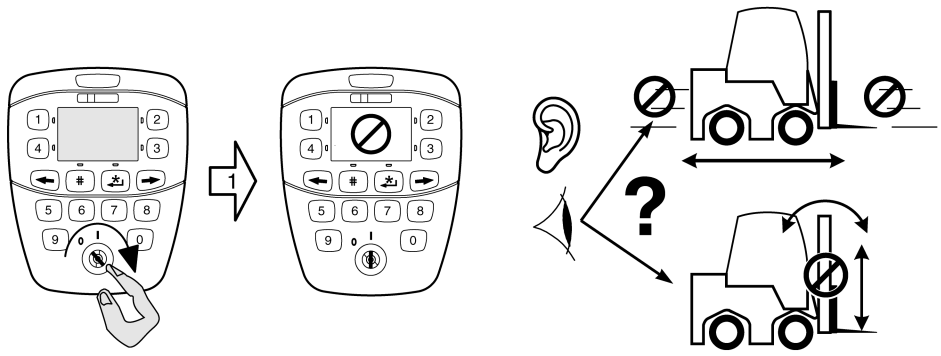


Fault Codes

DTC None
No Display/No Truck Operation

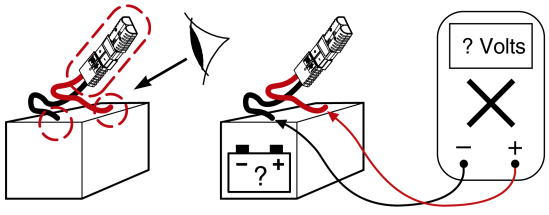
QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Symptom 1 No Display/No Truck Operation



Power **ON**→ No Display→ No truck Operation

Check 1



Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜< OORL	18	24	36	40
˜ OORH	48.6	57.6	97.2	108

1. Check Emergency Disconnect Button is Released↓
2. Check Battery Connections/Wiring↓
3. Check Battery Voltage→See Table↑
4. Battery Voltage OK→YES Check 2↓NO→See Battery Service Manual for Battery Charging Instruction?

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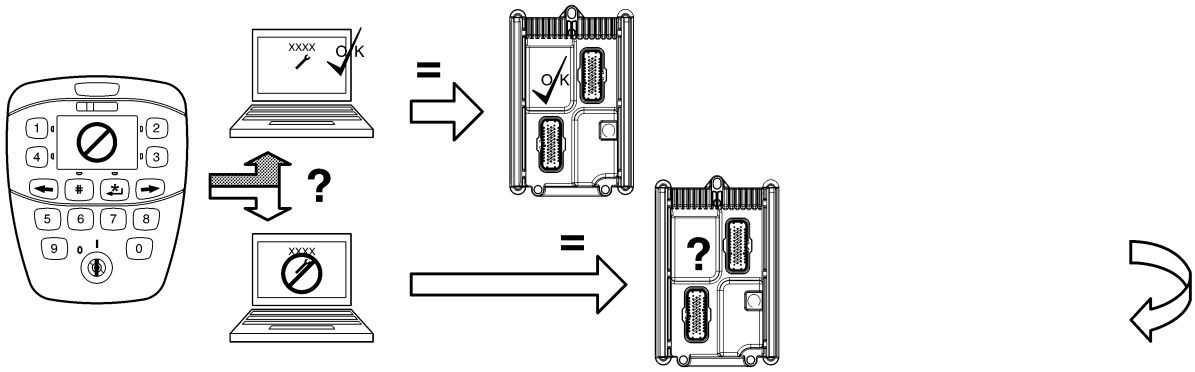
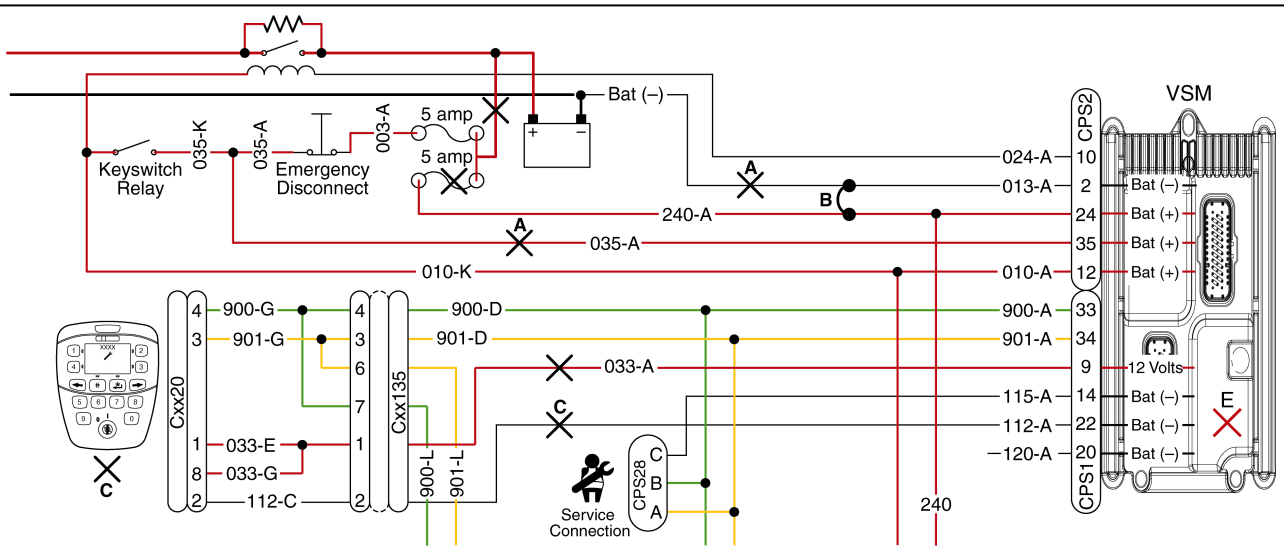
No Display/No Truck Operation (Cont)

Check 2



1. Use PC Service Tool to Check for DTCs↓
2. ? DTCs→YES→VSM OK→Check Display Power Connections→Component Operational Check↓
3. ? DTCs→NO Check 3↓

A935/K160 Refer to **Diagrams** 8000SRM1528.



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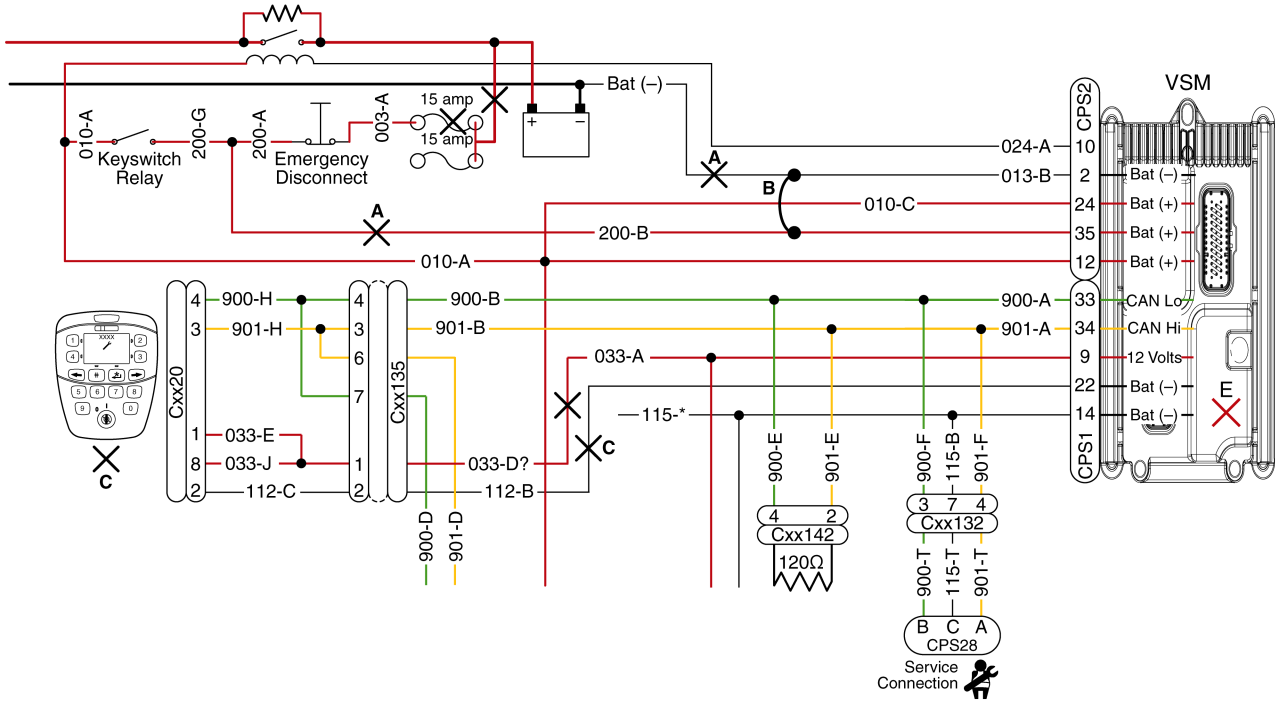
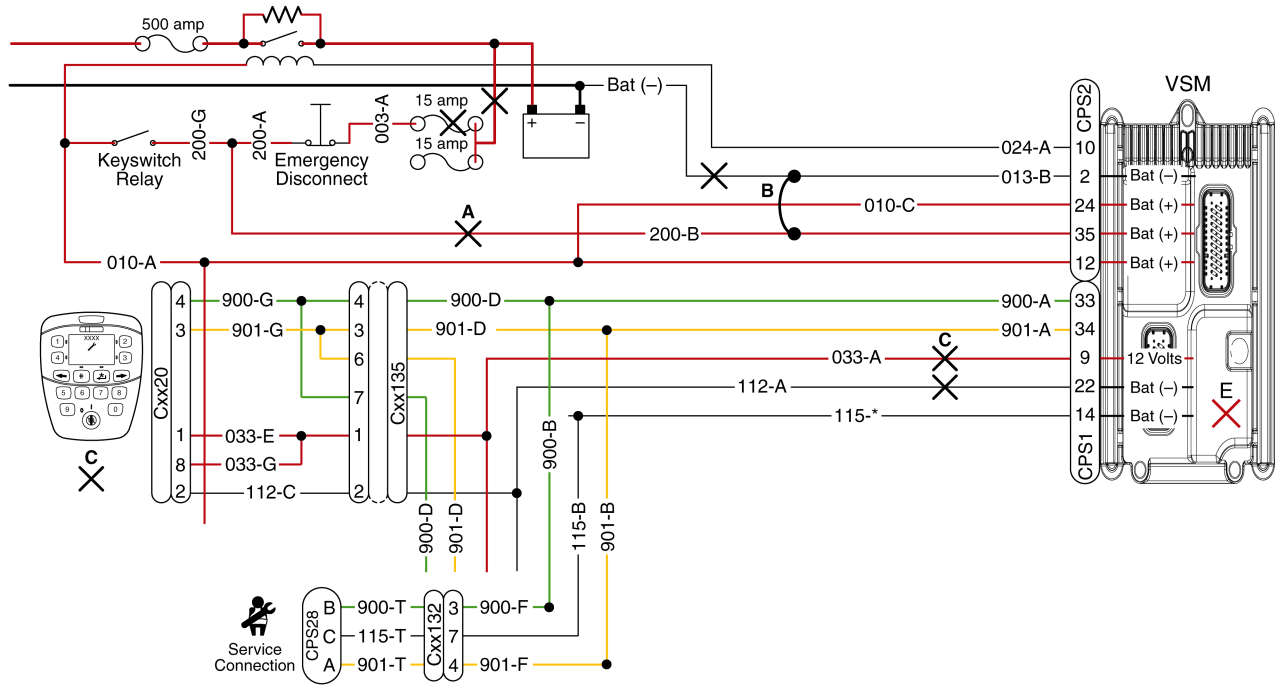
No Display/No Truck Operation (Cont)

4 Wheel CBB

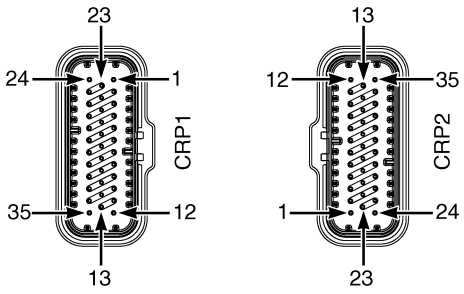


4 Wheel DBB

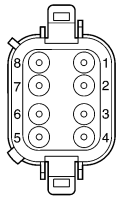


No Display/No Truck Operation (Cont)

Connectors



VSM Cxx 1 and Cxx 2



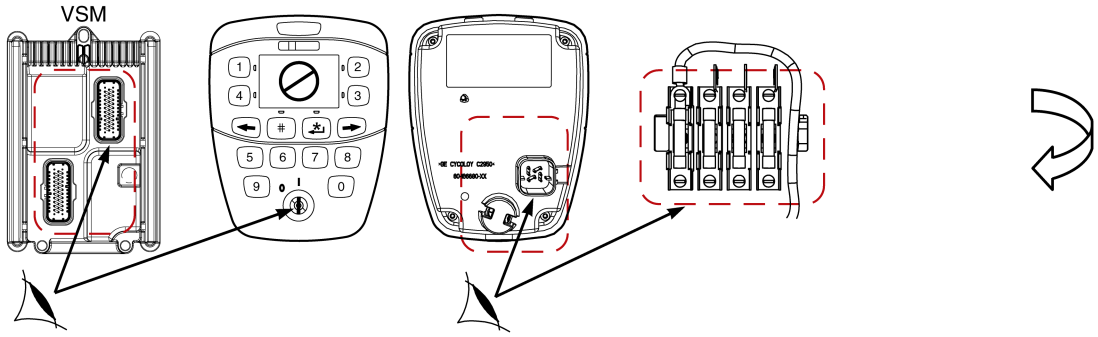
Display Cxx 20 and 135

For further information showing VSM/Display/Fuse location see General Description

Check 3

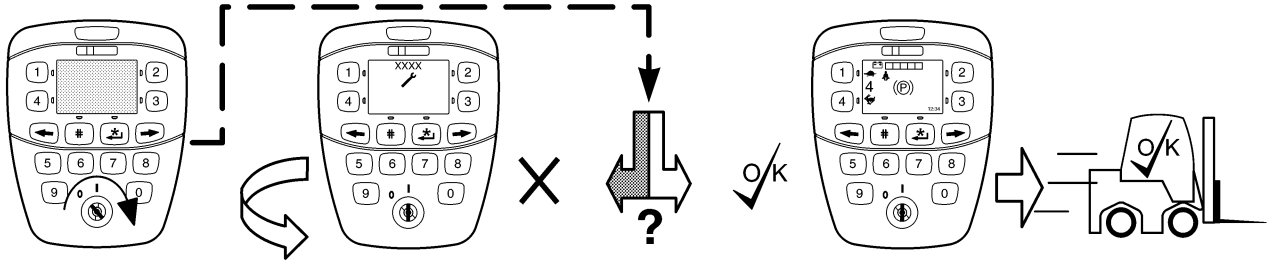
CAUTION:A Open Circuit Fuse Indicates a Short Circuit in the Wiring

Locate the Short before replacing the fuse



1. Is Key Switch Turning without binding?→YES Go to 2↓NO Go to 3 for Replacement Instructions↓
2. Check VSM/Display Power/Fuses/Connections/Wiring→Component Operational Check↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→
4. Repair/Replace→Reconnect→Test→Go to Check 4↓

Check 4



Retest - Power **ON**→	**NO** → ?	Does Display Turn ON? Is fault DTC gone? **NO** **YES** ← →	Fault corrected→ Continue operation.

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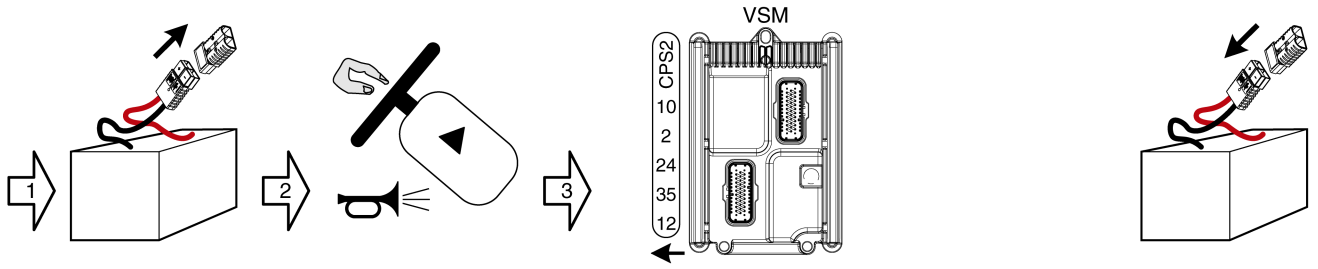
No Display/No Truck Operation (Cont)

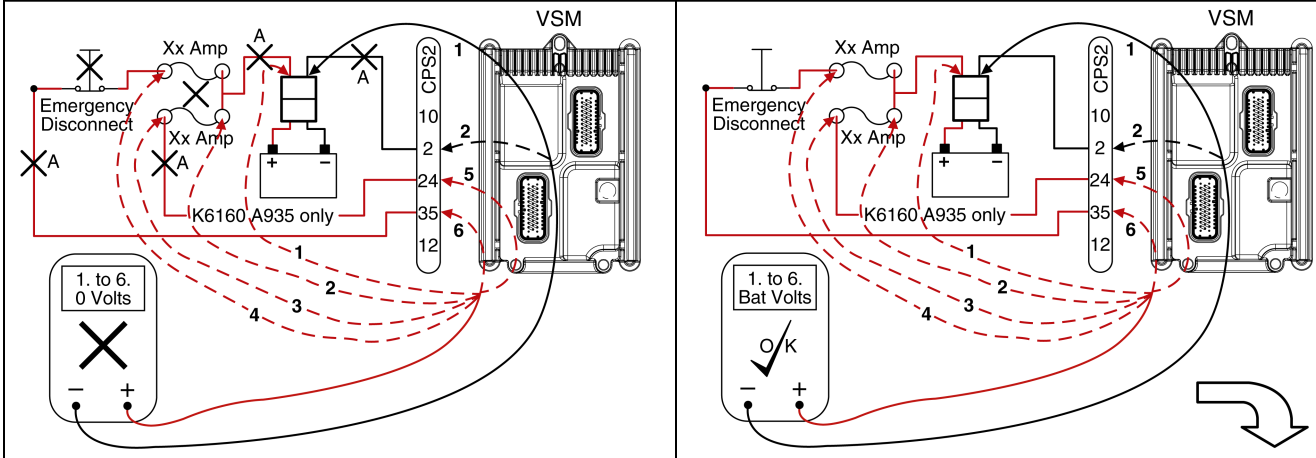
CAUSE A



Disconnect Battery and Sound Horn to Discharge Capacitors.→ Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. Disconnect VSM→Reconnect Battery→

STEP A1 CHECK VOLTAGE

VSM Power Connections



Disconnect VSM connector CPS2 and check for Battery Volts

1. <18 Volts = Flat Battery↓	1. Battery Volts = OK, Go to 2↓
2. 0 Volts = Open Circuit→Step A2↓	2. Battery Volts = OK, Go to 3↓
3. 0 Volts = ☠Fuse→Component Operational Check↓	3. Battery Volts = OK, Go to 4↓
4. 0 Volts = ☠Fuse→Component Operational Check↓	4. Battery Volts = OK, Go to 5↓
5. 0 Volts = Open Circuit→Go to 7↓	5. Battery Volts = OK, Go to 6↓
6. 0 Volts = Open Circuit→Go to 7↓	6. Battery Volts = OK, Component Operational Check↓
7. Open Circuit→Find/Repair Open Circuit, Go to 8↓	
8. Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
9. Recheck Volts at (+) 5 & 6 (-) 2↑→Battery Voltage Present?YES→Component Operational CheckResume OperationNo→Step A2↓	

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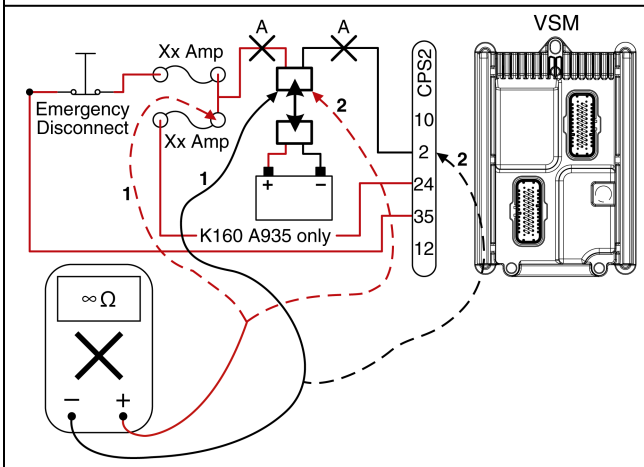
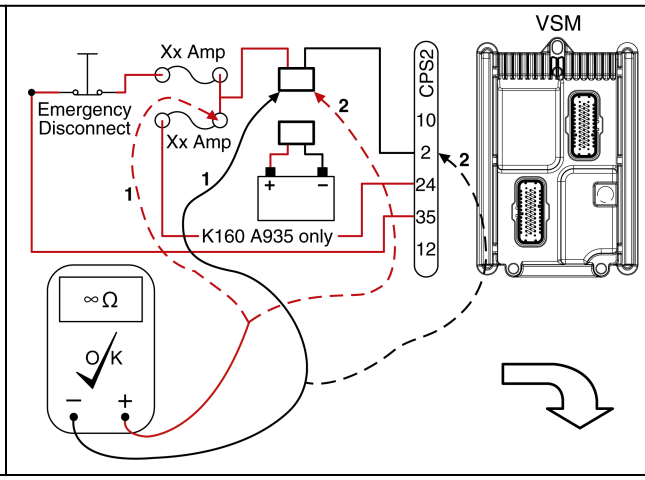
No Display/No Truck Operation (Cont)

STEP A2 CHECK RESISTANCE - Ω - OHMS

VSM Power Connections Open Circuit





Disconnect Battery→ Check for ?

1. 8? = Open Circuit, Go to 3↓	1. 0 ? = OK, Go to 2↓
2. 8? = Open Circuit, Go to 3↓	2. 0 ? = OK, Component Operational Check↓

3. Find/Repair Open Circuit, Go to 4↓

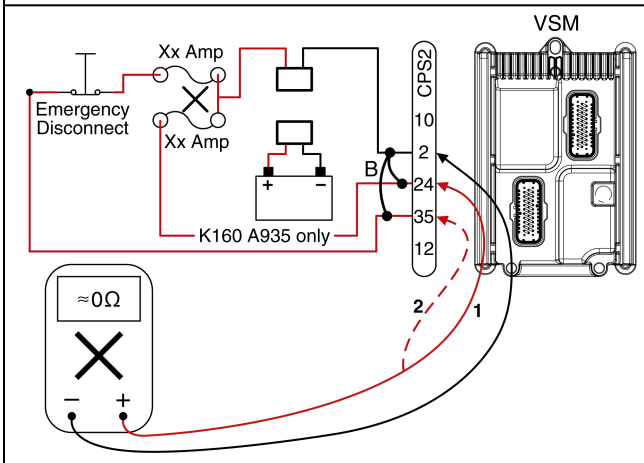
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→

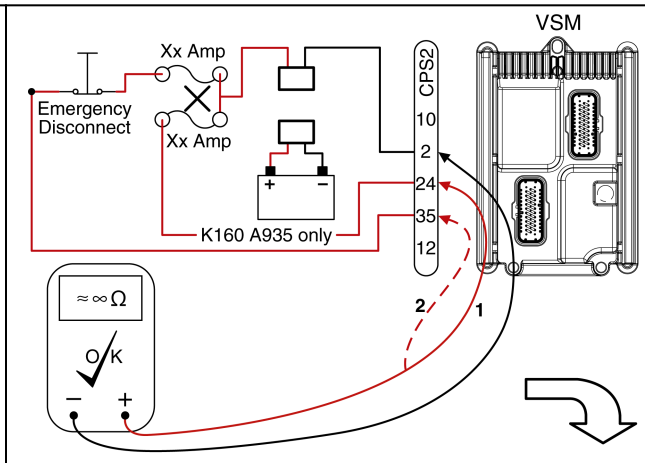
5. Recheck ? at 1 & 2↑→= 0 ??YES→Go to 6↓Resume OperationNo→Go back to 3↑

Reconnect Battery→ Test→ Battery Voltage Present? Yes→ Resume Operation→ No→ Component Operational Check ↓

CAUSE B CHECK RESISTANCE - Ω - OHMS

VSM Power Connections Fuse (Short Circuit)





1. 0? = Short Circuit→Go to 3↓	1. 8? = OK→Go to 2↓
2. 0? = Short Circuit→Go to 3↓	2. ˜ 8? = OK→Step B2↓

3. Find/Repair Short, Circuit Go to 4↓

4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Step B2↓

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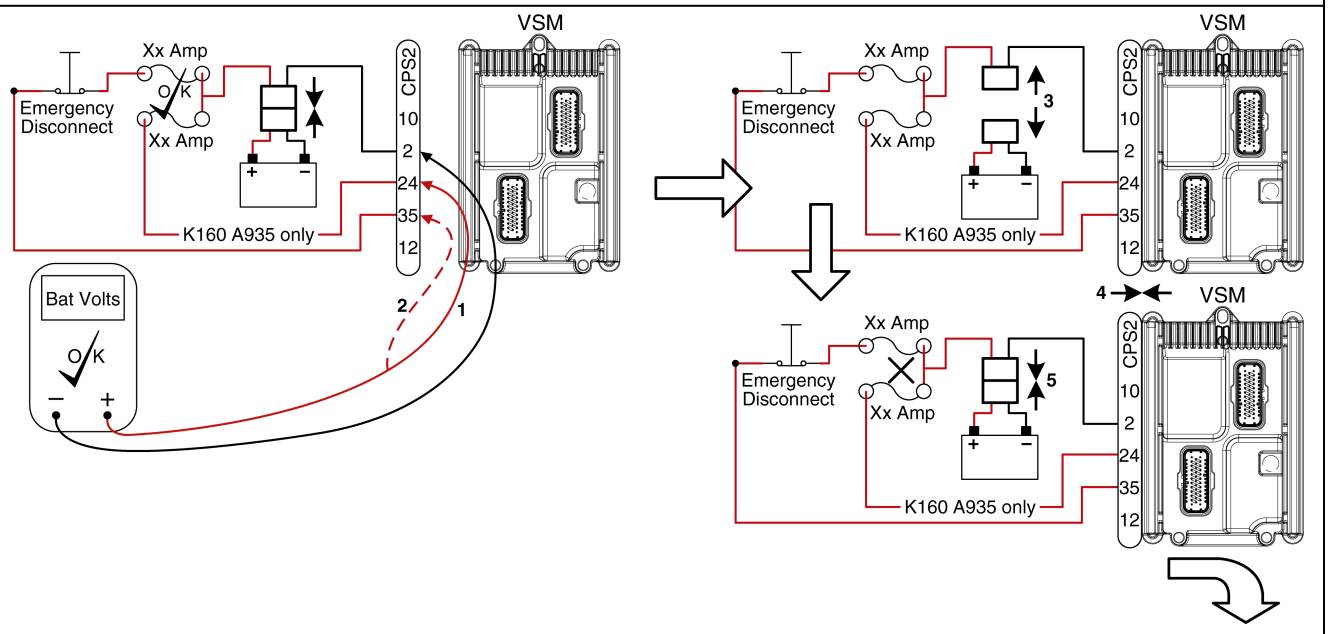
No Display/No Truck Operation (Cont)

STEP B1 CHECK RESISTANCE - Ω - OHMS

VSM Power Connections Open Circuit



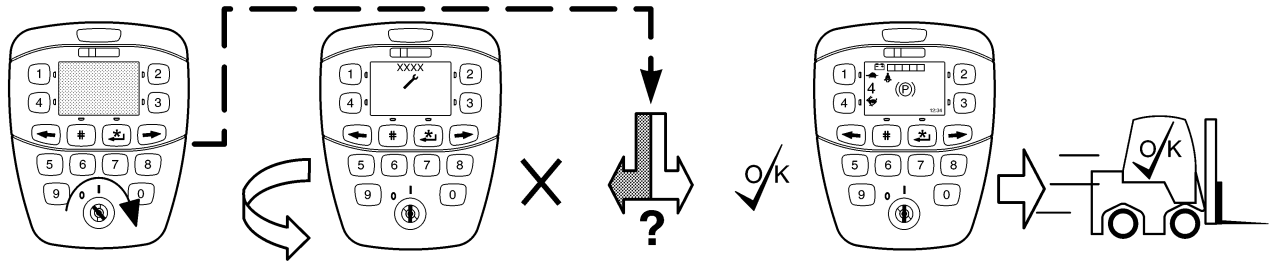
Replace Fuse(s)→ Reconnect Battery→ Check Volts→ Go to 1↓

1. Battery Volts Present?Yes→Go to 2↓

2. Battery Volts Present?Yes→Go to 3↓

3. Disconnect Battery→4. Reconnect VSM→5. Reconnect Battery, Step B2↓

STEP B2



Retest - Power **ON**→

NO → Component Operational Check

Does Display Turn ON?
Is fault DTC gone?

NO YES ← →

Fault corrected→ Continue operation.

CAUSE C

DISPLAY Connection Failure

See A935 – K160 CAN Communication Failure, CBB 4 Wheel CAN Communication, and DBB 4 Wheel CAN Communication→

END FAULT

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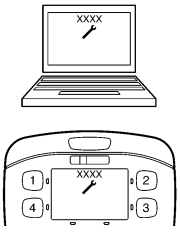
A935 – K160 D203 Motor Controller Fan Failure

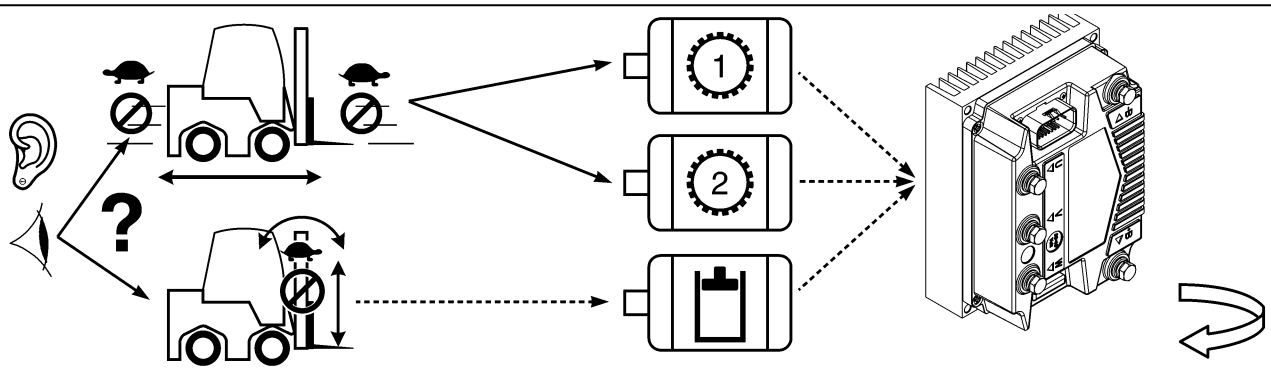


Fault Codes

DTC None
A935 – K160 Motor Controller Fan Failure

QUICK CHECK X Open Circuit/Fail) = Short Circuit

Check 1



? Function Failure/Reduced Performance/Uncommanded Continuous Operation?

POSSIBLE CAUSES

1. Fan/Motor Controller Connections/Wiring ?→
2. Fan Motor Failure ?→
3. Motor Controller(s) Failure ?→

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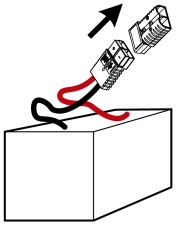
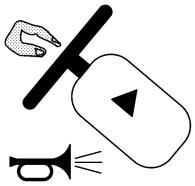
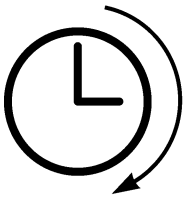
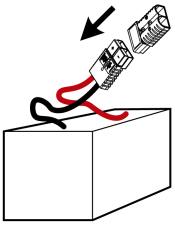
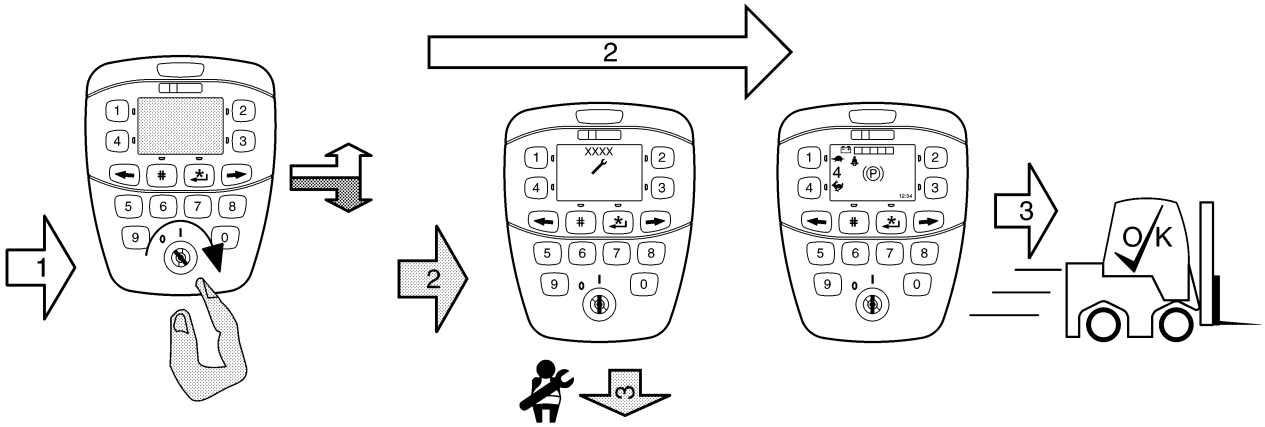
A935 – K160 D203 Motor Controller Fan Failure (Cont)

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

Check 3



Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

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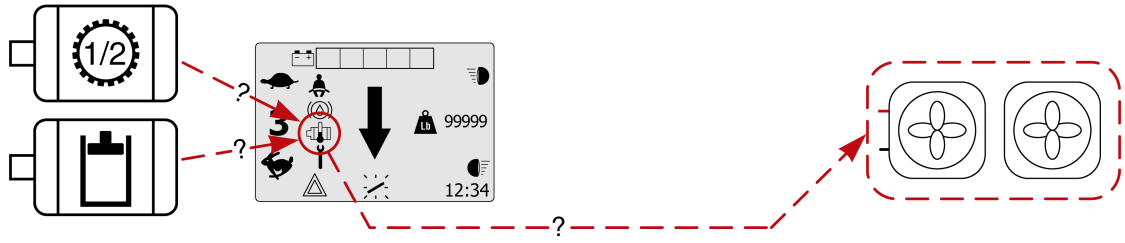
A935 – K160 D203 Motor Controller Fan Failure (Cont)

Check 4



Reduced Performance→ Check Display Icons?

Motor/Motor Controller Temperature Icon On

1. Check fan operation→Are fans operating?→NO →Component Operational CheckYES →Go to 2?

2. Temp Sensor/Sensor Connection→Open Circuit→Observed Symptoms, Page 9030-30-21

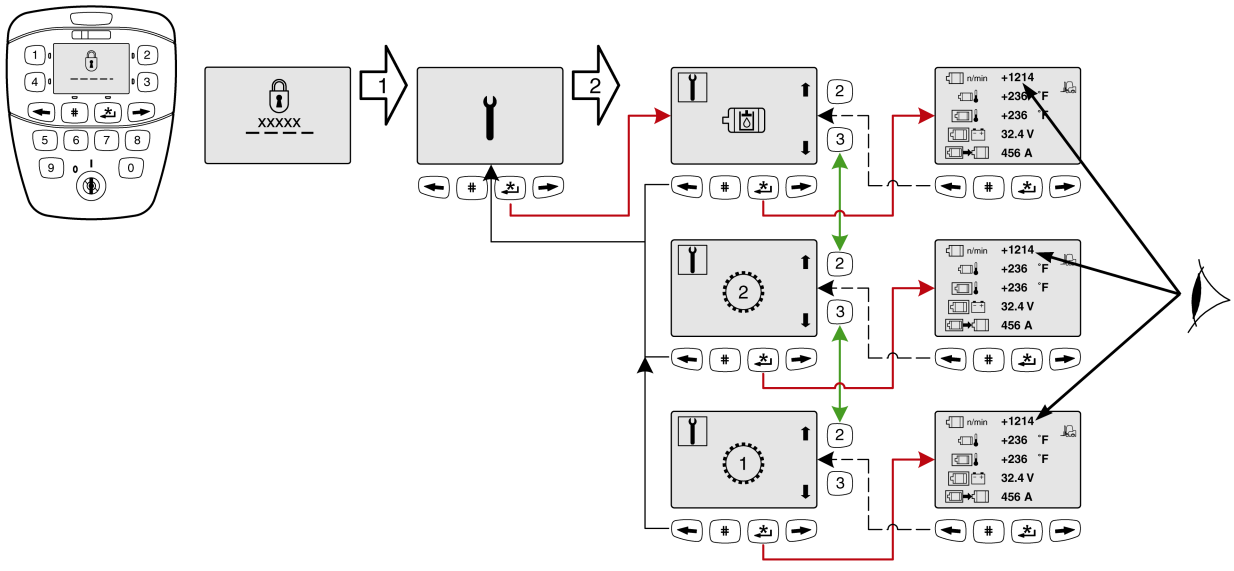
3. Use the following steps for viewing Motor Temperatures

Fan(s) Operation Temperature Threshold	**Traction = 55°C (131°F) Pump = 65°C (149°F)**
Reduced Performance:	**Traction = 80°C (176°F) Pump = 80°C (176°F)**

Temperature > Operation Threshold→ No Fan Operation = Faulty Fan/Fan Connections

Check 5

Diagnostics Temperature Analysis – Go to Display Menu Flowchart



Enter Service Password→	Diagnostics→ Motor→ Traction1/Traction2/Pump→	Motor/Controller Data

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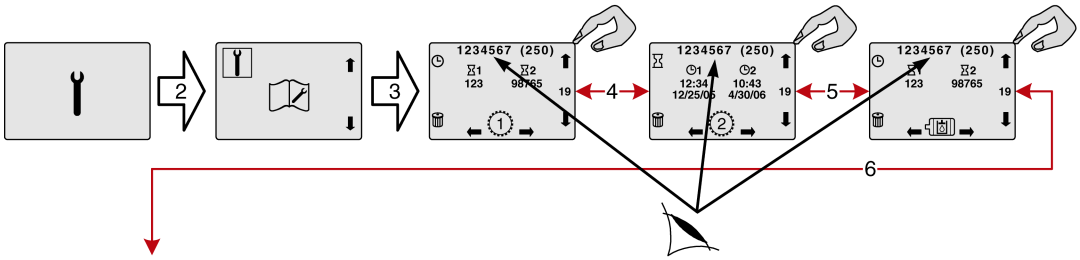
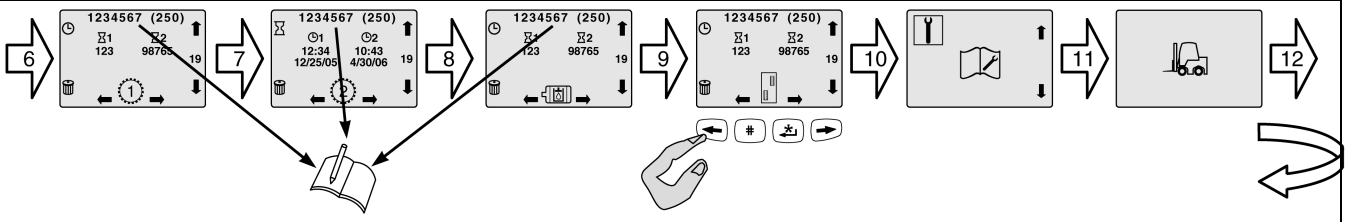
A935 – K160 D203 Motor Controller Fan Failure (Cont)

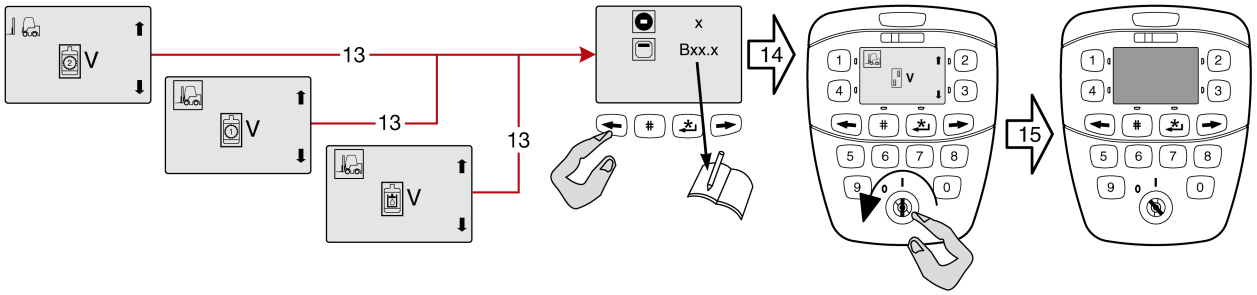
FAULT LOG Review - Go to Display Menu



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



📋✍ all Motor DTCs→ ☜ Exit Fault Log→ Truck Status ?



Motor Versions→ 📋✍Hardware/Software Versions→ ☜ Exit Versions→ Power **OFF**?

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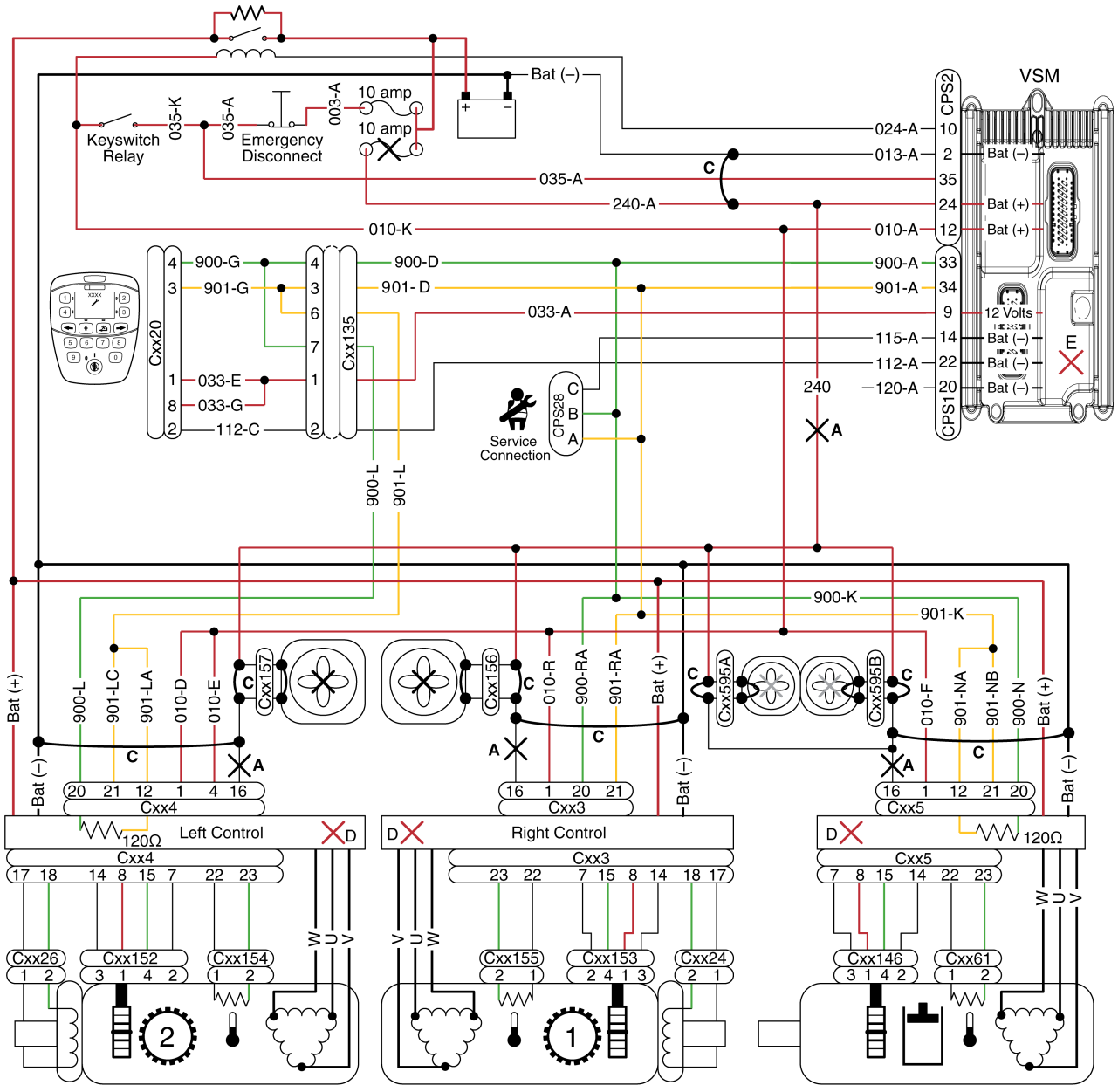
A935 – K160 D203 Motor Controller Fan Failure (Cont)

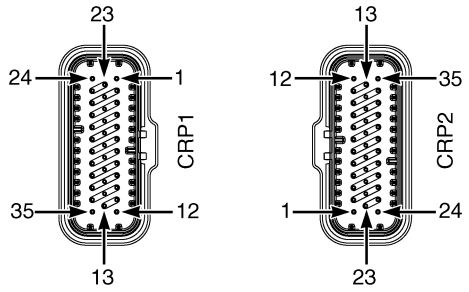
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

CAUSES A B C D E > ?

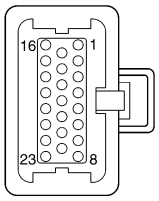


A935 – K160 D203 Motor Controller Fan Failure (Cont)

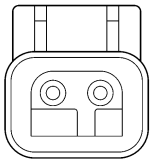
CONNECTORS



VSM Cxx 1 and Cxx 2

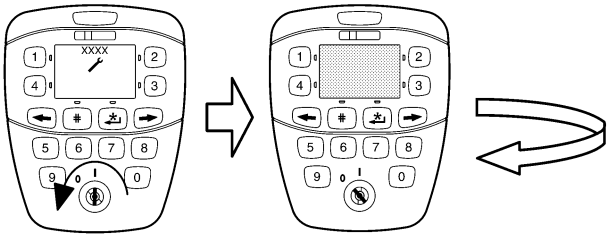


Traction/Pump Controller Cxx 3, 4, and 5



Fan Motor Connector Cxx 156, 157, 595A, 595B

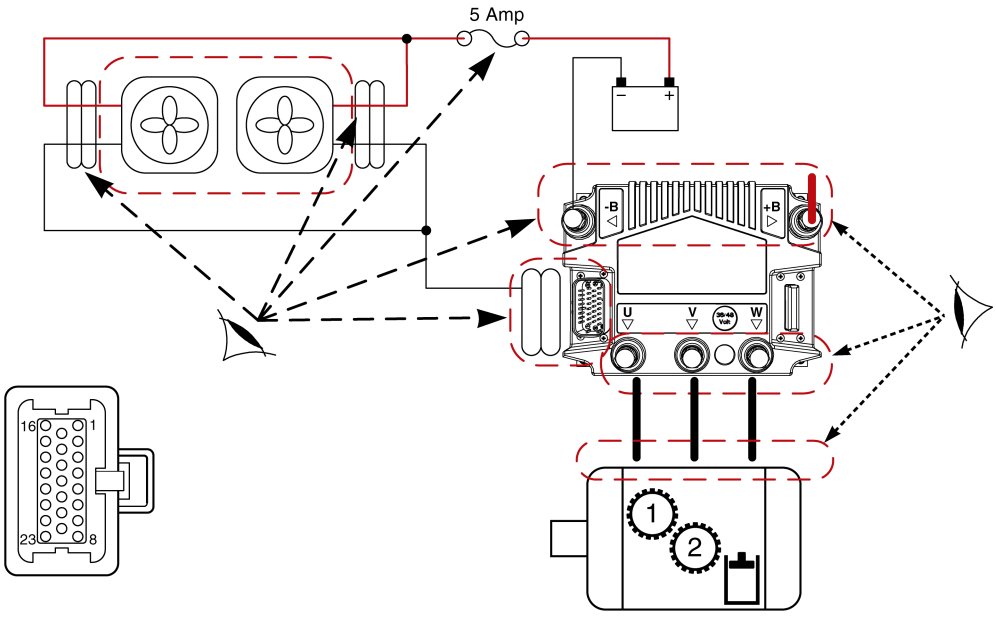
CAUSE A



Power **OFF**→ ?

STEP A1

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections



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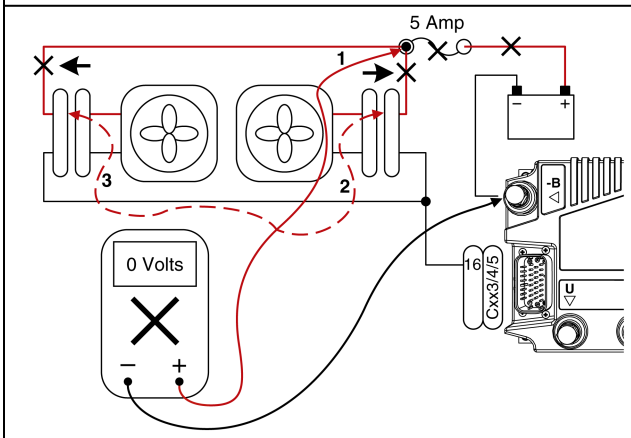
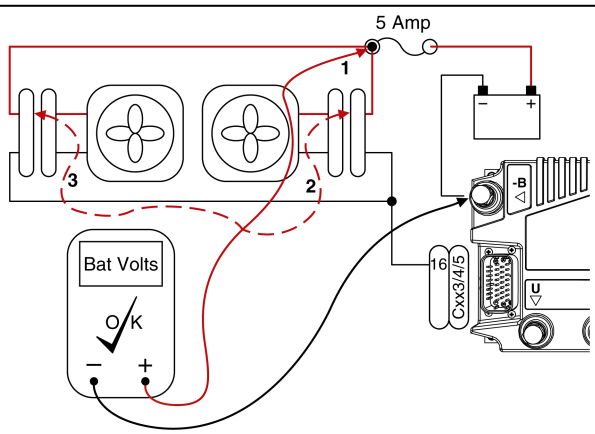
A935 – K160 D203 Motor Controller Fan Failure (Cont)

STEP A2 CHECK VOLTAGE

Fan Operation





Disconnect Fan(s) and connect DMM as indicated↓

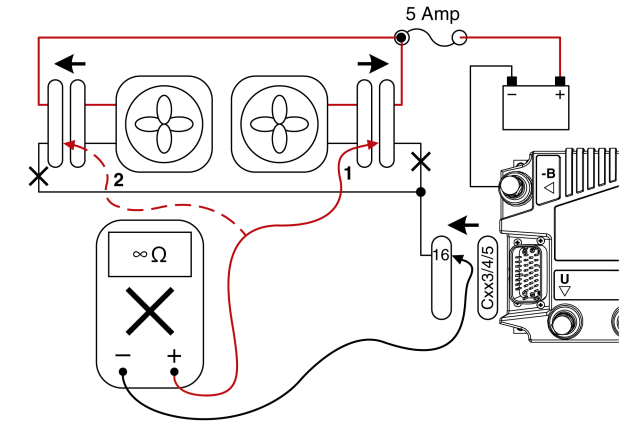
1. 0 Volts = Open Circuit (Fuse)→Step A6↓	1 ˜ Bat Volts = OK Go to 2↓
2. 0 Volts = Open Circuit→Go to 4↓	2. ˜ Bat Volts = OK Go to 3↓
3. 0 Volts = Open Circuit→Go to 4↓	3. ˜ Bat Volts = OK Go to Step A3↓

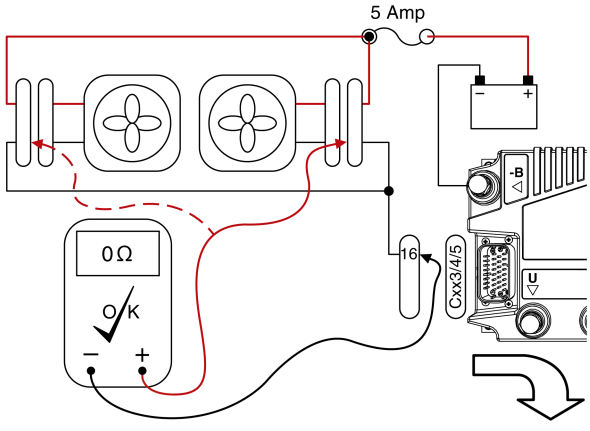
4. Find/Repair Open Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→

5. Recheck ?↑→ Reconnect→Retest→Step A5↓

STEP A3 CHECK RESISTANCE - Ω - OHMS

Fan Operation





Disconnect Relevant Controller and connect DMM as indicated↓

1. 8? = Open Circuit→Go to 3↓	1 ˜ 0? = OK Go to 2↓
2. 8? = Open Circuit→Go to 3↓	2. ˜ 0? = OK Go to Step A4↓

3. Find/Repair Open Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→

4. Recheck ?↑→ Reconnect→Retest→Step A5↓

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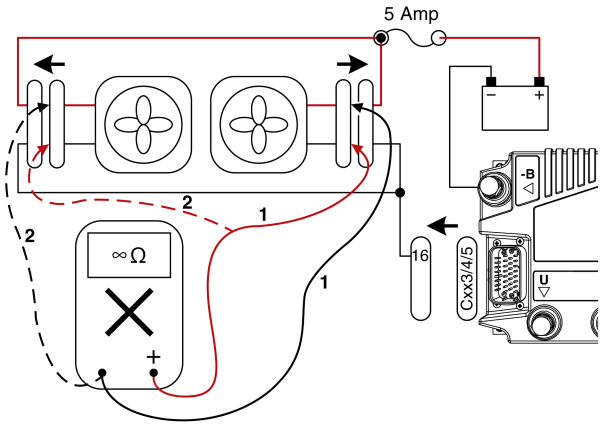
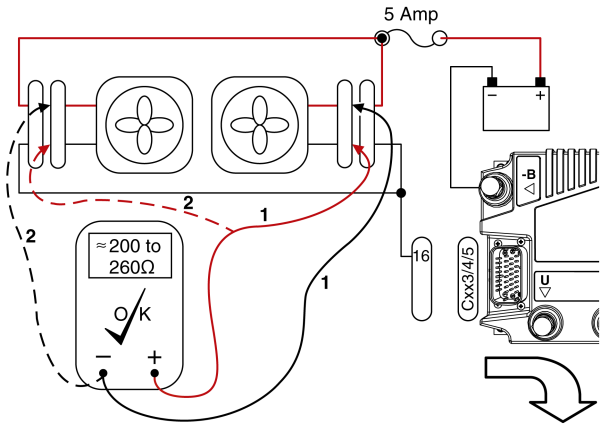
A935 – K160 D203 Motor Controller Fan Failure (Cont)

STEP A4 CHECK RESISTANCE - Ω - OHMS

Fan Operation

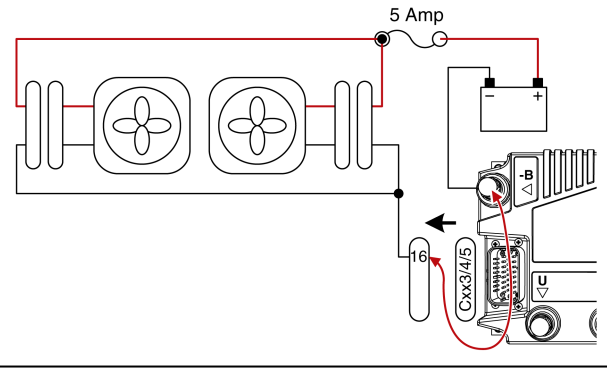


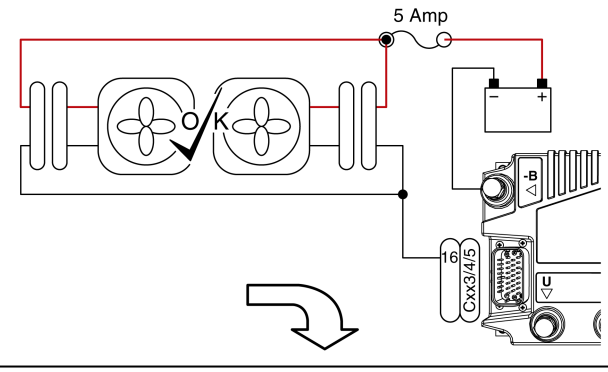


1. 8? = Open Circuit→Go to 3↓< 150?→Component Operational Check↓	1 ˜ 200 to 260? = OK Go to 2↓
2. 8? = Open Circuit→Go to 3↓< 150?→Component Operational Check↓	2. ˜ 200 to 260? = OK Go to Step A5↓
3. Find/Repair Open Circuit/Replace Fan See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
4. Recheck ?↑→ Reconnect→Retest→Step A5↓	

STEP A5

Fan Operation Test





1. Connect Fan(s) Circuit to Bat (-) as shown→Go to 2↓	
2. Fan(s) Do not operate→Go to 3↓	2. Fan(s) operate→Go to 4↓
3. Replace Fan→Retest with Jumper wire→Go to 4↓	
4. Reconnect Controller→Operate Truck (Traction/Hydraulics) for at least 10 minute↓	
5. Fan(s) operate→Resume Operation	
6. Fan(s) Do not operate→Component Operational Check↓	

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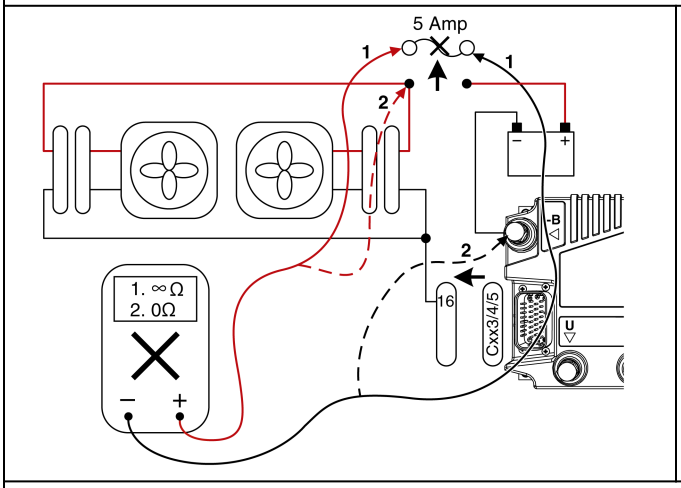
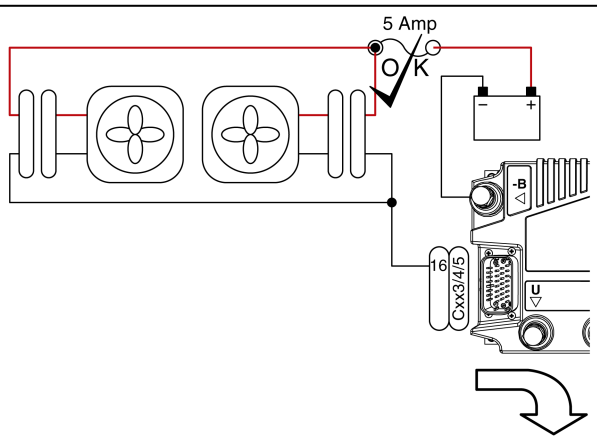
A935 – K160 D203 Motor Controller Fan Failure (Cont)

STEP A6 **CHECK RESISTANCE - Ω - OHMS**

Fan Operation from Step A1





1. Remove Fuse→Measure ?→8? = Fuse Open Circuit→Go to 2↓
2. 0? = Short Circuit→Go to 3↓
3. Find/Repair Short Circuit→Go to 4↓
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 5↓
5. Replace Fuse→Reconnect Controller→Operate Truck (Traction/Hydraulics) for at least 10 minute↓
6. Fan(s) operate→Resume Operation
7. Fan(s) Do not operate→Component Operational Check↓

CAUSE B

Not Applicable

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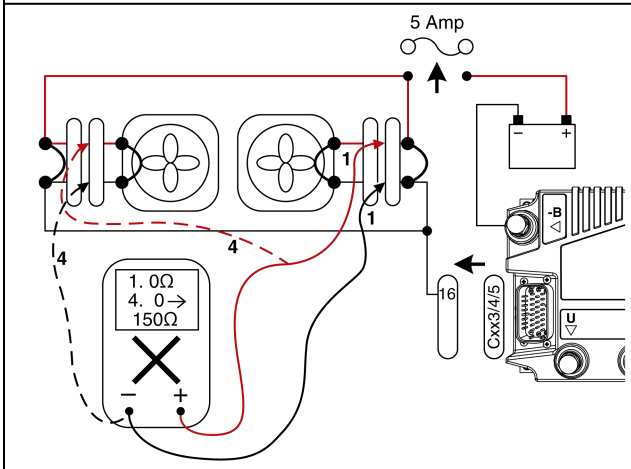
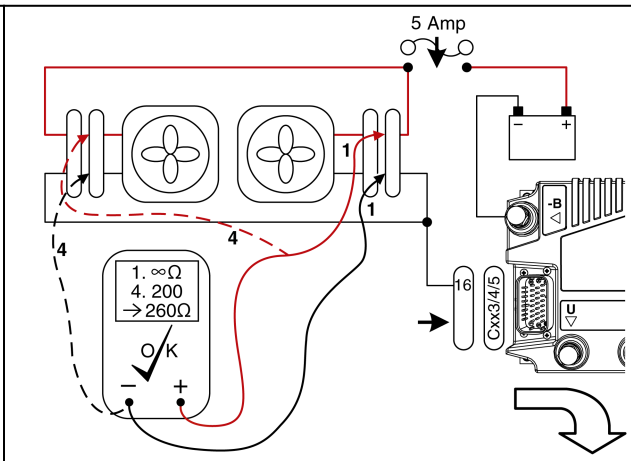
A935 – K160 D203 Motor Controller Fan Failure (Cont)

CAUSE C

Fan Operation





1. Remove Fuse→Measure ?→0? = Short Circuit→Go to 2↓
2. Find/Repair Short Circuit→Go to 3↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 6↓
4. From Step A30 to 150? = Fan Short Circuit→Go to 5↓
5. Replace Fan →See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 6↓
6. Replace Fuse→Reconnect Controller→Operate Truck (Traction/Hydraulics) for at least 10 minute↓
7. Fan(s) operate→Resume Operation
8. Fan(s) Do not operate→Component Operational Check↓

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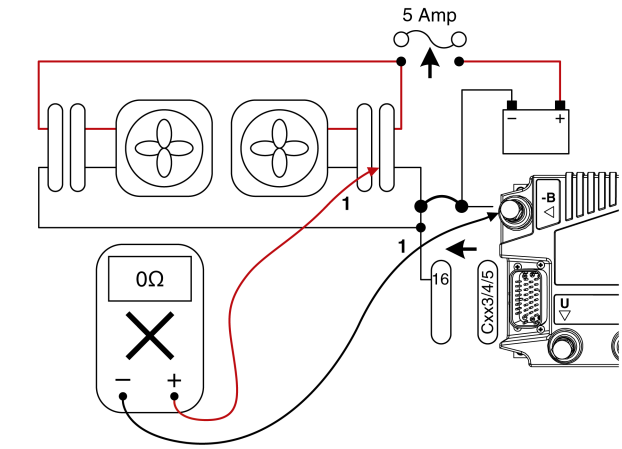
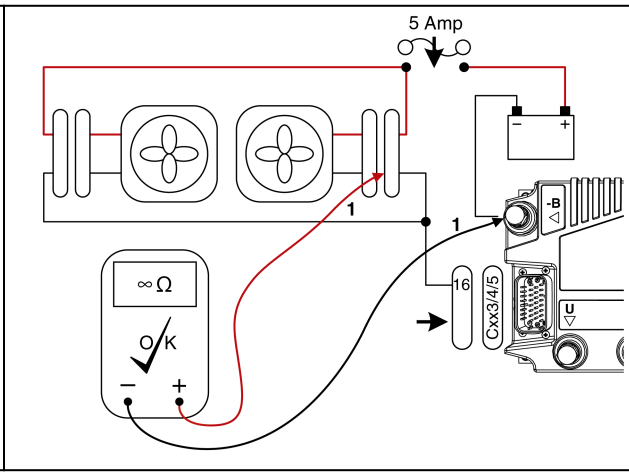
A935 – K160 D203 Motor Controller Fan Failure (Cont)

STEP C1	CHECK RESISTANCE - Ω - OHMS

Fan Operation (Continuous)





1. Remove Fuse→Measure ?→0? = Short Circuit→Go to 2↓
2. Find/Repair Short Circuit→Go to 3↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓
4. Replace Fuse→Reconnect Controller→Operate Truck (Traction/Hydraulics) for at least 10 minute↓
5. Fans Operate Continuously at Power **ON**→Faulty Controller→Component Operational Check↓
6. Fans operate briefly and then don't operate until at least 1 minute of Operation→Resume Normal Operation↓

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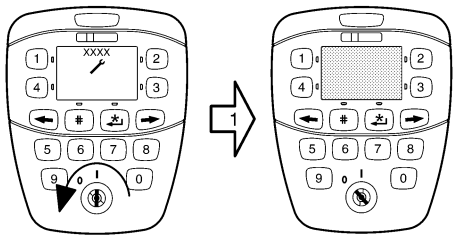
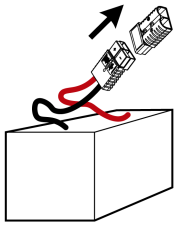
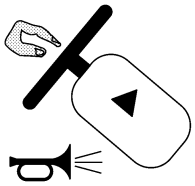
A935 – K160 D203 Motor Controller Fan Failure (Cont)

CAUSE D

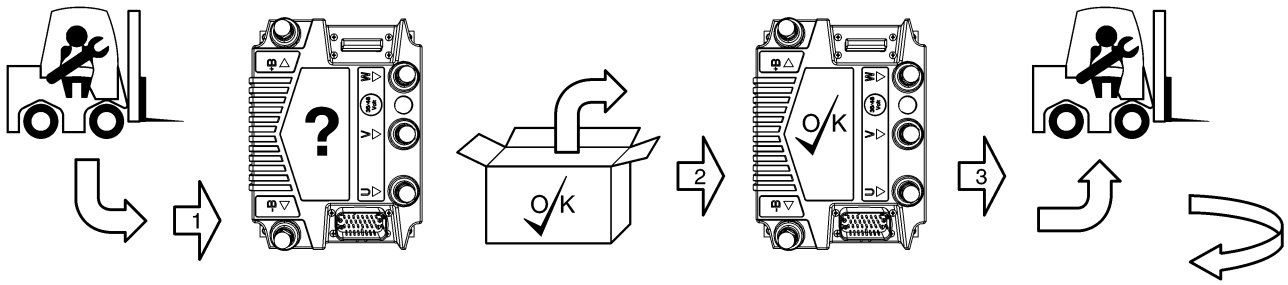






Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

STEP D1

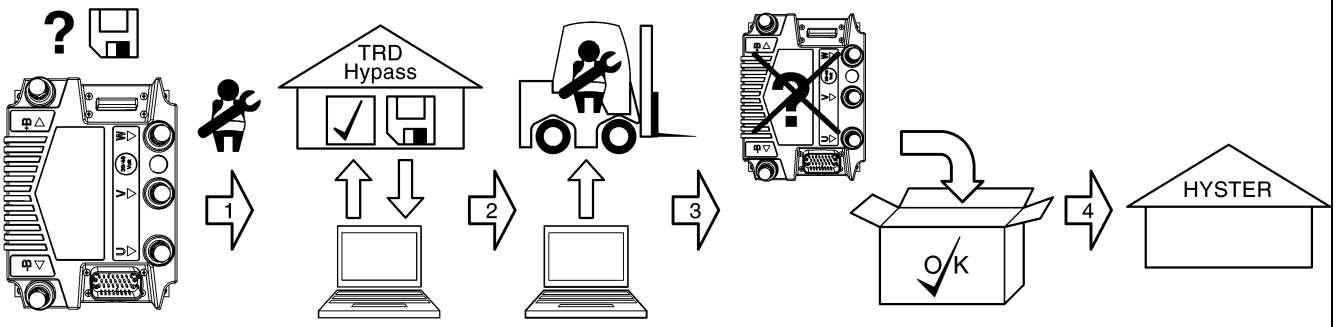


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

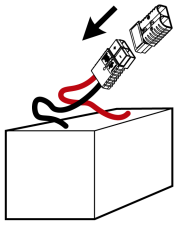
2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

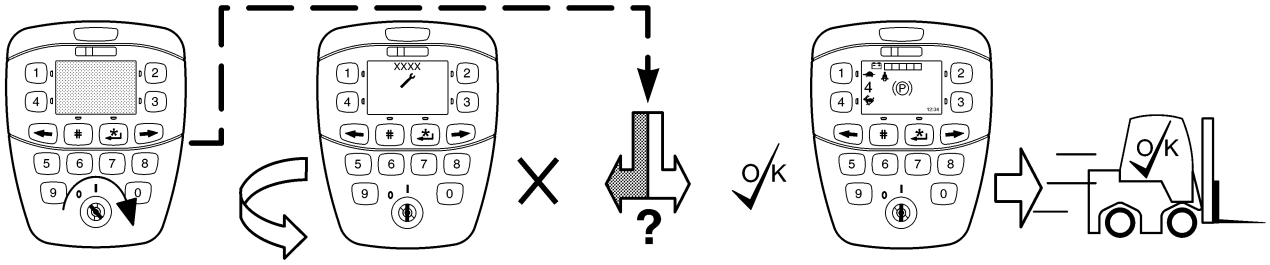
3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 D203 Motor Controller Fan Failure (Cont)

STEP D3

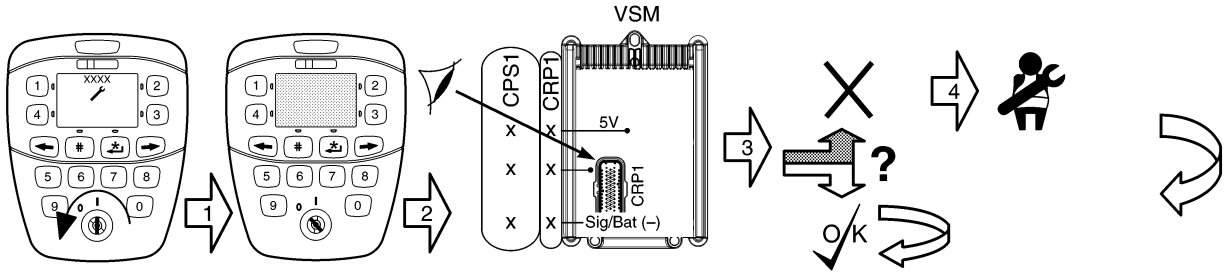




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

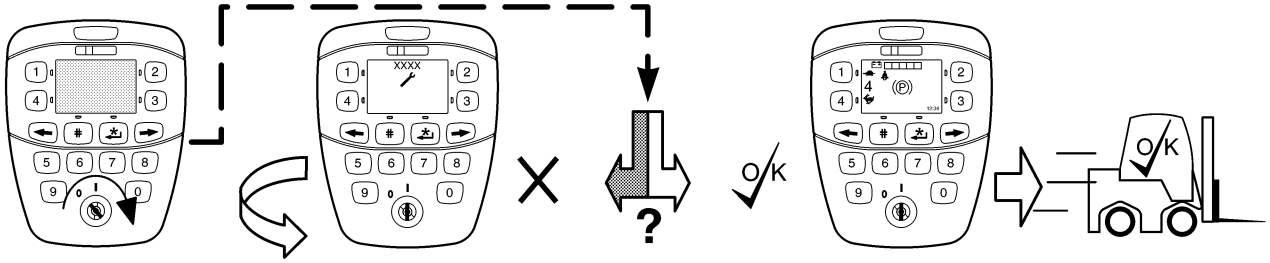
NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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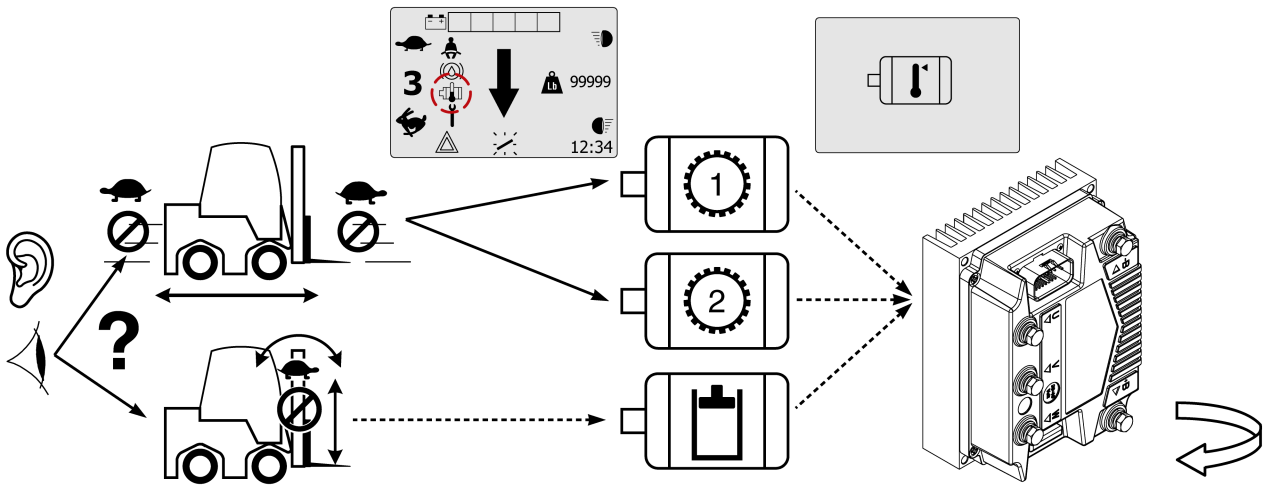
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure

Fault Codes

DTC None
A935 – K160 Motor/Motor Controller Temperature Sensor Failure

QUICK CHECK **X Open Circuit/Fail) = Short Circuit**

Check 1



? Over Temperature Icon Displayed at Power ON?

POSSIBLE CAUSES

1. Sensor(s) – Motor/Motor Controller – Connections/Wiring?→	Component Operational Check ↓
2. Sensor(s) Failure?→	Component Operational Check ↓
3. Motor Controller(s) Hardware Failure?→	Component Operational Check ↓
Note: Hydraulic Oil Over Temperature and Sensor Issues seeHydraulic Temperature Sensor Out of Range High (OORL) /Hydraulic Temperature Sensor Out of Range High (OORH)	

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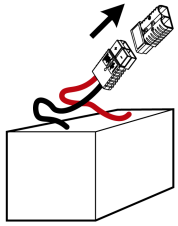
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

? Over Temperature Icon Displayed during Operation/Reduced Performance/Function Failure?	
POSSIBLE CAUSES	
1. Motor/Motor Controller/Hydraulic Fluid Overheating?→	Aggressive Operation?→
2. Sensor – Motor/Motor Controller/Hyd Tank – Connections/Wiring?→	Component Operational Check ↓
3. Sensor(s) Failure?→	Component Operational Check ↓
4. Motor Controller(s) Failure ?→	Component Operational Check ↓
Note: For further assistance on Silicon Temperature Sensor readings, see Motor Temperature Sensor.	

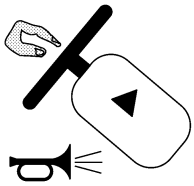
Temperature Control Chart Table

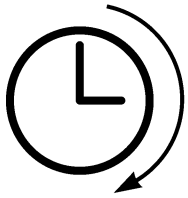
Application	Performance Cutback Start		Performance Cutback Finish		Fan ON	
	°C	°F	°C	°F	°C	°F
Traction Motor	165	329	185	365		
Traction Controller	80	176	115	239	65	149
Pump Motor	145	293	160	320		
Pump Controller	80	176	115	239	55	131
Hyd Fluid	85	185	100	212		

Check 2

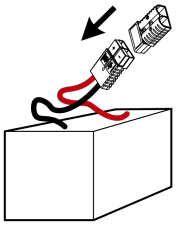


Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.





Wait 30 seconds



Reconnect Battery

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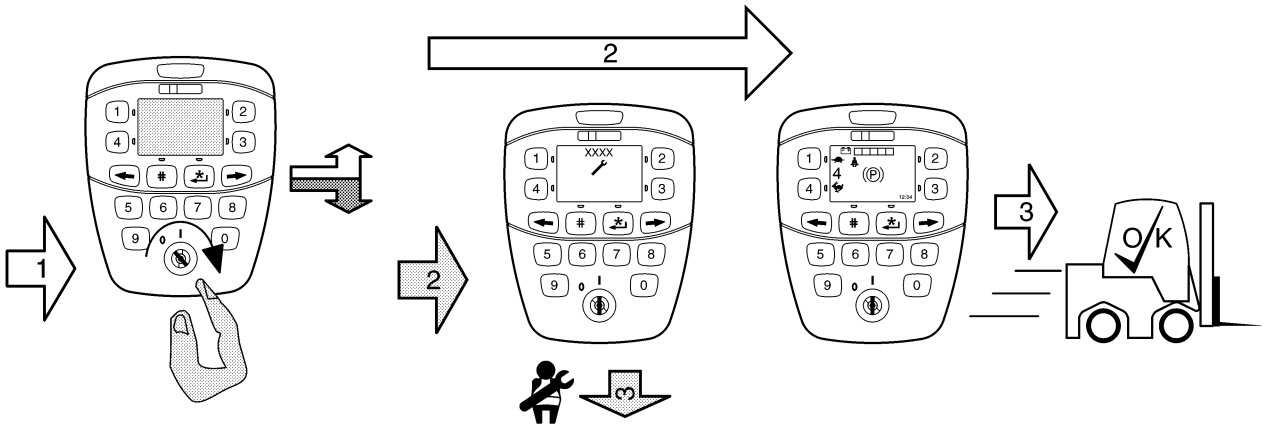
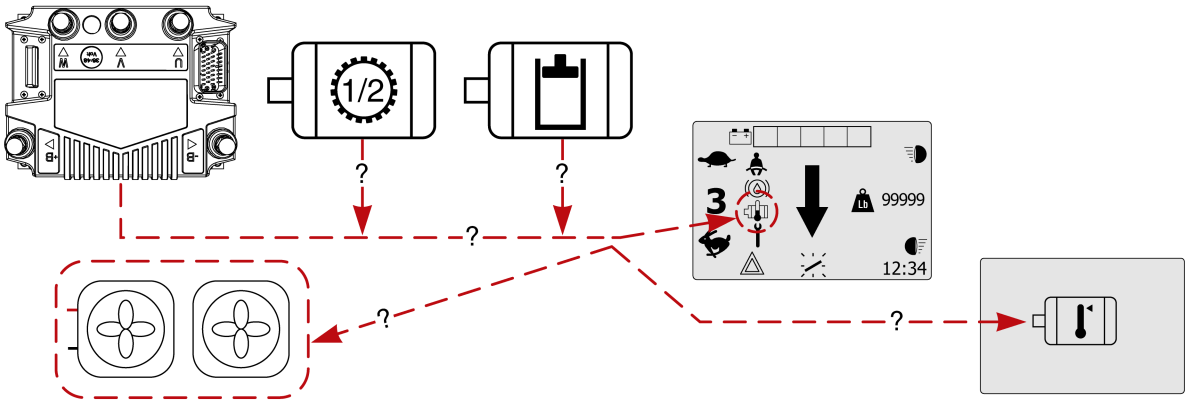
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

Check 3



Power **ON**→	Fault Remains Service Required ?	No Fault→ Resume Operation

Check 4



Reduced Performance→ Check Display Icons?

Motor/Motor Controller Temperature Icon On

1. Check fan operation→Are fans operating?→NO → A935 – K160 D203 Motor Controller Fan FailureYES →2. ?

2. Temp Sensor/Controller to Motor connection→Open Circuit→Component Operational Check↓

3. Use the following steps for viewing Motor Temperature

Note: The Motor Temperature ICON will be displayed for any Over Temperature of Traction 1/Traction 2, Pump Motor and their associated Controllers plus Hydraulic Fluid

Note: The Diagnostics Display Menu Flowchart will show which device is overheating See Check 5

Note: The Service Tech may need to operate the truck for an extended time on a 20% grade to have this Over temperature icon display again after it has been first reported

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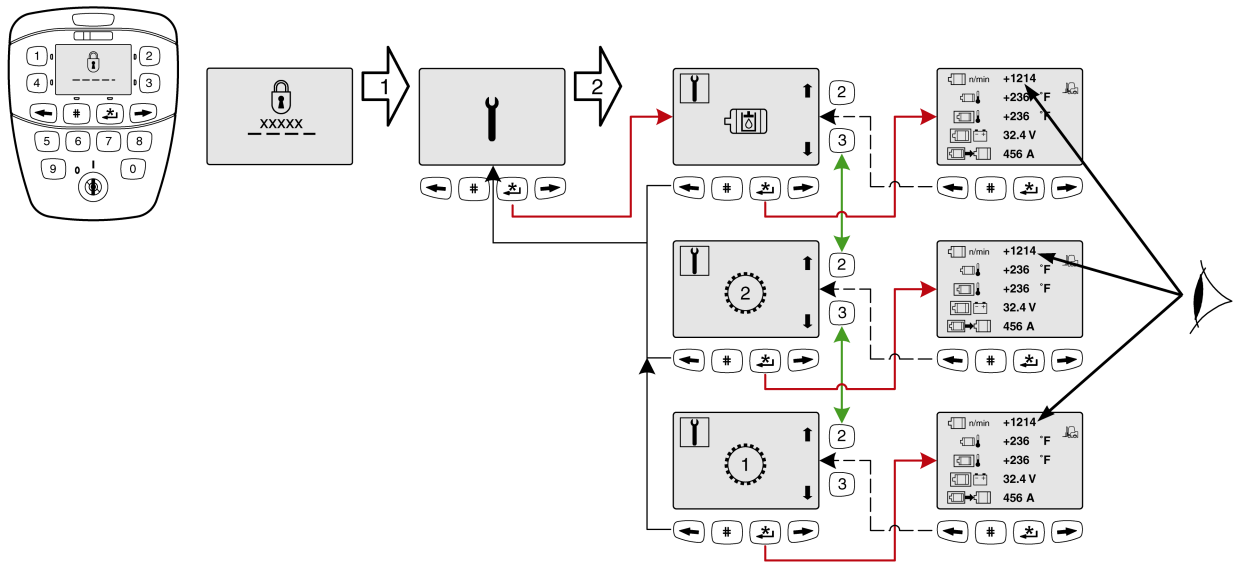
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

Check 5

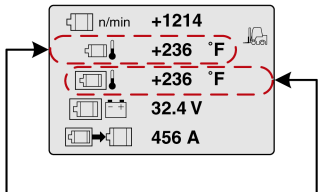
Diagnostics Temperature Analysis – Go to Display Menu Flowchart



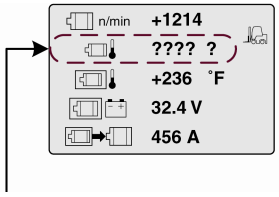
Enter Service Password→	Diagnostics→	Motor→ Traction1/Traction2/ Pump→	Motor/Control-ler Data

Fan(s) Operation Temperature Threshold: Traction = 55°C (131°F) Pump = 65°C (149°F)

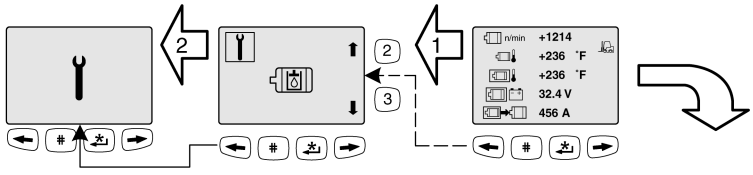
Reduced Performance: Traction = 80°C (176°F) Pump = 80°C (176°F)



Motor		Motor Controller



Invalid Temperature Signal (Traction/Pump Motor(s) Only): **Sensor Connections/Sensor Open Circuit**



Return to Diagnostics Menu→ ?

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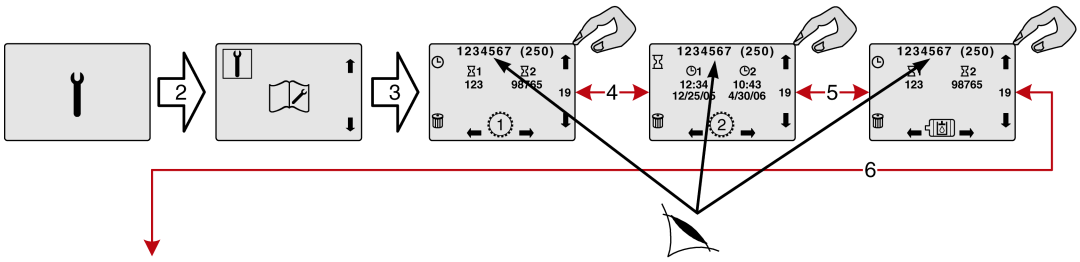
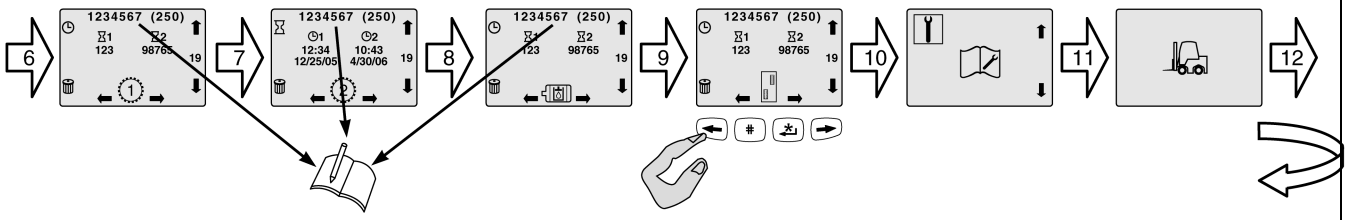
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

Check 6

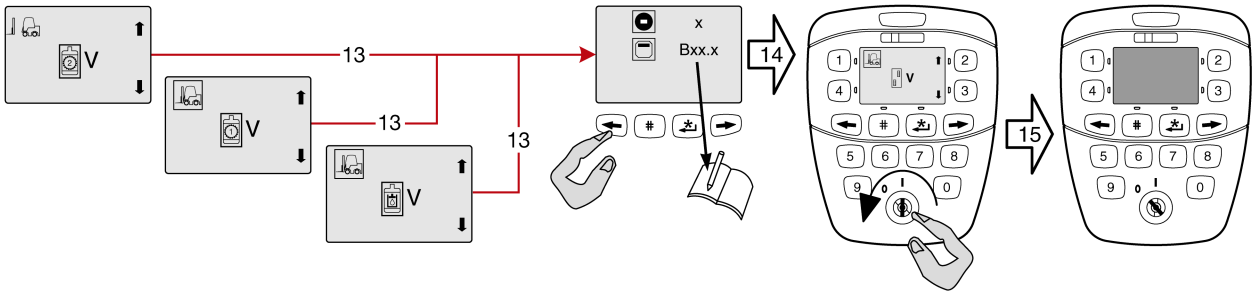
Fault Log DTC – Go to Display Menu Flowchart



Enter Service Password→ Diagnostic→ FAULT LOGs→ Motor Fault Log(s)→ View all Motor DTCs→ ?



all Motor Codes→ Exit Fault Log→ Truck Status ?



Motor Versions→ Hardware/Software Versions→ Exit Versions→ Power **OFF**?

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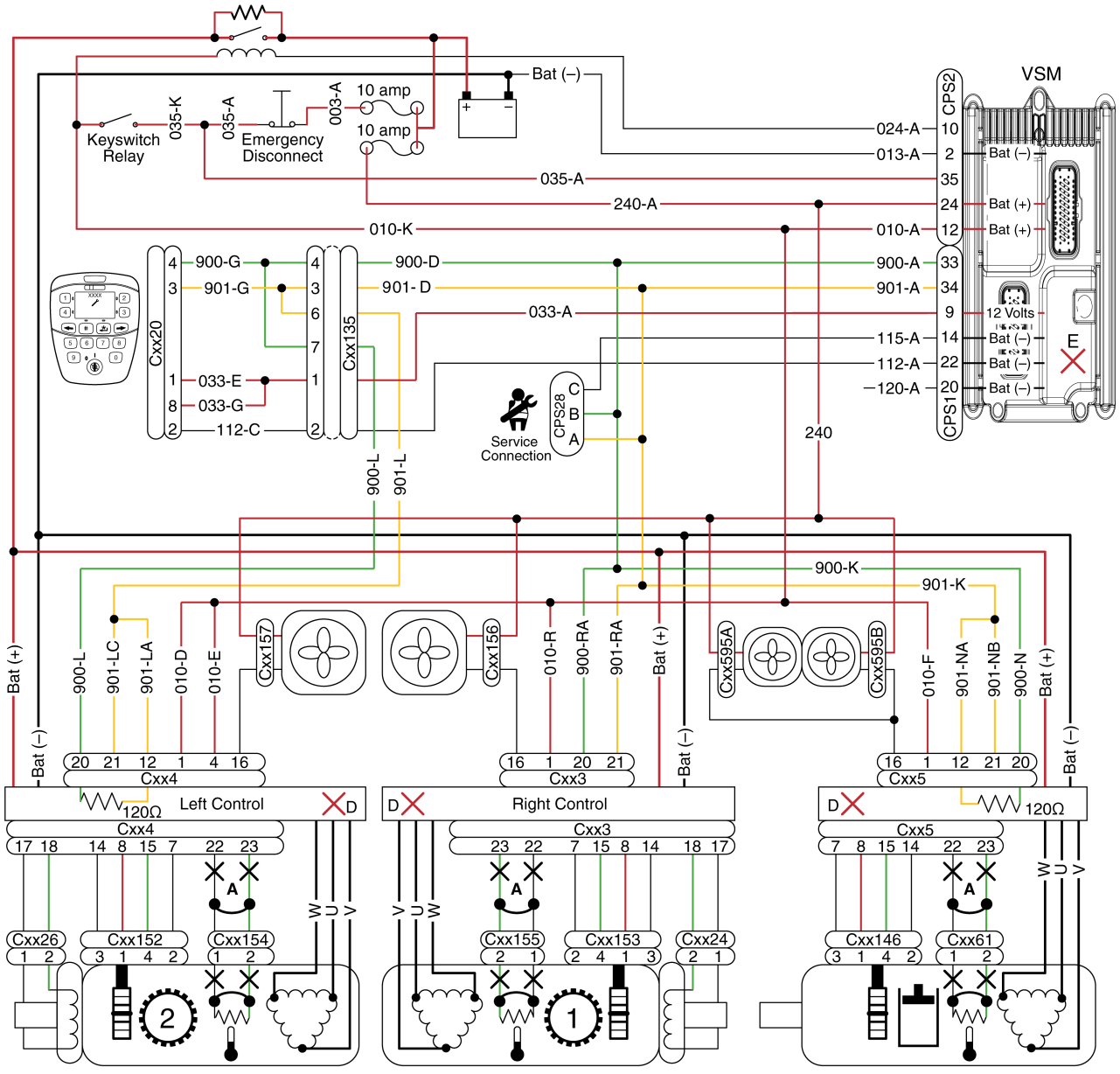
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

CAUSES A B C D E > ?



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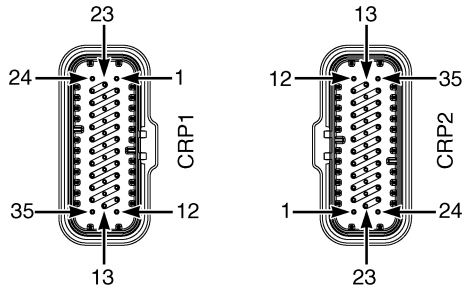
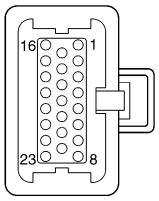
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

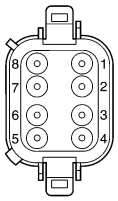
CONNECTORS



VSM Cxx 1 and Cxx 2

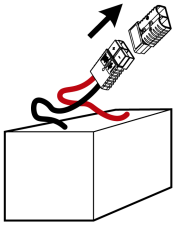


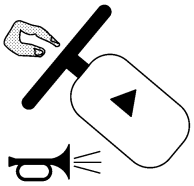
Traction/Pump Controller Cxx 3, 4, and 5



Fan Motor Connector Cxx 156, 157, 595A, and 595B

CAUSE A



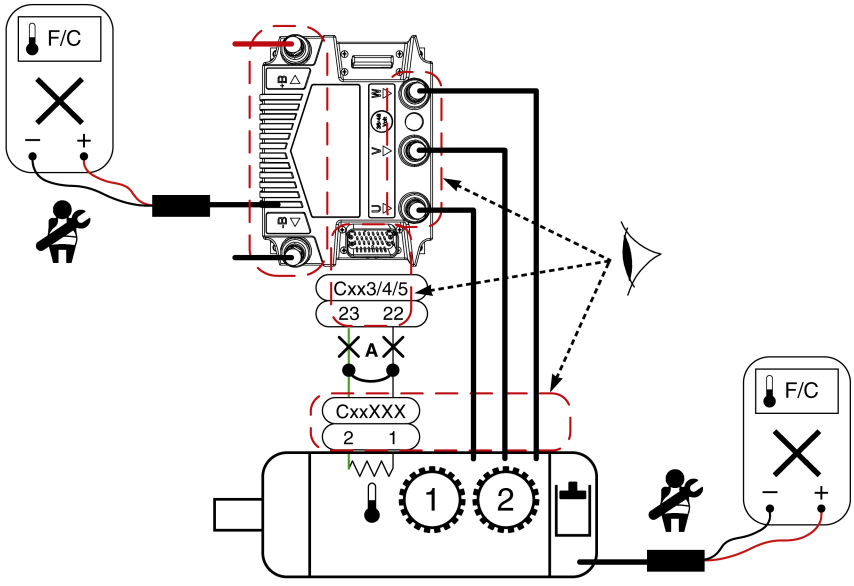


Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342. ?

STEP A1

For any Fault DTC→ Locate Device→ Inspect ALL Wiring/Connections

A DMM Temperature probe can also be used to determine which device is overheating



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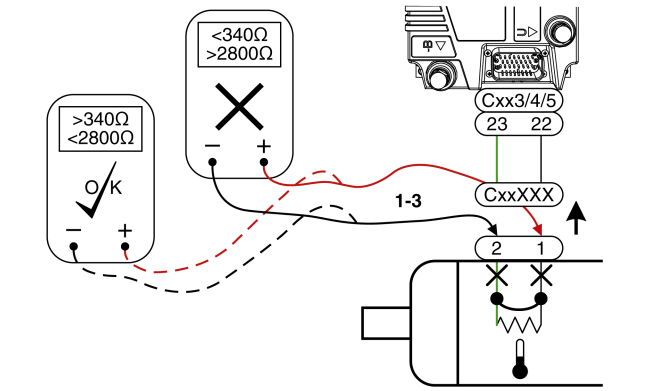
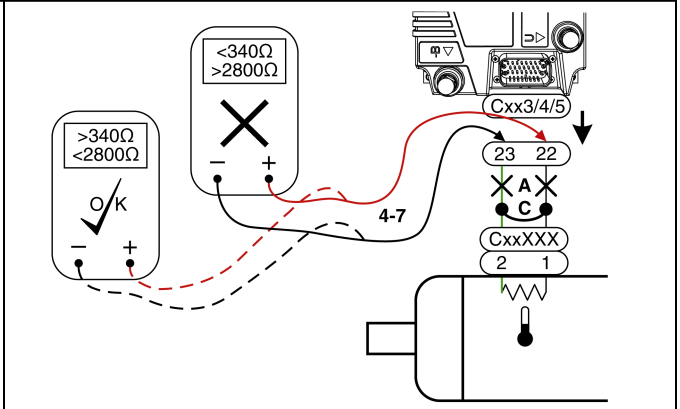
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

STEP A2	**CHECK RESISTANCE - Ω - OHMS**
Motor Temperature Sensor	
	
1. Disconnect Motor Connector→Measure ? as indicated→	
Note: For temperature sensor readings, see Motor Temperature Sensor.	
At xxx deg→ sensor ? ˜ match Temperature Chart 340? @ -40°C (25°F) to 2791? @ 300°C (572°F)→ ↓	
2. <300? to 0? = Motor Sensor Short Circuit→Go to 8↓	
3. >2800? to 8? = Motor Sensor Open Circuit/High Resistance Connection→Go to 8↓	
4. Reconnect Motor Connector↓	
5. Disconnect Controller Connector→Measure ? as indicated→See Temperature Sensor Chart↑↓	
6. <300? to 0? = Short Circuit→Go to 9↓	
7. >2800? to 8? = Open Circuit/High Resistance Connection→Go to 9↓	
8. **Replace Motor**→Go to 10↓	
9. Find/Repair Harness OPEN/SHORT Circuit→Go to 10↓	
10. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 11↓	
11. Recheck ?↑→ Reconnect→Resume Operation	

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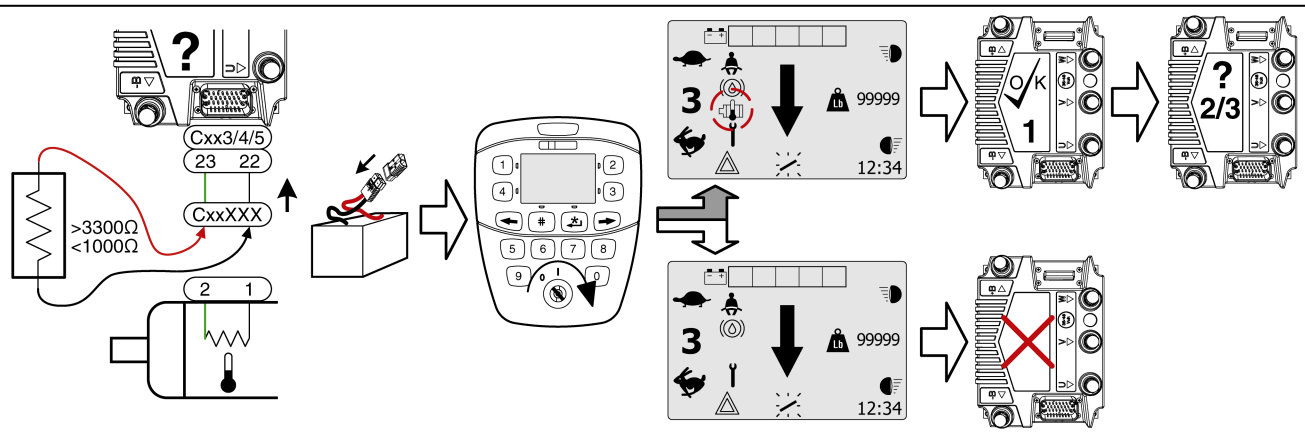
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

STEP A3

Motor Temperature Sensor (Controller Check)



1. Disconnect Motor Temperature Sensor Connector from suspect Controller→
2. Connect a ¼ watt resistor (>3300? to <10,000?) as shown
3. Reconnect Battery and all other Connectors
4. Does Over Temperature ICON Appear?↓
5. YES: Go to 7↓
6. NO: Controller is Faulty→Component Operational Check↓
7. Repeat Resistor Test on other Controllers↓
8. Temperature ICON is Displayed?→YES: Controller tested OK, Go to 9→NO: Controller tested Faulty→Component Operational Check↓
9. Reconnect other Motor Temperature Sensors

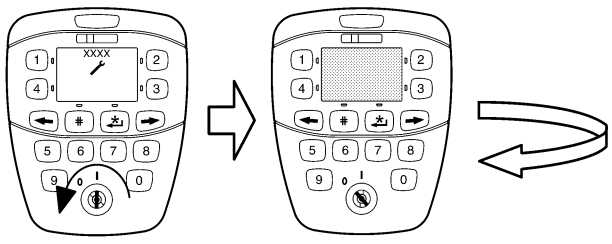
CAUSE B

Not Applicable

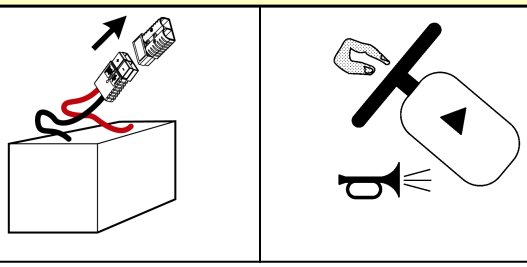
CAUSE C

Not Applicable

CAUSE D



Power **OFF**→



Disconnect Battery and Sound Horn to Discharge Capacitors. Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

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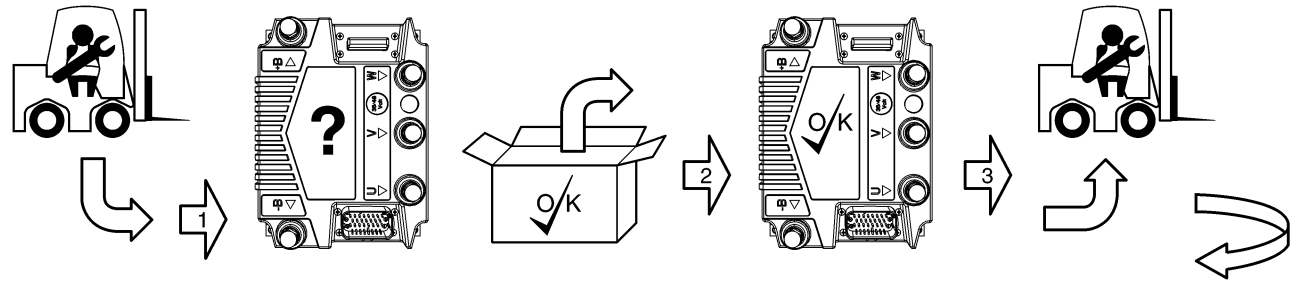
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

STEP D1

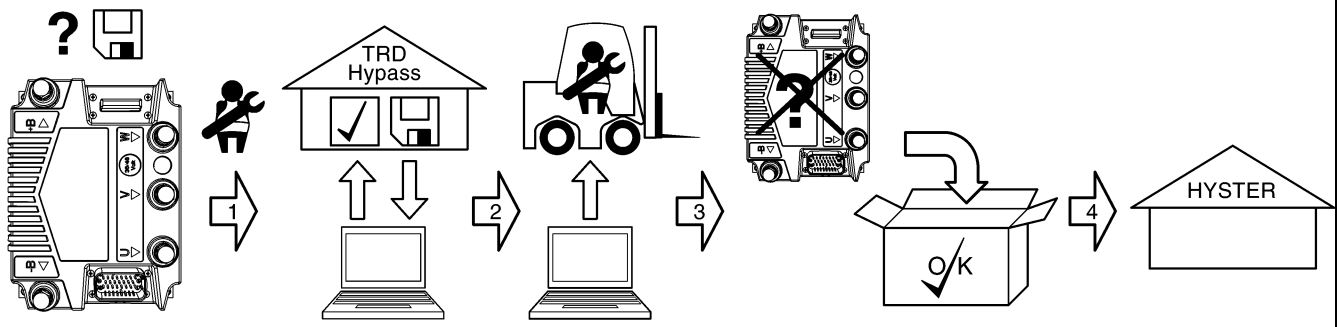


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→ See Label Information→ Step D2 ↓

STEP D2



1. Go to TRD/ Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

2. **NO**→Download the latest Application 🖫→Install on truck→Step D3↓

3. **YES**→Test New Installation→↓Step D3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

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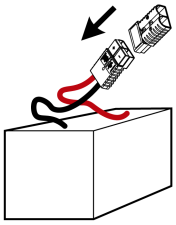
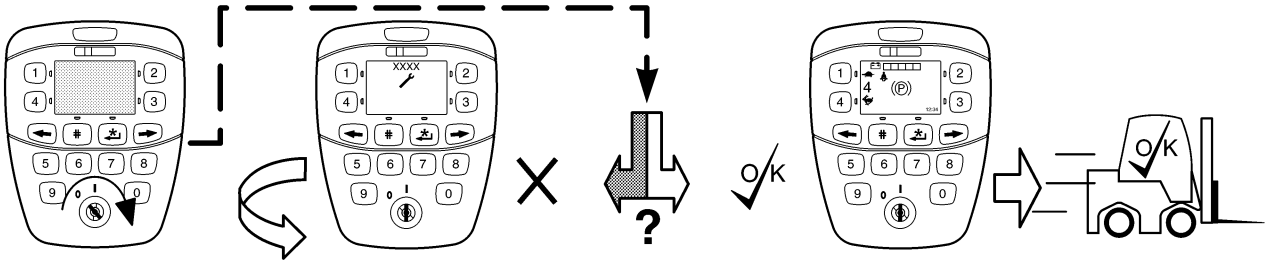
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

STEP D3

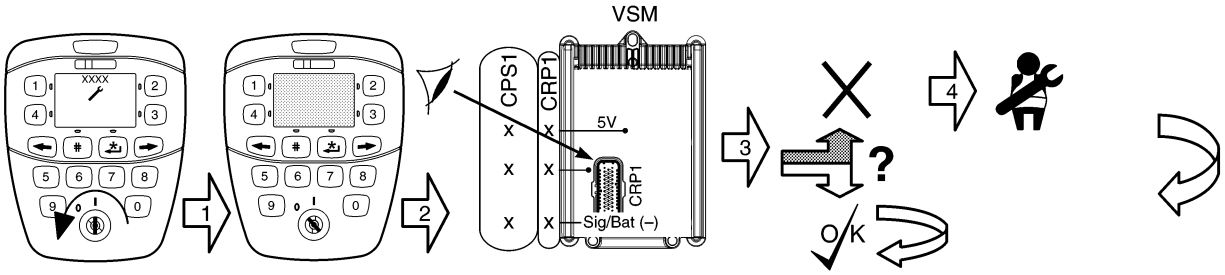




Retest - Power **ON**→ **NO** → ? Is fault DTC gone? Fault corrected→ Continue operation.

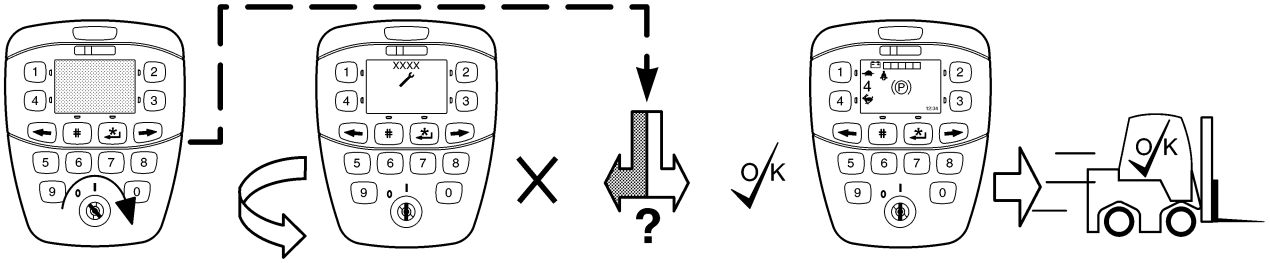
NO YES ← →

CAUSE E



Power **OFF**→ Inspect VSM Connections→ OK Step E1 Not OK Correct/Repair→ Step E1

STEP E1



Retest - Power **ON**→ **NO** → Go to VSM Controller Check Is fault DTC gone? Fault corrected→ Continue operation.

NO YES ← →

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

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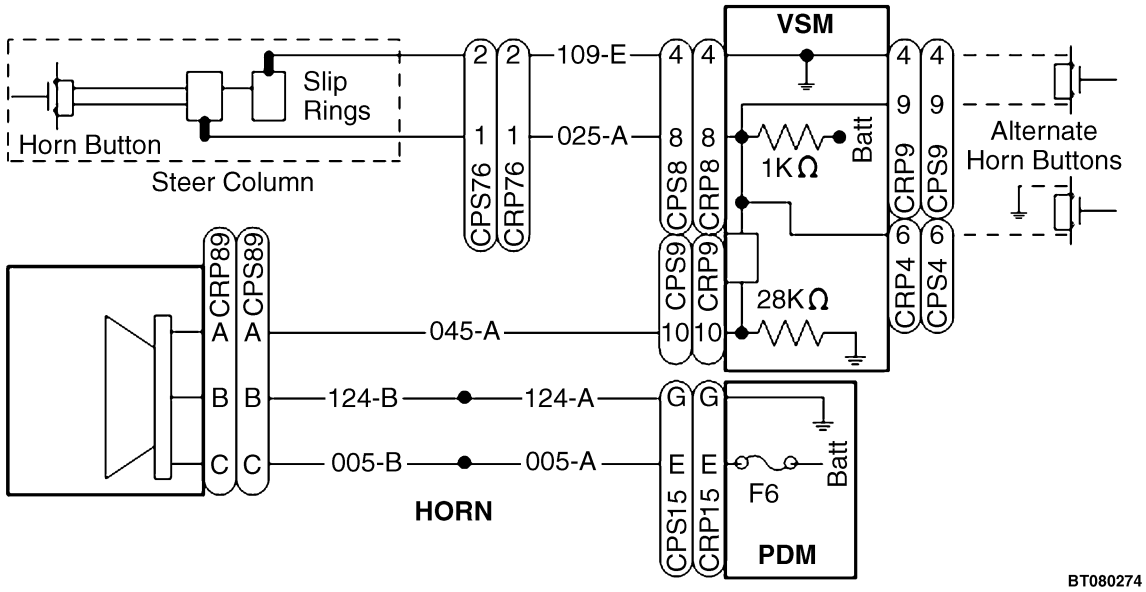
Horn Failure

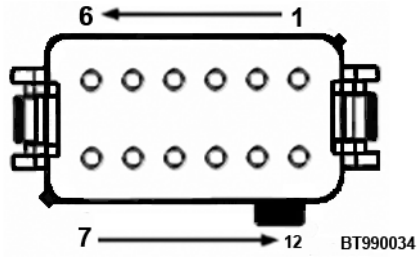
DIAGRAMS



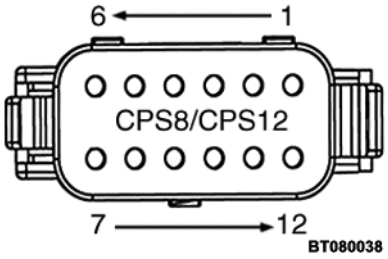
WIRE # 005 (RED) = HORN SUPPLY
WIRE # 045 (WHITE) = SIGNAL GROUND
WIRE # 124 (BLACK) = HORN GROUND

Horn Schematic

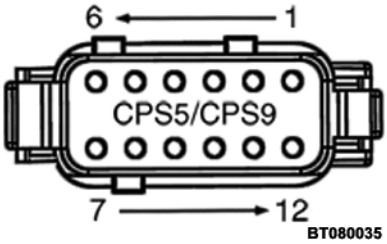
CONNECTOR(S)



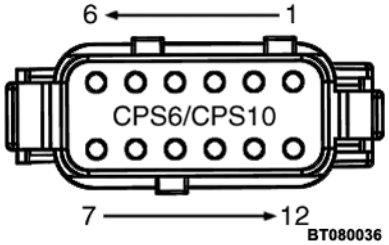
Connector CPS4



Connector CPS8



Connector CPS9



Connector CPS10

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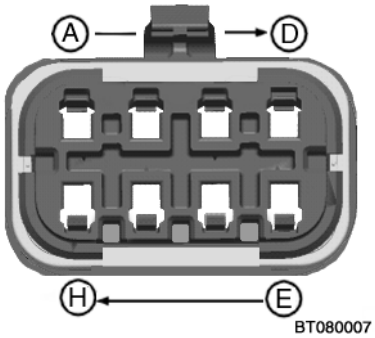

Connector CPS15

POSSIBLE CAUSE

A. FUSE BLOWN
B. OPEN CIRCUIT IN WIRING HARNESS
C. HORN FAILURE
D. VSM FAILURE

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Open engine cover to gain access to batteries. See **Operating Manual**.
2. Examine connections between batteries.
   Are connections correct and secure?
   YES: Go to Cause B.
   NO: Connect cables, as required. Depending on your lift truck, see **Electrical System** 2200SRM1369, or **Electrical System** 2200SRM1337.

CAUSE A - FUSE BLOWN

PROCEDURE OR ACTION:

1. At the fuse access cover, open access cover.
2. Using DMM, measure voltage on both sides of fuse F6 (+) with respect to ground (-).
   Is voltage on one side of fuse less than 0.5 Vdc?
   YES: Check wiring harness for shorts between wires 005 and 124 or 005 and the vehicles frame. Repair or Replace wiring harness. Depending on your lift truck, see **Wire Harness Repair** 2200SRM1128, or Fuse 6 is blown, replace blown fuse.
   NO: Fuse 6 is OK. Go to Cause C.

CAUSE B - OPEN CIRCUIT IN WIRING HARNESS

NOTE: If DTC 524213-4 appears, go to

PROCEDURE OR ACTION:

1. Disconnect horn at CPS 89.
2. Using DMM, measure voltage between Pin B and Pin C on CPS 89.
   Is battery voltage present?
   YES: Go to Step 3.
   NO: Check wiring harness for shorts between wires 005 and 124 for open circuit. Repair or Replace wiring harness. Depending on your lift truck, see **Wire Harness Repair** 2200SRM1128.
3. Change DMM to ohms scale. Verify DMM zero reading.
   Is the reading approximately 28??

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YES: Go to Step 4.
NO: Wire 045 has a short to ground in the wiring harness. Repair/Replace wiring harness. Depending on your lift truck, see **Wire Harness Repair** 2200SRM1128.

NOTE: Do not disconnect wiring harness at horn button.

4. Remove only horn button from top of steering wheel. Ensure that wire is still connected.
5. Set DMM to volts scale.
6. Measure voltage on both sides of horn button terminals with respect to ground (-).
   Is battery voltage present?
   YES: Go to Step 7.
   NO: Go to Step 8.
7. Connect DMM to slip ring wires. During voltage measurement, rotate steering wheel from lock-to-lock position to test the entire slip ring surface.
   Is battery voltage present?
   YES: Repair or Replace slip ring assembly. Refer to appropriate **Frame** manual, depending on lift truck model, **Steering Column Repair** section.
   NO: Wire 025 and 109 has open circuit in wiring harness. Repair/Replace wiring harness. Depending on your lift truck, see **Wire Harness Repair** 2200SRM1128.
8. Push horn button.
   Does DMM voltage go to zero?
   YES: Go to Cause D.
   NO: Replace horn button.

CAUSE C - HORN FAILURE

PROCEDURE OR ACTION:

1. Connect horn at CPS 89.
2. Using a jumper wire to short circuit, connect Pin A and Pin C at CPS 89.
   Does DMM voltage go to zero?
   YES: Go to Cause E.
   NO: Replace horn.

CAUSE D - VSM FAILURE

PROCEDURE OR ACTION:

1. Replace VSM. Depending on your lift truck, see **Electrical System** 2200SRM1369, or **Electrical System** 2200SRM1337.

END SYMPTOM

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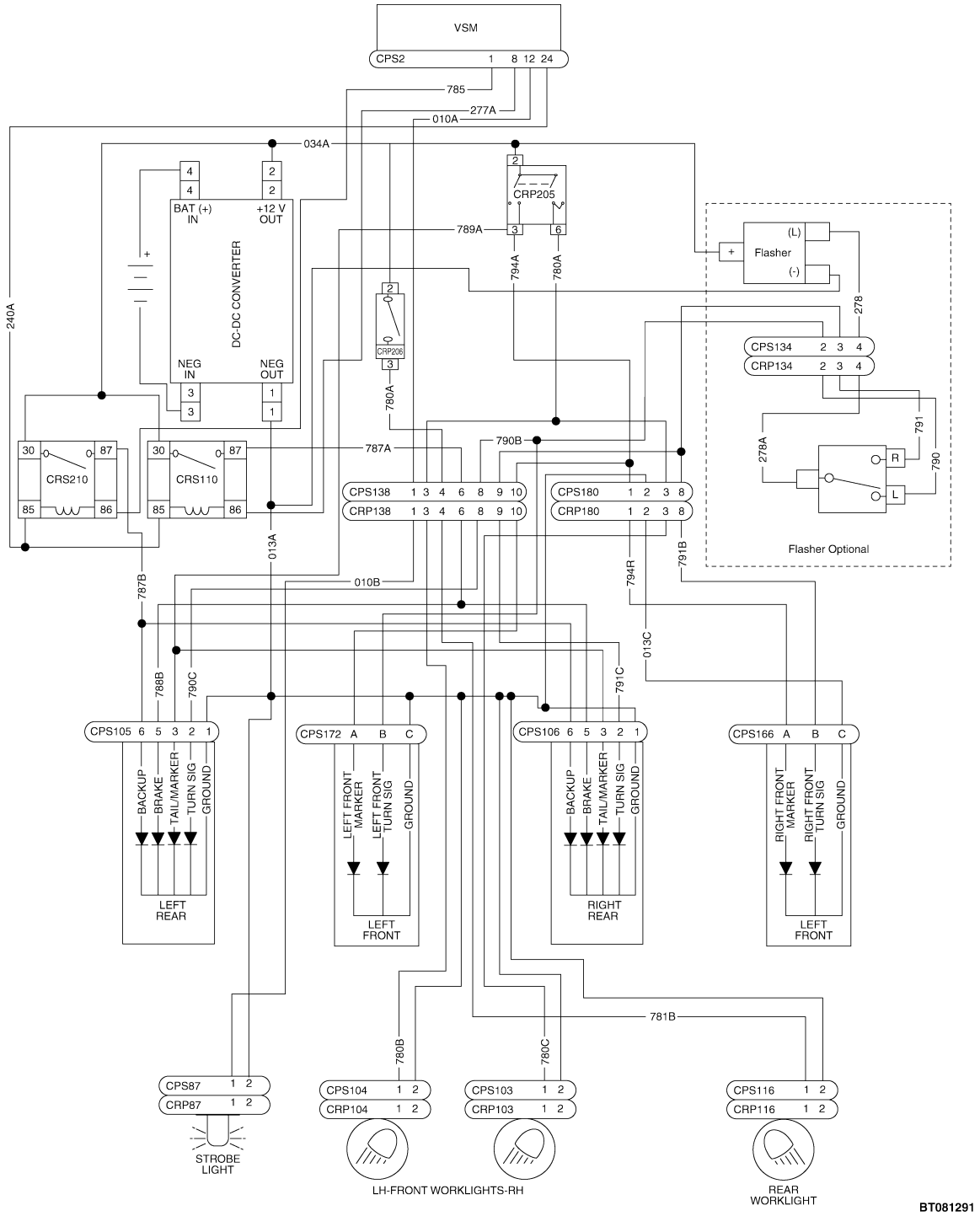
Lights Inoperative

DIAGRAMS



WIRE # 034A, (RED)= 12 V DC/DC SOURCE
WIRE # 013A, (BLACK)= DC/DC GROUND

3 Wheel Lift Trucks With or Without Turn Signal

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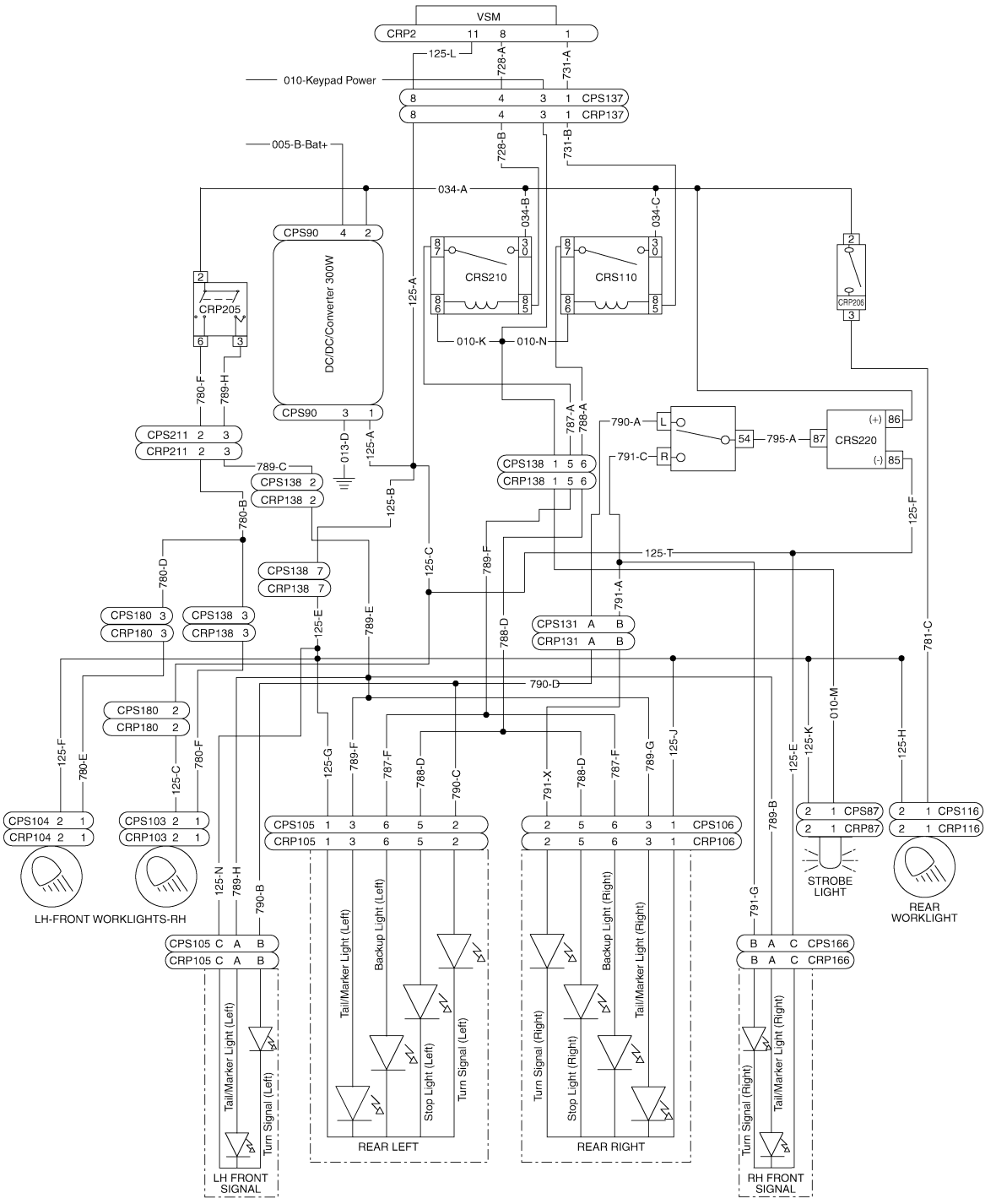

WIRE # 034A, (RED)= 12 V DC/DC SOURCE
WIRE # 125A, (BLACK)= DC/DC GROUND

4 Wheel Lift Trucks With Turn Signal

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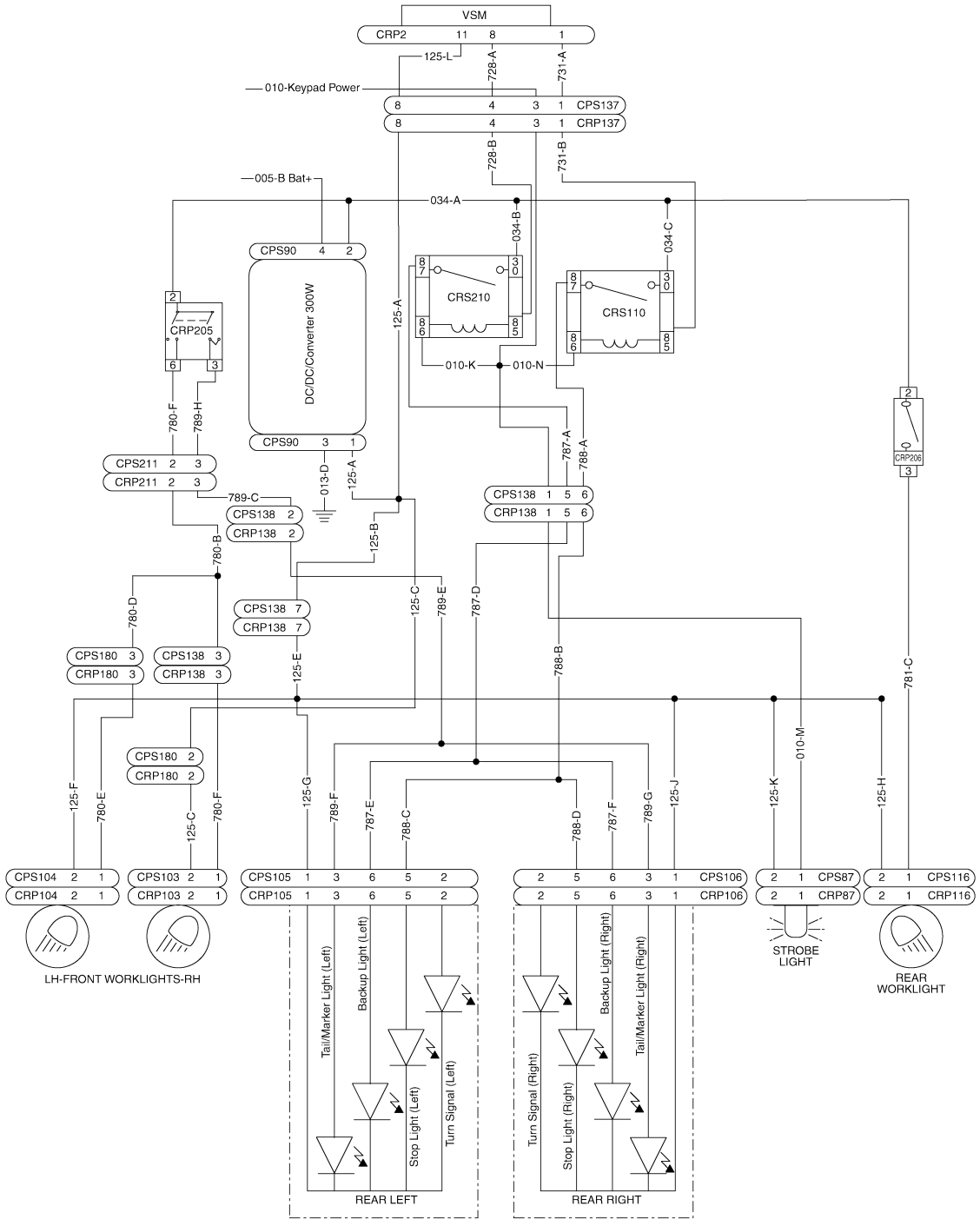

BT081293

WIRE # 034A, (RED)= 12 V DC/DC SOURCE
WIRE # 125A, (BLACK)= DC/DC GROUND

4 Wheel Lift Trucks Without Turn Signal

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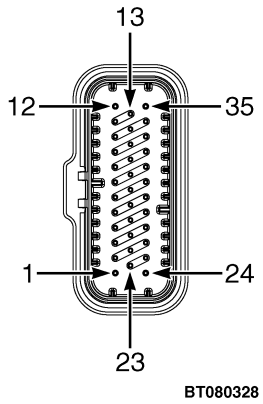
CONNECTOR(S)



CPS2

POSSIBLE CAUSE

A. DEFECTIVE LAMP
B. LIGHT CIRCUIT OPEN SUPPLY OR GROUND WIRE
C. POWER SUPPLY CIRCUIT FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn switch for light to **ON**.
   Does light operate correctly?
   YES: Problem not verified. Resume operation.
   NO: Go to Cause B.

CAUSE A - DEFECTIVE LAMP

PROCEDURE OR ACTION:

1. Replace lamp. Refer to the appropriate **Electrical System** manual, depending on lift truck model.
   Does light turn on?
   YES: Problem repaired. Resume operation.
   NO: Go to Cause C.

CAUSE B - LIGHT CIRCUIT OPEN SUPPLY OR GROUND WIRE

PROCEDURE OR ACTION:

1. Turn cab accessory fan **ON**.
   Does accessory fan operate?
   YES: Go to Step 2.
   NO: Go to Cause D
2. Remove light assembly to access wire connections.
3. Using DMM, measure the voltage across the terminals of the lamp socket.
   Is voltage approximately system voltage?
   YES: Circuit voltage and ground connections are OK. Replace cab light assembly. Refer to the appropriate **Electrical System** manual, depending on lift truck model.
   NO: Go to Step 4.
4. Change DMM to ohms scale. Verify zero reading.

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CAUTION

For this next measurement, make sure measurement is taken at the Black Wire. The red wire may have an applied voltage that could damage meter.

5. Measure resistance between terminal on black wire and a clean frame ground.
   Is the resistance less than 0.5 ohms?
   YES: Wire # 034A (RED) has open circuit to supply voltage. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.
   NO: For three wheel lift trucks, wire # 013A (BLACK) has open circuit to ground. For four wheel lift trucks with or without turn signal, wire # 125A (BLACK) has open circuit to ground. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.

CAUSE C - POWER SUPPLY CIRCUIT FAULT

PROCEDURE OR ACTION:

1. Remove floor mat and floor plate to access lighting modules, fuses, and relays mounted to front bulkhead.
2. Using DMM, measure voltage across diode (+) and the negative terminal of battery (−).
   Is the voltage on each side of diode approximately 12Vdc?
   YES: Go to Step 3.
   NO: Diode is blown. Replace defective lighting module with new lighting module.
3. Open dash cover near VSM and disconnect harness connector CPS 2.
4. Using DMM, measure voltage across pins 1(+) and 2(−) of CPS 2.
   Is voltage approximately system voltage?
   YES: Wire #034A/C (RED) has open circuit. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.
   NO: Go to Step 5.
5. Move the negative (−) meter lead to a clean frame ground on the truck.
   Is voltage approximately system voltage?
   YES: For three wheel lift trucks, wire # 013A (BLACK) has open circuit. For four wheel lift trucks with or without turn signal, wire # 125A (BLACK) has open circuit. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.
   NO: Wire # 034A/C (RED) has open circuit to supply voltage. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.

END SYMPTOM

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NOTES

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Group 55

Icons and Graphics

Icon Glossary

INTRODUCTION TO ICONS

An icon is a symbol that conveys a unique meaning without words, such as an arrow. The Operating Screen on this lift truck presents information to an operator solely through the use of symbols which are mostly icons, along with some numbers and a few text characters. Icons make it possible to simultaneously display up to 12 kinds of information graphically in a small space. In addition, the use of icons reduces the difficulty of communicating with operators who speak different languages.

The following table, are icons used during the Diagnostic Troubleshooting Procedures. For further details on displays and icons, see **User Interface Supervisor** 2200SRM1335 or **User Interface Service Technician** 2200SRM1336 .

Symbols/Icons	Definition
	Display FAULT Panel
_ _ _ _ _	Password Screen
	System Power OFF
	System Power ON/Display RUN Screen

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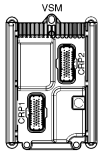
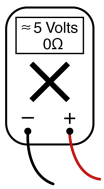
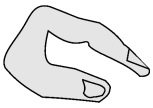
Symbols/Icons	Definition
	PC Service Tool
	Vehicle System Manager
	Operator Password
	Supervisor Password
	Service Password
	Service Required/Fault Code
	Digital Multimeter
	Operate the Indicated Button/Key/Device

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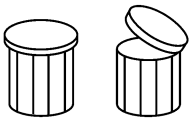
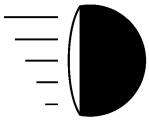
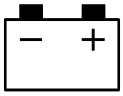
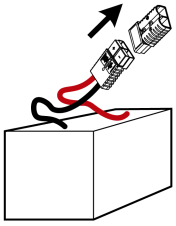
Symbols/Icons	Definition
	Look For/Find
	Garbage/Junk/Rubbish Receptacle
	Operator Presence
	Park Brake
	Wait 30-Seconds
	Work Lights
	Battery
	Battery Disconnect

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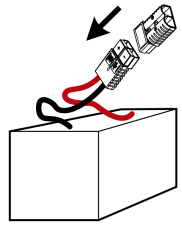
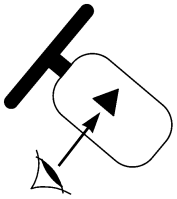
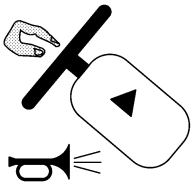
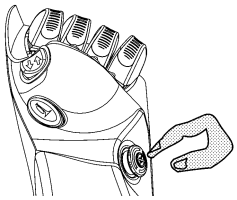
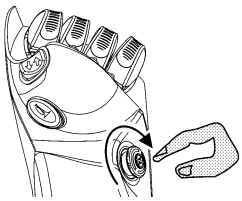
Symbols/Icons	Definition
	Reconnect Battery
	Locate Diagnostic Connector
	Sound Horn to Discharge Capacitors
	Fork Truck
	Travel Direction
	Mast Tilt Position
	Push in Emergency Stop
	Release Emergency Stop

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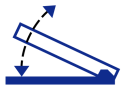
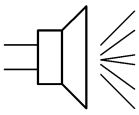
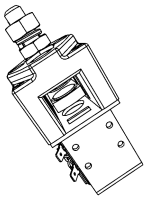
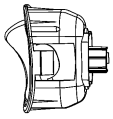
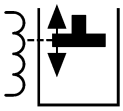
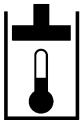
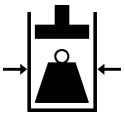
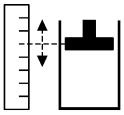
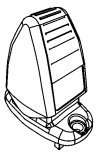
Symbols/Icons	Definition
	Accelerator Pedal
	Buzzer/Audible Warning Device
	Contactor
	DCS – Directional Control Selector
	E-Hydraulic
	Hydraulic Temperature
	Load Weigh Pressure
	Manual-Hydraulic
	MLM Lever

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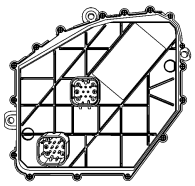
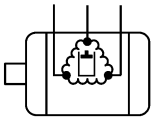
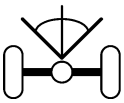
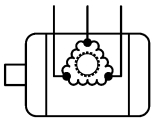
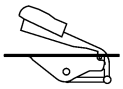
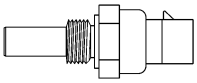
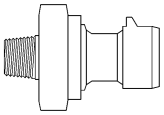
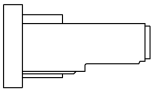
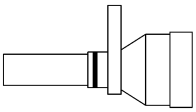
Symbols/Icons	Definition
	MLM PCB Cassette
	Pump Motor
	Service Brake Pressure
	Steering Wheel Position
	Steering Axle Position
	Traction Motor
	Accelerator Sensor
	Hydraulic Temperature Sensor
	Load Weight Pressure Sensor
	Manual Hydraulic Position Sensor
	Motor Speed Sensor

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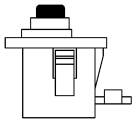
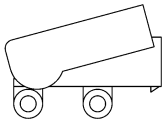
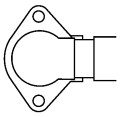
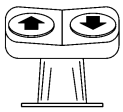
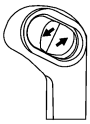
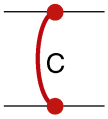
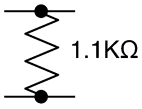
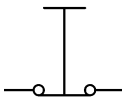
Symbols/Icons	Definition
	Operator Presence Sensor
	Park Brake/Mast Tilt Sensor
	Steering Axle/Wheel Sensor
	Temperature Sensor
	Travel Direction Foot Pedal Sensor
	Travel Direction Manual Hydraulic Sensor
	Failure/Cause/Occurence
	Failure A/Cause A/Occurence A
	Shorted Connection/Fault e.g.C
	Resistor e.g. Value = 1.1KOhms
	Fuse – xx Amps
	Emergency Disconnect

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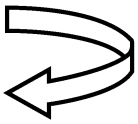
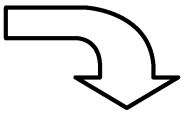
Symbols/Icons	Definition
	Coil – Relay/Contactor/Valve
	Contactor/Relay//Valve Coil
	Switch – Normally Open
	Switch – Normally Closed
	High Resistance
	Okay/Correct
	Record
	Software
	Repair Faulty Component
	Go to Next Step
	Go to Next Step
	Go to Next Cause
\	Display arrow Left
]	Display arrow Right
?	Go to next step
	Display Scroll UP/DOWN Push Buttons

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Symbols/Icons	Definition
G	Lift/Lower Hydraulic Lever(s)
	Not Equal
	Ohms
~	Approximately
	Infinite Value
?	Question/Questionable Operation
=	Equal/Compare to
<	Less Than
>	Greater Than
	Dead - Destroyed – Beyond Redemption

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NOTES

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SECTION 9035
DRIVE AXLE/UNIT

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Group 10

Principles of Operation

Drive Axle J1.5-2.0XNT (J30-40XNT) (K160) J1.6-2.0XN (A935)

DESCRIPTION

This series of lift trucks is equipped with a transaxle which consists of a drive motor, an in-line gear set drive unit, and a park brake on each drive wheel. This series of lift trucks is also equipped with a wet brake system which is located within the transaxle.

PRINCIPLES OF OPERATION

The lift truck uses two drive units. One drive unit is mounted on each side of the lift truck frame beneath the cowl. The drive unit is an in-line gear set that incorporates a wet disk service brake assembly within the drive unit. The traction motor and park brake is mounted on one side of the drive unit, and the drive wheel and tire assemblies are mounted to the other side of the drive unit. The drive unit is secured to the lift truck frame using a series of five capscrews. The drive unit housing provides the mounts needed to attach the mast to the lift truck. Power from the traction motor is transmitted to the drive unit through an internal spline in the input gear. See Figure 9035-10-1.

Drive Units

- Dual, in-line drive units are individually mounted in the frame with complete and separate traction motor and braking systems. This system allows for independent traction control for each wheel.
- The drive unit assemblies mount to the frame with five capscrews per side.
- The drive unit housings also support the mast through machined and bushed trunnion mounts. The hang-on mast mounting system, with its mounting hardware accessible from above, provides a convenient way to install/remove the mast. An easily accessible grease fitting is provided to lubricate the mast mounting and bushing.
- Wet disk brakes are designed as an integral part of the drive unit.

Brakes

- Dual, hydraulically operated, wet disk service brakes are designed into the drive unit.
- These brakes are inside the drive unit, and therefore are impervious to water and operate with no degradation of performance in these conditions.
- The master cylinder and integrated reservoir have fluid level sensor connected to a warning light on the display panel.
- Spring applied, electrically released park brake is mounted at the end of each motor. The parking brake is automatically set by the control system so that the brake is always applied whenever the truck is not moving, and no traction has been requested. A manual release mechanism has been designed into the park brake.

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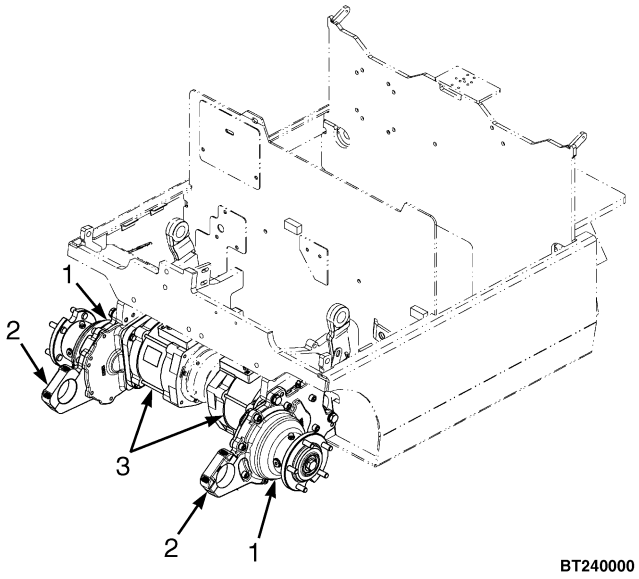


Figure 9035-10-1. Transaxle Mounting

Legend for Figure 9035-10-1

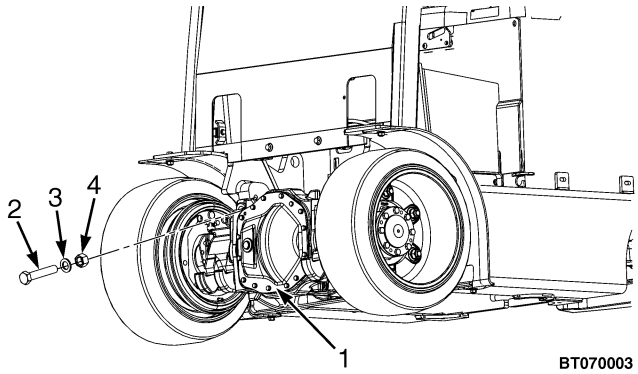
1. DRIVE UNIT
2. MAST MOUNTING CAPS
3. TRACTION MOTORS

Drive Axle E2.2-3.5XN (E40-70XN) (A268), E1.6-2.0XN E30-40XN (A269), J2.2-3.5XN (J45-70XN) (A276), E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099), And J4.0-5.0XN (A970)

DRIVE AXLE E2.2-3.5XN (E45-70XN) (A268) AND E1.6-2.0XN (E30-40XN) (A269)

DESCRIPTION

This lift truck is equipped with a conventional drive axle and uses dry service brakes. See the Dry Brake Systems section of this manual. The drive axle is fastened to the frame of the lift truck with four bolts, washers, and nuts. See Figure 9035-10-2. These lift truck models may have a manual or an automatic park brake.



NOTE: DRIVE AXLE FOR E2.2-3.5XN (E45-70XN) (A268) SHOWN. E2.2-3.5XN (E45-70XN) (A268) E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. DRIVE AXLE ASSEMBLY
2. AXLE MOUNTING BOLT
3. WASHER
4. NUT

Figure 9035-10-2. Drive Axle Mounting for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

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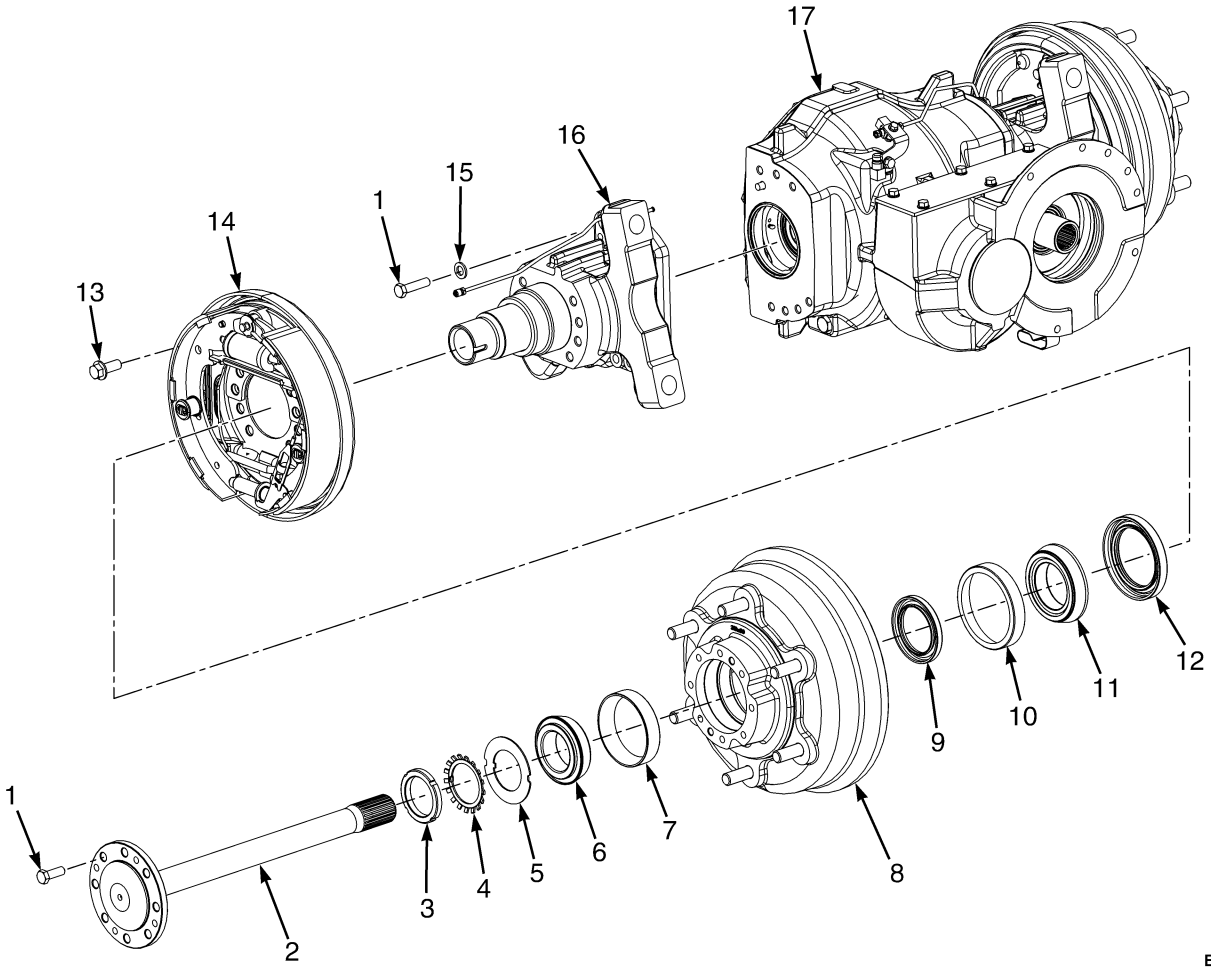
PRINCIPLES OF OPERATION

The outer ends of the axle housings are the spindles for the wheel bearings. The cups for the tapered roller bearings are pressed into the wheel hubs. The nut on the end holds and adjusts the preload on the wheel bearings. The axle shafts are fastened to the hubs by capscrews. Studs and nuts fasten the wheel to the hub and brake drum. The back plate and brake assemblies are fastened to the axle assembly or assemblies. The center section contains the speed reducer and differential assembly. See Figure 9035-10-3. The speed reducer has a gear that engages the splines on the shaft of the traction motor. A second speed reducer gear is fastened to the pinion shaft for the differential.



NOTE: DRIVE AXLE FOR E2.2-3.5XN (E45-70XN) (A268) SHOWN. E2.2-3.5XN (E45-70XN) (A268) E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. CAPSCREW
2. AXLE SHAFT
3. BEARING LOCK NUT
4. BEARING LOCK WASHER
5. WHEEL BEARING WASHER
6. OUTER BEARING CONE
7. OUTER BEARING CUP
8. HUB
9. OUTER SEAL
10. INNER BEARING CUP
11. INNER BEARING CONE
12. INNER SEAL
13. LOCK BOLT
14. BRAKE ASSEMBLY
15. WASHER
16. LH HANGER
17. CENTER SECTION ASSEMBLY

Figure 9035-10-3. Drive Axle Assembly for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

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TRANSAXLE J2.2-3.5XN (J45-70XN) (A276)

DESCRIPTION

This transaxle is a modular rigid axle for use in front-wheel-drive electric balance-weight forklift trucks and uses wet service brakes. See the Wet Brake Systems section of this manual.

PRINCIPLES OF OPERATION

The transaxle consists of a centrally located park and service brake system, two asynchronous traction motors, and two transmissions. The drive unit is joined to the vehicle chassis and to the lift mast by means of fixtures mounted on the axle.

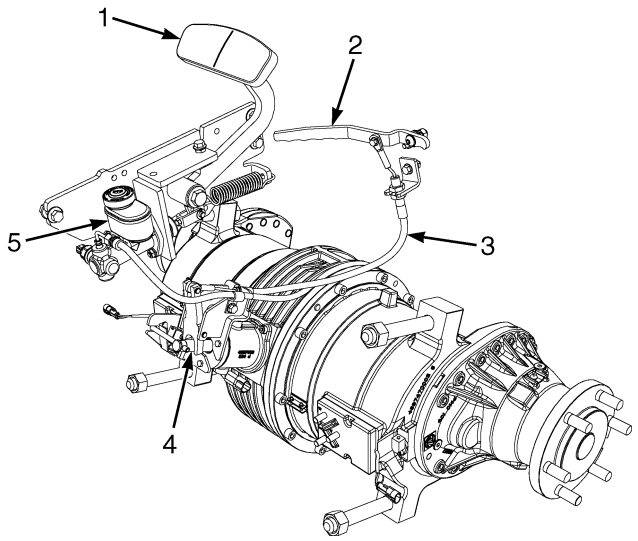
DRIVE AXLE E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

DESCRIPTION

This lift truck is equipped with a conventional drive axle and uses wet service brakes. See the Wet Brake Systems section of this manual. The drive axle is fastened to the frame of the lift truck with four bolts, washers, and nuts. See Figure 9035-10-5.

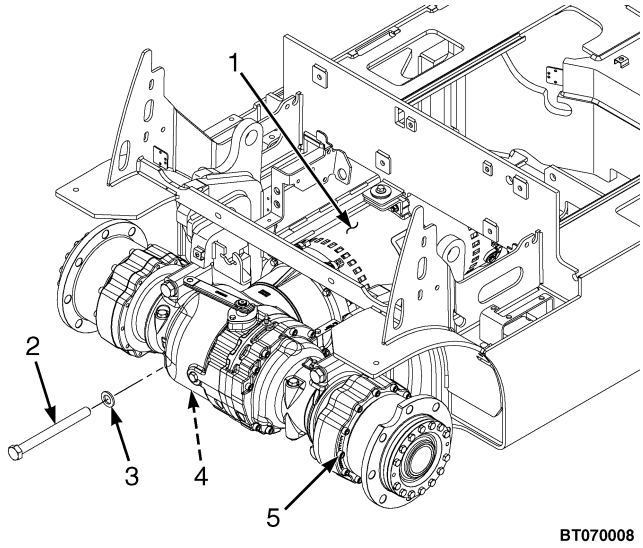
PRINCIPLES OF OPERATION

The outer ends of the axle housings are the reduction gear assemblies for the wheel hubs. The cups for the tapered roller bearings are pressed into the wheel hubs. The retaining plate on the end holds and adjusts the preload on the wheel bearings. Studs and nuts fasten the wheel to the wheel hub. Socket head capscrews fasten the reduction gear assemblies to the drive axle housing. Socket head capscrews fasten the left drive axle housing to the piston chamber and the piston chamber to the right drive axle housing. The right drive axle housing contains the differential housing and differential. Fastened to the right drive axle housing is the pinion and motor carrier. A traction motor fastened to the motor carrier supplies rotation to the pinion via a splined coupler which in turn engages the differential. See Figure 9035-10-6.



1. BRAKE PEDAL
2. PARK BRAKE MANUAL RELEASE
3. PARK BRAKE RELEASE CABLE
4. PARK BRAKE ACTUATOR
5. MASTER CYLINDER RESERVOIR

Figure 9035-10-4. Transaxle for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)



1. TRACTION MOTOR
2. AXLE MOUNTING BOLT
3. WASHER
4. NUT (NOT SHOWN)
5. DRIVE AXLE

Figure 9035-10-5. Drive Axle Mounting for Lift Truck Models E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

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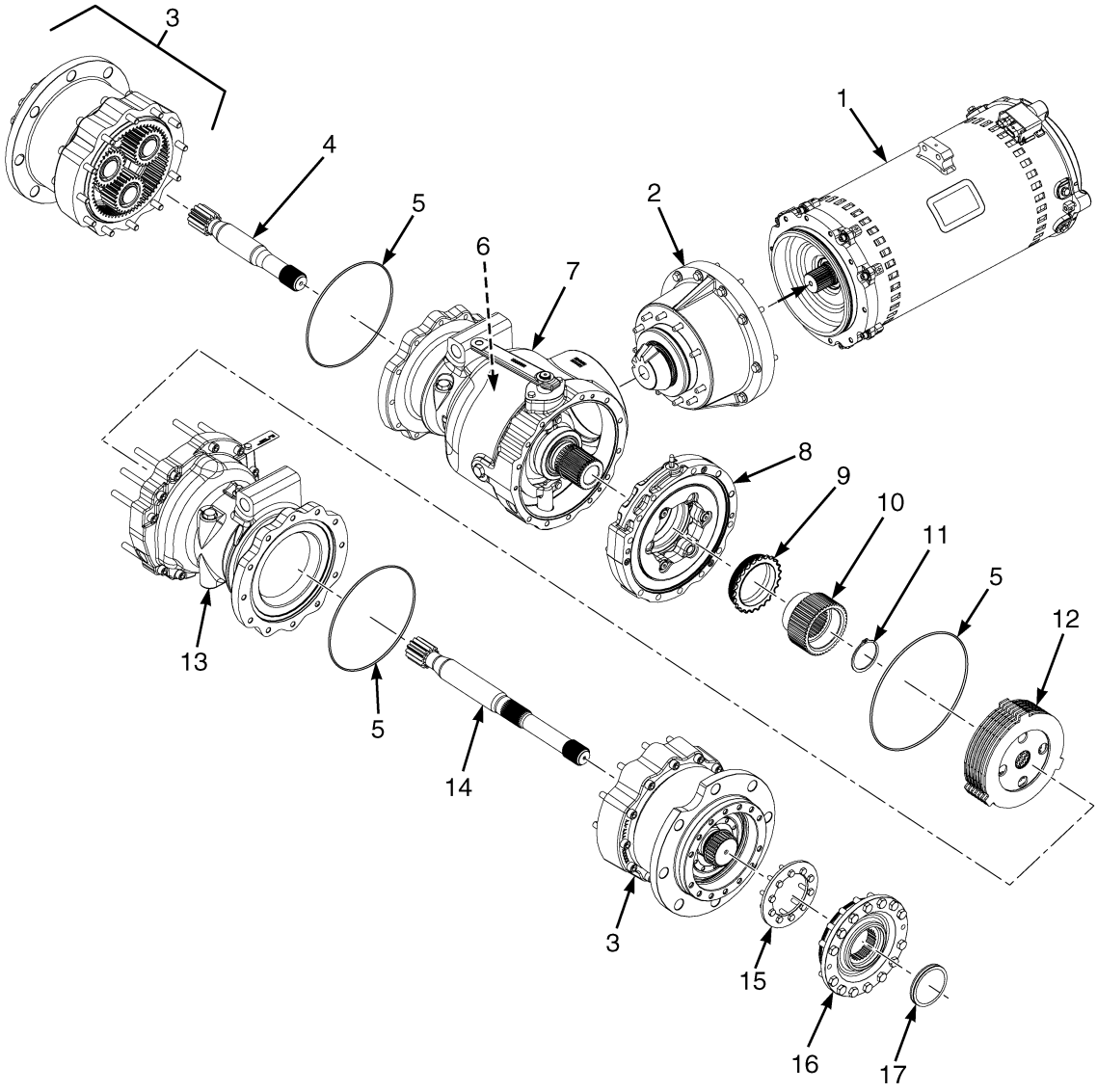

1. TRACTION MOTOR
2. PINION AND MOTOR CARRIER
3. REDUCTION GEAR ASSEMBLY
4. LEFT AXLE SHAFT
5. O-RING
6. DIFFERENTIAL HOUSING AND DIFFERENTIAL
7. RIGHT DRIVE AXLE HOUSING
8. PISTON CHAMBER
9. DIFFERENTIAL BEARING ADJUSTMENT NUT
10. COUPLER
11. SNAP RING
12. WET BRAKE DISC PACK
13. AXLE HOUSING
14. RIGHT AXLE SHAFT
15. RETAINING PLATE
16. WHEEL HUB COUPLER
17. BEARING CAP

Figure 9035-10-6. Drive Axle Assembly for Lift Truck Models E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

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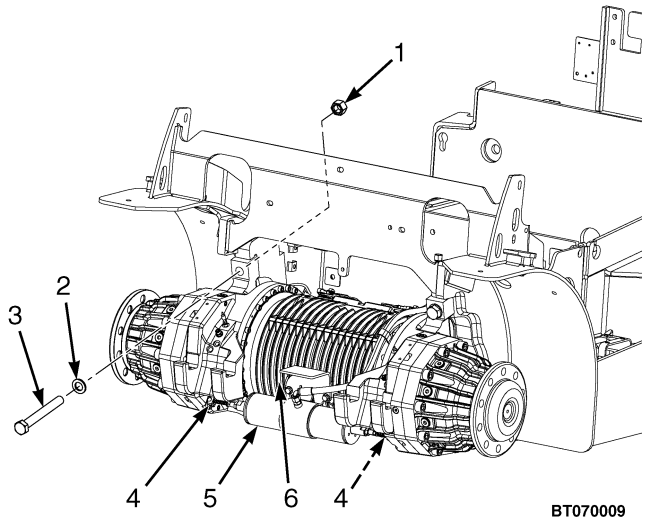
TRANSAXLE J4.0-5.0XN (J80-100XN) (A970)

DESCRIPTION

This series of lift trucks is equipped with a transaxle which consists of two drive motors, two gear boxes, two transmission output assemblies and an automatic park brake . This series of lift trucks is also equipped with a wet brake system which is located within the gear box housing. See the Wet Brake Systems section of this manual.

PRINCIPLES OF OPERATION

The lift truck uses two traction motors installed in a central traction motor housing. The traction motor housing has fins to allow the traction motors to cool. The wet brakes are contained within the gear box housing. The transaxle is mounted to the frame with four mounting bolts, washers and nuts. The transaxle housing provides the mounts needed to attach the mast to the lift truck. Power from the traction motors is transmitted to the gear box through an internal spline and on to the transmission output assembly. See Figure 9035-10-8.



1. NUT
2. WASHER
3. CAPSCREW
4. LEVER ARM
5. PARK BRAKE ACTUATOR
6. TRACTION MOTOR HOUSING

Figure 9035-10-7. Drive Axle Mounting for Lift Truck Models J4.0-5.0XN (J80-100XN) (A970)

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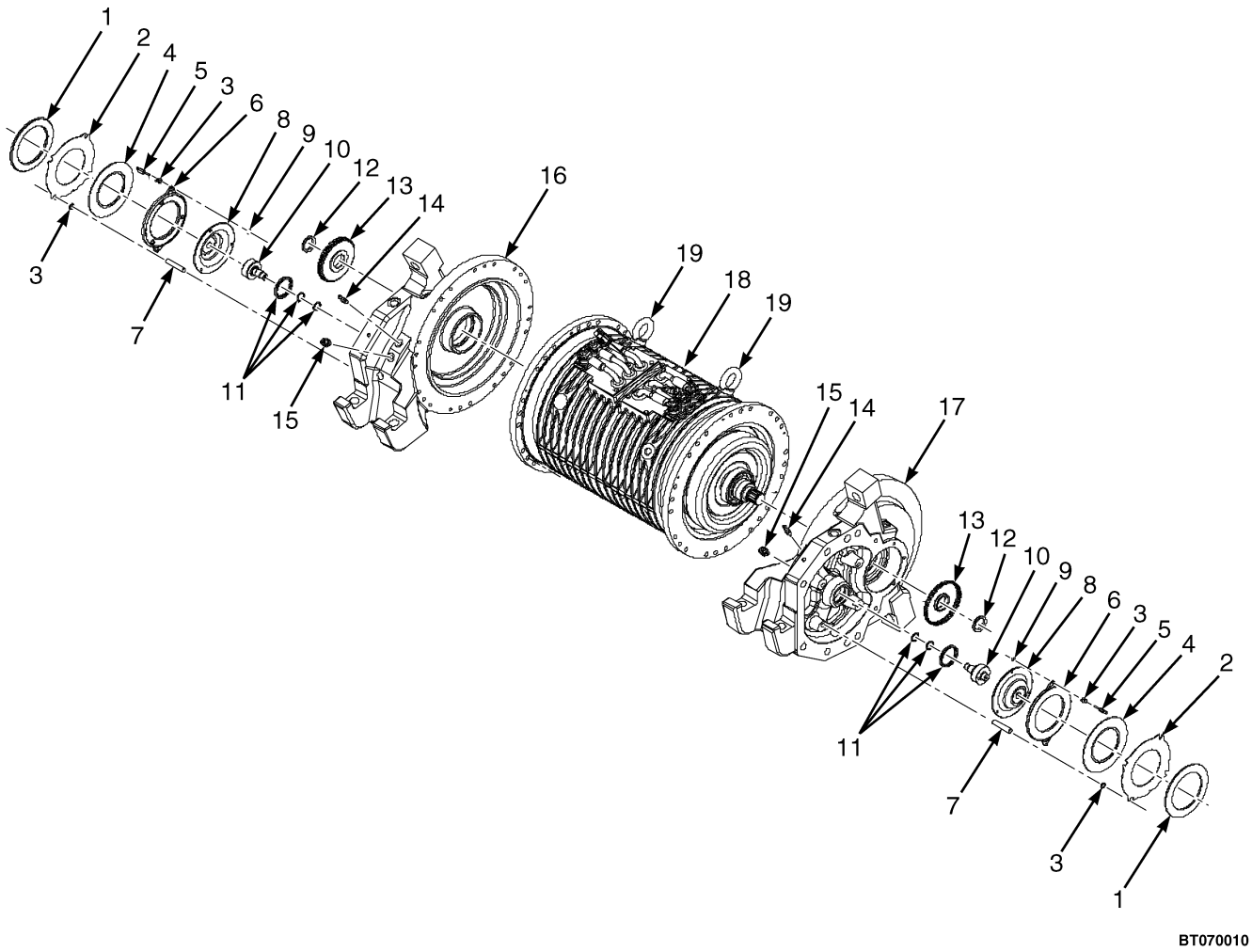

1. SUPPORT DISC
2. STEEL DISC
3. SPRING
4. SEPARATOR PLATE
5. STUD
6. DISC PUSHER
7. LOCKING PIN
8. ELASTIC DISC
9. RETAINING RING
10. PISTON
11. GASKET
12. V-RING
13. PHONIC WHEEL
14. BREATHER
15. SERVICE BRAKE PIPING CONNECTOR
16. RIGHT GEAR BOX
17. LEFT GEAR BOX
18. TRACTION MOTOR
19. LIFTING EYELET

Figure 9035-10-8. Drive Axle Assembly for Lift Truck Models J4.0-5.0XN (J80-100XN) (A970)

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SERVICE BRAKE SYSTEMS

Dry Brake Systems

General

The dry brake system includes the following parts: park brake, service brakes, master cylinder, and automatic park brake or manual. The manual park brake assembly contains a release handle, pedal, position sensor and cable. The service brake assembly contains the brake pedal, master cylinder, brake assembly (attached to wheel), and park brake cables. The automatic park brake assembly contains the brake (attached to the traction motor), cable, and manual override handle.

Wet Brake Systems

General

The brake systems for all wet brake axles operate on a common principal very similar to the transmission clutch packs. Rotating friction discs are interleaved with stationary separator discs within the axle housing. An annular piston forces the discs together when pressure is provided by the service brake system. An oil bath provides a shear film between the discs, greatly reducing wear of the friction material. For park brake function, an actuator and lever arm on the drive axle moves the piston instead of service brake oil pressure.

Master Cylinder

The master cylinder is designed for a single-circuit system. The master cylinder has a piston that operates in the bore of the master cylinder.

The reservoir is equipped with an indicator for low fluid level. A float in the reservoir moves up and down with the fluid level. When the fluid level is low, a magnet on the float activates a switch in the bottom of the reservoir. This switch signals the Vehicle System Manager (VSM) which illuminates an icon on the Display Panel (DP).

PARKING BRAKE SYSTEMS

Manual Parking Brake For Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

The parking brake system uses the service brake shoes. Additional linkage activates the parking brake system. When the pedal is moved to apply the parking brake, the cables and linkage expand the brake shoes against the drums. The design of the parking brake linkage adjusts each cable so that the tension is the same when the pedal is moved to apply the parking brake. The park brake sensor is located on the left side of the park brake pedal. See Figure 9035-10-9.

Automatic Park Brake For Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) , E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099) , and J4.0-5.0XN (J80-100XN) (A970)

On lift truck models E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) E1.6-2.0XN (E30-40XN) (A269) , the automatic park brake (APB) is attached to the traction motor. See Figure 9035-10-9 The automatic park brake activates at zero speed. If the driver leaves the seat; a switch notifies the operating software and the lift truck will slow to a stop. When the lift truck is stopped for a brief period, the park brake will apply automatically. When the accelerator is applied, the brake will release.

On lift truck model A276 , the automatic parking brake is driven by a spring applied/ hydraulic release accumulator assisted actuator mounted on the drive axle. The single pole actuator engages a wedge face on a ball ramp actuator which locks the brake disc set, parking the lift truck. The parking brake is automatically set by the control system so that the brake is always applied whenever the truck is not moving, and no traction has been requested. The manual override is a handle attached to the cable and for use when the lift truck has no power. The brake is in the applied position when the handle rests against the mechanical stop. The brake is manually released by pulling the handle upright.

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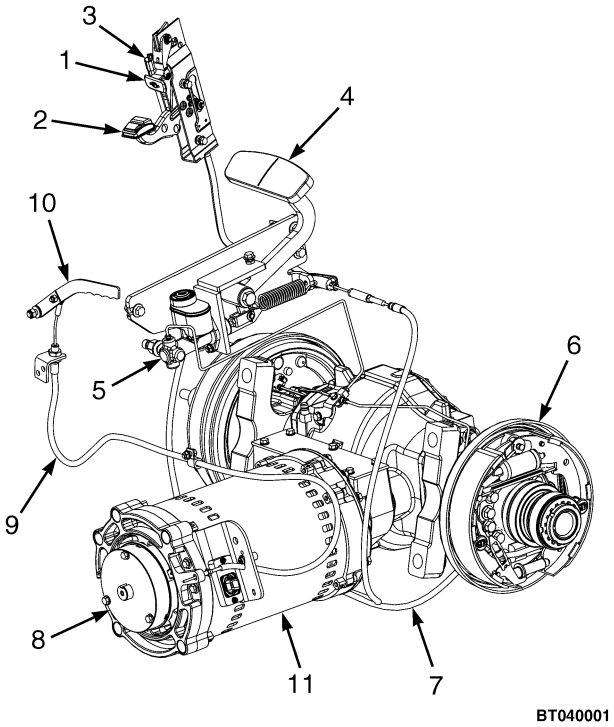
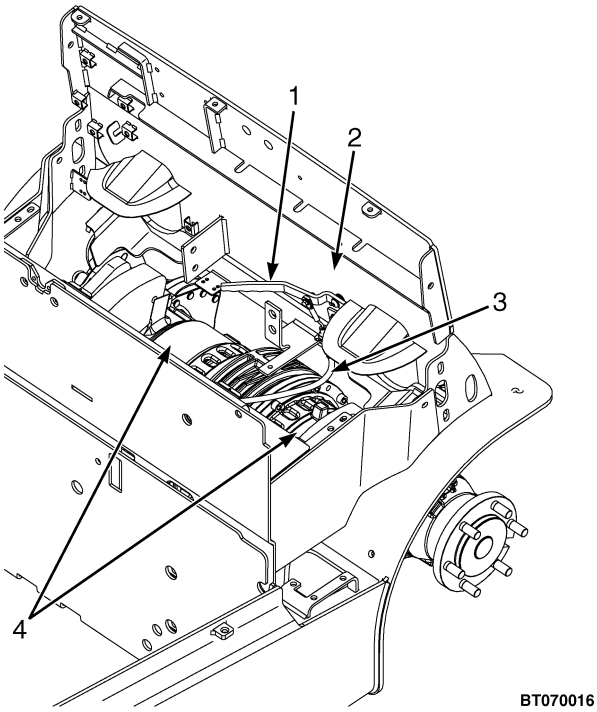


NOTE: BOTH MANUAL AND AUTOMATIC PARK BRAKE COMPONENTS SHOWN.

NOTE: DRIVE AXLE FOR E2.2-3.5XN (E45-70XN) (A268) SHOWN. E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. PARK BRAKE RELEASE HANDLE (MANUAL PARK BRAKE)
2. PARK BRAKE PEDAL (MANUAL PARK BRAKE)
3. PARK BRAKE POSITION SENSOR (LEFT-HAND SIDE) (MANUAL PARK BRAKE)
4. BRAKE PEDAL
5. MASTER CYLINDER
6. BRAKE ASSEMBLY
7. PARK BRAKE CABLES
8. AUTOMATIC PARK BRAKE ASSEMBLY
9. AUTOMATIC PARK BRAKE CABLE
10. AUTOMATIC PARK BRAKE MANUAL OVER-RIDE HANDLE
11. TRACTION MOTOR

Figure 9035-10-9. Brake System for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)



1. MANUAL OVERRIDE HANDLE
2. COWL
3. MANUAL OVERRIDE CABLE
4. TRANSAXLE

Figure 9035-10-10. Automatic Park Brake Manual Release for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

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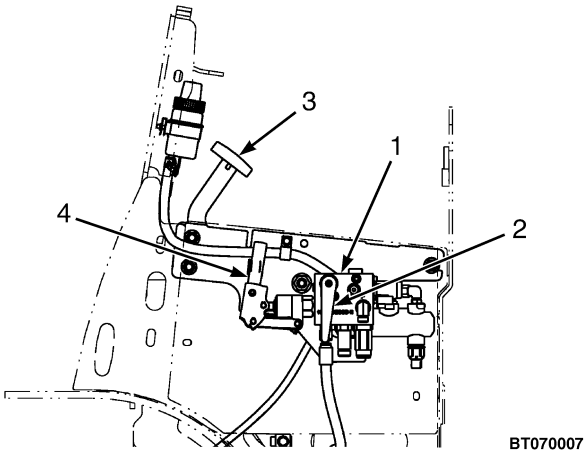
On lift truck model A970 , the automatic parking brake is driven by a spring applied/ hydraulic release actuator mounted beneath the traction motor housing. The actuator has two opposed rods that engage right and left park brake lever arms. The lever arms mechanically apply the wet brakes, parking the lift truck. The parking brake is automatically set by the control system so that the brake is always applied whenever the truck is not moving, and no traction has been requested. A manual release mechanism has been designed into the park brake for truck repairs.

On lift truck model A099 , the automatic parking brake is driven by a spring applied/ hydraulic release actuator mounted above the traction motor. The single pole actuator engages park brake lever arm on the drive axle. The lever arm mechanically applies the wet brakes, parking the lift truck. The parking brake is automatically set by the control system so that the brake is always applied whenever the truck is not moving, and no traction has been requested. A manual release mechanism has been designed into the park brake for truck repairs.

On lift trucks A099 and A970 the manual override is on a manifold valve under the floor plate. The needle valve handle must be swung clockwise to engage the bypass. Then the manual hand pump will need to be pump approximately fifteen times to release the automatic park brake. See Figure 9035-10-11.



1. MANIFOLD VALVE
2. NEEDLE VALVE HANDLE
3. PEDAL
4. MANUAL HAND PUMP

Figure 9035-10-11. Automatic Park Brake Manual Release for Lift Truck Models J4.0-5.0XN (J80-100XN) (A970) and E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

For lift truck models J4.0-5.0XN (J80-100XN) (A970) and E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099) , the park brake manifold valve consists of SV1, a 2-pos / 3-way solenoid valve, in the circuit. When this valve is not energized, i.e., “normal” state, the brake actuator is connected to the tank. In this condition there is no hydraulic pressure at the B Port. Park brake actuator spring applies the park brake and the truck is not moving. See Figure 9035-10-12 for schematic.

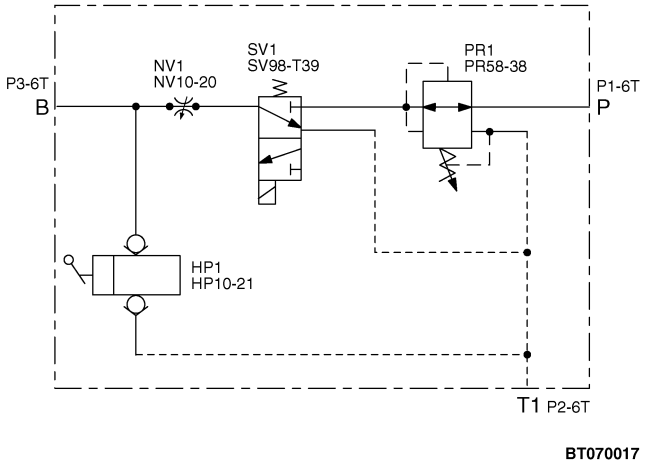


Figure 9035-10-12. Automatic Park Brake Manifold Valve for Lift Truck Model J4.0-5.0XN (J80-100XN) (A970) and E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

For lift truck models J2.2-3.5XN (J45-70XN) (A276) , the function of the accumulator (ACC1) is to store pressure and this stored pressure is used to release the Park Brake which is connected to the Port B. The Pressure Reducing Valve (PR1) reduces system pressure (from Port P) to 400 psi. Whenever a hydraulic (steering, hoist, tilt or aux) function is activated the accumulator gets charged. Steering standby flow is not sufficient to charge the accumulator. Once the accumulator is charged it can provide approximately 8-10 park brake releases before it has to be recharged. It is unlikely, but if the pressure in the accumulator drops below 200 psi it will not be able to release the park brake. In order to address this condition a pressure switch (PS1) is there to monitor the accumulator pressure. If the pressure drops below 200 psi the VSM will kick on the pump motor for a short burst to charge the accumulator.

The VSM energizes the solenoid (SV1). The pressure in the accumulator releases and holds the Park Brake. See Figure 9035-10-13 for schematic.

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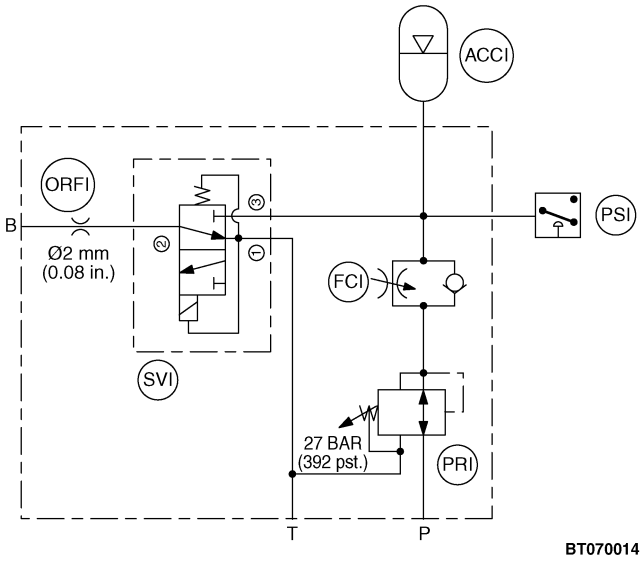

Figure 9035-10-13. Automatic Park Brake Manifold Valve for Lift Truck Model J2.2-3.5XN (J45-70XN) (A276)

MONOTROL® PEDAL

Description

The MONOTROL® pedal controls the speed of the traction motor and direction of the drive unit. There are two foot-actuated momentary-push-on switches on the left and right sides of the pedal. Pressing the left side of the pedal actuates the forward direction pedal switch. Pressing on the right side of the pedal actuates the reverse direction pedal switch. Releasing the pedal releases both pedal direction switches.

Principles of Operation

There is a small directional switch under each pad of the MONOTROL® pedal. Each switch controls one direction. If both sides of the MONOTROL® pedal are pushed at the same time no movement occurs.

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NOTES

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Group 30

Observed Symptoms

One Drive Wheel Will Not Move

POSSIBLE CAUSE

A. ELECTRICAL SYSTEM FAULT
B. DAMAGE TO TRACTION MOTOR.
C. DAMAGE TO GEAR REDUCTION SYSTEM IN DRIVE UNIT.

CAUSE A - ELECTRICAL SYSTEM FAULT

PROCEDURE OR ACTION:

1. Troubleshoot electrical system.
   Are any faults found during troubleshooting electrical system?
   YES: Correct faults. Depending on your lift truck, see **Electrical System** 2200SRM1369, or **Electrical System** 2200SRM1337.
   NO: Go to Cause B.

CAUSE B - DAMAGE TO TRACTION MOTOR.

PROCEDURE OR ACTION:

1. Inspect for damaged traction motor.
   Is traction motor apparently damaged?
   YES: Repair or replace traction motor. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to Cause C.

CAUSE C - DAMAGE TO GEAR REDUCTION SYSTEM IN DRIVE UNIT.

PROCEDURE OR ACTION:

1. Inspect for damaged drive unit.
   Does drive unit pass test?
   YES: Resume operation.
   NO: Replace drive unit. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

END SYMPTOM

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Noise During Operation That Is Not Normal

POSSIBLE CAUSE

A. MISSING OR LOOSE LUG NUTS
B. LOOSE DRIVE AXLE MOUNTING CAPSCREWS
C. LOW OIL LEVEL
D. BEARING DAMAGE
E. NOISE CONTINUES AFTER CORRECT OIL LEVEL
F. RING AND PINION BACKLASH IS NOT PROPER
G. NOISE CONTINUES

CAUSE A - MISSING OR LOOSE LUG NUTS

PROCEDURE OR ACTION:

1. Check for missing or loose lug nuts.
   Are any lug nuts missing or loose?
   YES: Tighten loose or missing lug nuts. Depending on your lift truck, see **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to Cause B.

CAUSE B - LOOSE DRIVE AXLE MOUNTING CAPSCREWS

PROCEDURE OR ACTION:

1. Check for loose drive axle mounting capscrews.
   Are any drive axle mounting capscrews loose?
   YES: Tighten drive axle mounting capscrew. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to Cause C

CAUSE C - LOW OIL LEVEL

PROCEDURE OR ACTION:

1. Check level of oil.
   Is oil level low?
   YES: Add oil to correct level. See **Operating Manual**.
   NO: Go to Cause E.

CAUSE D - BEARING DAMAGE

PROCEDURE OR ACTION:

1. Check for damage on bearings.
   Are bearings damaged?
   YES: Repair or replace traction motor. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to Cause F.

CAUSE E - NOISE CONTINUES AFTER CORRECT OIL LEVEL

PROCEDURE OR ACTION:

1. Check for wear and damage in the gear reduction system.
   Does gear reduction have wear and damage?

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YES: Repair the drive axle, speed reducer and differential assembly. See **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
NO: Go to Cause D.

CAUSE F - RING AND PINION BACKLASH IS NOT PROPER

PROCEDURE OR ACTION:

1. Check the ring and pinion backlash.
   Is ring and pinion backlash within specifications?
   YES: Go to Cause G.
   NO: Adjust ring and pinion backlash. See **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

CAUSE G - NOISE CONTINUES

PROCEDURE OR ACTION:

1. Check to make sure that the ring and pinion is a matched gear set.
   Are the ring and pinion a matched?
   YES: Resume operation.
   NO: repair or replace ring and pinion. See **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

END SYMPTOM

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Oil Leaks

POSSIBLE CAUSE

A. OIL LEAK BETWEEN DRIVE UNIT HOUSING AND COVER
B. DAMAGED O-RINGS OR OIL SEALS
C. DRAIN, LEVEL, OR FILL PLUG LOOSE
D. OIL BEING EJECTED THROUGH BREATHER DUE TO OVERFILLING

CAUSE A - OIL LEAK BETWEEN DRIVE UNIT HOUSING AND COVER

PROCEDURE OR ACTION:

NOTE: This procedure is to be performed during the initial two year warranty period for lift trucks J1.5-2.0XNT (J30-J40XNT) (K160) J1.6-2.0XN (A935)

1. Tighten housing bolts as directed in **Transaxle** 1300SRM1330, or **Transaxle** 1300SRM1370.
   Did the leak stop?
   YES: Continue lift truck operation.
   NO: Replace the drive unit. See **Transaxle** 1300SRM1330, or **Transaxle** 1300SRM1370. After the two year warranty period has expired on the above lift trucks go to Cause B.

CAUSE B - DAMAGED O-RINGS OR OIL SEALS

PROCEDURE OR ACTION:

NOTE: For lift trucks J1.5-2.0XNT (J30-J40XNT) (K160) J1.6-2.0XN (A935) the following procedure is to be performed only after the two year warranty period has expired.

1. Inspect O-rings and oil seals.
   Are O-rings or oil seals damaged?
   YES: Repair or replace damaged O-rings or oil seals. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to Cause C

CAUSE C - DRAIN, LEVEL, OR FILL PLUG LOOSE

PROCEDURE OR ACTION:

1. Inspect for loose drain, level, or fill plug.
   Is drain, level, or fill plug loose?
   YES: Tighten plug if necessary. Tighten to 22 N•m (16. lbf ft) Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to Cause D.

CAUSE D - OIL BEING EJECTED THROUGH BREATHER DUE TO OVERFILLING

PROCEDURE OR ACTION:

1. Inspect breather for ejection of excess oil.
   Is excess oil being ejected from breather?
   YES: Remove oil drain plug and allow excess to drain until level is at bottom of oil fill plug.
   NO: Resume operation.

END SYMPTOM

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Park Brake Does Not Operate Properly

POSSIBLE CAUSE

A. PARK BRAKE ACCUMULATOR IS FAULTY.

CAUSE A - PARK BRAKE ACCUMULATOR IS FAULTY.

PROCEDURE OR ACTION:

1. Bring truck to a complete stop.
2. Run tilt over relief for 15 seconds (this will fully charge the accumulator).
3. Press the accelerator pedal to move the lift truck 0.3 m (1 ft) with no hydraulic functions actuated including steering.
4. Come to a compete stop then repeat Step 3.
   Does hydraulic pump run at a fast rate for a brief period?
   YES: Replace accumulator. See **Transaxle** 1300SRM1370
   NO: Problem not Verified. Resume Operation.

END SYMPTOM

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Motion Inhibited

POSSIBLE CAUSE

A. TRACTION OR HYDRAULIC INTERLOCK
B. MOTOR CONTROLLER FAULTED OR NOT READY
C. KEY SWITCH
D. BRAKE LINKAGE
E. BRAKE APPLIED

CAUSE A - TRACTION OR HYDRAULIC INTERLOCK

PROCEDURE OR ACTION:

1. Check display for active interlocks.
   Is an interlock active?
   YES: Cycle the key. Check display for active interlocks.
   NO: Go to Cause B.

CAUSE B - MOTOR CONTROLLER FAULTED OR NOT READY

PROCEDURE OR ACTION:

1. Check operator presence.
   Is the Operator Presence system working properly?
   YES: Go to Cause C.
   NO: Repair or replace the Operator Presence sensor. Refer to the appropriate **Wiring Harness Repair** SRM or **Electrical System** SRM .

CAUSE C - KEY SWITCH

PROCEDURE OR ACTION:

1. Check for key switch related faults.
   Are there any key switch related faults?
   YES: Repair or replace the key switch. Refer to the appropriate **Wiring Harness Repair** SRM or **Electrical System** SRM .
   NO: Go to Cause D.

CAUSE D - BRAKE LINKAGE

PROCEDURE OR ACTION:

1. Check the brake linkage when motion is inhibited and there are no fault codes.
   Is the brake linkage in good condition and working properly?
   YES: Go to Cause E.
   NO: Repair or replace damaged or worn components. Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .

CAUSE E - BRAKE APPLIED

PROCEDURE OR ACTION:

1. Check brake pressure sensor voltage. Without brake applied voltage should be 0.5 volts.
   Is the brake pressure sensor reading 0.5 volts without the brake applied?
   YES: Resume operation.

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NO: Replace brake pressure sensor with new sensor. Refer to the appropriate **Wiring Harness Repair** SRM or **Electrical System** SRM .

END SYMPTOM

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PARK BRAKE TROUBLESHOOTING GUIDE

Symptoms	Possible Solutions	Action
Slow Park Brake Release	Check hose restrictions	Replace hoses that have been crushed or kinked.
	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check solenoid valve	Refer to the appropriate **Electrical System** SRM .
	Check standby pressure	Refer to the appropriate **Main Control Valves** SRM .
	Check accelerator pedal	Refer to the appropriate **Electrical System** SRM .
	Check linkage for damage	Replace sheared clevis pins, worn or damaged cables and springs and retaining clips.
	Check actuator rod damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check actuator rod interference	Secure hoses, lines, and wires out of the way to eliminate interference.
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
Slow Park Brake Apply	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check solenoid valve voltage, coil, contamination	Refer to the appropriate **Electrical System** SRM .
	Check Tank return hose for kinks, pinches or back pressure	Remove any excessive elbow joints or other restrictions in the tank return hose.

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Symptoms	Possible Solutions	Action
No Park Brake Apply	Check park brake cable for damage	Replace park brake cable if damaged.
	Check park brake cable adjustment	Refer to the appropriate **Periodic Maintenance** SRM .
	Check actuator stroke	Refer to the appropriate **Periodic Maintenance** SRM .
	Check brake pack wear	Refer to the appropriate **Periodic Maintenance** SRM .
	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check for sticking solenoid valve	Refer to the appropriate **Electrical System** SRM .
	Check actuator rod for damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
	Check speed sensor	Refer to the appropriate **Electrical System** SRM .
Partial Park Brake Apply	Check brake pack wear	Refer to the appropriate **Periodic Maintenance** SRM .
	Check park brake cable adjustment	Refer to the appropriate **Periodic Maintenance** SRM .
	Check for actuator damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check wheel size	See your lift trucks name plate for the appropriate tire type and size.
	Check oil type	Refer to the appropriate **Periodic Maintenance** SRM .
	Check hose leaks	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check linkage for damage	Replace sheared clevis pins, worn or damaged cables and springs and retaining clips.

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Symptoms	Possible Solutions	Action
No Park Brake Release	Check actuator stroke (locked)	Refer to the appropriate **Periodic Maintenance** SRM .
	Check for actuator damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check solenoid connection	Refer to the appropriate **Electrical System** SRM .
	Check solenoid valve voltage, current and coil	Refer to the appropriate **Electrical System** SRM .
	Confirm hose routing	Make sure all hoses have gradual slopes and do not interfere with moving components.
	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check standby pressure	Refer to the appropriate **Main Control Valves** SRM .
	Check accelerator pedal	Refer to the appropriate **Electrical System** SRM .
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
	Check pressure reducing valve	Replace the parking brake valve if a pressure of less than 2068±138 kPa (300±20 psi) is measured at the pressure port on the parking brake valve.
	Check hoses for leaks	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check actuator rod interference	Secure hoses, lines, and wires out of the way to eliminate interference.

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Symptoms	Possible Solutions	Action
Partial Park Brake Release	Check park brake rod interference	Secure hoses, lines, and wires out of the way to eliminate interference.
	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check pressure reducing valve	Replace the parking brake valve if a pressure of less than 2068±138 kPa (300±20 psi) is measured at the pressure port on the parking brake valve.
	Check hoses for leaks	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check hose for kinks and pinches	Replace hoses that have been crushed or kinked.
	Check actuator stroke (locked)	Refer to the appropriate **Periodic Maintenance** SRM .
	Check linkage for damage	Replace sheared clevis pins, worn or damaged cables and springs and retaining clips.
Unintentional Park Brake Apply	Check speed sensor	Refer to the appropriate **Electrical System** SRM .
	Check accelerator pedal	Refer to the appropriate **Electrical System** SRM .
	Check solenoid connection	Refer to the appropriate **Electrical System** SRM .
	Check solenoid hardness connection	Refer to the appropriate **Electrical System** SRM .
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.

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Symptoms	Possible Solutions	Action
Park Brake is noisy	Check actuator damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check park brake cable damage	Replace park brake cable if damaged.
	Check for actuator interference	Secure hoses, lines, and wires out of the way to eliminate interference.
	Check solenoid valve	Refer to the appropriate **Electrical System** SRM .
Park Brake judder/vibration	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check solenoid valve	Refer to the appropriate **Electrical System** SRM .
	Check pressure reducing valve	Replace the parking brake valve if a pressure of less than 2068±138 kPa (300±20 psi) is measured at the pressure port on the parking brake valve.
	Check hoses leaks	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check hose kinks or pinches	Replace hoses that have been crushed or kinked.
	Check brake pack wear	Refer to the appropriate **Periodic Maintenance** SRM .

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Symptoms	Possible Solutions	Action
No Manual Override	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check pump prime	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check for leaks in hoses	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check tank return hose for kinks or pinches	Replace return hose with new return hose if kinks or pinches are found.
	Check for actuator damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .
	Check actuator stroke (locked)	Refer to the appropriate **Periodic Maintenance** SRM .
Park Brake engagement frequency too high	Confirm software setting	Refer to the appropriate **User Interface** SRM .
	Check accelerator pedal	Refer to the appropriate **Electrical System** SRM .
	Check operator presence sensor	Refer to the appropriate **Electrical System** SRM .
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
Park Brake engagement frequency too low	Check speed sensor	Refer to the appropriate **Electrical System** SRM .
	Check accelerator pedal	Refer to the appropriate **Electrical System** SRM .
	Check partial brake apply	Refer to Observed Symptoms, Motion Inhibited, Page 9035-30-6

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NOTES

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SECTION 9050
HYDRAULIC SYSTEMS

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Group 10

Principles of Operation

Manual Hydraulic Main Control Valve

DESCRIPTION

The manual main control valve controls the lift, tilt, and auxiliary functions. The main control valve is installed to the right of the operator, below the floor plate.

The sections are held together with four through bolts and nuts. Each function of the main control valve is made as a separate section having a spool and valve body. Each valve body casting is the same. The control spools are different for each function. Other sections are added to the main control valve to control optional auxiliary functions.

Each spool has a spring that returns the spool to the neutral position when the control lever is released. Each valve section has a check valve in the valve body. The check valve and spring is held in the valve body by the next section.

This section will cover the principles of operation for two different types of manual hydraulic control valves. The open center type valve and the closed center type valve. For the control valve used on J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), and E1.6-2.0XN (E30-40XN) (A269) A1.3XNT, A1.5XNT (A25XNT, A30XNT) (D203) , see General Description (Open Center Valve). For the control valve used on E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) , see General Description (Closed Center Valve).

MANUAL HYDRAULIC CONTROL SYSTEM

The manual hydraulic control system controls all hydraulic functions, to include, lift/lower, tilt, and auxiliary functions. The system consists of the following components:

- Manual Hydraulic Control Valve
- Vehicle Master Controller
- Hydraulic Pump Motor Controller
- Dash Display
- Pump Motor and Fixed Displacement Gear Pump
- Operator's Seat and Armrest
- PC Based Service Software (ETACC)

See Figure 9050-10-1 for component location.

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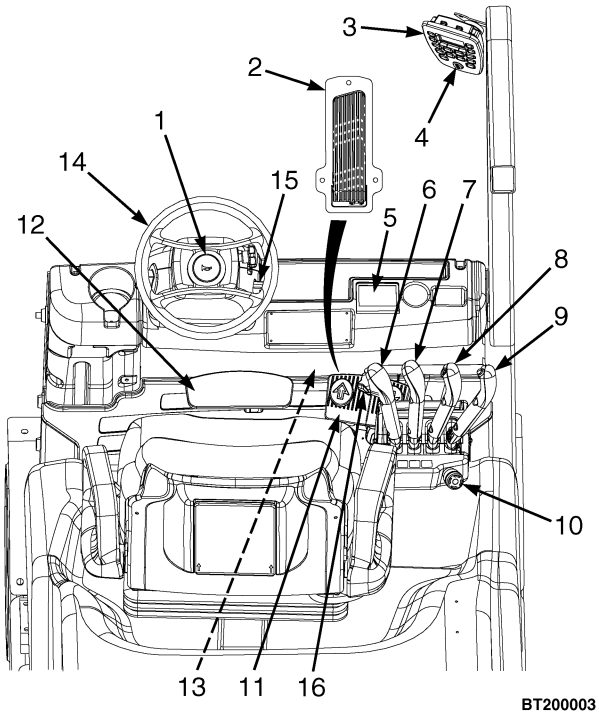
The manual hydraulic main control valve incorporates an emergency (manual) lowering valve. This valve allows the operator or service technician to lower the lift truck's mast assembly if the electrical power to the lift truck is disrupted.

The vehicle master controller, manual control levers, and hydraulic pump motor controller communicate with each other via the CANbus communication system. The master controller controls the hydraulic pump motor and the control valve based upon the inputs received from the manual control levers. The master controller converts the operator's input into controlled oil flow by simultaneously commanding the hydraulic pump motor controller to deliver a specific motor speed, and by commanding the manual hydraulic valve to deliver specific valve metering. Pump speed is variable up to the maximum speed preset in the master controller for the required hydraulic function.



1. HORN BUTTON
2. ACCELERATOR PEDAL
3. DISPLAY PANEL
4. KEY SWITCH AND KEYLESS SWITCH
5. LIGHT SWITCHES
6. LIFT/LOWER CONTROL LEVER
7. TILT CONTROL LEVER
8. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)
9. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)
10. EMERGENCY DISCONNECT SWITCH
11. DIRECTION CONTROL SWITCH
12. BRAKE PEDAL
13. AUTOMATIC PARKING BRAKE MANUAL OVERRIDE HANDLE (OPTIONAL)
14. STEERING WHEEL
15. STEERING COLUMN TILT MEMORY LEVER
16. MONOTROL® FOOT PEDAL CONTROL PEDAL

Figure 9050-10-1. Operator Station Components

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GENERAL DESCRIPTION (OPEN CENTER VALVE)

CONSTRUCTION

The valve assemblies for this application contain an inlet section, a lift section, a tilt section, an auxiliary section, and an outlet section. Some valve assemblies may include a dual (2nd) auxiliary section. All valves are assembled using tie rods and hex nuts. O-ring seals are placed between the various sections to prevent external fluid leakage between the sections.

VALVE TYPE

The valve assemblies are open-center type valve used in conjunction with a fixed displacement pump. A fixed displacement pump will provide a fixed amount of fluid with each revolution of the pump shaft. For example, if a 1 cubic inch per revolution pump is rotated at 1000 revolutions per minute, the pump output will be 1000 cubic inches per minute (1 cubic inch/rev x 1000 rev/min = 1000 cubic inches/min = 4.329 gal/min). In open center type valves, flow is passed through an open center core from the inlet port to the outlet port of the valve when all the spools are in the neutral (non-shifted) position. When a spool is shifted, flow is directed to the selected work port of the section and/or sections shifted. In open center systems fluid will follow the path of least resistance, meaning flow will be directed to the lowest load requirement when two or more valve spools are shifted. If flow is required by two or more sections at the same time, the operator generally must adjust the travel of each spool to get the desired flow rate from both work sections. See Figure 9050-10-2.

FEATURES AND OPERATION

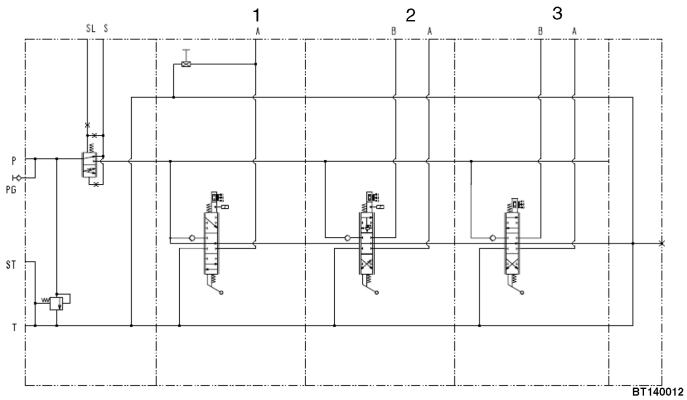
INLET ASSEMBLY

Construction and Purpose

Inlet assemblies provide the majority of the port connections used to connect various lines of the hydraulic circuit to the valve. All inlet assemblies include a priority spool for the steering circuit and a main relief valve to protect the pump from over pressurization. The housing is grey iron, and the major internal components are made of various types of steel.

Porting

The inlet housing provides ports for the pump in (P), tank (T), steer supply (S), steer return (ST), steer load sense (SL), and pump pressure (PG).



1. LIFT
2. TILT
3. AUXILIARY #1

Figure 9050-10-2. Basic Open Center Circuit

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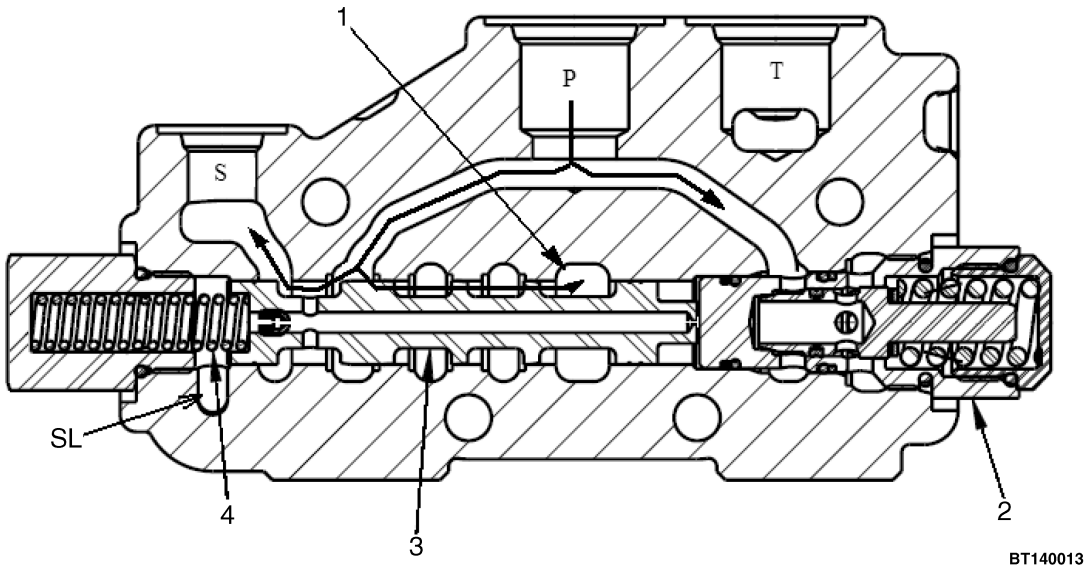
Priority Steer

Pump flow is directed across the priority spool before supplying flow for any downstream demands. Therefore, the steering circuit has priority over any downstream flow demands. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (PG) will increase just enough to overcome the priority spool's spring force. Since the inlet pressure is communicated to the blind end of the priority spool, via the drilled passages within the spool, the spool will shift towards the spring end and flow to the steering unit will decrease and pump flow will be directed across the priority spool into a downstream (open center) core. If there is a flow demand from the steering unit, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. The downstream core coming from the priority spool is directed to the open center core of the valve assembly. If none of the work section spools are shifted, total pump flow is directed through the valve assembly via the open center core, across the work section spools to the outlet (T) port. See Figure 9050-10-3.

Relief Cartridge

The primary function of a system relief valve is to prevent excessive system pressure. This valve assembly uses a direct acting relief cartridge and it is sized to pass total pump flow. The relief cartridge is in parallel with the pump inlet port. This design limits pressure to a predetermined level equal to the force generated by the relief spring. Inlet pressure is communicated through the relief body to the nose area of the poppet. When the force caused by pressure acting on the nose end of the poppet exceeds the force generated by the spring, the poppet will move towards the relief spring. Pump flow is then directed through the holes in the relief cartridge body and the poppet to the outlet side of the relief cartridge body. The outlet side of the cartridge is tied to the tank port (T) of the inlet assembly. If the pressure acting on the nose of the poppet decreases, the spring force will cause the poppet to move towards the nose end closing the outlet path. When actively relieving pressure, the inlet pressure (PG) will be slightly greater than the force generated by the relief spring.



1. OPEN CENTER CORE
2. RELIEF CARTRIDGE
3. PRIORITY STEER SPOOL
4. SPRING

Figure 9050-10-3. Cross-Sectional View of Inlet Assembly

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LIFT SECTION

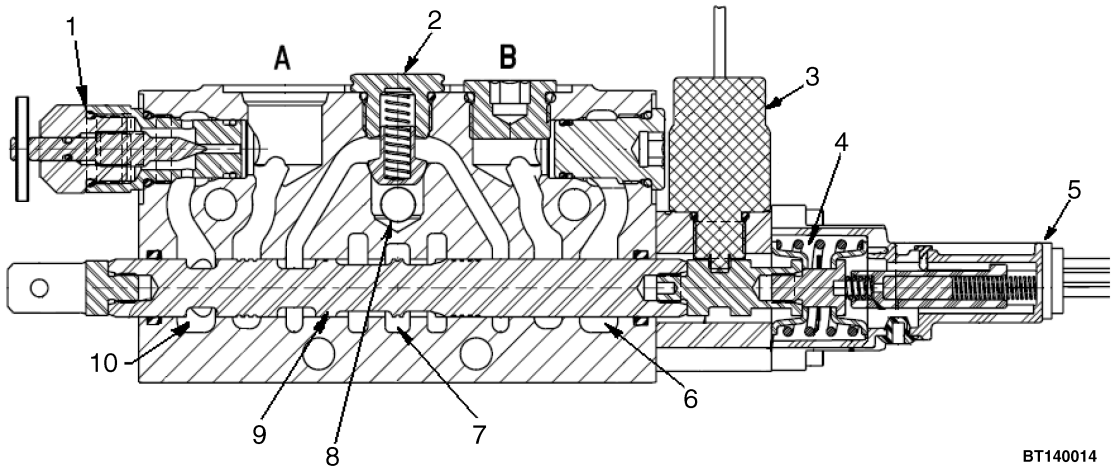
Construction

The lift section major components include: the housing, a main spool, an operator presence solenoid (OPS), a spool position sensor, a load check valve assembly and a manual emergency lowering cartridge.

Purpose

The purpose of the lift section is to allow for extending and retracting of the vehicle's lift cylinder. The lift section uses a 3-way spool for raising and lowering the mast and incorporates an Operator Presence Solenoid (OPS) to help improve operator safety. See Figure 9050-10-4.

When the spool is in neutral, flow passes through the open-center (OC) core and then to the next work section. If all the work section spools are in neutral, the flow will be directed to the tank (T) port in the inlet section. When the lift spool is shifted out of the housing, the open-center passage (OC) closes off, and flow is directed through power core at the inlet to the load check assembly into the high pressure bridge core. From the high pressure bridge core the flow is directed across metering notches of the spool, and out work port A to the lift cylinder and raises the mast. Shifting the spool into the housing from neutral connects work-port A to the tank core of the housing, thus allowing lowering of the mass. When lowering the mast, the open center core is open and directs flow to downstream functions. This allows other downstream functions to be used when lowering the mast.



1. MAST LOWER CARTRIDGE
2. LOAD CHECK
3. OPERATOR PRESENCE SOLENOID
4. SPOOL POSITIONER
5. POSITION SENSOR
6. TANK CORE
7. OPEN CENTER CORE
8. POWER CORE
9. MAIN SPOOL
10. TANK CORE

Figure 9050-10-4. Cross-Section of Lift Section

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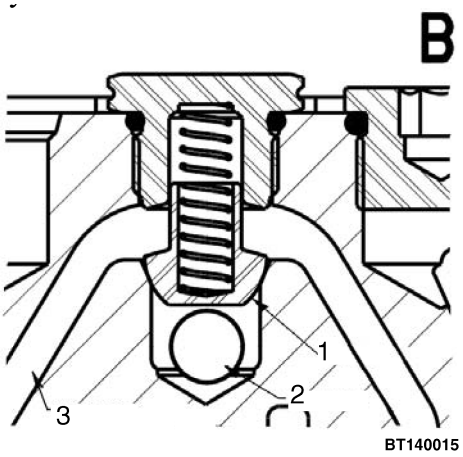
Load Check

The load-check assembly prevents back flow from the work ports under heavy load conditions. If the load check assembly was absent, under a heavy load condition the load would lower or drift when the spool is actuated, until the pressure builds to a sufficient level to move the load. Some drifting may occasionally occur since the load check assembly is not a zero leak device. See Figure 9050-10-5.

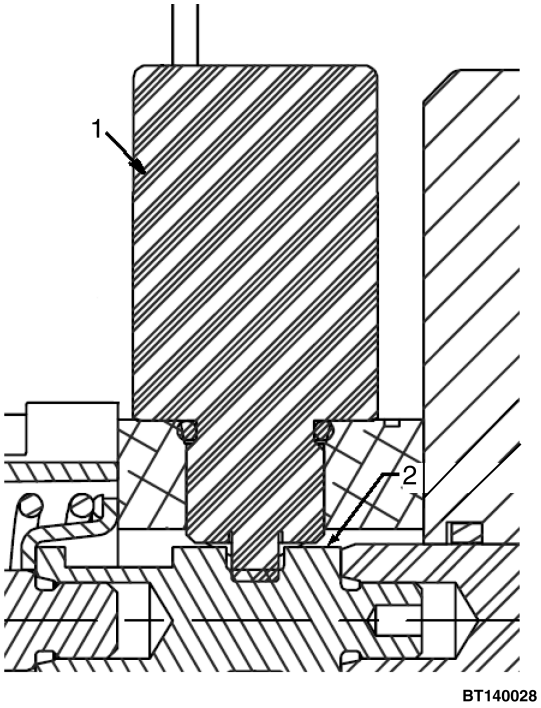


1. POPPET
2. POWER CORE
3. BRIDGE CORE

Figure 9050-10-5. Cross Section of Load Check Assembly

Operator Presence Solenoid

The Operator Presence Solenoid (OPS) has a spring loaded plunger which extends into an extension attached to the spool when de-energized. The plunger keeps the spool from moving when no electrical power is supplied to the solenoid's coil. When power is supplied to the coil, a force is generated which pulls the plunger upward and out of the spool extension. Once the plunger disengages, the spool can be moved out of its neutral position. See Figure 9050-10-6.



1. OPERATOR PRESENCE SOLENOID
2. SPOOL EXTENSION

Figure 9050-10-6. Cross-Section of Operator Presence Solenoid

Position Sensor Assembly

The position sensor monitors the travel of the valve spool and produces a variable output signal relative to how far the spool is from its neutral position. The vehicle's electronics supplies the sensor with a 5 volt dc signal. When the spool is in its' neutral position, the sensor output will be approximately 2.5 volts dc. As the spool is shifted from neutral, the sensor's output voltage will increase or decrease depending upon the direction of spool travel. The output signal from the sensor is used by the vehicle's electronic control system to vary the hydraulic pump flow. The intent is to meet predetermined function speed requirements. See Figure 9050-10-7.

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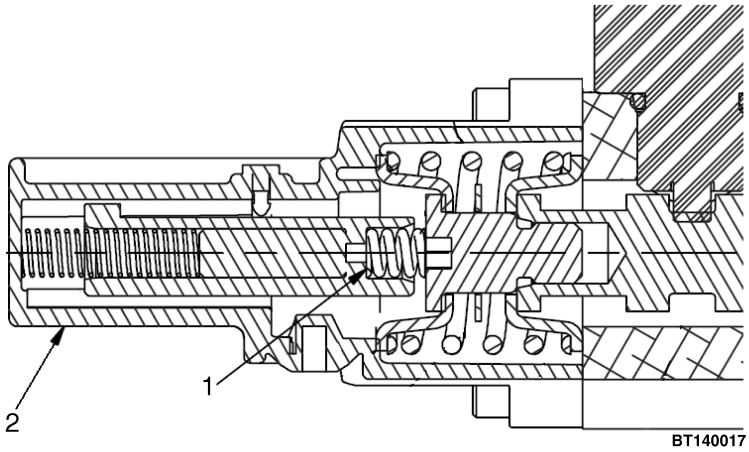
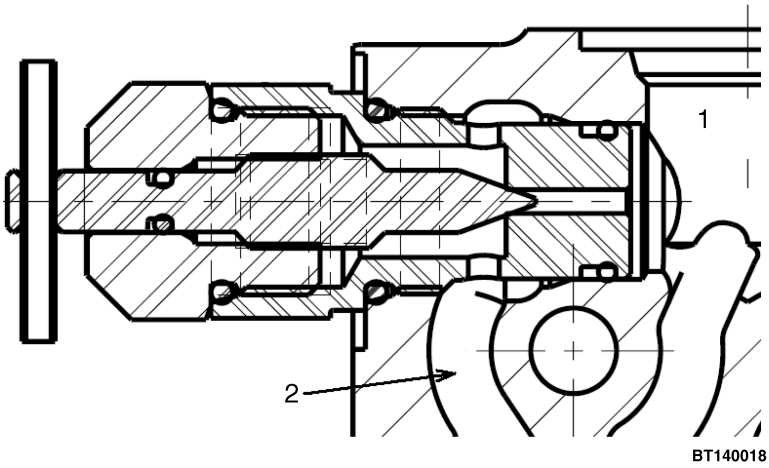


1. SPRING
2. POSITION SENSOR

Figure 9050-10-7. Cross-Section of Position Sensor

Mast Lowering Cartridge

The lift section housing incorporates a manual operated needle valve cartridge which allows the “A” work port to be directly connected to the tank core in the housing. When viewed from the lever end, turning the handle on the cartridge clockwise will shut the valve and turning it counter clockwise will open the valve. The cartridge is intended to be used only in emergency situations to lower the mast. See Figure 9050-10-8.



1. WORK PORT AREA
2. TANK CORE AREA

Figure 9050-10-8. Cross-Section of Manual Lower Valve Cartridge

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TILT SECTION

Construction

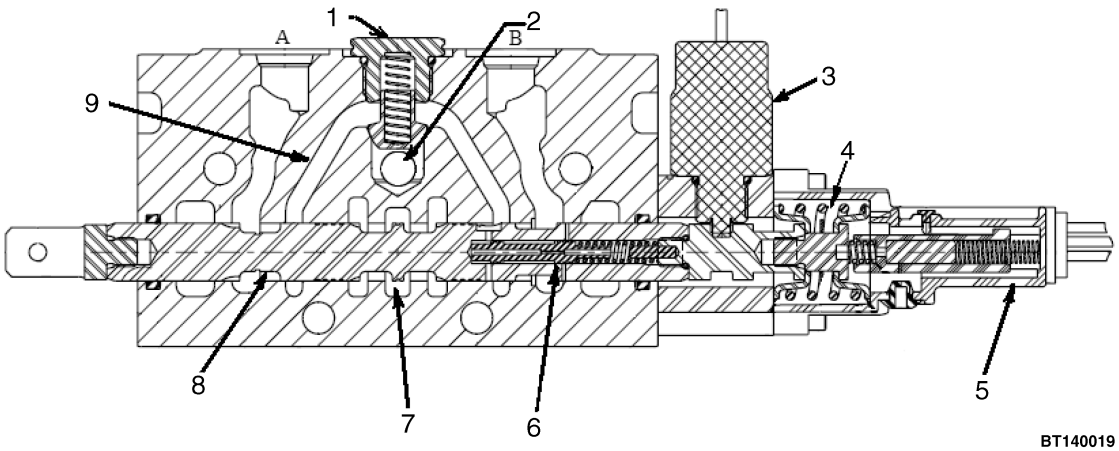
The tilt section major components include: the housing, a main spool, a tilt lock spool, an operator presence solenoid, a spool position sensor and a load check valve assembly.

Purpose

The purpose of the tilt section is to extend and retract the tilt cylinders, with an integrated “tilt-lock” shuttle spool which controls output flow when tilting the mast forward. The main function of the “tilt-lock” is that if the pump is not providing flow, the tilt cylinders will not extend. The tilt section uses a 4-way spool for tilting the mast forward and backward and incorporates an Operator Presence Solenoid (OPS) to help improve operator safety. See Figure 9050-10-9.

When the spool is in neutral, flow passes through the open-center (OC) core and then down stream to the next work section. If all the work section spools are in neutral, flow will be directed to the tank (T) port in the inlet section.

- **Tilt Backward** When the tilt spool is shifted out of the housing, the open-center (OC) core is closed off and flow is directed via the power core through the load check assembly, into the high pressure bridge core. From the high pressure bridge core the flow is directed out work port B to the rod end of the tilt cylinders. The flow from the base end of the tilt cylinders returns to the opposite work port (A), across metering notches in the main spool, and to the tank passage, thus tilting the mast backward.
- **Tilt Forward** During tilt forward operation, the internal “tilt-lock” shuttle spool helps to control unintended increases in forward tilt speed. When the tilt spool is shifted into the housing, the open-center (OC) core is closed off and flow is directed via the power core through the load check valve to the high pressure bridge core. The pressure is sensed at the base of the tilt-lock shuttle spool, sliding the shuttle spool open against the spring. From the high pressure bridge core the flow is directed out work port A to the base end of the tilt cylinders. Flow from the rod end of the tilt cylinders returns to the opposite work port (B), directed inside the main spool, and metered out through holes in the main spool to the tank core. If the pump is not providing flow, there is no pressure at the base end of the tilt-lock shuttle spool, and the shuttle spool will not move. Under this condition, if the main spool is shifted, the tilt-lock shuttle spool blocks off the internal passage of the spool, preventing flow from work port B to the tank core, therefore the mast will not tilt forward. Since these are not zero-leak devices, some cylinder drift may occur.



1. LOAD CHECK
2. POWER CORE
3. OPERATOR PRESENCE SYSTEM
4. SPOOL POSITIONER
5. POSITION SENSOR
6. TILT LOCK SHUTTLE SPOOL
7. OPEN CENTER CORE
8. MAIN SPOOL

Figure 9050-10-9. Cross-Section of Tilt Section

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AUXILIARY AND DUAL AUXILIARY SECTION

Construction

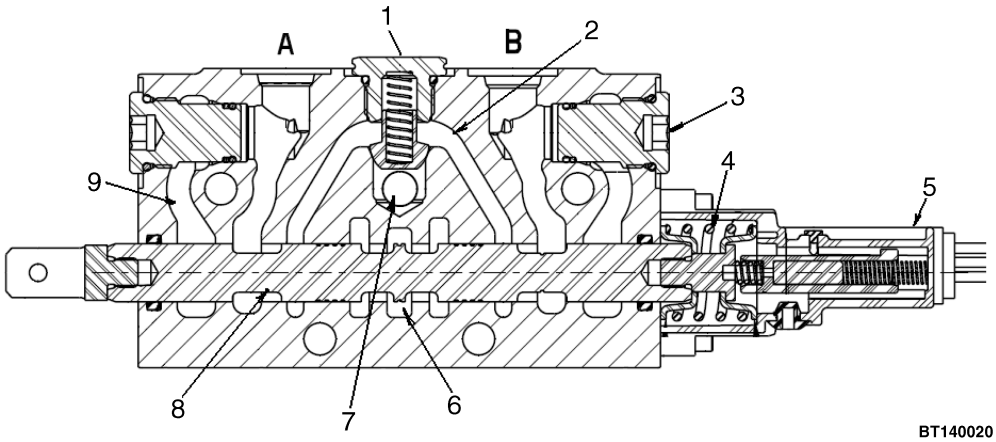
Auxiliary and/or a dual auxiliary section major components include: the housing, a main spool, a spool position sensor, and a load check valve assembly. Some auxiliary sections may include a spool lock solenoid device which is the same as an operator presence solenoid assembly.

Purpose

The auxiliary section is used to control various attachments that can be installed on the vehicle. See Figure 9050-10-10.

When the spool is in neutral, flow passes through the open-center (OC) passage and downstream to the tank port of the valve.

When the spool is actuated in or out, the open-center (OC) flow path is blocked off and forces the flow through power core across the load check valve into the high pressure bridge core. From the high pressure bridge core, the oil is directed out the selected work port (3A or 3B for three-function valve, 3A, 3B, 4A, or 4B for four-function valve) to the auxiliary attachment. Oil returns from the auxiliary attachment to the opposite work port in that section and is directed to the tank passage.



1. LOAD CHECK
2. BRIDGE CORE
3. WORK PORT OPTION PLUG
4. SPOOL POSITIONER
5. POSITION SENSOR
6. OPEN CENTER CORE
7. POWER CORE
8. MAIN SPOOL

Figure 9050-10-10. Cross-Section Dual Auxiliary Section

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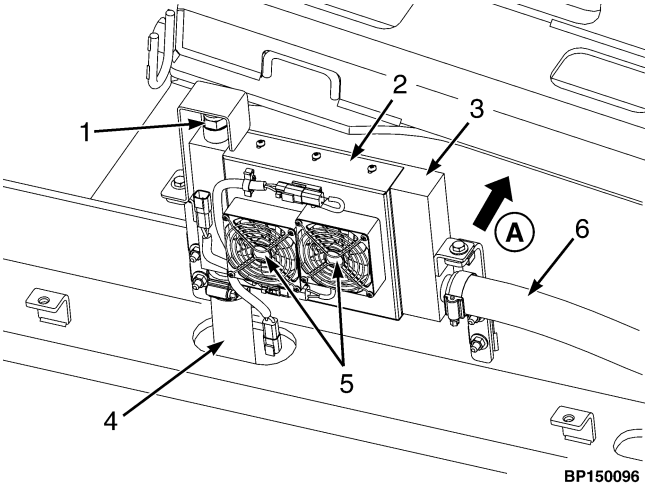
HYDRAULIC OIL COOLER

Construction and Purpose

The hydraulic oil cooler option consist of an oil cooler, hydraulic oil temperature switch, two 12 volts fans and shroud, and support bracketry. The purpose of the hydraulic oil cooler is to keep hydraulic oil temperature to the hydraulic tank no greater than 60°C (140°F).

Operation

The hydraulic oil cooler is in series with hydraulic supply circuit, between the filter assembly and main control valve. See Figure 9050-10-11. The cooling fans are triggered when the hydraulic oil temperature switch senses a hydraulic oil temperature of a 60°C (140°F).



A. DIRECTION OF AIR FLOW

1. HYDRAULIC OIL TEMPERATURE SWITCH
2. SHROUD
3. HYDRAULIC OIL COOLER
4. RETURN HOSE- FROM MAIN CONTROL VALVE
5. FANS
6. RETURN HOSE - TO HYDRAULIC TANK

Figure 9050-10-11. Hydraulic Oil Cooler

OUTLET COVER SECTION

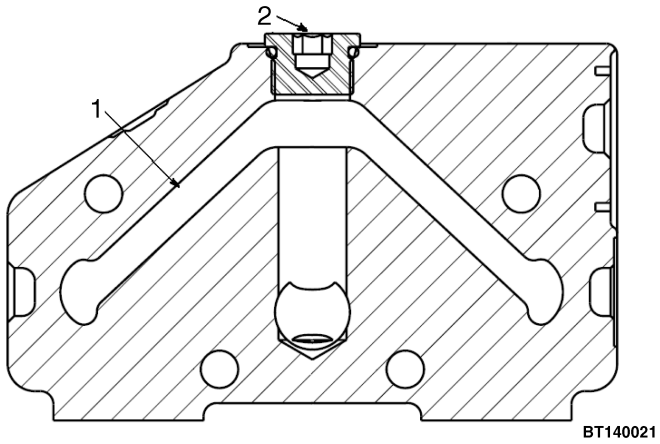
Construction and Purpose

The outlet cover connects the open-center to the exhaust core, and has an optional Tank port, which is plugged. The dual exhaust cores routed through the previous work-sections are joined together in the outlet. See Figure 9050-10-12.

GENERAL DESCRIPTION (CLOSED CENTER VALVE)

CONSTRUCTION

Valve assemblies for this application are manually shifted. All valve assemblies include an inlet section, a lift section, a tilt section, and an auxiliary section. Some valve assemblies may include a second dual auxiliary section. All valves are assembled using tie rods and hex nuts. O-ring seals are placed between sections to prevent external fluid leakage.



1. TANK CORE
2. OPTIONAL TANK PORT

Figure 9050-10-12. Cross Section of Outlet Cover

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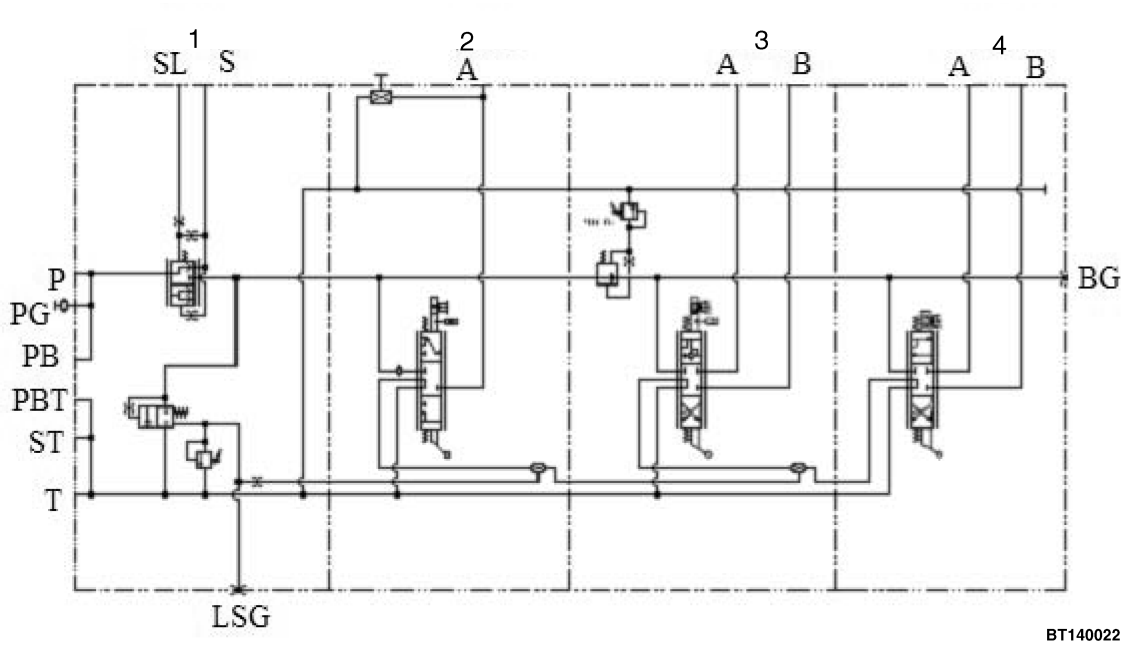
VALVE TYPE

Valves supplied are closed center load sense type. The valves are used with a fixed displacement pump. A fixed displacement pump will provide a fixed (known) amount of fluid with each revolution of the pump shaft. For example, if a 1 cubic inch per revolution pump is rotated at 1000 revolutions per minute, the pump output will be 1000 cubic inches per minute (1 cubic inch/rev x 1000 rev/min = 1000 cubic inches/min = 4.329 gal/min). These load sense type valves (VAL) direct flow to a closed center passageway called a power core. Flow is blocked from going out the work ports when the main spools, located within the sections are in the neutral position. Shifting a spool directs flow to the selected work port. In these valves, internal passageways in conjunction with shuttle valves, direct the highest loads pressure signal (load sense pressure) back to an unloading spool located in the inlet. Using an unloading spool allows the use of a fixed displacement pump, but incorporates the advantages of a load sensing circuit (system pressure slightly above the load requirement and flow to match the loads' demand). If flow is simultaneously required by two or more work sections, the operator must adjust the travel of each spool to get the desired flow rate from each work section. See Figure 9050-10-13.



1. INLET
2. LIFT
3. TILT
4. AUXILIARY #1

Figure 9050-10-13. Load Sense Control Valve With Unloader and Priority Steering

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FEATURES AND OPERATION

INLET ASSEMBLY

Construction and Purpose

Inlet assemblies provide the majority of the porting connections to connect various lines of the hydraulic circuit. All inlet assemblies for this type of valve include a priority steering spool to control flow to the steer unit, a main relief valve to protect the pump from over pressurization, and an unloading spool to unload (dump to tank) any excess pump flow.

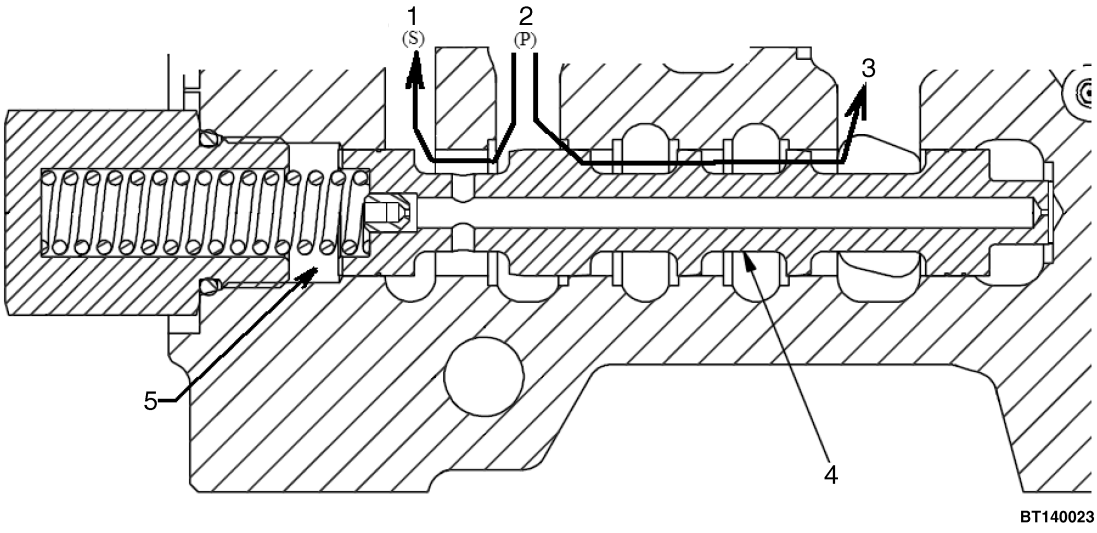
Porting

Port sizes vary based upon flow requirements and features within each inlet assembly. All inlets provide connections for: pump (P), tank (T), steer supply (S), steer return (ST), load sense signal coming from the steering control unit (SL), pump pressure (PG), load sense gage port (LSG) coming from the work section's shuttle circuit, and reduced pressure gage port (BG). If a hydraulic brake option is required, ports are provide for the brake supply (PB) and the brake return (PBT). Be aware that the PB port is exposed to full system pressure.

Priority Steer

Pump flow is directed across a priority spool before supplying flow to any downstream functions. The steering circuit flow demand has priority over any downstream flow requirements. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (P) will increase to overcome the priority spring force. The inlet pressure is communicated to the blind end of the priority spool via the drilled passages within the spool, the spool will shift towards the spring end and flow will be directed across the spool to a downstream core leading to the unloading spool. If there is a flow demand at the steer (S) port, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. See Figure 9050-10-14.

If no work section spools are shifted, total pump flow is directed across an unloading spool to the outlet (T) port.



1. STEER UNIT OUTLET
2. PUMP INLET
3. UNLOADER SPOOL OUTLET
4. PRIORITY SPOOL
5. STEER LS PORT

Figure 9050-10-14. Cross-Section of Priority Steering Layout

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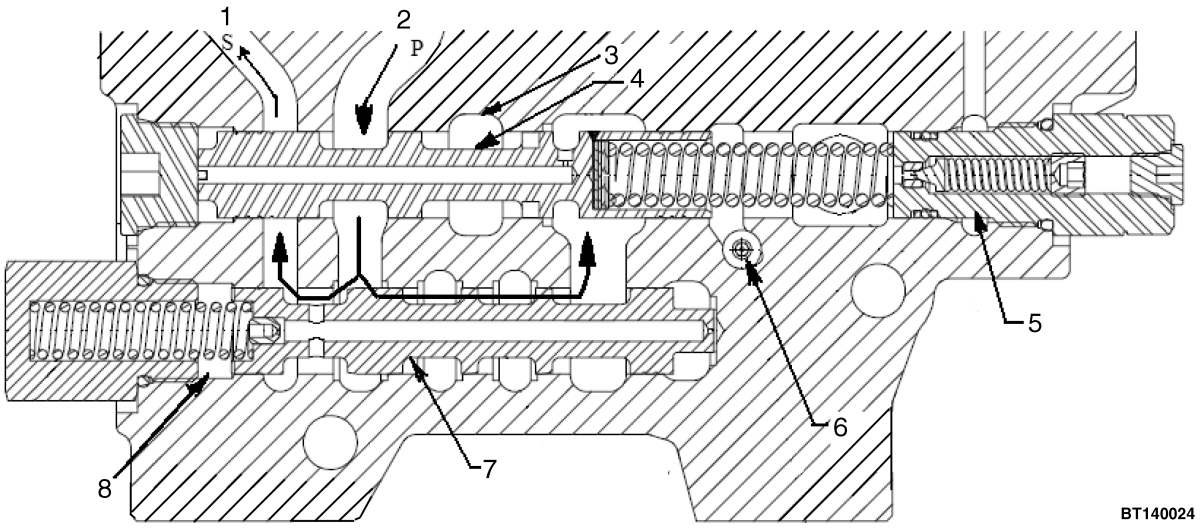
Unloading Spool and Relief Cartridge

The primary function of a relief cartridge is to prevent excessive system pressure. The relief cartridge works in conjunction with an unloading spool. The unloading spool directs excess flow (not required by any selected functions) back to tank (T). The advantage of this system is that a fixed (positive displacement) pump can be utilized. When there is no load from the steering control unit or the work sections, the pump will unload at a pressure which is only slightly higher than that required to overcome the forces generated by the priority spring and the unloading spring plus any pressure losses. See Figure 9050-10-15.

The flow from the downstream side of the priority spool is directed to the unloading spool and to the downstream work sections. Pressure at the P port side of the unloading spool is communicated to the blind end of the unloading spool via the internal pathway drilled within the spool. Pressure (PG) will rise until it overcomes the force generated by the unloading spring and the unloading spool will shift towards the spring end. Flow will then be directed across the unloading spool and into a core that connects to the tank (T) port of the inlet.

If a steering load demand is present in the priority spring chamber (LS area), the inlet pressure will rise. The priority spool will shift towards its blind end to meet the demand. If required, flow to the steer (S) port will increase and flow available to the core feeding the unloading spool will decrease. If no work section spools are shifted, the unloading spool will continue to unload any flow not required by the steering control unit to the tank (T) port.

When a downstream work function spool is shifted, internal passages (load sense shuttle circuit) of the valve assembly will communicate the pressure generated by the load at the work section port to the spring end of the unloading spool. Pump pressure will rise to meet the demand coming from the work section and the unloading spool will shift towards its blind end and restrict the amount of flow to the tank (T) port. If the pressure in the spring chamber of the unloading spool is high enough to overcome the force generated by the relief spring on the relief poppet, the poppet will open and limit the system pressure. The relief's spring chamber is vented to the tank (T) port via internal passages within the inlet housing. It should be noted that the load sense/unloading spool design does not limit the pressure in the steer control unit. The steer control unit incorporates its own relief to control maximum pressure.



1. STEER UNIT OUTLET
2. PUMP INLET
3. TANK CORE AREA
4. UNLOADING SPOOL
5. LOAD SENSE RELIEF CARTRIDGE
6. LOAD SENSE ORIFICE
7. PRIORITY SPOOL
8. LS FROM STEER UNIT

Figure 9050-10-15. Cross-Section of Unloading Spool Layout

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LIFT SECTION

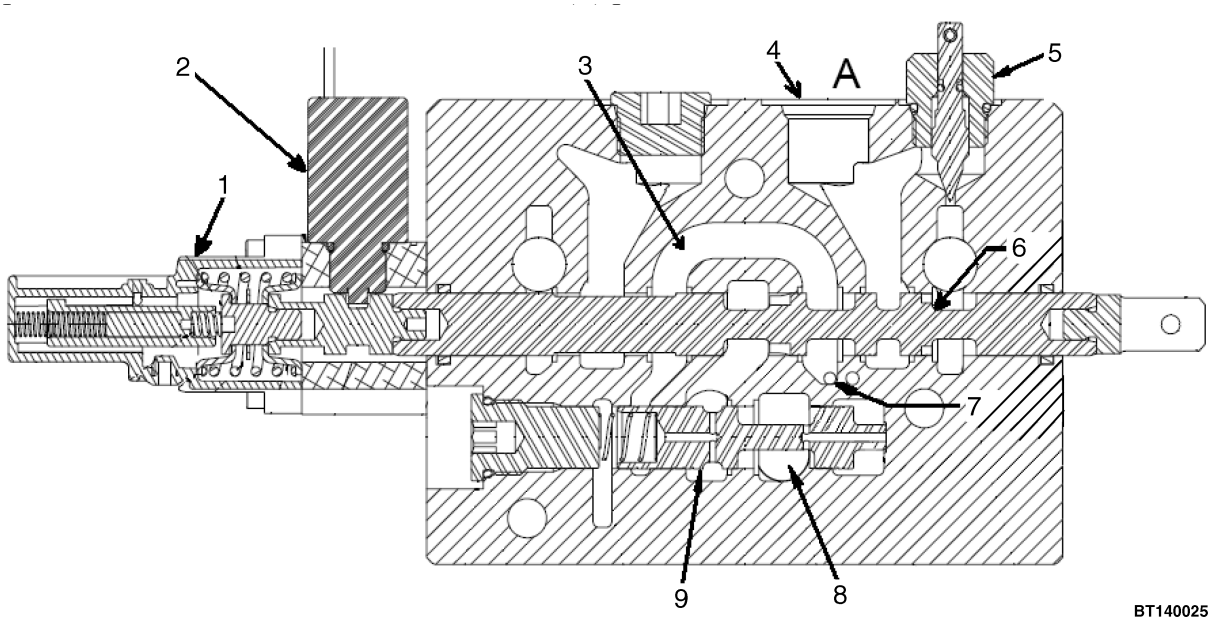
Purpose

The purpose of the lift section housing is to allow for extending and retracting of vehicle's lift cylinder (mast).

Operation - Main Spool

The lift section uses a 3-way spool for raising and lowering the mast. When all the spools of the valve assembly are in neutral (no flow requirement), pump flow comes into the inlet, travels across the priority spool and into the power core which directs flow to the various work sections. Since the power core is blocked (no spools shifted) at the last work section of the valve stack (thus called closed center type), flow is directed across the unloading spool, located in the inlet section to the tank (T) port. See Figure 9050-10-16.

When the lift spool is shifted to raise the mast (spool moved outward of the housing), flow travels from the inlet via the power core, across the load check spool, across the lift spool, and out work port A. Passageways within the lift section communicate the loads' pressure back to the spring chamber of the unloading spool and the unloading spool shifts to meet the flow demand of the work section, any excess pump flow is unloaded to the tank (T) port. If more than one work section spool is shifted (downstream of lift function), a load sense shuttle circuit allows only the highest load pressure to be communicated to the unloading spool. This allows the pump pressure to raise enough to meet the highest load demand. The shuttle valve assembly is physically located within each work section on the mating face between the sections. See Figure 9050-10-17.



1. POSITION SENSOR
2. OPERATOR PRESENCE SOLENOID
3. BRIDGE CORE
4. WORK PORT
5. MANUAL LOWERING VALVE
6. LIFT SPOOL
7. TO LS SHUTTLE
8. POWER CORE
9. LOAD CHECK SPOOL

Figure 9050-10-16. Cross-Section of Manual Lift Section

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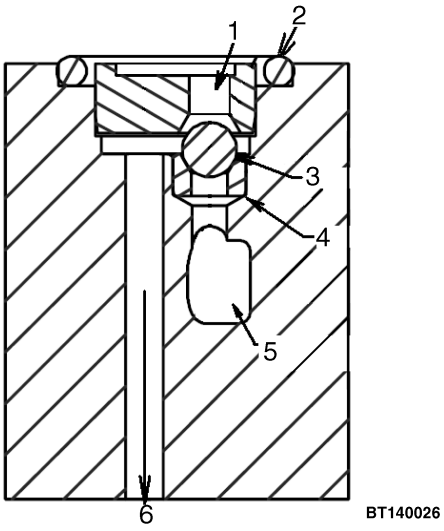
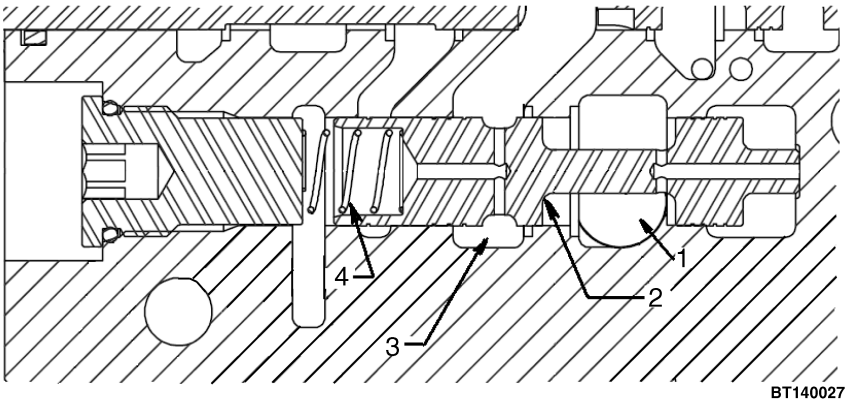


1. LS SIGNAL FROM DOWNSTREAM WORK SECTION
2. O-RING
3. SHUTTLE BALL
4. SEAT
5. FROM WORK CURRENT SECTION LS PICKUP
6. TO INLET UNLOADING SPOOL

Figure 9050-10-17. Cross-Section of Shuttle Valve Assembly

Load Check

When there is a flow demand at the work section (main spool is shifted), flow traveling through the power core will communicate the pressure within the power core to the blind end of the load check spool via holes drilled into the spool. Once the pressure is high enough to overcome the force caused by the spring at the other end of the spool, the spool will shift towards the spring end and flow will pass across the load check spool. Pressure within the downstream core (feeding the main spool) is communicated to the spring end of the spool via drilled holes within the load check spool. If the pressure on the downstream side of the load check spool increases too much, the load check spool will shift towards the blind end and flow across the check will be restricted. If pressure within the power core decreases, pressure at the blind end of the spool will decrease and the spring will try to close the check spool, thus flow across the spool will be restricted. It should be noted that the load check spool is not a zero leak device. It will not completely stop flow if a line were to break or if a leak develops between the work port and the cylinder. It will decrease the flow output to the work port, but it will not do anything to restrict the flow coming from the cylinder. The main purpose of the load check is to reduce the amount of cylinder drift when shifting the main spool from the raise to lower position. See Figure 9050-10-18.



1. POWER CORE
2. LOAD CHECK SPOOL
3. DOWNSTREAM CORE
4. LOAD CHECK SPRING

Figure 9050-10-18. Cross-Section of Load Check Assembly

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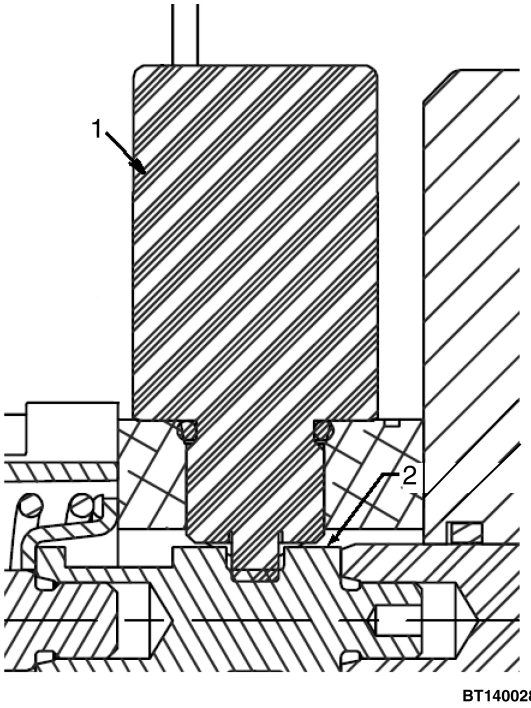
Operator Presence Solenoid

The Operator Presence Solenoid (OPS) has a spring loaded plunger which extends into an extension attached to the main spool. The plunger keeps the spool from moving when no electrical power is supplied to the solenoid's coil. When power is supplied to the coil, a force is generated which pulls the plunger upward and out of the spool extension. Once the plunger disengages, the spool can be moved out of its neutral position. See Figure 9050-10-19

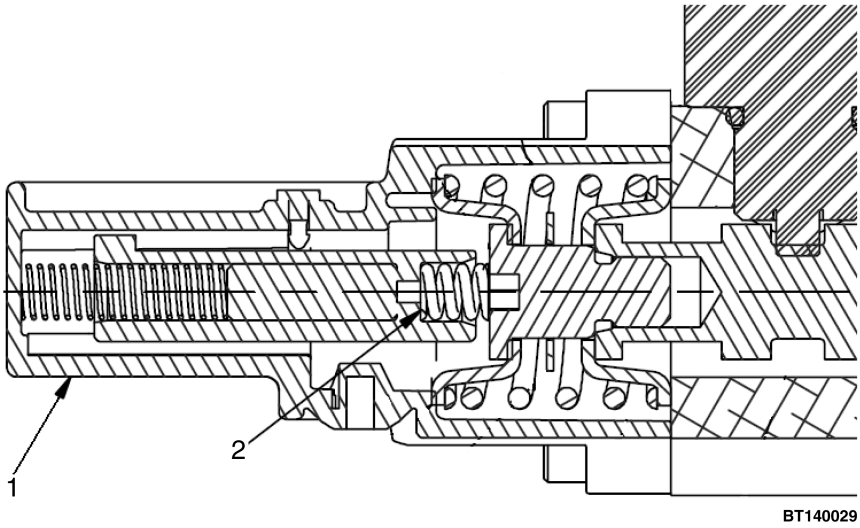
Position Sensor

The position sensor monitors the position of the valve spool and produces a variable output signal relative to how far the spool has traveled from its neutral position. The vehicle's electronics supplies the sensor with a 5 volt DC signal. When the spool is in its neutral position, the sensor output will be approximately 2.5 volts DC. As the spool is shifted from neutral, the sensor's output voltage will increase or decrease depending upon the direction of spool travel. The output signal from the sensor is used by the vehicle's electronic control system to vary the hydraulic pump flow. The intent is to meet predetermined function speed requirements. See Figure 9050-10-20.



1. OPERATOR PRESENCE SOLENOID
2. SPOOL EXTENSION

Figure 9050-10-19. Cross-Section of Operator Presence Solenoid



1. POSITION SENSOR
2. SPRING

Figure 9050-10-20. Cross-Section of Position Sensor Assembly

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Mast Lowering Cartridge

The lift section housing incorporates a manual operated needle valve cartridge which allows the “A” work port to be directly connected to the tank core. When viewed from the hex end, turning the handle on the cartridge clockwise will shut the valve and turning it counter clockwise will open the valve. The cartridge is intended to be use only in an emergency situation to lower the mast. See Figure 9050-10-21.

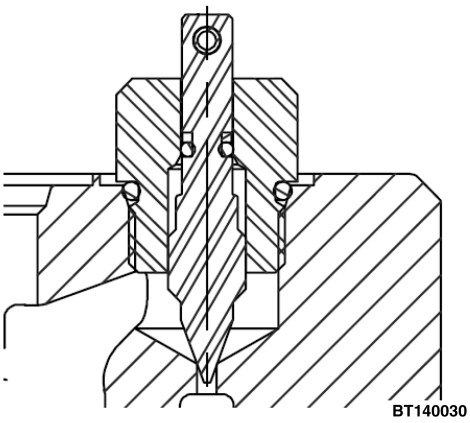

Figure 9050-10-21. Cross-Section of Manual Lowering Cartridge

TILT SECTION

Construction and Purpose

The tilt section includes a pressure reducing valve assembly, a relief cartridge, a main spool assembly, an operator presence solenoid (OPS), a position sensor assembly, and a load sense shuttle assembly. The operator presence solenoid, the position sensor and the load sense shuttle assembly are the same as in the lift section and operate the same. The tilt section’s purpose is to allow for extending and retracting of vehicle’s tilt cylinders. The major difference in this section versus a lift section is that the load check assembly has an additional feature of a pressure reducing spool assembly and the addition of an internal “tilt-lock” shuttle spool located inside a 4-way main spool. The purpose of the pressure reducing assembly is to restrict the maximum pressure available to the tilt section and any downstream sections. The purpose of the load check feature is to prevent the forks from tilting forward before they are commanded to tilt back. The main spool’s purpose is to direct flow to the section’s work ports when the spool is shifted out of neutral. The purpose of the “tilt-lock” shuttle spool is to limit unanticipated forward tilting (runaway condition) of the mast when trying to tilt back. The tilt-lock shuttle spool also prevents forward tilt of the mast when the hydraulic pump is not running.

Operation

The pressure reducing/load check assembly consists of a spool and two springs. Flow enters the tilt section via the power core and is directed across the pressure reducing/load check spool. The pressure reducing/load check spool is held in the normally open position by the springs. Pressure downstream of the spool is communicated to both ends of the spool via the holes drilled into the pressure reducing/load check spool. Once the pressure on the blind end of the spool is high enough, it will override the force generated by the springs and the spool will shift towards the spring end, thus limiting the pressure on the downstream side of the spool to balance the force of the springs plus the pressure on the downstream side of the pressure reducing/load check spool feeding the main spool. The lighter spring is used to limit the load check pressure setting and the heavier spring is used to limit the reduced pressure setting. A relief cartridge (same as the load sense relief in the inlet assembly) is utilized to limit the maximum pressure on the downstream side of the pressure reducing spool. Since the flow in the power core is available to any sections downstream of the tilt section, pressure to sections downstream of the lift function will be limited to the setting of the relief cartridge located in the pressure reducing/load check assembly of the lift section. See Figure 9050-10-22.

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Main Spool with Tilt-Lock

The section's main spool is shifted with manual input from the operator. The main spool is a 4 way type, meaning that flow is available to both the A and B work ports versus only the A port (3-way spool) in a lift section. Shifting the main spool out of the housing will pressurize work port B (tilt back) and shifting the main spool into the housing will pressurize work port A (forward tilt). The main spool assembly contains an internal "tilt-lock" spool which is active only in the tilt forward direction.

- **Tilt Back**
  Actuating the main spool to the tilt back position (B port pressurized) sends a load-sense signal to the unloading spool located in the inlet cover. The unloading spool in the inlet closes and flow is directed to the power core. Flow from the power core is directed across the pressure reducing/load check spool assembly and travels to the main spool via a feed core. Flow travels across the main spool into the bridge core and is directed out of work port B. This "meter-in" flow is out the B workport to the rod end of the cylinder and "meter-out" flow is from the base end of the cylinder to the A port. Return flow from the tilt cylinder(s) is routed through work port A across the main spool into the tank core of the housing. Flow in the tank core is directed through the valve sections back to the tank (T) port located in the inlet section.
- **Tilt Forward**
  During tilt forward operation, the internal "tilt-lock" shuttle spool helps to control any unintended increase in forward tilt speed. When the tilt spool is shifted into the housing (A work port pressurized), the unloading spool in the inlet closes and flow becomes available to the work sections. Flow travels from the power core across the pressure reducing/load check spool into the main spool feed core. Flow travels across the main spool into the bridge core. Flow passes across the main spool and out the A work port. This flows into the base end of the cylinder is known as "meter-in" flow. Return flow from the tilt cylinder(s) is directed into the B work port. Return flow is known as "meter-out" flow. Pressure in the bridge core and the A work port is communicated through cross holes in the main spool to the blind end of the "tilt-lock" spool. The tilt spool shifts toward the spring end and flow in work port B is throttled across the tilt-lock spool into the tank core. If pressure seen at the blind end of the tilt-lock spool decreases enough, the spring will force the tilt-lock spool to shift towards the blind end and flow from work port B crossing the tilt-lock spool into the tank core will be restricted. This allows the tilt-lock spool to act like a counterbalance valve to keep the forks from running away from the meter-in supply. If the load causes the tilt to move forward too fast, the tilt-lock spool will lose the pilot signal from the meter-in supply on the opposing work port, therefore preventing movement or ultimately slowing the flow rate so the meter-in flow can maintain the proper pilot signal to the tilt-lock spool. If the pump is not providing flow, there is no pressure at the blind end of the tilt-lock spool, and the spool will not open to allow flow to the tank core. Therefore the tilt cylinder(s) should not move. Since the tilt-lock spool and the main spool are not zero-leak devices, some cylinder(s) drift may occur.

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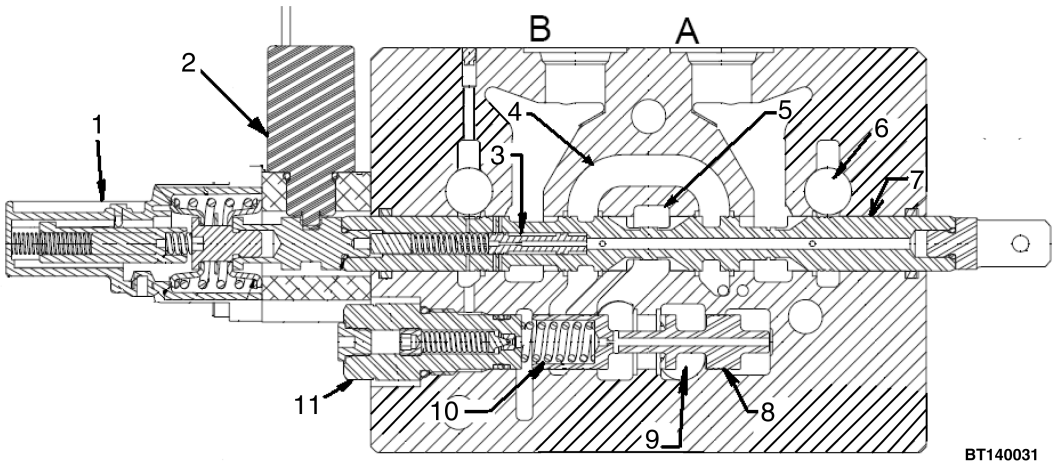

1. POSITION SENSOR
2. OPERATOR PRESENCE SENSOR
3. TILT SPOOL
4. BRIDGE CORE
5. FEED CORE
6. TANK CORE
7. MAIN SPOOL
8. PRESSURE REDUCING LOAD CHECK SPOOL
9. POWER CORE
10. SPRING
11. RELIEF CARTRIDGE

Figure 9050-10-22. Cross-Section of Manual Tilt Section

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AUXILIARY AND DUAL AUXILIARY SECTIONS

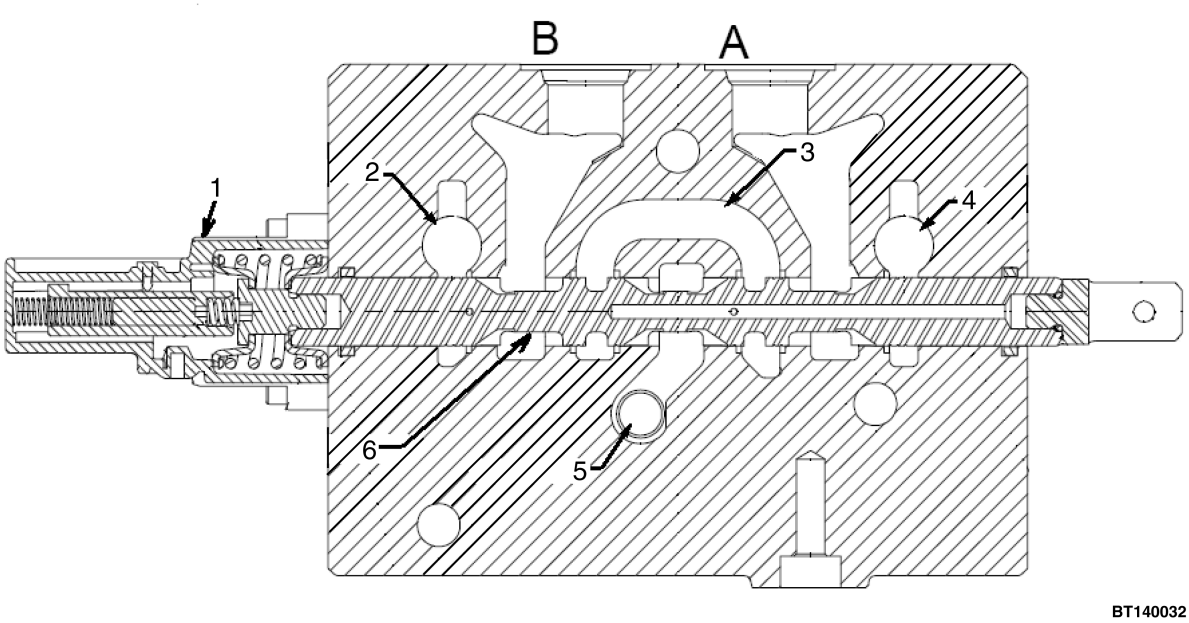
Construction and Purpose

Auxiliary and dual auxiliary sections housings are constructed of grey iron and contain internal components made from various steels. The purpose of auxiliary sections is to provide flow to any auxiliary functions (attachments). When more than one auxiliary section is used, the upstream section is labeled as a dual auxiliary section. All valve assemblies contain an end (single) auxiliary section. Both types of auxiliary sections contain a 4-way main spool, a position sensor and a load sense shuttle valve. These components are the same as used on the lift and tilt sections and operate the same. Some auxiliary sections include an optional clamp lock feature. See Figure 9050-10-23.

Operation

Both the dual and end auxiliary sections operate the same. Input flow to all auxiliary sections are downstream of the feed core of the tilt section, therefore the maximum load pressure is limited to the setting of the relief cartridge used in conjunction with the pressure reducing/load check assembly located in the tilt section. Auxiliary sections do not contain a load check assembly. Main spools are 4-way type, shifting the spool out of the housing will pressurize work port B and shifting the spool into the housing will pressurize work port A. To regulate the output flow of a work port, the operator must position the spool until the desired flow rate is obtained. Shifting the spool out of neutral communicates a load sense signal via the internal shuttle circuit to the unloading spool in the inlet. The unloading spool will shift and direct flow to downstream functions when a load demand is present.

The optional clamp lock feature uses a solenoid and a plunger assembly to prevent spool movement. This feature is controlled by the vehicle's electronic controls. If there is no electric signal supplied to the coil, the plunger is forced, via an internal spring within the solenoid assembly, into a groove on the spool extension to prevent movement of the spool. The clamp lock solenoid assembly is the same part number as the operator presence solenoid used on other sections. The position sensor assembly is the same as used on other sections. End auxiliary sections contain an SAE plug (BG port) on the outside surface which connects to the power core. Pressure at this port would represent the pressure setting of the pressure reducing valve assembly located in the tilt section.



1. POSITION SENSOR
2. TANK CORE
3. BRIDGE CORE
4. TANK CORE
5. FEED CORE
6. MAIN SPOOL

Figure 9050-10-23. Cross-Section of Auxiliary Section

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E-Hydraulic Main Control Valve

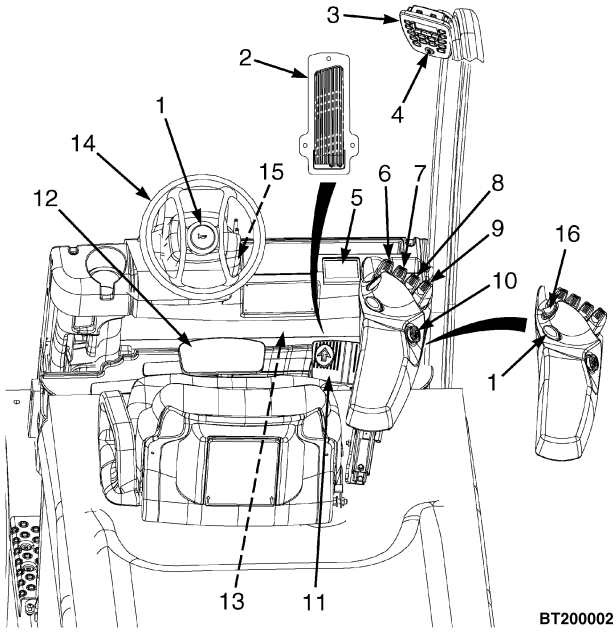
ELECTRO-HYDRAULIC CONTROL SYSTEM

The electro-hydraulic control system controls all hydraulic functions, to include, lift/lower, tilt, and auxiliary functions. The system consists of the following components:

- Electro-Hydraulic Control Valve
- Mini-Levers
- Vehicle Master Controller
- Hydraulic Pump Motor Controller
- Dash Display
- Pump Motor and Fixed Displacement Gear Pump
- Operator's Seat and Armrest
- PC Based Service Software

See Figure 9050-10-24 for component location.

The electro-hydraulic main control valve controls the lift, tilt, and auxiliary functions. The electro-hydraulic control valve is installed to the right of the operator, below the floor plate. The electro-hydraulic main control valve incorporates an emergency (manual) lowering valve. This valve allows the operator or service technician to lower the lift truck's mast assembly if the electrical signal to the electro-hydraulic main control valve is disrupted.



1. HORN BUTTON
2. ACCELERATOR PEDAL
3. DISPLAY PANEL
4. KEY SWITCH AND KEYLESS SWITCH
5. LIGHT SWITCHES
6. LIFT/LOWER CONTROL LEVER
7. TILT CONTROL LEVER
8. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)
9. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)
10. EMERGENCY DISCONNECT SWITCH
11. DIRECTION CONTROL SWITCH
12. BRAKE PEDAL
13. AUTOMATIC PARKING BRAKE MANUAL OVERRIDE HANDLE (OPTIONAL)
14. STEERING WHEEL
15. STEERING COLUMN TILT MEMORY LEVER
16. HYSTER MONOTROL® PEDAL PEDAL

Figure 9050-10-24. Operator Station Components

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The vehicle master controller, mini-levers, and hydraulic pump motor controller communicate with each other via the CANbus communication system. The master controller controls the hydraulic pump motor and the electro-hydraulic control valve based upon the inputs received from the mini levers. The master controller converts the operator's input into controlled oil flow by simultaneously commanding the hydraulic pump motor controller to deliver a specific motor speed, and by commanding the electro-hydraulic control valve to deliver specific valve metering. Pump speed is variable up to the maximum speed preset in the master controller for the required hydraulic function.

This section will cover the principles of operation for two different types of manual hydraulic control valves. The open center type valve and the closed center type valve. For the control valve used on J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), and E1.6-2.0XN (E30-40XN) (A269) A1.3XNT, A1.5XNT (A25XNT, A30XNT) (D203) , see General Description (Open Center Valve). For the control valve used on E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) , see General Description (Closed Center Valve).

GENERAL VALVE DESCRIPTION

Construction

Valve assemblies are electro-hydraulically shifted. All valve assemblies include an inlet section, a lift section, a tilt section, and an auxiliary section. Some valve assemblies may include a second dual auxiliary section and/or a spacer section. All valves are assembled using tie rods and hex nuts. O-ring seals are placed between sections to prevent external fluid leakage.

Valve Type

Valves supplied are closed center load sense type. The valves can be used with a fixed displacement pump. A fixed displacement pump will provide a fixed (known) amount of fluid with each revolution of the pump shaft. For example, if a 1 cubic inch per revolution pump is rotated at 1000 revolutions per minute, the pump output will be 1000 cubic inches per minute (1 cubic inch/rev x 1000 rev/min = 1000 cubic inches/min = 4.329 gal/min). These load sense type valves (VAL) direct flow to a closed center passageway called a power core. Flow is blocked from going out the work ports when the main spools, located within the sections, are in the neutral position. Shifting a function’s spool is accomplished by applying an electrical signal to a solenoid located on either end of the section. Pilot pressure is supplied by the main pump, but at a reduced pressure. The pilot supply pressure is reduced through the use of a pressure reducing pilot cartridge located in the inlet. Shifting a spool directs flow to the selected work port. In these valves, internal passageways in conjunction with shuttle valves, direct the highest load’s pressure signal (load sense pressure) back to an unloading spool located in the inlet. Using an unloading spool allows the use of a fixed displacement pump, but incorporates the advantages of a load sensing circuit (system pressure slightly above the load requirement and flow to match the load's demand). If flow is simultaneously required by two or more work sections, the operator must adjust the travel of each spool to get the desired flow rate from each work section. See Figure 9050-10-25.

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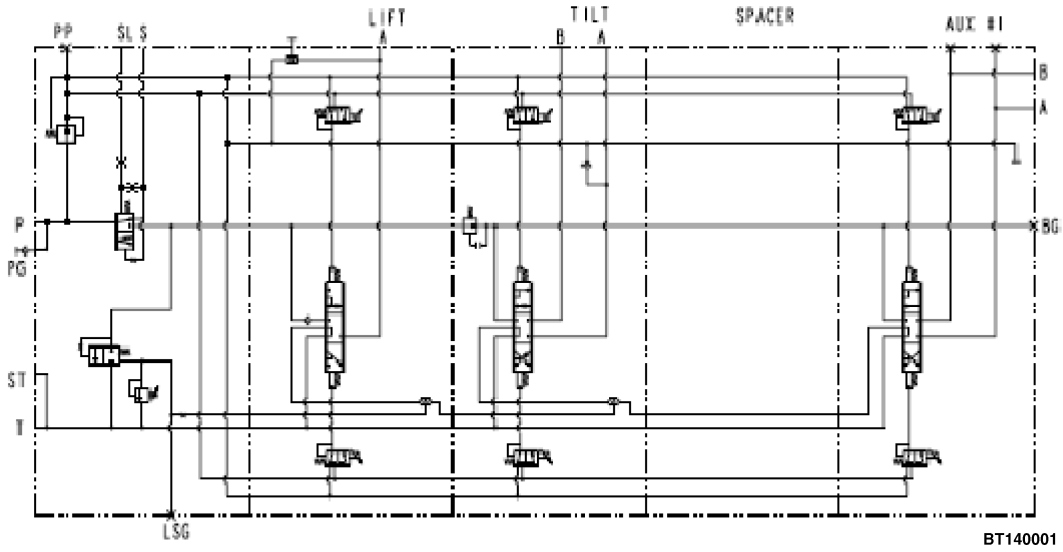

1. LIFT
2. TILT
3. SPACER
4. AUXILIARY 1

Figure 9050-10-25. Load Sense Control Valve With Unloader and Priority Steering

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FEATURES AND OPERATION

Inlet Section

Construction and Purpose

Inlet section provides the majority of the porting connections to connect various lines of the hydraulic circuit. All inlet sections for this type of valve include a priority steering spool to control flow to the steer unit, a main relief valve to protect the pump from over pressurization, an unloading spool to unload (dump to tank) any excess pump flow and a pressure reducing pilot cartridge.

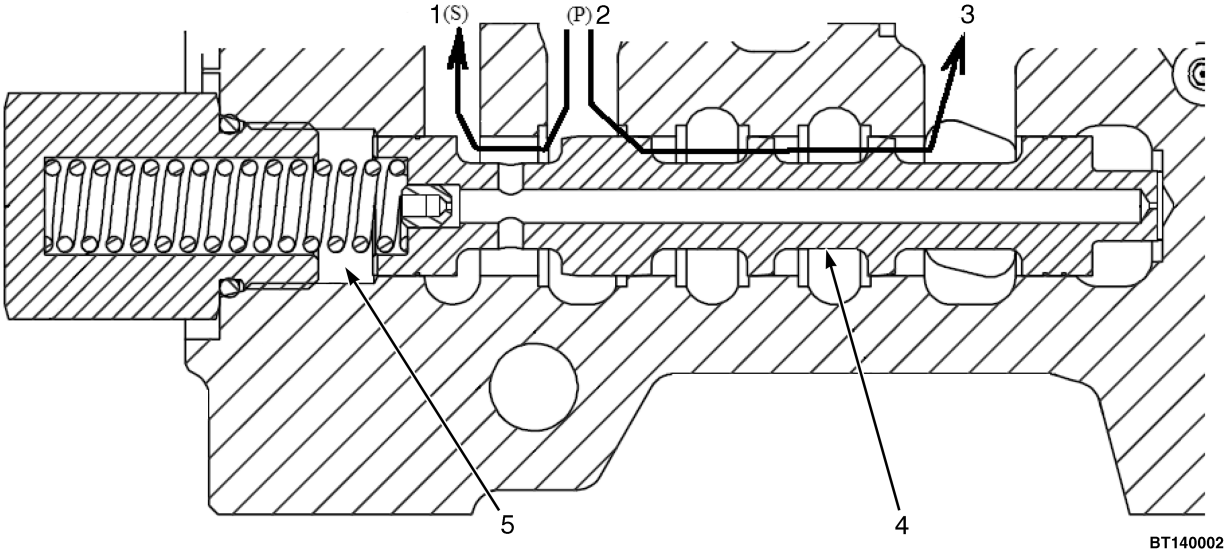
Porting

Port sizes vary based upon flow requirements and features within each inlet section. All inlets provide connections for: pump (P), tank (T), steer supply (S), steer return (ST), load sense signal coming from the steering control unit (SL), pump pressure (PG), load sense gage port (LSG) coming from the work section's shuttle circuit, reduced pressure gage port (BG) and pilot pressure (PP). If a hydraulic brake option is required, ports are provide for the brake supply (PB) and the brake return (PBT). Be aware that the PB port is exposed to full system pressure.

Priority Steer

Pump flow is directed across a priority spool before supplying flow to any downstream functions. The steering circuit flow demand has priority over any downstream flow requirements. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (P) will increase to overcome the priority spring force. The inlet pressure is communicated to the blind end of the priority spool via the drilled passages within the spool, the spool will shift towards the spring end and flow will be directed across the spool to a downstream core leading to the unloading spool. If there is a flow demand at the steer (S) port, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. See Figure 9050-10-26.

If no work section spools are shifted, total pump flow is directed across an unloading spool to the outlet (T) port.



1. TO STEER UNIT
2. FROM PUMP
3. TO UNLOADER SPOOL
4. PRIORITY SPOOL
5. STEER LS PORT

Figure 9050-10-26. Cross Section of Priority Steering Layout

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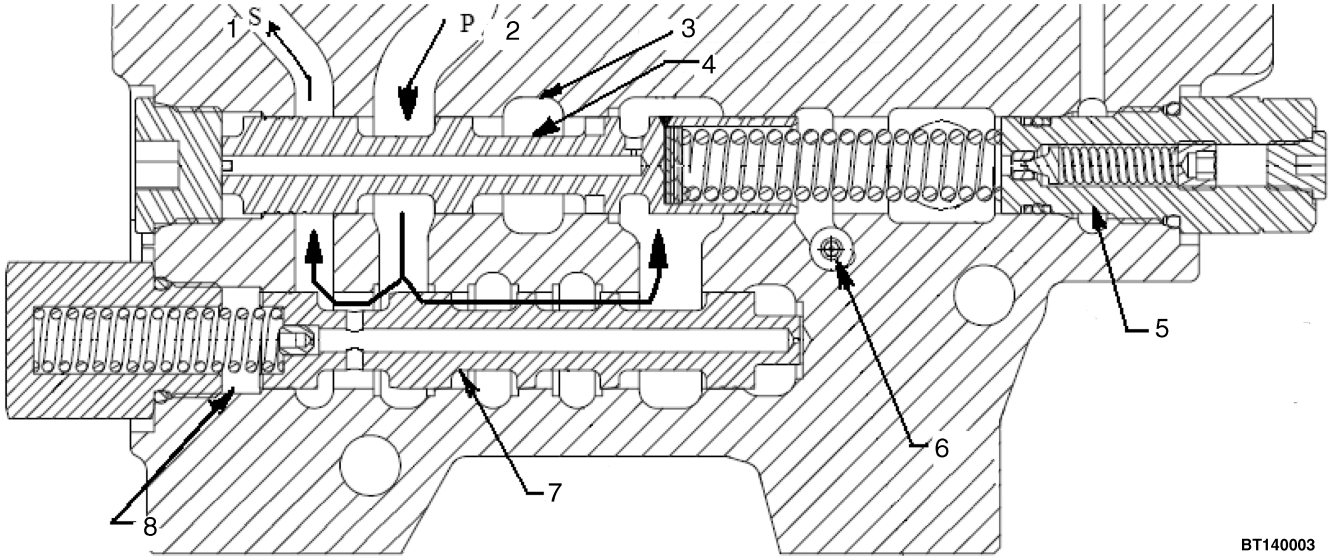
Unloading Spool and Relief Cartridge

The primary function of a relief cartridge is to prevent excessive system pressure. The relief cartridge works in conjunction with an unloading spool. The unloading spool directs excess flow (not required by any selected functions) back to tank (T). The advantage of this system is that a fixed (positive displacement) pump can be utilized. When there is no load from the steering control unit or the work sections, the pump will unload at a pressure which is only slightly higher than that required to overcome the forces generated by the priority spring and the unloading spring plus any pressure losses. See Figure 9050-10-27.

The flow from the downstream side of the priority spool is directed to the unloading spool and to the downstream work sections. Pressure at the (P) port side of the unloading spool is communicated to the blind end of the unloading spool via the internal pathway drilled within the spool. Pressure (PG) will rise until it overcomes the force generated by the unloading spring and the unloading spool will shift towards the spring end. Flow will then be directed across the unloading spool and into a core that connects to the tank (T) port of the inlet.

If a steering load demand is present in the priority spring chamber (LS area), the inlet pressure will rise. The priority spool will shift towards its blind end to meet the demand. If required, flow to the steer (S) port will increase and flow available to the core feeding the unloading spool will decrease. If no work section spools are shifted, the unloading spool will continue to unload any flow not required by the steering control unit to the tank (T) port.

When a downstream work function spool is shifted, internal passages (load sense shuttle circuit) of the valve assembly will communicate the pressure generated by the load at the work section port to the spring end of the unloading spool. Pump pressure will rise to meet the demand coming from the work section and the unloading spool will shift towards its blind end and restrict the amount of flow to the tank (T) port. If the pressure in the spring chamber of the unloading spool is high enough to overcome the force generated by the relief spring on the relief poppet, the poppet will open and limit the system pressure. The relief's spring chamber is vented to the tank (T) port via internal passages within the inlet housing. It should be noted that the load sense/unloading spool design does not limit the pressure in the steer control unit. The steer control unit incorporates its own relief to control maximum pressure.



1. TO STEER UNIT
2. FROM PUMP
3. TANK CORE AREA
4. UNLOADING SPOOL
5. LOAD SENSE RELIEF CARTRIDGE
6. LOAD SENSE ORIFICE
7. PRIORITY SPOOL
8. FROM STEER UNIT

Figure 9050-10-27. Cross Section of Unloading Spool Layout

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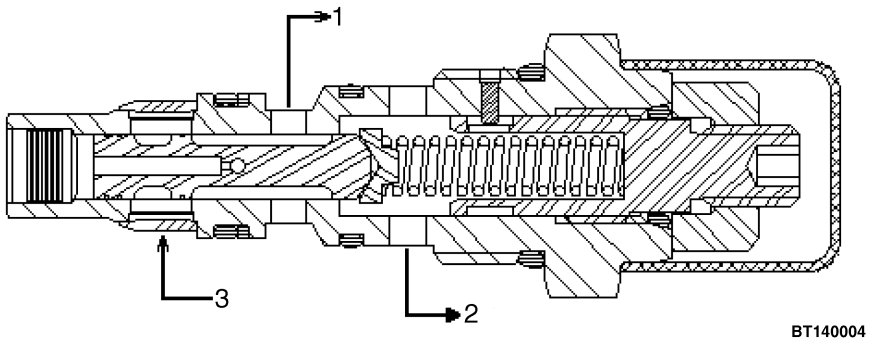
Pilot Cartridge

The pilot cartridge receives flow from the pump and maintains a constant reduced output pressure to feed the electro-hydraulic (EH) solenoids of the work sections. The supply pressure for the electro-hydraulic solenoids must be reduced because the solenoids will not withstand full system pressure. Flow enters the pilot cartridge at the IN passage and the OUT pressure is sensed at the blind end of the reducing spool through holes drilled into the spool. The pressure at the blind end of the spool will build to match the force generated by the spring. The spool will shift to the left or right to maintain a pressure equal to the force generated by the spring. The reducing spool is constantly modulating, and maintains the pilot pressure at the OUT passage based upon the spring force. Any leakage from the OUT side into the spring chamber is vented back to the tank side of the valve assembly. See Figure 9050-10-28.



1. OUT
2. TANK
3. IN

Figure 9050-10-28. Cross Section of Pilot Cartridge

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Lift Section

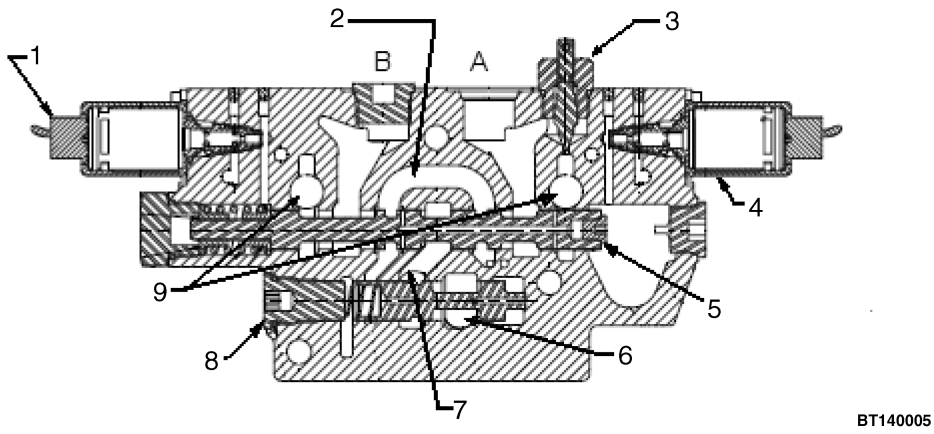
Construction and Purpose

The lift section's purpose is to allow for extending and retracting of vehicle's lift cylinder (mast).

Operation - Main Spool

The lift section uses a 3-way spool for raising and lowering the mast.

When all the spools of the valve assembly are in neutral (no flow requirement), pump flow comes into the inlet, travels across the priority spool and into the power core which directs flow to the various work sections. Since the power core is blocked (no spools shifted) at the last work section of the valve stack (thus called closed center type), flow is directed across the unloading spool, located in the inlet section to the tank (T) port. See Figure 9050-10-29.



1. EH SOLENOID
2. BRIDGE CORE
3. MAST LOWERING CARTRIDGE
4. EH SOLENOID
5. MAIN SPOOL
6. POWER CORE
7. FEED CORE
8. LOAD CHECK
9. TANK CORE

Figure 9050-10-29. Cross-Section of EH Lift Section

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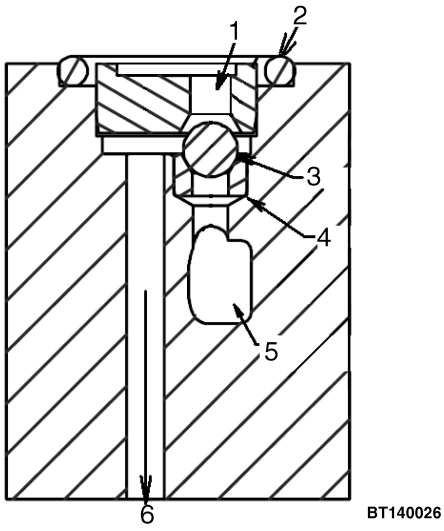
When the lift spool is shifted to raise the mast (solenoid on the A port side energized), flow travels from the inlet via the power core, across the load check spool, across the lift spool, and out workport A. Passageways within the lift section communicate the loads' pressure back to the spring chamber of the unloading spool and the unloading spool shifts to meet the flow demand of the work section, any excess pump flow is unloaded to the tank (T) port. If more than one work section spool is shifted (downstream of lift function), a load sense shuttle circuit allows only the highest load pressure to be communicated to the unloading spool. This allows the pump pressure to raise enough to meet the highest load demand. The shuttle valve assembly is physically located within each work section on the mating face between the sections. See Figure 9050-10-30.



1. LS SIGNAL FROM WORK SECTION
2. O-RING
3. SHUTTLE BALL
4. SEAT
5. FROM WORK CURRENT SECTION LS PICKUP
6. TO INLET UNLOADING SPOOL

Figure 9050-10-30. Cross-Section View of Shuttle Valve Assembly

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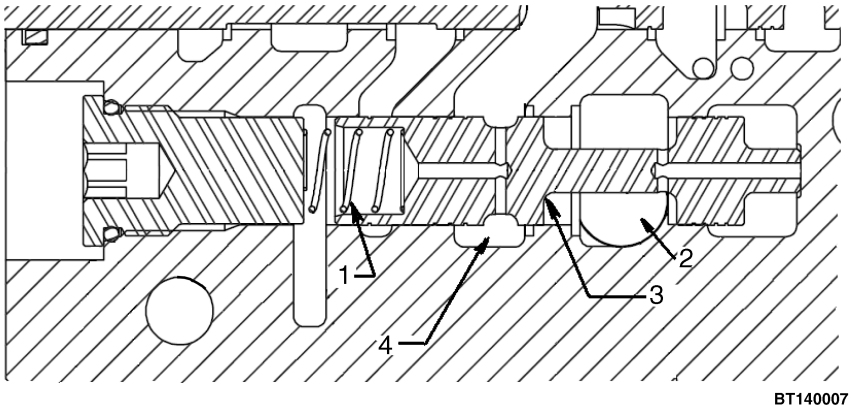
Load Check

When there is a flow demand at the work section (main spool shifted), flow traveling through the power core will communicate the pressure within the power core to the blind end of the load check spool via holes drilled into the spool. Once the pressure is high enough to overcome the force caused by the spring at the other end of the spool, the spool will shift towards the spring end and flow will pass across the load check spool. Pressure within the downstream core (feeding the main spool) is communicated to the spring end of the spool via drilled holes within the load check spool. If the pressure on the downstream side of the load check spool increases too much, the load check spool will shift towards the blind end and flow across the check will be restricted. If pressure within the power core decreases, pressure at the blind end of the spool will decrease and the spring will try to close the check spool, thus flow across the spool will be restricted. It should be noted that the load check spool is not a zero leak device. It will not completely stop flow if a line were to break or if a leak develops between the workport and the cylinder. It will decrease the flow output to the workport, but it will not do anything to restrict the flow coming from the cylinder. The main purpose of the load check is to reduce the amount of cylinder drift when shifting the main spool from the raise to lower position. See Figure 9050-10-31.



1. LOAD CHECK SPRING
2. POWER CORE
3. LOAD CHECK SPOOL
4. DOWNSTREAM CORE

Figure 9050-10-31. Cross-Section View Load Check Assembly

Mast Lowering Cartridge

The lift section housing incorporates a manually operated needle valve cartridge which allows the “A” workport to be directly connected to the tank core. When viewed from the hex end, turning the handle on the cartridge clockwise will shut the valve and turning it counter clockwise will open the valve. The cartridge is intended to be used only in an emergency situation to lower the mast. See Figure 9050-10-32.

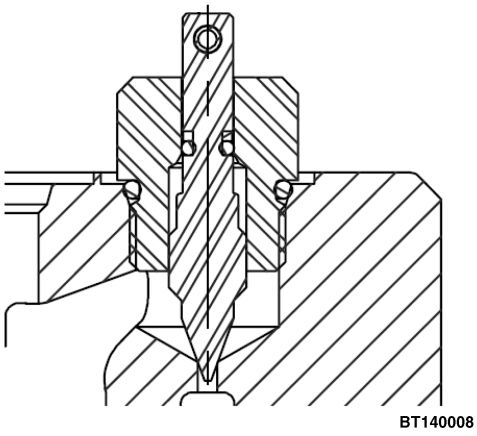


Figure 9050-10-32. Cross-Section View of Manual Lowering Cartridge

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Electro-Hydraulic (EH) Solenoid

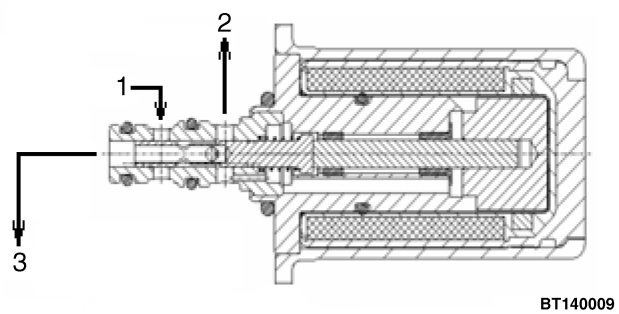
Reduced pressure flow coming from the pilot cartridge located in the inlet, is delivered to the inlet side of each electro-hydraulic (EH) solenoid via internal holes drilled into the work sections. When an electrical current is applied to the coil, a force is generated by the coil which moves the pin within the solenoid and in turn moves the spool in the solenoid assembly. As the spool moves away from the spring end of the assembly, flow is passed from the inlet side to the output side of the spool. When the force generated by the pressure acting on the spool area becomes equal to the force generated by the current acting on the pin of the solenoid, the spool will close and flow across the inlet to the outlet will stop. If the current applied to the solenoid coil is varied, the regulated output pressure will vary to maintain a force balance between the output pressure and the input current. In short, the output pressure is a function of input current.

The output pressure from the solenoid assembly is applied to the end of the main spool of the section being operated. Once the output pressure from the solenoid becomes great enough to overcome the force generated by the return spring and spool drag, the main spool will begin to shift. An increase in current at the solenoid will increase the regulated output pressure acting on the main spool and the spool will shift further. Due to metering notches located on the main spool, the flow across the main spool will increase with an increase in current applied to the solenoid. Therefore, the output flow of a work section is a function of input current to the solenoid. Thus the label of "proportional" is given to the section, since output varies as a function of input. See Figure 9050-10-33.

Tilt Section

Construction and Purpose

The tilt section includes a pressure reducing valve assembly, a relief cartridge, a main spool assembly, a load sense shuttle assembly, two electro-hydraulic solenoids and an anti-cavitation check. The tilt section's purpose is to allow for extending and retracting of vehicle's tilt cylinders. The major difference in this section versus a lift section is that the load check assembly has an additional feature of a pressure reducing spool assembly. The purpose of the pressure reducing assembly is to restrict the maximum pressure available to the tilt section and any downstream sections. The purpose of the load check feature is to prevent the forks from tilting forward before they are commanded to tilt back. The main spool's purpose is to direct flow to the section's workports when the spool is shifted out of neutral.



1. INLET
2. TANK
3. REGULATED OUTPUT PRESSURE

Figure 9050-10-33. Cross-Sectional View of Electro-Hydraulic (EH) Solenoid

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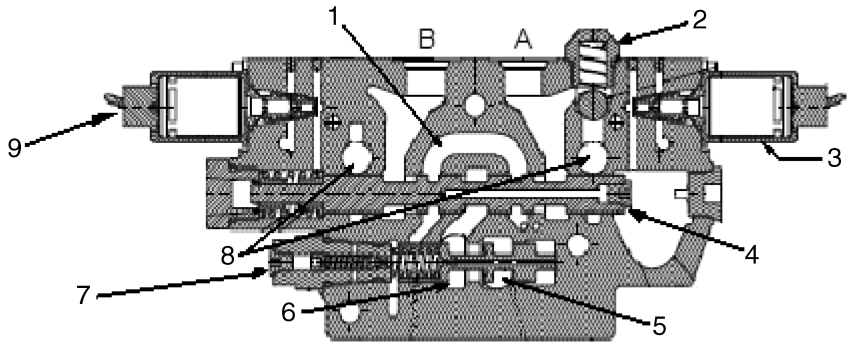
Operation

NOTE: 1-2 Ton valves do not include the relief cartridge, but they do contain the pressure reducing/load check spool. However the valve can be retrofitted with a relief cartridge kit when one may be required because of pressure limitations of auxiliary equipment.

The pressure reducing/load check assembly consists of a spool and two springs. Flow enters the tilt section via the power core and is directed across the pressure reducing/load check spool. The pressure reducing/load check spool is held in the normally open position by the springs. Pressure downstream of the spool is communicated to both ends of the spool via the holes drilled into the pressure reducing/load check spool. Once the pressure on the blind end of the spool is high enough, it will override the force generated by the springs and the spool will shift towards the spring end, thus limiting the pressure on the downstream side of the spool to balance the force of the springs plus the pressure on the downstream side of the pressure reducing/load check spool feeding the main spool. The lighter spring is used to produce the load check pressure and the heavier spring is used to regulate the reduced pressure setting. A relief cartridge (same as the load sense relief in the inlet assembly) is utilized to limit the maximum pressure on the downstream side of the pressure reducing spool. Since the flow into the offset power core is available to any sections downstream of the tilt section, pressure to sections downstream of the lift function will be limited to the setting of the relief cartridge located in the pressure reducing/load check assembly of the lift section. The anti-cavitation check, located next to the A work port become active when the pressure within the work port is lower than the pressure in the tank core. This allows oil to pass from the tank core into the work port to keep air out of the lines and the tilt cylinder. See Figure 9050-10-34.



1. BRIDGE CORE
2. ANTI CAVITY CHECK
3. EH SOLENOID
4. MAIN SPOOL
5. POWER CORE
6. FEED CORE
7. PRESSURE REDUCING LOAD CHECK
8. TANK CORE
9. EH SOLENOID

Figure 9050-10-34. Cross-Section of EH Tilt Section

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Main Spool

The main spool is a 4-way type, meaning that flow is available to both the A and B work ports versus only the A port (3-way spool) in a lift section. Energizing the solenoid on the A work port side of the section shifts the spool to power workport A. Energizing the solenoid on the B work port side of the section shifts the spool to power work port B.

- **Tilt Back**
  Actuating the main spool to the tilt back position (B port pressurized) sends a load-sense signal to the unloading spool located in the inlet cover. The unloading spool in the inlet closes and flow is directed to the power core. Flow from the power core is directed across the pressure reducing/load check spool assembly and travels to the main spool via a feed core. Flow travels across the main spool into the bridge core and is directed out of work port B. Return flow from the tilt cylinder(s) is routed through work port A across the main spool into the tank core of the housing. Flow in the tank core is directed through the valve sections back to the tank (T) port located in the inlet section.
- **Tilt Forward**
  When the tilt spool is shifted to pressurize work port A, the unloading spool in the inlet closes and flow becomes available to the work sections. Flow travels from the power core across the pressure reducing/load check spool into the main spool feed core. Flow travels across the main spool into the bridge core. Flow passes across the main spool and out the A work port. Return flow from the tilt cylinder(s) is directed into the B work port.

Spacer Sections

Construction and Purpose

Spacer sections are used in certain valve stacks to increase the length of the valve stack to overcome mechanical structure interference on certain vehicle models. They contain drilled passageways to allow oil to pass to the next work section. The only components they contain are common plugs and section seals.

Auxiliary and Dual Auxiliary Sections

Construction and Purpose

Auxiliary and dual auxiliary sections housings are constructed of grey iron and contain internal components made from various steels. The purpose of auxiliary sections is to provide flow to any auxiliary functions (attachments). When more than one auxiliary section is used, the upstream section is labeled as a dual auxiliary section. All valve assemblies contain an end (single) auxiliary section. Both types of auxiliary sections contain a 4-way main spool, two electro-hydraulic solenoids to shift the main spool, and a load sense shuttle valve. These components are the same as used on the lift and tilt sections and operate the same. See Figure 9050-10-35.

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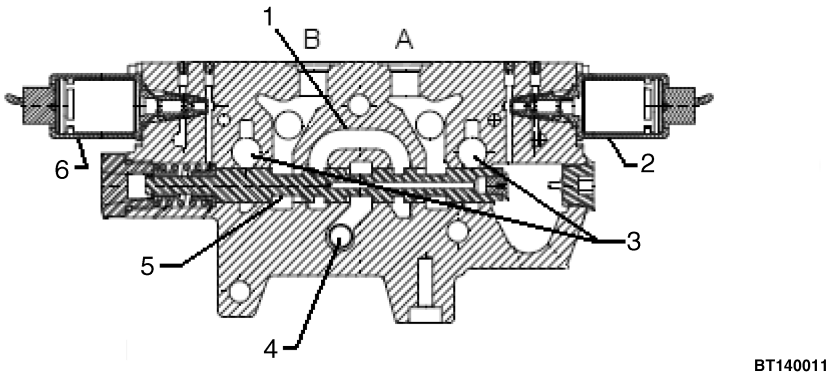
Operation

Both the dual and end auxiliary sections operate the same. Input flow to all auxiliary sections are downstream of the feed core of the tilt section, therefore the maximum load pressure is limited to the setting of the relief cartridge used in conjunction with the pressure reducing/load check assembly located in the tilt section. Auxiliary sections do not contain a load check assembly. Main spools are 4-way type, energizing solenoid A will power the A work port. Energizing solenoid B will provide power the B work port. To regulate the output flow of a work port, the operator must position the spool until the desired flow rate is obtained. Shifting the spool out of neutral communicates a load sense signal via the internal shuttle circuit to the unloading spool in the inlet. The unloading spool will shift and direct flow to downstream functions when a load demand is present. End auxiliary sections contain an SAE plug (BG port) on the outside surface which connects to the power core. Pressure at this port would represent the pressure setting of the pressure reducing valve assembly located in the tilt section.



1. BRIDGE CORE
2. EH SOLENOID
3. TANK CORE
4. FEED CORE
5. MAIN SPOOL
6. EH SOLENOID

Figure 9050-10-35. Cross-Section of EH Auxiliary Section

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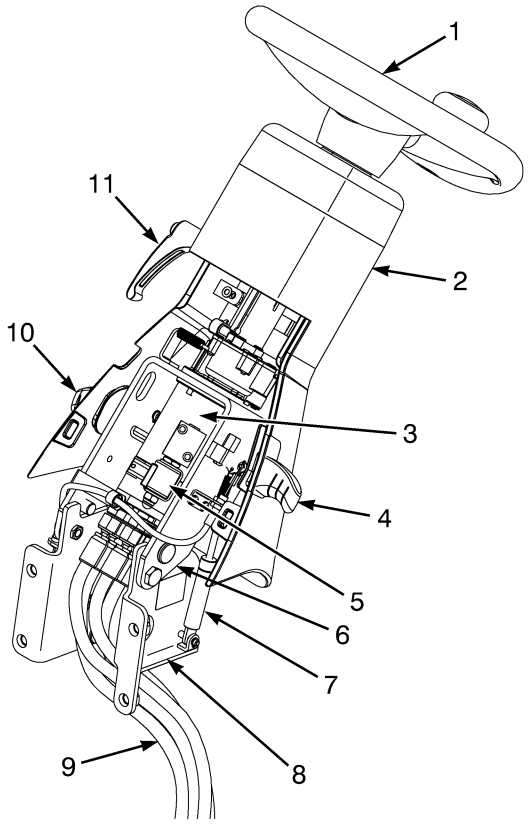
Steering System

DESCRIPTION

The steering column assembly uses a steering control unit with hose connections on the bottom of the unit to connect hydraulic hoses to the main control valve and the steering cylinder. The steering housing has mounts for the steering column and the steering control unit. The steering wheel is installed on the steering column. See Figure 9050-10-36. The housing is adjustable and is held in position by a latch. The position of the housing can be tilted up or down for operator comfort. If the lift truck is equipped with the telescopic option; the steering wheel may also be moved toward or away from the operator.

The steering system is a hydraulic system that does not have a mechanical connection between the steering wheel and the steering axle. The control of the steering is through a hydraulic circuit. See Priority Steer (E-Hydraulic Control Valve), Priority Steer (Manual Hydraulics Open Center Control Valve), or Priority Steer (Manual Hydraulics Closed Center Control Valve) as applicable for your lift truck.

If the hydraulic pump for the steering system does not operate, steering is still possible. A check valve permits the steering control unit to control the steering cylinder. The lift truck is difficult to steer when the steering pump is not operating, but the steering control unit can operate the steering cylinder and make steering possible.



1. STEERING WHEEL
2. STEERING COLUMN
3. STEERING CONTROL UNIT
4. TILT MEMORY LEVER
5. STEERING DIRECTION SENSOR
6. TILT BASE
7. STEERING COLUMN TILT CYLINDER
8. MOUNTING BASE
9. HYDRAULIC HOSES
10. TELESCOPIC COLUMN ADJUSTING LEVER
11. TELESCOPIC COLUMN LOCKING HANDLE

Figure 9050-10-36. Steering Housing Assembly

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Accumulator, Piston

The steering accumulator consists of a cylinder assembly, piston assembly, and two end-caps assemblies. The cylinder assembly houses a piston assembly, and incorporates provisions for securing the end-caps. An accumulator contains a free-floating piston with liquid on one side of the piston and pre-charged nitrogen on the other side. An increase of liquid volume decreases the gas volume and increases gas pressure, which provides a work potential when the liquid is allowed to discharge.

When the steering wheel is held at relief and a hydraulic function is “suddenly” actuated to a pressure higher than steering relief (eg., system relief) the following happens:

- There is a pressure spike in the LS line which causes the priority spool to shift momentarily.
- When the priority spool shifts it momentarily opens path for working hydraulic pressure to steering P line.
- The accumulator absorbs the pressure that comes from the momentary shift of the priority spool.

The steering supply incorporates a back flow check valve. This valve is the straight adapter in the main control valve.

The accumulator in the steering control unit supply circuit is designed to cushion any impulses that are generated within the hydraulic steering system.

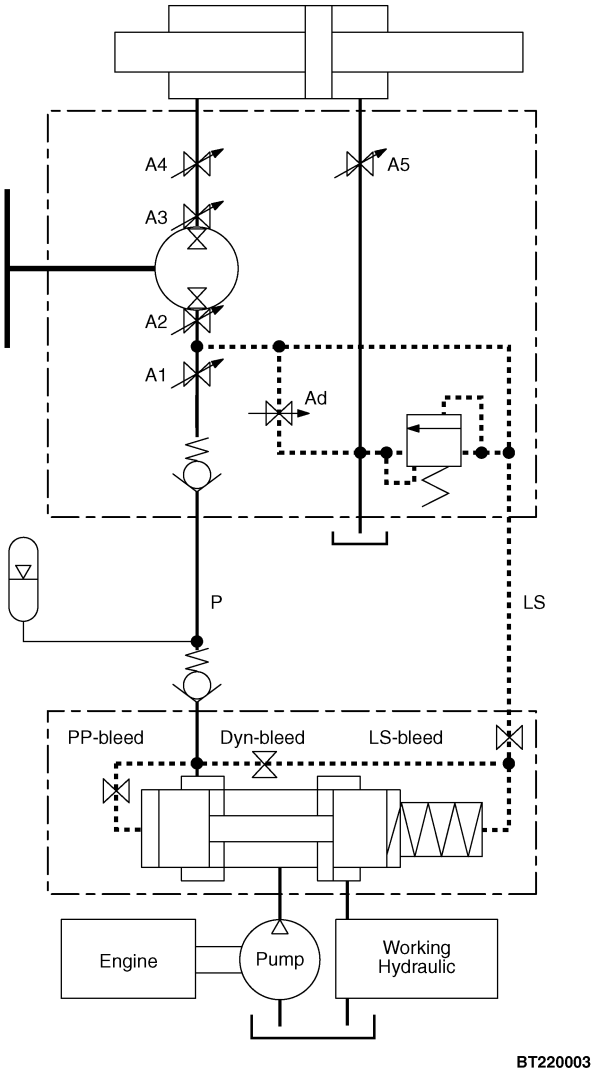

Figure 9050-10-37. Steering Accumulator Schematic

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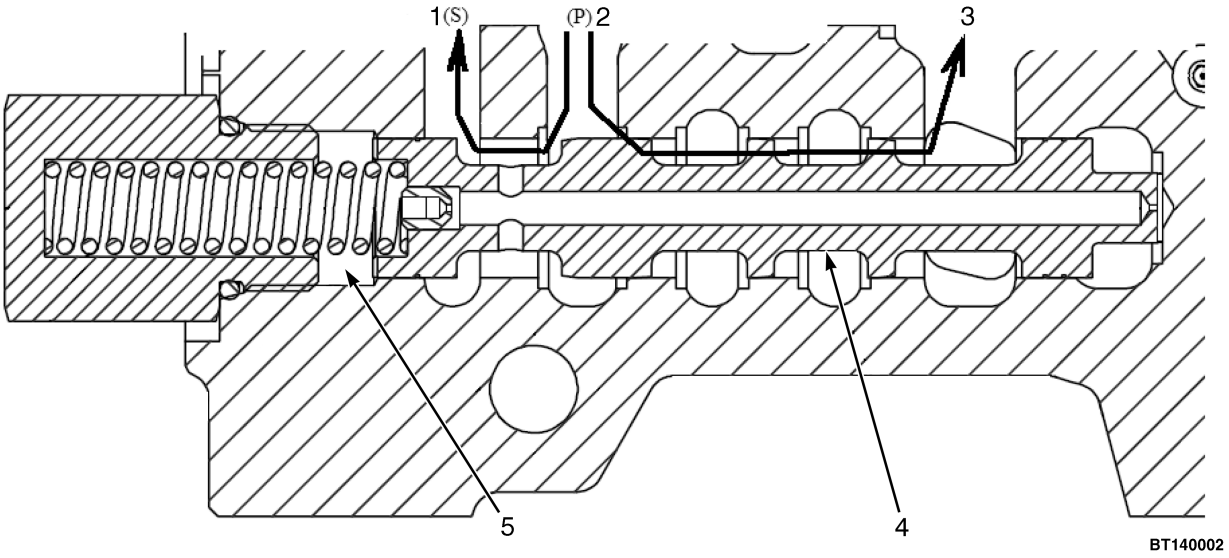
Priority Steer (E-Hydraulic Control Valve)

Pump flow is directed across a priority spool before supplying flow to any downstream functions. The steering circuit flow demand has priority over any downstream flow requirements. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (P) will increase to overcome the priority spring force. The inlet pressure is communicated to the blind end of the priority spool via the drilled passages within the spool, the spool will shift towards the spring end and flow will be directed across the spool to a downstream core leading to the unloading spool. If there is a flow demand at the steer (S) port, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. See Figure 9050-10-38.

If no work section spools are shifted, total pump flow is directed across an unloading spool to the outlet (T) port.



1. TO STEER UNIT
2. FROM PUMP
3. TO UNLOADER SPOOL
4. PRIORITY SPOOL
5. STEER LS PORT

Figure 9050-10-38. Cross Section of Priority Steering Layout

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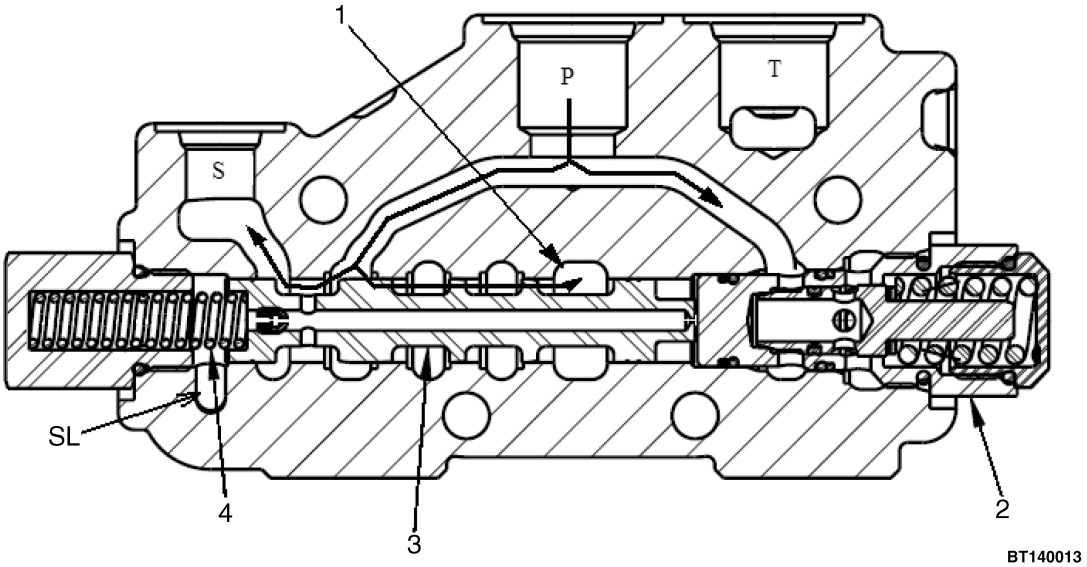
Priority Steer (Manual Hydraulics Open Center Control Valve)

Pump flow is directed across the priority spool before supplying flow for any downstream demands. Therefore, the steering circuit has priority over any downstream flow demands. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (PG) will increase just enough to overcome the priority spool's spring force. Since the inlet pressure is communicated to the blind end of the priority spool, via the drilled passages within the spool, the spool will shift towards the spring end and flow to the steering unit will decrease and pump flow will be directed across the priority spool into a downstream (open center) core. If there is a flow demand from the steering unit, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. The downstream core coming from the priority spool is directed to the open center core of the valve assembly. If none of the work section spools are shifted, total pump flow is directed through the valve assembly via the open center core, across the work section spools to the outlet (T) port. See Figure 9050-10-39.



1. OPEN CENTER CORE
2. RELIEF CARTRIDGE
3. PRIORITY STEER SPOOL
4. SPRING

Figure 9050-10-39. Cross-Sectional View of Inlet Assembly

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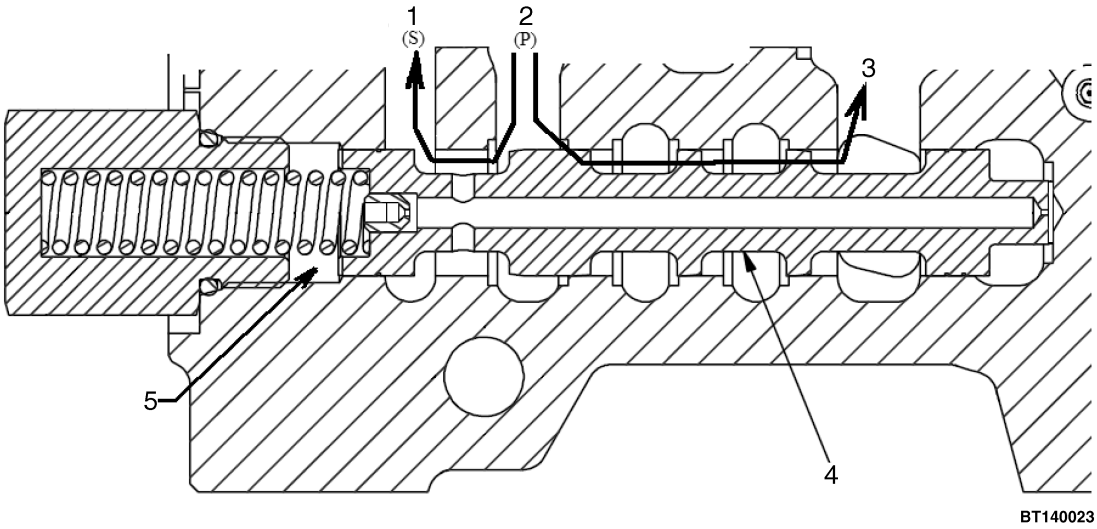
Priority Steer (Manual Hydraulics Closed Center Control Valve)

Pump flow is directed across a priority spool before supplying flow to any downstream functions. The steering circuit flow demand has priority over any downstream flow requirements. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (P) will increase to overcome the priority spring force. The inlet pressure is communicated to the blind end of the priority spool via the drilled passages within the spool, the spool will shift towards the spring end and flow will be directed across the spool to a downstream core leading to the unloading spool. If there is a flow demand at the steer (S) port, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. See Figure 9050-10-40.

If no work section spools are shifted, total pump flow is directed across an unloading spool to the outlet (T) port.



1. STEER UNIT OUTLET
2. PUMP INLET
3. UNLOADER SPOOL OUTLET
4. PRIORITY SPOOL
5. STEER LS PORT

Figure 9050-10-40. Cross-Section of Priority Steering Layout

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STEERING CONTROL UNIT (SCU) OPERATION

The steering control unit is a rotary valve operated by the steering wheel. See Figure 9050-10-41. During the steering operation, the steering control unit controls the direction and amount of oil flow to the steering cylinder. The steering cylinder in the axle actuates the steering linkage to move the steer tires. Hydraulic oil returns from the steering cylinder to the steering control unit and then to the hydraulic tank.

Turning the steering wheel actuates three main parts of the steering control unit: the spool for the control section, the sleeve for the control section, and the rotor in the metering section. When the steering wheel is not moving, the spool and sleeve are held in the **NEUTRAL** (center) position by springs. During this time, oil flows freely through the steering control unit but none flows to the steering cylinder.

As the steering wheel is turned, the spool begins to rotate. The springs try to move the sleeve to keep the **NEUTRAL** position between the spool and sleeve. However, the necessary force to turn the rotor is greater than the pressure of the springs. The springs begin to bend, letting the spool move a small amount within the sleeve. The spool stops moving when it touches the center pin. In this position, the holes in the sleeve and the spool are aligned. Oil coming into the control unit flows to the metering section.

More rotation of the steering wheel causes the spool to rotate the pin. This action causes the rotation of the sleeve and the rotor in the metering section. The oil then flows to one side of the steering cylinder. Oil from the other side of the cylinder returns through the control section of the steering control unit.

When the steering wheel stops moving, the metering action in the metering section also stops. The **NEUTRAL** position springs return the sleeve to the **NEUTRAL** position, stopping oil flow to or from the cylinder. The pressure stays in the steering cylinder to keep the steer tires in position. Oil from the pump flows through the steering control unit to the tank or other parts of the system. To return the steer wheels to the straight position, the steering wheel must be rotated in the opposite direction. The steering control unit will operate as described, but all parts will rotate in the opposite direction.

The makeup valve (see Figure 9050-10-41) controls steering synchronization between the steering wheel and the steered wheels to ensure that the steering wheel is always in the same position relative to the steered wheels when the steered wheels are in the straight ahead direction.

Calibration procedures allow the operator to establish a spinner knob comfort position when the steered wheels are in the straight ahead position. The system will maintain this relationship between the steering wheel and steered wheels through the use of the makeup valve. The steering control unit and the steered wheels have sensors mounted on them to determine relative angles.

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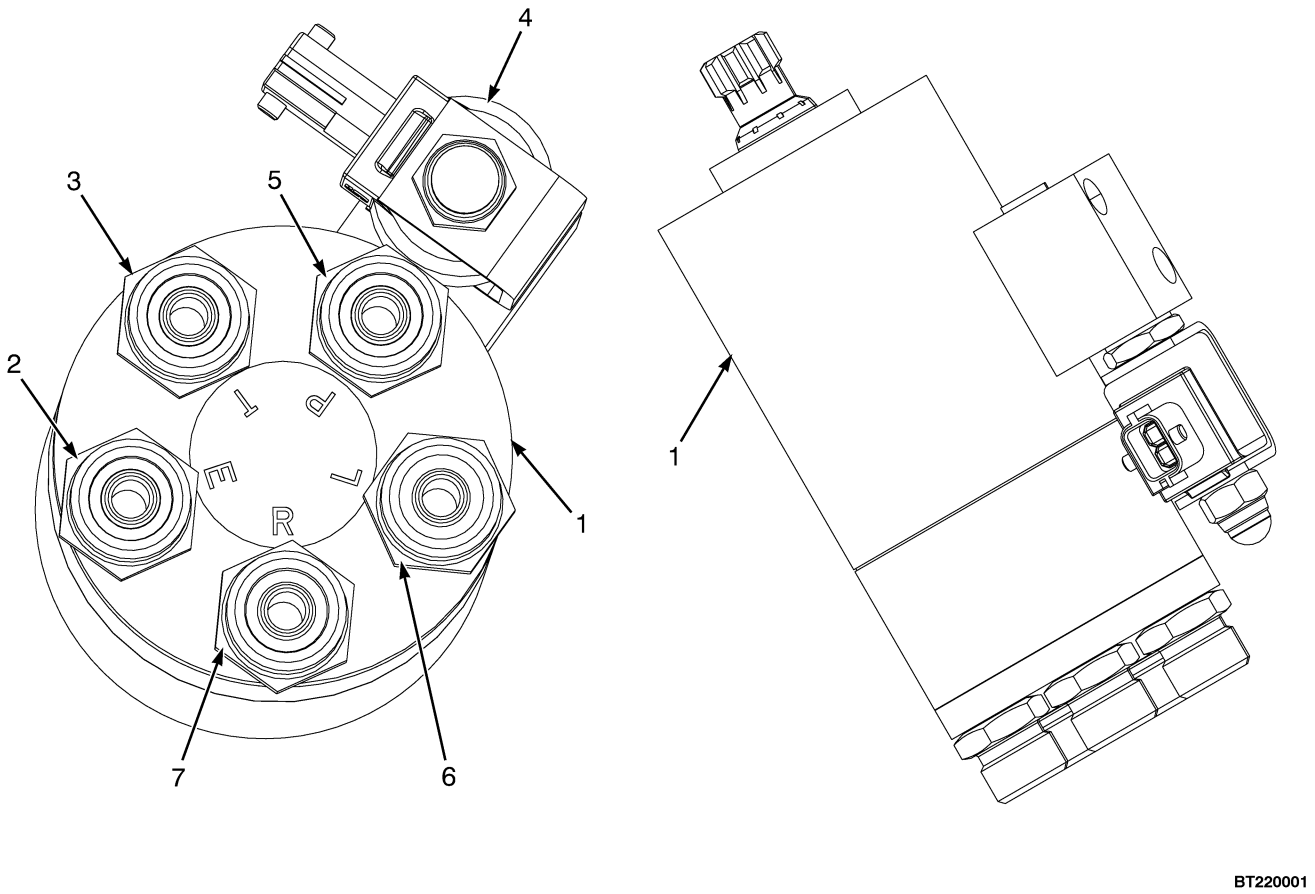

1. STEERING CONTROL UNIT
2. LOAD SENSE
3. RETURN TO CONTROL VALVE
4. MAKE-UP VALVE
5. SUPPLY PRESSURE
6. LEFT
7. RIGHT

Figure 9050-10-41. Steering Control Unit

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Group 33

Observed Symptoms-Gear Pump

Abnormal Hydraulic Noise and/or Vibration

POSSIBLE CAUSE

A. LOW OIL LEVEL IN TANK.
B. AIR TRAPPED IN CIRCUIT.
C. SUCTION SIDE OF HYDRAULIC PUMP IS RESTRICTED.
D. HYDRAULIC PUMP LEAK AT THE INLET SUCTION HOSES.
E. HYDRAULIC PUMP IS WORN.
F. VIBRATION WITH TILT FUNCTION ONLY.
G. UNSTABLE MAIN RELIEF VALVE.
H. UNSTABLE SECONDARY RELIEF VALVE.
I. HYDRAULIC SYSTEM OVERHEATING.
J. UNSTABLE UNLOADER SPOOL.
K. UNSTABLE PRIORITY VALVE IN CONTROL VALVE INLET.

CAUSE A - LOW OIL LEVEL IN TANK.

PROCEDURE OR ACTION:

NOTE: Cavitation of a hydraulic pump will cause noise and it is caused by air in the hydraulic oil. The hydraulic pump suction oil must be free of air and unrestricted to pump.

1. Check hydraulic oil level in tank.
   Is oil at correct level?
   YES: Go to Cause B.
   NO: Add oil to correct level. See **Operating Manual**.

CAUSE B - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling functions at one-second intervals, for E-Valve hoist and lower only. All other functions, cycle fully for 5 - 10 times. If symptom is still present, go to Cause C.

CAUSE C - SUCTION SIDE OF HYDRAULIC PUMP IS RESTRICTED.

PROCEDURE OR ACTION:

1. Check for restricted inlet screen.
   Is inlet screen restricted?
   YES: Clean or replace inlet screen.
   NO: Go to Step 2.
2. Check for collapsed suction hose.
   Is suction hose collapsed?
   YES: Replace suction hose.
   NO: Go to Cause D.

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CAUSE D - HYDRAULIC PUMP LEAK AT THE INLET SUCTION HOSES.

PROCEDURE OR ACTION:

1. Look at Steering System component location drawing to identify suction hose. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.
   - Inspect suction hoses between tank and pump. Check for loose hose clamps and oil seepage.

   Is oil leaking from suction side of hydraulic pump?
   YES: Check and tighten suction hose clamps.
   NO: Go to Cause E.
2. Inspect hydraulic oil. Check for foaming or aeration of oil.
   Is oil foaming or aerated?
   YES: Repair suction side air leak and test oil for contamination. See Maintenance, Oil Sampling Procedure. Depending on your lift truck, see **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to Cause E.

CAUSE E - HYDRAULIC PUMP IS WORN.

PROCEDURE OR ACTION:

1. Check hydraulic pump flow. See Hydraulic Pump Flow Test in this section.
   Is hydraulic pump flow out of specifications?
   YES: Replace hydraulic pump. Depending on your lift truck, see **Hydraulic System** 1900SRM1367 or **Hydraulic System** 1900SRM1333.
   NO: Go to Cause F.

CAUSE F - VIBRATION WITH TILT FUNCTION ONLY.

PROCEDURE OR ACTION:

1. Inspect tilt spool and orifices for contamination or damage. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is tilt spool or orifices contaminated or plugged?
   YES: Clean or replace valve section.
   NO: Go to Cause G.

CAUSE G - UNSTABLE MAIN RELIEF VALVE.

PROCEDURE OR ACTION:

1. Install pressure gauge in hydraulic control valve. See Primary Relief Valve Test and Adjustment.
2. Operate the hoist function while observing pressure gauge.
   Does pressure fluctuate during hoist function.
   YES: Go to Cause H.
   NO: Go to Step 3.
3. Hold hoist function over relief.
   Does relief pressure meet test specifications?
   YES: Go to Cause H.
   NO: Replace relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE H - UNSTABLE SECONDARY RELIEF VALVE.

PROCEDURE OR ACTION:

1. Install pressure gauge in hydraulic control valve. See Secondary Relief Valve Test and Adjustment.

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2. Operate a auxiliary function while observing pressure gauge.
   Does pressure fluctuate during auxiliary function.
   YES: Go to Cause I.
   NO: Go to Step 3.
3. Hold auxiliary function over relief.
   Does relief pressure meet test specifications?
   YES: Go to Cause I.
   NO: Replace relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE I - HYDRAULIC SYSTEM OVERHEATING.

PROCEDURE OR ACTION:

NOTE: If lift truck is equipped with Hydraulic Oil Cooler, see Observed Symptoms-Gear Pump, Page 9050-33-16.

1. Check temperature sensor for operation.
   Is temperature sensor working properly?
   YES: Go to Cause J.
   NO: Replace temperature sensor. Depending on your lift truck, see **Hydraulic System** 1900SRM1367 or **Hydraulic System** 1900SRM1333.

CAUSE J - UNSTABLE UNLOADER SPOOL.

PROCEDURE OR ACTION:

1. Inspect unloader valve for damage or contamination. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is unloader valve free of contamination and in good condition?
   YES: Go to Cause K.
   NO: Clean or replace unloader valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE K - UNSTABLE PRIORITY VALVE IN CONTROL VALVE INLET.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-8.
   Does priority flow divider valve pass the check?
   YES: Priority flow divider valve is OK.
   NO:
   - Cannot turn steering wheel, wheel locks up. See Observed Symptoms-Gear Pump, No Steering (All Other Hydraulic Functions OK), Page 9050-33-56.
   - Steering wheel turns but fails Priority Valve Flow Divider Valve Check. Remove and clean flow divider spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Abnormal Smell/Discoloration/Foaming of Oil

POSSIBLE CAUSE

A. HYDRAULIC SYSTEM HAS BEEN OVERHEATED.
B. HYDRAULIC FLUID CONTAMINATED OR WRONG TYPE.
C. AIR LEAK ON SUCTION SIDE OF HYDRAULIC PUMP.

CAUSE A - HYDRAULIC SYSTEM HAS BEEN OVERHEATED.

PROCEDURE OR ACTION:

NOTE: If lift truck is equipped with Hydraulic Oil Cooler, see Observed Symptoms-Gear Pump, Page 9050-33-16.

1. Inspect for the following:
   - Level and condition of hydraulic oil in tank
   - Valve stuck causing system to run at relief

   Are any of the above symptoms present?
   YES: Drain and refill hydraulic tank. **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442. Repair or replace stuck valve.
   NO: Go to Cause B.

CAUSE B - HYDRAULIC FLUID CONTAMINATED OR WRONG TYPE.

PROCEDURE OR ACTION:

1. Check hydraulic oil for contamination and correct type.
   Is hydraulic oil contaminated or incorrect type used?
   YES: Drain and refill hydraulic tank. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to Cause C.

CAUSE C - AIR LEAK ON SUCTION SIDE OF HYDRAULIC PUMP.

PROCEDURE OR ACTION:

1. Inspect condition of hydraulic oil.
   Is the hydraulic oil foaming or aerated?
   YES: Repair leak on suction side of hydraulic pump. For [A268], E2.2-3.5XN (E45-70XN); [A276], J2.2- 3.5XN (J40-70XN); see **Hydraulic System** 1900SRM1367, For [K160], J1.5-2.0XNT (J30-40XNT); [A955] ERP16-20VF; see **Hydraulic System** 1900SRM1333.
   NO: Check service record of lift truck to see if it requires periodic maintenance.

END SYMPTOM

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Cycle Times Too Fast - Fast Actuation (E-Valve)

POSSIBLE CAUSE

A. MAX FUNCTION SPEED SETTING TOO HIGH.
B. RAMP SETTING TOO HIGH FOR FUNCTION.
C. ORIFICES MISSING OR INSTALLED WRONG IN CYLINDER PORTS (ON AFTERMARKET CYLINDERS).
D. FAULTY MLCV FOR LOWERING FUNCTION ONLY.
E. UNLOADER VALVE PRODUCING TOO MUCH MARGIN PRESSURE.

CAUSE A - MAX FUNCTION SPEED SETTING TOO HIGH.

PROCEDURE OR ACTION:

1. Adjust function speed setting on Display Panel. If problem is still present, go to Cause B.

CAUSE B - RAMP SETTING TOO HIGH FOR FUNCTION.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause C.

CAUSE C - ORIFICES MISSING OR INSTALLED WRONG IN CYLINDER PORTS (ON AFTERMARKET CYLINDERS).

PROCEDURE OR ACTION:

1. Check cycle times. See aftermarket specifications.
   Do cycle times meet specifications?
   YES: Go to Cause D.
   NO: Inspect and repair orifices in cylinder ports. See aftermarket Service Manuals.

CAUSE D - FAULTY MLCV FOR LOWERING FUNCTION ONLY.

PROCEDURE OR ACTION:

1. Check the lowering cycle times.
   Are the lowering cycle times too fast?
   YES: Repair or replace Mast Lowering Control Valve (MLCV). Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause E.

CAUSE E - UNLOADER VALVE PRODUCING TOO MUCH MARGIN PRESSURE.

PROCEDURE OR ACTION:

1. Test unloader valve. See Main Control Valve Unloader Margin Test.
   Is margin pressure too high?
   YES: Replace unloader valve spool spring. Depending on your left truck, see **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

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NO: Perform operational check.

END SYMPTOM

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Jump/Delay In Lift or Lower Activation After Moving MLM (E-Valve)

POSSIBLE CAUSE

A. RAMP RATE NOT SET TO DESIRED LEVEL.
B. COIL NOT ATTACHED TO SOLENOID CORRECTLY.
C. AIR TRAPPED IN CIRCUIT.
D. OUTPUT THRESHOLD IS SET TOO HIGH.
E. MAST/ATTACHMENT IS BINDING.
F. STICKING UNLOADER SPOOL.
G. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - RAMP RATE NOT SET TO DESIRED LEVEL.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause B.

CAUSE B - COIL NOT ATTACHED TO SOLENOID CORRECTLY.

PROCEDURE OR ACTION:

1. Inspect coil installation. Depending on your left truck, see **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is coil installed correctly to solenoid?
   YES: Go to Cause C.
   NO: Replace coil or solenoid. Coil cannot be repaired.

CAUSE C - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function at one second intervals, for E-Valve hoist and lower only. All other functions, cycle fully for 5 - 10 times. If symptom is still present, go to Cause D.

CAUSE D - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check current at Electro-Hydraulic Valve.
   Is setting at valve correct?
   YES: Go to Cause E.
   NO: Decrease setting to specification or until operation is acceptable to operator.

CAUSE E - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555,**

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A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
NO: Go to Cause F.

CAUSE F - STICKING UNLOADER SPOOL.

PROCEDURE OR ACTION:

1. Inspect unloader valve for damage or contamination. Depending on your left truck, see **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is unloader free of contamination and in good condition?
   YES: Go to Cause G.
   NO: Clean or replace unloader valve.

CAUSE G - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: See Observed Symptoms-Gear Pump, Lift Function Will Not Move With MLM Movement (E-Valve), Page 9050-33-24.
   NO: Clean or replace main relief valve. Depending on your left truck, see **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Jump/Delay In Auxiliary Function Actuation After Moving MLM (E-Valve)

POSSIBLE CAUSE

A. RAMP RATE NOT SET TO DESIRED LEVEL.
B. AIR TRAPPED IN CIRCUIT.
C. OUTPUT THRESHOLD IS SET TOO HIGH.
D. MAST/ATTACHMENT IS BINDING.
E. PILOT PRESSURE NOT BEING PRODUCED FAST ENOUGH.
F. STICKING VALVE SPOOL.
G. STICKING UNLOADER SPOOL.
H. VALVE SPOOL END SPRINGS TOO SOFT.

CAUSE A - RAMP RATE NOT SET TO DESIRED LEVEL.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause B.

CAUSE B - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function full stroke of hydraulic hoist cylinder at one second intervals. If symptom is still present, go to Cause C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check current at valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is setting at valve correct?
   YES: Go to Cause D.
   NO: Decrease setting to specification or until operation is acceptable to operator.

CAUSE D - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause E.

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CAUSE E - PILOT PRESSURE NOT BEING PRODUCED FAST ENOUGH.

PROCEDURE OR ACTION:

1. Inspect filter. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is filter clean and in good condition?
   YES: Go to Cause F.
   NO: Clean or replace filter.

CAUSE F - STICKING VALVE SPOOL.

PROCEDURE OR ACTION:

1. Inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is spool clean and in good condition?
   YES: Go to Cause G.
   NO: Clean or replace spool.

CAUSE G - STICKING UNLOADER SPOOL.

PROCEDURE OR ACTION:

1. Inspect unloader valve for damage or contamination. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is unloader free of contamination and in good condition?
   YES: Go to Cause H.
   NO: Clean or replace unloader valve.

CAUSE H - VALVE SPOOL END SPRINGS TOO SOFT.

PROCEDURE OR ACTION:

1. Replace springs. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337. If problem is still present, see Observed Symptoms-Gear Pump, Auxiliary Function, Tilt Back and/or Tilt Forward Will Not Move With MLM Movement (E-Valve), Page 9050-33-37.

END SYMPTOM

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Jump/Delay In Tilt Forward or Back Actuation (E-Valve)

POSSIBLE CAUSE

A. RAMP RATE NOT SET TO DESIRED LEVEL.
B. AIR TRAPPED IN CIRCUIT.
C. OUTPUT THRESHOLD IS SET TOO HIGH.

CAUSE A - RAMP RATE NOT SET TO DESIRED LEVEL.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause B.

CAUSE B - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function full stroke of hydraulic hoist cylinder at one second intervals. If symptom is still present, go to Cause C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check current at E-Hydraulic Valve. See **Hydraulic System** 1900SRM1367.
   Is setting at valve correct?
   YES: Resume operation.
   NO: Decrease setting to specification or until operation is acceptable to operator.

END SYMPTOM

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Forks Drop Slightly Before Lifting (E-Valve)

POSSIBLE CAUSE

A. EXCESSIVE LEAKAGE IN LOAD CHECK VALVE.

CAUSE A - EXCESSIVE LEAKAGE IN LOAD CHECK VALVE.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Check for contamination or damage to load check valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is load check valve in good condition?
   YES: Clean lift low leak valve.
   NO: Replace lift low leak valve.

END SYMPTOM

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Forks Lower Without Command (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. EMERGENCY LOWER VALVE IS PARTIALLY OPEN.
C. EXCESSIVE LIFT CYLINDER LEAKAGE.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 2.
2. Turn Power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to Cause B.
   NO: Go to Step 5.
5. Power **OFF**. Replace lift/lower lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to Cause B.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position.
    Display value = 0%?
    YES: Repair Complete. Resume operation.
    NO: Go to Cause B.

CAUSE B - EMERGENCY LOWER VALVE IS PARTIALLY OPEN.

PROCEDURE OR ACTION:

NOTE: Emergency lower valve has tee handle located on control valve. See **Operating Manual** for location and correct use.

1. Check and close valve. If problem is still present, go to Cause C.

CAUSE C - EXCESSIVE LIFT CYLINDER LEAKAGE.

PROCEDURE OR ACTION:

1. Do lift cylinder leakage test. See Lift Cylinder Leakage Test.
   Is there leakage in the lift cylinder?
   YES: Repair or replace lift cylinder.

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NO: Resume operation.

END SYMPTOM

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Forks Raise or Actuate Without Command (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. AIR TRAPPED IN CIRCUIT.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 2.
2. Turn Power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to Cause B.
   NO: Go to Step 5.
5. Power **OFF**. Replace lift/lower lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to Cause B.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position.
    Does Display value = 0%?
    YES: Repair Complete. Resume Operation.
    NO: Go to Cause B.

CAUSE B - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function at one-second intervals, for E-Valve hoist and lower only. All other functions, cycle fully for 5 - 10 times.

END SYMPTOM

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Hydraulic Oil Cooler Not Functioning Correctly

POSSIBLE CAUSE

A. AIR FLOW THROUGH COOLER RESTRICTED OR INSUFFICIENT
B. HYDRAULIC OIL COOLER TEMPERATURE SWITCH NOT WORKING
C. HYDRAULIC OIL COOLER FANS NOT WORKING

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Conduct a quick visual inspection of all connectors/wiring associated with the hydraulic oil cooler. Make sure electrical connection is a good physical connection (i.e. sockets and pins are seated correctly; connector "clicks" indicating locking tab works correctly).
   Are any of the connectors/wiring damaged?
   YES: Repair/replace connector or wiring associated with hydraulic oil cooler. Refer to appropriate **Electrical System** manual, depending on lift truck model.
   NO: Go to Cause B.

CAUSE A - AIR FLOW THROUGH COOLER RESTRICTED OR INSUFFICIENT

PROCEDURE OR ACTION:

1. Check the condition of the hydraulic oil cooler.
   Is the hydraulic oil cooler fan shroud broken or hydraulic oil cooler blocked not allowing air flow through the cooler?
   YES: Replace hydraulic oil cooler fan shroud and/or remove any debris or blockage restricting air flow through cooler. Clean hydraulic oil cooler and resume operation.
   NO: Go to Cause C.

CAUSE B - HYDRAULIC OIL COOLER TEMPERATURE SWITCH NOT WORKING

PROCEDURE OR ACTION:

1. Warm up the hydraulic oil to a minimum of 60°C (140°F). Follow procedures in Hydraulic Warm-up Procedure. Park lift truck and check condition of hydraulic cooler cooling fans.
   Do the hydraulic cooler cooling fans turn on?
   YES: Truck is operating to specification.
   NO: Go to Step 2.
2. Turn lift truck **OFF**. Bypass the hydraulic oil cooler temperature switch with a jumper wire. Turn lift truck **ON**.
   Do the hydraulic cooler cooling fans turn on?
   YES: Replace faulty hydraulic oil cooler temperature switch with a new switch. Resume operation.
   NO: Remove bypass jumper wire and return hydraulic oil cooler temperature switch to it's original condition. Go to Cause D.

CAUSE C - HYDRAULIC OIL COOLER FANS NOT WORKING

PROCEDURE OR ACTION:

1. Turn lift truck **OFF**. Replace the hydraulic oil cooler fan(s) with a new fan(s). Be sure to install new fans in the correct direction for air flow through oil cooler. Turn lift truck **ON** and operate lift truck until hydraulic oil temperature is HOT. Park lift truck and raise hood.
   Do the hydraulic cooler cooling fans turn on?
   YES: Repeat Cause B. Check the level of the hydraulic oil in the hydraulic tank. Drain/fill as needed.
   NO: Go to Step 2.
2. Using a DMM, check the condition of the power and ground circuit for the fans.

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Do the fans have a good ground and 12 volts?
YES: Replace inoperative fans. Be sure to install new fans in the correct direction for air flow through hydraulic oil cooler.
NO: Go to VSM 12 Volts Supply OORL/OORH.

END SYMPTOM

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Intermittent Activation (E-Valve) While Commanding Function

POSSIBLE CAUSE

A. LOOSE WIRES OR CONNECTORS ON VALVE HARNESS.
B. MAST/ATTACHMENT IS BINDING.
C. CONTAMINATION IN HYDRAULIC CONTROL VALVE.

CAUSE A - LOOSE WIRES OR CONNECTORS ON VALVE HARNESS.

PROCEDURE OR ACTION:

1. Check the Display Panel for DTC.
   Is a DTC displayed?
   YES: Go to DTC diagnostic procedure.
   NO: Go to Step 2.
2. Check wire connection. See **Wire Harness Repair** 2200SRM1128. If problem is still present, go to Cause B.

CAUSE B - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause C.

CAUSE C - CONTAMINATION IN HYDRAULIC CONTROL VALVE.

PROCEDURE OR ACTION:

1. Inspect and clean control valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Forks Tilt Forward Without Command (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. PPRV GETTING STRAY SIGNAL.
C. EXCESSIVE TILT CYLINDER LEAKAGE.
D. EXCESSIVE SPOOL LEAKAGE.
E. PISTON STUCK.
F. TILT CONTROL SPOOL DAMAGED OR LEAKING EXCESSIVELY.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate tilt lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 2.
2. Turn power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to Cause B.
   NO: Go to Step 5.
5. Power **OFF**. Replace tilt lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Go to Cause B.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position.
    Does Display value = 0%?
    YES: Repair Complete. Resume operation.
    NO: Go to Cause B.

CAUSE B - PPRV GETTING STRAY SIGNAL.

PROCEDURE OR ACTION:

1. Check for proper harness installation. See **Wire Harness Repair** 2200SRM1128.
   Is valve harness installed wrong?
   YES: Install valve harness properly.
   NO: Go to Step 2.
2. Check for shorts in valve harness. See **Wire Harness Repair** 2200SRM1128.
   Does valve harness have shorts?
   YES: Repair or replace valve harness.
   NO: Go to Cause C.

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CAUSE C - EXCESSIVE TILT CYLINDER LEAKAGE.

PROCEDURE OR ACTION:

1. Do tilt cylinder leakage test. See Tilt Cylinder Leakage Test.
   Is there leakage in the tilt cylinder?
   YES: Repair or replace tilt cylinder.
   NO: Go to Cause D.

CAUSE D - EXCESSIVE SPOOL LEAKAGE.

PROCEDURE OR ACTION:

1. Check spool for:
   - Damage
   - Free movement
   - Debris or contamination

   Is spool and mating bore in good condition?
   YES: Go to Cause E.
   NO: Replace damaged parts.

CAUSE E - PISTON STUCK.

PROCEDURE OR ACTION:

1. Inspect tilt control piston. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does piston move freely in bore?
   YES: Go to Cause F.
   NO: Clean piston or replace valve section.

CAUSE F - TILT CONTROL SPOOL DAMAGED OR LEAKING EXCESSIVELY.

PROCEDURE OR ACTION:

1. Inspect valve section. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is spool in good condition?
   YES: See Observed Symptoms-Gear Pump, Forks Raise or Actuate Without Command (E-Valve), Page 9050-33-15.
   NO: Clean or replace spool.

END SYMPTOM

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Lift/Lower Function Maximum Speed Too Slow (E-Valve)

POSSIBLE CAUSE

A. MAX FUNCTION SPEED SETTING TOO LOW.
B. RAMP SETTING TOO LOW FOR FUNCTION.
C. OUTPUT THRESHOLD IS SET TOO LOW.
D. MAST/ATTACHMENT IS BINDING.
E. MLM CONTROL MALFUNCTION.
F. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN (LIFT FUNCTION ONLY).
G. EXCESSIVE PUMP LEAKAGE (LIFT FUNCTION ONLY).
H. UNLOADER NOT PRODUCING ENOUGH MARGIN PRESSURE (LIFT FUNCTION ONLY).
I. MAIN CONTROL VALVE LS (LOAD SENSE) LEAKAGE (LIFT FUNCTION ONLY).
J. FAULTY MAST LOWERING CONTROL VALVE.

CAUSE A - MAX FUNCTION SPEED SETTING TOO LOW.

PROCEDURE OR ACTION:

1. Adjust function speed setting on Display Panel. If problem is still present, go to Cause B.

CAUSE B - RAMP SETTING TOO LOW FOR FUNCTION.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Check current at Display Panel.
   Is setting at valve correct?
   YES: Go to Cause D.
   NO: Increase setting to specification or until operation is acceptable to operator.

CAUSE D - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause E.

CAUSE E - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Turn power **ON**.

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2. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
3. Move lever to full stroke position – both directions.
   Is Display value >=92%?
   YES: Go to Cause F.
   NO: Go to Step 4.
4. Power **OFF**. Replace lift/lower Lever(s). See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .
5. Retest. Turn power **ON**.
6. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
7. Move lever to full stroke position – both directions.
   Is Display value >=92%?
   YES: Go to Cause F.
   NO: Replace MLM PCB Cassette. See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .

CAUSE F - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Install pressure gauge in hydraulic control valve. See Primary Relief Valve Test and Adjustment.
2. Hold lift function over relief.
   Does relief pressure meet test specifications?
   YES: Go to Cause G.
   NO: Replace relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE G - EXCESSIVE PUMP LEAKAGE (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Test hydraulic pump for excessive leakage. See Hydraulic Pump Flow Test.
   Does hydraulic pump have excessive leakage?
   YES: Repair or replace pump. See **Hydraulic System** 1900SRM1333.
   NO: Go to Cause H.

CAUSE H - UNLOADER NOT PRODUCING ENOUGH MARGIN PRESSURE (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Test unloader spool spring. See Main Control Valve Unloader Margin Test.
   Does unloader valve pressure meet test specifications?
   YES: Go to Cause I.
   NO: Replace spring.

CAUSE I - MAIN CONTROL VALVE LS (LOAD SENSE) LEAKAGE (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: See Observed Symptoms-Gear Pump, Lift Function Will Not Move With MLM Movement (E-Valve), Page 9050-33-24.
   NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

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CAUSE J - FAULTY MAST LOWERING CONTROL VALVE.

PROCEDURE OR ACTION:

1. Inspect mast lowering control valve for blockage.
   Is mast lowering control valve blocking flow?
   YES: Repair or replace mast lowering control valve. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Resume operation.

END SYMPTOM

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Lift Function Will Not Move With MLM Movement (E-Valve)

POSSIBLE CAUSE

A. PUMP NOT GENERATING ENOUGH FLOW.
B. LOAD IS GREATER THAN TRUCK CAPACITY.
C. MLM CONTROL MALFUNCTION.
D. EMERGENCY LOWER VALVE IS PARTIALLY OPEN.
E. LIFT SPEED IS SET AT 0%.
F. MAIN RELIEF VALVE IS SET TOO LOW.
G. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.
H. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
I. MAST LOWERING CONTROL VALVE BLOCKING FLOW.
J. UNLOADER SPOOL IS STUCK OPEN.
K. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - PUMP NOT GENERATING ENOUGH FLOW.

PROCEDURE OR ACTION:

1. Do hydraulic pump flow check.
   Does pump pass check?
   YES: Pump is OK. Go to Cause B.
   NO: Do Hydraulic Pump Flow Test before replacing pump.

CAUSE B - LOAD IS GREATER THAN TRUCK CAPACITY.

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating. Adjust as necessary. If problem is still present, go to Cause C.

CAUSE C - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate lift/lower lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to Cause D.
2. Observe value
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values, then go to Step 3.
   NO: Go to Seat Sensor Out of Range Low (OORL).
3. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 4.
4. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Go to Cause D.
   NO: Go to Step 5.

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5. Power **OFF**. Replace lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
    Does Display value = 0%? at the center position and 92 to 100% at the full stroke position?
    YES: Repair complete. Resume Operation.
    NO: Go to Cause D.

CAUSE D - EMERGENCY LOWER VALVE IS PARTIALLY OPEN.

PROCEDURE OR ACTION:

NOTE: Emergency lower valve has tee handle located on control valve. See **Operating Manual** for location and correct use.

1. Check and close valve. If problem is still present, go to Cause E.

CAUSE E - LIFT SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of lift hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to Cause F.

CAUSE F - MAIN RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Primary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to Cause G.
   NO: Adjust pressure to test specifications.

CAUSE G - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is relief valve damaged or stuck open?
   YES: Install new relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Go to Cause H.

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CAUSE H - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

NOTE: This only affects hoist circuit when a auxiliary function is activated.

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to Cause I.
   NO: Adjust pressure to test specifications.

CAUSE I - MAST LOWERING CONTROL VALVE BLOCKING FLOW.

PROCEDURE OR ACTION:

1. Inspect mast lowering control valve for blockage.
   Is mast lowering control valve blocking flow?
   YES: Repair or replace mast lowering control valve. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause J.

CAUSE J - UNLOADER SPOOL IS STUCK OPEN.

PROCEDURE OR ACTION:

1. Inspect and repair unloader spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337. If problem is still present, go to Cause K.

CAUSE K - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: See Observed Symptoms-Gear Pump, Too Much MLM Movement (Deadband) to Start Function Moving (E-Valve), Page 9050-33-44.
   NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Lift/Lower Continues To Move For Awhile After MLM Is Released (E-Valve)

POSSIBLE CAUSE

A. RAMP SETTINGS TO HIGH/LOW FOR OPERATION.

CAUSE A - RAMP SETTINGS TO HIGH/LOW FOR OPERATION.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Depending on associated hydraulic function, adjust ramp settings until operation is acceptable to operator.

END SYMPTOM

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Lift/Lower/Auxiliary Function Suddenly Jumps In Middle of Stroke (E-Valve)

POSSIBLE CAUSE

A. STICKING VALVE SPOOL (AUXILIARY FUNCTIONS ONLY).
B. VALVE SPOOL END SPRINGS TOO SOFT (AUXILIARY FUNCTIONS ONLY).

CAUSE A - STICKING VALVE SPOOL (AUXILIARY FUNCTIONS ONLY).

PROCEDURE OR ACTION:

1. Remove and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is the spool undamaged and moves freely in bore?
   YES: Cause B.
   NO: Clean or replace valve spool.

CAUSE B - VALVE SPOOL END SPRINGS TOO SOFT (AUXILIARY FUNCTIONS ONLY).

PROCEDURE OR ACTION:

1. Replace springs. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Lower Function Will Not Move With MLM Movement (E-Valve)

POSSIBLE CAUSE

A. LOWER SPEED IS SET AT 0%.
B. MLM CONTROL MALFUNCTION.

CAUSE A - LOWER SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of lower hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to Cause B.

CAUSE B - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate lift/lower Lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to Step 3.
2. Observe Value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values, then go to Step 3.
   NO: Go to Seat Sensor Out of Range Low (OORL).
3. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 4.
4. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation
   NO: Go to Step 5.
5. Power **OFF**. Replace lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest.

END SYMPTOM

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Poor Metering on Lift or Lower Functions (E-Valve)

POSSIBLE CAUSE

A. AIR TRAPPED IN CIRCUIT.
B. RAMP SETTING TOO HIGH FOR FUNCTION.
C. OUTPUT THRESHOLD IS SET TOO HIGH.
D. MAST/ATTACHMENT IS BINDING.
E. MLM CONTROL MALFUNCTION.
F. MAST LOWERING CONTROL VALVE IS STICKING.
G. STICKING UNLOADER SPOOL (LIFT FUNCTION ONLY).
H. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function full stroke of hydraulic hoist cylinder at one second intervals. If symptom is still present, go to Cause B.

CAUSE B - RAMP SETTING TOO HIGH FOR FUNCTION.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check current at E-Hydraulic Valve.
   Is setting at valve correct?
   YES: Go to Cause D.
   NO: Decrease setting to specification or until operation is acceptable to operator.

CAUSE D - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair or lubricate mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause E.

CAUSE E - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?

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YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
NO: Go to Step 2.

2. Turn Power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to Cause F.
   NO: Go to Step 5.
5. Power **OFF**. Replace lift/lower lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Go to Cause F.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest.

CAUSE F - MAST LOWERING CONTROL VALVE IS STICKING.

PROCEDURE OR ACTION:

1. Inspect mast lowering control valve for proper operation. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is mast lowering control valve sticking?
   YES: Repair or replace mast lowering control valve.
   NO: Go to Cause G.

CAUSE G - STICKING UNLOADER SPOOL (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Inspect unloader valve for damage or contamination. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is unloader free of contamination and in good condition?
   YES: Go to Cause H.
   NO: Clean or replace unloader valve.

CAUSE H - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: See Observed Symptoms-Gear Pump, Lift Function Will Not Move With MLM Movement (E-Valve), Page 9050-33-24.
   NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Auxiliary Function Continues to Move for Awhile After MLM Is Released (E-Valve)

POSSIBLE CAUSE

A. RAMP SETTINGS TO HIGH/LOW FOR OPERATION.
B. STICKING VALVE SPOOL.

CAUSE A - RAMP SETTINGS TO HIGH/LOW FOR OPERATION.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Depending on associated hydraulic function, adjust ramp settings for proper operation. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause B.

CAUSE B - STICKING VALVE SPOOL.

PROCEDURE OR ACTION:

1. Remove and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is the spool undamaged and moves freely in bore?
   YES: Resume operation.
   NO: Clean or replace valve spool.

END SYMPTOM

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Auxiliary Function Maximum Speed Too Slow (E-Valve)

POSSIBLE CAUSE

A. MAX FUNCTION SPEED SETTING TOO LOW.
B. RAMP SETTING TOO LOW FOR FUNCTION.
C. OUTPUT THRESHOLD IS SET TOO LOW.
D. MAST/ATTACHMENT IS BINDING.
E. MLM CONTROL MALFUNCTION.
F. ORIFICES INSTALLED IN CIRCUIT TOO SMALL (ON AFTERMARKET CYLINDERS).
G. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.
H. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
I. PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.
J. STICKING SPOOL.
K. UNLOADER NOT PRODUCING ENOUGH MARGIN PRESSURE.
L. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - MAX FUNCTION SPEED SETTING TOO LOW.

PROCEDURE OR ACTION:

1. Adjust function speed setting on Display Panel. If problem is still present, go to Cause B.

CAUSE B - RAMP SETTING TOO LOW FOR FUNCTION.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Check current at Electro-Hydraulic Poppet Valve (EHPV). Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is setting at valve correct?
   YES: Go to Cause D.
   NO: Increase setting until operation is acceptable to operator.

CAUSE D - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Lubricate or repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause E.

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CAUSE E - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Turn power **ON**.
2. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
3. Move Lever to full stroke position – both directions.
   Is Display value >=92%?
   YES: Go to Cause F.
   NO: Go to Step 4.
4. Power **OFF**. Replace Auxiliary Lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
5. Retest. Turn power **ON**.
6. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
7. Move lever to full stroke position – both directions.
   Is Display value >=92%?
   YES: Go to Cause F.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)

CAUSE F - ORIFICES INSTALLED IN CIRCUIT TOO SMALL (ON AFTERMARKET CYLINDERS).

PROCEDURE OR ACTION:

1. Check cycle times. See aftermarket specifications.
   Do cycle times meet specifications?
   YES: Go to Cause G.
   NO: Inspect and replace orifices in cylinder ports. See aftermarket service manuals.

CAUSE G - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Install pressure gauge in hydraulic control valve. See Primary Relief Valve Test and Adjustment.
2. Hold lift function over relief.
   Does relief pressure meet test specifications?
   YES: Go to Cause H.
   NO: Replace relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE H - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to Cause I.
   NO: Adjust pressure to test specifications.

CAUSE I - PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.

PROCEDURE OR ACTION:

1. Test Proportional Pressure Reducing Valve (PPRV) pressure.
   Is PPRV pressure at specifications?
   YES: Go to Cause J.
   NO: Clean screen on PPRV. If problem is still present, replace PPRV. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

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CAUSE J - STICKING SPOOL.

PROCEDURE OR ACTION:

1. Inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is spool clean and in good condition?
   YES: Go to Cause K.
   NO: Clean or replace spool.

CAUSE K - UNLOADER NOT PRODUCING ENOUGH MARGIN PRESSURE.

PROCEDURE OR ACTION:

1. Test unloader spool spring. See Main Control Valve Unloader Margin Test.
   Does unloader valve pressure meet test specifications?
   YES: Go to Cause L.
   NO: Replace spring.

CAUSE L - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: Check for DTCs. See Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
   NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Auxiliary Function or Tilt Back Moves Without Command (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. EXCESSIVE SPOOL LEAKAGE.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 2.
2. Turn power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to Cause B.
   NO: Go to Step 5.
5. Power **OFF**. Replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to Cause B.
   NO: Replace MLM PCB Cassette. See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337.
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position.
    Does Display value = 0%?
    YES: Repair Complete. Resume operation.
    NO: Go to Cause B.

CAUSE B - EXCESSIVE SPOOL LEAKAGE.

PROCEDURE OR ACTION:

1. Check spool for items below. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   - Damage
   - Free movement
   - Debris or contamination

   Is spool and mating bore in good condition?
   YES: See Observed Symptoms-Gear Pump, Auxiliary Function Continues to Move for Awhile After MLM Is Released (E-Valve), Page 9050-33-32.
   NO: Replace damaged parts.

END SYMPTOM

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Auxiliary Function, Tilt Back and/or Tilt Forward Will Not Move With MLM Movement (E-Valve)

POSSIBLE CAUSE

A. PUMP NOT GENERATING ENOUGH FLOW.
B. LOAD IS GREATER THAN TRUCK CAPACITY.
C. MLM CONTROL MALFUNCTION.
D. HYDRAULIC FUNCTION SPEED IS SET AT 0%.
E. SECONDARY RELIEF VALVE IS SET TOO LOW.
F. MAST/ATTACHMENT IS BINDING.
G. STUCK SPOOL IN CONTROL VALVE.
H. PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.
I. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
J. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.
K. UNLOADER VALVE STUCK OPEN.
L. MAIN RELIEF LS (LOAD SENSE) STUCK OPEN.
M. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - PUMP NOT GENERATING ENOUGH FLOW.

PROCEDURE OR ACTION:

1. Do hydraulic pump flow check.
   Does pump pass check?
   YES: Pump is OK. Go to Cause B.
   NO: Perform Hydraulic Pump Flow Test before replacing pump.

CAUSE B - LOAD IS GREATER THAN TRUCK CAPACITY.

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating. Adjust as necessary. If problem is still present, go to Cause C.

CAUSE C - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate lever/s.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to Cause D.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values, then go to Step 3.
   NO: Go to Seat Sensor Out of Range Low (OORL).
3. Operate lever/s in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Next Step.
4. Move lever(s) to full stroke position and allow to snap back to the center position. Observe Value. Move the lever(s) to the full stroke position and hold. Observe Value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?

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YES: Go to Cause D.
NO: Go to Step 5.

5. Power **OFF**. Replace lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
    Does Display value = 0%? at the center position and 92 to 100% at the full stroke position?
    YES: Repair complete. Resume operation.
    NO: Go to Cause D.

CAUSE D - HYDRAULIC FUNCTION SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of tilt hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to Cause E.

CAUSE E - SECONDARY RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to Cause F.
   NO: Adjust pressure to test specifications.

CAUSE F - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Lubricate or repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause G.

CAUSE G - STUCK SPOOL IN CONTROL VALVE.

PROCEDURE OR ACTION:

1. Remove and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does the spool move freely in bore and in good condition?
   YES: Go to Cause H.

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NO: Repair or replace valve spool or section.

CAUSE H - PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.

PROCEDURE OR ACTION:

1. Test Proportional Pressure Reducing Valve (PPRV) pressure.
   Is PPRV pressure at specifications?
   YES: Go to Cause I.
   NO: Clean screen on PPRV. If problem is still present, replace PPRV. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE I - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

NOTE: This only affects hoist circuit when a auxiliary function is activated.

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to Cause J.
   NO: Adjust pressure to test specifications.

CAUSE J - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is relief valve damaged or stuck open?
   YES: Install new relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Go to Cause K.

CAUSE K - UNLOADER VALVE STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect unloader spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does unloader spool move freely in bore and in good condition?
   YES: Go to Cause L.
   NO: Repair or replace unloader spool.

CAUSE L - MAIN RELIEF LS (LOAD SENSE) STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is the LS relief clean and spring OK?
   YES: Go to Cause M.
   NO: Check for contamination. Clean or replace relief valve.

CAUSE M - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?

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YES: See Observed Symptoms-Gear Pump, Too Much MLM Movement (Deadband) to Start Function Moving (E-Valve), Page 9050-33-44.
NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Tilt Forward or Tilt Back Function Continues to Move for Awhile When MLM Is Released (E-Valve)

POSSIBLE CAUSE

A. RAMP SETTINGS TO HIGH/LOW FOR OPERATION.
B. STICKING VALVE SPOOL.
C. STICKING TILT CONTROL PISTON IN TILT SPOOL.

CAUSE A - RAMP SETTINGS TO HIGH/LOW FOR OPERATION.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Depending on associated hydraulic function, adjust ramp settings for proper operation. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause B.

CAUSE B - STICKING VALVE SPOOL.

PROCEDURE OR ACTION:

1. Remove and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is the spool undamaged and moves freely in bore?
   YES: Go to Cause C.
   NO: Clean or replace valve spool.

CAUSE C - STICKING TILT CONTROL PISTON IN TILT SPOOL.

PROCEDURE OR ACTION:

1. Inspect piston. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does piston move freely in bore?
   YES: Resume operation.
   NO: Clean piston or replace valve section.

END SYMPTOM

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Tilt Forward or Tilt Back Will Not Move With MLM Movement (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. TILT SPEED IS SET AT 0%.
C. PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.
D. STUCK SPOOL IN CONTROL VALVE.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Power **ON** and Operator in Seat. Operate Lever/s.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to Cause B.
2. Observe value
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values, then go to Step 3.
   NO: Go to Seat Sensor Out of Range Low (OORL).
3. Operate lever/s in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337. **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 4.
4. Move lever(s) to full stroke position and allow to snap back to the center position. Observe Value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Go to Cause B.
   NO: Go to Step 5.
5. Power **OFF**. Replace lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337. .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation.
   NO: Replace MLM PCB Cassette. See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337.
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
    Does Display value = 0%? at the center position and 92 to 100% at the full stroke position?
    YES: Repair complete. Resume operation.
    NO: Go to Cause B.

CAUSE B - TILT SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of tilt hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.

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Is Hydraulic Function set at 0%?
YES: Reset hydraulic function to appropriate level.
NO: Go to Cause C.

CAUSE C - PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.

PROCEDURE OR ACTION:

1. Test Proportional Pressure Reducing Valve (PPRV) pilot pressure.
   Is PPRV pressure at specifications?
   YES: Go to Cause D.
   NO: Clean screen on PPRV. If problem is still present, replace PPRV. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE D - STUCK SPOOL IN CONTROL VALVE.

PROCEDURE OR ACTION:

1. Remove, disassemble, and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does the spool move freely in bore and in good condition?
   YES: See Observed Symptoms-Gear Pump, Auxiliary Function, Tilt Back and/or Tilt Forward Will Not Move With MLM Movement (E-Valve), Page 9050-33-37.
   NO: Repair or replace valve spool or section.

END SYMPTOM

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Too Much MLM Movement (Deadband) to Start Function Moving (E-Valve)

POSSIBLE CAUSE

A. OUTPUT THRESHOLD IS SET TOO HIGH.

CAUSE A - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check threshold at Display Panel.
   Is setting at valve correct?
   YES:
   - For hoist/lower functions, see Observed Symptoms-Gear Pump, Jump/Delay In Lift or Lower Activation After Moving MLM (E-Valve), Page 9050-33-7.
   - For auxiliary functions, see Observed Symptoms-Gear Pump, Jump/Delay In Auxiliary Function Actuation After Moving MLM (E-Valve), Page 9050-33-9.
   - For tilt forward function, see Observed Symptoms-Gear Pump, Jump/Delay In Tilt Forward or Back Actuation (E-Valve), Page 9050-33-11.

   NO: Decrease setting to specification or until operation is acceptable to operator.

END SYMPTOM

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Wrong Actuation Operates or Actuation is Backward (E-Valve)

POSSIBLE CAUSE

A. WIRING HARNESS INSTALLED WRONG.
B. HYDRAULIC HOSES INSTALLED WRONG.
C. WIRING HARNESS HAS FAILED.

CAUSE A - WIRING HARNESS INSTALLED WRONG.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Inspect wiring harness. Depending on your lift truck, see **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .
   Is harness installed correctly?
   YES: Go to Cause B.
   NO: Adjust or repair harness. See **Wire Harness Repair** 2200SRM1128.

CAUSE B - HYDRAULIC HOSES INSTALLED WRONG.

PROCEDURE OR ACTION:

1. Inspect hydraulic hose routing and correct as required. If problem is still present, go to Cause C.

CAUSE C - WIRING HARNESS HAS FAILED.

PROCEDURE OR ACTION:

1. Inspect harness for shorts.
   Does harness have a short?
   YES: Repair wiring harness. See **Wire Harness Repair** 2200SRM1128.
   NO: Resume operation.

END SYMPTOM

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Actuation Exhibits Slight Movement in Opposite Direction Before Moving (Manual Valve)

POSSIBLE CAUSE

A. AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.
B. EXCESSIVE CONTROL VALVE SPOOL OR CYLINDER LEAKAGE.

CAUSE A - AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.

PROCEDURE OR ACTION:

1. Check service record of lift truck.
   Was hydraulic system repaired recently?
   YES: Check the repaired hose connections and remove air from system by cycling function full stroke of steering cylinder in each direction.
   NO: Go to Cause B.

CAUSE B - EXCESSIVE CONTROL VALVE SPOOL OR CYLINDER LEAKAGE.

PROCEDURE OR ACTION:

1. Identify if problem is in lift cylinder or control valve. Do Lift Cylinder Leakage Test.
   Does lift cylinder pass leakage test.
   YES: Problem is in control valve. Clean and repair. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Repair or replace lift cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

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Auxiliary Function is Slow or Does Not Function (Manual Valve)

POSSIBLE CAUSE

A. OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.
B. PUMP NOT GENERATING ENOUGH FLOW.
C. LOAD IS GREATER THAN TRUCK CAPACITY.
D. AUXILIARY FUNCTION SPEED IS SET AT 0%.
E. SPOOL IS NOT FULLY ACTUATED.
F. SECONDARY RELIEF VALVE IS SET TOO LOW.
G. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
H. MAIN RELIEF VALVE SET TOO LOW, DAMAGED, OR STUCK OPEN.
I. MAST/ATTACHMENT IS BINDING.
J. EXCESSIVE INTERNAL SPOOL LEAKAGE.

CAUSE A - OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate auxiliary lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to Cause B.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Cause B.
   NO: Go to Seat Sensor Out of Range Low (OORL).

CAUSE B - PUMP NOT GENERATING ENOUGH FLOW.

PROCEDURE OR ACTION:

1. Do hydraulic pump flow check.
   Does pump pass check?
   YES: Pump is OK. Go to Cause C.
   NO: Do Hydraulic Pump Flow Test before replacing pump.

CAUSE C - LOAD IS GREATER THAN TRUCK CAPACITY.

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating. Adjust as necessary. If problem is still present, go to Cause D.

CAUSE D - AUXILIARY FUNCTION SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Depending on associated hydraulic function, adjust ramp settings for proper operation. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to Cause E.

CAUSE E - SPOOL IS NOT FULLY ACTUATED.

PROCEDURE OR ACTION:

1. Inspect linkage. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

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Does linkage prematurely contact dash?
YES: Repair or replace linkage.
NO: Go to Cause F.

CAUSE F - SECONDARY RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to Cause G.
   NO: Adjust pressure to test specifications.

CAUSE G - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect relief valve. See **Hydraulic System** 1900SRM1333.
   Is relief valve damaged or stuck open?
   YES: Install new relief valve.
   NO: Go to Cause H.

CAUSE H - MAIN RELIEF VALVE SET TOO LOW, DAMAGED, OR STUCK OPEN.

PROCEDURE OR ACTION:

NOTE: This symptom only affects auxiliary functions when hoist function is activated.

1. Test and adjust pressure. See Primary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to Cause I.
   NO: Adjust pressure to test specifications and retest. If problem is still present, replace relief valve. See **Hydraulic System** 1900SRM1333.

CAUSE I - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause J.

CAUSE J - EXCESSIVE INTERNAL SPOOL LEAKAGE.

PROCEDURE OR ACTION:

1. Replace spool or complete control valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Cycle Times Too Fast - Fast Actuation (Manual Valve)

POSSIBLE CAUSE

A. ORIFICES MISSING OR INSTALLED IN WRONG CYLINDER PORTS (ON AFTERMARKET CYLINDERS).
B. FAULTY MAST LOWERING CONTROL VALVE (MLCV) FOR LOWERING FUNCTION ONLY.

CAUSE A - ORIFICES MISSING OR INSTALLED IN WRONG CYLINDER PORTS (ON AFTERMARKET CYLINDERS).

PROCEDURE OR ACTION:

1. Check cycle times. See aftermarket specifications.
   Are cycle times to specifications?
   YES: Go to Cause B.
   NO: Inspect and repair orifices in cylinder ports. Go to aftermarket Service Manuals.

CAUSE B - FAULTY MAST LOWERING CONTROL VALVE (MLCV) FOR LOWERING FUNCTION ONLY.

PROCEDURE OR ACTION:

1. Check the lowering cycle times.
   Are the lowering cycle times too fast?
   YES: Repair or replace MLCV. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Repeat lowering cycle times to make sure they are not too fast.

END SYMPTOM

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Function Continues to Activate After Returning to Neutral

POSSIBLE CAUSE

A. CONTROL LINKAGE BINDING (MANUAL VALVE).
B. VALVE SPOOL STICKING IN BORE (MANUAL VALVE).
C. MLM SWITCH PROBLEM (E-VALVE).
D. SPOOL STUCK OPEN.

CAUSE A - CONTROL LINKAGE BINDING (MANUAL VALVE).

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Inspect control linkage for sticking or binding. Repair or lubricate as required. If problem is still present, go to Cause B.

CAUSE B - VALVE SPOOL STICKING IN BORE (MANUAL VALVE).

PROCEDURE OR ACTION:

1. Inspect valve spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does valve spool move freely in bore?
   YES: Replace spool end cap centering springs. If problem is still present, go to Cause C.
   NO: Clean or replace valve spool.

CAUSE C - MLM SWITCH PROBLEM (E-VALVE).

PROCEDURE OR ACTION:

1. Check valve calibration.
   Is control valve calibrated correctly?
   YES: Go to Cause D.
   NO: Calibrate control valve.

CAUSE D - SPOOL STUCK OPEN.

PROCEDURE OR ACTION:

1. Inspect valve spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is valve spool damaged or stuck open?
   YES: Clean or replace valve spool.
   NO: Valve has excessive leakage. Replace valve spool.

END SYMPTOM

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Lift Function Is Slow or Does Not Function (Manual Valve)

POSSIBLE CAUSE

A. OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.
B. PUMP NOT GENERATING ENOUGH FLOW.
C. LOAD IS GREATER THAN TRUCK CAPACITY.
D. EMERGENCY LOWER VALVE IS PARTIALLY OPEN.
E. LIFT SPEED IS SET AT 0%.
F. LIFT SPOOL IS NOT FULLY ACTUATED.
G. MAIN RELIEF VALVE IS SET TOO LOW.
H. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.
I. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
J. MAST/ATTACHMENT IS BINDING.
K. EXCESSIVE INTERNAL SPOOL LEAKAGE.
L. MAST LOWERING CONTROL VALVE BLOCKING FLOW.

CAUSE A - OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate lift/lower lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to Cause B.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Cause B.
   NO: Go to Seat Sensor Out of Range Low (OORL).

CAUSE B - PUMP NOT GENERATING ENOUGH FLOW.

PROCEDURE OR ACTION:

1. Do hydraulic pump flow check.
   Does pump pass check?
   YES: Pump is OK. Go to Cause C.
   NO: Do Hydraulic Pump Flow Test before replacing pump.

CAUSE C - LOAD IS GREATER THAN TRUCK CAPACITY.

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating. Adjust as necessary. If problem is still present, go to Cause D.

CAUSE D - EMERGENCY LOWER VALVE IS PARTIALLY OPEN.

PROCEDURE OR ACTION:

NOTE: Emergency lower valve has tee handle located on control valve. See **Operating Manual** for location and correct use.

1. Check and close valve. If problem is still present, go to Cause E.

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CAUSE E - LIFT SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of lift hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to Cause F.

CAUSE F - LIFT SPOOL IS NOT FULLY ACTUATED.

PROCEDURE OR ACTION:

1. Inspect linkage. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does linkage prematurely contact dash?
   YES: Repair or replace linkage.
   NO: Go to Cause G.

CAUSE G - MAIN RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust pressure. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is relief set at specifications?
   YES: Go to Cause H.
   NO: Adjust pressure to test specifications.

CAUSE H - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is relief valve damaged or stuck open?
   YES: Install new relief valve.
   NO: Go to Cause I.

CAUSE I - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to Cause J.
   NO: Adjust pressure to test specifications.

CAUSE J - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to Cause K.

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CAUSE K - EXCESSIVE INTERNAL SPOOL LEAKAGE.

PROCEDURE OR ACTION:

1. Replace spool or complete control valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE L - MAST LOWERING CONTROL VALVE BLOCKING FLOW.

PROCEDURE OR ACTION:

1. Inspect mast lowering control valve for blockage.
   Is mast lowering control valve blocking flow?
   YES: Repair or replace mast lowering control valve. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Perform operational check.

END SYMPTOM

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Tilt Back Function Will Not Operate (Manual Valve)

POSSIBLE CAUSE

A. OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.
B. TILT BACK SPEED IS SET AT 0%.
C. CONTROL VALVE PISTON IS STUCK IN OPEN POSITION.

CAUSE A - OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate tilt back lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to Cause B.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Cause B.
   NO: Go to Seat Sensor Out of Range Low (OORL).

CAUSE B - TILT BACK SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of tilt hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to Cause C.

CAUSE C - CONTROL VALVE PISTON IS STUCK IN OPEN POSITION.

PROCEDURE OR ACTION:

1. Inspect control valve piston and exhaust orifices. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does the valve move freely and are exhaust orifices open?
   YES: Valve is OK. See Observed Symptoms-Gear Pump, Auxiliary Function is Slow or Does Not Function (Manual Valve), Page 9050-33-47.
   NO: Replace control valve piston.

END SYMPTOM

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Tilt Forward or Tilt Back Will Not Function When Activated (Manual Valve)

POSSIBLE CAUSE

A. OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.
B. TILT SPEED IS SET AT 0%.
C. TILT CONTROL VALVE IS STUCK IN CLOSED POSITION.
D. TILT CONTROL VALVE EXHAUST HOLES PLUGGED IN VALVE.

CAUSE A - OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate tilt forward/back lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to Cause B.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Cause B.
   NO: Go to Seat Sensor Out of Range Low (OORL).

CAUSE B - TILT SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of tilt hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to Cause C.

CAUSE C - TILT CONTROL VALVE IS STUCK IN CLOSED POSITION.

PROCEDURE OR ACTION:

1. Inspect tilt control valve and exhaust orifices. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does the control valve piston move freely and are exhaust orifices open?
   YES: Go to Cause D.
   NO: Clean or replace tilt control valve spool.

CAUSE D - TILT CONTROL VALVE EXHAUST HOLES PLUGGED IN VALVE.

PROCEDURE OR ACTION:

1. Inspect valve section. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Are exhaust holes open?
   YES: Valve is OK. See Observed Symptoms-Gear Pump, Auxiliary Function is Slow or Does Not Function (Manual Valve), Page 9050-33-47.
   NO: Clean or replace valve.

END SYMPTOM

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No Steering (All Other Hydraulic Functions OK)

POSSIBLE CAUSE

A. HYDRAULIC HOSES ARE NOT CONNECTED OR DAMAGED.
B. STEERING RELIEF VALVE IS SET TOO LOW.
C. TRANSAXLE/DRIVE UNIT IS BINDING.
D. PRIORITY FLOW DIVIDER VALVE IS CONTAMINATED.
E. STEERING CYLINDER PISTON SEALS ARE WORN OR DAMAGED.
F. SLEEVE AND SPOOL IN THE CONTROL UNIT WILL NOT MOVE.
G. STEERING CONTROL UNIT IS DAMAGED.

CAUSE A - HYDRAULIC HOSES ARE NOT CONNECTED OR DAMAGED.

PROCEDURE OR ACTION:

1. Look at Steering System component location drawing to identify steering hoses. Inspect hoses for wear, damage, and correct installation.
   Are steering hoses in good condition and installed correctly?
   YES: Go to Cause B.
   NO: Install new components as necessary.

CAUSE B - STEERING RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-14.
   Is steering relief pressure set too low?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to Cause C.

CAUSE C - TRANSAXLE/DRIVE UNIT IS BINDING.

PROCEDURE OR ACTION:

1. Inspect transaxle/drive unit for binding.
   Is transaxle/drive unit binding?
   YES: Replace transaxle/drive unit. Depending on your lift truck, see **Transaxle** 1300SRM1330 or **Transaxle** 1300SRM1370.
   NO: Go to Cause D.

CAUSE D - PRIORITY FLOW DIVIDER VALVE IS CONTAMINATED.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-8.
   Does priority flow divider valve pass the check?
   YES: Priority flow divider valve is OK. Go to Cause E.
   NO:
   - Cannot turn steering wheel, wheel locks up. Go to Cause F.
   - Steering wheel turns but fails Priority Valve Flow Divider Valve Check. Remove and clean flow divider spool. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

CAUSE E - STEERING CYLINDER PISTON SEALS ARE WORN OR DAMAGED.

PROCEDURE OR ACTION:

1. Do Steering Cylinder Leakage Test.

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Does steering cylinder pass leakage test?
YES: Cylinder is OK. Go to Cause G.
NO: Remove and repair steering cylinder. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering Axle** 1600SRM1360.

CAUSE F - SLEEVE AND SPOOL IN THE CONTROL UNIT WILL NOT MOVE.

PROCEDURE OR ACTION:

1. Turn steering wheel with engine running.
   Does steering wheel move?
   YES: Sleeve and spool are not seized. Go to Cause G.
   NO: Repair steering control unit. Replace components as required. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

CAUSE G - STEERING CONTROL UNIT IS DAMAGED.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Is steering control unit damaged?
   YES: Install new SCU. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.
   NO: Repair steering control unit. Replace components as required. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

END SYMPTOM

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Steering Is Slow or Difficult

POSSIBLE CAUSE

A. LOW PUMP FLOW.
B. STEERING RELIEF PRESSURE IS SET TOO LOW.
C. PRIORITY FLOW DIVIDER VALVE IS CONTAMINATED.
D. HYDRAULIC LINES ARE RESTRICTED.
E. SEAL IN THE STEERING CYLINDER LEAKS.
F. TRANSAXLE/DRIVE UNIT COMPONENTS ARE DAMAGED AND/OR BINDING.
G. SCU IS WORN, NOT ASSEMBLED CORRECTLY, OR DAMAGED.

CAUSE A - LOW PUMP FLOW.

PROCEDURE OR ACTION:

1. Do Hydraulic Pump Flow Test.
   Are other hydraulic functions OK?
   YES: Hydraulic pump output is OK. Go to Cause B.
   NO: Test hydraulic system relief pressure. See Primary Relief Valve Test and Adjustment.

CAUSE B - STEERING RELIEF PRESSURE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-14.
   Is steering relief pressure set too low?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to Cause C.

CAUSE C - PRIORITY FLOW DIVIDER VALVE IS CONTAMINATED.

PROCEDURE OR ACTION:

1. Perform Operational Check, seeOperational Diagnostic Procedures, Operational Checkout, Page 9010-05-8.
   Does priority flow divider valve pass check?
   YES: Priority flow divider valve is OK. Go to Cause D.
   NO:
   - Flow divider valve spool is stuck. Remove and clean flow divider spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   - LS signal pressure is leaking away. See Steering Control Unit LS Pressure Test.

CAUSE D - HYDRAULIC LINES ARE RESTRICTED.

PROCEDURE OR ACTION:

1. Look at Steering System component. Inspect hoses for wear, damage, and correct installation.
   Are steering hoses in good condition and correctly installed?
   YES: Go to Cause E.
   NO: Install new hoses as necessary.

CAUSE E - SEAL IN THE STEERING CYLINDER LEAKS.

PROCEDURE OR ACTION:

1. Perform Steering Cylinder Leakage Test.
   Does steering cylinder pass leakage test?
   YES: Cylinder is OK. Go to Cause F.

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NO: Remove and repair steering cylinder. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

CAUSE F - TRANSAXLE/DRIVE UNIT COMPONENTS ARE DAMAGED AND/OR BINDING.

PROCEDURE OR ACTION:

1. Turn steering wheel stop to stop in both directions while observing tires.
   Do tires shake or make noise while turning?
   YES: Inspect and repair damage transaxle/drive unit components. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   NO: Go to Cause G.

CAUSE G - SCU IS WORN, NOT ASSEMBLED CORRECTLY, OR DAMAGED.

PROCEDURE OR ACTION:

1. Inspect SCU. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is steering control unit damaged?
   YES: Install new SCU. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: See Observed Symptoms-Gear Pump, Steering Operation Is Not Smooth, Page 9050-33-60.

END SYMPTOM

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Steering Operation Is Not Smooth

POSSIBLE CAUSE

A. AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.
B. STEERING RELIEF PRESSURE SET TOO LOW.
C. HYDRAULIC STEER ACCUMULATOR IS NOT WORKING PROPERLY.
D. BINDING IN STEERING COLUMN.
E. LOW PUMP FLOW.
F. FAILED CENTERING SPRINGS IN SCU.
G. STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY, DAMAGED, OR CONTAMINATED.

CAUSE A - AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.

PROCEDURE OR ACTION:

1. Check service record of lift truck.
   Was hydraulic system repaired recently?
   YES: Check the repaired hose connections and remove air from system by cycling of steering cylinder full stroke in each direction.
   NO: Go to Cause B.

CAUSE B - STEERING RELIEF PRESSURE SET TOO LOW.

PROCEDURE OR ACTION:

1. Perform Operational Check, seeOperational Diagnostic Procedures, Operational Checkout, Page 9010-05-14.
   Is steering relief pressure set too low?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to Cause C.

CAUSE C - HYDRAULIC STEER ACCUMULATOR IS NOT WORKING PROPERLY.

PROCEDURE OR ACTION:

1. Turn steering wheel slowly while operating a mast function over relief, then suddenly release the control lever.
   Does steering wheel jerk abruptly?
   YES: Replace the steering accumulator. See **Hydraulic System** 1900SRM1367
   NO: Go to Cause D.

CAUSE D - BINDING IN STEERING COLUMN.

PROCEDURE OR ACTION:

1. Turn steering wheel stop to stop with engine running at slow idle.
   Is steering shaft binding in steering column?
   YES: Inspect and repair steering column. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   NO: Go to Cause E.

CAUSE E - LOW PUMP FLOW.

PROCEDURE OR ACTION:

1. Do Hydraulic Pump Flow Test.
   Are other hydraulic functions OK?
   YES: Hydraulic pump output is OK. Go to Cause F.
   NO: Test hydraulic system relief pressure. See Primary Relief Valve Test and Adjustment.

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CAUSE F - FAILED CENTERING SPRINGS IN SCU.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Are the centering springs in good condition?
   YES: Springs are OK. Go to Cause G.
   NO: Replace centering springs. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE G - STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY, DAMAGED, OR CONTAMINATED.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Is SCU properly assembled and clean?
   YES: Install new steering control unit. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Clean steering valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Steering Wheel End Lock Position Cannot Be Felt by Operator

POSSIBLE CAUSE

A. ANTI-KICKBACK VALVES ARE SAME PRESSURE SETTING AS RELIEF VALVE.
B. CONTAMINATION CAUSING IMPROPER SHOCK VALVE OPERATION.

CAUSE A - ANTI-KICKBACK VALVES ARE SAME PRESSURE SETTING AS RELIEF VALVE.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Are the anti-kickback valves in good condition?
   YES: Anti-kickback valves OK. Go to Cause B.
   NO: Replace anti-kickback valves. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE B - CONTAMINATION CAUSING IMPROPER SHOCK VALVE OPERATION.

PROCEDURE OR ACTION:

1. Inspect assembly of SCU.
   Is SCU properly assembled and clean?
   YES: Install new steering control unit. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Clean steering valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Steering Wheel Turns By Itself or Does Not Return To Neutral

POSSIBLE CAUSE

A. STEERING RELIEF PRESSURE SET TOO LOW.
B. BINDING IN STEERING COLUMN OR NO RESISTANCE.
C. FAILED CENTERING SPRINGS IN SCU.
D. DEFLECTION OF SPOOL AND SLEEVE CAUSED BY HIGH SYSTEM PRESSURE.
E. STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY OR IS DAMAGED.

CAUSE A - STEERING RELIEF PRESSURE SET TOO LOW.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-14.
   Is steering relief pressure set too low?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to Cause B.

CAUSE B - BINDING IN STEERING COLUMN OR NO RESISTANCE.

PROCEDURE OR ACTION:

1. Turn steering wheel stop to stop with engine running at slow idle.
   Is linkage binding in steering column?
   YES: Inspect and repair steering column. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   NO: Go to Cause C.

CAUSE C - FAILED CENTERING SPRINGS IN SCU.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Are the centering springs in good condition?
   YES: Springs are OK. Go to Cause D.
   NO: Replace centering springs. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE D - DEFLECTION OF SPOOL AND SLEEVE CAUSED BY HIGH SYSTEM PRESSURE.

PROCEDURE OR ACTION:

1. Perform Steering Relief Pressure Test and Adjustment.
   Does steering relief pass check?
   YES: Go to Cause E.
   NO: Adjust relief pressure. See Steering Relief Pressure Test and Adjustment.

CAUSE E - STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY OR IS DAMAGED.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Is SCU properly assembled and clean?
   YES: Install new steering control unit. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

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NO: Clean steering valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Steering Wheel Turns the Tires in the Wrong Direction

POSSIBLE CAUSE

A. HYDRAULIC HOSES ARE NOT CONNECTED CORRECTLY AT THE STEERING CYLINDER OR AT THE SCU.

CAUSE A - HYDRAULIC HOSES ARE NOT CONNECTED CORRECTLY AT THE STEERING CYLINDER OR AT THE SCU.

PROCEDURE OR ACTION:

1. Look at Steering System component to identify steering hoses.
   Are hoses correctly installed?
   YES: Problem is in SCU. Repair or replace SCU. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Correct steering hose routing at valve or steering cylinder.

END SYMPTOM

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Actuations Do Not Act Simultaneously

POSSIBLE CAUSE

A. LOW PUMP FLOW.
B. SECONDARY RELIEF VALVE SET TOO LOW.

CAUSE A - LOW PUMP FLOW.

PROCEDURE OR ACTION:

1. Check cycle times of lift function.
   Is lift function speed ok?
   YES: Go to Cause B.
   NO: Go to Observed Symptoms-Gear Pump, Abnormal Hydraulic Noise and/or Vibration, Page 9050-33-1.

CAUSE B - SECONDARY RELIEF VALVE SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust secondary relief pressure. See Secondary Relief Valve Test and Adjustment.

END SYMPTOM

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Oil Leaking/Component Life Too Short

POSSIBLE CAUSE

A. HYDRAULIC OIL TANK IS OVERFILLED.
B. LOOSE OR DAMAGED HARDWARE.
C. DAMAGED O-RING/ROD SEAL.
D. HYDRAULIC RELIEF PRESSURES SET TOO HIGH.
E. HYDRAULIC FLUID CONTAMINATED OR WRONG TYPE.
F. EXCESSIVE DEBRIS IN HYDRAULIC CIRCUIT.
G. HYDRAULIC OIL TANK OPEN TO ATMOSPHERE.
H. HYDRAULICS OPERATED ABOVE RECOMMENDED OPERATING RANGE.
I. WARPED COMPONENT SECTION OF HYDRAULIC CONTROL VALVE.
J. SEALS BETWEEN VALVE SECTIONS FAILED

CAUSE A - HYDRAULIC OIL TANK IS OVERFILLED.

PROCEDURE OR ACTION:

1. Check to see if hydraulic oil tank is overfilled.
   Is hydraulic oil tank overfilled?
   YES: Drain hydraulic oil to proper level.
   NO: Go to Cause B.

CAUSE B - LOOSE OR DAMAGED HARDWARE.

PROCEDURE OR ACTION:

1. Locate source of oil leak by checking the following items. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   - Check torque on fittings.
   - Check torque on tie rod at valve outlet housing.
   - Check torque on hardware between SCU and valve.

   Did leak stop after checking hardware?
   YES: Problem solved.
   NO: Go to Cause C.

CAUSE C - DAMAGED O-RING/ROD SEAL.

PROCEDURE OR ACTION:

1. Replace damaged O-ring or rod seal. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is problem fixed?
   YES: Problem solved.
   NO: Go to Cause D.

CAUSE D - HYDRAULIC RELIEF PRESSURES SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check main and secondary relief pressures. Go to Primary Relief Valve Test and Adjustment.
   Does relief pressure meet specifications?
   YES: Go to Cause E.
   NO: Adjust or replace relief valve.

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CAUSE E - HYDRAULIC FLUID CONTAMINATED OR WRONG TYPE.

PROCEDURE OR ACTION:

1. Check hydraulic oil for contamination and correct type.
   Is hydraulic oil contaminated or incorrect type used?
   YES: Drain and refill hydraulic tank. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to Cause F.

CAUSE F - EXCESSIVE DEBRIS IN HYDRAULIC CIRCUIT.

PROCEDURE OR ACTION:

1. Check for plugged and bypassing hydraulic oil filter.
   Is hydraulic oil filter plugged and bypassing?
   YES: Clean or replace hydraulic oil filter.
   NO: Go to Step 2.
2. Check for contaminated oil.
   Is hydraulic oil contaminated?
   YES: Drain and refill hydraulic tank. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to Cause G.

CAUSE G - HYDRAULIC OIL TANK OPEN TO ATMOSPHERE.

PROCEDURE OR ACTION:

1. Check hydraulic oil tank for missing breather or missing dipstick.
   Is breather or dipstick missing from hydraulic oil tank?
   YES: Replace breather or dipstick.
   NO: Go to Cause H.

CAUSE H - HYDRAULICS OPERATED ABOVE RECOMMENDED OPERATING RANGE.

PROCEDURE OR ACTION:

NOTE: If lift truck is equipped with Hydraulic Oil Cooler, see Observed Symptoms-Gear Pump, Page 9050-33-16.

1. Inspect hydraulic components and oil for signs of excessive heat.
   Do components and oil show signs of overheating?
   YES: Replace damaged components and service hydraulic system. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to Cause I.

CAUSE I - WARPED COMPONENT SECTION OF HYDRAULIC CONTROL VALVE.

PROCEDURE OR ACTION:

1. Check hydraulic control valve for warped component section.
   Does hydraulic control valve have warped component section?
   YES: Replace hydraulic control valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Go to Cause J.

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CAUSE J - SEALS BETWEEN VALVE SECTIONS FAILED

PROCEDURE OR ACTION:

1. Check hydraulic control valve for oil leakage between valve sections.
   Is oil leaking between valve sections?
   YES: Replace seals between valve sections. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Seals between valve sections OK.

END SYMPTOM

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Abnormal Steer Axle Noise

POSSIBLE CAUSE

A. WHEEL IS LOOSE.
B. STEER WHEEL CONTACTING STEERING AXLE OR CHASSIS.
C. TIE ROD AND/OR BUSHINGS ARE WORN.
D. WHEEL OR SPINDLE BEARING LUBRICATION IS INADEQUATE.
E. WHEEL OR SPINDLE BEARING FAILURE.
F. STEERING AXLE BUSHINGS WORN.
G. STEERING AXLE DAMAGED.

CAUSE A - WHEEL IS LOOSE.

PROCEDURE OR ACTION:

1. Inspect wheels, lug nuts, and studs for damage.
   Are wheels, lug nuts, and studs damaged or loose?
   YES: If loose, tighten wheel lugs. Repair or replace damaged parts.Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to Cause B.

CAUSE B - STEER WHEEL CONTACTING STEERING AXLE OR CHASSIS.

PROCEDURE OR ACTION:

1. Inspect steer wheels, steering axle, and chassis.
   Are wheels contacting steering axle or chassis?
   YES: Repair or replace steer wheel or steering axle, or repair chassis. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   NO: Go to Cause C.

CAUSE C - TIE ROD AND/OR BUSHINGS ARE WORN.

PROCEDURE OR ACTION:

1. Inspect tie rod and bushing.
   Are tie rods and bushing in good condition?
   YES: Go to Cause D.
   NO: Repair or adjust tie rods or bushings. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

CAUSE D - WHEEL OR SPINDLE BEARING LUBRICATION IS INADEQUATE.

NOTE: See **Operating Manual** for lubrication procedures.

PROCEDURE OR ACTION:

1. Lubricate wheel and spindle bearings.
   Did the bearings lack lubrication?
   YES: Service lift truck per **Operating Manual** instructions.
   NO: Go to Cause E.

CAUSE E - WHEEL OR SPINDLE BEARING FAILURE.

PROCEDURE OR ACTION:

1. Inspect bearings and spindle.

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Are the bearings and spindle in good condition?
YES: If bearings are OK, go to Cause F.
NO: Replace bearings and/or spindle. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

CAUSE F - STEERING AXLE BUSHINGS WORN.

PROCEDURE OR ACTION:

1. Inspect steering axle bushings for wear. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   Are the steering axle bushings in good condition?
   YES: Go to Cause G.
   NO: Replace bushings.

CAUSE G - STEERING AXLE DAMAGED.

PROCEDURE OR ACTION:

1. Inspect steering axle for damage.
   Is steering axle in good condition?
   YES: Resume operation while monitoring systems to locate source of noise.
   NO: Repair as required. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

END SYMPTOM

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Abnormal Steering Wheel Vibration

POSSIBLE CAUSE

A. WORN TIRES.
B. LOW OIL LEVEL IN TANK.
C. AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.
D. STEERING AXLE COMPONENTS WORN.

CAUSE A - WORN TIRES.

PROCEDURE OR ACTION:

1. Inspect tires.
   Are tires worn?
   YES: Replace tires. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to Cause B.

CAUSE B - LOW OIL LEVEL IN TANK.

PROCEDURE OR ACTION:

NOTE: Cavitation of a hydraulic pump will cause noise and it is caused by air in the hydraulic oil. The hydraulic pump suction oil must be free of air and unrestricted to pump.

1. Check hydraulic oil level in tank.
   Is oil at correct level?
   YES: Go to Cause C.
   NO: Add oil to correct level. See **Operating Manual**.

CAUSE C - AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.

PROCEDURE OR ACTION:

1. Check service record of lift truck.
   Was hydraulic system repaired recently?
   YES: Check the repaired hose connections. Remove air from system by cycling function full stroke of steering cylinder in each direction.
   NO: Go to Cause D.

CAUSE D - STEERING AXLE COMPONENTS WORN.

PROCEDURE OR ACTION:

1. Operate truck to determine if vibration is hydraulic or mechanical.
   Is the vibration caused by hydraulics?
   YES: See Observed Symptoms-Gear Pump, Abnormal Hydraulic Noise and/or Vibration, Page 9050-33-1.
   NO: Repair or replace worn or damaged steer axle components. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

END SYMPTOM

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Back Lash/Kick Back in Steering Wheel

POSSIBLE CAUSE

A. LOOSE STEERING AXLE COMPONENTS.
B. SPLINES OR STEERING SHAFT UNIVERSAL JOINT IN STEERING COLUMN WORN OR BROKEN.
C. STEERING RELIEF PRESSURE IS NOT SET CORRECTLY.
D. FAILED CENTERING SPRINGS IN SCU.
E. STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY OR IS DAMAGED.

CAUSE A - LOOSE STEERING AXLE COMPONENTS.

PROCEDURE OR ACTION:

1. Turn steering wheel back and forth while observing steer axle wheels at slow idle.
   Do the tires respond directly to steering wheel movement?
   YES: Go to Cause B.
   NO: Inspect wheel studs and steering axle components for damage. Repair as required. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering Axle** 1600SRM1360.

CAUSE B - SPLINES OR STEERING SHAFT UNIVERSAL JOINT IN STEERING COLUMN WORN OR BROKEN.

PROCEDURE OR ACTION:

1. Turn steering wheel back and forth while observing steer axle wheels at slow idle.
   Does the steer axle wheels movement match steering wheel movement in both directions?
   YES: Go to Cause C.
   NO: Inspect and repair steering column. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

CAUSE C - STEERING RELIEF PRESSURE IS NOT SET CORRECTLY.

PROCEDURE OR ACTION:

1. Do steering relief pressure test.
   Is steering relief pressure set to specification?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to Cause D.

CAUSE D - FAILED CENTERING SPRINGS IN SCU.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Are the centering springs in good condition?
   YES: Springs are OK. Go to Cause E.
   NO: Replace centering springs. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

CAUSE E - STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY OR IS DAMAGED.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Is SCU properly assembled and clean?
   YES: Replace the SCU. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

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NO: Repair steering control unit. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

END SYMPTOM

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Group 43

Tests and Adjustments-Gear Pump

Hydraulic Warm-up Procedure

Use this procedure to get the hydraulic oil temperature to test specification. Install the test equipment on lift truck before starting this procedure to reduce handling of hot component or oil.

Table 9050-43-1. Test Specifications

Oil Temperature	50 - 65°C (122 - 150 °F)

Table 9050-43-2. Service Tools

Temperature Reader - Thermocouple

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing or installing test equipment.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

1. Install test equipment as called out in test.
2. Insert thermocouple in dipstick hole.
3. Turn key or keyless switch to the **ON** position.
4. Tilt the mast back and hold over relief for 20 seconds, then release lever. Cycle both tilt and lift cylinders to circulate oil and equalize temperature in system.
5. Read temperature and compare to temperature specifications of test to be performed.
6. Repeat Step 4 and Step 5 until oil temperature is at test specifications.

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Primary Relief Valve Test and Adjustment

CAUTION

Typically, the Main Relief Valve (MRV) should NOT be adjusted in the field for general purposes. Increasing the setting of the MRV past its specified setting may damage truck.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

1. Lower forks to ground and turn **OFF** key. Apply park brake.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Remove panels that cover MRV. Remove cover from diagnostic port and install pressure gauge. See Figure 9050-43-42, Figure 9050-43-43 and Figure 9050-43-45.
3. Operate the hydraulic system until the oil temperature is at test specifications. See Hydraulic Warm-up Procedure.

WARNING

Forks contacting overhead electrical wires or fixtures can cause serious injury or death. Make sure area is clear of hazards before raising forks to maximum height.

4. Raise the mast until it stops. Hold the lever and check the reading of the gauge when the relief valve opens. Compare to specifications.
5. Replace primary relief valve, if not within specification, by unscrewing the relief cartridge from the inlet section and installing a new relief cartridge.
6. Cycle lever over relief to verify the setting is within specification. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439. .
7. Remove test equipment and reinstall cap onto diagnostic port.

Table 9050-43-3. Service Tools

275 - 345 MPa (4000 - 5000 psi) Pressure Gauge	
Excess Flow (EF) Test Plug Port Size	SAE #4 O-ring Port (7/16-20 UNF)

Table 9050-43-4. Test Specifications

Lift Truck	Capacity	Main Relief Pressure	Pump Flow
J1.5-2.0XNT (J30-40XNT) (K160)	1.5-2.0 Tons	17.9 MPa (2596 psi)	63.6 liter/min (16.8 gal/min)
A1.3-1.5XNT (A25-30XNT) (D203 E2.2-3.5XN (E45-70XN) (A268) J2.2-3.5XN (J40-70XN) (A276)	2.2-2.75 Tons	21.9 MPa (3176 psi)	81.4 liter/min (21.5 gal/min)
E2.2-3.5XN (E45-70XN) (A268) J2.2-3.5XN (J40-70XN) (A276)	3.0-3.5 Tons	23.9 MPa (3466 psi)	81.4 liter/min (21.5 gal/min)

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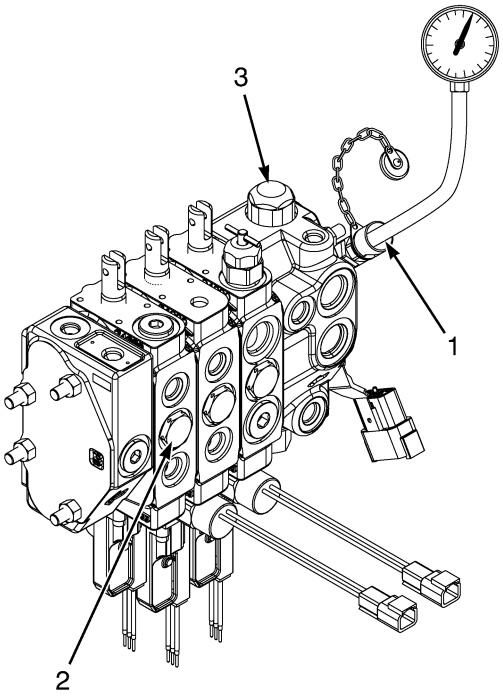


1. DIAGNOSTIC PORT WITH GAUGE
2. OPTIONAL SECONDARY RELIEF VALVE LOCATION
3. PRIMARY RELIEF VALVE LOCATION

Figure 9050-43-42. Manual Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) Shown

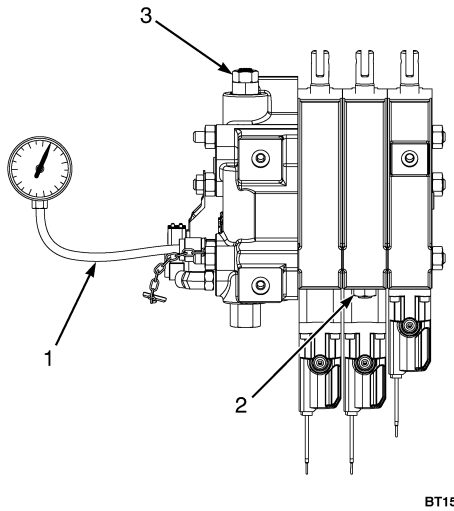
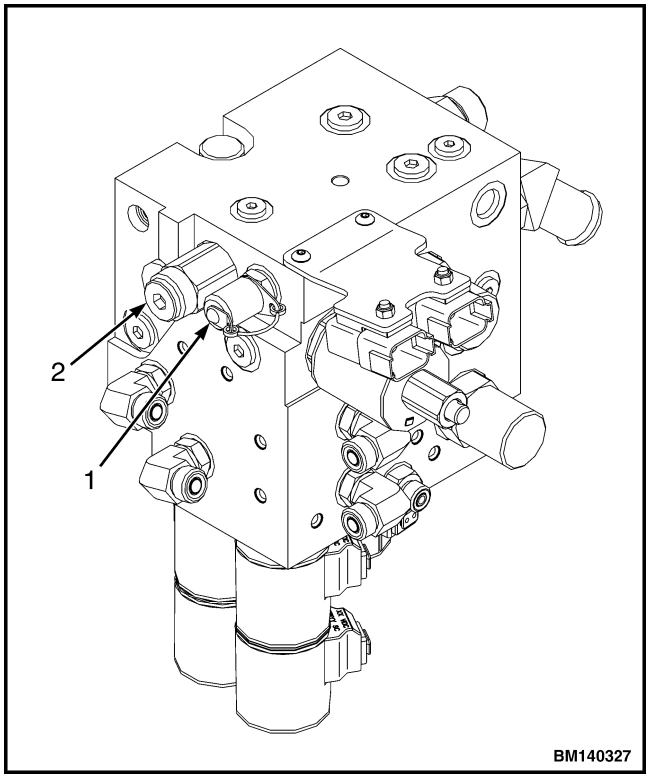


Figure 9050-43-43. Manual Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276) Shown

Legend for Figure 9050-43-43

1. DIAGNOSTIC PORT WITH GAUGE
2. SECONDARY RELIEF VALVE LOCATION
3. PRIMARY RELIEF VALVE LOCATION



1. DIAGNOSTIC FITTING WITH CAP
2. PRIMARY RELIEF VALVE

Figure 9050-43-44. E-Hydraulic Valve for Lift Trucks A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203]

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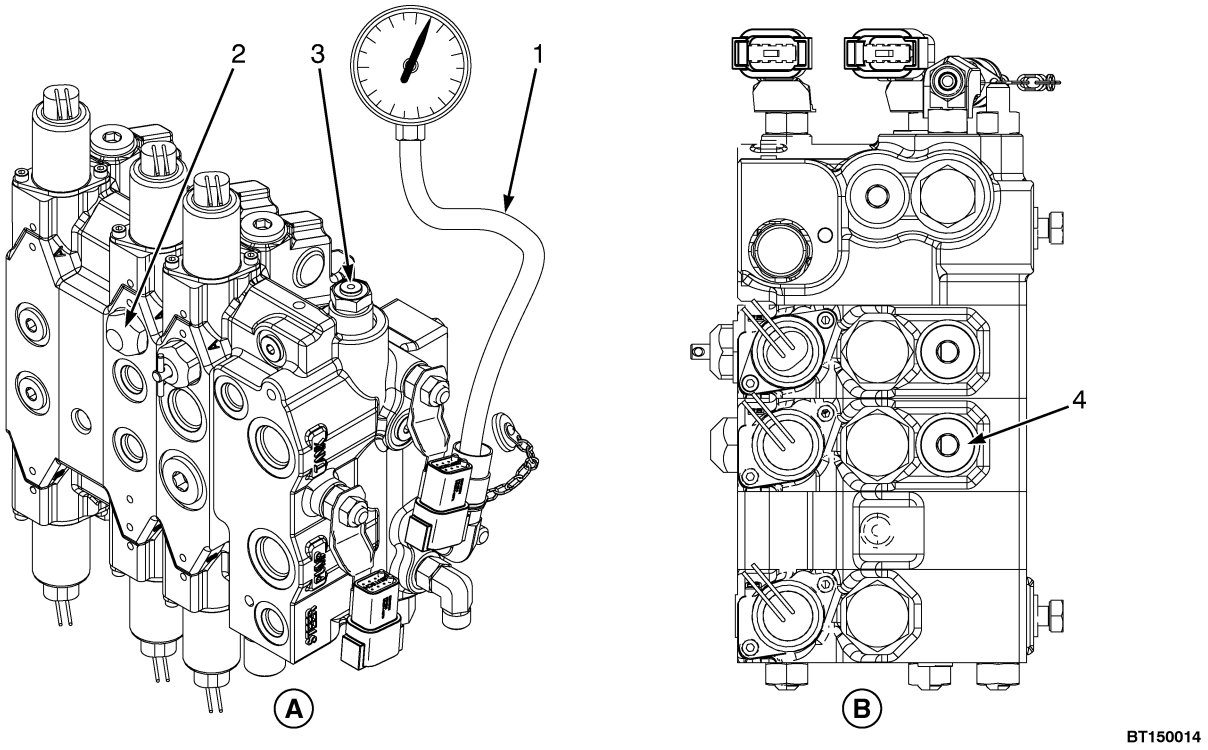

A. FRONT VIEW

1. DIAGNOSTIC PORT WITH GAUGE
2. ANTI-CAVITATION CHECK

B. BOTTOM VIEW

3. PRIMARY RELIEF VALVE LOCATION
4. SECONDARY RELIEF VALVE LOCATION

Figure 9050-43-45. E-Hydraulic Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (A935), E2.2-3.5XN (E45-70XN) (A268), and J2.2-3.5XN (J40-70XN) (A276) Shown

Secondary Relief Valve Test and Adjustment

It may be necessary to adjust the setting of the Optional Relief Valve (ORV) depending on what attachments are used for the auxiliary function.

NOTE: The Relief Pressure setting is the working range that the secondary relief can be set to meet requirements of attachments.

The Factory Default setting is the pressure that the secondary relief is set at the factory.

NOTE: Secondary relief valves for manual control valves on lift trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) are installed into auxiliary sections for special attachments. Standard relief pressure for these lift trucks is set with primary relief valve only.

Table 9050-43-5. Test Specifications for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)

Oil Temperature	50 - 65°C (122 - 150 °F)
Secondary Relief Pressure	17.9 MPa (2596 psi)
Factory Default Setting	15.0 - 16.0 MPa (2180 - 2320 psi)

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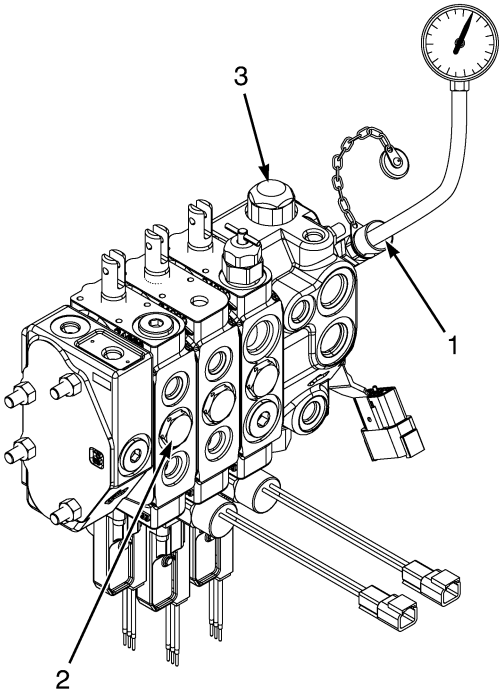
Table 9050-43-6. Test Specifications for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)

Oil Temperature	50 - 65°C (122 - 150 °F)
Secondary Relief Valve Setting	15.0 - 16.0 MPa (2180 - 2320 psi)
Factory Default Setting	15.0 - 16.0 MPa (2180 - 2320 psi)

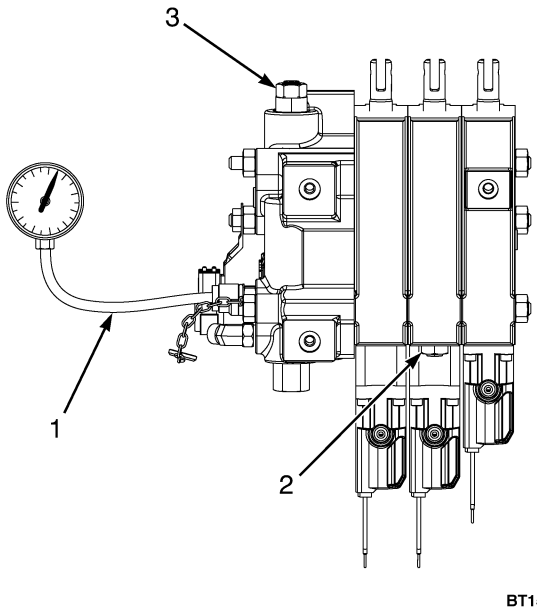
Table 9050-43-7. Service Tools

0 - 35.0 MPa (0 - 5000 psi) Pressure Gauge	
Excess Flow (EF) Test Port Plug Size	SAE #4 O-ring Port (7/16-20 UNF)



1. DIAGNOSTIC PORT WITH GAUGE
2. OPTIONAL SECONDARY RELIEF VALVE LOCATION
3. PRIMARY RELIEF VALVE LOCATION

Figure 9050-43-46. Manual Control Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) Shown



1. DIAGNOSTIC PORT WITH GAUGE
2. SECONDARY RELIEF VALVE LOCATION
3. PRIMARY RELIEF VALVE LOCATION

Figure 9050-43-47. Manual Control Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276) Shown

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

1. Lower forks to ground and turn key or keyless switch to **OFF** position. Apply park brake.

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CAUTION

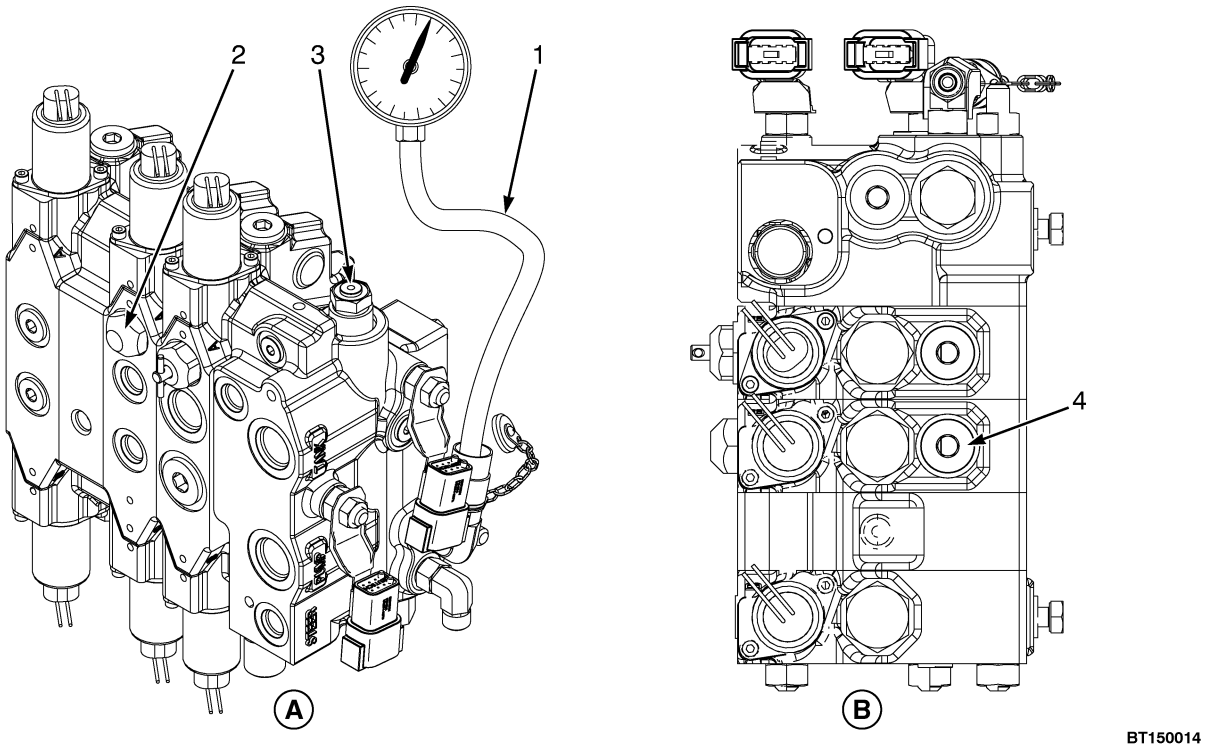
Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Remove covers. Install pressure gauge in control valve diagnostic port. See Figure 9050-43-46.

CAUTION

Setting relief valve above specification can cause damage to hydraulic and mechanical components of lift truck. Do not increase pressure above specifications.

3. Operate the hydraulic system until the oil temperature is at test specifications. See Hydraulic Warm-up Procedure.



A. FRONT VIEW

1. DIAGNOSTIC PORT WITH GAUGE
2. ANTI-CAVITATION CHECK
3. PRIMARY RELIEF VALVE LOCATION

B. BOTTOM VIEW

4. OPTIONAL SECONDARY RELIEF VALVE LOCATION

Figure 9050-43-48. E-Hydraulic Control Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) , J1.6-2.0XN (A935) Shown

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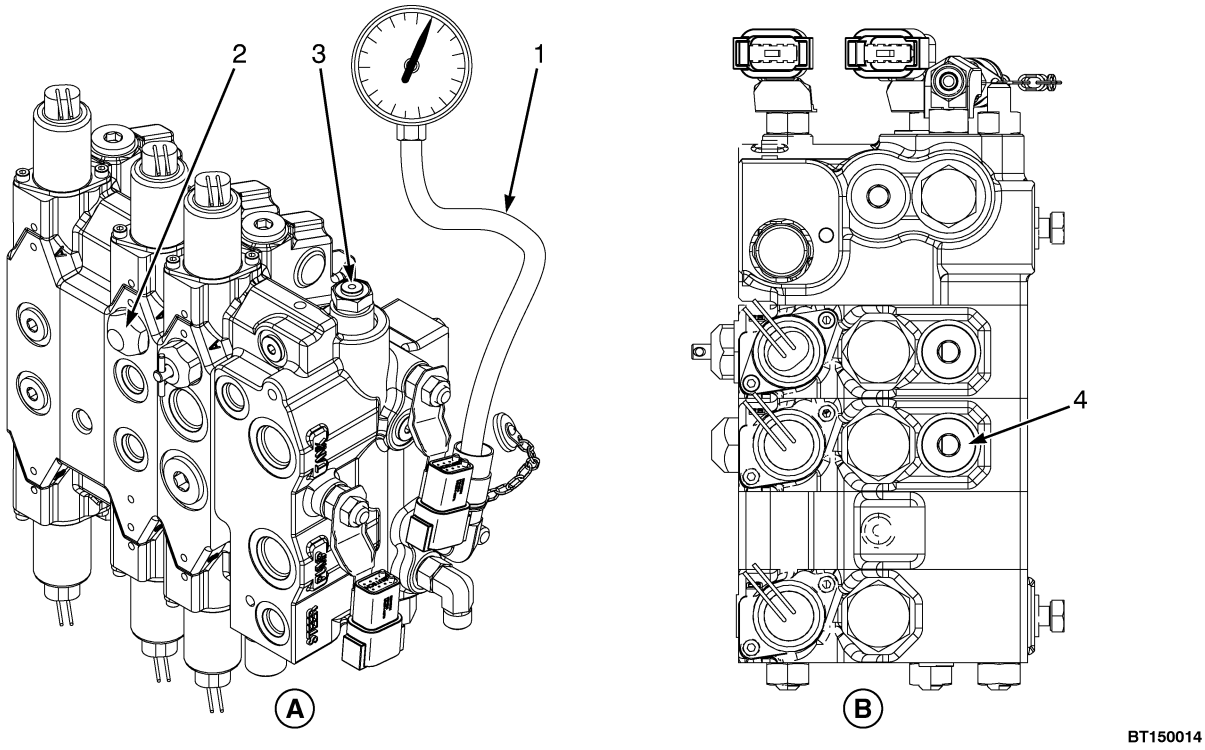

A. FRONT VIEW

1. DIAGNOSTIC PORT WITH GAUGE
2. ANTI-CAVITATION CHECK

B. BOTTOM VIEW

3. PRIMARY RELIEF VALVE LOCATION
4. SECONDARY RELIEF VALVE LOCATION

Figure 9050-43-49. E-Hydraulic Control Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) , and J2.2-3.5XN (J40-70XN) (A276) Shown

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4. Tilt the mast back until it stops. Hold the lever and check the reading of the gauge when the relief valve opens. Compare to test specifications.

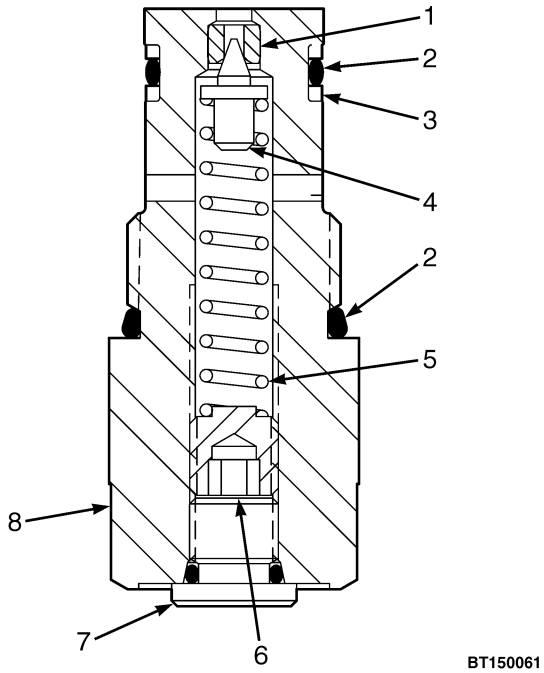
NOTE: Cycling the tilt or auxiliary function over relief after adjustment gives the relief valve spring opportunity to reposition itself inside the valve. This must be done after each adjustment until pressure is repeatable on gauge.

5. If pressure is not within specifications, remove hex plug (see Figure 9050-43-50), while holding tilt hydraulics over relief, slowly turn the adjustment screw, in (clockwise) to increase pressure, out (counterclockwise) to reduce pressure. Cycle the tilt or auxiliary control lever on and off against the relief three times to see if pressure is repeatable.

6. Insert hex plug. Cycle lever over relief a few more times to verify the setting is still correct. If setting does not stabilize, clean or replace relief valve. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

7. If relief pressure cannot be maintained or adjusted up, the control valve may have contamination or have excess leakage in Load Sense (LS) circuit. See Main Control Valve LS Leakage Test (E-Valve).

8. Remove test equipment and reinstall diagnostic port cap.



1. SEAT
2. O-RING
3. BACKUP RING
4. POPPET
5. SPRING
6. ADJUSTMENT SCREW
7. HEX PLUG
8. RELIEF CARTRIDGE

Figure 9050-43-50. Optional/Secondary Relief Valve

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Hydraulic Pump Flow Test

This test is done to accurately check the hydraulic pump output. This will isolate if performance problems are in hydraulic pump or elsewhere in hydraulic circuit.

NOTE: If a flowmeter is not available, use lift speed charts. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442. to determine pump output. If lift raise times with capacity load on forks is more than 25% greater than specifications, the pump should be replaced.

1. Lower forks to ground and turn key or keyless switch to the **OFF** position. Apply park brake.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Remove floor panels. Remove hose assembly to hydraulic pump and install flowmeter. Install hose assembly from flow meter to hydraulic pump. Install pressure gauge to the diagnostic port of control valve if flowmeter does not have internal gauge. See Figure 9050-43-51.

CAUTION

Hydraulic pump will be damaged if flowmeter gate valve is closed. Open the gate valve all the way open (counterclockwise) on the flowmeter before running lift truck.

3. Operate the hydraulic system until the oil temperature is to test specifications. See Hydraulic Warm-up Procedure.
4. Raise empty mast and hold over relief, record pump flow. Compare pump flow to specifications.
5. Return forks to ground level and turn key or keyless switch to **OFF** position.

NOTE: A collapsed suction hose or plugged suction screen in hydraulic tank could affect pump flow. Be sure to check these components before replacing pump.

6. If the flow is less than the specifications, inspect suction hoses to pump and suction screen in hydraulic tank. If they are OK then replace pump. Depending on your lift truck, see **Hydraulic System** 1900SRM1367, or **Hydraulic System** 1900SRM1333.
7. Remove test equipment, reinstall hoses and floor panel.

Table 9050-43-8. Test Specifications

Oil Temperature	50 - 65°C (122 - 150 °F)
Minimum Pump Output for Lift Truck J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)	**Pump:** 63.6 liter/min (16.8 gal/min)
Minimum Pump Output for Lift Truck E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)	**Pump:** 81.4 liter/min (21.5 gal/min)
Excess Flow (EF) Test Pressure	Tilt Function Over Relief (Optional/Secondary Relief Valve Setting)

Table 9050-43-9. Service Tools

125 liter/min (33 gal/min) Flowmeter, Rated at 24.0 MPa (3500 psi)	
0 - 35.0 MPa (0 - 5000 psi) Pressure Gauge	
Excess Flow (EF) Test Port Plug Size	SAE #4 O-ring Port (7/16-20 UNF)
Steering Control Valve Inlet Port Size	SAE #12 O-ring Port (1-1/16-12 UNF)

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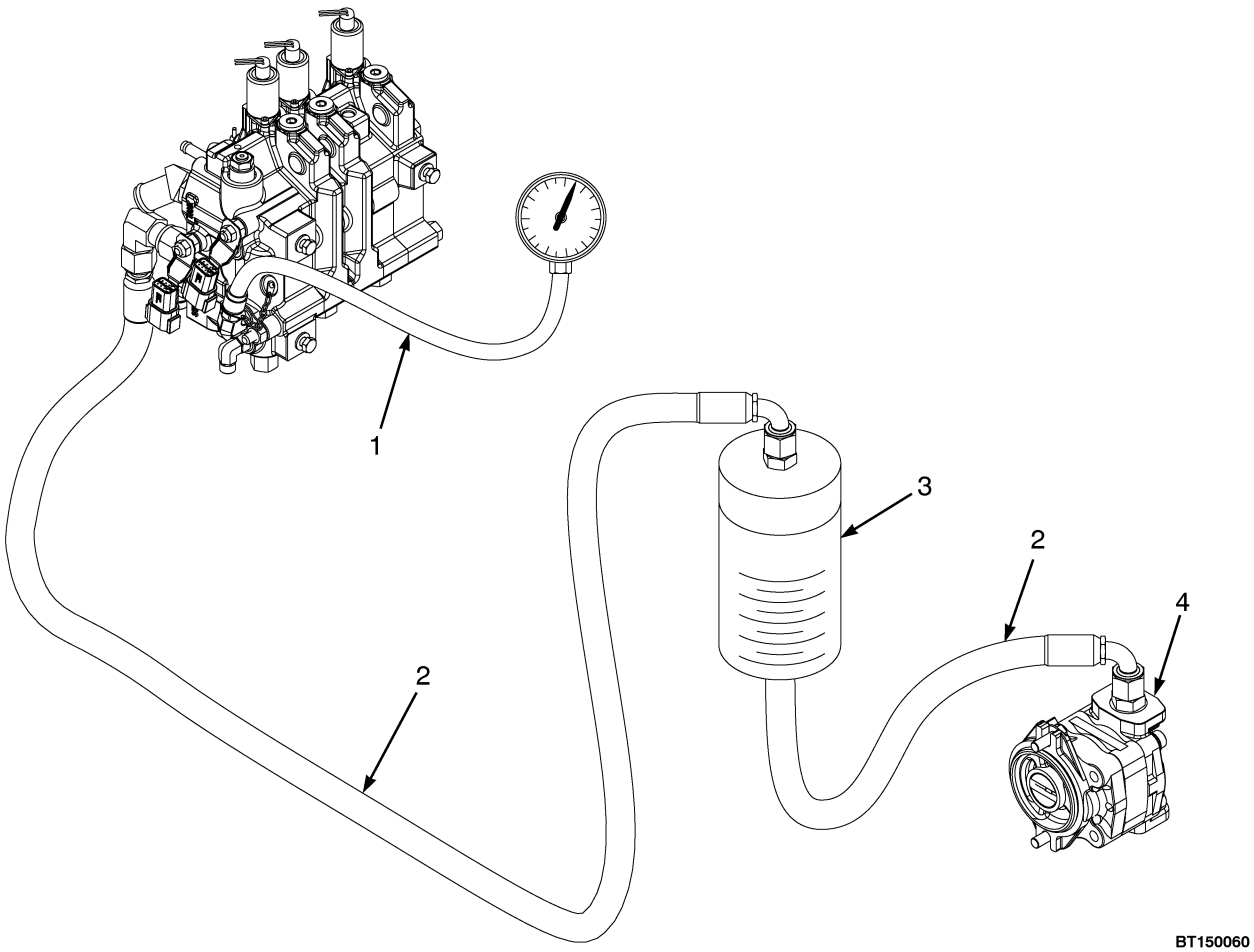
8. Check oil level in hydraulic tank. Add oil, as required.



NOTE: CONTROL VALVE SHOWN IS FOR LIFT TRUCKS J1.5-2.0XNT (J30-40XNT) (K160) AND J1.6-2.0XN (A935) .

1. DIAGNOSTIC PORT WITH GAUGE
2. HOSE ASSEMBLY
3. FLOWMETER
4. HYDRAULIC PUMP

Figure 9050-43-51. E-Hydraulic Pump Shown

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Main Control Valve LS Leakage Test (E-Valve)

This test is done to check if there is leakage in the Load-Sense (LS) pressure circuit.

Table 9050-43-10. Test Specifications

Oil Temperature	50 - 65°C (122 - 150 °F)

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

1. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure. Operate until temperature is at test specifications.
2. Turn key or keyless switch to **ON** position and apply park brake.
3. Measure and record the lift rate with lift lever fully actuated at:
   - No Load
   - Rated Load
4. If the difference from specified rates in chart, it is likely that the LS passage has an internal leakage within the monoblock section. Replace the valve monoblock section. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

Main Control Valve Unloader Margin Test

This test is done to check if unloader pressure margin is within test specification.

1. Lower forks to ground, turn key or keyless switch to **OFF** position, and apply park brake.
2. Remove floor plates that cover main control valve.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

3. Install a hose in load sense port and the other hose in the reduced pressure port on the control valve. See Figure 9050-43-52.

NOTE: Test gauges must be calibrated. Gauge accuracy is very important for this test. A pressure differential gauge or switching block should be used so both readings are on same gauge. If you do not have this equipment, you will need to switch gauges to verify gauge readings.

4. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure. Operate until temperature is at test specifications.

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Table 9050-43-11. Test Specifications

Oil Temperature	50 to 65°C (122 to 150 °F)
Maximum Unloader Pressure Margin	1034 to 1138 kPa (150 to 165 psi)
Flow Rate	For [A268], E2.2-3.5XN (E45-70XN): **Primary Pump:** 81.4 liter/min (21.5 gal/min) For [A276], J2.2-3.5XN (J40-70XN): **Primary Pump:** 81.4 liter/min (21.5 gal/min) For [K160], J1.5-2.0XNT (J30-40XNT): **Primary Pump:** 63.6 liter/min (16.8 gal/min) For [A935], J1.6-2.0XN: **Primary Pump:** 63.6 liter/min (16.8 gal/min)

Table 9050-43-12. Service Tools

0-3450 kPa (0-500 psi) Pressure Gauge

5. Measure pressure. If the pressure margin is below specification, go to Step 6.
6. If the pressure margin is below specification, proceed as follows:
   - Remove unloader spool and check for a broken spring or contamination. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
   - Check main relief valve for contamination or broken spring. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
7. If actions performed in Step 6 do not solve the problem, replace hydraulic control valve inlet section. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
8. Remove test equipment and reinstall plugs in control valve.

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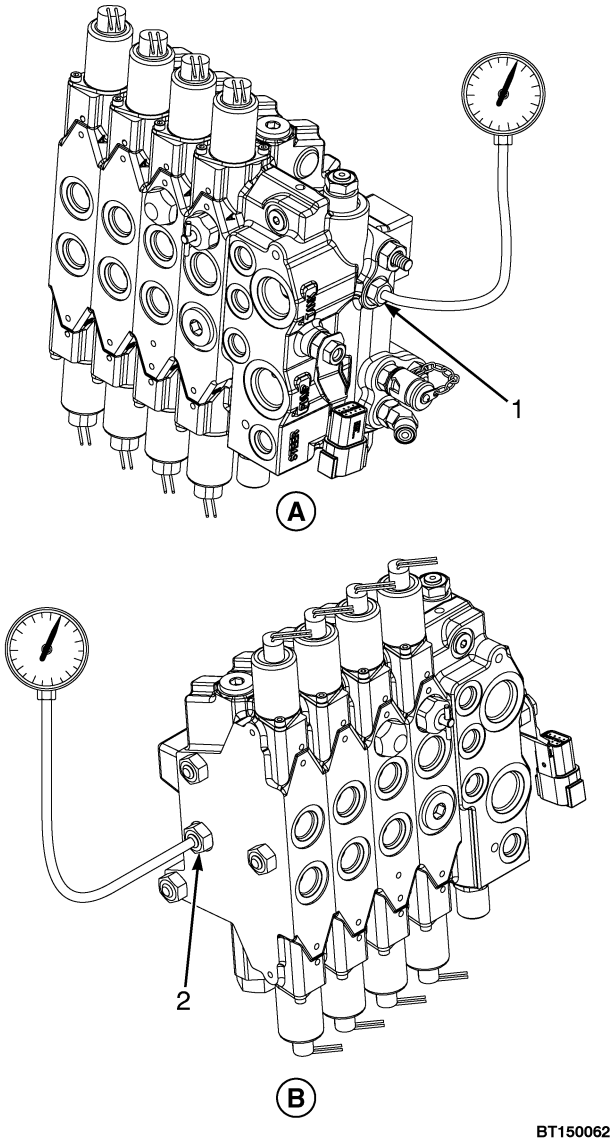

Figure 9050-43-52. Unloader Valve Test Setup

Legend for Figure 9050-43-52

NOTE: E-HYDRAULIC CONTROL VALVE FOR LIFT TRUCKS E2.2-3.5XN (E45-70XN) (A268) AND J2.2-3.5XN (J40-70XN) (A276) SHOWN.

A. LEFT VIEW
B. RIGHT VIEW

1. LOAD SENSE PORT WITH GAUGE
2. REDUCED PRESSURE PORT WITH GAUGE

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E-Hydraulic Valve Leakage Test

This test is to determine if the E-Hydraulic Valve spool is damaged or if there is internal leakage between the section housing and the spool. This test should only be performed after doing the Lift Cylinder Leakage Test and leakage has been diagnosed to be in control valve.

1. Lower forks to ground, turn key or keyless switch to **ON** position and apply park brake.
2. Remove floor mats and floor plates.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing EHPV assembly.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

3. Ensure that tank port is connected to the return line.

NOTE: Purge cool oil out of leakage hose until oil is 42°C (108°F) before connecting to the first work port.

NOTE: Work port leakage for port 1A must exceed 10 cc/min and ports 2A, 2B, 3A, 3B, 4A, and 4B must exceed 4 cc/min.

4. Connect "leakage" supply hose to each individual work port while spools are in neutral.
5. Operate hydraulic functions, read the pressure and compare to specifications. Disconnect "leakage" supply hose from work port.
6. Repeat Step 4 and Step 5 for each work port.
7. If the pressure is not within specification, replace control valve section. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
8. Install floor plates and floor mats.
9. Lower forks to ground, turn key or keyless switch to **OFF** position and apply park brake.

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Table 9050-43-13. Test Specifications

Oil Temperature	42°C (108°F) or Higher		
Maximum Leakage			
For J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) with 3-Function Control Valve	1A Port: 16.6 cc/min @ 16.8 MPa (2450 psi)	2A or 2B Port: 12.2 cc/min @ 6.8 MPa (1000 psi)	3A or 3B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) with 4-Function Control Valve	1A Port: 16.6 cc/min @ 16.8 MPa (2450 psi)	2A or 2B Port: 12.2 cc/min @ 6.8 MPa (1000 psi)	3A, 3B, 4A, or 4B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For E2.2-3.0XN (E45-60XN) (A268) J2.2-3.0XN (J40-60XN) (A276) with 3-Function Control Valve	1A Port: 18.6 cc/min @ 19.6 MPa (2850 psi)	2A or 2B Port: 22.0 cc/min @ 8.2 MPa (1200 psi)	3A or 3B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For E2.2-3.0XN (E45-60XN) (A268) J2.2-3.0XN (J40-60XN) (A276) with 4-Function Control Valve	1A Port: 18.6 cc/min @ 19.6 MPa (2850 psi)	2A or 2B Port: 22.0 cc/min @ 8.2 MPa (1200 psi)	3A, 3B, 4A, or 4B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For E3.0-3.5XN (E60-70XN) (A268) J3.0-3.5XN (J60-70XN) (A276) with 3-Function Control Valve	1A Port: 21.1 cc/min @ 21.3 MPa (3100 psi)	2A or 2B Port: 22.0 cc/min @ 8.2 MPa (1200 psi)	3A or 3B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For E3.0-3.5XN (E60-70XN) (A268) J. 30-3.5XN (J60-70XN) (A276) with 4-Function Control Valve	1A Port: 21.1 cc/min @ 21.3 MPa (3100 psi)	2A or 2B Port: 22.0 cc/min @ 8.2 MPa (1200 psi)	3A, 3B, 4A, or 4B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)

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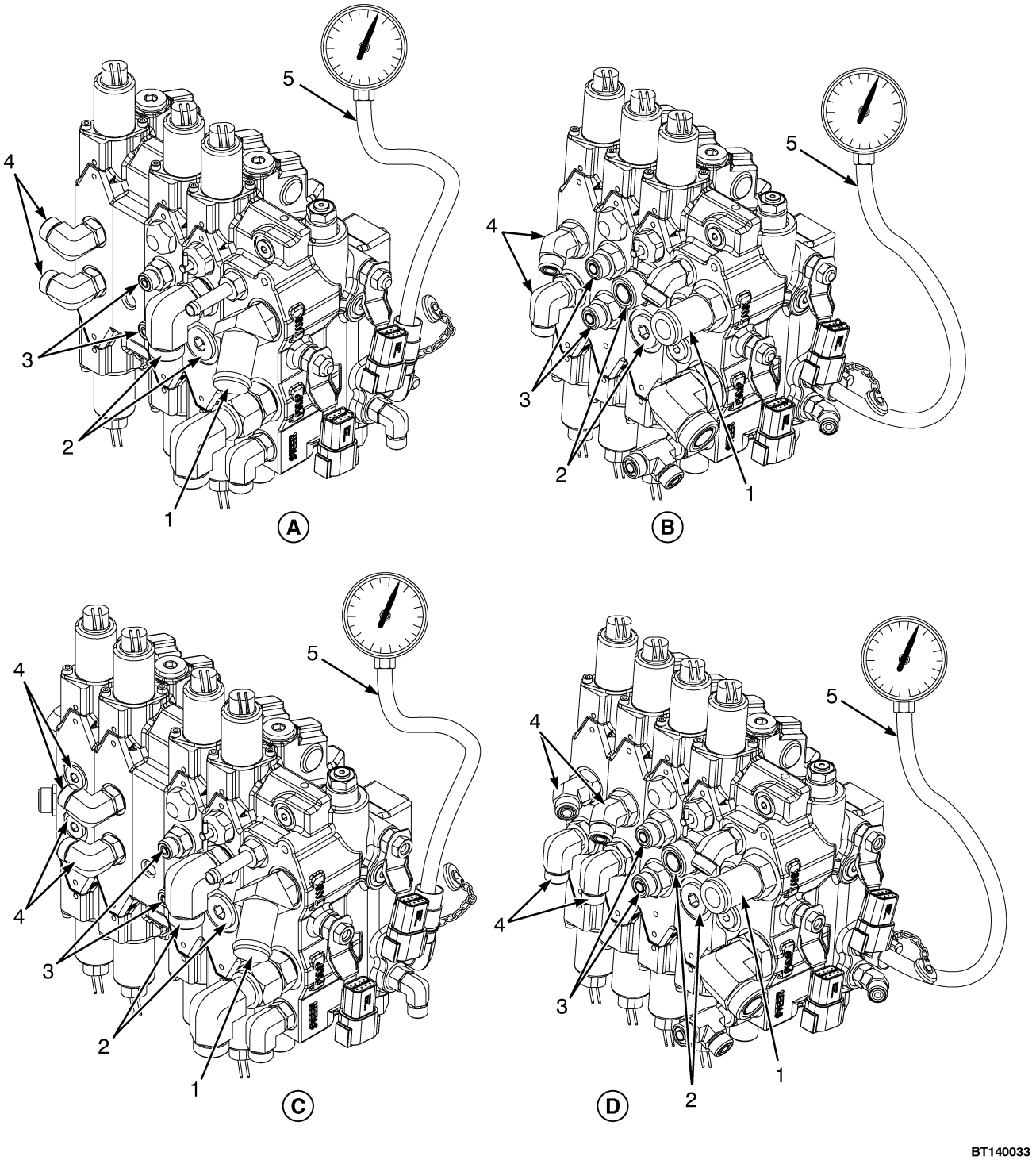

Figure 9050-43-53. E-Hydraulic Control Valve Fittings

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Legend for Figure 9050-43-53

A. 3-FUNCTION CONTROL VALVE FOR LIFT TRUCK MODELS J1.5-2.0XNT (J30-40XNT) (K160) AND J1.6-2.0XN (A935)
B. 3-FUNCTION CONTROL VALVE FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) AND J2.2-3.5XN (J40-70XN) (A276)
C. 4-FUNCTION CONTROL VALVE FOR LIFT TRUCK MODELS J1.5-2.0XNT (J30-40XNT) (K160) AND J1.6-2.0XN (A935)
D. 4-FUNCTION CONTROL VALVE FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) AND J2.2-3.5XN (J40-70XN) (A276)

1. TANK PORT
2. 1A PORT (LIFT/LOWER)
3. 2A, 2B PORTS (TILT)
4. 3A, 3B, 4A, 4B PORTS (AUXILIARY)
5. DIAGNOSTIC PORT WITH GAUGE

Steering Relief Pressure Test and Adjustment

Table 9050-43-14. Test Specifications

Oil Temperature	50 to 65°C (122 to 150 °F)
Steering Relief Pressure	For [A268], E2.2-3.5XN (E45-70XN): 11.0 MPa (1595 psi) For [A276], J2.2- 3.5XN (J40-70XN): 12.4 MPa (1798 psi) For [K160], J1.5-2.0XNT (J30-40XNT): 7.5 MPa (1088 psi) For [A935], J1.6-2.0XN: 7.5 MPa (1088 psi)

Table 9050-43-15. Service Tools

0 - 35.0 MPa (0 to 5000 psi) Pressure Gauge
6 mm Hex wrench
8 mm Hex wrench
T-Fitting Hyster Part No. 8546398

1. Lower forks to ground and turn key or keyless switch to **OFF**. Apply park brake.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

2. Remove steering column covers, floor mat, and floor plates.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

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3. Connect pressure gauge to steering hose as shown in Figure 9050-43-55 and Figure 9050-43-56.

4. Operate hydraulic system until the oil temperature is at test specifications. See Hydraulic Warm-up Procedure.

5. Turn steering wheel to stop. Apply turning effort against stop, causing steering system pressure to go over relief.

6. Check pressure gauge reading. Compare reading to specifications.

NOTE: Steering relief adjuster is very sensitive. Make changes in 1/8 turn increments to avoid over pressurizing system.

7. If pressure is lower or higher than specifications, perform steps below: See Figure 9050-43-54.

a. Remove steering control unit (SCU) from steering column. See **Steering System** 1600SRM1331 for lift truck model J1.5-2.0XNT (J30-40XNT) (K160) or **Steering System** 1600SRM1363 for lift truck models E2.2-3.5XN (E45-70XN) (A268) , J2.2-3.5XN (J40-70XN) (A276) , and J1.6-2.0XN (J30-40XN) (A935) for procedures.

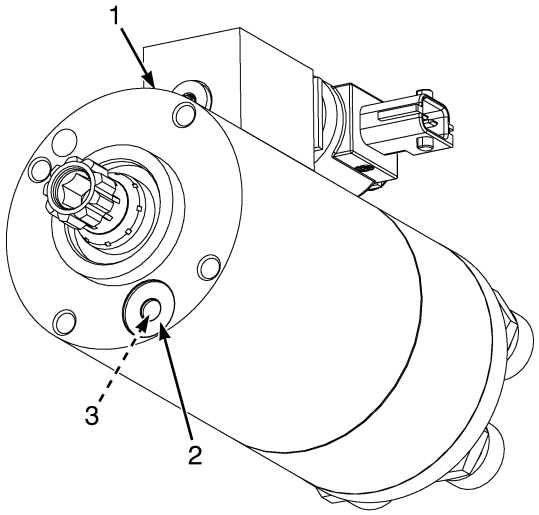
b. If pressure is less than specifications, install hex wrench (1) and turn relief valve adjuster clockwise. See Figure 9050-43-54.

c. If pressure is higher than specifications, install hex wrench (1) and turn relief valve adjuster counterclockwise. See Figure 9050-43-54.

d. Install hex wrench (2) in placement shown in Figure 9050-43-55 or Figure 9050-43-56. Apply turning effort against stop causing steering system pressure to go over relief.

e. Check pressure gauge reading. Compare reading to specifications.

f. Repeat Step b through Step d. If pressure is to specifications, install steering control unit (SCU) onto steering column and remove test equipment. Install test port and adjuster plug.



1. STEERING CONTROL UNIT (SCU)
2. PLUG
3. RELIEF VALVE ADJUSTER

Figure 9050-43-54. SCU Adjustment

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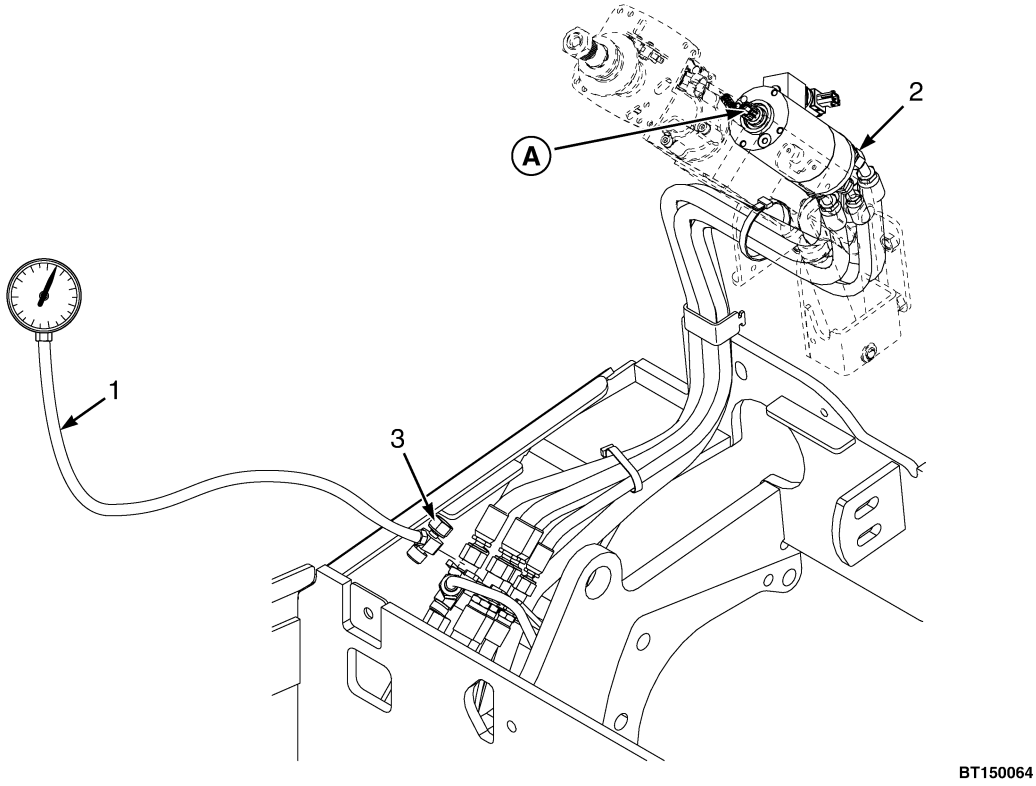

A. PLACEMENT OF HEX WRENCH (2) TO TURN STEERING COLUMN.

1. TEST GAUGE HOSE
2. STEERING CONTROL UNIT (SCU) HOSE CONNECTIONS
3. T-FITTING

Figure 9050-43-55. Steer Relief Pressure for Lift Truck models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)

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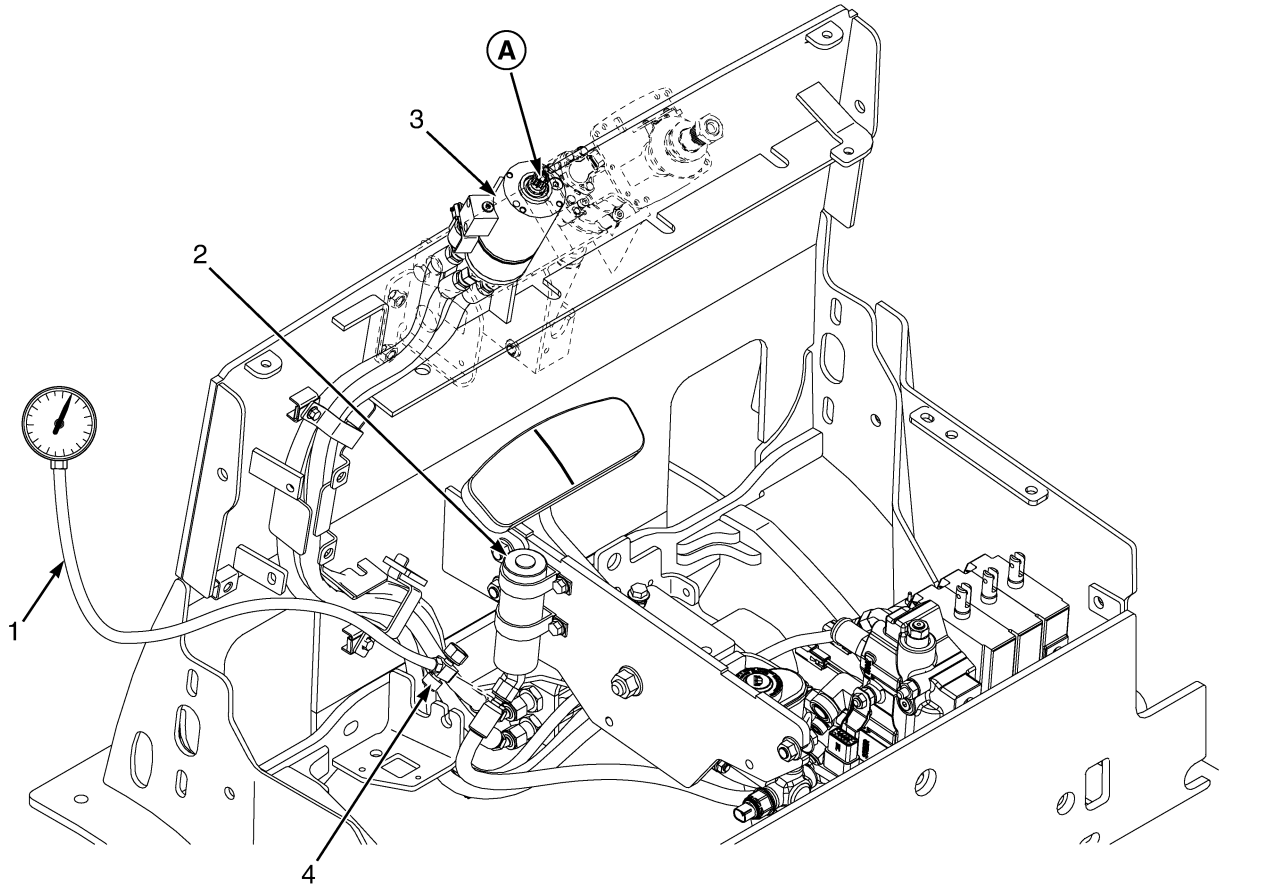

A. PLACEMENT OF HEX WRENCH (2) TO TURN STEERING COLUMN.

1. TEST GAUGE HOSE
2. STEER ACCUMULATOR
3. STEERING CONTROL UNIT (SCU)
4. T-FITTING

Figure 9050-43-56. Steer Relief Pressure for Lift Truck models E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)

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Steering Control Unit LS Pressure Test

This test checks if LS (Load-Sense) pressure is correct to operate the flow divider spool functions of the Steering Control Unit (SCU).

Table 9050-43-16. Test Specifications

Oil Temperature	50 - 65°C (122 - 150 °F)
Minimum LS Pressure	For [A268], E2.2-3.5XN (E45-70XN): 11.0 MPa (1595 psi) For [A276], J2.2- 3.5XN (J40-70XN): 12.4 MPa (1798 psi) For [K160], J1.5-2.0XNT (J30-40XNT): 7.5 MPa (1088 psi) For [A935], J1.6-2.0XN: 7.5 MPa (1088 psi)

Table 9050-43-17. Service Tools

Pressure differential gauge or switching block	
0 - 35.0 MPa (0 - 5000 psi) Pressure Gauge	
Steering Control Unit (SCU) "P" & "LS" Test Port Size	SAE #4 O-ring Port (7/16-20 UNF)
T-Fitting	Hyster Part No. 8546398

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

1. Lower forks to ground, turn key or keyless switch to **OFF** position, and apply park brake.
2. Remove steering column covers to access Steering Control Unit (SCU); remove floor plates to access main control valve and hydraulic lines.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

3. Install one test hose in LS port and the other test hose in fitting on (P) main pressure port hose of the SCU. See Figure 9050-43-57.
4. Check hydraulic temperature. If not within specifications. See Hydraulic Warm-up Procedure.
5. Hold steering over relief and measure relief pressure, then LS pressure and compare to specifications.
6. If LS pressure is not within specifications, remove SCU. Inspect and clean LS orifices. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
7. Remove test equipment and reinstall test plugs.

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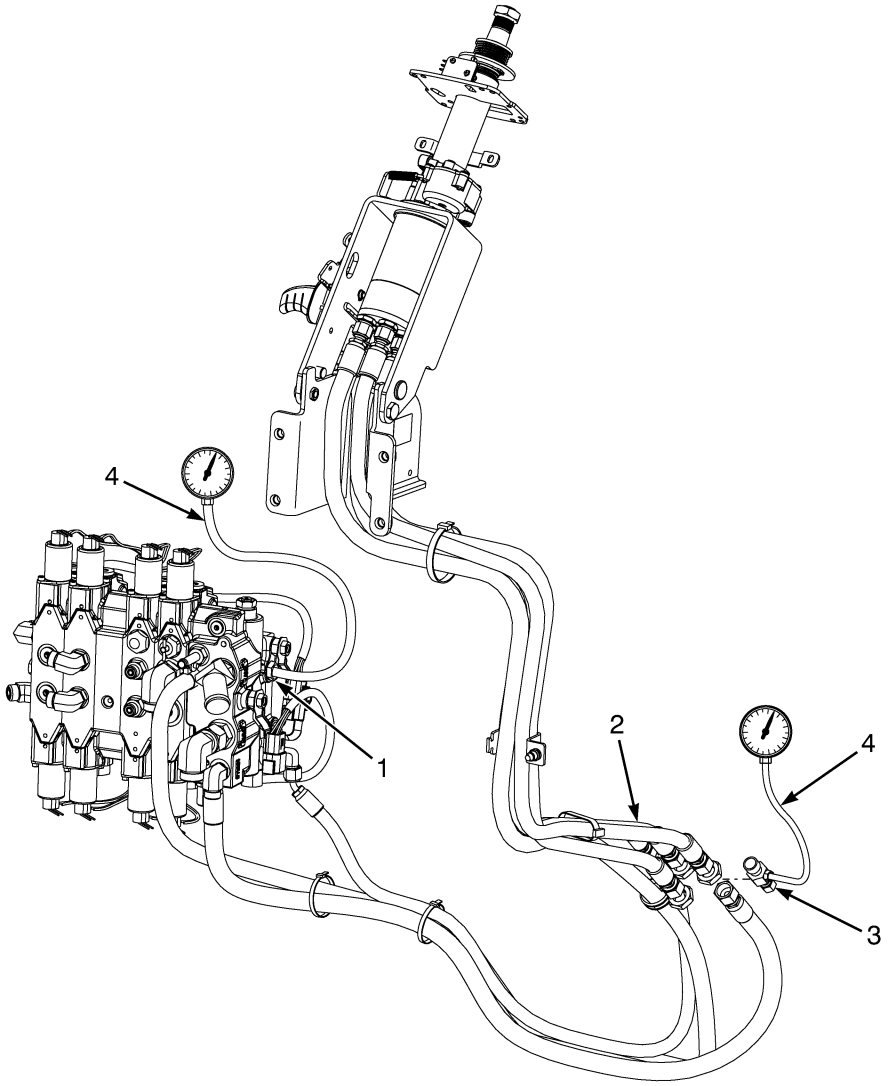

NOTE: E-HYDRAULIC CONTROL VALVE FOR LIFT TRUCK MODEL J1.5-2.0XNT (J30-40XNT) (K160) SHOWN.

1. "LS" LOAD SENSE PORT
2. "P" MAIN PRESSURE PORT HOSE
3. T-FITTING
4. TEST GAUGE HOSE

Figure 9050-43-57. SCU LS Pressure Test

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Lift Cylinder Leakage Test

Hydraulic leakage causes heat and poor performance in a hydraulic system. This test is done to determine if the leakage is in the cylinder or the hydraulic control valve.

Table 9050-43-18. Test Specifications

Oil Temperature	50°C (122 °F)
Maximum Carriage Travel in 10 minutes	102 mm (4.0 in.)

Table 9050-43-19. Service Tools

Tape measure or ruler	
Ball Valve rated at 24 MPa (3500 psi) minimum	
Control Valve Lift Port Size	SAE #12 O-ring Port (1-1/16 - 12 UNF)

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing hoses from cylinders.

1. Lower forks to ground, turn key or keyless switch to **OFF** position, and apply park brake.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Slowly loosen hose fitting to relieve pressure. Remove hose and install ball valve in the supply line between the main control valve and the lift cylinder. Open ball valve fully to allow maximum flow during warm-up procedure. See Figure 9050-43-58, Figure 9050-43-59, and Figure 9050-43-60.

3. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure.

WARNING

Lowering of forks with load can cause personal injury. Do not place body parts under load.

4. Put a capacity load on the forks, and raise and lower the load several times. Lower the load and tilt the mast forward and backward several times. Check for external cylinder or hose leaks.

5. Raise the carriage and load 2.5 m (8.2 ft). Observe load, if the carriage slowly lowers when the control valve is in the neutral position, there are leaks in the hydraulic system. Go to Step 7.

6. If carriage is not dropping fast enough for visual check, use a tape measure and record movement. Turn key or keyless switch to the **OFF** position and let truck sit for 10 minutes. If movement exceeds specifications, go to Step 7.

7. To check the lift cylinders for internal leaks, close the ball valve in the supply line between the main control valve and the mast. Let truck sit for 10 minutes and measure movement. If it does not meet specifications, the seals in the lift cylinders have leaks. Repair cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

NOTE: Contamination in the hydraulic system can cause the control valve to leak. Remove and clean valve before replacing.

8. If the carriage does not move, open the ball valve and check the movement again. If the carriage lowers when the ball valve is open, check for leaks in the hydraulic lines and fittings. If no leaks are found, the main control valve could be worn, contaminated, or damaged. Remove and clean hydraulic control valve. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

9. Remove the load from the forks and remove ball valve.

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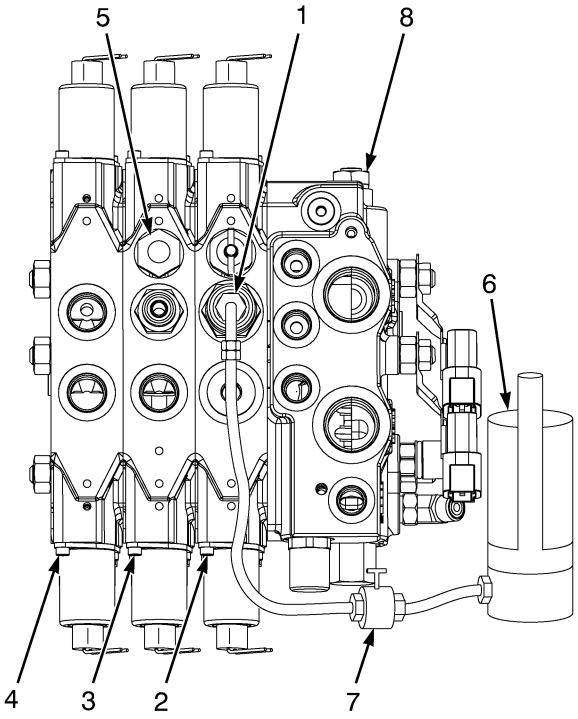
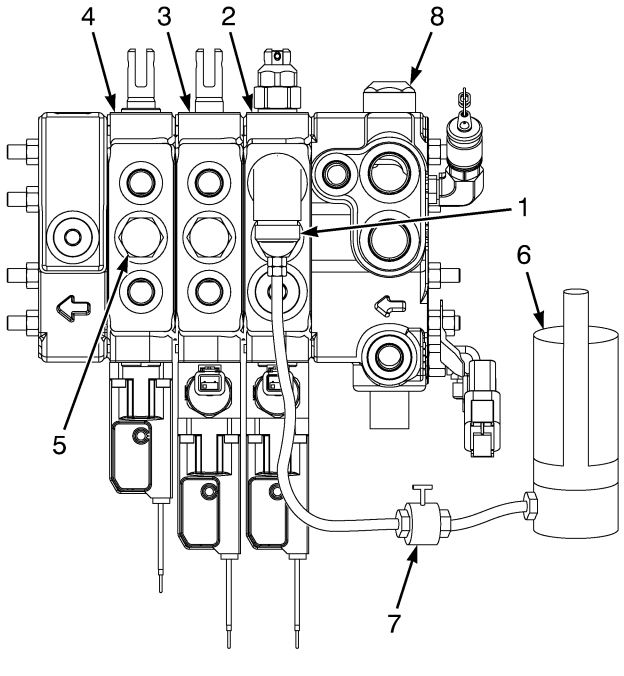


1. LIFT PORT
2. LIFT VALVE SECTION
3. TILT VALVE SECTION
4. AUXILIARY VALVE SECTION
5. OPTIONAL RELIEF VALVE LOCATION
6. LIFT CYLINDER
7. BALL VALVE
8. MAIN RELIEF VALVE

Figure 9050-43-58. Lift Cylinder Leakage Test - E-Hydraulic Control Valve



1. LIFT PORT
2. LIFT VALVE SECTION
3. TILT VALVE SECTION
4. AUXILIARY VALVE SECTION
5. OPTIONAL RELIEF VALVE LOCATION
6. LIFT CYLINDER
7. BALL VALVE
8. MAIN RELIEF VALVE

Figure 9050-43-59. Lift Cylinder Leakage Test - Manual Control Valve for Lift Trucks J1.6-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)

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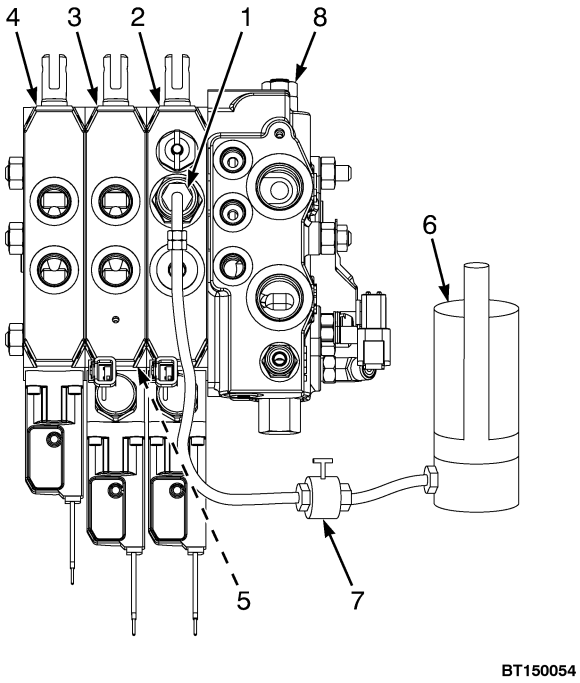

Figure 9050-43-60. Lift Cylinder Leakage Test - Manual Control Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)

Legend for Figure 9050-43-60

1. LIFT PORT
2. LIFT VALVE SECTION
3. TILT VALVE SECTION
4. AUXILIARY VALVE SECTION
5. OPTIONAL RELIEF VALVE LOCATION
6. LIFT CYLINDER
7. BALL VALVE
8. MAIN RELIEF VALVE

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Tilt Cylinder Leakage Test

Hydraulic leakage causes heat and poor performance in a hydraulic system. This test is done to determine if the leakage is in the cylinder or the hydraulic control valve.

Table 9050-43-20. Test Specifications

Oil Temperature	50°C (122 °F)
Maximum Rod Travel in 10 minutes	5° rotation of mast

Table 9050-43-21. Service Tools

Angle Meter	
Ball Valve rated at 24 MPa (3500 psi) minimum	
Tilt Valve Section Port Size	SAE #8 O-ring Port (3/4-16 UNF)

1. Lower forks to ground, turn key or keyless switch to **OFF** position, and apply park brake.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing hoses from cylinders.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Slowly loosen hose fitting to relieve pressure. Remove hose and install ball valve inline with hose on cylinder to be tested. Open ball valve fully to allow maximum flow during warm-up procedure.

3. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure. Operate until temperature is at test specifications.

4. Put a capacity load on the forks, and raise the capacity load to 2.5 m (8.2 ft) and lower the load several times. Lower the load and slowly tilt the mast forward to 90° to floor and backward several times.

5. Check for external cylinder or hose leaks.

6. Slowly tilt the mast forward to 90° to floor. If the mast continues to slowly tilt forward when the control valve is in the neutral position, there are leaks inside the hydraulic system. Go to Step 8.

7. If mast is not dropping forward fast enough for visual check, use angle meter to record mast movement. Stop lift truck and let machine sit for 10 minutes. If movement exceeds specifications go to Step 8.

8. To check the tilt cylinders for internal leaks, close the ball valve in the supply line between the main control valve and the tilt cylinders. Measure movement and compare to specifications.
   - If movement does not meet test specifications, the seals in the tilt cylinders have leaks. Repair cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

NOTE: • Contamination in the hydraulic system can cause the control valve to leak, remove and clean valve before replacement.

If the mast does not move, open the ball valve and check the movement again. If the mast moves when the ball valve is open, check for leaks in the hydraulic lines and fittings. If no leaks are found, the main control valve can be worn or damaged. Remove and clean hydraulic control valve. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

9. Remove the load from the forks and remove ball valve. Reconnect all hoses.

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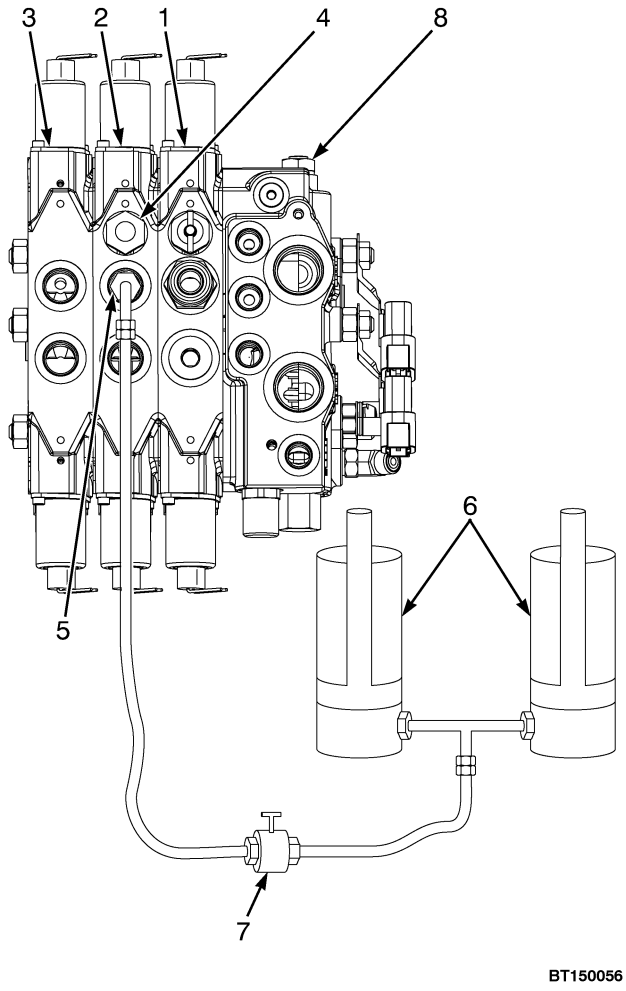
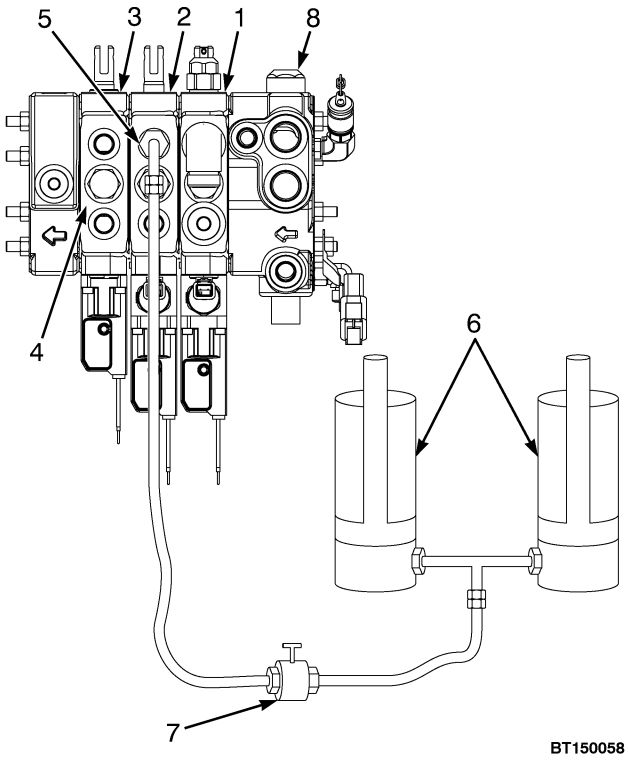


1. LIFT VALVE SECTION
2. TILT VALVE SECTION
3. AUXILIARY VALVE SECTION
4. OPTIONAL RELIEF VALVE LOCATION
5. TILT PORT
6. TILT CYLINDERS
7. BALL VALVE
8. MAIN RELIEF VALVE

Figure 9050-43-61. Tilt Cylinder Leakage Test - E-Hydraulic Control Valve



1. LIFT VALVE SECTION
2. TILT VALVE SECTION
3. AUXILIARY VALVE SECTION
4. OPTIONAL RELIEF VALVE LOCATION
5. TILT PORT
6. TILT CYLINDERS
7. BALL VALVE
8. MAIN RELIEF VALVE

Figure 9050-43-62. Tilt Cylinder Leakage Test - Manual Control Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)

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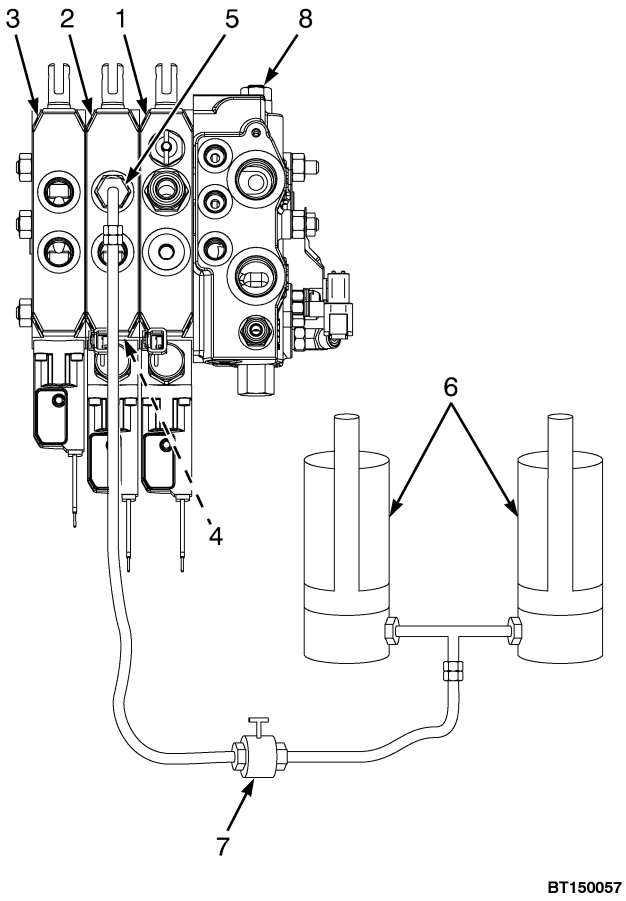

Figure 9050-43-63. Tilt Cylinder Leakage Test - Manual Control Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)

Legend for Figure 9050-43-63

1. LIFT VALVE SECTION
2. TILT VALVE SECTION
3. AUXILIARY VALVE SECTION
4. OPTIONAL RELIEF VALVE LOCATION
5. TILT PORT
6. TILT CYLINDERS
7. BALL VALVE
8. MAIN RELIEF VALVE

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Steering Cylinder Leakage Test

Cylinder leakage causes heat and poor performance in a steering system. This test is done to determine if the leakage is in the steering cylinder or the steering control unit.

Table 9050-43-22. Test Specifications

Oil Temperature	21 - 43°C (70 - 110 °F)
Maximum Leakage	10 ml (0.35 oz) Per Minute

Table 9050-43-23. Service Tools

Container	
Left and Right Work Port Size	SAE #8 O-ring Port (3/4-16 UNF)
T-Fitting	Hyster Part No. 8546398

1. Lower forks to ground and turn steering wheel until steer axle is against right axle stop. Turn key or keyless switch to **OFF** position and apply park brake.
2. Remove floor plates to expose steering cylinder hose connections.
3. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing hoses from cylinders.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system.

Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

4. Slowly loosen left steering hose fitting that goes into SCU top left port marked (L). Remove left steering hose and keep it elevated so oil is not lost. Install O-ring Face Seal (ORFS) high pressure cap on left port fitting of SCU to seal valve against high pressure leakage when steering wheel is turned.

NOTE: Turning the steering wheel by hand with lift truck off will generate hydraulic pressure in cylinder. If leakage is noted at this lower pressure, cylinder has excessive leakage.

5. Attempt to turn the steering wheel by hand. If oil flows out of hose at noticeable rate (approximately 50% of test specification), steering cylinder needs repair. Stop test and repair steering cylinder. If no oil flow, go to Step 6.

WARNING

A open steering port can expel hydraulic oil under pressure and it can be injected into skin. Seal SCU port with high pressure ORFS cap before turning lift truck on.

6. Turn key or keyless switch **ON** and hold steering against right axle stop. Measure oil after it starts to flow from end of removed steering hose for 1 minute.
7. Turn key or keyless switch to **OFF** position and compare measured oil to test specifications.
   - If leakage is below specifications, the steering cylinder is OK.
   - If leakage is more than specifications, remove and repair steering cylinder. Depending on your lift truck, see **Steering System** 1600SRM1331**Steering System** 1600SRM1363
8. Remove caps and reinstall hose and valve covers.

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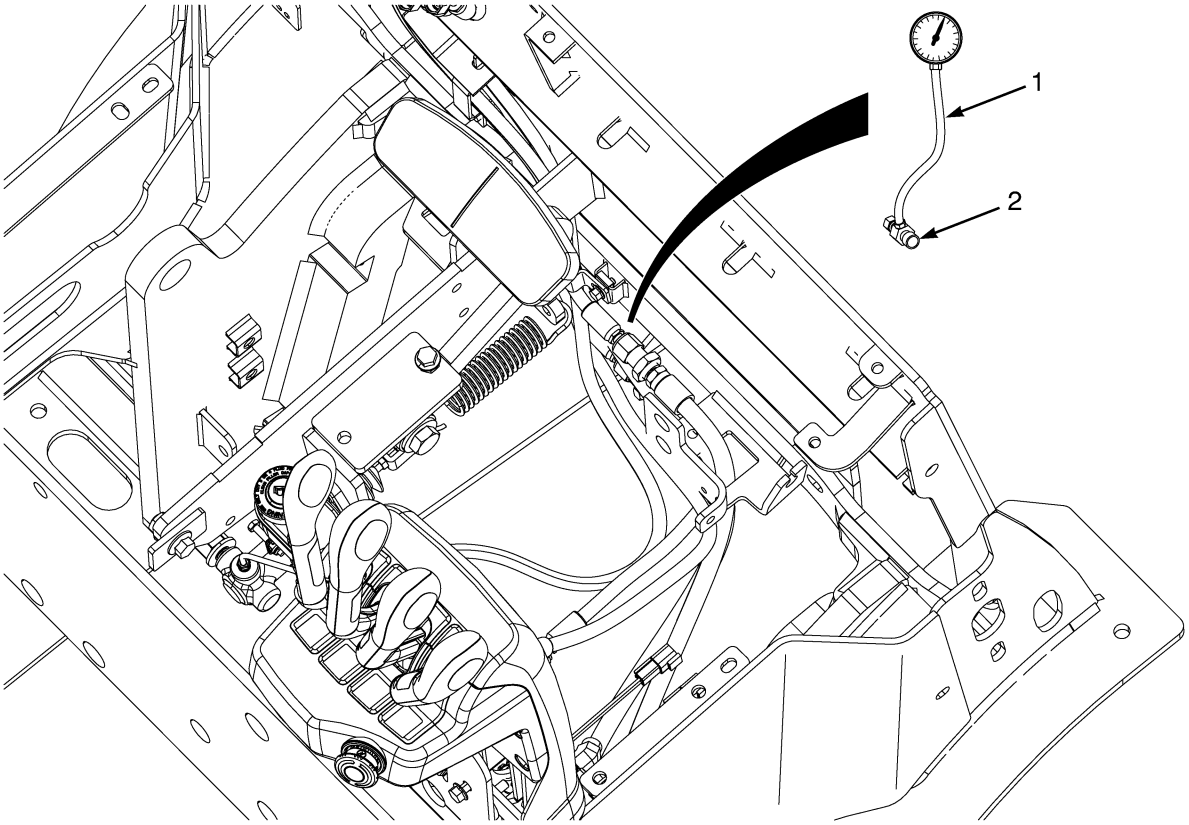

1. TEST GAUGE HOSE
2. FITTING

Figure 9050-43-64. Steering Cylinder Leakage Test

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SECTION 9060
OPERATORS STATION

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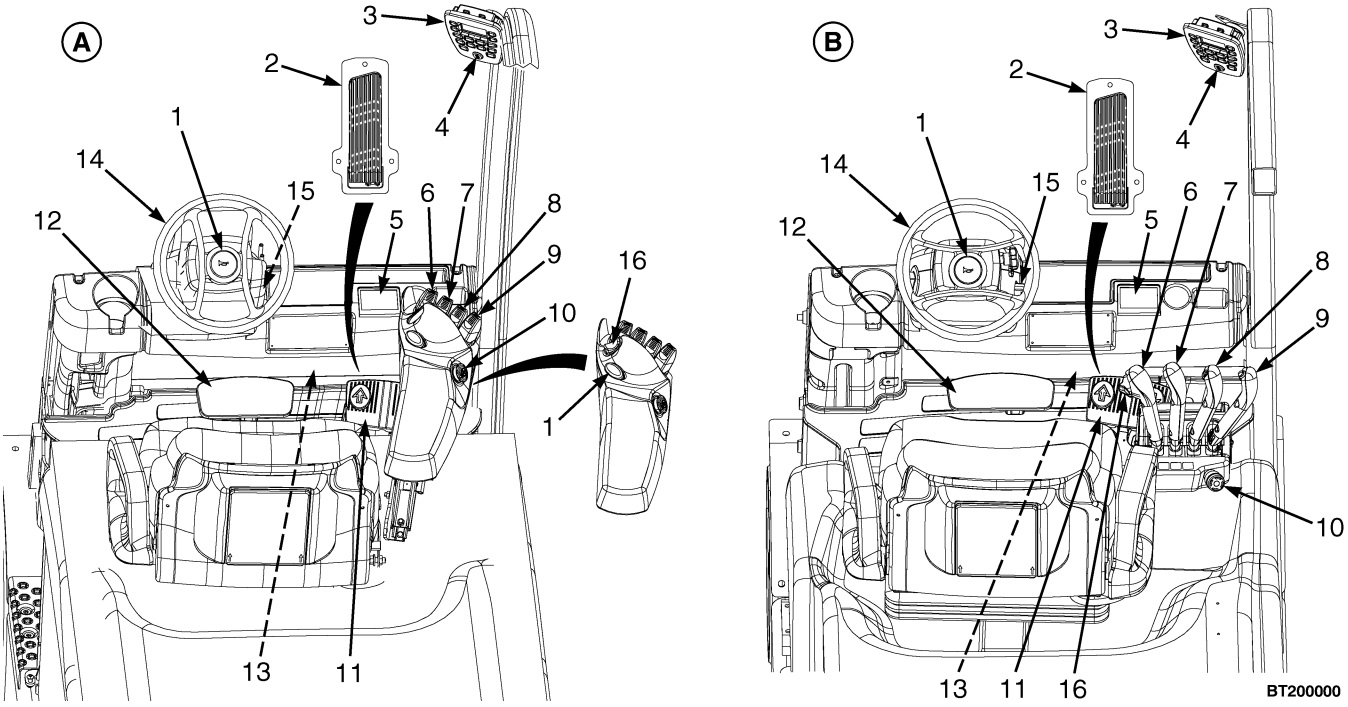
Group 10

Principles of Operation

Operator Station General Description and Principles of Operation

GENERAL DESCRIPTION AND LOCATION

The major components of the operator station for the lift truck are shown in Figure 9060-10-1. The conventional hydraulic steering, braking, and drive system elements are not included in this section. Refer to the **Operating Manual** for related information on common systems. See Figure 9060-10-1.



A. E-HYDRAULIC CONTROL

1. HORN BUTTON
2. ACCELERATOR PEDAL (OPTIONAL)
3. DISPLAY PANEL
4. KEY SWITCH OR KEYLESS SWITCH
5. LIGHT SWITCHES
6. LIFT/LOWER CONTROL LEVER
7. TILT CONTROL LEVER
8. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)
9. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)

B. MANUAL HYDRAULIC CONTROL

10. EMERGENCY DISCONNECT SWITCH
11. MONOTROL® FOOT PEDAL PEDAL (OPTIONAL)
12. BRAKE PEDAL
13. AUTOMATIC PARKING BRAKE MANUAL OVERRIDE HANDLE (OPTIONAL)
14. STEERING WHEEL
15. STEERING COLUMN TILT MEMORY LEVER
16. DIRECTION CONTROL SWITCH (OPTIONAL)

Figure 9060-10-1. Operator Station Components

Check the Service Manual section in Hypass Online for possible updates and check pertinent Grams

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The components shown in Figure 9060-10-1 include multiple options which are customer determined. These options are explained in greater detail in the appropriate sections of this manual. The indicated devices are used for various control inputs and operation of the lift truck systems.

Display Panel provides:

- Power **ON/OFF** selection
- Display and Input for menu-driven data entry, navigation, and readout
-

Manual Hydraulic Levers (if equipped) provides:

- Control of lift
- Lower
- Tilt
- Sideshift
- Fork spread functions
- Emergency disconnect switch
- Directional Control Switch (Optional)

Mini Lever Module (MLM) (if equipped) provides:

- Control of lift
- Lower
- Tilt
- Sideshift
- Fork spread functions
- Emergency disconnect switch
- Horn
- Directional Control Switch (Optional)

Vehicle System Manager (VSM) provides:

- Controls or monitors most electrical operations of the lift truck
- Safe shutdown for critical faults
- Manages operator inputs and stores operational/fault data history

Steering Wheel provides:

- The steering wheel controls the movement of the steer wheels. Rotate the steering wheel clockwise to make a right turn, and counterclockwise to make a left turn.

Horn provides:

- Push the horn button to warn pedestrians and others when approaching intersections and other blind areas.
- If lift truck is equipped with E-Hydraulic controls, there is another horn button located on the armrest.

Light Switches provides rocker switches for the following light functions:

- Front Driving/Brake/Reverse/Parking lights.
- Rear Driving light and the Strobe light or Strobe light only.
- Operator Compartment light (if equipped with a cab) or Strobe light only.

Tilt Memory Lever provides:

- The ability to move the steering column so that the hood can be raised. Lift and hold the lever while moving the steering column. Release the lever when the steering column is in the desired position.

Standard Accelerator provides:

- Accelerator function for speed control on lift trucks equipped with a FWD/REV Directional Control Switch (DCS); which may be located on the armrest of lift trucks equipped with e-hydraulics, or on the lift/lower hydraulic control lever of lift trucks equipped with manual hydraulics.

MONOTROL® Pedal provides:

- Foot pedal input control for FWD or REV travel.
- Accelerator function for speed control.

The foot pedal direction control is configured with analog position sensors that input the direction command to the VSM. Pressing on the right side of the pedal selects the REV direction with corresponding backup lights and backup alarm activated. Pressing the left side of the pedal selects the FWD direction. The foot pedal direction control also serves as the accelerator pedal, pushing it down further will increase the speed of the truck in the applied direction.

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Service Brake Provides:

- Includes a hydraulically operated brake mechanism at the drive wheels. These wheel brakes are controlled by movement of the brake pedal, providing braking proportional to the applied pedal force.
- When the service brake is applied, the E-Boost feature is activated. This will direct the traction system to brake the vehicle.

NOTE: Further troubleshooting procedures for park brake can be found in Park Brake Troubleshooting Guide.

Parking Brake provides:

- Mechanical brake operated through a separate pedal; it applies parking-brake mechanisms at the two drive wheels

Auto Park Brake provides:

- Automatic braking to the traction motor; slowing it down and eventually bringing it to a stop.
- If the lift truck loses power and has to be towed, there is a manual override handle that will disable the auto park brake. The manual override handle is located underneath the floor mat and floor plate and mounted to the front bulkhead.
- The auto park brake will activate under the following condition when the operator:
  - Gets up from the seat without applying the parking brake and turning the lift truck power **OFF**.
  - Takes his foot off of the accelerator pedal or **MONOTROL® Pedal (if equipped)** while the lift truck is moving.
  - The lift truck does not move for a period of 15 minutes.
  - To release the auto park brake, the operator needs to either return to the seat or depress the accelerator pedal or **MONOTROL® Pedal (if equipped)**

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Display Panel

GENERAL DESCRIPTION

There is one display panel. See Figure 9060-10-2.

Display Panel Features

- Liquid Crystal Display (LCD)
- Numerical key pad
- Battery Discharge Indicator (BDI)
- Diagnostic Trouble Codes (DTC)
- System time/date
- Hourmeter for the traction motor and hydraulic pump motor.
- Performance mode selection
- Password controls
- Maintenance reminders
- System interlocks
- Operator checklist
- Preassigned operator passwords to control operator access to the lift truck.
- Four driving Performance Modes that are accessed through the key pad.
- Scheduled maintenance reminders to be programmed in and will alert the operator through an audible and visual alarm when scheduled maintenance is due.
- Operator checklist where the operator must answer YES or NO to a set of questions before the lift truck can be operated.
- Hydraulic fluid low icon. This icon will appear if the system detects low hydraulic fluid. Available with the Hydraulic Fluid Level Monitoring option.
- Hydraulic filter restriction icon. This icon will appear if the system detects a restriction in the hydraulic filter. This is an optional feature.

Display Panel

WARNING

If any of the instruments, levers, or pedals do not operate as described in the following tables, report the problem immediately. Injury to personnel can occur if the instruments, levers, or pedals do not operate as described. DO NOT operate the lift truck until the problem is corrected.

The display panel is equipped with 10 numeric keys, two arrow keys (left and right arrows) and two symbol keys (the Star (*) Key and the Pound (#) Key).

If multiple keys are pressed at the same time, by default the display panel will ignore all keys. If a key has already been pressed and a second one is pressed immediately, the display panel will ignore the second key.

All key presses are accepted for a single entry and key entries cannot be repeated by holding down the key. For example, holding the 5 key down while entering a password number, will only result in one instance of 5 being entered regardless of how long the user presses the 5 key. To enter multiple 5's, the user must press the 5 key multiple times.

Each lift truck can be equipped with several different options and configurations. Depending on the equipment on the lift truck, the key functions described in Table 9060-10-1 will vary and may not apply to your lift truck.

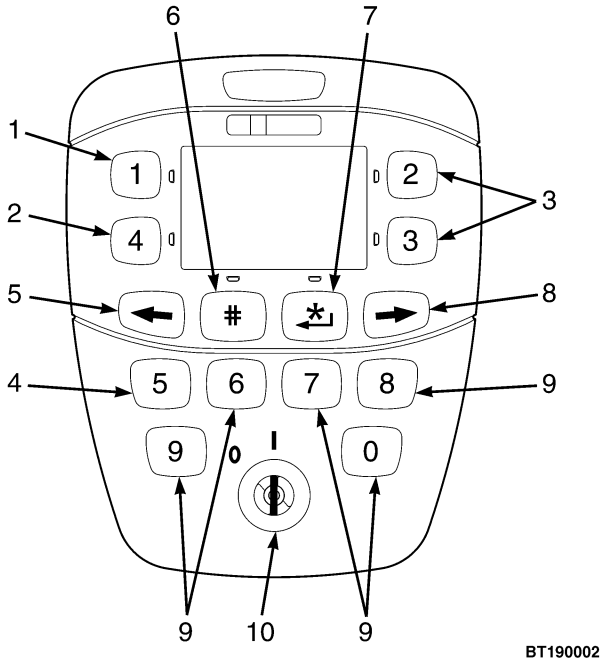

Figure 9060-10-2. Display Panel

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Table 9060-10-1. Display Panel

Item No.	Item	Function
1	1 Key	When an operator is in the Password Screen, if enabled, for entering passwords, this key allows entry of the number 1 for password purposes. Once a password has been successfully entered, or if a password is not required, the display panel will go to the Operator Screen. This screen contains all the necessary components for normal operation of the lift truck. In this screen Key 1 is enabled to decrease Performance Mode; press the 1 key to go to the next lower level of performance; level 1 performance mode is the slowest and level 4 is the fastest. When an operator, if authorized, is in any of the additional menus that are available (Calibrations, Diagnostics, and Truck Setup menus) the 1 key is enabled to enter the number 1 for data entry purposes.
2	4 Key	When an operator is in the Password Screen, if enabled, for entering passwords, this key allows entry of the number 4 for password purposes. Once a password has been successfully entered, the display panel will go to the Operator Screen. This screen contains all the necessary components for normal operation of the lift truck. In this screen, Key 4 is enabled to increase Performance Mode; press the 4 key to go to the next highest level of performance; level 1 performance mode is the slowest and level 4 is the fastest. When an operator, if authorized, is in any of the additional menus that are available (Calibrations, Diagnostics, and Truck Setup menus) the 4 key is enabled to enter the number 4 for data entry purposes.
3	2 and 3 Keys	When an operator is in the Password Screen, if enabled, for entering passwords, these keys allow entry of the number 2 and 3 for password purposes. Once a password has been successfully entered, or if a password is not required, the display panel will go to the Operator Screen. When an operator, if authorized, is in any of the additional menus that are available (Calibrations, Diagnostics, and Truck Setup menus) the 2 and 3 keys allow the operator to scroll up or down within the menu. Press the 2 key to scroll up and press the 3 key to scroll down. When an operator, if authorized, is working in any of the menus, other than the Password menu, is prompted to enter a data value that contains numbers, the scrolling features of the 2 and 3 keys will be disabled and keys 2 and 3 can be used to enter numeric values. Once the numeric data value has been entered and the Enter key pressed, the scrolling feature for keys 2 and 3 will be enabled again.

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Table 9060-10-1. Display Panel (Continued)

Item No.	Item	Function
4	5 Key	When an operator is in the Password Screen, if enabled, for entering passwords, this key is enabled to enter the number 5 for password purposes. Once a password has been successfully entered, or if a password is not required, the display panel will to the Operator Screen. When an operator, if authorized, is in any of the additional menus that are available (Calibrations, Diagnostics, and Truck Setup menus) the 5 key is enabled to enter the number 5 for data entry purposes.
5	Scroll Back (Left Arrow Key)	This key is used for the following functions: • Scrolling backwards through a list of possible menu selections.
6	(#) Pound Key	If the Operator Checklist is enabled on the lift truck, the (#) Pound Key is used to indicate an issue with the current item in the list. See **Operating Manual** for your lift truck to obtain more information on using the Operator Checklist. • Scrolling through a list of possible menu selections.
7	(*) Enter Key (STAR Key)	This key is used for menu entry and menu navigation. Use the (*) STAR key to select a menu to be viewed. Within the selected menu, use the (*) STAR key to select sub menus associated with the selected menu. • Scrolling through a list of possible menu selections.
8	Scroll Forward (Right Arrow Key)	This key is used for the following functions: • Scrolling forward through a list of possible menu selections.
9	6, 7, 8, 9, and 0 Keys	The 6, 7, 8, 9, and 0 keys are enabled to enter the numbers 6, 7, 8, 9, and 0 for data entry purposes.
10	Keyless Start Switch or Key Switch	The lift trucks covered in this manual can be equipped with either a key switch or keyless switch. Both options will have two positions: • **OFF** position. Deenergizes all electric circuits except for the horn. • **ON** position. Energizes all electric circuits. The key or keyless switch will be in this position during normal operation.

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LCD Screen and Warning and Indicator Lights

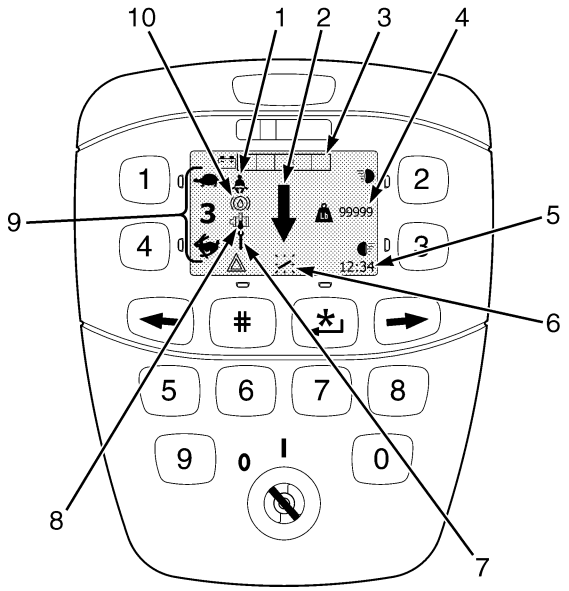
The LCD screen uses a series of icons and numeric values to communicate important truck information to the operator, supervisor, and service technician.

The warning and indicator icons appear when the LCD screen is displaying the Operator Screen. The Operator Screen contains all the components necessary for normal operation of the lift truck. After 10 seconds, the seat belt, low brake fluid, service due (if equipped), motor temperature icons, and low hydraulic fluid (if equipped) will no longer be illuminated and will illuminate again only if there is a problem in that particular area. Detailed information for Warning and Indicator lights can be found in the **Operating Manual**.

The following icons are displayed at all times on the LCD screen when the truck is running, and the LCD screen is displaying the Operator Screen:

- The current performance mode the truck is operating under
- The Battery Display Indicator (BDI)
- The direction indicators showing which direction the truck is traveling in
- The neutral/park brake indicator
- The truck hourmeter
- System time

See Figure 9060-10-3:



1. FASTEN SEAT BELT ICON,
2. DIRECTION INDICATOR ICON
3. BATTERY DISPLAY INDICATOR (BDI) ICON
4. LOAD WEIGHT ICON
5. SYSTEM TIME ICON
6. STEER TIRE ANGLE ICON
7. SERVICE DUE ICON
8. MOTOR TEMPERATURE HIGH WARNING ICON
9. PERFORMANCE MODE ICON
10. LOW BRAKE FLUID ICON

Figure 9060-10-3. Display Panel - LCD Screen / Warning and Information Icons

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Programming - Menus

MENU

The On-Board Menu Structure is accessible while the system power is on by pressing the "*" button. If accessed without a password or by an operator password, the menu structure will automatically exit if no button presses have been detected for 30 seconds. Unless otherwise specified, menu items are only accessible with a service password. See Display Menu Flowchart for further details.

Operator Cycle Main Menu

- Operating Screen
- Password Entry
- Load Weight (Optional)
- Checklist (Optional

Supervisor/Service Cycle Main Menu

- Operating Screen
- Password Entry
- Load Weight (Optional)
- Checklist (Optional
- Activity Log
- Calibration
- Diagnostics
- Truck Set-Up
- Truck Status
- Display Adjustment

Activity Log

- Check List Log
- Password Log
- Impact Log

Calibration

- Load Weight
- Manual Hydraulic Valve
- Steer Axle
- Steer Wheel
- Hydraulic Valve Threshold
- Return to Set Tilt (RTST)

Diagnostic

- Fault Logs/Controllers/Other CAN Device
- Steering Sensor
- Battery/Other Power Supplies
- Mast Sensor
- Hydraulic Valve
- Hydraulic Inputs
- Hydraulic Pump Motor
- Brakes
- Seat (Operator Presence)
- Traction Motor 2
- Traction Motor 1
- Directional Indicator Operation
- Speedometer

Truck Set-Up

- Passwords
- Restore Defaults
- Optional Hydraulic (Diverter Valve) ON/OFF
- Rear Lamp Assembly OFF/ON
- Hydraulic Function
- Hydraulic Function 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b (E-Hydraulics Only)
- Hydraulic Function 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b (Manual Hydraulics Only
- Motion Alarm OFF/ON
- Impact Thresholds
- Auto Power OFF
- Return To Set Tilt (RTST)
- Traction Speed Limit
- Scheduled Maintenance (Deferred)
- Minimum Pump Speed
- Check List
- Impact Shutdown
- Hour Meter
- Acceleration
- BDI Adjustment
- Battery
- Braking

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Truck Status

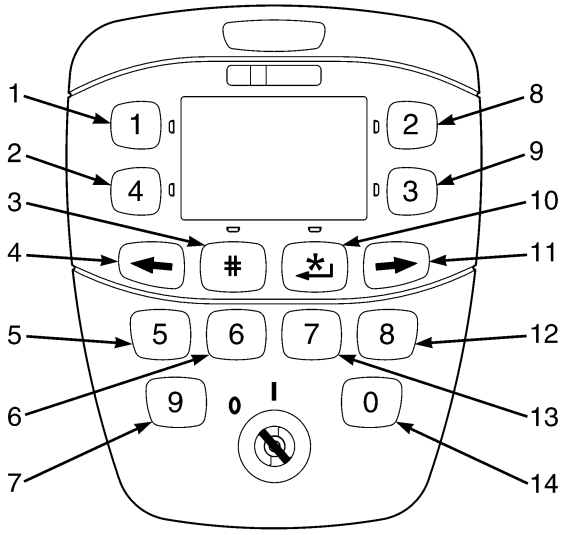
- VSM Version
- Impact Sensor Version
- Light 1 Controller Version
- Traction 2 Controller Version
- Traction 1 Controller Version
- Pump Controller Version
- Hydraulic Input Controller Version
- Hour Meters
- Serial Number
- Display Version

Display Adjustments

- Date/Time Format
- Units Selection (Imperial/Metric)
- Date and Time
- Daylight Savings

Display Menu Flowchart

DISPLAY MENU FLOWCHART

Note: This chart indicates all available menu options for this model series. Only those options ordered on your specific truck will be displayed and accessible using the Service Level password.
DTC's are stored in the DTC LOGS, where a history of repeat failures is maintained, until cleared by an authorized service technician. All DTC's are to be cleared prior to operating the lift truck. DTC logs should only be cleared once the data is recorded by a authorized service technician.↓


1. 1/Soft Key	6. 6 Key	11. Scroll (Right Arrow Key)
2. 4/Soft Key	7. 9 Key	12. 8 Key
3. (#) Pound Key/Soft Key	8. 2/Soft Key	13. 7 Key
4. Scroll Back (Left Arrow Key)	9. 3/Soft Key	14. 0 Key
5. 5 Key	10. (*) STAR Key Select/Enter/ Accept	

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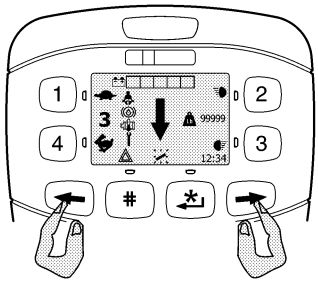
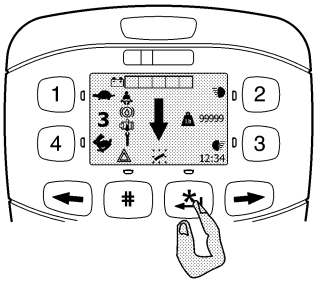
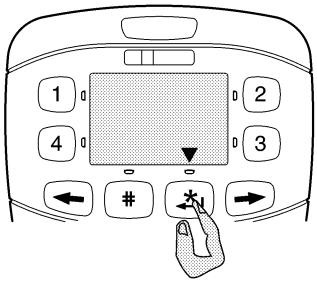
DISPLAY MENU FLOWCHART (Con't)



Return to Previous Menu←

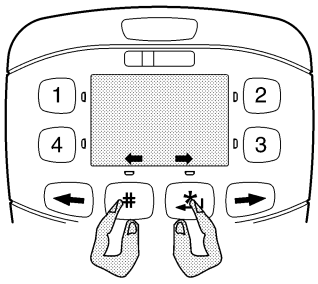


Select/Enter/Accept *

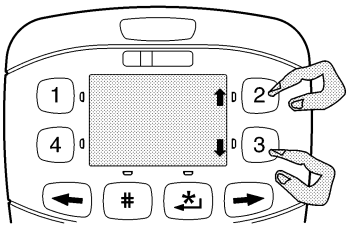


Enter/Accept *

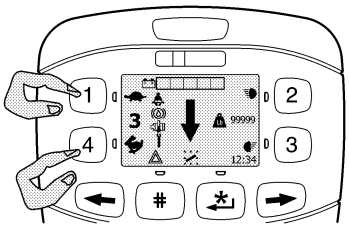
Scroll ← →



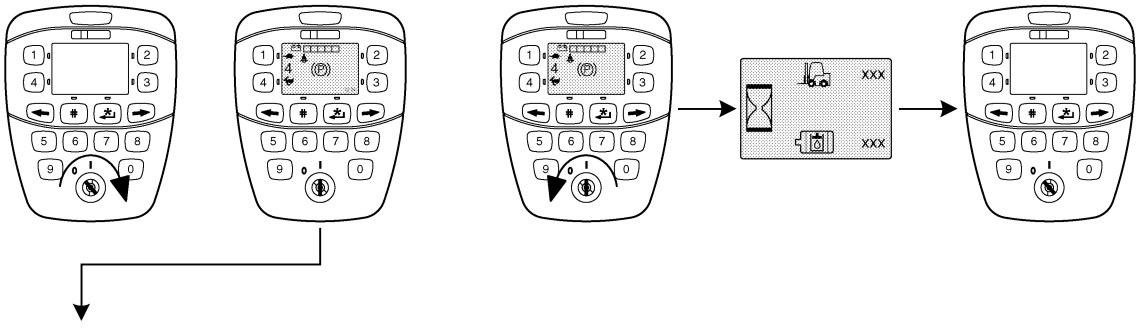
Scroll ← →



Scroll Up/Down ↑ ↓



Increase/Decrease Performance



Power ON

Power OFF

Hour Meter Displayed for 5 seconds

Power ON→ Operator Cycle→ Enter Password→ Supervisor/Service Cycle→ Power OFF→ Power ON→ Operator Cycle

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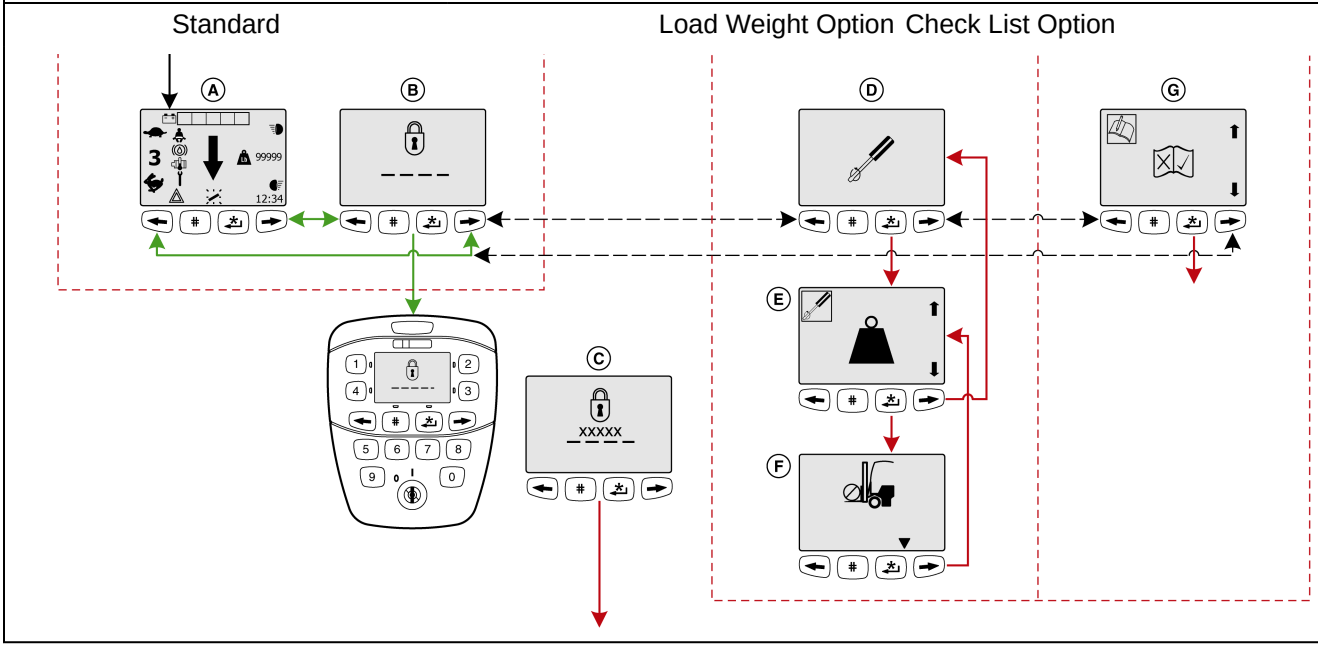
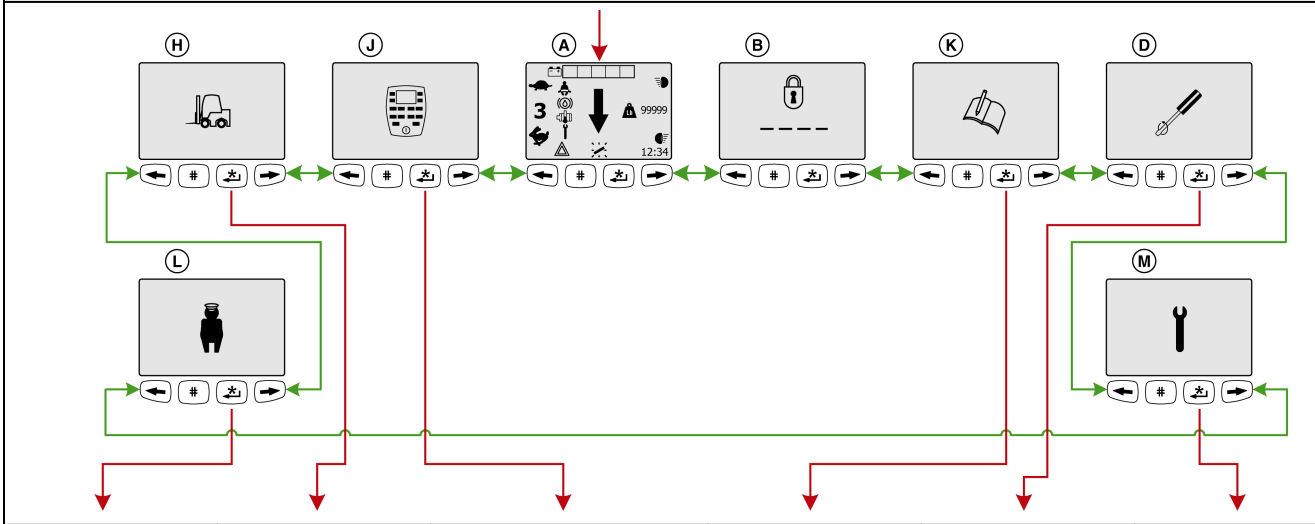
OPERATOR CYCLE		
Legend		
A. Operating Screen	E. Load Weight	J. Display Adjustment
B. Password Entry	F. Tare Weight	K. Activity Log
C. Enter Password	G. Checklist	L. Truck Setup
D. Calibration	H. Truck Status	M. Diagnostics



SERVICE CYCLE



Truck-Setup	Truck Status	Display Adjustments	Activity Logs	Calibration	Diagnostics

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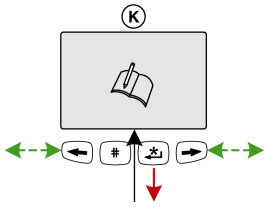
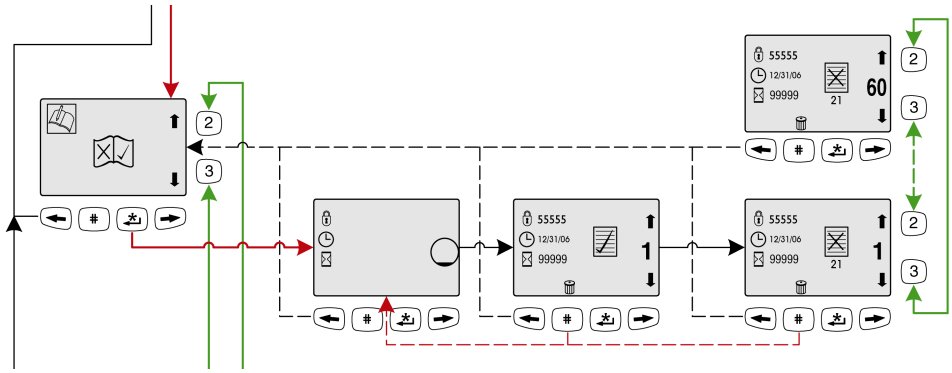
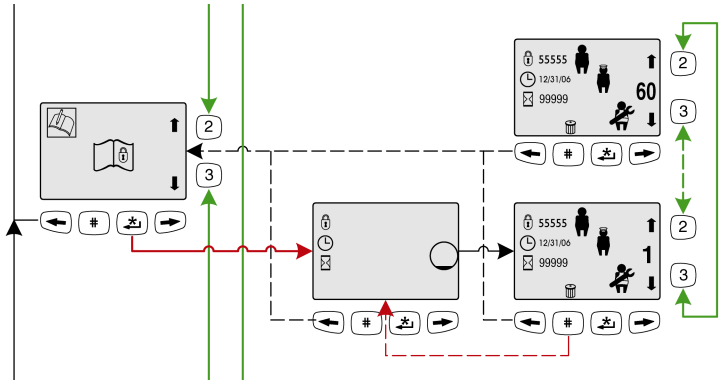
Table 9060-10-2. Activity Logs

ACTIVITY LOGS


Check List			
			
☞*	No Logs	Check List OK	Check List Not OK

Password Log		
		
☞*	No Logs	Operator/Supervisor/Service

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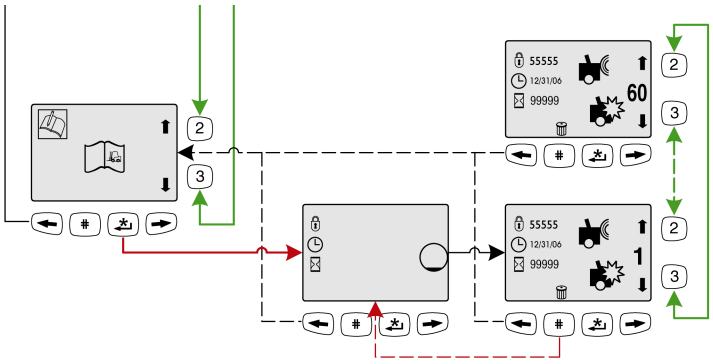
Impact Log



☞*	No Logs	Soft Impact/Hard Impact

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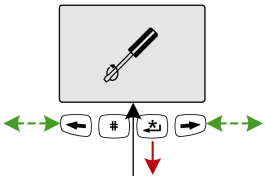
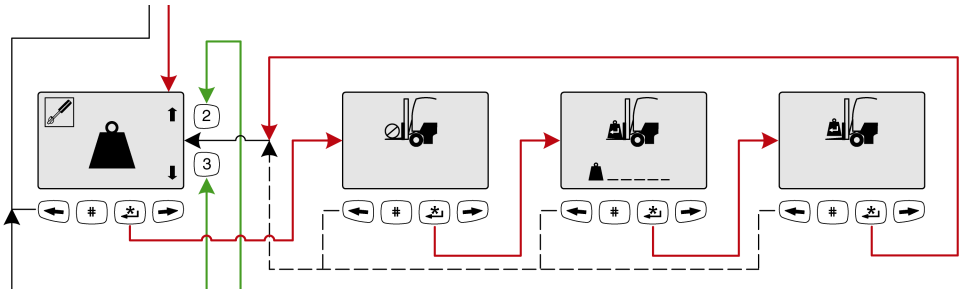
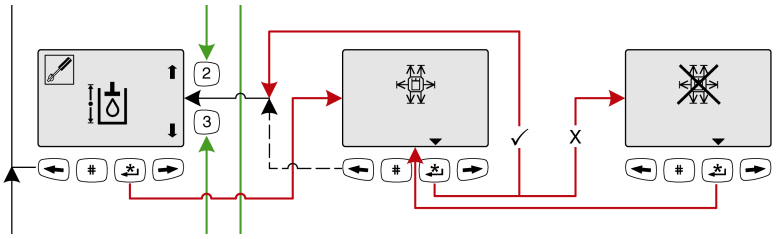
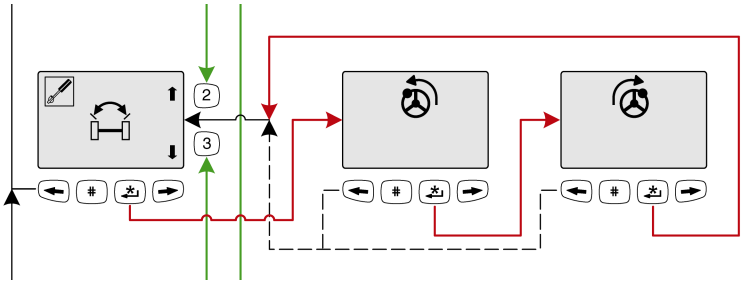
Table 9060-10-3. Calibration

CALIBRATION


Load Weight			
			
☞*	No Load Entry ☞*	Known Load Entry ☞*	Test Load Entry ☞*

Manual Hydraulic Valve		
		
☞*	Move each lever to end of travel ☞*√	X = Calibration Fail I_touchup FontFamname="Wingdings" 🗁 3 seconds ☞* Repeat Calibration

Steer Axle			
			
☞*	Rotate Fully CCW ☞*	Rotate Fully CW ☞*	

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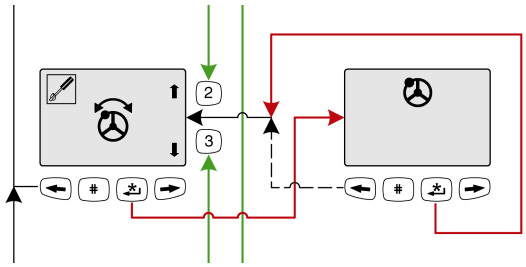
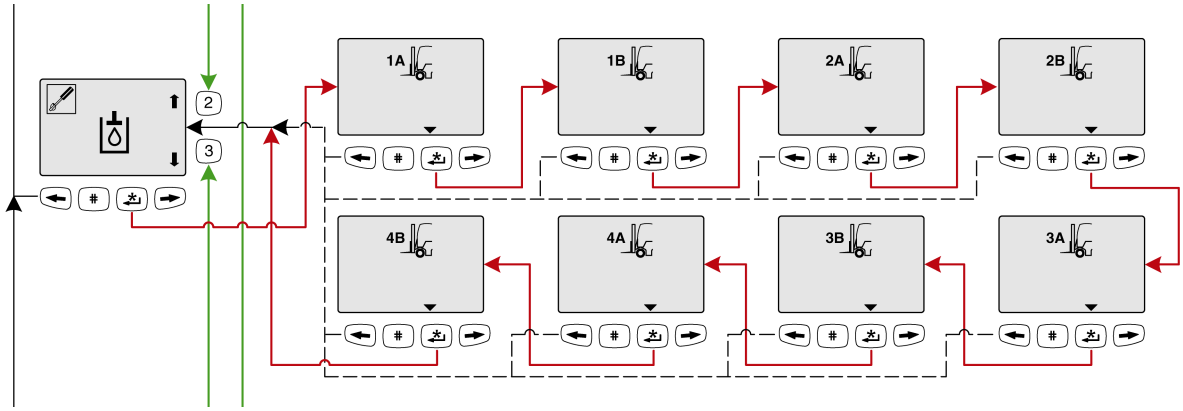
Steer Wheel



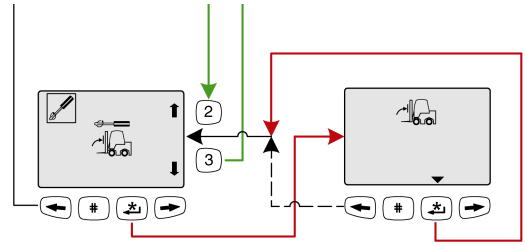
☞*	Set Steering Wheel to desired (Spinner) Position ☞*

Hydraulic Valve Threshold



☞*	Operate Indicated Control until movement is detected ☞*	Repeat for each function ☞*

Return To Set Tilt (RTST)



☞*	Set Tilt Angle ☞*

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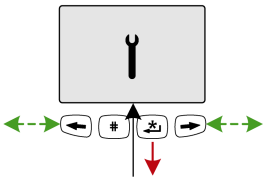
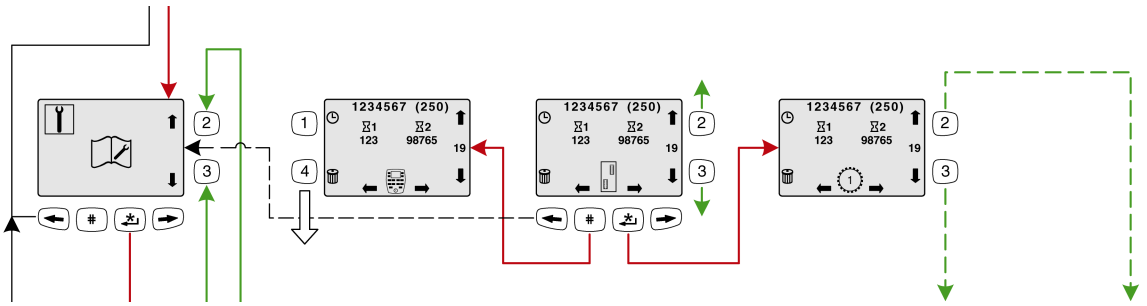
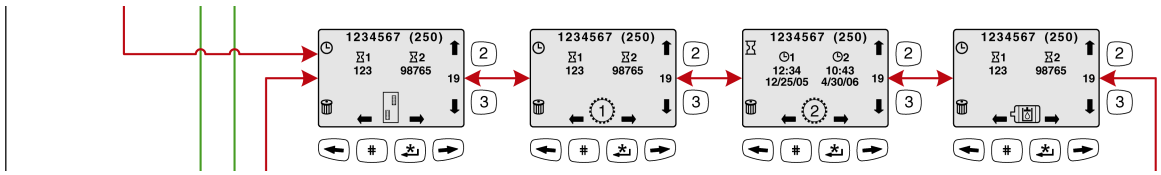
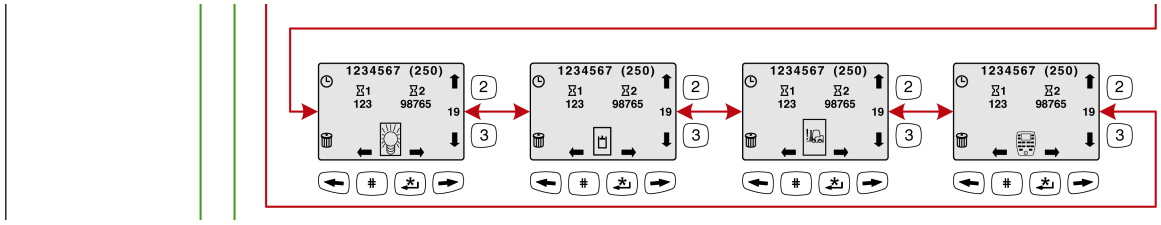
Table 9060-10-4. Diagnostics

DIAGNOSTICS


Fault Logs / Controllers / Other CAN Device			
	↓ Previous ↓	↓ VSM ↓	↓ Next ↓
			
	Delete All Logs	↑ Navigation example ↑	Next Log Record	Previous Log Record
			
☞*	VSM← →	Traction 1← →	Traction 2← →	Pump← →
			
	Light← →	MLM← →	Impact← →	Display← →

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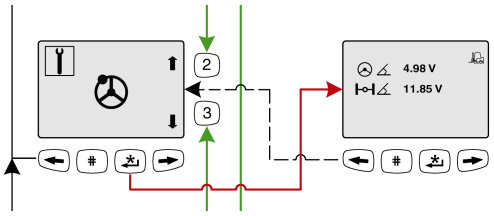
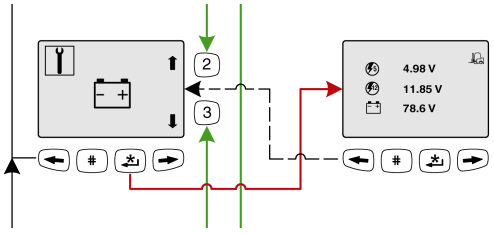
Steering Sensor



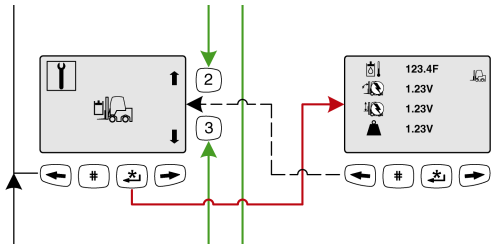
☞*

Battery / Other Power Supplies

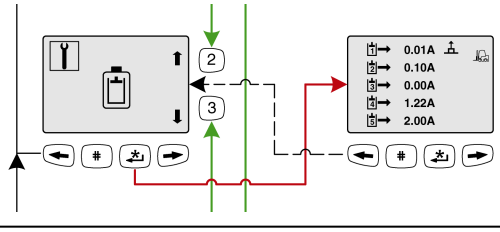


☞*

Mast Sensor



Hydraulic Valve



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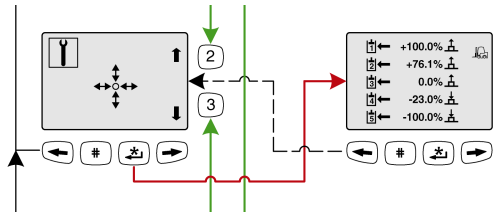
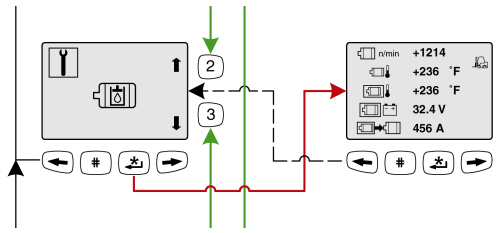
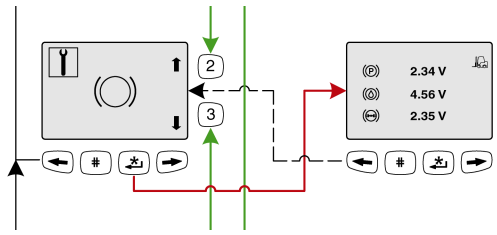
Hydraulic Inputs



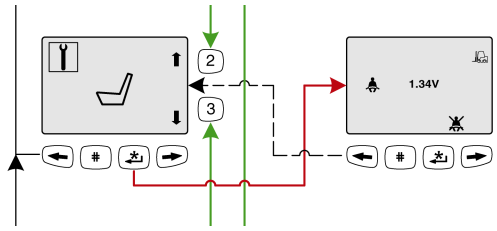
Hydraulic Pump Motor



Brakes



Seat (Operator Presence)



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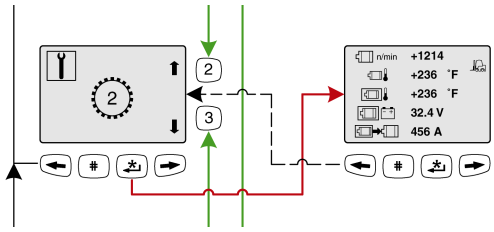
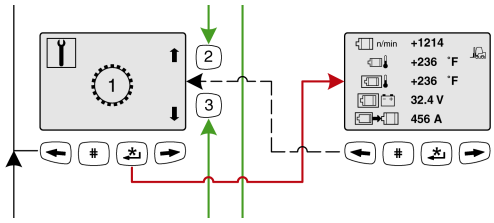
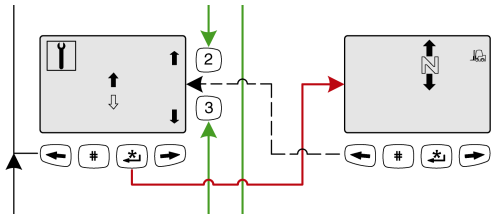
Traction Motor 2



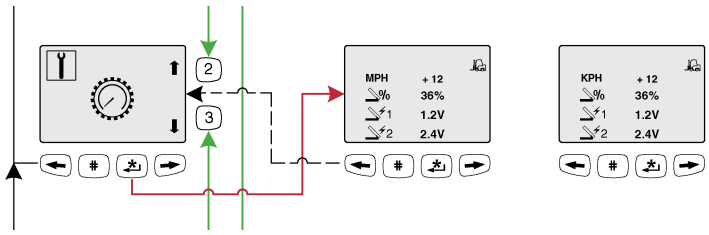
Traction Motor 1



Directional Indication Operation



Speedometer



	Imperial	Metric	

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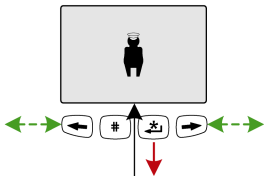
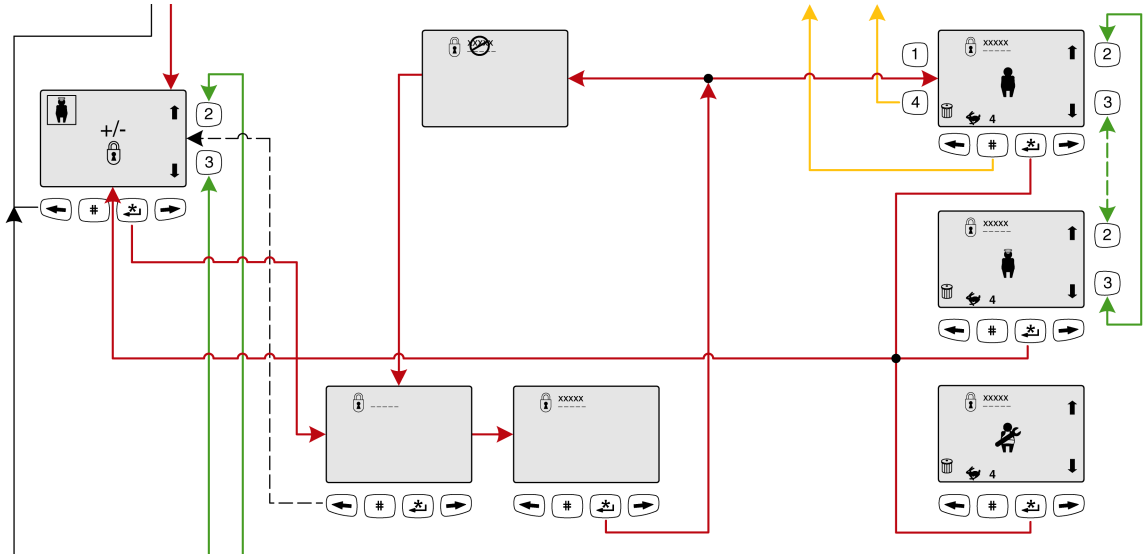
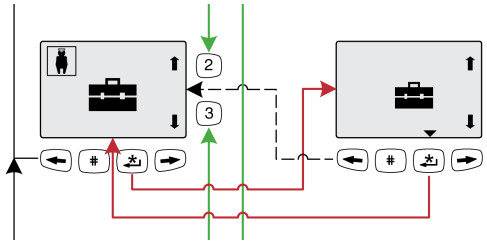
Table 9060-10-5. Truck-Setup

TRUCK SETUP


Passwords		
Incorrect Password	Set Max Performance	Delete Password
		
☞*	Enter / Re-Enter Password ☞*	↑ ↓ Select Operator / Supervisor / Service for Password ☞*

Restore Defaults

☞*To restore defaults

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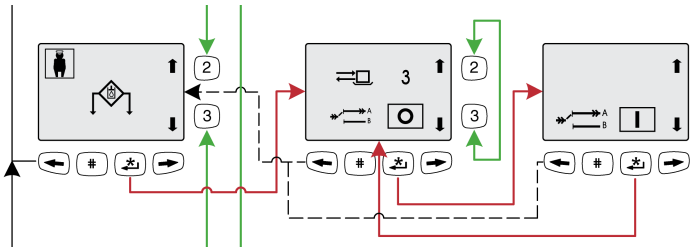
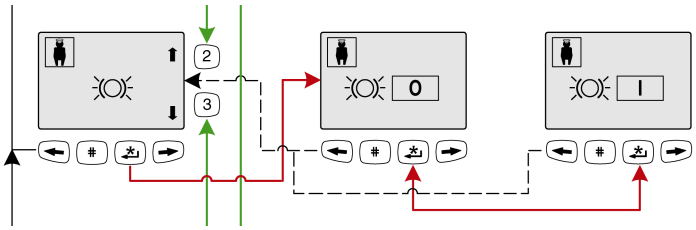
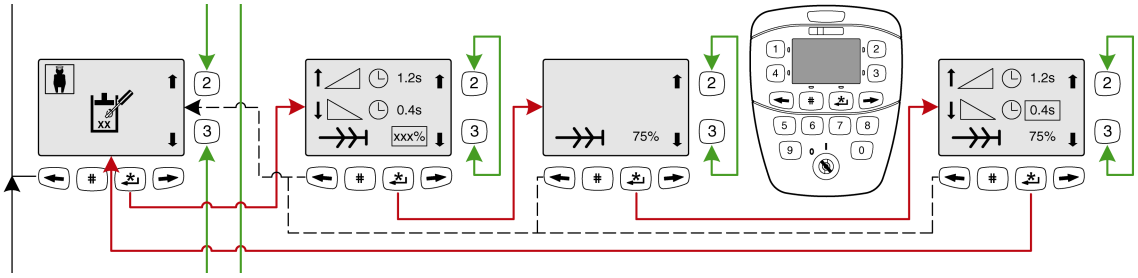
Optional Hydraulic (Diverter Valve) ON/OFF		
		
☞*	☞*☜ Valve ON/OFF	

Rear Lamp Assembly OFF/ON		
		
☞*	☞* Rear Lamp OFF	☞* Rear Lamp ON

Hydraulic Function 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b (E Hydraulics Only)			
			
☞* Scroll to Function ↑ ↓	☞* To Select	Enter Value Using Number Buttons ☞*	Repeat for other functions

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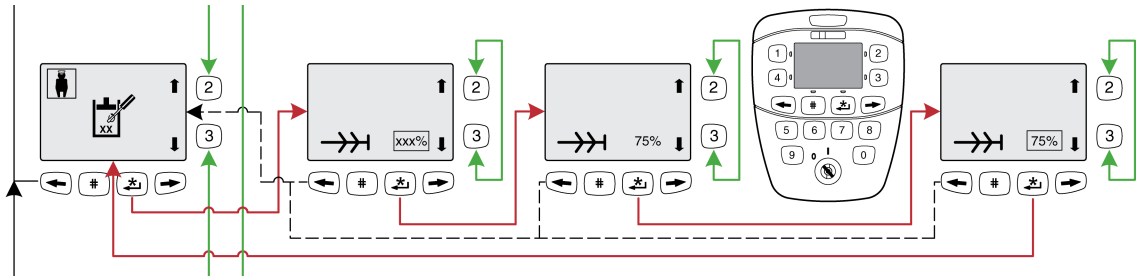
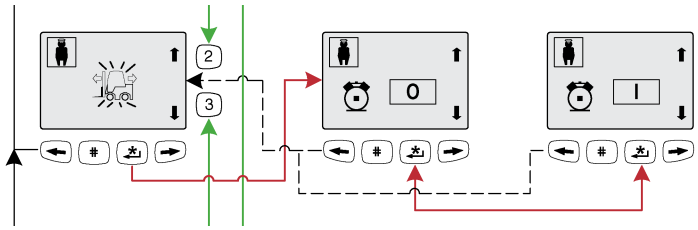
Hydraulic Function 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b (Manual Hydraulics Only)



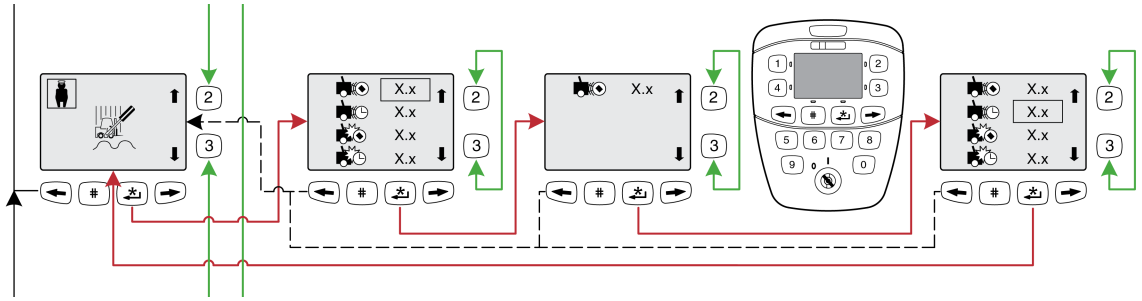
☞*	☞* Enter Value Using Number Buttons ☞*

Motion Alarm OFF/ON



☞*	☞* Motion Alarm OFF	☞* Motion Alarm ON

Impact Thresholds



☞* Scroll to function ↑ ↓ ☞* To Select	Enter Value Using Number Buttons or Scroll ↑ ↓ ☞*	Repeat for other functions

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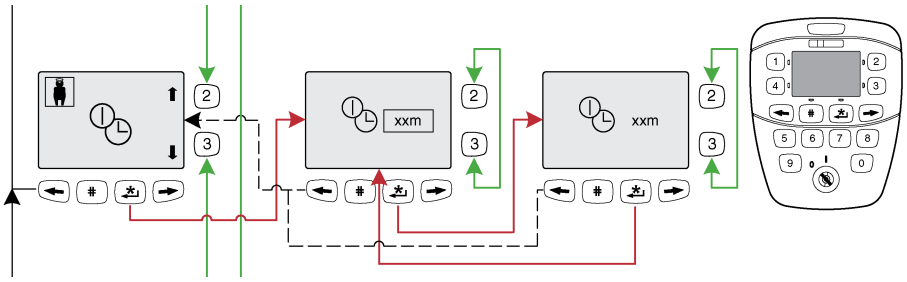
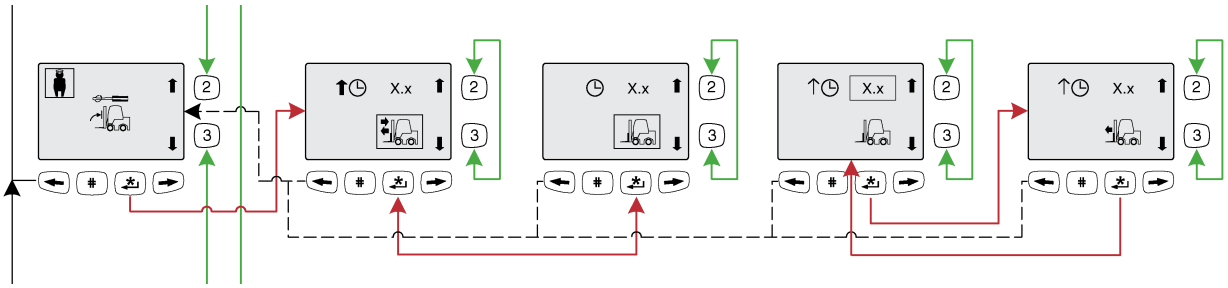
Auto Power OFF



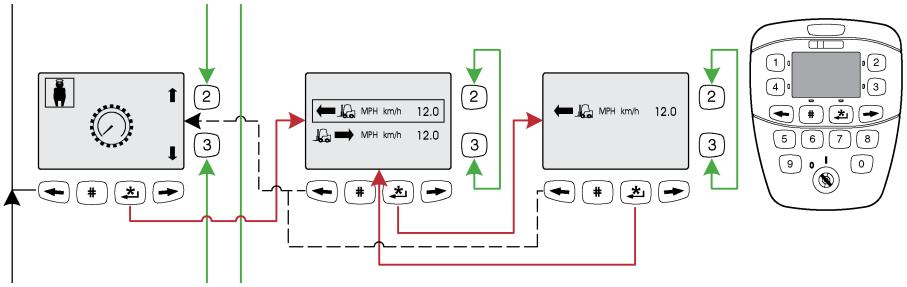
☞*	☞*Enter Value Using Number Buttons ☞*

Return To Set Tilt (RTST)



☞*Scroll to Function ↑ ↓	☞* ☜ To Select	↑ ↓ Next Function	☞* Enter Value Using Number Buttons ↑ ↓ ☞*

Traction Speed Limit



☞*	☞* Enter Value Using Number Buttons ☞*

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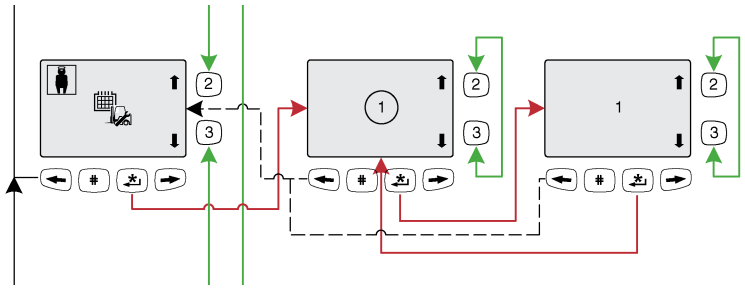
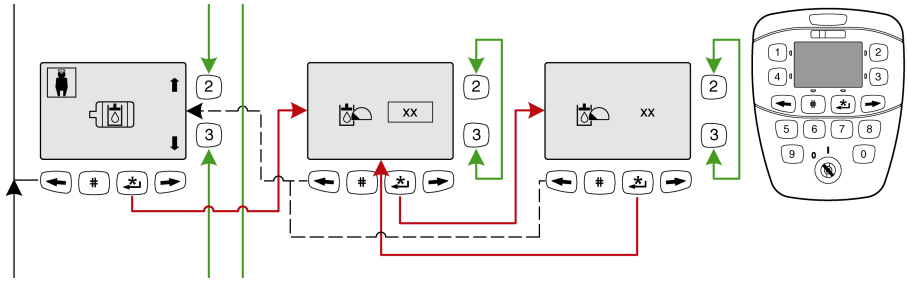
Scheduled Maintenance

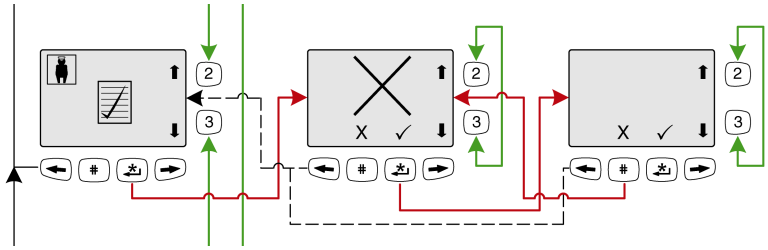


Minimum Pump Speed



☞*	☞* Enter Value 0 % to 100 % Using Number Buttons ☞*

Check List



☞*	☞✓(*) Active ☞ X (#) Inactive	↑ ↓ Scroll to Next Check List Item

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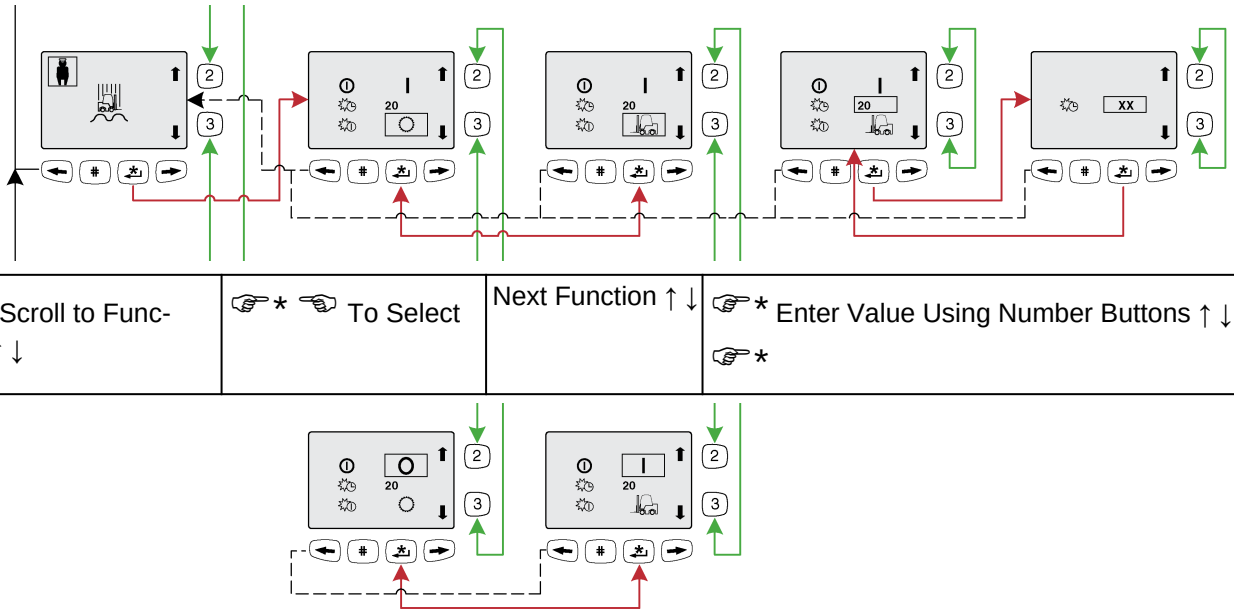
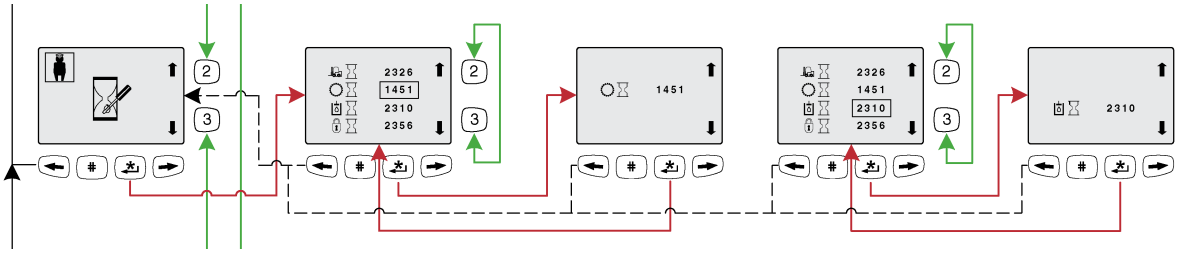
Impact Shutdown



☞*Scroll to Function ↑ ↓	☞* ☜ To Select	Next Function ↑ ↓	☞* Enter Value Using Number Buttons ↑ ↓ ☞*

Hour Meter



☞*Scroll to Function ↑ ↓	☞* To Select	Enter Value Using Number Buttons ☞*	Next Function ↑ ↓

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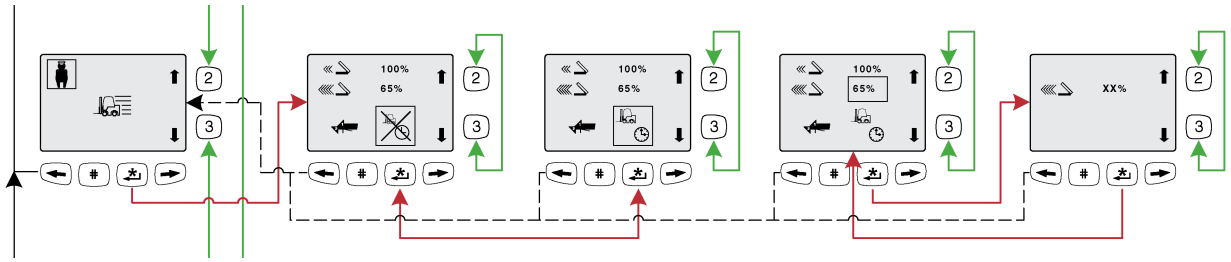
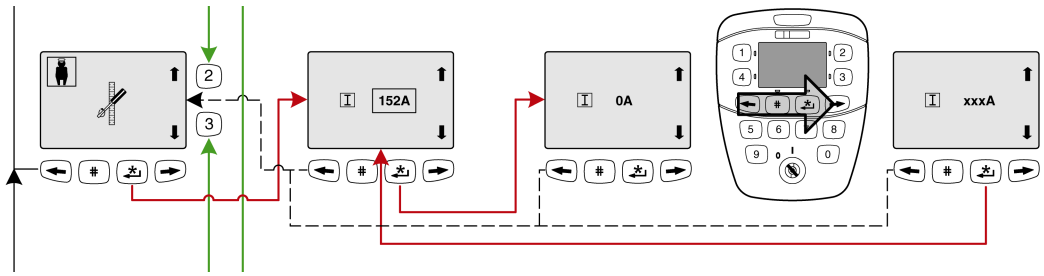
Acceleration



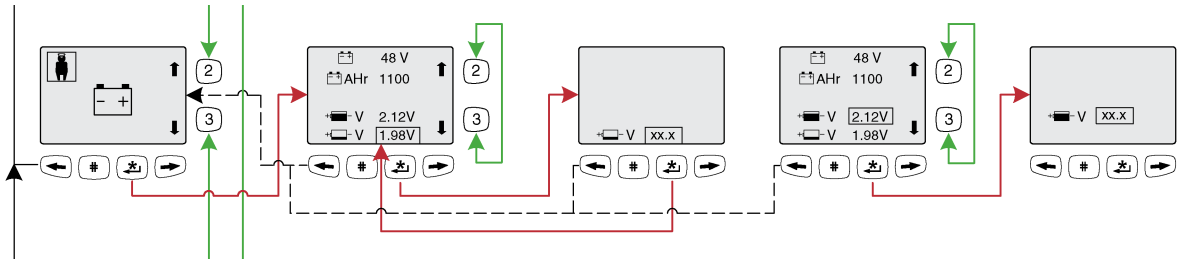
☞*Scroll to Function ↑ ↓	☞* ☜ To Select	Next Function ↑ ↓	☞* Enter Value Using Number Buttons ↑ ↓ ☞*

BDI Adjustment



☞* Scroll to Function ↑ ↓	☞* To Select	Enter Zero then desired number using Number Buttons ☞*

Battery



☞*Scroll to Function ↑ ↓	☞* To Select	Enter Value Using Number Buttons ☞*	Next Function ↑ ↓

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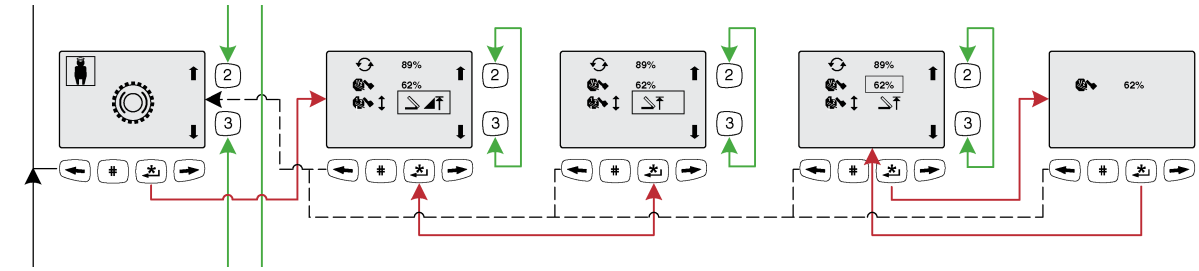
Braking			
			
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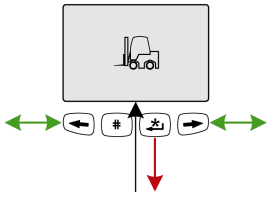
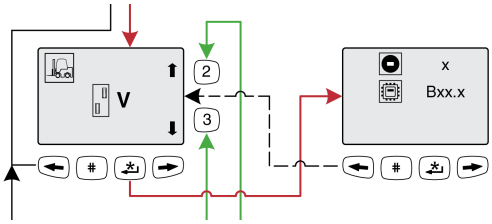
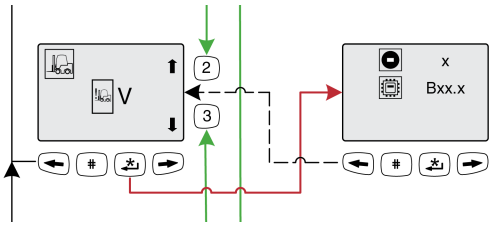
Table 9060-10-6. Truck Status

TRUCK STATUS		
		

VSM Version		
		
☞*	Hardware/Software Versions	

Impact Sensor Version


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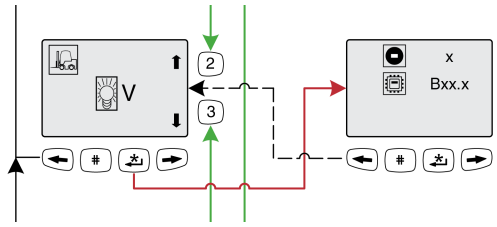
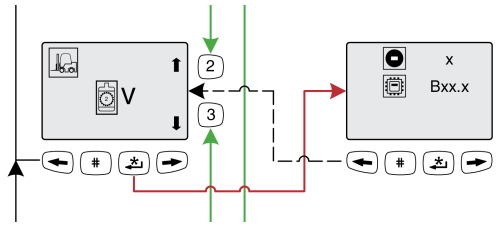
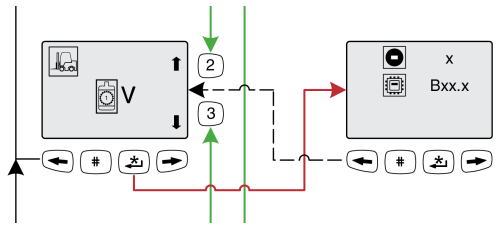
Light 1 Controller Version



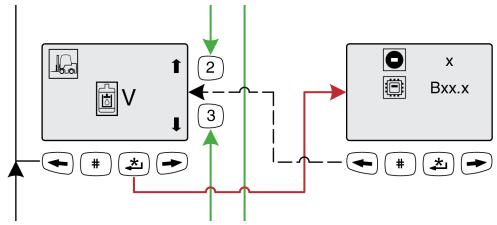
Traction 2 Controller Version



Traction 1 Controller Version



Pump Controller Version



☞*	Hardware/Software Versions	

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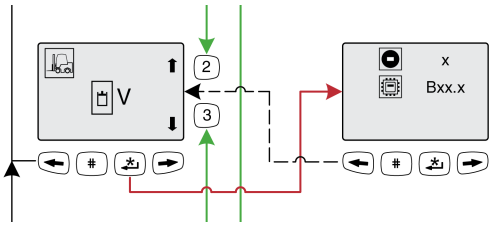
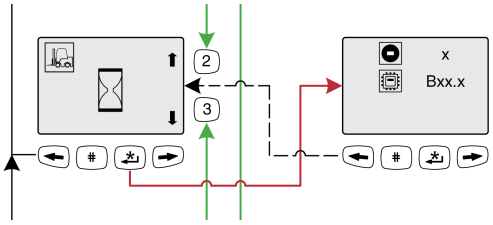
Hydraulic Input Controller Version

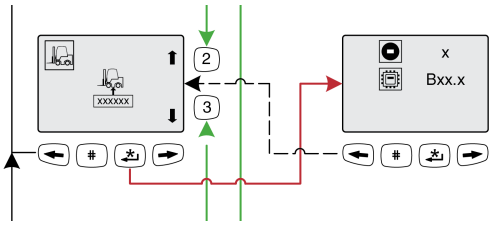


Hour Meters



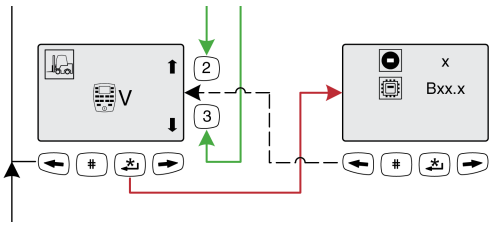
☞*	Traction/Pump/Truck/Secure	

Serial Number



☞*

Display Version



☞*	Hardware/Software Versions

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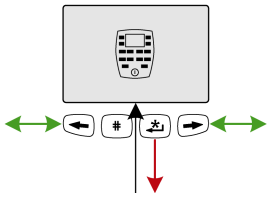
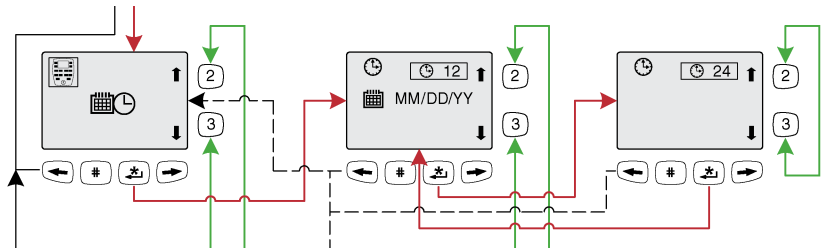
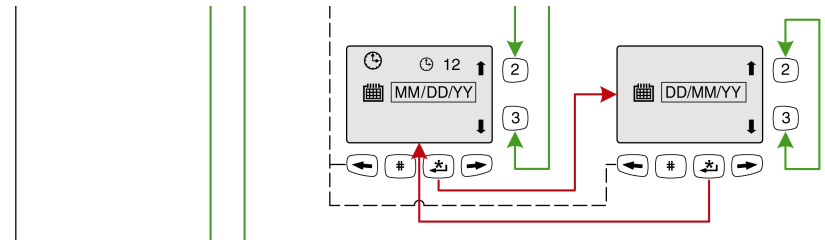
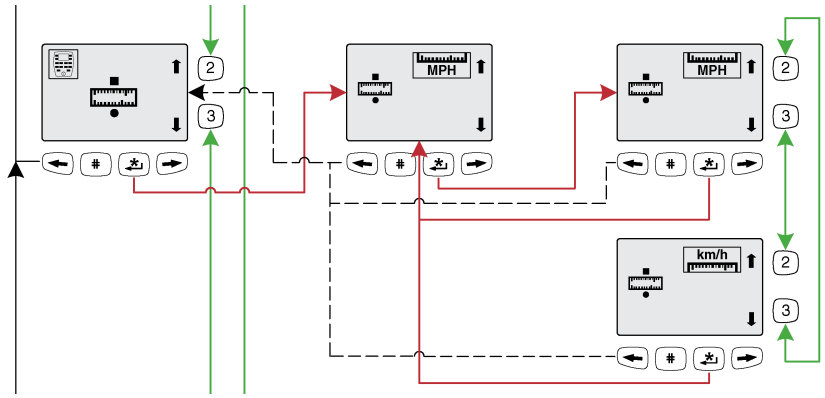
Table 9060-10-7. Display Adjustments

DISPLAY ADJUSTMENTS


Date/Time Format		
		
☞* Scroll to Function ↑ ↓	☞*Select	Scroll ↑ ↓ 12 - 24 ☞*
		
☞* Scroll to Function↑ ↓	☞*Select	Scroll ↑ ↓ MM/DD/YY - DD/MM/YY - YY/MM/DD ☞*

Units Selection (Imperial/Metric)		
		
☞*	☞*	Scroll ↑ ↓ Imperial - Metric ☞* ←

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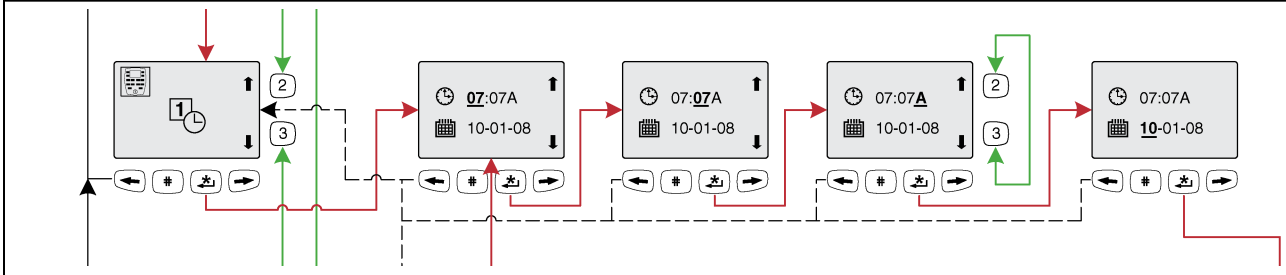
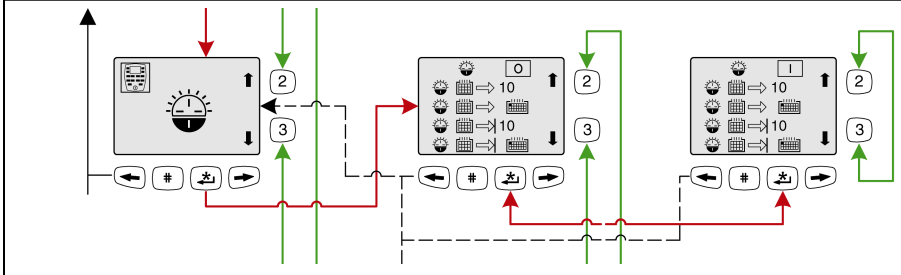
Date and Time



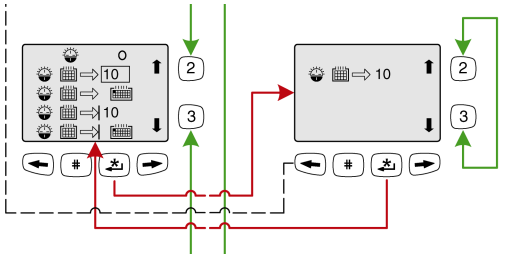
☞*	Enter Hours ☞*	Enter Minutes ☞*	Scroll ↑ ↓ AM - PM ☞*	Enter Month ☞*

		*☞ Enter Year	*☞ Enter Day

Daylight Savings



Daylight Savings OFF/ON ☞*	☞*☞	↑ ↓ Scroll to other Setups



Daylight Savings Start Month ☞*	Scroll to Month ↑ ↓ ☞*	

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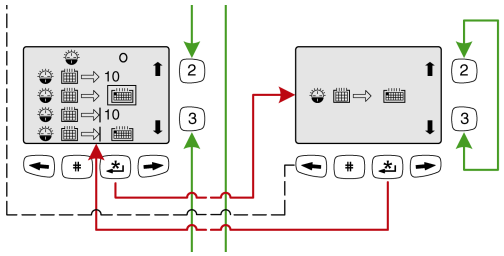
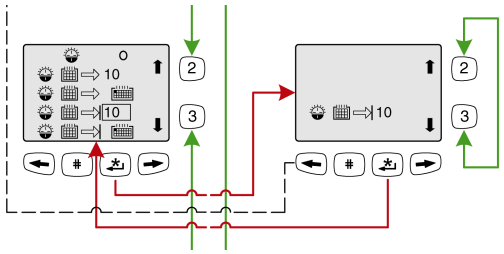
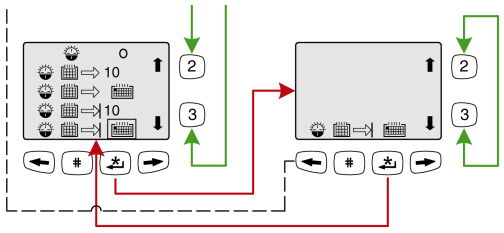
Daylight Savings		
		
Daylight Savings Start Day ☞*	Scroll to Day ↑ ↓ ☞*	
		
Daylight Savings End Month ☞*	Scroll to Month ↑ ↓ ☞*	
		
Daylight Savings End Day ☞*	Scroll to Day ↑ ↓ ☞*	

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Manual Hydraulic Control Levers

GENERAL DESCRIPTION

The Manual Control Levers (if installed) are used to control hydraulic operation of the mast lift/lower, tilt, and auxiliary functions.

SYSTEM COMPONENTS

The control levers are located to the right of the operator's seat. Each lever is explained below. See Figure 9060-10-4.

Lift/Lower

The lift/lower control lever is the first lever to the right of the operator's seat. Pull backward toward operator to raise the carriage and forks. Push forward to lower the carriage and forks.

Tilt

The tilt control lever is the second lever to the right of the operator's seat. Push the lever forward to tilt the mast and forks forward. Pull the lever backward toward operator to tilt the mast and forks backward.

Auxiliary 1

The third control lever is installed to the right of the tilt control lever. This lever can have two methods of operation, depending on the attachment.

- Trucks with clamp attachment: To engage the clamp attachment, press and hold the button on the left top side of the lever and move lever forward. When finger is removed from the button, the lever is locked in the neutral position and cannot be moved. To disengage the clamp function, press the button again and move lever backward.
- Trucks without clamp attachment: The lever is operated by moving it forward and backward. The lever is spring loaded to return to the neutral position when released.

Auxiliary 2

The fourth control lever is installed to the right of the third control lever. This lever can have two methods of operation, depending on the attachment.

- Trucks with clamp attachment: To engage the clamp attachment, press and hold the button on the left top side of the lever and move lever forward. When finger is removed from the button, the lever is locked in the neutral position and cannot be moved. To disengage the clamp function, press the button again and move lever backward.
- Trucks without clamp attachment: The lever is operated by moving it forward and backward. The lever is spring loaded to return to the neutral position when released.

Emergency Disconnect Switch

NOTE: The emergency disconnect switch does not remove power to the front or rear service lights.

The emergency disconnect switch, is located behind the Auxiliary 2 lever.

The operator can disconnect all electrical power to the lift truck by pushing the emergency disconnect switch in until it clicks. To reset the emergency disconnect switch and energize the electrical circuits, the operator must turn the switch clockwise until it pops out.

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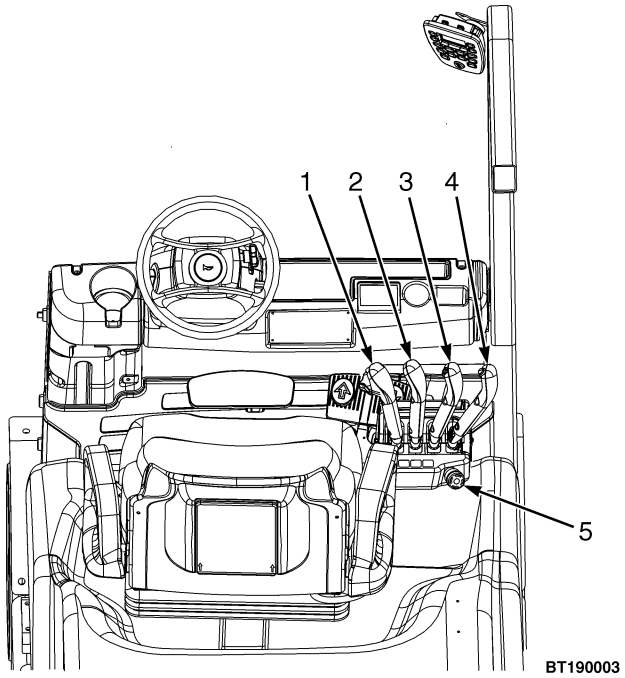

1. LIFT/LOWER CONTROL LEVER (1ST LEVER)
2. TILT CONTROL LEVER (2ND LEVER)
3. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)
4. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)
5. EMERGENCY DISCONNECT SWITCH

Figure 9060-10-4. Manual Hydraulic Control Levers

E-Hydraulic System Interface

GENERAL DESCRIPTION TO E-HYDRAULIC SYSTEM INTERFACE

Lift trucks may be equipped with an optional Electro-Hydraulic (E-Hydraulic) system. It controls hydraulic operation of the mast lift/lower, tilt, and auxiliary functions. This E-Hydraulic option replaces the manual control levers with simple, single-handed, finger-operated electronic controls, located on the right-hand armrest. The E-Hydraulic system is controlled by the VSM that provides drive commands to the hydraulic valves based on the operator inputs. This system automatically adjusts the flow control based on conditions such as speed, load, and functions activated, etc., to provide better controllability, and flexibility with the controls necessary to operate the E-Hydraulics. The VSM also monitors the performance of the system and reports faults to the operator through the Display Panel (DP).

To operate the Mini Lever Module (MLM), the operator must be positioned on the seat.

The MLM commands are sent to the VSM through the CANbus. The VSM supplies proportional commands to drive the electro-hydraulic valves. The VSM monitors the input and outputs signals, hydraulic response, and adjust the system performance as required. Faults or interlock conflicts are detected by the VSM which sends an error message (fault codes) to the Display Panel for operator awareness and correction.

The MLM consists of up to four individual proportional levers and may have additional momentary switches.

The control levers are located on the armrest. See Figure 9060-10-5.

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Lift/Lower

The electronic lift/lower control lever is the first mini-lever to the right of the operator's seat. Pull backward toward operator to raise the carriage and forks. Push forward to lower the carriage and forks.

Tilt

The electronic tilt control lever is the second mini-lever to the right of the operator's seat. Push the lever forward to tilt the mast and forks forward. Pull the lever backward toward operator to tilt the mast and forks backward.

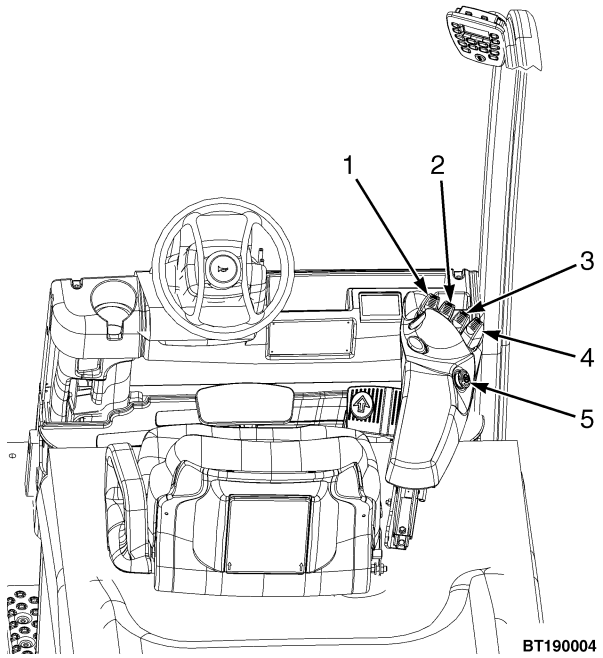
Return-To-Set-Tilt (RTST)

Optional: Return-To-Set-Tilt (RTST) — The RTST option assists the operator in positioning the mast at a predetermined set point. Note that the RTST function does not provide for "hands free" activation of the tilt valve. The operator must manually control both tilt speed and direction of the mast toward the set point.

When the mast is far away from the stop point, the operator is allowed to tilt at the maximum tilt flow rate. When the mast is close to the set point, the maximum tilt flow rate is limited.

If the RTST override button is not depressed before pushing the tilt lever. The RTST control soft stops the mast at the set point and disables the tilt valve even if the operator command is not at neutral. Once stopped the system waits for one of three options:

1. Return the tilt control lever back to neutral position, which places the tilt control to neutral.
2. Depress the RTST override button, which will override the RTST control and allow the tilt control to function. If the delay time is set to "continuous", the operator MUST press the override button to resume tilt control past the set point.
3. Waits for the RTST time delay of 0.1 to 3 seconds to time out, at which time the tilt control will be enabled and the mast will continue to tilt in the direction the control lever is pushed.



1. LIFT/LOWER MINI-LEVER (1ST LEVER)
2. TILT MINI-LEVER (2ND LEVER)
3. MINI-LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)
4. MINI-LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)
5. EMERGENCY DISCONNECT SWITCH

Figure 9060-10-5. E-Hydraulic Mini Lever Module

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If the RTST override button is depressed before pushing the tilt lever, and the RTST override button is depressed for 1/20th of a second and the tilt lever is moved out of neutral within one second of the button being released, the RTST control will not stop the mast at the set point. Once the lever is returned to neutral the override command will be cancelled and the RTST control will become active.

NOTE: The following time delay adjustments are available:

- Disable RTST
- 8 increments of time delay from 0.1 to 3.0 seconds
- "Continuous" time delay. If the time delay is set to continuous the operator MUST press the override button to resume tilt control.

A service technician may adjust the time delay.

Auxiliary 1

The third mini-lever is installed to the right of the tilt control lever. This lever can have two methods of operation, depending on the attachment.

- Trucks with clamp attachment: To engage the clamp, move the mini-lever backward. To disengage the clamp, press the override button located directly behind the mini-levers, and push the mini-lever forward.
- Trucks without clamp attachment three levers, and three function control valve: The lever is operated by moving it forward and back. The lever is spring loaded to return to the neutral position when released.
- Trucks with clamp attachment, three levers, and four function control valve: The third lever becomes a dual function lever. Move the lever forward and back to operate the auxiliary 1 function. Press and hold the lever down and move lever either forward or backward to operate the auxiliary 2 function. Remove hand from lever to disable the auxiliary 2 function and return lever to auxiliary 1 position. Do not press the override button. If the override button is pressed, the clamp will be engaged.

Auxiliary 2

NOTE: If truck is equipped with four function control valve, four levers and clamp attachment, the last (4th) lever controls clamp functions. If truck is equipped with five function control valve, four levers and clamp attachment, the clamp is the fifth function and the last (4th) lever controls clamp functions.

The fourth mini-lever is installed to the right of the control lever. This lever can have two methods of operation, depending on the attachment.

- Trucks with clamp attachment: To engage the clamp, move the mini-lever backward. To disengage the clamp, press the override button located directly behind the mini-levers, and push the mini-lever forward.
- Trucks without clamp attachment, four levers, and four function control valve: The lever is operated by moving it forward and back. The lever is spring loaded to return to the neutral position when released.
- Trucks with clamp attachment, four levers, and five function control valve: The third lever becomes a dual function lever. Move the lever forward and back to operate the auxiliary 1 function. Press and hold the lever down and move lever either forward or backward to operate the auxiliary 2 function. Remove hand from lever to disable the auxiliary 2 function and return lever to auxiliary 1 position. Do not press the override button. If the override button is pressed, the clamp will be engaged.

Emergency Disconnect Switch

NOTE: The emergency disconnect switch does not remove power to the front or rear service lights.

The emergency disconnect switch, is located on the right side of the armrest.

The operator can disconnect all electrical power to the lift truck by pushing the emergency disconnect switch in until it clicks. To reset the emergency disconnect switch and energize the electrical circuits, the operator must turn the switch clockwise until it pops out.

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Lighting Control

GENERAL DESCRIPTION

WARNING

Before replacing any of the lights, fully lower the mast and tilt the mast forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

Never have any metal on your fingers, arms, or neck. These metal items can cause short circuit and possible damage or injury.

CAUTION

A short circuit and damage can occur if wires are not installed correctly. Make sure wire connectors do not touch the other metal terminals or wire connectors, metal brackets, or the bracket mounting nuts. Make sure the wires are not pulled tight and are not touching other parts to damage the insulation.

There are several different options for lights used on the lift trucks. See Figure 9060-10-6. Your lift truck may not be equipped with all the lights.

The lighting control system consists of work lights, marker lights, strobe light, turn signal lights, stop/backup lights and dome light. The work lights are controlled by rocker switches located on the right side of the dash; turn signal lights are controlled by a lever on the steering column.

Front Work Lights

The front work lights rocker switch is located on the right side of the dash. The front work lights can be operated when the truck system power is **ON** or **OFF**. If the power is turned **OFF**, the work lights will continue to operate until the light switch on the dash is turned OFF.

Front Marker Lights

The front marker lights operate with the front work lights.

Front/Rear Turn Signal Lights

The front/rear turn signal lights are activated by a lever mounted on the left of the steering column. The activated signal light will continue to operate until the lever is manually returned to the center position or until system power is turned to **OFF**.

Rear Tail Lights

The rear tail light operate with the operation of the front work lights.

Rear Work Light

The rear work light switch is located on the right side of the dash. The rear work lights can only be operated when the truck system power is **ON** or **OFF**. If the power is turned **OFF**, the work lights will continue to operate until the light switch on the dash is turned OFF.

Rear Backup Lights

The rear backup lights operate when Reverse direction is selected.

Rear Stop Lights

The rear stop lights operate when the brake pedal is pressed.

Strobe Light

The strobe light operate when the truck power is **ON** or when a programmed function is selected.

Dome Light

The dome light is located on the left behind the operator. There is an ON/OFF switch on the dome light. The dome light is powered through an unswitched battery source and will operate with or without system power turned **ON**.

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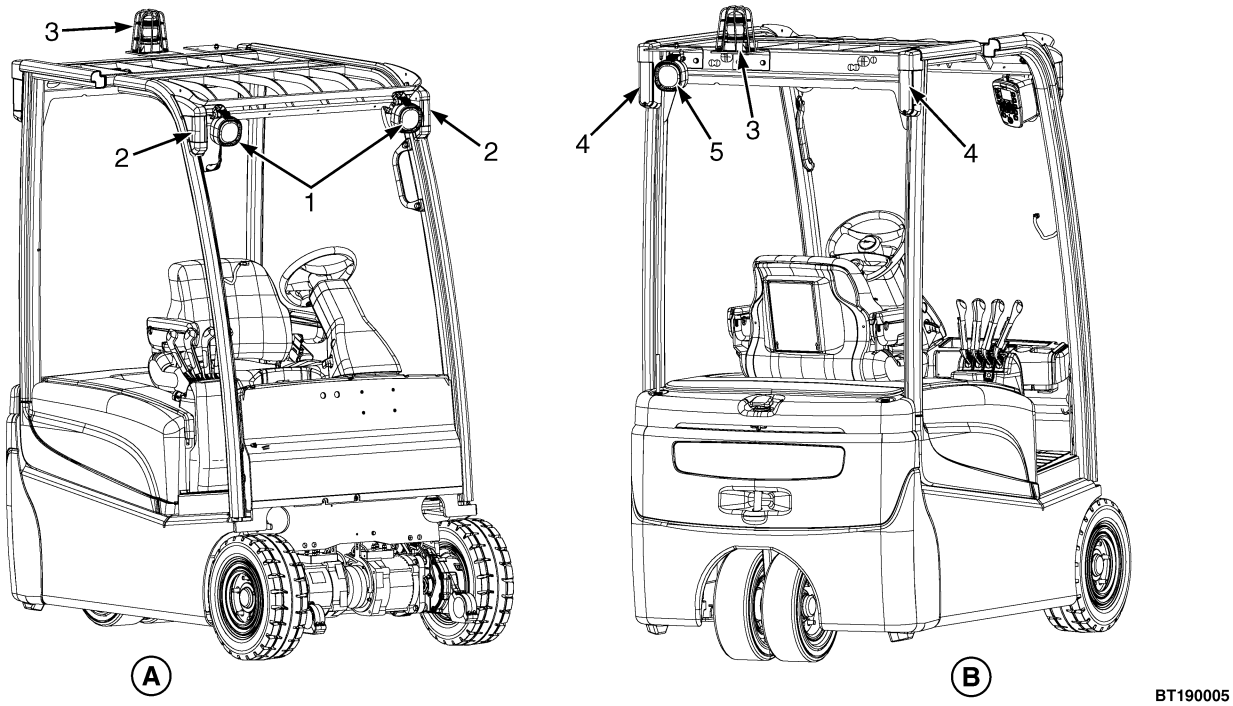

NOTE: LIGHT LOCATION ON LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268), J2.2- 3.5XN [J45-70XN] (A276), J1.5-2.0XNT (J30-40NT) (K160), AND J1.6-2.0XN (A935) ARE THE SAME. J1.5-2.0XNT (J30-40NT) (K160) IS SHOWN.

A. FRONT VIEW

1. FRONT WORK LIGHTS
2. FRONT MARKER/TURN SIGNAL LIGHTS*
3. STROBE LIGHT

B. REAR VIEW

4. LED TAIL, BACKUP, AND BRAKE LIGHTS
5. REAR WORK LIGHT

* FRONT MARKER/TURN SIGNAL LIGHTS USED ONLY ON J2.2- 3.5XN [J45-70XN] (A276), J1.5-2.0XNT (J30-40NT) (K160), AND J1.6-2.0XN (A935) LIFT TRUCK MODELS.

Figure 9060-10-6. Lights Arrangement

Cab Panels

GENERAL DESCRIPTION

Cab panels are offered as an option with the lift truck. The cab unit consists of individual panels installed on the overhead guard using cap screws. The panels include, a roof, side doors, front and rear windows. Front and rear window wipers, and heater system are available.

Covers and Floor Plates

Various covers and floor plates provide access to components during service and securely cover areas during normal operation. Covers in the floor of the operator compartment allow access to the traction controllers, AC drive motors, service and parking brakes. A cover on the top of the counterweight provides access to the hydraulic tank, hydraulic pump and motor assembly, and the hoist controller.

Hood and Seat

Hood

The hood is a stamped steel battery cover. Two hinges at the back attach to the overhead guard.

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The hood is the platform for the seat assembly and is located above the battery. It functions as a battery restraint that completely covers the battery compartment.

Seat

The seat assembly slides on seat rails that are fastened to the hood by four capscrews. A lever at the left front side of the base controls the adjustment of the seat to the forward and backward positions. Optional seats are available in cloth or vinyl with features such as non-suspension, full suspension, and limited swivel.

All seats have a seat switch installed in the bottom cushion that senses operator presence. When the operator is not on the seat, the seat switch opens and interrupts the controller stopping operation of the lift truck.

Cab Heating System

If included, the cab heater is located on the right hand door. The optional cab heater consists of the main plenum assembly, motor, fan, wiring harness, control unit with keypad, primary filter media, secondary filter media, and mounting hardware.

The fan draws outside air through the cab vent and into both filters before finally entering the plenum. A thermostat regulates operation of the electric heating element. Cab air is heated until plenum air temperature reaches a maximum of 35°C (95°F). At this maximum temperature the thermostat will automatically cut power to the element as a protective measure.

Operator keypad inputs command the control unit **ON** or **OFF**, change temperature and fan speed. Temperature settings can be adjusted in 1° increments shown on corresponding LCD screen. Operators can choose to display temperature in Celsius (C) or Fahrenheit (F). Fan speed is also adjusted using the keypad and corresponding displayed on a segmented graph.

By monitoring input voltage and current flow through components this heater will trigger error codes in the event of a malfunction. Basic onboard diagnostics guide service personnel in troubleshooting by displaying a variety of error codes. For details see **Operator's Cab** 0100SRM1446.

Control Panel

Controls the speed of the heater fan. The operator may choose to have the fan off or select from three fan speeds (low, medium, or high).

Plastic casing 85 x 72 x 25mm, for retractable or standalone mounting. 2 digits indicate selected temperature. The selected fan speed is indicated with a LED ladder.

Quartz crystal controlled microprocessor with program memory of flash type and EEPROM memory for operating parameters.

Operating voltage 12VDC from control board. Communication via RS- 485 interface. Different cable lengths up to 4m are available.

Heater Core

Functions as a heat exchanger allowing air that passes through the core to be heated. Battery power heats the elements within the core.

Heater Fan

Consists of a motor and two drum fans. Air is drawn in from outside the cab and is directed to flow across the heater core. The air is warmed by the heater core and flows out through adjustable vents located on the interior RH door housing.

24 VDC max 80W, of commutator or brush-less type. Driven by DC-DC converter with 8 speed levels at 14-24V

Wiper/Washer System

The wiper/washer system consists of the wiper motors, wiper arms, wiper blades and a washer bottle and pump. The front wiper and washer is operated by switches located on the dash. The rear wiper and washer switch is located in the headliner on the right side of the truck.

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NOTES

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SECTION 9070
FRONT END (MAST) AND CHASSIS

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Group 10

Principles of Operation

Front End, Mast

DESCRIPTION

This section provides general Principles of Operation for front end components. Therefore, the illustrations used are intended to provide only a general description of front end components. Since many details and specific repair procedures, vary, depending on your lift truck, see **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441. Depending on your lift truck, the description and repair for the tilt cylinders see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

The mast is used to lift a load vertically.

The mast has two movements controlled by hydraulic cylinders: forward and backward tilt, and the lifting and lowering of the mast and carriage. The outer mast tilts on the pivot pins at the mast mounts. The operation of the tilt cylinders causes the mast to tilt forward and backward. The tilt cylinders are fastened between the frame of the lift truck and the outer mast. Hydraulic lift cylinders are installed vertically in the mast. The lift cylinders raise and lower the intermediate/inner masts and the carriage.

There are four types of masts available:

- Two-Stage Limited Free-Lift
- Two-Stage Full Free-Lift
- Three-Stage Full Free-Lift
- Four-Stage Full Free-Lift.

Each type of mast is described separately in this section.

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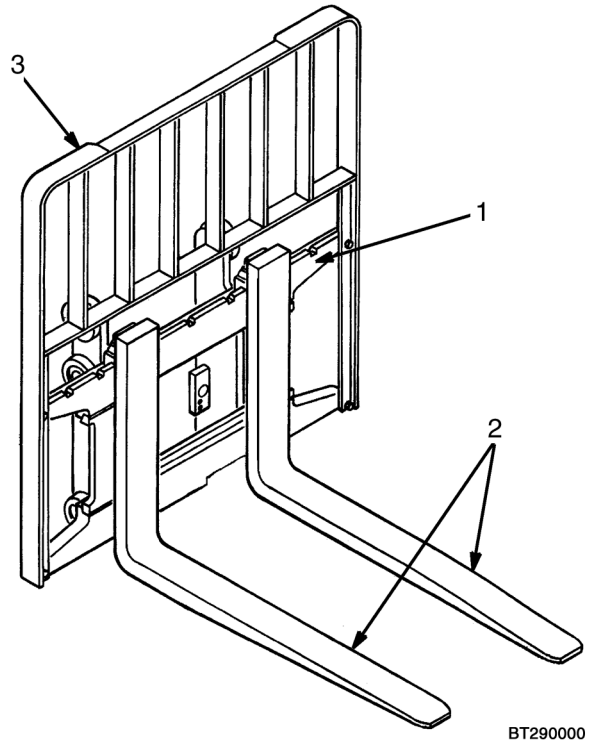
Carriages

DESCRIPTION

The carriage is a part of the mast assembly and moves within the vertical channels of the inner weldment. Load rollers, attached to the carriage, travel in the channels of the inner weldment. Forks or other types of load handling equipment are attached to the carriage. A load backrest extension is attached to the carriage and adds support for a load that has multiple pieces. See Figure 9070-10-1.



1. STANDARD CARRIAGE
2. FORKS
3. LOAD BACKREST EXTENSION

Figure 9070-10-1. Carriage

PRINCIPLES OF OPERATION

Integral Sideshift Carriage

The integral sideshift carriage lets the operator move the forks and load from side to side. This function makes it easier for the operator to align the forks with a load or align the load with a stack. The integral sideshift carriage is a complete inner carriage and outer frame assembly. The sideshift cylinder moves the outer frame assembly on the inner carriage. The fork spread control lever is the fourth manual lever. **PUSH** the lever **FORWARD** to move the forks apart. **PULL** the lever **BACKWARD** toward the operator to move the forks together. See Figure 9070-10-2.

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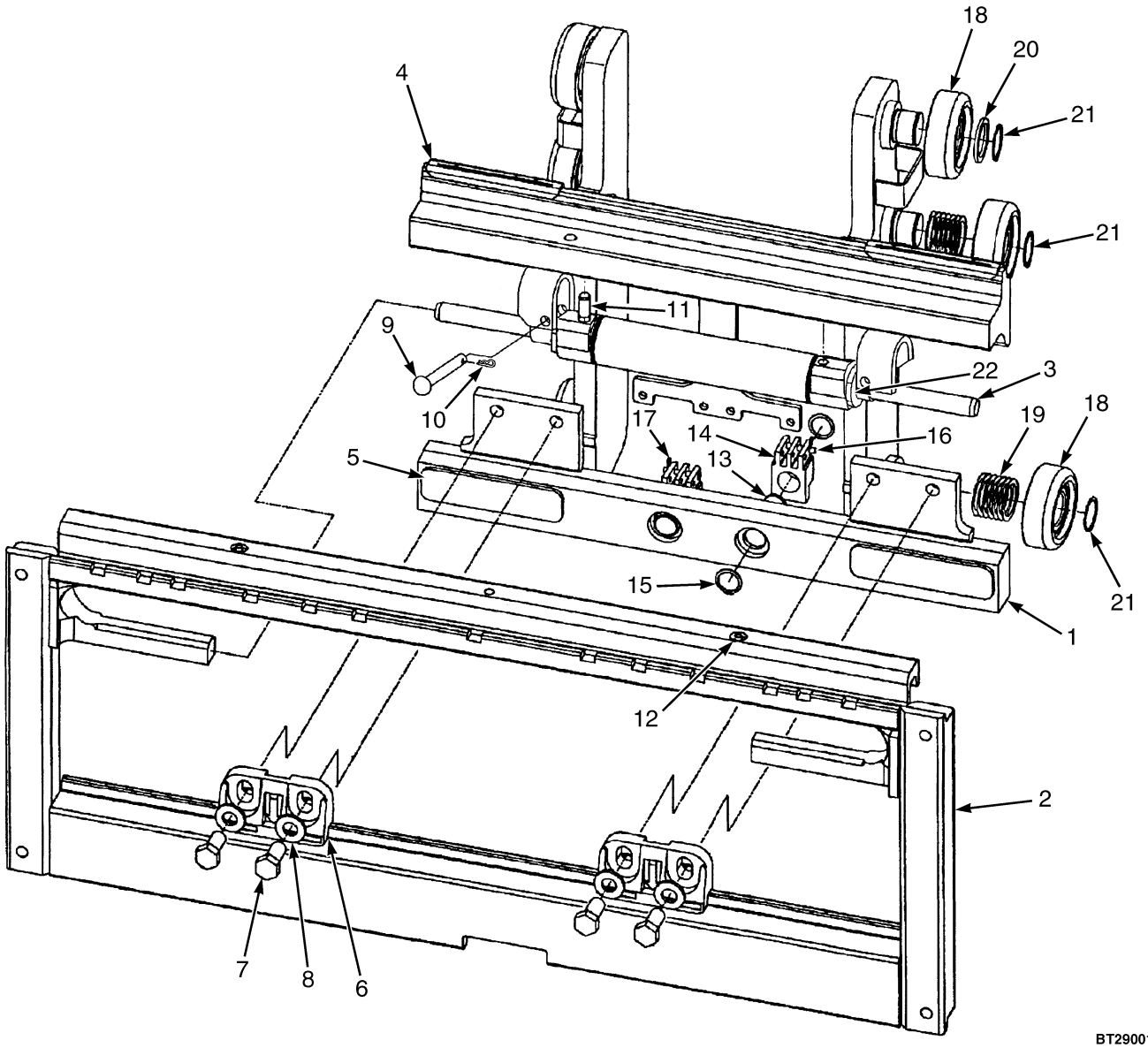

1. INNER CARRIAGE
2. OUTER FRAME
3. SIDESHIFT CYLINDER
4. UPPER BEARING
5. LOWER BEARING
6. LOWER HOOK
7. CAPSCREW
8. WASHER
9. CLEVIS PIN
10. HAIRPIN
11. PIN
12. LUBE FITTING
13. PIN
14. CHAIN ANCHOR
15. SNAP RING
16. PIN
17. COTTER PIN
18. LOAD ROLLER
19. SHIMS
20. SPACER
21. SNAP RING
22. SPACER

Figure 9070-10-2. Integral Sideshift Carriage

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Mast Mounts

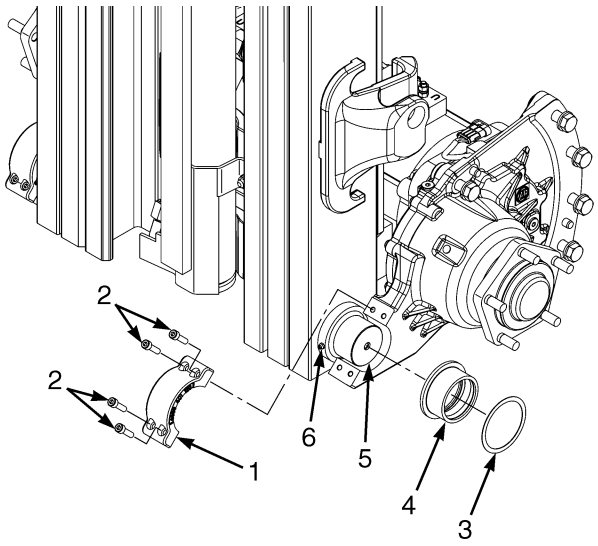
DESCRIPTION

The lower crossmember of the outer mast has castings to mount the mast mounting stubshaft. The mounting stubshafts are installed in the castings and the mast is hung on the hangers of the drive axle housing. Capscrews secure the mounting stubshaft to the drive axle housing. See Figure 9070-10-3.

The mast tilt cylinders are attached to the mast upper attachment castings using rod end fittings. Pins attach the rod end fittings to the casting and are secured with anchor pins and capscrews.

PRINCIPLES OF OPERATION

The mast and attached forks can tilt forward and backward. Tilt cylinders are fastened between the lift truck frame and the outer mast upper attachment points. The operator uses the Mini Lever Module controls to extend or retract the tilt cylinders, changing the angle of the mast that pivots on the mounting stubshafts mounted on the drive axle housing.



1. RETAINER CAP
2. CAPSCREWS
3. SHIM
4. BUSHING
5. MAST MOUNT STUBSHAFT
6. GREASE FITTING

Figure 9070-10-3. Mast Mounts

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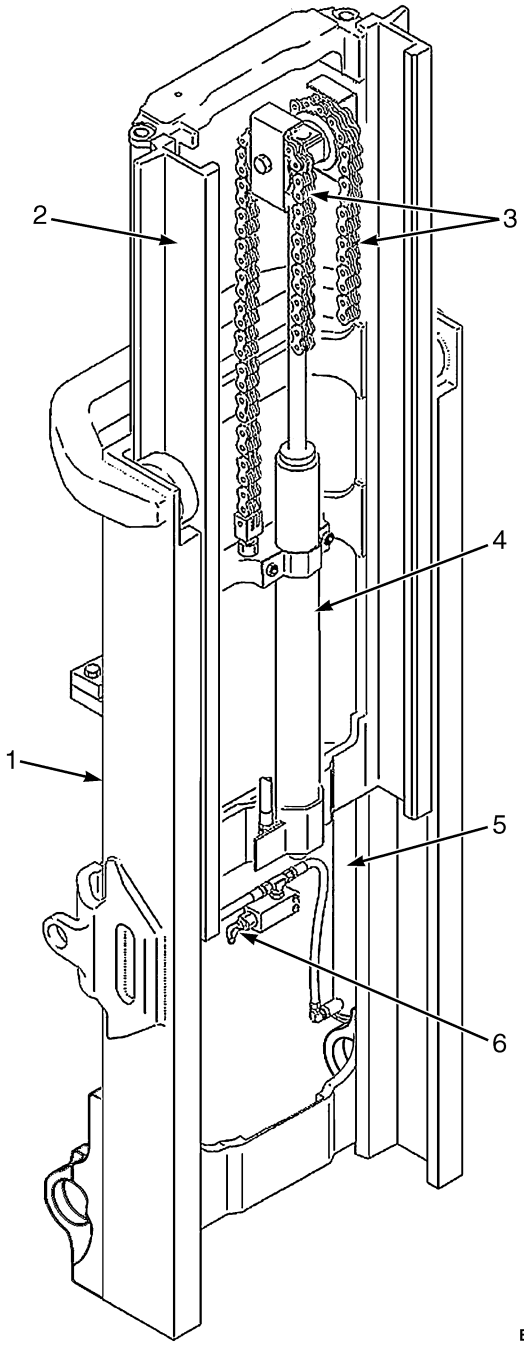
Two-Stage Full Free-Lift (FFL) Mast

DESCRIPTION

The Two-Stage Full Free-Lift Mast has an inner mast and an outer mast. See Figure 9070-10-4. It is called a full free-lift mast because the carriage can travel to the top of the inner mast without extending the inner mast. The full free-lift mast has the same load roller and strip bearing arrangements as the two-stage, limited free-lift mast.

The two main lift cylinders are installed at the back of the outer mast. The base of each lift cylinder sits in a mount on the bottom crossmember of the outer mast. The top of each lift cylinder rod fits into a guide on the top crossmember of the inner mast. The free-lift cylinder is installed in the inner mast. Each of the lift cylinders has an internal lowering control valve. A single external lowering control valve is connected by tubing and hoses to all the lift cylinders.

The free-lift chains connect at one end to the mid-crossmember of the inner mast. Two chain sheaves are installed on a crosshead on the rod of the free-lift cylinder. The chains go over sheaves on the crosshead and connect to the carriage.



NOTE: TYPICAL MAST ASSEMBLY IS SHOWN.

1. OUTER MAST
2. INNER MAST
3. FREE-LIFT CHAIN
4. FREE-LIFT CYLINDER
5. MAIN LIFT CYLINDER(S)
6. LOWERING CONTROL VALVE (EXTERNAL)

Figure 9070-10-4. Two-Stage (FFL) Mast

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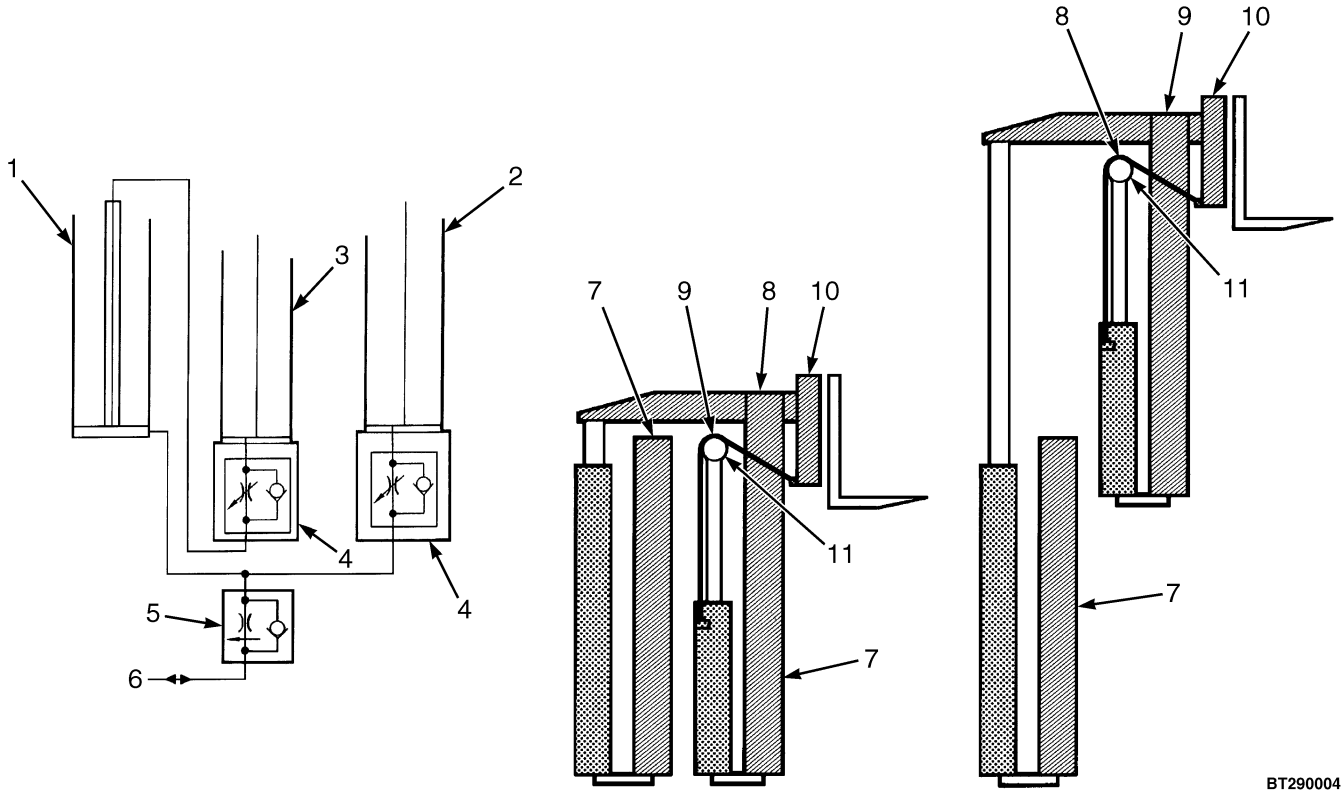
PRINCIPLES OF OPERATION

The three lift cylinders are connected by hoses and tubing as shown in Figure 9070-10-5. When the mast is extended, oil flows from the main control valve to the base of the main lift cylinders. The oil flows through the left-hand cylinder rod and through tubing to the base of the free-lift cylinder. The free-lift cylinder raises only the carriage. When the free-lift cylinder is fully extended, the two main lift cylinders extend the inner mast. The free-lift cylinder extends first because it has less weight to lift and a lower operating pressure. When the load is lowered, the main lift cylinders lower first because they have a greater load and a higher operating pressure. The oil flows from the main lift cylinders, through the lowering control valve to the hydraulic tank. Oil from the free-lift cylinder flows from the cylinder through tubing to the left-hand main lift cylinder rod. The oil flows from the left-hand main lift cylinder to the hydraulic tank.

The free-lift cylinder must have 150 cc (5 oz) of oil above the piston. This oil provides a hydraulic cushion when the cylinder reaches the top of its stroke. An orifice system in the piston provides the hydraulic cushioning. When the cylinder is fully extended, any excess oil above the piston is forced through the check valve in the piston.

The right-hand main lift cylinder has an orifice system in the bottom of the rod assembly. This system provides a hydraulic cushion when the cylinder reaches the bottom of its stroke.



1. RIGHT-HAND LIFT CYLINDER
2. LEFT-HAND LIFT CYLINDER
3. FREE-LIFT CYLINDER
4. LOWERING CONTROL VALVE (INTERNAL)
5. LOWERING CONTROL VALVE (EXTERNAL)
6. TO/FROM MAIN CONTROL VALVE
7. OUTER MAST
8. INNER MAST
9. FREE-LIFT CHAINS
10. CARRIAGE
11. CHAIN SHEAVES

Figure 9070-10-5. Operation of Two-Stage (FFL) Mast

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Two-Stage Limited Free-Lift (LFL) Mast

DESCRIPTION

The Two-Stage Limited Free-Lift Mast has an outer mast, an inner mast, and two lift cylinders. See Figure 9070-10-6. At the base of the inner mast there is one load roller on each side. These load rollers travel along the flanges inside the outer mast channel. At the top of the outer mast there is also one load roller on each side. These load rollers travel along the flanges on the outside of the inner mast. The angle of the load rollers permits them to control the forces from the front, back, and sides of the mast. The strip bearings are installed at the top of the outer mast. The strip bearings can be adjusted by shims to help keep the correct clearance between the outer mast and the inner mast.

The two single-stage lift cylinders are installed at the back of the outer mast. The base of each lift cylinder sits in a mount on the bottom crossmember of the outer mast. The top of each lift cylinder rod fits into a guide on the top crossmember of the inner mast. Operation of the lift cylinders extends and retracts the inner mast. See Figure 9070-10-7.

PRINCIPLES OF OPERATION

Two lift chains move the carriage. The chains fasten to mounts that are near the top of the lift cylinder shells as shown in Figure 9070-10-7. The chains go up and over the chain sheaves and connect to the carriage. The chain sheaves are installed at the top crossmember of the inner mast. When the lift cylinders extend, the lift chains transfer the force from the lift cylinders to the carriage. The inner mast and carriage raise a small amount before the overall height of the mast increases. During lifting, the inner mast moves at the same speed as the lift cylinders. The carriage moves at twice the speed of the inner mast/lift cylinders.

When the lift cylinders retract, the weight of the load, carriage, forks, load backrest extension and attachment, and inner mast pushes the oil from the lift cylinders. The oil flows from the lowering control valves in the lift cylinders, through the external lowering control valve to the hydraulic tank.

Each cylinder has a check valve in the bottom of the rod assembly. When the cylinder is fully extended, any oil above the piston is forced through the check valve.

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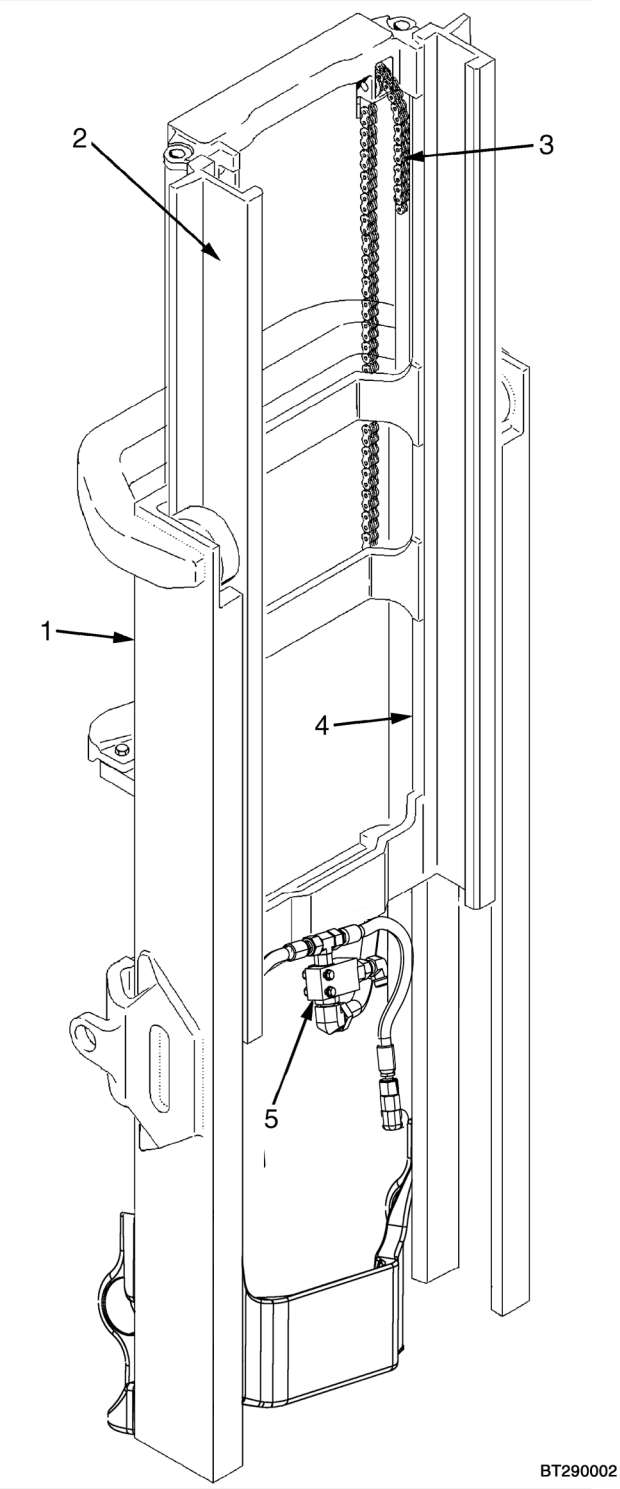

Figure 9070-10-6. Two-Stage (LFL) Mast

Legend for Figure 9070-10-6

NOTE: TYPICAL MAST ASSEMBLY IS SHOWN.

1. OUTER MAST
2. INNER MAST
3. LIFT CHAIN(S)
4. LIFT CYLINDER(S)
5. LOWERING CONTROL VALVE (EXTERNAL)

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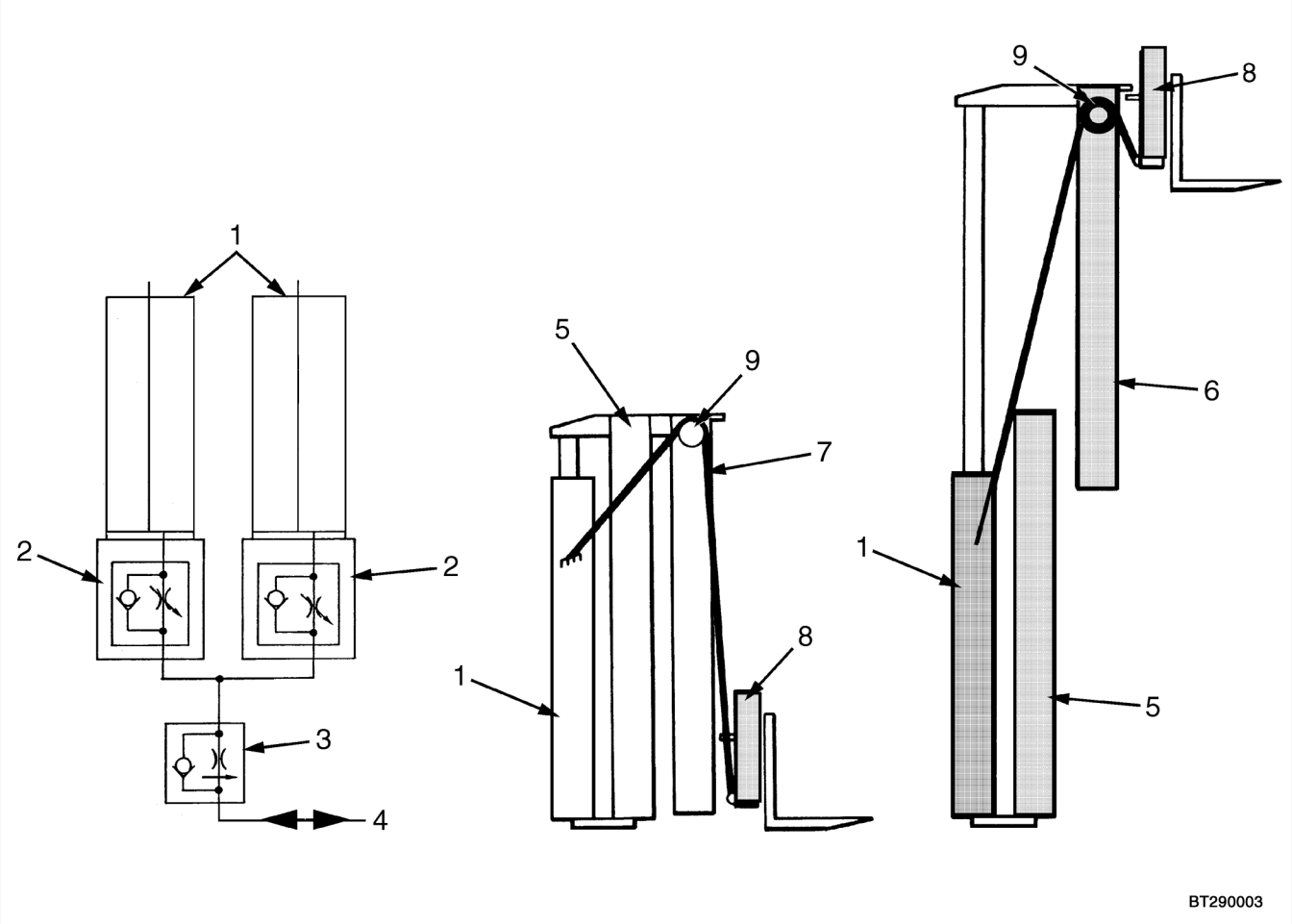

1. LIFT CYLINDER
2. LOWERING CONTROL VALVE (INTERNAL)
3. LOWERING CONTROL VALVE (EXTERNAL)
4. TO/FROM MAIN CONTROL VALVE
5. OUTER MAST
6. INNER MAST
7. LIFT CHAINS
8. CARRIAGE
9. CHAIN SHEAVES

Figure 9070-10-7. Operation of Two-Stage (LFL) Mast

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Three-Stage Full Free-Lift (FFL) Mast

DESCRIPTION

The Three-Stage Full Free-Lift Mast has three masts: outer, intermediate, and inner. See Figure 9070-10-8. Two single-stage main lift cylinders and a free-lift cylinder are used to raise the carriage and extend the intermediate and inner mast. It is called a full free-lift mast because the carriage can travel to the top of the inner mast without extending the inner mast. The masts are telescopic and have the load roller and strip bearing arrangements similar to the two-stage mast.

The load rollers are installed at the top of the outer and intermediate masts. Load rollers are also used at the bottom of the intermediate and inner masts. These load rollers travel along the flanges of the mast channels. The angle of the load rollers permits them to control the forces from the front, back, and sides of the mast. The strip bearings are installed at the top of the outer and intermediate masts and help keep the correct clearance between the masts. The load rollers and strip bearings are adjustable with shims.

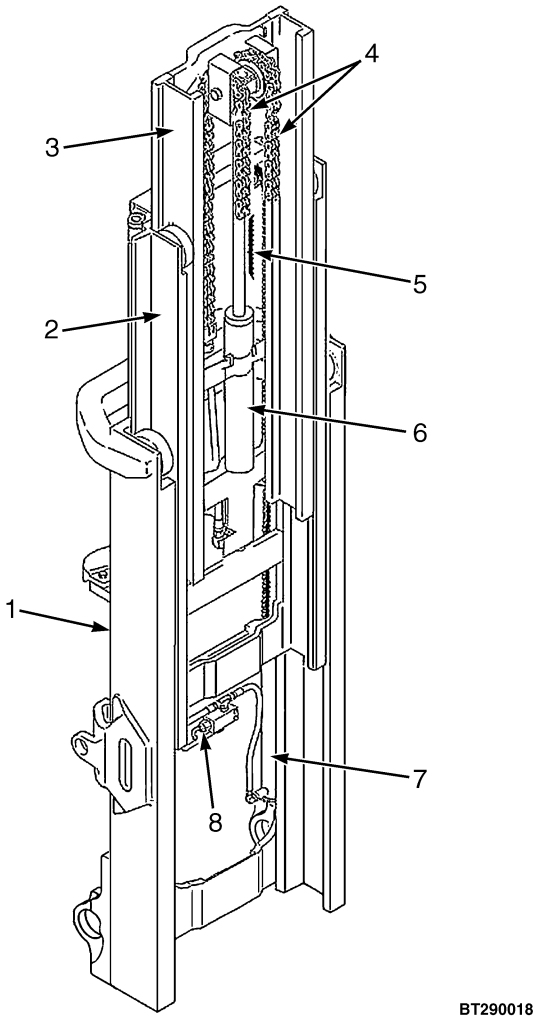
The two main lift cylinders are installed at the back of the outer mast. The base of each main lift cylinder sits in a mount on the bottom crossmember of the outer mast. The top of each main lift cylinder rod fits into a guide in the top crossmember of the intermediate mast. The free-lift cylinder is installed to the inner mast. Each lift cylinder has an internal lowering control valve. A single external lowering control valve is connected by tubing and hoses to all of the lift cylinders.

The two main lift chains are connected to mounts that are welded near the top of the main lift cylinder shells. The lift chains go over sheaves at the top of the intermediate mast and fasten at the bottom of the inner mast.

The free-lift chains connect at one end to the mid-crossmember of the inner mast. Two chain sheaves are installed on a crosshead on the cylinder rod of the free-lift cylinder. The chains go over sheaves on the crosshead and connect to the carriage.

PRINCIPLES OF OPERATION

The three hydraulic cylinders are connected by hoses and tubing as shown in Figure 9070-10-9. When the mast is extended, oil from the main control valve flows to all cylinders at the same time. The free-lift cylinder extends first because it lifts the least amount of weight and has a lower operating pressure. The free-lift cylinder raises only the carriage. After the free-lift cylinder reaches the end of its stroke, the main lift cylinders begin to extend. As the main lift cylinders extend, the intermediate mast is raised by the main lift cylinders and the inner mast is raised by the main lift chains.



NOTE: TYPICAL MAST ASSEMBLY IS SHOWN.

1. OUTER MAST
2. INTERMEDIATE MAST
3. INNER MAST
4. FREE-LIFT CHAIN
5. MAIN LIFT CHAIN(S)
6. FREE-LIFT CYLINDER
7. MAIN LIFT CYLINDER(S)
8. LOWERING CONTROL VALVE (EXTERNAL)

Figure 9070-10-8. Three-Stage (FFL) Mast

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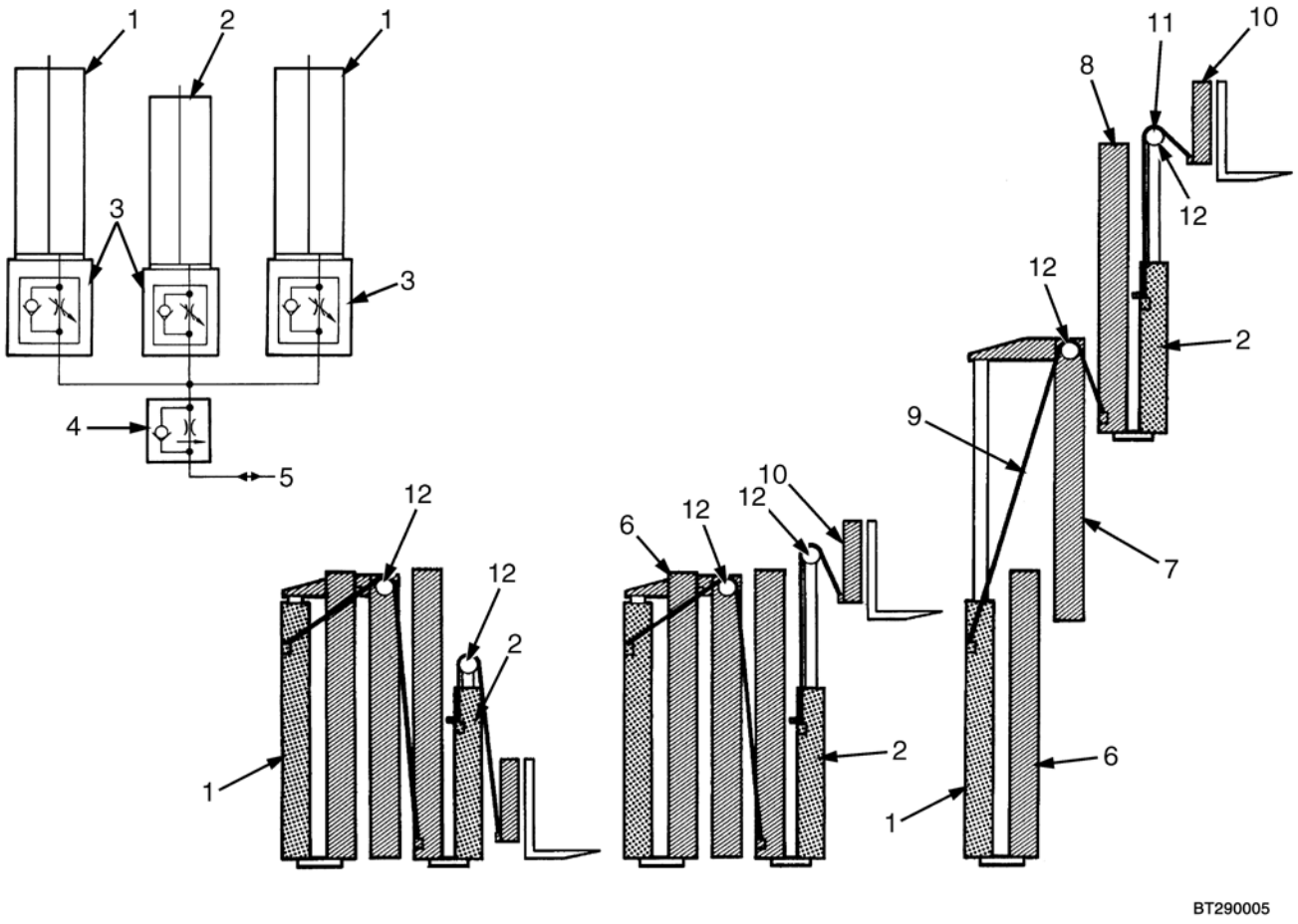
During lowering, the main lift cylinders lower first because they have a greater load and higher operating pressure. After the main lift cylinders have retracted, the free-lift cylinder lowers. All oil from the lift cylinders flows through the lowering control valves to the hydraulic tank.

The free-lift cylinder must have 150 cc (5 oz) of oil above the piston. This oil provides a hydraulic cushion when the cylinder reaches the top of its stroke. An orifice system in the piston provides the hydraulic cushioning. When the cylinder is fully extended, any excess oil above the piston is forced through the check valve.

Each main lift cylinder has an orifice system and a check valve in the bottom of the rod assembly. When the cylinder is fully extended, any oil between the rod end and the gland is forced through the check valve. The orifice system provides a hydraulic cushion when the cylinder reaches the bottom of its stroke.



1. LIFT CYLINDER
2. FREE-LIFT CYLINDER
3. LOWERING CONTROL VALVE (INTERNAL)
4. LOWERING CONTROL VALVE (EXTERNAL)
5. TO/FROM MAIN CONTROL VALVE
6. OUTER MAST
7. INTERMEDIATE MAST
8. INNER MAST
9. MAIN LIFT CHAINS
10. CARRIAGE
11. FREE-LIFT CHAINS
12. CHAIN SHEAVES

Figure 9070-10-9. Operation of Three-Stage (FFL) Mast

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Four-Stage Full Free-Lift (FFL) Mast

DESCRIPTION

The Four-Stage Full Free-Lift (FFL) Mast has four masts: outer, first intermediate, second intermediate, and inner. See Figure 9070-10-10. Two single-stage main lift cylinders and a free-lift cylinder are used to raise the carriage and extend the intermediate and inner masts. It is called a full free-lift mast because the carriage can travel to the top of the inner mast without extending the inner mast.

The masts are telescopic and have load roller and strip bearing arrangements similar to the three-stage mast. The load rollers are installed at the top of the outer, first, and second intermediate masts. Load rollers are also used at the bottom of the first and second intermediate masts and the inner mast. These load rollers travel along the flanges of the mast channels. The angle of the load rollers permits them to control the forces from the front, back, and sides of the mast. The strip bearings are installed at the top of the outer, first, and second intermediate masts and help keep the correct clearance between the masts. The load rollers and strip bearings are adjustable with shims.

The two main lift cylinders are installed at the back of the outer mast. The base of each main lift cylinder sits in a mount on the bottom crossmember of the outer mast. The top of each main lift cylinder rod fits into a guide in the top crossmember of the first intermediate mast. The free-lift cylinder is installed to the inner mast. The free-lift and left-hand main lift cylinder has an internal lowering control valve. A single external lowering control valve is connected by tubing and hoses to all of the lift cylinders.

The main lift chains connect to mounts that are near the top of the outer mast. The lift chains then go over sheaves at the top of the first intermediate mast and fasten at the bottom of the second intermediate mast.

The intermediate lift chains connect to mounts that are near the top of the first intermediate mast. The lift chains then go over sheaves at the top of the second intermediate mast and fasten at the bottom of the inner mast.

The free-lift chains connect at one end to the mid-crossmember of the inner mast. Two chain sheaves are installed on a crosshead on the cylinder rod of the free-lift cylinder. The chains then go over sheaves on the crosshead and connect to the carriage.

PRINCIPLES OF OPERATION

The three hydraulic cylinders are connected by hoses and tubing as shown in Figure 9070-10-11. When the mast is extended, oil flows from the main control valve to the base of the main cylinders. The oil flows through the right-hand cylinder rod and through a tube and hose to the base of the free-lift cylinder. The free-lift cylinder extends first because it lifts the least amount of weight and has a lower operating pressure. The free-lift cylinder raises only the carriage. After the free-lift cylinder reaches the end of its stroke, the main lift cylinders begin to extend. As the main lift cylinders extend, the first intermediate mast is raised by the main lift cylinders. The second intermediate and inner masts are raised by the main and intermediate lift chains. See Figure 9070-10-12.

During lowering, the main lift cylinders lower first because they have a greater load and higher operating pressure. After the main lift cylinders have retracted, the free-lift cylinder lowers. All oil from the lift cylinders flows through the lowering control valves to the hydraulic tank.

The free-lift cylinder must have 150 cc (5 oz) of oil above the piston. This oil provides a hydraulic cushion when the cylinder reaches the top of its stroke. An orifice system in the piston provides the hydraulic cushioning. When the cylinder is fully extended, any excess oil above the piston is forced through the check valve in the piston.

The left-hand main cylinder has an orifice system and check valve in the bottom of the rod assembly. The top of the right-hand cylinder is connected to the left-hand main cylinder by a tube. When the main cylinders are fully extended, any oil between the rod end and the gland is forced through the check valve in the bottom of the left-hand main cylinder. The orifice system in the bottom of the left-hand main cylinder provides a hydraulic cushion when the cylinder reaches the bottom of its stroke.

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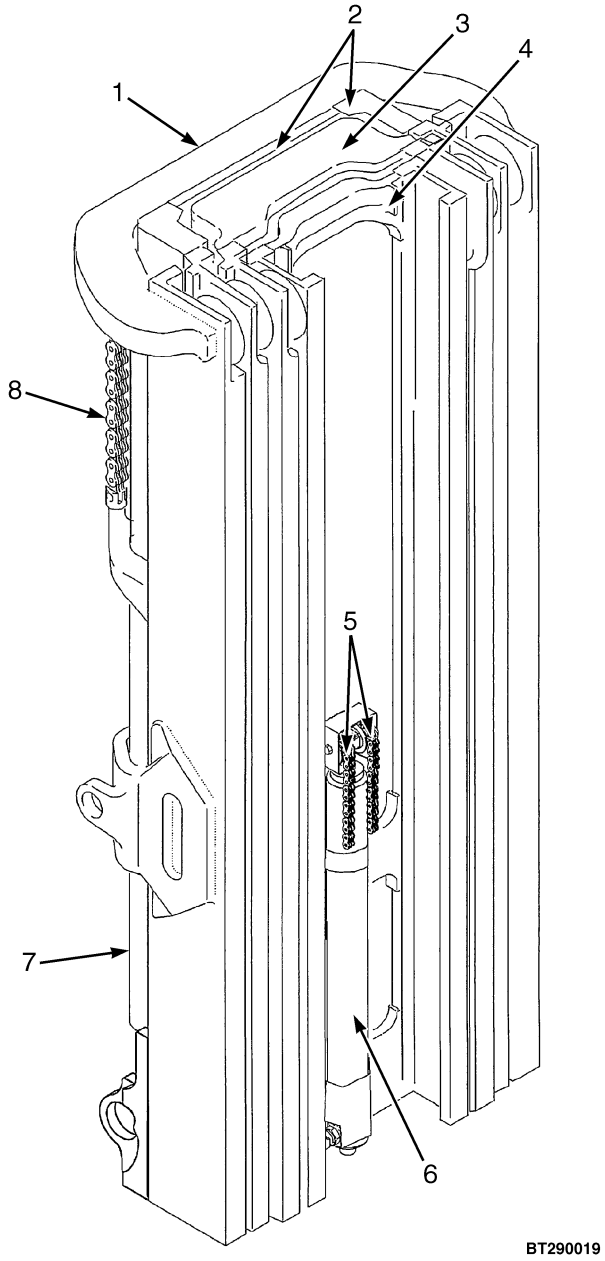
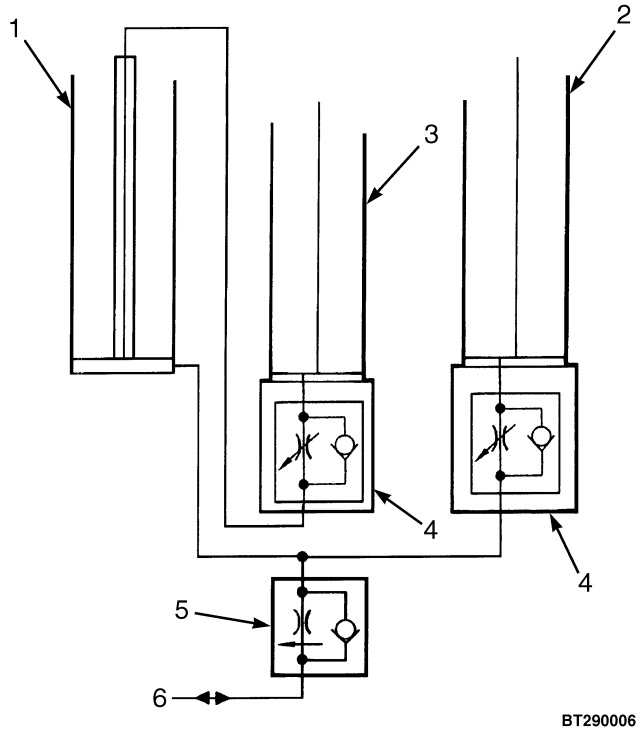


1. OUTER MAST
2. FIRST INTERMEDIATE MAST
3. SECOND INTERMEDIATE MAST
4. INNER MAST
5. FREE-LIFT CHAINS
6. FREE-LIFT CYLINDER
7. MAIN LIFT CYLINDERS
8. LIFT CHAINS

Figure 9070-10-10. Four-Stage (FFL) Mast



1. MAIN LIFT CYLINDER (LEFT-HAND)
2. FREE-LIFT CYLINDER
3. MAIN LIFT CYLINDER (RIGHT-HAND)
4. SECONDARY LOWERING CONTROL VALVE (EXTERNAL)
5. PRIMARY LOWERING CONTROL VALVE (EXTERNAL)
6. TO/FROM MAIN CONTROL VALVE

Figure 9070-10-11. Hydraulic Schematic for Mast Cylinders

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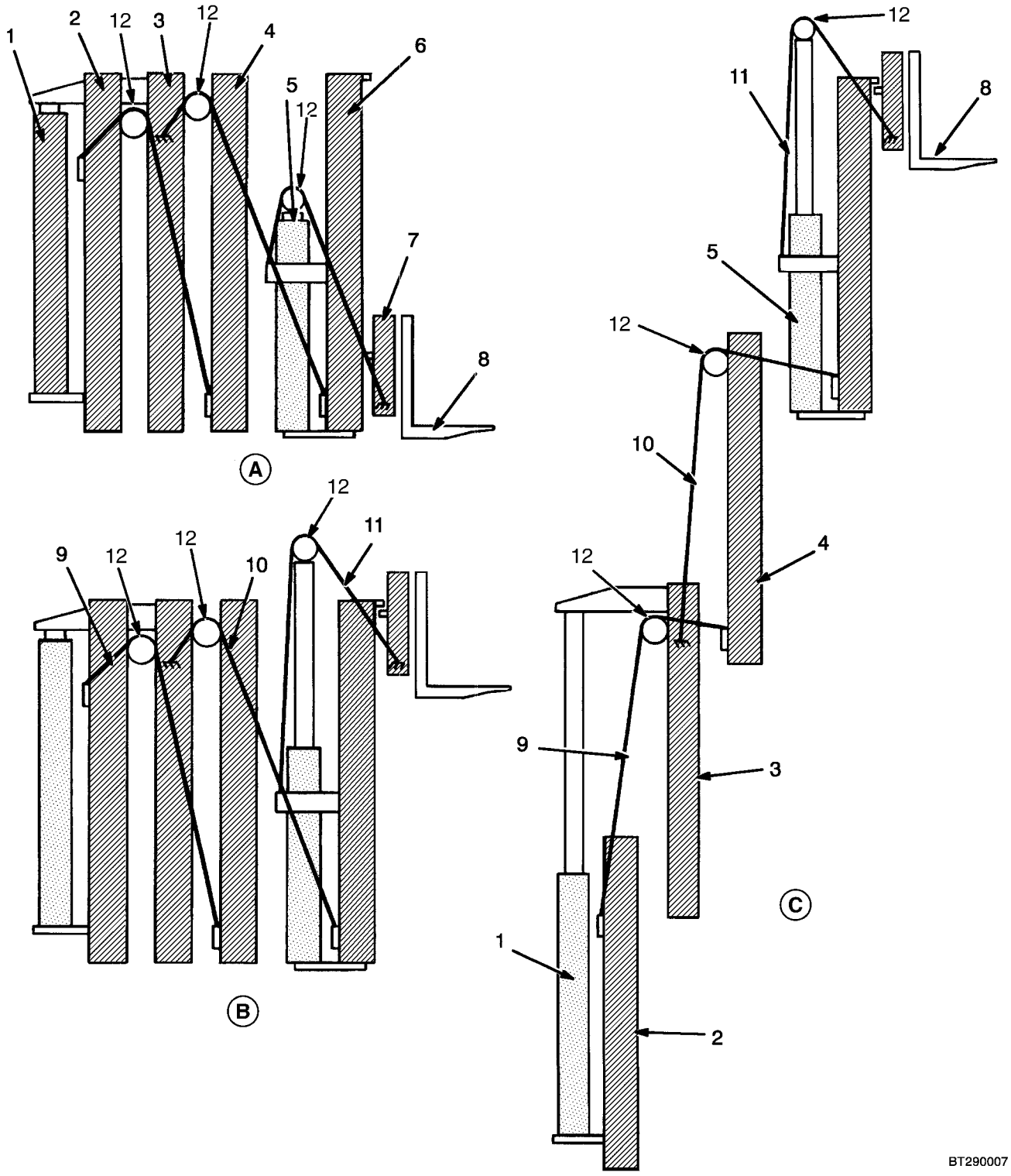

Figure 9070-10-12. Operation of Four-Stage (FFL) Mast

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Legend for Figure 9070-10-12

A. LOWERED
B. FREE-LIFT
C. FULLY RAISED

1. MAIN LIFT CYLINDER
2. OUTER MAST
3. FIRST INTERMEDIATE MAST
4. SECOND INTERMEDIATE MAST
5. FREE-LIFT CYLINDER
6. INNER MAST
7. CARRIAGE
8. FORK
9. MAIN LIFT CHAINS
10. INTERMEDIATE LIFT CHAINS
11. FREE-LIFT CHAINS
12. CHAIN SHEAVES

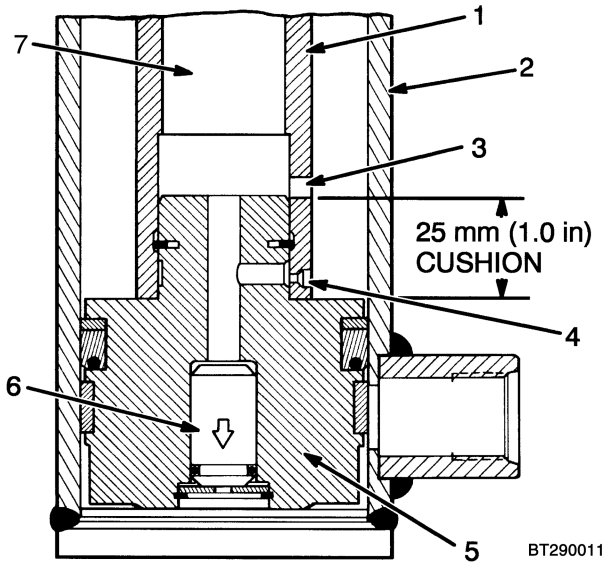
Cylinder Cushion During Lifting Sequence

DESCRIPTION

The hydraulic action at the end of the free-lift stroke provides a cushion effect for the free-lift cylinder and a smooth transition between the free-lift phase and the mast extension phase (main cylinder extension). All masts with a free-lift cylinder in this section use this design.

PRINCIPLES OF OPERATION

There is hydraulic oil on the rod side of the piston of the free-lift cylinder. When the cylinder rod extends to the last 25 mm (1.0 in.) of its stroke, the gland at the top of the cylinder closes the larger hole. During this part of the cylinder stroke, the hydraulic oil must flow through the orifice to the air cavity. This action increases the hydraulic pressure so the main lift cylinders begin to extend. See Figure 9070-10-13.



1. CYLINDER ROD
2. CYLINDER SHELL
3. LARGE ORIFICE
4. SMALL ORIFICE
5. PISTON
6. INTERNAL CHECK VALVE
7. AIR CAVITY

Figure 9070-10-13. Free-Lift Cylinder Operation

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Cylinder Cushion During Lowering Sequence

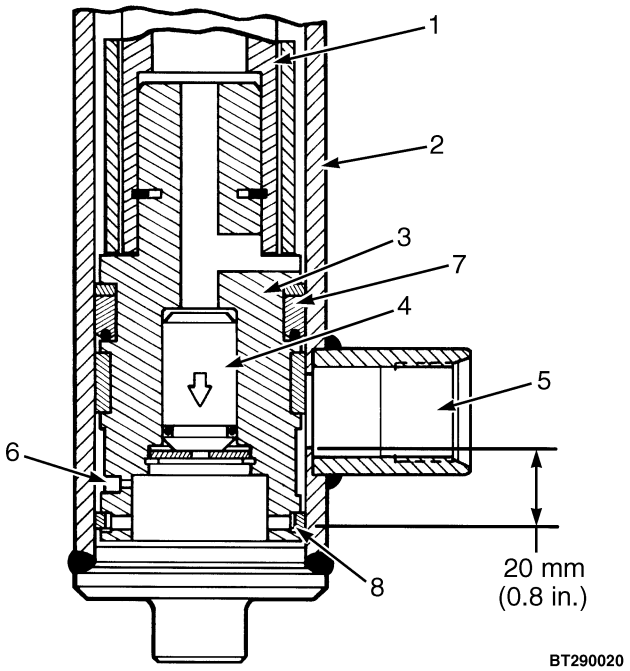
DESCRIPTION

This cushion effect prevents a sudden stop of the main cylinders, which causes smoother operation during lowering. All masts in this section, except Two-Stage Limited Free-Lift Masts, use this design in the main lift cylinders.

PRINCIPLES OF OPERATION

NOTE: An internal check valve is not used on the Two-Stage Full Free-Lift Mast.

When the main lift cylinders retract, the hydraulic oil flows out of the cylinder through the hydraulic port until the cushion ring moves past the hydraulic port. During the last 20 mm (0.79 in.) of the retraction stroke, the hydraulic oil must flow through the orifice. See Figure 9070-10-14. This action causes the cylinder rod to move much more slowly at the end of the retraction stroke.



NOTE: LEFT-HAND LIFT CYLINDER SHOWN.

1. CYLINDER ROD
2. CYLINDER SHELL
3. PISTON
4. INTERNAL CHECK VALVE
5. HYDRAULIC PORT
6. ORIFICE
7. PISTON SEAL
8. CUSHION RING

Figure 9070-10-14. Main Lift Cylinder Operation

Tilt and Sideshift Cylinders

DESCRIPTION

Tilt Cylinder

The tilt cylinders are used to move the mast forward and backward. To extend the cylinder rod (tilt forward), oil enters the tilt cylinder port behind the piston. The oil pressure pushes the cylinder rod out of the cylinder. Oil in front of the piston returns to the hydraulic tank. To retract the cylinder rod (tilt backward), the oil enters the port in front of the piston. The oil pressure pushes the cylinder rod into the tilt cylinder. The oil behind the piston returns to the hydraulic tank.

Sideshift Cylinder

The sideshift cylinder is removable for service. It is a double-acting, non-differential, piston-type cylinder, which allows the sideshift to attain the same speed moving either left or right. The cylinder also has flow restricting orifices in the ports.

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Lowering Control Valves

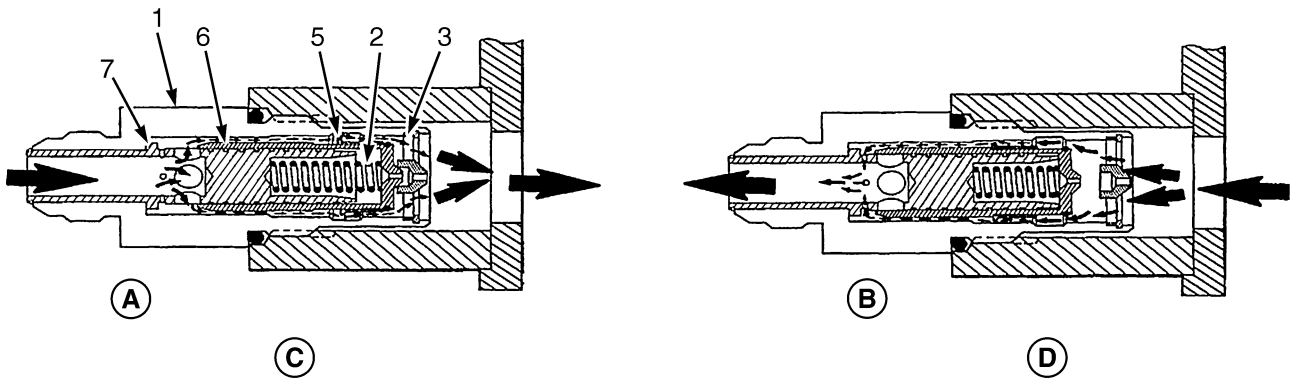
DESCRIPTION

The lowering control system permits easy entry of hydraulic oil into the cylinder during lifting, but restricts flow when rod is retracted to limit the speed at which a load maybe lowered. A pressure-compensated lowering control valve regulates the lowering speed to a more uniform value over the entire capacity range. The two types of lowering control valves used are designated as primary and secondary.

PRINCIPLES OF OPERATION

The Primary lowering control valve limits the lowering speed of the mast to a maximum controlled rate over the full range of loads. This valve is mounted externally on the middle crossmember of the outer mast. This type of lowering control valve uses these basic parts: (1) valve body, (2) spring, (3) special washer, (5) orifice sleeve, (6) plunger, and (7) main sleeve. The orifice sleeve position is controlled completely by oil flow. The plunger position is controlled by oil pressure and spring tension. During lifting, oil entering the lift cylinder goes through the center of the main sleeve to the large holes. The oil flow through the plunger and bore moves the orifice sleeve to the end of the plunger. The flange of the orifice sleeve is then aligned with the large part of the bore in the body. This alignment lets the oil flow past the orifice sleeve to the cylinder. During lowering, oil from the lift cylinder moves the orifice sleeve. The orifice sleeve moves away from the larger inner diameter area of the bore in the valve body. This movement makes a restriction to the oil flow. As the pressure increases, the plunger begins to move against the spring. The movement begins to close the openings of the large holes in the main sleeve. Additional pressure will push the plunger against the main sleeve to close the large holes completely. All the oil must then go through the small holes to the center of the main sleeve. This restriction permits the piston rod to lower only at a maximum controlled speed. See Figure 9070-10-15.

The Secondary lowering control valve is installed in each cylinder and is used only for emergency lowering. In the event an hydraulic line ruptures, this valve will lower the mast at a controlled rate. This type of lowering control valve uses these parts: (1) special fitting for the valve body, (2) spring, (3) special washer, and (4) cylinder. There is a variation in the shapes of the special washer. The volume of the hydraulic oil flowing through the inlet port controls the shape of the special washer. When the piston rod is lowered, the oil flow pushes against the special washer and spring. When the oil flow reaches the limit, the special washer is moved against the special fitting. The oil then flows only through the hole in the center of the special washer. This restriction permits the piston rod to lower only at a maximum controlled speed. See Figure 9070-10-16.



A. LIFTING
B. LOWERING
C. FREE FLOW
D. RESTRICTED FLOW

1. SPECIAL FITTING OR VALVE BODY
2. SPRING
3. SPECIAL WASHER
4. NOT SHOWN, CYLINDER (SECONDARY ONLY)
5. ORIFICE SLEEVE
6. PLUNGER
7. MAIN SLEEVE

Figure 9070-10-15. Primary Lowering Control Valve

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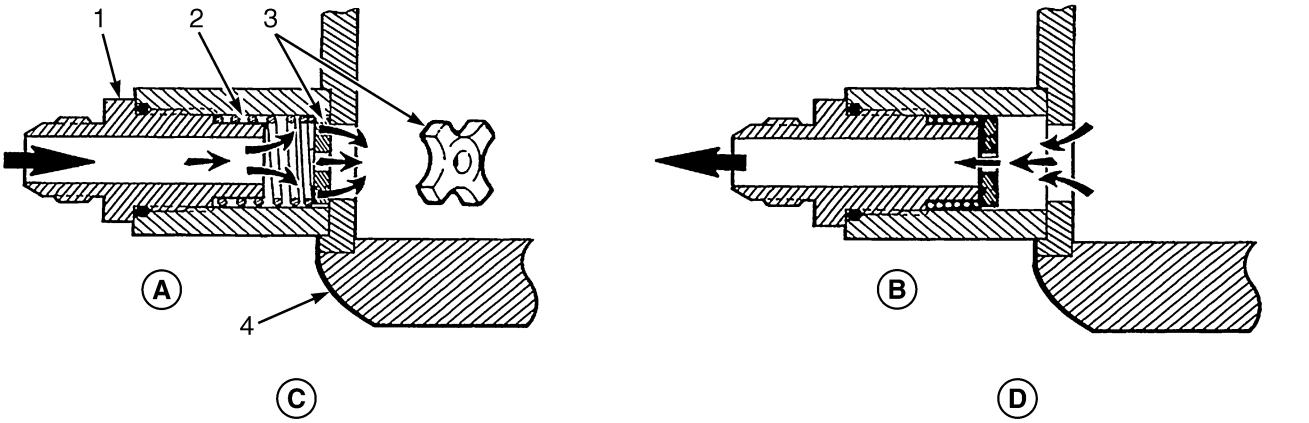

A. LIFTING
B. LOWERING
C. FREE FLOW
D. RESTRICTED FLOW

1. SPECIAL FITTING OR VALVE BODY
2. SPRING
3. SPECIAL WASHER
4. CYLINDER (SECONDARY ONLY)

Figure 9070-10-16. Secondary Lowering Control Valve

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Chassis

DESCRIPTION

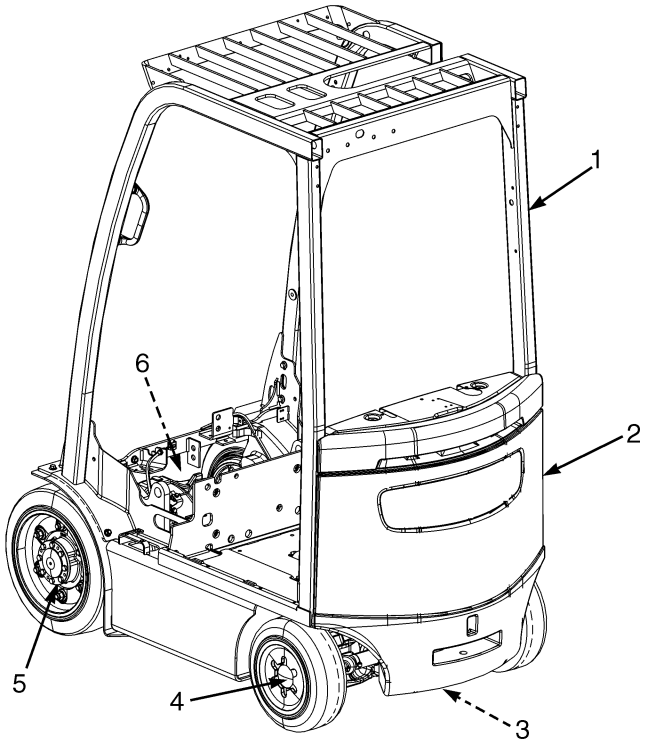
The chassis consists of the following components as shown in Figure 9070-10-17. The frame is one weldment which includes the hydraulic tank which can be accessed with removal of the counterbalance. The counterweight is attached to the frame and varies in weight depending on truck capacity.

Overhead Guard

The overhead guard is designed to provide protection to the operator from falling objects and in the event of a tip over. A high visibility design allows for an unobstructed view while maintaining structural integrity. Removal of the battery is simplified by the slot in the overhead guard. This provides access to the battery with an overhead lifting device without removing the overhead guard. See Figure 9070-10-17.

Counterweight

A one-piece, cast iron counterweight is used to offset the weight of the load and attached to the rear suspension of the lift truck. See Figure 9070-10-17.



1. OVERHEAD GUARD
2. COUNTERWEIGHT
3. STEER AXLE MOUNTS
4. STEER AXLE AND WHEEL
5. DRIVE AXLE AND WHEEL
6. DRIVE AXLE MOUNTS

Figure 9070-10-17. Chassis Component Location

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NOTES

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Group 30

Observed Symptoms

Abnormal Channel Wear

POSSIBLE CAUSE

A. MAST DAMAGED
B. MAST CHANNELS LACK LUBRICATION
C. CHAINS ARE LOOSE OR NOT EQUAL
D. MAST IS SHIMMED INCORRECTLY
E. LOAD ROLLERS ARE NOT ROTATING FREELY WITHIN CHANNEL
F. DAMAGED OR WORN LOAD ROLLERS OR STRIP BEARINGS
G. LIFT CYLINDER BINDING

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - MAST CHANNELS LACK LUBRICATION

PROCEDURE OR ACTION:

1. Inspect grease on mast channels.
   Is a thin coat of grease spread evenly on channels?
   YES: Go to Cause C.
   NO: Apply grease to mast sliding surfaces. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

CAUSE C - CHAINS ARE LOOSE OR NOT EQUAL

PROCEDURE OR ACTION:

1. Inspect lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are chains adjusted correctly and in good condition?
   YES: Go to Cause D.
   NO: Adjust or repair chains.

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CAUSE D - MAST IS SHIMMED INCORRECTLY

PROCEDURE OR ACTION:

NOTE: A mast that is shimmed too loose will cause the rollers to ride up on the flange edge and produce a flaring wear pattern.

1. Inspect mast and carriage shimming. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is mast shimmed correctly?
   YES: Go to Cause E.
   NO: Adjust or repair as required.

CAUSE E - LOAD ROLLERS ARE NOT ROTATING FREELY WITHIN CHANNEL

PROCEDURE OR ACTION:

1. Inspect mast channel rollers. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Do the rollers rotate freely?
   YES: Go to Cause F.
   NO: Replace load rollers. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE F - DAMAGED OR WORN LOAD ROLLERS OR STRIP BEARINGS

PROCEDURE OR ACTION:

1. Inspect load rollers and strip bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the load rollers and strip bearings in good condition?
   YES: Go to Cause G.
   NO: Adjust, repair, or replace load rollers and strip bearings as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE G - LIFT CYLINDER BINDING

PROCEDURE OR ACTION:

1. Remove and repair cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
2. Manually extend cylinder exterior.
   Does cylinder extend freely?
   YES: Mast is loose. See Observed Symptoms, Mast is Loose, Page 9070-30-26.

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NO: Service or replace cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

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Abnormal Hose Wear

POSSIBLE CAUSE

A. MAST DAMAGED
B. HOSES RUBBING ON COMPONENTS
C. IMPROPER HOSE ROUTING
D. HYDRAULIC RELIEF PRESSURE SET TOO HIGH
E. TOO HIGH/LOW HYDRAULIC OIL TEMPERATURE

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause D.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - HOSES RUBBING ON COMPONENTS

PROCEDURE OR ACTION:

1. Inspect hoses for wear and tension.
   Is hose tension correct?
   YES: Go to Cause C.
   NO: Adjust or replace hoses or sheaves as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - IMPROPER HOSE ROUTING

PROCEDURE OR ACTION:

1. Inspect and adjust lift cylinder hoses. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the hoses in good condition and adjusted correctly?
   YES: Go to Cause D.
   NO: Adjust or replace hoses as required.

CAUSE D - HYDRAULIC RELIEF PRESSURE SET TOO HIGH

PROCEDURE OR ACTION:

1. Test hydraulic relief pressure. See Main System Relief Test and Adjustment. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
   Is pressure within test specifications?
   YES: Go to Cause E.
   NO: Adjust pressure to test specifications. See Primary Relief Valve Test and Adjustment.

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CAUSE E - TOO HIGH/LOW HYDRAULIC OIL TEMPERATURE

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Insure that hydraulic oil temperature is within the recommended operating range for the lift truck.

END SYMPTOM

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Abnormal Mast Noise

POSSIBLE CAUSE

A. MAST DAMAGED
B. LOOSE OR MISSING MAST MOUNTING HARDWARE
C. LOOSE FORK FIT TO CARRIAGE
D. DAMAGED CHAIN SHEAVES
E. AIR IN HYDRAULIC SYSTEM
F. MAST CHANNELS LACK LUBRICATION
G. MAST MOUNTING BUSHINGS LACK LUBRICATION OR DAMAGED
H. MAST TILT BUSHINGS LACK LUBRICATION OR DAMAGED
I. CHAINS LOOSE OR NOT EQUAL
J. WORN LOAD ROLLERS OR STRIP BEARINGS
K. MAST CHANNELS ARE WORN
L. NOISY LIFT CYLINDER SEALS

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - LOOSE OR MISSING MAST MOUNTING HARDWARE

PROCEDURE OR ACTION:

1. Inspect mast mounting hardware.
   Is hardware in good condition and torqued correctly?
   YES: Go to Cause C.
   NO: Replace mast mounting hardware. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - LOOSE FORK FIT TO CARRIAGE

PROCEDURE OR ACTION:

1. Inspect carriage bar and fork hooks for wear.
   Do forks fit correctly and in good condition?
   YES: Go Cause D.
   NO: Replace carriage or forks if worn. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

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CAUSE D - DAMAGED CHAIN SHEAVES

PROCEDURE OR ACTION:

1. Inspect chain sheaves.
   Do chain sheaves rotate freely without noise?
   YES: Go to Cause E.
   NO: Replace chain sheaves. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - AIR IN HYDRAULIC SYSTEM

PROCEDURE OR ACTION:

1. Inspect oil condition and level in hydraulic tank.
   Is the hydraulic oil level in the operating range and in good condition?
   YES: Cause F.
   NO: If oil level is low, add oil. If hydraulic oil is aerated, locate source of suction side leak and repair.

CAUSE F - MAST CHANNELS LACK LUBRICATION

PROCEDURE OR ACTION:

1. Inspect grease on mast channels.
   Is a thin coat of grease spread evenly on channels?
   YES: Go to Cause G.
   NO: Apply grease to mast sliding surfaces. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

CAUSE G - MAST MOUNTING BUSHINGS LACK LUBRICATION OR DAMAGED

PROCEDURE OR ACTION:

1. Inspect mast bushings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the mast bushings greased and in good condition?
   YES: Go Cause H.
   NO: Lubricate mast bushings. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

CAUSE H - MAST TILT BUSHINGS LACK LUBRICATION OR DAMAGED

PROCEDURE OR ACTION:

1. Inspect mast tilt bushings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the mast tilt bushings greased and in good condition?
   YES: Go to Cause I.
   NO: Lubricate mast tilt bushings. Replace as required. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

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CAUSE I - CHAINS LOOSE OR NOT EQUAL

PROCEDURE OR ACTION:

1. Inspect chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are chains adjusted correctly and in good condition?
   YES: Go to Cause J.
   NO: Adjust or repair chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE J - WORN LOAD ROLLERS OR STRIP BEARINGS

PROCEDURE OR ACTION:

1. Inspect load rollers and strip bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the load rollers and strip bearings in good condition?
   YES: Go to Cause K.
   NO: Adjust, repair, or replace load rollers and strip bearings as required.

CAUSE K - MAST CHANNELS ARE WORN

PROCEDURE OR ACTION:

1. Inspect mast channels for wear or damage. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the mast channels in good condition?
   YES: Go to Cause L.
   NO: Repair or replace worn mast components.

CAUSE L - NOISY LIFT CYLINDER SEALS

NOTE: Confirm that correct hydraulic oil is being used, see **Operating Manual**.

PROCEDURE OR ACTION:

1. On 2-Stage LFL, 3-Stage FFL, and 4-Stage FFL, apply thin film of hydraulic oil on cylinder rods.
   Does the noise stop?
   YES: Remove gland and add hydraulic oil. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Install new cylinder seal. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

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Body Panels Making Noise

POSSIBLE CAUSE

A. ATTACHING HARDWARE IS LOOSE
B. FAILED LATCHES OR HINGES

CAUSE A - ATTACHING HARDWARE IS LOOSE

PROCEDURE OR ACTION:

1. Visually inspect mounting points for damage and loose or missing hardware. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Are body panels and attaching hardware in good condition?
   YES: Inspect and repair hinges and latches. Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

CAUSE B - FAILED LATCHES OR HINGES

PROCEDURE OR ACTION:

1. Inspect hinges and latches for correct operation.
   Are the hinges and latches in good condition?
   YES: Operating lift truck too fast on rough surface, reduce speed.
   NO: Adjust or repair latches and hinges as required. Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

END SYMPTOM

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External Leakage From Free-Lift or Main Lift Cylinders

POSSIBLE CAUSE

A. MAST DAMAGED
B. CYLINDER HOSES OR FITTINGS LOOSE OR DAMAGED
C. CYLINDER SEAL DAMAGE OR INCORRECT INSTALLATION
D. CYLINDER ROD DAMAGE

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - CYLINDER HOSES OR FITTINGS LOOSE OR DAMAGED

PROCEDURE OR ACTION:

1. Inspect hoses and fittings for damage and proper torque.
   Are hose and fittings in good condition and torqued correctly?
   YES: Go to Cause C.
   NO: Adjust or replace hoses or fittings as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - CYLINDER SEAL DAMAGE OR INCORRECT INSTALLATION

PROCEDURE OR ACTION:

1. Inspect lift cylinder seals.
   Are the seals in good condition and installed correctly?
   YES: Go to Cause D.
   NO: Adjust or replace seals as required. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

CAUSE D - CYLINDER ROD DAMAGE

PROCEDURE OR ACTION:

1. Inspect cylinder rod for damage.
   Is cylinder rod in good condition?
   YES: Problem solved. Resume operations.

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NO: Replace cylinder rod or cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

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FFL Mast Banging During Phasing

POSSIBLE CAUSE

A. MAST DAMAGED
B. FREE-LIFT CYLINDER TOP STROKE CUSHIONING NOT OPERATING
C. MAIN CYLINDER CUSHION NOT OPERATING WHEN FULLY LOWERED
D. CARRIAGE BINDING IN INNER MAST
E. CARRIAGE CONTACTS STOP AT TOP OF INNER MAST

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - FREE-LIFT CYLINDER TOP STROKE CUSHIONING NOT OPERATING

PROCEDURE OR ACTION:

1. Confirm that cushioning oil is on top side of cylinder piston. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Is cushioning oil level correct?
   YES: Go to Cause C.
   NO: Add oil.

CAUSE C - MAIN CYLINDER CUSHION NOT OPERATING WHEN FULLY LOWERED

PROCEDURE OR ACTION:

1. Operate lift lower and note speed as cylinder reached end of stroke.
   Does cylinder speed slow during final 25 mm (1.0 in.) of cylinder stroke?
   YES: Go to Cause D.
   NO: Repair or replace cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

CAUSE D - CARRIAGE BINDING IN INNER MAST

PROCEDURE OR ACTION:

1. Observe carriage travels to the end of free lift cylinder stroke.
   Does the carriage go to end of free lift cylinder stroke?
   YES: Go to Cause E.
   NO: Shim carriage rollers. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

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CAUSE E - CARRIAGE CONTACTS STOP AT TOP OF INNER MAST

PROCEDURE OR ACTION:

1. Inspect free lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Can lift chains be adjusted?
   YES: Adjust chains.
   NO: Replace free lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

END SYMPTOM

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High Tire Wear - Drive Axle

POSSIBLE CAUSE

A. RUNNING OVER OIL/SOLVENTS AND DEBRIS
B. LOW PNEUMATIC TIRE INFLATION
C. HIGH PNEUMATIC TIRE INFLATION
D. EXCESSIVE SPEED ON TURNS AND STOPS
E. EXCESSIVE LOADS
F. FAILED WHEEL BEARINGS

CAUSE A - RUNNING OVER OIL/SOLVENTS AND DEBRIS

PROCEDURE OR ACTION:

1. Visually inspect work area for contaminates and debris.

CAUSE B - LOW PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE C - HIGH PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE D - EXCESSIVE SPEED ON TURNS AND STOPS

PROCEDURE OR ACTION:

1. Reduce speed and spinning of wheels.

CAUSE E - EXCESSIVE LOADS

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating.

CAUSE F - FAILED WHEEL BEARINGS

PROCEDURE OR ACTION:

1. Inspect wheel bearings.
   Are bearings in good condition?
   YES: Tires are defective. See tire manufacture for warranty.
   NO: Replace wheel bearing. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

END SYMPTOM

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High Tire Wear - Steer Axle

POSSIBLE CAUSE

A. RUNNING OVER OIL/SOLVENTS AND DEBRIS
B. EXCESSIVE SPEED ON TURNS AND STOPS
C. TURNING WITH MACHINE STOPPED OR NO LOAD ON FORKS
D. LOW PNEUMATIC TIRE INFLATION
E. HIGH PNEUMATIC TIRE INFLATION
F. FAILED WHEEL BEARINGS
G. LOOSE TIE RODS

CAUSE A - RUNNING OVER OIL/SOLVENTS AND DEBRIS

PROCEDURE OR ACTION:

1. Visually inspect work area for contaminates and debris.

CAUSE B - EXCESSIVE SPEED ON TURNS AND STOPS

PROCEDURE OR ACTION:

1. Reduce speed and spinning of wheels.

CAUSE C - TURNING WITH MACHINE STOPPED OR NO LOAD ON FORKS

PROCEDURE OR ACTION:

NOTE: Steering without load on forks puts the highest load on steer axle because of counterweight. Avoid steering wheels when not moving to reduce tire wear.

1. Steer while moving whenever possible.

CAUSE D - LOW PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE E - HIGH PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE F - FAILED WHEEL BEARINGS

PROCEDURE OR ACTION:

1. Inspect wheel bearings.
   Are bearings in good condition?
   YES: Tires are defective. See tire manufacturer for warranty.
   NO: Replace wheel bearing. Depending on your lift truck, see **Transaxle** 1300SRM1330 or **Steering Axle** 1600SRM1360.

CAUSE G - LOOSE TIE RODS

PROCEDURE OR ACTION:

1. Inspect joint where tie rods are attached to pinion assembly.
   Is the tie rod tight in bore?
   YES: See wheels appear to be tipped or misaligned.

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NO: Replace tie rod. Depending on your lift truck, see **Transaxle** 1300SRM1330 or **Steering Axle** 1600SRM1360.

END SYMPTOM

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Hoses Not Tracking Correctly

POSSIBLE CAUSE

A. MAST DAMAGED
B. IMPROPER HOSE TENSION
C. IMPROPER HOSE ROUTING
D. HOSES WORN

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - IMPROPER HOSE TENSION

PROCEDURE OR ACTION:

1. Check hose tension. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is hose tension correct?
   YES: Go to Cause C.
   NO: Adjust hose tension.

CAUSE C - IMPROPER HOSE ROUTING

PROCEDURE OR ACTION:

1. Inspect lift cylinder hoses. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the hoses in good condition and adjusted correctly?
   YES: Go to Cause D.
   NO: Adjust or replace hoses as required.

CAUSE D - HOSES WORN

PROCEDURE OR ACTION:

1. Inspect hoses for uneven or excessive wear.
   Are hoses wearing evenly?
   YES: Locate cause of hoses wear. See Observed Symptoms, Abnormal Hose Wear, Page 9070-30-4.
   NO: Adjust or replace hoses as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551,**

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A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

END SYMPTOM

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Integral Sideshift Moving Too Fast

POSSIBLE CAUSE

A. ORIFICES IN SIDESHIFT CYLINDER MISSING OR INSTALLED BACKWARD
B. ELECTRO-HYDRAULIC CONTROL VALVE OUT OF CALIBRATION

CAUSE A - ORIFICES IN SIDESHIFT CYLINDER MISSING OR INSTALLED BACKWARD

PROCEDURE OR ACTION:

CAUTION

Cylinder orifices are made from soft metal and can be easily damaged. Do not alter cylinder orifice size while cleaning.

1. Inspect cylinder port orifices. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Are the orifices clean and installed correctly?
   YES: Reduce engine speed or control lever speed of movement to slow function. See **Parts Manual** to see if smaller size orifices are available.
   NO: Adjust or install orifices.

CAUSE B - ELECTRO-HYDRAULIC CONTROL VALVE OUT OF CALIBRATION

PROCEDURE OR ACTION:

1. Check electro-hydraulic control valve calibration. Install Service Tool.
   Is valve calibration correct?
   YES: Calibrate valve to operator's preference or reduce engine speed to slow function.
   NO: Resume operation.

END SYMPTOM

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Integral Sideshift Not Moving or Slow

POSSIBLE CAUSE

A. NO OIL OR NOT ENOUGH OIL IN HYDRAULIC TANK
B. LINKAGE TO CONTROL VALVE DISCONNECTED OR DAMAGED (MANUAL CONTROL VALVE)
C. WIRING CONNECTOR LOOSE OR DISCONNECTED ON CONTROL VALVE (E-VALVE)
D. INTEGRAL SIDESHIFT CARRIAGE DAMAGED
E. CLAMP BLOCKS TOO TIGHT
F. CONTAMINATION OR LACK OF LUBRICATION IS BINDING BEARINGS
G. DAMAGED CARRIAGE BEARINGS
H. HOSES NOT INSTALLED CORRECTLY
I. NO OIL FLOW TO SIDESHIFT CYLINDER
J. INCORRECT HYDRAULIC RELIEF PRESSURE SETTING
K. INSUFFICIENT OIL FLOW TO CYLINDER
L. DEFECTIVE SIDESHIFT CYLINDER

CAUSE A - NO OIL OR NOT ENOUGH OIL IN HYDRAULIC TANK

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Check hydraulic tank oil level and adjust as required.

CAUSE B - LINKAGE TO CONTROL VALVE DISCONNECTED OR DAMAGED (MANUAL CONTROL VALVE)

PROCEDURE OR ACTION:

1. Inspect valve linkage.
   Is the linkage moving the valve spool full travel?
   YES: Go to Cause D.
   NO: Repair or adjust linkage. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

CAUSE C - WIRING CONNECTOR LOOSE OR DISCONNECTED ON CONTROL VALVE (E-VALVE)

PROCEDURE OR ACTION:

1. Inspect wiring connections at valve and MLM controller.
   Are the connectors in good condition and installed correctly?
   YES: Go to Cause D.
   NO: Repair or replace wiring connectors. See **Wire Harness Repair** 2200SRM1128.

CAUSE D - INTEGRAL SIDESHIFT CARRIAGE DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect carriage for damage.
   Is the carriage in good condition?
   YES: Go to Cause E.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

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CAUSE E - CLAMP BLOCKS TOO TIGHT

PROCEDURE OR ACTION:

1. Adjust clamp blocks. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE F - CONTAMINATION OR LACK OF LUBRICATION IS BINDING BEARINGS

PROCEDURE OR ACTION:

1. Inspect bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are bearings worn or need lubrication?
   YES: Lubricate or replace bearings.
   NO: Go to Cause G.

CAUSE G - DAMAGED CARRIAGE BEARINGS

PROCEDURE OR ACTION:

1. Disassemble outer frame. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are bearings in good condition?
   YES: Go to Cause H.
   NO: Service or replace bearings.

CAUSE H - HOSES NOT INSTALLED CORRECTLY

NOTE: Check maintenance records to determine last repairs done to truck.

PROCEDURE OR ACTION:

1. Inspect hose routing and connections. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are hoses adjusted correctly and in good condition?
   YES: Go to Cause I.
   NO: Adjust or repair hoses.

CAUSE I - NO OIL FLOW TO SIDESHIFT CYLINDER

PROCEDURE OR ACTION:

1. Remove pin from rod end of cylinder. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
2. Slowly operate sideshift cylinder control and observe cylinder rod movement.
   Does the cylinder rod move when controls are activated?
   YES: Install cylinder rod pin. Go to Cause J.
   NO: Determine if problem is in cylinder or control valve. Go to Cause K.

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CAUSE J - INCORRECT HYDRAULIC RELIEF PRESSURE SETTING

PROCEDURE OR ACTION:

1. Test secondary relief valve pressure. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
   Is the secondary relief pressure at specifications?
   YES: Go to Cause K.
   NO: Adjust or replace secondary relief valve.

CAUSE K - INSUFFICIENT OIL FLOW TO CYLINDER

PROCEDURE OR ACTION:

1. Perform Cycle Times. Depending on your lift truck, see **Capacities and Specifications** 8000SRM1340, **Capacities and Specifications** 8000SRM1374, **Capacities and Specifications** 8000SRM1376, **Capacities And Specifications** 8000SRM1375, or **Capacities and Specifications** 8000SRM1443.
   Is the sideshift the only hydraulic function that is slow.
   YES: Go to Step 2.
   NO: Problem is in hydraulic pump circuit. See Hydraulic Pump Flow Test.
2. Check electro-hydraulic control valve calibration. Install Service Tool.
   Is valve calibration correct?
   YES: Go to Cause L.
   NO: Calibrate valve to operator's preference. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

CAUSE L - DEFECTIVE SIDESHIFT CYLINDER

PROCEDURE OR ACTION:

CAUTION

Cylinder orifices are made from soft metal and can be easily damaged. Do not alter cylinder orifice size while cleaning.

1. Inspect and clean cylinder port orifices. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Are the orifices clean and installed correctly?
   YES: Remove and repair cylinder.
   NO: Adjust or replace orifices.

END SYMPTOM

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Fork Positioner Not Moving or Slow

POSSIBLE CAUSE

A. NO OIL OR NOT ENOUGH OIL IN HYDRAULIC TANK
B. LINKAGE TO CONTROL VALVE DISCONNECTED OR DAMAGED (MANUAL CONTROL VALVE)
C. HYDRAULIC CONTROL VALVE CALIBRATED WRONG (E-VALVE)
D. WIRING CONNECTOR LOOSE OR DISCONNECTED ON CONTROL VALVE (E-VALVE)
E. SIDESHIFT CARRIAGE DAMAGED
F. CONTAMINATION OR LACK OF LUBRICATION IS BINDING BEARINGS
G. DAMAGED CARRIAGE BEARINGS
H. HOSES NOT INSTALLED CORRECTLY
I. NO OIL FLOW TO FORK POSITIONER CYLINDER
J. INCORRECT HYDRAULIC RELIEF PRESSURE SETTING
K. INSUFFICIENT OIL FLOW TO CYLINDER
L. DEFECTIVE FORK POSITIONER CYLINDER

CAUSE A - NO OIL OR NOT ENOUGH OIL IN HYDRAULIC TANK

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Check hydraulic tank oil level and adjust as required.

CAUSE B - LINKAGE TO CONTROL VALVE DISCONNECTED OR DAMAGED (MANUAL CONTROL VALVE)

PROCEDURE OR ACTION:

1. Inspect valve linkage.
   Is the linkage moving the valve spool full travel?
   YES: Go to Cause E.
   NO: Repair or adjust linkage. Refer to the appropriate **Main Control Valve** SRM .

CAUSE C - HYDRAULIC CONTROL VALVE CALIBRATED WRONG (E-VALVE)

PROCEDURE OR ACTION:

1. Check electro-hydraulic control valve calibration. Install Service Tool.
   Is valve calibration correct?
   YES: Calibrate valve to operator's preference or reduce engine speed to slow function.
   NO: Calibrate valve to operator's preference. Refer to the appropriate **Calibration Procedures** SRM .

CAUSE D - WIRING CONNECTOR LOOSE OR DISCONNECTED ON CONTROL VALVE (E-VALVE)

PROCEDURE OR ACTION:

1. Inspect wiring connections at valve and joystick/MLM controller.
   Are the connectors in good condition and installed correctly?
   YES: Go to Cause E.
   NO: Repair or replace wiring connectors. Refer to the appropriate **Wire Harness Repair** SRM .

CAUSE E - SIDESHIFT CARRIAGE DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect carriage for damage.
   Is the carriage in good condition?

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YES: Go to Cause F.
NO: Repair or replace damaged components. Refer to the appropriate **Mast Repair** SRM .

CAUSE F - CONTAMINATION OR LACK OF LUBRICATION IS BINDING BEARINGS

PROCEDURE OR ACTION:

1. Inspect bearings. Refer to the appropriate **Mast Repair** SRM .
   Are bearings worn or need lubrication?
   YES: Lubricate or replace bearings.
   NO: Go to Cause G.

CAUSE G - DAMAGED CARRIAGE BEARINGS

PROCEDURE OR ACTION:

1. Disassemble outer frame. Refer to the appropriate **Mast Repair** SRM .
   Are bearings in good condition?
   YES: Go to Cause H.
   NO: Service or replace bearings.

CAUSE H - HOSES NOT INSTALLED CORRECTLY

NOTE: Check maintenance records to determine last repairs done to truck.

PROCEDURE OR ACTION:

1. Inspect hose routing and connections. Refer to the appropriate **Mast Repair** SRM .
   Are hoses adjusted correctly and in good condition?
   YES: Go to Cause I.
   NO: Adjust or repair hoses.

CAUSE I - NO OIL FLOW TO FORK POSITIONER CYLINDER

PROCEDURE OR ACTION:

1. Remove pin from rod end of cylinder. Refer to the appropriate **Mast Repair** SRM .
2. Slowly operate sideshift cylinder control and observe cylinder rod movement.
   Does the cylinder rod move when controls are activated?
   YES: Install cylinder rod pin. Go to Cause J.
   NO: Determine if problem is in cylinder or control valve. Go to Cause K.

CAUSE J - INCORRECT HYDRAULIC RELIEF PRESSURE SETTING

PROCEDURE OR ACTION:

1. Test secondary relief valve pressure. Refer to the appropriate **Main Control Valve** SRM .
   Is the secondary relief pressure at specifications?
   YES: Go to Cause K.
   NO: Adjust or replace secondary relief valve.

CAUSE K - INSUFFICIENT OIL FLOW TO CYLINDER

PROCEDURE OR ACTION:

1. Perform Cycle Times. Refer to the appropriate **Capacities and Specifications** SRM .
   Is the sideshift the only hydraulic function that is slow.
   YES: Go to Step 2.
   NO: Problem is in hydraulic pump circuit. See Hydraulic Pump Flow Test.
2. Check electro-hydraulic control valve calibration. Install Service Tool.
   Is valve calibration correct?

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YES: Go to Cause L.
NO: Calibrate valve to operator's preference. Refer to the appropriate **Calibration Procedures** SRM .

CAUSE L - DEFECTIVE FORK POSITIONER CYLINDER

PROCEDURE OR ACTION:

CAUTION

Cylinder orifices are made from soft metal and can be easily damaged. Do not alter cylinder orifice size while cleaning.

1. Inspect and clean cylinder port orifices. Refer to the appropriate **Cylinder Repair** SRM .
   Are the orifices clean and installed correctly?
   YES: Remove and repair cylinder.
   NO: Adjust or replace orifices.

END SYMPTOM

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Mast is Loose

POSSIBLE CAUSE

A. MAST DAMAGED
B. LOOSE OR MISSING MAST MOUNTING HARDWARE
C. MAST NOT SHIMMED CORRECTLY
D. DAMAGED LOAD ROLLERS OR WORN STRIP BEARINGS
E. CHANNELS WORN

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - LOOSE OR MISSING MAST MOUNTING HARDWARE

PROCEDURE OR ACTION:

1. Inspect mast mounting hardware.
   Is mounting hardware in good condition and torqued correctly?
   YES: Go to Cause C.
   NO: Replace mast mounting hardware. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - MAST NOT SHIMMED CORRECTLY

PROCEDURE OR ACTION:

1. Inspect mast shimming. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is the mast shimmed correctly?
   YES: Go to Cause D.
   NO: Shim or adjust as required.

CAUSE D - DAMAGED LOAD ROLLERS OR WORN STRIP BEARINGS

PROCEDURE OR ACTION:

1. Inspect load rollers and strip bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the load rollers and strip bearings in good condition?
   YES: Go to Cause E.

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NO: Adjust, repair, or replace load rollers and strip bearings as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - CHANNELS WORN

PROCEDURE OR ACTION:

1. Repair or replace mast components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

END SYMPTOM

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Mast Lift Chains Are Loose

POSSIBLE CAUSE

A. MAST DAMAGED
B. DAMAGED CHAIN SHEAVES
C. INCORRECT CHAIN ADJUSTMENT

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause C.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - DAMAGED CHAIN SHEAVES

PROCEDURE OR ACTION:

1. Inspect chain sheaves.
   Do chain sheaves rotate freely without noise?
   YES: Go to Cause C.
   NO: Replace chain sheaves. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - INCORRECT CHAIN ADJUSTMENT

PROCEDURE OR ACTION:

1. Inspect lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the chains in good condition and adjusted correctly?
   YES: See Observed Symptoms, Mast or Carriage Binding, Page 9070-30-29.
   NO: Adjust or replace chain.

END SYMPTOM

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Mast or Carriage Binding

POSSIBLE CAUSE

A. MAST OR CARRIAGE DAMAGED
B. MAST CHANNELS LACK LUBRICATION
C. MAST NOT SHIMMED CORRECTLY
D. CHAINS ARE LOOSE OR NOT EQUAL
E. CONTAMINATION IN CHANNELS IS BINDING LOAD ROLLERS
F. DAMAGED OR WORN LOAD ROLLERS OR STRIP BEARINGS
G. LIFT CYLINDER BINDING

CAUSE A - MAST OR CARRIAGE DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast and carriage for damage.
   Are components in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - MAST CHANNELS LACK LUBRICATION

PROCEDURE OR ACTION:

1. Inspect grease on mast channels.
   Is a thin coat of grease spread evenly on channels?
   YES: Go to Cause C.
   NO: Apply grease to mast sliding surfaces. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

CAUSE C - MAST NOT SHIMMED CORRECTLY

PROCEDURE OR ACTION:

1. Inspect mast shimming. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is the mast shimmed correctly?
   YES: Go to Cause E.
   NO: Shim or adjust as required.

CAUSE D - CHAINS ARE LOOSE OR NOT EQUAL

PROCEDURE OR ACTION:

1. Inspect lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are chains adjusted correctly and in good condition?

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YES: Go to Cause E.
NO: Adjust or repair chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - CONTAMINATION IN CHANNELS IS BINDING LOAD ROLLERS

PROCEDURE OR ACTION:

1. Inspect mast channels. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Do the rollers rotate freely?
   YES: Go to Cause F.
   NO: Replace load rollers. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE F - DAMAGED OR WORN LOAD ROLLERS OR STRIP BEARINGS

PROCEDURE OR ACTION:

1. Inspect load rollers and strip bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the load rollers and strip bearings in good condition?
   YES: Go to Cause G.
   NO: Adjust, repair, or replace load rollers and strip bearings as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE G - LIFT CYLINDER BINDING

PROCEDURE OR ACTION:

1. Remove cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
2. Manually extend cylinder exterior.
   Does cylinder extend freely?
   YES: Mast is loose. See Observed Symptoms, Mast is Loose, Page 9070-30-26.
   NO: Service or replace cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

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Mast/Carriage Bounces or is Spongy

POSSIBLE CAUSE

A. MAST DAMAGED
B. AIR IN HYDRAULIC SYSTEM
C. TRAPPED AIR IN LIFT CYLINDER(S)
D. TWO-STAGE FFL MAST MAIN CYLINDERS NOT BLED OF AIR

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - AIR IN HYDRAULIC SYSTEM

PROCEDURE OR ACTION:

1. Inspect oil condition and level in hydraulic tank.
   Is the hydraulic oil level in the operating range and in good condition?
   YES: Go to Cause C.
   NO:
   - If oil level is low, add oil.
   - If hydraulic oil is aerated, locate source of suction side leak and repair.

CAUSE C - TRAPPED AIR IN LIFT CYLINDER(S)

PROCEDURE OR ACTION:

1. Fully extend and lower the mast several times.
   Does the mast raise and lower without hesitation?
   YES: Go to Cause D.
   NO: Go to Step 2.
2. Open mast, lower valve, and operate all hydraulic functions in both directions.
3. Close mast lower valve.
4. Repeat Step 1 to see if problem has been solved.

CAUSE D - TWO-STAGE FFL MAST MAIN CYLINDERS NOT BLED OF AIR

PROCEDURE OR ACTION:

1. Bleed air from cylinders. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

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Misphasing of Full Free-Lift Mast

POSSIBLE CAUSE

A. MAST DAMAGED
B. COLD OPERATING CONDITIONS
C. CARRIAGE IS BINDING
D. HYDRAULIC RESTRICTION TO FREE-LIFT CYLINDER
E. EXCESSIVE OIL ON TOP SIDE OF FREE-LIFT CYLINDER PISTON

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - COLD OPERATING CONDITIONS

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Confirm that oil is at correct operating temperature. See Hydraulic Warm-up Procedure.
   Does mast misphase after oil is at operating temperature?
   YES: Go to Cause C.
   NO: Incorrect hydraulic oil is being used. Consult **Operating Manual** for correct grade of hydraulic oil for your operating conditions.

CAUSE C - CARRIAGE IS BINDING

PROCEDURE OR ACTION:

1. Check carriage shimming. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is carriage shimmed correctly?
   YES: Go to Cause D.
   NO: Adjust or repair carriage. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE D - HYDRAULIC RESTRICTION TO FREE-LIFT CYLINDER

PROCEDURE OR ACTION:

1. Visually inspect hoses and fittings for damage
   Are hoses and fitting in good condition?
   YES: Go to Cause E.

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NO: Replace damaged hoses and fittings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - EXCESSIVE OIL ON TOP SIDE OF FREE-LIFT CYLINDER PISTON

PROCEDURE OR ACTION:

1. Raise mast to full lift height without load and hold at relief pressure for 5 seconds.
2. Recheck for misphasing.
   Does the mast still misphase?
   YES: Remove cylinder, check piston seal, and check valve. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   NO: Problem solved.

END SYMPTOM

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Overhead Guard Loose or Damaged

POSSIBLE CAUSE

A. OVERHEARD GUARD DAMAGED
B. ATTACHING HARDWARE IS LOOSE
C. OPERATING TOO FAST OVER ROUGH FLOORS

CAUSE A - OVERHEARD GUARD DAMAGED

PROCEDURE OR ACTION:

WARNING

Death or injury can occur from falling objects. Do not operate lift truck with a damaged overhead guard.

1. Inspect overhead guard. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Is the overhead guard in good condition?
   YES: Go to Cause B.
   NO: Replace overhead guard. Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

CAUSE B - ATTACHING HARDWARE IS LOOSE

PROCEDURE OR ACTION:

1. Visually inspect mounting points for damage and loose or missing hardware. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Is overhead guard and attaching hardware in good condition?
   YES: Go to Cause C.
   NO: Repair or replace damaged components. Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

CAUSE C - OPERATING TOO FAST OVER ROUGH FLOORS

PROCEDURE OR ACTION:

1. Reduce speed and listen for noise.
   Does noise reduce with reduction in ground speed?
   YES: Reduce speed or install softer tires.
   NO: Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

END SYMPTOM

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Racking During Lift

POSSIBLE CAUSE

A. MAST DAMAGED
B. MAIN LIFT CYLINDER NOT SHIMMED CORRECTLY
C. MAIN LIFT CYLINDER CHAINS LOOSE OR UNEQUAL
D. UNEQUAL MAIN LIFT CYLINDER ROD STROKE
E. LIFT CYLINDER BINDING

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - MAIN LIFT CYLINDER NOT SHIMMED CORRECTLY

PROCEDURE OR ACTION:

1. Check cylinder shimming. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Is cylinder shimmed correctly?
   YES: Go to Cause C.
   NO: Adjust or repair cylinder.

CAUSE C - MAIN LIFT CYLINDER CHAINS LOOSE OR UNEQUAL

PROCEDURE OR ACTION:

1. Check chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the chains adjusted correctly?
   YES: Go to Cause D.
   NO: Adjust or replace chains.

CAUSE D - UNEQUAL MAIN LIFT CYLINDER ROD STROKE

PROCEDURE OR ACTION:

1. Operate lift and compare each cylinder rod stroke.
   Are the cylinder rod strokes equal?
   YES: Go to Cause E.
   NO: Replace cylinder or cylinders spacers (if equipped). Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

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CAUSE E - LIFT CYLINDER BINDING

PROCEDURE OR ACTION:

1. Remove cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
2. Manually extend cylinder.
   Does cylinder extend freely?
   YES: Cylinder is OK. See Observed Symptoms, Mast is Loose, Page 9070-30-26.
   NO: Repair or replace cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

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Racking During Tilt

POSSIBLE CAUSE

A. MAST DAMAGED
B. TILT ROD OUT OF ADJUSTMENT
C. UNEQUAL LENGTH OF BACK TILT SPACERS

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - TILT ROD OUT OF ADJUSTMENT

PROCEDURE OR ACTION:

1. Inspect tilt rod. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Is tilt rod adjusted correctly?
   YES: Go to Cause C.
   NO: Adjust tilt rod.

CAUSE C - UNEQUAL LENGTH OF BACK TILT SPACERS

PROCEDURE OR ACTION:

1. Inspect length of spacers. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Are back tilt spacers equal?
   YES: Mast is too loose. See Observed Symptoms, Mast is Loose, Page 9070-30-26.
   NO: Adjust or replace spacers. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

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Truck Feels Unstable

POSSIBLE CAUSE

A. OPERATING WITH TOO LARGE A LOAD
B. LOW PNEUMATIC TIRE INFLATION
C. LOAD IS BEING CARRIED TOO HIGH
D. OPERATING AT TOO HIGH A SPEED
E. OPERATING OFF HARD SURFACES
F. MAST IS TOO LOOSE

CAUSE A - OPERATING WITH TOO LARGE A LOAD

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

NOTE: Carrying a load that exceeds truck capacity will cause the steer axle wheels to loose contact with ground and negatively affect control of truck.

1. Check load weight and compare to truck capacity rating.

CAUSE B - LOW PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE C - LOAD IS BEING CARRIED TOO HIGH

PROCEDURE OR ACTION:

1. Carry load as low as possible to lower center of gravity and improve stability.

CAUSE D - OPERATING AT TOO HIGH A SPEED

PROCEDURE OR ACTION:

1. See **Operating Manual** for correct operating speeds.

CAUSE E - OPERATING OFF HARD SURFACES

PROCEDURE OR ACTION:

1. Operate truck only on hard surfaces.

CAUSE F - MAST IS TOO LOOSE

PROCEDURE OR ACTION:

1. See Observed Symptoms, Mast is Loose, Page 9070-30-26.

END SYMPTOM

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Truck Wanders, Does Not Track Straight or Steer Well

POSSIBLE CAUSE

A. EXCESSIVE LOADS
B. LOW PNEUMATIC TIRE INFLATION
C. HIGH PNEUMATIC TIRE INFLATION
D. DAMAGED UPPER AXLE MOUNTING EAR
E. STEERING VALVE PROBLEM

CAUSE A - EXCESSIVE LOADS

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

NOTE: Carrying a load that exceeds truck capacity will cause the steer axle wheels to loose contact with ground and negatively affect control of truck.

1. Check load weight and compare to truck capacity rating.

CAUSE B - LOW PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE C - HIGH PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE D - DAMAGED UPPER AXLE MOUNTING EAR

PROCEDURE OR ACTION:

NOTE: The upper axle ear can be bent if lift truck suddenly drops its load while rear steer axle wheels are off the ground.

1. Inspect axle pinion bearings vertical movement.
   Does pinion bearings have excessive endplay?
   YES: Replace axle. Depending on your lift truck, see **Transaxle** 1300SRM1330 or **Steering Axle** 1600SRM1360.
   NO: Go to Cause E.

CAUSE E - STEERING VALVE PROBLEM

PROCEDURE OR ACTION:

1. Check steering hydraulics. Perform Steering Control Unit LS Pressure Test.

END SYMPTOM

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Wheel Studs Breaking

POSSIBLE CAUSE

A. ATTACHING HARDWARE IS LOOSE
B. WHEEL STUDS ARE OVER TORQUED

CAUSE A - ATTACHING HARDWARE IS LOOSE

PROCEDURE OR ACTION:

1. Visually inspect wheel studs for damage and loose or missing hardware. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Do wheels and attaching hardware appear to be in good condition?
   YES: Go to Cause B.
   NO: Repair or replace damaged components. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, **Steering Axle** 1600SRM1360, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

CAUSE B - WHEEL STUDS ARE OVER TORQUED

PROCEDURE OR ACTION:

1. Check wheel stud torque. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Are the wheels studs at correct torque?
   YES: Check maintenance records to see what repairs were made that may have caused problem.
   NO: Replace all studs and torque correctly. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, **Steering Axle** 1600SRM1360, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

END SYMPTOM

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SECTION 9080
SUPPLEMENTARY DATA

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Group 50

Abbreviations and Acronyms

ABBREVIATIONS AND ACRONYMS

Table 9080-50-1. Abbreviations and Acronyms

Term	Definition or Description
AC	Alternating Current
ACC	Accessory
A/D	Analog to Digital
AUX	Auxiliary
BAT	Battery
Baud	A line's signaling rate, the switching speed, or number of voltage or frequency changes made per second
BIT	Smallest element of binary data storage
BDI	Battery Discharge Indicator
bit	Smallest element of binary data storage
°C	Celsius Temperature
Calbr	Adjustment to accommodate truck-to-truck variations. Typical usage in system specifications applies to software processes to "learn" and store sensor baseline or extreme values. Calibration procedures may require repeating when controllers are replaced or if a specific sensor or mounting mechanism is replaced.
CANbus	Controller Area Network bus
CBDC	Counter Balanced Development Center
CD or CD-ROM	Compact Disc Read-Only Memory - a compact disc format used to hold text, graphics and hi-fi stereo sound in excess of 650MB of data, which is equivalent to about 250,000 pages of text
CDF	Configuration Data File (previously known as Cal Data) - factory-created file defining truck configuration details, dependent on truck model and option permutations (considered unique for a given truck). Not modified by service technicians, but a replacement file (with alternate options) may be factory-generated and loaded into a truck's controller by a service technician
CO	Carbon Monoxide
COP	Computer Operating Properly
CMP	Cam Position Sensor
CPS	Connector Plug Socket
CPU	Central Processing Unit

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Table 9080-50-1. Abbreviations and Acronyms (Continued)

Term	Definition or Description
CRC	Cyclic Redundancy Checksum
CRP	Connector Receptacle Pin
CRS	Connector Receptacle Socket
DC	Direct Current
DCS	Direction Control Selector
Deactivated	A feature which is not currently Activated
Defaults	The set of factory values for all truck parameters. A setup menu function can restore the default values of all parameters.
Disabled	A Software Enabled Feature which is NOT present on a given truck
DM	Diagnostic Message
DMM	Digital Multi-Meter
DP	Display Panel – equipped with 10 numeric keys, two arrow keys (left and right arrows) and two symbol keys (the Star (*) key and the pound (#) key).
DSC	Display Switch Cluster
DTC	Diagnostic Troubleshooting Code
DTM	Diagnostic Troubleshooting Manual
EDBP	Extended Drawbar Pull
EEPROM	Electronically Erasable Programmable Read Only Memory
EF	Excess Flow
EFI	Electronic Fuel Injection
EGI	Electronic Gasoline Injection
EGO	Exhaust Gas Oxygen
EHP	Electro-Hydraulic Pilot
EHPV	Electro-Hydraulic Poppet Valve
E-Hyd	Electro-Hydraulic - hydraulic option utilizing electronic inputs and electrically-driven valves to actuate hydraulic functions, as opposed to manual hydraulics using mechanical levers
Embedded	Software that is installed on Lift Truck control system
EMI	Electro-Magnetic Interference
Enabled	A Software Enabled Feature which is present on a given truck, but not necessarily Activated (i.e., purchased but not necessarily in use)
EPA	Environmental Protection Agency
EPR	Electronic Pressure Regulator
EST	Electronic Spark Timing
ETC	Electronic Throttle Control
FFL	Full-Free Lift
FIFO	First In, First Out

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Table 9080-50-1. Abbreviations and Acronyms (Continued)

Term	Definition or Description
FOSI	Format Output Specification Instances - an instance of the Output Specification (OS) that assigns values to the style characteristics for a particular document type declaration. The FOSI uses the syntax of an SGML/XML document instance and is designed to format documents for paper delivery.
FWD	Forward travel direction command signal to system
GB	Gigabyte - equal to 1024 Megabytes
H	Henry - Unit of measurement of electrical inductance
HYDR	Hydraulic
Hz	Basic unit of frequency measurement, 1 Hz = 1 periodic interval in one second
IAC	Idle Air Control
IAT	Intake Air Temperature
IBPP	Inching/Brake Pedal Position
ISR	Interrupt Service Routine
kBps	KiloBytes per second
kHz	KiloHertz - common frequency measurement of Hertz X 1000
kilobit	1,000 bits
kilobyte	A standard quantity measurement for disk and diskette storage. One kilobyte of memory equals 1024 bytes (8-bit characters) of computer memory.
kg	Kilogram, equal to 1000 grams
kPa	Kilo-Paschals, metric unit of pressure measurement X 1000
kph	Kilometers per Hour
L	Liter
LAN	Local Area Network
lbf ft	Foot Pounds
lbf in	Inch Pounds
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LFL	Limited Free Lift
MB	Megabyte - 1,048,576 bytes, equal to 1,024 kilobytes. The basic unit of measurement of mass storage
MDU	Master Drive Unit
MHz	Megahertz - a unit of frequency equal to 1024 kilohertz. A common method for describing the speed of a computer CPU
MIL	Malfunction Indicator Lamp
MLCV	Mast Lowering Control Valve
MLM	Mini Lever Module

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Table 9080-50-1. Abbreviations and Acronyms (Continued)

Term	Definition or Description
mH	Milli-Henry, 1 one thousandth of a Henry
Modem	Modulator-Demodulator - a device that adapts a terminal or computer to a telephone line converting the computer's digital pulses into audio frequencies (analog) for the telephone system and converts the frequencies back into digital pulses at the receiving side
MPH	Miles Per Hour
MRV	Main Relief Valve
ms	Milli-second, 1 one thousandth of a second
MSB	Most Significant Bit
NEU	Neutral travel direction command signal to system
N•m	Newton Meters
NOR	Normal
OBD	On Board Diagnostics
OC	Open Circuit - indicates an open connection or break in an electrical path
OORH	Out-Of-Range High
OORL	Out-Of-Range Low
OPS	Operator Presence System
OS	Operating System - the embedded system of instructions and applications that control the operation of the processor
Parameter	A system characteristic which may be adjusted by a technician, e.g., Auto-Deceleration, which may be set on a scale of from 1 to 10. Each parameter will also have a default value.
PC	Personal Computer
PC Tool	Any software that is installed on a PC that is used to service the lift truck control system
PCB	Printed Circuit Board
PGN	Parameter Group Number
PPRV	Proportional Pressure Reducing Valve
PTC	Positive Temperature Coefficient Resistor
RAM	Random Access Memory - the computer's primary workspace where the contents of each byte can be accessed directly without regard to the bytes before or after it
REV	Reverse travel direction command signal to system
Rev.	Revision - the issue control or version number of an item
RL	Relay
ROM	Read Only Memory
RPM	Revolutions Per Minute
RTST	Return to Set Tilt
SAE	Society of Automotive Engineers

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Table 9080-50-1. Abbreviations and Acronyms (Continued)

Term	Definition or Description
Scroll Repeat	The repeating, incrementing, or decrementing of a displayed value when continuously pressing the scroll buttons
Scroll Wrap-around	In the setup menu, if wrap-around is specified, when extreme-adjustment values are reached while scrolling, the value shall change to the other extreme of adjustment. I.e., scrolling down to lowest point on menu shall jump back to the top of the menu.
SCU	Steering Control Unit
SEF	Software Enabled Function - options which are Enabled by software (either entirely or in combination with additional hardware). For all SEFs, enabling the function requires a new CDF. An SEF may be Selectable, allowing it to be Activated or Deactivated by the technician once it has been enabled, or it may be non-selectable, such that it cannot be deactivated after being enabled.
Selectable	See Software Enabled Function (SEF)
Service Pack	Software update provided by a software manufacturer to fix an error and/or improve quality
SPED	Special Products Engineering Department - responsible for options not in the standard price book, but available by special order
SPI	Serial Peripheral Interface
SPN	Suspect Parameter Number
SRM	Service Reference Manual
SRV	Secondary Relief Valve
STB	Short-To-Battery - indicates a short to a battery level voltage source
STG	Short-To-Ground - indicates a short to a ground or frame connection
STS	Short-To-Supply - indicates a short to a supply voltage source other than battery level
TBC	To Be Continued
TBD	To Be Determined
Truck Settings	The specific adjustments of the various parameters on a given truck. They may be saved to a data file through the Service PC software and copied to additional similar trucks.
TSP	Troubleshooting Procedure
USB	Universal Serial Bus - serial 4-wire connection that has advanced features over a serial port. Normally found on computers as a slotted connector configuration

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NOTES

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