https://truckmanualshub.com/

RAYMOND

Maintenance Manual

EAS*i*™ Orderpicker Lift Truck



Serial No. 15,000 and up

PDMM-0101 **Issued: 6/18/03**

https://truckmanualshub.com/

This publication, PDMM-0101, applies to the EAS*i*™ Orderpicker Lift Truck, S/N 15,000 and up, and to all subsequent releases of this product until otherwise indicated in new editions or bulletins. Changes occur periodically to the information in this publication.

To order additional copies of this manual, contact your local authorized Raymond Dealer.

If you need assistance with your lift truck, contact your local authorized Raymond Dealer.

To locate a dealer, go to www.raymondcorp.com.

© 2003 The Raymond Corporation.
The following terms are trademarks of The Raymond Corporation: EAS*i*, *intellidrive*, *Maintenance Minder*, *Raymond* and *Smarti*. All other brand and product names are trademarks or registered trademarks of their respective companies.

https://truckmanualshub.com/

Table of Contents

Section 1. How to Use This Manual 1-1

Map of the Manual 1-2
Manual Design 1-4
Abbreviations & Symbols 1-5

Section 2. Safety 2-1

Definitions 2-2
General Safety 2-3
Battery Safety 2-6
Static Precautions 2-9
Jacking 2-11
Emergency Lower Valve 2-12
Tie-Down for Transport 2-13
Towing 2-15
Welding Safety 2-16

Section 3. Systems Overview 3-1

General System Data 3-2
Lift Truck Specifications 3-4
Modes of Operation 3-5
Installation 3-21
Wire Guidance 3-24
Cold Storage 3-25
Configuration Codes 3-26
Storage 3-28

Section 4. Scheduled Maintenance 4-1

Maintenance Guidelines 4-2
Maintenance Minder™ Tool 4-3
Decals 4-5
Operator's Daily Checklist 4-8
Every 60 Days or 250 Deadman Hours (HD) 4-9
Initial 90 Day Maintenance 4-12
Every 360 Days or 3000 Deadman Hours (HD) 4-13

Section 5. Troubleshooting 5-1

Electrical Troubleshooting Guidelines 5-2

https://truckmanualshub.com/

Motors 5-5
Shorts to Frame Test 5-8
Wiring 5-10
Power Transistor (Q1) Test 5-11
REGEN Transistor (Q2) Test 5-12
Field and Steering Transistor Test 5-13
Testing Electrical Components 5-14
Electrical Connector Location 5-15
Drive Unit Troubleshooting Guide 5-22
Communication Error Code Troubleshooting 5-23
G Series Error Code Troubleshooting 5-26
Troubleshooting Procedure 5-29
Symptom Tables: Hydraulic Functions 5-31
Symptom Tables: Travel Functions 5-34
Symptom Tables: Electrical Symptoms 5-35

Section 6. Messages, Codes and Tests 6-1

Operator Display Messages 6-2
Messages, Codes and Tests Summary List 6-3
Analog Input Tests 6-115
Digital Input Tests 6-147
Digital Output Tests 6-191

Section 7. Component Procedures 7-1

Section 8. Theory of Operation 8-1

Navigation Instructions for the Pin-Out Matrix 8-2
Pin-Out Matrix 8-3
Traction System Architecture 8-25
Traction System Functional Operation 8-33
Steering Systems 8-54
Electric Steering Functional Operation 8-58
Wire Guidance System Architecture 8-59
Wire Guidance Functional Operation 8-61
Lift/Lower System 8-67

Section A. Appendix A-1

Lubrication Specification Chart A-2
Thread Adhesives, Sealants, and Lubricants A-3
Component Specific Torque/Information Chart A-4
Torque Chart - Standard (Ferrous) A-5
Torque Chart - Metric A-6

https://truckmanualshub.com/

Torque Chart - Standard (Brass) A-7
Decimal Equivalent Chart A-8
Standard/Metric Conversions A-10
Schematics A-13

Section I. Index I-1

https://truckmanualshub.com/

https://truckmanualshub.com/

Page Revision Record

This page is a record of the revision of all pages in this manual. Whenever a page is revised, this section is updated and included in the revision.

This manual supersedes EASi™ Orderpicker Maintenance Manual PDMM-0032, dated 10/15/95, Revised 3/30/97.

All pages; Issued: 6/18/03

https://truckmanualshub.com/

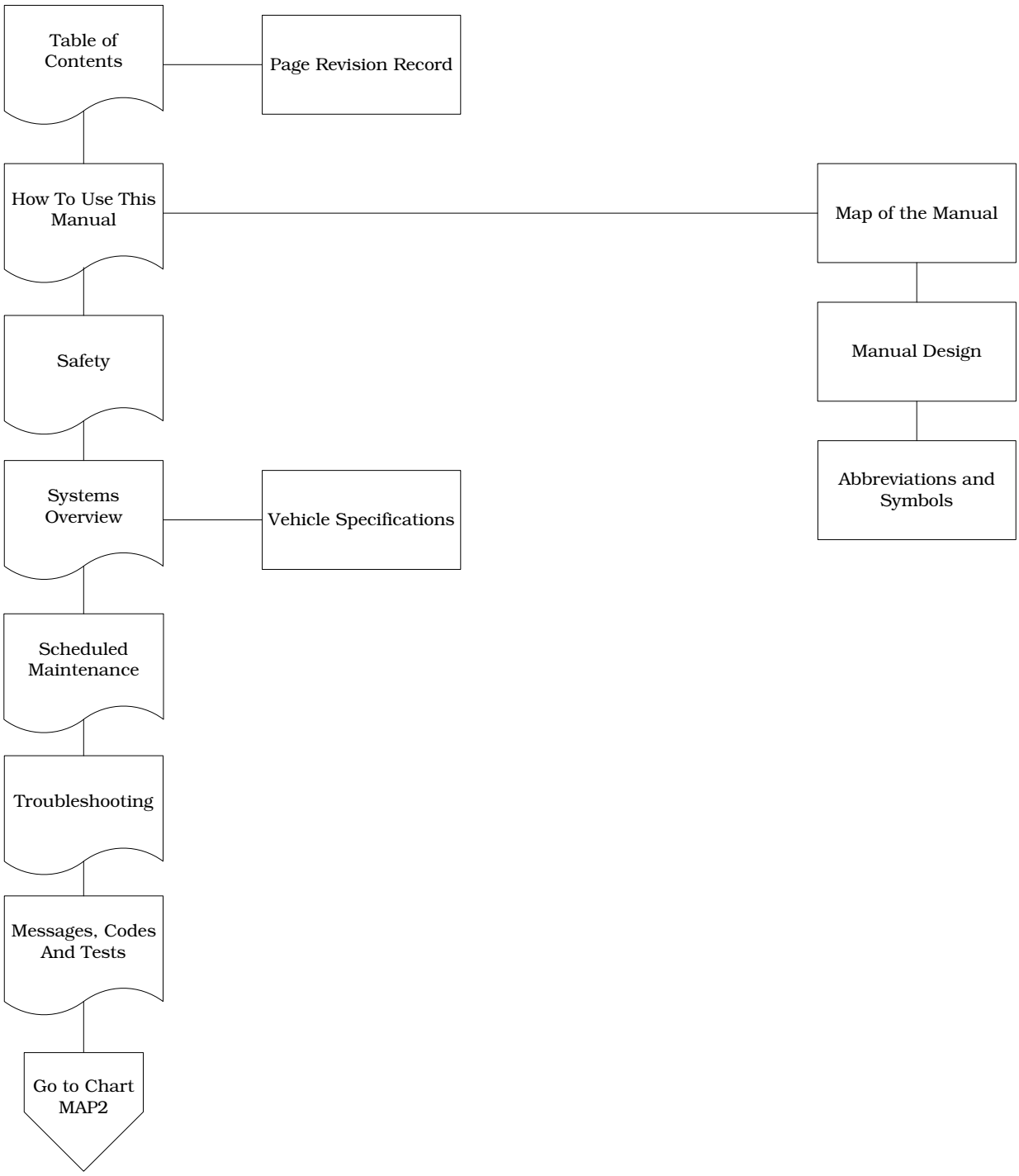
RAYMOND

https://truckmanualshub.com/

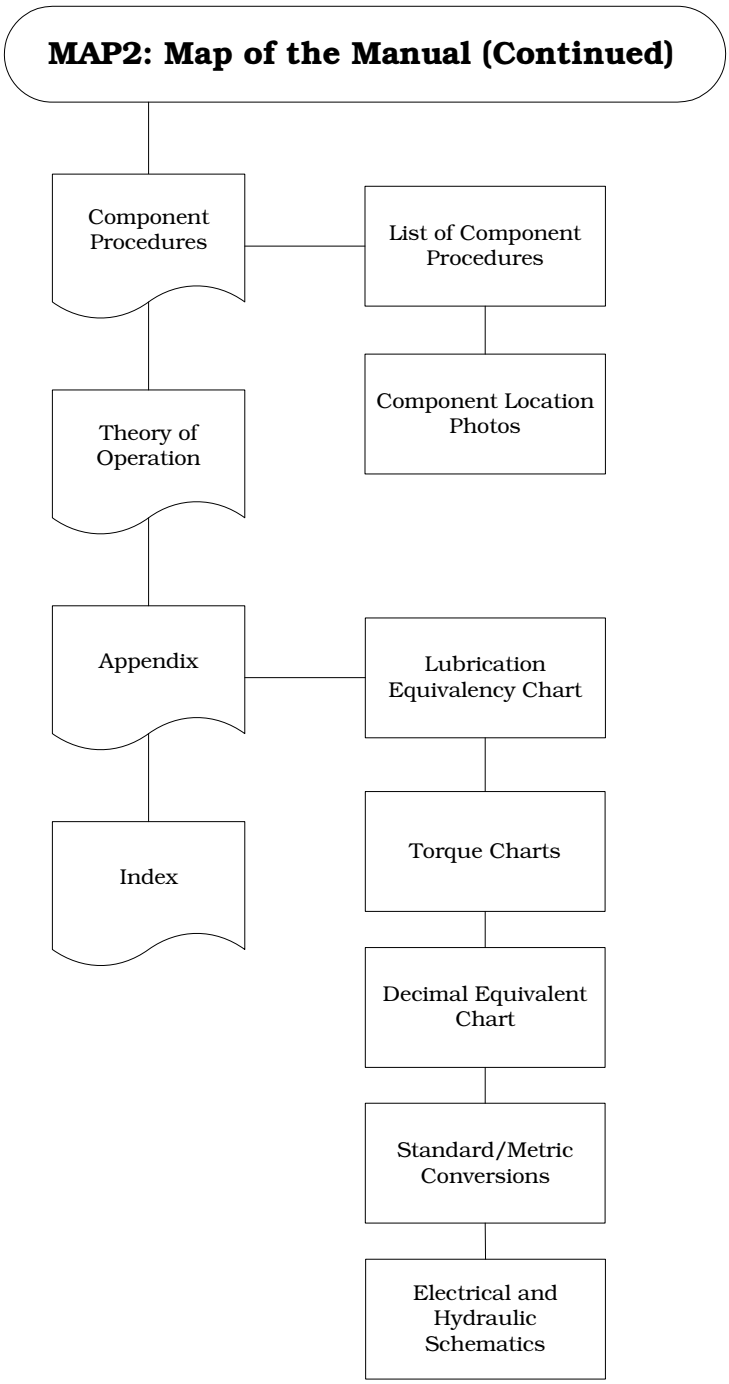
Section 1. How to Use This Manual

https://truckmanualshub.com/

Map of the Manual



https://truckmanualshub.com/



https://truckmanualshub.com/

Manual Design

The EASi™ Orderpicker Maintenance Manual is designed with the following objectives in mind:

- Provide technical coverage for expected levels of user expertise.
- Anticipate your needs and reduce your decisions regarding maintenance.
- Reduce page flipping through a “one-stop shopping” approach.

The two-line running page header at the top of each page tells you:

- Name of the manual (EASi™ Orderpicker Maintenance Manual)
- Current Chapter Title (for example, this page; How to Use This Manual)
- Current topic (for example, this page; Manual Design)

This manual consists of the following sections:

- **How to Use This Manual** explains the manual format and design as well as abbreviations and symbols used.
- **Safety** explains warning and caution notes, general safety rules and safety rules for batteries, static, jacking, and welding.
- **Systems Overview** includes lift truck dimensions and specifications.
- **Scheduled Maintenance** outlines the recommended schedule of preventive services to keep your lift truck working most efficiently.
- **Troubleshooting** is designed to take you from a symptom to a specific sequence of tests in order to isolate a failing component.
- **Messages, Codes and Tests** lists the electrical fault codes and procedures for running firmware electrical tests.
- **Component Procedures** gives step-by-step procedures for testing, removal, installation, and adjustment of individual truck components. Components are grouped by truck system.

  To find a component procedure, you may use one of three methods:
  - Look up the component name in the **List of Component Procedures**.
  - Find the component in the **Component Locator Photos**.
  - Look up the component name in the maintenance manual **Index**.
- **Theory of Operation** contains a detailed connection point table (Pin-Out Matrix) designed to assist in testing and troubleshooting the truck. This chapter also explains signal flow within the hydraulic and electrical schematics for various conditions of lift truck operation.
- **Appendix** contains reference information such as torque values, lubricants, standard/metric conversions, and system schematics.
- **Index** lists subjects alphabetically.

https://truckmanualshub.com/

Abbreviations & Symbols

The following abbreviations, acronyms and symbols are used in this manual.

Term/Symbol	Definition
A	Ampere
AC	Alternating Current
amp	Ampere or amplifier
ANSI	American National Standards Institute
approx	approximately
Assy	assembly
aux	auxiliary
AWG	American Wire Gauge
BSOC	Battery State-of-Charge
BWI	brush wear indicator
CAN	Controller Area Network
CCC	Carriage Control Card
CCW	counterclockwise
CFP	Contactor Fuse Panel
cm	centimeter
COP	Computer Operating Program
CW	clockwise
C/S	cold storage
DC	Direct Current
Dgnd	digital ground
DMM	Digital Multi Meter
DTIC	Dealer Technician intellidrive Configurator
DVM	Digital Voltmeter
EASi	Ergonomically Advanced System with intellidrive controls
EE	UL Electric Truck Type Certification Rating where electrical equipment is completely enclosed
EMF	ElectroMotive Force
EOA	End-of-Aisle
EPO	Emergency Power Off
EPROM	Erasable Programmable Read Only Memory
ESD	Electrostatic Discharge
ESM	Electric Steer Manager
FF	Forks First
fpm	feet per minute
ft.	foot or feet
gal.	gallon or gallons
gm	gram
Gnd	ground
HD	hours on deadman
Ht	height
Ht/Wt	Height/Weight
Hz	Hertz
in.	inch or inches
ITA	International Truck Association
kg	kilogram(s)
kHz	kilohertz
km/h	kilometers per hour
kPa	kilo Pascal
lb.	pound or pounds
LED	Light Emitting Diode
LPC	Lift Power Control
L/H	Load Holding
L/L	Lift/Lower
mA	milliampere
max	maximum

https://truckmanualshub.com/

Abbreviations & Symbols

Term/Symbol	Definition
min	minute or minimum
mm	millimeter
MM	*Maintenance Minder*™
mph	miles per hour
mS	millisecond or milliseconds
mV	millivolt or millivolts
mVAC	millivolts - alternating current
No.	number
NV	non-volatile
NVM	Non-Volatile Memory
N•m	newton meter
OACH	Overall Collapsed Height
OD	Operator's Display
OI	Operator Interface
OSHA	Occupational Safety and Health Association
oz.	ounce
prox	proximity
pot	potentiometer
psi	pounds per square inch
PWM	Pulse Width Modulation
P/N	Part Number
RAM	Random Access Memory
REGEN	Regenerative Braking
ROM	Read Only Memory
RPM	Revolutions per Minute
SAE	Society of Automotive Engineers
sec	second
SG	specific gravity
SOL	Solenoid
spec	specification
temp	Temperature
TF	Tractor First
TM	Tractor Manager
TM1 & 2	Transistor Module 1 & 2
TM3 & 4	Transistor Module 3 & 4
TS	Traction Speed
T/S	troubleshoot
UL	Underwriters Laboratories, Inc.
V	Volt or Volts
VDC	Volts Direct Current
VFC	Vehicle Function Controller
wrt	with respect to
Wt	Weight
w/	with
w/o	without
@	at
™	trademark
©	copyright
+	plus or positive
–	minus or negative
±	plus or minus
°	degrees
°F	degrees Fahrenheit
°C	degrees Celsius
<	less than
>	greater than
%	percent
=	equals

https://truckmanualshub.com/

Section 2. Safety

https://truckmanualshub.com/

Definitions

Throughout this manual, you will see two kinds of safety reminders:

⚠ WARNING

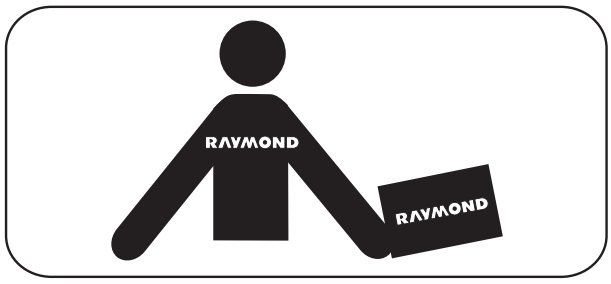
A Warning indicates a potentially hazardous situation that, if not avoided, could result in serious bodily injury or death.

⚠CAUTION

A Caution indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate bodily injury or damage to the lift truck or nearby objects. It also can be used to alert personnel against unsafe practices.

https://truckmanualshub.com/

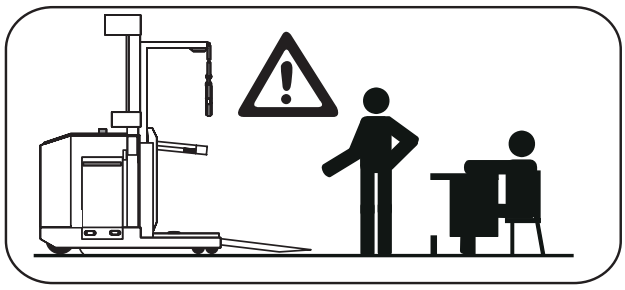
General Safety



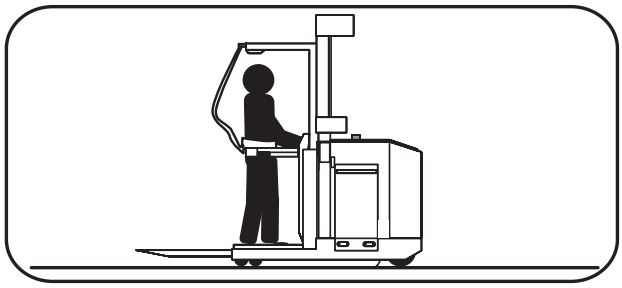
Do *not* operate or work on this truck unless you are trained, are qualified and are authorized to do so, and you have read the Owner/Operator Manual.



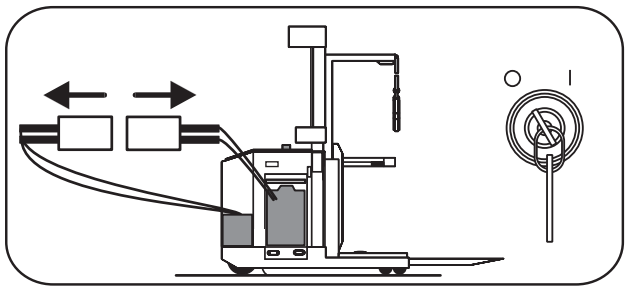
Know the truck's controls and what they do.



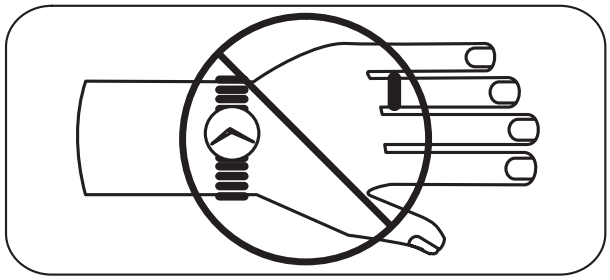
Do *not* operate this truck if it needs repair or if it is in any way unsafe.



Operate this truck only from the operator's position. When elevated, be sure to wear a safety belt attached to a secured tether.

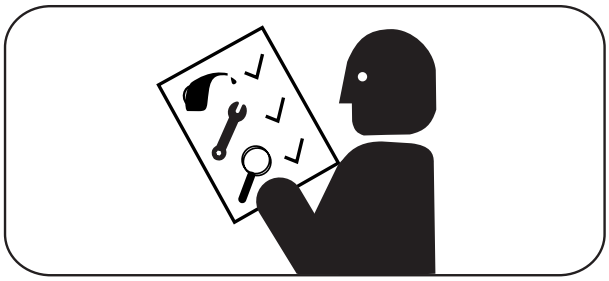


Before working on this truck, always turn the key switch OFF and disconnect the truck's battery connector (unless this manual tells you otherwise).

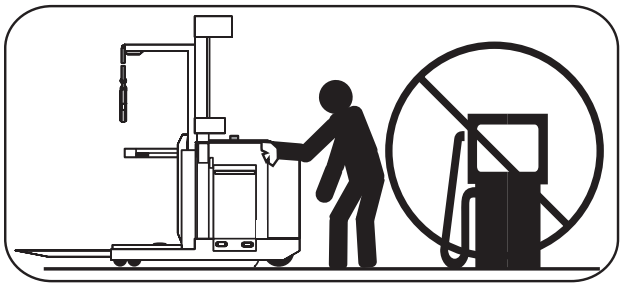


Do *not* wear watches, rings, or jewelry when working on this truck.

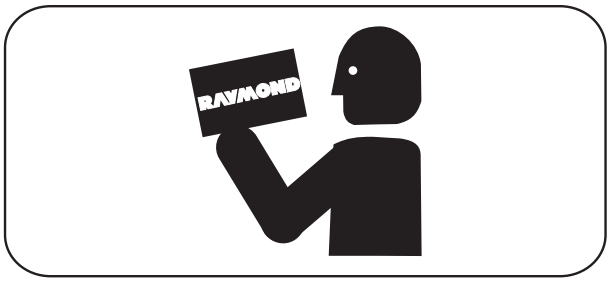
https://truckmanualshub.com/



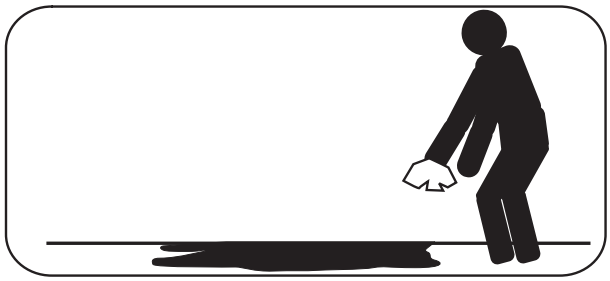
Follow the scheduled lubrication, maintenance and inspection steps.



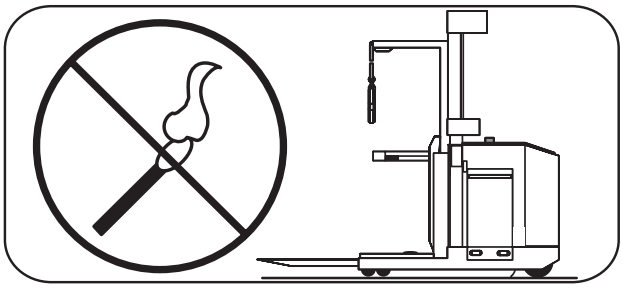
Do *not* use gasoline or other flammable liquids for cleaning parts.



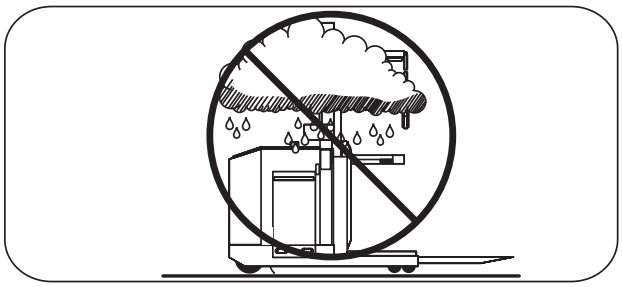
Follow exactly the safety and repair instructions in this manual. Do not take *shortcuts*.



Clean up any hydraulic fluid, oil or grease that has leaked or spilled on the floor.



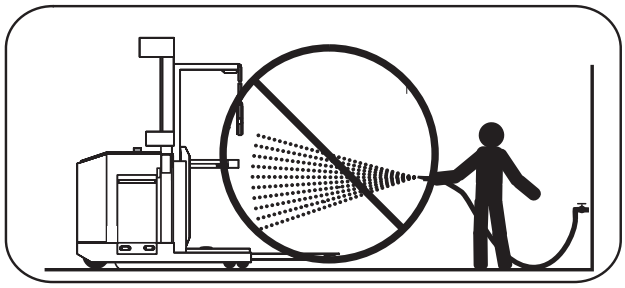
Do *not* use an open flame near the truck.



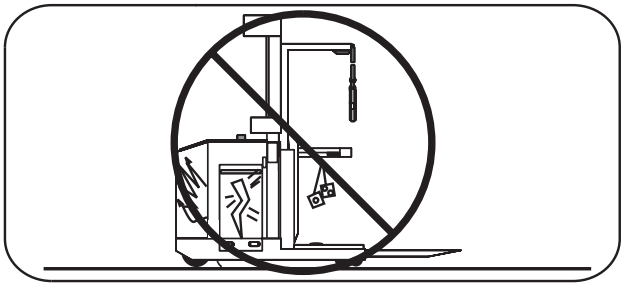
Always use and park this truck indoors.

Do *not* park a truck in a cold storage area overnight unless the truck is conditioned for cold storage.

https://truckmanualshub.com/



Do *not* wash this truck with a hose.



Do *not* add to or modify this truck until you contact your local authorized Raymond Dealer to receive written manufacturer approval.

https://truckmanualshub.com/

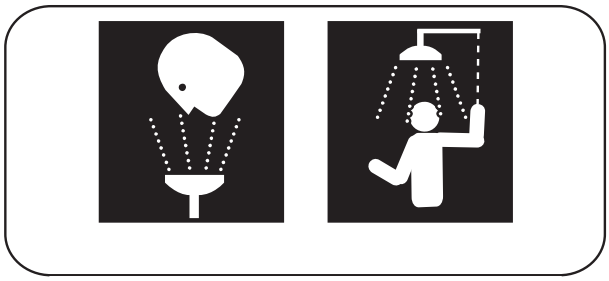
Battery Safety

⚠ WARNING

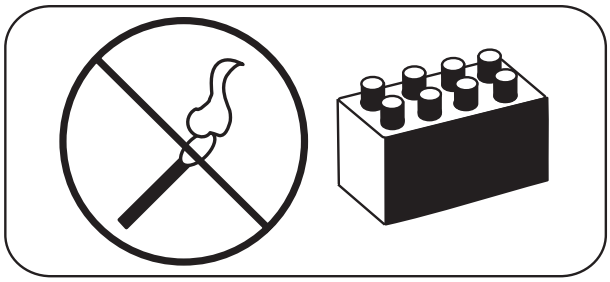
As a battery is charged, an explosive gas mixture forms within and around each cell. If the area is not properly ventilated, this explosive gas can remain in or around the battery for several hours after charging. Make sure there are no open flames or sparks in the charging area. An open flame or spark can ignite this gas, resulting in serious damage or injury.

⚠ WARNING

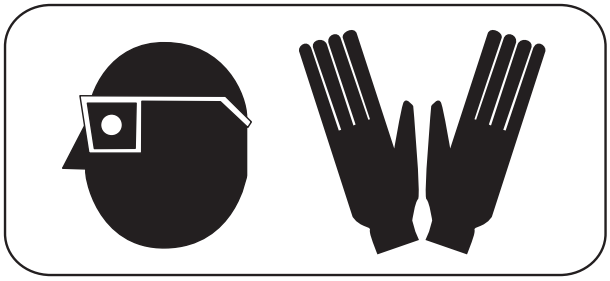
Battery electrolyte is a solution of sulfuric acid and water. Battery acid causes burns. Should any electrolyte come in contact with your clothing or skin, flush the area immediately with cold water. Should the solution get on your face or in your eyes, flush the area with cold water and get medical help immediately.



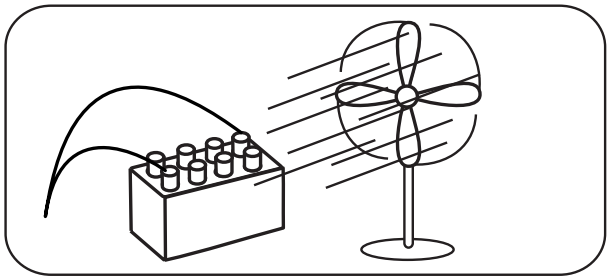
Make sure a shower and eyewash station are nearby in case there is an accident.



A battery gives off explosive gases. *Never* smoke, use an open flame, or use anything that gives off sparks near a battery.

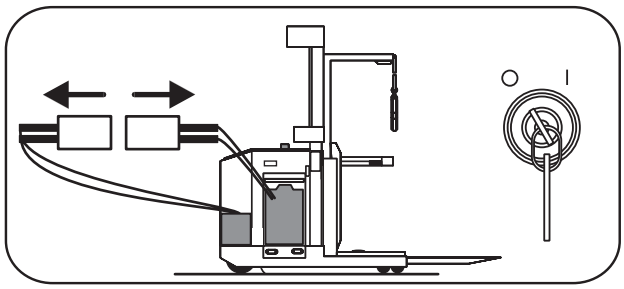


Wear personal protective equipment to protect eyes, face and skin when checking, handling or filling batteries. This equipment includes goggles or face shield, rubber gloves (with or without arm shields) and a rubber apron.

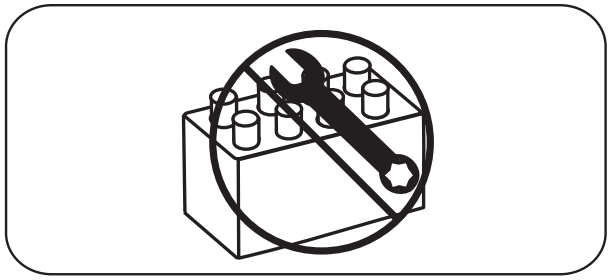


Keep the charging area well-ventilated to avoid hydrogen gas concentration.

https://truckmanualshub.com/



Turn the key switch OFF *before* disconnecting the battery from the truck at the battery connector. Do not break live circuits at the battery terminals. A spark often occurs at the point where a live circuit is broken.

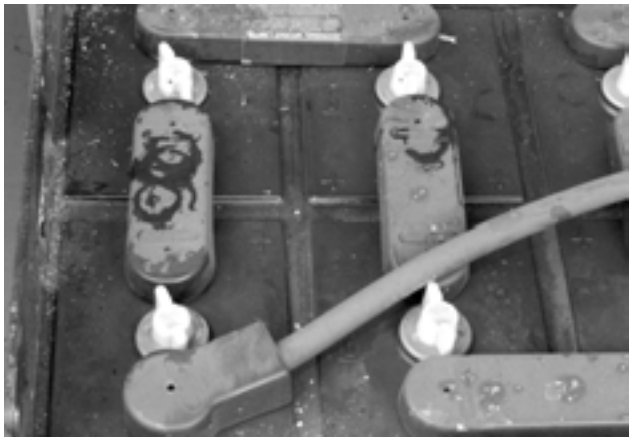


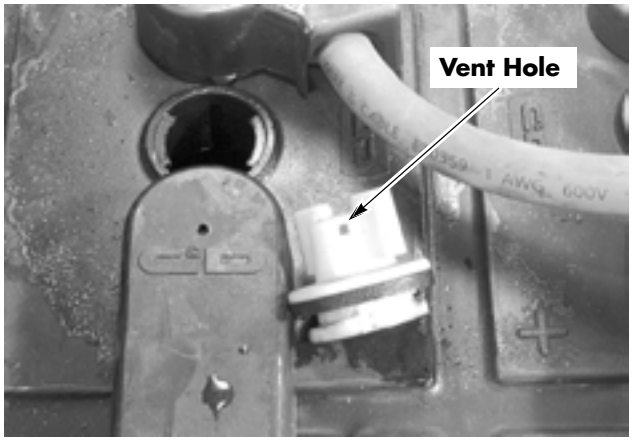
Do not lay tools or metal objects on top of the battery. A short circuit or explosion could result.

Keep batteries clean. Corrosion causes shorts to the frame and possibly sparks.

Keep plugs, terminals, cables and receptacles in good condition to avoid shorts and sparks.

Keep filler plugs firmly in place at all times except when the electrolyte level is checked, when water is added to the cells or when the specific gravity is checked.





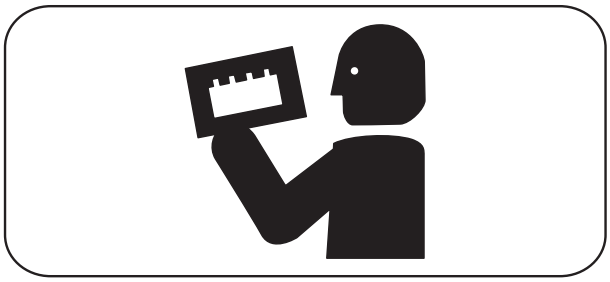
Make sure the vent holes in the filler plugs are open to allow the gas to escape from the cells.

Do not allow cleaning solution, dirt or any foreign matter to enter the cells.

Make sure you install the correct size battery. A smaller or lighter weight battery could seriously affect truck stability. See the truck's specification plate for more information.

Never plug a battery charger into the truck's battery connector. Plug the battery charger only into the battery connector from the battery.

https://truckmanualshub.com/



Follow the charging procedures in the Battery Instruction Manual and in the Battery Charger Instruction Manual.

https://truckmanualshub.com/

Static Precautions

Electronic circuit boards and devices used on the EASi™ Orderpicker can be damaged by the discharge of static electricity, called Electrostatic Discharge (ESD).

Static charges can accumulate from normal operation of the lift truck as well as movement or contact between non-conductive materials such as plastic bags, synthetic clothing, synthetic soles on shoes, and styrofoam coffee cups.

Accumulated static can be discharged through human skin to a circuit board or component by touching the parts. Static discharge is also possible through the air, when a charged object is placed close to another surface at a different electrical potential. *Static discharge can occur without seeing or feeling it.*

Whenever working on or near static-sensitive electronics, always follow these ESD precautions:

- Wear an ESD wrist strap.
- Connect the ground plug to the ESD ground jack on the lift truck. See Figure 2-1. If you cannot use the ground jack, connect the ground clamp to an unpainted, grounded surface on the lift truck frame.
- Handle circuit boards by the edges only. Avoid touching the edge connectors.
- If you will be removing or installing static-sensitive components, place them on a properly grounded antistatic mat.
- To transport static sensitive components, including failed components being returned, place the components in an antistatic bag or box (available from your local authorized Raymond Dealer).

The wrist strap and associated accessories should be tested monthly to verify they are working properly.

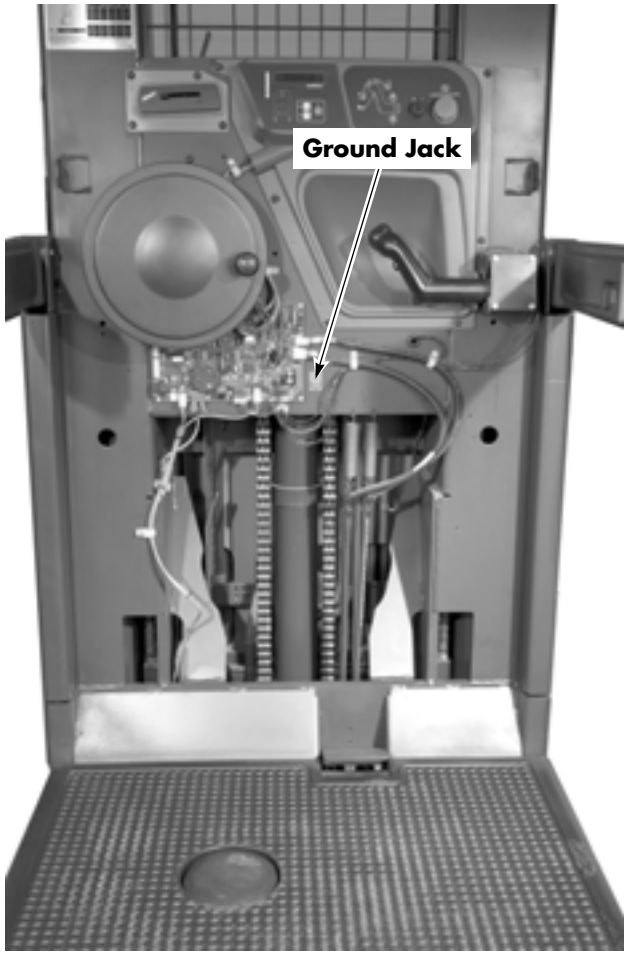


Figure 2-1. ESD Ground Jack

https://truckmanualshub.com/

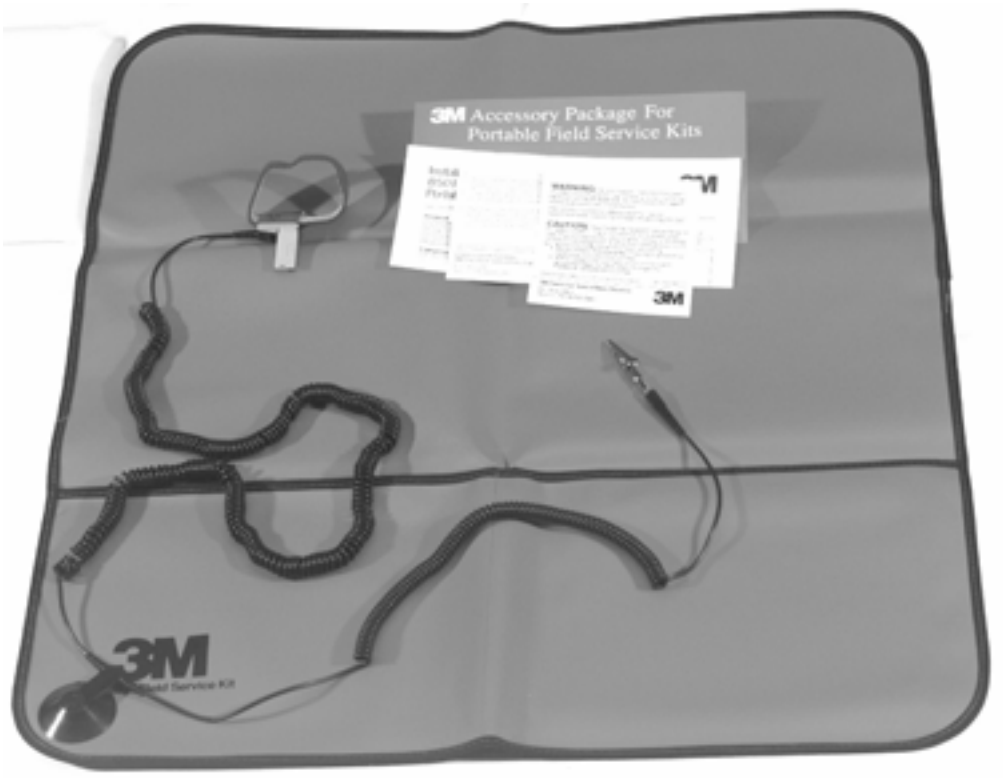


Figure 2-2. Anti-Static Kit (P/N 1-187-059) with Wrist Strap and Mat

Figure 2-2 shows the components of the Raymond antistatic field service kit (P/N 1-187-059). The kit includes a wrist strap, ground cord, and static-dissipative work surface (mat). Follow the instructions packaged with the kit.

Wrist straps are available in quantities of 25, as P/N 1-187-058/001.

A wrist strap tester is available as P/N 1-187-060.

Contact your local authorized Raymond Dealer for information.

https://truckmanualshub.com/

Jacking

Jacking Truck

When the truck is jacked up for any reason, take the necessary precautions listed here to ensure that the truck will not tip over.

- Lower the forks completely. Remove any load.
- Place all controls in neutral.
- Block the wheels to prevent movement of the vehicle.
- Turn the key switch OFF and disconnect the battery connector.
- Place the jack under the designated jacking points. See Figures 2-3 and 2-4.
- Always use solid blocks to support the vehicle. Never rely on jacks or chains to hold the vehicle.



Figure 2-3. Jacking Drive Tire Off Floor

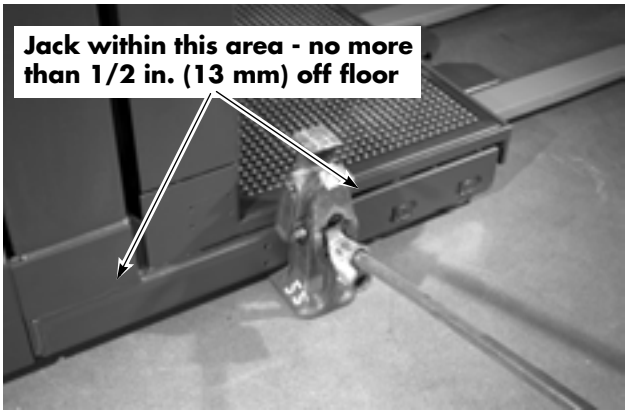


Figure 2-4. Jacking Side of Truck

⚠ WARNING

Attach a chain to the top of the mast and an overhead hoist to stabilize the mast if jacking more than described in this procedure.

Operator's Platform

When it is necessary to perform a procedure with the operator's platform elevated, place a safety stand between the carriage and baseleg as follows.

1. Use the lift knob and raise the operator platform until you have enough clearance to perform the procedure.
2. Place a safety stand or block between the carriage and a baseleg and carefully lower the operator platform onto the safety stand. See Figure 2-5.
3. Turn the key switch OFF and disconnect the battery connector.



Figure 2-5. Blocking Operator's Platform

https://truckmanualshub.com/

Emergency Lower Valve

In the event that it is necessary to lower the carriage from the ground, do the following:

1. Remove tractor cover. The Emergency Lower Valve is located on the lift/lower manifold. See Figures 2-6 and 2-7.
2. *Slowly* turn the valve counterclockwise, allowing the operator platform to lower by its own weight.

NOTE: Leaving the valve open will prevent the operator platform from elevating.

3. Turn the valve clockwise to close. This will allow the operator platform to elevate when the main lift control is operated.



Figure 2-7. Emergency Lower Valve - Variable Speed Lift

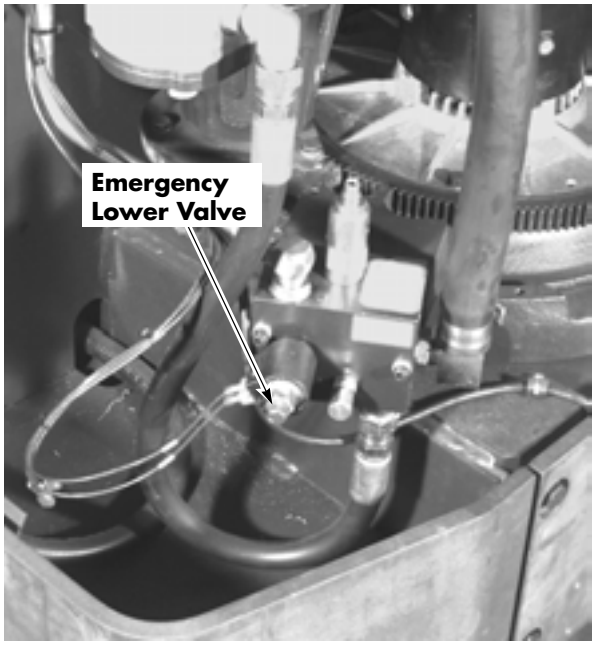


Figure 2-6. Emergency Lower Valve - Single Speed Lift

https://truckmanualshub.com/

Tie-Down for Transport

Vertical Transport

To transport this lift truck in an over-the-road vehicle or rail car, follow these steps:

1. Lower operator platform and locate truck in center of transport vehicle.
2. Turn the key switch OFF and disconnect the battery connector.

NOTE: If guide rollers are present, place straps through guide rollers and secure to floor; skip to step 4.

3. If guide rollers (used for rail guidance) are not present:
   a. Install eye-bolts (3/4 in. [19 mm] thread size) in holes in the bumper. See Figure 2-8.
   b. Secure chain from eye-bolts to vehicle bed. See Figure 2-9.
4. Strap truck from bumper or guide roller to floor of transport vehicle.
5. Chock drive wheel to prevent tractor-first movement.
6. Place block between baseleg and platform, 7.5 in. (190.5 mm) from front edge of platform.
7. Position additional adjustable chain or strap perpendicular to forks over operator's platform and attach it to vehicle bed. This will prevent tip-over during transportation. See Figure 2-9.

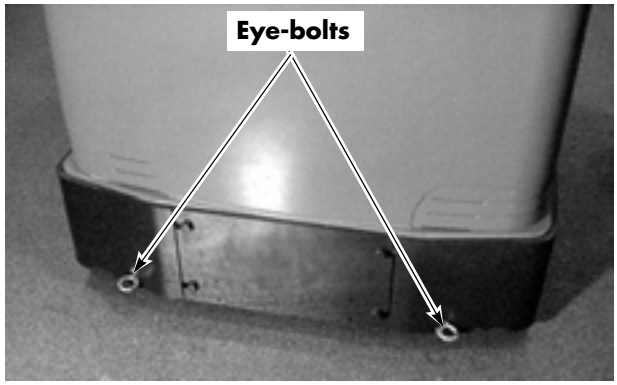


Figure 2-8. Eye-Bolts Installed for Transport

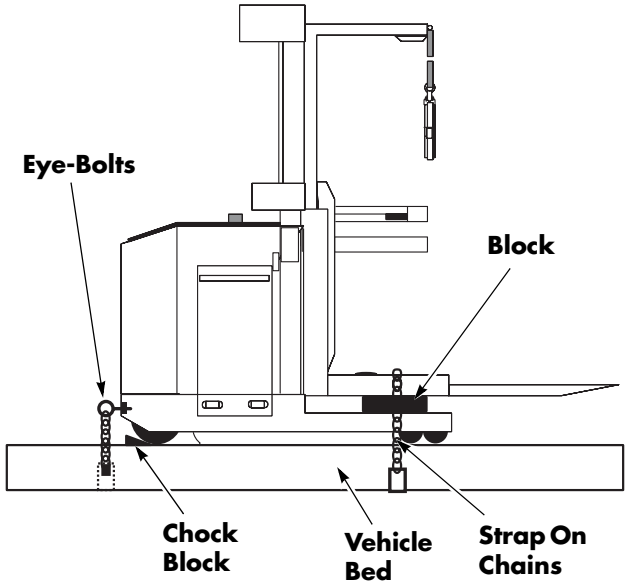


Figure 2-9. Tie-Down for Vertical Transport

https://truckmanualshub.com/

Horizontal Transport

1. Remove forks from carriage.
2. Replace cap and screen in hydraulic reservoir with shipping cap and screws (P/N 5-010-016).
3. Band down carriage and battery rollers.
4. Remove dipstick, and plug drive unit.
5. Remove the bottom two bumper plate bolts (to be reinstalled after shipping).
6. Use two hoists in conjunction and lay truck on cradle.
7. Install long bolts through the holes in the bumper and secure to cradle.
8. Band truck to cradle.
9. Secure forks to cradle below mast.

https://truckmanualshub.com/

Towing

To safely tow an EASi™ Orderpicker:

1. Lower the operator platform and remove any load.
2. Turn the key switch OFF and disconnect the battery connector.
3. Using a suitable towing vehicle, lift the tractor end of the truck until the drive tire is no more that 1 in. (25.4 mm) off the floor.
4. Tow the truck slowly in the tractor-first direction.

NOTE: If you must tow the truck flat on the ground, you must install the brake release bolts provided. See Figures 2-10 and 2-11.

Steering is disabled while you are towing, so you will need to manually turn the drive unit to steer.

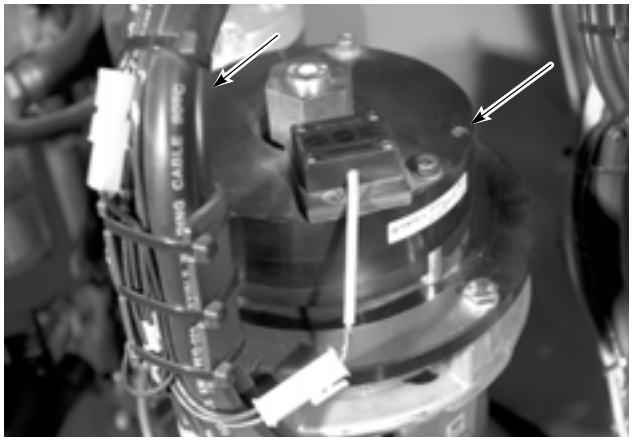


Figure 2-10. Brake Release Bolt Installation

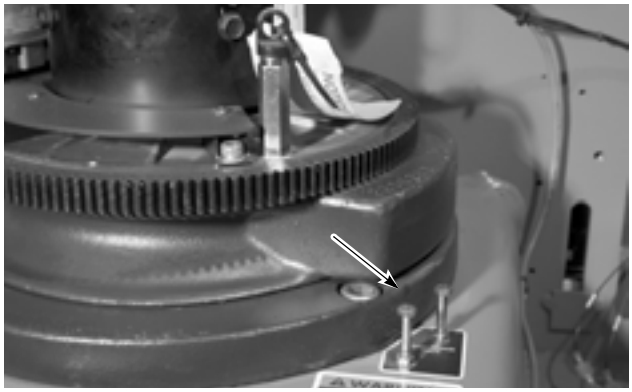


Figure 2-11. Location of Stowed Brake Release Bolts

https://truckmanualshub.com/

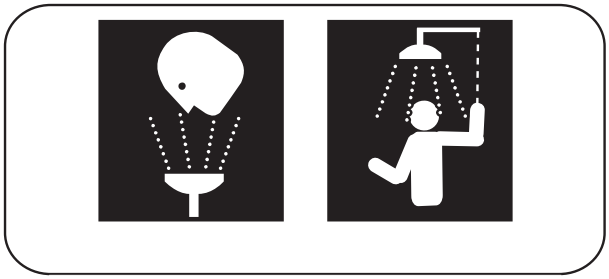
Welding Safety

⚠ WARNING

Flame cutting or welding on painted surfaces may produce potentially harmful fumes, smoke and vapors. Prior to performing flame cutting or welding operations, it is recommended that the coating be removed in the vicinity where the operation(s) will be performed.

⚠ WARNING

Coating removal may be by mechanical methods, chemical methods or a combination of methods. Flame cutting and/or welding operations should be carried out only in well ventilated areas using local exhaust if necessary.



Before working on this truck, make sure that:

- Fire protection equipment is nearby.
- You know where the nearest eyewash station is.

⚠ CAUTION

Disconnect the battery before you attempt to inspect, service or repair the lift truck.

- Check for any shorts to the frame. See Shorts to Frame Test on page 5-8. If any shorts are detected, remove them before you proceed with the welding operation.
- Clean the area to be welded.
- Protect all truck components from heat, weld spatter and debris.
- Attach the ground cable as close to the weld area as possible.
- Do not perform any welding operation near the electrical components.
- If welding must be done near the battery compartment, remove the battery.
- When you are finished welding, perform all ground tests and electrical inspections before the vehicle is operated.

https://truckmanualshub.com/

Section 3. Systems Overview

https://truckmanualshub.com/

General System Data

Carriage

The carriage is the part of the truck which can be elevated and from which the lift truck is operated. The carriage includes the operator's platform, the overhead guard, and the forks.

Chassis

The chassis is the basic frame of the lift truck which includes the tractor, baselegs and mast.

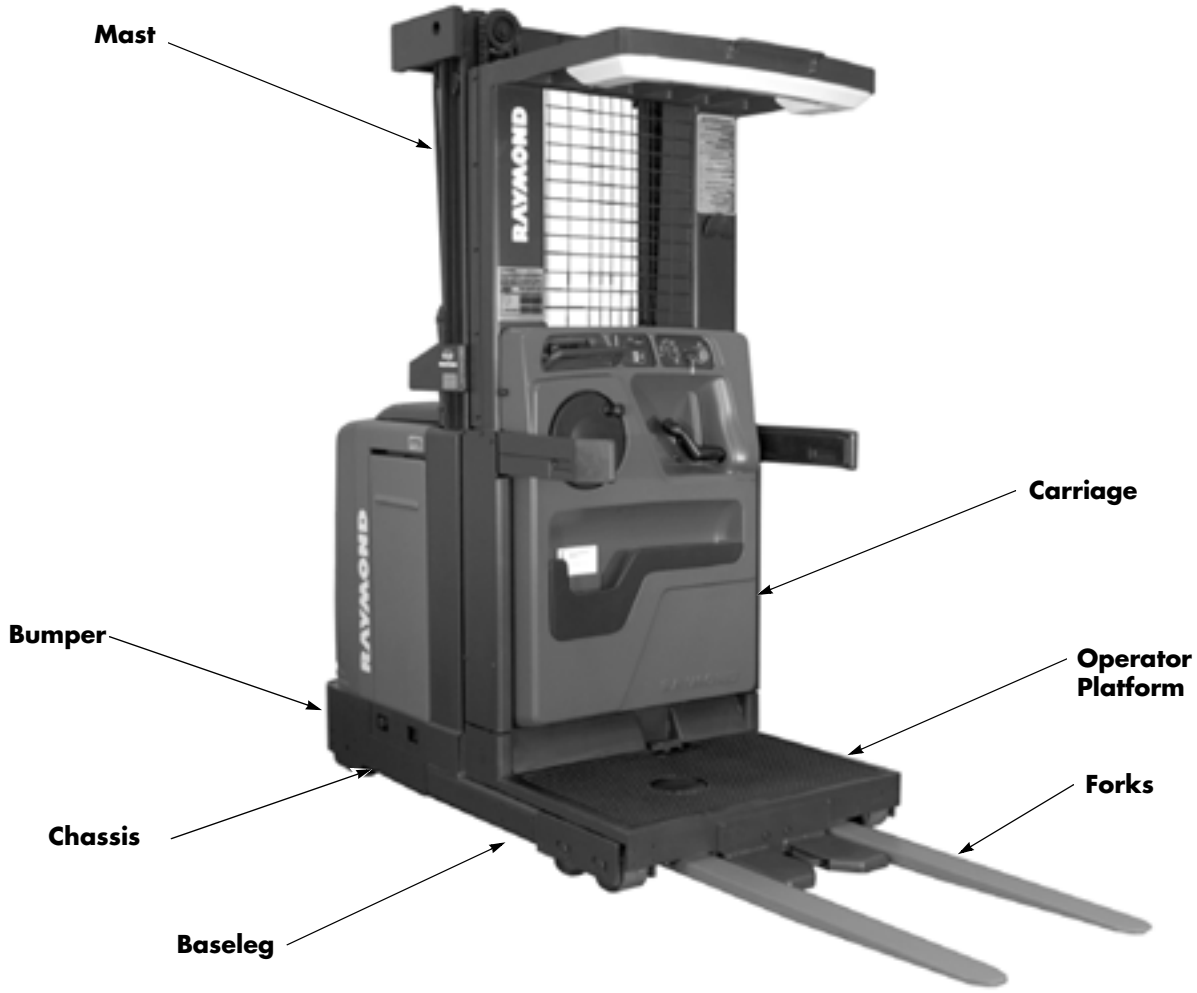


Figure 3-1. EASi™ Orderpicker

https://truckmanualshub.com/

Tractor

The tractor holds the majority of electrical and hydraulic components of the lift truck, including the battery, power section, pumps and motors. For the location of specific components, see Component Locator Photos on page 7-3.



Figure 3-2. View Inside Tractor Compartment

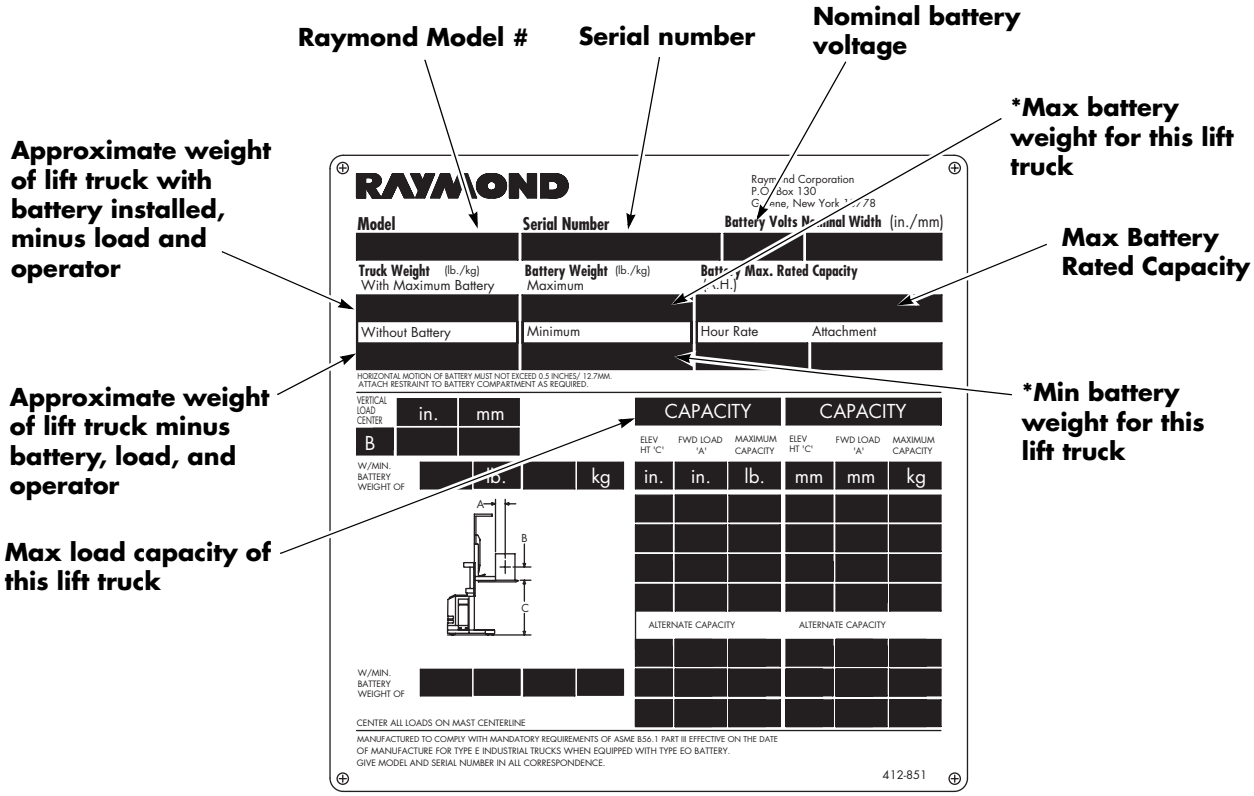
https://truckmanualshub.com/

Lift Truck Specifications

Specification Plate

This lift truck is rated for performance by load center and load weight. Review the specification plate for detailed load capacity and load center information. See Figure 3-3.

Due to continuous product improvement, specifications are subject to change without notice or obligation.



***Battery weight must be between the min and max weight.**

Figure 3-3. Lift Truck Specification Plate

https://truckmanualshub.com/

Modes of Operation

This vehicle can operate in one of two modes of operation:

- Run Mode
- Program Mode

Run Mode

Run Mode is the normal operating mode for the vehicle. Run Mode is the only mode in which normal vehicle travel is allowed. In this mode, the selectable display will be shown on the Operator's Display (OD). Run Mode will start automatically when Program Mode is exited or after SelfTest has passed.

Audible Alarm Description

Within Run Mode, various truck situations are identified using different audible tones and patterns. The following are the tones/patterns and possible cause for different operating conditions.

Run Mode Tones

Tone 1. A single tone which indicates:

- UP/DOWN/ENTER key is pressed.
- Maximum steer request is reached.

Tone 2. Two tones (high/low) which indicate the PC contactor is disabled (opened). Travel, steering, and lift/lower are disabled and the brake is applied until the problem is corrected.

Tone 3. Three tones (high/medium/low) which indicate:

- A travel performance limitation.

  A travel performance limitation will only allow the truck to travel at a maximum of 1 mph (1.6 km/h). Lift, lower, steering, and horn functions will operate normally.
- A traction system shutdown.

  A traction system shutdown will not allow the truck to travel. Lift, lower, steering, and horn functions will operate normally.
- A shutdown in the lift system.

  If a problem occurs in the lift system, lift will be prevented. Travel, lower, horn, and steering functions will still be permitted.
- A shutdown in the lower system.

  A problem in the lower function will disable the load holding solenoid. Steering, lift, travel, and horn functions will operate normally.

Tone 4. A continuous tone w/deadman pedal pressed and Auto/Manual switch in Manual indicates the truck is over the guide wire.

Tone 5. Tone ramps up then repeats indicates the truck is seeking and aligning over the guide wire. The tone will continue until the truck is locked on the guide wire or the Auto/Manual switch is changed to Manual.

Tone 6. Descending tone (bomb drop) which indicates an incorrect Password or Electronic Passkey was entered.

The tones described will not repeat continuously. A fault code and associated message will scroll across the Operator's Display. The message will repeat continuously until the key switch is turned OFF.

https://truckmanualshub.com/

Program Mode

Program Mode is divided into three categories:

- Configure (**CONFIG**)
- LEARN (**LEARN**)
- Maintenance (**MNT**) - Static or Active

Configure Mode

The Configure Mode (**CONFIG**) is used to adjust the vehicle's performance to specific customer requirements. To access **CONFIG**, Password or SuperWord must be used. For a detailed description of Configure Mode, refer to page 3-9.

LEARN Mode

The LEARN Mode is used to calibrate:

- Throttle potentiometer (VR1) (Controls)
- Lift/lower potentiometer (VR2) (Controls)
- *intellispeed*™ sensor - height (optional)
- Pressure transducer - weight (optional)
- Wire guidance frequency and offset (optional)
- Steering (electric steer option)*

A discussion of the LEARN process for the above items is included in this section.

NOTE: To access **LEARN**, SuperWord must be used.

Maintenance Mode

The Maintenance Mode (**MNT**) is used to verify the operation of various circuits of the truck. In Maintenance Mode, individual circuits can be energized and cycled to aid in troubleshooting. Some tests can be performed under both active and static conditions to further aid in problem diagnosis.

Static Maintenance Mode

This mode allows one function to be tested at a time while in Maintenance Mode.

Active Maintenance Mode

This mode allows all input and analog tests to be active in Run Mode. Enter Maintenance Mode to select the tests to be active. Press the Up/Down buttons on the OD to toggle between the selected tests.

To access **MNT**, SuperWord must be used. For a detailed description of Maintenance Mode, refer to page 3-19.

Password Levels

Two password levels are used with this system:

- Password
- SuperWord

Password

Password allows access to Configure Mode only. Instructions for using **CONFIG** are outlined on page 3-9.

SuperWord

SuperWord allows access to all program levels available. Only qualified service technicians should have access to SuperWord.

Instructions for entering or changing Password or SuperWord are described on page 3-7.

NOTE: It is *strongly* recommended that the SuperWord be changed from the factory default to something else during installation so access to programming is limited to qualified personnel. With that in mind, it is very important to remember the unique SuperWord code that has been entered and saved. If the code is lost or forgotten, it will be necessary for a technician to reset the truck to factory default settings. This would require the reconfiguration of all variable settings (Speed, Acceleration, Password, SuperWord, and so on).

https://truckmanualshub.com/

Entering Program Mode

Program Mode can be entered by one of the following two methods.

Method 1

1. With key switch OFF, hold the horn button in and move the lift/lower control to full lift.
2. Turn the key switch to the ON position.
3. The OD will show all eight segments with a solid bar in each segment. See Figure 3-4.

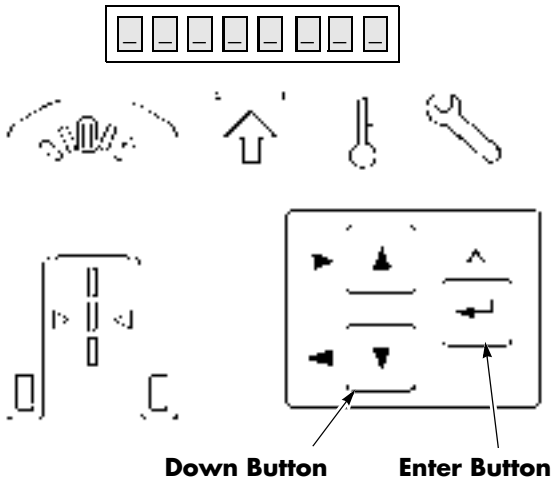


Figure 3-4. Operator's Keypad

Method 2

1. With the key switch OFF, press and hold the ENTER button and DOWN button at the same time. See Figure 3-4.
2. Turn the key switch to the ON position.
3. The OD will show all eight segments with a solid bar in each segment.

Entering Password or SuperWord

Refer to Figure 3-5.

1. Observe the OD. The flashing bar at the bottom of the left-most segment indicates the segment which is currently active.
2. Hold the ENTER button down and press the UP button to move the cursor to the right. Hold the ENTER button down and press the DOWN button to move the cursor to the left. Release the ENTER button.
3. Once the segment that you want to change is selected:
   a. Press the **UP** button to advance through the numbers then letters, (0, 1, 2, 3, 4... x, y, z).
   b. Press the **DOWN** button to select letters then numbers, (z, y, x, w, v...4, 3, 2, 1, 0).

   Repeat steps 2 and 3 for all character positions in the Password or SuperWord.
4. When the Password or SuperWord is displayed, press the ENTER button once.

NOTE: If an invalid Password or SuperWord is entered, the following message will appear:

INVALID CODE...TRY AGAIN

To make a correction, repeat steps 2 thru 4.

5. What appears on the OD will depend on whether SuperWord or Password was entered. Refer to Table 3-1.
   a. When SuperWord is entered, **QUIT PGM** is the first selection on the OD. If **QUIT PGM** is the desired menu selection, press the ENTER button. If **CONFIG**, **LEARN**, or **MAINT** is wanted, use the UP/DOWN buttons to get to that menu, then press ENTER.

NOTE: If the output tests are selected in **MAINT**, the OD will remind the service technician to jack the drive tire off the floor and to open the emergency lowering valve while in Maintenance Mode. When **READY?** appears on the OD, press ENTER to enter Maintenance Mode output tests.

   b. When PASSWORD is entered, **QUIT CFG** will be the first selection on the OD. Configure Mode submenus are described on page 3-9.

https://truckmanualshub.com/

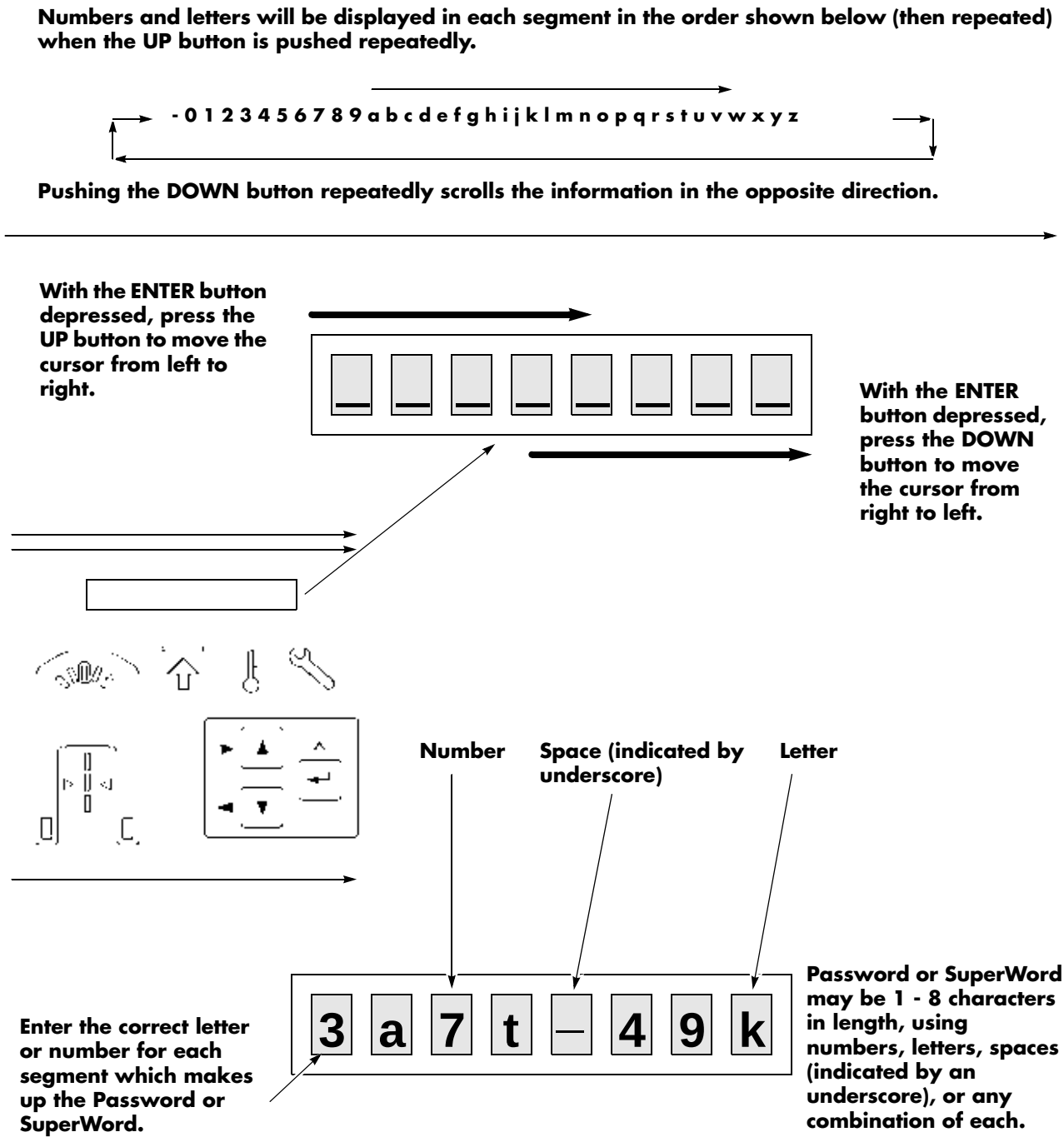


Figure 3-5. Operator Display for Program Mode (Example Only)

https://truckmanualshub.com/

Table 3-1. Program Mode Menu Structure

Program Mode Menu Structure		
Item	**Values**	**Description**
QUIT PGM		Exits Program Mode
CONFIG		Configure Mode - Refer to Configure Mode and Table 3-2, Configure Mode Menu on page 3-10.
LEARN (SuperWord req'd)	Quit Controls Speed Hgt/Wgt Steer Wg Offset	Learn Mode - Refer to LEARN Mode on page 3-13. Exits LEARN Mode
MAINT (SuperWord req'd)	Quit Analog Input Output Clr ActM	Maintenance Mode - Refer to Maintenance Mode on page 3-19. Exits Maintenance Mode See Analog Input Tests on page 6-115. See Digital Input Tests on page 6-147. See Digital Output Tests on page 6-191. Clears ALL selected Active Maintenance tests.

Configure Mode

Configure Mode can be accessed with SuperWord or Password, however some items in **CONFIG** will only appear if SuperWord is entered.

If SuperWord is entered, **QUIT PGM** will be displayed. If Password is entered, **QUIT CFG** is displayed. If SuperWord was entered, use the UP/DOWN arrow buttons until **CONFIG** is displayed. Press ENTER. Table 3-2 outlines all menus and submenus available in **CONFIG**.

Each time the UP/DOWN button is pressed, the selection changes. Continue to press the UP/DOWN button until the item you want to modify is displayed; then press ENTER. This will take you into the submenu for that item.

Current values will appear in the submenu. To change the value, press the UP or DOWN button. When the desired value appears, press ENTER. Pressing the ENTER button will select the item currently displayed and return to the main menu.

All possible truck configurations and options are listed in these instructions. Only the options associated with that particular truck will be displayed on the OD.

To save changes made in **CONFIG**, select **QUIT CFG** from the main menu and press ENTER. Selecting **SAVE? Y** saves the changes made and exits **CONFIG**.

To reinstate the factory default settings:

1. Select **DEFAULT** from the main menu and press ENTER.
2. Select **QUIT CFG** and **SAVE? Y** to save the settings.

NOTE: If, after modifying **CONFIG**, you change your mind, simply select **SAVE? N** from **QUIT CFG**, then press ENTER. **SAVE? N** exits the **CONFIG** without saving any of the changes.

https://truckmanualshub.com/

Changing Access Codes

Both Password and SuperWord can be changed to any combination of letters and/or numbers. Blank spaces are not allowed [spaces may be represented by a down bar (_)].

NOTE: If Password is entered, only Password can be changed. If SuperWord is entered, either Password or SuperWord can be changed.

The minimum number of characters is one, the maximum is eight.

To change the access code:

1. Enter **CONFIG** using the current SuperWord.
2. Select **SUPERWRD** or **PASSWORD** from the main menu using the UP/DOWN buttons.
3. Press ENTER.
4. Enter the new code using the UP/DOWN/ENTER buttons.
5. When the new code is displayed, press ENTER.
6. The display returns to the main menu.

Table 3-2. Configure Mode Menu

Configure Mode Menu (entered with Password or Superword)		
Menu	**Sub-menu**	**Description**
Quit		Exits Configure Mode
	Save? Y	Save changes and leave Configure Mode
	Save? N	Abandon changes and leave Configure Mode
Defaults		Restore Factory Defaults
	Reset? Y	Restore to Factory Defaults
	Reset? N	Do not restore to Factory Defaults
Speed		Set Max Speed 0.0 to 6.5 mph (0.0 - 10.46 km/h) (shown in
	X.X	increments of 0.1 mph). Default Setting Depends On Model
*EOA Speed**	@1.0 mph	Set End Of Aisle Slowdown Speed (0.0 to Maximum Speed) @1.0 mph (1.6 km/h)
Accel		Set Acceleration
	Hard	
	@Medium	
	Soft	
Lift		Set Lift/Lower Start/Stop Acceleration (Not For Single Speed Lift)
	Hard	
	@Medium	
	Soft	
LwrDecel		Set Lower Deceleration Speed (optional on earlier trucks)
	0 thru 9	Set lowering speed below 24 in. (610 mm). Select setting from 0 (no
	@3	lower deceleration) to 9 (highest amount of deceleration)
BSOC**		Battery State-of-Charge
	@75%	Variable from 55 to 100% in 1% increments
Cutout**		Select Battery Cutout Voltage
	@20%	0% - 50% in 1% increments
*24 Speed**		Set the 24 in. (610 mm) mast switch speed from 0.5 to 2.5 mph
	@2.5	(1.6 to 4 km/h)
*L Bypass**		Set Lift/Lower Bypass
	@Enable	
	Disable	
*LBPTrvCt**		Set Lift Limit Bypass and Travel Cutout
	@Enable	
	Disable	

NOTE: @Factory default; *Optional item; **Visible only if entered with SuperWord

https://truckmanualshub.com/

Table 3-2. Configure Mode Menu

Configure Mode Menu (entered with Password or Superword)		
Menu	**Sub-menu**	**Description**
*LBPAlarm**	@Enable Disable	Set Lift Limit Bypass Alarm
Units	@English Metric	Select Between English and Metric Units of Measure
*Wirefreq**	5.2 khz 6.25 khz Other	Select Wire Guidance Frequency
*Guidance**	Wire Rail	Select Between Wire and Rail Guidance (will only appear if both options are installed on the truck)
*Guideset**	Quit HA SLOW HA STOP DFW SLOW DFW STOP	Set Heading Angle and Distance From Wire Exit Guideset 0.6-2.0° in 0.2° increments (@1.6) 2.0-4.0° in 0.2° increments (@3.0) 0.6-1.6 in. (1.5-4.0 cm) in 0.2 in. (5 cm) increments [@1.6 in. (40 mm)] 1.2-3.0 in. (1.5-4.0 cm) in 0.2 in. (5 cm) increments [@3.0 in. (76 mm)]
*Acquire**	X.X mph	Set Acquire Speed (tractor first only) 1.0 to full speed in 0.1 mph increments (0.16 km/h)
*WrSnCrp**	@Enable Disable	Set Wire Sense Creep Speed
*Elec Key	XXXXXXX	Enter New Elec Key (default is 3) Display Current Elec Key
Password	XXXXXXXX	Enter New Password (default is 1) Display Current Password
Superwrd**	XXXXXXXX	Enter New SuperWord (default is 2) Display Current SuperWord
Version	Quit Ver CCC TM TS ESA *SMi	Display Software Version Exit Version xx.y (S/W Version for Carriage Control Card) xx.y (S/W version for Tractor Manager on VFC) xx.y (S/W version for Tractor Speed on Tractor Manager) xx.y (S/W version for Electric Steer Manager) x.y (S/W version for SMARTi® System)
Serial #	XXXXX	Display the Serial Number Assigned to the Vehicle
UPRrefSW**	XXX in.	Display Height of Upper Reference Switch [145-160 in. (3683-4064 mm)]
Clock	Time Date Quit Clk	Set Time/Date Set Time of Day (AM or PM) Set Current Date Exit Clock
*AlarmT**	Quit @Both Fork Ld? Fork Trl?	Set Alarm for Travel Exit AlarmT On in Both directions Fork Lead On/Off Fork Trail On/Off
NOTE: @Factory default; *Optional item; **Visible only if entered with SuperWord		

https://truckmanualshub.com/

Table 3-2. Configure Mode Menu

Configure Mode Menu (entered with Password or Superword)		
Menu	**Sub-menu**	**Description**
*AlarmL**		Set Alarm for Lift
	Quit	Exit AlarmL
	@Both	On in Both directions
	Lift?	On/Off
	Lower?	On/Off
*SMARTi		Set SMARTi
	@Enable	
	Disable	
Valve**		Identify the proportional valve installed on the truck
	A	Wandfluh
	B	Continental
	C	Hydra Force
Mnt Mind		Setup for Maintenance Minder (optional on earlier trucks)
	Quit MM	Quit Maintenance Minder Menu
	Enable	Turn on MM
	Reset	Update MM to the Current Interval
	Disable	Turn off MM
	Setup	Setup the MM Interval (See Maintenance Minder™ Tool on page 4-3.)
Auto Off		Set idle time for automatic shut-off
	Disable	
	10 Min	
	5 Min	
	4 Min	
	3 Min	
	2 Min	
	1 Min	
Dual Enc**		Identify truck as having Single/Dual Channel Steering Encoder
	Enable	Truck has Dual Channel Steering Encoder
	Disable	Truck has Single Channel Steering Encoder
NOTE: @Factory default; *Optional item; **Visible only if entered with SuperWord		

Table 3-3. Maintenance Minder Menu (after Enable is Activated)

MAINTENANCE MINDER MENU		
Item	**Values**	**Description**
Setup		See Mnt Mind in Table 3-2, Configure Mode Menu
	50 to 500 (in 50 Hr increments)	Hours of use (Deadman Pedal) (factory set at 200)
	Msg Only	Message Only
	L Cutout	Cut-Out Lift Function and Message

https://truckmanualshub.com/

LEARN Mode

LEARN Mode is used to calibrate the control circuits to the operator controls and the truck's external sensors, [such as throttle (VR1), lift/lower potentiometer (VR2), and the optional flow sensor used with advanced *intellispeed*™].

After entering the SuperWord, **QUIT PGM** is displayed on the OD. Scroll (Up/Down) through the menu until **LEARN** is displayed, then press ENTER. The alarm will beep, indicating that you are in LEARN Mode.

Select the item you want to learn. Follow the instructions as they appear on the OD. **LEARN** instructions will vary slightly between vehicles with different options. Instructions will repeat until they have been completed.

After the system is satisfied that the instructions on the OD have been followed, the alarm will beep and the next instruction will appear. This will continue until all required components are learned. After all steps have been satisfied, **QUIT LRN** will be displayed, allowing **LEARN** to be exited.

When to Run LEARN

See Table 3-4.

LEARN Controls

LEARN Controls is necessary on all EASi™ Orderpickers. During LEARN Controls, the Carriage Control Card is calibrating its control circuits to the output voltage from the Travel Potentiometer (VR1) and the Lift Potentiometer (VR2).

During LEARN Controls, the CCC measures and stores the neutral voltage value and the maximum forward and reverse voltage values from VR1. These values are used by the CCC to determine direction and speed requested by the operator during Run Mode.

The CCC also measures and stores the neutral and the maximum lift and lower voltage values from VR2. These values are used by the CCC to determine if lift or lower is being requested and the percentage of full speed that is being requested.

LEARN Ht/Wt

LEARN Ht/Wt is only present if the *intellispeed* option is installed on the truck.

The Electric Steer Manager interprets the height and weight inputs during Run, and passes that information to the Carriage Control Card as needed. During LEARN, the CCC is obtaining a base line for height and weight from which to calculate those parameters. The position of the upper and lower reference switches is part of the information that is installed into the trucks primary memory at the factory or as a result of a change with a passkey.

When LEARN Ht/Wt is performed, the carriage passes through both the lower and the upper reference switches. As hydraulic oil flows through the Flow Sensor to move the carriage, the Flow Module produces two pulsed outputs which are quadrature phased which the ESM sends to the CCC. The CCC counts and stores the number of pulses between the reference switches. During Run Mode, the ESM sends direction and pulse count information to the CCC. The CCC uses this information to determine the position of the carriage as the truck is operated during Run Mode.

The formula for calculating weight from the pressure transducer voltage is programmed into the CCC, but it needs to know the reference voltage from which to start the calculation. It monitors and stores the voltage from the pressure transducer as the carriage is lifted between the reference switches during LEARN. This value is used for the reference voltage for lifting an empty carriage.

After the carriage has been lifted between the reference switches, the carriage will elevate about 12 in. and pause before lowering again. During this pause, the CCC is storing the value that is produced by the ESM from the pressure transducer when an empty carriage is elevated and stationary.

https://truckmanualshub.com/

Table 3-4. When to Run LEARN

Component Repaired/Adjusted	Is LEARN Required?		Portion of LEARN to run
Upper Mast Switch	—	No	—
Lower Mast Switch	—	No	—
Power Card	—	No	—
Carriage Control Card (CCC)	Yes	—	All
Carriage Control Card PROM	Yes	—	All
Steer Position Proximity Home Sensor	—	No	—
Deadman Switch (S2/S23)	—	No	—
Lift Pot (VR2)	Yes	—	Controls
Speed Feedback Proximity Sensor	—	No	
Tractor Manager PROM	—	No	
Tractor Speed PROM (TS)	—	No	
Tractor Manager VFC	Yes	—	All
Electric Steer Manager	Yes	—	Steering, Frequency, and Offset[a]
Pressure Transducer	Yes	—	Height, Weight
Power Transistor (Q1)	—	No	—
Steer Feedback Encoder	Yes	—	Steering
L/L Sol	—	No	—
L/H Sol	—	No	—
Brake	—	No	—
Throttle Pot (VR1)	Yes	—	Controls
Temperature Sensor (HT)	—	No	—
Flow Sensor Module	Yes	—	Height, Weight
Steer Motor	Yes	—	Steering
Drive Unit	Yes	—	Steering
Filter Card	Yes	—	Freq, Offset[a]
Guidance Antenna Coil	Yes	—	Freq, Offset[a]

a. LEARN required for Offset and Frequency only if “Other” is selected through Configure Mode.

https://truckmanualshub.com/

⚠CAUTION

Prior to LEARNing height and weight, the vehicle should be placed in an area where the platform is able to lift beyond the upper mast reference switch (156 in. [396 cm] plus the height of the carriage).

When **HT/WT** is selected, the following message appears:

CARRIAGE WILL AUTOMATICALLY LIFT/LOWER BETWEEN THE REFERENCE SWITCHES

The operator is prompted as follows:

STEP ON DEADMAN TO BEGIN

This message will scroll continuously until the operator steps on the deadman. After the operator steps on the deadman, the carriage will immediately begin to lift. The display will continuously scroll the following message:

TO ABORT, STEP OFF DEADMAN

If all the parameters measured during **LEARN** are within tolerance, the following message will appear:

DONE LEARNING HEIGHT AND WEIGHT

If, at any time during **LEARN**, the operator steps off the deadman pedal or the measurements fall outside a tolerance, the following message appears:

UNABLE TO LEARN... LOWER THEN PRESS ENTER TO CONTINUE

If the failure is not the result of stepping off the deadman, attempt to learn again. If repeated attempts to learn fail, run tests:

- Test A05 - Pressure Sensor Voltage (Page 6-121)
- Test I00 - Lower Mast Reference Switch (Page 6-148)
- Test I01 - Upper Mast Reference Switch (Page 6-149)
- Test I10 - Display Flow Sensor Count (Page 6-156) (use active maintenance)

LEARN Steer

Run LEARN Steer to calibrate the steer motor assembly with the electronic steering control circuits.

NOTE: Before beginning this portion of LEARN, jack the tractor up so the drive tire is off the floor.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath the vehicle while jacking. Use jack stands or solid blocks to support truck - do not rely on jacks. Refer to page 2-11.

1. Select **STEER** from the **LEARN** menu. The following message will appear:

   JACK UP DRIVE UNIT AND BLOCK VEHICLE READY?

2. After the lift truck is jacked and blocked, press ENTER. The following message will appear:

   STEP ON DEADMAN TO START TEST

3. After the deadman is depressed, the following message is displayed:

   LEARNING STEER UNIT, TO ABORT PRESS ENTER

   For optimum responsiveness of the steering, the ESM needs to know the power required to move the drive unit and the speed at which the drive unit rotates when steering. During LEARN Steer, the ESM calibrates its steer motor control circuits to the individual characteristics in the steer system to optimize the operation of the steering.

   The following is a description of what occurs during LEARN Steer:

   - The CCC informs the ESM via BUS+/– to begin LEARN Steering.
   - The ESM Auto Steer centers the drive unit.

https://truckmanualshub.com/

- The system then pauses to allow the drive unit to stabilize and resets the drive unit position counter register to 0° from center.
- The ESM learns the power required to start rotation of the drive unit. It does this by slowly ramping up the power to the steer motor (CW) while monitoring the output of the Steer Feedback Encoder. As soon as the ESM detects pulses from the Steer Feedback encoder, it pauses and records the value. It repeats the procedure in the other direction (CCW) and records this value. The average of the two values is used as the starting point for ramping TM3 & TM4.
- The ESM rotates the drive unit left of center (CCW) about 45° and back to 45° right of center. This is repeated up to 10 times. While the drive unit is rotating, the ESM is calculating the average rotational speed when the drive unit is steered.
- LEARN Steer is complete. The drive unit will Auto Center and the truck will beep.

If any step cannot be completed, the ESM will inform the CCC that it could not complete LEARN and the CCC will inform the operator.

NOTE: At no time during **LEARN STEER** should the drive unit hit the mechanical stops.

If all parameters measured during **LEARN STEER** are within reference limits, the following message is displayed:

DONE LEARNING

If any measurements fall outside the reference limits, or if the operator steps off the deadman pedal, the following message will be displayed:

UNABLE TO LEARN... PRESS ENTER TO CONTINUE

4. If repeated attempts to LEARN Steer fail, run the following tests:
   - Test I22 - Steer Position Encoder Count (Page 6-168)
   - Test I24 - Home Position Proximity Sensor (Page 6-170)

Learning Guidance Parameters

The EASi™ Orderpicker may be equipped with an optional wire guidance system. This truck wire guidance system can be configured in either of two ways. If **OTHER** is selected under **WIREFREQ** in Configure, the ESM will need to calibrate its circuits to the frequency and amplitude of the guide wire current in order to correctly calculate wire guidance offsets. If either 5.2 kHz or 6.25 kHz is selected, the ESM will assume guide wire frequency and strength, and calculate only the wire guidance offsets. Both scenarios are discussed in the following paragraphs.

LEARN Wire Frequency

This selection is visible in the LEARN menu only if **OTHER** is selected under **WIREFREQ** in Configure, and must be completed before LEARN Offsets is attempted. When **OTHER** is selected, the ESM must learn the frequency and strength of the AC current flowing through the guide wire. This is done as follows:

- The truck must be centered over the guide wire.
- When LEARN Frequency is initiated, the ESM scans the inputs from the wire guidance sensors.
- The ESM selects the frequency with the greatest amplitude detected from the guide wire and tunes the wire guidance filters and amplifiers to that input.
- After the frequency and amplitude of the guide wire have been learned, the ESM informs the CCC and the operator is informed by the display.

NOTE: Learning the guide wire frequency can only be done if **WIREFREQ** is configured to **OTHER** on the Configure Mode menu.

1. Verify that the line driver is correctly adjusted to the proper frequency and amplitude.
2. Center the lift truck over the guide wire to within ±0.5 in. (±13 mm).

https://truckmanualshub.com/

3. Select **WIREFREQ** from the **LEARN** menu and press ENTER. The following message appears:

   CENTER OVER WIRE, THEN PRESS ENTER

   After ENTER is pressed, the following message is displayed:

   LEARNING GUIDE WIRE, TO ABORT PRESS ENTER

NOTE: This process takes several seconds.

4. When the frequency and amplitude of the guide wire has been LEARNed, the following message will be displayed:

   DONE LEARNING GUIDE WIRE

5. Exit LEARN Mode. Cycle the key switch OFF, then ON. Re-enter LEARN Mode prior to learning wire guidance offsets.
6. If a valid frequency is not found, or if at any time during the learning process, the operator presses the ENTER button, the following message will be displayed:

   UNABLE TO LEARN... PRESS ENTER TO CONTINUE

7. If repeated attempts to learn wire frequency fail, run the following tests:
   - Test A16 - Display Left Tractor Guidance Coil Voltage (Page 6-130)
   - Test A17 - Display Right Tractor Guidance Coil Voltage (Page 6-131)
   - Test A18 - Display Left Load Guidance Coil Voltage (Page 6-132)
   - Test A19 - Display Right Load Guidance Coil Voltage (Page 6-133)
   - Test A20 - Tractor Near Wire Coil Voltage (Page 6-134)
   - Test A21 - Load Near Wire Coil Voltage (Page 6-135)

LEARN Guide Wire Offsets

For correct guidance, the ESM must calibrate its internal guidance circuits to the voltage it receives from each guidance coil on the Sensor Cards. The ESM must also know the straight ahead position of the drive unit. These values are obtained while learning the wire guidance offsets as follows:

1. For correct learn, the Coast value in Configure *must* be set to **LONG**, and the truck must be driven in the tractor first direction.
2. The truck must be centered over the guide wire as closely as possible.
3. The Auto/Manual switch is set to Auto to initiate the LEARN procedure.
4. Next, the truck is driven tractor first on the guide wire for at least 60 ft. and allowed to coast to a stop. This is done to allow the truck to center correctly to its neutral position. If the brake or plugging is applied, the drive unit may shift position.
5. After the truck has coasted to a stop, the Auto/Manual switch is placed in the Manual position. When the Auto/Manual switch changes state, the ESM stores the voltage it measured from each guidance sensor coil. This voltage value is used to determine the wire guidance offsets and establish the scale factors required to determine heading angle and distance from wire when in Run mode.
6. When the truck powered up, it auto centered, which reset the pulse counter which monitors the Steer Feedback Encoder. As the truck was traveling on the wire in step 5, the pulse counter was keeping track of the deviation of the drive unit from the auto center position. When the Auto/Manual switch changed states in step 5, the ESM also stored the number of Feedback Encoder pulses between the Auto Center position and the position at which the drive unit was located when the Auto/Manual switch changed state. That is the value that the ESM will use as straight ahead when determining how to position the drive unit to keep the truck centered over the wire (sensor coil voltages at the learned value) as the truck drives on the wire.

   If the truck was not centered over the wire when the Auto/Manual switch changed states in step 5, the ESM would learn incorrect values (truck position) from the sensor coils. The ESM would then attempt to keep the truck in a position other than centered over the wire. If the drive unit was not straight ahead, the ESM would learn an incorrect angle and the truck may wander on the wire. Re-learn the wire guidance offsets as many times as

https://truckmanualshub.com/

necessary to make the truck track within 0.5 in. (13 mm) of the guide wire.

7. If the LEARN procedure is completed correctly, the following message will be displayed:

   DONE LEARNING OFFSETS

   The truck should guide centered over the guide wire.

   If ENTER is pressed during this learn process, the session is aborted and the following message is displayed:

   UNABLE TO LEARN... ENTER TO CONTINUE

8. If the truck was unable to acquire the wire or correctly learn offsets, perform the following procedure.

   a. Center the truck over the wire.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath the vehicle while jacking. Use jack stands or solid blocks to support truck - do not rely on jacks. Refer to page 2-11.

   b. Jack up the drive tire just enough to allow it to rotate when travel is requested.

   c. Select **WGOFFSET** from the **LEARN** menu and follow the directions.

NOTE: After coasting, when the Auto/Man switch is moved from Auto to Manual, the truck will learn the voltages where it was positioned. This should enable the truck to guide well enough to learn offsets again with the truck on the floor.

If LEARN still fails, run Tests A16 thru A21.

LEARN Speed Sensor

NOTE: LEARN Speed Sensor is not required.

NOTE: Before beginning this portion of LEARN, jack the tractor up so the drive tire is off the floor.

The deadman pedal must be depressed during this procedure. Do not touch the travel control handle. Releasing the deadman before the process is complete will cause the following message:

UNABLE TO LEARN

When **SPEED** is selected from the **LEARN** menu, the following message appears:

JACK UP DRIVE UNIT AND BLOCK VEHICLE READY?

After the lift truck is jacked and blocked, press ENTER. The following message will appear:

STEP ON DEADMAN TO START TEST

Step on the deadman. The following message is displayed:

LEARNING SPEED, TO ABORT PRESS ENTER

The drive motor runs in the first direction at top speed.

NOTE: This procedure could take longer than 2.5 minutes.

When complete in the first direction, the motor will stop, then run in the opposite direction at top speed.

The test may be aborted by:

- Stepping off the deadman
- Turning the key switch OFF

If the display shows:

SENSOR MALFUNCTION

during the LEARN cycle, run the following tests:

- Test I29 - Speed Feedback Proximity Sensor, Channel A (Page 6-173)
- Test I30 - Speed Feedback Proximity Sensor, Channel B (Page 6-174)

https://truckmanualshub.com/

Maintenance Mode

Maintenance Mode allows service technicians to test individual circuits within the *intellidrive*® system. Maintenance Mode is accessed through Program Mode after the SuperWord is entered. Refer to page 3-7 for information on procedures for accessing Maintenance Mode.

NOTE: If the test does not appear in the Maintenance Mode menu for an option when you think it should, either that option is not enabled (through the Dealer Technician intellidrive Configurator (DTIC) or factory setup) or the truck does not have the latest software.

General

- If you go into and out of **MAINT** several times to resolve a problem, it may save time if Superword is temporarily changed to a single digit code. That way, when Program Mode is started, a long password does not have to be entered. Remember to re-enter the correct Superword when you are done.

⚠CAUTION

Disconnecting wires or connectors to integrated circuits with power ON can result in premature failure of those or other components. Always disconnect the battery before making or breaking any connections.

- When removing a connector, do not pull on the wires to separate the connection.
- All circuit cards are conformal coated. Make sure a good electrical connection is made with test leads before replacing circuit cards.

⚠ WARNING

During Static Maintenance Output Tests, always jack the drive tire off the floor and open the Emergency Lowering Valve.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath the vehicle while jacking. Use jack stands or solid blocks to support truck - do not rely on jacks. Refer to page 2-11.

⚠ WARNING

By entering Static Maintenance Mode, the safety circuits associated with the *intellidrive*® system are disabled. Extra precautions must be exercised in Static Maintenance Mode. Follow all instructions contained in this manual for each test. If you are unsure how to conduct a test while in Maintenance Mode, do not proceed with the test. Contact a certified *Raymond*® technician.

https://truckmanualshub.com/

Static Maintenance Mode

In Static Maintenance Mode, the truck is inoperative. This mode allows the technician to test and operate individual circuits without operating the truck. All tests are available during static testing.

If Digital Outputs are selected from **MAINT**, the OD will display:

JACK DRIVE WHEEL, BLOCK VEHICLE READY?

Press ENTER button to start Maintenance Mode. The UP/DOWN buttons are used to turn the test ON/OFF.

Active Maintenance Mode

Active Maintenance Mode permits the testing of circuits related to the *intellidrive, intelliguide*™, and *intellispeed*™ systems. In Active Maintenance, up to six analog or digital tests can be selected with the results displayed while operating the truck in Run Mode. To enable a test for Active Maintenance, proceed as you would for Static Maintenance Mode. When the analog or digital test you want is displayed, press the ENTER button. An asterisk (*) appears next to the test number indicating that this test is selected for Active Maintenance.

Up to six tests may be selected. If a seventh test is selected, an audible alarm will sound. If six tests are already selected, you must turn one selected test OFF before another can be selected. Individual tests may be turned OFF by going back to that test in Maintenance Mode and pressing the ENTER button (the asterisk disappears). All tests may be cleared at once by selecting **Clr ActM** in Maintenance Mode. **Clr ActM** will only appear if a test is selected for Active Maintenance. The tests selected for Active Maintenance are stored in memory even if the key switch is turned OFF.

To select one of the Active Maintenance tests, press the deadman pedal and use the UP/DOWN arrow keys to select the test you want displayed while operating the truck. The test selected will remain on the display until another test or display selection is made.

NOTE: To select an Active Maintenance test on an EASi™ Orderpicker without the *intellispeed*™ option, the truck must first be initialized.

https://truckmanualshub.com/

Installation

Installation procedures must be performed by a Raymond Certified Dealer Technician to ensure full warranty coverage.

During installation, a visual and functional inspection must be performed.

Installation Procedure

NOTE: Two technicians are required for the installation/assembly of this truck.

⚠ WARNING

Place the mast, tractor, and pallets in an open area where it is safe to work.

- **The truck components are heavy, unstable, and difficult to handle. Use caution when lifting and assembling this truck.**
- **Personnel involved in the installation and assembly of this truck should wear gloves, safety glasses, steel toe boots and a safety helmet.**

⚠ WARNING

Do NOT remove the banding that secures the operator's platform to the baselegs until the truck is upright.

Uprighting a Cradled Vehicle

Two Hoist Method

This procedure requires two chain hoists of suitable weight capacity.

1. Position the cradled truck directly beneath and parallel to the chain hoist rail.
2. Attach one hoist to the upper crosstie of the mast.

NOTE: Place blocks between the crossties to avoid bending them.

3. Attach the second hoist to the baselegs.
4. Slowly raise each hoist until there is no slack in the chains.

⚠ CAUTION

While performing step 5, make sure the hoist attached to the baselegs does not lift the cradle off the floor. Also, do not let the chain become slack as this will allow the truck to drop.

5. Continue to slowly lift the hoist attached to the mast until the center of gravity shifts, causing the weight of the truck to shift to the hoist attached to the baselegs.
6. Lower the truck with the hoist attached to the baselegs until it is standing upright on the floor.
7. Remove the chain from the baselegs.
8. Remove the chain from the upper cross tie of the mast and attach it to the upper cross-piece of the cradle.
9. Loosen and remove the nuts holding the wooden cradle cross-piece to the mast, then remove the wooden cross-piece.
10. Remove the bolts from the bottom cradle cross-piece attached to the truck's front bumper.
11. Lift the cradle up and away from the truck and lower it to the floor.
12. Carefully remove the strapping securing the operator's platform to the baselegs.
13. Remove the solid gasket beneath the breather cap on top of the hydraulic oil reservoir.
14. Check the fluid level of the hydraulic reservoir.
15. Remove the plug from the drive unit and install the dip stick.

https://truckmanualshub.com/

Hoist and Lift Truck Method

This procedure requires a lift truck and a chain hoist of suitable weight capacity.

NOTE: Use this procedure when only one chain hoist is available.

1. Position the cradled truck directly beneath and parallel to the chain hoist rail.
2. Position the forks of the lift truck under the upper cross-piece of the cradle.
3. Attach a safety chain between the fork carriage and upper cross-piece of the cradle.
4. Attach the chain hoist to the baselegs of the truck.
5. Slowly raise the hoist until there is no slack in the chain.
6. Raise the upper end of the cradle with the forks of the lift truck.

⚠CAUTION

While performing step 6, make sure the hoist attached to the baselegs does not lift the cradle off the floor. Also, do not let the chain become slack as this will allow the truck to drop.

7. Continue to slowly lift the cradle until the center of gravity shifts, causing the weight of the truck to shift to the hoist.
8. Lower the truck with the hoist until it is standing upright on the floor.
9. Remove the chain between the fork carriage and the upper cross-piece of the cradle and back the lift truck away.
10. Remove the chain from the baselegs and attach it to the upper cross-piece of the cradle.
11. Loosen and remove the nuts holding the wooden cradle cross-piece to the mast, then remove the wooden cross-piece.
12. Remove the bolts from the bottom cradle cross-piece attached to the truck's front bumper.
13. Lift the cradle up and away from the truck and lower it to the floor.
14. Carefully remove the strapping securing the operator's platform to the baselegs.
15. Remove the solid gasket beneath the breather cap on top of the hydraulic oil reservoir.
16. Check the fluid level of the hydraulic reservoir.
17. Remove the plug from the drive unit and install the dip stick.

Greasing the Mast Uprights

Before placing the vehicle into service, clean the uprights, elevate the carriage so the telescopic section of the mast is accessible, and coat the main frame and telescopic uprights with grease using a 2 in. (51 mm) wide brush. See Lubrication Specification Chart on page A-2.

Functional Inspection

Before a truck can be put into service, a Raymond Installation Report MUST be completed.

Vehicle Operation

Refer to the Owner/Operator Manual for truck function information.

Warranty

The Installation Report activates the Raymond warranty on the truck. Failure to properly complete the Installation Report can void the warranty on the truck.

Password/Superword Changes

Upon completion of truck installation, change the Password and Superword to the customer's specifications. See Changing Access Codes on page 3-10.

https://truckmanualshub.com/

Cold Storage Conditioning

If the truck is to be used in a Cold Storage (CS) application, it will be equipped with CS option components when delivered from the factory. However, the oil in the hydraulic reservoir *must* be changed.

Make sure the truck is in a clean area, away from any possible contaminating elements that could enter the hydraulic system.

1. Drain the hydraulic reservoir completely. Also drain as much oil as possible from the hydraulic lines and cylinders.

⚠CAUTION

Use of the wrong hydraulic oil for a specific application can cause damage to hydraulic system components. Warranty claims will not be paid on component damage resulting from incorrect oil use.

2. Fill the hydraulic reservoir with the proper oil. See Lubrication Specification Chart on page A-2.
3. Operate all truck functions and check for hydraulic leaks.
4. Bleed the entire hydraulic system before placing the truck into service.
5. Check reservoir oil level.

https://truckmanualshub.com/

Wire Guidance

Wire guidance is a means to automatically steer the truck while traveling in an aisle. It offers precise steering at full-speed travel in Very Narrow Aisle (VNA) applications.

A wire guidance system consists of two sub-systems.

- Warehouse-installed equipment includes a guide wire and line driver. The guide wire is installed in the floor and emits an Alternating Current (AC) signal at a specific frequency and amplitude generated from the line driver.
- Truck-installed equipment includes:
  - Two guidance sensors, tractor end and load end
  - Electric Steer Manager (ESM), in tractor
  - Filter card, on ESM
  - Travel speed feedback encoder
  - Steer feedback encoder
  - Auto manual switch, on operator console
  - Associated cables and mounting brackets

  The truck must learn the amplitude and frequency of the guidance signal to properly track the guide wire.

NOTE: This manual covers all truck-installed equipment. For information on warehouse-installed equipment, refer to PDSS-0051, Raymond Wire Guidance.

To operate wire guidance, refer to the *EASi*™ Orderpicker Owner/Operator Manual, PDDM-0129.

Wire Guidance Setup

This procedure should not normally have to be performed. For the truck to guide properly, the following must be true:

- for 5.2 kHz, the current through the guide wire must be 100 mA peak-to-peak ±10%
- for 6.25 kHz, the current through the guide wire must be 225 mA peak-to-peak ±10%

If the warehouse portion of the guidance system has a different line driver output or the existing line driver is out of tolerance, refer to LEARN Wire Frequency on page 3-16.

https://truckmanualshub.com/

Cold Storage

Cold storage is an option that enables truck operation in temperatures of –20°F (–28.86°C) to 40°F (4°C).

On cold storage trucks, the electrical panel on the tractor is completely enclosed to contain heat. Components added to the truck for cold storage are listed in the tables below and shown on the electrical schematic. See Schematics on page A-13.

Heater Assemblies			
Components	**Location**		
	Carriage Control Card	**Tractor Compartment**	**Deadman Pedal**
Heating elements	HTRC	HTR2, HTR3	HTRDM
Thermostats	S81	S78, S79	S80
Fuses	FU21	FU20	FUDM

Cold Storage Schematic Legend	
Identification	**Description**
FU20	Control fuse for tractor heaters, 15A (on electrical panel)
FU21	Control fuse for Carriage Control Card heater, 10A (on operator console, below heating element)
FUDM	Control fuse for deadman heaters, 5A (on electrical panel)
HTRC	Heater for Carriage Control Card (behind CCC)
HTRDM	Heater for deadman (below deadman pedal)
HTR3	Heater for tractor compartment
HTR2	Heater for tractor compartment
HTR3-1	Splice for deadman heater
HTR3-2	Splice for deadman heater
S78	Thermostat for tractor heater HTR3
S79	Thermostat for tractor heater HTR2
S80	Thermostat for deadman heater
S81	Thermostat for CCC heater

https://truckmanualshub.com/

Configuration Codes

The vehicle configuration code is included in the serial number of the truck. The configuration code allows you to easily determine whether or not the vehicle is UL EE rated, the voltage, the type of steering system, the size of the drive motor and type of drive unit, and type of lift system.

Example: EASi-96-**AA**16218. Here, **AA** is the configuration code. Refer to the table below under the Code column and **AA**. Moving to the right, the various combinations of components are detailed. The configuration code allows for up to two characters, AA thru ZZ.

Configuration Code Cross Reference

Code	UL EE	Voltage	Steering	Traction System	Lift Motor	Lift System
AA	No	24	Manual	5.5 in. Drive Motor/Std. Drive Unit	Small	Single Speed
AB	No	24	Electric	5.5 in. Drive Motor/Std. Drive Unit	Small	Single Speed
AC	No	24	Manual	6.7 in. Drive Motor/Std. Drive Unit	Large	Variable
AD	Yes	24	Manual	6.7 in. Drive Motor/Std. Drive Unit	Large	Variable
AE	No	24	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	Variable
AF	Yes	24	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	Variable
AG	No	36	Manual	6.7 in. Drive Motor/Std. Drive Unit	Large	Variable
AH	Yes	36	Manual	6.7 in. Drive Motor/Std. Drive Unit	Large	Variable
AJ	No	36	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	Variable
AK	Yes	36	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	Variable
AL	No	24	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	*intellispeed*
AM	Yes	24	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	*intellispeed*
AN	No	36	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	*intellispeed*
AP	Yes	36	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	*intellispeed*
AQ	No	24	Electric	6.7 in. Drive Motor/Heavy Duty (HD) Drive Unit	Large	Variable
AR	No	36	Electric	6.7 in. Drive Motor/HD Drive Unit	Large	Variable
AS	No	24	Electric	6.7 in. Drive Motor/HD Drive Unit	Large	*intellispeed*
AT	No	36	Electric	6.7 in. Drive Motor/HD Drive Unit	Large	*intellispeed*

https://truckmanualshub.com/

Configuration Code Cross Reference						
Code	**UL EE**	**Voltage**	**Steering**	**Traction System**	**Lift Motor**	**Lift System**
AU	No	24	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	Limit Switch Speed Enhanced
AV	Yes	24	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	
AW	No	36	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	
AY	Yes	36	Electric	6.7 in. Drive Motor/Std. Drive Unit	Large	
BB	No	24	Electric	6.7 in. Drive Motor/Std. Drive Unit	Small	Single Speed
BC	No	24	Electric	6.7 in. Drive Motor/Std. Drive Unit	Small	Variable
BD	No	24	Electric	5.5 in. Drive Motor/Std. Drive Unit	Small	Variable
BE	No	24	Electric	5.5 in. Drive Motor/Std. Drive Unit	Large	Variable
BF	No	24	Electric	6.7 in. Drive Motor/Std. Drive Unit	Small	*intellispeed*
BG	No	24	Manual	6.7 in. Drive Motor/Std. Drive Unit	Small	Single Speed
BH	No	24	Manual	6.7 in. Drive Motor/Std. Drive Unit	Small	Variable
BJ	No	24	Manual	5.5 in. Drive Motor/Std. Drive Unit	Small	Variable
BK	No	24	Manual	5.5 in. Drive Motor/Std. Drive Unit	Large	Variable
BL	No	24	Manual	6.7 in. Drive Motor/Std. Drive Unit	Small	*intellispeed*

https://truckmanualshub.com/

Storage

If the truck is going to be stored for any length of time, cover the truck with canvas or plastic.

If the truck is going to be stored for more than 30 days, jack and block the truck up off the floor.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support truck. DO NOT rely on the jack alone. **See Jacking on page 2-11.**

Warranty

The Raymond Corporation should be contacted by an authorized Raymond Dealer for the proper warranty procedures.

Motors

The brushes in each motor should be lifted away from the commutator surface. When preparing the truck for service, the surface should be inspected and polished, if necessary, using a rubber abrasive polish. Polishers are specifically made for polishing commutators. DO NOT use a stone.

Periodically rotate the motor shafts to coat the bearings with lubricant, reducing the possibility of oxidation and corrosion.

Hydraulic System

The hydraulic system will absorb moisture when left standing for a long time. Make sure the reservoir is full before storing. Before returning the truck to service, drain the reservoir and change the filter. Fill the reservoir with new hydraulic oil. Operate the hydraulic systems slowly to allow internal components to be lubricated.

NOTE: If the truck is going to be stored for more than six months, spray hydraulic components with a silicone protectant. Do not let silicone protectant spray get on circuit cards.

Hydraulic Cylinders

It is recommended that the truck be stored with the cylinder pistons retracted. Coat all exposed chrome surfaces of the piston with hydraulic oil.

Lift Chains

Liberally coat all chains with oil to prevent rust and corrosion.

Electronics

Make sure all electronics stay dry.

https://truckmanualshub.com/

Section 4. Scheduled Maintenance

https://truckmanualshub.com/

Maintenance Guidelines

Following a regularly scheduled maintenance program:

- promotes maximum truck performance
- prolongs truck life
- reduces costly down time
- avoids unnecessary repairs

Scheduled maintenance includes:

- Lubrication
- Cleaning
- Inspection
- Service

Perform all of the scheduled checks and maintenance during the suggested intervals. The time intervals given in this guide are based on Deadman Hours (HD) under normal operating conditions.

When operating under Severe or extreme conditions, perform these services more often as indicated in the chart below.

Operating Conditions	Working Environment	Service Frequency
Normal	An eight hour day of basic material handling	60 days or 250 hours, whichever comes first
Severe	Extended operating hours or constant use A duty cycle greater than 100 picks per hour	175 hours
Extreme	All UL Type EE rated lift trucks Dusty or sandy conditions such as in cement plants, lumber or flour mills, coal dust or stone-crushing areas High temperature areas such as in steel mills, foundries, enclosed (Type EE) applications Sudden temperature changes such as going from freezer to room temperature Corrosive atmosphere such as in chlorine or salt-sea air environments	100 hours

https://truckmanualshub.com/

Maintenance Minder™ Tool

Maintenance Minder™ Tool is a feature which alerts the operator when the truck is due for scheduled maintenance.

Maintenance Minder, when configured and enabled, monitors the Hours on Deadman (HD) meter. When the time interval for scheduled maintenance has been exceeded, the operator is informed in the following ways:

- One of two messages scrolls on the Operator Display for at least 30 seconds following the **DAILY CHECKLIST** message:

  SCHEDULED MAINTENANCE DUE

  or

  LIFT CUTOUT, SCHEDULED MAINTENANCE DUE
- A wrench icon flashes
- The audible alarm sounds the high-low tone for approximately 5 seconds

Lift Cutout, when active, will not disable the lift function until power to the control circuits is cycled (key switch OFF or battery disconnected). When control circuit power is cycled, lift is disabled until *Maintenance Minder* has been reset or disabled, or the lift cutout option has been turned OFF.

For field installations, this feature must be added to the configuration options via the DTIC program. The factory default is OFF.

Enabling

Once installed in the configuration options, **MAINTENANCE MINDER** appears in the Configure Mode menu. The initial factory setting is **DISABLE**. To enable the feature, enter Configure Mode.

NOTE: For instructions on selecting Modes of Operation, see Modes of Operation on page 3-5.

With Configuration Mode selected, use the UP/DOWN button to scroll to display **MAINTENANCE MINDER**. Press the ENTER button. When entered from a disabled state, *Maintenance Minder* offers a submenu with the options **QUIT MM** and **ENABLE**. Use the UP/DOWN button to select **ENABLE**. Press the ENTER button.

Setting Time Interval and Action Option

The first time you enter the time interval menu, the Factory Suggested setting, followed by the letters **FS** is displayed. Subsequently, when you enter the time interval menu, the last used setting will be displayed. Values from 50 to 500 hours, in increments of 50, are available. Use the UP/DOWN button to scroll to the desired time interval. With the desired value displayed, press the ENTER button.

Use the UP/DOWN button to select the desired action option. Then press the ENTER button.

- **MSG ONLY** causes the Operator Display to show **SCHEDULED MAINTENANCE DUE** when the scheduled maintenance time interval has been exceeded.
- **L CUTOUT** causes the Operator Display to show **LIFT CUT OUT, SCHEDULED MAINTENANCE DUE** when the scheduled maintenance time interval has been exceeded. Lift will be disabled the next time the power circuits are cycled.

Use the UP/DOWN button to select **QUIT MM** from the submenu. If the status has changed, you will be prompted to save changes. Press the ENTER button.

NOTE: From the Config Menu, exit by selecting **QUIT CFG**. You will not be prompted again to save changes, but any changes saved when you **QUIT MM** are retained.

Changing Time Interval or Action Option

When *Maintenance Minder* is active, and you wish to change the time interval or action option, enter Configure Mode.

With Configuration Mode selected, use the UP/DOWN button to display the **MNT MIND** item. Press the ENTER button. When entered from an

https://truckmanualshub.com/

enabled state, *Maintenance Minder* offers a submenu with the options **QUIT MM**, **RESET**, **DISABLE**, and **SETUP**. Use the UP/DOWN button to select **SETUP**, then press the ENTER button. The current time interval is displayed (hours). Proceed as described under Setting Time Interval and Action Option.

Resetting *Maintenance Minder*

When *Maintenance Minder* is active, and, after you have performed scheduled maintenance, you wish to reset the reminder prompt, enter Configure Mode.

With Configuration Mode selected, use the UP/DOWN button to display the **MNT MIND** item. Press the ENTER button. Use the UP/DOWN button to select **Reset**, then press the ENTER button. Select **QUIT MM** and press the ENTER button again. Save changes, as prompted.

Disabling

When *Maintenance Minder* is active and you wish to disable it, enter Configure Mode.

With Configuration Mode selected, use the UP/DOWN button to display the **MNT MIND** item. Press the ENTER button. Use the UP/DOWN button to select **DISABLE**, then press the ENTER button. Select **QUIT MM** and press the ENTER button again. Save changes, as prompted.

https://truckmanualshub.com/

Decals

Replace any damaged or missing decals.

Location

Refer to Table 4-1 and Figure 4-1 for decal locations on the lift truck. For complete decal location/part number information, refer to the applicable Parts Catalog.

Removal

1. Use a sharp edge to peel the decal from the surface. Be careful not to scratch or damage the paint on the truck.
2. Clean the surface thoroughly and allow to dry before applying new decals. Touch up paint as required.

Installation

1. Peel off the backing and place the decal into position.
2. Press the decal into place. Avoid wrinkling.
   - If the decal does not have a protective sheet over the surface, smooth the decal into place using clean fingers. Be sure all edges are secured to the surface.
   - If the decal has a protective sheet over the surface, rub over the protective sheet with a firm, straight plastic edge to remove any air bubbles and wrinkles. Then peel off the protective sheet.

Table 4-1. Decal Location Chart

Identifier (ref. Fig. 4-1)	Description	Location
1	Prior to Operation decal	Operator platform, right side
2	Specification Plate (placard)	Operator platform, left side
3	Identification Plate (placard)	Mast, left side
4	ISO 9001 decal	Mast, left side
5	Replacement Operator Manual decal	Storage compartment
6	Bypass/Steer Centering decal	Operator platform, under control handle
7	Raymond decals	Side covers (each side), operator platform, left side
8	Overhead Guard decal	Overhead guard
9	Battery Removal Warning decal	Tractor frame, above battery compartment
10	Battery Notice decal	Tractor frame, above battery compartment
11	Emergency Lower Valve decals	Upper right side tractor cover (outside), lift/lower manifold (inside)
12	Hose Material Warning (placard)	Hydraulic hose near lift/lower manifold
13	ESD Jack	Carriage frame, near Carriage Control Card
14	Drive Unit Warning	Next to drive unit
15	Brake Release Bolts	Next to drive unit

https://truckmanualshub.com/

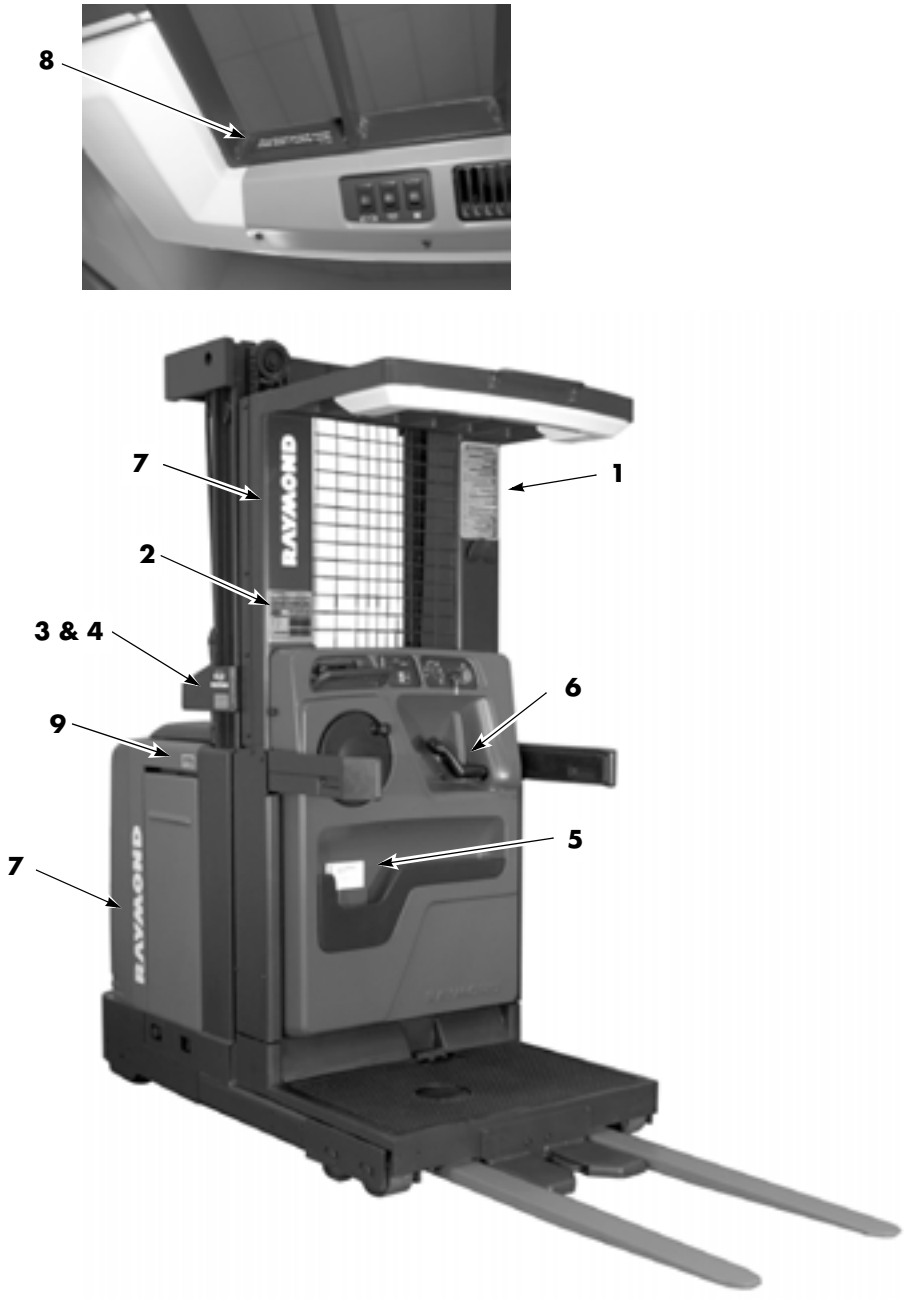


Figure 4-1. Decal Locations

https://truckmanualshub.com/

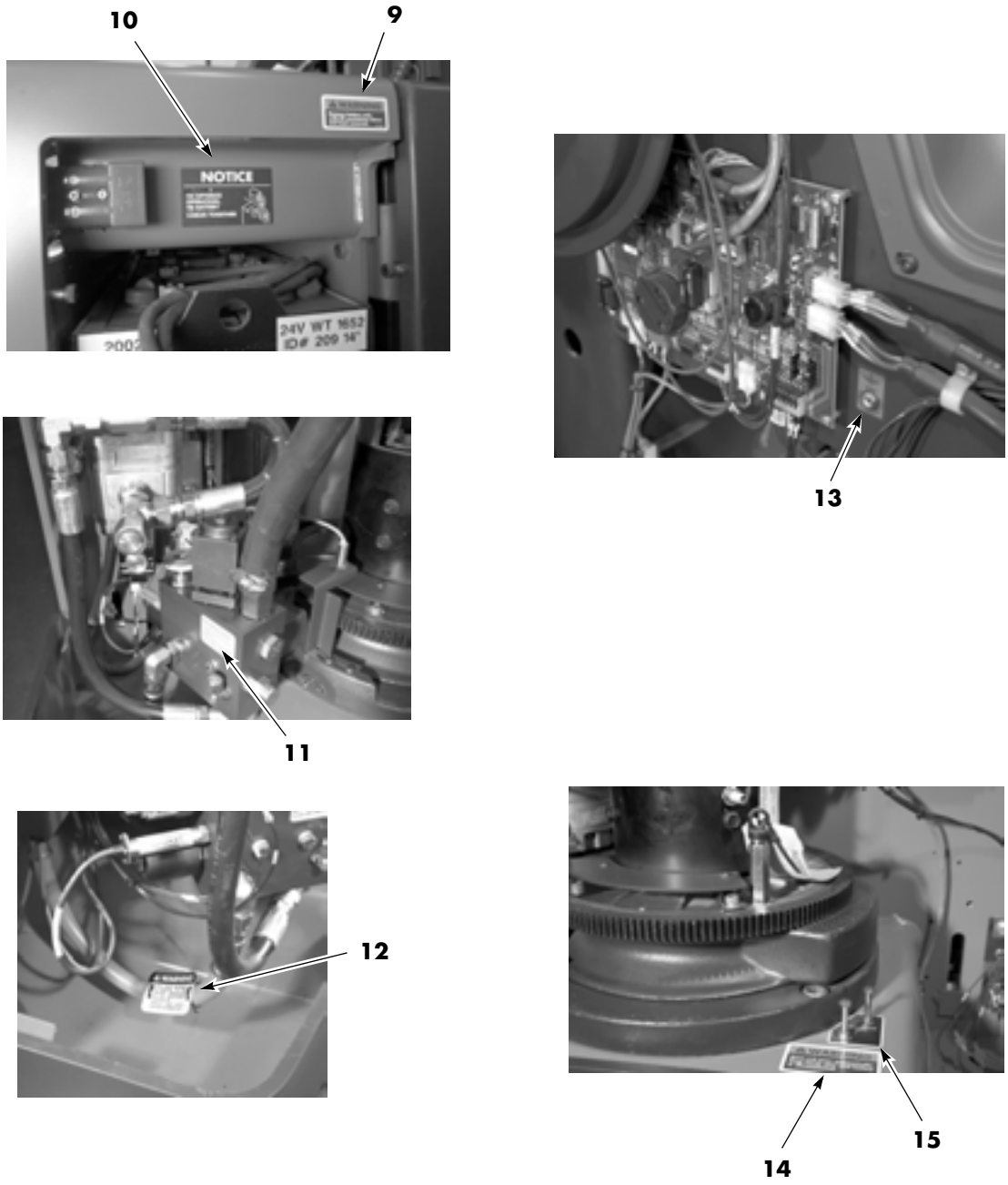


Figure 4-1 (Cont.). Decals Continued

https://truckmanualshub.com/

Operator's Daily Checklist

Visual Inspection - Key Switch Turned OFF		
Component	**What to Check**	**Mark**
Tires	No gouges, chunking, or flat spots No bond failure Adequate tread (if applicable)	
Battery	Fully charged/correct voltage and weight/no leakage Properly installed Gates properly installed Condition of battery/connectors Emergency disconnect functions properly	
Lift/Lower System	No damage to chains, hoses, or limit switches	
Controls	Move smoothly without binding Return to neutral when released	
Safety	Guards and covers installed and secure Decals - (warning/safety/operational) in place and legible Mast guard not cracked Check floor under truck for any dripping oil that might indicate a leak Fire Extinguisher (optional) Overhead guard Check baselegs and rollers on rail guided trucks for damage Check condition of static straps Check safety belt and tether for fraying or damage	
Operational Inspection - Key Switch Turned ON		
Horn	Sounds when button is depressed	
Steering	Smooth, without binding or excess play	
Directional/Speed Control	Moves smoothly without binding Returns to neutral when released Controls speed and direction properly Plugging functions properly Speed limits function properly	
Lift/Lower Mast System	Lift/lower control moves freely and returns to neutral when released All controls perform their functions as indicated Auxiliary lift (optional) functions properly	
Hour Meters and Total Miles Indicator	Records hours of lift truck operation, hours spent lifting, and total miles traveled	
Deadman Pedal	Pedal moves freely without binding	
Emergency Power OFF	Shuts down all functions when depressed	
Safety	All warning and working lights are functional All limit switches function properly Travel alarm (optional) and/or lift/lower alarm functions	

https://truckmanualshub.com/

Every 60 Days or 250 Deadman Hours (HD)

Every 60 days or 250 HD		
Perform ALL Daily Checks plus the following:		
Component	**What to do**	**Refer to**
Battery	Check the weight stamped on the battery in the lift truck against the minimum and maximum allowable weights on the spec tag for the lift truck. Report any lift trucks that are running with batteries under the minimum, or over the maximum allowable weight. Verify that the emergency disconnect is working properly. Check for voltage leaks to frame. Connect a 12V test light between B+ side of connector and battery case. If the light lights at all, even momentarily, the battery must be cleaned. Repeat the procedure, connecting the test light between B– side of battery and battery case. If cleaning does not remove voltage to frame, install a new battery.	Page 7-48
Battery Connectors and Leads	Inspect all battery connectors and leads for damage and cuts in protective coatings. Shorts to the truck frame will cause electronic component failure or intermittent electrical failures.	
Brake and Brake Pads	Check stopping distance by performing one of the following tests: • Drive the truck approximately 2-3 mph (3.2-4.8 k/hr). Push the EPO switch. The truck should stop within approx. 5 ft. (1.5 m). OR • With truck jacked up so drive tire is off the floor, push control handle until maximum speed is reached (transmission is rotating at constant speed), push EPO switch. The Drive Unit should rapidly decelerate to a stop. Check for signs of oil on the pads or rotor. If present, disassemble brake and clean the pads and rotor. A file may be used to clean the brake pad surface. Check minimum thickness of pad and steel backing plate: 0.80 in. (20 mm). Check for proper gap: 0.005 to 0.008 in. (0.13 to 0.20 mm) rotor-to-bottom-pad, at least 0.010 in. (0.25 mm) rotor-to-top-pad. **NOTE:** Failure to keep brakes adjusted will cause premature pad and rotor wear and excessive motor heat. Inspect for loose mounting hardware.	Page 7-42
Contactors	Inspect contact tips for burnt or pitted surfaces. Failure to replace the tips may cause surfaces to weld together, causing unscheduled down time. With the key switch OFF and the battery disconnected, check the plunger for smooth operation with no binding. If binding occurs, the lift truck may exhibit intermittent fault codes.	
Control Handle Functions	Verify lift/lower function is smooth and controllable. Verify travel function is smooth and responsive through full range of acceleration. Check for play in the center position of lift or travel control; repair/replace control handle if necessary. Run Test A03 - Throttle Potentiometer Voltage (Page 6-119) and Test A04 - Lift/Lower Potentiometer Voltage (Page 6-120). Verify smooth voltage change throughout the entire range of movement.	Page 7-24
Deadman Pedal	Check for smooth operation with no binding.	

https://truckmanualshub.com/

Every 60 Days or 250 Deadman Hours (HD)

Every 60 days or 250 HD		
Perform ALL Daily Checks plus the following:		
Component	**What to do**	**Refer to**
Drive Unit	Check fluid level. If low, check for leaks and refill. Inspect for leaks. Verify O-ring is present on the dipstick. Check for drive unit radial ring wear.	
Electrical Cables	Inspect all power cables for nicks or cuts. Give special attention to those cables which are not stationary, for example, cables to the drive motor. Replace any cable that is damaged or shows signs of excessive heat. Failure to do so will cause intermittent system shutdowns and/or electronic failures. Check the tension of the over-the-mast pulley cables. Set tension so the cables just stay on the pulleys. Higher tension will cause premature failure. Maximum spring tension is 5 to 7 in. lb. (0.57 to 0.79 N•m).	
Forks	Check for excessive wear, bends, cracks, welding arcs, excessive heat, or unauthorized modifications. Replace if found.	
Guide Wire Line Driver	Check for correct frequency and signal amplitude.	
Hardware	Check tightness of all hardware connecting wires and cables. Check bolt torque of major components (motors, pumps, brake, drive unit, manifolds, mast-to-tractor mounting bolts). Tighten any loose hardware. Replace any broken or missing hardware.	
Horn	Check that horn sounds properly when activated. Check mounting bracket insulators.	
Hydraulic Hoses	Inspect for leaks, nicks, cuts, chafing, and bulges. Replace damaged or worn hoses immediately. Inspect fittings for leaks; repair immediately.	
Hydraulic Reservoir	Check fluid level and type.	
Learn Mode	Enter Program Mode and run **LEARN** for all functions.	Page 3-13
Lift Chains	Check adjustment. Inspect for excessive stretch or wear (tool P/N 950-350/CG). Lubricate.	Page A-2
Lubrication	Apply grease to all fittings on drive unit. Apply small amount of grease to steering gear on drive unit. Coat all chains with film of spray lubricant.	Page A-2
Mast	Inspect rails for abnormal wear, metal flakes or shavings. Inspect mast and carriage stops for tightness and wear. Check mast bearings Check main frame mounting bolt torque (170 ft. lb. or 230 N•m). If loose, reapply thread-locking compound (P/N 990-544). If grease on mast uprights is contaminated, wipe off and apply new grease.	Page A-2

https://truckmanualshub.com/

<table>
<tr><th colspan="3">Every 60 days or 250 HD</th></tr>
<tr><td colspan="3">Perform ALL Daily Checks plus the following:</td></tr>
<tr><th>Component</th><th>What to do</th><th>Refer to</th></tr>
<tr><td>Motors</td><td>Visually inspect brushes for excessive heat (discoloration of the pigtails). If excessive heat is evident, inspect the armature circuit for loose connections.
Find the shortest brush in the holder.
Remove the brush and check the overall dimension. Inspect the brush for even wear over the full surface of the brush. If the brush is not contacting the complete surface, replace the brushes.
Inspect the brush rigging for damage or loose brush holders. Ensure that the connections on the brush leads are tight. Check brush spring tension.
<table>
<tr><th>Motor</th><th>Minimum Brush Length</th><th>Spring Tension</th></tr>
<tr><td>Drive</td><td>0.62 in. (16 mm)</td><td>40-65 oz. (1134-1843 gm)</td></tr>
<tr><td>Lift</td><td>0.62 in. (16 mm)</td><td>40-65 oz. (1134-1843 gm)</td></tr>
<tr><td>Steer</td><td>0.60 in. (15 mm)</td><td>35-55 oz. (995-1559 gm)</td></tr>
</table>
Blow out the inside of the motor with compressed air.
Check the cable lugs to make sure they are tight to the terminal studs. Torque both the inside and outside nut to the proper values.
Replace any cable that shows signs of excessive heat.</td><td>Page 7-51

Page 7-52

Page 7-53</td></tr>
<tr><td>Overhead Guard</td><td>Inspect guard for physical damage. If structurally damaged, replace the carriage.</td><td></td></tr>
<tr><td>Shorts and Voltage Leaks to Frame</td><td>Using a non-flammable cleaner, clean any dirt and oil buildup from inside the tractor compartment.
Check for electrical leakage to frame.</td><td>Page 7-48</td></tr>
<tr><td>Static Straps</td><td>Make sure static straps are not worn or broken.
Clean debris from straps.
Check resistance of resistor in standoff.</td><td></td></tr>
<tr><td>Switches</td><td>Check all switches for proper operation and adjustment.</td><td></td></tr>
<tr><td>Ventilation Slots</td><td>Make sure ventilation slots in the tractor frame are clear of obstructions and debris.</td><td></td></tr>
<tr><td>Warning Decals</td><td>Replace any unreadable or damaged decals.</td><td></td></tr>
<tr><td>Wheels/Tires</td><td>Check for bond failure, chunking, and excessive or uneven wear.
Check mounting hardware for proper torque.
Inspect load wheel bearings for binding or excessive play.
Inspect drive axle for excessive play.</td><td></td></tr>
</table>

https://truckmanualshub.com/

Initial 90 Day Maintenance

After the truck has been in service for 90 days, perform the following:			
Item No.	**Component**	**What to do**	**Refer to**
	Drive Unit	Change fluid.	
	Hydraulic Reservoir	Change fluid and filter.	

https://truckmanualshub.com/

Every 360 Days or 3000 Deadman Hours (HD)

Every 360 Days or 3000 HD		
Perform all 60 day/250-hour checks plus the following:		
Component	**What to do**	**Refer to**
Drive Unit	Change fluid.	
Frame and Baselegs	Visually inspect baselegs and frame members for cracks.	
Hydraulic Reservoir	Change fluid and filter.	

https://truckmanualshub.com/

Every 360 Days or 3000 Deadman Hours (HD)

RAYMOND

https://truckmanualshub.com/

Section 5. Troubleshooting

https://truckmanualshub.com/

Electrical Troubleshooting Guidelines

⚠ WARNING

Block the lift truck so that the drive tire is off the floor whenever a troubleshooting procedure requires turning key switch S1 ON. This will prevent accidents caused by unexpected lift truck travel. Opening the Emergency Lowering Valve will prevent unexpected lifting.

⚠CAUTION

Unless otherwise directed, disconnect the battery connector when you check electrical circuits or components with an ohmmeter. Electrical current can damage an ohmmeter. Discharge residual charge in the motor controller by pressing the PC and P contactors closed simultaneously.

Many problems are caused by a faulty or dirty battery. Make sure the battery is clean.

- Save time and trouble by looking for simple causes first.
- For information on electrical connector location and function, See Electrical Connector Location on page 5-15.
- Use a Digital Multi Meter (DMM) such as a Fluke meter for all measurements. Analog meters can give inaccurate readings and load down sensitive electronic circuits enough to cause failure. Make sure meter cables are connected to the proper meter jacks and that the proper function and scale are selected.
- Printed circuit boards are conformal coated. Clean test points in order to obtain accurate readings.
- When measuring voltage, connect the positive meter lead to the connector or probe point marked (+) in the test. Connect the negative meter lead to the connector or probe point marked (–).
- Whenever measuring resistance, turn the key switch OFF and disconnect the battery connector. Battery current can damage an ohmmeter. Isolate the component from the circuit.

Battery State-of-Charge

Battery State-of-Charge (BSOC) is an option that monitors and remembers the charge level of the battery connected to the truck and prevents excessive discharging of that battery. Operating a truck using a discharged battery can damage both the battery and the electrical components in the truck's electrical system.

At power-up, BSOC tests the battery to determine if it is the same battery that was installed at powerdown. If it is the same battery, it continues to monitor the battery for discharge and updates the OD as required.

If a different battery is detected, BSOC tests to determine the state-of-charge of the new battery as follows:

1. BSOC computes the difference between the charge of the battery that was connected to the truck and the charge of the new battery. A charge difference of a least 50% between the two batteries resets BSOC to show the state-of-charge of the new battery (for example - the displayed state of charge of the new battery minus the displayed state of charge of the old battery must equal or exceed 50%). This reset can be higher or lower than the old battery. Example - A battery in the truck is at 10% charge; the new battery is at 95%. With more than a 50% difference in the charge levels, BSOC will reset the OD to show the new battery's charge.
2. BSOC looks at the configured reset point. BSOC reset is programmable from 55% to 100% of total battery charge and can be changed by entering Configure Mode using the Superword. The new battery must be

https://truckmanualshub.com/

equal to or greater than the configured percent of charge before the BSOC will change. Example - BSOC configured at 95%. Plugging in a battery at anything below 95% charge will not change the OD. Older batteries may require a lower configured value for BSOC since older batteries may be unable to reach a higher percent charge. Therefore, older batteries may require BSOC configure to 85% before the OD will reset to show the charge of the new battery.

Either Step 1 or 2 will cause BSOC to reset.

The following examples describe installing a new battery where the OD does not reset. Assume the following:

- BSOC is configured at 95%, the battery connected is at 45% charge and the new battery is at 92% charge.
- Since the new battery charge has not changed by at least 50% and the state-of charge of the new battery is not greater than the BSOC reset configured value, the OD will continue to show the old battery's charge of 45% (even though the new battery is at 92%). The OD will remain at 45% until the charge of the new battery declines to 45%. The display will then resume its normal descent.

One final example. Assume the following:

- BSOC is configured at 95%, the battery connected is at 65% charge and the new battery is at 20% charge.
- Again, the change in charge is not at least 50% and the new battery is not above the configured BSOC level. The OD will continue to show 65%, but then descends rapidly as the truck operates until the OD shows the original charge of 20%. Once the display shows 20% it resumes a normal descent.

See Figure 5-1 for a graphic representation of the BSOC process.

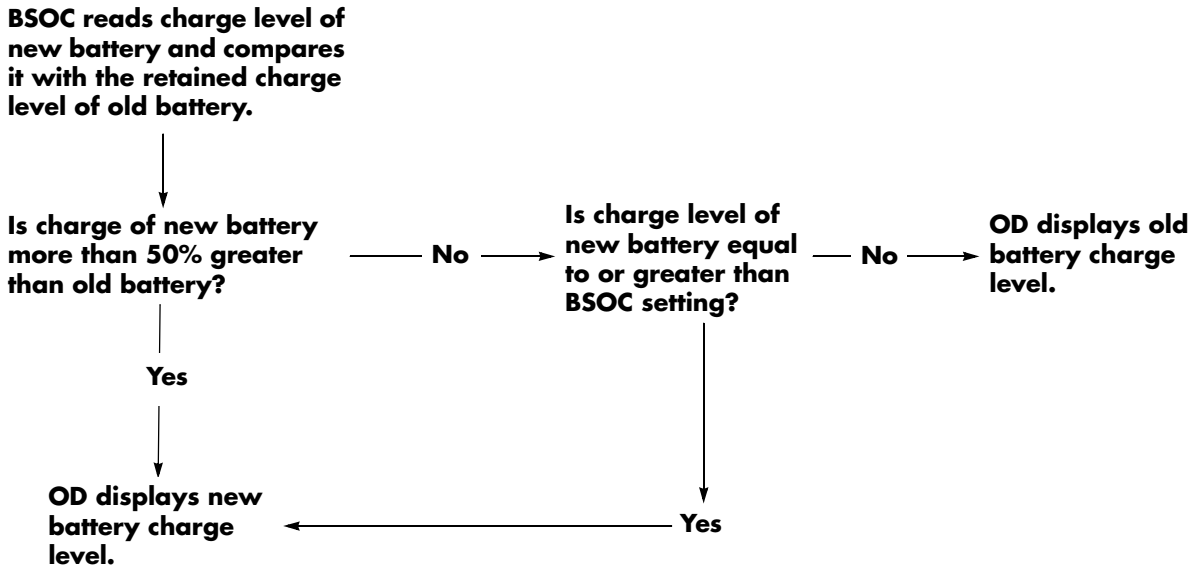


Figure 5-1. Battery State-of-Charge Process

https://truckmanualshub.com/

Electrostatic Discharge

Electrostatic discharge can cause certain fault codes, such as F4, F5, and F6. Over time, electrostatic discharge can damage circuit cards. Static tends to be higher in environments with low relative humidity, such as freezers. See Static Precautions on page 2-9.

Make sure static straps are installed on the truck and work properly.

https://truckmanualshub.com/

Motors

⚠CAUTION

If a problem is suspected with the drive motor, use the deadman pedal to stop instead of plugging.

Before trying to find the cause of the problem:

- Disconnect all power to the motor.
- Let the motor cool.

⚠CAUTION

Do not breathe any fumes from a motor that has been severely overheated. Burning insulation can create noxious fumes.

- Thoroughly ventilate the area to clear away any fumes.

When troubleshooting an electric motor related problem:

- Check cable and terminal ends, look for poor crimps and/or broken wire strands (see Wiring on page 5-10).
- Look for areas indicating excessive heat.
- Check for loose motor stud terminal hardware (see Motor Stud Terminals on page 7-52).

Overheating

Motor overheating can be caused by any one of the causes listed below.

- **Lack of Ventilation** - make sure that the ventilating holes or slots in the motor housing are not obstructed. Also make sure that the ventilation slots in the lift truck covers are free of obstructions.
- **Dirt** - See Motor, General on page 7-51.
- **Bad Bearings** - to check a motor for bad bearings:
  - Remove the motor from the lift truck.
  - Remove the brushes from the motor.
  - Rotate the armature shaft by hand. It should rotate smoothly without any binding. If there is binding, the motor bearings are probably bad and the motor assembly should be replaced.
  - Check for end play on the armature shaft. There should be no noticeable end play.

Low Battery Voltage

Check battery voltage. If it is too low, replace or recharge the battery. Adjust the lift cutout setting. See Configure Mode on page 3-6.

Heavy Loads

Do not try to lift loads that are beyond the lift truck's capacity. Heavy loads may cause the lift truck to become unstable. (See the specification plate on the lift truck for maximum allowable loads.)

Open or Short Circuit in Motor

See Electric Motor Tests on page 5-6.

https://truckmanualshub.com/

Electric Motor Tests

Motor Types

- A shunt-wound or separately excited motor, such as a drive motor, has four external connections: two armature (A) and two field (E) or (S). See Figure 5-2.
- A series-wound motor, such as a lift motor, has two external connections. The armature and field windings are connected internally. See Figure 5-2.
- A permanent magnet motor, such as a steer motor, has two external connections. The field is produced by an internal magnet. See Figure 5-2.

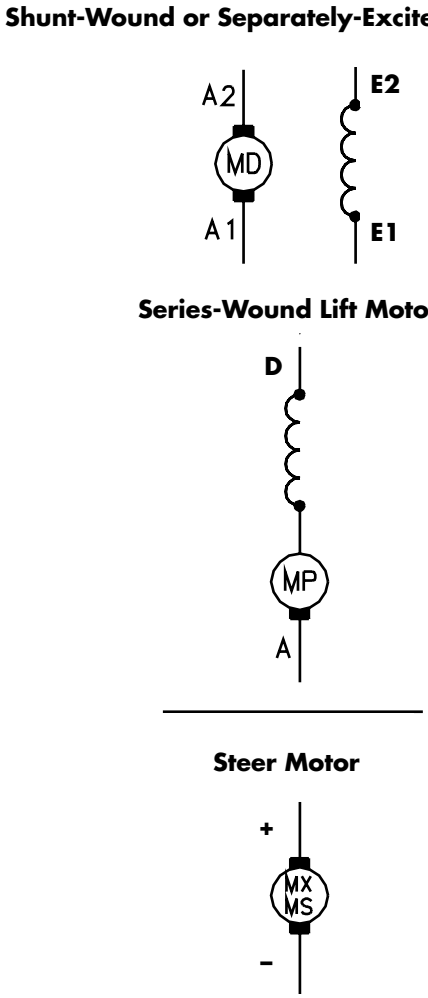


Figure 5-2. Motor Circuit Types

NOTE: Shunt wound motor field connections are labeled S or E. Series wound motor field connections are labeled S or D.

Open Circuit Motor Test

An open circuit is where the electrical circuit within the motor was broken. Possible causes are:

- Bad brushes or brush springs
- A broken wire in the field or armature winding
- A loose or bad connection

Refer to Figure 5-2 for the following procedure:

1. Isolate the motor from the truck circuit by removing the power cables. Use two wrenches to avoid twisting the terminal stud.
2. With the motor at room temperature, connect the leads of a DMM between the individual circuits in the motor.
3. Observe the measurements given in Table 5-1.
4. If the meter indicates high resistance in the armature, check the condition of the brushes before replacing the motor.
5. If you find an open circuit in a series-wound motor, a motor rebuilding facility must disassemble the motor to isolate the problem to the field or armature circuit.

https://truckmanualshub.com/

Table 5-1. Motor Resistance Values

Motor		Probe Points	Resistance
Traction (Drive)	Armature	A1 to A2	greater than 0.5 ohms
	Field	E1 to E2	greater than 1.8 ohm
Lift		A to D	less than 0.5 ohm
Steer		+ to –	less than 0.5 ohm

Grounded Motor Test

In a grounded motor, an electrical circuit exists between the current-carrying conductors and the motor housing. Causes are either by direct contact or through conductive foreign material.

The ground can be caused by:

- Insulation breakdown
- Brush leads touching the motor housing
- Build-up of carbon dust or other materials

To test for a grounded motor, see Shorts to Frame Test on page 5-8.

Maximum Amp Draw

Table 5-2. Motor Maximum Amp Draw Chart

Motor/Load		Code							
		AL w/AUX	AB/BB	AE/AL	AF/AM	AJ/AK/ AN/AP	BC/BF	AQ/AS	AR/AT
Main Lift	Empty	275A	215A	400A	260A	235A	215A	420A	275A
	Max Load	400A	315A	450A	380A	370A	315A	480A	420A
Mini Lift	Empty	200A	NA						
	Max Load	475A							
Travel	Empty	180A 60A typical at armature							
	Max Load	200A 150A typical at armature							

https://truckmanualshub.com/

Shorts to Frame Test

"Shorts to frame" is an industry term for unintentional current leakage paths between normally isolated electrical circuits and their metal enclosures.

Shorts to frame may be metallic connections, such as a wire conductor contacting metal through worn insulation. More often, shorts to frame are resistive "leakage" paths caused by contamination and/or moisture.

These leakage paths can result in unwanted electrical noise on the metallic lift truck structure, and may result in improper operation.

Shorts to frame are caused by:

- Accumulation of dirt
- Battery electrolyte leakage
- Motor brush dust
- Motor brush leads touching the housing
- Breakdown in insulation
- Bare wires
- Pinched wiring harness
- Improper mounting of circuit cards

Shorts to frame can occur at numerous locations on a lift truck, including:

- Batteries
- Motors
- Cables, wiring, and harnesses
- Heat sinks
- Bus bars
- Solenoids
- Contactors
- Terminal strips
- Switches
- Power panel insulation
- Circuit card mounts

To test for shorts to frame:

1. Turn the key switch OFF and disconnect the battery connector.
2. To test the battery for shorts to case, connect a 12V test light to the battery case from battery B+, and then to the battery case from battery B–. If the light illuminates at all, even momentarily, there is a *serious* problem with the battery, either external contamination or internal damage. *Do not continue until this condition is corrected.* The meter may be damaged if you proceed before correcting this condition.

   Install another battery in the truck and repeat this procedure from Step 1.

   If the test light does not light, continue to the next step.
3. Use a DMM set on the ampere function to measure the current leakage from the battery case to battery B+ and from the battery case to battery B–. Begin measuring at the highest ampere scale and work toward the lowest. A reading of more than 0.001A (1mA) indicates a *serious* short. *Do not continue until this condition is corrected.* The meter may be damaged if you proceed before correcting this condition.

   Install another battery in the lift truck and repeat this procedure from Step 1.

   If the current is less than 0.0002A (0.2mA), go to Step 4. If the current is greater than 0.0002A (0.2mA) and less than 0.001A (1mA), remove the battery from the truck, then continue with Step 4. Make sure the battery case does not touch the truck frame during the remaining tests.
4. With the battery disconnected (or removed and disconnected) from the truck, use a DMM to measure the resistance from lift truck frame to truck B+, to truck B– (NOT battery B+ and B–), and to all fuses and motors. A reading of less than 1000 ohms indicates a *serious* short. *Do not continue until this condition is corrected.* The meter

https://truckmanualshub.com/

may be damaged if you proceed before correcting this condition.

a. To identify the cause of the short to frame, disconnect circuit components until the low resistance condition disappears. Do not reconnect components one at a time, but leave them disconnected until the low resistance reading disappears. Prevent disconnected terminals or connectors from touching the lift truck frame or other conductive surfaces.

b. The most likely areas to check are:

- Motors
- Heat sinks
- Power cables
- Power circuit components
- Control circuit components

c. Repair or replace the component causing the low resistance condition. Repeat Step 4.

d. Reconnect all other components previously disconnected, one at a time, measuring resistance between steps. If a reading is less than 1000 ohms when reconnecting a component, that component or its wiring is faulty; repair or replace as appropriate.

e. When, after all components are reconnected, you get readings greater than 1000 ohms, continue with the next step.

5. Reconnect the battery connector and turn the key switch ON. If the battery was previously removed, make sure the battery case does not touch the lift truck frame.

NOTE: The functions being checked must be energized. Example: to check for shorts to frame in the travel circuit, travel must be requested.

6. Use a DVM set to the current function to measure current leakage to the truck frame from B+, B–, and all fuses and motor terminals. Begin measuring at the highest ampere scale and work toward the lowest. If the current is less than 0.001A (1mA), go to step 7. If the current is more than 0.001A (1mA), continue with the following steps.

a. To identify the cause of the short to frame, disconnect circuit components until the leakage current reads less than 0.001A (1mA). Do not reconnect components one at a time, but leave them disconnected until the leakage current reads less than 0.001A (1mA). Prevent disconnected terminals or connectors from touching the lift truck frame or other conductive surfaces.

b. The most likely areas to check are:

- Motors
- Heat sinks
- Power cables
- Power circuit components
- Control circuit components

c. Repair or replace the component(s) causing the leakage current. Repeat Step 6.

d. Reconnect all other components previously disconnected, measuring current between steps. If a reading is more than 0.001A (1mA) when reconnecting a component, that component or its wiring is defective. Repair or replace as appropriate.

7. When, after all components are reconnected, you get a reading less than 0.001A (1mA) there is no short to frame condition with the truck or the battery. If you previously removed the battery from the truck, re-install the battery.

https://truckmanualshub.com/

Wiring

Visually inspect all wiring and electrical components for:

- Loose connections or connectors
- Loose or broken terminals
- Damaged terminals, blocks, or strips
- Exposed wire at terminations, excessive strip gap
- Abrasions, scrapes, nicks in the wire, damage from overheating or burns, or other general insulation damage
- Broken wire strands and shorted conditions (especially those that are close to metal edges or surfaces)

During troubleshooting and repairs, it may be necessary to unplug a connector, move a harness, cut a cable tie, or remove the wire from a bracket. Note the location of the wire and all protective or securing attachments before moving the harness.

After repair, return or replace all protective and/or securing hardware to its original condition. Protective materials are necessary to provide reliable performance of the interconnect system.

Examine and maintain any added materials used to dress and protect the wire. This includes spiral wrap, brackets, cable ties, fasteners and flexible conduit.

Do not attach cable ties so tight that they pinch cable harnesses. Avoid tie wrapping to hydraulic hoses which expand with pressure, pinching the tie wrapped electrical cables.

Use a DMM to check for wiring continuity.

https://truckmanualshub.com/

Power Transistor (Q1) Test

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the tractor covers.

⚠CAUTION

Observe proper ESD precautions. See Static Precautions on page 2-9.

3. Disconnect all wires connected to Q1.
4. Set a DMM to the *Diode Test* function. See Figure 5-3. Connect leads as shown in Table 5-3.

NOTE: Consult the owner's manual for the meter being used to ensure correct readings. On the *Diode Test* function, the voltage across an electronic device is being measured. If the component(s) being measured are open, the meter will read open or OL. If the component(s) have some resistance to current flow, the voltage drop across that resistance will be shown on the meter.

a. If these results are not obtained, the transistor is bad. See Q1 Replacement on page 7-56.

⚠CAUTION

Test the Power Card BEFORE installing a new Power Transistor. See Diagnosis and Repair for Test O14 - Armature PWM Test (Page 6-205).

b. If these results are obtained, the transistor is good. Reconnect all wires to Q1 and torque the connections per Table 5-4.

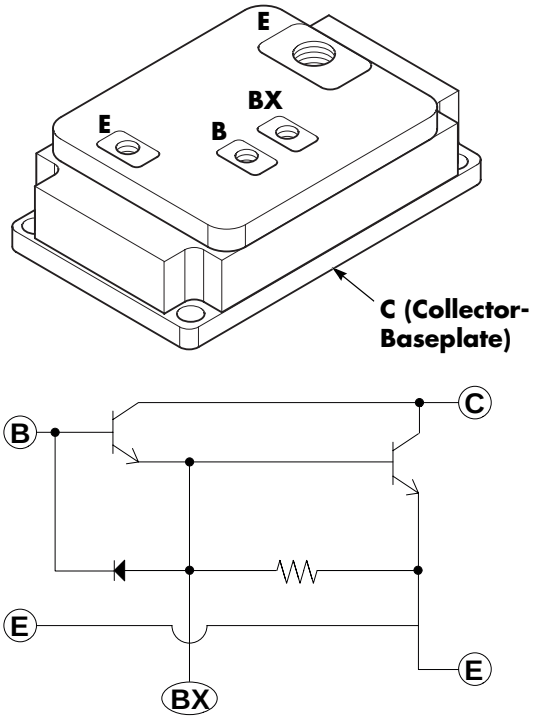


Figure 5-3. Q1 Connections and Schematic

Table 5-3. Q1 Meter Readings

+ Lead	– Lead	Meter Reading
C	E	OL
E	C	<1V
E	B	<1V
C	B	OL
B	E	<1V
B	C	<1V

Table 5-4. Transistor Module Torque Values

Screw Size		Torque	
ANSI	Metric	in. lb.	N•m
#8	M4	10-14	1.12-1.58
#10	M5	14-17	1.58-1.92
1/4 in.	M6	22-26	2.5-2.93
3/8 in.	M8	70-75	7.9-8.4

https://truckmanualshub.com/

REGEN Transistor (Q2) Test

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the tractor covers.

⚠CAUTION

Observe proper ESD precautions. See Static Precautions on page 2-9.

⚠CAUTION

Before disconnecting wires from Q2, install a jumper between gate (G) and emitter (E). This will prevent Q2 from accidentally turning on.

3. Disconnect all wires connected to Q2.
4. Set a DMM to the *Diode Test* function. See Figure 5-4. Connect leads as shown in Table 5-5.

NOTE: Consult the owner's manual for the meter being used to ensure correct readings. On the *Diode Test* function, the voltage across an electronic device is being measured. If the component(s) being measured are open, the meter will read open or OL. If the component(s) have some resistance to current flow, the voltage drop across that resistance will be shown on the meter.

a. If these results are not obtained, the transistor is bad.

b. If these results are obtained, the transistor is good. Reconnect all wires to Q2 and torque the connections per Table 5-4.

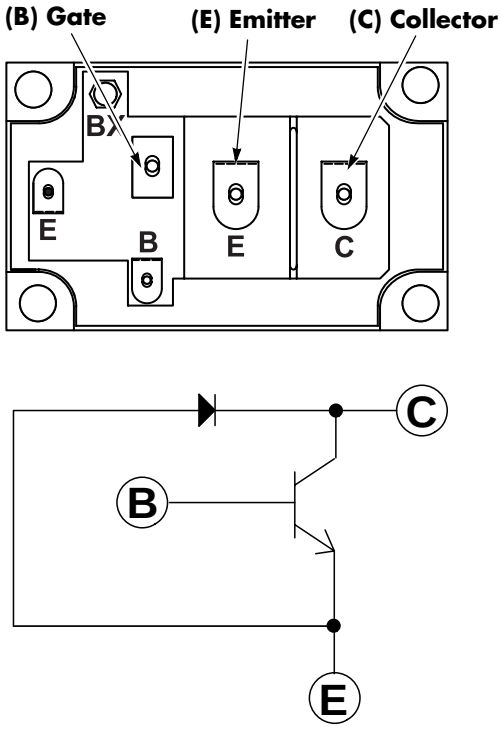


Figure 5-4. Q2 REGEN Transistor Connections

Table 5-5. Q2 Meter Readings

+ Lead	– Lead	Meter Reading
C	E	OL
E	C	<1V
E	B	OL
C	B	OL
B	E	OL
B	C	OL

https://truckmanualshub.com/

Field and Steering Transistor Test

TM1/TM2 are used on all trucks. TM3/TM4 are used on trucks with electric steering only.

⚠CAUTION

TM1/TM2 and TM3/TM4 are tested the same, however, they do not have the same current rating. They are NOT interchangeable.

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the tractor covers.

⚠CAUTION

Observe proper ESD precautions. See Static Precautions on page 2-9.

3. Disconnect all wires connected to the transistor module.
4. Set a DMM to the *Diode Test* function. See Figure 5-5. Connect leads as shown in Table 5-6.

NOTE: Consult the owner's manual for the meter being used to ensure correct readings. On the *Diode Test* function, the voltage across an electronic device is being measured. If the component(s) being measured are open, the meter will read open or OL. If the component(s) have some resistance to current flow, the voltage drop across that resistance will be shown on the meter.

a. If these results are not obtained, the transistor is bad. See TM1/TM2 Replacement on page 7-62 or TM3/TM4 Replacement on page 7-61 as applicable.

b. If these results are obtained, the transistor is good. Reconnect all wires and torque the connections per Table 5-4.

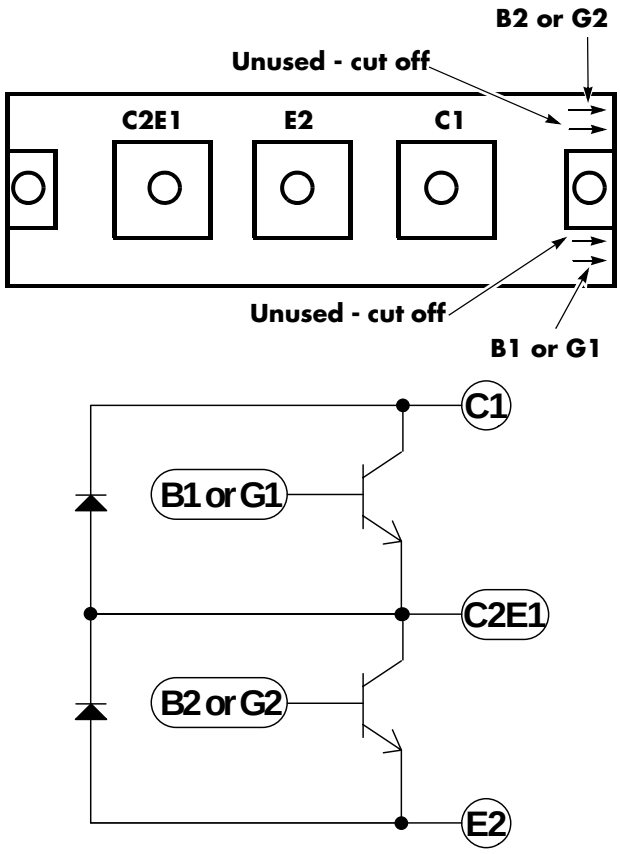


Figure 5-5. Field Transistor Connections and Schematic

Table 5-6. Field and Steering Transistor Meter Readings

+ Lead	– Lead	Meter Reading
C1	C2E1	OL
C1	B1 or G1	OL
C2E1	B1 or G1	OL
C2E1	B2 or G2	OL
C2E1	C1	<1V
C2E1	E2	OL
E2	C2E1	<1V
E2	B2 or G2	OL

https://truckmanualshub.com/

Testing Electrical Components

Table 5-7 gives the recommended test procedures for electrical components not previously covered. A correct reading does not prove the component will function properly in the system under all current and voltage conditions. However, most shorted or open circuit conditions can be identified by performing these tests.

NOTE: Consult the owner's manual for the meter being used to ensure correct readings. On the *Diode Test* function, the voltage across an electronic device is being measured. If the component(s) being measured are open, the meter will read open or OL. If the component(s) have some resistance to current flow, the voltage drop across that resistance will be shown on the meter.

To ensure accurate readings, disconnect the component from the circuitry for testing.

Table 5-7. Test Procedures for Electrical Components

Component	Meter Setting	Connections	Readings
24V Relay Coil	Ohms	Between coil terminals	Approx 1 kohm
Contactor and Solenoid Coils			10-50 ohm depending on component tested.
Rectifiers	Diode Test	Across the device	Anode to Cathode: <1V Cathode to Anode: OL
Snubber Resistor (R1)	Ohms		Approx 1 ohm
Capacitors	The condition of a capacitor cannot accurately be checked with a DMM. If the capacitor is suspected to be bad, replace it.		
Suppressor Modules	The condition of a suppressor module (light/fan package, travel alarm) cannot be checked with a DMM. If the suppressor module is suspected to be bad, replace it.		

https://truckmanualshub.com/

Electrical Connector Location

Locator Chart

Connector	Function or Routing	Location
JPA1	Connector on ESM to flow sensor module	Electric Steer Manager
JPA2	Connector on ESM to TM	
JPA3	Connector on ESM to wire guidance filter card	
JPA5	Connector on ESM to pressure transducer A	
JPA7	Connector on ESM to home sensor prox	
JPA8	Connector on ESM to steer position encoder	
JPB+	Battery connector B+	Battery
JPB–	Battery connector B–	
JPC1	Connector on Power Card for Q1	Power Card
	Connector on CCC for steering encoder (primary)	Carriage Control Card
JPC2	Connector or Power Card for Regen	Power Card
	Connector on CCC for display card	Carriage Control Card
JPC3	Connector on CCC for 60 in. limit switch	
JPC4	Connector on CCC for optional lower inhibit switch	
JPC6	Connector on CCC for lift/lower bypass, EPO & key switch	
JPC7	Connector on CCC for deadman switches	
JPC8	Connector on CCC for 24 in. limit	
JPC9	Connector on CCC for control handle	
JPC10	Connector on CCC for SMARTi®	
JPC11	Connector on CCC for over-the-mast cable #1	
JPC13	Connector on CCC for left sidegate switch	
JPC14	Connector on CCC for right sidegate switch	
JPC15	Connector on CCC for light display card	
JPC16	Connector on CCC for over-the-mast cable #2	
JPC17	Connector on CCC for Aux Card	
JPC18	Connector on CCC for Aux Card	
JPC19	Connector for switches (S31, S32, S33) on auxiliary lift option	Aux Card
JPC20	Connector for switches (S34, S35) on auxiliary lift option	
JPC21	Connector on CCC for steering encoder (S/N 31,000 and higher)	Carriage Control Card
JPP1	Steering Encoder board connector	Steer Encoder

https://truckmanualshub.com/

Connector	Function or Routing	Location
JPR1	Connector on SMARTi® for CCC	SMARTi® Card
JPS6	Connector on TM for aisle detect	Tractor Manager
JPS7	Connector on TM for steer prox 1	
JPS8	Connector on TM for 150 in. limit	
JPS9	Connector on TM for steer prox 2	
JPS10	Connector on TM for lift inhibit	
JPS12	Connector on TM for CD3+ sol. card	
JPS13	Connector on TM for rail sense	
JPS14	Connector on TM for contactor assembly	
JPS16	Connector on TM for travel cutout	
JPS18	Connector on TM for speed feedback prox.	
JPS19	Connector on TM for emergency stop	
JPS25	Connector on TM for over the mast cable #1	
JPS26	Connector on TM for over the mast cable #2	
JPS29	Connector on CD3+ sol. card for auxiliary sol.	CD3+ Sol. Card
JS3	Connector on TM to Power Card	Tractor Manager
JS4	Connector on TM to traction encoder	
JS5	Connector on TM to Power Card	
JS11	Connector on coil driver to TM	Coil Driver
JS17	Connector on TM to diagnostic/elect. steer interface	Tractor Manager
JPW1	Connector on Filter Card for load sensor	Filter Card
JPW2	Connector on Filter Card for tractor sensor	
JPY1	Connector on flow module to ESM	Flow Module
JPY2	Connector on flow module to flow sensor temperature sensor	
JPY6	Connector on flow module to flow sensor channel 1	
JPY7	Connector on flow module to flow sensor channel 2	
JP1T	Connector from tractor wire guidance antenna to filter card	Filter Card
JP1L	Connector from load wire guidance antenna to filter card	
JP2	Temperature sensor power panel connector	Traction Heatsink
JP5	Connector at pressure transducer A to ESM	Pressure Transducer A
JP20	Connector from TM to warning light	Warning Light

https://truckmanualshub.com/

Circuit Card Connectors

The following figures show the location of circuit card connectors, LEDs, and EPROMs.

Power Card

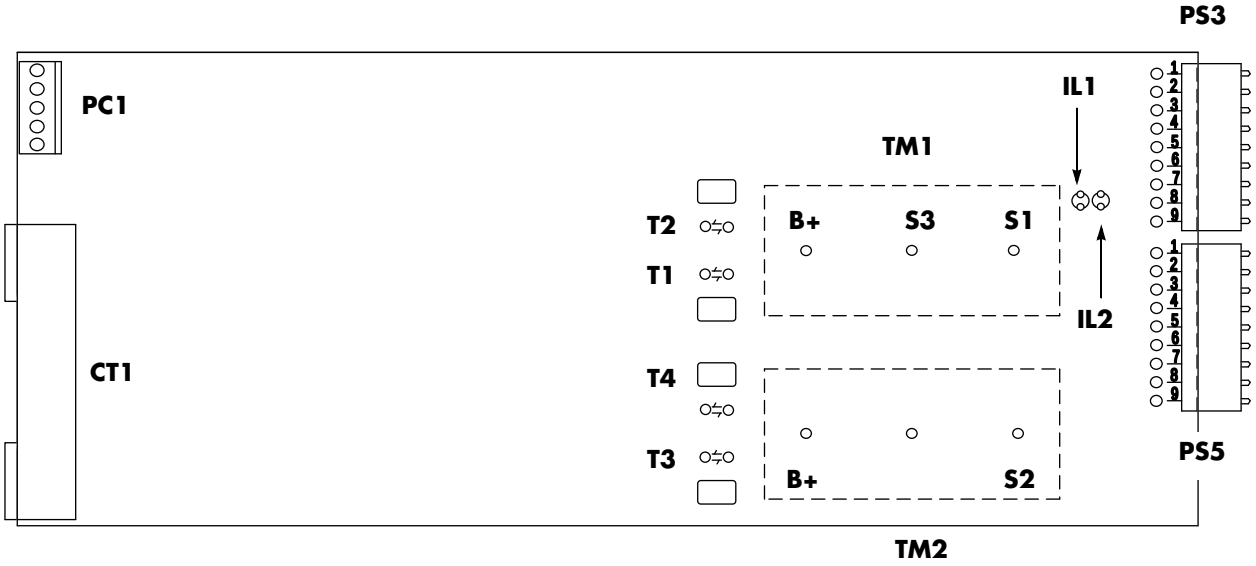


Figure 5-6. Power Card Connectors

Tractor Manager Vehicle Function Controller

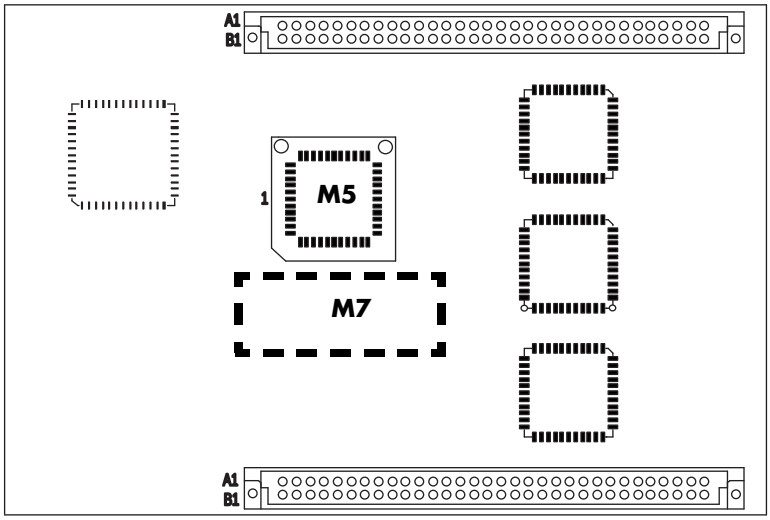


Figure 5-7. Vehicle Function Controller Connectors

https://truckmanualshub.com/

Tractor Manager

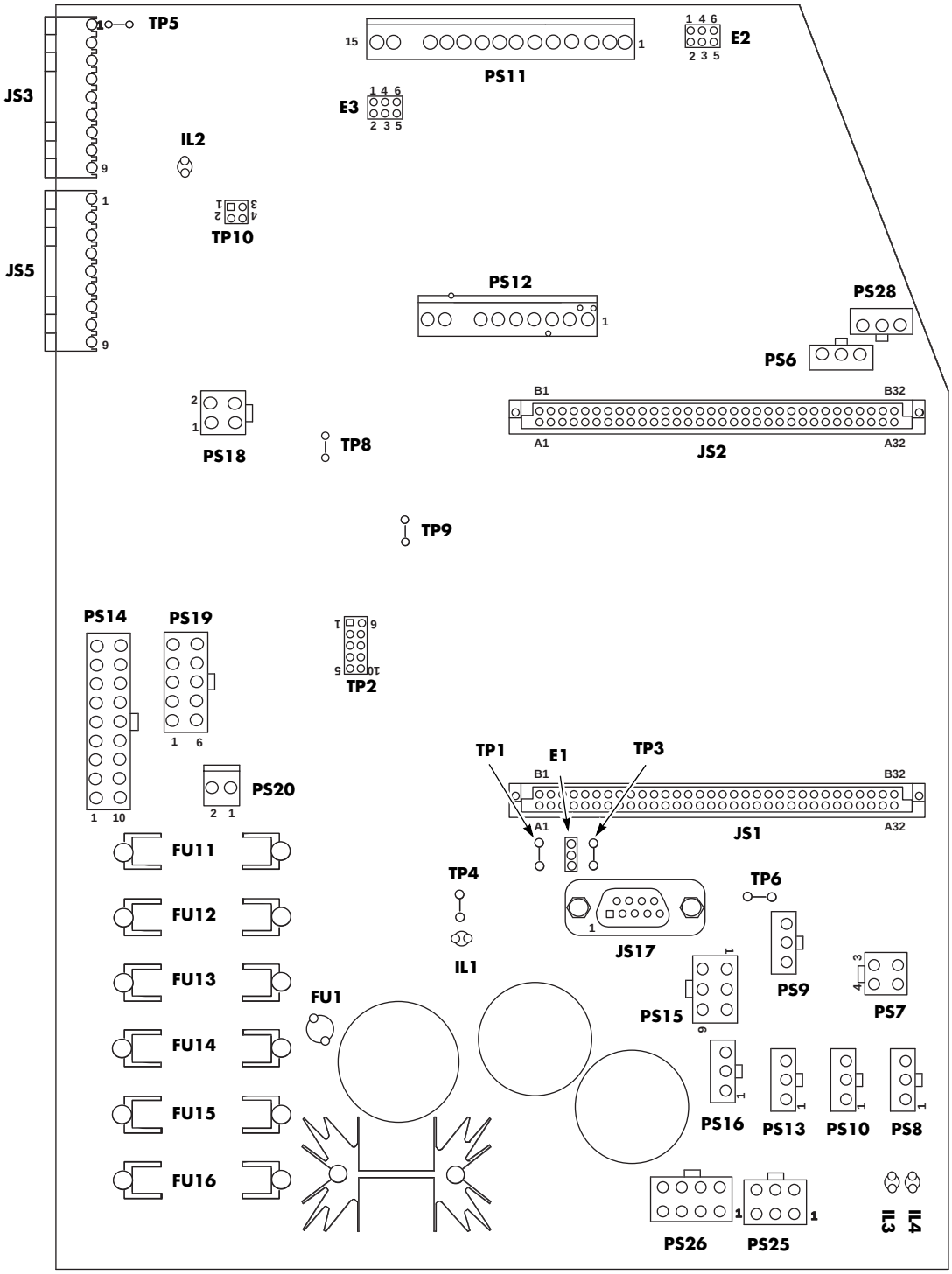


Figure 5-8. Tractor Manager Connectors

https://truckmanualshub.com/

Carriage Control Card

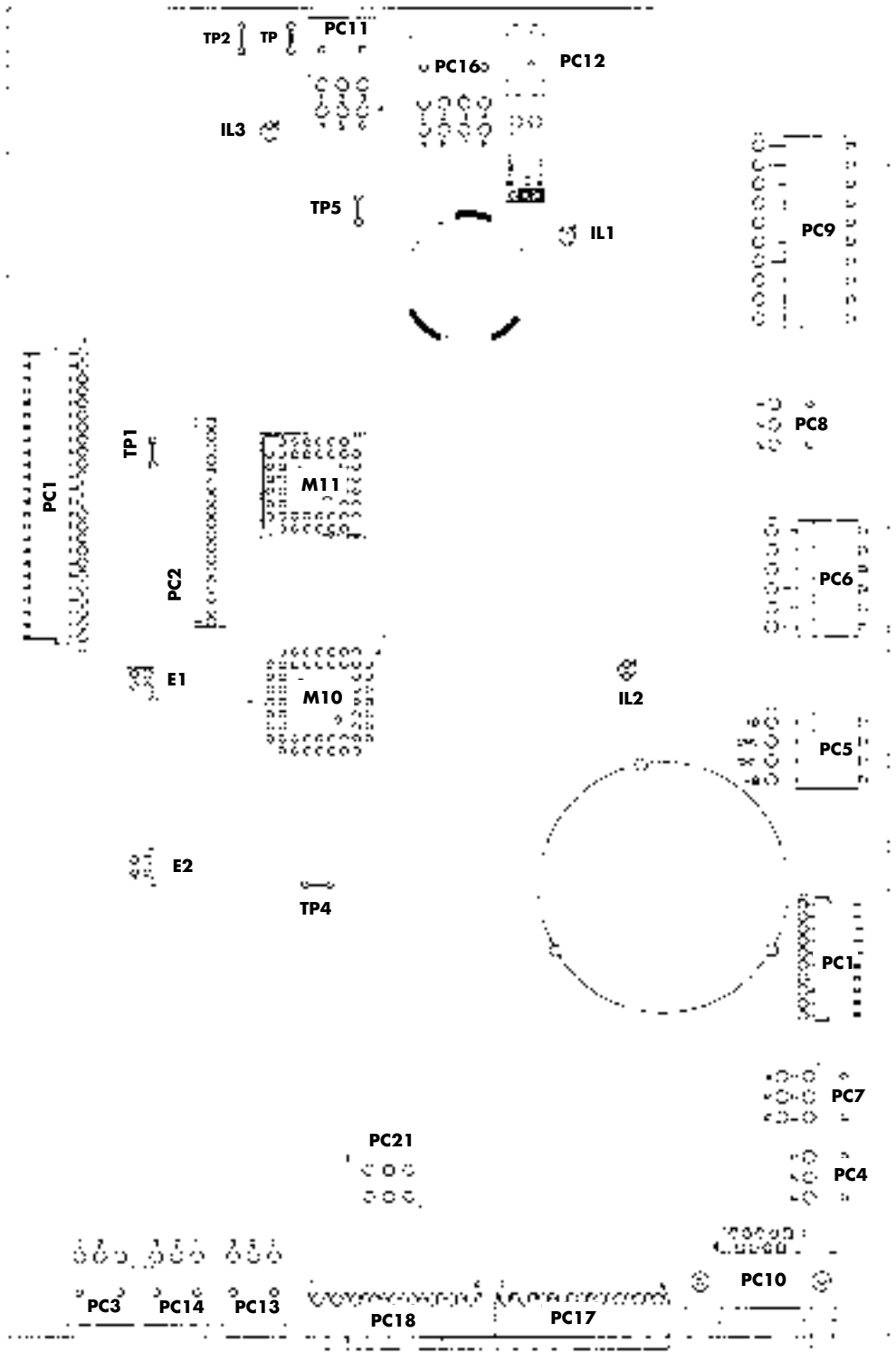


Figure 5-9. Carriage Control Card Connectors

https://truckmanualshub.com/

Electric Steer Manager

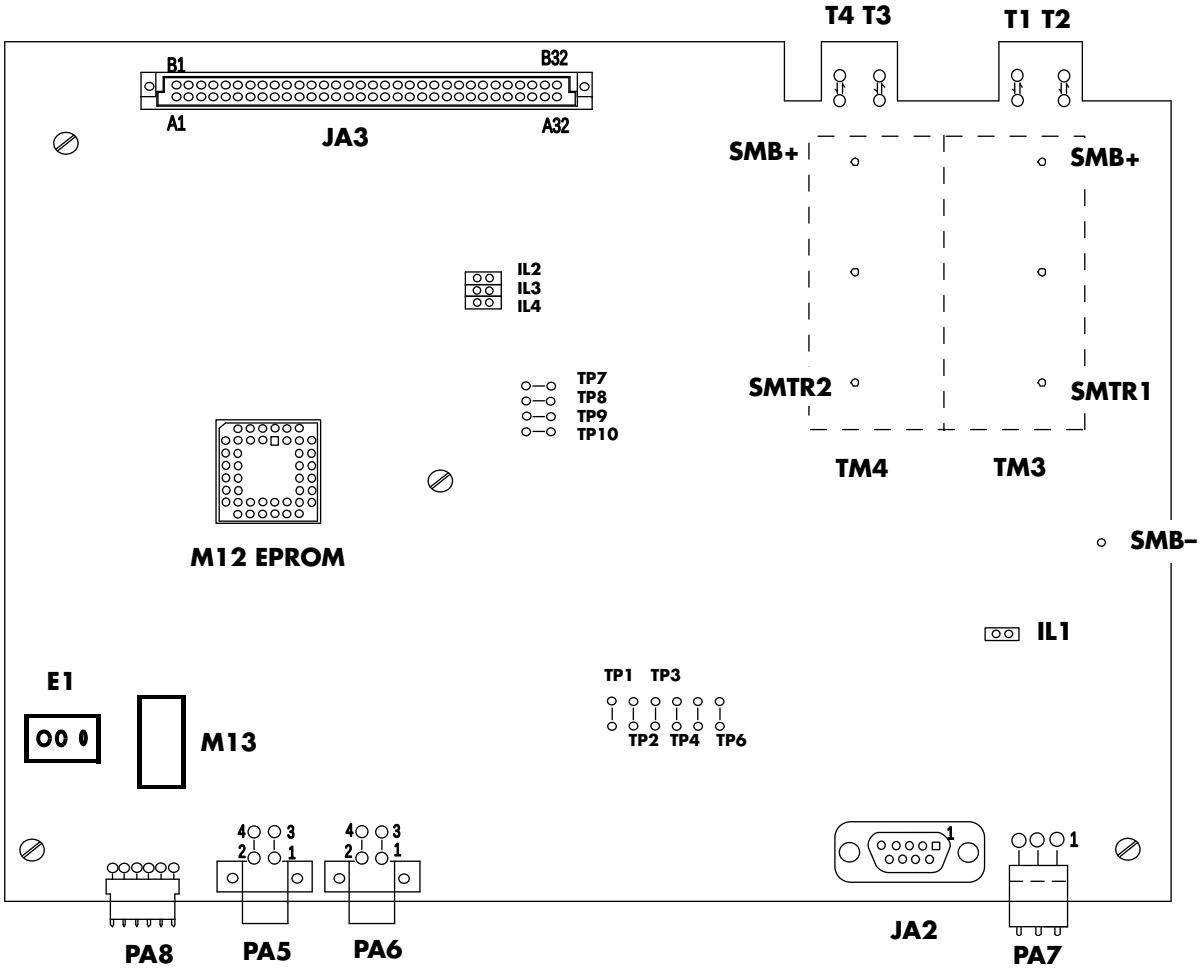


Figure 5-10. Electric Steer Manager Connectors

https://truckmanualshub.com/

Filter Card

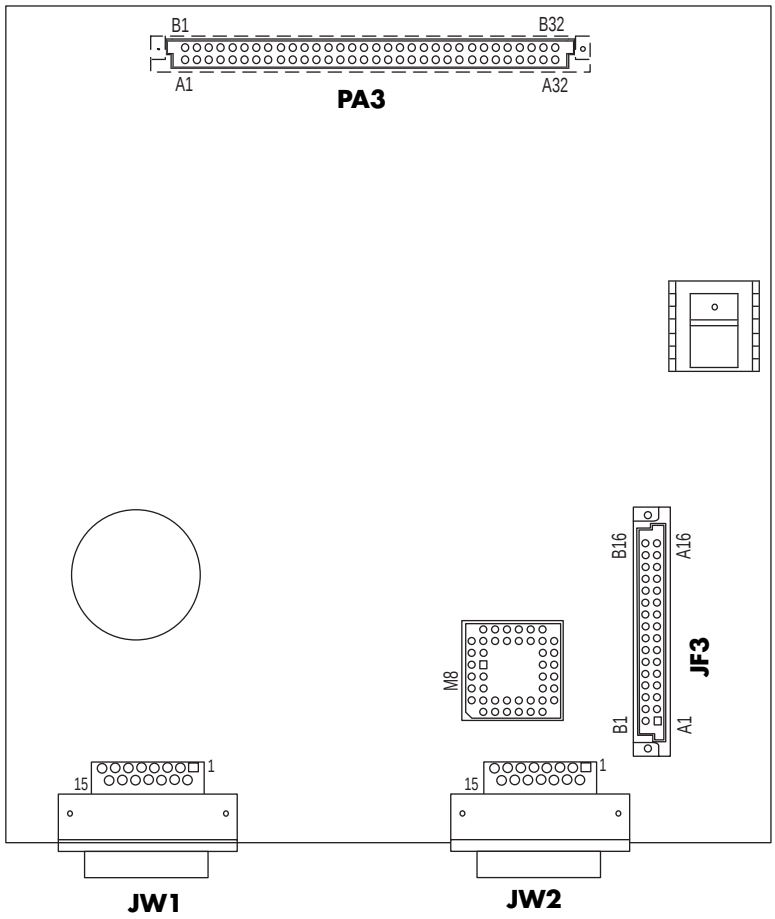


Figure 5-11. Filter Card Connectors

https://truckmanualshub.com/

Drive Unit Troubleshooting Guide

Symptom	Probable Cause	Required Action
Oil leaks	Damaged sealing rings	Replace sealing rings, bearing shims, and drive shaft bearings
	Worn or damaged drive shaft	Replace sealing rings, bearing shims, drive shaft bearings, and drive shaft
	Housing/cover joint	Reseal
	Worn or damaged housing	Replace drive unit
Drive wheel wobbles	Worn or damaged drive shaft bearings	Replace sealing rings, bearing shims, and drive shaft bearings
	Worn or damaged drive shaft	Replace sealing rings, bearing shims, drive shaft bearings, and drive shaft
	Loose wheel mounting hardware	Inspect housing and drive shaft for damage; Re-torque mounting hardware
Noise	Worn or damaged drive shaft bearing	Replace sealing rings, bearing shims, and drive shaft bearings
	Worn or damaged pinion bearings	Replace pinion bearing and pinion shaft nut
	Worn or damaged gear set (drive shaft is in good condition)	Replace sealing rings, bearing shims, drive shaft bearings, pinion bearings, pinion shaft nut, and gear set
	Worn or damaged gear set (drive shaft is worn or damaged)	Replace sealing rings, bearing shims, drive shaft bearings, pinion bearings, pinion shaft nut, gear set, and drive shaft
	Worn or damaged helical gear and pinion	Replace helical gear and pinion
Steering binds	Inadequate bearing lubrication	Grease steering bearing
	Worn or damaged steering bearing	Replace complete drive unit upper section

https://truckmanualshub.com/

Communication Error Code Troubleshooting

Intermittent Communication Codes

If possible, determine what the operator was doing when the codes were generated; driving, plugging, lifting, sounding horn, and so on.

Focus on these circuits for shorts to frame and external noise being generated which can interfere with the communication circuits. Determine where in the SelfTest Cycle the code is generated (for instance, when the drive motor is energized or when the horn was sounded).

During SelfTest

Make sure the key switch is turned OFF for at least 5 seconds before turning it back on. Test the key switch for high resistance. If nothing is found in the following steps replace the key switch.

Inspect the termination jumpers on the cards as follows:

- Tractor Manager: E1 Jumper IN without Electronic Steering; OUT with Electronic Steering. See Figure 5-12.
- Carriage Control Card: E3 jumper IN without SMARTi; OUT with SMARTi. See Figure 5-13.
- Electronic Steer Manager: E1 jumper IN on all trucks. See Figure 5-14

Test for shorts to frame. See Shorts to Frame Test on page 5-8.

If equipped with optional light/fan package, disconnect PC5. If code goes away, troubleshoot light/fan circuitry.

NOTE: The condition of the light/fan suppressor module cannot be checked with a DMM. If the suppressor module is suspected to be bad, replace it.

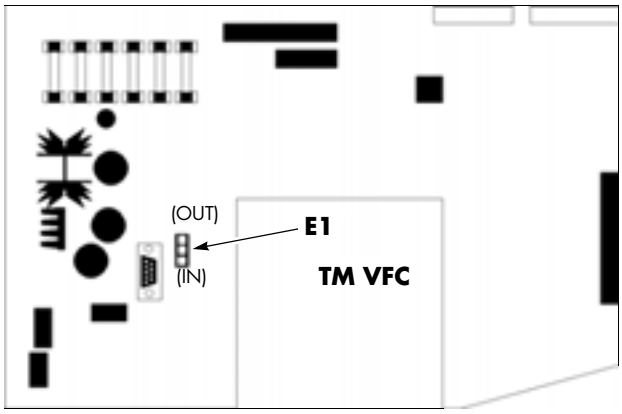


Figure 5-12. Jumper Positions on Tractor Manager

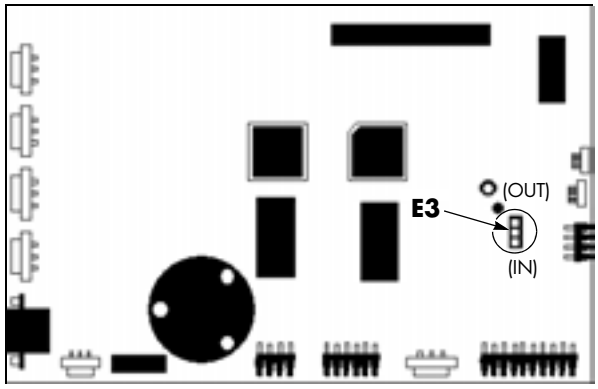


Figure 5-13. Jumper Positions for SMARTi® on Carriage Control Card

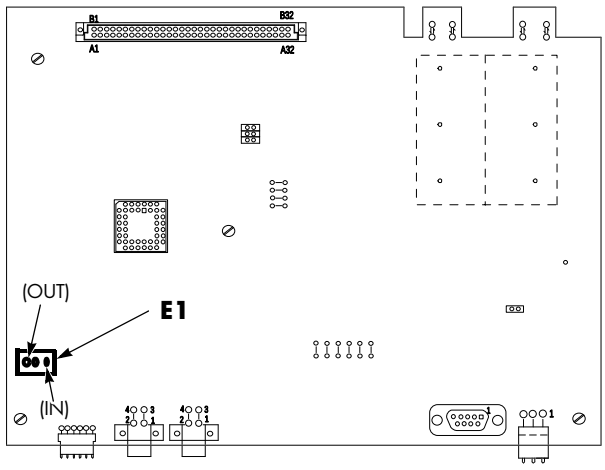


Figure 5-14. Jumper Location on Electronic Steer Manager

https://truckmanualshub.com/

During Travel and/or Plugging

Test snubber components. See Testing Electrical Components on page 5-14.

If truck is equipped with optional travel alarm, disconnect PS15. If code goes away, troubleshoot travel alarm circuitry.

NOTE: The condition of the travel alarm suppressor module cannot be checked with a DMM. If the suppressor module is suspected to be bad, replace it.

Test and clean static straps.

Test for shorts to frame. See Shorts to Frame Test on page 5-8.

Remove the Q1 heatsink and inspect for holes in the insulating paper. Look at the mounting surface of the heatsink for burrs and sharp edges. Clean and install two sheets of insulation paper.

Inspect the termination jumpers on the cards as follows:

- Tractor Manager - E1 Jumper IN without Electronic Steering; OUT with Electronic Steering. See Figure 5-12.
- Carriage Control Card - E3 jumper IN without SMART*i*; OUT with SMART*i*. See Figure 5-13.
- Electronic Steer Manager - E1 jumper IN on all trucks. See Figure 5-14.

Inspect the drive motor brushes and armature for excessive or unusual wear. Clean the armature commutator and replace the brushes and brush springs. See Motor, General on page 7-51.

Check for loose connections to the cards, especially from devices using the 12V and 5.3V power supplies.

Test the over-the-mast cable for opens and shorts between wires.

Remove the EPROMs and reinstall them. This may clean corrosion from the contact surfaces.

https://truckmanualshub.com/

Communication Code Every Time Key Is Turned ON

If truck is equipped with SMART*i*, disconnect the cable from the CCC and disable the option. If the code clears, test the cable. If OK, replace the SMART*i* module. For the tests in the following table, leave SMART*i* disconnected and place the E3 jumper on the CCC in the IN position.

NOTE: See Example Diagnosis and Repair Table on page 6-115 for an explanation of how to use the following table.

Communication Code Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Ohms	JS25-2	JS25-3	Approx 40 ohms	Perform step 5	Perform step 2
2	JPC11 disconnected, measurements on CCC pins/Ohms	PC11-2	PC11-3	Approx 80 ohms w/jumper IN Approx 220 ohms w/jumper OUT	Perform step 3	Check position of E3 jumper. If correct replace CCC.
3	JPS25 and JPS17 disconnected, measurements on TM pins/Ohms	PS25-2	PS25-3	Approx 220 ohms w/jumper IN Approx 80 ohms w/jumper OUT	Perform step 4	Check position of E1 jumper. If correct replace TM.
4	JPS17 disconnected, measurements on ESM pins/Ohms	JS17-6	JS17-7	Approx 120 ohms w/jumper IN Approx 37 kohms w/jumper OUT	Replace over-the-mast cable	Check position of E1 jumper. If correct replace ESM.
5	DCV	JPS25-2	B–	2-3V	Perform step 6	Perform step 7
6		JPS25-3			Refer to Corrective Action for specific code	
7	JPS17 disconnected/DCV	JPS25-2			Perform step 9	Perform step 8
8		JPS25-3				Perform step 10
9	Disconnect all external devices one at a time from ESM and check voltage after each one/DCV	JPS25-2 & JPS25-3			Troubleshoot circuit pulling down the BUS	Replace ESM
10	JPC11 disconnected/DCV				Perform step 12	Perform step 11
11	Disconnect all external devices one at a time from CCC and check voltage after each one/DCV	JPC11-2 & JPC11-3			Troubleshoot circuit pulling down the BUS	Replace CCC
12	Disconnect all external devices one at a time from TM and check voltage after each one/DCV	JPS25-2 & JPS25-3				Replace TM

https://truckmanualshub.com/

G Series Error Code Troubleshooting

LEARN can be used to assist in troubleshooting some G Series error codes. During LEARN Steer, a repeatable set of tasks are completed. Different component failures will cause the system to react differently and can pinpoint the circuit that is not functioning correctly. Use the steps below EXACTLY as described.

NOTE: After running each step, the key must be turned OFF and LEARN must be run again. If the LEARN process fails, the system will not be allowed to activate LEARN Steer again until the key is cycled.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support truck. DO NOT rely on the jack alone. See Jacking on page 2-11.

1. Jack the truck so the drive tire is off the floor.
2. Manually turn the drive unit to the straight ahead position.
3. Run LEARN Steer.
4. Observe the response of the steering system and select the symptom below to start troubleshooting the error.
   a. The drive unit turns to the left mechanical stop. Once against the stop, the sound created by the steering system as current to the steer motor is increased is heard. Release the deadman and press the ENTER button to abort LEARN no more than 8 seconds after the stop is contacted. Failure to do so can cause damage to the steer transistors. This indicates a failure in the Steer Feedback Encoder circuit. Refer to Diagnosis and Repair in Test I22 - Steer Position Encoder Count (Page 6-168).
   b. The drive unit turns quickly to the right mechanical stop. After contacting the stop, power to the steer transistors is removed very quickly and the system is shut down. This indicates a failure in the Steer Home Prox circuitry. Troubleshoot per Test I24 - Home Position Proximity Sensor (Page 6-170).
   c. No movement is detected in the drive unit but the steering system can be heard trying to turn the drive unit. Troubleshoot the steer motor and gearbox or the drive unit for binding.
   d. No movement or a small amount of movement is detected in the drive unit and a constant noise *cannot* be heard from the steering system. This indicates an open in at least one side of the steer motor power circuit. An open in the half of the power circuit activated by T1 and T3 base leads is identified by the drive unit moving just enough for the Home Prox to transition from *metal to no metal*. At this point the steer system will shut down and no other movements can be made. An open in the half of the power circuit activated by T2 and T4 base leads is identified by the drive unit moving just enough for the Home Prox to transition from *no metal to metal*. At this point the steer system will shut down and no other movements can be made. Troubleshoot per the following table.

NOTE: See Example Diagnosis and Repair Table on page 6-115 for an explanation of how to use the following table.

https://truckmanualshub.com/

G Series Error Code Diagnosis and Repair

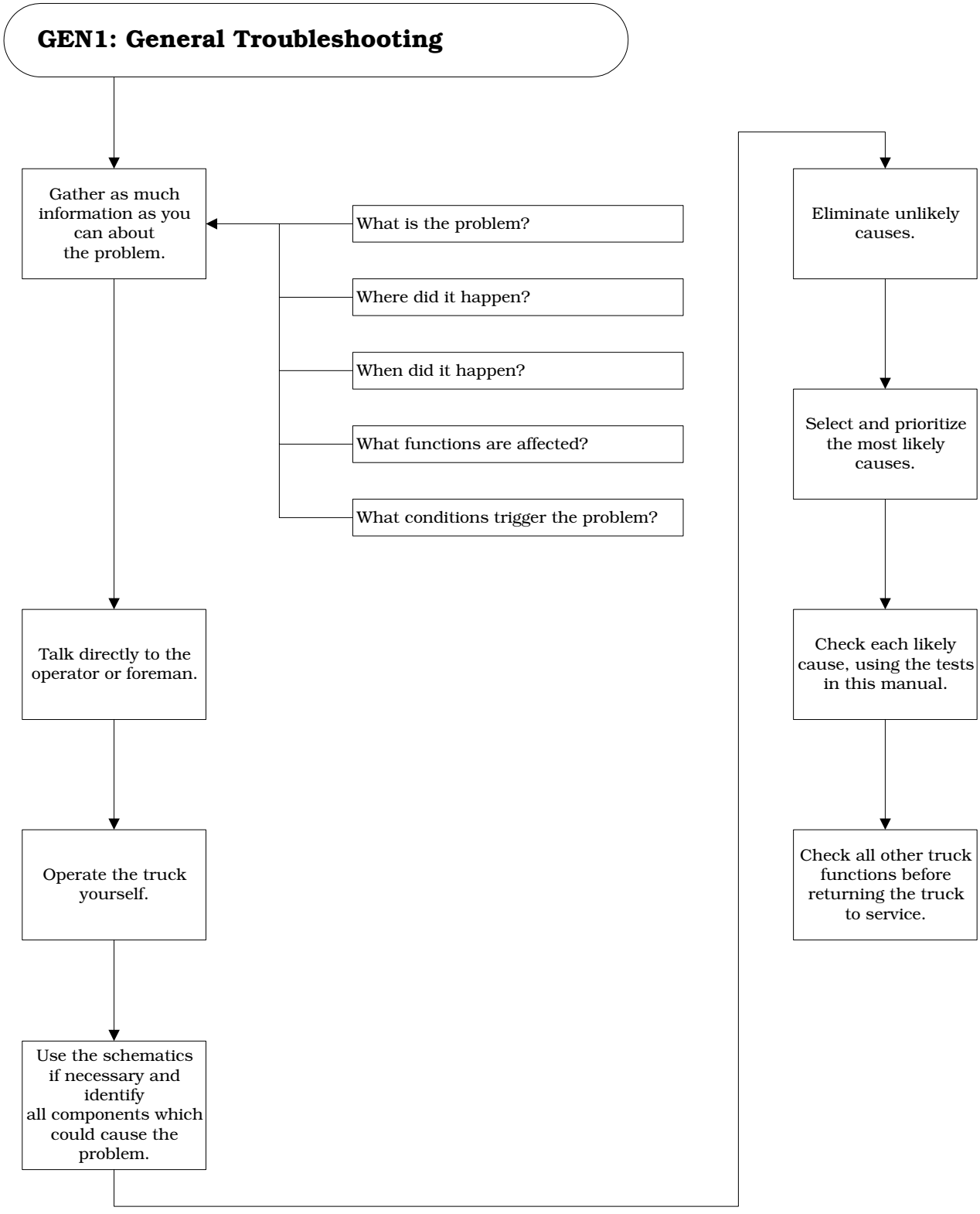
Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	SelfTest Passed/ DCV	SMB+ on ESM	SMB– on ESM	B+	Perform step 2	Troubleshoot cables and connections
2	Steer motor cables disconnected from ESM/Ohms	SMTR1	SMTR2	Circuit not open	Perform step 3	Troubleshoot cables and motor
Prior to running steps 3 thru 6, connect a jumper wire (cable is not required) from TP4 (B–) to one of the steer motor terminals. Disconnect T1 thru T4 from TM3/TM4 at the ESM. After each step, a "GX" code will be displayed. The key must be cycled to reset the system for the next step to operate. The voltages at T1 thru T4 will only be displayed for a second or less on the meter and the system will shut down. *Run each step several times and watch the meter closely.*						
3	Home Prox *not over* metal/DCV	T1@ESM	B–	Deadman Up: <1V Deadman depressed: approx 13.75V	Perform step 4	Replace ESM
4		T3@ESM			Perform step 5	
5	Home Prox *over* metal/DCV	T2@ESM			Perform step 6	
6		T4@ESM			Test wires to TM3/TM4 from ESM. Test TM3/TM4 (see Field and Steering Transistor Test on page 5-13)	Replace ESM and test TM3/TM4 (see Field and Steering Transistor Test on page 5-13)

https://truckmanualshub.com/

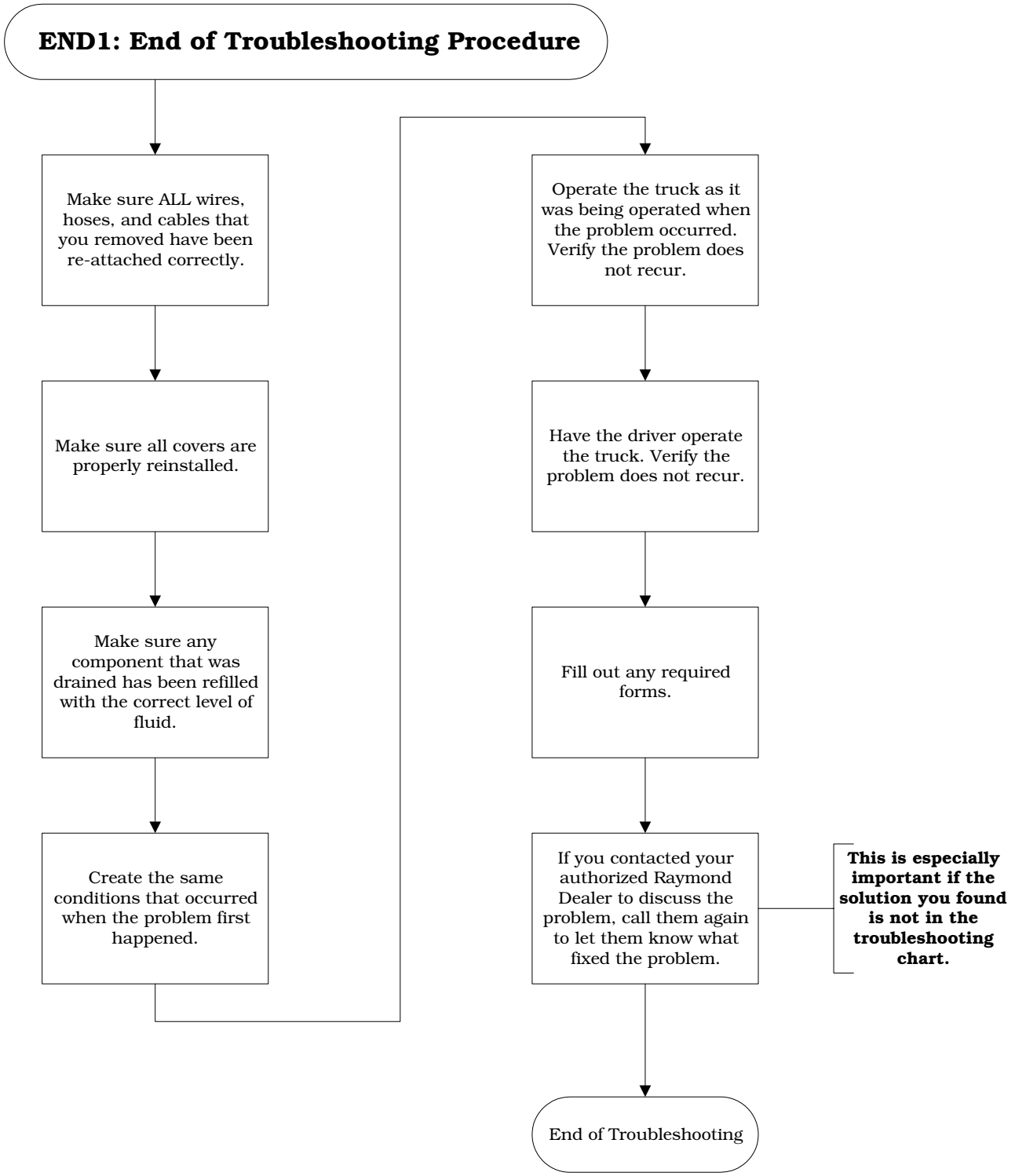
RAYMOND

https://truckmanualshub.com/

Troubleshooting Procedure



https://truckmanualshub.com/



https://truckmanualshub.com/

Symptom Tables: Hydraulic Functions

NOTE: If it is determined that a component failed as a result of hydraulic fluid contamination, replace the failed component and flush, fill and bleed the hydraulic system.

NOTE: Reference schematics on page A-13.

Intermittent Lift/Lower

Possible Cause	Action
Bad lift/lower pot	Run Test A04 - Lift/Lower Potentiometer Voltage (Page 6-120).
Bad wiring	Check wiring harnesses.
Hydraulic contamination (can cause binding proportional valve or load holding solenoid)	Replace damaged component and flush, fill, and bleed the hydraulic system.

Lift Function

No Lift

Possible Cause	Action
Battery problems	Adjust lift cutout as necessary. Replace battery with fully charged battery. Test battery for bad cells. See “Battery Procedures” on page 7-48.
Bad lift/lower potentiometer VR2 or associated wiring	Run Test A04 - Lift/Lower Potentiometer Voltage (Page 6-120).
Relief valve REL1 stuck open	Test system pressure. Check for contamination in hydraulic fluid. If contamination is present, flush, fill and bleed the hydraulic system and clean the relief valve.
Bad auxiliary card	Run Test O21 - Main Select Solenoid (optional) (Page 6-213).
Bad lift pump	Test system pressure.
Bad lift motor	Test lift motor. See Electric Motor Tests on page 5-6.
Bad optional lift limit switch	Run Test I15 - Lift Inhibit Switch (S24) (Page 6-160) and Test I17 - Lift/Lower Inhibit Bypass (S7) (Page 6-162).

https://truckmanualshub.com/

Slow Lift

Possible Cause	Action
Battery problems	Adjust lift cutout as necessary. Replace battery with fully-charged battery. Test battery for bad cells. See "Battery Procedures" on page 7-48.
Bad lift/lower potentiometer VR2 or associated wiring	Run Test A04 - Lift/Lower Potentiometer Voltage (Page 6-120).
Plugged or malfunctioning flow control valve in lift cylinder.	Check for contamination in hydraulic fluid. If contamination is present, flush, fill and bleed the hydraulic system and clean the relief valve. If no contamination is found, replace the flow control valves in the main lift cylinders.
Binding in the mast	Inspect the mast and bearings for signs of binding.
Bad lift pump	Test system pressure.
Bad lift motor	Test lift motor. See Electric Motor Tests on page 5-6. Check amp draw.
Relief valve	Test system pressure.

Unable to Pick Up a Load

Possible Cause	Action
Battery problems	Adjust lift cutout as necessary. Replace battery with fully-charged battery. Test battery for bad cells. See "Battery Procedures" on page 7-48.
Incorrect lift pressure adjustment	Check and adjust lift pressure setting.
Bad lift pump	Test system pressure.
Bad lift motor	Test lift motor. See Electric Motor Tests on page 5-6. Check amperage draw.

https://truckmanualshub.com/

Lower Function

Slow Lower

Possible Cause	Action
Plugged or malfunctioning flow control valve	Open Emergency Lower Valve. If still slow, remove and inspect. Check for contamination in hydraulic fluid. If contamination is present, flush, fill and bleed the hydraulic system and clean the relief valve. If no contamination is found, replace the flow control valves in the main lift cylinders.
Bad lift/lower potentiometer or associated wiring.	Run Test A04 - Lift/Lower Potentiometer Voltage (Page 6-120).
Mechanical binding in bearings or telescopic	Adjust or replace bearings. Check shimming.
Binding proportional valve	Check valve operation.

Intermittent Lower

Possible Cause	Action
Plugged or malfunctioning flow control valve	Open Emergency Lower Valve. If still slow, remove and inspect. Check for contamination in hydraulic fluid. If contamination is present, flush, fill and bleed the hydraulic system and clean the relief valve. If no contamination is found, replace the flow control valves in the main lift cylinders.
Bad lift/lower potentiometer VR2 or associated wiring.	Run Test A04 - Lift/Lower Potentiometer Voltage (Page 6-120).
Bad load hold solenoid	Run Test O06 - Toggle Main Load Hold Solenoid (Page 6-196).

Load Drifting/Settling

Possible Cause	Action
Incorrect lift pressure adjustment	Check and adjust lift pressure setting.
Contaminated load hold solenoid	Check for contamination in hydraulic fluid. If contamination is present, flush, fill and bleed the hydraulic system
Load too large for lift truck capacity	Check load weight. Check lift pressure setting.

https://truckmanualshub.com/

Symptom Tables: Travel Functions

Slow or Sluggish Acceleration

Possible Cause	Action
Note: Determine if problem is mechanical or electrical.	
Mechanical:	
Dragging brake	Adjust brake.
Worn wheel bearings	Replace wheel bearings.
Debris in wheel axle	Remove debris.
Binding drive unit	Remove motor and check movement.
Electrical:	
Battery problems	Replace battery with fully-charged good battery. Adjust cutout as required.
Bad throttle pot (VR1)	Run Test A03 - Throttle Potentiometer Voltage (Page 6-119).
Bad drive motor (may test OK with no load, but fail under load)	Test resistance of field and armature. Check amp draw.
Current is limited due to drive motor or power panel temperature or bad temperature sensor	Run Test A02 - Temperature Sensor Voltage (Page 6-118) and Test A15 - Display the Drive Motor Temperature Voltage (Page 6-128).

Slow Travel

Possible Cause	Action
Note: Determine if problem is mechanical or electrical.	
Mechanical:	
Dragging brake	Adjust brake.
Debris in wheel axle	Remove debris.
Binding drive unit	Remove motor and check movement.
Electrical:	
Battery problems	Replace battery with fully-charged good battery. Adjust cutout as required.
Bad throttle pot (VR1)	Run Test A03 - Throttle Potentiometer Voltage (Page 6-119).
Bad mast speed limit switch (S10 or S11) or associated wiring	Run Test I00 - Lower Mast Reference Switch (Page 6-148), Test I01 - Upper Mast Reference Switch (Page 6-149), or Test I18 - 60 in. Limit Switch (S28) (Page 6-163).
Incorrect configuration	Reconfigure the lift truck.
Bad drive motor (may test OK with no load, but fail under load) or worn brushes	Test resistance of field and armature. Check amp draw.
Speed limited due to drive motor or power panel temperature or bad temperature sensor	Run Test A02 - Temperature Sensor Voltage (Page 6-118) and Test A15 - Display the Drive Motor Temperature Voltage (Page 6-128).

https://truckmanualshub.com/

Symptom Tables: Electrical Symptoms

NOTE: Reference schematics beginning on page A-13.

Electrical Motors

Motor Arcing

Possible Cause	Action
Worn brushes or incorrect brush tension	Replace brushes and brush springs.
Battery BSOC Cutout too low	Check battery specific gravity at cutout, after battery has stabilized. Compare to battery manufacturer specifications for discharged battery. Adjust BSOC Cutout as needed.
Partially shorted motor armature or field	Clean motor and test resistance.
Rough or pitted motor commutator	Replace motor.

Motor Overheating

Possible Cause	Action
Dragging brake	Adjust brake. See “Brake” on page 7-42.
Application exceeds designed workload -- short runs with plugging/acceleration or heavy-duty lifting cycles Using deadman pedal to stop all the time	Check with Dealer Service Manager to verify application.
Bad battery	Check voltage, both open circuit and under load. Replace if necessary with fully-charged good battery.
Incorrect BSOC Cutout value	Check battery specific gravity at cutout, after battery has stabilized. Compare to battery manufacturer specifications for discharged battery. Adjust BSOC Cutout as needed.
Cable, terminal, or wiring problems. Look for discolored terminals, loose or damaged crimps	Repair/replace wiring or cables as necessary. Check cable connection torque. See “Motor Stud Terminals” on page 7-52.
Worn, damaged, or bad brushes or springs	Inspect motor brushes. Check brush spring tension.
Binding gearbox or pump	Check gearbox or pump for binding. Clean, repair, or replace as necessary.
Hydraulic fluid viscosity too high or too low	Replace hydraulic fluid with correct fluid. See Lubrication Specification Chart on page A-2.
Pressure relief set too high	Adjust pressure relief.

https://truckmanualshub.com/

Operator Display Problems

Scrambled or Intermittent Display

Possible Cause	Action
Loose J1-PS8 harness or card connectors	Reseat cards and harness connections.
Intermittent wires or connectors in harness	Test for continuity while flexing harness. If discontinuity is found, replace wiring harness.
Electrical noise in motors	Check tightness of motor power cable connections. Check motor brushes for arcing. Replace if necessary.
Bad key switch	Replace key switch.
Worn or missing static straps	Replace as necessary.

Dead Lift Truck

Display is Dark; No Functions Operate

Possible Cause	Action
No LEDs illuminated on circuit cards	1. Check fuses on the TM. 2. Check for B+ and B– to the TM at JPS14. 3. Check voltages on the TM at TP1, 2, 3, 4 & 6. a. If no B+ or B–, replace the TM. b. If no B+Key at TP1, troubleshoot wires from/to CCC. c. If no 12V at TP4, disconnect JPC11. If 12V returns, troubleshoot devices on carriage that use 12V. If 12V does not return, disconnect all devices using 12V until 12V returns and troubleshoot that circuit. If 12V still does not return, replace TM. 4. If no 5.3V, but 12V is OK, disconnect JPC11 and JPS12 one at a time. a. If 5.3V returns with JPC11 disconnected, unplug all devices using 5.3V. • If 5.3V returns, troubleshoot wiring and suspect component. • If 5.3V does NOT return, replace the CCC. b. If 5.3V returns with JPS12 disconnected, reconnect JPS12 and disconnect JPA8. • If 5.3V returns, troubleshoot associated wiring and components. • If 5.3V does NOT return, replace the ESM.
LEDs on TM and ESM illuminate	1. Check for 12V to CCC on JPC11-1. 2. Check for Agnd to CCC on JPC11-6. 3. Disconnect ALL connectors on the CCC except JPC6, JPC11 & JPC16. a. If truck powers up, plug connectors in one at a time. Troubleshoot the circuit that disables the truck. b. If truck does NOT power up, replace the CCC.

https://truckmanualshub.com/

Section 6. Messages, Codes and Tests

https://truckmanualshub.com/

Operator Display Messages

The Operator Display (OD) displays data received from the Carriage Control Card. The displayed data includes:

- Time or calendar
- BSOC (Battery State-of-Charge)
- Hour meters (hours on deadman [HD], hours spent lifting [HL], total miles [TM])
- Status/Fault messages
- Weight of load (option)
- Fork Height (option)
- Maintenance required indicator
- Over-temperature indicator
- Lift-limit indicator (optional)
- Steering direction indicator
- Guidance indicator (optional)

The OD is not required for operation or to pass SelfTest.

Steering Indicator Lights

The steering indicator lights are located on the Operator's Control Console. The steer indicator lights show the operator the approximate position of the steerable drive unit.

Wire Guidance LEDs

The wire guidance LEDs are located on the Operator's Console. See Figure 6-1. The LEDs consist of two green triangles and three yellow rectangles. The LEDs indicate when the wire guidance system is turned ON and the truck is locked on the guide wire.

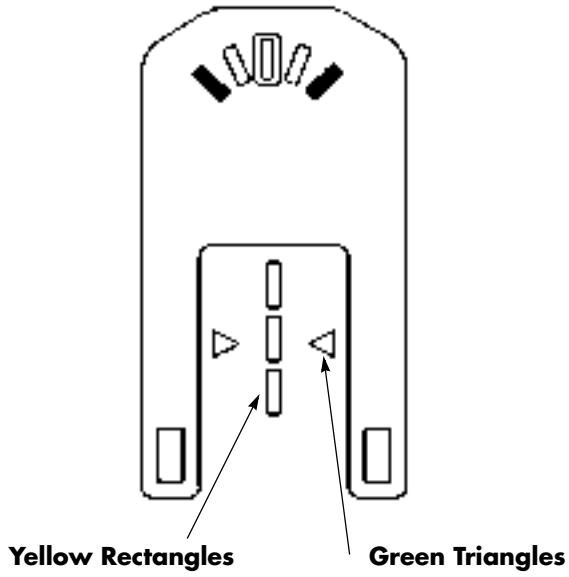


Figure 6-1. Wire Guidance LEDs on the Operator's Console

https://truckmanualshub.com/

Messages, Codes and Tests Summary List

Messages and Codes

Analog Tests

Digital Input Tests

Digital Output Tests

Initialize To Allow Full Speed 6-10
Aligning 6-11
Seeking 6-12
Code 1C - Cross Upper Or Lower Limit Switch 6-13
Speed Limited Due To Steer Angle 6-14
Lower Side Gate 6-15
Code 1H - Power Panel Overheated 6-16
Lower Inhibited 6-17
Code 1L - Emergency Power Off Switch Pressed 6-18
Throttle Moved Before Deadman Pressed 6-19
Lift Inhibited 6-20
Guidance Not Learned 6-21
Code 20 - Temperature Sensor Circuits Not Responding 6-22
Code 21 - Short Detected In Main Transistor Circuit 6-23
Code 23 - Open Detected In Main Transistor Circuit 6-24
Code 24 - Main Transistor Current Sensor Circuit Not Responding 6-25
Code 25 - Short Detected In Field Circuit (H-bridge) 6-26
Code 26 - Open Detected In Field Circuit 6-27
Code 29 - No Movement Detected When Travel Requested 6-28
Code 2A - Traction Motor Overheated 6-29
Code 2B - Main Transistor Current Sensor Out-of-range 6-30
Code 2C - Power Panel Temperature Sensor Out-of-range 6-31
Code 2D - Field Current Sensor Out-of-range 6-32
Code 2E - Traction Motor Temperature Sensor Out-of-range 6-33
Code 2F - Failure Detected In Regen Circuit 6-34
Code 2H - Failure Detected In Velocity Feedback Circuit 6-35
Code 2J - Failure Detected In Plugging Circuit 6-36
Code 42 - Lift Contactor Detected Closed When Commanded Open 6-37
Code 43 - Lift Contactor Detected Open When Commanded Closed 6-38
Code 44 - PC Contactor Detected Closed When Commanded Open 6-39
Code 45 - PC Contactor Detected Open When Commanded Closed 6-40
Code 50 - No Tractor Manager Communications Received By Carriage Control Card 6-41
Code 51 - No Carriage Control Card Communications Received By Tractor Manager 6-42
Code 52 - No Carriage Control Card Communications Received By Electric Steer Manager . 6-43
Code 53 - No Electric Steer Manager (Esm) Communications Received By Carriage Control Card 6-44
Code 59 - Carriage Control Card Transmit Failure (detected by CCC) 6-45
Code 5A - CAN Communications Failed - Message Overrun 6-46
Code 5B - CAN Communications Failed - Message Overrun 6-47
Code 5C - CAN Bus Off - Communications Transmission Error Counters High 6-48

https://truckmanualshub.com/

Messages, Codes and Tests Summary List

Code 5D - No SMARTi System Response 6-49
Code 63 - Upper And Lower Reference Switches Do Not Agree 6-50
Code 64 - No Flow Sensor Pulses When Lift/Lower Requested 6-51
Code 66 - Calculated Height Does Not Match At Upper Reference Switch 6-52
Code 67 - Calculated Height Does Not Match At Lower Reference Switch 6-53
Code 6D - Lift Pressure Out-of-range 6-54
Code 6K - 60 in. Switch Does Not Agree With The Lower Mast Reference Switch. 6-55
Code 6L - Upper Reference Switch Disconnected 6-56
Code 6M - 60 in. And/Or Lower Reference Switch Disconnected 6-57
Code 6N - Flow Sensor Temperature Out-of-range 6-58
Code 6P - 60 in. Limit Switch Is Out Of Sequence With The Upper Mast Reference Switch . 6-59
Code 80 - Throttle Controller Reading Out-of-range 6-60
Code 81 - Lift Controller Reading Out-of-range. 6-61
Code 84 - Brake Inoperable Or Not Properly Adjusted 6-62
Code 8C - Travel Deadman Switches Do Not Agree. 6-63
Code 8D - Plugging Detector Malfunction. 6-64
Code 8E - Brake Deadman Signals Do Not Agree 6-65
Code 91 - Drive Unit Turned Greater Than 10° While Guiding On Wire 6-66
Code 92 - Tracking Limits Exceeded. 6-67
Code 93 - Not Near Wire - Tractor Coil Pair 6-68
Code 94 - Not Near Wire - Load Coil Pair 6-69
Code 96 - Not Near Wire - Both Coil Pairs 6-70
Code 9E - Track and Hold Signal Failed 6-71
Code 9F - Wire Guidance Board Not Installed. 6-72
Code 9G - No Signal - Load Antenna 6-73
Code 9H - No Signal - Tractor Antenna 6-74
Code 9J - Load Antenna Signal Too High 6-75
Code 9K - Tractor Antenna Signal Too High 6-76
Code 9L - Signal Too High at Both Coil Pairs 6-77
Code A0 - Incorrect Software For Proper Vehicle Operation 6-78
Code A1 - Carriage Control Card Not Initialized 6-79
Code AK - Invalid RAM Data 6-80
Code EC - Tractor Manager Operating System Error 6-81
Code EG - Carriage Control Card Operating System Error 6-82
Code F1 - Carriage Control Card COP Time Out 6-83
Code F2 - Carriage Control Card Invalid OP Code. 6-84
Code F3 - Carriage Control Card EPROM Or CAN Reset 6-85
Code F4 - Tractor Manager VFC COP Time Out 6-86
Code F5 - Tractor Manager VFC Invalid OP Code 6-87
Code F6 - Tractor Manager VFC ASIC, EPROM, Or CAN Reset 6-88
Code F7 - Carriage Control Card Computer Operating Program (COP) Not Enabled 6-89
Code F8 - Tractor Manager VFC COP Not Enabled 6-90
Code F9 - Electric Steer Manager - COP Time Out 6-91
Code FA - Electric Steer Manager Invalid OP Code 6-92
Code FB - Electric Steer Manager - ASIC, EPROM, Or CAN Reset 6-93
Code FC - Electric Steer Manager COP Not Enabled 6-94
Code FD - Uncalibrated Carriage Control Card. 6-95
Code FE - Uncalibrated Tractor Manager VFC 6-96
Code FG - Tractor Manager +12V Power Supply Out-of-Range 6-97
Code FH - Battery Voltage Out-of-Range 6-98
Code FJ - Diagnostic Pendant Sense Line Voltage Out-of-Range. 6-99
Code G0 - Manual Steering Error. 6-100

https://truckmanualshub.com/

Code G1 - Electronic Steering Power Supply Out-of-Range 6-101
Code G2 - No Steer Position Reference Input Or Steer Position Encoder Pulses Detected Without A Steer Command To Turn. 6-102
Code G3 - No Steer Encoder Signal Or No Home Sensor Input 6-103
Code G4 - Open Detected In Steer Power Circuit. 6-104
Code G5 - Short Detected In Steer Power Circuit 6-105
Code G6 - Encoder - Steer Motor Mismatch 6-106
Code G8 - Amplifier Current Out-of-Range 6-107
Code G9 - No Drive Power When Travel Requested 6-108
Code GA - Manual Steer Drive Unit Feedback Sensor Failure 6-109
Code J1 - Aisle Entry Error 6-110
Code J2 - Aisle Exit Error. 6-111
Code J4 - Aisle Sensor Not Present. 6-112
Code VC - CAN Bus Off 6-113
Test A00 - Tractor Manager +12V Power Supply 6-116
Test A01 - Armature Sense Voltage. 6-117
Test A02 - Temperature Sensor Voltage 6-118
Test A03 - Throttle Potentiometer Voltage. 6-119
Test A04 - Lift/Lower Potentiometer Voltage. 6-120
Test A05 - Pressure Sensor Voltage 6-121
Test A07 - PC Sense Voltage. 6-122
Test A08 - Lift Motor Sense Voltage 6-123
Test A10 - Display Q1-C Sense Voltage. 6-124
Test A11 - Display Battery Voltage 6-125
Test A13 - Display the Diagnostic Pendant Voltage. 6-126
Test A14 - Display the Field Current Sense Voltage 6-127
Test A15 - Display the Drive Motor Temperature Voltage 6-128
Test A16 - Display Left Tractor Guidance Coil Voltage 6-130
Test A17 - Display Right Tractor Guidance Coil Voltage 6-131
Test A18 - Display Left Load Guidance Coil Voltage 6-132
Test A19 - Display Right Load Guidance Coil Voltage 6-133
Test A20 - Tractor Near Wire Coil Voltage. 6-134
Test A21 - Load Near Wire Coil Voltage. 6-135
Test A22 - Steer Motor Current 6-136
Test A23 - Steer Controller Power Supply Voltage. 6-137
Test A24 - ESM Battery Sense Voltage 6-138
Test A25 - Flow Sensor Temperature Voltage 6-139
Test A27 - Maximum Drive Unit Rotation 6-140
Test A31 - Average Distance From Wire 6-141
Test A32 - Peak Distance From Wire. 6-142
Test A33 - Average Heading Angle Magnitude 6-143
Test A34 - Peak Heading Angle. 6-144
Test A35 - Average Guide Wire Signal Strength. 6-145
Test I00 - Lower Mast Reference Switch 6-148
Test I01 - Upper Mast Reference Switch 6-149
Test I03 - Brake Deadman Switch (S2) 6-150
Test I04 - EPO Switch 6-151
Test I05 - Display Speed Feedback Proximity Sensor Value. 6-152
Test I06 - Display Current Limit Signal. 6-153
Test I07 - Display Temperature Limit Signal. 6-154
Test I08 - Rail Guidance Switch 6-155
Test I10 - Display Flow Sensor Count. 6-156

https://truckmanualshub.com/

Messages, Codes and Tests Summary List

Test I11 - Display Auto/Manual Switch 6-157
Test I13 -Horn Switch 6-158
Test I14 - Sidegate Switches. 6-159
Test I15 - Lift Inhibit Switch (S24) 6-160
Test I16 - Travel Cutout Switch (S27). 6-161
Test I17 - Lift/Lower Inhibit Bypass (S7) 6-162
Test I18 - 60 in. Limit Switch (S28) 6-163
Test I19A - Channel A, Steer Proximity Sensor 1 6-164
Test I19B - Pressure Switch 6-165
Test I20 - Channel B, Steer Proximity Sensor 2 6-166
Test I21 - Steer Motor Current Limit 6-167
Test I22 - Steer Position Encoder Count. 6-168
Test I23 - Wire Guidance Board Status 6-169
Test I24 - Home Position Proximity Sensor. 6-170
Test I25 - End of Aisle Sense, Sensor 2 6-171
Test I27 - End of Aisle Sense, Sensor 1 6-172
Test I29 - Speed Feedback Proximity Sensor, Channel A 6-173
Test I30 - Speed Feedback Proximity Sensor, Channel B 6-174
Test I31 - Carriage Deadman 6-175
Test I32 - Brake Deadman Signal to Tractor Manager. 6-176
Test I33 - Display Channel A of Steer Encoder 6-177
Test I34 - Display Channel B of Steer Encoder 6-178
Test I35 - Lower Inhibit Switch (S25) 6-179
Test I36 - 24 in./60 in. Switch Sense 6-180
Test I37 - Upper Reference Switch Sense (S10). 6-181
Test I38 - EPO (S21). 6-182
Test I39 - Alarm and Spare Limit Switch (PS15) 6-183
Test I41 - Auxiliary Lift Switch (S32) 6-184
Test I42 - Auxiliary Lower Switch (S33) 6-185
Test I44 - Auxiliary Mast Limit Switch 1 (S34) 6-186
Test I59 - Auxiliary Mast Limit Switch 2 (S35) 6-187
Test I60 - Display Channel A-E2 of Steer Encoder 6-188
Test I61 - Display Channel B-E2 of Steer Encoder 6-189
Test I62 - Dual Channel Steer Encoder Detect 6-190
Test O00 - Toggle the PC Contactor 6-192
Test O02 - Toggle the P Contactor 6-193
Test O04 - Reverse Enable Test (Forks First) 6-194
Test O05 - Forward Enable Test (Tractor First). 6-195
Test O06 - Toggle Main Load Hold Solenoid 6-196
Test O07 - Toggle Horn 6-197
Test O08 - Brake Release Signal. 6-198
Test O09 - Display Lights. 6-199
Test O10 - Audible Alarm. 6-200
Test O11 - Chopper Enable Signal 6-201
Test O12 - Proportional Solenoid PWM Ramp. 6-202
Test O13 - Field PWM Ramp 6-203
Test O14 - Armature PWM Test 6-205
Test O15 - Limit 1 6-207
Test O16 - Limit 2 6-208
Test O17 - Optional Alarm Test 6-209
Test O18 - REGEN Enable (optional) 6-210
Test O19 - Aux Load Hold or 2 Stage Select Solenoid (optional) 6-211

https://truckmanualshub.com/

Test O20 - Aux Select Solenoid (optional) 6-212
Test O21 - Main Select Solenoid (optional) 6-213

https://truckmanualshub.com/

Messages, Codes and Tests Summary List

https://truckmanualshub.com/

Messages and Codes

https://truckmanualshub.com/

Initialize To Allow Full Speed

Code Title	**Initialize To Allow Full Speed**
Reason	After SelfTest, the operator's carriage needs to cross the lower reference switch. Basically, this allows the *intellidrive*® system to figure out where the operator's carriage is located.
System Response	
Alarm Sounds	No
Operator Display	Initialize To Allow Full Speed
Speed Limit	1 mph (1.6 km/h)
How to Clear	Cross the lower mast reference switch to clear this speed limit condition.
Tests to Run	Test I00 - Lower Mast Reference Switch (Page 6-148)

https://truckmanualshub.com/

Aligning

Code Title	**Aligning**
Reason	The Auto/Manual switch is in the Auto position. The guide wire has been sensed; the truck is trying to acquire the wire.
System Response	
Alarm Sounds	Yes
Operator Display	Aligning
Speed Limit	As configured (tractor first) 1 mph (1.6 km/h) (forks first)
How to Clear	Acquire the guide wire or switch the Auto/Manual switch to Manual.
Tests to Run	None

Corrective Actions and Checks

Check line driver output. Run Learn Wire Frequency and Guide Wire Offsets. See “LEARN Wire Frequency” on page 3-16 and “LEARN Guide Wire Offsets” on page 3-17.

https://truckmanualshub.com/

Seeking

Code Title	**Seeking**
Reason	The Auto/Manual switch is in the Auto position. The guide wire has NOT been sensed.
System Response	
Alarm Sounds	Yes
Operator Display	Seeking
Speed Limit	As configured (tractor first) 1 mph (1.6 km/h) (forks first)
How to Clear	Acquire the guide wire or switch the Auto/Manual switch to Manual.
Tests to Run	Test A16 - Display Left Tractor Guidance Coil Voltage (Page 6-130) Test A17 - Display Right Tractor Guidance Coil Voltage (Page 6-131) Test A18 - Display Left Load Guidance Coil Voltage (Page 6-132) Test A19 - Display Right Load Guidance Coil Voltage (Page 6-133) Test A20 - Tractor Near Wire Coil Voltage (Page 6-134) Test A21 - Load Near Wire Coil Voltage (Page 6-135) Test I11 - Display Auto/Manual Switch (Page 6-157)

Corrective Actions and Checks

1. If the switch is in the manual position, run Test I11 - Display Auto/Manual Switch (Page 6-157).
2. Make sure the warehouse portion of the wire guidance system is operating properly.

https://truckmanualshub.com/

Code 1C

NOTE: This message only applies to vehicles equipped with *intellispeed*.

Code Title	**Code 1C - Cross Upper Or Lower Limit Switch**
Reason	If more than an accumulated total of 1,024 in. (2,600 cm) in either the lift or lower direction is registered, and neither the lower, upper, or 60 in. (152 cm) switch has been detected, then this code is displayed. Occasionally this code may be encountered in normal operation. Simply reset by crossing a mast reference switch.
System Response	
Alarm Sounds	Yes
Operator Display	Code 1C. Cross Upper or Lower Limit Switch
Speed Limit	Non-*intellispeed*™ limit
How to Clear	Cross the upper or lower mast reference switch.
Tests to Run	Test I00 - Lower Mast Reference Switch (Page 6-148) Test I01 - Upper Mast Reference Switch (Page 6-149) Test I18 - 60 in. Limit Switch (S28) (Page 6-163)

https://truckmanualshub.com/

Speed Limited Due to Steer Angle

Code Title	**Speed Limited Due To Steer Angle**
Reason	This message is an indication to the operator that a speed limiting condition due to a combination of steering angle and height is in effect. 1. If height is between 24 in. (610 mm) and 60 in. (1520 mm) and steering angle is >10°, max travel speed is limited to 2.5 mph (4 km/h). 2. If height is between 60 in. (1520 mm) and 150 in. (3810 mm) (w/*intellispeed*™) or the Upper Reference Switch (w/o *intellispeed*) and steering angle is >10°, max travel speed is limited to 1 mph (1.6 km/h). 3. If height is greater than 150 in. (381 cm) (w/*intellispeed*) or the Upper Reference Switch (w/o *intellispeed*) and steering is >10°, travel is not permitted.
System Response	
Alarm Sounds	No
Operator Display	Speed Limited Due to Steer Angle
Speed Limit	2.5 mph (4 km/h), 1 mph (1.6 km/h), or 0 mph
How to Clear	Straightening the steering wheel to within 10° of straight ahead or Lower the carriage below the lower mast reference switch. **NOTE:** While this code is in effect, a message will be displayed on the Operator's Display (OD).
Tests to Run	Test I00 - Lower Mast Reference Switch (Page 6-148) Test I01 - Upper Mast Reference Switch (Page 6-149) Test I18 - 60 in. Limit Switch (S28) (Page 6-163) Test I39 - Alarm and Spare Limit Switch (PS15) (Page 6-183)

https://truckmanualshub.com/

Lower Side Gate

NOTE: This message only applies to vehicles equipped with the optional side gate interlock.

Code Title	**Lower Side Gate**
Reason	Deadman down while the sidegate is detected in its up position when you attempt to travel or lift.
System Response	
Alarm Sounds	Yes
Operator Display	Lower Side Gate to Resume Operation
Brake	Applied
Speed Limit	0 mph
How to Clear	Lower the sidegate, then attempt to travel or lift/lower. **NOTE:** While this code is in effect, a message will be displayed on the OD. Both travel and lift/lower will be inhibited until the gate is lowered.
Tests to Run	Test I14 - Sidegate Switches (Page 6-159)

https://truckmanualshub.com/

Code 1H

Code Title	**Code 1H - Power Panel Overheated**
Reason	The temperature reading from the temperature sensor HT to the Tractor Manager exceeded 215°F (102°C).
System Response	
Alarm Sounds	Yes
Operator Display	Code 1H. Overheated, Allow Time To Cool.
Speed Limit	1 mph (1.6 km/h)
How to Clear	Turn key switch OFF. Allow time for the Power Panel to cool.
Tests to Run	Test A02 - Temperature Sensor Voltage (Page 6-118)

https://truckmanualshub.com/

Lower Inhibited

NOTE: This message will only occur if the option is enabled on the truck.

Code Title	**Lower Inhibited**
Reason	As the carriage was being lowered, it activated the lower inhibit switch (S25).
System Response	
Alarm Sounds	No
Operator Display	Press Bypass Switch to Resume Operation
PC Contactor	Energized
Lift/Lower Limit	Lowering prevented
How to Clear	Press Lower Inhibit Bypass switch (S7) to continue lowering.
Tests to Run	Test I17 - Lift/Lower Inhibit Bypass (S7) (Page 6-162) Test I35 - Lower Inhibit Switch (S25) (Page 6-179)

https://truckmanualshub.com/

Code 1L

Code Title	**Code 1L - Emergency Power Off Switch Pressed**
Reason	The emergency power off switch has been pressed.
System Response	
Alarm Sounds	Yes
Operator Display	Code 1L. Emergency Off Button Pressed
PC Contactor	De-energized
Brake	Applied
How to Clear	Turn the key switch OFF, lift the emergency off button, then turn the key switch ON to resume operation.
Tests to Run	Test I04 - EPO Switch (Page 6-151)

https://truckmanualshub.com/

Throttle Moved Before Deadman Pressed

Code Title	**Throttle Moved Before Deadman Pressed**
Reason	The throttle was moved from the neutral position before the deadman was pressed.
System Response	
Alarm Sounds	No
Operator Display	Release Throttle to Resume Operation
Brake	Applied
How to Clear	To resume operation, release the throttle, press the deadman pedal, then move the throttle.
Tests to Run	Test A03 - Throttle Potentiometer Voltage (Page 6-119)

Corrective Actions and Checks

The throttle calibration may be out of tolerance. Run the Controls portion of LEARN. Record neutral voltage for future reference (in case message returns).

https://truckmanualshub.com/

Lift Inhibited

NOTE: This message will only occur if the option is enabled on the truck.

Code Title	**Lift Inhibited**
Reason	As the carriage was being elevated, it activated the lift inhibit switch (S24).
System Response	
Alarm Sounds	No
Operator Display	Press Bypass Switch to Resume Operation
Lift/Lower Limit	Lifting prevented
How to Clear	Press Lift/Lower Inhibit Bypass switch (S7) to continue lifting.
Tests to Run	Test I15 - Lift Inhibit Switch (S24) (Page 6-160) Test I17 - Lift/Lower Inhibit Bypass (S7) (Page 6-162)

https://truckmanualshub.com/

Guidance Not Learned

NOTE: This message will only occur on trucks with Wire Guidance.

Code Title	**Guidance Not Learned**
Reason	When the Auto/Manual switch was placed in the “Auto” position, the wire guidance parameters were out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Guidance Not learned
PC Contactor	Energized
How to Clear	Learn guidance.
Tests to Run	None

Corrective Actions and Checks

1. Run Learn Guide Wire Offsets. See LEARN Guide Wire Offsets on page 3-17.
2. Replace ESM. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 20

Code Title	**Code 20 - Temperature Sensor Circuits Not Responding**
Reason	The analog temperature signal (JPS5-7) and digital temperature signal (JPS5-2) do not agree.
System Response	
Alarm Sounds	Yes
Operator Display	Code 20. Inform Service
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h)
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A02 - Temperature Sensor Voltage (Page 6-118) Test I07 - Display Temperature Limit Signal (Page 6-154)

https://truckmanualshub.com/

Code 21

Code Title	**Code 21 - Short Detected In Main Transistor Circuit**
Reason	During operation maximum armature current was exceeded as sensed by CT1. OR Q1-C sense line did not see B+ when travel was requested.
System Response	
Alarm Sounds	Yes
Operator Display	Code 21. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	Test A01 - Armature Sense Voltage (Page 6-117) Test A10 - Display Q1-C Sense Voltage (Page 6-124) Test O14 - Armature PWM Test (Page 6-205)

Corrective Actions and Checks

If the problem is intermittent, the cause may be noise spikes. Check:

- the snubber circuit for Q1 (REC3, C1, R2). See Testing Electrical Components on page 5-14.
- the snubber circuit for Q2 (REC4, C2, R3 - with REGEN only). See Testing Electrical Components on page 5-14.
- if horn activation causes the code, make sure there is an insulator between the horn bracket and the tractor frame.
- the horn may be shorted or the varistor on the horn may be bad. Try a different horn assembly.

If all the tests check good:

1. Check for shorts to frame. See Shorts to Frame Test on page 5-8.
2. On trucks equipped with REGEN, check for a shorted REC2. See Testing Electrical Components on page 5-14.

https://truckmanualshub.com/

Code 23

Code Title	**Code 23 - Open Detected In Main Transistor Circuit**
Reason	During SelfTest, proper current levels were not sensed by CT1 (on the Power Card) from the Power Transistor (Q1). Correct voltage not seen at Q1C sense.
System Response	
Alarm Sounds	Yes
Operator Display	Code 23. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	Test A01 - Armature Sense Voltage (Page 6-117) Test A10 - Display Q1-C Sense Voltage (Page 6-124) Test O14 - Armature PWM Test (Page 6-205)

Corrective Actions and Checks

If the problem is intermittent, the cause may be noise spikes. Check:

- the snubber circuit for Q1 (REC3, C1, R2). See Testing Electrical Components on page 5-14.
- the snubber circuit for Q2 (REC4, C2, R3 - with REGEN only). See Testing Electrical Components on page 5-14.
- if horn activation causes the code, make sure there is an insulator between the horn bracket and the tractor frame.
- the horn may be shorted or the varistor on the horn may be bad. Replace horn.

If all the tests check good, then:

1. Check for shorts to frame. See Shorts to Frame Test on page 5-8.
2. Check that the power cable runs through the current transducer of the Power Card in the correct direction. See Printed Circuit Board Remove and Replace on page 7-58.

NOTE: Failure to route the power cable in the correct direction through the transducer may cause a false Code 23 to occur.

https://truckmanualshub.com/

Code 24

Code Title	**Code 24 - Main Transistor Current Sensor Circuit Not Responding**
Reason	During operation maximum current was exceeded and current limit signal was not activated. OR Current limit active with low current.
System Response	
Alarm Sounds	Yes
Operator Display	Code 24. Inform Service
PC Contactor	De-energized
Speed Limit	Traction system shutdown
How to Clear	Cycle the key switch OFF/ON.
Tests to Run	Test A01 - Armature Sense Voltage (Page 6-117) Test I06 - Display Current Limit Signal (Page 6-153)

https://truckmanualshub.com/

Code 25

Code Title	**Code 25 - Short Detected In Field Circuit (H-bridge)**
Reason	Maximum field current was exceeded and current limit signal was activated.
System Response	
Alarm Sounds	Yes
Operator Display	Code 25. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	Test A14 - Display the Field Current Sense Voltage (Page 6-127) Test O13 - Field PWM Ramp (Page 6-203)

Corrective Actions and Checks

If the problem is intermittent, the cause may be noise spikes. Check:

- the snubber circuit for Q1 (REC3, C1, R2). See Testing Electrical Components on page 5-14.
- the snubber circuit for Q2 (REC4, C2, R3 with REGEN only). See Testing Electrical Components on page 5-14.
- if horn activation causes the code, make sure there is an insulator between the horn bracket and the tractor frame.
- the horn may be shorted or the varistor on the horn may be bad. Replace horn.

Check for shorts to frame. See Shorts to Frame Test on page 5-8.

https://truckmanualshub.com/

Code 26

Code Title	**Code 26 - Open Detected In Field Circuit**
Reason	Current was not detected in the field circuit when it should be.
System Response	
Alarm Sounds	Yes
Operator Display	Code 26. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	Test A14 - Display the Field Current Sense Voltage (Page 6-127) Test O13 - Field PWM Ramp (Page 6-203)

Corrective Actions and Checks

If the problem is intermittent, the cause may be noise spikes. Check:

- the snubber circuit for Q1 (REC3, C1, R2). See Testing Electrical Components on page 5-14.
- the snubber circuit for Q2 (REC4, C2, R3 with REGEN only). See Testing Electrical Components on page 5-14.
- if horn activation causes the code, make sure there is an insulator between the horn bracket and the tractor frame.
- the horn may be shorted or the varistor on the horn may be bad. Replace horn.

https://truckmanualshub.com/

Code 29

Code Title	**Code 29 - No Movement Detected When Travel Requested**
Reason	This fault code is detected if all four of the following conditions occur at the same time for more than 2 seconds: 1. Speed request from throttle is greater than 25%. 2. Velocity from the proximity speed sensor is zero. 3. The PWM command to the Power Card and transistor is greater than 50%. 4. No current limit detected from the Power Card.
System Response	
Alarm Sounds	Yes
Operator Display	Code 29. Inform Service
PC Contactor	Energized
Speed Limit	Minimum Power Setting (will be less than 1 mph [1.6 km/h]). Speed will vary on vehicle configuration and battery state-of-charge.
How to Clear	Follow the procedure below.
Tests to Run	If truck travels: Test I29 - Speed Feedback Proximity Sensor, Channel A (Page 6-173) Test I30 - Speed Feedback Proximity Sensor, Channel B (Page 6-174) If truck does not travel: Test O08 - Brake Release Signal (Page 6-198)

Corrective Actions and Checks

Cycle the key switch. If Code 29 changes to Code 23, then troubleshoot Code 23 (page 6-24).

A dragging brake may overheat the proximity sensor to cause this fault code. See Brake Adjustment on page 7-42.

https://truckmanualshub.com/

Code 2A

Code Title	**Code 2A - Traction Motor Overheated**
Reason	Drive motor temperature has exceeded 329°F (165°C).
System Response	
Alarm Sounds	Yes
Operator Display	Code 2A. Overheated, Allow Time to Cool
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h)
How to Clear	Allow motor to cool.
Tests to Run	Test A15 - Display the Drive Motor Temperature Voltage (Page 6-128)

Corrective Actions and Checks

See Motor Overheating on page 5-35.

https://truckmanualshub.com/

Code 2B

Code Title	**Code 2B - Main Transistor Current Sensor Out-of-range**
Reason	The Main Transistor Current Sensor analog input was detected out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Code 2B. Inform Service
PC Contactor	Energized
Speed Limit	Traction system shutdown
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A01 - Armature Sense Voltage (Page 6-117)

https://truckmanualshub.com/

Code 2C

Code Title	**Code 2C - Power Panel Temperature Sensor Out-of-range**
Reason	The power panel temperature sensor analog input was detected out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Code 2C. Inform Service
PC Contactor	Energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A02 - Temperature Sensor Voltage (Page 6-118)

https://truckmanualshub.com/

Code 2D

Code Title	**Code 2D - Field Current Sensor Out-of-range**
Reason	The analog signal from the Power Card is not correct.
System Response	
Alarm Sounds	Yes
Operator Display	Code 2D. Inform Service
PC Contactor	Energized
Speed Limit	Traction system shutdown
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A14 - Display the Field Current Sense Voltage (Page 6-127)

https://truckmanualshub.com/

Code 2E

Code Title	**Code 2E - Traction Motor Temperature Sensor Out-of-range**
Reason	The traction motor analog signal is not correct.
System Response	
Alarm Sounds	Yes
Operator Display	Code 2E. Inform Service
PC Contactor	Energized
Speed Limit	Traction shutdown
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A15 - Display the Drive Motor Temperature Voltage (Page 6-128)

https://truckmanualshub.com/

Code 2F

Code Title	**Code 2F - Failure Detected In Regen Circuit**
Reason	When REGEN was requested, current at CT1 did not go high or REGEN requested, but no deceleration.
System Response	
Alarm Sounds	Yes
Operator Display	Code 2F. Inform Service
PC Contactor	Energized
Speed Limit	Top speed minus 2 mph (3.2 km/h) and plugging only
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test O18 - REGEN Enable (optional) (Page 6-210)

https://truckmanualshub.com/

Code 2H

Code Title	**Code 2H - Failure Detected In Velocity Feedback Circuit**
Reason	The velocity feedback circuit is either not communicating, inoperative, or not installed in the truck.
System Response	
Alarm Sounds	Yes
Operator Display	Code 2H. Inform Service
PC Contactor	Energized
Speed Limit	Minimum Power Setting (will be less than 1 mph [1.6 km/h]). Speed will vary on vehicle configuration and battery state-of-charge.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I29 - Speed Feedback Proximity Sensor, Channel A (Page 6-173) Test I30 - Speed Feedback Proximity Sensor, Channel B (Page 6-174)

https://truckmanualshub.com/

Code 2J

Code Title	**Code 2J - Failure Detected In Plugging Circuit**
Reason	This error will appear when the truck does not decelerate fast enough when commanded to do so. The command to decelerate occurs when the deadman pedal is released or a speed related limit occurs.
System Response	
Alarm Sounds	Yes
Operator Display	Code 2J. Inform Service
PC Contactor	Energized
Speed Limit	Traction system shutdown
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I29 - Speed Feedback Proximity Sensor, Channel A (Page 6-173) Test I30 - Speed Feedback Proximity Sensor, Channel B (Page 6-174)

https://truckmanualshub.com/

Code 42

Code Title	**Code 42 - Lift Contactor Detected Closed When Commanded Open**
Reason	The P sense line (JPS14-7) detected voltage after the P contactor was commanded open.
System Response	
Alarm Sounds	Yes
Operator Display	Code 42. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
Lift/Lower Limit	Lift system shutdown and lowering system shutdown
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A08 - Lift Motor Sense Voltage (Page 6-123) Test O02 - Toggle the P Contactor (Page 6-193)

https://truckmanualshub.com/

Code 43

Code Title	**Code 43 - Lift Contactor Detected Open When Commanded Closed**
Reason	The P sense line (JPS14-7) does not detect the correct voltage after the P contactor was commanded closed.
System Response	
Alarm Sounds	Yes
Operator Display	Code 43. Inform Service
PC Contactor	Energized
Lift Speed	0 fpm
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A08 - Lift Motor Sense Voltage (Page 6-123) Test O02 - Toggle the P Contactor (Page 6-193)

https://truckmanualshub.com/

Code 44

Code Title	**Code 44 - PC Contactor Detected Closed When Commanded Open**
Reason	The PC sense line (JPS14-8) detected voltage after the PC contactor was commanded open.
System Response	
Alarm Sounds	Yes
Operator Display	Code 44. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A07 - PC Sense Voltage (Page 6-122) Test O00 - Toggle the PC Contactor (Page 6-192)

https://truckmanualshub.com/

Code 45

Code Title	**Code 45 - PC Contactor Detected Open When Commanded Closed**
Reason	The PC sense line (JPS14-8) does not detect the correct voltage after the PC contactor was commanded closed.
System Response	
Alarm Sounds	Yes
Operator Display	Code 45. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A07 - PC Sense Voltage (Page 6-122) Test O00 - Toggle the PC Contactor (Page 6-192)

https://truckmanualshub.com/

Code 50

Code Title	**Code 50 - No Tractor Manager Communications Received By Carriage Control Card**
Reason	The Carriage Control Card has not received a message from the Tractor Manager for more than 100ms. This could be caused by a problem in the Tractor Manager VFC or Electric Steer Manager.
System Response	
Alarm Sounds	Yes
Operator Display	Code 50. Inform Service
PC Contactor	De-energized
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	See Communication Error Code Troubleshooting on page 5-23.

Corrective Actions and Checks

If Steps 1 thru 6 in the Communication Code Diagnosis and Repair on page 5-25 pass, replace the VFC. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 51

Code Title	**Code 51 - No Carriage Control Card Communications Received By Tractor Manager**
Reason	The Tractor Manager has not received a message from the Carriage Control Card for more than 100ms.
System Response	
Alarm Sounds	Yes
Operator Display	Code 51. Inform Service
PC Contactor	De-energized
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	See Communication Error Code Troubleshooting on page 5-23.

Corrective Actions and Checks

If Steps 1 thru 6 in the Communication Code Diagnosis and Repair on page 5-25 pass:

- Code 51 only - Replace VFC
- Codes 51 & 52 - Replace CCC

See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 52

Code Title	**Code 52 - No Carriage Control Card Communications Received By Electric Steer Manager**
Reason	The Electric Steer Manager has not received a message from the Carriage Control Card for more than 100ms.
System Response	
Alarm Sounds	Yes
Operator Display	Code 52. Inform Service
PC Contactor	De-energized
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	See Communication Error Code Troubleshooting on page 5-23.

Corrective Actions and Checks

If Steps 1 thru 6 in the Communication Code Diagnosis and Repair on page 5-25 pass:

- Code 52 only - Replace ESM
- Codes 52 & 51 - Replace CCC

See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 53

Code Title	**Code 53 - No Electric Steer Manager (Esm) Communications Received By Carriage Control Card**
Reason	The Carriage Control Card has not heard from the Electric Steer Manager for more than 100ms.
System Response	
Alarm Sounds	Yes
Operator Display	Code 53. Inform Service
PC Contactor	De-energized
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	See Communication Error Code Troubleshooting on page 5-23.

Corrective Actions and Checks

If Steps 1 thru 6 in the Communication Code Diagnosis and Repair on page 5-25 pass, replace the ESM. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 59

Code Title	**Code 59 - Carriage Control Card Transmit Failure (detected by CCC)**
Reason	During power up or run time, the Carriage Control Card fails to transmit within 100ms. This is reported by the Carriage Control Card.
System Response	
Alarm Sounds	Yes
Operator Display	Code 59. Inform Service
PC Contactor	De-energized
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	See Communication Error Code Troubleshooting on page 5-23.

Corrective Actions and Checks

If Steps 1 thru 6 in the Communication Code Diagnosis and Repair on page 5-25 pass, replace the CCC. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 5A

Code Title	**Code 5A - CAN Communications Failed - Message Overrun**
Reason	The Tractor Manager is unable to process information fast enough.
System Response	
Alarm Sounds	Yes
Operator Display	Code 5A. Inform Service
PC Contactor	De-energized
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	See Communication Error Code Troubleshooting on page 5-23.

Corrective Actions and Checks

If Steps 1 thru 6 in the Communication Code Diagnosis and Repair on page 5-25 pass, replace the VFC. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 5B

Code Title	**Code 5B - CAN Communications Failed - Message Overrun**
Reason	The Carriage Control Card is unable to process information fast enough.
System Response	
Alarm Sounds	Yes
Operator Display	Code 5B. Inform Service
PC Contactor	De-energized
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	See Communication Error Code Troubleshooting on page 5-23.

Corrective Actions and Checks

If Steps 1 thru 6 in the Communication Code Diagnosis and Repair on page 5-25 pass, replace the CCC. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 5C

Code Title	**Code 5C - CAN Bus Off - Communications Transmission Error Counters High**
Reason	Communications between the Carriage Control Card and the Tractor Manager and/or Electric Steer Manager is intermittent.
System Response	
Alarm Sounds	Yes
Operator Display	Code 5C. Inform Service
PC Contactor	De-energized
How to Clear	If cycling the key switch OFF/ON does not clear this code, follow the procedure below.
Tests to Run	See Communication Error Code Troubleshooting on page 5-23.

Corrective Actions and Checks

If Steps 1 thru 6 in the Communication Code Diagnosis and Repair on page 5-25 pass:

- replace the ESM. See Printed Circuit Board Remove and Replace on page 7-58. Cycle the key switch. If error code is still displayed:
- replace the VFC. See Printed Circuit Board Remove and Replace on page 7-58. Cycle the key switch. If error code is still displayed:
- replace the CCC. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 5D

NOTE: This fault code will only occur if the SMARTi® option is enabled on the truck.

Code Title	**Code 5D - No SMARTi System Response**
Reason	The Carriage Control Card is not receiving inputs from the SMARTi Card Module.
System Response	
Alarm Sounds	No
Operator Display	Code 5D. Inform Service
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h)
How to Clear	If cycling the key switch OFF/ON does not clear this code, follow the procedure below.
Tests to Run	See Communication Error Code Troubleshooting on page 5-23.

Corrective Actions and Checks

If Steps 1 thru 6 in the Communication Code Diagnosis and Repair on page 5-25 pass, replace the CCC. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 63

Code Title	**Code 63 - Upper And Lower Reference Switches Do Not Agree**
Reason	The Carriage Control Card sensed that the positions of the upper and lower reference switches were out of sequence.
System Response	
Alarm Sounds	Yes
Operator Display	Code 63. Inform Service
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h)
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I00 - Lower Mast Reference Switch (Page 6-148) Test I01 - Upper Mast Reference Switch (Page 6-149)

https://truckmanualshub.com/

Code 64

Code Title	**Code 64 - No Flow Sensor Pulses When Lift/Lower Requested**
Reason	No flow sensor pulses were detected by the Electric Steer Manager during lift or lower.
System Response	
Alarm Sounds	Yes
Operator Display	Code 64. Inform Service
PC Contactor	Energized
Speed Limit	Non-*intellispeed*™ Limit
How to Clear	Make sure that the forks/carriage are not actually hung up on an object. Cycle key switch OFF/ON.
Tests to Run	Test I10 - Display Flow Sensor Count (Page 6-156)

https://truckmanualshub.com/

Code 66

Code Title	**Code 66 - Calculated Height Does Not Match At Upper Reference Switch**
Reason	After crossing the upper reference switch, the height of the operator's carriage, as determined by the Carriage Control Card, was out of tolerance OR the Carriage Control Card thinks the carriage should have crossed the upper reference switch, but the carriage has not.
System Response	
Alarm Sounds	Yes
Operator Display	Code 66. Invalid Height... Turn Key OFF/ON
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h) (maximum height assumed)
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	Test I01 - Upper Mast Reference Switch (Page 6-149)

Corrective Actions and Checks

If the CD3+ card was replaced, make sure that the jumpers are installed in both JS30 and JS31. See Figure 6-2.

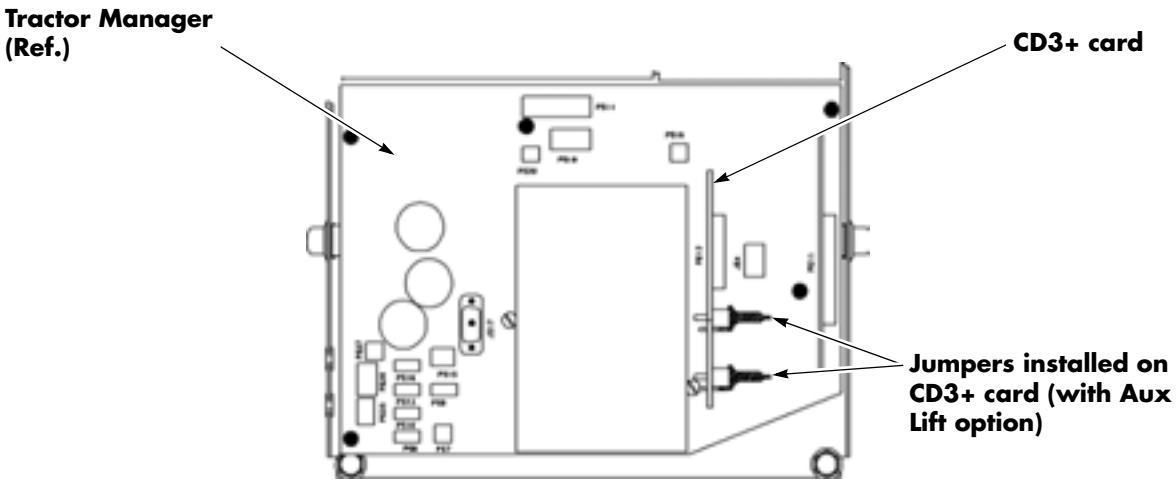


Figure 6-2. Jumpers On CD3+ Card

https://truckmanualshub.com/

Code 67

Code Title	**Code 67 - Calculated Height Does Not Match At Lower Reference Switch**
Reason	After crossing the lower reference switch, the height of the operator's carriage, as determined by the Carriage Control Card, was out of tolerance.
System Response	
Alarm Sounds	Yes
Operator Display	Code 67. Invalid Height... Turn Key OFF/ON
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h) (maximum height assumed)
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	Test I00 - Lower Mast Reference Switch (Page 6-148)

Corrective Actions and Checks

If the CD3+ card was replaced, make sure that the jumpers are installed in both JS30 and JS31. See Figure 6-2.

https://truckmanualshub.com/

Code 6D

Code Title	**Code 6D - Lift Pressure Out-of-range**
Reason	The Electric Steer Manager has determined that the pressure sensor voltage has exceeded the programmed limits.
System Response	
Alarm Sounds	Yes
Operator Display	Code 6D. Inform Service
PC Contactor	Energized
Lift/Lower Limit	Non-*intellispeed*™ Limit
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A05 - Pressure Sensor Voltage (Page 6-121)

https://truckmanualshub.com/

Code 6K

Code Title	**Code 6K - 60 in. Switch Does Not Agree With The Lower Mast Reference Switch**
Reason	The 60 in. switch is out of sequence with the lower mast reference switch.
System Response	
Alarm Sounds	Yes
Operator Display	Code 6K. Inform Service
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h)
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I00 - Lower Mast Reference Switch (Page 6-148) Test I18 - 60 in. Limit Switch (S28) (Page 6-163)

https://truckmanualshub.com/

Code 6L

Code Title	**Code 6L - Upper Reference Switch Disconnected**
Reason	The system detected that the upper reference switch stopped drawing current.
System Response	
Alarm Sounds	Yes
Operator Display	Code 6L. Inform Service
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h)
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I37 - Upper Reference Switch Sense (S10) (Page 6-181)

https://truckmanualshub.com/

Code 6M

Code Title	**Code 6M - 60 in. And/Or Lower Reference Switch Disconnected**
Reason	The system detected that the 60 in. and/or lower reference switch stopped drawing current.
System Response	
Alarm Sounds	Yes
Operator Display	Code 6M. Inform Service
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h)
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I00 - Lower Mast Reference Switch (Page 6-148) Test I18 - 60 in. Limit Switch (S28) (Page 6-163)

Corrective Actions and Checks

If the truck is equipped with *intellispeed*™, a resistor (P/N 114-008-958/002) must be on the Carriage Control Card between JPC3-2 and JPC3-1.

https://truckmanualshub.com/

Code 6N

Code Title	**Code 6N - Flow Sensor Temperature Out-of-range**
Reason	The value sensed by the Electric Steer Manager exceeded the allowable limit.
System Response	
Alarm Sounds	Yes
Operator Display	Code 6N. Inform Service
PC Contactor	Energized
Speed Limit	Non-*intellispeed*™ Limit
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A25 - Flow Sensor Temperature Voltage (Page 6-139)

https://truckmanualshub.com/

Code 6P

Code Title	**Code 6P - 60 in. Limit Switch Is Out Of Sequence With The Upper Mast Reference Switch**
Reason	The system senses that the 60 in. limit switch and the upper mast reference switch are out of sequence.
System Response	
Alarm Sounds	Yes
Operator Display	Code 6P. Inform Service
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h)
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I01 - Upper Mast Reference Switch (Page 6-149) Test I18 - 60 in. Limit Switch (S28) (Page 6-163)

https://truckmanualshub.com/

Code 80

Code Title	**Code 80 - Throttle Controller Reading Out-of-range**
Reason	Throttle potentiometer out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Code 80. Inform Service
PC Contactor	Energized
Speed Limit	Traction System shutdown
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A03 - Throttle Potentiometer Voltage (Page 6-119)

https://truckmanualshub.com/

Code 81

Code Title	**Code 81 - Lift Controller Reading Out-of-range**
Reason	Lift potentiometer out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Code 81. Inform Service
PC Contactor	Energized
Speed Limit	1 mph (1.6 km/h)
Lift/Lower Speed	0 fpm
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A04 - Lift/Lower Potentiometer Voltage (Page 6-120)

https://truckmanualshub.com/

Code 84

Code Title	**Code 84 - Brake Inoperable Or Not Properly Adjusted**
Reason	The restraining ability of the brake is checked every time the truck is powered up. Q1 is briefly pulsed. If the motor rotates more than 1.5°, this fault code is displayed.
System Response	
Alarm Sounds	Yes
Operator Display	Code 84. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	If motor does not rotate: Test I29 - Speed Feedback Proximity Sensor, Channel A (Page 6-173) Test I30 - Speed Feedback Proximity Sensor, Channel B (Page 6-174) If motor rotates: Test O08 - Brake Release Signal (Page 6-198)

Corrective Actions and Checks

The brake may be loose. Adjust the brake. See Brake Adjustment on page 7-42.

⚠ WARNING

Brakes require periodic maintenance (see Brake on page 7-42.).

https://truckmanualshub.com/

Code 8C

Code Title	**Code 8C - Travel Deadman Switches Do Not Agree**
Reason	Deadman switch S2 was pressed while S23 is not pressed for at least 3 seconds while traveling or lifting.
System Response	
Alarm Sounds	Yes
Operator Display	Code 8C. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I31 - Carriage Deadman (Page 6-175) Test I32 - Brake Deadman Signal to Tractor Manager (Page 6-176)

https://truckmanualshub.com/

Code 8D

Code Title	**Code 8D - Plugging Detector Malfunction**
Reason	Deadman pedal released, no drive current sensed, and the hardware circuit on the Tractor Manager is not trying to apply the brake. OR Deadman pedal is pressed, drive current is sensed, and the brake is not commanded to release.
System Response	
Alarm Sounds	Yes
Operator Display	Code 8D. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	If cycling the key switch OFF/ON does not clear this fault code, then follow the procedure below.
Tests to Run	None

Corrective Actions and Checks

Replace the Tractor Manager. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code 8E

Code Title	**Code 8E - Brake Deadman Signals Do Not Agree**
Reason	The Tractor Manager has been told across BUS+/BUS– that the deadman switches have been pressed, but the Tractor Manager has not received the position voltage across the brake deadman line.
System Response	
Alarm Sounds	Yes
Operator Display	Code 8E. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I32 - Brake Deadman Signal to Tractor Manager (Page 6-176)

https://truckmanualshub.com/

Code 91

Code Title	**Code 91 - Drive Unit Turned Greater Than 10° While Guiding On Wire**
Reason	While guiding on the wire, the drive unit has turned greater than 10°.
System Response	
Alarm Sounds	Yes
Operator Display	Code 91. Wire Lost, Step Off/On Deadman pedal
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Step Off/On deadman pedal.
Tests to Run	Test I22 - Steer Position Encoder Count (Page 6-168)

https://truckmanualshub.com/

Code 92

Code Title	**Code 92 - Tracking Limits Exceeded**
Reason	The truck has drifted beyond the configured HA Stop or DFW Stop values.
System Response	
Alarm Sounds	Yes
Operator Display	Code 92. Wire Lost, Step Off/On Deadman pedal
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Step Off/On deadman pedal.
Tests to Run	Test A16 - Display Left Tractor Guidance Coil Voltage (Page 6-130) Test A17 - Display Right Tractor Guidance Coil Voltage (Page 6-131) Test A18 - Display Left Load Guidance Coil Voltage (Page 6-132) Test A19 - Display Right Load Guidance Coil Voltage (Page 6-133) Test A20 - Tractor Near Wire Coil Voltage (Page 6-134) Test A21 - Load Near Wire Coil Voltage (Page 6-135)

Corrective Actions and Checks

The output of the line driver may be incorrect. Refer to Publication PDSS-0051 if it is a Raymond line driver or to the manufacturer's specifications if it is not.

https://truckmanualshub.com/

Code 93

Code Title	**Code 93 - Not Near Wire - Tractor Coil Pair**
Reason	The guide wire is not being sensed by the tractor coil pair.
System Response	
Alarm Sounds	Yes
Operator Display	Code 93. Wire Lost, Step Off/On Deadman pedal
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Step Off/On deadman pedal.
Tests to Run	Test A16 - Display Left Tractor Guidance Coil Voltage (Page 6-130) Test A17 - Display Right Tractor Guidance Coil Voltage (Page 6-131) Test A20 - Tractor Near Wire Coil Voltage (Page 6-134)

https://truckmanualshub.com/

Code 94

Code Title	**Code 94 - Not Near Wire - Load Coil Pair**
Reason	The guide wire is not being sensed by the load coil pair.
System Response	
Alarm Sounds	Yes
Operator Display	Code 94. Wire Lost, Step Off/On Deadman pedal
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Step Off/On deadman pedal.
Tests to Run	Test A18 - Display Left Load Guidance Coil Voltage (Page 6-132) Test A19 - Display Right Load Guidance Coil Voltage (Page 6-133) Test A21 - Load Near Wire Coil Voltage (Page 6-135)

https://truckmanualshub.com/

Code 96

Code Title	**Code 96 - Not Near Wire - Both Coil Pairs**
Reason	The guide wire is not being sensed by either set of coil pairs.
System Response	
Alarm Sounds	Yes
Operator Display	Code 96. Wire Lost, Step Off/On Deadman
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Step Off/On deadman pedal.
Tests to Run	Test A16 - Display Left Tractor Guidance Coil Voltage (Page 6-130) Test A17 - Display Right Tractor Guidance Coil Voltage (Page 6-131) Test A18 - Display Left Load Guidance Coil Voltage (Page 6-132) Test A19 - Display Right Load Guidance Coil Voltage (Page 6-133) Test A20 - Tractor Near Wire Coil Voltage (Page 6-134) Test A21 - Load Near Wire Coil Voltage (Page 6-135)

Corrective Actions and Checks

1. The output of the line driver may be incorrect. Refer to Publication PDSS-0051 if it is a Raymond line driver or to the manufacturer's specifications if it is not.
2. Verify that the truck is configured to the correct wire guidance frequency.

https://truckmanualshub.com/

Code 9E

Code Title	**Code 9E - Track and Hold Signal Failed**
Reason	The truck is moving while on the wire and the guidance signals are not fluctuating at all.
System Response	
Alarm Sounds	Yes
Operator Display	Code 9E. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A16 - Display Left Tractor Guidance Coil Voltage (Page 6-130) Test A17 - Display Right Tractor Guidance Coil Voltage (Page 6-131) Test A18 - Display Left Load Guidance Coil Voltage (Page 6-132) Test A19 - Display Right Load Guidance Coil Voltage (Page 6-133)

https://truckmanualshub.com/

Code 9F

Code Title	**Code 9F - Wire Guidance Board Not Installed**
Reason	Filter Card not connected to the Electric Steer Manager.
System Response	
Alarm Sounds	Yes
Operator Display	Code 9F. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test I23 - Wire Guidance Board Status (Page 6-169)

https://truckmanualshub.com/

Code 9G

Code Title	**Code 9G - No Signal - Load Antenna**
Reason	The signal from the load antenna is not being received by the Filter Card.
System Response	
Alarm Sounds	Yes
Operator Display	Code 9G. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A18 - Display Left Load Guidance Coil Voltage (Page 6-132) Test A19 - Display Right Load Guidance Coil Voltage (Page 6-133) Test A21 - Load Near Wire Coil Voltage (Page 6-135)

https://truckmanualshub.com/

Code 9H

Code Title	**Code 9H - No Signal - Tractor Antenna**
Reason	The signal from the tractor antenna is not being received by the Filter Card.
System Response	
Alarm Sounds	Yes
Operator Display	Code 9H. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A16 - Display Left Tractor Guidance Coil Voltage (Page 6-130) Test A17 - Display Right Tractor Guidance Coil Voltage (Page 6-131) Test A20 - Tractor Near Wire Coil Voltage (Page 6-134)

https://truckmanualshub.com/

Code 9J

Code Title	**Code 9J - Load Antenna Signal Too High**
Reason	Near wire voltage is greater than 4.75V.
System Response	
Alarm Sounds	Yes
Operator Display	Code 9J. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A21 - Load Near Wire Coil Voltage (Page 6-135)

Corrective Actions and Checks

1. The output of the line driver may be incorrect. Refer to Publication PDSS-0051 if it is a Raymond line driver or to the manufacturer's specifications if it is not.
2. LEARN wire guidance frequency and offsets.

https://truckmanualshub.com/

Code 9K

Code Title	**Code 9K - Tractor Antenna Signal Too High**
Reason	Near wire voltage is greater than 4.75V.
System Response	
Alarm Sounds	Yes
Operator Display	Code 9K. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A20 - Tractor Near Wire Coil Voltage (Page 6-134)

Corrective Actions and Checks

Refer to the Corrective Actions and Checks for Code 9J (Page 6-75).

https://truckmanualshub.com/

Code 9L

Code Title	**Code 9L - Signal Too High at Both Coil Pairs**
Reason	Near wire voltage is greater than 4.75V.
System Response	
Alarm Sounds	Yes
Operator Display	Code 9L. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A20 - Tractor Near Wire Coil Voltage (Page 6-134) Test A21 - Load Near Wire Coil Voltage (Page 6-135)

https://truckmanualshub.com/

Code A0

Code Title	**Code A0 - Incorrect Software For Proper Vehicle Operation**
Reason	The model number stored in the Carriage Control Card EPROM is not the proper model number for the vehicle type.
System Response	
Alarm Sounds	Yes
Operator Display	Code A0. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

If this fault code appears, upgrade the software in the truck.

https://truckmanualshub.com/

Code A1

Code Title	**Code A1 - Carriage Control Card Not Initialized**
Reason	The card has been damaged.
System Response	
Alarm Sounds	Yes
Operator Display	Code A1. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Replace the Carriage Control Card with a pre-programmed card. See Printed Circuit Board Remove and Replace on page 7-58.

NOTE: Program modes (Maintenance, LEARN, or Configure) cannot be entered until this fault code is cleared.

https://truckmanualshub.com/

Code AK

Code Title	**Code AK - Invalid RAM Data**
Reason	The Carriage Control Card checksum is incorrect and the Tractor Manager checksum is also incorrect.
System Response	
Alarm Sounds	Yes
Operator Display	Code AK. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

1. Cycle the key switch OFF/ON several times to see if the fault code clears.

NOTE: This problem could be the result of static electricity or shorts to frame. Check and clean all static straps for proper operation. Inspect for shorts to frame.

2. Replace the Carriage Control Card with a pre-programmed card. See Printed Circuit Board Remove and Replace on page 7-58.

NOTE: Program modes (Maintenance, LEARN, or Configure) cannot be entered until this fault code is cleared.

https://truckmanualshub.com/

Code EC

Code Title	**Code EC - Tractor Manager Operating System Error**
Reason	Tractor Manager EPROM/Software failed/EPROM or RAM has bad locations.
System Response	
Alarm Sounds	Yes
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

1. Cycle the key switch OFF/ON several times to see if the fault code clears.

NOTE: This problem could be a result of static electricity or shorts to frame. Check and clean all static straps. Inspect for shorts to frame.

2. Replace the Tractor Manager VFC and EPROM. See “Printed Circuit Board Remove and Replace” on page 7-58. and EPROM/Microprocessor Remove and Replace on page -63.

NOTE: Program modes (Maintenance, LEARN, or Configure) cannot be entered until this fault code is cleared.

https://truckmanualshub.com/

Code EG

Code Title	**Code EG - Carriage Control Card Operating System Error**
Reason	Carriage Control Card EPROM/Software failed/EPROM or RAM has bad locations.
System Response	
Alarm Sounds	Yes
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

1. Cycle the key switch OFF/ON several times to see if the fault code clears.

NOTE: This problem could be a result of static electricity or shorts to frame. Check and clean all static straps. Inspect for shorts to frame.

2. Replace the Carriage Control Card and EPROM. See “Printed Circuit Board Remove and Replace” on page 7-58. and EPROM/Microprocessor Remove and Replace on page -63.

NOTE: Program modes (Maintenance, LEARN, or Configure) cannot be entered until this fault code is cleared.

https://truckmanualshub.com/

Code F1

Code Title	**Code F1 - Carriage Control Card COP Time Out**
Reason	Static electricity or a short to frame.
System Response	
Alarm Sounds	Yes
Operator Display	Code F1. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

1. This problem can be caused by static electricity or shorts to frame. Check and clean all static straps. Check the connection on either the Carriage Control Card or devices connected to the Carriage Control Card. Inspect for shorts to frame.
2. If truck is equipped with optional travel alarms, check the suppressors for those circuits.
3. Check for a loose connection at the Carriage Control Card.
4. Check for a loose connection between a light bulb and its socket.
5. Replace the Carriage Control Card and EPROM. See “Printed Circuit Board Remove and Replace” on page 7-58. and EPROM/Microprocessor Remove and Replace on page -63.

https://truckmanualshub.com/

Code F2

Code Title	**Code F2 - Carriage Control Card Invalid OP Code**
Reason	A bad connection on either the Carriage Control Card or a device connected to the Carriage Control Card could cause this fault code.
System Response	
Alarm Sounds	Yes
Operator Display	Code F2. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Refer to the Corrective Actions and Checks for
Code F1 (Page 6-83).

https://truckmanualshub.com/

Code F3

Code Title	**Code F3 - Carriage Control Card EPROM Or CAN Reset**
Reason	A bad connection on either the Carriage Control Card or a device connected to the Carriage Control Card could cause this fault code.
System Response	
Alarm Sounds	Yes
Operator Display	Code F3. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Refer to the Corrective Actions and Checks for
Code F1 (Page 6-83).

https://truckmanualshub.com/

Code F4

Code Title	**Code F4 - Tractor Manager VFC COP Time Out**
Reason	Static electricity or a short to frame.
System Response	
Alarm Sounds	Yes
Operator Display	Code F4. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

1. This problem can be caused by static electricity or shorts to frame. Check and clean all static straps. Check the connection on the Tractor Manager or devices connected to the Tractor Manager. Inspect for shorts to frame.
2. If truck is equipped with optional travel alarm, disconnect PS15. If code goes away, troubleshoot travel alarm circuitry.

NOTE: The condition of the travel alarm suppressor module cannot be checked with a DMM. If the suppressor module is suspected to be bad, replace it.

3. Check the snubber circuits for Q1. See Testing Electrical Components on page 5-14.
4. If the truck is equipped with REGEN, test the snubber circuit for Q2. See Testing Electrical Components on page 5-14.
5. If code is present all the time, replace the Tractor Manager VFC and EPROM. See “Printed Circuit Board Remove and Replace” on page 7-58. and EPROM/Microprocessor Remove and Replace on page -63.

https://truckmanualshub.com/

Code F5

Code Title	**Code F5 - Tractor Manager VFC Invalid OP Code**
Reason	A bad connection on either the Tractor Manager or a device connected to the Tractor Manager could cause this fault code.
System Response	
Alarm Sounds	Yes
Operator Display	Code F5. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Refer to the Corrective Actions and Checks for
Code F4 (Page 6-86).

https://truckmanualshub.com/

Code F6

Code Title	**Code F6 - Tractor Manager VFC ASIC, EPROM, Or CAN Reset**
Reason	A bad connection on either the Tractor Manager or a device connected to the Tractor Manager could cause this fault code.
System Response	
Alarm Sounds	Yes
Operator Display	Code F6. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Refer to the Corrective Actions and Checks for
Code F4 (Page 6-86).

https://truckmanualshub.com/

Code F7

Code Title	**Code F7 - Carriage Control Card Computer Operating Program (COP) Not Enabled**
Reason	This fault code indicates that the start-up procedure detected a Carriage Control Card malfunction.
System Response	
Alarm Sounds	Yes
Operator Display	Code F7. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Replace the Carriage Control Card. See “Printed Circuit Board Remove and Replace” on page 7-58..

https://truckmanualshub.com/

Code F8

NOTE: This fault code should never be detected in normal operation.

Code Title	**Code F8 - Tractor Manager VFC COP Not Enabled**
Reason	This fault code indicates that the start-up procedure detected a Tractor Manager/VFC malfunction.
System Response	
Alarm Sounds	Yes
Operator Display	Code F8. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Replace the Tractor Manager VFC. See “Printed Circuit Board Remove and Replace” on page 7-58..

https://truckmanualshub.com/

Code F9

Code Title	**Code F9 - Electric Steer Manager - COP Time Out**
Reason	Static electricity or a short to frame.
System Response	
Alarm Sounds	Yes
Operator Display	Code F9. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

1. This problem can be caused by static electricity or shorts to frame. Check and clean all static straps. Check the connection on the Electric Steer Manager or devices connected to the Electric Steer Manager. Inspect for shorts to frame.
2. If truck is equipped with optional travel alarm, disconnect PS15. If code goes away, troubleshoot travel alarm circuitry.

NOTE: The condition of the travel alarm suppressor module cannot be checked with a DMM. If the suppressor module is suspected to be bad, replace it.

3. If code is present all the time, replace the ESM and EPROM. See “Printed Circuit Board Remove and Replace” on page 7-58. and EPROM/Microprocessor Remove and Replace on page -63.

https://truckmanualshub.com/

Code FA

Code Title	**Code FA - Electric Steer Manager Invalid OP Code**
Reason	A bad connection on either the Electric Steer Manager or a device connected to the Electric Steer Manager could cause this fault code.
System Response	
Alarm Sounds	Yes
Operator Display	Code FA. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Refer to Corrective Actions and Checks for Code F9 (Page 6-91).

https://truckmanualshub.com/

Code FB

Code Title	**Code FB - Electric Steer Manager - ASIC, EPROM, Or CAN Reset**
Reason	A bad connection on either the Electric Steer Manager or a device connected to the Electric Steer Manager could cause this fault code.
System Response	
Alarm Sounds	Yes
Operator Display	Code FB. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Refer to the Corrective Actions and Checks for Code F9 (Page 6-91).

https://truckmanualshub.com/

Code FC

Code Title	**Code FC - Electric Steer Manager COP Not Enabled**
Reason	This fault code indicates that the start-up procedure detected an Electric Steer Manager malfunction.
System Response	
Alarm Sounds	Yes
Operator Display	Code FC. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Replace ESM. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code FD

NOTE: This fault code should never be detected in normal operation.

Code Title	**Code FD - Uncalibrated Carriage Control Card**
Reason	This fault code indicates that the start-up procedure detected that the Carriage Control Card EPROM was never calibrated at the factory.
System Response	
Alarm Sounds	Yes
Operator Display	Code FD. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Replace CCC. See Printed Circuit Board Remove and Replace on page 7-58.

https://truckmanualshub.com/

Code FE

NOTE: This fault code should never be detected in normal operation.

Code Title	**Code FE - Uncalibrated Tractor Manager VFC**
Reason	This fault code indicates that the start-up procedure detected that the Tractor Manager VFC was never calibrated at the factory.
System Response	
Alarm Sounds	Yes
Operator Display	Code FE. Inform Service
PC Contactor	De-energized
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Replace VFC. See Printed Circuit Board Remove and Replace on page 7-58.

NOTE: Program modes (Maintenance, LEARN, or Configure) cannot be entered until this fault code is cleared.

https://truckmanualshub.com/

Code FG

Code Title	**Code FG - Tractor Manager +12V Power Supply Out-of-Range**
Reason	+12V was detected out-of-range at the Tractor Manager.
System Response	
Alarm Sounds	Yes
Operator Display	Code FG. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A00 - Tractor Manager +12V Power Supply (Page 6-116)

Corrective Actions and Checks

Watch the Operator's Display carefully during power up. Another fault code may appear briefly before this fault code. If another fault code appears before this fault code, troubleshoot that fault code first.

NOTE: This problem could be a result of static electricity or shorts to frame. Clean and check all static straps for proper operation. Inspect for shorts to frame.

https://truckmanualshub.com/

Code FH

Code Title	**Code FH - Battery Voltage Out-of-Range**
Reason	Wrong battery voltage or battery voltage out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Code FH. Inform Service
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A11 - Display Battery Voltage (Page 6-125)

Corrective Actions and Checks

This problem could be the result of static electricity or shorts to frame. Clean and check all static straps for proper operation. Inspect for shorts to frame. See Shorts to Frame Test on page 5-8.

NOTE: If the battery was just removed from the charger, wait several minutes and try again.

https://truckmanualshub.com/

Code FJ

Code Title	**Code FJ - Diagnostic Pendant Sense Line Voltage Out-of-Range**
Reason	Diagnostic pendant sense line voltage out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Code FJ. Inform Service
PC Contactor	Energized
Speed Limit	0 mph
Lift/Lower Limit	0 fpm
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A13 - Display the Diagnostic Pendant Voltage (Page 6-126)

https://truckmanualshub.com/

Code G0

Code Title	**Code G0 - Manual Steering Error**
Reason	A steering encoder channel discrepancy has occurred or a start-up mismatch between the Dual Enc (Dual Channel Encoder) option setting and the detection of steering encoder hardware on the truck has occurred.
System Response	
Alarm Sounds	Yes
Operator Display	Code G0. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug to <1 mph (1.6 km/h), then apply brake
How to Clear	Cycle key switch OFF/ON.
Tests to Run	For lift trucks with Single Channel Encoders: Test I33 - Display Channel A of Steer Encoder (Page 6-177) Test I34 - Display Channel B of Steer Encoder (Page 6-178) **NOTE:** If error occurs at start-up, make sure Dual Enc configuration option is “Disabled”. For lift trucks with Dual Channel Encoders: Test I33 - Display Channel A of Steer Encoder (Page 6-177) Test I34 - Display Channel B of Steer Encoder (Page 6-178) Test I60 - Display Channel A-E2 of Steer Encoder (Page 6-188) Test I61 - Display Channel B-E2 of Steer Encoder (Page 6-189) Test I62 - Dual Channel Steer Encoder Detect (Page 6-190) **NOTE:** If error occurs at start-up, make sure Dual Enc configuration option is “Enabled” and that Dual Encoder wiring is connected to the Carriage Control Card.

NOTE: This code should only appear on vehicles with electric steering.

Corrective Actions and Checks

1. Check for shorts to frame. See Shorts to Frame Test on page 5-8.
2. Remove Q1 heatsink and inspect the insulator paper for tears. Check the heatsink for metal burrs.
3. Test Q1 snubber components. See Testing Electrical Components on page 5-14.

https://truckmanualshub.com/

Code G1

Code Title	**Code G1 - Electronic Steering Power Supply Out-of-Range**
Reason	+12V detected out-of-range at the Electric Steer Manager.
System Response	
Alarm Sounds	Yes
Operator Display	Code G1.
PC Contactor	De-energized
Speed Limit	0 mph
How to Clear	Cycle key switch OFF/ON.
Tests to Run	If this fault code is intermittent, run the following test using active maintenance with the truck operating under a load: Test A23 - Steer Controller Power Supply Voltage (Page 6-137)

https://truckmanualshub.com/

Code G2

NOTE: This fault code will only appear if there is no input received from the home reference proximity sensor after SelfTest centering has been completed.

If the home reference proximity sensor is bad, a fault code G3 will appear when auto-centering the drive unit after SelfTest.

Code Title	**Code G2 - No Steer Position Reference Input Or Steer Position Encoder Pulses Detected Without A Steer Command To Turn**
Reason	No input from the home reference proximity sensor to the Electric Steer Manager.
System Response	
Alarm Sounds	Yes
Operator Display	Code G2. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	See G Series Error Code Troubleshooting on page 5-26.

https://truckmanualshub.com/

Code G3

Code Title	**Code G3 - No Steer Encoder Signal Or No Home Sensor Input**
Reason	1. No pulses are being sent from the steer position encoder to the Electric Steer Manager. 2. No home reference proximity sensor input was received while trying to center. 3. There is an open circuit in the steer motor system.
System Response	
Alarm Sounds	Yes
Operator Display	Code G3. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	See G Series Error Code Troubleshooting on page 5-26.

https://truckmanualshub.com/

Code G4

Code Title	**Code G4 - Open Detected In Steer Power Circuit**
Reason	No encoder pulses from steer feedback encoder and no current feedback.
System Response	
Alarm Sounds	Yes
Operator Display	Code G4. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then aply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	See G Series Error Code Troubleshooting on page 5-26.

https://truckmanualshub.com/

Code G5

Code Title	**Code G5 - Short Detected In Steer Power Circuit**
Reason	Steer feedback encoder pulses detected without steer commanded to turn.
System Response	
Alarm Sounds	Yes
Operator Display	Code G5. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	See G Series Error Code Troubleshooting on page 5-26.

https://truckmanualshub.com/

Code G6

Code Title	**Code G6 - Encoder - Steer Motor Mismatch**
Reason	Drive unit turns opposite of commanded direction.
System Response	
Alarm Sounds	Yes
Operator Display	Code G6. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	None

Corrective Actions and Checks

Motor leads or Steer Position Encoder wiring connected in reverse. Check connections by tracing the circuit using an ohmmeter and schematic.

https://truckmanualshub.com/

Code G8

Code Title	**Code G8 - Amplifier Current Out-of-Range**
Reason	Current feedback voltage exceeds 4.75V.
System Response	
Alarm Sounds	Yes
Operator Display	Code G8. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A22 - Steer Motor Current (Page 6-136)

https://truckmanualshub.com/

Code G9

Code Title	**Code G9 - No Drive Power When Travel Requested**
Reason	No B+ to the Electric Steer Manager.
System Response	
Alarm Sounds	Yes
Operator Display	Code G9. Inform Service
PC Contactor	Energized
Speed Limit	Hard plug until less than 1 mph (1.6 km/h), then apply brake.
How to Clear	Cycle key switch OFF/ON.
Tests to Run	Test A24 - ESM Battery Sense Voltage (Page 6-138)

https://truckmanualshub.com/

Code GA

NOTE: This fault code only applies to trucks with manual cable steering.

Code Title	**Code GA - Manual Steer Drive Unit Feedback Sensor Failure**
Reason	One proximity switch has not changed state when the other proximity switch has changed state 16 times while the truck was traveling.
System Response	
Alarm Sounds	No
Steering Display	Outside LEDs are illuminated.
PC Contactor	Energized
Speed Limit	• Below 24 in. (60 cm) - no speed limit • Above 24 in. (60 cm), below 60 in. (152 cm) - 2.5 mph (4.0 km/h) • Above 60 in. (152 cm), below 150 in. (381 cm) - 1 mph (1.6 km/h) • Above 150 in. (381 cm) - no travel permitted
How to Clear	Steer truck both to the left and to the right to clear fault code.
Tests to Run	Test I19A - Channel A, Steer Proximity Sensor 1 (Page 6-164) Test I20 - Channel B, Steer Proximity Sensor 2 (Page 6-166)

https://truckmanualshub.com/

Code J1

Code Title	**Code J1 - Aisle Entry Error**
Reason	The vehicle entry sensed one magnet when entering the guided aisle.
System Response	
Alarm Sounds	Yes
Operator Display	Code J1. Inform Service
Speed Limit	Hard plug to a stop, then maximum of 1.5 mph (2.4 km/h).
How to Clear	Back out of aisle and enter again.
Tests to Run	Test I25 - End of Aisle Sense, Sensor 2 (Page 6-171) Test I27 - End of Aisle Sense, Sensor 1 (Page 6-172)

https://truckmanualshub.com/

Code J2

Code Title	**Code J2 - Aisle Exit Error**
Reason	Only one magnet was sensed when the guided aisle was exited.
System Response	
Alarm Sounds	Yes
Operator Display	Code J2. Inform Service
Speed Limit	Decelerate to 0 mph
How to Clear	While out of the guided aisle, turn the auto/manual switch to manual. Turn the drive unit to an angle greater than 10° and travel until the fault code clears.
Tests to Run	Test I25 - End of Aisle Sense, Sensor 2 (Page 6-171) Test I27 - End of Aisle Sense, Sensor 1 (Page 6-172)

https://truckmanualshub.com/

Code J4

Code Title	**Code J4 - Aisle Sensor Not Present**
Reason	One of the aisle sensors is disconnected.
System Response	
Alarm Sounds	Yes
Operator Display	Code J4. Inform Service
Speed Limit	2.5 mph (4 km/h)
How to Clear	Connect or replace sensor.
Tests to Run	Test I25 - End of Aisle Sense, Sensor 2 (Page 6-171) Test I27 - End of Aisle Sense, Sensor 1 (Page 6-172)

https://truckmanualshub.com/

Code VC

Code Title	**Code VC - CAN Bus Off**
Reason	Communications between the Carriage Control Card and the Tractor Manager and/or Electric Steer Manager is intermittent.
System Response	
Alarm Sounds	Yes
Operator Display	Code VC. Inform Service
PC Contactor	De-energized
How to Clear	Replace VFC.
Tests to Run	None

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Analog Input Tests

A Diagnosis and Repair table is provided for most tests. If a test fails, refer to the Diagnosis and Repair table. Through the process of elimination, these tables provide the technician with a step-by-step approach to diagnosing a problem and the necessary corrective action. See the table below.

Example Diagnosis and Repair Table

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
This is the order in which the testing must be performed.	This column identifies the action(s) required (if any) before testing the circuit. If no instructions are given, all circuits should be connected. **Note: If something was disconnected in the prior step, reconnect it before performing the next step.** This column also identifies the required setting on the meter for this step.	Connection point for the Positive (+) meter lead.	Connection point for the Negative (–) meter lead.	The reading required to consider the step a success.	The next action to be performed if the **Expected Result**s are met.	The next action to be performed if the **Expected Result**s are ***not*** met.

NOTES:

1. Some tests require unplugging the TM from the Power Card. By removing the screws that secure the TM, the two cards can be slid apart and the truck powered back up for testing.
2. When testing at the VFC, a small socket from a pin kit can be used to slide over the wire sticking out the back side of the card.
3. Some Analog and Input tests tell you to run an Output test. This is used to activate the circuit being tested and you do not have to complete all the steps related to the Output test.

https://truckmanualshub.com/

Test A00 - Tractor Manager +12V Power Supply

This test measures the +12V power supply voltage.

Related messages, codes and tests

- Code FG - Tractor Manager +12V Power Supply Out-of-Range (Page 6-97)
- Code G1 - Electronic Steering Power Supply Out-of-Range (Page 6-101)
- Test A23 - Steer Controller Power Supply Voltage (Page 6-137)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The display should read 10.8-13V. If the voltage fluctuates more than 0.8V in 10 seconds, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+)Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	TP4 on TM	TP6 on TM	10.8-13V	Replace VFC	Perform step 2
2	JPS25-1 disconnected/DCV				Perform step 5	Perform step 3
3	PS12 disconnected/DCV				Perform step 7	Perform step 4
4	All 12V connectors on TM disconnected - one at a time. Test 12V after each one/ DCV				Replace TM	T/S circuit pulling down 12V
5	JPC11-1 disconnected/DCV				Perform step 6	Replace over-the-mast cable
6	All 12V connectors on CCC dis-connected - one at a time. Test 12V after each one/DCV	TP5 on CCC	TP2 on CCC		Replace CCC	T/S circuit pulling down 12V
7		TP4 on TM	TP6 on TM		Replace ESM	

https://truckmanualshub.com/

Test A01 - Armature Sense Voltage

This test displays the voltage the Tractor Manager (TM) reads from the current sensor (CT) on the Power Card (at JS3-4).

Related messages, codes and tests

- Code 21 - Short Detected In Main Transistor Circuit (Page 6-23)
- Code 23 - Open Detected In Main Transistor Circuit (Page 6-24)
- Code 24 - Main Transistor Current Sensor Circuit Not Responding (Page 6-25)
- Code 2B - Main Transistor Current Sensor Out-of-range (Page 6-30)

The current sensor continuously monitors the current flowing through the drive motor armature. The TM monitors this current, and adjusts its performance accordingly.

It is normal for the Power Card to go into current limit, particularly when accelerating. The Power Card's current limit threshold is preset at the factory and is not adjustable.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The Operator's Display (OD) displays the voltage the TM reads from the current sensor.

The value displayed should be within 5.7 and 6.3V with the lift truck at rest. The reading should remain steady, and should not fluctuate by more than 0.02V.

- During acceleration, the voltage should increase.
- During deceleration (REGEN), the voltage should decrease.

The voltage should increase 1V per 100A through the armature of the traction motor. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	TM disconnected from Power Card/DCV	B+	JS3-4	B+	Perform step 2	Replace TM
2	Run Test O14/DCV	JPS3-4	B–	Ramps from approx 6 to 9V	Perform step 3	Replace Power Card
3		JS1-B2 (VFC)		Ramps from approx 2.4 to 3.7V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test A02 - Temperature Sensor Voltage

This test displays the voltage the TM is reading from the HT temperature sensor that is threaded into the Power Transistor's heat sink through JS5-7.

A successful test proves the TM is properly reading the temperature sensor.

Related messages, codes and tests

- Code 1H - Power Panel Overheated (Page 6-16)
- Code 2C - Power Panel Temperature Sensor Out-of-range (Page 6-31)

While operating, the TM continually monitors the temperature of the heatsink. If the temperature reaches >158°F (70°C), performance is reduced until the heatsink cools down.

For example, to see a range of voltage (temperature) values, heat the truck up by driving it hard for 30 min, then run this test. The heat sink cools quite rapidly, and a significant change will be seen within 5 min.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The OD will display the voltage the System Card reads from the HT (temperature sensor).

The test is a success if the voltage displayed is within these limits:

Heat Sink Block	Voltage Displayed
Room temperature (70°F/21°C)	Approx 4V
Normal operation	4.0 to 5.8V
Hot	5.8 to 5.95V
Overheated (or JP2 disconnected)	>5.95V

If the reading is outside these limits, the test has failed.

With the temperature stable on the heatsink, if the reading fluctuates by more than 0.2V in 10 seconds, the test has failed. If the truck had just been operated aggressively just prior to this test, the reading will drop fairly quickly before leveling off.

Measure the voltage at JS5-7 wrt JS3-2 on the Power Card. The voltage should be the same as shown on the OD.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC1@Power Card disconnected/ Ohms	JC1-4	JC1-3	Approx 2K Ohms @ 70°F (21°C)	Perform step 2	T/S wires and sensor
2	JPC1@Power Card disconnected/DCV	PC1-4	PC1-3	OD; approx 11V, red overtemp LED ON Meter; approx 11V	Perform step 3	Replace Power Card
3		JPS5-7	B–	Approx 11V	Perform step 4	
4	DCV			Approx 3.8V @ 70°F (21°C)	Replace TM	

https://truckmanualshub.com/

Test A03 - Throttle Potentiometer Voltage

This test measures the voltage the CCC produces based on input from the throttle potentiometer (VR1).

Related messages, codes and tests

- Code 80 - Throttle Controller Reading Out-of-range (Page 6-60)

NOTE: LEARN mode should be run whenever the throttle assembly is replaced, repaired or adjusted.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Throttle Position	Voltage Displayed
Full forward position Tractor First (TF)	0.4-1.5V
Neutral position	2.0-3.0V
Full reverse position Forks First (FF)	3.5-4.6V

If the voltage reading is outside these limits or does not change in a smooth linear fashion, the test has failed. Any voltage fluctuation indicates a bad cable or VR1.

The voltage reading should decrease when the throttle is moved from the reverse to the forward position. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC9 disconnected/ DCV	JPC9-8	JPC9-7 (solid state)	5.3V	Perform step 2	Replace CCC
			JPC9-10 (non-solid state)			
2			JPC9-9		Perform step 3	
3	DCV	JPC9-9	JPC9-10	Neutral; 1.23-1.83V FF; increase TF; decrease	Replace CCC	Replace pot

https://truckmanualshub.com/

Test A04 - Lift/Lower Potentiometer Voltage

This test displays the voltage the CCC produces based on input from the lift/lower pot (VR2).

Related messages, codes and tests

- Code 81 - Lift Controller Reading Out-of-range (Page 6-61)

NOTE: Run this test if the voltage output by the lift/lower potentiometer (pot) exhibits problems.

NOTE: LEARN should be run whenever the lift/lower pot is replaced or repaired.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Lift/Lower Control Position	Voltage Displayed
Full lift position	0.4-1.5V
Neutral position	2.0-3.0V
Full lower position	3.5-4.6V

If the voltage reading is outside these limits, the test has failed.

The voltage reading should increase smoothly in a linear fashion (does not jump) when the lift/lower control is moved from the lift to the lower position. If these results are not observed, the test has failed. Any voltage fluctuation indicates a bad cable or VR2.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC9 disconnected/DCV	PC9-5	PC9-7 (non solid state) PC9-4 (solid state)	5.3V	Perform step 2	Replace CCC
2			PC9-6		Perform step 3	
3	DCV	JPC9-6	JPC9-7 (non solid state) JPC9-4 (solid state)	Neutral; 0.97-1.46V Lower; increase Lift; decrease	Replace CCC	Replace pot

https://truckmanualshub.com/

Test A05 - Pressure Sensor Voltage

This test displays the voltage the Steer Manager produces based on input from the pressure transducer (JPA5-2).

Related messages, codes and tests

- Code 6D - Lift Pressure Out-of-range (Page 6-54)

NOTE: LEARN mode should be run whenever the pressure transducer is replaced or wiring is repaired.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The OD will display the voltage the Electric Steer Manager (ESM) calculates from the pressure transducer (PRESS A).

Any reading greater than 4.8V on the OD is an immediate failure.

As the load on the forks increases, the voltage on the display decreases. Use the following as a reference when performing this test:

Without a load on the forks, the voltage displayed will be approximately 4.4V.

NOTE: This is approximate because the configuration of the truck and the weight of the operator will have a direct affect on the displayed value.

1000 lb. increase on the forks = 0.5V (approx) decrease on the OD

Use this basic rule of thumb: as the weight on the forks increases, the voltage displayed should decrease.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPA5 disconnected/DCV	PA5-1	PA5-2	Approx 11.5V	Perform step 2	Replace ESM
2			PA5-3		Perform step 3	
3	No weight on forks/DCV	JPA5-1	JPA5-2	Fully lowered; approx 10.5V Elevated 2 ft.; approx 0.5V less	Replace ESM	Replace transducer

https://truckmanualshub.com/

Test A07 - PC Sense Voltage

This test displays the voltage the TM produces based on input from the PC sense line. The PC sense line goes from the TM at JPS14-8 to P-1.

A successful test proves the TM is properly reading the battery voltage. It also proves the PC contactor is closing properly.

NOTE: This test does not verify that the contact tips on the PC contactor are good.

Related messages, codes and tests

- Code 44 - PC Contactor Detected Closed When Commanded Open (Page 6-39)
- Code 45 - PC Contactor Detected Open When Commanded Closed (Page 6-40)
- Test O00 - Toggle the PC Contactor (Page 6-192)

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Run Test O00 /DCV	JPS14-8	B–	Test ON; B+ Test OFF; approx 6V	Replace TM	T/S wires and contactor tips
2	If the test still fails, replace the VFC.					

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is 3.0 to 5.0V with the truck not moving or lifting.

If the reading is outside these limits or fluctuates by more than 0.5V in 10 seconds, the battery is in bad condition or the test has failed.

https://truckmanualshub.com/

Test A08 - Lift Motor Sense Voltage

This test displays the voltage the TM is producing based on input from the P Sense line (JPS14-7).

Related messages, codes and tests

- Code 42 - Lift Contactor Detected Closed When Commanded Open (Page 6-37)
- Code 43 - Lift Contactor Detected Open When Commanded Closed (Page 6-38)
- Test O02 - Toggle the P Contactor (Page 6-193)

NOTE: This test does not verify that the contact tips on the PC contactor are good.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

⚠ WARNING

Open the emergency lowering valve before performing this test.

The test is a success if the voltage displayed is within these limits:

P Contactor Open	P Contactor Closed
Less than 1.0V	Approx 3.8 to 4.8V

If the reading is outside these limits or fluctuates by more than 0.5V in 10 seconds, the test has failed.

1. Manually close the P contactor firmly. The pump will start but the carriage will not lift.
2. Use Static Maintenance Mode. If the reading fluctuates by more than 0.5V in 10 seconds, the test has failed. In Active Maintenance Mode, 3.8-4.8V should be displayed while the contactor is closed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Run Test O02/ DCV	JPS14-7	B–	Test ON; approx B+ minus 2V Test OFF; 0V	Perform step 2	T/S wires, FU6 and contactor tips
2		JS1-B3 (VFC)		Test ON; approx 4 to 6V Test OFF; 0V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test A10 - Display Q1-C Sense Voltage

This test displays the voltage produced by the TM based on input from JPS14-9 (Q1-C Sense).

Related messages, codes and tests

- Code 21 - Short Detected In Main Transistor Circuit (Page 6-23)
- Code 23 - Open Detected In Main Transistor Circuit (Page 6-24)
- Test O14 - Armature PWM Test (Page 6-205)

For information on how to use Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
All cables connected	3.8 to 5.0V

With the truck at rest, the reading should remain steady and not fluctuate by more than 0.2V. During Active Maintenance, the voltage on the OD should decrease as the speed of the truck increases.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Run Test O14/ DCV	JPS14-9	B–	Test ON; ramp B+ to B+ minus 6V Test OFF; approx 6V	Perform step 2	T/S wires, FU6 and contactor tips
2		JS1-B4 (VFC)		Test ON; ramp approx 3.9 to 3.5V Test OFF; approx 2.7V	Replace VFC	Replace TM

NOTE: A failure in the Q1-C Sense circuit will not prevent Test O14 from functioning. If Test O14 does not function, troubleshoot per the Diagnosis and Repair steps in Test O14.

https://truckmanualshub.com/

Test A11 - Display Battery Voltage

This test displays the voltage the TM VFC is reading from the battery sense line.

A successful test proves the TM is properly reading the battery sense line (B+PC) at JP14-10 & 11.

Related messages, codes and tests

- Code FH - Battery Voltage Out-of-Range (Page 6-98)

NOTE: This voltage is used by the TM VFC to calculate the battery state-of-charge.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

PC must be closed.	
Nominal Battery Voltage	**Voltage Displayed**
24V	22.0-26.0V
36V	33.0-39.0V

If the reading fluctuates by more than 0.8V in 10 seconds with the truck not moving or lifting, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	FU11 removed/ Ohms	Fuse	Fuse	0 Ohms	Perform step 2	Replace fuse. T/S circuit
2	Battery disconnected/ DCV	B+	B–	24V; 22-26V 36V; 33-39V	Perform step 3	Replace/charge battery
3	DCV	JPS14-10			Perform step 4	T/S wire
4		JPS14-11			Perform step 5	
5		FU11-2			Perform step 6	Test fuse: if OK, replace TM
6		JS1-A2 (on VFC)		Approx 2.6V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test A13 - Display the Diagnostic Pendant Voltage

This test displays the voltage the TM reads from the Diagnostic Pendant line.

A successful test proves the TM is properly reading JPS17-1.

Related messages, codes and tests

- Code FJ - Diagnostic Pendant Sense Line Voltage Out-of-Range (Page 6-99)

NOTE: JPS17-1 is used for factory test procedures. This test allows the voltage on the line to be displayed.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is between 3.75-4.25V, with nothing connected to JPS17.

If the reading fluctuates by more than 0.25V in 10 seconds, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	JS1-B1	B–	3.75-4.25V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test A14 - Display the Field Current Sense Voltage

This test displays the voltage the TM reads from RS1 (shunt) on the Power Card.

Related messages, codes and tests

- Code 25 - Short Detected In Field Circuit (H-bridge) (Page 6-26)
- Code 26 - Open Detected In Field Circuit (Page 6-27)
- Code 2D - Field Current Sensor Out-of-range (Page 6-32)

The current sensor continually monitors the current flowing through Power Transistors TM1 and TM2 in the Power Card. The Tractor Manager constantly monitors this current, and adjusts its performance accordingly.

The current sensor is dynamically tested for proper operation by SelfTest every time the key is turned ON. While monitoring the current sensor, the Tractor Manager sends a brief pulse of current through transistors TM1 and TM2 during start-up.

The Power Card will automatically limit the maximum current through TM1 and TM2. Whenever the field is in current limit by the Power Card, a green LED (IL1) may flash ON. The Power Card current limit threshold is preset at the factory and is not adjustable.

For information on how to use Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
All cables connected, truck at rest.	0.8-1.2V

With the truck at rest, the reading should remain steady, and should not fluctuate by more than 0.02V. In Active Maintenance, as the current through the fields increase, the voltage increases. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Run Test O13/DCV	JPS5-3	B–	Ramps from approx 1 to 3V	Perform step 3	Perform step 2
2	TM disconnected from Power Card/ DCV	B+	JS5-3	B+	Replace Power Card	Replace TM
3	Run Test O13/DCV	JS1-A4 (VFC)	B–	Ramps from approx 1 to 3V	Replace VFC	

https://truckmanualshub.com/

Test A15 - Display the Drive Motor Temperature Voltage

This test displays the voltage the TM produces based on input from the drive motor temperature sensor (DT).

A successful test proves the TM is properly reading the drive motor temperature sensor.

Related messages, codes and tests

- Code 20 - Temperature Sensor Circuits Not Responding (Page 6-22)
- Code 2A - Traction Motor Overheated (Page 6-29)
- Code 2E - Traction Motor Temperature Sensor Out-of-range (Page 6-33)

While operating, the TM continually monitors the temperature of the drive motor. If the temperature gets too high, performance is reduced until the motor cools down.

Use Active Maintenance to see a range of voltages from the temperature sensor. Heat the truck up by driving it hard for approximately 30 minutes. As the motor heats the voltage will increase. This voltage can be measured at JPS19-6 with respect to JPS19-7.

For information on how to use Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Traction Motor Case Temperature	Voltage Displayed
Cold; Room temperature	2.8-3.4V
Normal operation	3.4-4.35V
Hot	4.35-4.8V
Overheated	>4.9V
If the value on the display does not change when JPS19 is disconnected during static maintenance, exit Maintenance Mode. With JPS19 disconnected, re-enter Maintenance Mode. The value should be 5.0V.	

If the reading is outside these limits, the test has failed.

If the reading fluctuates by more than 0.2V in 10 seconds, the test has failed. If the truck had been operated aggressively just before this test, the reading will drop fairly quickly before leveling off.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPS19 disconnected/ Ohms	JS19-6	JS19-7	Approx 2K	Replace TM	T/S wires and sensor
2	If the test still fails, replace the VFC.					

https://truckmanualshub.com/

Wire Guidance Coil Tests

Figure 6-3 shows the location of the Wire Guidance Coils and their associated test.

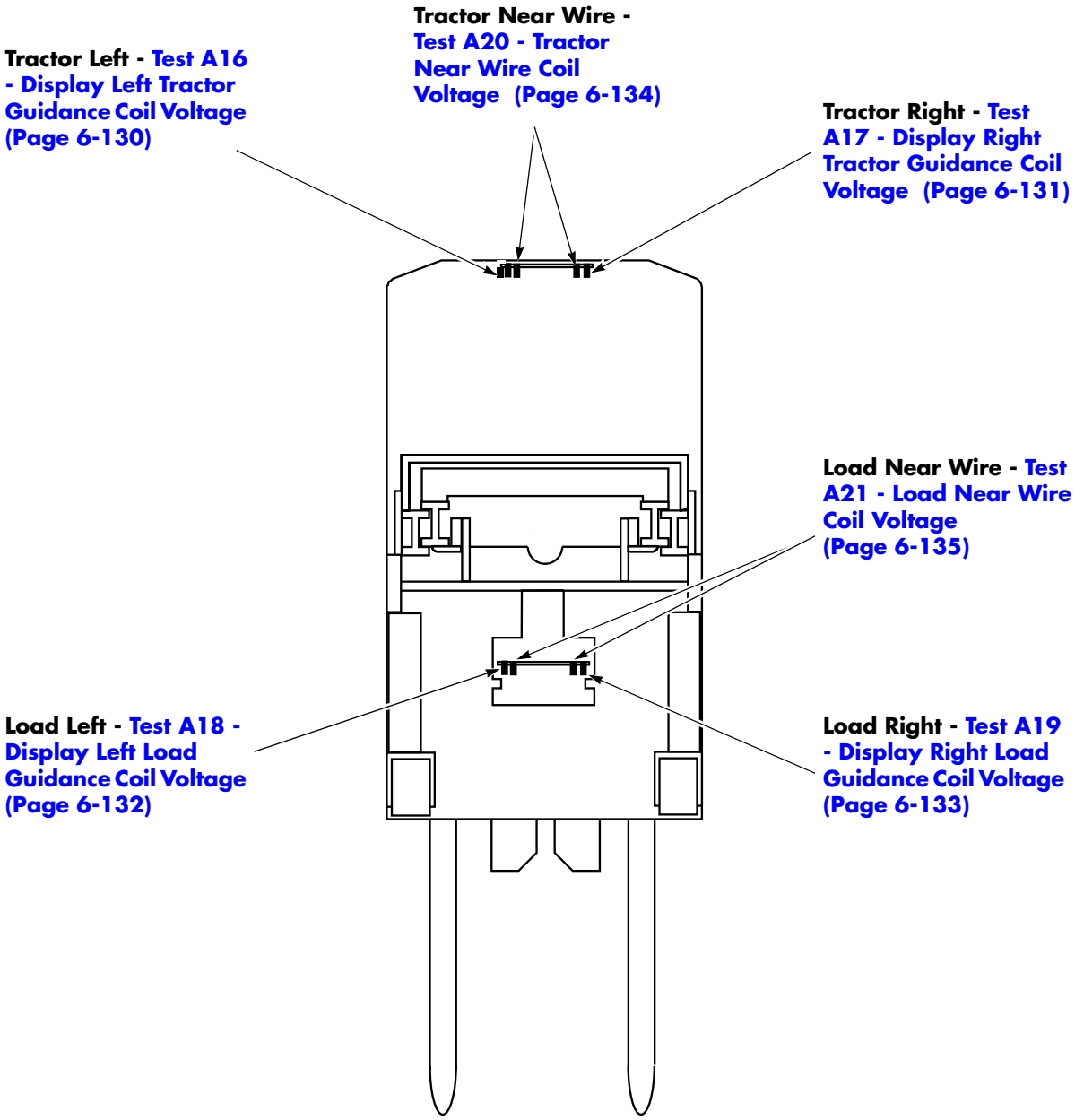


Figure 6-3. Location of Wire Guidance Coils and Related Tests

https://truckmanualshub.com/

Test A16 - Display Left Tractor Guidance Coil Voltage

This test displays the voltage of the left tractor guidance coil as sensed by the ESM.

Refer to Figure 6-3 on page 6-129 to determine which coil this test checks.

Related messages, codes and tests

- Code 92 - Tracking Limits Exceeded (Page 6-67)
- Code 93 - Not Near Wire - Tractor Coil Pair (Page 6-68)
- Code 9H - No Signal - Tractor Antenna (Page 6-74)

Make sure the truck is set to the proper frequency. If the frequency used is not standard, it must first be LEARNed. See LEARN Wire Frequency on page 3-16.

Test line driver output. Refer to Raymond Publication PDSS-0051.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
Truck centered on wire	0.83-2.17V
Truck not near wire	<0.5V

If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Cable dis-connected/ Ohms	JPW2-1 to 15	JP1T-1 to 15	0 Ohms	Perform step 2	Replace cable
2	JPW2 dis-connected/ DCV	PW2-15	PW2-14	Approx 11.5V	Perform step 4	Perform step 3
3	DCV	PA3-B1 Filter Card	PA3-B30 Filter Card		Replace Filter Card	Replace ESM
4	Bumper removed/ mVAC	JPW2-3	B–	Centered; 32mV 1.5 in. left; 15mV 1.5 in. right; 76mV	Perform step 5	Replace Antenna Card
5	Bumper removed/ DCV	PA3-A3 Filter Card		Centered; 1.1V 1.5 in. left; 0.6V 1.5 in. right; 2.8V	Replace ESM	Replace Filter Card

NOTE: Steps 4 & 5 are approximate readings. Floor settings will cause them to vary. If a similar change in values is seen, the test has passed.

https://truckmanualshub.com/

Test A17 - Display Right Tractor Guidance Coil Voltage

This test displays the voltage of the right tractor guidance coil as sensed by the ESM.

Refer to Figure 6-3 on page 6-129 to determine which coil this test checks.

Related messages, codes and tests

- Code 92 - Tracking Limits Exceeded (Page 6-67)
- Code 93 - Not Near Wire - Tractor Coil Pair (Page 6-68)
- Code 9H - No Signal - Tractor Antenna (Page 6-74)

Make sure the truck is set to the proper frequency. If the frequency used is not standard, it must first be LEARNed. See LEARN Wire Frequency on page 3-16.

Test line driver output. Refer to Raymond Publication PDSS-0051.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
Truck centered on wire	0.83-2.17V
Truck not near wire	<0.5V

If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Cable disconnected/ Ohms	JW2-1 to 15	J1T-1 to 15	0 Ohms	Perform step 2	Replace cable
2	JPW2 disconnected/ DCV	PW2-15	PW2-14	Approx 11.5V	Perform step 4	Perform step 3
3	DCV	PA3-B1 Filter Card	PA3-B30 Filter Card		Replace Filter Card	Replace ESM
4	Bumper removed/ mVAC	JPW2-1	B–	Centered; 32mV 1.5 in. left; 76mV 1.5 in. right; 15mV	Perform step 5	Replace Antenna Card
5	Bumper removed/ DCV	PA3-A8 Filter Card		Centered; 1.1V 1.5 in. left; 2.8V 1.5 in. right; 0.6V	Replace ESM	Replace Filter Card

NOTE: Steps 4 & 5 are approximate readings. Floor settings will cause them to vary. If a similar change in values is seen, the test has passed.

https://truckmanualshub.com/

Test A18 - Display Left Load Guidance Coil Voltage

This test displays the voltage of the left load guidance coil as sensed by the ESM.

Refer to Figure 6-3 on page 6-129 to determine which coil this test checks.

Related messages, codes and tests

- Code 91 - Drive Unit Turned Greater Than 10° While Guiding On Wire (Page 6-66)
- Code 92 - Tracking Limits Exceeded (Page 6-67)
- Code 94 - Not Near Wire - Load Coil Pair (Page 6-69)
- Code 9G - No Signal - Load Antenna (Page 6-73)

Make sure the truck is set to the proper frequency. If the frequency used is not standard, it must first be LEARNed. See LEARN Wire Frequency on page 3-16.

Test line driver output. Refer to Raymond Publication PDSS-0051.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
Truck centered on wire	0.83-2.17V
Truck not near wire	<0.5V

If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Cable dis-connected/ Ohms	JW1-1 to 15	J1L-1 to 15	0 Ohms	Perform step 2	Replace cable
2	JPW1 dis-connected/ DCV	PW1-15	PW1-14	Approx 11.5V	Perform step 4	Perform step 3
3	DCV	PA3-B1 Filter Card	PA3-B30 Filter Card		Replace Filter Card	Replace ESM
4	Sensor removed/ mVAC	JPW1-3	B–	Centered; 32mV 1.5 in. left; 15mV 1.5 in. right; 76mV	Perform step 5	Replace Antenna Card
5	Sensor removed/ DCV	PA3-A4 Filter Card		Centered; 1.1V 1.5 in. left; 0.6V 1.5 in. right; 2.8V	Replace ESM	Replace Filter Card

NOTE: Steps 4 & 5 are approximate readings. Floor settings will cause them to vary. If a similar change in values is seen, the test has passed.

https://truckmanualshub.com/

Test A19 - Display Right Load Guidance Coil Voltage

This test displays the voltage of the right load guidance coil as sensed by the ESM.

Refer to Figure 6-3 on page 6-129 to determine which coil this test checks.

Related messages, codes and tests

- Code 91 - Drive Unit Turned Greater Than 10° While Guiding On Wire (Page 6-66)
- Code 92 - Tracking Limits Exceeded (Page 6-67)
- Code 93 - Not Near Wire - Tractor Coil Pair (Page 6-68)
- Code 9G - No Signal - Load Antenna (Page 6-73)

Make sure the truck is set to the proper frequency. If the frequency used is not standard, it must first be LEARNed. See LEARN Wire Frequency on page 3-16.

Test line driver output. Refer to Raymond Publication PDSS-0051.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
Truck centered on wire	0.83-2.17V
Truck not near wire	<0.5V

If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Cable dis-connected/ Ohms	JW1-1 to 15	J1L-1 to 15	0 Ohms	Perform step 2	Replace cable
2	JPW1 dis-connected/ DCV	PW1-15	PW1-14	Approx 11.5V	Perform step 4	Perform step 3
3	DCV	PA3-B1 Filter Card	PA3-B30 Filter Card		Replace Filter Card	Replace ESM
4	Sensor removed/ mVAC	JPW1-1	B–	Centered; 32mV 1.5 in. left; 76mV 1.5 in. right; 15mV	Perform step 5	Replace Antenna Card
5	Sensor removed/ DCV	PA3-A14 Filter Card		Centered; 1.1V 1.5 in. left; 2.8V 1.5 in. right; 0.6V	Replace ESM	Replace Filter Card

NOTE: Steps 4 & 5 are approximate readings. Floor settings will cause them to vary. If a similar change in values is seen, the test has passed.

https://truckmanualshub.com/

Test A20 - Tractor Near Wire Coil Voltage

This test displays the voltage of the tractor near wire guidance coil voltage as sensed by the ESM.

Refer to Figure 6-3 on page 6-129 to determine which coil this test checks.

Related messages, codes and tests

- Code 9H - No Signal - Tractor Antenna (Page 6-74)
- Code 9K - Tractor Antenna Signal Too High (Page 6-76)

Make sure the truck is set to the proper frequency. If the frequency used is not standard, it must first be LEARNed. See LEARN Wire Frequency on page 3-16.

Test line driver output. Refer to Raymond Publication PDSS-0051.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
Truck centered on wire	1.44-3.01V
Truck not near wire	<0.5V

If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Cable dis-connected/ Ohms	JW2-1 to 15	J1T-1 to 15	0 Ohms	Perform step 2	Replace cable
2	JPW2 dis-connected/ DCV	PW2-15	PW2-14	Approx 11.5V	Perform step 4	Perform step 3
3	DCV	PA3-B1 Filter Card	PA3-B30 Filter Card		Replace Filter Card	Replace ESM
4	Bumper removed/ mVAC	JPW2-2	B–	Centered; 70mV 1.5 in. left; 100mV 1.5 in. right; 100mV	Perform step 5	Replace Antenna Card
5	Bumper removed/ DCV	PA3-A9 Filter Card		Centered; 2.5V 1.5 in. left; 3.7V 1.5 in. right; 3.7V	Replace ESM	Replace Filter Card

NOTE: Steps 4 & 5 are approximate readings. Floor settings will cause them to vary. If a similar change in values is seen, the test has passed.

https://truckmanualshub.com/

Test A21 - Load Near Wire Coil Voltage

This test displays the voltage of the load near wire guidance coil voltage as sensed by the ESM.

Refer to Figure 6-3 on page 6-129 to determine which coil this test checks.

Related messages, codes and tests

- Code 9H - No Signal - Tractor Antenna (Page 6-74)
- Code 9K - Tractor Antenna Signal Too High (Page 6-76)

Make sure the truck is set to the proper frequency. If the frequency used is not standard, it must first be LEARNed. See LEARN Wire Frequency on page 3-16.

Test line driver output. Refer to Raymond Publication PDSS-0051.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
Truck centered on wire	1.44-3.01V
Truck not near wire	<0.5V

If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Cable dis-connected/ Ohms	JW1-1 to 15	J1L-1 to 15	0 Ohms	Perform step 2	Replace cable
2	JPW2 dis-connected/ DCV	PW1-15	PW1-14	Approx 11.5V	Perform step 4	Perform step 3
3	DCV	PA3-B1 Filter Card	PA3-B30 Filter Card		Replace Filter Card	Replace ESM
4	Sensor removed/ mVAC	JPW1-2	B–	Centered; 70mV 1.5 in. left; 100mV 1.5 in. right; 100mV	Perform step 5	Replace Antenna Card
5	Sensor removed/ DCV	PA3-A13 Filter Card		Centered; 2.5V 1.5 in. left; 3.7V 1.5 in. right; 3.7V	Replace ESM	Replace Filter Card

NOTE: Steps 4 & 5 are approximate readings. Floor settings will cause them to vary. If a similar change in values is seen, the test has passed.

https://truckmanualshub.com/

Test A22 - Steer Motor Current

This test displays the steer motor current as sensed by the ESM.

A successful test proves the ESM is properly reading the steer motor current reading.

Related messages, codes and tests

- Code G3 - No Steer Encoder Signal Or No Home Sensor Input (Page 6-103)
- Code G4 - Open Detected In Steer Power Circuit (Page 6-104)
- Code G5 - Short Detected In Steer Power Circuit (Page 6-105)
- Code G8 - Amplifier Current Out-of-Range (Page 6-107)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run Test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Current	Voltage Displayed
None required	0.0 to 60A	Approx 3.5V

If the readings are within range, enter Active Maintenance and run this test with the drive tire on the floor.

If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Test ON	N/A	N/A	3.5V	N/A	Check for B– from the Power Card. If OK, replace ESM

https://truckmanualshub.com/

Test A23 - Steer Controller Power Supply Voltage

This test displays the steer controller power supply voltage (+12V) as sensed by the ESM at JPA2-9.

A successful test proves the ESM is properly reading the steer controller power supply voltage.

Related messages, codes and tests

- Code G1 - Electronic Steering Power Supply Out-of-Range (Page 6-101)
- Test A00 - Tractor Manager +12V Power Supply (Page 6-116)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
None required	11.0-13.0V

If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPA2 disconnected /DCV	PA2-9	PA2-5	Approx 12V	Perform step 3	Perform step 2
2	PS17 disconnected /DCV	JS17-9	JS17-5		Replace cable to ESM	T/S using Test A00
3	Disconnect all devices using 12V - one at a time/DCV	TP2 on ESM	B–	Check for return of 12V after disconnecting each device	T/S circuit pulling down the 12V	Replace ESM

https://truckmanualshub.com/

Test A24 - ESM Battery Sense Voltage

This test displays the voltage the ESM senses at SMB+.

A successful test proves the ESM is properly reading the battery voltage sense line.

Related messages, codes and tests

- Code G9 - No Drive Power When Travel Requested (Page 6-108)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the voltage displayed is within these limits:

Test Setup	Voltage Displayed
PC Closed	4.74 to 5.25V
PC Open	0.0 to 0.25V

If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	SMB+	B–	B+	Replace the ESM	Repair/replace SMB+ cable to Power Card

https://truckmanualshub.com/

Test A25 - Flow Sensor Temperature Voltage

This test displays the flow sensor temperature voltage as sensed by the ESM at JPA1-4.

A successful test proves the ESM is properly reading the flow sensor temperature voltage.

Related messages, codes and tests

- Code 6N - Flow Sensor Temperature Out-of-range (Page 6-58)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The test is a success if the current displayed is within these limits:

Test Setup None required.	Voltage Displayed
Allowable range	0.2-4.86V
Sensor at room temperature (@86°F/30°C)	3.15-3.20V

The voltage increases as the temperature increases. If the reading is outside these limits, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPY dis-connected/ Ohms	JY2-1	JY2-2	2K @ 70°F (21°C)	Perform step 2	Replace sensor
2	DCV	PA1-5	PA1-3	Approx 12V	Perform step 3	Replace ESM
3		JY1-5	JY1-3		Perform step 4	Repair/replace wiring
4		B+	JPY2-1	B+	Perform step 5	Replace flow module
5		JPY2-2		5.5V @ 70°F (21°C)	Perform step 6	
6		JPY1-4	B–	Approx 2.5V	Perform step 7	
7		JPA1-4			Replace ESM	Repair/replace wiring

https://truckmanualshub.com/

Test A27 - Maximum Drive Unit Rotation

Not used.

https://truckmanualshub.com/

Test A31 - Average Distance From Wire

Not used.

https://truckmanualshub.com/

Test A32 - Peak Distance From Wire

Not used.

https://truckmanualshub.com/

Test A33 - Average Heading Angle Magnitude

Not used.

https://truckmanualshub.com/

Test A34 - Peak Heading Angle

Not used.

https://truckmanualshub.com/

Test A35 - Average Guide Wire Signal Strength

Not used.

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Digital Input Tests

A Diagnosis and Repair table is provided for most tests. If a test fails, refer to the Diagnosis and Repair table. Through the process of elimination, these tables provide the technician with a step-by-step approach to diagnosing a problem and the necessary corrective action. See the table below.

Example Diagnosis and Repair Table

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
This is the order in which the testing must be performed.	This column identifies the action(s) required (if any) before testing the circuit. If no instructions are given, all circuits should be connected. **Note: If something was disconnected in the prior step, reconnect it before performing the next step.** This column also identifies the required setting on the meter for this step.	Connection point for the Positive (+) meter lead.	Connection point for the Negative (–) meter lead.	The reading required to consider the step a success.	The next action to be performed if the **Expected Result**s are met.	The next action to be performed if the **Expected Result**s are ***not*** met.

NOTES:

1. Some tests require unplugging the TM from the Power Card. By removing the screws that secure the TM, the two cards can be slid apart and the truck powered back up for testing.
2. When testing at the VFC, a small socket from a pin kit can be used to slide over the wire sticking out the back side of the card.
3. Some Analog and Input tests tell you to run an Output test. This is used to activate the circuit being tested and you do not have to complete all the steps related to the Output test.

https://truckmanualshub.com/

Test I00 - Lower Mast Reference Switch

This test monitors the state of the lower mast reference switch. This test displays what the Carriage Control Card (CCC) is reading from the switch.

Related messages, codes and tests

- Code 63 - Upper And Lower Reference Switches Do Not Agree (Page 6-50)
- Code 67 - Calculated Height Does Not Match At Lower Reference Switch (Page 6-53)
- Code 6K - 60 in. Switch Does Not Agree With The Lower Mast Reference Switch (Page 6-55)
- Code 6M - 60 in. And/Or Lower Reference Switch Disconnected (Page 6-57)
- Test I36 - 24 in./60 in. Switch Sense (Page 6-180)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Carriage Height	Switch Actuator	Operator's Display
Below 24 in. (61 cm)	Depressed	**Belw**
Above 24 in. (61 cm)	Released	**Abov**

If these results are not observed, the test has failed.

Use Active Maintenance to check that the display indicates the lower mast reference switch is **Belw** at all positions below 24 in. (61 cm). Check that the display indicates the 24 in. (61 cm) switch is **Abov** at all positions above 24 in. (61 cm).

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	S11-1	S11-3	6-12V	Perform step 3	Perform step 2
2		JPC8-2	JPC8-3	6-12V	Repair/replace wires	Replace CCC
3		S11-1	S11-2	Closed; 6-12V Open; 0 to –3V	Perform step 4	Adjust/replace S11
4		JPC8-2	JPC8-1	S11 Closed; 6-12V Open; 0 to –3V	Replace CCC	Repair/replace wires

https://truckmanualshub.com/

Test I01 - Upper Mast Reference Switch

This test monitors the state of the upper mast reference switch. This test shows what the Tractor Manager (TM) is reading from the upper mast reference switch at JPS8-1. A successful test proves the TM is correctly reading the upper mast reference switch.

Related messages, codes and tests

- Code 63 - Upper And Lower Reference Switches Do Not Agree (Page 6-50)
- Code 66 - Calculated Height Does Not Match At Upper Reference Switch (Page 6-52)
- Code 6L - Upper Reference Switch Disconnected (Page 6-56)
- Code 6P - 60 in. Limit Switch Is Out Of Sequence With The Upper Mast Reference Switch (Page 6-59)
- Test I37 - Upper Reference Switch Sense (S10) (Page 6-181)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Carriage Height	Switch Actuator	Operator's Display
Below Upper Reference Switch	Depressed	**Belw**
Above Upper Reference Switch	Released	**Abov**

If these results are not observed, the test has failed.

Use Active Maintenance to check that the display indicates the upper reference switch is closed at all positions below the upper reference switch. Check that the display indicates the upper reference switch is not closed at all positions above upper reference switch.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	S10-1	S10-3	6-12V	Perform step 3	Perform step 2
2		JPS8-2	JPS8-3		Repair/replace wires	Replace TM
3		S10-1	S10-2	Closed; 6-12V Open; 0 to –3V	Perform step 4	Adjust/replace S10
4		JPS8-2	JPS8-1	S10 Closed; 6-12V Open; 0 to –3V	Replace VFC	Repair/replace wires
5		JS1-A27	B–	S10 Closed; 0V Open; 5.3V		Replace TM

https://truckmanualshub.com/

Test I03 - Brake Deadman Switch (S2)

Run Test I32 - Brake Deadman Signal to Tractor Manager (Page 6-176).

https://truckmanualshub.com/

Test I04 - EPO Switch

This test monitors the state of the Emergency Power Off (EPO) switch. A successful test proves the CCC is correctly reading the EPO switch.

Related messages, codes and tests

- Code 1L - Emergency Power Off Switch Pressed (Page 6-18)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Emergency Off Button	Operator's Display
Out	**Out**
In	**In**

If these results are not observed, the test has failed.

NOTE: If Code IL is present, troubleshoot per the table below even if the test passes.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	B+	JPC16-4	B+	Perform step 2	Repair/replace over-the-mast cable
2		JPC6-4	B–		Perform step 3	Replace CCC
3		JPC6-3			Perform step 4	Repair/replace wires or switch
4		JPC16-1			Perform step 5	Replace CCC
5		JPS26-1			Perform step 6	Replace over-the-mast cable
6		JS2-A17 (VFC)		EPO switch Open; 4.4V Closed; 0V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I05 - Display Speed Feedback Proximity Sensor Value

Run Test I29 - Speed Feedback Proximity Sensor, Channel A (Page 6-173) and Test I30 - Speed Feedback Proximity Sensor, Channel B (Page 6-174).

https://truckmanualshub.com/

Test I06 - Display Current Limit Signal

This test monitors the Current Limit signal from the Power Card. A successful test proves the TM is correctly reading the Current Limit signal.

Related messages, codes and tests

- Code 24 - Main Transistor Current Sensor Circuit Not Responding (Page 6-25)
- Test A01 - Armature Sense Voltage (Page 6-117)

The Power Card sends two indications of transistor current to the TM:

- An analog Current Sense signal at JS3-4

  and
- A digital Current Limit signal at JS5-1

This test allows the Current Limit signal to be checked.

Refer to Test A01 - Armature Sense Voltage (Page 6-117) to check the Current Sense signal. The green LED (IL2) on the Power Card will be illuminated whenever the Current Limit signal is active.

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

During static testing, the display should show **No**. If **Yes** is displayed, the test has failed.

Run Test O14. The green LED should be off until maximum ramp is reached.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–)Lead	Expected Results	Step Passed	Step Failed
1	Run Test O14/DCV	JPS5-1	B–	>10V quickly drops to approx 9V when current limit activates	Perform step 3	Perform step 2
2	TM dis-connected from Power Card/DCV	JS5-1		Key ON; 11V	Replace Power Card	Replace TM
3	Run Test O14/DCV	JS2-B16 (on VFC)		Test ON; 5.3V drops to <4V when current limit activates Test OFF; approx 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I07 - Display Temperature Limit Signal

Using this test, the Temperature Limit signal from the Power Card can be monitored. A successful test proves the TM is correctly reading the Temperature Limit signal.

Related messages, codes and tests

- Code 20 - Temperature Sensor Circuits Not Responding (Page 6-22)
- Code 2C - Power Panel Temperature Sensor Out-of-range (Page 6-31)

The Power Card sends two indications of power panel temperature to the TM:

- An analog Temperature Sense signal at JS5-7
- A digital Temperature Limit signal at JS5-2

This test allows the Temperature Limit signal to be checked.

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

When the sensor is below the maximum temperature, the display should show **No**. If **Yes** is displayed, the test has failed.

⚠CAUTION

Turn power OFF before removing any connections. Failing to do so can ruin the Power Card.

The Temperature Limit signal can be activated by unplugging JP2 from HT (heatsink thermister). The display should now show **Yes**. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–)Lead	Expected Results	Step Passed	Step Failed
1	JPC1 @ Power Card disconnected/ Ohms	JC1-4	JC1-3	Approx 2.1K @ 70°F (21°C)	Perform step 2	Troubleshoot wires and sensor
2	DCV	JPS5-2	B–	JP2 disconnected; <5V connected; approx 11V	Perform step 4	Voltage present but does not change; replace Power Card. No voltage present; Perform step 3
3	TM dis-connected from Power Card/DCV	JS5-2		Key ON; approx 11V	Replace Power Card	Replace TM
4	DCV	JS2-B23 (VFC)		JP2 disconnected; 0V connected; 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I08 - Rail Guidance Switch

NOTE: This test applies to trucks equipped with rail guidance.

Using this test, the state of the rail guidance switch (S15) can be verified.

Related messages, codes and tests

None.

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Rail Guidance Switch (S15)	Operator's Display
Depressed	**On**
Released	**Off**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	S15-1	S15-3	10.7-13V	Perform step 3	Perform step 2
2		JPS13-2	JPS13-3		Repair/replace wires	Replace TM
3		S15-1	S15-2	S15 closed; 10.7-13V open; <1V	Perform step 4	Test cable for short S15-2 to S15-3; if OK, adjust/replace S15
4		JPS13-2	JPS13-1		Perform step 5	Repair/replace wires
5		JS2-A24 (VFC)	B–	S15 closed; 0V open; 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I10 - Display Flow Sensor Count

NOTE: This test applies to trucks equipped with the *intellispeed*™ option.

This test displays the flow sensor pulses which the ESM reads. A successful test proves the ESM is correctly reading pulses from the flow sensor.

Related messages, codes and tests

- Code 64 - No Flow Sensor Pulses When Lift/Lower Requested (Page 6-51)
- Code 66 - Calculated Height Does Not Match At Upper Reference Switch (Page 6-52)
- Code 67 - Calculated Height Does Not Match At Lower Reference Switch (Page 6-53)

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

A three digit number is displayed representing the number of flow pulses counted. When the count exceeds 255, it starts over at 0. If the count goes below 0, it starts over at 255.

Place test in Active Maintenance. The count should increase during lift and decrease during lower. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Ohms	JPY7-1	J21-1	0 Ohms	Perform step 2	Repair/replace wires
2		JPY7-2	J21-2		Perform step 3	
3		JPY6-1	J22-1		Perform step 4	
4		JPY6-2	J22-2		Perform step 5	
5	JPY1 dis-connected/ DCV	JPA1-5	JPA1-3	12V	Perform step 6	Replace ESM
6		JPY1-5	JPY1-3		Perform step 7	Repair/replace wires
7	DCV	JPY7-1	JPY7-3	2.6V	Perform step 8	Replace Flow Sensor Module
8		JPY6-1	JPY6-3		Perform step 9	
9	Lift or Lower/ mVAC	JPY7-2	JPY7-3	At rest; <2mV Lift/Lower: Ramps from approx 0 to between 200 and 300mV as speed increases	Perform step 10	Clean or replace Flow Sensor
10		JPY6- 2	JPY6-3		Perform step 11	
11	Lift or Lower/ DCV	JPY1-1	B–	At rest; 0 or 5V Lift/Lower; approx 2.8V	Perform step 12	Replace Flow Sensor Module
12		JPY1-2			Perform step 13	
13		JPA1-1			Perform step 14	Repair/replace wires
14		JPA1-2			Replace ESM	

https://truckmanualshub.com/

Test I11 - Display Auto/Manual Switch

This test displays the position of the AUTO/MANUAL switch. A successful test proves the CCC is correctly reading the AUTO/MANUAL switch.

Related messages, codes and tests

None.

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Switch Position	Operator's Display
O (open)	**Auto**
| (closed)	**Manual**

If these results are not observed, the test has failed.

NOTE: If the wire between the AUTO/MANUAL switch and the CCC becomes disconnected, the system defaults to AUTO.

Operation of the AUTO/MANUAL switch and CCC can also be checked by observing the green triangles on the display. The green triangles should illuminate when the switch is in AUTO and extinguish when the switch is in MANUAL.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC9 dis-connected/ Ohms	JC9-1	JC9-2	Auto; open circuit Manual; 0 ohms	Replace CCC	Troubleshoot wires and switch

https://truckmanualshub.com/

Test I13 -Horn Switch

This test checks the input from the horn switch (S3) to the CCC at JPC9-3 and JPC9-4.

Related messages, codes and tests

- Test O07 - Toggle Horn (Page 6-197)

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Horn Switch Position	Operator's Display
Out	**Off**
Depressed	**On**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC9 disconnected/ Ohms	JC9-3	JC9-4	Released; open circuit Depressed; 0 ohms	Replace CCC	T/S wires and switch

https://truckmanualshub.com/

Test I14 - Sidegate Switches

Using this test, the state of the sidegate switches (S60, S61) can be tested. This test displays what the CCC is reading from the switch. This test will only work on trucks equipped with the sidegate switch option.

Related messages, codes and tests

- Lower Side Gate (Page 6-15)

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

The state of the sidegate switch is displayed. Both sidegates must be down for the display to change states.

Sidegates	Operator's Display
One sidegate up	**Up**
Both sidegates up	**Up**
Both sidegates down	**Down**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
Switch S60						
1	DCV	S60-1	S60-3	10.7-13V	Perform step 3	Perform step 2
2		JPC14-2	JPC14-3		Repair/replace wires	Replace CCC
3		S60-1	S60-2	S60 closed; 6-12V open; 1V	Perform step 4	Test cable for short S60-2 to S60-3; if OK, adjust/replace S60
4		JPC14-2	JPC14-1		Replace CCC	Repair/replace wires
Switch S61						
1	DCV	S61-1	S61-3	10.7-13V	Perform step 3	Perform step 2
2		JPC13-2	JPC13-3		Repair/replace wires	Replace CCC
3		S61-1	S61-2	S61 closed; 6-12V open; 1V	Perform step 4	Test cable for short S61-2 to S61-3; if OK, adjust/replace S61
4		JPC13-2	JPC13-1		Replace CCC	Repair/replace wires

https://truckmanualshub.com/

Test I15 - Lift Inhibit Switch (S24)

Using this test, the state of the lift inhibit switch (S24) can be monitored. This test displays what the TM is reading from the switch. This test will only work on trucks equipped with the lift inhibit option.

Related messages, codes and tests

- Test I17 - Lift/Lower Inhibit Bypass (S7) (Page 6-162)

For information on using Maintenance Mode, refer to page 3-19.

Run test:

When the test is run, observe the following results:

Operator's Carriage	Operator's Display
Below Switch (closed)	**Belw**
Above Switch (open)	**Abov**

If these results are not observed, the test has failed.

NOTE: If test passes, make sure Maintenance Minder has not been activated.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	S24-1	S24-3	10.7-13V	Perform step 3	Perform step 2
2		JPS10-2	JPS10-3		Repair/replace wires	Replace TM
3		S24-1	S24-2	S24 closed; 6-12V open; 1V	Perform step 4	Test cable for short S24-2 to S24-3; if OK, adjust/replace S24
4		JPS10-2	JPS10-1		Perform step 5	Repair/replace wires
5		JS1-B27 (VFC)	B–	S24 closed; 0V open; 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I16 - Travel Cutout Switch (S27)

Using this test, the state of the travel cutout switch (S27) can be monitored. This test displays what the TM is reading from the switch. This test will only work on trucks equipped with the travel cutout option.

Related messages, codes and tests

None.

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

When the test is run, observe the following results.

Carriage Position with respect to S27	Operator's Display
Below	**Belw**
Above	**Abov**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	S27-1	S27-3	10.7-13V	Perform step 3	Perform step 2
2		JPS16-2	JPS16-3		Repair/replace wires	Replace TM
3		S27-1	S27-2	S27 closed; 6-12V open; <1.5V	Perform step 4	Test cable for short S27-2 to S27-3; if OK, adjust/replace S27
4		JPS16-2	JPS16-1		Perform step 5	Repair/replace wires
5		JS2-A22 (VFC)	B–	S27 closed; 0V open; 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I17 - Lift/Lower Inhibit Bypass (S7)

Using this test, the state of the lift inhibit bypass switch (S7) can be tested. This test displays what the CCC is reading from the switch. This test will only be visible on trucks equipped with the Lift/Lower inhibit bypass option.

Related messages, codes and tests

- Test I15 - Lift Inhibit Switch (S24) (Page 6-160)
- Test I35 - Lower Inhibit Switch (S25) (Page 6-179)

For information on using Maintenance Mode, refer to page 3-19.

Run test:

When the test is run, observe the following results.

Lift Inhibit Switch (S7)	Operator's Display
Up	**Up**
Held Depressed	**Down**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC6 dis-connected/ Ohms	JC6-6	JC6-5	Released; open circuit Depressed; 0 ohms	Replace CCC	T/S wires and switch

https://truckmanualshub.com/

Test I18 - 60 in. Limit Switch (S28)

Using this test, the state of the 60 in. switch can be monitored. This test displays what the CCC is reading from the switch.

Related messages, codes and tests

- Code 6K - 60 in. Switch Does Not Agree With The Lower Mast Reference Switch (Page 6-55)
- Code 6M - 60 in. And/Or Lower Reference Switch Disconnected (Page 6-57)
- Code 6P - 60 in. Limit Switch Is Out Of Sequence With The Upper Mast Reference Switch (Page 6-59)

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Carriage Height	Switch	Operator's Display
Below 60 in.	Depressed	**Belw**
Above 60 in.	Extended	**Abov**

If these results are not observed, the test has failed.

Using Active Maintenance, check that the display indicates the 60 in. switch is **Belw** at all positions below 60 in. Check that the display indicates **Abov** for all positions above the 60 in. switch.

Trucks without S28 require a jumper (P/N 114-008-958/002) between JPC3-2 and JPC3-1.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	S28-1	S28-3	6-12V	Perform step 3	Perform step 2
2		JPC3-2	JPC3-3		Repair/replace wires	Replace CCC
3		S28-1	S28-2	S28 closed; 6-12V open; 0 to –3V	Perform step 4	Test cable for short S28-2 to S28-3; if OK, adjust/replace S28
4		JPC3-2	JPC3-1		Replace CCC	Repair/replace wires

https://truckmanualshub.com/

Test I19A - Channel A, Steer Proximity Sensor 1

NOTE: This test applies to trucks below S/N 31,000 with mechanical steering.

This test monitors input from Steer Prox 1 to the TM.

Related messages, codes and tests

- Code GA - Manual Steer Drive Unit Feedback Sensor Failure (Page 6-109)
- Test I20 - Channel B, Steer Proximity Sensor 2 (Page 6-166)

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Sensor Over Metal	Operator's Display
Yes	**On**
No	**Off**

If these results are not observed, the test has failed.

NOTE: If the test fails in Active Maintenance, pass a screwdriver or metal ruler under the sensor to activate it. If the test passes, adjust the switch. See "Proximity Sensor Adjustment" on page 7-23.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	JPS7-2	JPS7-3	Approx 12V	Perform step 2	Replace TM
2		JPS7-2	JPS7-1	Over metal; approx 12V No metal; 0V	Perform step 3	Replace sensor
3		JS1-A21	B–	Over metal; 0V No metal; 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I19B - Pressure Switch

NOTE: This test applies to 24V trucks, S/Ns 31,000 and up, equipped with the High Performance Lift (Hi Pro) option (*except trucks with EE option*).

This test checks the input from the pressure switch (PRESS SW1) to the TM at JPS7-1 and JPS7-3.

Related messages, codes and tests

None.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Weight	Switch Position	Operator's Display
Greater than 1000 lb.	Open	**Off**
Less than 1000 lb.	Closed	**On**

If these results are not observed, the test has failed.

NOTE: If the test fails in Active Maintenance, make sure the pressure switch is set per "Pressure Switch Adjustment" on page 7-73.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Ohms	JPS7-1	JPS7-3	0 lb on forks; 0 ohms 1000 lb; open circuit	Perform step 2	Test wires, adjust/replace pressure switch (see "Pressure Switch Adjustment" on page -73)
2	DCV	JS1-A21	B–	0 lb on forks; 0V 1000 lb; 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I20 - Channel B, Steer Proximity Sensor 2

NOTE: This test applies to trucks below S/N 31,000 with mechanical steering.

This test monitors input from Steer Prox 2 to the TM.

Related messages, codes and tests

- Code GA - Manual Steer Drive Unit Feedback Sensor Failure (Page 6-109)
- Test I19A - Channel A, Steer Proximity Sensor 1 (Page 6-164)

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Sensor Over Metal	Operator's Display
Yes	**On**
No	**Off**

If these results are not observed, the test has failed.

NOTE: If the test fails in Active Maintenance, pass a screwdriver or metal ruler under the sensor to activate it. If the test passes, adjust the switch. See "Proximity Sensor Adjustment" on page 7-23.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	JPS9-2	JPS9-3	Approx 12V	Perform step 2	Replace TM
2		JPS9-2	JPS9-1	Over metal; approx 12V No metal; 0V	Perform step 3	Replace sensor
3		JS1-B25	B–	Over metal; 0V No metal; 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I21 - Steer Motor Current Limit

This test shows if the steer motor is in Current Limit. Current Limit for the steer motor is monitored by the Electric Steer Manager.

Related messages, codes and tests

None.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Steer Motor in Current Limit	Operator's Display
Yes	**Yes**
No	**No**

If these results are not observed, the test has failed.

Diagnosis and Repair

Replace the ESM.

https://truckmanualshub.com/

Test I22 - Steer Position Encoder Count

This test displays the value which the ESM sees from the Steer Position Encoder at JPA8. A successful test proves the ESM is reading the encoder properly.

The ESM uses the input from the Steer Position Encoder to determine the rate and direction of steering. The displayed number will vary between 0 and 255. The value has little correlation to the actual steering angle. The displayed value should change as the drive unit is steered.

Related messages, codes and tests

- Code G3 - No Steer Encoder Signal Or No Home Sensor Input (Page 6-103)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

1. Enter Maintenance Mode and enable this test.
2. Remove the encoder from its mount.
3. Turn the encoder with Test I22 on the display. The count on the display should vary.

   If the number displayed does not vary or the count only changes from 0 to 1 or 0 to 255, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	JPA8-3	B–	5.3V	Perform step 2	Replace ESM
2		B+	JPA8-2	B+	Perform step 3	
3			JPA8-5		Perform step 4	
4		ENC-2	B–	5.3V	Perform step 5	Repair/replace wires
5		B+	ENC-5	B+	Perform step 6	
6		JPA8-3	ENC-3	Steer; approx 2.9V No steer; 5.3 or 0V	Perform step 7	Replace Encoder
7			ENC-1		Perform step 8	
8		ENC-2	JPA8-1		Perform step 9	Repair/replace wires
9		ENC-2	JPA8-4		Replace ESM	

https://truckmanualshub.com/

Test I23 - Wire Guidance Board Status

NOTE: This test applies to trucks equipped with wire guidance.

This test determines whether or not the ESM sees that the Filter Card is installed.

Related messages, codes and tests

- Code 9F - Wire Guidance Board Not Installed (Page 6-72)

For information on using Maintenance Mode, refer to page 3-19.

Run test:

When the test is run, observe the following results:

Filter Card	Operator's Display
Installed	**Yes**
Not installed	**No**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Meter Setting	(+)Lead	(–) Lead	ExpectedResults	Step Passed	Step Failed
1	DCV	B+	*B-23 (Filter Card)	B+	Perform step 2	Replace ESM
2			*B-22 (Filter Card)		Replace ESM	Replace filter card
*See Figure 6-1for Filter Card pin locations.						

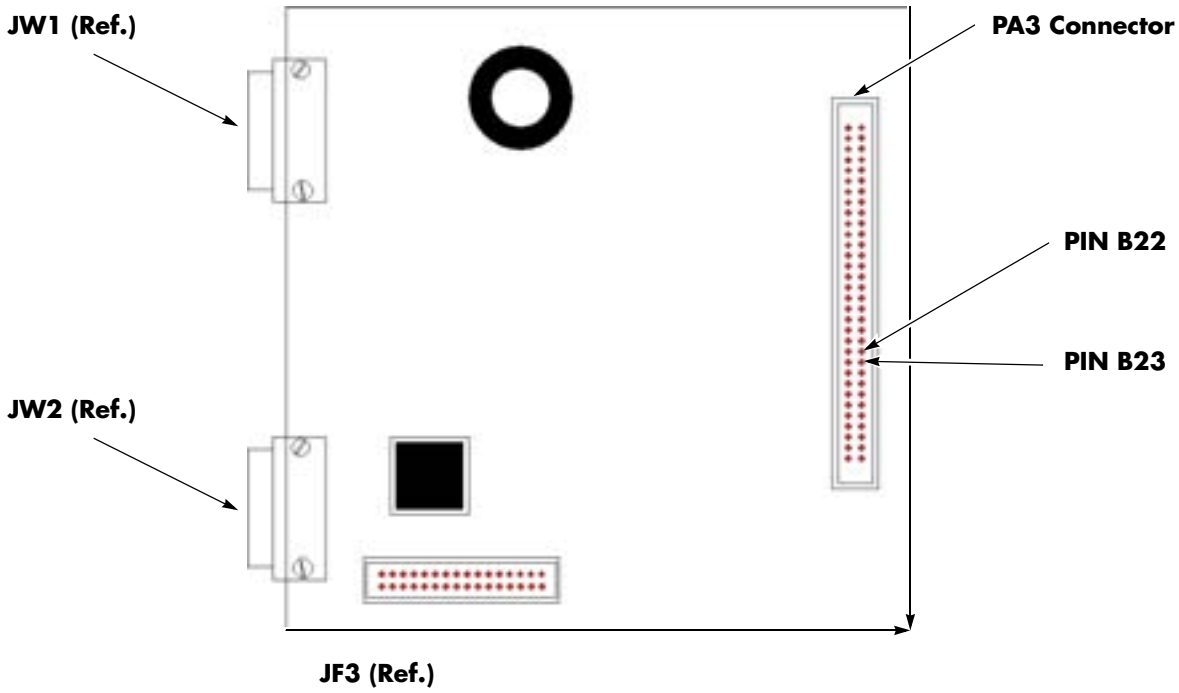


Figure 6-1. Filter Card Pin Locations

https://truckmanualshub.com/

Test I24 - Home Position Proximity Sensor

NOTE: This test applies to trucks with electric steering.

This test displays what the ESM sees from the Home Position Proximity Sensor.

Related messages, codes and tests

- Code G2 - No Steer Position Reference Input Or Steer Position Encoder Pulses Detected Without A Steer Command To Turn (Page 6-102)
- Code G4 - Open Detected In Steer Power Circuit (Page 6-104)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

When the test is run, observe the following results:

Home Proximity Sensor	Operator's Display	Red LED on Sensor
Over metal	**On**	ON
Away from metal	**Off**	OFF

If these results are not observed, the test has failed.

NOTE: If the test fails in Active Maintenance, pass a screwdriver or metal ruler under the sensor to activate it. If the test passes, adjust the switch. See "Proximity Sensor Adjustment" on page 7-23.

Diagnosis and Repair

Step	Action/Meter Setting	(+)Lead	(–) Lead	ExpectedResults	Step Passed	Step Failed
1	DCV	JPA7-3	JPA7-2	Approx 12V	Perform step 2	Replace ESM
2	Sensor over metal/DCV		JPA7-1	Approx 10V	Replace ESM	Adjust/Replace sensor

https://truckmanualshub.com/

Test I25 - End of Aisle Sense, Sensor 2

NOTE: This test applies to trucks equipped with End-of-Aisle Detect.

This test displays what the TM sees from Aisle Detect Sensor 2. Sensor 2 (S47) is located on the left side of the wire guidance sensor bracket as you stand on the platform facing the tractor.

Related messages, codes and tests

- Code J1 - Aisle Entry Error (Page 6-110)
- Code J2 - Aisle Exit Error (Page 6-111)
- Code J4 - Aisle Sensor Not Present (Page 6-112)
- Test I27 - End of Aisle Sense, Sensor 1 (Page 6-172)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

You have two choices when running this test:

1. If this test is to be run statically, park the truck away from any magnets in the floor. Obtain a magnet (P/N 591-552/002) and pass the magnet under the sensor. Remember that this is a transitional state. The sensor will revert to its original position even if the magnet remains under the sensor. It may be helpful if two people are available for this test. When a magnet is placed under the sensor, the OD will show **On** briefly. Even if the magnet remains under the sensor, the display will change back to **Off**.
2. To run this test in Active Maintenance, position the truck away from any floor magnets. Select this test for Active Maintenance. Have this test on the operator's display. While observing the display, drive the truck so the sensor passes over a floor magnet. The OD will show **On** briefly. Even if the magnet remains under the sensor, the display will change back to **Off**.

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPS28 dis-connected/ DCV	PS28-1	PS28-3	Approx 11V	Perform step 2	Replace TM
2		PS28-2		Approx 10.5V	Perform step 3	
3	DCV	JPS28-2	JPS28-3	Approx 8V	Perform step 4	Test cable; if OK, replace sensor
If Steps 1 thru 3 pass and you are troubleshooting a J4 code, proceed to step 6.						
4	DCV	JPS28-1	JPS28-3	11V drops below 8V w/magnet under sensor. Returns to 11V	Perform step 5	Test cable; if OK, replace sensor
5		JS2-B20 (VFC)	B–	5.3V drops below 4.3V w/magnet under sensor. Returns to 5.3V	Replace VFC	Replace TM
6		JS2-A19 (VFC)		JPS28 connected; 0V disconnected; 5.3V	Replace VFC	

https://truckmanualshub.com/

Test I27 - End of Aisle Sense, Sensor 1

NOTE: This test applies to trucks equipped with End-of-Aisle Detect or Auto Steer Center.

This test displays what the TM sees from Aisle Detect Sensor 1. Sensor 1 (S46) is located on the right side of the wire guidance sensor bracket as you stand on the platform facing the tractor.

Related messages, codes and tests

- Code J1 - Aisle Entry Error (Page 6-110)
- Code J2 - Aisle Exit Error (Page 6-111)
- Code J4 - Aisle Sensor Not Present (Page 6-112)
- Test I25 - End of Aisle Sense, Sensor 2 (Page 6-171)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

You have two choices when running this test:

1. If this test is run statically, park the truck away from any magnets in the floor. Obtain a magnet (P/N 591-552/002) and pass the magnet under the sensor. Remember that this is a transitional state. The sensor will revert to its original position even if the magnet remains under the sensor. It may be helpful if two people are available for this test. When a magnet is placed under the sensor, the OD will show **On** briefly. Even if the magnet remains under the sensor, the display will change back to **Off**.
2. To run this test under Active Maintenance, position the truck away from any floor magnets. Select this test for Active Maintenance. Have this test on the operator's display. While observing the display, drive the truck so the sensor passes over a floor magnet. The OD will show **On** briefly. Even if the magnet remains under the sensor, the display will change back to **Off**.

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPS6 dis-connected/ DCV	PS6-1	PS6-3	Approx 11V	Perform step 2	Replace TM
2		PS6-2		Approx 10.5V	Perform step 3	
3	DCV	JPS6-2	JPS6-3	Approx 8V	Perform step 4	Test cable; if OK, replace sensor
If Steps 1 thru 3 pass and you are troubleshooting a J4 code, proceed to step 6.						
4	DCV	JPS6-1	JPS6-3	11V drops below 8V w/magnet under sensor. Returns to 11V	Perform step 5	Test cable; if OK, replace sensor
5		JS2-B19 (VFC)	B–	5.3V drops below 4.3V w/magnet under sensor. Returns to 5.3V	Replace VFC	Replace TM
6		JS2-A19 (VFC)		JPS6 connected; 0V disconnected; 5.3V	Replace VFC	

https://truckmanualshub.com/

Test I29 - Speed Feedback Proximity Sensor, Channel A

This test verifies Channel A of the Speed Feedback Proximity Sensor is operating correctly.

NOTE: Run Test I30 at the same time.

When the proximity sensor is over metal, it should be OFF.

Related messages, codes and tests

- Code 29 - No Movement Detected When Travel Requested (Page 6-28)
- Code 2H - Failure Detected In Velocity Feedback Circuit (Page 6-35)
- Test I30 - Speed Feedback Proximity Sensor, Channel B (Page 6-174)

The gap between the proximity rotor disc and the sensor is very important. The gap from the disc to the sensor must measure 0.060 - 0.100 in. (1.52 - 2.54 mm).

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

Place Tests I29 and I30 in Active Maintenance.

During travel, the display toggles between **On** and **Off**.

NOTE: If the test fails in Active Maintenance, pass a screwdriver or metal ruler under the sensor to activate it. If the test passes, adjust the switch.

Diagnosis and Repair

Step	Meter Setting	(+) Lead	(–)Lead	Expected Results	Step Passed	Step Failed
1	DCV	JPS18-3	B–	Approx 12V	Perform step 2	Replace TM
2		SPS-3			Perform step 3	Repair/replace wires
3		SPS-1		Ramps down from approx 5 to 4V as speed increases	Perform step 4	Adjust/replace sensor
4		SPS-2			Perform step 5	
5		JPS18-1			Perform step 6	Repair/replace wires
6		JPS18-2			Replace TM, then VFC	

https://truckmanualshub.com/

Test I30 - Speed Feedback Proximity Sensor, Channel B

This test verifies Channel B of the Speed Feedback Proximity Sensor is operating correctly.

NOTE: Run Test I29 at the same time.

When the proximity sensor is over metal, it should be OFF.

Related messages, codes and tests

- Code 29 - No Movement Detected When Travel Requested (Page 6-28)
- Code 2H - Failure Detected In Velocity Feedback Circuit (Page 6-35)
- Test I29 - Speed Feedback Proximity Sensor, Channel A (Page 6-173)

The gap between the proximity rotor disc and the sensor is very important. The gap from the disc to the sensor must measure 0.060 - 0.100 in. (1.52 - 2.54 mm).

For information on using Maintenance Mode, refer to page 3-19. This test should be run from Active Maintenance.

Run test:

Place Tests I29 and I30 in Active Maintenance.

During travel, the display toggles between ON and OFF.

Diagnosis and Repair

If test fails, troubleshoot per Test I29.

https://truckmanualshub.com/

Test I31 - Carriage Deadman

This test shows what the TM is reading from S23. The switch is hard wired through the CCC to the TM.

Related messages, codes and tests

- Code 8C - Travel Deadman Switches Do Not Agree (Page 6-63)
- Code 8E - Brake Deadman Signals Do Not Agree (Page 6-65)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The state of the switch is displayed:

Deadman Pedal	Operator's Display
Up	**Up**
Down	**Down**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	JPC7-5	JPC7-6	12V	Perform step 2	Replace CCC
2			S23-3		Perform step 3	Repair/replace wire
3		S23-1			Perform step 4	
4			S23-2	pedal down = 12V pedal up = 0V	Perform step 5	Adjust/replace S23
5		JPC7-5	JPC7-4		Perform step 6	Repair/replace wires
6		B+	JPC11-5	pedal down = B+ pedal up = 0V	Perform step 7	Replace CCC
7			JPS25-5		Perform step 8	Replace over-the-mast cable
8		JS2-A23	B–	pedal down = 0V pedal up = 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I32 - Brake Deadman Signal to Tractor Manager

This test displays the carriage deadman brake voltage sent to the TM from the CCC.

Related messages, codes and tests

No travel, no lift, no steering, no code displayed

- Code 8C - Travel Deadman Switches Do Not Agree (Page 6-63)
- Code 8E - Brake Deadman Signals Do Not Agree (Page 6-65)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The state of the switch is displayed:

Deadman Pedal	Operator's Display
Up	**Up**
Down	**Down**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	JPC7-2	JPC7-3	12V	Perform step 2	Replace CCC
2			S2-3		Perform step 3	Repair/replace wires
3		S2-1			Perform step 4	
4			S2-2	Pedal Down; 12V Up; 0V	Perform step 5	Adjust/replace S2
5		JPC7-2	JPC7-1		Perform step 6	Repair/replace wires
6		PC1-8	B–	Pedal Down; 5.3V Up; 0V	Perform step 7	Replace CCC
7		PC1-9			Perform step 8	Repair/replace jumper PC1-8 to PC1-9
8		JPC11-4		Pedal Down; 0V Up; 10V	Perform step 9	Replace CCC
9		JPS25-4			Perform step 10	Replace over-the-mast cable
10		JS1-B6		Pedal Down; 0V Up; 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I33 - Display Channel A of Steer Encoder

NOTE: This test applies to trucks with electric steering.

This test displays what the system senses from channel A of the manual steering encoder.

Related messages, codes and tests

- Code G0 - Manual Steering Error (Page 6-100)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The OD will show **On/Off** pulses from channel A as the steering wheel is turned. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC1 @ CCC disconnected/ DCV	PC1-1	PC1-2	5.3V	Perform step 2	Replace CCC
2		PC1-3			Perform step 3	
3		PC1-4			Perform step 4	
4	DCV	JPC1-3	JPC1-2	Changes between 5.3 & 0V as wheel is turned	Perform step 5	Test cable if possible, then replace encoder
5		JPC1-4			Replace CCC	

https://truckmanualshub.com/

Test I34 - Display Channel B of Steer Encoder

NOTE: This test applies to trucks with electric steering.

This test displays what the system senses from channel B of the manual steering encoder.

Related messages, codes and tests

- Code G0 - Manual Steering Error (Page 6-100)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The OD will show **On/Off** pulses from channel B as the steering wheel is turned. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC1 @ CCC disconnected/ DCV	JC1-1	JC1-2	5.3V	Perform step 2	Replace CCC
2		JC1-3			Perform step 3	
3		JC1-4			Perform step 4	
4	DCV	JPC1-3	JPC1-2	Changes between 5.3 & 0V as wheel is turned	Perform step 5	Test cable if possible, then replace encoder
5		JPC1-4			Replace CCC	

https://truckmanualshub.com/

Test I35 - Lower Inhibit Switch (S25)

This test monitors the state of the lower inhibit switch (S25). This test displays what the CCC is reading from the switch. This test will only work on trucks equipped with the lower inhibit option.

Related messages, codes and tests

None.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The state of the lower inhibit switch (S25) is displayed.

Carriage Position (w/respect to S25)	**Operator's Display**
Below	**Belw**
Above	**Abov**

If these results are not observed, the test has failed.

Using Active Maintenance, check that the display indicates the carriage is **Belw** at all positions below the lower inhibit switch. Check that the display indicates **Abov** for all positions above the lower inhibit switch.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC4 dis-connected/ DCV	PC4-2	PC4-3	12V	Perform step 2	Replace CCC
2	DCV	JPC4-2	S25-3		Perform step 3	Repair/replace wires
3		S25-1			Perform step 4	
4			S25-2	S25 Closed; 12V Open; 0V	Perform step 5	Adjust/replace S25
5		JPC4-2	JPC4-1		Replace CCC	Repair/replace wires

https://truckmanualshub.com/

Test I36 - 24 in./60 in. Switch Sense

Run Test I00 - Lower Mast Reference Switch (Page 6-148) and Test I18 - 60 in. Limit Switch (S28) (Page 6-163).

https://truckmanualshub.com/

Test I37 - Upper Reference Switch Sense (S10)

Run Test I01 - Upper Mast Reference Switch (Page 6-149).

https://truckmanualshub.com/

Test I38 - EPO (S21)

Run Test I04 - EPO Switch (Page 6-151).

https://truckmanualshub.com/

Test I39 - Alarm and Spare Limit Switch (PS15)

This test monitors the state of the switch. This test displays what the TM is reading from the switch. This switch could be used for *intellispeed*™ for cold storage (180 in. switch).

Related messages, codes and tests

None.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The state of the spare TM switch is displayed.

Switch	Operator's Display
Closed	**Belw**
Open	**Abov**

If these results are not observed, the test has failed.

If cold storage, use Active Maintenance to check all positions above and below 180 in.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPS15 dis-connected/ DCV	PS15-2	PS15-3	10.7 to 13V	Perform step 2	Replace TM
2	DCV	JPS15-2	S-3		Perform step 3	Repair/replace wires
3		S-1			Perform step 4	
4			S-2	Closed; 6 to 12V Open; <1V	Perform step 5	Adjust/replace switch
5		JPS15-2	JPS15-1		Perform step 6	Repair/replace wires
6		JS2-A18	B–	Closed; 0V Open; 5.3V	Replace VFC	Replace TM

https://truckmanualshub.com/

Test I41 - Auxiliary Lift Switch (S32)

This test monitors the state of the auxiliary lift switch (S32). This switch causes the auxiliary mast to lift. This test displays what the CCC is reading from the switch.

NOTE: S31 (aux lift left hand deadman) must also be depressed during this test.

Related messages, codes and tests

- Test I42 - Auxiliary Lower Switch (S33) (Page 6-185)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The state of the switch is displayed:

S31 Switch Actuator	Operator's Display
Depressed	**On**
Up	**Off**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	B+	JPC19-3	B+	Perform step 3	Perform step 2
2			JPC18-3		Replace Aux Card	Replace CCC
3	S31 & S32 Closed/DCV		JPC19-2		Perform step 4	Repair/replace wires or switches
4	Aux Card dis-connected/ DCV	PC18-8	PC18-1		Perform step 5	Replace CCC
5		PC18-5	PC18-3	5.3V	Perform step 6	
6		PC18-7		12V	Replace Aux Card, then CCC	

https://truckmanualshub.com/

Test I42 - Auxiliary Lower Switch (S33)

This test monitors the state of the auxiliary lower switch (S33). This switch causes the auxiliary mast to lower. This test displays what the CCC is reading from the switch.

NOTE: S31 (aux lift left hand deadman) must also be depressed during this test.

Related messages, codes and tests

- Test I41 - Auxiliary Lift Switch (S32) (Page 6-184)

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The state of the switch is displayed:

S31 Switch Actuator	Operator's Display
Depressed	**On**
Up	**Off**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	B+	JPC19-3	B+	Perform step 3	Perform step 2
2			JPC18-3		Replace Aux Card	Replace CCC
3	S31 & S33 Closed/DCV		JPC19-1		Perform step 4	Repair/replace wires or switches
4	Aux Card dis-connected/ DCV	PC18-8	PC18-1		Perform step 5	Replace CCC
5		PC18-5	PC18-3	5.3V	Perform step 6	
6		PC18-7		12V	Replace Aux Card, then CCC	

https://truckmanualshub.com/

Test I44 - Auxiliary Mast Limit Switch 1 (S34)

This test monitors the state of the auxiliary mast limit switch #1 (S34). What the CCC is reading from the switch is displayed.

Related messages, codes and tests

None.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The state of the auxiliary mast switch is displayed:

S34/S35	Operator's Display
Below actuation point	**Belw**
Above actuation point	**Abov**

If these results are not observed, the test has failed.

Use Active Maintenance to check all positions above and below S34.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Aux Card dis-connected/ DCV	PC18-8	PC18-1	B+	Perform step 2	Replace CCC
2		PC18-5	PC18-3	5.3V	Perform step 3	
3	DCV	JPC18-7	JPC18-3	12V	Perform step 4	
4		JPC20-2	JPC20-3		Perform step 5	Replace Aux Card
5	S34 Closed/ DCV		JPC20-1		Replace Aux Card	Test wires; then replace switch

https://truckmanualshub.com/

Test I59 - Auxiliary Mast Limit Switch 2 (S35)

This test monitors the state of the auxiliary mast limit switch #2 (S35). What the CCC is reading from the switch is displayed.

Related messages, codes and tests

None.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The state of the auxiliary mast switch is displayed:

S35	Operator's Display
Below actuation point	**Belw**
Above actuation point	**Abov**

If these results are not observed, the test has failed.

Use Active Maintenance to check all positions above and below S35.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Aux Card dis-connected/ DCV	PC18-8	PC18-1	B+	Perform step 2	Replace CCC
2		PC18-5	PC18-3	5.3V	Perform step 3	
3	DCV	JPC18-7	JPC18-3	12V	Perform step 4	
4		JPC20-5	JPC20-6		Perform step 5	Replace Aux Card
5	S34 Closed/ DCV		JPC20-4		Replace Aux Card	Test wires; then replace switch

https://truckmanualshub.com/

Test I60 - Display Channel A-E2 of Steer Encoder

NOTE: This test applies to trucks with electric steering.

This test displays what the system senses from Channel A-E2 of the manual steering signal. This signal is generated by the Steer Encoder (SE) mounted behind the steering wheel.

Related messages, codes and tests

- Code G0 - Manual Steering Error (Page 6-100)

Code G0 can only appear when:

- The truck is traveling and is **not** on the wire

  OR

- There is a mismatch at Start-up between the truck's Dual Encoder selection in Configuration Mode and the detection of the dual channel encoder (SE with channels A & B and A-E2 & B-E2) by the CCC.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

ON/OFF pulses from Channel A-E2 are displayed as the steering wheel is turned. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC21 dis-connected/ DCV	PC21-1	PC21-2	5.3V	Perform step 2	Replace CCC
2		PC21-3			Perform step 3	
3	JPC21 dis-connected/ DCV	PC21-4			Perform step 4	
4	DCV	JPC21-3	JPC21-2	Changes between 5.3 and 0V as wheel is turned	Perform step 5	Replace Encoder
5		JPC21-4			Replace CCC	

https://truckmanualshub.com/

Test I61 - Display Channel B-E2 of Steer Encoder

NOTE: This test applies only to trucks with electric steering.

This test displays what the system senses from Channel B-E2 of the manual steering signal. This signal is generated by the Steering Encoder (SE) mounted behind the steering wheel.

Related messages, codes and tests

- Code G0 - Manual Steering Error (Page 6-100)

Code G0 can only appear when:

- The truck is traveling and is **not** on the wire

  OR

- There is a mismatch at Start-up between the truck's Dual Encoder selection in Configuration Mode and the detection of the dual channel encoder (SE with channels A & B and A-E2 & B-E2) by the CCC.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

ON/OFF pulses from Channel B-E2 are displayed as the steering wheel is turned. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC21 dis-connected/ DCV	PC21-1	PC21-2	5.3V	Perform step 2	Replace CCC
2		PC21-3			Perform step 3	
3	JPC21 dis-connected/ DCV	PC21-4			Perform step 4	
4	DCV	JPC21-3	JPC21-2	Changes between 5.3 and 0V as wheel is turned	Perform step 5	Replace Encoder
5		JPC21-4			Replace CCC	

https://truckmanualshub.com/

Test I62 - Dual Channel Steer Encoder Detect

NOTE: This test applies to trucks with electric steering.

This test displays what the system senses from the Dual Channel Steer Encoder Detect voltage.

Related messages, codes and tests

- Code G0 - Manual Steering Error (Page 6-100)

Code G0 can only appear when:

- The truck is traveling and is **not** on the wire

  OR

- There is a mismatch at Start-up between the truck's Dual Encoder selection in Configuration Mode and the detection of the dual channel encoder (SE with channels A & B and A-E2 & B-E2) by the CCC.

For information on using Maintenance Mode, refer to page 3-19. This test can also be run from Active Maintenance.

Run test:

The display will show the presence of the Encoder Detect. With JC21 disconnected, the display should show OFF. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC21 dis-connected/ DCV	PC21-5	PC21-6	5.2V	Repair/replace jumper between JPC21-5 and JPC21-6	Replace CCC

https://truckmanualshub.com/

Digital Output Tests

A Diagnosis and Repair table is provided for most tests. If a test fails, refer to the Diagnosis and Repair table. Through the process of elimination, these tables provide the technician with a step-by-step approach to diagnosing a problem and the necessary corrective action. See the table below.

Example Diagnosis and Repair Table

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	StepPassed	StepFailed
This is the order in which the testing must be performed.	This column identifies the action(s) required (if any) before testing the circuit. If no instructions are given, all circuits should be connected. **Note: If something was disconnected in the prior step, reconnect it before performing the next step.** This column also identifies the required setting on the meter for this step.	Connection point for the Positive (+) meter lead.	Connection point for the Negative (–) meter lead.	The reading required to consider the step a success.	The next action to be performed if the **Expected Result**s are met.	The next action to be performed if the **Expected Result**s are ***not*** met.

NOTES:

1. Some tests require unplugging the TM from the Power Card. By removing the screws that secure the TM, the two cards can be slid apart and the truck powered back up for testing.
2. When testing at the VFC, a small socket from a pin kit can be used to slide over the wire sticking out the back side of the card.
3. Some Analog and Input tests tell you to run an Output test. This is used to activate the circuit being tested and you do not have to complete all the steps related to the Output test.

https://truckmanualshub.com/

Test O00 - Toggle the PC Contactor

This test turns the PC contactor ON and OFF.

Related messages, codes and tests

- Code 44 - PC Contactor Detected Closed When Commanded Open (Page 6-39)
- Code 45 - PC Contactor Detected Open When Commanded Closed (Page 6-40)
- Test A07 - PC Sense Voltage (Page 6-122)

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

PC Contactor	Operator's Display
Closed	**On**
Open	**Off**

The test is a success if the PC contactor tracks the **On/Off** shown on the display. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Inspect contactor for mechanical binding	NA	NA	No binding	Perform step 2	Repair/replace contactor
2	JPS14 dis-connected/ Ohms	JS14-5	JS14-18	Approx 40 ohms	Perform step 3	T/S wires & coil
3	PC contactor closed/DCV	JPS14-5	B–	B+	Perform step 4	Remove/replace TM
4	Test ON/ DCV	JPS2-B14 (VFC)		ON; 5.3V OFF; 0V	Perform step 5	Replace VFC
5		JPS11-3		24V; approx 10.6V 36V; approx 7.2V	Perform step 6	Replace TM
6		B+	JPS11-8	ON; approx 24V OFF; <2V	Perform step 7	Replace coil driver board
7			JPS14-18		Perform step 2	Replace TM

https://truckmanualshub.com/

Test O02 - Toggle the P Contactor

This test turns the P contactor ON and OFF.

Related messages, codes and tests

- Code 42 - Lift Contactor Detected Closed When Commanded Open (Page 6-37)
- Code 43 - Lift Contactor Detected Open When Commanded Closed (Page 6-38)
- Test A08 - Lift Motor Sense Voltage (Page 6-123)

For information on how to use Maintenance Mode, refer to 3-19.

⚠ WARNING

Open the emergency lowering valve before using this test.

Run test:

P Contactor	Operator's Display
Closed	**On**
Open	**Off**

The test is a success if the P contactor tracks the **On/Off** shown on the display. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Inspect contactor for mechanical binding	NA	NA	No binding	Perform step 2	Repair/replace contactor
2	Disconnect K30 & JPS14/ Ohms	JS14-14	JS14-16	Approx 19 ohms	Perform step 3	T/S wires & coil
3	PC contactor closed/DCV	JPS14-14	B–	B+	Perform step 4	Remove/replace TM
4	Test ON/DCV	JPS2-A15 (VFC)		ON; 5.3V OFF; 0V	Perform step 5	Replace VFC
5		JPS11-1		24V; approx 10.6V 36V; approx 7.2V	Perform step 6	Replace TM
6		B+	JPS11-6	ON; 24V OFF; <2V	Perform step 7	Replace coil driver board
7			JPS14-16		Perform step 2	Replace TM

https://truckmanualshub.com/

Test O04 - Reverse Enable Test (Forks First)

This test verifies the proper operation of the Tractor Manager's reverse enable signal.

A successful test proves the wiring and related circuitry in the Tractor Manager and the Tractor Manager VFC are functioning properly.

NOTE: Test O13 must be run to verify the Power Card is correctly enabling its output.

Related messages, codes and tests

- Test O13 - Field PWM Ramp (Page 6-203)

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

Connect the (+) lead of a voltmeter to JPS5-9 (+12VF) on the Power Card. Connect the (–) lead of the voltmeter to JPS5-6.

The voltmeter should display the following:

Voltage Reading	Operator's Display
>10.5V	**Off**
<1.0V	**On**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Test ON/DCV	JPS5-6	B–	ON; >10.5V OFF; <1V	Run Test O13	Perform step 2
2		JS2-B11		ON; approx <1V OFF; approx 5.3V	Replace TM	Replace VFC

https://truckmanualshub.com/

Test O05 - Forward Enable Test (Tractor First)

This test verifies proper operation of the Tractor Manager's forward enable signal.

A successful test proves the wiring and related circuitry in the TM and TM VFC are all functioning properly.

NOTE: Test O13 must be run to verify that the Power Card is correctly enabling its output.

Related messages, codes and tests

- Test O13 - Field PWM Ramp (Page 6-203)

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

Connect the (+) lead of a voltmeter to JPS5-9 (+12VF) on the Power Card. Connect the (–) lead of the voltmeter to JPS5-5.

The voltmeter should display the following:

Voltage Reading	Operator's Display
>10.5V	**Off**
<1.0V	**On**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Test ON/DCV	JPS5-5	B–	ON; >10.5V OFF; <1V	Run Test O13	Perform step 2
2		JS2-A11		ON; approx <1V OFF; approx 5.3V	Replace TM	Replace VFC

https://truckmanualshub.com/

Test O06 - Toggle Main Load Hold Solenoid

NOTE: This test does not function with some Firmware Versions. If this test does not function on your truck, perform Diagnosis and Repair in run mode.

This test turns the Main Load Hold (L/H) Solenoid ON and OFF.

⚠ WARNING

Make sure the forks are fully lowered before performing this test.

Turning the Load Holding Solenoid ON during this test will cause the carriage to lower because the proportional lift/lower valve is open in Maintenance Mode.

Related messages, codes and tests

- Code 64 - No Flow Sensor Pulses When Lift/Lower Requested (Page 6-51)

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

1. Lower the forks to the floor.
2. Disconnect wire from Load Holding solenoid L/H-1 (and K29 if present).
3. Connect an ammeter in series with the L/H solenoid as follows:
   - (–) lead to terminal of L/H-1
   - (+) lead to wire removed from L/H-1

L/H Solenoid	Ammeter Reading	Operator's Display
Open	0.5 to 1.0A	**On**
Closed	0.0 to 0.02A	**Off**

If these results are not observed, the test has failed. Reconnect wire to L/H-1.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPS19 (and K29 if present) disconnected/ Ohms	JS19-2	JS19-3	Approx 29 ohms	Perform step 2	T/S wires & coil
2	Test ON/DCV	JPS11-5	B–	24V; approx 10.6V 36V; approx 7.2V	Perform step 4	Perform step 3
3		JPS1-B22 (VFC)		ON; 5.3V OFF; 0V	Replace TM	Replace VFC
4		B+	JPS11-10	ON; approx 24V OFF; <2V	Perform step 5	Replace coil driver board
5			JPS19-3		Perform step 1	Replace TM

https://truckmanualshub.com/

Test O07 - Toggle Horn

This test turns the Horn ON and OFF.

Related messages, codes and tests

- Test I13 -Horn Switch (Page 6-158)

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

The horn should sound when test is activated. If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	K1-3 & 4 disconnected/ Ohms	K1-3 (on relay)	K1-4 (on relay)	Test ON; 0 ohms OFF; open circuit	T/S horn and wires	Perform step 2
2	PC closed/DCV	JPS19-8	B–	B+	Perform step 3	Replace TM
3	Test ON/DCV	B+	JPS19-9	ON; B+ OFF; <2V	T/S wires and relay	Perform step 4
4		JS1-A23 (VFC)	B–	ON; 5.3V OFF; 0V	Replace TM	Replace VFC

https://truckmanualshub.com/

Test O08 - Brake Release Signal

Use this test to check for proper brake coil operation.

Related messages, codes and tests

- Code 84 - Brake Inoperable Or Not Properly Adjusted (Page 6-62)

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

The deadman pedal must be used when running this test.

Deadman Pedal	Brake
Up	Applied
Down	Released

If these results are not observed, the test has failed.
If this test passes, check brake adjustment. See “Brake Adjustment” on page 7-42.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPS19 dis-connected/ Ohms	JS19-5	JS19-10	Approx 13 ohms	Perform step 2	T/S wires & coil
2	DCV	JPS19-10	B–	B+	Perform step 3	Replace TM
3a	24V trucks/ DCV	JPS11-2		ON; approx 10V OFF; 0V	Perform step 5	
3b	36V trucks/ DCV	JPS1-B9 (VFC)		ON; approx 3.5V OFF; 0V	Perform step 4	Replace VFC
4		JPS11-2		ON; approx 7V OFF; 0V	Perform step 5	Replace TM
5	Test ON/DCV	B+	JPS11-7	ON; B+ OFF; <2V	Perform step 1	Replace coil driver board

https://truckmanualshub.com/

Test O09 - Display Lights

This test verifies all the lights operate properly on the OD.

Related messages, codes and tests

None.

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

When the test is turned on 13 LED's on the display should light. See Figure 6-1. If all the LED's do not light, the test has failed.

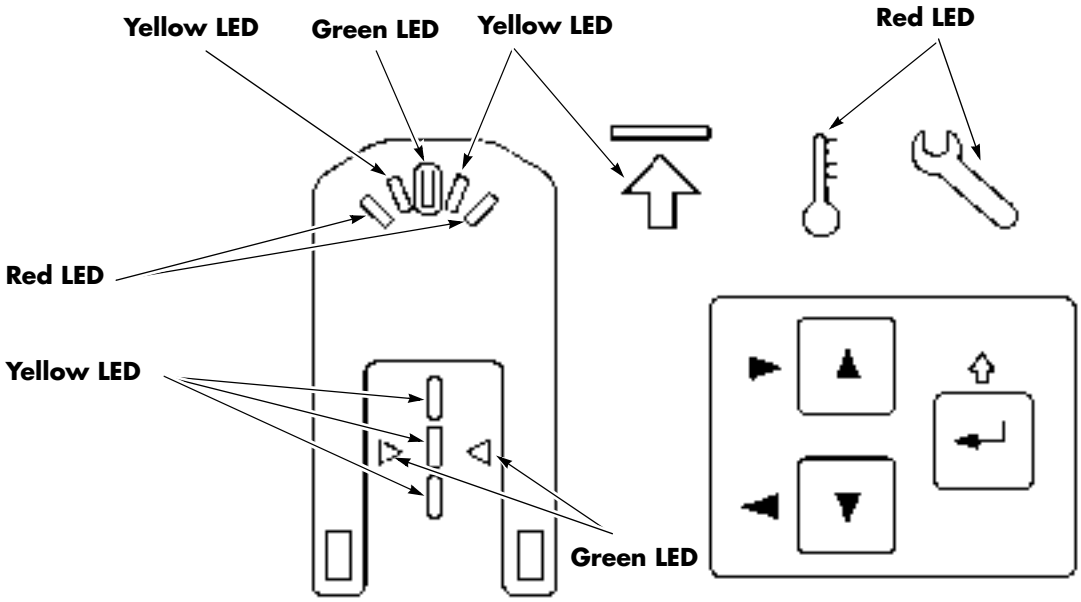


Figure 6-1. Operator Display LED Identification

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPS15 & JPC2 disconnected/ Ohms	JC15-1 thru JC15-24	JD15-1 thru JD15-24	0 ohms	Replace display	Replace cable

https://truckmanualshub.com/

Test O10 - Audible Alarm

Using this test, the operation of the audible alarm in the CCC can be verified.

A successful test proves the CCC is functioning and the audible alarm is functioning.

Related messages, codes and tests

None.

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

Alarm	Operator's Display
Sounding	**Ramp**
OFF	**Off**

This test will generate a sound on the audible alarm in the CCC. The sound begins at a low pitch and ramps up to a high pitch, then repeats.

If these results are not observed, the test has failed.

Diagnosis and Repair

Replace the CCC.

After replacing the CCC, run LEARN Mode before running the test again.

https://truckmanualshub.com/

Test O11 - Chopper Enable Signal

This test verifies proper operation of the Chopper Enable voltage from the TM.

A successful test proves the wiring and related circuitry in the Tractor Manager are all functioning properly.

NOTE: Test O14 must be run to verify the Power Card is correctly enabling its output.

Related messages, codes and tests

- Code 23 - Open Detected In Main Transistor Circuit (Page 6-24)
- Test O14 - Armature PWM Test (Page 6-205)

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

Connect the (+) lead of a DVM to JPS3-5 and the (–) lead to JPS3-2 (on Power Card).

Voltmeter Reading (at PS3-5)	Operator's Display
<1.0V	**On**
>10.5V	**Off**

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Test ON/DCV	JS2-B10 (VFC)	B–	ON; 5.3V OFF; 0V	Replace TM	Replace VFC

https://truckmanualshub.com/

Test O12 - Proportional Solenoid PWM Ramp

NOTE: This test applies to trucks equipped with a variable lift/lower systems.

This test ramps the proportional Lift/Lower (L/L) solenoid from full OFF to full ON.

A successful test proves the wiring and related circuitry in the TM VFC, TM, and proportional L/L solenoid coil driver are all functioning correctly. It also proves the harness is electrically functional. It does not prove the L/L solenoid itself is mechanically functional.

Related messages, codes and tests

- Code 64 - No Flow Sensor Pulses When Lift/Lower Requested (Page 6-51)

Ramping the proportional L/L solenoid should not allow the carriage to lower, since the Load Holding (L/H) Valve should be closed. If there is a fault in the L/H circuit or a fault in L/H itself, the carriage may lower. To guard against unexpected motion of the carriage, fully lower the forks before entering this test.

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

1. Turn key switch OFF.
2. Loosen the screw that secures the 90° connector to the L/L solenoid. Unplug the connector from the solenoid. Remove the cover to expose the connector terminals. Reconnect the connector.
3. Connect the (–) lead of a DVM to L/L-2 and the (+) lead to L/L-1.
4. Turn key switch ON and run this test.

Voltmeter Reading	Operator's Display
0-24V	**Ramp**
0-1V	**Off**

The voltage shown on the display will start at 0 and increase (ramp). The process will repeat until the test is stopped.

If the meter ramps, the wiring and related circuitry are functional. (It does not prove the L/L solenoid itself is mechanically functional.)

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPS-19 dis-connected/ Ohms	JS19-2	JS19-4	Approx 25 ohms	Perform step 2	T/S wires & coil
2	Test ON/ DCV	JPS19-2	B–	B+	Perform step 3	Replace TM
3		JPS2-A21 (VFC)		ON; ramp 0 to 5.3V OFF; 0V	Perform step 4	Replace VFC
4		JPS11-4		24V; ramp 0 to 10.5V 36V; ramp 0 to 7.5V	Perform step 5	Replace TM
5		B+	JPS11-9	ON; ramp 0 to 24V OFF; <2V	Perform step 6	Replace coil driver board
6			JPS19-4		Perform step 1	Replace TM

https://truckmanualshub.com/

Test O13 - Field PWM Ramp

This test verifies proper operation of the circuitry.

A successful test proves the wiring and related circuitry are functioning properly.

Related messages, codes and tests

- Code 25 - Short Detected In Field Circuit (H-bridge) (Page 6-26)
- Code 26 - Open Detected In Field Circuit (Page 6-27)
- Test O04 - Reverse Enable Test (Forks First) (Page 6-194)
- Test O05 - Forward Enable Test (Tractor First) (Page 6-195)

This test generates an increasing PWM voltage to the Power Card. During this test, the armature is not powered up, so the truck should not move. If, however, there is a fault in the traction motor circuit, the traction motor may start. To guard against unexpected movement of the truck, elevate the drive tire off the floor before entering this test.

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath the truck while jacking. Use jack stands or solid blocks to support truck - do not rely on jacks.

1. Elevate the drive tire off the floor.

⚠CAUTION

Do not run this test for an extended period of time as it may damage the Power Card or Field Wiring Assembly.

2. Connect a voltmeter across motor terminals as follows:
   - (+) to MD-S1
   - (–) to MD-S2

Test ON	
Voltmeter Reading	**Operator's Display**
36V Truck ramps from approx 0 to +30V and 0 to –30V **24V Truck** ramps from approx 0 to +18V and 0 to –18V Both readings must be seen.	**Ramp**
0.0 ±1.0	**Off**

Ramping will repeat until test is stopped. If these results are not observed, the test has failed.

If test fails, run tests O04 and O05. If both tests pass, proceed to Diagnosis and Repair.

https://truckmanualshub.com/

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	TM1 B+	Power Card B–	B+	Perform step 2	Test cables and Fuse 8
2	T1, 2, 3, 4 base wires dis-connected. Jumper from TP4 to MDS2/ DCV	T1	B–	ON; toggle from 14V to 0V every 15 sec OFF; 0V	Perform step 3	Perform step 5
3		T2		ON; ramps 0 to approx 15V every 15 sec OFF; approx 6V	Perform step 4	
4		T3		ON; toggle from 14V to 0V every 15 sec OFF; 0V	Perform step 5	
5		T4		ON; ramps 0 to approx 15V every 15 sec OFF; approx 6V	Perform step 8	
6	TM dis-connected from Power Card/DCV	JS1-A15 (VFC)		OFF; 5.3V ON; ramp 5.3 to 0V	Perform step 7	Replace VFC
7		B+	JS5-8	OFF; 24V ON; ramps 24 to 15V	Perform step 8, then replace Power Card	Replace TM
8	Test TM1/TM2	NA	NA	See Field and Steering Transistor Test on page 5-13.	Perform step 9	Replace TM1 & 2 and perform step 9
9	Test motor field & cables			See Electric Motor Tests on page 5-6.	Perform step 2	Repair/replace cables or motor

https://truckmanualshub.com/

Test O14 - Armature PWM Test

This test verifies proper operation of the Power Card and the Power Transistor (Q1).

A successful test proves the wiring and related armature circuitry are functioning properly.

Related messages, codes and tests

- Code 21 - Short Detected In Main Transistor Circuit (Page 6-23)
- Code 23 - Open Detected In Main Transistor Circuit (Page 6-24)
- Test O11 - Chopper Enable Signal (Page 6-201)

This test ramps the voltage to the Power Card. During this test, the field is not powered up, so the truck should not move. If there is a fault in the traction motor circuit, the traction motor may start. To guard against unexpected movement of the truck, elevate the drive tire off the floor before entering this test.

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath the truck while jacking. Use jack stands or solid blocks to support truck - do not rely on jacks.

1. Elevate the drive tire off the floor.
2. Connect a voltmeter across power transistor Q1 as follows:
   - (+) to TP6
   - (–) to TP4 (on contactor panel)

Voltmeter Reading	Operator's Display	If Not As Specified
<10V	**Off**	See Diagnosis and Repair
B+ (Hold PC in)	**Off**	Check FU5, Cables, Brushes
B+ to B+ minus 6V	**Ramp**	See Diagnosis and Repair

The meter will ramp from B+ to B+ minus 6V. If these results are not observed, the test has failed.

If this is observed and you are troubleshooting a Code 21 or 23, the problem may be with the armature current sense. Run Test A01.

⚠ CAUTION

Do not run this test for an extended period of time as it may damage Q1 and/or the Power Card due to overheating.

NOTE: Run Test O11 before troubleshooting per Diagnosis and Repair.

https://truckmanualshub.com/

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Q1 base wire disconnected/ DCV	Q1 base wire	B–	ON; ramp 0 to 1.5V OFF; 0V	Test Q1 & REC1. See pages 5-11 and 5-14.	Perform step 2
2		JPC1-2 @ Power Card			Test wire to Q1-B	Perform step 3
3	TM disconnected from Power Card/DCV	B+	JS3-3	ON; ramp 15 to 20V OFF; 0V	Replace Power Card	Perform step 4
4		JS2-B18 (VFC)	B–	ON; ramp 0 to 1.5V OFF; 0V	Replace TM	Replace VFC

NOTE: If repeat failures of Q1 and REC1 are experienced:

- test Q1 snubber resistor and REC3. Replace capacitor C1.
- Remove the Q1 heat sink and inspect for holes in the insulation paper. Inspect heatsink for burrs.

https://truckmanualshub.com/

Test O15 - Limit 1

Not used.

https://truckmanualshub.com/

Test O16 - Limit 2

Not used.

https://truckmanualshub.com/

Test O17 - Optional Alarm Test

This test verifies the operation of the optional alarm.

A successful test proves the wiring and related circuitry in the TM VFC and TM are functioning properly.

Related messages, codes and tests

None.

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

Connect a voltmeter at JPS15-5 wrt JPS15-6.

Voltage Output	Operator's Display
0.0-1.0V	**Off**
22.0V	**On**

When the display shows ON, the optional device should be activated.

If these results are not observed, the test has failed.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	Test ON/DCV	AL+	AL–	B+	Replace alarm	Perform step 2
2	PC Closed/DCV		B–		Perform step 3	Test wire to AL+
3		B+	K2-4		Perform step 4	Test wire to K2-4
4	K2-3 & 4 unplugged, Test ON/Ohms	K2-3		Test ON; 0 ohms OFF; open circuit	Perform step 5	Perform step 6
5	Ohms		AL–	0 ohms	Perform step 1	Repair/replace wire
6	PC Closed/DCV	JPS15-5	B–	B+	Perform step 7	Verify Option is enabled, then replace TM
7	DCV	B+	JPS15-6	ON; B+ OFF; approx 1.5V	Replace K2	Perform step 8
8		JPS1-A8 (VFC)	B–	ON; 5.3V OFF; 0V	Replace TM	Replace VFC

https://truckmanualshub.com/

Test O18 - REGEN Enable (optional)

This test verifies the REGEN enable is sent from the TM (JS3-9), through the Power Card (PS3-9 to JPC2-2, to the REGEN Card (PD1-2).

A successful test proves the wiring and related circuitry in the Tractor Manager VFC, Tractor Manager, Power Card, and REGEN Card are all functioning.

NOTE: This test does not check the operation of REGEN; only that the enable has been sent to the REGEN Card.

Related messages, codes and tests

- Code 2F - Failure Detected In Regen Circuit (Page 6-34)

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

Refer to Diagnosis and Repair.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	JPC2 dis-connected/ DCV	PC2-1	PC2-3	12V	Perform step 2	Replace Power Card
2		PC2-2	B–	ON; 0V OFF; 12V	Replace Regen Assy	Perform step 3
3	TM dis-connected from Power Card/DCV	B+	JS3-9	ON; B+ OFF; 0V	Replace Power Card	Perform step 4
4		JS1-B3 (VFC)	B–	ON; 5.3V OFF; 0V	Replace TM	Replace VFC

https://truckmanualshub.com/

Test O19 - Aux Load Hold or 2 Stage Select Solenoid (optional)

NOTE: This test applies to trucks equipped with the auxiliary lift option

OR

24V trucks, S/Ns 31,000 and up, equipped with the High Performance Lift (Hi Pro) option (*except trucks with EE option and 2 Stage Select*).

This test turns the solenoid OFF and ON, verifying its correct operation electrically.

NOTE: This test does *not* prove that the solenoid valve is mechanically functional.

A successful test proves that the solenoid coil, coil driver, wiring and related circuitry in the TM VFC and TM are functioning correctly.

Related messages, codes and tests

None.

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

1. Turn the key switch OFF and disconnect the battery connector.
2. Disconnect the wire from the solenoid coil at SOL-1.
3. Connect a digital ammeter in series with the solenoid; (–) lead to SOL-1, (+) lead to the wire removed from SOL-1.
4. Reconnect the battery connector and turn the key switch ON. Run test and observe the following results.

Ammeter Reading	Operator's Display
0.0-0.02A	**Off**
1.0-2.0A	**On**

   If the above results are not observed, the test has failed.
5. Turn the key switch OFF and disconnect the battery connector. Remove the ammeter from the circuit and reconnect the wire.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	JPS12-10	B–	B+	Perform step 2	Replace TM
2		JPS29-2			Perform step 3	Replace coil driver board
3	JPS29 disconnected/ Ohms	JS29-2	JS29-4	Approx 26 Ohms	Perform step 4	T/S wires and coil
4	Test ON/DCV	JPS2-A26 (VFC)	B–	ON; 5.3V OFF; 0V	Perform step 5	Replace VFC
5		JPS12-3		ON; 10.6V OFF; 0V	Perform step 6	Replace TM
6		B+	JPS29-4	ON; approx 24V (IL3 on) OFF; 18.5V (IL3 off)	Perform step 1	Replace coil driver board

https://truckmanualshub.com/

Test O20 - Aux Select Solenoid (optional)

NOTE: This test applies to trucks equipped with the auxiliary lift option.

This test turns the Aux Select Solenoid OFF and ON, verifying its correct operation electrically.

A successful test proves that the Aux Select Solenoid coil, coil driver, wiring and related circuitry in the TM are functioning correctly.

NOTE: This test does **not** prove that the Aux Select Solenoid valve is mechanically functional.

Related messages, codes and tests

None.

NOTE: For information on how to use Maintenance Mode, refer to 3-19.

Run test:

1. Turn the key switch OFF and disconnect the battery connector.
2. Disconnect the wire from the Aux Select Solenoid coil at AUX SEL SOL-X.
3. Connect a digital ammeter in series with the Aux Select Solenoid; (–) lead to AUX SEL SOL-X terminal; (+) lead to the removed wire.
4. Reconnect the battery connector and turn the key switch ON. Run test and observe the following results.

Ammeter Reading	Operator's Display
0.0-0.02A	**Off**
1.0-2.0A	**On**

   If the above results are not observed, the test has failed.
5. Turn the key switch OFF and disconnect the battery connector. Remove the ammeter from the circuit and reconnect the wire.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	JPS12-10	B–	B+	Perform step 2	Replace TM
2		JPS29-2			Perform step 3	Replace coil driver board
3	JPS29 disconnected/ Ohms		JPS29-3	Approx 30 Ohms	Perform step 4	T/S wires and coil
4	Test ON/DCV	JPS1-A22 (VFC)	B–	ON; 5.3V OFF; 0V	Perform step 5	Replace VFC
5		JPS12-2		ON; 24V truck-10.6V 36V truck-7.2V OFF; 0V	Perform step 6	Replace TM
6		B+	JPS29-3	ON; approx 24V(IL2 on) OFF; 18.5V(IL2 off)	Perform step 1	Replace coil driver board

https://truckmanualshub.com/

Test O21 - Main Select Solenoid (optional)

NOTE: This test applies to trucks equipped with the auxiliary lift option.

This test turns the Main Select Solenoid OFF and ON, verifying its correct operation electrically.

A successful test proves that the Main Select Solenoid coil, coil driver, wiring and related circuitry in the TM are functioning correctly.

NOTE: This test does **not** prove that the Main Select Solenoid valve is mechanically functional.

Related messages, codes and tests

None.

For information on how to use Maintenance Mode, refer to 3-19.

Run test:

1. Turn the key switch OFF and disconnect the battery connector.
2. Disconnect the wire from the Main Select Solenoid coil at MAIN SEL SOL-X.
3. Connect a digital ammeter in series with the Main Select Solenoid; (–) lead to MAIN SEL SOL-X terminal; (+) lead to the removed wire.
4. Reconnect the battery connector and turn the key switch ON. Run test and observe the following results.

Ammeter Reading	Operator's Display
0.0-0.02A	**Off**
1.0-2.0A	**On**

   If the above results are not observed, the test has failed.
5. Turn the key switch OFF and disconnect the battery connector. Remove the ammeter from the circuit and reconnect the wire.

Diagnosis and Repair

Step	Action/ Meter Setting	(+) Lead	(–) Lead	Expected Results	Step Passed	Step Failed
1	DCV	JPS12-10	B–	B+	Perform step 2	Replace TM
2		JPS29-2			Perform step 3	Replace coil driver board
3	JPS29 disconnected/ Ohms		JPS29-1	Approx 30 Ohms	Perform step 4	T/S wires and coil
4	Test ON/DCV	JPS1-B21 (VFC)	B–	ON; 5.3V OFF; 0V	Perform step 5	Replace VFC
5		JPS12-2		ON; 24V truck-10.6V 36V truck-7.2V OFF; 0V	Perform step 6	Replace TM
6		B+	JPS29-1	ON; approx 24V(IL1 on) OFF; 18.5V(IL1 off)	Perform step 1	Replace coil driver board

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Section 7. Component Procedures

Messages and Codes 6-9

Component Locator Photos . . . 7-3

General 7-13

Forks 7-14
Removal 7-14
Installation 7-14
Skid Pads 7-15
Location 7-15
Inspection 7-15
Replacement 7-15

Steering and Controls 7-17

Manual Steering Wire Rope 7-18
Adjustment 7-18
Replacement 7-19
Electric Steering 7-22
Service Notes 7-22
Proximity Sensor Adjustment 7-23
Control Handle 7-24
Removal 7-24
Lift/Lower Pot (VR2), Lift Spring and/or Horn Switch Replacement 7-24
Travel Pot (VR1) 7-26
Travel Spring and Pinion 7-27
Lift/Lower Knob Installation/Adjustment 7-28
Cleaning and Inspection 7-29
Hand Soldering Procedures 7-30
Installation 7-30
Deadman Pedal 7-31
Rectangular Pedal 7-31
Round Pedal 7-32
Emergency Power Off Switch 7-33
Removal 7-33
Installation 7-33

Drive and Brake 7-35

Drive Motor 7-36
Removal/Installation 7-36
Drive Unit Power Section 7-37
Drive Transmission Service 7-37
Drive Unit Removal 7-37
Drive Axle Seal Replacement 7-38
Brake 7-42
Brake Adjustment 7-42
Brake Rotor Replacement 7-43

Electrical Components 7-47

Battery Procedures 7-48
Cleaning 7-48
Electrical Leakage To Frame Test . . 7-48
Charging 7-48
Hydrometer Use 7-49
Voltage Check 7-49
Adding Water To Battery 7-49
Battery History Record 7-50
Motor, General 7-51
Brushes 7-51
Motor Stud Terminals 7-52
Fuses 7-54
Drive Motor/Heatsink Temperature Sensors 7-55
Removal 7-55
Installation 7-55
Q1 Replacement 7-56
Removal 7-56
Installation 7-56
Rectifier Replacement 7-57
Removal 7-57
Installation 7-57
Printed Circuit Board Remove and Replace 7-58
Carriage Control Card Replacement 7-58
Tractor Manager Card Replacement 7-59
Vehicle Function Controller Card Replacement 7-59
Power Card Replacement 7-59
Electric Steer Manager Replacement 7-60
Filter Card Replacement 7-60
TM3/TM4 Replacement 7-61
Removal 7-61
Installation 7-61
TM1/TM2 Replacement 7-62
Removal 7-62
Installation 7-62
EPROM/Microprocessor Remove and Replace 7-63
Removal 7-63
Installation 7-63

Hydraulic Components 7-65

Flow Sensor Service Notes 7-66
O-Ring Replacement 7-66
Disassembly 7-66
Assembly 7-67
High Pressure Relief Valve Adjustment 7-69
Lift/Lower and Load Holding Valves . . 7-70
Bleeding Lift Cylinders 7-71

https://truckmanualshub.com/

Side Lift Cylinders 7-71
Center Cylinder 7-71
Lift Pump and Motor 7-72
Removal 7-72
Installation 7-72
Pressure Switch Adjustment 7-73
Two-Stage Lift Cylinder 7-74
Removal 7-74
Disassembly 7-74
Cleaning 7-75
Reassembly 7-75
Installation 7-75
Three-Stage Center Lift Cylinder 7-76
Removal 7-76
Service of Cylinder without Cushions 7-76
Service of Cylinder with Cushions . 7-78
Installation 7-79

Mast Section 7-81

Mast Bearing Shimming 7-82
Upper Mast Bearing Replacement . . 7-82
Mast Disassembly and Shimming . . 7-84

https://truckmanualshub.com/

Component Locator Photos

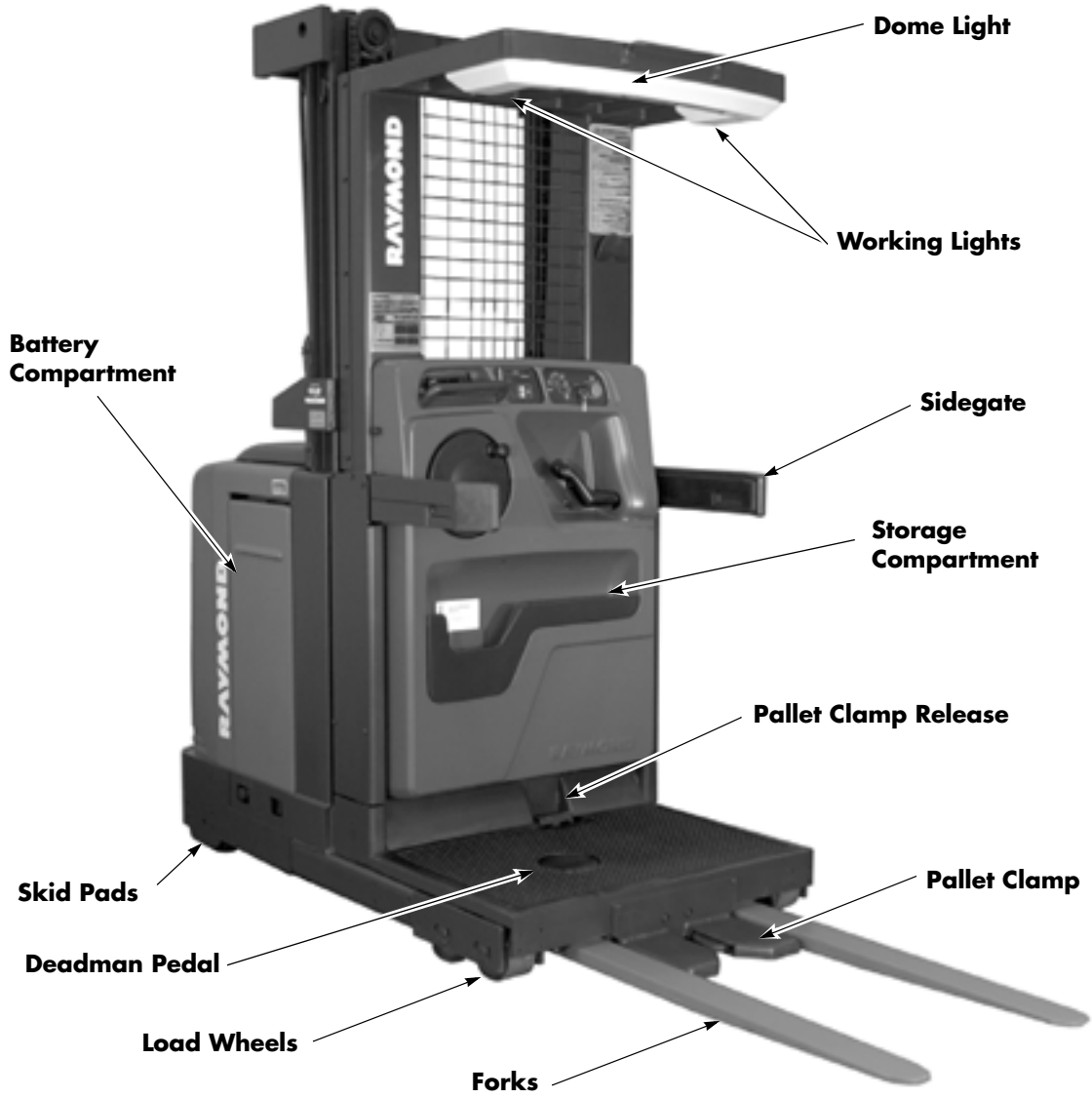


Figure 7-1. EASi™ Orderpicker - Overall View

https://truckmanualshub.com/

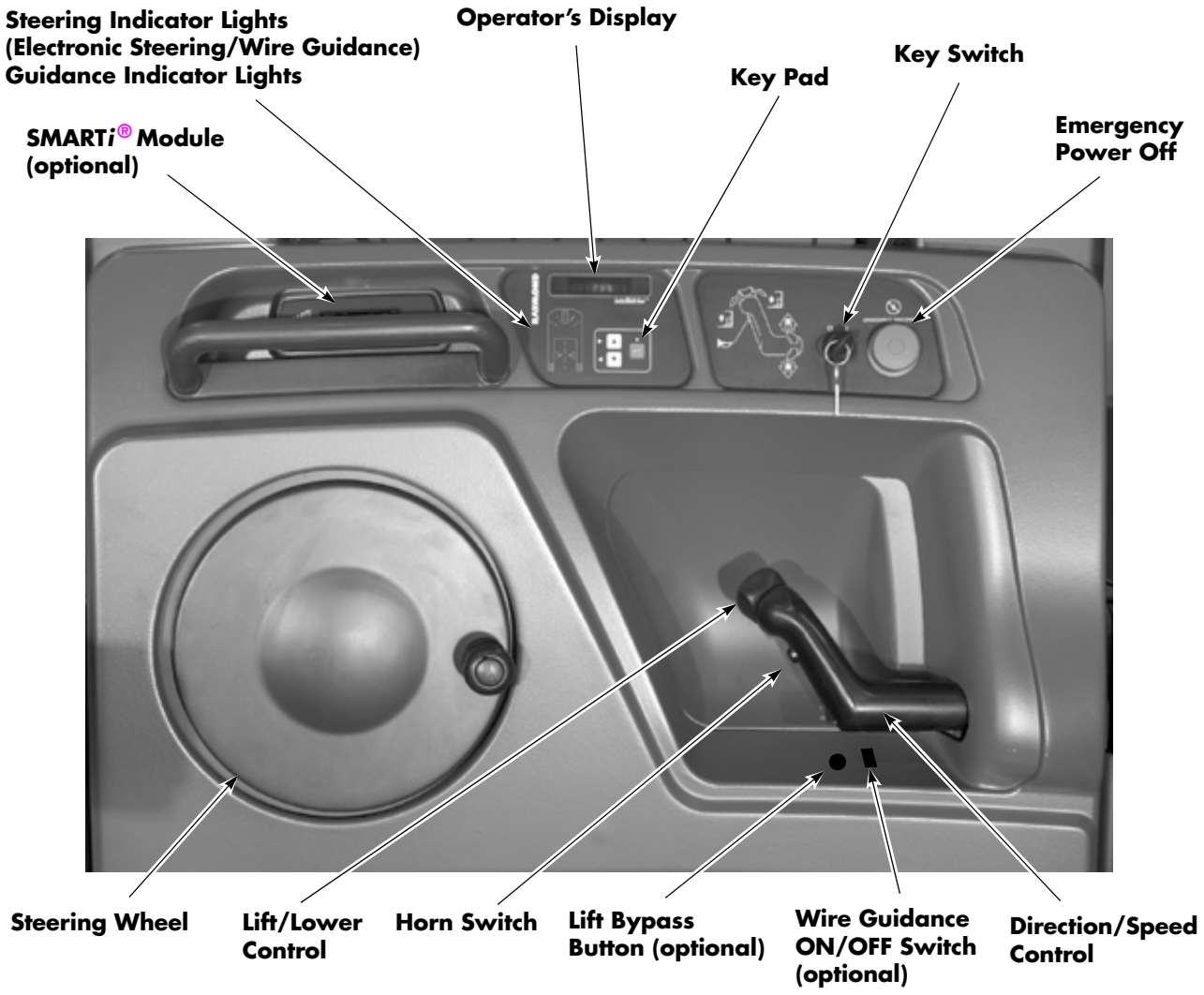


Figure 7-2. Operator's Console (Shown with Wire Guidance and Electronic Steering Options)

https://truckmanualshub.com/

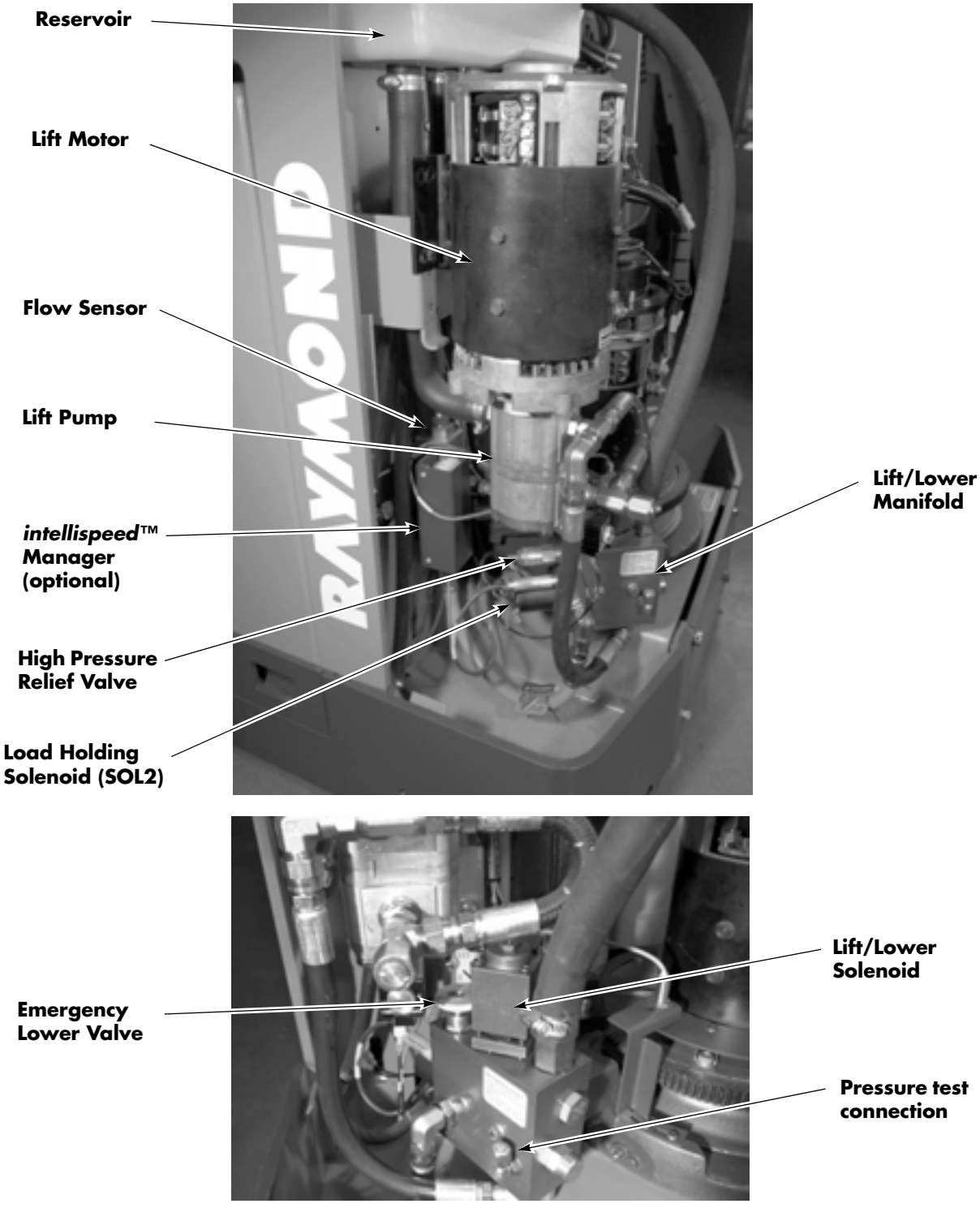


Figure 7-3. Hydraulic Compartment Components (Shown with Variable Lift/Lower and intellispeed options)

https://truckmanualshub.com/

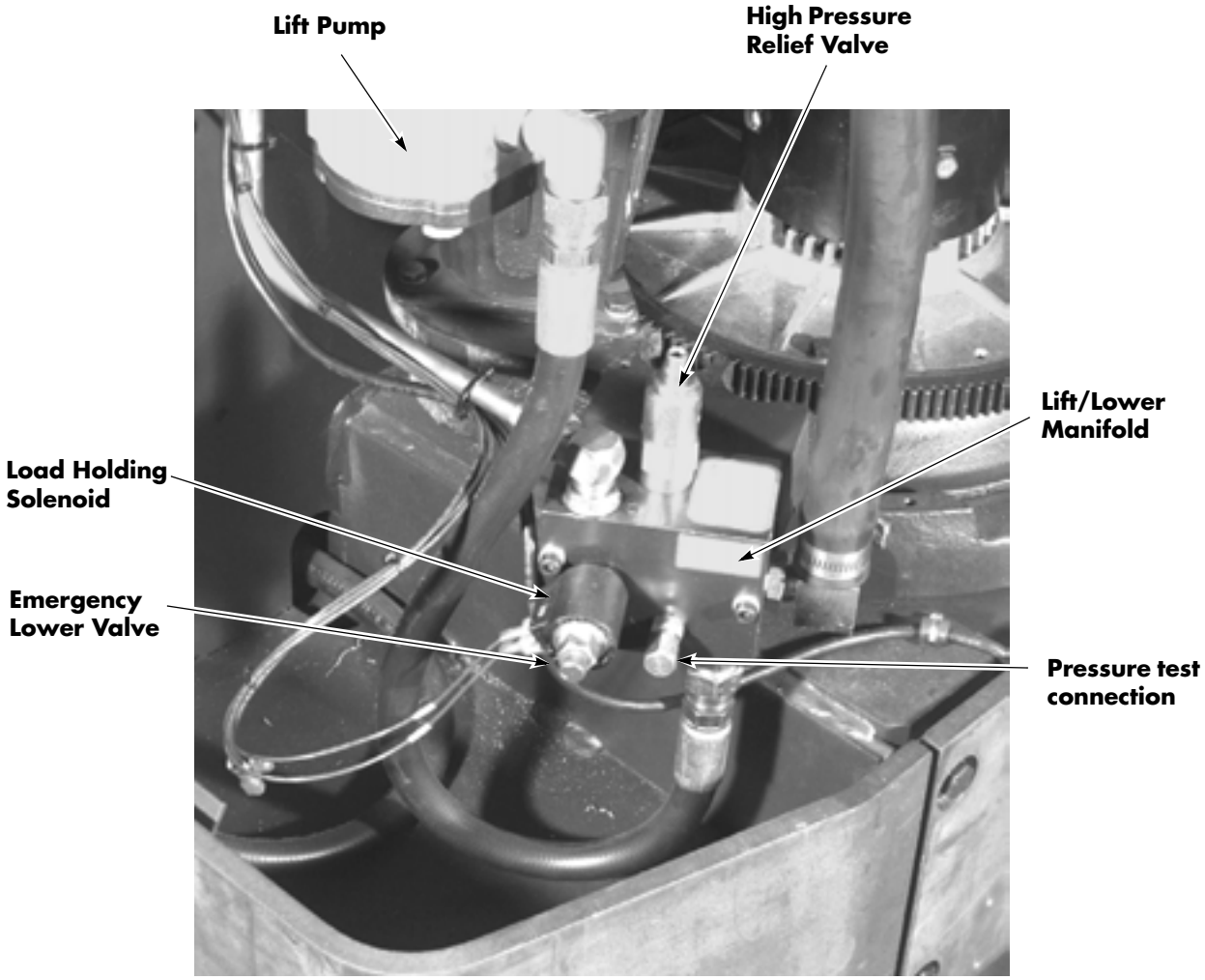


Figure 7-4. Hydraulic Compartment Components (Shown with Single Speed Lift/Lower)

https://truckmanualshub.com/

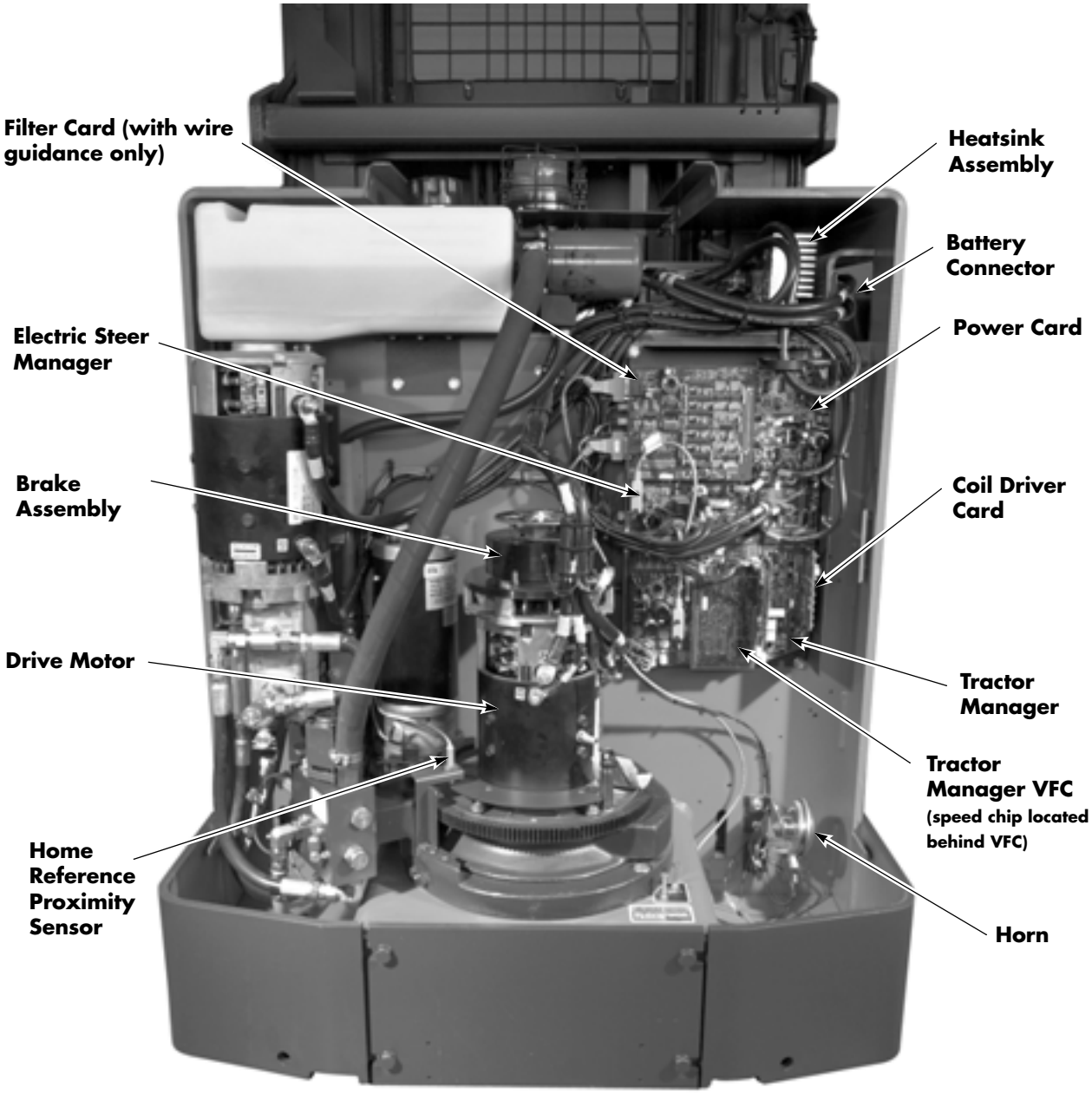


Figure 7-5. Electrical Compartment Components (Shown with Electric Steering and Wire Guidance)

https://truckmanualshub.com/

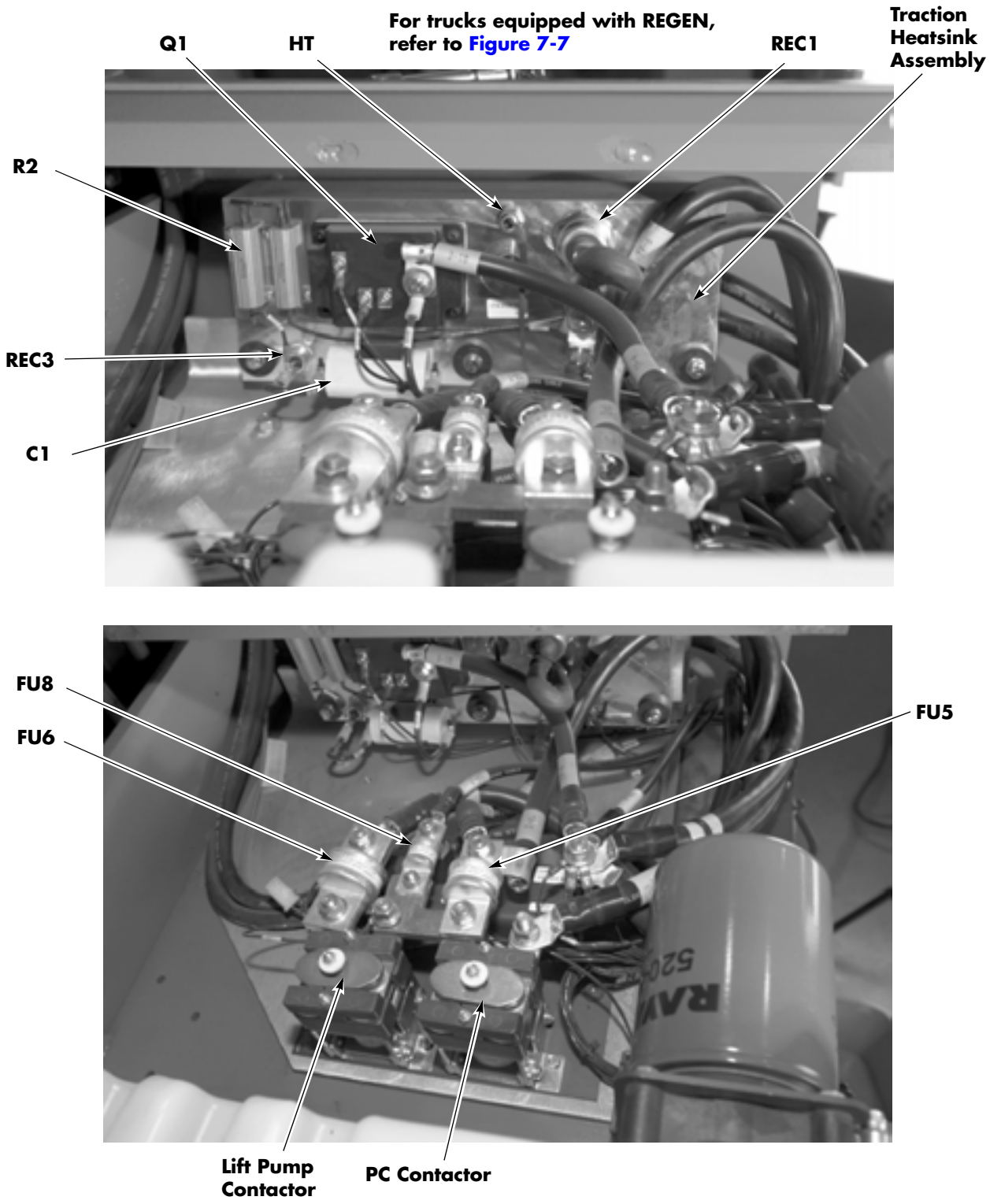


Figure 7-6. Electrical Compartment Components (Components Located on Upper Deck of Power Section)

https://truckmanualshub.com/

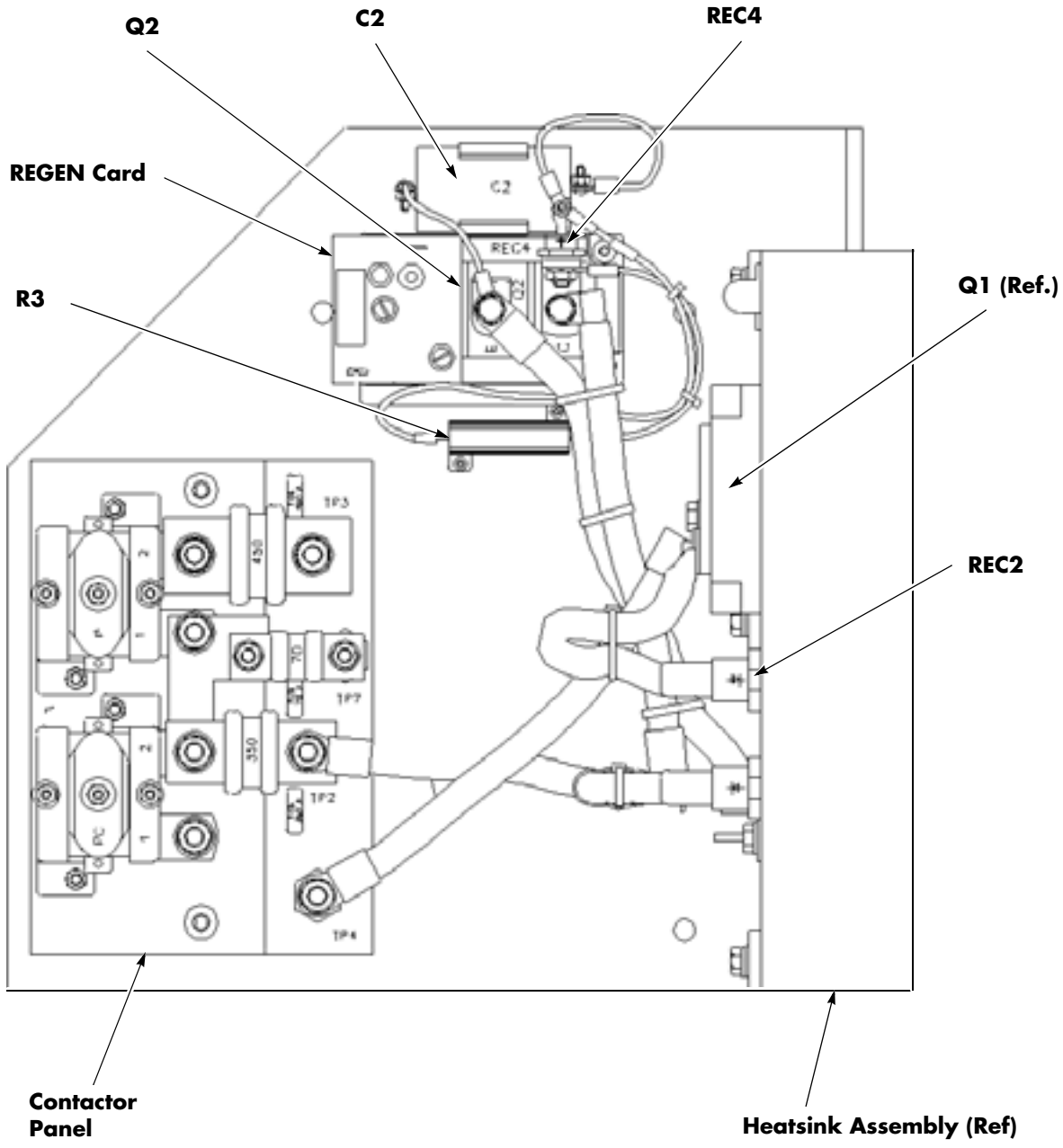


Figure 7-7. REGEN Components (optional)

https://truckmanualshub.com/

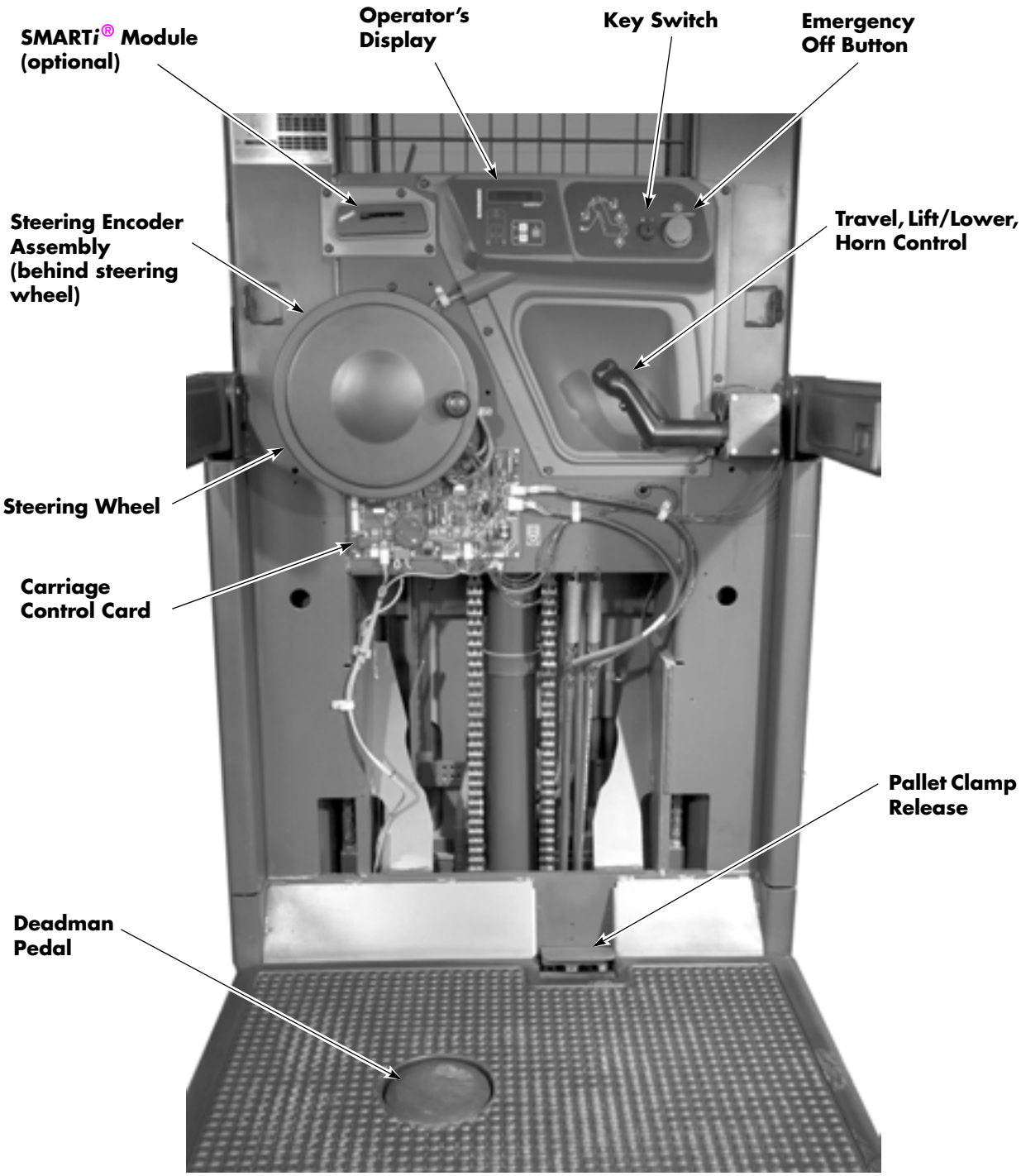


Figure 7-8. Platform Components (w/Electric Steering, Cover Removed)

https://truckmanualshub.com/

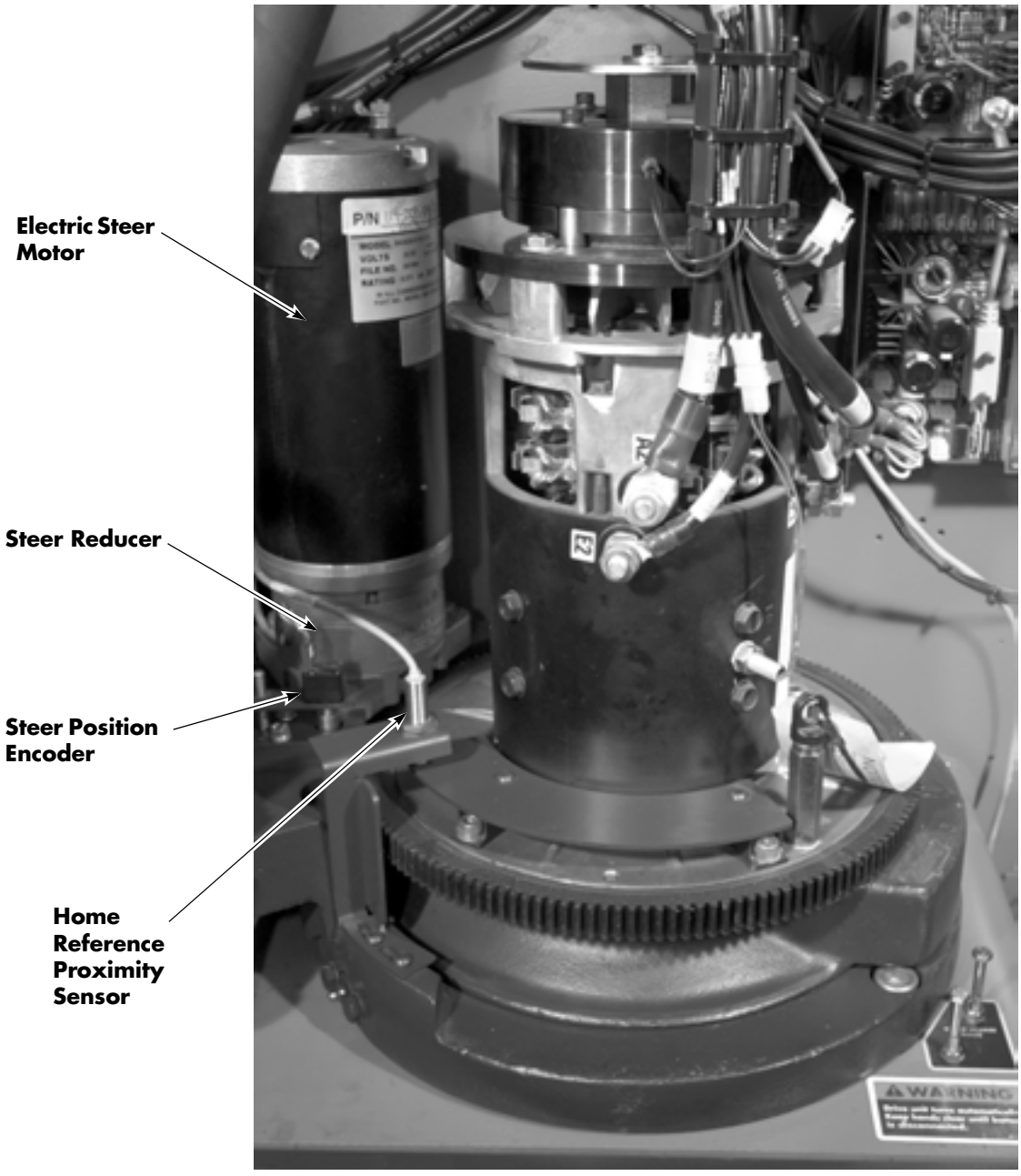


Figure 7-9. Electric Steering Components

https://truckmanualshub.com/

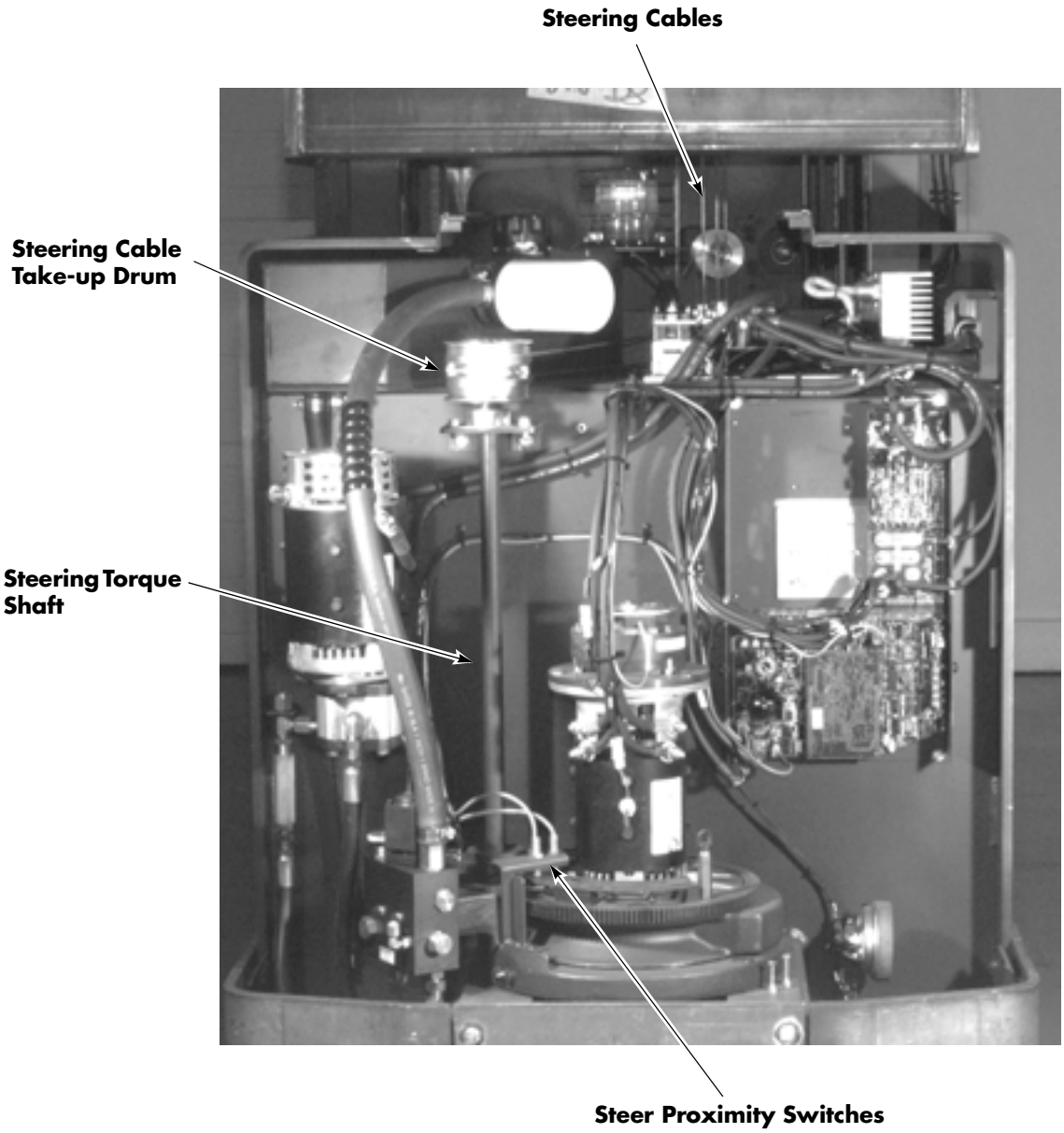


Figure 7-10. Mechanical Steering Components

https://truckmanualshub.com/

General

https://truckmanualshub.com/

Forks

Removal

1. Raise operator platform high enough to reach bottom of forks.
2. Block operator platform.
3. Secure fork to hoist using a suitable strap or chain. See Figure 7-11.
4. Remove socket head cap screw from underneath fork at tractor end.

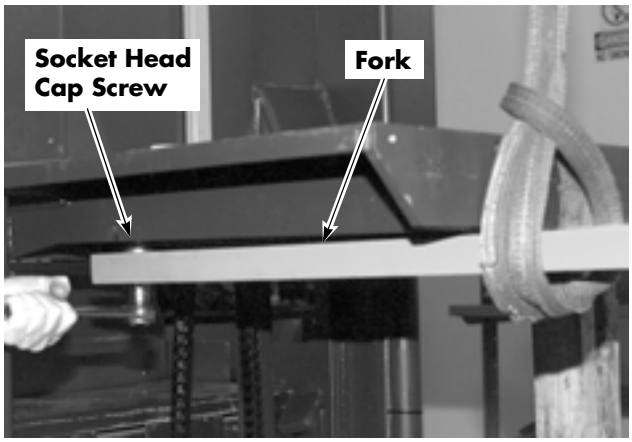


Figure 7-11. Fork Removal

5. Remove snap ring from pivot pin in mounting block of fork. See Figure 7-12.

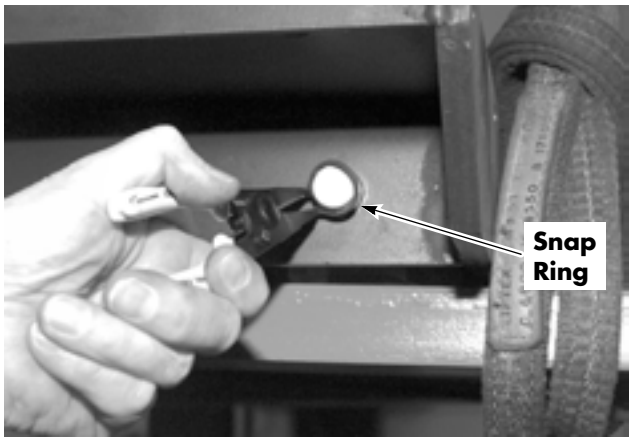


Figure 7-12. Snap Ring, Pivot Pin and Mounting Block

⚠ WARNING

The fork will drop in step 6. It weighs approx 150 lb. (68 kg).

6. Drive out pivot pin. The fork, washers or shim will drop.
7. Replace damaged fork.

Installation

1. Hold new fork in place underneath operator platform.
2. Install pivot pin through fork.

NOTE: Always use new snap rings when assembling components.

3. Install new snap ring in pivot pin.
4. Install correct amount of washers or shims at back side of fork to maintain a level fork. See Figure 7-13.

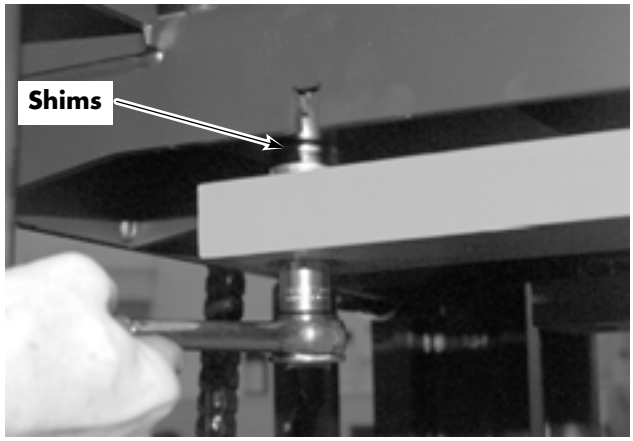


Figure 7-13. Installing Forks and Shims

5. Install socket head cap screw at tractor end of fork.
6. Remove block from operator platform.
7. Lower operator platform to floor and make sure forks are level. If forks are not level, add more shims to fork.

https://truckmanualshub.com/

Skid Pads

Location

There are 2 skid pads on each truck. See Figure 7-14.



Figure 7-14. Skid Pad Location

Inspection

1. Check clearance between each skid pad and floor.
2. If clearance is more than 0.75 in. (19.1 mm) on either side, replace skid pad.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support truck. DO NOT rely on the jack alone. See Jacking on page 2-11.

Replacement

Weld new skid pad inside worn skid pad. Clearance from floor should be 0.75 in. (19.1 mm).

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Steering and Controls

https://truckmanualshub.com/

Manual Steering Wire Rope

Adjustment

NOTE: Adjustments should be done with the carriage fully lowered.

1. With the operator's carriage fully lowered, adjust each turnbuckle to get 3/8 to 5/8 in. (9.5 to 16 mm) cable deflection when 2.5 lb (1134 gm) is applied at the midpoint. See Figure 7-15.
2. Repeat the procedure for the remaining cable.

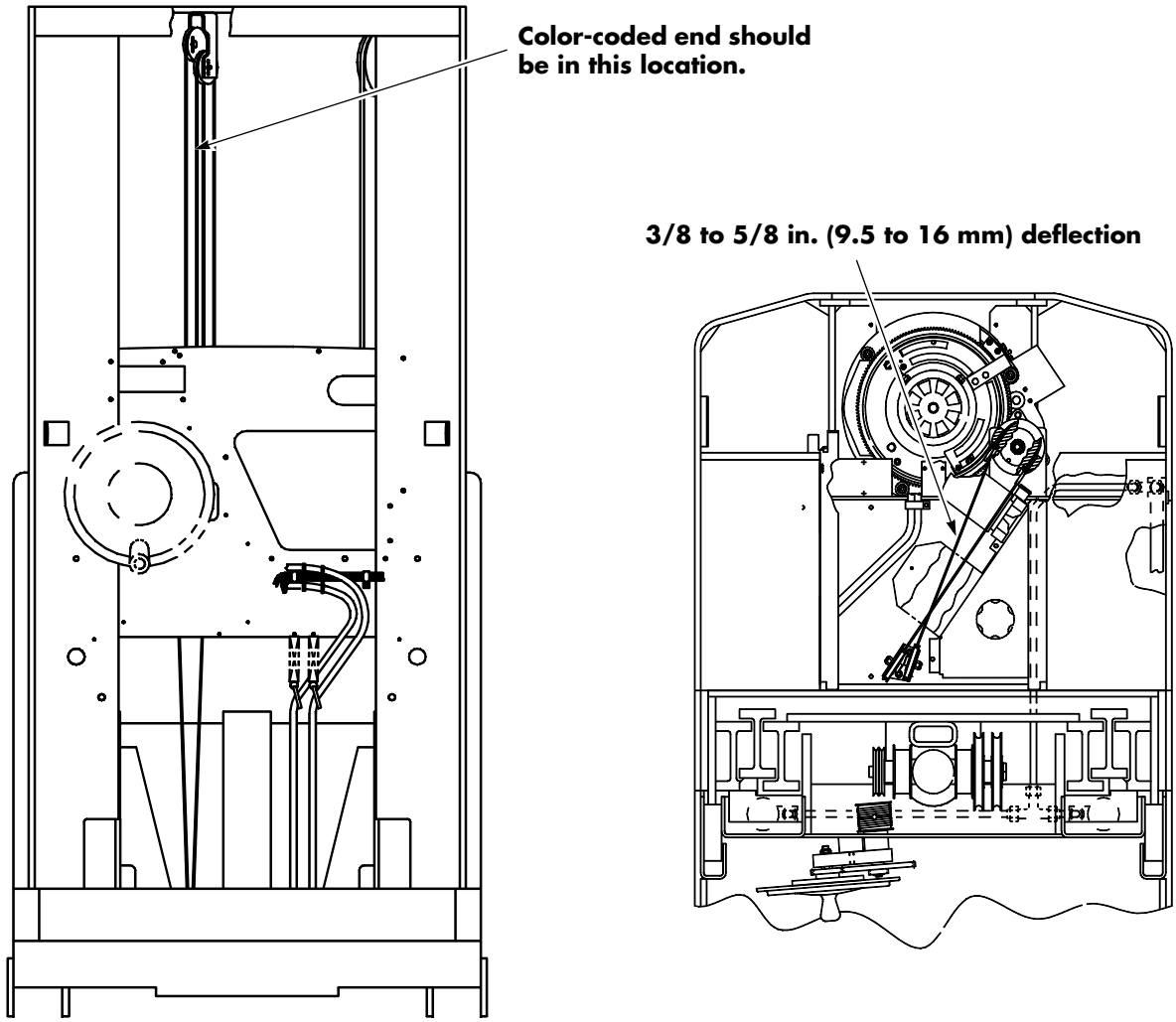


Figure 7-15. Adjusting Steering Cables

https://truckmanualshub.com/

Replacement

It is recommended that two people perform this procedure. Refer to Figure 7-16 for two-stage masts and Figure 7-17 for three-stage masts.

1. Make sure that the part numbers are correct for the application. Refer to the appropriate Parts Catalog for the model and serial number truck being repaired.
2. Make sure the drive tire is pointed as close to straight ahead as possible before you begin. This can be accomplished by driving the truck a short distance to verify that the steering is positioned correctly.
3. Raise the operator's platform approximately 72 in. (2 meters).

⚠ WARNING

Before performing any work under the elevated platform, place a safety stand capable of supporting the weight of the carriage under the operator's platform.

4. Lower the carriage onto a safety stand. Open the Emergency Lower Valve and lower the telescopic 1 in. (254 mm). This allows easier installation of the wire rope assemblies on the lower drum. Make sure you close the Emergency Lowering Valve.
5. Remove the jam nuts and adjusting nuts from the ends of the cables. These nuts are located on the lower drum. Refer to Figure 7-16 for two-stage masts and Figure 7-17 for three-stage masts.
6. Remove the cable assembly from the jack shaft take-up drum.
7. Remove the cable assembly from the mast pulleys. On three-stage trucks, the right mounting bracket for the pulley assembly (**1**) and (**2**) must be unbolted from the operator's platform to allow the cable assembly to be removed. See Figure 7-17.
8. On the steering control, make sure the steering knob is pointed straight down (6 o'clock) and the slot for the cable ball is at 12 o'clock.
9. Remove the cable assembly from the package. Do not kink the cable.
10. At the drum located near the steering control, place the swaged ball in the hole located at the top of the drum. The end of the cable which is *not color-coded* is to be wound *first*.
11. The end of the cable that is not color-coded is installed to the right on the cable drum as viewed from **-B-** in Figures 7-16 or 7-17. Wind the cable clockwise around the drum 3¼ turns. The cable will travel towards the steering wheel as it is wound around the drum.
12. Wind the color-coded end of the cable counterclockwise around the drum 3¼ times.
13. Temporarily secure the cable to the drum using tape or a cardboard tube.
14. Starting with the color-coded side of the cable, thread the cable through pulley (**1**). The pulley bracket will have to be removed to allow the cable end to pass through.
15. Thread the end *not* color-coded through the pulley (**2**). Tighten the pulley bracket.

NOTE: As the cables are threaded around the remaining pulleys, make sure the cables do not get crossed.

Two-stage trucks.

Thread the cables around the pulleys in front of the ones just tightened in the previous step. The next pulley set is at the top of the mast. Go to step 17.

Three-stage trucks.

The next pulleys are located at the top of the center lift cylinder.

16. Install the cables around the pulleys near to battery compartment.
17. Keeping the cables parallel, route the cables through the pulleys on the inner telescopic.
18. Keeping the cables parallel, route the cables through the pulleys on the power section.
19. Temporarily anchor the color-coded end somewhere on the tractor.

https://truckmanualshub.com/

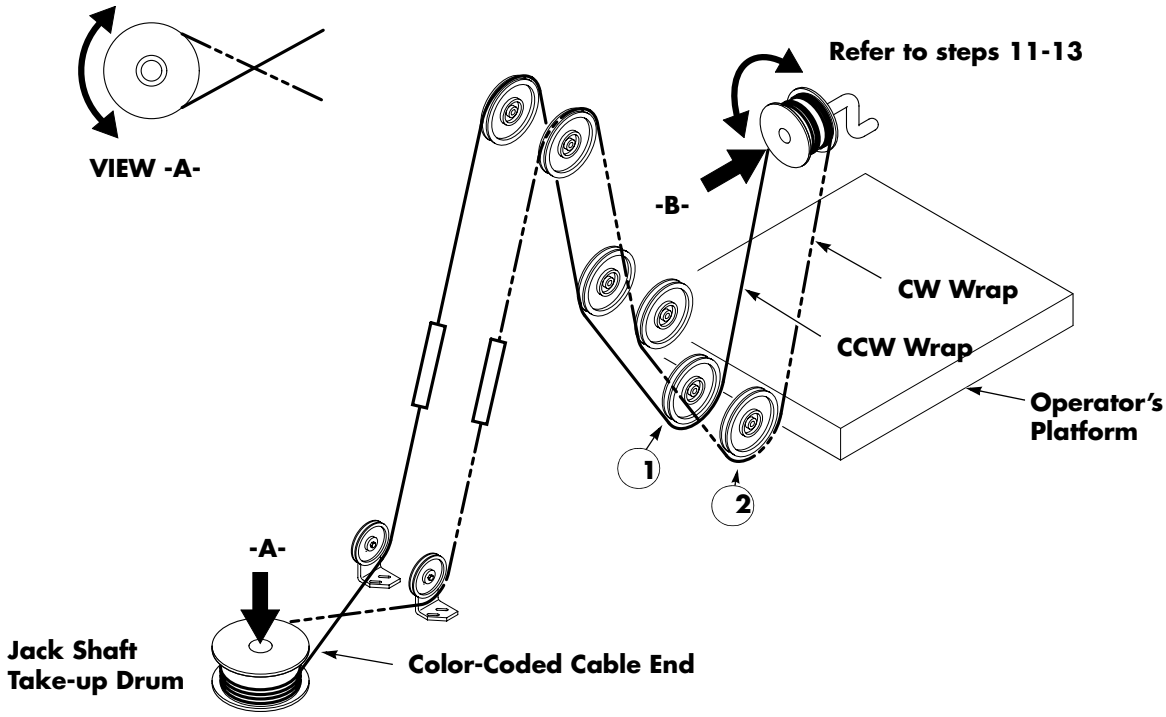


Figure 7-16. Steer Cable Routing for Two-Stage Mast

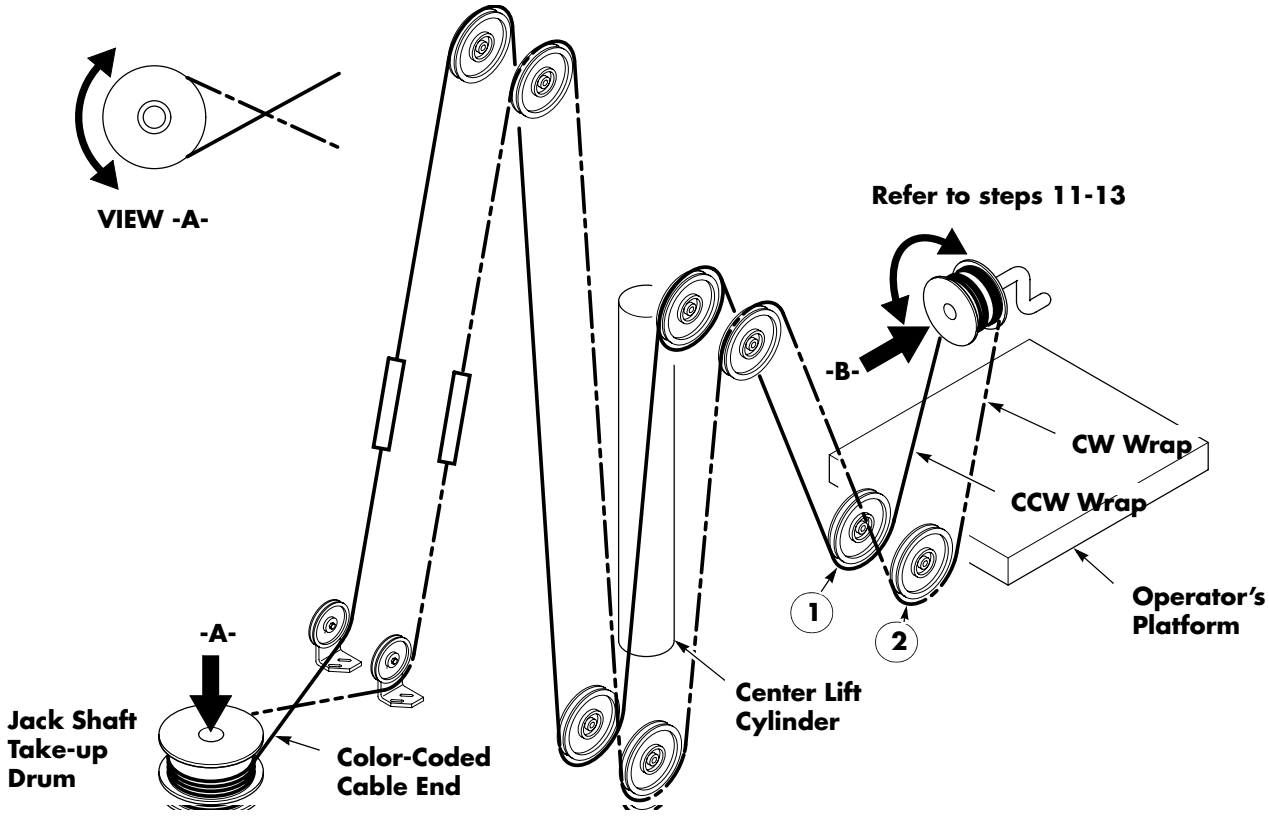


Figure 7-17. Steer Cable Routing for Three-Stage Mast

https://truckmanualshub.com/

20. Take the non color-coded end and wind the cable around the lower section of the jack shaft take-up drum two full turns.
21. Insert the threaded end through the lower hole in the drum. Install one nut. Hand tighten for now.
22. With the color-coded end, wrap the cable around the jack shaft take-up drum two full turns.
23. Insert the threaded end through the remaining hole in the drum. Install one nut. Hand tighten for now.
24. If properly installed, the cables should cross as viewed from **-A-** in Figures 7-16 or 7-17.
25. Tighten all hardware and remove any tape or devices used to temporarily hold the cable in position.
26. Remove the safety stand. Lower the operator's compartment.
27. Adjust the cable tension per "Adjustment" on page 7-18. Make sure the jam nuts on the turnbuckles and the adjusters are tight.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support truck. DO NOT rely on the jack alone. See Jacking on page 2-11.

28. Jack the power section so the drive tire is off the floor.
29. Turn the steering control. Make sure the steering control can travel from lock to lock and the cable tracks correctly within the grooves on the cable drums as the steering control is turned.
30. Lower truck. Test.

https://truckmanualshub.com/

Electric Steering

Service Notes

Figure 7-18 is a cross-sectional view of the steering control and applicable service notes for trucks below S/N 31,000.

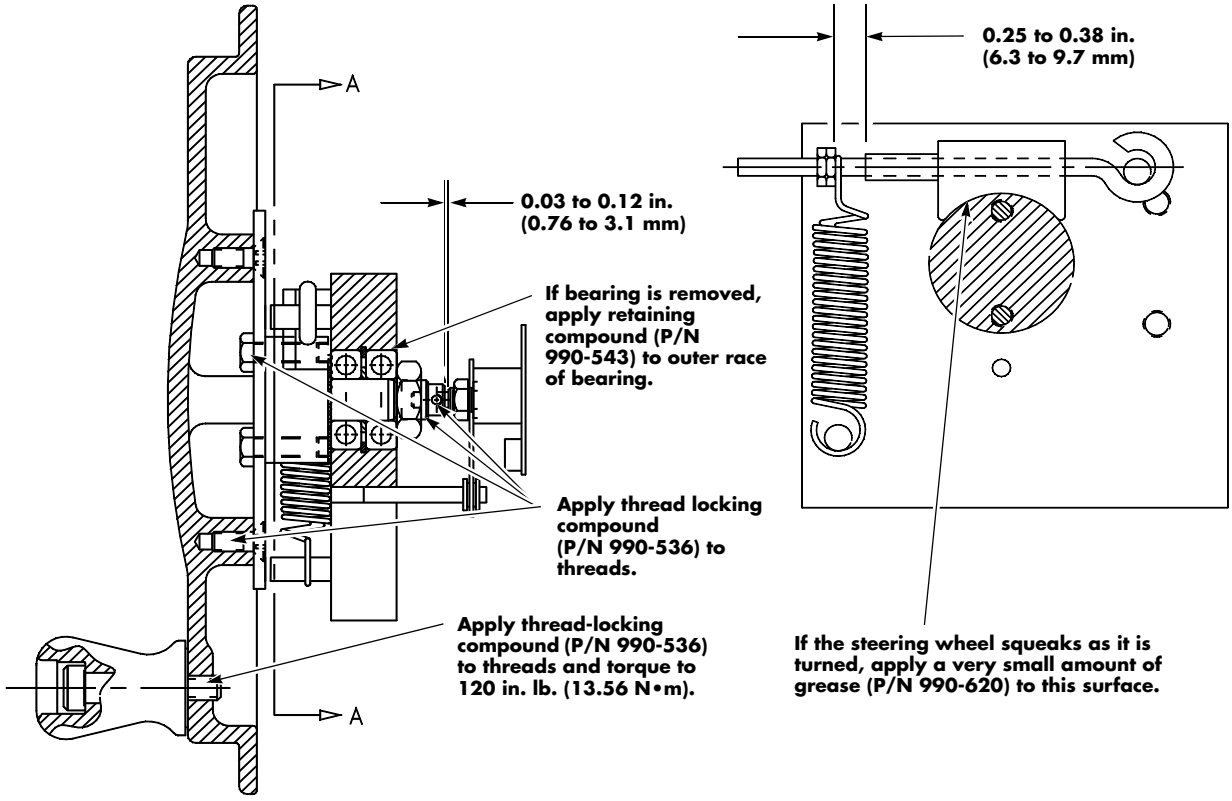


Figure 7-18. Steering Control Assembly (below S/N 31,000)

https://truckmanualshub.com/

Proximity Sensor Adjustment

1. Turn the key switch OFF and disconnect the battery connector.
2. Loosen the two lock nuts securing the sensor to the bracket. See Figure 7-19.

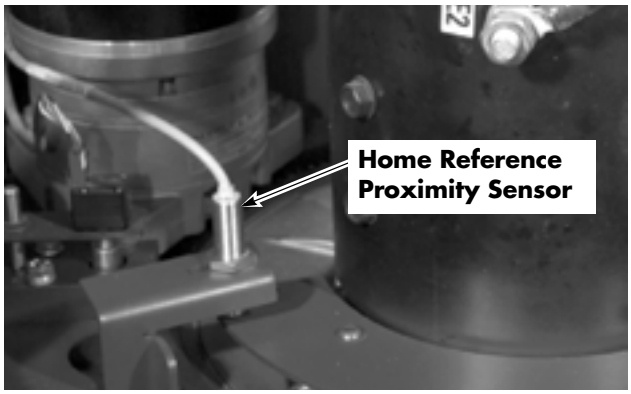


Figure 7-19. Home Reference Proximity Sensor

3. Adjust the vertical gap between the sensor and the sensor rail to 0.06 ± 0.04 in. (1.5 ±1 mm). Tighten the lock nuts.
4. Reconnect the battery connector and turn the key switch ON.
5. Center the drive wheel. The sensor should be located horizontally just past the end of the sensor rail.

https://truckmanualshub.com/

Control Handle

For replacement parts, refer to the parts manual for the truck the handle is installed on.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Disconnect JPC9 and remove the Control Handle from the truck.

NOTE: Observe orientation of switches/ potentiometers and routing of cables/wires as the handle is disassembled to make reassembly easier.

⚠CAUTION

Be sure to observe proper precautions against electrostatic discharge. See "Static Precautions" on page 2-9.

Before disassembly, determine which components require replacement:

- Lift/Lower Potentiometer (Pot), Lift Spring, and/or Horn Switch
- Travel Pot and/or Gear
- Travel Spring, Shaft Gear, and so on
- Lift/Lower Knob

Lift/Lower Pot (VR2), Lift Spring and/or Horn Switch Replacement

Disassembly

1. Remove the two 3/32 socket head nylon set screws in the lift/lower knob (thumb lever). If stripped, use a small 1/8 in. blade flat screwdriver and carefully back out the set screw.
2. Loosen the two metal set screws in the lift/lower knob two full turns and remove the lift/lower knob.

NOTE: Carefully slide the two spacer washers, lift/lower spring, and third spacer washer off of the lift pot shaft. See Figure 7-20.

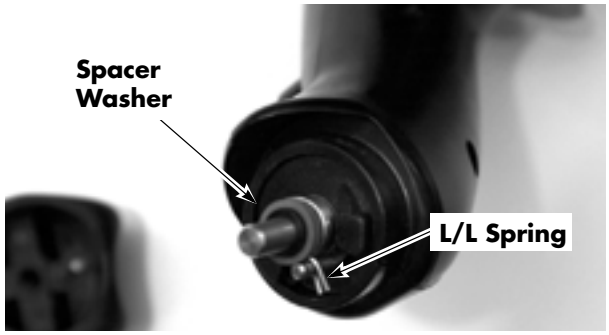


Figure 7-20. Spacer Washer and L/L Spring Removal

3. Remove the three 3mm socket head cap screws from the handle assembly. See Figures 7-21 and 7-22. Separate the cover from the handle.

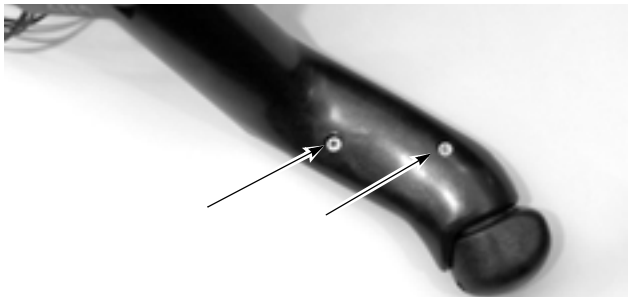


Figure 7-21. Cover Retaining Screws - Bottom

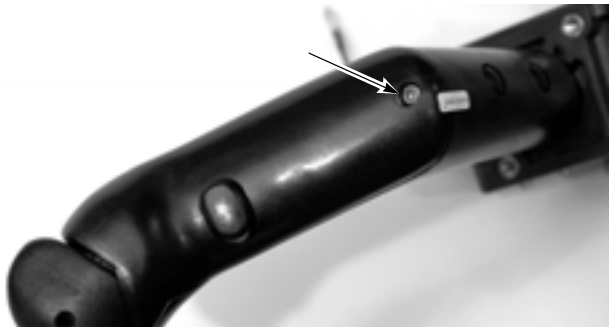


Figure 7-22. Cover Retaining Screw - Top

NOTE: Before sliding the pot bracket off the pot shaft, identify which slot in the pot bracket is used to hold the pot anti-rotate tab. The anti-rotate tab should be located in the slot furthest from the pin in the pot bracket.

https://truckmanualshub.com/

4. Remove the lift/lower pot and bracket from the cover. See Figure 7-23.

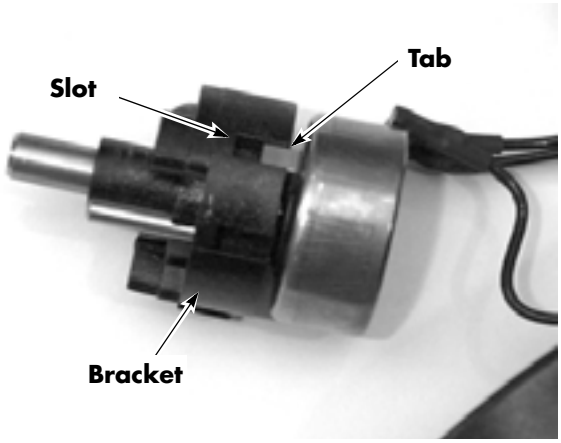


Figure 7-23. Anti-Rotate Tab

5. Carefully pry the horn switch from the cover using a small screwdriver. See Figure 7-24.



Figure 7-24. Horn Switch Removal

NOTE: The button, pin, and spring can easily slide apart. Identify the proper position of these components before disassembly.

6. If replacing the lift/lower pot, carefully remove heat shrink tubing from the terminals. Identify the wires so they can be installed in the same location on the new pot.
7. Carefully unsolder the harness wires from the lift/lower pot.

Assembly

1. Carefully solder harness wires to the proper terminals on the new lift/lower pot. Refer to "Hand Soldering Procedures" on page 7-30.
2. Install horn switch assembly into the handle cover by snapping the pin into the plastic detents.
3. Slide lift/lower pot bracket onto the shaft. Make sure the anti-rotation tab is inserted into the proper slot on the bracket. See Figure 7-23.
4. Press the lift/lower pot and bracket into the handle cover. Make sure the key on the bracket engages the keyway in the handle cover.
5. Make sure all wires are routed properly. Tuck the common ground wire into handle between the bottom of the potentiometer and the screw boss to prevent the wire from being pinched or interfering with the horn button. See Figure 7-25.



Figure 7-25. Control Handle Wire Routing

6. Install the cover onto the handle assembly with the three socket head cap screws. Torque to 15-20 in. lb. (1.7-2.25 N•m).
7. Install a fiber washer and lift/lower spring (lightly greased with P/N 990-635) on the lift/lower pot shaft. Install the spring with the tangs straddling the pot bracket pin. See Figure 7-20.

https://truckmanualshub.com/

NOTE: Replace the spring if the tangs are not parallel. *Do not* bend the spring.

8. Install the two remaining fiber washers.
9. Install the lift/lower knob. See "Lift/Lower Knob Installation/Adjustment" on page 7-28.

Travel Pot (VR1)

Disassembly

1. Remove the four hex head cap screws from the front of the travel pot enclosure and remove cover. See Figure 7-26.

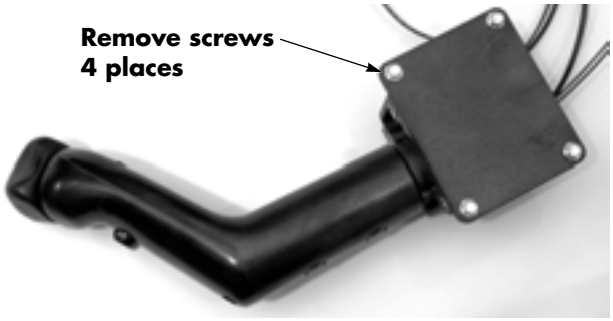


Figure 7-26. Travel Pot Cover Removal

2. Remove the two pan head machine screws from the back of the enclosure. Carefully pull the travel pot/bracket assembly from the enclosure. See Figures 7-27 and 7-28.

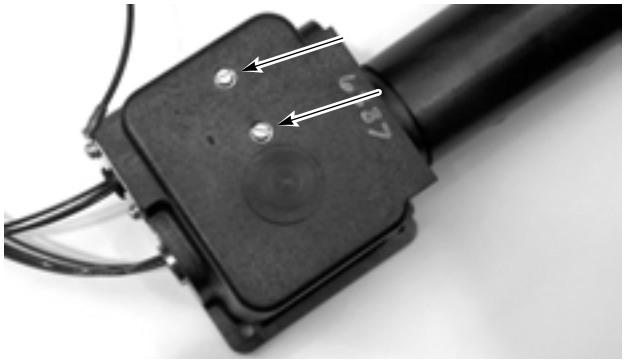


Figure 7-27. Travel Pot Bracket Screws

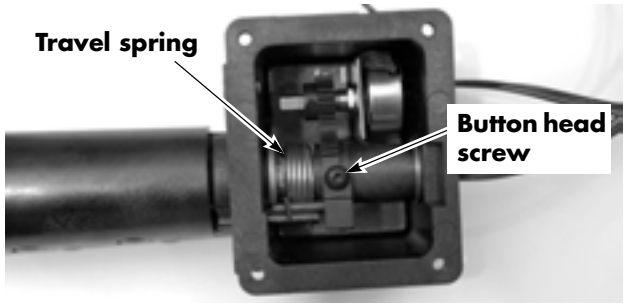


Figure 7-28. Travel Pot Enclosure (Cover Removed)

3. Loosen the set screw on the gear two full turns and slide the gear off the shaft. See Figure 7-29.
4. Remove retaining nut and lock washer from pot and separate from the bracket. See Figure 7-29.

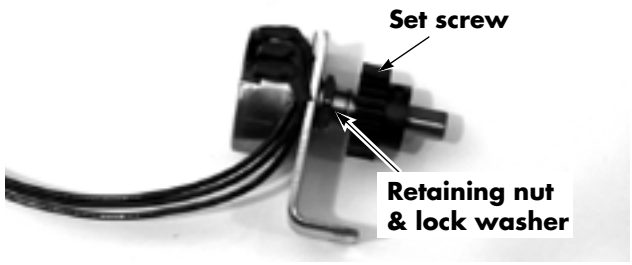


Figure 7-29. Travel Pot/Bracket Disassembly

5. Carefully remove heat shrink tubing from the terminals and identify the wires so they can be installed in the same location on the new pot.
6. Carefully unsolder the harness wires.

Assembly

1. Slide 3/8 in. (9.5 mm) long shrink sleeving over previously sleeved wires.
2. Solder all electrical components to the harness. See "Hand Soldering Procedures" on page 7-30.
3. Shrink sleeving as necessary.
4. Assemble pot and bracket and install retaining nut and lock washer. When installing the travel pot into the bracket, leave the mounting nut finger tight. See Figure 7-29.

https://truckmanualshub.com/

5. Install the gear on the pot shaft, aligning the set screw with the flat portion of the shaft.
6. Install the travel pot/bracket assembly into the enclosure. Engage the travel pot gear with the shaft gear (there is one large tooth that is used to align the gears). Tighten the pot gear set screw and torque to 3 to 4 in. lb. (0.3 to 0.4 N•m).

⚠CAUTION

It is very easy to over torque and ruin the gear.

7. Tighten the two pan head machine screws on the back of the enclosure while moving the handle to ensure there is no binding. See Figure 7-27.
8. Install the handle in the truck.
9. Adjust the travel pot. Run Test A03 - Throttle Potentiometer Voltage (Page 6-119) and adjust the travel pot voltages to the values given.
10. Tighten the retaining nut.
11. Install the cover on the travel pot enclosure with the four hex head cap screws. See Figure 7-26.

Travel Spring and Pinion

Disassembly

1. Remove the four hex head cap screws from the front of the travel pot enclosure and remove cover. See Figure 7-26.
2. Use a pin removal tool and pull pins 3 thru 6 from JC-9. These wires pass through the shaft to the lift/lower pot and horn switch.

NOTE: The washer and shims can easily slip off of the shaft gear. Observe the proper position of these components before disassembling them.

3. Remove the button head screw from the shaft gear and slide shaft out of enclosure. See Figure 7-28.
4. Carefully rotate the shaft gear assembly to disengage the spring tangs from the pin. Remove the shaft gear assembly from the enclosure.

Assembly

1. Slide the shaft gear assembly back into enclosure. Engage the travel pot gear with the shaft gear (there is one large tooth that is used to align the gears).
   a. Make sure the spring tangs straddle the pin (tangs should be parallel). If the spirol pins were replaced, make sure they are installed such that when the spring is installed, the spring sits on an even edge of the pin and not on the gap.

NOTE: Replace the spring if the tangs are not parallel. *Do not* bend the spring.

   b. Make sure the washer and shims are properly aligned to allow the handle shaft to slide easily through the enclosure. See Figure 7-30.

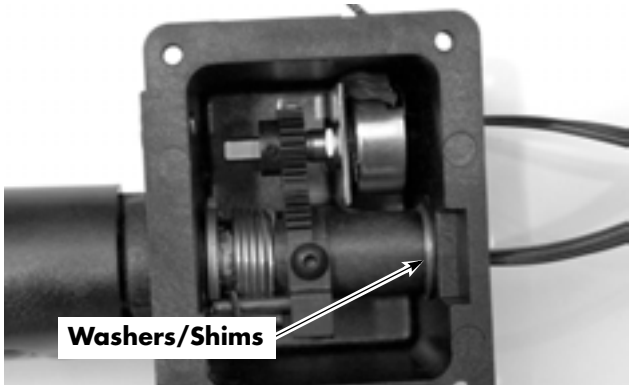


Figure 7-30. Travel Pot/Bracket Assembly Installation

2. Route the lift/lower pot and horn wires through the enclosure. Carefully slide the shaft through the enclosure, passing through the shaft gear assembly, washer, and shims.
3. Align the screw hole in the handle shaft with the hole in the shaft gear. Apply thread locking compound (P/N 990-412) to the threads in the shaft and on the button head screw. Install the screw and torque to 8 to 12 in. lb. (0.9 to 1.3 N•m).
4. Reinstall the wire pins into the connector.

https://truckmanualshub.com/

5. Inspect the tab on the plate ground to ensure that it is in contact with the bronze handle shaft bushing. See Figure 7-31.

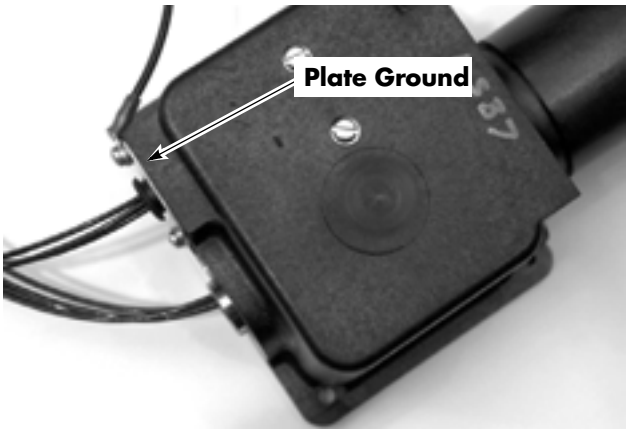


Figure 7-31. Plate Ground

6. Install the cover on the travel pot enclosure with the four hex head cap screws. See Figure 7-26.

Lift/Lower Knob Installation/Adjustment

1. Rotate the lift/lower potentiometer shaft fully counterclockwise.
2. Install the lift knob on the potentiometer shaft. The pin on the knob must fit between the tangs of the potentiometer return spring.
3. Rotate the lift/lower knob fully counterclockwise and tighten the metal set screws to 6 to 8 in. lb. (0.7 to 0.9 N•m).
4. Check the potentiometer for proper operation and spring return to neutral. Correct any binding.
5. Install and tighten two nylon set screws on top of the metal set screws.
6. Verify the potentiometer reference voltages. Refer to “Test A04 - Lift/Lower Potentiometer Voltage” on page 6-120.

https://truckmanualshub.com/

Cleaning and Inspection

⚠CAUTION

When cleaning plastic parts, use a dry rag or a cleaner that is safe on plastics. Most chemicals can damage plastic.

While performing a repair on the Control Handle, clean and inspect the parts listed in Table 7-1.

Table 7-1. Control Handle Checks

Part	Check for:
Horn button assembly (button, pin, & spring)	Cracks or deformation
Lift/lower pot bracket	Cracks, deformation, loose dowel pin, over round or oversized shaft hole
Travel pot gear	Cracks, gear deformation, stripped threads
Travel shaft gear assembly	Cracks, gear deformation or loose spirol pin
Travel pot enclosure	Cracks, loose spirol pin, stripped threads, deformation or indents on external stops
Handle halves	Cracks, damage or deformation/indents on external stops
Lift/lower knob	Cracks, deformation, stripped threads, loose dowel pin
Plate ground	Check for continuity between the control handle shaft and the truck frame
Other hardware	Stripped threads. All screw threads should be cleaned.

https://truckmanualshub.com/

Hand Soldering Procedures

When hand soldering is performed on solid state potentiometers, the following is recommended:

- Flux - rosin base
- Solder - 60/40 rosin core or equivalent
- Solder Iron - 55 watt max.
- Tip Size - 0.118 in. (3 mm) dia. x 1.182 in. (30 mm) long screwdriver
- Tip Temperature - 500°F (260°C) max.
- Terminal Contact Time - 6 seconds max.

NOTE: Apply light soldering iron pressure on the terminal. Make sure the tip is clean. A dirty tip does not transfer heat well, therefore requiring longer dwell time and greater tip pressure.

⚠CAUTION

Contact contamination can occur if cleaning solvent is allowed to enter switches or potentiometers.

After soldering, clean terminals with a brush dampened with an alcohol based cleaner (P/N 990-600/FOF). Make sure cleaner does not seep into the electrical component.

NOTE: Components damaged due to solvent saturation *will not* be covered under warranty.

Installation

1. Install control handle on truck. Connect JPC9.
2. Reconnect the battery connector and turn the key switch ON.
3. Perform LEARN and test truck operation before returning to service. See LEARN Mode on page 3-13.

https://truckmanualshub.com/

Deadman Pedal

Make sure the area around and beneath the deadman pedal is clean.

Rectangular Pedal

EASi™ Orderpicker's with Serial Numbers less than 31,000 have a rectangular deadman pedal. Adjust the pedal as shown in Figure 7-32.

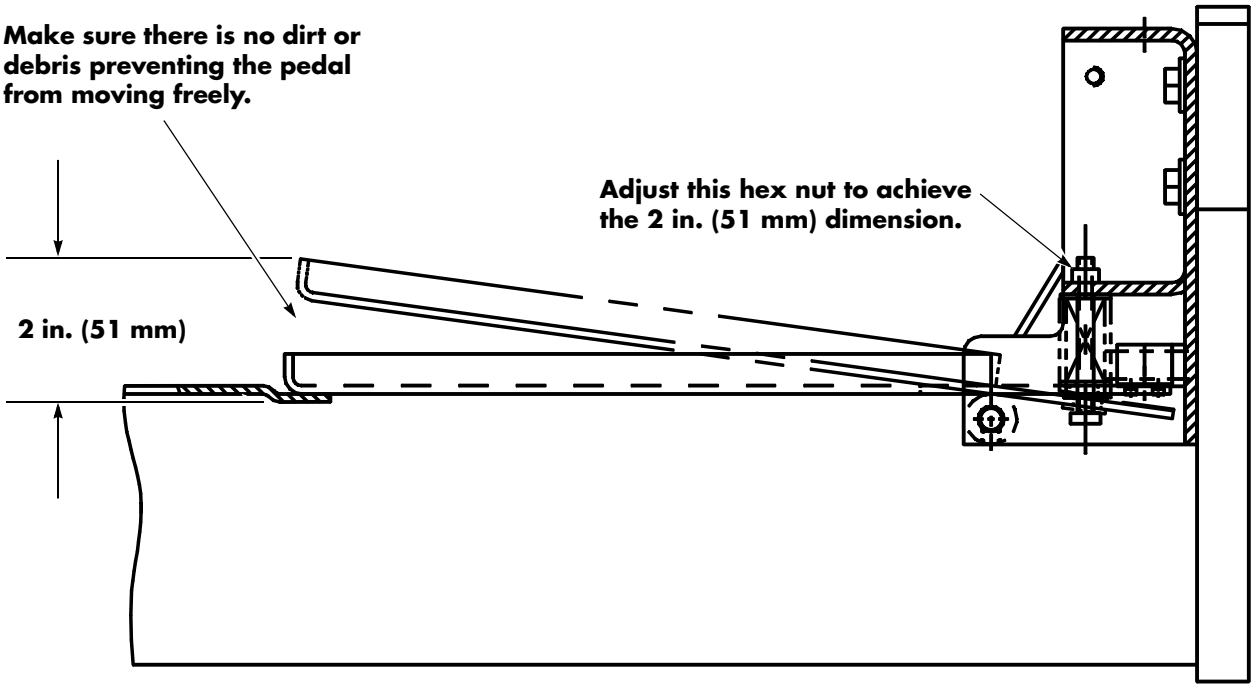


Figure 7-32. Adjusting Deadman Pedal

https://truckmanualshub.com/

Round Pedal

EASi™ Orderpicker S/N's 31,000 and up have a round deadman pedal. See Figure 7-33.

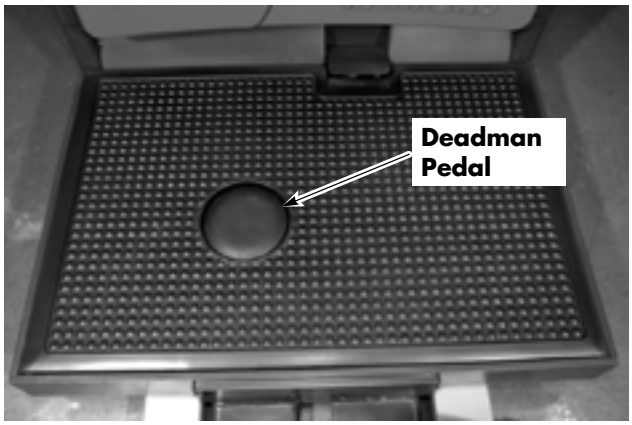


Figure 7-33. Deadman Pedal

Switch Replacement

There are two deadman switches (S2 and S23).

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support truck. DO NOT rely on the jack alone. See Jacking on page 2-11.

1. Raise operator platform high enough (at least 3 ft. [91.44 cm]) to access bottom of deadman pedal from under platform.
2. Block operator platform with a 4 in. x 4 in. (100 x 100 mm) wooden block.
3. Turn the key switch OFF and disconnect the battery connector.
4. Remove snap ring from bottom of deadman pedal post. See Figure 7-34.
5. While holding the two return springs in place, lift pedal straight up.

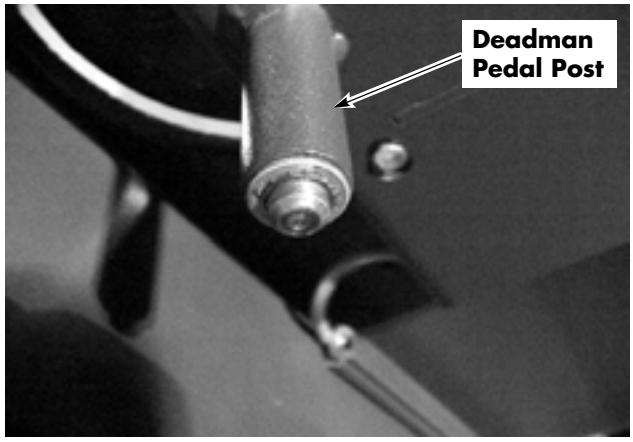


Figure 7-34. Deadman Pedal Post Under Platform

6. Remove two screws mounting deadman switch to bracket.
7. Disconnect wires from deadman switch(es). Note location and mark if necessary for recognition later.
8. Replace bad switch(es). See Figure 7-35.
9. Reconnect wires.
10. Align washers with holes.
11. While holding the two return springs in place, install pedal assembly. See Figure 7-35.
12. Install snap ring on bottom of deadman pedal post.
13. Reconnect the battery connector and turn the key switch ON. Test truck operation before returning to service.

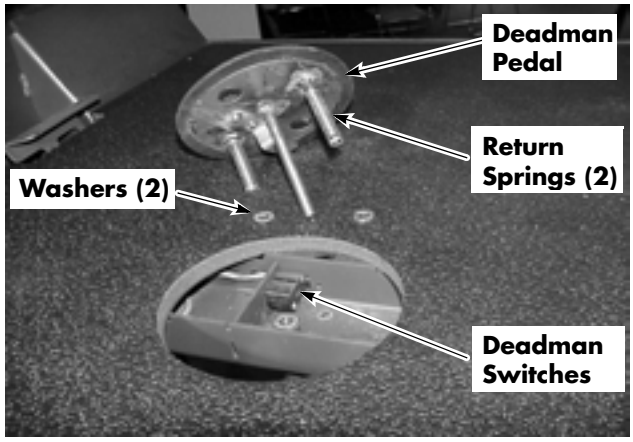


Figure 7-35. Deadman Pedal Components

https://truckmanualshub.com/

Emergency Power Off Switch

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove operator console cover.
3. Disconnect wires EPO-1 and -2 from back of EPO switch. See Figure 7-36.

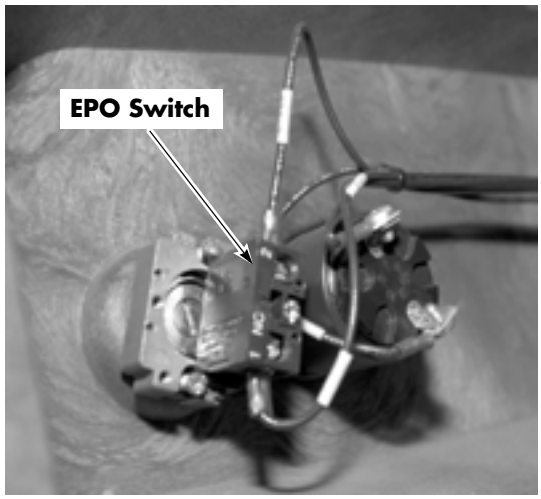


Figure 7-36. EPO Switch

4. Loosen two screws on backside of EPO switch.
5. Hold lower half of switch, push in and rotate top half 90° counterclockwise to unlock halves of EPO switch.

NOTE: The switch may turn hard.

6. Lift top half of EPO switch from bezel.

Installation

1. Insert lower portion of EPO switch in its hole in bezel.
2. Slide upper half of EPO switch over lower half until it is seated. Rotate top half 90° clockwise to lock.
3. Tighten screws on backside of EPO switch.
4. Re-connect wires.
5. Install operator console cover.
6. Reconnect the battery connector and turn the key switch ON. Test truck operation before returning truck to service.

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Drive and Brake

https://truckmanualshub.com/

Drive Motor

Removal/Installation

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove any proximity sensor(s) and associated hardware on the drive unit. See Figure 7-37.
3. Remove disc rotor and brake assembly including the rotor hub nut and rotor hub. Note the number of spacers used.

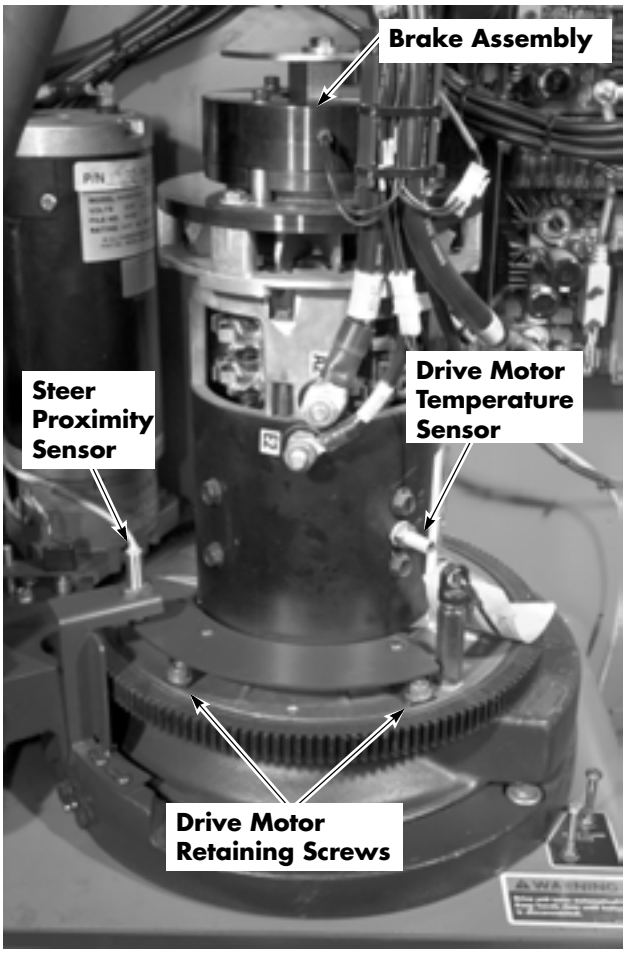


Figure 7-37. Drive Motor

4. Identify and remove power cables from drive motor.
5. Remove the drive motor temperature sensor (DT).
6. Remove the drive motor retaining screws.
7. Remove the drive motor.
8. For reassembly, reverse steps 1 thru 7 noting the following:
   - Clean motor mounting flange and drive unit. Apply a coat of gasket sealant (P/N 990-556) to flange or install a new gasket, as applicable.
   - Clean screws. Apply thread-locking compound (P/N 990-536) to screws and torque equally to 13 ft. lb. (18 N•m).
   - Check brake adjustment.
   - The gap between the proximity sensor(s) and metal should be approx 3/32 in. (2.3 mm).
9. If the pinion on the drive motor needs to be installed:
   a. Clean threads using thread-locking compound primer (P/N 990-533).
   b. Install key and gear.
   c. Apply thread-locking compound (P/N 990-462) to threads.
   d. Torque nut to 45 ft. lb. (63 N•m).

https://truckmanualshub.com/

Drive Unit Power Section

Drive Transmission Service

Maintenance or replacement of components used in the drive transmission are limited to the following:

- Steering Gear
- Pivot bearing and related components
- Drive axle
- Axle oil seal
- Cover
- Miscellaneous hardware

NOTE: The parts manual lists specific part numbers for serviceable items. Major drive transmission rework/service requires the unit to be sent back to the factory.

Drive Unit Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the bumper gate. See Figure 7-38.

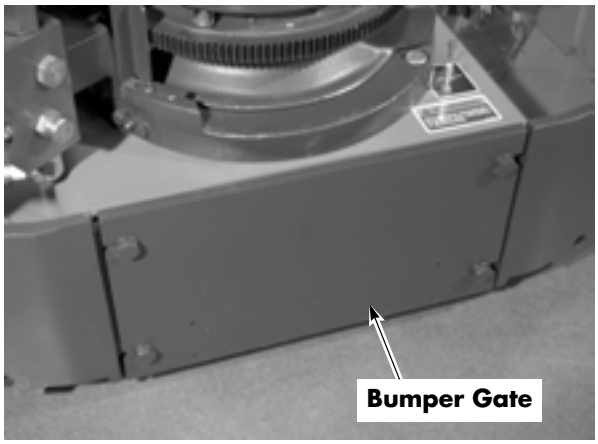


Figure 7-38. Removing Drive Unit

3. If the truck is wire guided, remove the sensor mounted on the backside of the bumper gate.
4. If the drive tire is to be removed, loosen the lug nuts using a 19mm socket.
5. Remove the proximity sensor and associated hardware on the drive unit casting.
6. Remove drive motor. See “Drive Motor” on page 7-36.

NOTE: If the drive unit is the only item requiring service, separating the brake assembly from the drive motor is not necessary.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support truck. DO NOT rely on the jack alone. See Jacking on page 2-11.

7. Jack and block the tractor so the drive tire is off the floor.
8. Drain oil from drive unit.
9. Unbolt the lift/lower manifold from the drive unit casting.
10. Remove the steering mechanism. This will either be a torque shaft for manual steering or a motor/gear reducer assembly on trucks with electric steering.
11. Remove cap screws holding the drive unit assembly to the tractor.
12. Slide drive unit toward front of tractor.

https://truckmanualshub.com/

Drive Axle Seal Replacement

If the axle is removed for replacement or for any other reason, replace the axle oil seal.

Tools required to replace the axle and axle oil seal include (See Figures 7-39 and 7-40):

- 4 mm Allen Wrench (for clamp nut)
- Seal Pressing Ring (P/N 828-004-901)
- Clamp Nut Spanner Wrench (P/N 828-004-902)
- Bearing Puller
- Torque Wrench
- 1/2 in. socket (for lower cover)
- Hydraulic or Arbor Press

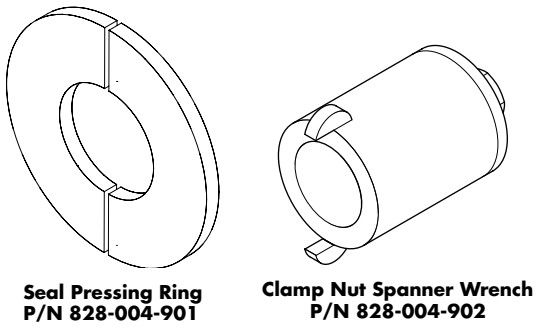


Figure 7-39. Drive Unit Service Tools

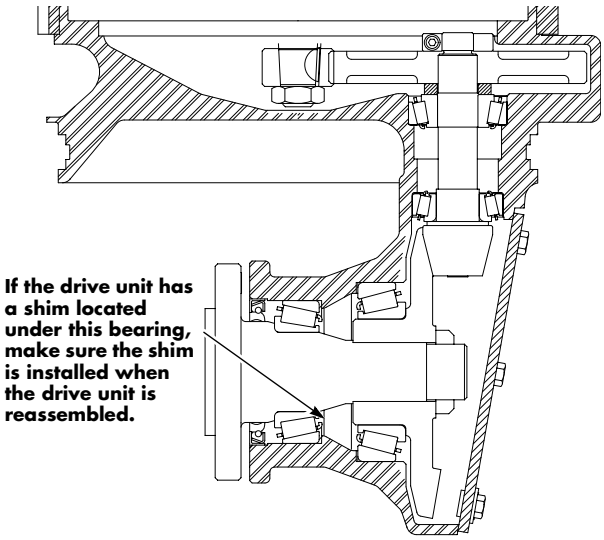


Figure 7-40. Drive Unit Cross Section

Drive Unit Disassembly

1. Remove the drive unit. See Drive Unit Removal on page 7-37.
2. Remove the lower cover on the drive unit housing using a 1/2 in. socket. See Figure 7-41.
3. Use a 4mm allen wrench to loosen the screw in the clamp nut.
4. Use a spanner wrench to remove the clamp nut from axle.
5. Press the axle out of the housing.
6. Use a bearing puller to carefully remove the bearing cone from the axle. See Figure 7-42.
7. Remove old axle seal.
8. Clean/inspect all components.

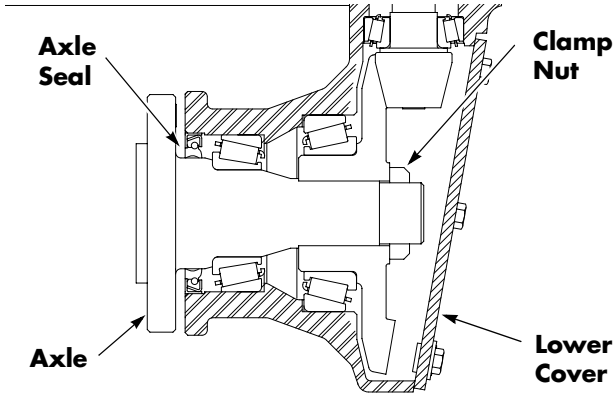


Figure 7-41. Drive Unit Components - Lower End

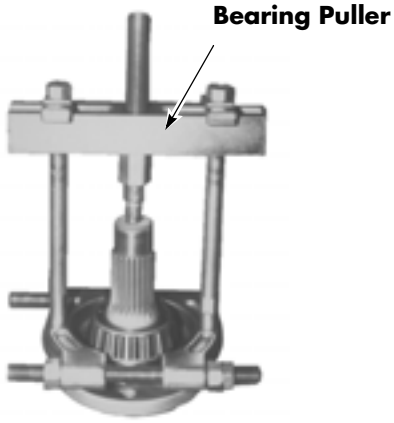


Figure 7-42. Removing Axle Bearing

https://truckmanualshub.com/

Drive Unit Assembly

1. After lubricating the lip of the new seal, place new axle seal onto axle. This can be done by hand.
2. Carefully place bearing cone onto axle. Press onto axle. See Figure 7-43.

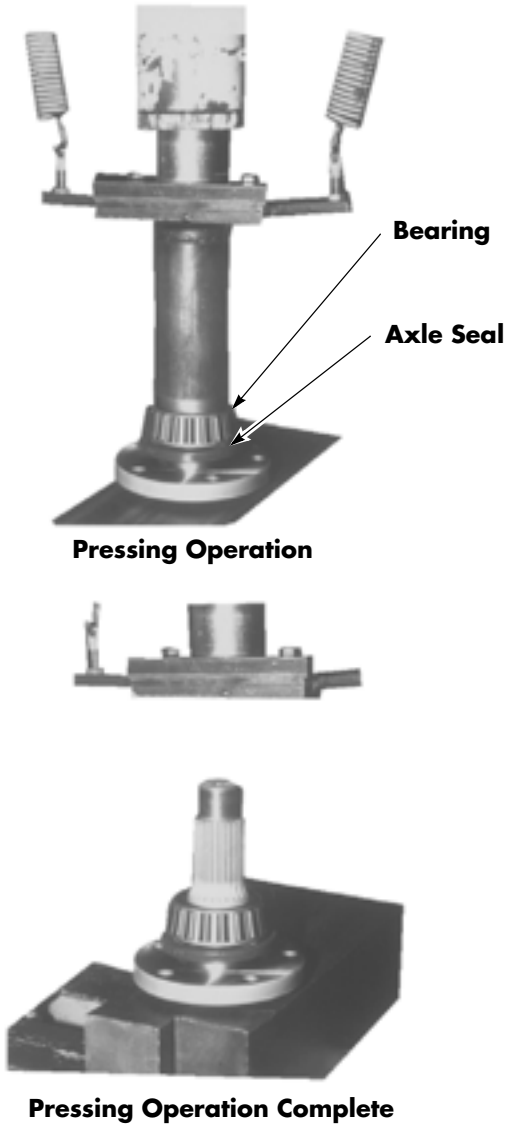


Figure 7-43. Pressing Bearing Cone onto Axle

3. Place axle assembly into housing. Mate axle with main drive gear. See Figure 7-44.

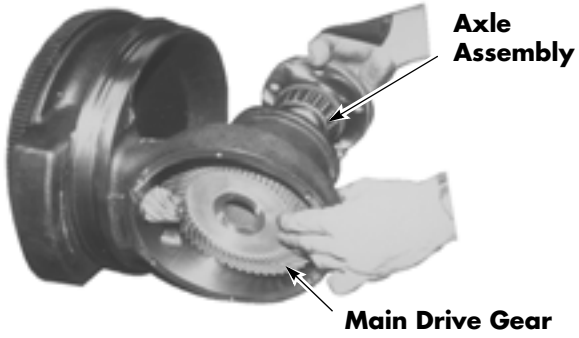


Figure 7-44. Assembly of Axle into Housing

4. Place seal pressing tool between seal and tire mounting flange on axle. See Figure 7-45.

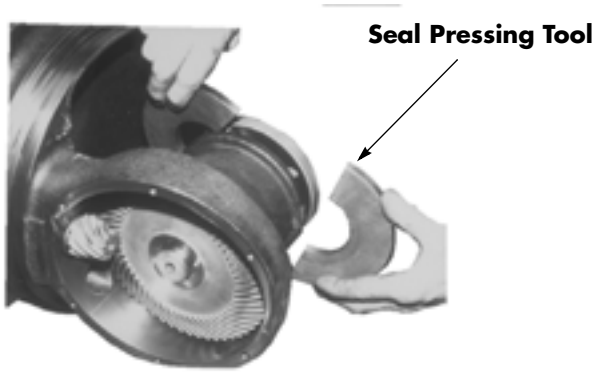


Figure 7-45. Preparing Axle Seal for Assembly into Housing

5. Press the axle seal into the housing. The seal must be flush with the housing.
6. Push the axle out of the housing *just enough* to allow removal of the pressing tool.
7. Push axle back in until bearing cone and bearing cup make contact.
8. Install the clamp nut on the axle. To set the bearing rollers, rotate the axle shaft and torque the clamp nut to 150 in. lb. (17 N•m). Loosen clamp nut. While turning the axle shaft, torque the clamp nut to 40 in. lb. (4.52 N•m). See Figure 7-46.

https://truckmanualshub.com/

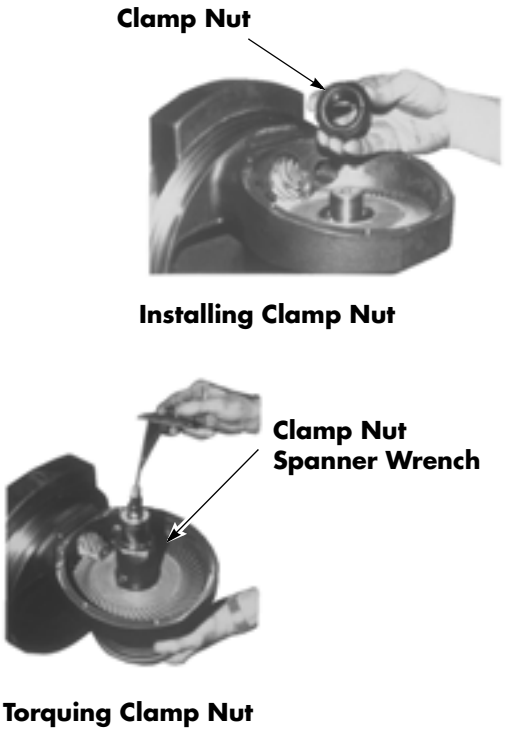


Figure 7-46. Install/Torque Clamp Nut on Axle

9. Apply thread-locking compound (P/N 990-462) and tighten the screw in the clamp nut to prevent clamp nut from loosening. See Figure 7-47.

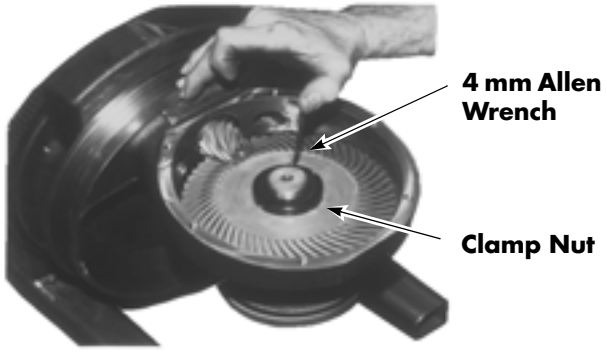


Figure 7-47. Securing Clamp Nut by Tightening Retaining Screw

10. Clean cover plate and mating surface. Apply silicone rubber sealant (P/N 990-542) to sealing surface.
11. Install cover. Tighten all screws equally to 20 ft. lb. (28 N•m).
12. Apply gasket sealant (P/N 990-520) to drain plug and install.

Drive Unit Installation

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support truck. DO NOT rely on the jack alone. See Jacking on page 2-11.

1. Slide the drive unit toward the rear of the tractor until the three mounting holes in the drive unit line up with corresponding holes on the tractor.
2. Attach the drive unit to the tractor with the drive unit mounting cap screws. Torque the screws to 120 ft. lb. (163 N•m).
3. Install the steering mechanism. This will either be a torque shaft for manual steering or a motor/gear reducer assembly on trucks with electric steering.
4. Bolt the lift/lower manifold onto the drive unit casting.
5. Refill the drive unit with the proper lubricant. See Lubrication Specification Chart on page A-2.
6. Install the drive motor. See “Drive Motor” on page 7-36.
7. Install proximity sensor(s) and associated hardware on the drive unit casting.
8. If the drive tire has been removed, attach the drive tire using a 21mm socket to tighten the lug nuts. Torque lug nuts to 107 ft. lb. (145 N•m).
9. Lower the truck.
10. If the truck is wire guided, install the wire guidance sensor near the front bumper.
11. Attach the bumper to the truck using a 19mm socket to tighten the screws.

https://truckmanualshub.com/

12. Reconnect the battery connector and turn the key switch ON.

Drive Tire Replacement

1. Remove covers from tractor.
2. Turn the drive unit so the lug nuts on the wheel can be loosened.
3. Turn the key switch OFF and disconnect the battery connector.
4. Remove center section of bumper using a 19mm socket.
5. If the truck is wire guided, remove the sensor near the front bumper.
6. Loosen lug nuts on drive wheel using a 19mm socket.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support truck. DO NOT rely on the jack alone. **See Jacking on page 2-11.**

7. Jack up front of truck and block and remove the drive tire.
8. With the drive tire removed, a new tread surface can be installed. Press the old tread off and the new tread on the hub.

NOTE: If the pressure required to press the new tire on the hub is less than five tons, replace the wheel hub.

9. Reinstall drive wheel on the truck. Torque the lug nuts to 108 ft. lb. (151 N•m).

⚠CAUTION

Installing the drive tire on the axle backwards will have an adverse effect on steering when the brake is applied.

10. Remove blocking and lower truck to floor.
11. Reinstall bumper.
12. Reconnect the battery connector and turn the key switch ON. Test.

https://truckmanualshub.com/

Brake

The brake assembly is mounted on top of the drive motor. The brake is spring applied and electrically released. The brake can be manually released by installing the brake release bolts. See Figure 7-48.

⚠ WARNING

When brake release bolts are used, make sure they are removed before the truck is returned to service. If the bolts are not removed, the brake will not work properly.

Brake Adjustment

Brake gap inspections should be done on a regular schedule.

This procedure is for brake assembly P/Ns 605-013/200 and 605-014/200.

⚠ WARNING

Use extreme care whenever the truck is jacked up for any reason. Never block the truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support truck. DO NOT rely on the jack alone. See Jacking on page 2-11.

1. Jack and block the tractor so the drive tire is off the floor.
2. With the brake de-energized (fully applied), use a feeler gauge to measure the total gap. See Figure 7-48.
3. Take measurements at three equally-spaced locations around the armature disk. The total gap should be 0.010 to 0.015 in. (0.25 to 0.38 mm). The gap should be uniform all the way around the armature disk. Brake wear is indicated if the total gap is greater than 0.015 in. (0.38 mm).

NOTE: Different thickness shims and spacers are available to maintain proper brake gap.

4. Add/remove spacers/shims as necessary to achieve proper gap.

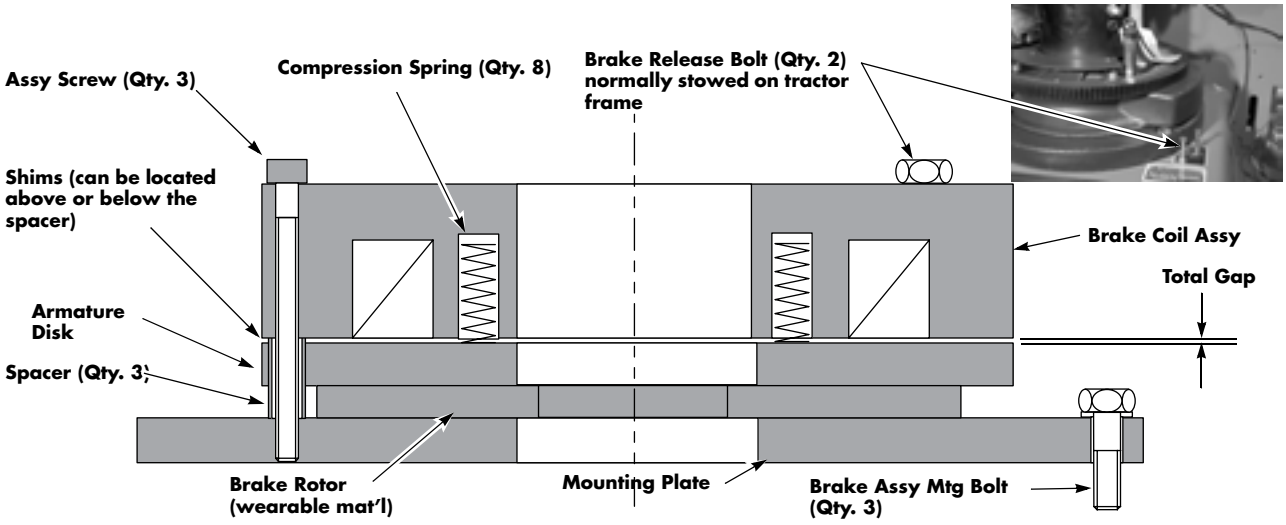


Figure 7-48. Brake Assembly Components (P/N's 605-013/200 & 605-014/200)

https://truckmanualshub.com/

Brake Rotor Replacement

This procedure is for brake P/N 605-013/200 or 605-014/200 only.

Replace the rotor if worn to a thickness of 0.236 in. (6 mm) or less.

Removal/Disassembly

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the covers from the power section.
3. Remove the hardware securing the proximity disc above the brake assembly. Lift off the proximity disk and set aside. Be aware of any spacers which may be below the proximity disc. These will be required for reassembly.
4. Remove the proximity sensor from the brake.
5. Disconnect the electrical cable to the brake assembly.
6. Remove the three screws which secure the brake to the drive unit.
7. Remove the cable support.
8. Lift the brake unit up and off the drive unit. Take the assembly to a workbench. You will need the brake release screws located on the tractor.
9. Insert the brake release screws into the brake assembly. Tighten the two brake release screws to release the brake completely.
10. Remove one of the three screws which hold the brake assembly together. Be careful not to lose any shims that may be used.
11. Slide the rotor out of the assembly.

Assembly/Installation

1. Slide the new rotor into the assembly. The rotor is positioned between the armature disk and the brake mounting plate. See Figures 7-49 and 7-50.
2. Install the one assembly screw removed to replace the rotor. Be sure to install any spacers removed. Torque the three M6 screws which secure the coil to the assembly to 9 ft. lb. (12 N•m) with the threads lubricated.
3. Carefully center the rotor within the assembly and remove the brake release bolts.
4. Measure the total gap as shown below. The total gap must be between 0.010 in. (0.25 mm) and 0.015 in. (0.38 mm). If the gap is not within tolerance, add or remove shims and/or spacers as necessary. Different thickness shims and spacers are available.

⚠CAUTION

If the total gap exceeds 0.015 in. (0.38 mm), brake release problems will result particularly when the brake is hot and/or the battery is low.

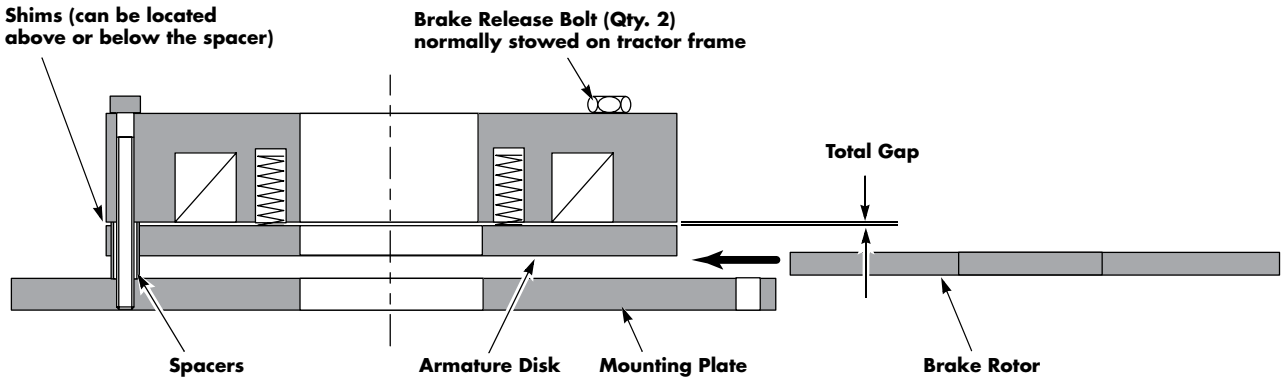


Figure 7-49. Installing Brake Rotor

https://truckmanualshub.com/

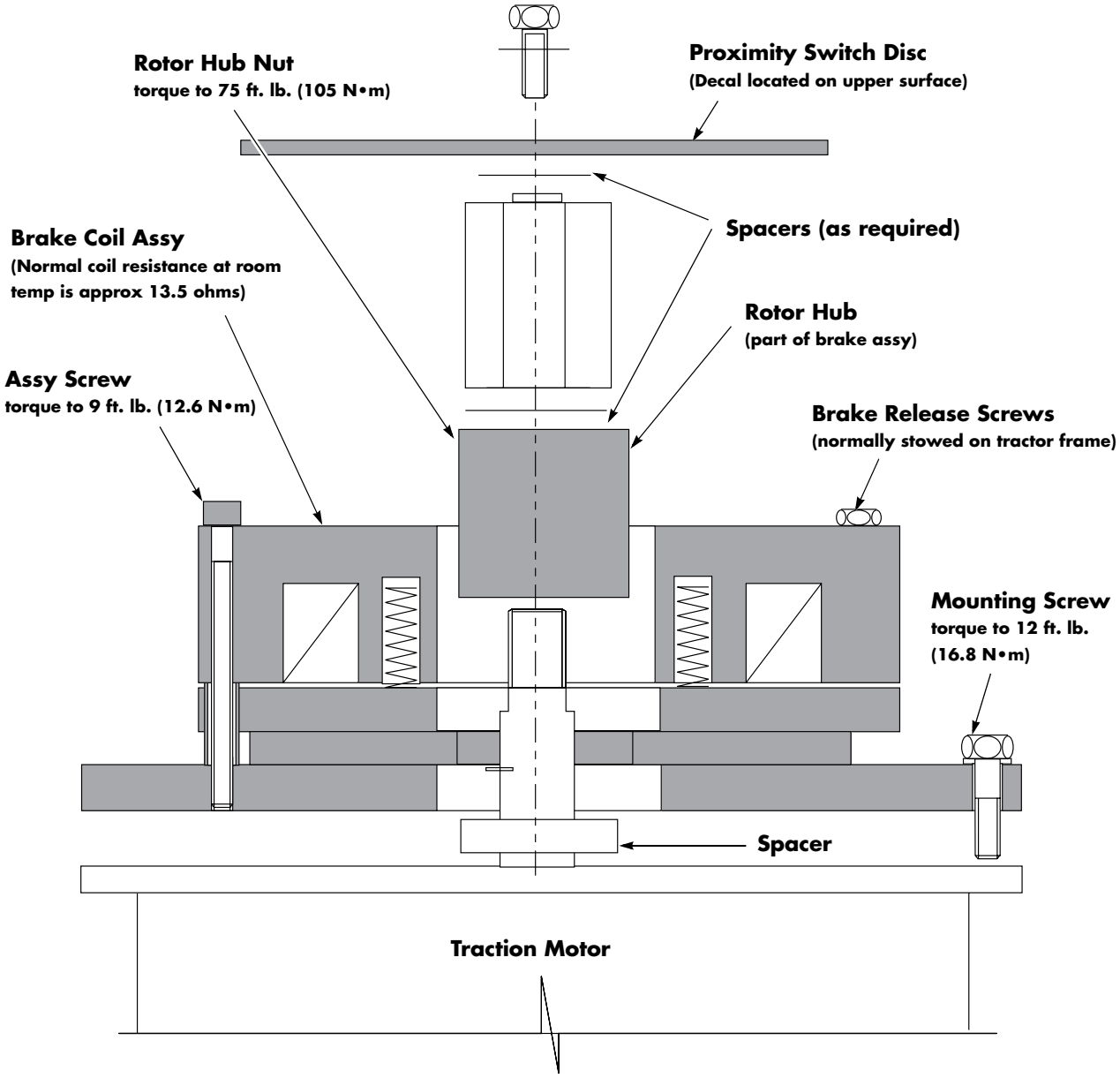


Figure 7-50. Brake Assembly - Section View (P/N's 605-013/200 & 605-014/200)

5. After the proper gap is achieved, torque the assembly screws as specified in step 2.
6. Inspect the splines on the rotor hub (on the drive motor). If the splines on the rotor hub have excessive wear, replace the hub before proceeding. Using a rotor hub with worn splines may cause rotor damage when the truck is driven.
7. Carefully install the brake assembly on the drive motor. It is critical that the splines on the rotor are not damaged during assembly.

⚠CAUTION

Damaging the splines on the brake rotor may cause brake failure.

8. Install the cable clamp that holds the power cables on the drive motor.

https://truckmanualshub.com/

9. Secure the brake assembly to the drive motor. Apply thread-locking compound (P/N 990-462). Torque the three mounting screws to 12 ft. lb. (16.8 N•m).
10. Connect the brake to the truck electrical circuit.
11. Install the proximity sensor.
12. If the rotor hub nut was removed, apply thread-locking compound (P/N 990-462) to threads on rotor hub nut. Install then torque the rotor hub nut holding the rotor hub to 25 ft. lb. (35 N•m).
13. Install the proximity disc. Make sure any spacers/shims removed during disassembly are re-installed.

    Check that the clearance between the proximity disc and the proximity switch does not exceed 0.100 in. (2.54 mm).

⚠ WARNING

Make sure the brake release bolts are completely removed before placing the truck back into service. If the brake release bolts are not removed, the brake will not work properly.

14. Reconnect the battery connector and turn the key switch ON.

⚠ WARNING

If the brake does not work while performing the next step, the truck will not stop but will coast for approximately 30 ft. (9 m).

15. Test the brake. In an open area allowing for travel over a long distance, perform the following:
    a. Drive the truck approximately 2-3 mph (3.2-4.8 k/hr).
    b. Push the EPO switch. The truck should stop within approximately 5 ft. (1.5 m).

    OR

    With truck jacked up so drive tire is off the floor, push control handle until maximum speed is reached (transmission is rotating at constant speed), push EPO switch. The Drive Unit should rapidly decelerate to a stop.

⚠ WARNING

Stepping off the deadman pedal does not test the brake.

NOTE: During acceleration a slight rattle from the brake rotor is considered normal and does not affect brake durability or function.

16. Install covers.

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Electrical Components

https://truckmanualshub.com/

Battery Procedures

The battery is the energy source for the truck. Its condition should be of primary importance to the user to achieve maximum satisfactory service. Lack of proper battery maintenance will lead to short battery life and other component problems.

Lead acid batteries furnish all power requirements of the truck. Most industrial batteries can be expected to function properly for more than five years. The following section contains essential battery maintenance information:

- cleaning
- leak test
- charging
- hydrometer check
- voltage check
- record keeping

This information should extend battery life and increase truck efficiency.

⚠ WARNING

Wear eye protection when you clean a battery.

Cleaning

1. Mix 1 lb (0.45 Kg) baking soda and 1/2 gal (1.89 L) of hot water.
2. Tighten the battery vent caps.
3. Use a brush with flexible bristles and apply the soda solution over the top of the battery. Allow solution to *work* until fizzing stops, indicating that the acid has been neutralized.
4. Rinse thoroughly with clean water.
5. Blow battery case dry using compressed air (30 psi/206 kPa max).

NOTE: Wet covers can be an indication of overfilling, leaky seals at posts or excessive gassing during charge. When observed, the cause should be determined and corrected.

Electrical Leakage To Frame Test

1. Turn the key switch OFF and disconnect the battery connector.
2. Using a test light, attach leads between:
   - B– and truck frame
   - B+ and truck frame

   If light illuminates, clean battery and retest. If light still illuminates, service battery.

Charging

⚠CAUTION

When charging batteries, observe the following precautions:

- **Do not smoke, use open flame, or spark producing devices near the batteries.**
- **Charge in a well-ventilated area to avoid hydrogen gas concentration.**
- **Keep batteries clean; corrosion causes grounds and the possibility of sparks.**
- **Charge batteries at the indicated rates.**
- **Keep plugs, terminals, cables, and receptacles in good condition to avoid shorts and sparks.**
- **Never lay tools on top of the batteries.**
- **Wear protective clothing and eye protection when handling, checking, or filling batteries.**

NOTE: Recharge the battery only when it is effectively discharged. *Do not* routinely recharge a battery when it is partially discharged; this will decrease battery life.

https://truckmanualshub.com/

To charge a battery, direct current is passed through the battery cells in the direction opposite of discharge.

1. Become familiar with the following:
   - Charging rate, starting rate, and finish rate
   - Time available for charge
   - Variations in cell voltage
   - Avoiding overheating, excessive gassing or overcharging.
2. Consult the battery manufacturer's manual for specific charging procedures.

Hydrometer Use

The hydrometer measures the Specific Gravity (SG) of the electrolyte. SG varies directly with the state-of-charge of a lead acid battery as follows:

Charge	Specific Gravity
100%	1.280 to 1.300
75%	1.250 to 1.260
50%	1.200 to 1.210
25%	1.150 to 1.160
0%	1.080

NOTE: Most industrial deep-cell discharge batteries are considered discharged when 20% of the charge remains (SG of 1.140).

Procedure

1. Insert the nozzle of the hydrometer into the battery cell and draw enough electrolyte into the tube to permit the float to ride free.
2. Determine the SG of the cell. See Chart above.

NOTE: If there is not enough electrolyte in the cell to obtain a hydrometer reading, add enough water to cover the battery plates. Because the electrolyte level will rise during charging, DO NOT add too much water to the cell.

   Charge the battery and take a new reading.
3. The SG for each cell should be taken and recorded on a battery chart. These charts can be obtained from the battery manufacturer.

NOTE: No amount of charging will increase battery capacity or raise the SG above its fully charged level (1.280 to 1.300).

NOTE: Water can be added to the cell after the charging process is completed. Consult the battery manufacturer's manual for further information.

Voltage Check

Check the voltage on each cell after performing the hydrometer check. Connect the leads of a DVM to the (+) and (–) terminals of each cell. The readings will vary with the state of charge:

Charge	Voltage Reading
100%	2.14
75%	2.07
50%	1.95
25%	1.80

There should not be more than 0.2V variation between cells. Record the voltage reading for each cell on the battery maintenance chart.

Adding Water To Battery

Water must be added to battery cells periodically. Frequency and quantity depend on the water level above the plates and the amount of gassing during charge.

- Use only approved or distilled water.
- Add water after hydrometer and voltmeter readings are taken.
- Add water after charging to minimize overfilling.
- Always have plates entirely covered.
- Keep outside of battery case clean and dry.

https://truckmanualshub.com/

Battery History Record

A battery record system is essential because battery failure can cause production slowdowns and increased battery operating costs. A properly supervised record system can detect and call attention to such operating irregularities as:

- Overcharging
- Undercharging
- Over discharging
- Excessive water consumption
- Excessive dirt and corrosion
- Worn out batteries
- Excessive current consumption of trucks

Records should be kept for each battery. Your battery supplier should be able to provide maintenance record sheets. Each report should contain:

- Battery number, type, serial number, and service data
- SG and voltage readings for each cell
- Temperature of the air and electrolyte
- Electrolyte
- Amperes
- Condition of connectors, covers, sealing compound and tray
- General cleanliness
- Number of total cycles
- Average SG drop
- Watering frequency
- User comments and observations

Cutout Adjustment

1. Run truck until lift cutout is activated.
2. Allow battery to set unused for two hours. Check SG and compare to manufacturer's recommendations.
3. Adjust cutout in **CONFIG** until proper discharge is obtained.

https://truckmanualshub.com/

Motor, General

Periodic cleaning is essential to prevent overheating and electrical leakage (short).

Wear safety glasses or goggles to protect your eyes from dust and debris.

Using an OSHA approved air nozzle, use clean, dry, low pressure (30 psi/206 kPa) compressed air to blow carbon dust and other foreign matter from:

- Motor Housing
- Brush Holders
- Commutator
- Field and Armature Windings (if accessible)

See Figure 7-51.

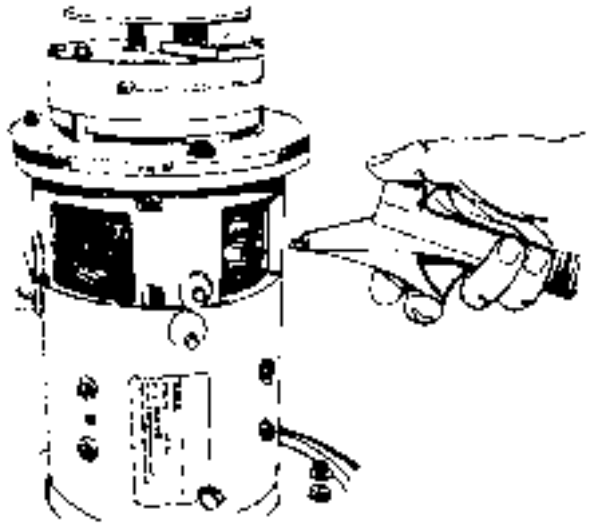


Figure 7-51. Motor Cleaning with Compressed Air

⚠CAUTION

Never use a chemical solvent to clean a motor, as it can carry carbon dust to inaccessible areas and cause shorts within the motor.

⚠CAUTION

Cleaning a motor requires complete disassembly and drying. Motor cleaning should only be performed by an authorized motor repair shop.

Brushes

Brushes should be inspected for:

- Proper wear
- Signs of overheating
- Physical damage to brush holders
- Proper spring pressure/alignment
- Freedom of movement within brush holders

Inspection

Position motors to provide easiest access to brushes. Inspect the brushes in all motors for:

- Proper Wear - the brush surface should be polished and show even wear.
- Overheating - overheating will be indicated if the brush shunts or brush springs are discolored.
- Physical Damage - Inspect the brush holders for damage. Make sure the holders are not loose on the end head or brush holder plate.
- Spring Pressure/Alignment - check spring pressure as follows:
  - Insufficient spring pressure will cause excessive arcing and reduced motor performance. Excessive spring pressure will result in premature wear of the commutator.
  - A brush spring that does not apply even pressure on the center of the brush will cause the brush to wear unevenly.
- Freedom of Movement - Check for correct clearance and freedom of brush movement within the holder. Make sure connections are clean, tight and that brush wires do not ground on motor frame or armature.

https://truckmanualshub.com/

Replacement

If any of the brushes require replacement, the complete brush and spring set should be replaced. Refer to Table 7-2 for minimum brush lengths.

When ordering replacements, refer to the motor serial number on the motor nameplate.

Do not substitute brushes. Brushes are matched to the motor type and application to provide the best service. Substituting brushes of the wrong grade can cause commutator damage or excessive brush wear.

Where accessible, new brushes should be seated to the commutator curvature. This can be accomplished by wrapping a piece of 00 sandpaper around the commutator, seating the brush in the brush holder, and turning the armature. On smaller motors where space is limited, a brush seating stone may be used. *Do not* use emery cloth to seat brushes.

After the brushes are seated, the dust should be blown out of the motor with dry compressed air [30 psi (206 Kpa)].

Motor Stud Terminals

To prevent premature motor failure, the nuts that secure the power leads to the motors should be checked for proper torque. The torque should be checked each time the motor brushes are inspected.

Figure 7-52 shows a drive motor armature terminal. Figure 7-53 shows a terminal for all other motors.

NOTE: The torque values given are the same for all terminal sizes.

Table 7-2. Minimum Brush Length

Motor	Manufacturer	Part Number	Volts	Minimum Commutator Diameter	Minimum Brush Length[a]
Drive	Advanced	570-279/500	24/36	2.75 in. (69.85 mm)	0.63 in. (16.00 mm)
	Advanced	570-283/500	24	1.93 in. (49.02 mm)	0.60 in. (15.24 mm)
Lift	Advanced	570-268/500	24	2.00 in. (50.80 mm)	0.50 in. (12.70 mm)
	Advanced	570-268/501	24	2.00 in. (50.80 mm)	0.50 in. (12.70 mm)
	Advanced	570-280/500	24/36	2.75 in. (69.85 mm)	0.63 in. (16.00 mm)
	Prestolite	570-235/100 Used on “EE” trucks only	24	2.938 in. (74.63 mm)	0.57 in. (14.48 mm)
Steer	Lenze	114-008-594/100	24	2.05 in. (52.07 mm)	0.50 in. (12.70 mm)
	Ohio Electric	114-008-594/221	24	1.85 in. (46.99 mm)	0.50 in. (12.70 mm)
	Pacific Scientific	114-008-594/200	24	1.75 in. (44.45 mm)	0.56 in. (14.22 mm)

a. Measurement of brush length refers to the “Long” side dimension.

https://truckmanualshub.com/

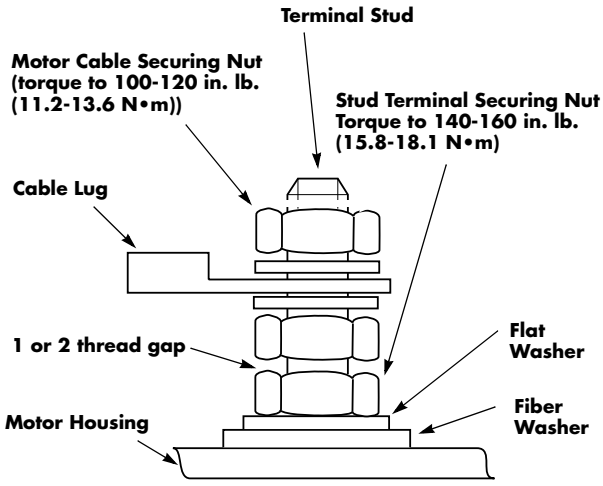


Figure 7-52. Drive Motor Armature Terminal Torque Specs

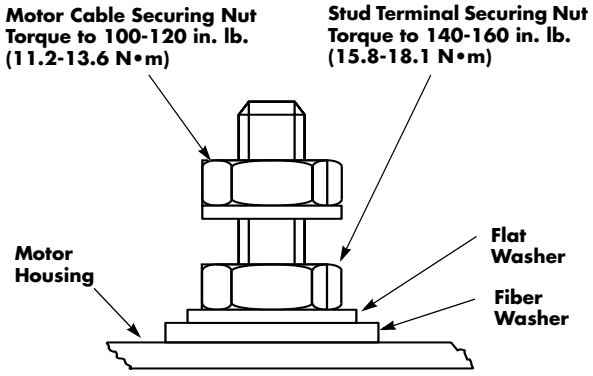


Figure 7-53. Motor Terminal Torque Specs for All Other Motors

https://truckmanualshub.com/

Fuses

Table 7-3 lists the fuses for a truck with all available options. Not all trucks will have all of the fuses listed. Figure 7-54 shows Tractor Manager fuse locations.

Table 7-3. Fuses

Fuse	Protects	Location	Amps
FU11	B+ Control for B+ PCF	Tractor Manager	15
FU12	B– Control for B– PCF		15
FU13	B– Control for B– Fused		15
FU14	B+ Control for B+ Fused		15
FU15	B– Control for B– Fused (Spare)		6
FU16	B+ Control for B+ Fused (Spare)		6
FU17	+12V Control		2
FU5	Travel B+	Contactor Panel	350
FU6	Lift B+		450 (350 for single speed lift)
FU8	B+ for Power Card and Electric Steering		70
Refer to Figure 7-6 on page 7-8 for the location of contactor panel fuses FU5, FU6, and FU8.			

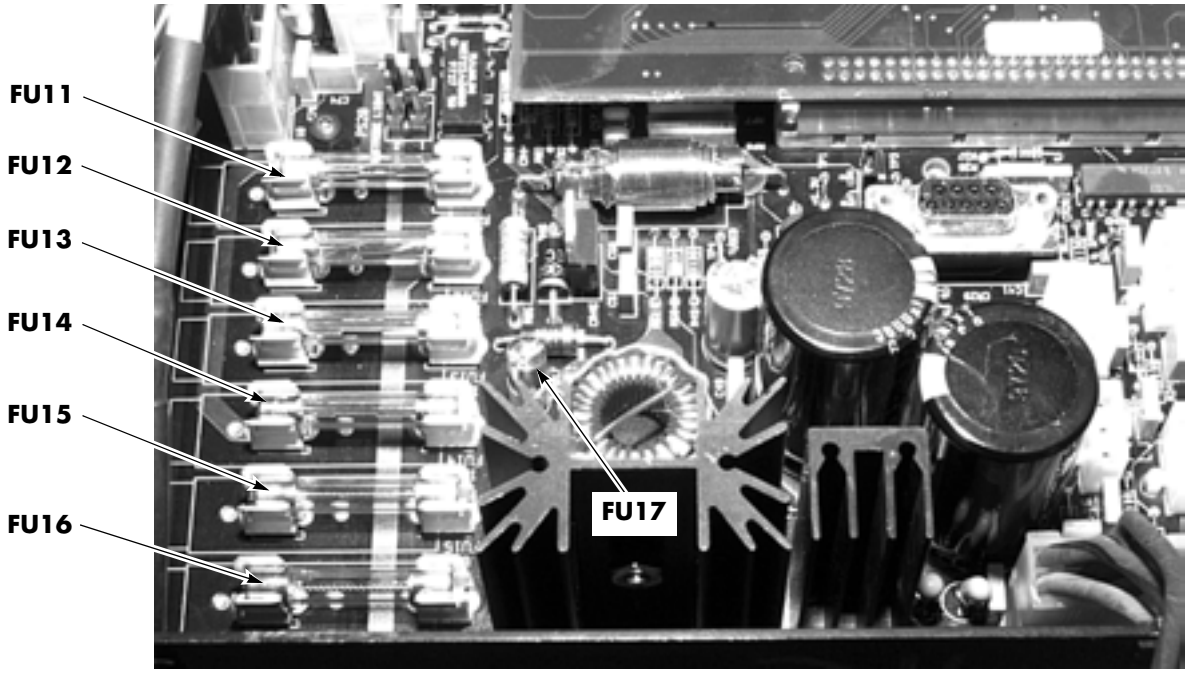


Figure 7-54. Tractor Manager Fuse Locations

https://truckmanualshub.com/

Drive Motor/Heatsink Temperature Sensors

Removal

1. Turn the key switch OFF and disconnect the battery connector.

⚠CAUTION

Be sure to observe proper precautions against electrostatic discharge. See "Static Precautions" on page 2-9.

2. Disconnect the sensor wiring harness. See Figure 7-55.
3. Loosen the retaining nut holding the sensor.
4. Remove the sensor by unthreading.

Installation

1. Apply heatsink compound (P/N 990-508) to the threads of the sensor.
2. Install the sensor.
3. Tighten the retaining nut.
4. Connect the wiring harness.

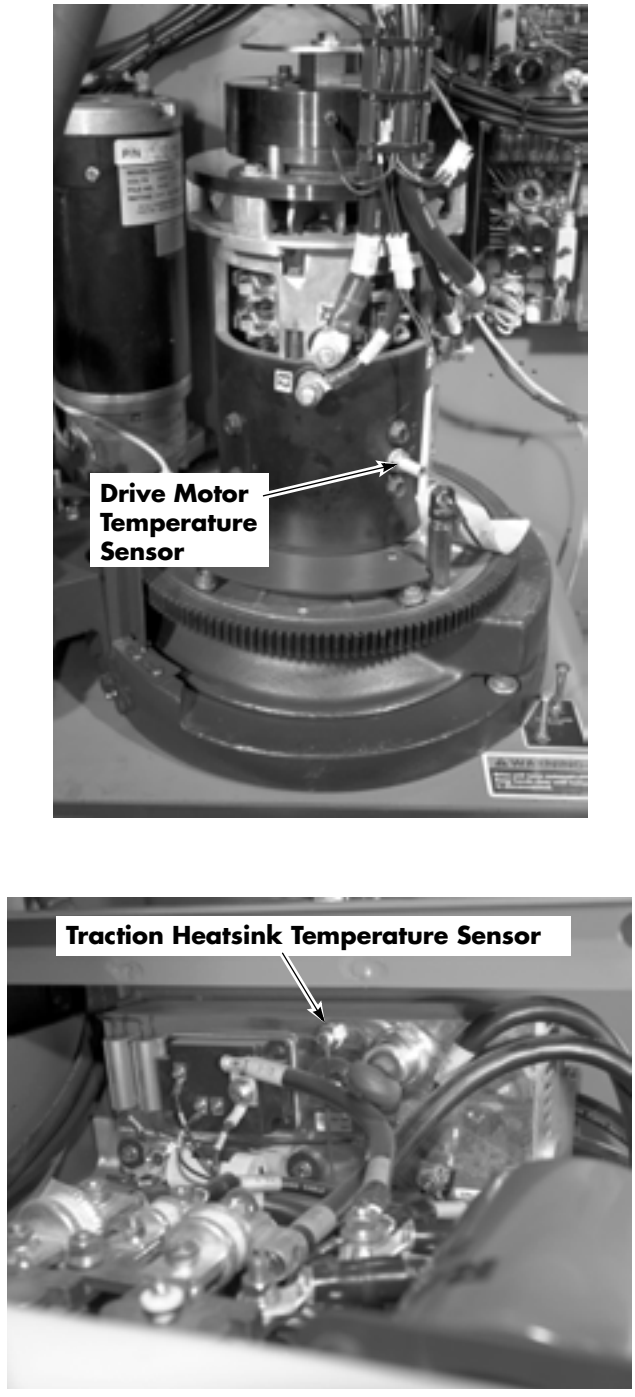


Figure 7-55. Temperature Sensors

https://truckmanualshub.com/

Q1 Replacement

Removal

1. Turn the key switch OFF and disconnect the battery connector.

⚠CAUTION

Be sure to observe proper precautions against electrostatic discharge. See "Static Precautions" on page 2-9.

2. Remove the tractor covers.
3. Disconnect all wires at Q1. See Figure 7-56.

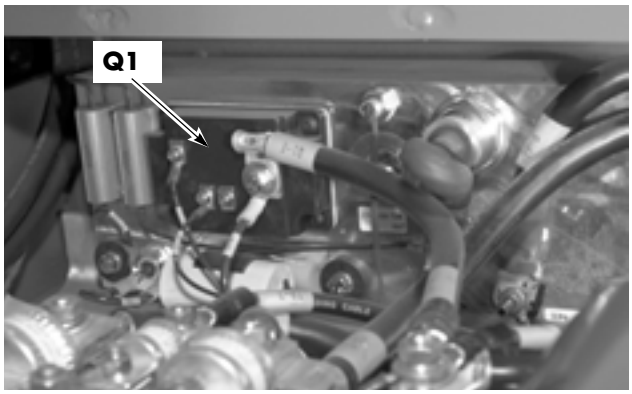


Figure 7-56. Q1 Transistor

4. Remove four machine screws holding the transistor to the heatsink.
5. Remove the thermal conducting pad between the transistor and the heatsink.

Installation

1. Install new thermal conducting pad to the bottom of the transistor.
2. Install the Q1 transistor to the traction heatsink with four machine screws.
3. Connect all wires previously disconnected at Q1.
4. Torque all connections per the table below.

Screw Size		Torque	
ANSI	**Metric**	**in. lb.**	**N•m**
#8	M4	10-14	1.12-1.58
#10	M5	14-17	1.58-1.92
1/4 in.	M6	22-26	2.5-2.93
3/8 in.	M8	70-75	7.9-8.4

5. Install tractor covers.

https://truckmanualshub.com/

Rectifier Replacement

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the tractor covers.
3. Disconnect the rectifier lead.
4. Use a wrench or deep socket and remove rectifier from the heatsink.

Installation

1. Apply heatsink compound (P/N 990-508) to the threads of the new rectifier.
2. Thread the new rectifier into the heatsink. Tighten with a wrench or deep socket.
3. Connect the lead to the proper terminal.
4. Re-install the tractor covers.

https://truckmanualshub.com/

Printed Circuit Board Remove and Replace

NOTE: The portions of the LEARN program required for the card being replaced is provided in each procedure. If time and space permits, running the entire LEARN process is recommended.

When replacing any printed circuit board, turn the key switch OFF and disconnect the battery connector.

⚠CAUTION

Be sure to observe proper precautions against electrostatic discharge. See "Static Precautions" on page 2-9.

Carriage Control Card Replacement

Observe the following guidelines when replacing the Carriage Control Card (CCC).

1. The CCC has truck specific information programmed in the microprocessor. See Figure 7-57. This information includes Model Number, Serial Number (S/N), Date of Manufacture, Hour Meters and a list of enabled Options. A backup copy of this information is also stored in the microprocessor on the TM VFC.

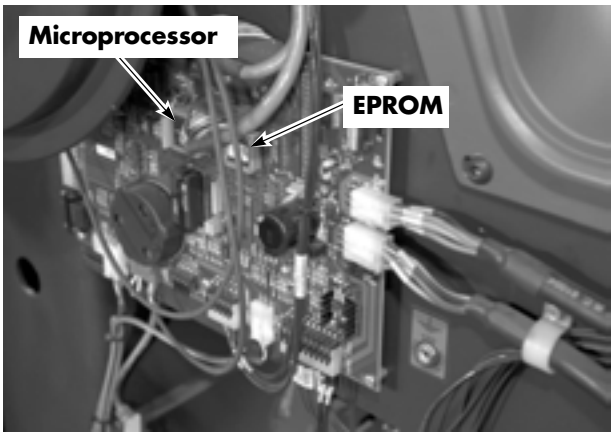


Figure 7-57. Carriage Control Card Chip Locations

If a blank CCC is installed, the information from the VFC will be uploaded into the CCC. A Pre-programmed CCC *must* be ordered and installed anytime the Error Code corrective actions tells you to or if the CCC and VFC are being replaced at the same time. Another way to retain the correct programming for the specific truck is to remove the microprocessor from the CCC being replaced and install it in the new CCC. See "EPROM/Microprocessor Remove and Replace" on page 7-63. This can be done only if the error code being corrected does not instruct you to install a pre-programmed CCC. Some error codes indicate the possible corruption of the data stored in the microprocessor.

2. Properly position the E3 jumper for BUS+/– termination. On trucks with the SMART*i* option installed, the jumper *must* be in the OUT position. On trucks without SMART*i*, the jumper *must* be in the IN position. See Figure 7-58.

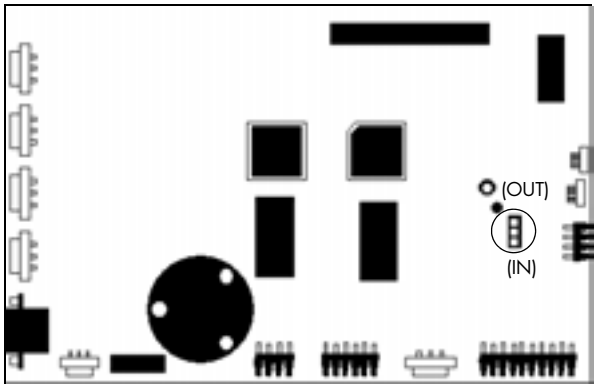


Figure 7-58. Jumper Positions for SMARTi® on CCC

3. On trucks without the 60 in. limit switch option, a jumper/resistor assembly must be installed at JPC3. Remove the assembly from the original CCC and install it on the new one.
4. Remove the EPROM from the original CCC and install it in the new card or install a new set of EPROMS in all of the cards. See "EPROM/Microprocessor Remove and Replace" on page 7-63.

https://truckmanualshub.com/

5. Enter Configure Mode and verify the truck S/N stored in the CCC matches the S/N on the truck Specification Tag. If not, a new pre-programmed CCC must be obtained and installed prior to operating the truck.
6. Reset all of the information in the Configure Menu to the customer's specifications.
7. Run the complete LEARN process.

Tractor Manager Card Replacement

Observe the following guidelines when replacing the Tractor Manager Card.

1. Properly position the E1 jumper for BUS+/– termination. On trucks with Electronic Steering installed, the jumper *must* be in the OUT position. On trucks without Electronic Steering, the jumper *must* be in the IN position. See Figure 7-59.

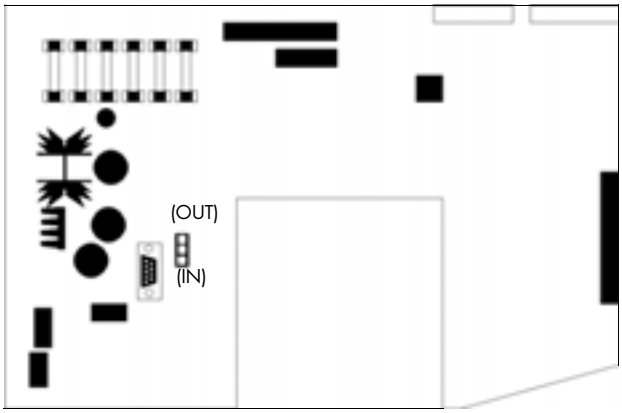


Figure 7-59. Jumper Positions on Tractor Manager

2. Properly position the jumpers for the brake coil driver. On 24V trucks, the jumpers *must* be in the E2 position. On 36V trucks, the jumper *must* be in the E3 position.

Vehicle Function Controller Card Replacement

Observe the following guidelines when replacing the Vehicle Function Controller Card.

Remove the EPROM from the original VFC and install it in the new VFC or install a new set of EPROMS in all of the cards. See "EPROM/Microprocessor Remove and Replace" on page 7-63.

Power Card Replacement

Observe the following guidelines when replacing the Power Card.

1. Disconnect the drive motor cable at TP6 on the main heat sink.
2. Observe how the cable is routed through the current sensing ring (CT-1). The cable *must* be routed the same way when re-installed. See Figure 7-60.
3. Make sure the TM1/TM2 base tabs are standing straight up and the E1 and E2 tabs are removed on the transistors.
4. Torque B– stud to 12 in. lb. (1.3 N•m).
5. Make sure the M1 heatsink does not contact the panel.

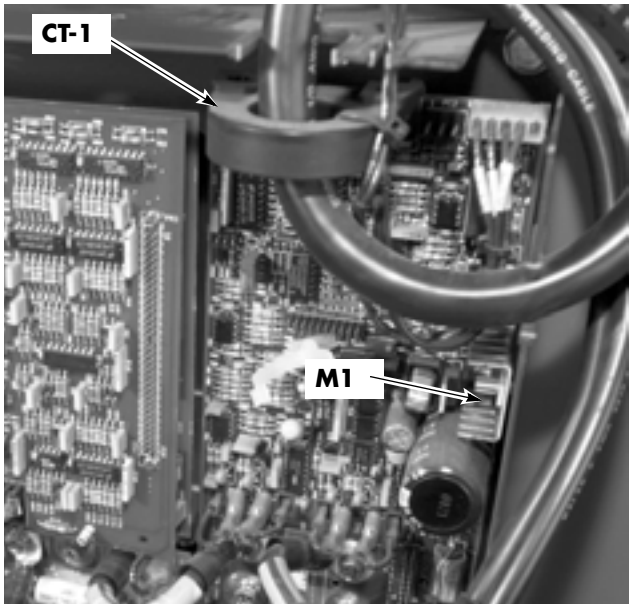


Figure 7-60. Power Card Cable Routing

https://truckmanualshub.com/

Electric Steer Manager Replacement

Observe the following guidelines when replacing the Electronic Steer Manager.

1. Make sure the TM3/TM4 base tabs are standing straight up and the E1 and E2 tabs are removed on the transistors.
2. Properly position the E1 jumper for BUS+/– termination. The jumper must be in the IN position.
3. Torque SMB– studs to 12 in. lb. (1.3 N•m).
4. Run LEARN Steer and LEARN for all Wire Guidance portions of the LEARN Program.

Filter Card Replacement

Run LEARN Steer and LEARN for all Wire Guidance portions of the LEARN Program.

https://truckmanualshub.com/

TM3/TM4 Replacement

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the tractor covers.

⚠CAUTION

Be sure to observe proper precautions against electrostatic discharge. See "Static Precautions" on page 2-9.

3. If present, remove the wire guidance filter card.
4. Remove the ESM. See "Printed Circuit Board Remove and Replace" on page 7-58.
5. Before removing transistors, install a jumper between the base tabs (B1 and B2) and the secondary emitter connection (E2). Remove the mounting nuts and washers.

Installation

1. Install new thermal conducting pad between the transistors and the heatsink.
2. Install jumpers between the base tabs (B1 and B2) and the secondary emitter connection (E2) (if new transistor module does not have these points tied together).
3. Install TM3/TM4 to the heatsink.

NOTE: Replace transistors in pairs.

4. Remove the jumper from B1 and B2 to E2.
5. Make sure the base tabs are standing up straight and that the E1 and E2 tabs have been removed.
6. Reinstall the ESM.
7. Reinstall the wire guidance filter card if equipped.

https://truckmanualshub.com/

TM1/TM2 Replacement

Removal

⚠CAUTION

Be sure to observe proper precautions against electrostatic discharge. See "Static Precautions" on page 2-9.

1. Remove the power card. See "Printed Circuit Board Remove and Replace" on page 7-58.
2. Attach a jumper between the base tabs (B1 and B2) and the secondary emitter (E2) on each transistor. This helps protect against static damage to the transistor.

Installation

1. Install a new thermal conducting pad between the transistors and the heatsink.
2. Install jumpers between the base tabs (B1 and B2) and the secondary emitter connection (E2) (if new transistor module does not have these points tied together).

NOTE: Replace transistors in pairs.

3. Remove the jumper material from B1 and B2 to E2.
4. Make sure the base tabs are standing up straight and that the E1 and E2 tabs have been removed.
5. Reinstall power card.

https://truckmanualshub.com/

EPROM/Microprocessor Remove and Replace

Removal

1. Turn the key switch OFF and disconnect the battery connector.

⚠CAUTION

Be sure to observe proper precautions against electrostatic discharge. See "Static Precautions" on page 2-9.

Failure to use approved EPROM Extraction Tool P/N 950-032 may result in damage to the chip or socket.

2. Look at the circuit chip's socket on the circuit board. Of the four slots in the corners of the socket, two diagonally opposite slots open into the chip cavity. These holes receive the prongs of the removal tool.
3. Insert the prongs of the extraction tool into the holes identified in the previous step. Hold the tool straight up. See Figure 7-61.
4. Gently but firmly squeeze the jaws of the tool together. The prongs will retract, lifting and loosening the chip from its socket. *Do not rock or pull on the chip to release it.*



Figure 7-61. Chip Removal

Installation

1. Inspect the chip. Make sure there is no bent, broken or missing pins or other signs of physical damage. See Figure 7-62.

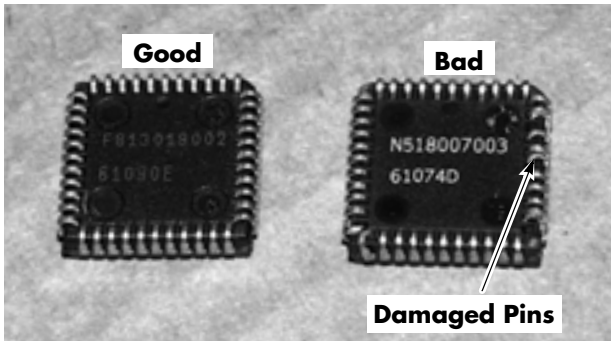


Figure 7-62. Chip Inspection

2. Notice the beveled corner and the arrow in the socket. Notice the beveled corner and the dot on the beveled edge of the chip
3. Position the chip so the dot is aligned with the arrow on the socket and the beveled corner is aligned with the beveled corner of the socket.
4. Gently press the chip into the socket with your thumb. Make sure it is completely seated on all four edges. See Figures 7-63 and 7-64.

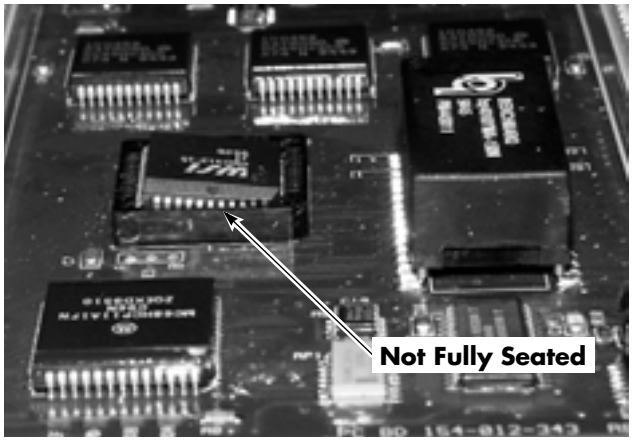


Figure 7-63. Chip Improperly Seated In Socket

https://truckmanualshub.com/

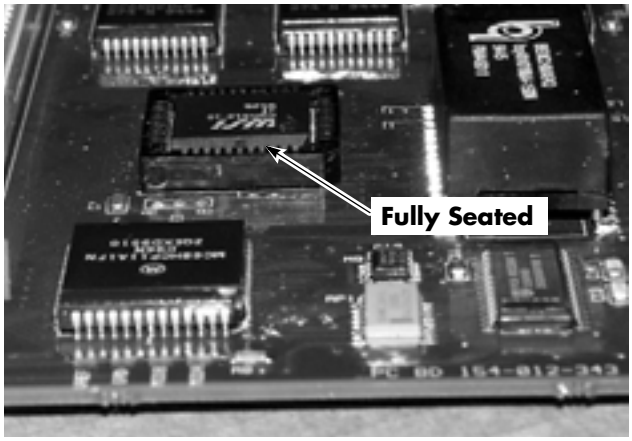


Figure 7-64. Chip Fully Seated In Socket

https://truckmanualshub.com/

Hydraulic Components

https://truckmanualshub.com/

Flow Sensor Service Notes

Servicing of the hydraulic flow sensor is limited to checking the turbine assembly inside the hydraulic flow sensor for cleanliness and freedom of movement.

NOTE: The flow sensor is electrically isolated from the truck chassis with insulating material and orange non-conductive hydraulic hose. Be careful that the connector plugs do not cause shorts between the body of the flow sensor and the truck chassis.

⚠CAUTION

The flow sensor must be electrically isolated. When servicing the flow sensor, make sure there is at least 2 megohm resistance between the body of the flow sensor and the truck chassis with JPY6 and JPY7 disconnected from the flow sensor pickups.

Make sure the connectors are reconnected to the correct pickup. Identify connector placement for correct reassembly. See Figure 7-65.

O-Ring Replacement

1. To ensure proper alignment during reassembly, use a pencil to mark the block and pickup on the small black nut, the large gold nut and the main block in a straight line.
2. Remove the assembly by unscrewing the large gold nut closest to the main block. Make sure the small black nut does not turn in relation to the large gold nut or the calibration of the pickup will be altered.
3. Remove the bad O-ring and install a new one.
4. Install the pickup back into the main block and tighten the large gold nut. Make sure the marks made in step 1 are aligned.
5. Run Test I10 - Display Flow Sensor Count (Page 6-156) to make sure the pickup functions properly.

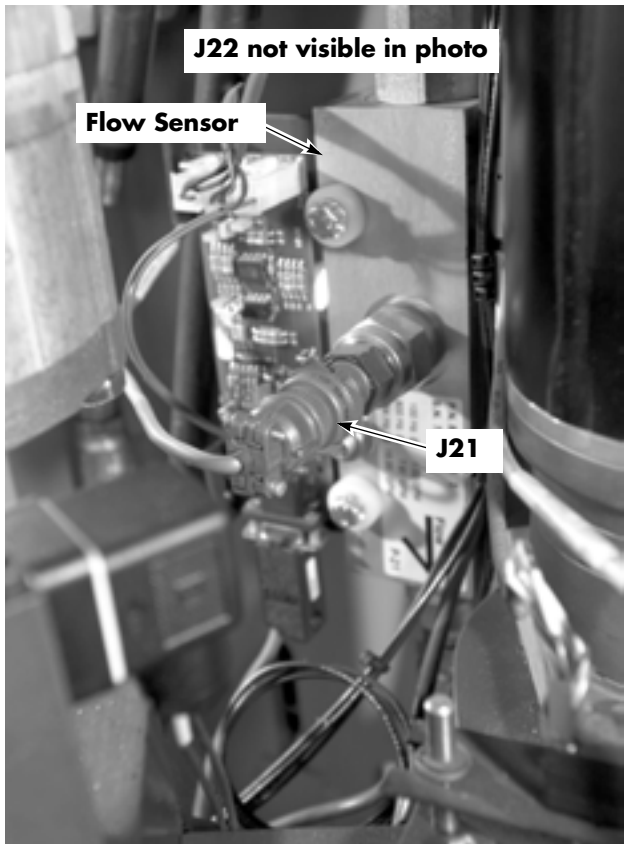


Figure 7-65. Flow Sensor

Disassembly

Disassembly of the flow sensor should be done in a clean area to prevent contamination from entering the turbine section of the flow sensor.

1. Remove the retaining ring from the inlet port. See Figure 7-66.

https://truckmanualshub.com/



Figure 7-66. Retaining Ring Removal

2. Using a soft object (eraser end of a pencil will do), carefully push the turbine assembly out of the sensor body from the outlet end. See Figures 7-67 and 7-68.



Figure 7-67. Removing Turbine Assembly

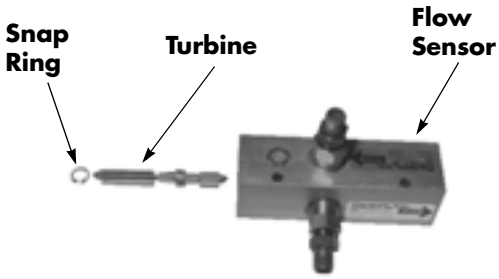


Figure 7-68. Turbine Assembly Removed

3. With the turbine assembly removed, inspect the turbine blades for damage and/or for debris that may have become entangled around the turbine. If the turbine is damaged, the entire assembly must be replaced.
4. Wash the turbine assembly in clean mineral spirits (or equivalent) and shake dry.

⚠CAUTION

Do not use compressed air to dry the turbine. Compressed air may overspeed the turbine damaging the bearing surfaces.

5. With the longer section of the turbine assembly pointed up, compress the turbine shaft and spin the turbine using your fingers. The turbine should spin freely for several seconds without chattering. If the turbine does not spin freely, the entire flow sensor assembly must be replaced.

Assembly

1. Reinstall the turbine assembly in the body of the sensor so that one of the vanes of the straightening section is between two stake marks located in the turbine bore. See Figure 7-69.

https://truckmanualshub.com/

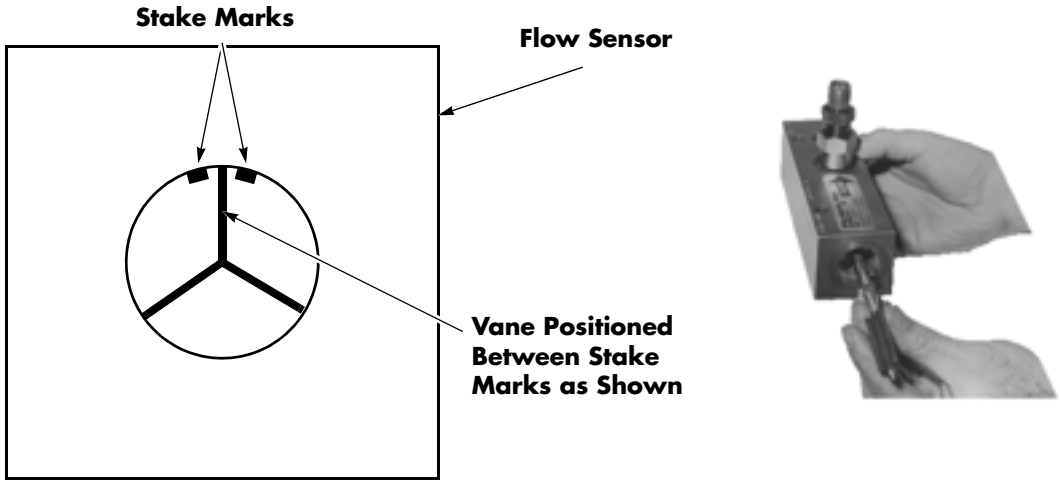


Figure 7-69. Reinstalling Turbine Assembly in Flow Sensor

2. Using the pencil eraser, depress the turbine assembly and reinstall the inlet snap ring.
3. Reinstall the flow sensor in the truck.
4. Bleed the hydraulic system and refill the reservoir. Check for leaks.
5. Run LEARN. See LEARN Ht/Wt on page 3-13.

https://truckmanualshub.com/

High Pressure Relief Valve Adjustment

1. Install a calibrated pressure gauge (3000 psi/20,682 kPa) in the test port. See Figures 7-70 or 7-71 as applicable.
2. Back-out high pressure relief.
3. Check to see that the Emergency Lower Valve is closed.
4. Place a rated load on the forks plus 200 lb. (90.7 kg).
5. Start the lift system and turn the pressure relief screw clockwise until the platform starts to lift. Note the pressure required when the platform starts to elevate. On three-stage trucks, continue lifting until the third stage of the mast starts lifting. Record the pressure reading.
6. Lower platform and remove weight.
7. Chain mast sections together and lift or lift against the stops.
8. Adjust the pressure relief valve to a pressure 100 to 300 psi (689.4 to 2068 kPa) greater than the values recorded in step 5.
9. After the adjustment is complete, tighten the relief valve lock nut.
10. Check the lift system for proper operation.

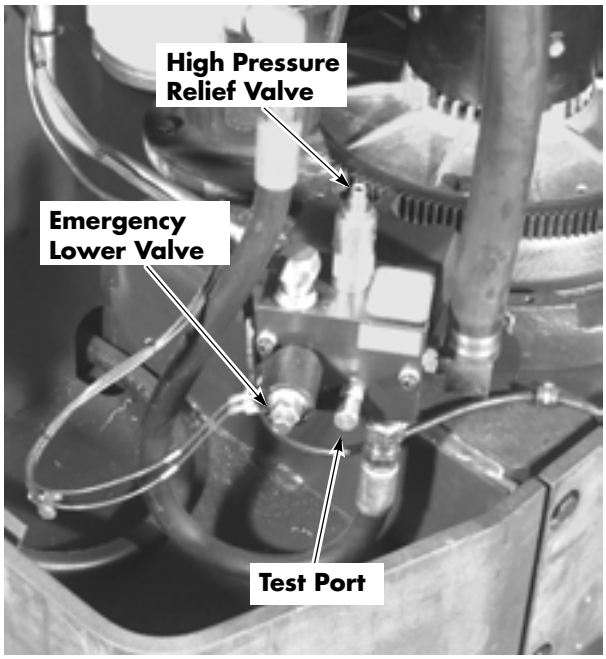


Figure 7-70. Single Speed Lift

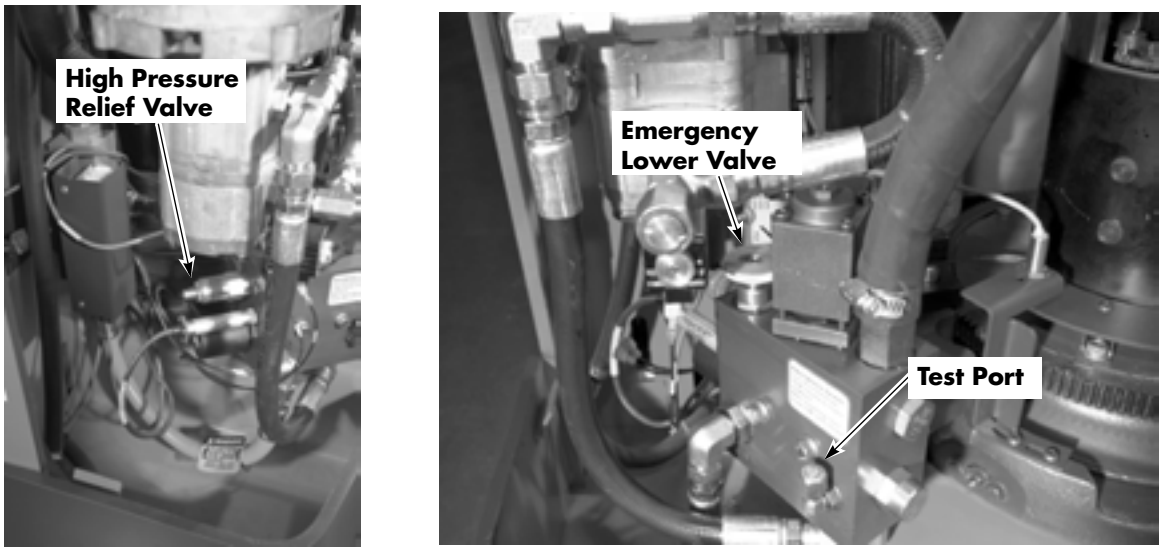


Figure 7-71. Variable Speed Lift

https://truckmanualshub.com/

Lift/Lower and Load Holding Valves

Use this procedure when it is necessary to remove and install a lift/lower or load holding valve.

⚠CAUTION

When servicing hydraulic components, keep the work area clean. Contaminants can cause damage to hydraulic system.

1. Make sure the operator platform is completely lowered.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the valve.
4. Inspect the sealing surface for contaminants. Clean the surface as necessary.
5. Lubricate O-rings with clean hydraulic fluid.
6. Install valve. See Figure 7-72.

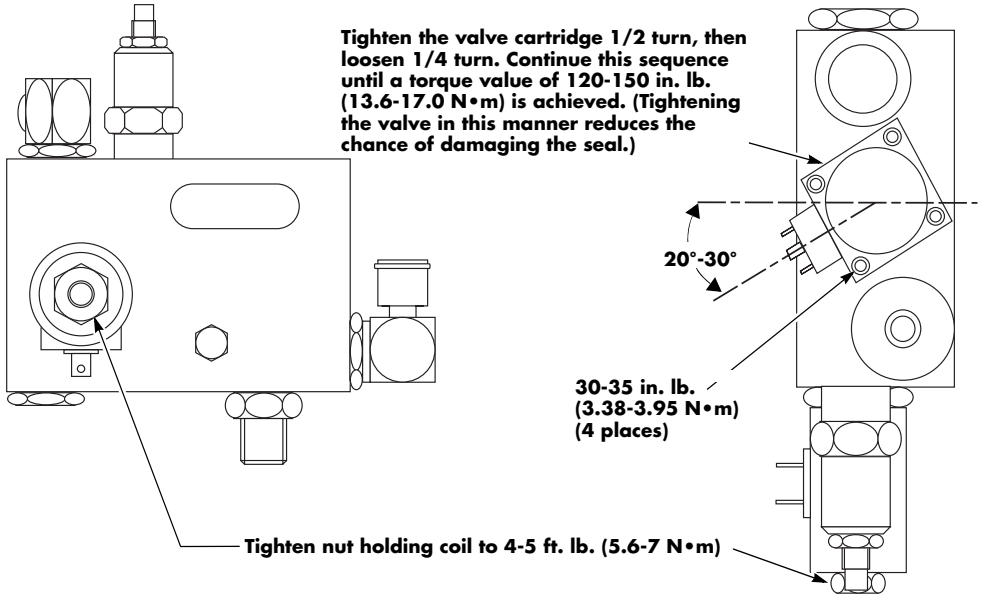


Figure 7-72. Lift/Lower and Load Holding Valve Installation

https://truckmanualshub.com/

Bleeding Lift Cylinders

Lift cylinders should be bled after maintenance or when operation indicates that air has entered the system (such as a bouncing operator's platform).

Side Lift Cylinders

NOTE: For trucks with an OACH of less than 95 in. (241 cm), see Figure 7-73.

1. For trucks with an OACH above 95 in. (241 cm), elevate the operator's platform approx 3 in. (7.6 cm).
2. Loosen, *do not remove,* the bleed screw near the top of the side cylinder just enough to bleed the air from the cylinder.

⚠CAUTION

The bleed screw should only be loosened enough to allow the air to escape.

3. When only oil flows from the cylinder, tighten the bleed screw. Repeat the process on the other cylinder.

Center Cylinder

If the truck has a three-stage mast, it will have a center cylinder. To bleed the center cylinder:

1. Elevate the operator's platform enough to extend the center cylinder approx 3 in. (7.6 cm).
2. Carefully loosen *(do not remove)* the bleed screw located on the side of the center cylinder.
3. When only oil flows from the cylinder, tighten the bleed screw.

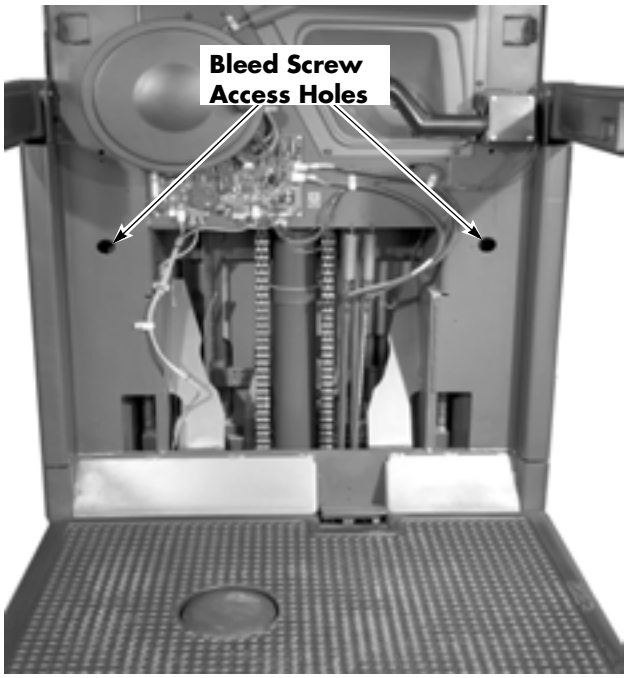


Figure 7-73. Bleed Screw Access - trucks with OACH of less than 95 in. (241 cm)

https://truckmanualshub.com/

Lift Pump and Motor

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Clamp suction hose closed. See Figure 7-74.
3. Remove two mounting bolts securing the lift pump to the lift motor.
4. Carefully separate the pump from the motor, taking care not to damage the toothed spline.
5. Remove the hydraulic fittings from the lift pump.

Installation

1. Attach the hydraulic fittings to the pump.
2. Apply molybdenum anti-seize compound (P/N 990-638) to the mating surfaces of the lift motor spline and pump.
3. Apply thread-locking compound (P/N 990-536) to the lift pump mounting bolts.
4. Carefully mate the lift pump spline to the lift motor and attach the lift pump to the lift motor with the two mounting bolts.
5. Unclamp the suction hose and add hydraulic fluid to the reservoir if necessary.
6. Reconnect the battery connector and turn the key switch ON.
7. Bleed the hydraulic system.
8. Test the lift function for smooth and proper operation.
9. Check the lift pump for leaks.

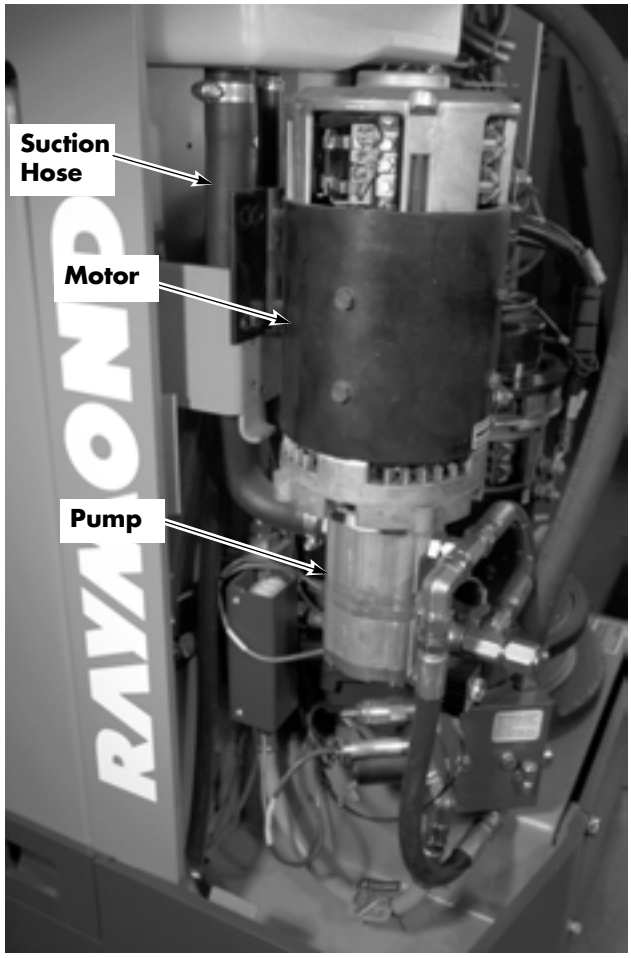


Figure 7-74. Lift Pump and Motor

https://truckmanualshub.com/

Pressure Switch Adjustment

This procedure applies to all 24V non-*intellispeed* lift trucks equipped with the High Performance Lift (Hi Pro) option *(except EE rated trucks)*.

1. Disconnect JPS7 at the Tractor Manager.
2. Connect a meter across terminals JS7-1 and JS7-3.
3. Raise the operator's platform approximately 2 ft. (610 mm) with a 1000 lb. (454 kg) load on the forks.
4. Adjust the screw on the back of the switch until the switch just opens.
5. Turn the screw until the switch just closes.
6. Adjust the screw until the switch re-opens.

https://truckmanualshub.com/

Two-Stage Lift Cylinder

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove console and tractor covers.
3. Disconnect all over-the-mast electrical cables.
4. On vehicles equipped with cable steering, remove the wire rope from the steering system.
5. Using a chain hoist, or another suitable lifting device, raise the carriage to slacken the lift chains.
6. Remove the chain pulleys.
7. Remove the chain anchors from the mast main frame.

NOTE: On trucks with an OACH of less than 102 in. (259.1 cm), the chain anchors are behind the carriage frame. Lift the carriage enough to gain access to the chain anchors on the mast main frame.

8. Remove the nut at the top of the piston.
9. Lift the carriage out of the telescopic.
10. Remove the nut from the bottom of the lift cylinder housing.
11. Disconnect and plug the hydraulic line to the bottom of the lift cylinder.
12. Place a sling attached to a hoist around the cylinder to be removed.
13. Remove the shoulder bolt securing the upper lift cylinder guide.
14. Lift cylinder may now be removed.

Disassembly

Refer to Figure 7-75 for the following steps.

1. Remove snap ring (**1**) from housing.
2. Remove wiper ring (**2**) from housing.
3. Remove snap ring (**9**) from housing.
4. Pull piston out until piston stop forces piston seal (**3**), back-up ring (**4**), O-ring (**5**), double gland seal (**6**), U-cup seal (**7**), and back-up ring (**8**) out of housing.
5. Pull piston out of housing. Carefully place piston on a cushioned stand.

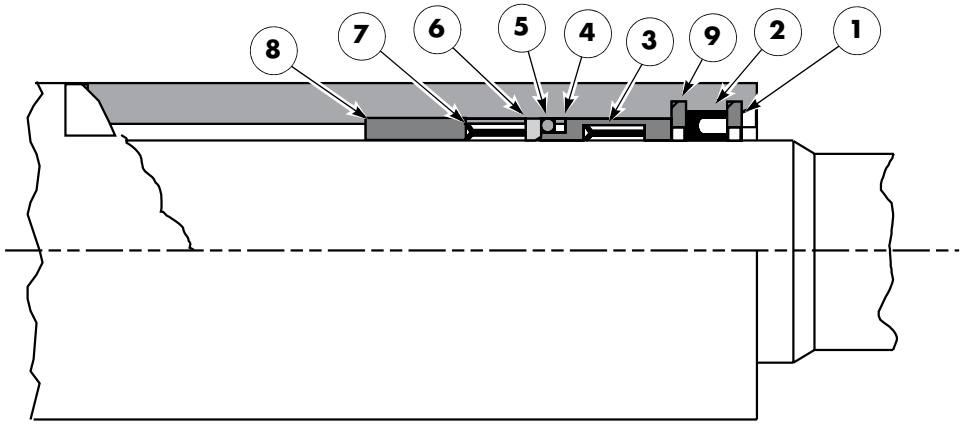


Figure 7-75. Two-Stage Lift Cylinder (Top End)

https://truckmanualshub.com/

Refer to 7-76 for the following steps.

6. Push plunger (**10**) in slightly at base of piston.
7. Remove snap and retaining rings (**11**) and (**12**).
8. Release pressure on plunger (**10**) and remove.
9. Remove spring (**13**).
10. Remove seal (**14**) from plunger.
11. Do not separate piston (**16**) and piston plug (**15**) unless absolutely necessary. If disassembly is required, use a strap wrench. Do not scratch piston surface.

NOTE: When repacking the cylinder, replace all packings. For packing kit part numbers, refer to the appropriate Parts Catalog for the model and serial number truck being repaired.

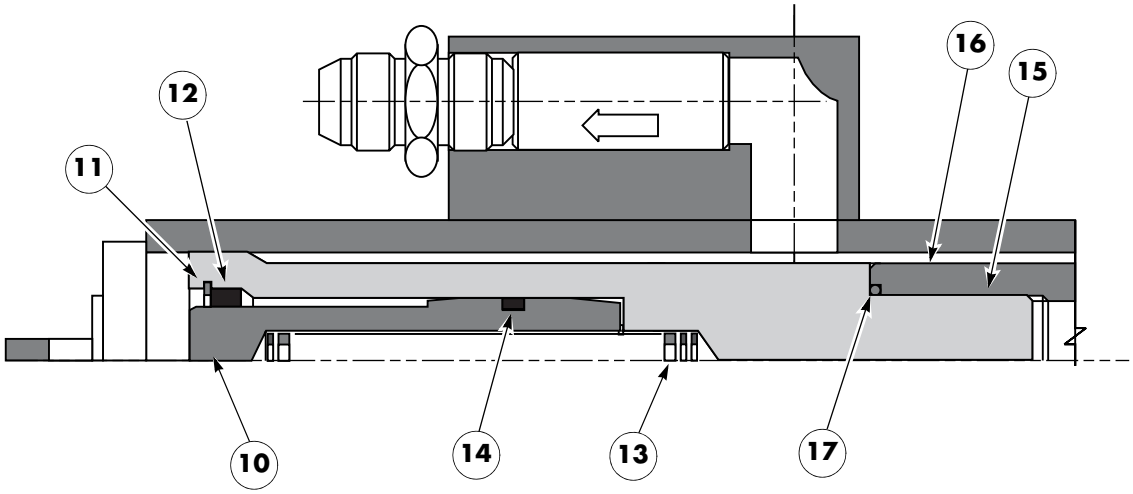


Figure 7-76. Two-Stage Lift Cylinder (Bottom End)

Cleaning

1. Flush inside of housing and wipe piston clean using a suitable industrial solvent.
2. Inspect all surfaces for galling or heavy scratches. Minor imperfections may be removed using fine emery cloth.
3. Inspect all parts. Replace as necessary.

Reassembly

1. Dip all packings and O-rings *except* (**17**) in new hydraulic fluid before assembly.
2. Lubricate inside of cylinder housing with new hydraulic fluid.
3. Reassemble cylinder by reversing disassembly procedure. Note the following:
   - Tighten piston plug (**16**) and piston (**15**) using a strap wrench. *Do not scratch chrome plating on piston.*
   - If items (**15**) and (**16**) were separated, clean threads on piston plug (**16**) using thread-locking primer (P/N 990-533). Apply thread-locking compound (P/N 990-571) to threads. Tighten using a strap wrench.
   - Pressure test cylinder in less than fully extended position at 4500 psi (31026.4 kPa).
   - Plug fitting opening to prevent foreign matter from entering cylinder.

Installation

1. Reverse the removal procedure.
2. Reconnect the battery connector and turn the key switch ON.
3. Bleed hydraulic system after reassembly. Check for leaks.
4. Test all vehicle functions.

https://truckmanualshub.com/

Three-Stage Center Lift Cylinder

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove console and tractor covers.
3. Disconnect all over-the-mast electrical cables.
4. On vehicles equipped with cable steering, remove the wire rope from the steering system.
5. Use a chain hoist or other suitable lifting device to raise the carriage enough to slacken the lift chains.
6. Remove the lift chains from the equalizer on the backside of the center lift cylinder.
7. Disconnect and plug supply hose at bottom of center lift cylinder.
8. Lift the end cap off of center cylinder.
9. Remove the nut from the bottom of the center lift cylinder.
10. Support the cylinder with a sling attached to a hoist.
11. Remove the clamp supporting the center cylinder.
12. Remove the center cylinder.

NOTE: To remove and/or service the outboard lift cylinders, see "Two-Stage Lift Cylinder" on page 7 -74.

Service of Cylinder without Cushions

Disassembly

Refer to Figure 7-77 for the following steps.

1. Remove snap ring (**1**) and oil seal (**2**).
2. Remove snap ring (**3**) in housing.
3. Pull piston out until the piston stop pushes packing ring (**4**), packing (**5**), and adapter (**6**) out.
4. Pull piston out of housing. Carefully place piston on a cushioned stand.

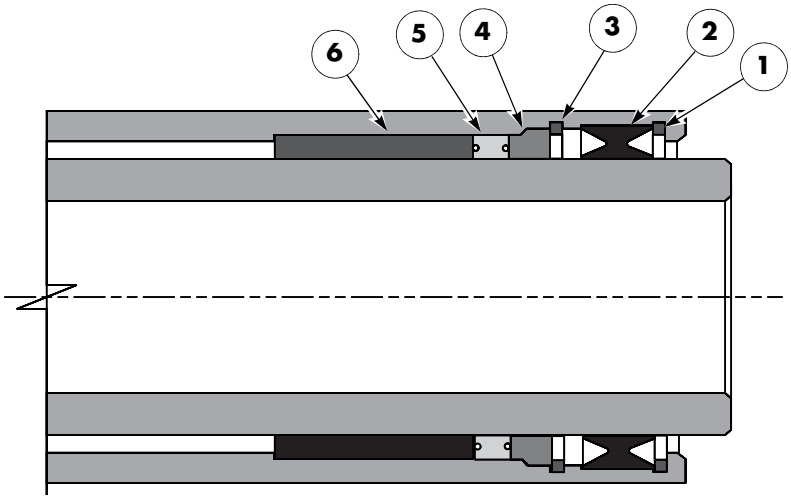


Figure 7-77. Center Lift Cylinder, Three-Stage without Cushions (Top End)

https://truckmanualshub.com/

Refer to Figure 7-78 for the following steps.

5. Push plunger (**7**) in slightly at base of piston.
6. Remove snap and retaining rings (**8**) and (**9**).
7. Release pressure on plunger and pull out.
8. Remove spring (**10**).
9. Remove seal (**11**) from plunger.
10. Do not separate piston (**13**) from piston plug (**14**) unless absolutely necessary. If disassembly is required, use a strap wrench. Do not scratch piston surface.

NOTE: When repacking the cylinder, replace all packings. For packing kit part numbers, refer to the appropriate Parts Catalog for

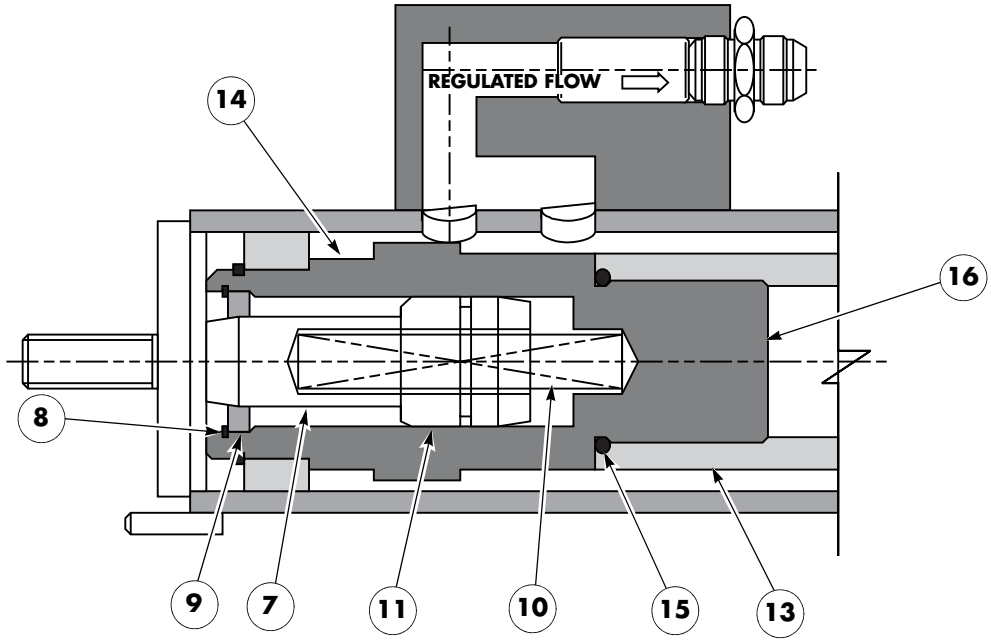


Figure 7-78. Center Lift Cylinder, Three-Stage without Cushions (Bottom End)

Cleaning

1. Flush inside of housing and wipe piston clean using a suitable industrial solvent.
2. Inspect all surfaces for galling or heavy scratches. Minor imperfections may be removed using fine emery cloth.
3. Inspect all parts. Replace as necessary.

Reassembly

1. Dip all packings and O-rings *except* (**15**) in new hydraulic fluid before assembly.
2. Lubricate inside of cylinder housing with new hydraulic fluid.
3. Reassemble cylinder by reversing disassembly procedure. Note the following:
   - To prevent damage to packings at the top of the cylinder, use the following tools: Service Driver (P/N 401-000-058) and Service Guide (P/N 401-000-059)
   - If removed, clean threads on piston plug (**16**) using thread-locking primer (P/N 990-533). Apply thread-locking compound (P/N 990-571) to threads on piston plug. Tighten using a strap wrench. *Do not scratch chrome plating on piston.*
   - Pressure test cylinder in less than fully extended position at 4500 psi (31026.4 kPa).
   - Plug fitting opening to prevent foreign matter from entering cylinder.

https://truckmanualshub.com/

Service of Cylinder with Cushions

Cushion Replacement

Refer to Figure 7-79 for the following steps.

1. Remove retaining ring (**1**) and top bearing (**2**).

NOTE: When the retaining ring is removed, a spring behind the top bearing may push the bearing out of the housing.

2. Remove the spring (**3**) and pressure ring (**4**).
3. Remove the three torx screws (**5**) located about 6 in. from the top of the housing.
4. Remove piston (**6**) from cylinder housing.
5. Remove the cushion assembly (**7**).
6. Coat the threads of the new cushion assembly with thread locking compound primer (P/N 990-553) and apply thread locking compound (P/N 990-571).
7. Assemble the new cushion assembly (**7**) to piston rod.
8. Re-install piston assembly in cylinder housing.
9. Re-install the three torx screws (**5**).
10. Lightly oil a new seal (**8**) and install in pressure ring (**4**). Check to make sure the small orifice in the pressure ring is not obstructed.
11. Install spring (**3**).
12. Remove the bad parts from the top bearing.
13. Lightly oil new seal (**9**), O-ring (**10**), backup ring (**11**) and wiper (**12**) and install into the top bearing.
14. Install the top bearing (**2**).
15. Install the retaining ring (**1**).

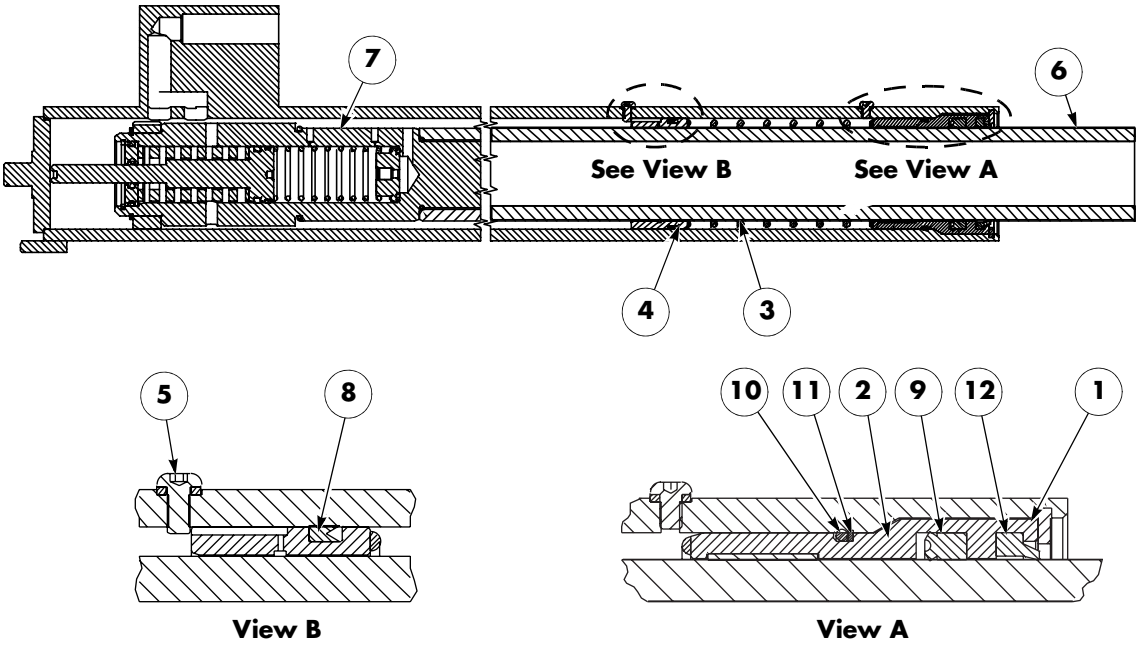


Figure 7-79. Center Lift Cylinder, Three-Stage with Cushions

https://truckmanualshub.com/

Seal Replacement

Refer to Figure 7-79 on page 7-78 for the following steps.

1. Remove retaining ring (**1**) and top bearing (**2**).

NOTE: When the retaining ring is removed, a spring behind the top bearing may push the bearing out of the housing.

2. Remove the spring (**3**) and pressure ring (**4**).
3. Check to make sure the small orifice in the pressure ring is not obstructed.
4. Lightly oil a new seal (**8**) and install in pressure ring (**4**).
5. Remove the bad parts from the top bearing.
6. Lightly oil new seal (**9**), O-ring (**10**), backup ring (**11**) and wiper (**12**) and install into the top bearing.
7. Install the top bearing (**2**).
8. Install the retaining ring (**1**).

Installation

1. Reverse the removal procedure.
2. Reconnect the battery connector and turn the key switch ON.
3. Bleed hydraulic system after reassembly. Check for leaks.
4. Test all vehicle functions.

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Mast Section

https://truckmanualshub.com/

Mast Bearing Shimming

Shimming a mast is done to ensure a smooth running unit which is not too tight or too loose. Total movement between the bearings and telescopics should be between 0.030 to 0.045 in. (0.76 to 1.14 mm).

If any marks are found within the telescopics or main frame where the rollers have been running, they should be removed with a sanding disk with 80 grit paper. Do not attempt to remove all marks, only the ridges.

A properly adjusted mast should show no more than a 0.5 in. (13 mm) mark where the roller touches the respective telescopic or main frame. The assembly should be shimmed to the tightest spot on the assembly (as the rollers run up and down the rail). Small areas that are slightly higher than the rest of the web can be buffed to avoid shimming the major portion of the rail too loose. While shimming the mast, the telescopics and carriage must be loose enough to slide them in and out by hand. Shimming the assembly in an upright position can result in shimming that is too tight and could cause premature wear.

The shims used under each roller bearing come in the following sizes: thin, medium, and thick. When the truck is built, the factory typically installs a thick shim on each side. If the bearings are too loose, you should add shims to the bearing. If the roller bearings are shimmed too tight, causing wear along the I-beam or mast shaving, reduce the shim thickness. Although different combinations of shims may be used to obtain the proper adjustment, you should try to maintain equal shim thickness on each side of the mast mainframe and telescopics. See Figure 7-80.

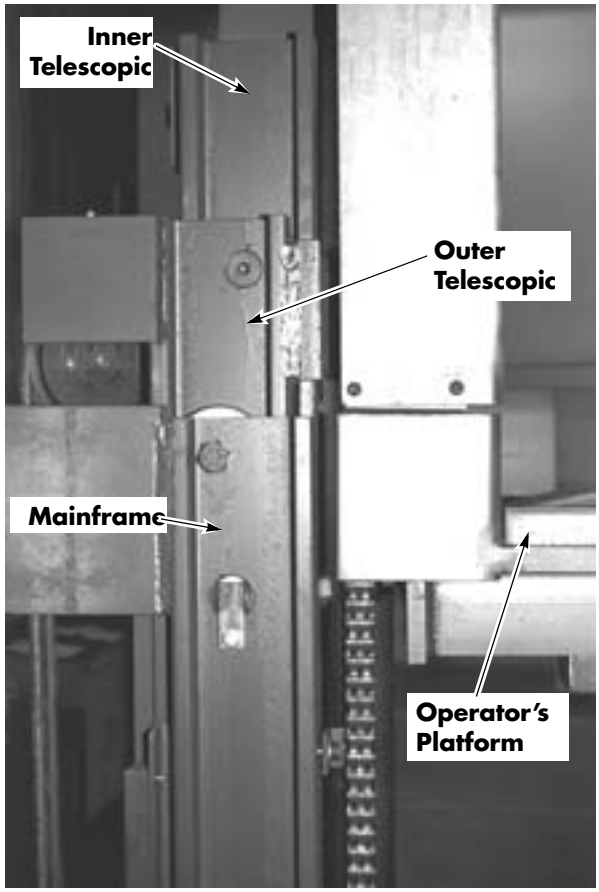


Figure 7-80. Staging of Mast Prior to Shimming Bearings

Upper Mast Bearing Replacement

⚠ WARNING

Use extreme care when blocking the mast for any reason. Never remove the block when it is supporting the mast.

1. Slightly elevate the carriage to gain access to the bearings.
2. Block the carriage before you attempt to remove the roller bearing. See Figure 7-81.

https://truckmanualshub.com/



Figure 7-81: Blocking Carriage

You may also use a lift hoist to pull the carriage upward to gain access to the roller bearing. Put a strap suitable to handle the weight of the carriage around the uppermost cross tie. Once the carriage is raised in place, block it into position.

3. Turn the key switch OFF and disconnect the battery connector.

⚠CAUTION

Do not damage the telescopic when prying with the screwdriver.

NOTE: For the upper mast bearings, wedge a screw driver between the roller bearing and the mast to prevent the bearing from falling.

NOTE: When removing the roller bearing, use caution not to let the bearing fall down into the mast assembly.

4. Remove the bolt securing the roller bearing to the respective mast or telescopic.

NOTE: If the bearings are worn or damaged, replace them.

5. Install the same number of shims under the bearing that were removed.
6. Make sure the roller bearing mounting bolts are clean before you install them.
7. Apply thread-locking compound (P/N 990-536) on the threads. Torque the bolts per Table 7-4.
8. Reconnect the battery connector and turn the key switch ON.
9. Lift the carriage and mast and unblock the mast.
10. Test the operation of the telescopics.
11. Return the truck to service.

Table 7-4: Mast Bearing Stud Retaining Bolt Torque Values

Location	*Torque
Main Frame	300 ft. lb. (406.7 N•m)
Outer Tele Upper	250 ft. lb. (339 N•m)
*After torquing, back bolt off 1/4 to 1/2 turn.	

https://truckmanualshub.com/

Mast Disassembly and Shimming

This section describes procedures for:

- Disassembling the three-stage mast
- Shimming main frame to outer telescopic
- Shimming outer telescopic to inner telescopic
- Shimming inner telescopic to carriage

NOTE: Two stage masts require similar procedures with the references to the center lift cylinder and inner telescopic not applying.

Mast Disassembly

1. Remove the forks and mast guard.
2. Fully lower the carriage and make sure the pressure is out of the cylinders.
3. Turn the key switch OFF and disconnect the battery connector. Remove the battery.
4. Disconnect the over-the-mast cables and hoses inside the tractor compartment and plug the hoses. Disconnect the lift hose to the side cylinders inside the tractor compartment and plug. Disconnect all other cables that run from the tractor to the mast.
5. Secure the main carriage and telescopics so they cannot move.
6. Remove the tractor from the mast and block each securely.
7. Disconnect and remove the lift chains from the center lift cylinder. Remove the over pulley cables and hoses. Remove the center cylinder end cap assembly. See Figure 7-82.
8. With a suitable hoist, carefully lay the mast assembly down and block securely in place. Remove the carriage stops from the inner telescopic.
9. Remove the main carriage by sliding it out the top of the inner telescopic. Set it aside for later reassembly.



Figure 7-82. End Cap Assembly, Three-Stage Mast

10. Remove the lift chains, chain pulleys, hose and cable pulleys.
11. Disconnect and remove the lift cylinders from the telescopics.
12. Attach the hoist to the inner telescopic.
13. Remove the upper roller bearing bosses and roller bearings from the outer telescopic.
14. Remove the telescopics and mainframe stops.
15. Slide the inner telescopic out of the top of the outer telescopic. Attach the hoist to the outer telescopic.
16. Remove the upper roller bearing bosses and roller bearings from the main frame.
17. Slide the inner telescopic out of the top of the main frame.

Shimming Main Frame to Outer Telescopic

1. Install the mast roller bearings at the bottom of the outer telescopic.
2. Use a suitable lifting device and insert the outer telescopic into the main frame all the way to the bottom.
3. Using a pry bar, move the outer telescopic and roller bearing to one side.
4. Use spare shim(s) as a gauge to determine the amount required to move the roller bearings outward to make contact with the main frame.

https://truckmanualshub.com/

5. Remove the outer telescopic from the main frame.
6. Remove the roller bearings from both roller bearing bosses at the bottom of the outer telescopic.
7. Install half of the total shim thickness required to each roller bearing boss at the bottom of the outer telescopic. (Applying one half of the total shim thickness to each side of the telescopic maintains the center line of the mast assembly.)
8. Reinstall the roller bearings. Torque the bolts per Table 7-4 on page 7-83.
9. Use a suitable lifting device and reinstall the outer telescopic into the main frame. Check for tightness while moving the outer telescopic to the bottom of the main frame. Add/remove shims as necessary to maintain a snug, but free-running, fit.

NOTE: If the outer telescopic hangs up, a pry bar may be used to move the telescopic.

10. Assemble the two top mainframe roller bearings and bosses without shims.
11. Install the roller bearing assemblies, attach with a retaining bolt, and snug up to the main frame.

NOTE: Failure to snug the assemblies to the main frame will result in the wrong amount of shims, since the studs are canted.

12. With the outer telescopic fully nested, use a pry bar and carefully move the outer telescopic to the opposite side. Using spare shims between the bearing and outer telescopic, determine the amount of shims required to remove side play.
13. Remove the roller bearing assemblies.
14. Install half of the total shim thickness to each roller bearing assembly.
15. Install the roller bearing assemblies and attach with the mounting bolts and tighten.
16. With the outer telescopic fully nested, use a pry bar to check for bearing tightness. If more shims can be inserted between the bearing and the outer telescopic, remove the roller bearing assembly and install the shim(s). Reinstall the bearing assembly.
17. Check for proper shimming by pulling the outer telescopic out and then pushing it in all the way. The outer telescopic should not hang up while moving it in and out. Torque the bearing stud retaining bolts per Table 7-4 on page 7-83.
18. Install the stops in the mainframe.

Shimming Outer Telescopic to Inner Telescopic

1. Install the mast roller bearings at the bottom of the inner telescopic.
2. Use a suitable lifting device and insert the inner telescopic into the outer telescopic all the way to the bottom.
3. Use a pry bar and carefully move the inner telescopic and bearings to one side.
4. Use spare shim(s) as a gauge to determine the amount required to move the bearings outward to make contact with the outer telescopic.
5. Remove the inner telescopic from the outer telescopic.
6. Remove the bearings from both roller bosses at the bottom of the inner telescopic.
7. Install half the total shim thickness required to each roller boss at the bottom of the inner telescopic.
8. Reinstall the roller bearings. Torque the bolts per Table 7-4 on page 7-83.
9. Use a suitable lifting device and reinstall the inner telescopic into the outer telescopic. Check for tightness while moving the inner telescopic to the bottom of the outer telescopic.

NOTE: If the inner telescopic hangs up, a pry bar may be used to move the telescopic.

10. With the inner telescopic fully nested, use a pry bar to check for bearing tightness. If a thin shim can be inserted between the bearing and the outer telescopic, remove the inner telescopic and install the shim between the bearing and the roller boss. Torque the bearing stud retaining bolt per

https://truckmanualshub.com/

Table 7-4 on page 7-83. Leave the lifting device connected to the outer telescopic. *Do not apply excessive pressure to the bearings with the pry bar.*

11. Assemble the two roller bearings and bosses for the top inner telescopic without shims.
12. Insert the bearing/boss assemblies and attach with the retaining bolts. Draw the bearing bosses up snug to the outer telescopic.

NOTE: Failure to snug the assemblies to the main frame will result in the wrong amount of shims, since the studs are canted.

13. Use a pry bar and carefully move the inner telescopic to the other side. Using spare shims between the bearing and inner telescopic, determine the number of shims required to remove side play.
14. Remove the bearing/boss assemblies.
15. Install half the total shim thickness to each bearing/boss assembly.
16. Install the bearing/boss assemblies into the outer telescopic/inner telescopic. Attach with a mounting bolt and tighten.
17. With the inner telescopic fully nested, use a pry bar to check for bearing tightness. If more shims can be inserted between the bearing and the inner telescopic, remove the bearing/boss assembly and install the shim(s). Reinstall the bearing/boss assembly. Torque the bearing stud retaining bolt per Table 7-4 on page 7-83.
18. Check for proper shimming by pulling the inner telescopic out and then pushing it in all the way. The inner telescopic should not hang up while moving it in and out.
19. Install the stops at the upper cross tie.
20. Install the outer lift cylinders.
21. Install the chain rollers and lift chains.
22. Install the center lift cylinders

Shimming Inner Telescopic to Carriage

1. Install the mast roller bearings on the carriage roller bosses.
2. Use a suitable lifting device and insert the carriage into the inner telescopic all the way to the bottom.

NOTE: The carriage may have to be removed several times to obtain the proper fit.

3. Using a pry bar, move the bottom carriage bearings to one side.
4. Use spare shim(s) as a gauge to determine the amount required to move the bearings outward to make contact with the inner telescopic.
5. Move the carriage to the top of the inner telescopic and repeat the process for the top set of bearings.
6. Remove the carriage from the inner telescopic.
7. Install half of the total shim thickness required to each roller boss.
8. Reinstall the roller bearings.
9. Use a suitable lifting device and reinstall the carriage into the inner telescopic. Check for tightness while moving the carriage to the bottom of the inner telescopic.
10. Use a pry bar to check for bearing tightness. If a thin shim can be inserted between the bearing and the inner telescopic, remove the carriage and install the shim between the bearing and the roller boss. *Do not apply excessive pressure to the bearings with the pry bar.*
11. Use a suitable lifting device and reinstall the carriage, checking for tightness. Make sure the carriage can be moved in and out by hand.
12. When the correct fit is obtained, measure the gap between the top of the platform and the inner telescopic on both sides. If the gap between the platform and the inner telescopic is not within 1/16 in. (1.59 mm) of each other, remove the platform.

https://truckmanualshub.com/

13. Take shims from the top roller on the side that is farthest away and install them on the opposite side. Repeat this procedure until 1/16 in. (1.59 mm) is obtained. If all shims are on one side of the top rollers, remove shims from the bottom roller on the side that is farthest away and install them on the opposite side.
14. Repeat this procedure until the required clearance at the top of the platform is obtained.
15. Install the carriage and the carriage stops.
16. Install the pulleys for the over mast hoses and cables.
17. Secure the main carriage and telescopics in place so that they do not move while standing the assembly back up.
18. Install all the other items removed during the disassembly process after laying the assembly down.
19. Attach the hoist to the mast assembly and stand the mast back up. Install all the other items removed during the disassembly process prior to laying the assembly down.
20. Attach the tractor to the mast.
21. Install the remaining components.
22. Connect the hoses and cables inside the tractor compartment.

⚠ WARNING

Make sure all mast stops are installed and securely tightened before operating the lift truck.

23. Reinstall the battery.
24. Reconnect the battery connector and turn the key switch ON.
25. Adjust the lift chains.
26. Install the forks and mast guard.
27. Check for proper operation.
28. Grease the channels.
29. Bleed the lift cylinders. See Bleeding Lift Cylinders on page 7-71.

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Section 8. Theory of Operation

https://truckmanualshub.com/

Navigation Instructions for the Pin-Out Matrix

The Pin-Out Matrix is designed to be used in conjunction with the electrical schematic (see page A-13) to assist in testing and troubleshooting the truck. The following text describes the columns in which the information appears and the information given.

No. - line sequence number in the matrix. Has no relevance to the schematic.

Wire/Comp - the actual wire/connection references or component abbreviations on the electrical schematics.

Function Description - brief description of the voltage carried on the wire.

Theory of Operation - detailed description of the voltage carried on the wire. If the voltage can be variable, it indicates the state of a related component that will cause the voltage to vary. Also identifies possible causes for lack of proper voltage.

Device - identifies the major system component related to the voltage.

Normal Voltage - voltage value that is usually seen on that wire for the state indicated.

Voltage Source - device or connection that supplies the voltage directly to the wire.

Voltage User - device or connection that the wire directly delivers the voltage to.

List of Abbreviations and Symbols

The following abbreviations and symbols are used in the Pin-Out Matrix. For a complete list on abbreviations and symbols, see page -5.

approx - approximately
Assy - Assembly
CCC - Carriage Control Card
EPO - Emergency Power OFF
ESM - Electric Steer Manager
L/H - Load Holding
L/L - Lift/Lower
OI - Operator Interface
PWM - Pulse Width Modulation
TM - Tractor Manager
TM1 & 2 - Transistor Module 1 & 2
TM3 & 4 - Transistor Module 3 & 4
VFC - Vehicle Function Controller
wrt - with respect to

> - greater than
< - less than

https://truckmanualshub.com/

Pin-Out Matrix

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
1	JPS18-1 & JPS18-2	Chan B In & Chan A In	Chan B In & Chan A In are generated whenever there is movement of the sensor disc over the proximity sensor. They are two independent square waves generated by the Speed Feedback Prox when it detects the metal spokes in the sensor disc. Voltage is high (>7V) when not sensing metal and low (<1V) when sensing metal. The frequency varies directly with the speed of the Drive Motor. The TM/VFC uses the quadrature phase relationship between Channels A & B to determine travel direction and speed.	Speed Feedback Prox	Approx 5V when Drive Motor is turning. Scope will show square wave approx 8V in amplitude	Speed Feedback Prox	TM/VFC
2	JPS18-3	+12VF	Supplies working voltage to the Speed Feedback Prox. If not present, check voltage at TP4 (+12VF) on the TM.	Speed Feedback Prox	10.8 - 13V	TM	Speed Feedback Prox
3	JPS5-1	Arm Current Limit	Digital voltage generated by the Power Card when the current flowing in the armature of the drive motor exceeds a preset value. The TM/VFC and CCC use this voltage to adjust truck performance and to determine travel codes such as Code 29.	Power Card	>10V not limited <5V limited	Power Card	CCC
4	JPS5-2	PP Temp Limit	Digital voltage generated when the temperature of the power panel heatsink exceeds a preset value. When limit is exceeded, the Power Card reduces the voltage to <5V and the TM/VFC limits travel speed to 1mph.	Sensor HT	>10V not limited <5V limited Approx 1.5V disconnected	Power Card	TM/VFC
5	JPS5-3	Field Current	Analog voltage generated when there is current flowing in the field of the drive motor. Field Current, read from current shunt RS1 on the Power Card, varies directly with the drive motor field current. It is used by the Power Card to determine when to limit field current and is also sent from the Power Card to the TM/VFC.	Power Card	0.8-1.2V @ rest 3.5V in current limit	Power Card	TM/VFC
6	JPS5-4	Boost	Not used on this truck.				
7	JPS5-5	Tractor First	Generated via a request for forward travel. This voltage, sent from the TM/VFC through the TM to the Power Card, enables the Power Card to pulse TM1 & 2 for travel in the Tractor First (Forward) direction. If it is not present, the truck will not travel even if Field PWM is present at JPS5-8, measured wrt to TP6.		JPC5-5 wrt TP6 >10.5V enabled <1V not enabled	TM/VFC	Power Card
8	JPS5-6	Forks First	Generated via a request for reverse travel. This voltage, sent from the TM/VFC through the TM to the Power Card, enables the Power Card to pulse TM1 & 2 for travel in the Forks First (Reverse) direction. If not present, the truck will not travel even if Field PWM is present at JPS5-8, measured wrt to TP6.		JPC5-6 wrt TP6 >10.5V enabled <1V not enabled	TM/VFC	Power Card

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
9	JPS5-7	PP Temp	Generated whenever the key switch is ON. This analog voltage, read from HT on the heatsink, varies from approx 4-6V as the heatsink temperature increases above normal. The TM/VFC reduces drive motor current as this voltage (and temperature) increases above normal.	Sensor HT	Approx 4V @ 70°F 3-6V @ normal operating temp >10V disconnected	Power Card	TM/VFC
10	JPS5-8	Field PWM	Generated whenever there is a request for travel. It is a chopped DC voltage sent from the TM/VFC, through the TM to the Power Card. It controls the ON/OFF time of TM1 & 2 when either Tractor First or Forks First is present at JPS5-5 or 6.		3-7V during travel Approx 11.5V in current limit	TM/VFC	Power Card
11	JPS5-9	+12VF	Supplies working voltage to the Power Card. If not present, check voltage at TP4 (+12VF) on the TM & FU17.		10.8-13V	TM	Power Card
12	JPS3-1	NC	No connection				
13	JPS3-2	AGND	AGND (Analog Ground) is used as the reference and negative for the circuits on the Power Card. Although it eventually connects to B–, it is kept separate from the other grounds to help reduce the effects of noise on system operation. If more than 0.3V is measured to TP4, there may be a noise or connection problem. If voltage varies with operation, there is probably a noise problem.		<0.3V wrt TP4. Measure battery voltage to PC1 (B+) to verify connections.	TM	Power Card
14	JPS3-3	Chopper PWM	Chopper PWM is generated when there is a request for travel. Chopper PWM is a varying voltage sent from the TM/VFC, through the TM to the Power Card. It is used to control the ON/OFF time of Q1 when Chopper Enable is present at JPS3-5. The DC value measured with a meter should vary from >10V at rest down to approx 1V depending on speed request and speed limiting.		>10V @ rest Approx 1V @ full speed	TM/VFC	Power Card
15	JPS3-4	Arm Current	Analog voltage generated when there is current flowing in the armature of the drive motor. Voltage, read from CT-1 on the Power Card, varies directly with drive motor armature current. This voltage is used by the Power Card to limit armature current and is also sent from the Power Card, through the TM, to the TM/VFC. Voltage increases approx 1V per 100A of armature current.	Drive Motor Armature	5.7 - 6.3V w/truck @ rest Current limit is approx 3V greater than voltage at rest	Power Card	TM/VFC
16	JPS3-5	Chopper Enable	Digital voltage generated when there is a request for travel. This is sent from the TM/VFC, through the TM, to the Power Card. It allows the Power Card to pulse Q1 when Chopper PWM (JPS3-3) is present. If Chopper Enable is missing, Q1 cannot be turned ON, even if Chopper PWM is present.		<1V enabled >10.5V not enabled	TM/VFC	Power Card
17	JPS3-6	B+Key	Battery positive from B+F at FU14 that is present only when the key switch (S1) is closed. It is used internally by the Power Card.	S1	B+ when S1 is closed	TM	Power Card
18	JPS3-7	Limit1	Not used on this truck.		NA	NA	NA
19	JPS3-8	Limit2	Same as above.		Same as above	NA	NA

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
20	JPS3-9	Regen Enable	Digital voltage generated when the truck is braked electrically. This voltage is sent from the TM/VFC, through the TM to the Power Card, is used to allow Regen to function when the truck directional control handle is reversed to slow the truck. This signal is only used if the Regen Option is on the truck.	Regen Assy	<1V enabled >10.5V not enabled	TM/VFC	Regen Assy
21	JPS11-1	P Control	Generated whenever there is a request for lift. P Control is a chopped control voltage sent from the TM/VFC, through the TM to the Coil Driver Card to control the P contactor coil driver. The chop rate (DC value) is determined by the voltage of the truck that was coded into the truck Primary Memory through the computer PassKey. This voltage is present whenever the P contactor is energized and depends on the voltage of the truck.	P Contactor	**All trucks** 0V w/coil de-energized **24V truck** >10.5V w/coil energized **36V truck** approx 7.5V w/coil energized	TM/VFC	Coil Driver Card
22	JPS11-2	Brake Control	Generated whenever the brake is energized (released). Brake Control is a chopped control voltage sent from the TM/VFC, through the TM to the Coil Driver Card to control the operation of the brake coil driver. The DC value is determined by the truck voltage as set when the PassKey was entered and the location of the shunts on the TM. If the voltage is incorrect, verify the position of the E2 & E3 jumpers on the TM. Voltage is present when there is a request for travel and the deadman is depressed.	Brake	**All trucks** 0V w/coil de-energized **24V truck** >10.5V w/coil energized **36V truck** >10.5V for approx 1 sec w/coil energized, then approx 7.5V	TM/VFC	Coil Driver Card
23	JPS11-3	PC Control	Generated whenever there is a requirement for the PC contactor to be energized. PC Control is a chopped control voltage sent from the TM/VFC, through the TM to the Coil Driver Card to control the PC contactor coil driver. The chop rate (DC value) is determined by the voltage of the truck that was coded into the truck Primary Memory through the computer PassKey.		**All trucks** 0V w/coil de-energized **24V truck** >10.5V w/coil energized **36V truck** >10.5V for approx 1 sec w/coil energized, then approx 7.5V	TM/VFC	Coil Driver Card
24	JPS11-4	L/L Control	Generated by a request for lift or lower. L/L Control is a PWM voltage sent from the TM/VFC, through the TM to the Coil Driver Card to control the L/L solenoid coil driver. The PWM (therefore the DC value) is determined by the position of the L/L pot, VR2. This voltage is present whenever there is a L/L request and varies from 0V to about 10V.		**Note:** All voltages approx 0.3V w/no request creep lift = 5V; full lift = 0.3V creep lower = 1V; decel = 2V **24V truck**; full lower = 10.5V **36V truck**; full lower = 7V	TM/VFC	Coil Driver Card
25	JPS11-5	L/H Control	Generated whenever there is a request for lower. L/H Control is a chopped control voltage sent from the TM/VFC, through the TM to the Coil Driver Card to control the L/H solenoid coil driver. The chop rate (therefore the DC value) is determined by the voltage of the truck that was coded into the truck Primary Memory through the computer PassKey.		**All trucks** 0V w/coil de-energized **24V truck** >10.5V w/coil energized **36V truck** approx 7.5V w/coil energized	TM/VFC	Coil Driver Card

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
26	JPS11-6	P Cntr	Generated when P Control is present at JPS11-1. P Cntr is output of the P coil driver and is connected to the P coil terminal Y at JPS14-16. It provides the negative path for the P coil through the P coil driver to B–.		**All trucks** B+ w/coil de-energized **24V truck** <1V w/coil energized **36V truck** 11-12V w/coil energized	TM/VFC	P Contactor Coil
27	JPS11-7	Brake	Brake is the negative path (B–) for the electric brake. Brake is connected through the TM to Brake at JPS19-5 to the Brake coil. It is switched to B– when the TM/VFC and the CCC both agree to energize the brake and release it. Both the position of the shunt jumpers on the E2 & E3 terminations on the TM and the truck voltage coded in the PassKey determine the voltage applied to the electric brake. If the voltage is incorrect, verify the position of the E2 & E3 shunts.		**All trucks** B+ w/brake de-energized **24V truck** <1V w/brake energized **36V truck** 1V for 1-2 seconds, then approx 12V w/brake energized	TM/VFC	Brake
28	JPS11-8	PC Cntr	Generated when PC Control is present at JPS11-3. PC Cntr is output from the PC coil driver and is connected to the PC coil, terminal Y at JPS14-18. It provides the negative path for the PC Coil through the PC coil driver to B–.		**All trucks** B+ w/coil de-energized **24V truck** <1V w/coil energized **36V truck** 1V for 1-2 seconds, then approx 12V w/coil energized	TM/VFC	PC Contactor Coil
29	JPS11-9	L/L Sol	Generated when L/L Control is present at JPS11-4. L/L Sol is the output of the L/L coil driver and is connected to the L/L Sol coil, terminal 2, at JPS19-4. It provides a negative path for the L/L Sol coil through the L/L Sol coil driver to B–. The voltage here varies directly as the L/L Control voltage varies, based on the amount of lift or lower requested at VR2.		**Note:** All voltages approx **36V truck** creep lift = 16V; full lift = 32V creep lwr = 32V; full lwr = 12V **24V truck** creep lift = 6V; full lift = 20V creep lwr = 20V; full lower = 1V *Optional lower decel applies 4-8V less to the coil than creep lower*	TM/VFC	L/L Solenoid Coil
30	JPS11-10	L/H Sol	Generated when L/H Control is present at JPS11-5. L/H Sol is output of the L/H coil driver and is connected to the L/H Sol coil, terminal 2 at JPS19-3. It provides the negative path for the L/H Sol Coil through the L/H Sol coil driver to B–.		**24V truck** B+ w/coil de-energized <1V w/coil energized **36V truck** B+ w/coil de-energized 11-12V w/coil energized	TM/VFC	L/H Solenoid Coil

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
31	JPS11-11	PGND	PGND (Power Ground), the B– for the solenoid & contactor coils, is switched by the coil drivers on the Coil Driver Card. It is connected on the TM to JPS14-1 & 2 to B– at TP4 on the Power Panel.		<0.3V wrt TP4 Measure B+ to PC to verify connections	TM	Coil Drivers on Coil Driver Card
32	JPS11-12	B+PCF	B+PCF is B+ supplied when the PC contactor is energized. It is fused by FU11 on the TM. It is used to supply those circuits that must be de-energized when the PC contactor is dropped out.		B+ when PC is energized	TM	Coil Driver Card
33	JPS11-13	B+PCF	B+PCF is B+ supplied when the PC contactor is energized. It is fused by FU11 on the TM. It is used to supply those circuits that must be de-energized when the PC contactor is dropped out.		B+ when PC is energized	TM	Coil Driver Card
34	JPS11-14	B+Estop	B+Estop is B+ provided from the EPO when both the key switch & the EPO switches are closed. It is used to energize those circuits that must be energized before the PC Contactor is energized, or when the PC is dropped out.		B+ w/key switch & Estop closed	CCC through the VM	Coil Driver Card
35	JPS11-15	PGND	PGND (Power Ground), the B– for the solenoid & contactor coils, is switched by the coil drivers on the Coil Driver Card. It is connected on the TM to JPS14-1 & 2 to B– at TP4 on the Power Panel.		<0.3V wrt TP4 Measure B+ to PC1 to verify connections	TM	Coil Driver Card
36	JPS14-1	B–PC	One of the two B– lines that provide a return path for the circuits that are powered by B+PC.		B+ from PC1 to JPS14-1	B–	TM
37	JPS14-2	B–PC	One of the two B– lines that provide a return path for the circuits that are powered by B+PC.		B+ from PC1 to JPS14-2	B–	TM
38	JPS14-3	B–	One of the two B– lines that provide a return path for the circuits that are powered by B+ through FU14 & FU16.		B+ from PC1 to JPS14-3	B–	TM
39	JPS14-4	B–	One of the two B– lines that provide a return path for the circuits that are powered by B+ through FU14 & FU16.		B+ from PC1 to JPS14-4	B–	TM
40	JPS14-5	B+Estop	B+Estop is present when both the key switch and the EPO switch are closed. This provides B+ to the PC contactor coil. If not present, there will be no B+PC.	PC Coil	Measure B+ from PC-X or JPS14-5 w/S1 & EPO closed	TM	PC Contactor Coil
41	JPS14-7	P Sense	Monitors voltage in the lift motor circuit. The TM/VFC uses this voltage to determine that the P Contactor tips are in the correct state and to initiate P Contactor codes. It is also used to detect when the lift motor stops rotating. That information is used for proper sequencing of the L/L & L/H Sol Valves.		<0.5V w/P Contactor open B+ w/P Contactor closed	Pump Motor	TM/VFC
42	JPS14-8	PC Sense	Monitors voltage on the output side of the PC Contactor. It is used by the TM/VFC to verify the correct state of the PC Contactor and initiate PC codes.		B+ w/PC tips closed <0.5V w/PC tips open	PC Contactor	TM/VFC

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
43	JPS14-9	Q1C Sense	Monitors voltage at the collector of the main transistor, Q1. It is used by the TM/VFC to verify the correct operation of Q1. This voltage is supplied through the drive motor armature circuit.		B+ from Q1-C or JPS14-9 to TP6 on TM w/PC tips closed B+ minus 2V @ creep Approx 8V @ full speed	Drive Motor-	TM/VFC
44	JPS14-10	B+PC	B+ to the TM when the PC tips are closed. This voltage supplies FU11 and is then used to supply anything labeled as B+PCF.		B+ w/PC tips closed	Pump Contactor P1	All B+PCF
45	JPS14-11	B+PC	B+ to the TM when the PC tips are closed. This voltage supplies FU11 and is then used to supply anything labeled as B+PCF.		B+ w/PC tips closed	Pump Contactor P1	All B+PCF
46	JPS14-12	B+	B+ from PC1 present when the battery is plugged in. It is fused by FU14 and then used to supply anything labelled B+F.		B+ w/battery connected	PC1	All B+F
47	JPS14-13	B+	B+ from PC1 present when the battery is plugged in. It is fused by FU14 and then used to supply anything labelled B+F.		B+ w/battery connected	PC1	All B+F
48	JPS14-14	B+PCF	B+ supply to the P Contactor coil, the optional Lift Alarm Relay, and the Horn. Voltage is present whenever the PC tips are closed and FU11 is good.		B+ w/PC tips closed	FU11	P Contactor, Lift alarm, & Horn
49	JPS14-16	P CNTR	Negative path (B–) for the P contactor coil. It is connected through the TM to JPS11-6 to the Coil Driver Card. P CNTR is switched to B– when there is an input at P Control (JPS11-1).	P Contactor	**24V truck** B+ w/coil de-energized <1V w/coil energized **36V truck** B+ w/coil de-energized 11-12V w/coil energized	Coil Driver Card	P Contactor coil
50	JPS14-18	PC CNTR	Negative path (B–) for the PC Contactor coil. It is connected through the TM to JPS11-8 to the Coil Driver Card. PC CNTR is switched to B– when there is an input at PC Control (JPS11-3).	PC Contactor	**24V truck** B+ w/coil de-energized <1V w/coil energized **36V truck** B+ w/coil de-energized 1V for 1-2 sec, then 11-12V w/coil energized	Coil Driver Card	PC Contactor coil
51	JPS19-2	B+Estop	B+Estop is present when both the key switch the EPO switch are closed. It provides B+ to the L/H Sol, the L/L Sol, and the optional Lower Alarm.	L/H Sol	Measure B+ from L/H Sol-1, L/L Sol-1 or JPS19-2 w/S1 and EPO closed	TM	L/H Sol, L/L Sol, & Lower Alarm

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
52	JPS19-3	Main L/H Sol	Negative path (B–) for both the Main L/H Sol & K29, the optional Lower Alarm Relay which are energized together. Main L/H Sol is connected through the TM to L/H Sol (JPS11-10) on the Coil Driver Card. It is switched to B– when there is an input at L/H Control (JPS11-5).	L/H Sol	**24V truck** B+ w/coil de-energized <1V w/coil energized **36V truck** B+ w/coil de-energized 11-12V w/coil energized	Coil Driver Card	Main L/H Sol & K29, Lower Alarm Relay
53	JPS19-4	L/L Sol	Negative path (B–) for the Lift/Lower Solenoid coil. It is connected through the TM to JPS11-9 to the Coil Driver Card. L/L Sol is switched to B– when there is an input at L/L Control (JPS11-4). Connect to JPS19-4 or L/L Sol2 and measure B+ when the L/L solenoid is de-energized.	L/L Sol	**Note:** All voltages approx **36V truck** creep lift = 16V; full lift = 32V creep lwr = 32V; full lwr = 12V **24V truck** creep lift = 6V; full lift = 20V creep lwr = 20V; full lower = 1V *Opt. lower decel applies 4-8V less to the coil than creep lower*	Coil Driver Card	L/L Solenoid Coil
54	JPS19-5	Brake	Negative path (B–) for the electric brake. Brake is connected through the TM to Brake at JPS11-7 to the Coil Driver Card. It is switched to B– when the TM/VFC and the CCC both agree to energize the brake and release it. The position of the shunt jumpers on the E2 & E3 terminations on the TM determine the voltage applied to the electric brake.	Brake	**24V truck** B+ w/coil de-energized <1V w/coil energized **36V truck** B+ w/coil de-energized <1V for 1-2 sec, then approx 12V w/coil energized	Coil Driver Card	Brake
55	JPS19-10	B+PCF	B+ supply to the electric brake coil. Voltage is present whenever the PC tips are closed and FU11 is good.	Brake	B+ when PC tips closed	FU11	Brake
56	JPS19-6	Trac Temp Sensor	Voltage that varies directly as the resistance of DT changes.	Drive Motor Temp Sensor	Approx 3V @ 70° F Approx 4V @ normal operation >4.4V = over heating >9V = open circuit	TM	TM/VFC
57	JPS19-7	PGND	B– for the temperature sensing circuits. It is connected on the TM to JPS14-1 & 2 to B– at TP4 on the Power Panel.		<0.3V wrt TP4 Measure B+ to PC1 to verify connections	TM	Trac Temp Sensor
58	JPS19-1	B+KEY	Used to supply the Horn+ on trucks built prior to April 2001.	Horn	B+ wrt TP4 w/S1 closed	CCC through the VM	Horn
59	JPS19-8	24V	Supply voltage to the Horn Relay coil.	Horn	B+ wrt TP4 w/relay de-energized or open 24V w/relay energized	TM	Horn Relay
60	JPS19-9	Horn Enable	B– for the Horn Relay coil. Horn Relay is switched to B– when there is a command to sound the horn.	Horn	B+ wrt TP4 w/relay de-energized; <1V w/relay energized	TM	Horn Relay

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
61	JPS25-1	+12VF	Supplies working voltage to the CCC. If not present, check voltage at TP4 & FU17 (+12VF) on the TM.		10.8 - 13V w/key switch closed	TM	CCC
62	JPS25-2	Bus–	Carries the negative component of the digital communications between the CCC and the managers on the tractor side of the communications bus. No usable information can be gained by measuring the voltage on this wire.		Not usable	TM/VFC & CCC	TM/VFC & CCC
63	JPS25-3	Bus+	Carries the positive component of the digital communications between the CCC and the managers on the tractor side of the communications bus. No usable information can be gained by measuring the voltage on this wire.		Not usable	TM/VFC & CCC	TM/VFC & CCC
64	JPS25-4	Brake Deadman	Sent by the CCC to the TM to enable the TM/VFC to energize the brake when all other conditions are met. This output is sent when S2 (Brake Deadman switch) is closed. The CCC uses this output to apply the brake when it detects a fault, regardless of the position of the deadman switches. If the output is >4V, the brake will not be released. If no output, check loop on Steer Encoder Card.		>9.5V w/deadman up <0.5V w/deadman down OR >9.5V w/brake applied <0.5V w/brake released	CCC	TM/VFC
65	JPS25-5	Carriage Deadman	Wired through the CCC to S23 (Carriage Deadman switch). This is used by the TM/VFC to determine when the Deadman pedal is depressed and to enable the brake to be energized. If this is missing, the brake will not be energized.		>9.5V w/deadman up <0.5V w/deadman down OR >9.5V w/brake applied <0.5V w/brake released	CCC	TM/VFC
66	JPS25-6	AGND	Used as a reference and negative for the circuits on the CCC. Although it eventually connects to B–, it is kept separate from the other grounds to help reduce the effects of noise on system operation. If more than 0.3V is measured to TP4 (B–), there may be a noise or connection problem. If voltage varies with operation, there is probably a noise problem.		<0.3V wrt TP4 Measure B+ to PC1 to verify connections	TM	CCC
67	JPS26-1	B+Estop	B+Estop is present when both the key switch & EPO switch are closed. This wire provides B+Estop from the CCC to the TM where it is distributed to all the other B+Estop connections on the TM & ESM.		B+ w/S1 & EPO closed	CCC	TM
68	JPS26-2	B–F Spare	B– for the Spare Power connector (JPC12) on the CCC. It supplies B– for optional lights, fan, & RF Unit. It is fused through FU15 on the TM.		<0.5V wrt TP4	TM	Lights, fan, & RF option
69	JPS26-3	B+F Spare	B+ for the Spare Power connector (JPC12) on the CCC. It supplies B+ for optional lights, fan, & RF Unit. It is fused through FU16 on the TM.		B+ wrt TP4	TM	Lights, fan, & RF option
70	JPS26-4	B–F	B– for the CCC from the TM. It is fused through FU13 on the TM.		<0.5V wrt TP4	TM	CCC
71	JPS26-6	B+Key	B+ that is switched by the key switch (S1) and is sent from the CCC to supply all B+Key on the TM.		B+ w/S1 closed	CCC	TM

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
72	JPS26-8	B+F	This is the main B+ supply to the CCC and is fused through FU14 on the TM. It supplies the key switch and is present whenever the battery is connected.		B+ wrt TP4	TM	CCC
73	JPS8-2	6-12VF	+12V supply to S10 (Hall Effect switch) when B+Key is present on the TM. If not present, the switch remains electrically open regardless of the mechanical state of the switch and a Code 6L may occur. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S10	6 - 8.8V w/switch connected >8.8V w/switch disconnected	TM	S10
74	JPS8-1	150_Lim	This input is read by the TM/VFC to determine when the carriage crosses the limit switch, and whether the carriage is above or below the switch. This is communicated to the CCC. The CCC uses the change in state of S10 to reset the height count. When above the switch, travel speed is limited to 1mph when the steer angle <10°, and 0 mph when steer angle >10°. When the carriage is below the reference switch, the switch is closed. When the carriage is above the reference switch, the switch is open.	S10	<1V closed >10V open	S10	CCC
75	JPS8-3	PGND	B– for S10 circuits. It is connected on the TM to JPS14-1 & 2 to B– at TP4 on the Power Panel. If not present, the switch is inoperative.	S10	<0.3V wrt TP4	TM	S10
76	JPS10-2	+12VF	Supplies working voltage to the Lift Inhibit Switch (S24) when B+Key is present on the TM. If not present, the switch remains electrically open regardless of the mechanical state of the switch and the truck will operate as if it was above the inhibit height. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S24	10.8 - 13V w/key switch closed	TM	S24
77	JPS10-1	Lift Inhibit	Input read by the TM/VFC to determine if the carriage is above or below the Lift Inhibit Switch (S24). The position is communicated to the CCC which determines if lift should be inhibited. When the carriage is below Lift Inhibit, the switch is closed. When the carriage is above the reference switch, the switch is open and lift is inhibited.	S24	<1V closed Approx 10V open	S24	CCC
78	JPS10-3	PGND	B– for S24 circuits. It is connected on the TM to JPS14-1 & 2 to B– at TP4 on the Power Panel. If not present, the switch is inoperative.	S24	<0.3V wrt TP4	TM	S24
79	JPS13-2	+12VF	Supplies working voltage to the Rail Sense Switch (S15) when B+Key is present on the TM. If not present, the switch remains electrically open regardless of the mechanical state of the switch and the truck will operate as if it was out of the rail, regardless of the truck position. Verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S15	10.8 - 13V w/key switch closed	TM	S15

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
80	JPS13-1	Rail_Sen	Read by the TM/VFC to determine if the truck is in or out of the rail. The TM/VFC communicates truck position to the CCC, limiting travel speed based on truck location and position of the Auto/Man switch. When the truck is in the rail, S15 is closed. If the voltage is >6V with the switch closed, the truck will operate as if it is out of the rail, regardless of truck position.	S15	<1V closed Approx 10V open	S15	TM
81	JPS13-3	PGND	B– for S15 circuits. It is connected on the TM to JPS14-1 & 2 to B– at TP4 on the Power Panel. If not present, the switch is inoperative.	S15	<0.3V wrt TP4	TM	S15
82	JPS7-2	+12VF	Supplies working voltage to the Steer Prox1 when B+Key is present on the TM. If not present, the Prox switch will not sense metal and the truck will operate as if the drive unit was rotated more than 10°. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	Steer Prox 1	+10.8 - 13V w/key switch closed	TM	Steer Prox 1
83	JPS7-1	Steer Prox1	**Used on Manual steer trucks only.** Output of the Steer Prox switches read by the TM/VFC to determine the amount of drive unit rotation. This is communicated to the CCC which uses it to limit travel speed depending on the combination of height and steering angle.	Steer Prox 1	<5V @ <10° rotation (over metal) >10V @ >10° rotation (not over metal)	Steer Prox1	CCC
84	JPS7-3	AGND	B– for Steer Prox 1. It is connected through FU13 on the TM at JPS14-3 & 4 to TP4 (B–) on the Power Panel.	Steer Prox 1	<0.3V wrt TP4	TM	Steer Prox 1
85	JPS9-2	+12VF	Supplies working voltage to Steer Prox 2 when B+Key is present on the TM. If not present, the Prox switch cannot sense metal and the truck will operate as if the drive unit was rotated more than 10°. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	Steer Prox 2	+10.8 - 13V w/key switch closed	TM	Steer Prox 2
86	JPS9-1	Steer Prox2	**Used on Manual steer trucks only.** Output of the Steer Prox switches and is read by the TM/VFC to determine the amount of drive unit rotation. This is communicated to the CCC which uses it to limit travel speed depending on the combination of height and steering angle.	Steer Prox 2	<5V @ <10° rotation (over metal) >10V @ >10° rotation (not over metal)	Steer Prox 2	CCC
87	JPS9-3	AGND	B– for Steer Prox 1. It is connected through FU13 on the TM at JPS14-3 & 4 to TP4 (B–) on the Power Panel.	Steer Prox 2	<0.3V wrt TP4	TM	Steer Prox 2
88	JPS16-2	+12VF	Supplies working voltage to the Travel Cutout Switch (S27) when B+Key is present on the TM. If not present, the Cutout switch will not operate and the truck will not travel. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S27	+10.8 - 13V w/key switch closed	TM	S27
89	JPS16-1	TRVL Cutout	Output of S27 (optional Travel Cutout switch). Position is read by the TM/VFC and communicated to the CCC which eliminates travel when above the switch. It is a normally open switch held closed when below cutout. When it opens, travel is prohibited.	S27	<1V closed (below cutout) Approx 10V open (above cutout)	S27	CCC

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
90	JPS16-2	PGND	B– for S27 circuits. It is connected on the TM to JPS14-1 & 2 to B– at TP4 on the Power Panel. If not present, the switch is inoperative.	S27	<0.3V wrt TP4	TM	S27
91	JPS20-1	B+Key	Power from JPS26-6 for the Warning Light. Present when the key switch S1 is ON.	Warn Light	B+	TM	Warn Light
92	JPS20-2	PGND	B– for Warning light circuit. It is connected on the TM to JPS14-1 & 2 to B– at TP4 on the Power Panel. If not present, the Warning light is inoperative.	Warn Light	<0.3V wrt TP4	TM	Warn Light
93	JPS15-1	Spare Input Limit	Read by the TM/VFC which communicates the state of S124 to the CCC. The CCC alters truck operation depending on how the switch is configured. This input can be configured through Configuration PassKey as either a Lift Cutout switch or as a Travel Cutout Switch on the Stepped-up Speed Enhancement option. In either case, this normally open switch is held closed during normal operation and opens to prohibit the intended function.	S124	<1V closed Approx 10V open	S124	CCC
94	JPS15-2	+12VF	Supplies working voltage to S124 when B+Key is present on the TM. If not present, the Limit switch will not operate and the function will not operate. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S124	10.8 - 13V w/key switch closed	TM	S124
95	JPS15-3	AGND	B– for the Spare Limit Switch. It is connected through FU13 on the TM at JPS14-3 & 4 to TP4 (B–) on the Power Panel.	S124	<0.3V wrt TP4	TM	S124
96	JPS15-4	PGND	Not used at this connector.				
97	JPS15-5	Alarm(24V)	This is the supply voltage to the Alarm Relay coil.	Alarm	B+ wrt TP4 w/relay coil de-energized or open 24V w/relay coil energized	TM	Alarm
98	JPS15-6	Alarm Enable	B– for the Alarm Relay coil. Alarm Relay is switched to B– when there is a command to energize the alarm.	Alarm	B+ w/relay coil de-energized <1V w/relay coil energized	TM	Alarm
99	JPS17-1	N/C	Not connected.				
100	JPS17-2	N/C	Not connected.				
101	JPS17-3	N/C	Not connected.				
102	JPS17-4	+12VF	Not used on this truck.				
103	JPS17-5	AGND	B– for the ESM. It is connected through FU13 on the TM at JPS14-3 & 4 to TP4 (B–) on the Power Panel.		<0.3V wrt TP4	TM	ESM
104	JPS17-6	BUS+	Carries the positive component of the digital communications between the ESM and the other managers on the communications bus. No usable information can be gained by measuring the voltage on this wire.		Not usable	All Mgrs on Bus	All Mgrs on Bus

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
105	JPS17-7	BUS–	Carries the negative component of the digital communications between the ESM and the other managers on the communications bus. No usable information can be gained by measuring the voltage on this wire.		Not usable	All Mgrs on Bus	All Mgrs on Bus
106	JPS17-8	PGND	Not used on this truck.				
107	JPS17-9	+12VF	Supplies working voltage to the ESM when B+Key is present on the TM. If not present, the ESM will not function and Code 53 is displayed during SelfTest. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	ESM	10.8 - 13V w/key switch closed	TM	ESM
108	JPS6-2	+12VF	Supplies working voltage to S46 (optional Aisle Detect Switch) when B+Key is present on the TM. If not present, S46 will not function and a Code J1, J2, or J4 may be displayed. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S46	10.8 - 13V w/key switch closed	TM	S46
109	JPS6-1	Sensor 1	Read by the TM/VFC, and is used along with Sensor 2 (JPS28-1) to determine if the truck is in or out of the aisle. This information is communicated to the CCC and controls travel speed based on truck location and position of the Auto/Man switch.	S46	10.8 - 13V when magnet is not sensed <1V for 0.1 sec after magnet is sensed, then 10.8 - 13V	S46	CCC
110	JPS6-3	AGND	B– for S46. It is connected through FU13 on the TM at JPS14-3 & 4 to TP4 (B–) on the Power Panel.	S46	<0.3V wrt TP4	S46	TM/VFC
111	JPS28-2	+12VF	Supplies working voltage to S47 (optional Aisle Detect Switch) when B+Key is present on the TM. If not present, S47 will not function and a Code J1, J2, or J4 may be displayed. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S47	10.8 - 13V w/key switch closed	TM	TM/VFC
112	JPS28-1	Sensor 2	Read by the TM/VFC, and is used along with Sensor 1 (JPS6-1) to determine if the truck is in or out of the aisle. This information is communicated to the CCC and controls travel speed based on truck location and the position of the Auto/Man switch.	S47	10.8 - 13V when magnet is not sensed <1V for 0.1 sec after magnet is sensed, then 10.8 - 13V	S47	CCC
113	JPS28-3	AGND	B– for S47. It is connected through FU13 on the TM at JPS14-3 & 4 to TP4 (B–) on the Power Panel.	S47	<0.3V wrt TP4	S47	TM/VFC
114	JPC11-1	+12VF	Supplies working voltage to the CCC. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	CCC	10.8 - 13V w/key switch closed	TM	CCC
115	JPC11-2	Bus–	Carries the negative component of the digital communications between the CCC and the managers on the tractor side of the communications bus. No usable information can be gained by measuring the voltage on this wire.		Not usable	TM/VFC & CCC	TM/VFC & CCC
116	JPC11-3	Bus+	Carries the positive component of the digital communications between the CCC and the managers on the tractor side of the communications bus. No usable information can be gained by measuring the voltage on this wire.		Not usable	TM/VFC & CCC	TM/VFC & CCC

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
117	JPC11-4	Brake Deadman	Sent by the CCC to the TM to enable the TM/VFC to energize the brake when all other conditions are met. This output is sent when S2 (Brake Deadman) is closed. The CCC uses this output to apply the brake when it detects a fault, regardless of the position of the deadman switches. If the output is >4V, the brake will not be released. If no output, check connection at Steer Encoder Card JPP1-8 & 9.	S2	>9.5V deadman up <0.5V deadman down OR >9.5V w/brake applied <0.5V w/brake released	CCC	TM/VFC
118	JPC11-5	Carriage Deadman	Wired through the CCC to S23 (Carriage Deadman). This is used by the TM/VFC to determine when the Deadman pedal is depressed and to enable the brake to be energized. If this is missing, the brake will not be energized.	S23	>9.5V deadman up <0.5V deadman down OR >9.5V w/brake applied <0.5V w/brake released	CCC	TM/VFC
119	JPC11-6	AGND	Reference and negative for the circuits on the CCC. Although it eventually connects to B–, it is kept separate from the other grounds to help reduce the effects of noise on system operation. If more than 0.3V is measured wrt TP4 (B–), there may be a noise or connection problem. If voltage varies with operation, there is probably a noise problem.	CCC	<0.3V wrt TP4 Measure B+ to PC1 to verify connections	TM	CCC
120	JPC16-1	B+Estop	Present when both the key switch the EPO switch are closed. This wire provides B+Estop to the TM where it is distributed to all other B+Estop connections on the TM & ESM.		Measure B+ from L/H-1, L/L-1or PC-X JPS19-2 w/S1 & EPO closed	CCC	TM
121	JPC16-2	B–FSpare	B– for the Spare Power connector (JPC12) on the CCC. It supplies B– for optional lights, fan, and RF Unit. It is fused through FU15 on the TM.		<0.3V wrt TP4	TM	Lights, fan, & RF option
122	JPC16-3	B+F(Spare)	B+ for the Spare Power connector (JPC12) on the CCC. It supplies B+ for optional lights, fan, and RF Unit. It is fused through FU16 on the TM.		B+ wrt TP4 w/battery connected	TM	Lights, fan, & RF option
123	JPC16-4	B–F	B– for the CCC from the TM. It is fused through FU13 on the TM.		<0.3V wrt TP4	TM	CCC
124	JPC16-6	B+Key	B+ that is switched by the key switch (S1) and sent from the CCC to supply all B+Key and B+Estop on the truck.	TM	B+ w/S1 closed	CCC	TM
125	JPC16-8	B+F	Main B+ supply to the CCC and is fused through FU14 on the TM. It supplies the key switch and is present whenever the battery is connected.		B+ wrt TP4	TM	CCC
126	PC12-1	B+F Spare	B+ power for optional Work Lights and RF Unit power and is present when the battery is connected. It is fused through FU16 on the TM.		B+ wrt TP4 w/battery connected	TM	Work Lights, & RF option
127	PC12-2	B–F Spare	B– power for optional Work Lights and RF Unit power and is present when the battery is connected. It is fused through FU15 on the TM.		<0.3V wrt TP4	TM	Work Lights, & RF option

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
128	JPC10-1		Not usable.				
129	JPC10-2	RXD	Not usable.				
130	JPC10-3	TXD	Not usable.				
131	JPC10-4		Not usable.				
132	JPC10-5	DGND	B– for the SMART*i* module.	SMART*i*	<0.3V wrt TP4	CCC	SMART*i*
133	JPC10-6	Bus+	Carries the positive component of the digital communications between the SMART*i* module and the other managers on the communications bus. No usable information can be gained by measuring the voltage on this wire.	SMART*i*	Not usable		
134	JPC10-7	Bus–	Carries the negative component of the digital communications between the SMART*i* module and the other managers on the communications bus. No usable information can be gained by measuring the voltage on this wire.	SMART*i*	Not usable		
135	JPC10-8	DGND	B– for the circuits in the SMART*i* module.	SMART*i*	<0.3V wrt TP4	CCC	SMART*i*
136	JPC10-9	+12VF	Supplies +12VF to operate the SMART*i* module. This is present through the over-the-mast cable when the battery is connected and is fused through FU17 on the TM. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	SMART*i*	10.8 - 13V w/key switch closed	TM	SMART*i*
137	JC5-1	B+KEY	B+ that is switched by the key switch and powers the optional Lights & Fan package. Fused through FU14 on the TM.	Lights & Fan option	B+ w/S1 closed	CCC	Lights & Fan option
138	JC5-2	B–F	B– for optional Lights & Fan package. Fused through FU13 on the TM.	Lights & Fan option	<0.3V wrt TP4	CCC	Lights & Fan option
139	JC5-3	B–F	B– for optional Warning Light. Fused through FU13 on the TM.	Lights & Fan option	<0.3V wrt TP4	CCC	Warning Light
140	JC5-4	B+KEY	B+ that is switched by the key switch (S1) and powers the optional Warning Light. Fused through FU14 on the TM.	Lights & Fan option	B+ w/S1 closed	CCC	Warning Light
141	JPC1-1	+5.3V	Supplies +5.3V to the Steer Encoder. Is dependant on the presence of +12VF from the TM at JPC11-1.	Steer Encoder	>5V	CCC	Steer Encoder
142	JPC1-2	DGND	B– for the circuits on the Steer Encoder.	Steer Encoder	<0.3V wrt TP4	CCC	Steer Encoder
143	JPC1-3	CHB	One part of the steering request from the Steer Encoder on electric steer trucks when the steering tiller is moved. It is a square wave signal (0V & 5V) identical to CHA but different phase. The CCC uses the phase relationship of CHA/CHB to determine the direction and speed of the steering request.	Steer Encoder	Square wave 0V & 5V nominal w/tiller moving. >4.5V or <0.5V w/tiller is stationary. DC value when turning handle 2-3V	Steer Encoder	CCC

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
144	JPC1-4	CHA	One part of the steering request from the Steer Encoder on electric steer trucks when the steering tiller is moved. It is a square wave signal (0 & 5V) identical to CHB but different phase. The CCC uses the phase relationship of CHA/CHB to determine the direction and speed of the steering request.	Steer Encoder	Square wave 0V & 5V nominal w/tiller moving. >4.5V or <0.5V w/tiller stationary. DC value when turning handle 2-3V	Steer Encoder	CCC
145	JPC1-7	+5.3V	Supplies +5.3V to the Steer Encoder. Is dependant on the presence of +12VF from the TM at JPC11-1.	Steer Encoder	>5V	CCC	CCC
146	JPC1-8	Brake Deadman	Output of the Brake Deadman switch (S2 at JPC7-1) which is looped through the Steer Encoder at JPC1-8 & 9 and sent to the TM to inform the TM/VFC of the status of S2. If the Steer Encoder Cable becomes unplugged, the TM/VFC will not release the brake.	Steer Encoder	>5V w/pedal depressed <0.5V w/pedal released	CCC	CCC
147	JPC1-9	Brake Deadman	Output of the Brake Deadman switch (S2 at JPC7-1) which is looped through the Steer Encoder at JPC1-8 & 9 and sent to the TM to inform the TM/VFC of the status of S2. If the Steer Encoder Cable becomes unplugged, the TM/VFC will not release the brake.	Steer Encoder	>5V w/pedal depressed <0.5V w/pedal released	CCC	CCC
148	JPC21-1	+5.3V	Supplies +5.3V to the E2 Steer Encoder. Is dependant on the presence of +12VF from the TM at JPC11-1.	E2 Steer Encoder	>5V	CCC	E2 Steer Encoder
149	JPC21-2	DGND	B– for the circuits on the E2 Steer Encoder.	E2 Steer Encoder	<0.3V wrt TP4	CCC	E2 Steer Encoder
150	JPC21-3	CHB-E2	One part of the steering request from the E2 Steer Encoder on electric steer trucks when the steering tiller is moved. It is a square wave signal (0V & 5V) identical to CHA-E2 but different phase. The CCC uses the phase relationship of CHA-E2/CHB-E2 along with CHA/CHB to determine the direction and speed of the steering request.	E2 Steer Encoder	Square wave 0V & 5V nominal w/tiller moving. >4.5V or <0.5V w/tiller is stationary. DC value when turning handle 2-3V	E2 Steer Encoder	E2 Steer Encoder
151	JPC21-4	CHA-E2	One part of the steering request from the E2 Steer Encoder on electric steer trucks when the steering tiller is moved. It is a square wave signal (0V & 5V) identical to CHB-E2 but different phase. The CCC uses the phase relationship of CHA-E2/CHB-E2 along with CHA/CHB to determine the direction and speed of the steering request.	E2 Steer Encoder	Square wave 0V & 5V nominal w/tiller moving. >4.5V or <0.5V w/tiller is stationary. DC value when turning handle 2-3V	E2 Steer Encoder	E2 Steer Encoder
152	JPC21-5	CD Supply	5.3V output from the CCC power supply. This voltage is dependant upon the presence of 12V from the TM at JPC11-1. This voltage goes back to the CCC microprocessor to let the CCC know that JPC21 is connected. If not connected, Code G0 will be displayed.	E2 Steer Encoder	>5V	E2 Steer Encoder	CCC
153	JPC21-6	CD	5.3V output from the CCC power supply. This voltage is dependant upon the presence of 12V from the TM at JPC11-1. This voltage goes back to the CCC microprocessor to let the CCC know that JPC21 is connected. If not connected, Code G0 will be displayed.	E2 Steer Encoder	>5V	E2 Steer Encoder	CCC

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
154	JPC14-2	+12VF	+12V supply to S60 (Right Sidegate switch) when B+Key is present on the TM. If not present, the switch remains electrically open regardless of the mechanical state of the switch. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S60	10.8 - 13V w/key switch closed	TM	S60
155	JPC14-1	Sidegate Right (optional)	Output from S60 used by the CCC to detect the position of the sidegates. The CCC will prohibit travel when the sidegate is up and the sonalert will sound.	S60	<1V w/sidegate down Approx 10V w/sidegate up	S60	CCC
156	JPC14-3	PGND	B– for S60 supplied through JPC16-4 from FU13 on the TM.	S60	<0.3V wrt TP4	TM	S60
157	JPC13-2	+12VF	+12V supply to S61 (Left Sidegate switch) when B+Key is present on the TM. If not present, the switch remains electrically open regardless of the mechanical state of the switch. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S61	10.8 - 13V w/key switch closed	TM	S61
158	JPC13-1	Sidegate Left (optional)	Output from S61 used by the CCC to detect the position of the sidegates. The CCC will prohibit travel when the sidegate is up and the sonalert will sound.	S61	<1V w/sidegate down Approx 10V w/sidegate up	S61	CCC
159	JPC13-3	PGND	B– for S61 supplied through JPC16-4 from FU13 on the TM.	S61	<0.3V wrt TP4	TM	S61
160	JPC4-2	+12VF	+12V supply to S25 (Lower Inhibit switch) when B+Key is present on the TM. If not present, the switch will remain electrically open regardless of the mechanical state of the switch. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S25	10.8 - 13V w/key switch closed	TM	S25
161	JPC4-1	Lower Inhibit (optional)	Output from S25 used by the CCC to detect the location of the carriage. The CCC will allow lowering until the switch is open.	S25	<1V w/carriage below switch Approx 10V w/carriage above switch	S25	CCC
162	JPC4-3	PGND	B– for S25 supplied through JPC16-4 from FU13 on the TM.	S25	<0.3V wrt TP4	TM	S25
163	JPC6-1	B+F	B+F to the S1 key switch. It is supplied from fuse FU14 on the TM. It supplies the key switch and is present whenever the battery is connected.	S1	B+ wrt TP4 w/battery connected & FU14 is good	TM	S1
164	JPC6-2	B+Key	B+ switched by the key switch. B+Key from JPC6-2 powers all other B+Key on the truck.	S1	B+ from JPC6-1 w/key switch ON & FU14 is good	TM	All
165	JPC6-3	B+Estop	B+Key after going through the Estop switch (S21). B+Estop from JPC6-3 powers all other B+Estop on the truck.	S21	B+ when Estop is up (closed)	B+Key	All
166	JPC6-4	B+Key	B+Key from JPC6-2 to supply B+Estop when S21 is up (Closed).	S21	B+ from JPC6-1 w/key switch ON & FU14 is good	S1	S21
167	JPC6-6	L/L Inhibit Bypass (optional)	Determines whether the CCC will allow lift or lower when either Lift or Lower Limit is reached. When S7 is up, lift/lower is prevented when the cutout switch is activated. When S7 is depressed, lift/lower beyond the cutout switch is allowed.	S7	>5V w/S7 up <0.5V w/S7 depressed	CCC	CCC
168	JPC6-5	DGND	B– for S7, supplied through JPC16-4 from FU13 on the TM.	S7	<0.3V wrt TP4	TM	S7

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
169	JPC8-2	6-12VF	+12V supply to S11 (24" Limit Switch) when B+Key is present on the TM. If not present, the switch remains electrically open regardless of the mechanical state of the switch and a Code 6M may be displayed. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S11	6 - 8.8V w/S11 connected >8.8V w/S11 disconnected	TM	S11
170	JPC8-1	24" Limit	The voltage on this line changes when the carriage crosses the switch. This change in voltage is used by the CCC to reset the height counter and enable correct speed. When S11 is open, the carriage is above S11 and speed is determined by height. When S11 is closed, the carriage is below S11 and full speed is allowed.	S11	<1V w/S11 closed >10V w/S11 open	CCC	CCC
171	JPC8-3	DGND	B– for S11 supplied through JPC16-4 from FU13 on the TM.	S11	<0.3V wrt TP4	TM	S11
172	JPC7-2	+12VF	+12V supply to S2 (Brake Deadman) when B+Key is present on the TM. If not present, the switch remains electrically open regardless of the mechanical state of the switch and the brake will not release. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S2	10.8 - 13V w/key switch closed	TM	S2
173	JPC7-1	Brake Deadman	The CCC monitors the voltage on this line to determine the state of S2. This signal is looped through the Steer Encoder at JPC1-8 & 9 and sent to the TM at JPS25-4. The voltage is high when the switch is released and low when it is depressed.	S2	>10V released <0.5V depressed	CCC	TM/VFC & CCC
174	JPC7-3	DGND	B– for S2 supplied through JPC16-4 from FU13 on the TM.	S2	<0.3V wrt TP4	TM	S2
175	JPC7-5	+12VF	+12V supply to S23 (Carriage Deadman) when B+Key is present on the TM. If not present, the switch remains electrically open regardless of the mechanical state of the switch and the brake will not release. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S23	10.8 - 13V w/key switch closed	TM	S23
176	JPC7-4	CRG Deadman	The CCC monitors the state of S23 (Carriage Deadman) directly. The TM/VFC detects the state of S23 at JPS25-5. The CCC and the TM/VFC communicate S23 status and must agree that it is depressed before the brake is released.	S23	>10V released <0.5V depressed	CCC	TM/VFC & CCC
177	JPC7-6	DGND	B– for S23 supplied through JPC16-4 from FU13 on the TM.	S23	<0.3V wrt TP4	TM	S23
178	JPC3-2	6-12VF	+12V supply to S28 (60" Limit Switch) when B+Key is present on the TM. If not present, the switch remains electrically open regardless of the mechanical state of the switch and a Code 6M may be displayed. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).	S28	6 - 8.8V w/switch connected >8.8V w/switch disconnected	TM	S26

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
179	JPC3-1	60" Limit (not on Intellispeed trucks)	The voltage on this line changes when the carriage crosses the switch. This change in voltage is used by the CCC to limit travel speed. When S28 is open, the carriage is above S28 and speed is determined by height. When S28 is closed, the carriage is below S28 and full speed is allowed.	S28	S28 closed <1V S28 open >10V	CCC	CCC
180	JPC3-3	DGND	B– for S28 supplied through JPC16-4 from FU13 on the TM.	S28	<0.3V wrt TP4	TM	S28
181	JPC9-3	Horn	This input is monitored by the CCC. When S3 is depressed, the CCC tells the TM to blow the horn.	S3	>5V open <0.5V closed	CCC	CCC
182	JPC9-4	DGND	B– for S3 supplied through JPC16-4 from FU13 on the TM. If missing on a solid state handle, a Code 81 may be displayed.	S3	<0.3V wrt TP4	TM	S3
183	JPC9-8	+5.3V	Supply voltage for VR1 (Travel Pot).	VR1	>5V	CCC	VR1
184	JPC9-9	Travel	Variable voltage from VR1 wiper. The CCC monitors this voltage and determines the direction and amount of travel request. If the voltage is not between 0.4 and 4.6V, a Code 80 may be displayed.	VR1	Non-Solid State handle: 2-3V neutral, 0.4-1.5V full fwd, 3.5-4.6V full rev Solid State handle: 1.6V neutral, 0.8V full fwd, 2.6V full rev	CCC	CCC
185	JPC9-10 (non solid-state) JPC9-7 (solid state)	DGND	B– for VR1 supplied through JPC16-4 from FU13 on the TM.	VR1	<0.3V wrt TP4	TM	VR1
186	JPC9-5	+5.3V	Supply voltage for VR2 (Lift/Lower Pot).	VR2	>5V	CCC	VR2
187	JPC9-6	L/L	Variable voltage from VR2 wiper. The CCC monitors this voltage and determines lift/lower speed that has been requested. If the voltage is not between 0.4 and 4.6V, a Code 81 may be displayed.	VR2	Non-Solid State handle: 2-3V neutral, 0.4-1.5V full lift, 3.5-4.6V full lower Solid State handle: 1.3V neutral, 0.4V full lift, 2.1V full lower	CCC	CCC
188	JPC9-7 (non solid-state) JPC9-4 (solid state)	DGND	B– for VR2, supplied through JPC16-4 from FU13 on the TM.	VR2	<0.3V wrt TP4	TM	VR2
189	JPC9-1	Auto/Man (optional)	The CCC monitors the state of S4 (Auto/Man switch) to determine if the truck is in manual steering or Wire/Rail guided mode which it communicates to the other managers. A low reading indicates manual operation. A high reading indicates that W/G has been selected.	S4	<1V in manual >5V in wire/rail	CCC	CCC
190	JPC9-2	DGND	B– for S4 supplied through JPC16-4 from FU13 on the TM.	S4	<0.3V wrt TP4	TM	S4
191	JPC15-1		Not usable.				

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
192	JPC15-15	DGND	B– for the Carriage Control Light Display Card.		<0.3V wrt TP4	TM	Light Display Card
193	JPC15-16	+5.3V	Supply voltage for the Carriage Control Light Display Card.		>5V	CCC	Light Display Card
194	JPC15-24		Not usable.				
195	JPC2-1	DGND	B– for the Operator Interface (OI) Card.	OI	<0.3V wrt TP4	TM	OI
196	JPC2-2	UP Arrow	The CCC monitors this input to determine when the Up Arrow on the Operator Interface has been depressed.	OI	>5V switch open <0.5 switch depressed	OI	CCC
197	JPC2-3	DN Arrow	The CCC monitors this input to determine when the Down Arrow on the Operator Interface has been depressed.	OI	>5 switch open <0.5 switch depressed	OI	CCC
198	JPC2-4	ETR/Shift	The CCC monitors this input to determine when the Enter/Shift button on the Operator Interface has been depressed.	OI	>5 switch open <0.5 switch depressed	OI	CCC
199	JPC2-17		Not usable.				
200	SMB+		B+ to the ESM.		B+	FU8	Steer Motor
201	SMTR1		Connection for the cable to the steer motor. Voltage depends on the speed of the steering request.	Steer Motor	14V @ rest; 2.7V steer CW; 9V steer CCW	TM3&4 on ESM	Steer Motor
202	SMTR2		Connection for the cable to the steer motor. Voltage depends on the speed of the steering request.	Steer Motor	14V @ rest; 2.5V steer CW; 12V steer CCW	TM3&4 on ESM	Steer Motor
203	SMB–		B– for the ESM.		B–	TP4	Steer Motor
204	JPA5-1	+12VF	Supplies +12VF to Pressure Transducer A. It is provided by the TM at JPS17-9 and is fused through FU17 (TM). If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).		10.8 - 13V w/key switch closed	TM	Press A
205	JPA5-2	P/T_A	This voltage varies directly with the weight on the carriage.		1V w/forks on floor. Increases approx 0.5V per 1000 lb	P/T A	ESM
206	JPA5-3	AGND	B– for the Pressure Transducer A from JPS17-5 on the TM.		<0.3V wrt TP4	TM	P/T A
207	JPA5-4	AGND	Not used on this truck				
208	PA6-1	+12VF	Not used on this truck				
209	PA6-2	P/T_B	Not used on this truck				
210	PA6-3	AGND	Not used on this truck				
211	PA6-4	AGND	Not used on this truck.				

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
212	JPA1-1 JPA1-2	Flow_A Flow_B	Square waves generated whenever there is movement of the turbine in the flow sensor. The frequency varies directly with the speed of the turbine which is driven by oil flowing through the sensor. The TM/VFC uses the quadrature phase relationship between Flow_A & _B to determine flow direction and speed to calculate carriage height. A very slow lift may not indicate a change in voltage as the turbine may not spin adequately.		Approx 2.7V during lift @ 1/3 speed or greater >5V or <0.5V when stopped	Flow Module	ESM
213	JPA1-3	AGND	B– for the Flow Module from JPS17-5 on the TM.		<0.3V wrt TP4	TM	Flow Module
214	JPA1-4	FS_Temp	Variable voltage that is representative of the temperature of the oil in the hydraulic system. It is connected, but not used on this truck.		0.2 - 4.86V (approx 3.2V @ 86°F)	Flow Module	ESM
215	JPA1-5	+12VF	Supplies +12VF to operate Flow Module. It is provided by the TM at JPS17-9 and is fused through FU17 on the TM. If not present, verify voltage from FU17 to TP4 (Power Panel) or TP6 (TM).		10.8 - 13V w/key switch closed	TM	Flow Module
216	JPA8-1	Steer A	Square wave generated whenever there is movement of the Steer Feedback Encoder. Voltage varies between about 4V and 0V as the encoder shaft rotates. The frequency varies directly with the speed of the Drive Motor. The signal is identical to Steer B. The TM/VFC uses the quadrature phase relationship between Steer A & B to determine travel direction and speed.	Steer Encoder	Voltage should vary between >3V to <1V as encoder shaft is rotated slowly	Steer Position Encoder	ESM
217	JPA8-2	DGND	B– for the Steer Position Encoder from JPS17-5 on the TM.	Steer Encoder	<0.3V wrt TP4	TM	Steer Encoder
218	JPA8-3	+5V	+5V supply to the Steer Position Encoder. This voltage is dependant on +12V at JPA2-9 from the TM.	Steer Encoder	>4.8V	ESM	Steer Encoder
219	JPA8-4	Steer B	Square wave generated whenever there is movement of the Steer Feedback Encoder. Voltage varies between approx 4 & 0V as the encoder shaft rotates. The frequency varies directly with the speed of the Drive Motor. The signal is identical to Steer A. The TM/VFC uses the quadrature phase relationship between Steer A & B to determine travel direction and speed.	Steer Encoder	Voltage should vary between >3V to <1V as encoder shaft is rotated slowly	Steer Encoder	ESM
220	JPA8-5	DGND	B– for the Steer Position Encoder from JPS17-5 on the TM.	Steer Encoder	<0.3V wrt TP4	TM	Steer Encoder
221	JPA8-6		Not used.				
222	JPY7-1	VR	VR & IN2 carry the voltage generated by one of the turbines in the flow sensor to the Flow Module. This voltage is conditioned in the Flow Module and becomes Flow_A used by the ESM to calculate carriage movement.		Approx 0.25VAC between JPY7-1 & 2 when turbine is rotating (lift or lower)	Flow Sensor	Flow Module
223	JPY7-2	IN2	Return/reference for VR, JPY7-1. See JPY7-1, VR.				

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
224	JPY7-3	SHLD	Shield that helps reduce noise interference in the AC voltage from the VR/IN2 to the Flow Module.		<0.5V		
225	JPY6-1	VR	VR & IN1 carry the voltage generated by one of the turbines in the flow sensor to the Flow Module. This voltage is conditioned in the Flow Module and becomes Flow_B used by the ESM to calculate carriage movement.		Approx 0.25Vac between JPY7-1 & 2 when turbine is rotating (lift or lower)	Flow Sensor	Flow Module
226	JPY6-2	IN1	Return/reference for VR, JPY6-1. See JPY6-1, VR.				
227	JPY6-3	SHLD	Shield that helps reduce noise interference in the AC voltage from the VR/IN2 to the Flow Module.		<0.5V		
228	JPY2-1	GND	B– for the Flow Sensor thermistor.		<0.3V	ESM	
229	JPY2-2	F/S_Temp	Voltage that varies as the temperature of the Flow Sensor varies. It is conditioned by the Flow Module and sent to the ESM as FS_Temp, JPA1-4.		Not used	Flow Sensor Thermistor	Flow Module
230	JPA2-1	N/C	Not connected				
231	JPA2-2	N/C	Not connected				
232	JPA2-3	N/C	Not connected				
233	JPA2-4	+12VF	Not used on this truck				
234	JPA2-5	DGND	B– for the ESM. It is connected through FU13 on the TM at JPS14-3 & 4 to TP4 (B–) on the Power Panel.		<0.3V wrt TP4	TM	ESM
235	JPA2-6	BUS+	Carries the positive component of the digital communications between the ESM and the other managers on the communications bus. No usable information can be gained by measuring the voltage on this wire.		Not usable	All Mgrs on Bus	All Mgrs on Bus
236	JPA2-7	BUS–	Carries the negative component of the digital communications between the ESM and the other managers on the communications bus. No usable information can be gained by measuring the voltage on this wire.		Not usable	All Mgrs on Bus	All Mgrs on Bus
237	JPA2-8	PGND	Not used on this truck				
238	JPA2-9	+12VF	Supplies working voltage to the ESM when B+Key is present on the TM. If not present, the ESM will not function and Code 53 may be displayed during SelfTest. Check voltage at TP4 & FU17 (+12VF) on the TM.		10.8 - 13V w/key switch closed	TM	ESM
239	JPA7-1	HOMESENSE	Output of Home Sensor Prox used by the ESM to determine if the drive unit is CW or CCW of center. When over metal (CW), the switch is closed and the output is low. When not over metal (CCW), the switch is open and the output is hi.	Home Sensor Prox	<5V CW (over metal) >10V CCW (not over metal)	Home Sensor	ESM

https://truckmanualshub.com/

No.	Wire/ Comp.	Function Description	Theory of Operation	Device	Normal Voltage	Voltage Source	Voltage User
Unless otherwise specified, all voltages at Wire/Comp. are measured to B– on the associated card; TP6 on TM, TP2 on CCC, TP6 on ESM. (> = greater than, < = less than)							
240	JPA7-2	AGND	B– for the Home Sensor Prox. It is connected through FU13 on the TM at JPS14-3 & 4 to TP4 (B–) on the Power Panel.	Home Sensor Prox	<0.3V wrt TP4	TM	Home Sensor Prox
241	JPA7-3	+12VF	Supplies working voltage to the Home Sensor Prox. It is supplied from the TM at JPA2-9/JPS17-9 and fused by FU17 on the TM. If not present, a G-series code may appear.	Home Sensor Prox	10.8 - 13V w/key switch closed	TM	Home Sensor Prox

https://truckmanualshub.com/

Traction System Architecture

Refer to Table 8-1 for travel circuit components located on the Power Panel Assembly. Refer to Figure 8-1 for a schematic representation of the travel circuit components.

https://truckmanualshub.com/

Table 8-1. Travel Circuit Components

Ident	Component	Location	Function
Tractor Manager (TM)		Power Panel	See Tractor Manager/Vehicle Function Controller Functions on page 8-29.
Power Card		Plugs into TM	See Power Card Functions on page 8-30.
Vehicle Function Controller		Plugs into TM	See Tractor Manager/Vehicle Function Controller Functions on page 8-29.
Q1	Main Transistor	Traction Heatsink	Controls current flow from battery through the drive motor armature
Q2*	REGEN Power Transistor	REGEN Heatsink	Controls armature current during regenerative braking
Coil Driver Card		Plugs into TM	Contains coil drivers for Lift/Lower Solenoid, Load Holding Solenoid, Lift Contactor, PC Contactor, and Brake
REC1	Recirculation Rectifier	Heatsink Assembly	Provides current path for collapsing armature field when Q1 is turned off during drive mode
REC2**	Regenerative Braking Rectifier		Provides current path for the generated voltage during regenerative braking
REC3	Snubber Rectifier for Q1		Keeps voltage in C1 from being discharged into Q1 when Q1 is turned on
REC4**	Snubber Rectifier for Q2		Keeps voltage in C2 from being discharged into Q2 when Q2 is turned on
CT1	Current Transducer	Power Card	Measures current in main power lead to motor armature
HT	Temperature Sensor	Traction Heatsink	Monitors temperature of Traction Heatsink
R2	Snubber Resistor for Q1		Snubber current limiting for Q1
C1	Snubber Capacitor for Q1		Suppresses voltage spike when Q1 turns off
C2**	REGEN Card Capacitor	REGEN Heatsink	Suppresses voltage spike when Q2 turns off
FU	Fuses	—	Protects circuits
TM1/ TM2	H-Bridge Transistor Modules	Power Card	Control direction and amplitude of current through drive motor field windings
DT	Drive Motor Temp Sensor	Drive Motor	Inputs drive motor temperature signal to TM
R3	Resistor	Regen Heatsink	Snubber current limiting for Q2
Carriage Control Card (CCC)		Operator's Compartment	See Carriage Control Card Functions on page 8-28.
* Optional ** Not used on all models.			

https://truckmanualshub.com/

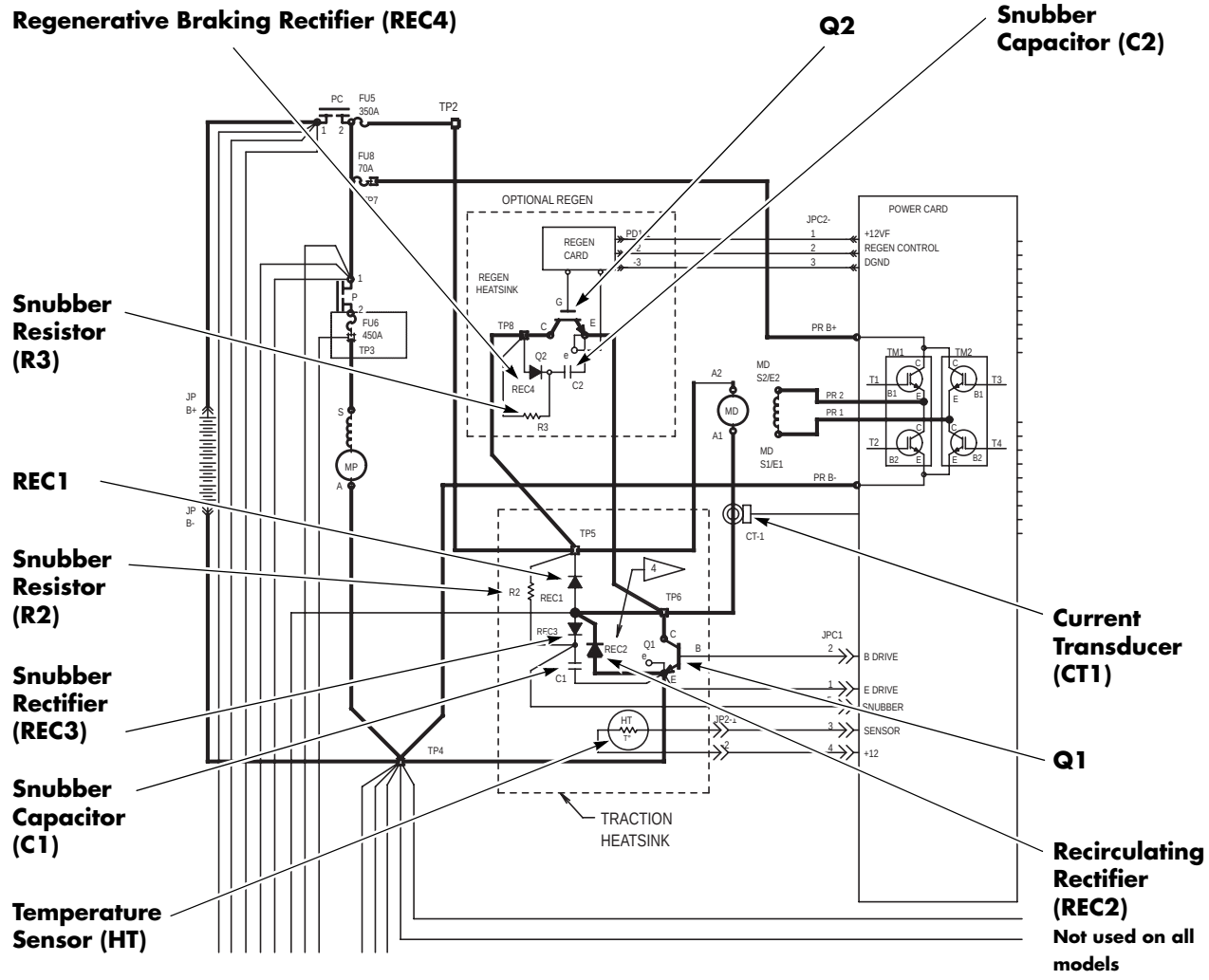


Figure 8-1. Travel Circuit Component Schematic

https://truckmanualshub.com/

Circuit Cards

The EASi™ Orderpicker can have up to four intelligent circuit cards working together to:

- respond to and monitor operator requests
- perform vehicle functions
- monitor operating conditions of the truck
- display information to the operator

Each circuit card has a specific responsibility. The circuit cards are:

- Operator Interface Card
- Carriage Control Card (CCC)
- Tractor Manager (TM) with Vehicle Function Controller (VFC)
- Electric Steer Manager (ESM)
- Power Card
- Filter Card

The TM, CCC, and ESM control the operation of the truck based on operator input. Truck operation status information is provided to the operator via the Operator Display (OD).

Operation of the truck requires the TM, CCC, and ESM working together to comply with operator requests, while maintaining safe control of the truck. The TM, CCC, and ESM comply with operator requests only if all safe operating conditions are met. This is accomplished via intelligent modules communicating to each other what is happening in each area of responsibility. This communication uses special signal lines (BUS+ and BUS–). The Power Card is also discussed in this section.

Operator Interface Card Functions

The Operator Interface Card contains:

- Buttons for the operator interface
- LED's for displaying messages.

Carriage Control Card Functions

The Carriage Control Card:

- Monitors the following switch inputs:
  - Sidegate
  - Deadman
  - 24 in. and 60 in.
  - Horn
  - Auto Manual
  - EPO
  - Lift Inhibit Bypass
  - Lower inhibit and bypass
- Outputs data to the OD
- Interprets keypad inputs
- Interprets lift/lower pot inputs
- Interprets forward/reverse pot inputs
- Stores all LEARNed values except steering/ guidance and speed
- Keeps date and time data
- Stores primary memory
- Stores configurable data
- Allows password and superword entry
- Stores hourmeter data
- Interprets TM and ESM messages
- Controls travel requests to the TM by comparing VR1 inputs to speed limits and travel shutdown inputs
- Interprets inputs from the steer request encoder
- Monitors height information from ESM
- Contains a power supply to produce 5.3V using 12V from the TM
- Contains three LEDs:
  - IL1 - indicates 12V is present
  - IL2 - indicates the Brake deadman switch is depressed
  - IL3 - indicates the brake deadman output to the TM has been activated.

https://truckmanualshub.com/

Tractor Manager/Vehicle Function Controller Functions

The Tractor Manager (TM)/Vehicle Function Controller (VFC):

- Controls and monitors contactors
- Controls load handling and proportional solenoid
- Controls operation of Q1
- Controls operation of TM1/TM2
- Determines required field and armature strength
- Invokes speed limits from the CCC by controlling field and armature strength
- Controls the horn relay
- Monitor inputs from:
  - the 150 in. switch and sends to the CCC
  - the lift cutout switch and stops lift/informs the CCC
  - both deadman pedals
- Interprets Speed prox inputs and uses them to control the drive motor
- Relays speed and direction information to the CCC
- Interprets steer prox inputs on manual steer trucks and relays them to the CCC
- Monitors DM temp sensor and supplies this information to the CCC
- Monitors HT temp sensor and supplies this information to the CCC
- Monitors Arm Current and supplies this information to the CCC
- Monitors Field current and supplies this information to the CCC
- Chops voltage to coils as per programmed truck voltage
- Monitors EOA sensors and sends information to CCC
- Monitors and controls lift/lower system per requests from the CCC
- Contains a power supply to produce 12V and 5.3V from battery voltage
- Supplies 12V to the CCC and ESM
- Stores LEARNed values for speed
- Supplies the horn relay with 24V
- Performs BSOC calculations
- Monitors EPO position
- The TM card contains four LEDs:
  - IL1 - indicates the 12V supply is functioning
  - IL2 - indicates Chopper Enable voltage is being generated
  - IL3 - indicates the carriage deadman is depressed
  - IL4 - indicates the brake deadman switch is depressed
- The VFC card contains one LED; IL1 flashes on and off when the micro-processor is communicating with the CCC
- The TM contains three jumpers:
  - E1 is for BUS termination and should be in the OUT position for electric steer trucks
  - E2 should have a jumper for the brake coil supply voltage on 24V trucks
  - E3 should have a jumper for the brake coil supply voltage on 36V trucks.

Electric Steer Manager Functions

The Electric Steer Manager (ESM):

- Stores LEARNed values for guidance and steering
- Keeps track of height counts and sends them to the CCC
- Interprets weight information from the pressure transducer and sends it to CCC
- Controls current to TM3/TM4 as per steer requests from the CCC or feedback from guidance sensors
- Activates and deactivates guidance per the CCC
- Monitors input from steer prox for home reference and supplies the information to the CCC
- Monitors input from steer feedback encoder to determine direction, speed and distance from center

https://truckmanualshub.com/

- Measures distance from wire and heading angle based on filter card inputs and supplies the information to the CCC
- Makes decisions on steer direction and slew rate during guidance based on speed inputs from the TM
- Contains a power supply to produce 15V and 5.3V using the 12V supply from the TM
- Contains a power supply that produces 9.1V from B+ used for battery sense voltage
- The ESM contains four LEDs:
  - IL1 - flashes on and off when the microprocessor is powered
  - IL2 - indicates that the ESM is pulsing TM3/TM4
  - IL3 - indicates a command to turn clockwise has been generated by the ESM
  - IL4 - indicates a command to turn counterclockwise has been generated by the ESM
- Contains jumper E1 for BUS termination which should be in the IN position

Power Card Functions

The Power Card:

- Amplifies PWM outputs from the TM to the field transistors
- Places the truck in current limit when armature current reaches the value required to activate internal hardware and illuminates the green LED
- Removes current to the drive system if the TM fails to do so when the HT reaches the voltage required to activate internal hardware and illuminates the red LED. This LED is only illuminated when the power card removes the current.
- Monitors the armature current during REGEN and controls the on and off time of Q2
- Uses the B Drive to control the power transistor
- The Limit 1 & 2 connections and the snubber wire connection are not used
- Places the truck in current limit when field current reaches the value required to activate internal hardware
- Contains circuits that activate the REGEN assembly based on the current through CT1

Filter Card Functions

The Filter Card filters, conditions and amplifies inputs from the guidance sensor coils.

https://truckmanualshub.com/

Control Devices

Brake Deadman Switch (S2)

The CCC monitors the state of the brake deadman switch (S2) and sends the information over BUS+/BUS–. The CCC also passes the S2 input to the TM VFC via an over-the-mast cable.

Carriage Deadman Switch (S23)

The CCC and TM VFC both monitor the state of S23. The TM VFC senses the position of S23 through a hard-wired sense line via the over-the-mast cables. When the TM VFC senses that S23 is closed, it sends a message over BUS+/BUS– to the CCC. When the CCC senses that S23 is closed, it sends a message to the TM VFC. Only after both S2 and S23 are verified closed by both the TM VFC and the CCC, will travel and lift be permitted.

Hall Effect Switches

The limit switches used on this truck are Hall Effect switches.

These switches consist of a transistor that is turned on when a magnet is positioned next to the transistor. (Keep in mind that the magnet is part of the switch assembly and can only be seen if the switch is disassembled).

See Figure 8-2 for an example of a typical Hall Effect switch. Refer to Figure 8-3 for a schematic representation of a Hall Effect switch.

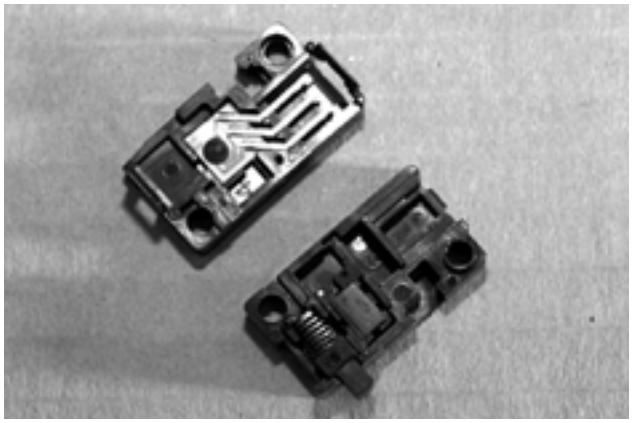


Figure 8-2. Typical Hall Effect Switch

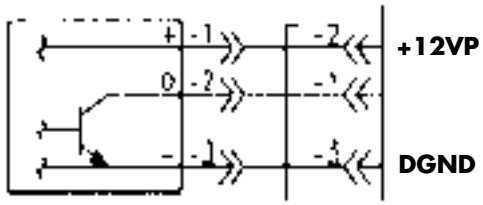


Figure 8-3. Example of Hall Effect Switch Schematic

The switch is powered as follows:

- +6 to +12V is applied to the positive (+) terminal
- battery negative is applied to the negative (–) terminal
- When a magnet is not present, the transistor is in an off state and the output lead is in a high state.
- When a magnet is present, the transistor is turned on, creating a path from the negative (–) terminal to the 0 terminal. Terminal 0 will now be a negative (–) potential.

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Traction System Functional Operation

NOTE: The schematics in this chapter are intended for general understanding of theory of operation and may not reflect latest developments in circuitry.

DO NOT use these schematics to troubleshoot or repair the lift truck.

ALWAYS USE the schematics in the Appendix for troubleshooting and repair.

Battery Plugged In

See Figure 8-4. When the Battery is plugged into the truck, B+ is supplied to FU14 and FU16 on the TM. B+ passes through FU14, now called B+F, to the over-the-mast cables and over to the CCC. B+F passes through the CCC to the open key switch S1. B+ also passes through FU16, now called B+FSpare to the over-the-mast cables and over to the CCC. It is used for optional devices attached to the carriage. Battery negative is supplied from TP4 by two wires to FU13 and FU15 on the TM. It is then dispersed throughout the control system as B–F and B–FSpare. The B–F is used by the control circuits and cards on the tractor as B–F, Analog Ground (AGND), and Digital Ground (DGND). B–F and B–Spare go through the TM and over the mast through the cables to the CCC. On the CCC, they are used as PGND, B–F and B–FSpare. AGND also goes through the over-the-mast cables and is used on the CCC internally and as DGND for devices connected to the CCC.

Key Switch (S1) Turned ON

See Figure 8-5. When the Key is turned ON and S1 is closed, B+ (now B+Key) is dispersed through the CCC. It leaves the CCC to the EPO switch. With S21 closed, it passes through the EPO and back into the CCC as B+ESTOP. B+ESTOP flows through the over-the-mast cable to the TM. It is dispersed throughout the TM to supply battery positive to various solenoids and portions of the coil driver cards. Circuits on both the CCC and TM are activated so the microprocessors know when the circuit is complete. Loss of B+ESTOP at either card will cause an error code to be displayed and no travel or lift functions will operate. B+Key also goes through the over-the-mast cable to the TM. On the TM, it supplies B+ to various circuits including the power supply. The power supply reduces battery voltage to 12V and keeps it steady as long as the supply voltage remains above 17V. The 12V is dispersed through a fuse (FU17) on the TM as 12VF to various components and connectors. There is also a 5.3V power supply on the TM that reduces the 12V to 5.3V. The 5.3V is used for internal circuitry on the TM, including the microprocessor. The 12VF is carried through the over-the-mast cable to the CCC and the cable connecting the ESM to the TM. The CCC disperses it to the various components and connectors. There is also a 5.3V power supply on the CCC that reduces the 12V to 5.3V. The 5.3V is dispersed to various connectors on the board. The 5.3V is also used for internal circuitry on the CCC, including the micro-processor. The ESM disperses it to the various components and connectors. There is also a 5.3V power supply on the ESM that reduces the 12V to 5.3V. The 5.3V is dispersed to various connectors on the board. The 5.3V is also used for internal circuitry on the ESM and Filter Card, including the microprocessor on the ESM. The ESM also contains a 15V power supply that is produced from the 12V from the TM. The 15V is used for internal circuitry by the ESM. With the micro- processors powered on the boards, the SelfTest routine is started.

Power ON SelfTest

CCC SelfTest Sequence

- Checks the microprocessor to make sure it is enabled and all portions are functional.
- Runs software checksum calculation.
- Tests the RAM.

https://truckmanualshub.com/

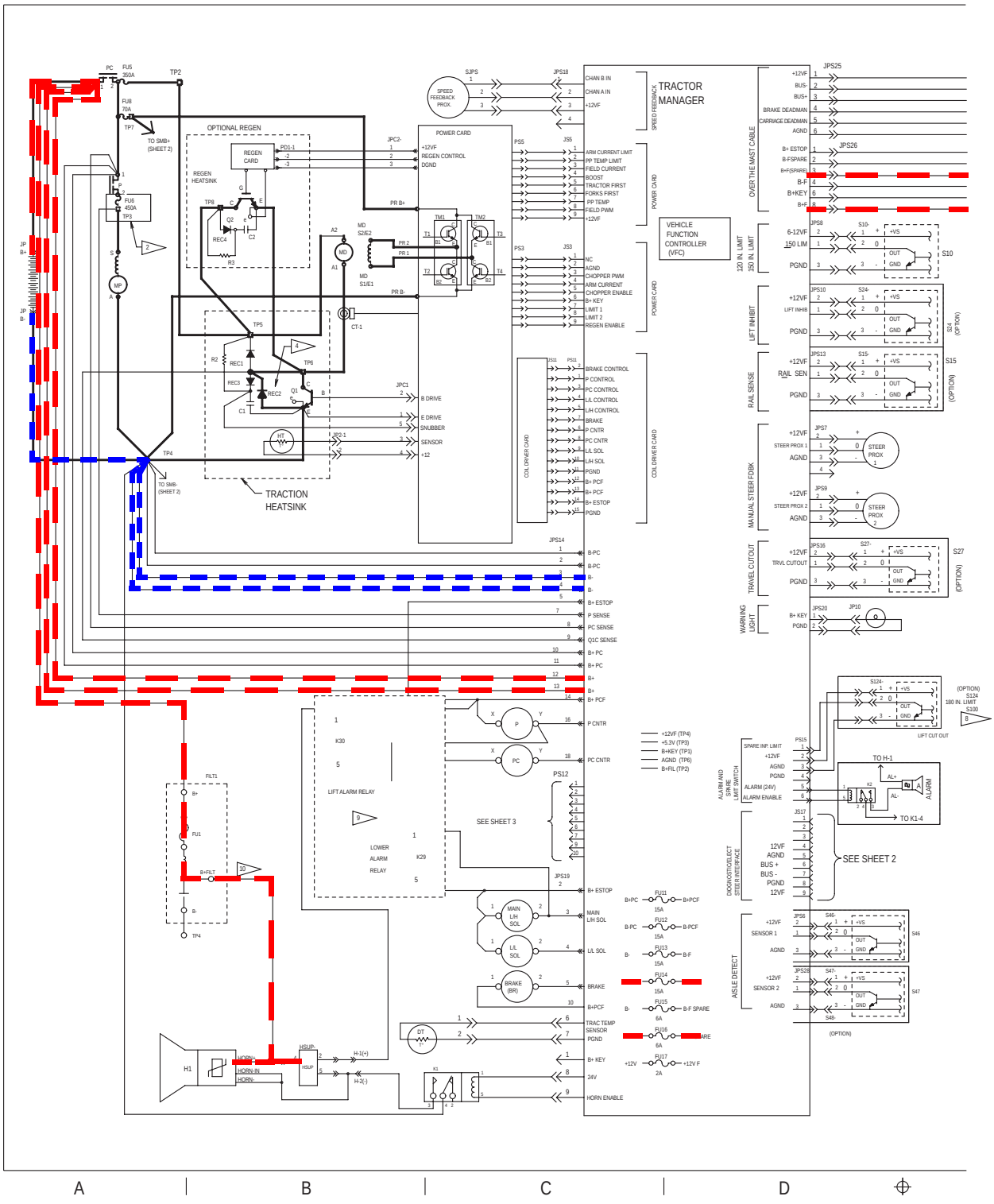


Figure 8-4. Battery Plugged In

https://truckmanualshub.com/

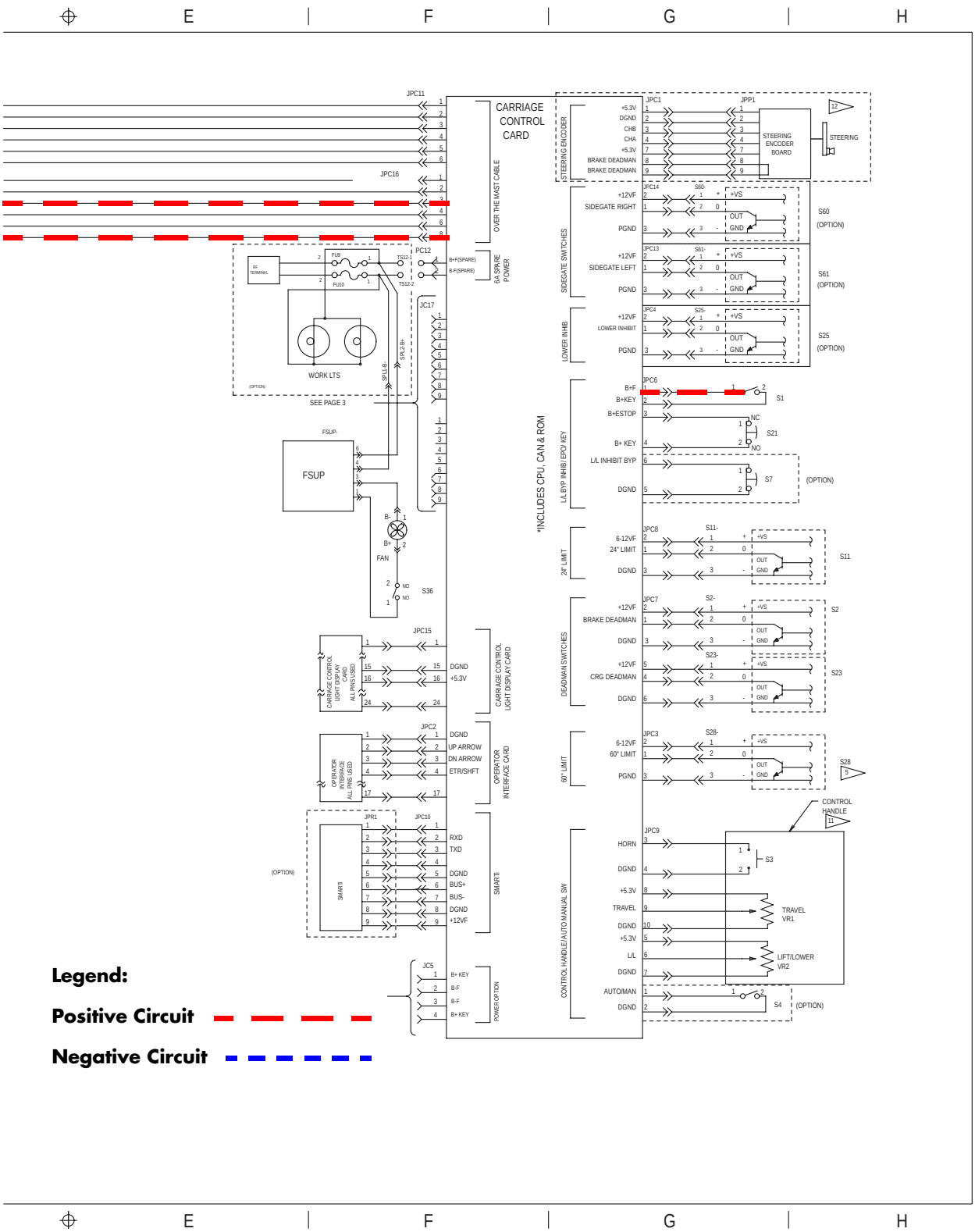


Figure 8-4 (Cont.).

https://truckmanualshub.com/

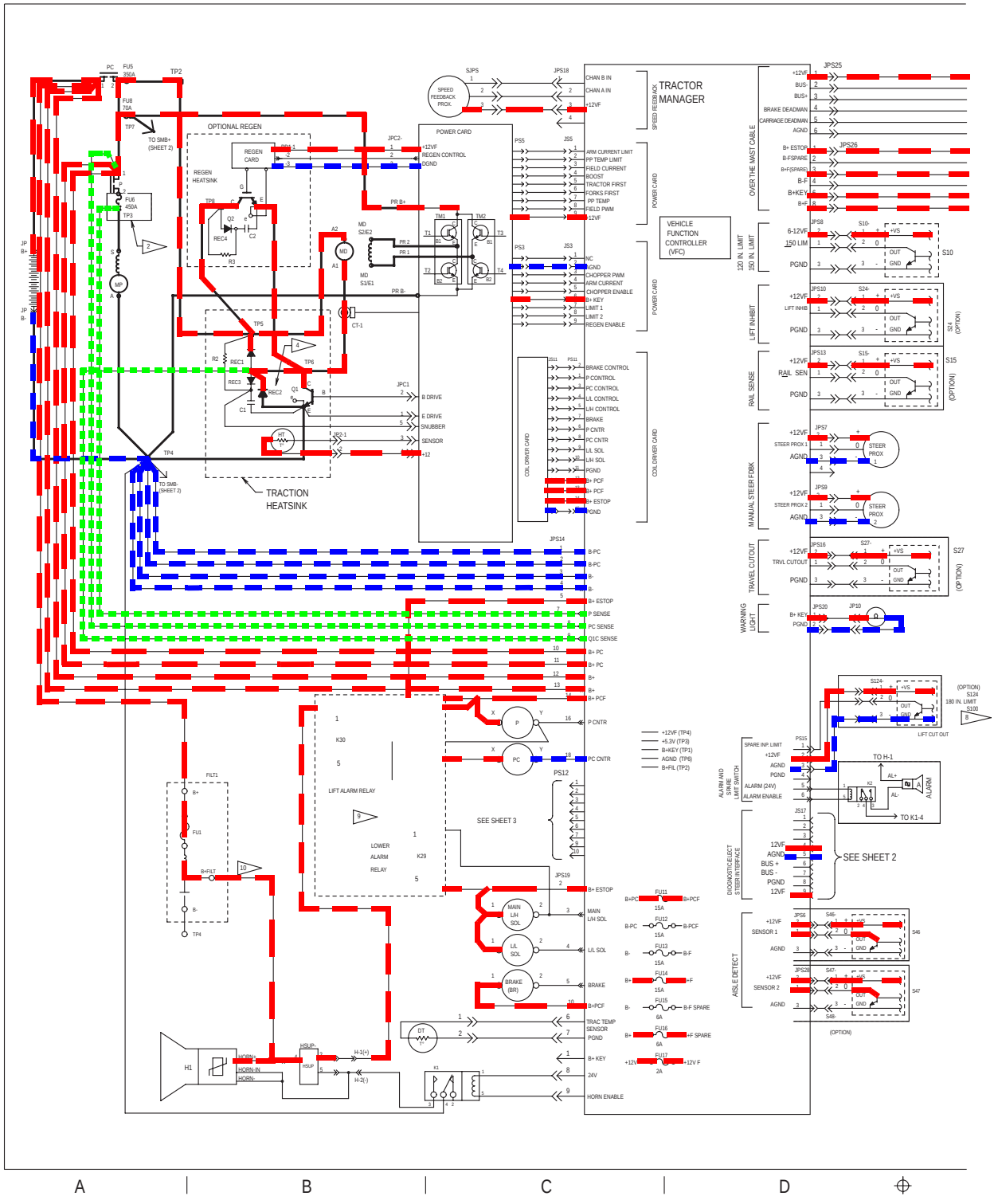


Figure 8-5. Key Switch (S1) Turned ON

https://truckmanualshub.com/

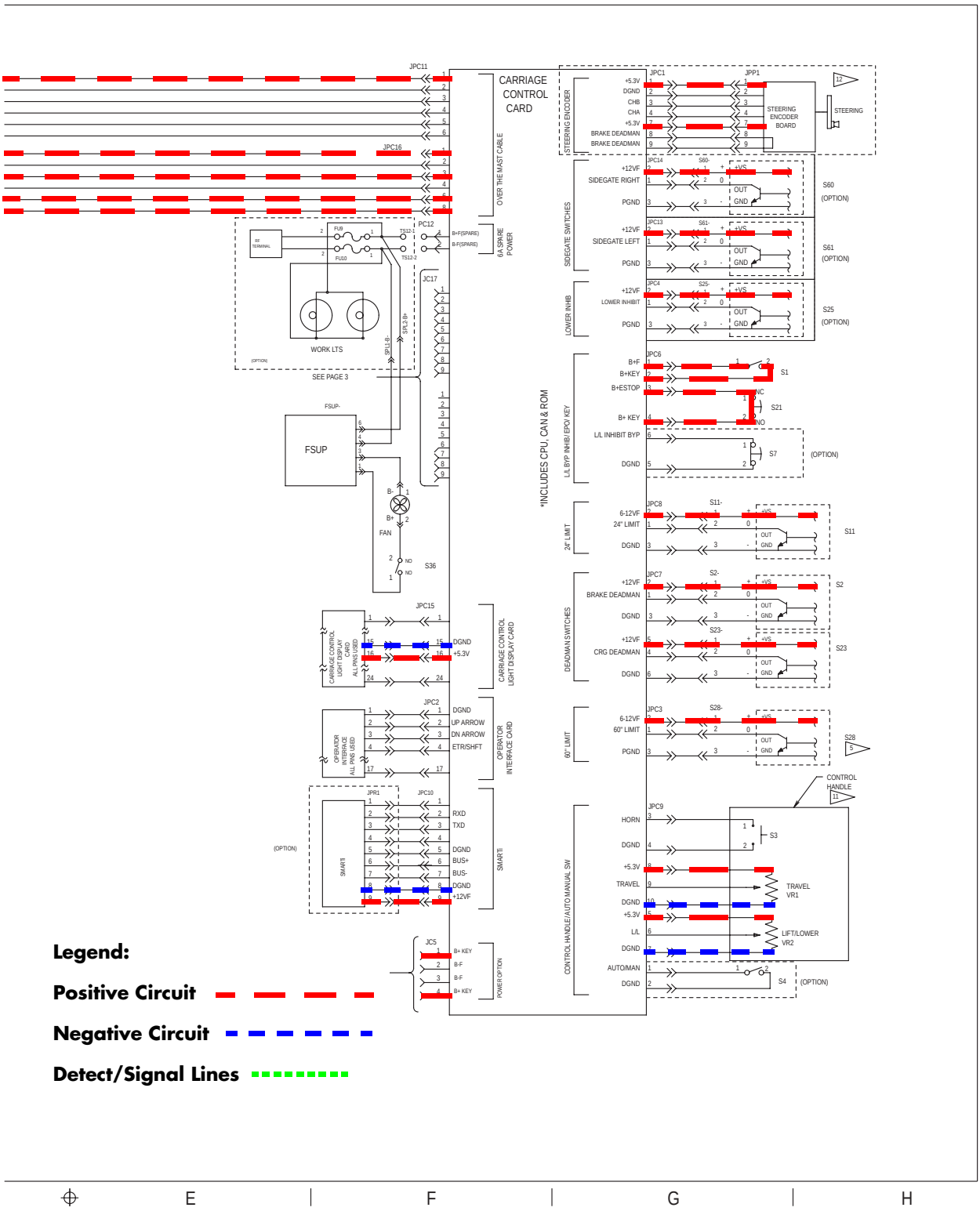


Figure 8-5 (Cont.).

https://truckmanualshub.com/

- Checks the EPROM and restores information from the backup copy on the TM if necessary.
- Checks to make sure the TM is responding over the BUS lines.
- Checks the truck specific information that can be seen using DTIC.
- Checks the VFC card to make sure it is properly setup for operation.
- Checks to make sure the model number the software is written for matches the model number programmed in the truck.
- Checks to see if the truck has a dual channel steer encoder installed by comparing the information in the configuration menu to the inputs from the encoder connectors on the CCC.
- Checks memory to see if the last time the truck was powered down it was due to a COP time-out or microprocessor crash, rather than key OFF.
- Checks deadman switches for proper position.
- Looks for the proper battery voltage and calculates BSOC.
- The CCC starts its checks by looking for proper hardware connections and voltage inputs from switches and pots. Commands the ESM and TM to start SelfTest.
- CCC completes its checks and waits for the ESM and TM to complete SelfTest and report back. Generates a Code 50 if the TM does not respond and a Code 53 if the ESM does not respond.

TM SelfTest Sequence

- Checks the microprocessor to make sure it is enabled and all portions are functional.
- Runs software checksum calculation.
- Tests the RAM.
- Checks EPROM.
- Checks to see if the PC sense line has a low reading.
- Checks to see if the EPO line from the CCC has a high reading.
- Activates the coil driver to close the PC contactor and looks to see if the PC sense line changed state.
- Checks to see if the P sense line has a low reading.
- Checks memory to see if the prior shutdown was caused by a COP time-out rather than a key OFF.
- Waits for a communication message from the CCC to continue with SelfTest in order to synchronize CCC & TM startup.
- Checks for proper battery voltage.
- Checks to see if the P sense line has a low reading again.
- Looks at the field current circuit to make sure there are no shorts.
- Powers the field and looks at the field current circuit to make sure there is no open.
- Looks at the power panel temperature circuits to make sure the readings are within limits.
- Looks at Q1C Sense to make sure the main transistor is not shorted.
- Turns on the main transistor and checks for open circuits.
- Looks at Q1C Sense to make sure the main transistor is not shorted again.
- Looks at the power panel temperature circuits to make sure the readings are within limits again.
- Calculates power panel temperature and checks for overheating.
- Looks at the drive motor temperature circuits to make sure the readings are within limit.
- Calculates drive motor temperature and checks for overheating.
- Looks at the speed feedback to make sure there were not any counts registered when the drive motor circuits were energized.
- Checks the remaining input statuses. Sends a startup complete message over the BUS to CCC along with a SelfTest PASS/FAIL status.

https://truckmanualshub.com/

ESM SelfTest Sequence

- Checks the microprocessor to make sure it is enabled and all portions are functional.
- Runs software checksum calculation.
- Tests the RAM.
- Checks EPROM.
- Checks input status. Sends a “startup complete” message via the BUS to the CCC along with a SelfTest PASS/FAIL status.

Power ON SelfTest Complete

After all SelfTest sequences are complete and all processors report a PASS status, the CCC commands the TM to sound the horn, informing the operator that the truck is now ready for operation.

Deadman Pedal Depressed

See Figure 8-6. When the deadman is depressed, switches S2 and S23 are closed. When S2 closes, it supplies B– to an input circuit on the CCC called Brake Deadman. This circuit activates an electronic device on the CCC which supplies 5.3V to JPC1-8. There is a jumper between JPC1-8 & 9. The purpose of the jumper is to make sure the steer encoder is plugged in prior to allowing truck operation. 5.3V passes through the steer encoder back to the CCC where it branches off to two places. One leg goes on to the microprocessor. The other illuminates IL2 on the card, indicating S2 is closed. Once the microprocessor has the 5.3V input, it activates another circuit which illuminates IL3 on the CCC and takes the 10V seen at JPC11-4 by the TM to 0V. When the TM no longer sees the high input, it realizes S2 is closed. The microprocessor also sends a message via the BUS to inform the other processors the switch is closed. When S23 is closed, a path for battery negative is completed through the switch. It passes through the CCC to JPC11-4 and over the mast to the TM. This B– activates a circuit that illuminates IL3 on the TM and removes a 5.3V input to the VFC. The microprocessor compares this input to the brake deadman input and informs the CCC of the status it has for both switches. If the CCC's inputs agree, the OK to release the brake is given to the TM.

Travel

See Figure 8-7. When the deadman is depressed and the control handle is moved from neutral, the CCC compares the reading from VR1 to the learned values for VR1. It determines travel direction and the percent of full speed that has been requested. It looks at all the inputs that can reduce the maximum allowable travel speed. If a speed limit condition is present, the CCC will only command the speed allowed per that criteria. This command is sent via the BUS to the VFC. The VFC receives the command and looks at the Q1C Sense line to make sure the main transistor is not in a shorted state. It sends out a voltage to activate the enable circuits for Q1 (Chopper Enable). The current reading from the field circuit is checked to make sure TM1/TM2 are not shorted. It sends out a voltage to activate the enable circuits for the appropriate halves of TM1/TM2 (tractor first or forks first) to the Power Card. Voltage for Q1 (Chopper PWM) and TM1/TM2 (Field PWM) base leads are sent to the Power Card. At the same time, the VFC activates the coil driver circuit for the brake and the brake is released. The VFC now starts sampling the feedback circuits associated with the travel system. These circuits are Speed Feedback Prox, Armature Current, Armature Current Limit, Power Panel Temp, Power Panel Temp Limit and Field Current. The Power Card amplifies the base lead voltages received from the VFC and begins turning the transistors on and off. The base voltage to T1 or T3, depending on travel direction, is turned on first and is on 100% of the time. Prior to T2 and T4 being turned on, B– must be present at the motor fields. Once B– is present, it allows voltage to start flowing to the base leads, turning on T2 or T4, depending on travel direction. These voltages are pulses on and off. The transistors only conduct when the voltage is applied to the base lead. The longer voltage is applied to the base of the transistor, the longer it stays on. Longer on times allow more voltage and current to flow through the fields. This increases the field strength and creates more torque from the motor. The base lead to Q1 is turned on and off like T2 and T4, allowing variation to the voltage and current supplied to the armature.

https://truckmanualshub.com/

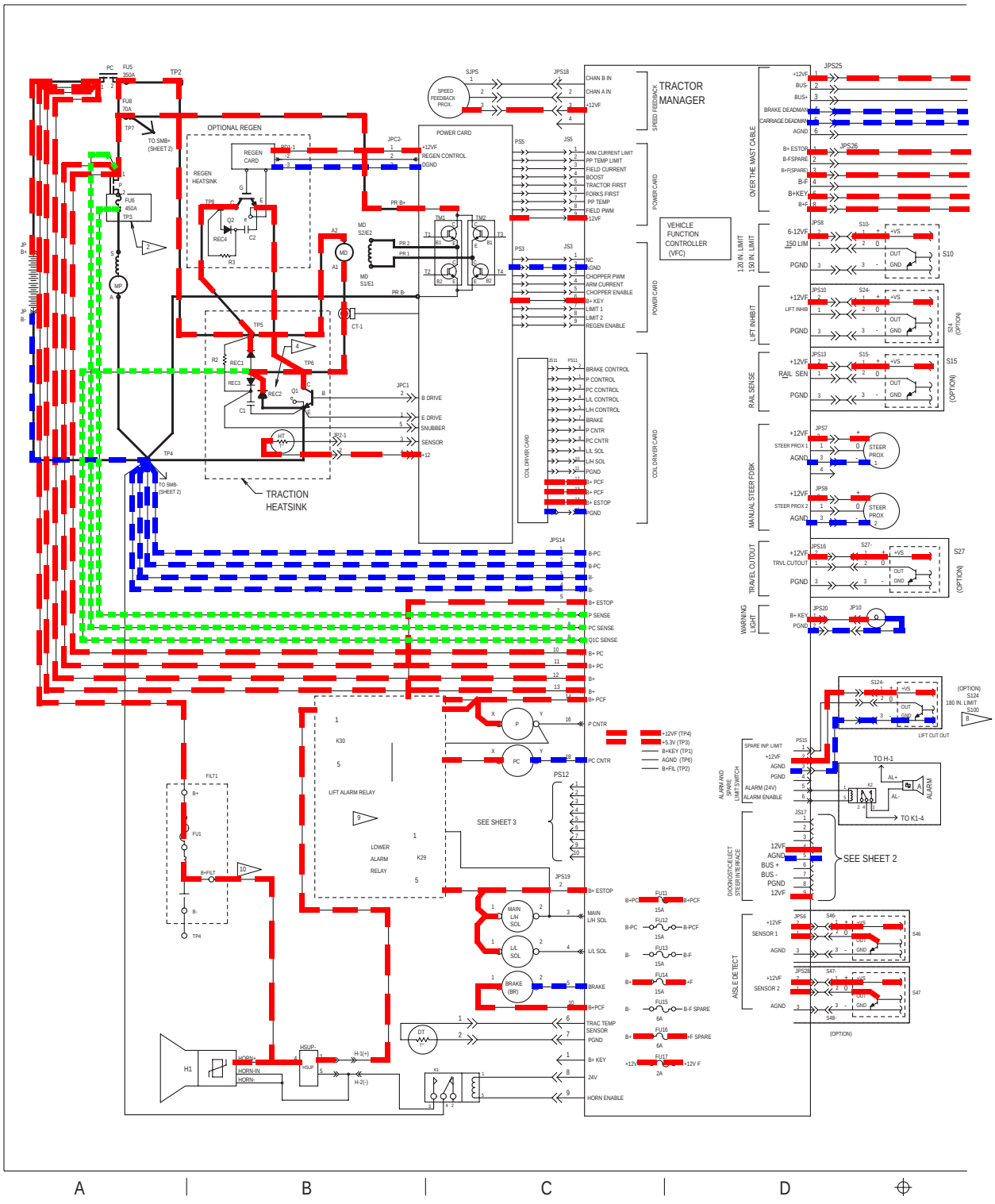


Figure 8-6. Deadman Pedal Depressed

https://truckmanualshub.com/

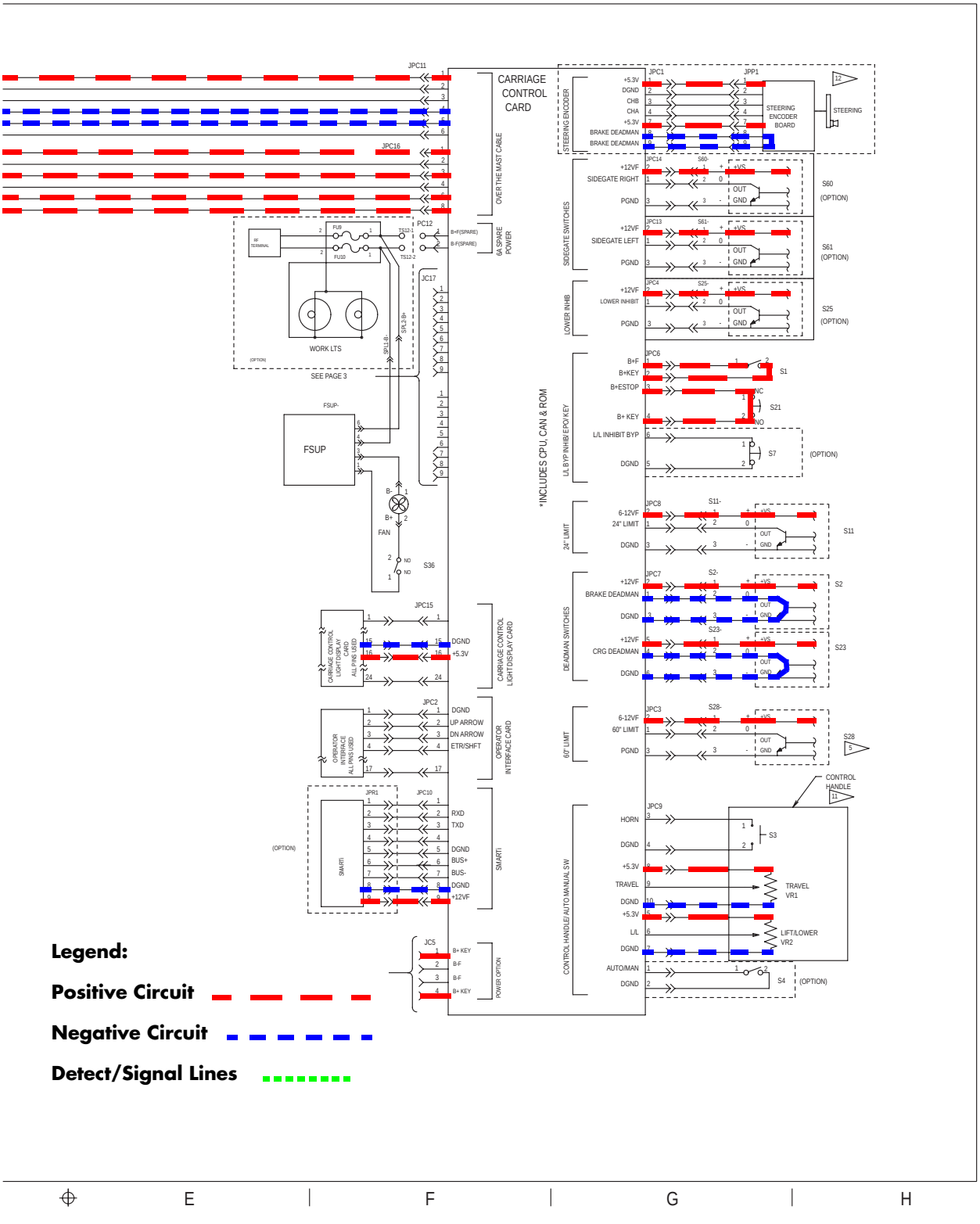


Figure 8-6 (Cont.).

https://truckmanualshub.com/

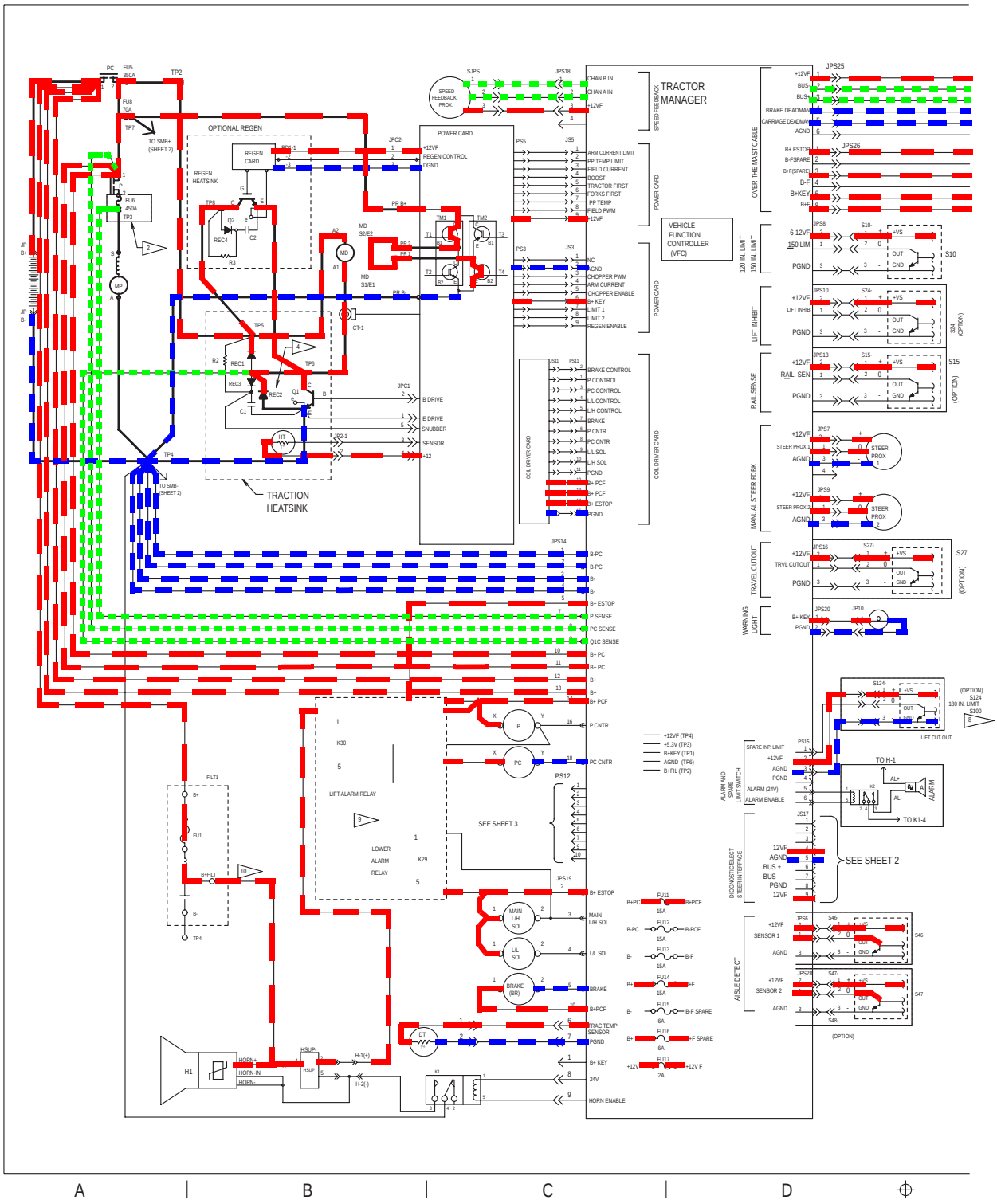


Figure 8-7. Travel

https://truckmanualshub.com/

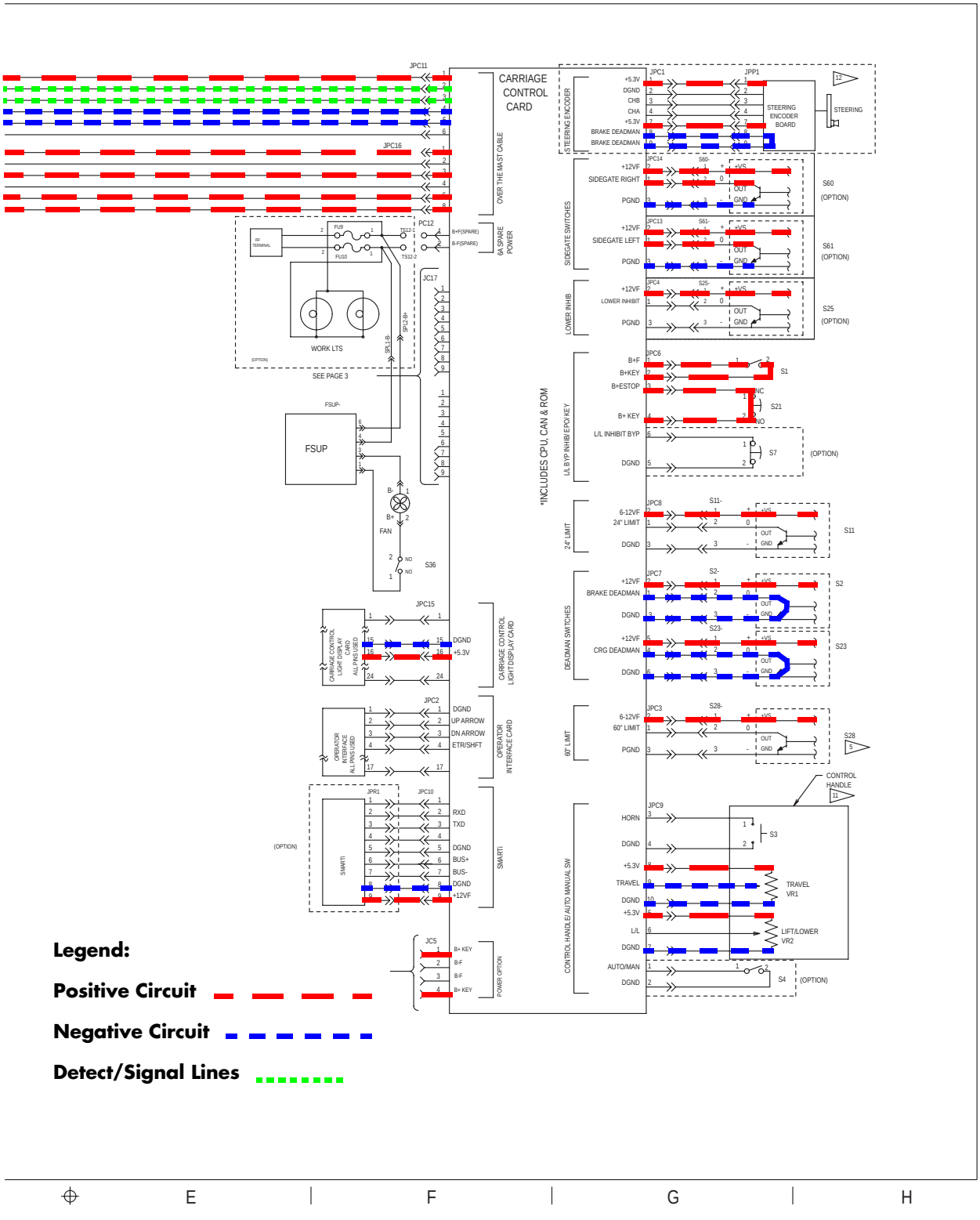


Figure 8-7 (Cont.).

https://truckmanualshub.com/

The Power Card uses the voltage at E Drive as a reference to turn off B Drive for Q1. If this voltage is not available, Q1 will not be turned off and will fail due to over current. During the times when Q1 is turned off, the armature field collapses and induces a voltage higher than battery voltage. This voltage forward biases REC1, which allows it to recirculate back to the A2 terminal of the armature. If the voltage from the armature is high enough to forward bias REC3, the snubber cap (C1) will charge and absorb any voltage spike that could damage Q1. Once C1 charges, REC3 turns off. Recirculation continues through REC1 until Q1 is turned back on or the voltage drops to a point where REC1 is no longer forward biased. At this point in time, any charge in C1 that is larger than the voltage at TP5 will bleed off, returning C1 to a charge level about the same as battery voltage. During the first few yards of acceleration, the green Armature Current Limit LED is illuminated on the Power Card. This indicates that the current limit setting on the Power Card has been exceeded (approx 350A). The Power Card will interrupt the voltage to the base lead of Q1 when maximum allowable current is reached, as reported by CT1 on the Power Card. Once current is below the maximum, the Power Card will again allow the base voltage to go out to Q1 until current limit is reached again and the cycle will repeat. During this time, the VFC is monitoring the inputs from the Power Card at Armature Current Sense and Armature Current Limit. This information is sent to the CCC over BUS+/–. The Power Card also has an internal current limit circuit for the fields. Any time the Field Current reaches the maximum allowable current, it is reduced the same way as the Armature Current. The VFC monitors the Field Current from the Power Card and if the maximum allowable current is exceeded, the truck will shut down and display an error code. While traveling, the CCC is also monitoring the drive motor and drive heatsink temperatures. The heatsink temperature is monitored via inputs to the Power Card from HT Sensor. The Power Card continuously supplies this information to the VFC who sends it on to the CCC. The drive motor temperature is monitored via the DT Sensor connected to the TM at Trac Temp Sensor. The CCC monitors the temperatures and if they increase too much, it reduces drive system performance as required to keep the temperatures at acceptable levels. If the temperatures reach an unacceptable level, the CCC will reduce travel to 1 mph (1.6 km/h). If the CCC and VFC fail to place the drive system into maximum thermal limit (1 mph. travel speed) and the HT readings exceed the maximum range, there is hardware on the Power Card that is activated. This supplies an input to the TM at PP TEMP LIMIT. The CCC compares this input to the reading it gets from PP TEMP and displays an error code that means the two inputs do not agree. Travel speed is limited to 1 mph (1.6 km/h). When this circuit is activated, the red LED on the Power Card is activated. The TM contains the programs and is responsible for maintaining the speed commanded by the CCC. It compares the actual speed of the truck, as calculated by the VFC using input from the Speed Feedback Prox, to the speed commanded by the CCC. The speed is then sent to the CCC and ESM. The TM increases and decreases field and armature strength to obtain and maintain the commanded speed. The CCC is the only manager that can determine and command the travel speed criteria.

Contactor Coils

The coil drivers allow the use of 24V contactor coils even though this is a 36V truck. This is accomplished by the TM determining the voltage of the battery and pulsing the appropriate contactor coil to a level that does not exceed 24V.

For a 24V truck, the contactor coils would not need to be pulsed. Therefore, for 24V trucks, a coil (when energized) is on 100% of the time. On a 36V truck, the coil (when energized) is pulsed at a rate of 66% on and 34% off,
(36V x 0.66 = 24V).

Elevated Height Limits

The EASi™ Orderpicker uses several limit switches to limit travel speeds as the operator's platform is elevated. These switches are hall effect switches that are activated with the platform below the specified height and deactivated above the specified height.

https://truckmanualshub.com/

The following is a list of reference switches and the respective connection points:

- S11 is the 24 in. reference switch. It makes a connection between JPC8-1 and JPC8-3 on the CCC
- S28 is the 60 in. reference switch. It makes a connection between JPC3-1 and JPC3-3 on the CCC
- S10 is the upper reference switch. It makes a connection between JPS8-1 and JPS8-3 on the TM
- S100 is the 315 in. reference switch. It makes a connection between JPS15-1 and JPS15-3 on the TM

Refer to Table 8-2 for speed limits on trucks with Advanced *intellispeed*. Refer to Table 8-3 for speed limits on trucks without Advanced *intellispeed*.

Table 8-2. Speed Limits for Trucks with Advanced intellispeed

Selected Elevated Heights of Operator's Compartment	Angle of Drive Wheel	Approximate Maximum Travel Speed
Below 24 in. (61 cm)	More than 10°	Full Speed is 5.5 to 6.5 mph (8.8 to 10.4 km/h) [Max. speed forks-first is 5.5 mph (8.8 km/h)]
Below 60 in. (152 cm)	Less than 10°	
Between 24 and 60 in. (61 and 152 cm)	More than 10°	2.5 mph (4.0 km/h)
Between 60 and 240 in. (152 and 610 cm)	Less than 10°	Approx 0.5 mph (0.8 km/h) reduction in speed for every 18 in. (46 cm) of elevated height
Between 60 and 150 in. (152 and 381 cm)	More than 10°	1.0 mph (1.6 km/h)
Above 240 in. (609 cm)	Less than 10°	
Above 150 in. (381 cm)	More than 10°	0.0 mph

Table 8-3. Speed Limits for Trucks without Advanced intellispeed

Elevation	Angle of drive wheel	Speed Limits
Below 24 in. (61 cm)	More than 10°	Full speed is 5.5 to 6.5 mph (8.8 to 10.4 km/h)] [Max. speed forks-first is 5.5 mph (8.8 km/h)]
From 24 to 60 in.* (61 to 152 cm)	More than 10°	2.5 mph (4 km/h)
Below 60 in. (152 cm)*	Less than 10°	5.5 to 6.5 mph (8.8 to 10.46 km/h) [Max. speed forks-first is 5.5 mph (8.8 km/h)]
From 60 to 150 in. (152 to 386 cm)*	Less than 10°	3.0 mph (4.8 km/h)
	More than 10°	1.0 mph (1.6 km/h)
From 150 to 315 in. (386 to 800 cm)	Less than 10°	1.0 mph (1.6 km/h)
Above 150 in. (386 cm)	More than 10°	No travel allowed
Above 315 in. (800 cm)	Less than 10°	No travel allowed
* If this truck has the configurable travel speed option, you can set its top speed from 1.0 to 2.5 mph (1.6 to 4.0 km/h) whenever the operator's platform is between 24 and 150 in. (61 and 381 cm).		

https://truckmanualshub.com/

Current Limiting

The Power Card continually monitors the drive motor armature current at CT1 and interrupts the PWM to the Main transistor to keep the armature current from exceeding the current limit.

When travel is requested, the TM produces a PWM that is based on the travel request from VR1 and all other speed limiting inputs such as temperature and height. This PWM is sent to the Power Card at JPS3-3 (Chopper PWM).

The Power Card does not change the overall pulse width or frequency (envelope) of the Chopper PWM, but passes it on to the gate of Q1 at JPC1-2 (B Drive).

To protect Q1, the Power card will interrupt the PWM to the base of Q1 when current limit is reached. When armature current drops below current limit, the Power Card again passes the PWM from the TM to Q1.

This interruption of the PWM results in a "chopped" ON time of the Chopper PWM that was sent from the TM, as depicted in Figure 8-8. The OFF time is not affected because there is no current through CT1 when Q1 is off.

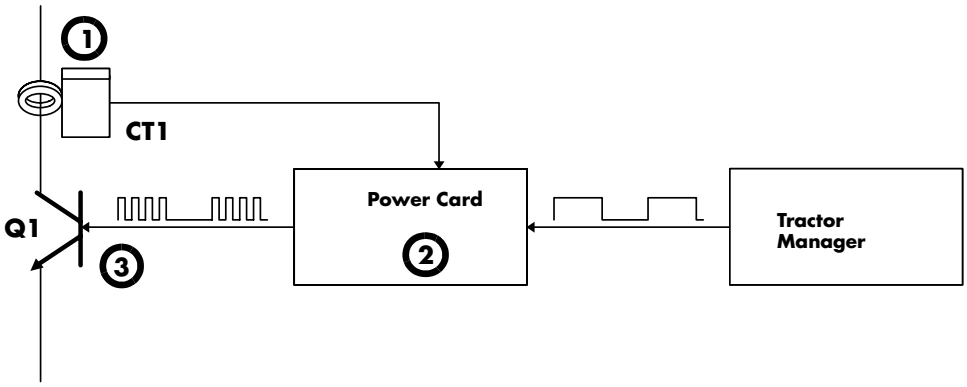


Figure 8-8. Current Limiting

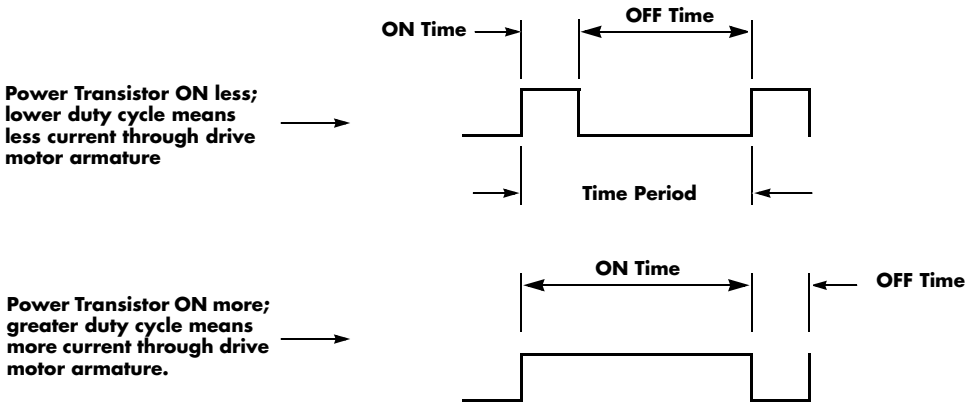


Figure 8-9. Duty Cycle Comparison for Current Limiting

https://truckmanualshub.com/

Proportional Plugging

Proportional plugging is the recommended method of reducing travel speed and changing travel direction. See Figure 8-10.

While traveling, if the control handle is moved through neutral and the opposite travel direction is requested, the truck is in a plugging condition. The CCC sends the command over BUS+/– to start travel in the opposite direction at the percentage of full speed travel requested by VR1. The VFC looks at the command and determines the strength the fields must be, based on the percentage of travel commanded. The farther VR1 is moved past neutral, the higher the field strength is and the faster the truck will slow down. The VFC then turns off Q1 and TM1/TM2. It then sends the enable voltage for the other pair of transistor halves and starts to pulse them. The momentum of the truck keeps the armature spinning in the same direction, which is opposite of the energized fields. This makes the armature act like a generator, producing its own voltage and current. This current wants to return to its source through the path of least resistance. The voltage produced by the armature is more positive at the A1 terminal than at A2. This causes REC1 to be forward biased, allowing the current to flow from the A1 terminal through REC1 and back to the A2 terminal. With the magnetic field of the armature opposing the one produced by the drive motor fields, the truck is slowed down. When the truck has almost completely stopped the VFC turns Q1 back on and starts driving in the direction commanded by the CCC.

https://truckmanualshub.com/

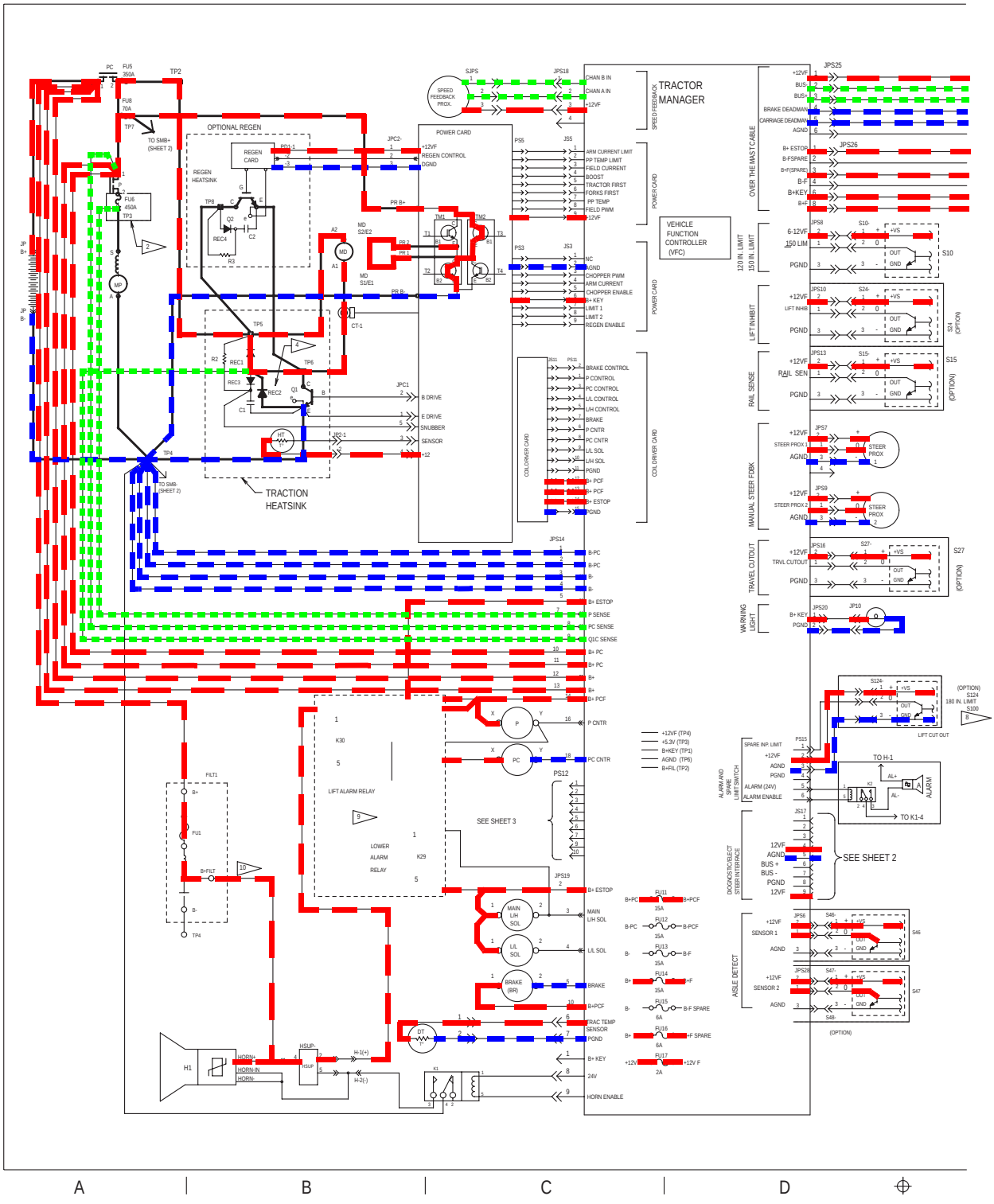


Figure 8-10. Proportional Plugging

https://truckmanualshub.com/

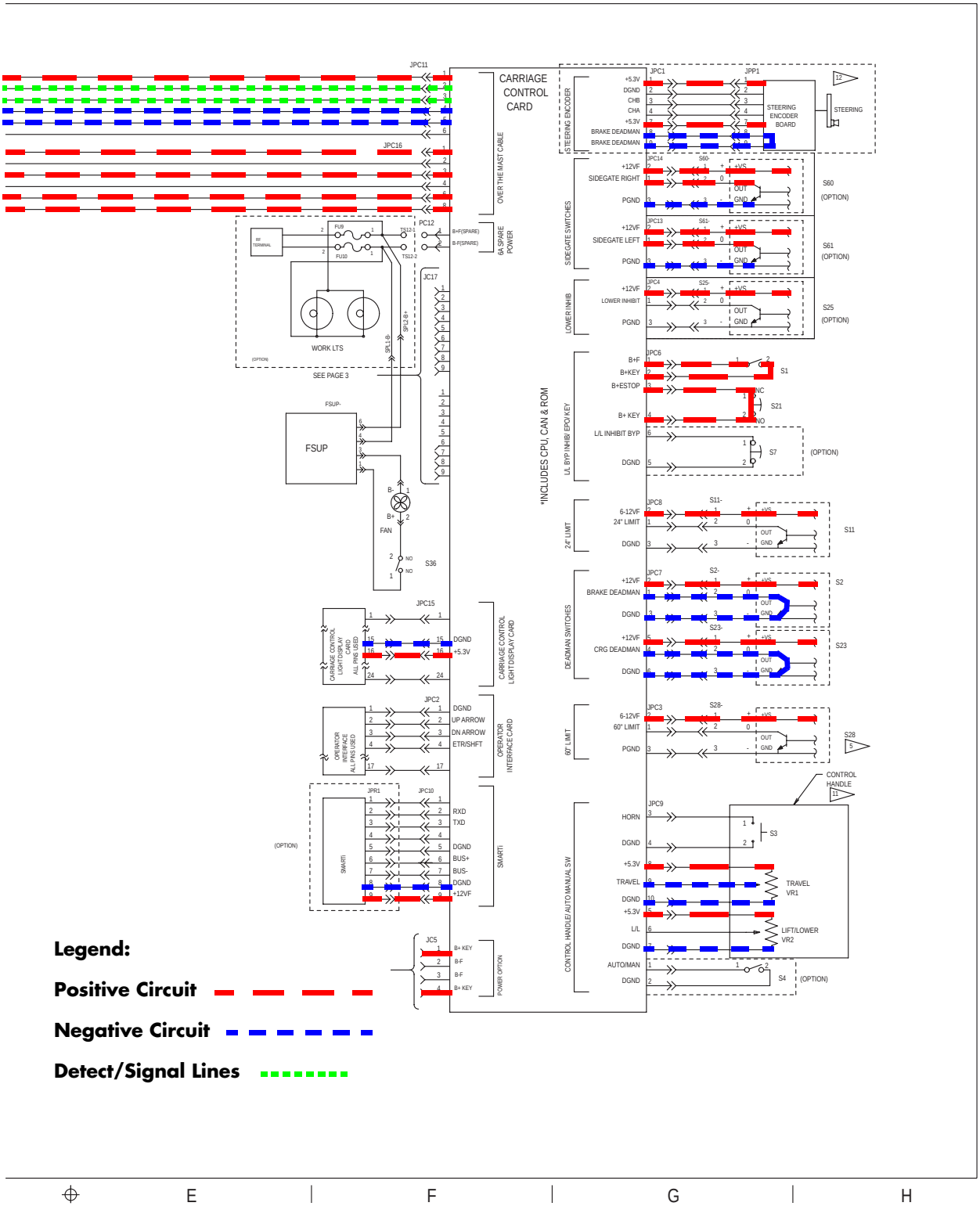


Figure 8-10 (Cont.).

https://truckmanualshub.com/

Regenerative Braking

NOTE: Regenerative Braking is not used on all models.

Regenerative braking will occur when the lift truck is traveling at or near full speed [greater than approx 5 mph (8 km/h)] and the control handle is moved in the opposite direction of travel. In the following description, the lift truck is traveling full speed in the tractor-first (forward) direction. See Figure 8-11. The following steps occur within the traction system:

Regen

1. The change in the input voltage from VR1 is sensed by the CCC.
2. The TM determines travel direction and speed, based on inputs from the speed feedback prox.
3. The TM determines this as a Regen condition and turns the power transistor (Q1) off. Q1 remains off during the entire regenerative braking process.
4. The TM continues to command motor fields current in the same direction (forward).
5. With Q1 turned off, the armature field collapses, inducing a momentary voltage across the armature in the opposite polarity (MDA1 positive). This causes a brief recirculation current from MDA1 through REC1 to MDA2. See Figure 8-11.
6. With the lift truck still traveling forward and Q1 off (no battery current supplied to the armature) and the fields still energized, the motor acts as a generator, producing a voltage potential between MDA2 (+) and MDA1 (–). The amount of potential is dependent on speed of rotation and the field strength (as requested by handle position).
7. A circuit is completed from the MDA2 through the battery (positive post to negative post) through REC2 and back to the motor armature (MDA1). This circuit is completed only when the voltage produced between MDA2 & MDA1 is at least 1V greater than battery voltage, thereby forward biasing REC2. See Figure 8-12.

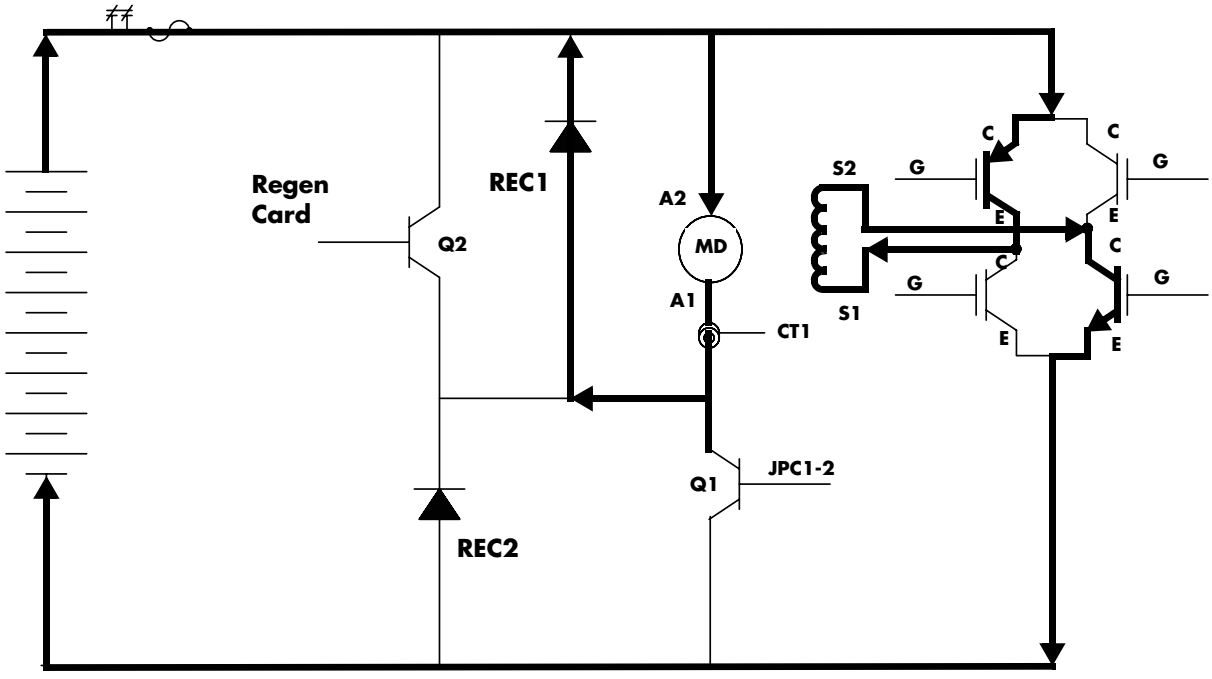


Figure 8-11. Regenerative Braking

https://truckmanualshub.com/

8. Initially, the current in this circuit is very high (since the lift truck is traveling at full speed), but since the battery voltage opposes this circuit, it will act as a substantial resistor and reduce the current after a short time. The battery is the load in this case, causing the lift truck to slow due to the inductive drag on the armature.
9. When the current drops to approximately 200A as detected by CT1 on the Power Card, the Power Card outputs the Regen Control (JPC2-2) to the Regen Card (PD1-2). The Regen Card then turns on the regen transistor Q2 by outputting a base signal to Q2-G.
10. A circuit is now completed from MDA2 through TP5, TP8, Q2, and TP6, then back to the armature at MDA-1, essentially short circuiting the prior circuit through the battery. This instantly causes the voltage across the armature to deteriorate below battery voltage, which shuts off REC2 and the regenerative circuit through the battery. This short circuit path through Q2 causes the current to rise rapidly.
11. When this rising current reaches approximately 400A as detected by CT1, the Power Card turns off the Regen Control output to the Regen Card which turns off the regen transistor Q2. See Figure 8-12.
12. With the motor still being rotated (by momentum of the lift truck) and no path for the regenerative current, the armature voltage quickly increases to exceed the battery voltage. This allows REC2 to conduct and once again complete the regenerative circuit through the battery (as in step 7).
13. As the motor speed slows, it will reach a point where the armature can no longer generate enough current to reach the 400A threshold. Therefore, Q2 remains on through the remainder of the regenerative braking phase. See Figure 8-13.
14. This cycle (steps 4 thru 11) repeats until the TM determines that the regenerative braking mode is no longer effective (based on speed, direction, armature current and travel request).

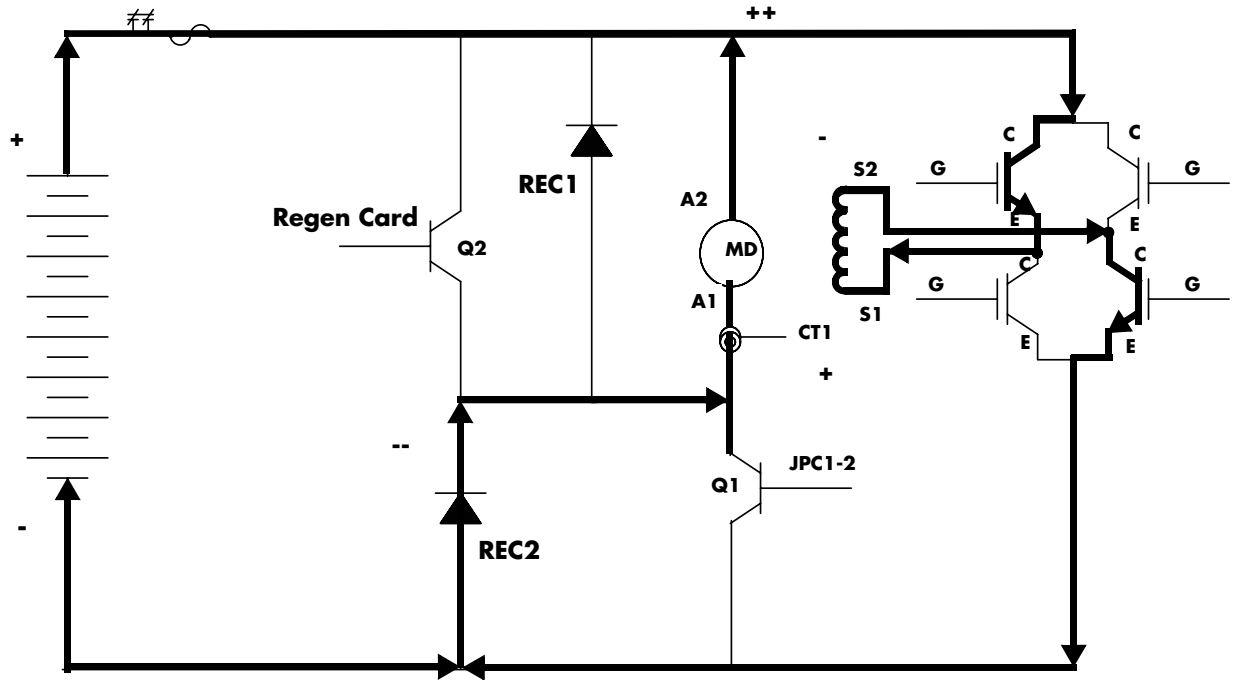


Figure 8-12. Regenerative Braking - Q2 Off

https://truckmanualshub.com/

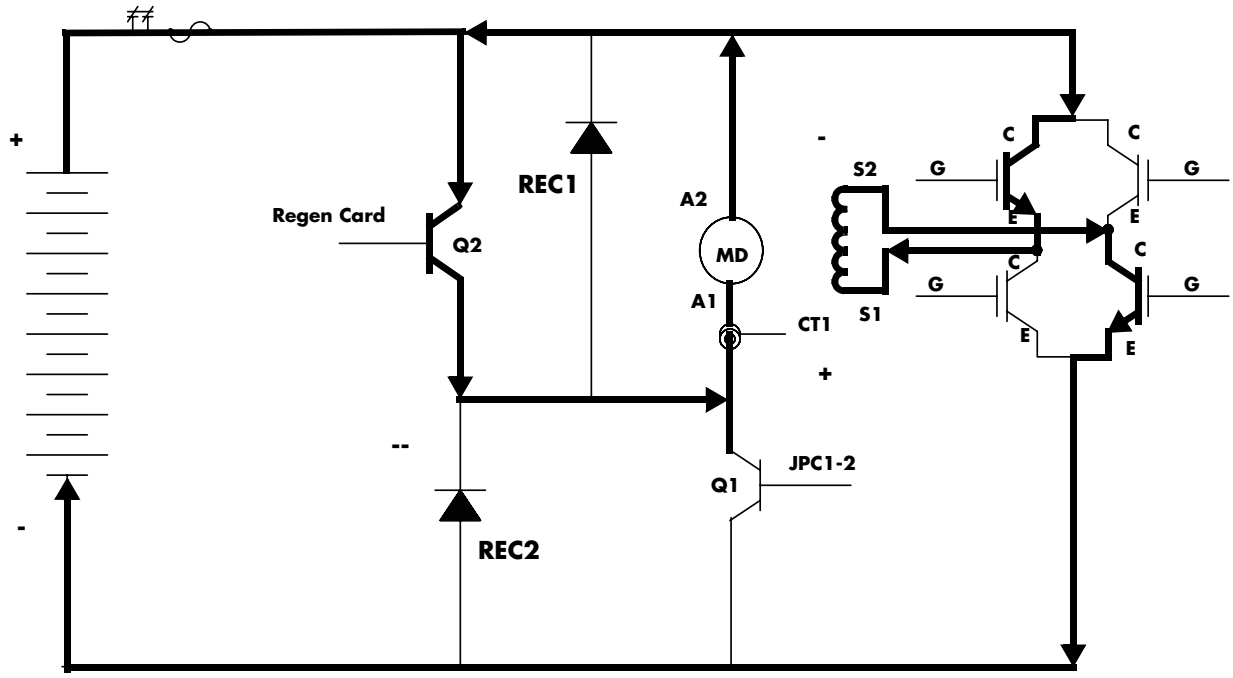


Figure 8-13. Regenerative Braking - Q2 On

https://truckmanualshub.com/

Drive Mode

When the lift truck has slowed to the point [generally between 0.5 mph and 1.0 mph (0.8 and 1.6 km/h)] where the TM ends the regenerative braking sequence, it is shifted into regular drive mode (provided the travel request for the opposite direction is maintained). See Figure 8-14.

The TM commands the field polarity to be reversed by turning off the Forward (enable) output at JPS5-5 and turning on the Reverse output at JPS5-6. The Field PWM is sustained. The Power Card executes this change by turning on the opposite pair of field transistors TM1/TM2.

At the same time, the TM turns on power transistor Q1 via the Power Card by outputting the Armature Enable and Armature PWM on JPS3. The Power Card amplifies the PWM and outputs it on JPC1-2 (B– Drive) which pulses Q1 to control the armature current.

The traction system drives the lift truck to a stop and then accelerates it in the opposite direction (reverse in this case.)

NOTE: If a fault is detected in the regenerative braking operation (such as Code 2F), the maximum speed is reduced and proportional plugging is utilized.

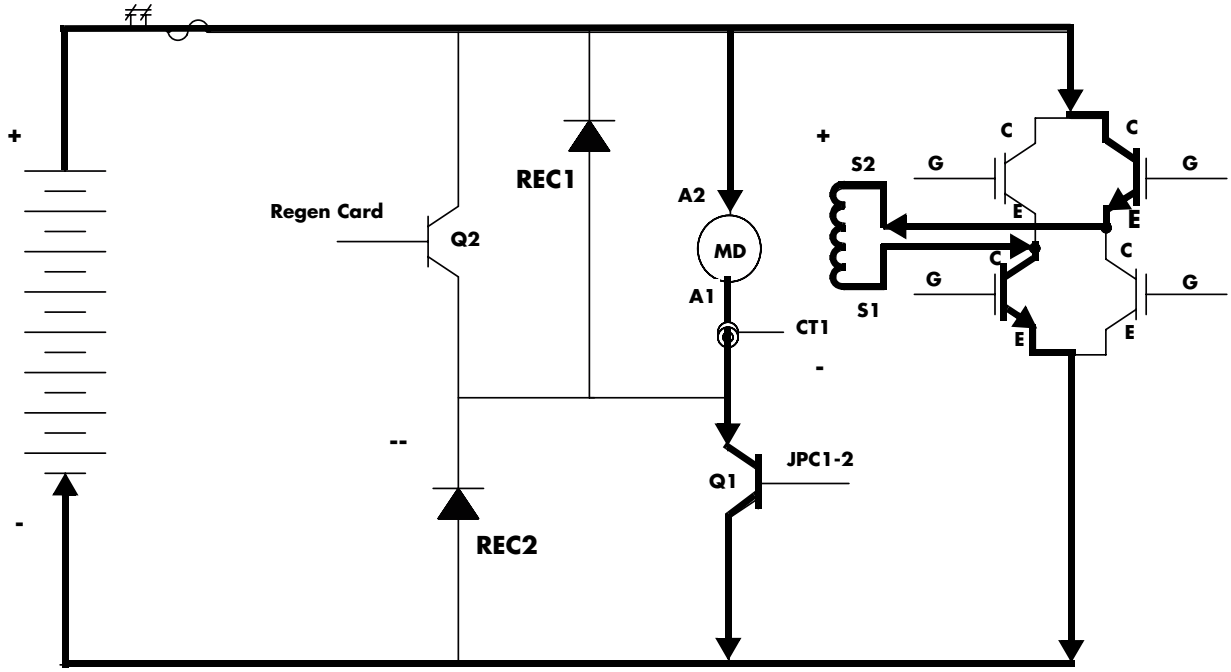


Figure 8-14. Drive Mode (After Regenerative Braking)

https://truckmanualshub.com/

Steering Systems

The EASi™ Orderpicker is equipped with one of two steering systems:

- Manual Cable Steering
- Electric Steering

Manual Cable Steering

Manual Cable Steering components include:
See Figure 8-15.

- Steering Control (in operator's compartment)
- Over-the-Mast wire ropes
- Torque Shaft
- Pinion Gear
- Ring Gear

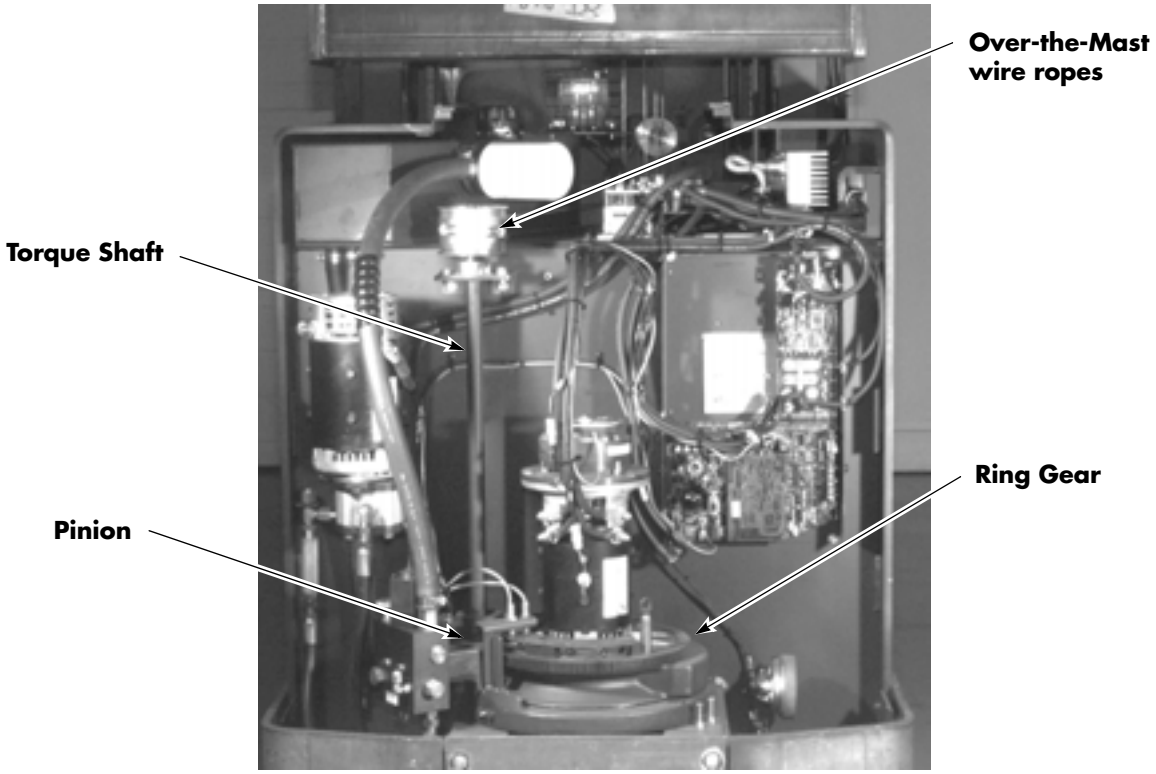


Figure 8-15. Manual Steering Components

https://truckmanualshub.com/

Electric Steering

The electric steering system performs two functions:

- Manages the overall operation of the steering system
- Positions the drive unit based on inputs from the steering encoder

See Figure 8-16.

Electric Steering Components

Electric steering components include:

- Steering Encoder (located behind steering wheel on operator's carriage)
- Carriage Control Card
- Electronic Steer Manager
- Electric Steer Motor
- Gear Reducer
- Home Reference Proximity Sensor
- Steer Position Encoder (located near the steer gear reducer)
- Steer Indicator Lights

See Figure 8-17.

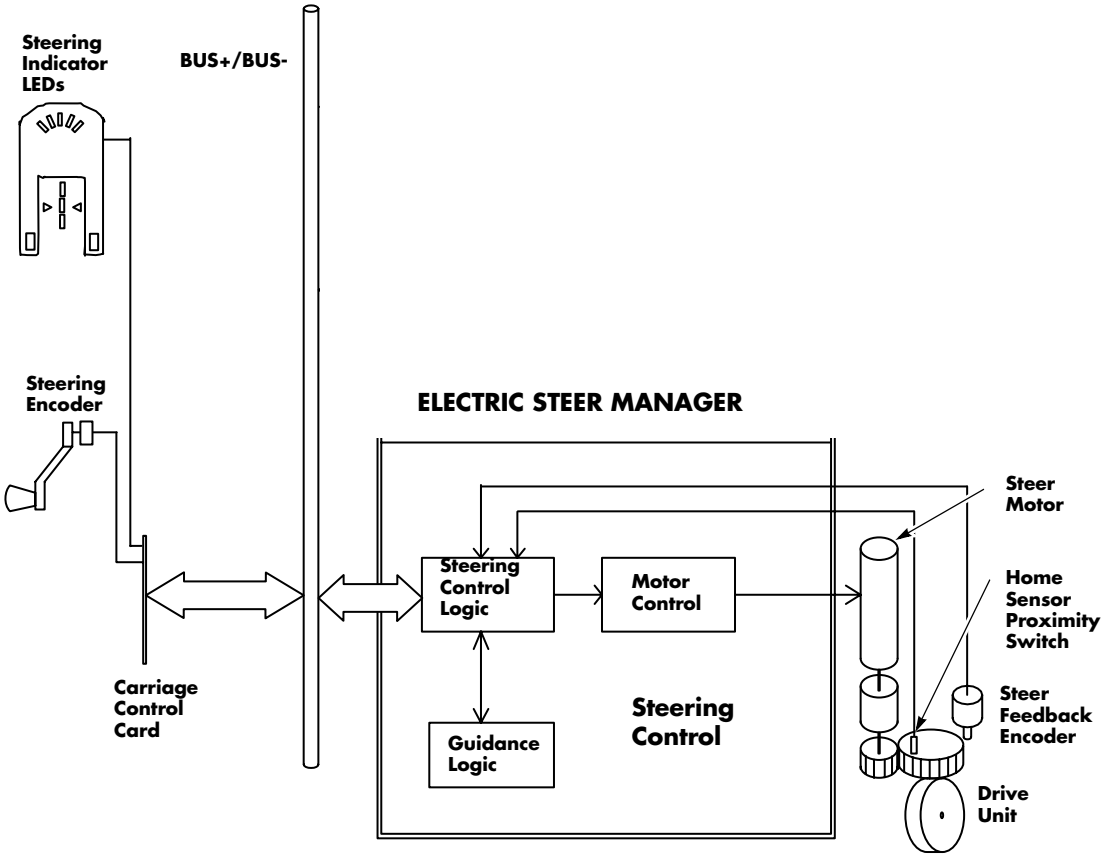


Figure 8-16. Electric Steering Functional Block Diagram

https://truckmanualshub.com/

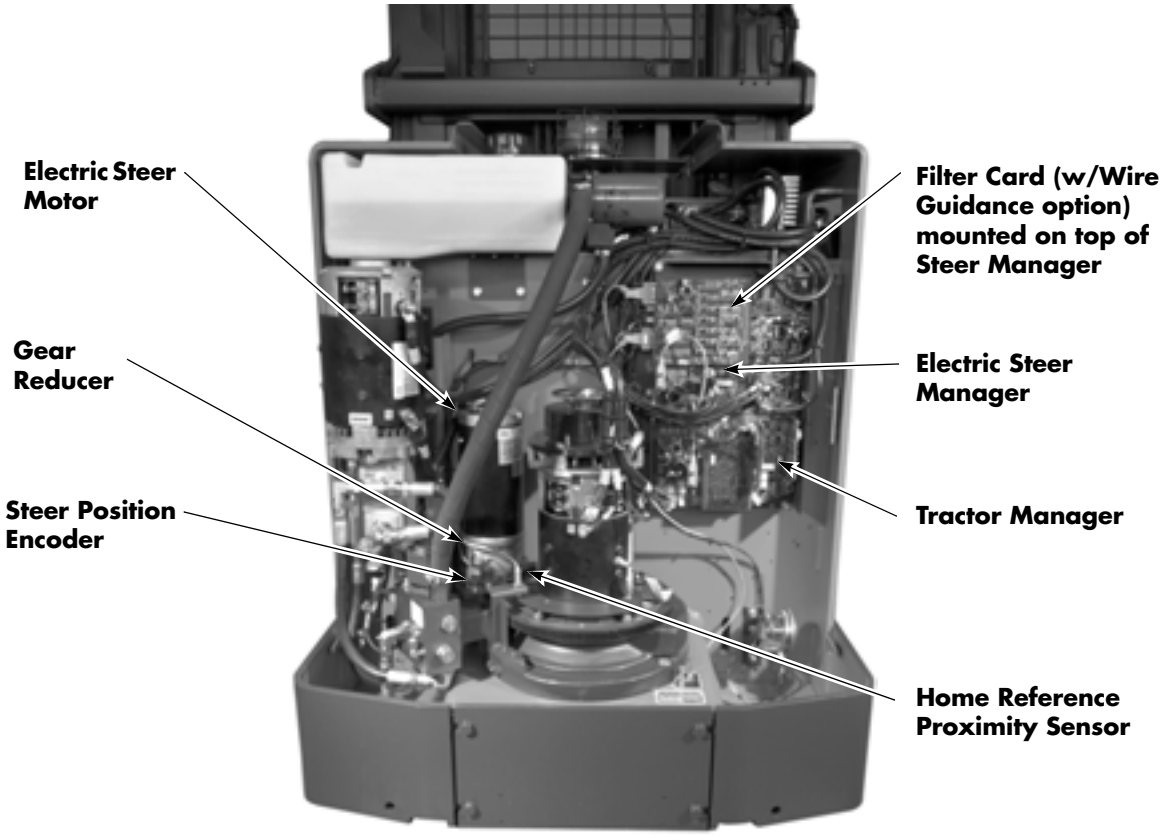


Figure 8-17. Electric Steering Components

Steering Encoder

The Steering Encoder is located on the operator's carriage, behind the steering wheel. The steering encoder sends a quadrature-phase output to the CCC when the steering wheel is turned.

As the steering wheel is turned, two individual square waves are produced. The relationship between these two square waves is an indication of which way the steering wheel is turning. The number of pulses generated is an indication of how far and how fast the steering wheel has been turned. See Figure 8-18.

Determining which way the steering wheel is turned is based on the *phase* between the two square waves. One of the two square waves is always ahead of the other. The one that is ahead tells which way the wheel is turning.

These square waves are read by the CCC. The CCC interprets the inputs from the Steering Encoder and sends steering commands via BUS+/–.

Electric Steer Manager

The Electric Steer Manager receives steering information via BUS+/– and determines the correct steering response. The Wire Guidance option also connects to the ESM.

The following test points are available on the ESM:

- TP1 - Digital ground
- TP2 - +12V (wrt TP1)
- TP3 - +5.3V (wrt TP1)
- TP4 - +15V (wrt TP6)

https://truckmanualshub.com/

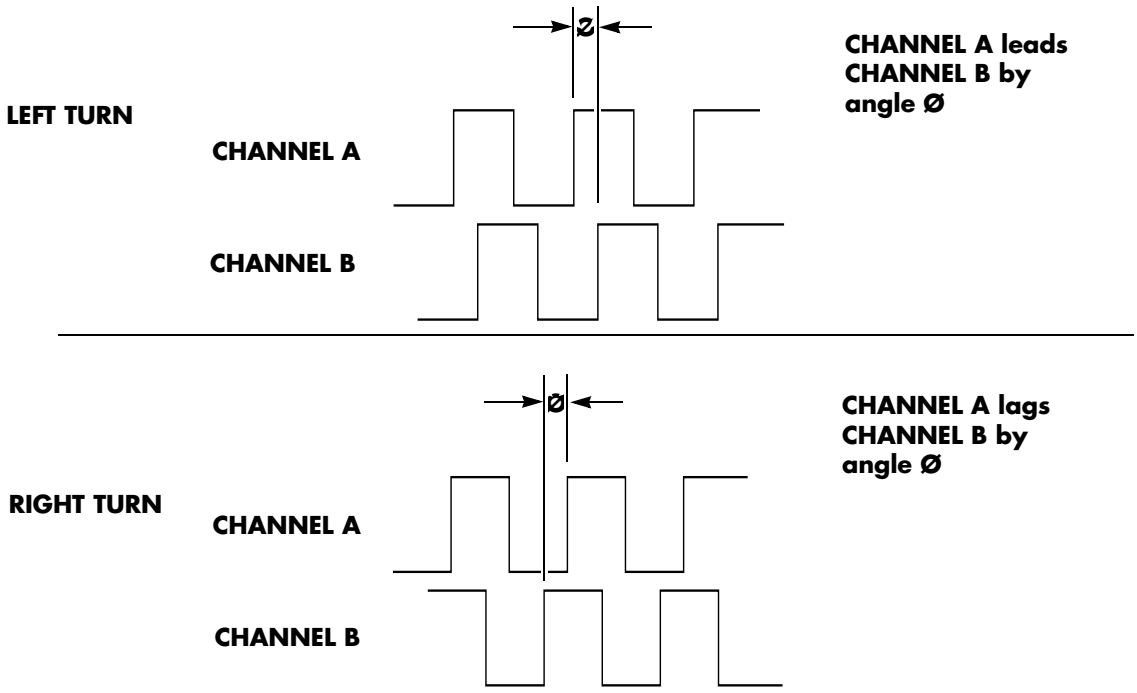


Figure 8-18. Steer Position Encoder Output

Electric Steer Motor
The Electric Steer Motor is a permanent magnet motor. Both direction and magnitude of current through the steer motor is controlled by the ESM through TM3/TM4.

Gear Reducer
The Gear Reducer is powered by the Steer Motor. The output shaft turns a gear that powers a gear on the drive unit.

Home Reference Proximity Sensor
The Home Reference Proximity Sensor senses the metal plate that it is positioned over. The transition from metal to no metal indicates straight ahead (when adjusted correctly).

Steer Position Encoder
The Steer Position Encoder is located near the steering gear reducer. As the drive unit steers, a corresponding quadrature-phase is sent to the ESM at JPA8. This allows the ESM to determine the position (angle) of the drive unit relative to the straight ahead position.

https://truckmanualshub.com/

Electric Steering Functional Operation

Auto Steer Center

After the truck has completed SelfTest and the deadman pedal is depressed, the ESM looks at the input from the Home Reference Proximity Sensor. If the prox is over metal, the ESM will turn the drive unit to the left. As soon as the prox switch transitions from metal to no metal the ESM removes the steer command. If it is not over metal, the drive unit turns to the right. Once the home prox transitions from off to on, the ESM turns the drive unit back to the left until the switch transitions to no metal and removes the steer command. This position is considered center and the position register for the steer feedback encoder is set to a zero reference point. During the auto steer center function, the ESM monitors the steer feedback encoder and the steer motor current to verify the drive unit is actually powered and moving in the proper direction. If the ESM does not see current or encoder pulses, an error code displays. If the ESM does not see a home reference proximity sensor transition, it turns the drive unit to the physical stop. Current limit is invoked and an error code is displayed.

Manual (Non-Guided) Steering

Every time the Home Reference Proximity Sensor transitions during run mode, the ESM resets the position register used to calculate the steer angle and the direction the wheel is turned away from center. When the operator makes a steering request by moving the steering wheel, a set of square waves from the steer request encoder are input to the CCC. These inputs are transformed into a steer command to be sent to the ESM over BUS+/–. Once received, the ESM determines the direction and rate of rotation to move the drive unit. A voltage is sent to the base leads of TM3/TM4 to energize the armature of the steer motor in the proper direction. The ESM begins monitoring the feedback circuits for the steering system, motor current, Home Reference Proximity Sensor and Steer Feedback Encoder. Motor current is measured using a shunt attached to the ESM. Once the ESM has commanded TM3/TM4 to be turned on, it is looking for motor current to make sure the circuit is energized and the steer motor is not in current limit (around 60A). As the drive unit begins to move, the Steer Feedback Encoder begins spinning. There are two outputs from the encoder; Steer A and Steer B. They are a quadrature phase input to the ESM. When the encoder is turned in one direction, the input from Steer A leads Steer B and in the other direction Steer B leads Steer A. This is how the ESM knows if the drive unit is turning to the right or left. The ESM uses this information to calculate the position of the drive unit. Each count is added to or subtracted from the center reference point established when the Home Prox changed state. The microprocessor also knows the number of counts from center to full left or right. From this information, it calculates the angle of the drive unit. This is used by the ESM for wire guidance and to stop turning the drive unit just prior to contacting the mechanical stops when fully turned right or left. This information is sent to the CCC over BUS+/–. The CCC uses this information to invoke speed limiting when turned more than 10° and elevated above the 24 in. switch. It also uses it to know when to illuminate the LEDs on the OD for drive unit position.

https://truckmanualshub.com/

Wire Guidance System Architecture

In addition to the electric steering components, the following items are required for wire guidance:

- Wire guidance sensor assemblies
- Filter Card
- Wire guidance AUTO/MANUAL switch (S4)
- Wire guidance LEDs

(See Figure 8-19.)

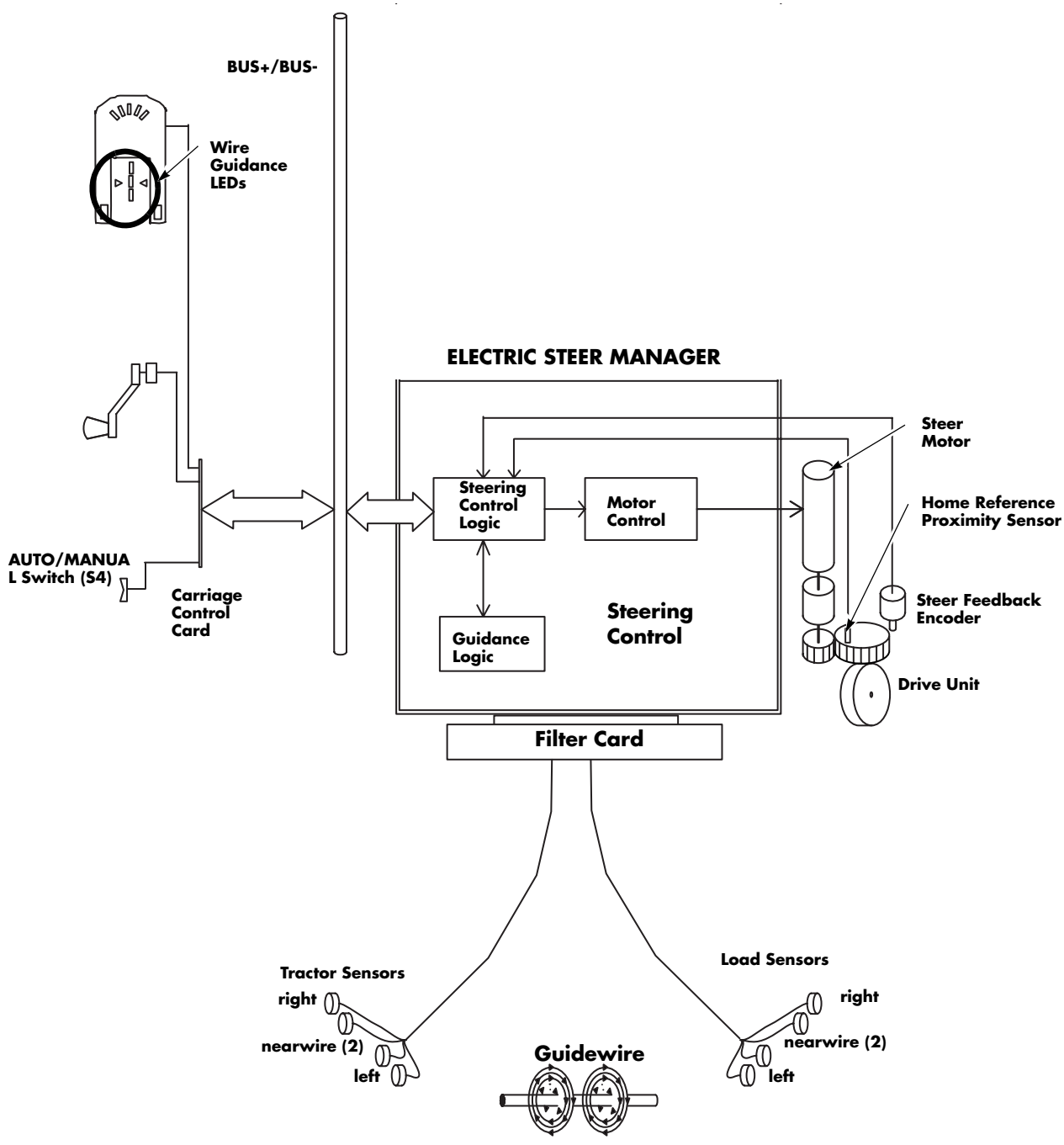


Figure 8-19. Wire Guidance Functional Block Diagram

https://truckmanualshub.com/

Wire Guidance Sensor Assemblies

The lift truck has two wire guidance sensor assemblies. One is mounted behind the center plate of the tractor bumper (tractor end coils). The other is mounted between the load wheels under the steel sensor cover (load end coils). The sensor cards contain antennas and amplifiers to detect the frequency and amplitude in the guide wire and increase them to a level that can be used by the filter card. See Figure 8-20.

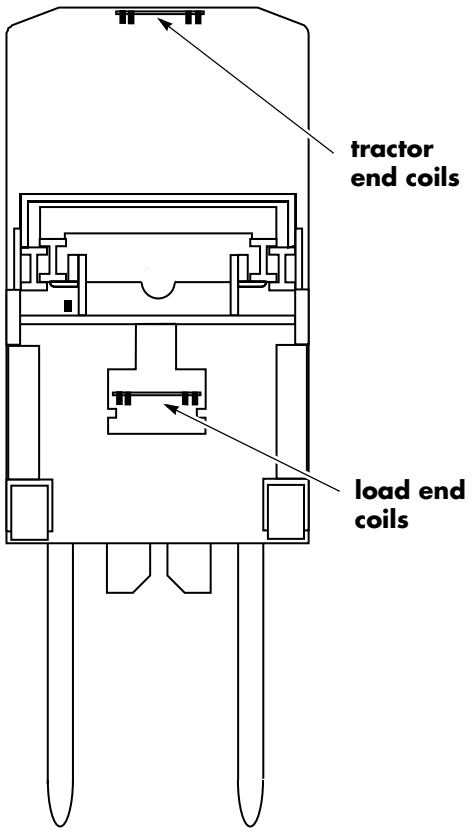


Figure 8-20. Wire Guidance Antenna Locations

Sensor Adjustment

Each sensor should be adjusted so that they are 2 in. ±1/8 in. (5 cm ±3 mm) off the floor.

Filter Card

The Filter Card mounts on and mates with the ESM at JPA3. The Filter Card processes inputs from the antennas and removes unwanted frequencies/noise from sources other than the guidewire. The Filter Card converts the Alternating Current (AC) voltage from the guidewire to Direct Current (DC), which is sent to the ESM.

AUTO/MANUAL Switch (S4)

This switch is located near the directional speed control. Its purpose is to allow the operator to select between manual (electric steering) or automatic (wire guided) steering.

When the truck has locked onto a guide wire, the operator has no control over the steering system.

LEDs

The Wire Guidance LEDs are located on the Operator's console. The LEDs consist of two green triangles and three yellow rectangles. See Figure 8-21. The LEDs indicate when the wire guidance system is powered ON and when locked on the guide wire.

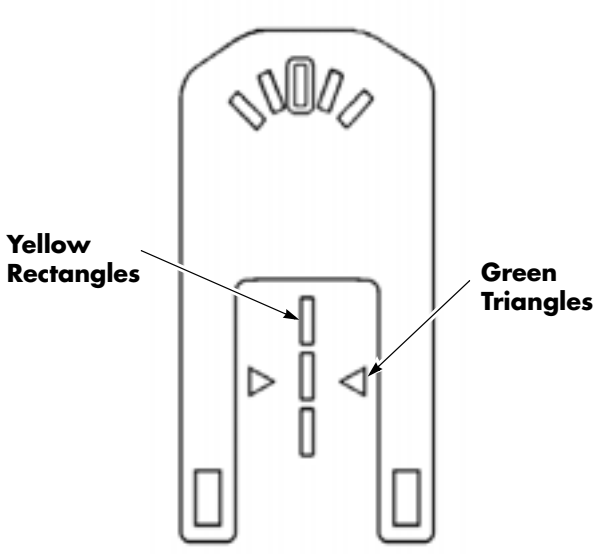


Figure 8-21. Wire Guidance LEDs

https://truckmanualshub.com/

Wire Guidance Functional Operation

Operation

When the truck is in wire guidance mode, the steering system functions the same way as when in manual steering. The only difference is the commands to steer do not come from the CCC. The ESM generates the steering commands internally. To change from manual steering to wire guidance mode, the ESM requires a number of inputs. The AUTO/MANUAL switch must be in the AUTO position (switch turned OFF). When the AUTO/MANUAL switch circuit opens, the CCC sends the information to the ESM. The CCC also informs the ESM of travel speed and direction. With the AUTO command recognized by the ESM and no inputs seen from the guidance coils, the ESM is still looking for and reacting to manual steer commands from the CCC. Travel speed in the forks-first direction is limited to 1 mph (1.6 km/h) and tractor-first is limited to the acquire speed set in Configure. An audible tone will sound and **Seeking** is displayed on the OD. The green triangles on the OD will also be flashing. When one of the center coil pairs (near wire coil pair) is close enough to the guide wire, it picks up the magnetic field emitted from the wire. The truck will not attempt to acquire the wire if no input is seen from the near wire coil pairs, even if there are proper inputs from the outer coil pairs. The sensor coils transform this field to an AC voltage which is sent to the wire guidance Filter card. The Filter card removes any excess noise picked up by the antenna coils. The AC voltage is then changed to a DC voltage and sent to the ESM. Once the near wire voltage seen at the ESM is high enough, the truck goes into an aligning mode. The ESM now ignores the commands from the CCC for manual steering. The ESM looks at the voltage inputs from the two outer coils on both antenna cards. It compares the voltage level of the four coils to the values recorded and stored on the ESM during LEARN from each coil. Based on which coils are a higher voltage and which are a lower voltage than the LEARNed values, the ESM determines the truck position in relation to the guide wire. It then looks at the travel direction from the CCC so it knows which way to turn the drive unit. The ESM also continually receives travel speed information from the CCC, based on speed prox input, to determine how fast the drive unit should be moved. At higher travel speeds, the steering is turned slower to keep the truck from over shooting the center of the wire. After all of this criteria is evaluated, the ESM calculates the required output to TM3/TM4 to bring the four outer coils to a point where the voltages are all equal. The ESM also uses these voltages to determine how many inches away from the wire the center line of the antennas are and the angle (in degrees) the center line of the antennas are in relation to the guide wire. Once both of these measurements are below the configured Heading Angle and Distance From Wire values stored in the ESM, the ESM informs the CCC over BUS+/–. The CCC then allows the truck to travel at full speed. These distances are monitored continuously while locked on the wire and if exceeded, the truck is slowed or stopped by the CCC, depending on the amount of deviation. The ESM continuously monitors the voltages from the antenna coils and commands steer corrections while traveling to keep the antennas centered over the guide wire.

The output voltage of each antenna coil depends on several factors:

- How far the coil is from the wire
- The amplitude of the current in the wire
- The frequency of the wire
- The angle between the wire and the coil

LEARN Mode

Wire Frequency

Learn Wire Frequency is performed to program the ESM, tune the Filter Card and adjust the gain on the antenna assemblies. This allows these components to Learn the wire frequency and amplitude. See LEARN Wire Frequency on page 3-16.

https://truckmanualshub.com/

Guide Wire Offsets

Learning the guide wire offsets allows the ESM to determine the location of the guide wire in relation to the antennas when the truck is centered over the guide wire. Keep in mind that the physical center of the truck and the electrical center of the antenna assemblies are probably not identical.

NOTE: Learning guide wire offsets for this lift truck are in the tractor-first direction only. See LEARN Guide Wire Offsets on page 3-17.

End-of-Aisle Control

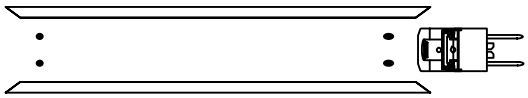
The End-of-Aisle system consists of truck mounted components and magnets embedded in the floor inside of the aisle. The truck mounted hardware consists of two magnet sensors mounted between the baselegs under the operator's platform. They are connected directly to the TM. When the system is activated, the VFC card monitors the inputs from the sensors. When entering the aisle and both sensors cross a magnet in less than 24 in. (610 mm), the VFC recognizes this as In-Aisle-State. This information is stored in Non Volatile Memory (NVM). NVM cannot be changed by a loss of power to the system. The only way to change it is by another input from the VFC. This input can only be initiated by crossing another set of magnets or by traveling and turning the steering more than 10°. This allows the truck to be powered down inside the aisle and remember that it is in an In-Aisle-State when powered back up. System operation is not changed upon aisle entry.

When the truck is exiting an aisle and each sensor is activated by magnets within 10 in. of each other, the VFC will inform the CCC and the truck will plug to reduce speed until the speed is reached that is stored in the Configuration Menu. Once this speed is reached, travel speed is limited by the CCC to the speed programmed in the Configuration Menu until the control handle is returned to neutral and travel is requested again. During the plugging sequence, the operator can override the plugging strength with a request for a more aggressive plug from the control handle. When the sensors are activated by magnets that are more than 11 in. (279 mm) but less than 30 in. (762 mm) apart, the VFC tells the CCC to plug the truck to a complete stop. The operator must then return the control handle to neutral and request travel again.

End-of-Aisle Configurations

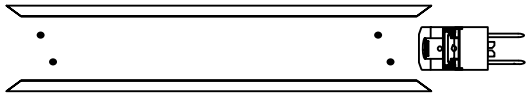
Figure 8-22 shows the various EOA configurations possible within a system.

https://truckmanualshub.com/



Vehicle will slow to configured end-of-aisle speed when parallel magnets are crossed.

Magnets Parallel

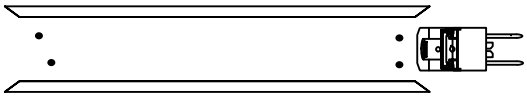


Vehicle will plug to a stop when staggered magnets are crossed (or just one magnet is sensed).

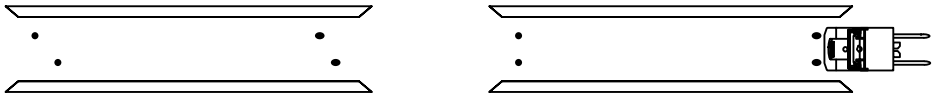
Magnets Staggered

Vehicle will slow to configured end-of-aisle speed when parallel magnets are crossed.

Vehicle will plug to a stop when staggered magnets are crossed (or just one magnet is sensed).



Magnets parallel at one end and staggered at the other.



Magnets parallel in one aisle and staggered in the next.

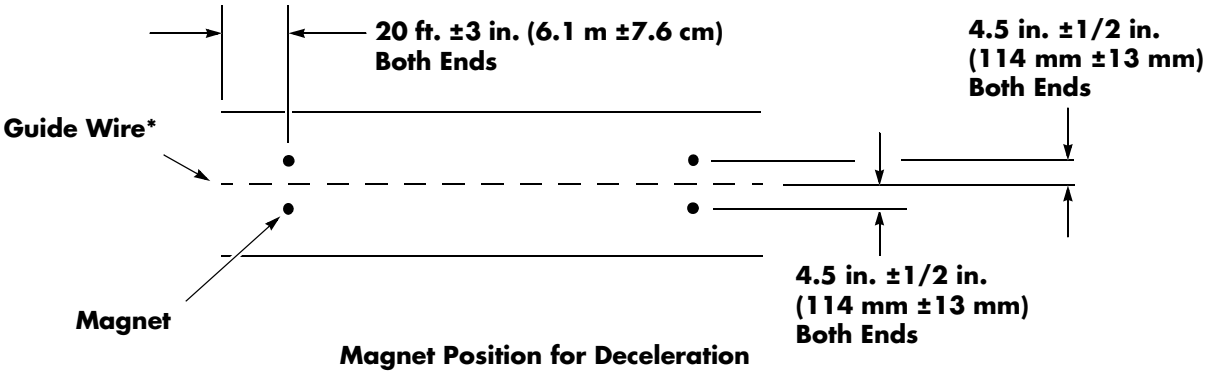
Vehicle will slow to configured speed in aisle that has parallel magnets and plug to a stop in aisle that has staggered magnets.

Figure 8-22. End-of-Aisle Configurations

https://truckmanualshub.com/

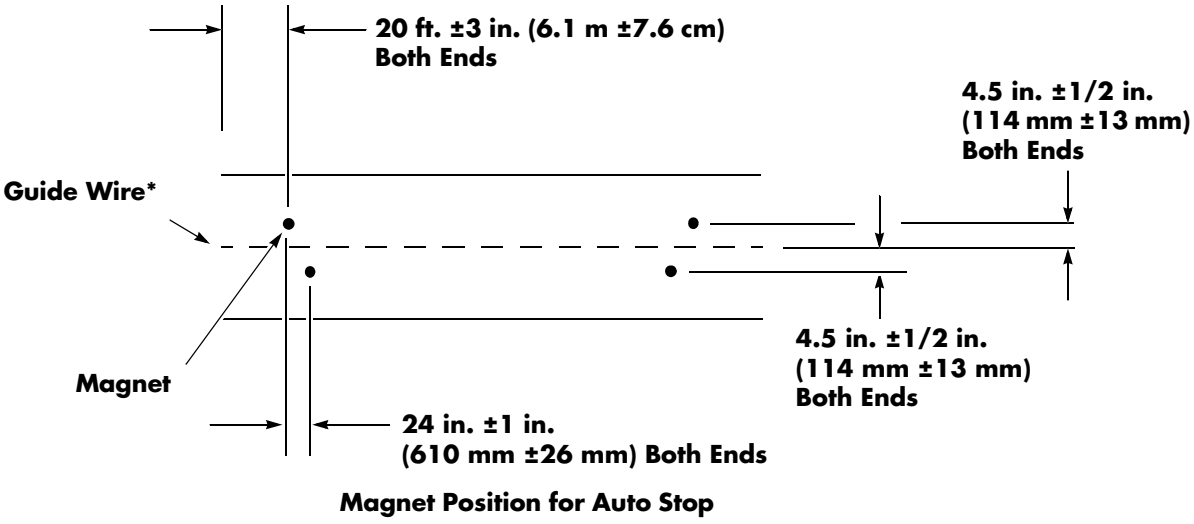
End-of-Aisle Magnet Installation Information

If there are consistent, repetitive problems with end-of-aisle operation, and the truck appears to be OK, the magnets may have been installed out of tolerance. Figures 8-23 and 8-24 depict the correct location of the magnets.



*** In rail guided applications, use the center of the aisle as the reference point for the dimensions.**

Figure 8-23. End-of-Aisle Magnet Position (Deceleration)



***In rail guided applications, use the center of the aisle as the reference point for the dimensions.**

Figure 8-24. End-of-Aisle Magnet Position (Auto Stop)

https://truckmanualshub.com/

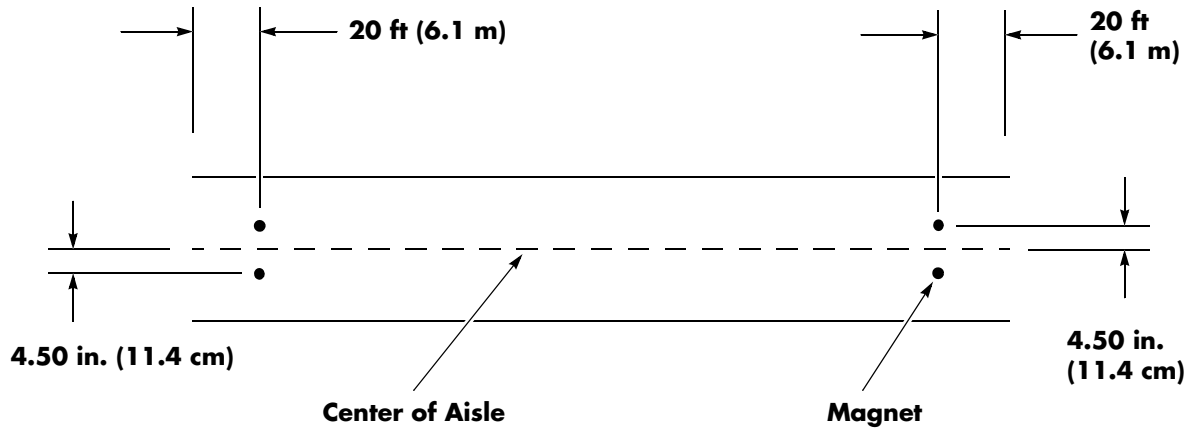


Figure 8-25. End of Aisle Magnet Location

End-of-Aisle Slow Down

With Wire Guidance

When the truck is locked on the guide wire, the VFC will start looking for the input from the magnet sensors. When a set of magnets is crossed entering the aisle, the system functions as described in End-of-Aisle Control. If the magnets are crossed while exiting the aisle with the AUTO/MANUAL switch in the AUTO position, the truck will slow down or stop; whichever the system is configured for. If the AUTO/ MANUAL switch is moved to the MANUAL position prior to crossing the magnets, the system will not look for the magnets. Steering is reverted to the operator and normal operation is resumed. Once out of the aisle and the steering is turned more than 10° while traveling, the aisle state is reset to out-of-aisle.

With auto steer center in a rail guided system WITH a rail switch installed on one guide roller assembly.

When the truck enters the rails, the switch mounted on the guide roller assembly is closed. When the switch is activated, a tone will sound and the truck is speed limited until the AUTO/MANUAl switch is placed in the AUTO position. When the switch is placed in the AUTO position, the drive unit auto steer centers and steering control is taken away from the operator. The speed restriction is removed and full speed travel is allowed. The VFC then starts looking for floor magnet inputs. When exiting the aisle, if the magnets are crossed with the AUTO/MANUAL switch in the AUTO position, the truck will slow down or stop, depending on system configuration. If the AUTO/MANUAL switch is moved to the MANUAL position prior to crossing the magnets, the system will not look for the magnets. Steering is reverted to the operator and normal operation is resumed. An audible tone sounds until either the AUTO/MANUAL switch is turned back to AUTO or the rail switch on the guide roller opens. Once out of the aisle and the steering is turned more than 10° while traveling, the aisle state is reset to out-of-aisle.

With auto steer center in a rail guided system WITHOUT a rail switch installed on the guide roller assembly.

When the truck is in the aisle and the AUTO/MANUAL switch is in AUTO, the VFC will start looking for the input from the magnet sensors. When a set of magnets is crossed entering the aisle, the system functions as described in End-of-Aisle Control on page 62. When exiting the aisle, if the magnets are crossed with the AUTO/MANUAL switch in either position, the truck will slow down or stop, depending on how the system is configured.

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Lift/Lower System

Single Speed Lift/Lower

Moving the Lift/Lower control out of the neutral position causes the voltage from VR2 to change. The CCC senses this change at JPC9-6 and determines whether a lift or lower command is desired. The CCC sends the appropriate Lift/Lower command to the TM via BUS+/–.

NOTE: On electrical schematics, only circuits related directly to Lift/Lower are addressed.

Lift

Refer to Figures 8-26 and 8-27.

- As VR2 is moved to lift, the voltage at JPC9-6 on the CCC changes.
- The CCC determines that a request for lift has been made. This is done by comparing the present voltage at JPC9-6 with the LEARNed values for lift, lower, and neutral.
- The CCC sends a lift command message to the TM over BUS+/–. The TM provides a negative potential for the lift pump contactor coil driver control (PS11-1). The coil driver is turned on. Negative potential for the pump contactor coil is then provided at PS11-6.
- With the P contactor coil driver activated, negative potential is supplied to the P contactor coil at JPS14-16. The P contactor coil is energized.
- With the lift pump contactor coil energized, the lift pump contactor tips close, supplying B+ to the lift pump motor.
- The lift pump motor/lift pump assembly runs, supplying hydraulic pressure and flow to the lift system. The operator's carriage elevates at a constant rate, regardless of the control's position.
- Pump motor operation is monitored at JPS14-7 (P Sense).

Lower

Refer to Figures 8-28 and 8-29.

- As VR2 is moved to lower, the voltage at JPC9-6 on the CCC changes.
- The CCC determines that a request for lower has been made. This is done by comparing the present voltage at JPC9-6 with the LEARNed values for lift, lower, and neutral.
- The CCC sends a lower command message to the TM over BUS+/–. The TM provides negative potential for the load holding solenoid coil driver control (PS11-5). The coil driver is turned on. Negative potential for the load holding solenoid coil is now at PS11-10.
- With the load holding coil driver activated, negative potential is supplied to the load holding coil at JPS19-3. The load holding solenoid valve opens, allowing hydraulic fluid to flow from the lift cylinders back to the reservoir.

Emergency Lower

Provisions are made to lower the carriage from the ground. When the Emergency Lower Valve is opened, hydraulic fluid is allowed to pass through the emergency lower valve at a constant rate. See Figure 8-30.

https://truckmanualshub.com/

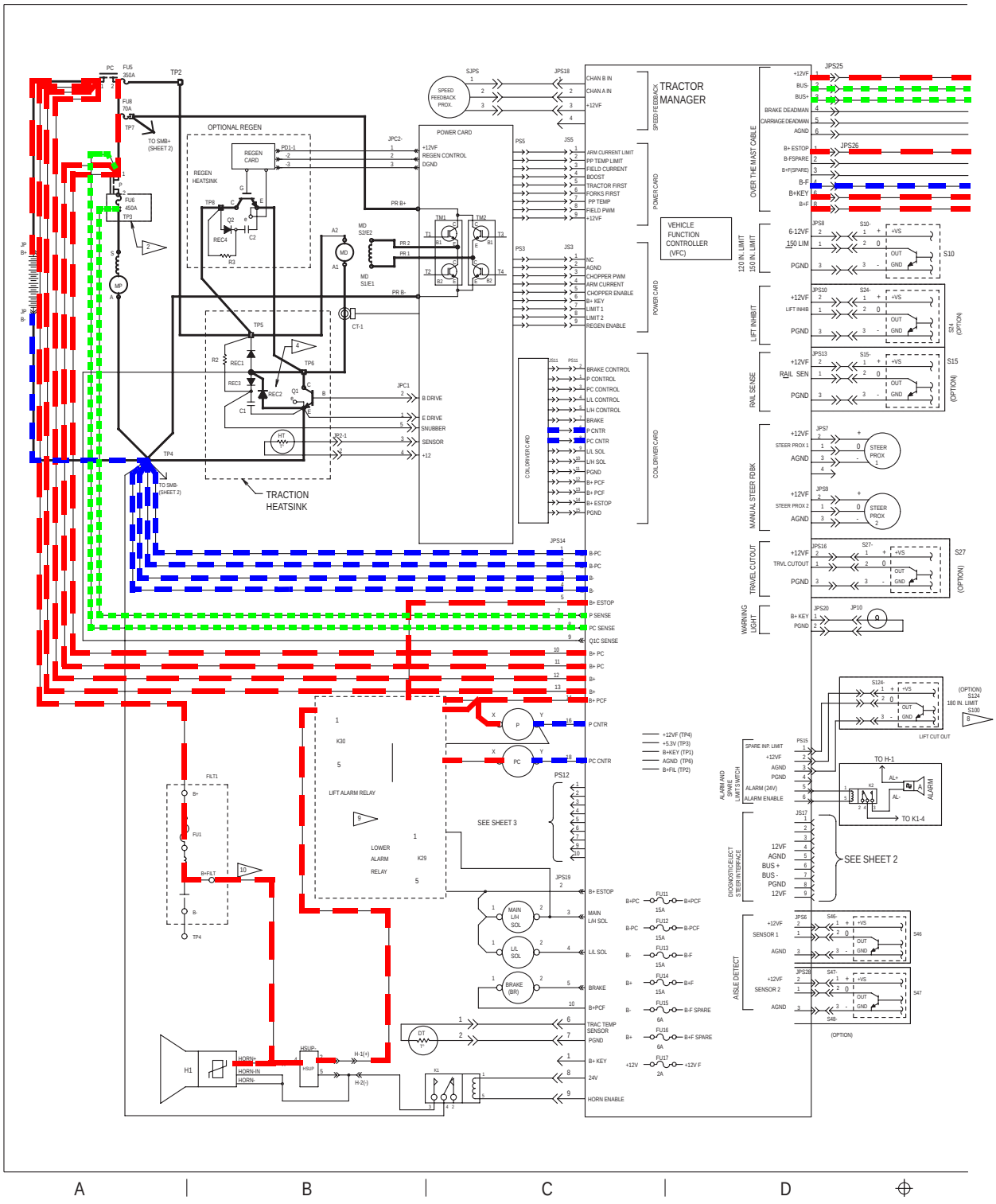


Figure 8-26. Electrical Schematic - Single Speed Lift

https://truckmanualshub.com/

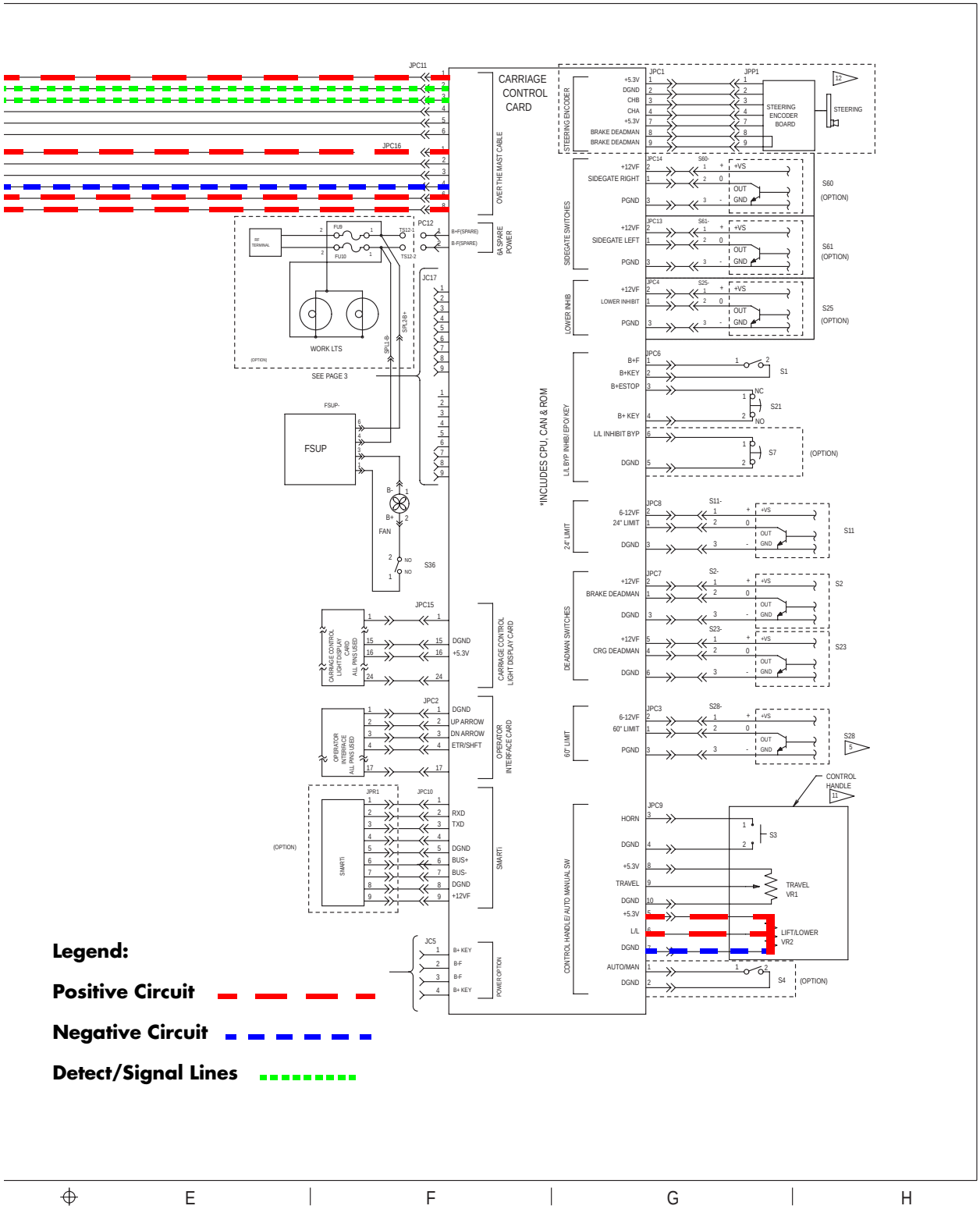


Figure 8-26 (Cont.).

https://truckmanualshub.com/

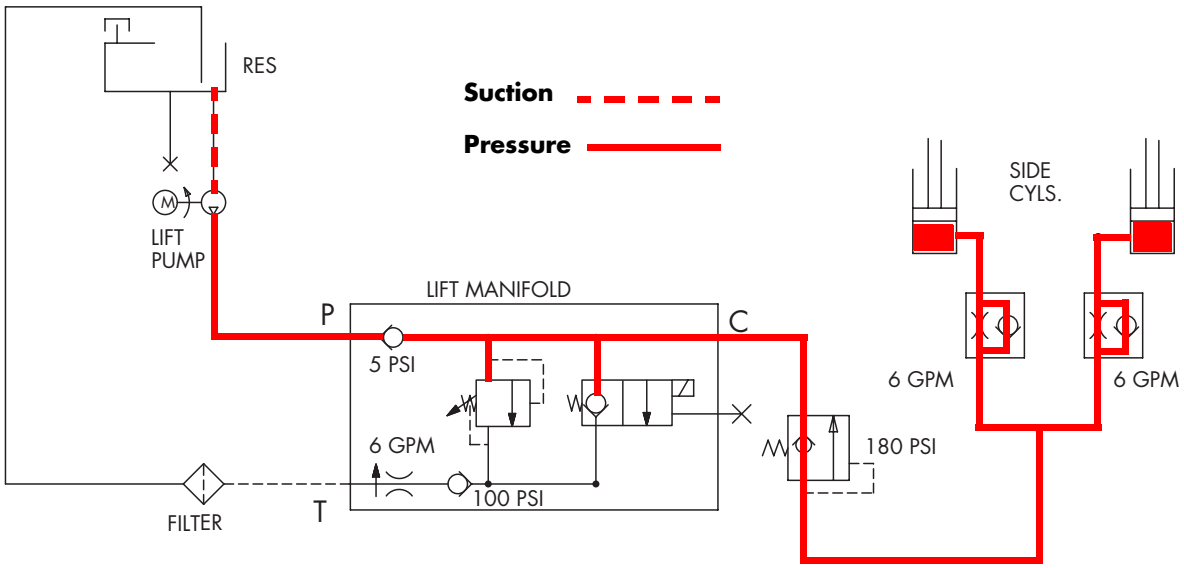


Figure 8-27. Hydraulic Schematic - Single Speed Lift

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

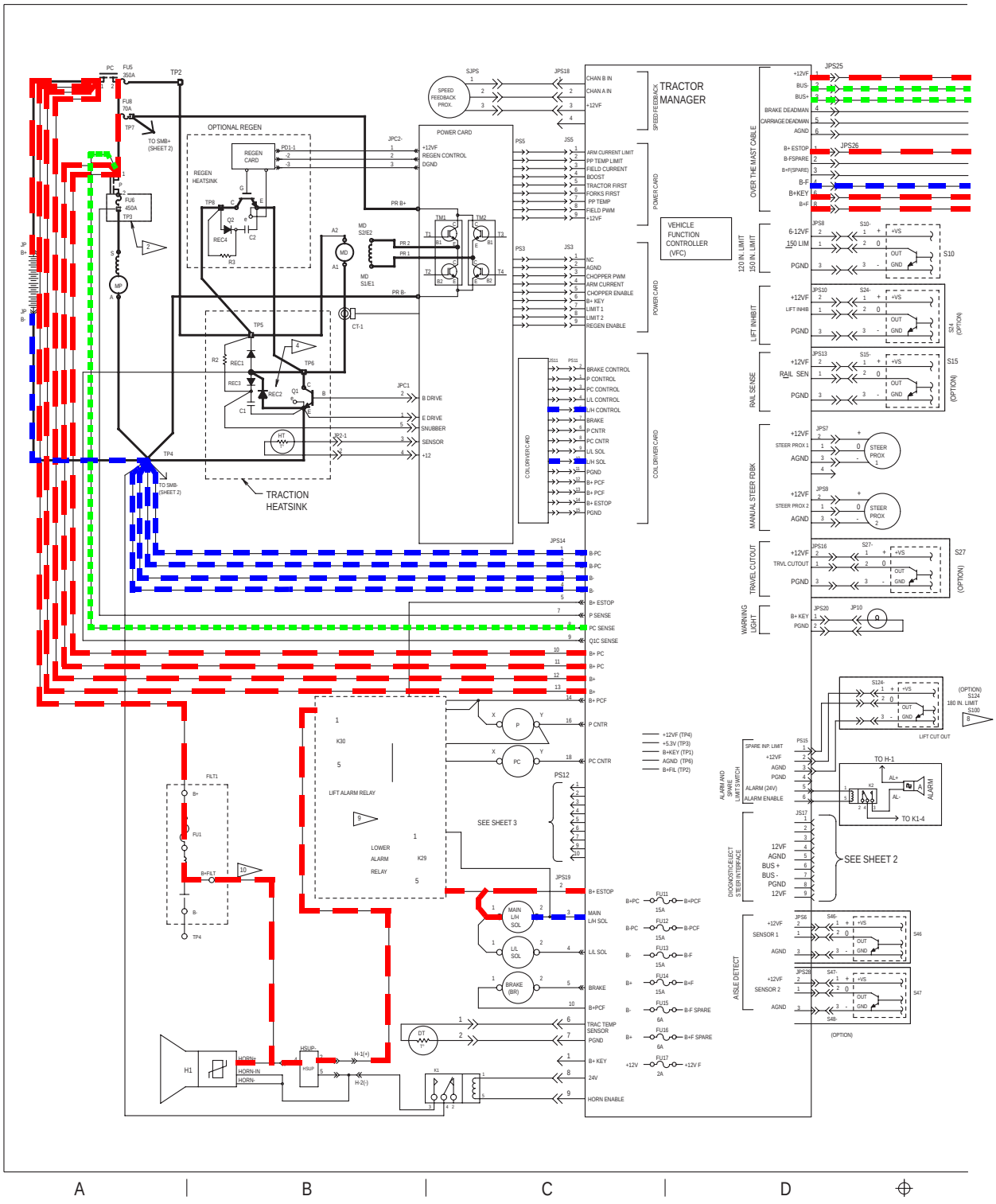


Figure 8-28. Electrical Schematic - Single Speed Lower

https://truckmanualshub.com/

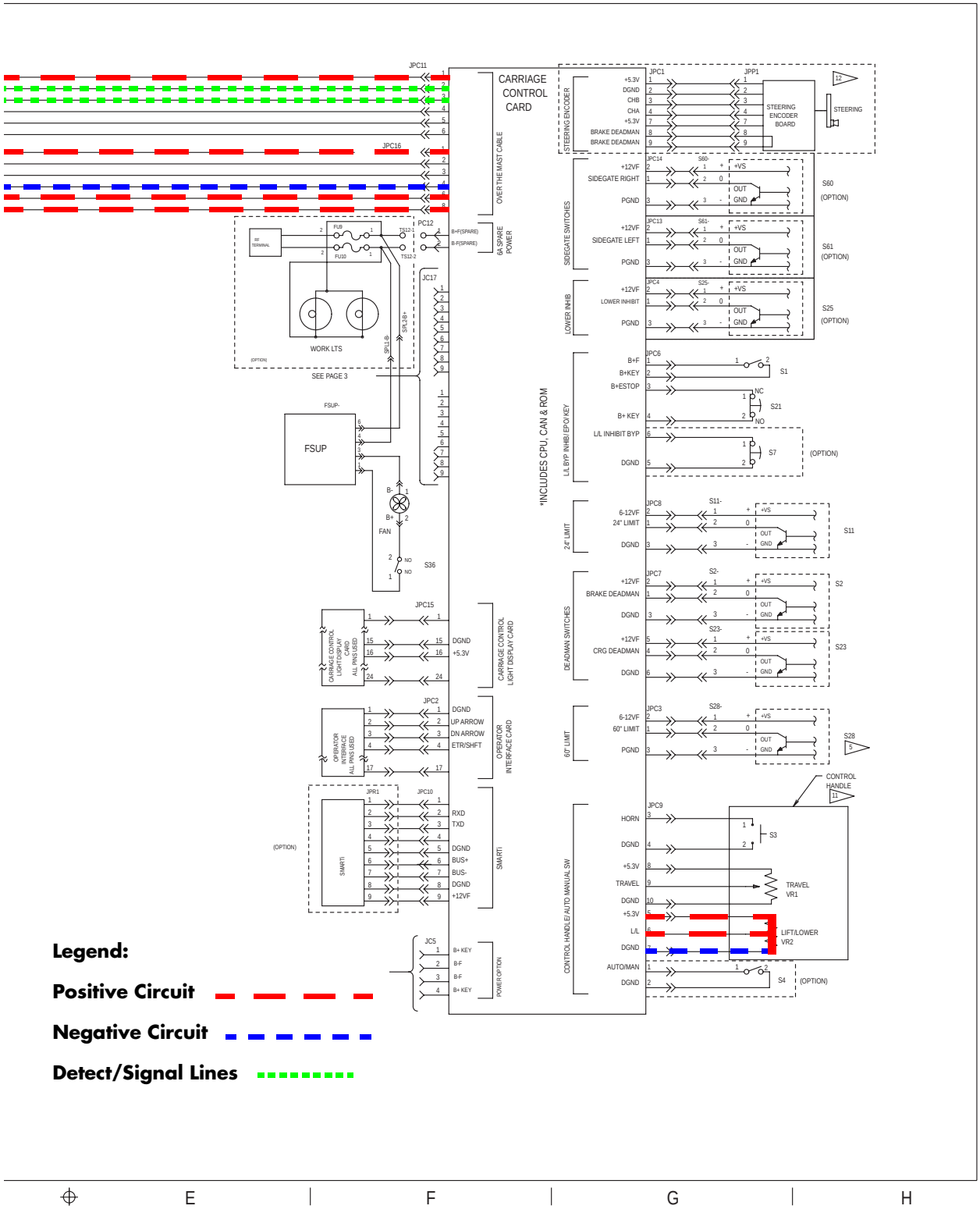


Figure 8-28 (Cont.).

https://truckmanualshub.com/

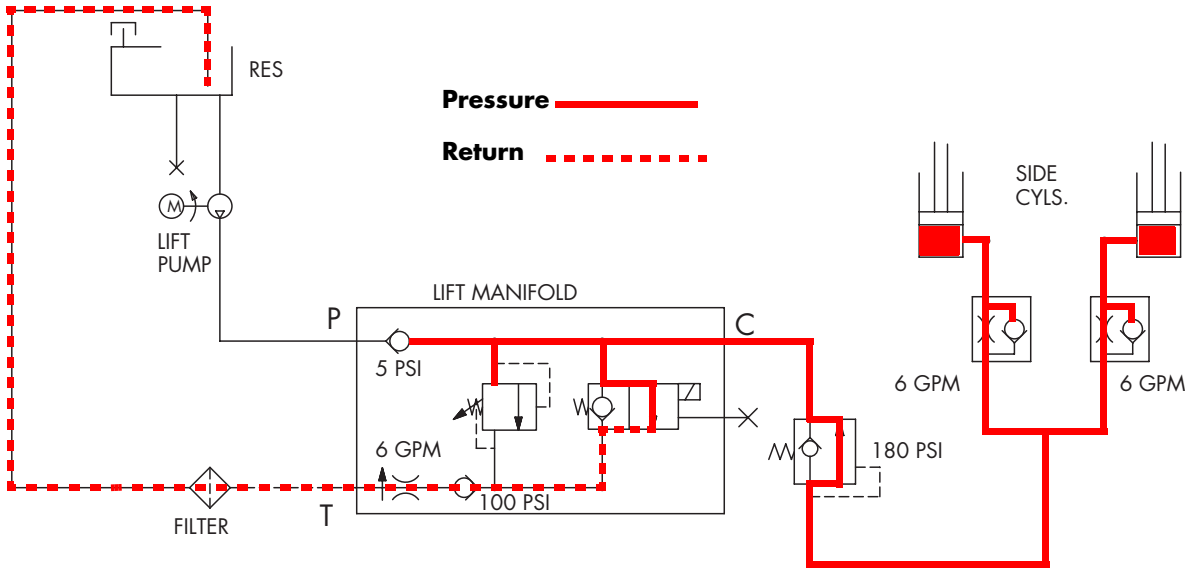


Figure 8-29. Hydraulic Schematic - Single Speed Lower

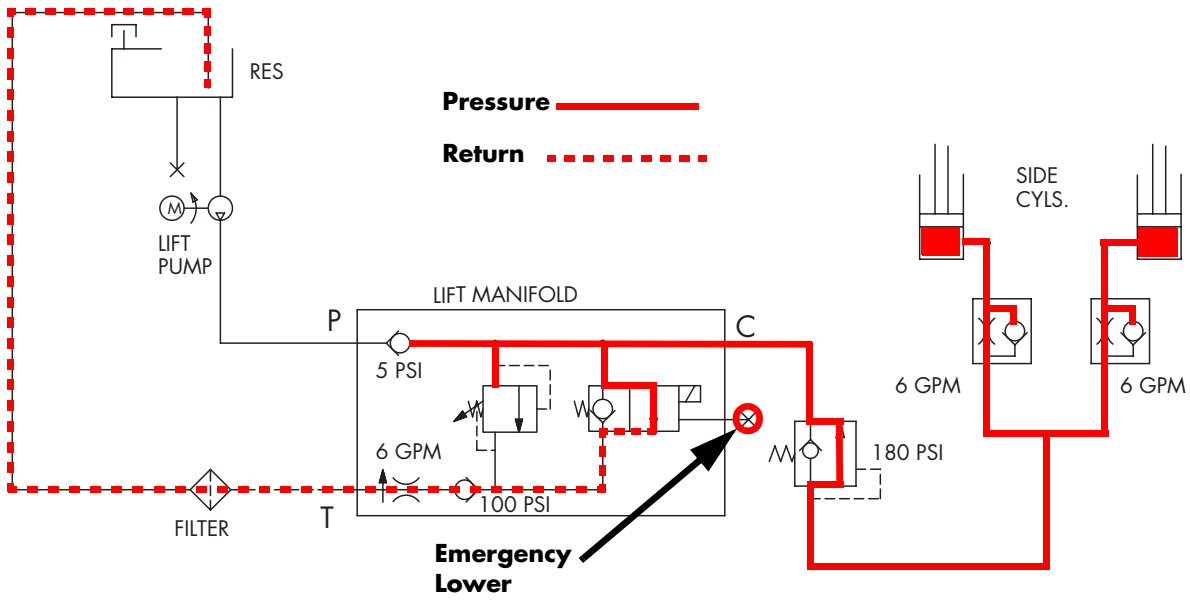


Figure 8-30. Hydraulic Schematic - Single Speed Emergency Lower

https://truckmanualshub.com/

Variable Speed Lift with *intellispeed*

See Figures 8-31 and 8-32.

NOTE: For trucks without *intellispeed*, all functions are the same excluding references to the flow sensor, *intellispeed* manager and height counts.

The CCC compares the voltage from the wiper of VR2 to the voltages stored during the LEARN process. The CCC checks all enabled options and switches that could prevent the activation of the lift system. When satisfied that no criteria is present to prevent lift, it then determines the requested percentage of full speed lift and sends this information over BUS+/– to the VFC. The VFC then activates the lift/lower proportional valve fully open and closes the lift pump contactor through the respective coil drivers. This prevents sudden movement of the platform when the lift pump is first activated by allowing the oil to return to the tank. As soon as the command to close the P contactor is activated, the VFC looks at the P sense input, verifying the contactor closed as commanded. It then slowly reduces the PWM output to the coil driver for the lift/lower proportional valve to match the percentage of full speed lift commanded by the CCC. As the lift/lower proportional valve closes, hydraulic fluid passes through the 5psi check valve, the normally closed check valve in the load holding valve, through the flow sensor to the flow controls at the bottom of the lift rams. The check valve in the center cylinder is opened and oil flows to the center lift ram. The center ram elevates first because less pressure is required to lift the platform. Once the platform hits the stops on the inner telescopic, the pressure increases enough to start elevating the side cylinders. As the lift rams start to elevate, the oil flow starts to spin the turbine in the flow sensor once the volume is large enough. As the turbine spins, the vanes pass by the pickups screwed into the flow sensor housing. This creates a series of high and low inputs that go into the flow sensor module. The pickups are 90° out of phase. This allows the system to determine if the carriage is elevating or lowering. The flow sensor module passes these counts to the ESM. The ESM calculates the direction of travel and the number of counts. It sends this information to the CCC to calculate the fork height which it uses to determine speed reductions at elevated height. When the CCC first commands the activation of the lift system, it is looking for the feedback from the flow sensor. If the lift is commanded to activate and no counts from the flow sensor are present, the CCC will flag an error condition and assume it is at maximum elevated height for speed limiting. A low volume of oil flow will not cause the turbine to spin. Because of this, if the lift system is *feathered* often, an error can be registered. When the truck is traveling less than 0.5 mph (0.8 km/h) and is lifting, lowering or sitting idle, the pressure transducer is also being monitored by the ESM. The values recorded by the ESM are passed on to the CCC and weight calculations are done. If the flow sensor option is not on the truck, the travel is reduced each time a mast limit switch is opened. Refer to Table 8-2 on page 45.

24V Trucks Above Serial Number 31,000

24V trucks above S/N 31,000 may have a two stage lift pump. This lift pump has a 2nd stage select solenoid on the bottom of the pump. This solenoid is activated whenever there is less than 1000 lb. (454 kg) on the forks. The weight calculation is done either with a pressure transducer or a pressure switch (non *intellispeed* trucks) located on the hydraulic manifold. The input from the pressure switch goes directly to the TM and activates a circuit on the VFC to turn off the 2nd stage select solenoid. On trucks with the pressure transducer, the CCC calculates the weight and sends a command over BUS+/– to the VFC to turn off the solenoid when a reading of 1000 lb. or more is registered.

https://truckmanualshub.com/

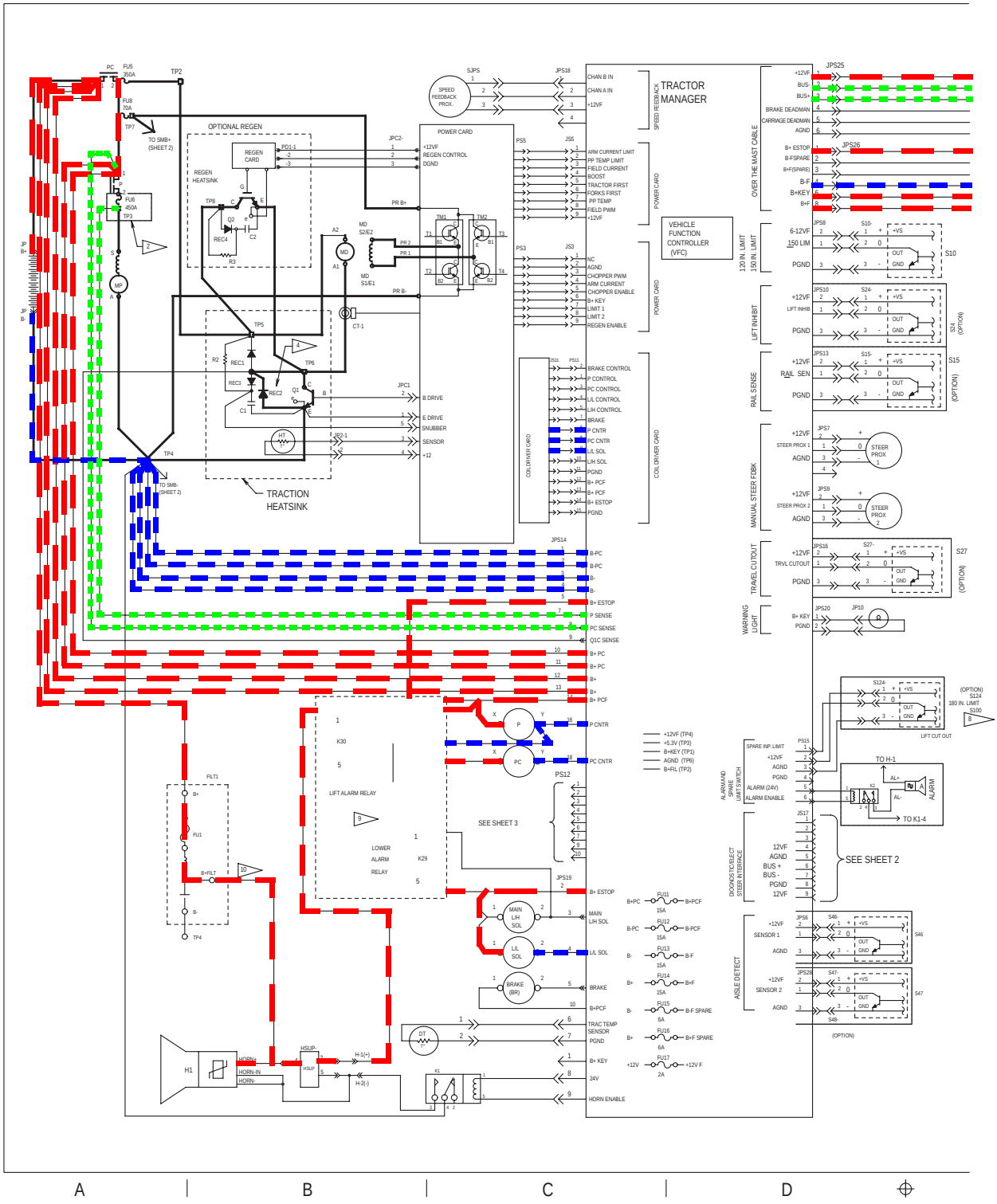


Figure 8-31. Electrical Schematic - Variable Speed Lift

https://truckmanualshub.com/

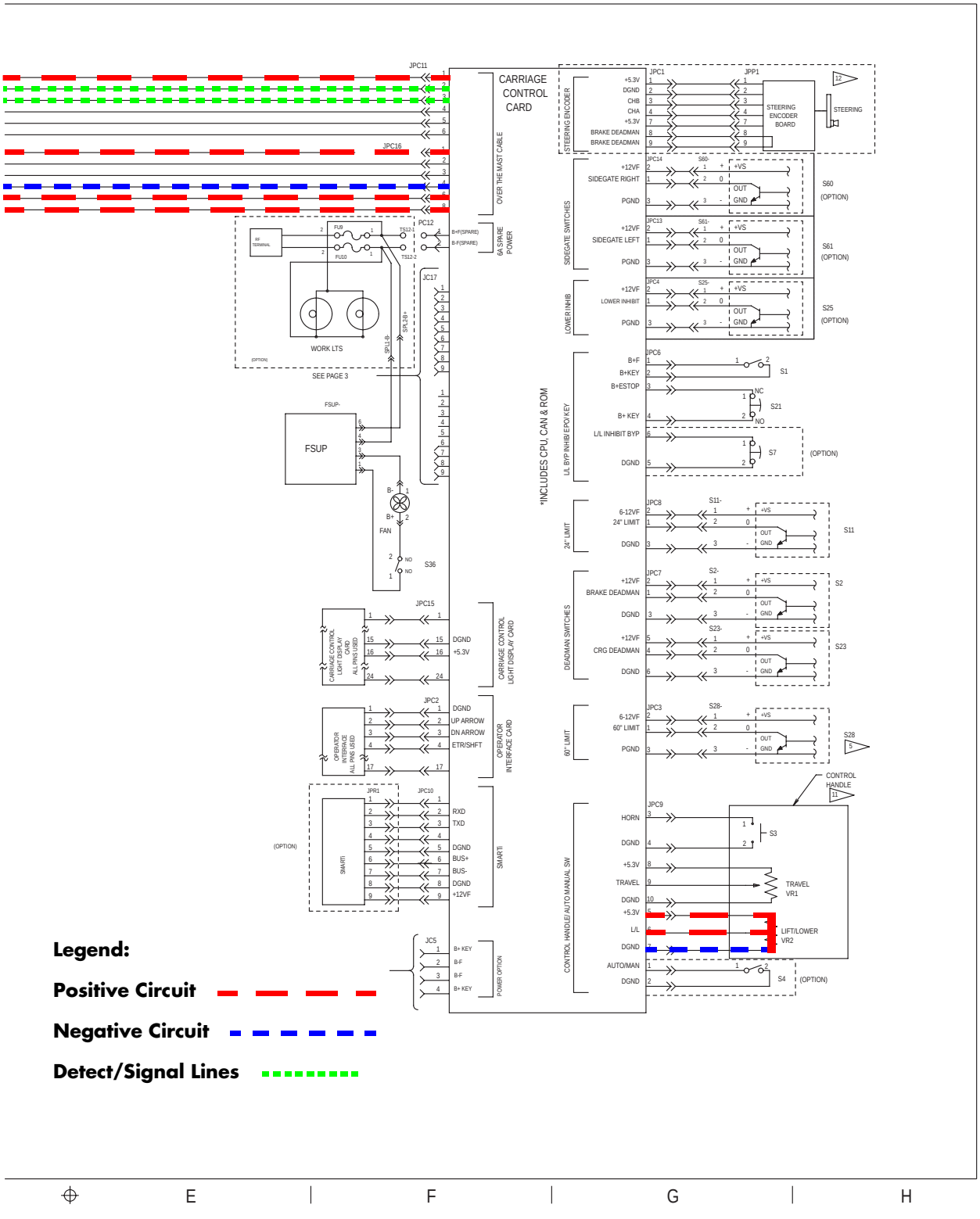


Figure 8-31 (Cont.).

https://truckmanualshub.com/

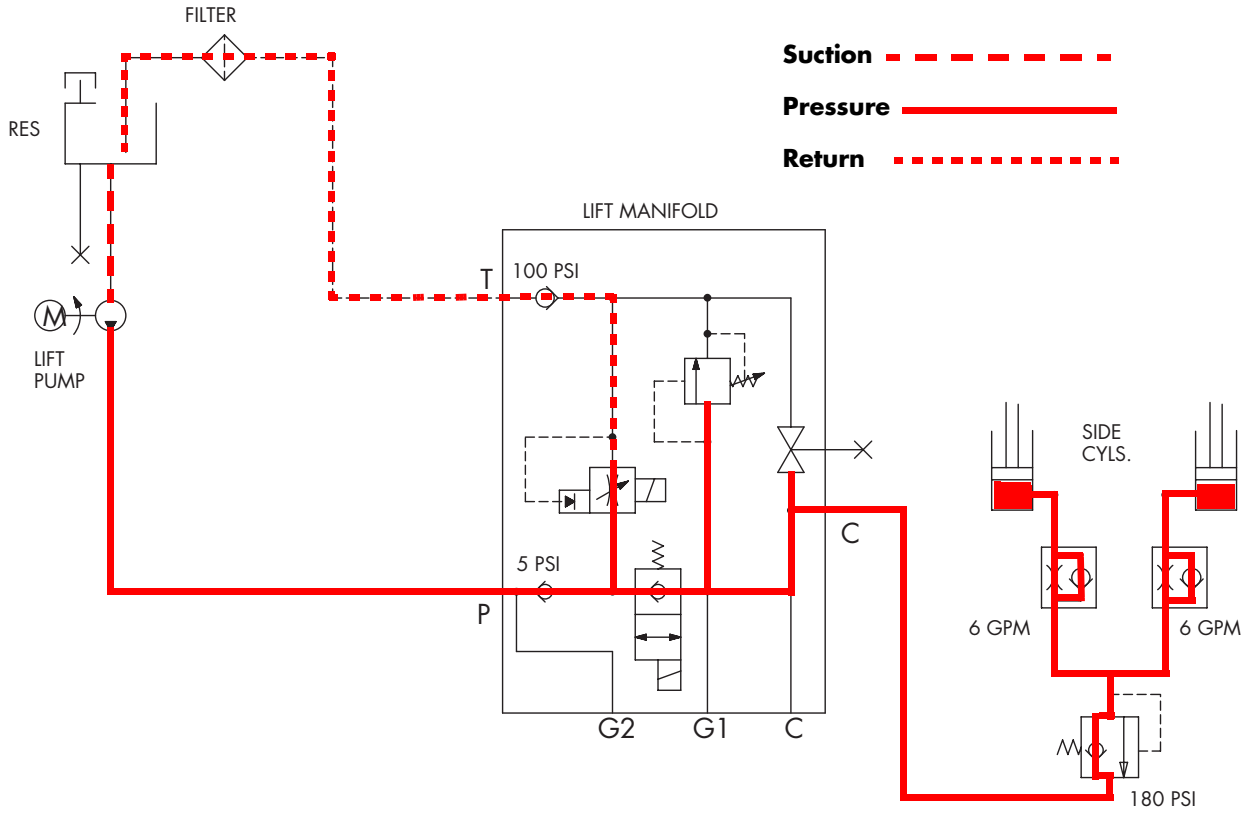


Figure 8-32. Hydraulic Schematic - Variable Speed Lift

https://truckmanualshub.com/

Proportional Lift/Lower Solenoid

Proportional lift/lower solenoid output voltages for fast and slow lift rates are shown in Figures 8-33 and 8-34.

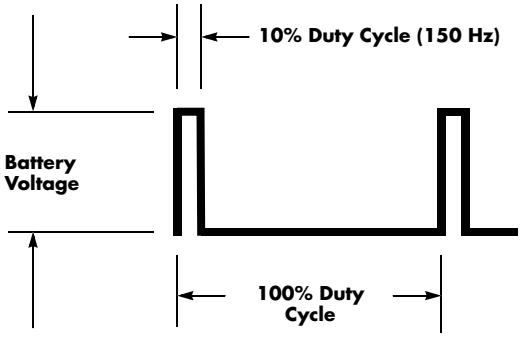


Figure 8-33. PWM for Fast Lift Rate at L/L SOL

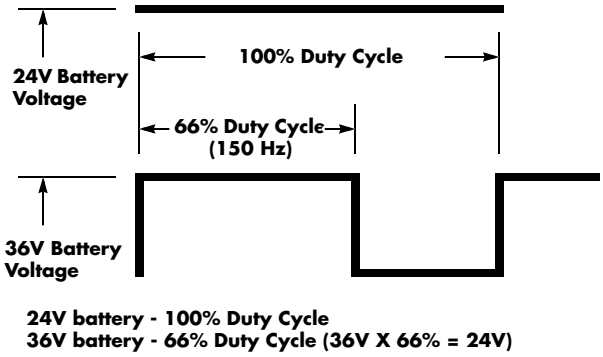


Figure 8-34. PWM for Slow Lift Rate at L/L SOL

Variable Speed Lower Activation

See Figures 8-35 and 8-36.

(Theory based on a lower request from a full speed lift situation)

VR2 passes through neutral to a full speed lower request. The CCC recognizes the change and realizes a full speed lower is required. All enabled options and switches that can prohibit lower are checked. Once the CCC is satisfied that lower can be allowed, the command is sent over BUS+/– to the VFC to activate lowering at the percentage of full speed lower. The VFC card monitors the back EMF of the lift motor through the P sense line. Once the motor has stopped spinning, the coil driver for the lift/lower proportional valve is turned off. The coil driver for the Load Hold solenoid is activated by the VFC. The VFC then gradually opens the lift/lower solenoid to the percentage of lower the CCC commanded. This allows the oil to flow from the side lift rams through the flow controls at the bottom of the rams, the 180psi telescopic hangup valve, the flow sensor, the load holding sol, the L/L prop valve, the 100psi platform hangup valve, the flow control and back to the reservoir. The telescopics will lower first due to the greater amount of pressure on the hydraulic fluid in the side cylinders. Once the telescopics fully lower, the center cylinder will begin to lower. This spins the turbine in the flow sensor in the opposite direction of lift and reverses the counts to the ESM, lowering the height count in the CCC. In the event of the forks being hung up while lowering, there is a 180psi (1241 kPa) check valve in series with the side lift rams and a 100psi (689 kPa) check valve in the manifold for the center cylinder to stop the lift cylinders from lowering. This keeps oil from draining out of the cylinders and the over pulley hoses, cables and lift chains from falling off the pulleys.

https://truckmanualshub.com/

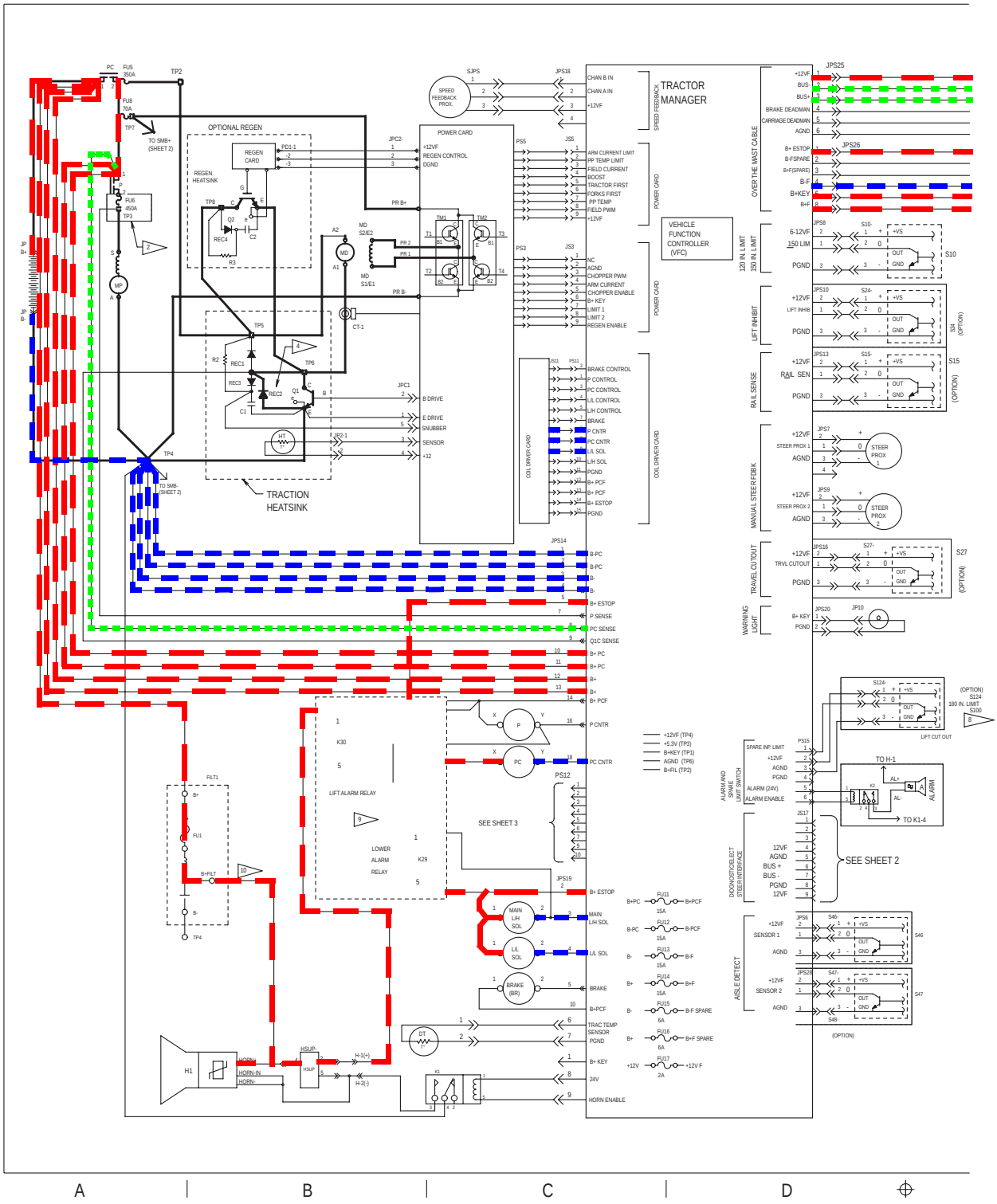


Figure 8-35. Electrical Schematic - Variable Speed Lower

https://truckmanualshub.com/

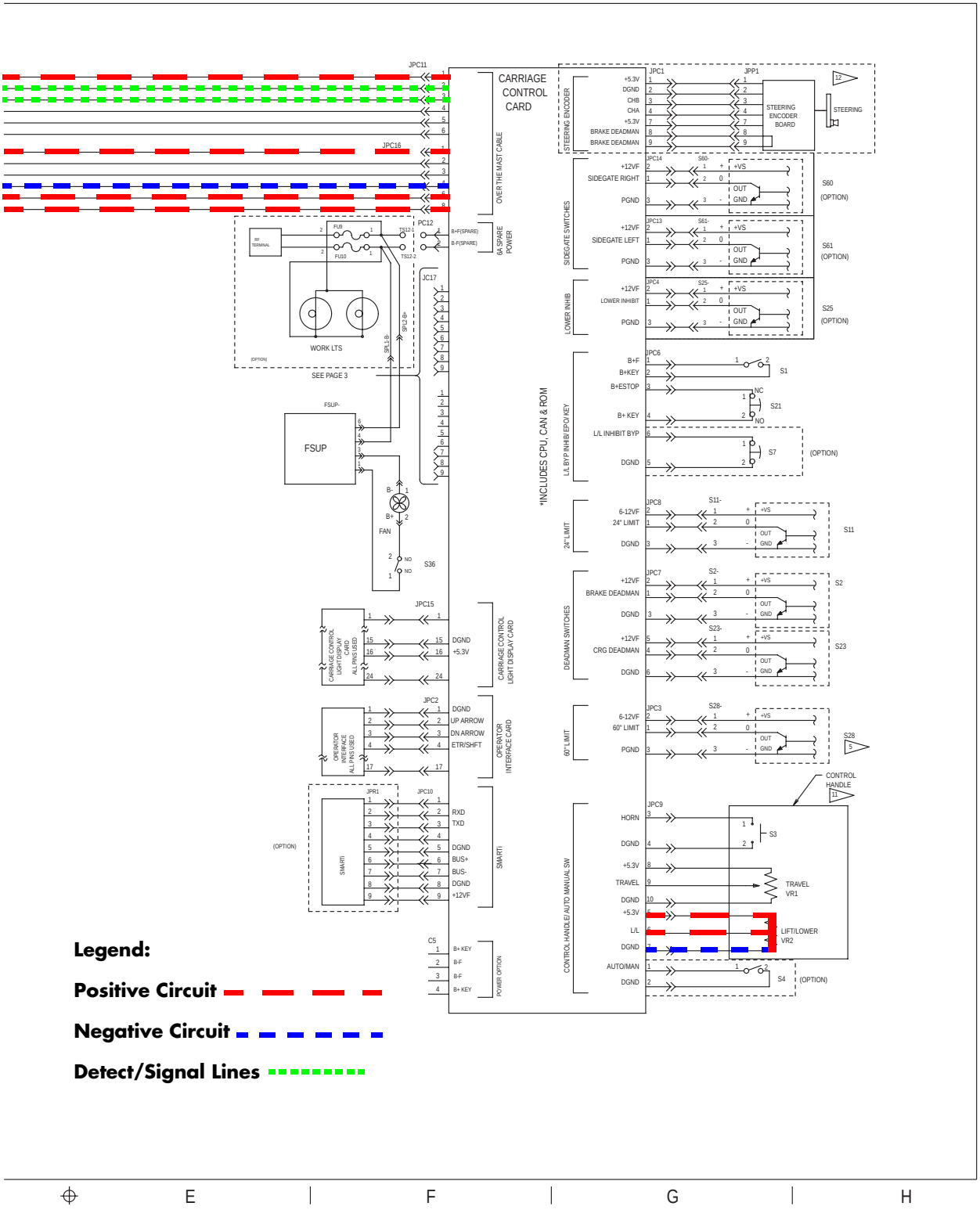


Figure 8-35 (Cont.).

https://truckmanualshub.com/

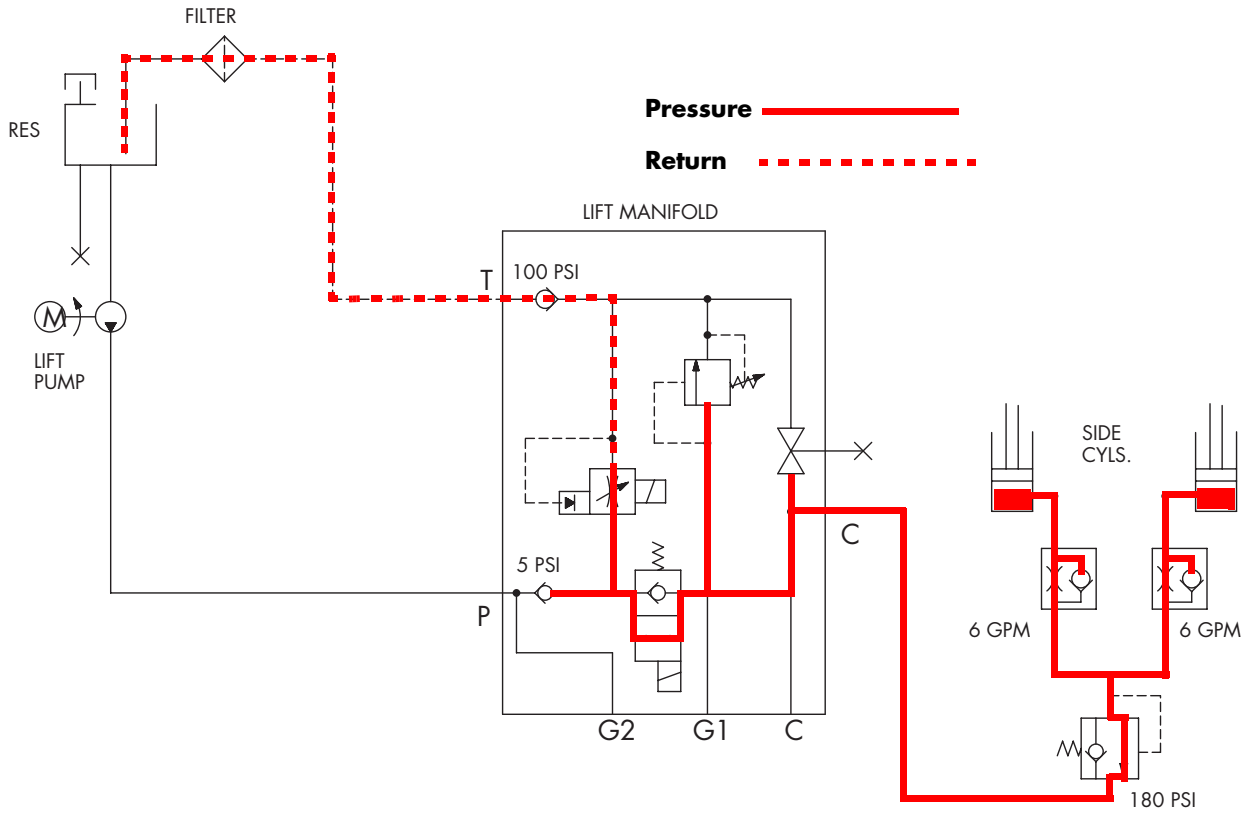


Figure 8-36. Hydraulic Schematic - Variable Speed Lower

https://truckmanualshub.com/

Section A. Appendix

https://truckmanualshub.com/

Lubrication Specification Chart

Approved Raymond Lubricants			
Where Used	**Type**	**Specification**	**Raymond Part Number**
Drive Unit Gear Case (all applications)	Gear Lubricant	75W-90 Synthetic Gear Oil API Service GL-5	990-655/001 (1 qt./0.9 liter) 990-655/003 (1 gal/3.8 liters)
Lift Chains	Oil	10W-30 Motor Oil API Service CE,CD,CC,SG,SF	990-603/04 (1 qt./0.9 liter) 990-603/03 (5 gal/18.9 liters)
Hydraulic Reservoir (Non-CS trucks) (+50°F to +120°F) (+10°C to +49°C)	Hydraulic Fluid	ISO 46 Anti-Wear Hydraulic Fluid	990-616/04 (1 qt./0.9 liter) 990-616/01 (1 gal/3.8 liters) 990-616/02 (2 gal/7.6 liters) 990-616/03 (5 gal/18.9 liters)
Hydraulic Reservoir (CS trucks) (-20°F to -0°F) (-29°C to -18°C) (confined to freezer)	Hydraulic Fluid	MIL-H-5606E	990-618/TX1 (1 gal/3.8 liters) 990-618/01 (1 gal/3.8 liters)
Hydraulic Reservoir (CS trucks) (-20°F to +70°F) (-29°C to +21°C) (in and out of freezer)	Hydraulic Fluid	ISO 32	990-617/01 (1 gal/3.8 liters) 990-617/03 (5 gal/18.9 liters)
Hydraulic Reservoir (high performance/ high temp conditions)	Hydraulic Fluid	ISO 46 Multi-Viscous Hydraulic Fluid	990-615/01 (1 gal/3.8 liters) 990-615/03 (5 gal/18.9 liters)
Mast Uprights, Bearings, (etc.)	Grease	NLGI Grade 2	990-620/01 (10 cartridges/case) 990-620/02 (5 gal/18.9 liters)
Mast Uprights, Bearings, (etc.) (CS trucks)	Grease w/Teflon	NLGI Grade 2	990-652/01 (10 cartridges/case) 990-652/02 (5 gal/18.9 liters)
Hydraulic Brake	Brake Fluid	SAE Standard J1705F Federal Motor Vehicle Standard No. 116, DOT-5	990-625/01 (1 gal/3.8 liters) 990-625/02 (1 qt./0.9 liter) 990-625/03 (1 pt./0.47 liter)

https://truckmanualshub.com/

Thread Adhesives, Sealants, and Lubricants

Application	Raymond P/N	*Loctite** Number/Color
Thread-locking 1/4 in. and below	990-403	222/Purple
Thread-locking 1/4 to 3/4 in. contamination tolerant	990-536	243/Blue
Thread-locking 1 in. and under	990-544	271/Red
Thread-locking 1 in. and under, contamination tolerant	990-463	603/Green
Thread-locking 1 in. and over	990-571	277/Red
Thread-locking Cleaner/Primer	990-538	7075
Thread-locking Primer	990-533	T7471
Hydraulic Sealant, fittings up to 2 in.	990-552	569
Molybdenum Anti-Seize Compound (Molykote)	990-638	Silver
Gasket Cement	990-556	Permatex 300
Cover Plate Sealant	990-443	587/UltraBlue
Corrosion Inhibitor Coating	990-456/001	
Silicone Sealant (cold storage)	990-445	Dow Corning III

NOTE: * *Loctite* is a registered trademark of the Loctite Corporation. Brand endorsement is not implied here, but listed only as a commonly identified product.

https://truckmanualshub.com/

Component Specific Torque/Information Chart

Component	Sub-Component(s)	Thread-Locking Compound	Torque to:
Drive Wheels	mounting bolts	N/A	108 ft. lb. (146 N•m)
Electric Steer Manager	SMB– stud	N/A	12 in. lb. (1.3 N•m)
Hydraulic Steer Motor	sprocket set screws	P/N 990-536	N/A
Lift Cylinders	end caps	P/N 990-571	200 ft. lb. (271 N•m)
Overhead Guard	mounting bolts	N/A	181 ft. lb. (245 N•m)
Power Card	B– stud	N/A	12 in. lb. (1.3 N•m)
Solenoid Coils	securing nut	N/A	5 ft. lb. (7 N•m)
Solenoid Valves	N/A	N/A	60 ft. lb. (81 N•m)
Speed Feedback Sensor	mounting bolts	P/N 990-536	N/A
Speed Feedback Sensor Disc	shim as necessary to maintain a 0.06 ±0.04 in. (1.5 ±1.0 mm) gap between the sensor and the bottom of the sensor disc		
Steer Motor	impeller shroud mounting screws	P/N 990-536	N/A
	power cable securing nuts	N/A	45-55 in. lb. (5.0-6.2 N•m)
	mounting bolts (qty 4)	P/N 990-536	Reference “Torque Chart - Standard (Ferrous)” on page A-5.
Steer Reference (Home) Proximity Sensor	sensor mounting screws (qty 4)	P/N 990-536	N/A
	bracket mounting bolts (qty 2)	P/N 990-536	N/A
Tire Replacement	A minimum pressure of 5 tons (4536 kg) is required to press on a new tire. If the minimum pressure is not met, replace the hub.		
TM1/2/3/4	electrical connections	N/A	17 in. lb. (1.9 N•m)

https://truckmanualshub.com/

Torque Chart - Standard (Ferrous)

Grade Identification Marking	None					
Size	SAE Grade 2 Bolts Tightening Torque		SAE Grade 5 Bolts Tightening Torque		SAE Grade 8 Bolts Tightening Torque	
	Dry	Oiled*	Dry	Oiled*	Dry	Oiled*
	in. lb.	in. lb.	in. lb.	in. lb.	in. lb.	in. lb.
4-40	5	4	8	6	12	9
4-48	6	5	9	7	13	10
6-32	10	8	16	12	23	17
8-32	19	14	30	22	41	31
8-36	20	15	31	23	43	32
10-24	27	21	43	32	60	45
10-32	31	23	49	36	68	51
1/4-20	66	49	96	75	144	108
1/4-28	78	56	120	86	168	120
	ft. lb.	ft. lb.	ft. lb.	ft. lb.	ft. lb.	ft. lb.
5/16-18	11	8	17	13	25	18
5/16-24	12	9	19	14	25	20
3/8-16	20	15	30	23	45	35
3/8-24	23	17	35	25	50	35
7/16-14	30	24	50	35	70	55
7/16-20	35	25	55	40	80	60
1/2-13	50	35	75	55	110	80
1/2-20	55	40	90	65	120	90
9/16-12	65	50	110	80	150	110
9/16-18	75	55	120	90	170	130
5/8-11	90	70	150	110	220	170
5/8-18	110	85	180	130	240	180
3/4-10	160	120	260	200	380	280
3/4-16	180	140	300	220	420	320
7/8-9	140	110	400	300	600	460
7/8-14	155	120	440	320	660	500
1-8	220	160	580	440	900	680
1-12	240	170	640	480	1000	740
1 1/8-7	300	220	800	600	1280	960
1 1/8-12	340	260	880	660	1440	1080
1 1/4-7	420	320	1120	840	1820	1360
1 1/4-12	460	360	1240	920	2000	1500
1 3/8-6	560	420	1460	1100	2380	1780
1 3/8-12	640	460	1680	1260	2720	2040
1 1/2-6	740	560	1940	1460	3160	2360
1 1/2-12	840	620	2200	1640	3560	2660

Note: Use "oiled" values for bolts with thread-locking compound

https://truckmanualshub.com/

Torque Chart - Metric

Ferrous Metric Bolts, Coarse Thread (The grade rating is stamped on the head of the bolt)				
Diameter (in millimeters)	Grade 8.8		Grade 10.9	
	Torque (with bolts oiled*)		Torque (with bolts oiled*)	
	N•m	ft. lb.	N•m	ft. lb.
6	8.6	6	12	9
8	21	15	29	21
10	42	30	68	43
12	72	55	101	75
16	174	130	245	181
20	340	255	475	350
24	580	435	820	605
Note: Use "oiled" values for bolts with thread-locking compound				

Brass MS63 Metric Bolts, Coarse Thread		
Diameter (in millimeters)	Torque (with bolts oiled*)	
	N•m	in. lb.
3	0.5	4.4
3.5	0.79	7.0
4	1.2	10
5	2.2	19
6	3.9	34
8	9	79
10	17	150
Note: Use "oiled" values for bolts with thread-locking compound		

https://truckmanualshub.com/

Torque Chart - Standard (Brass)

Brass MS63 Standard Bolts, Coarse Thread		
Size	**Torque (with bolts oiled*)**	
	N•m	**in. lb.**
4-40	0.37	3.3
4-48	0.40	3.6
6-32	0.69	6.1
6-40	0.77	6.8
8-32	1.24	11
8-36	1.24	11
10-24	1.58	14
10-32	1.92	17
1/4-20	3.96	35
1/4-28	4.52	40
5/16-18	8.25	73
5/16-24	9.15	81
3/8-16	14.69	130
3/8-24	16.61	147
Note: Use "oiled" values for bolts with thread-locking compound		

https://truckmanualshub.com/

Decimal Equivalent Chart

4ths	8ths	16ths	32nds	64ths	To 3 Places	To 2 Places	MM Equivalent
				1/64	.016	.02	0.397
			1/32		.031	.03	0.794
				3/64	.047	.05	1.191
		1/16			.062	.06	1.587
				5/64	.078	.08	1.984
			3/32		.094	.09	2.381
				7/64	.109	.11	2.778
	1/8				.125	.12	3.175
				9/64	.141	.14	3.572
			5/32		.156	.16	3.969
				11/64	.172	.17	4.366
		3/16			.188	.19	4.762
				13/64	.203	.20	5.159
			7/32		.219	.22	5.556
				15/64	.234	.23	5.593
1/4					.250	.25	6.350
				17/64	.266	.27	6.747
			9/32		.281	.28	7.144
				19/64	.297	.30	7.540
		5/16			.312	.31	7.937
				21/64	.328	.33	8.334
			11/32		.344	.34	8.731
				23/64	.359	.36	9.128
	3/8				.375	.38	9.525
				25/64	.391	.39	9.922
			13/32		.406	.41	10.319
				27/64	.422	.42	10.716
		7/16			.438	.44	11.112
				29/64	.453	.45	11.509
			15/32		.469	.47	11.906
				31/64	.484	.48	12.303
1/2					.500	.50	12.700

https://truckmanualshub.com/

4ths	8ths	16ths	32nds	64ths	To 3 Places	To 2 Places	MM Equivalent
				33/64	.516	.52	13.097
			17/32		.531	.53	13.494
				35/64	.547	.55	13.891
		9/16			.562	.56	14.288
				37/64	.578	.58	14.684
			19/32		.594	.59	15.081
				39/64	.609	.61	15.478
	5/8				.625	.62	15.875
				41/64	.641	.64	16.272
			21/32		.665	.66	16.669
				43/64	.672	.67	17.065
		11/16			.688	.69	17.462
				45/64	.703	.70	17.859
			23/32		.719	.72	18.256
				47/64	.734	.73	18.653
3/4					.750	.75	19.050
				49/64	.766	.77	19.447
			25/32		.781	.78	19.844
				51/64	.797	.80	20.241
		13/16			.812	.81	20.637
				53/64	.828	.83	21.034
			27/32		.844	.84	21.431
				55/64	.859	.86	21.828
	7/8				.875	.88	22.225
				57/64	.891	.89	22.622
			29/32		.906	.91	23.019
				59/64	.922	.92	23.416
		15/16			.938	.94	23.812
				61/64	.953	.95	24.209
			31/32		.969	.97	24.606
				63/64	.984	.98	25.003
					1.000	1.00	25.400

https://truckmanualshub.com/

Standard/Metric Conversions

To Convert...	Multiply...
Inches to Millimeters	Inches x 25.4
Millimeters to Inches	Millimeters x 0.039
Inches to Centimeters	Inches x 2.54
Centimeters to Inches	Centimeters x 0.394
Feet to Meters	Feet x 0.305
Meters to Feet	Meters x 3.281
Yards to Meters	Yards x 0.914
Meters to Yards	Meters x 1.094
Miles to Kilometers	Miles x 1.609
Kilometers to Miles	Kilometers x 0.621
Square Inches to Square Centimeters	Square Inches x 6.452
Square Centimeters to Square Inches	Square Centimeters x 0.155
Square Feet to Square Meters	Square Feet x 0.093
Square Meters to Square Feet	Square Meters x 10.753
Square Yards to Square Meters	Square Yards x 0.836
Square Meters to Square Yards	Square Meters x 1.196
Pints to Liters	Pints x 0.473
Liters to Pints	Liters x 2.113
Quarts to Liters	Quarts x 0.946
Liters to Quarts	Liters x 1.057
Gallons to Liters	Gallons x 3.785
Liters to Gallons	Liters x 0.26
Ounces to Grams	Ounces x 28.35
Grams to Ounces	Ounces x 0.035
Ounces to Kilograms	Ounces x 0.028
Kilograms to Ounces	Kilograms x 35.27

https://truckmanualshub.com/

To Convert...	Multiply...
Pounds to Kilograms	Pounds x 0.454
Kilograms to pounds	Kilograms x 2.2
Pounds per Square Inch (PSI) to Kilopascals (kPa)	Pounds per Square Inch x 6.894
Kilopascals to Pounds per Square Inch	Kilopascals x 0.145
Pounds per Square Inch (PSI) to Kilograms per Square Centimeter (kg/cm^2)	Pounds per Square Inch (PSI) x 0.0704
Kilograms per Square Centimeter (kg/cm^2) to Pounds per Square Inch (PSI)	Kilograms per Square Centimeter ($kg/cm^{2)}$ x 14.2
Inch Pounds (in. lbs.) to Newton Meters (N•m)	Inch Pounds x 0.113
Newton Meters (N•m) to Inch Pounds (in. lb.)	Newton Meters x 8.85
Foot Pounds (ft lb) to Newton Meters (N•m)	Foot Pounds x 1.3568
Newton Meters (N•m) to Foot Pounds (ft. lb.)	Newton Meters x 0.737
Miles per Hour to Kilometers per Hour	Miles per Hour x 1.609
Kilometers per Hour to Miles per Hour	Kilometers per Hour x 0.6214
Fahrenheit to Celsius	(°F - 32) x 0.555
Celsius to Fahrenheit	(°C x 1.8) + 32

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Schematics

https://truckmanualshub.com/

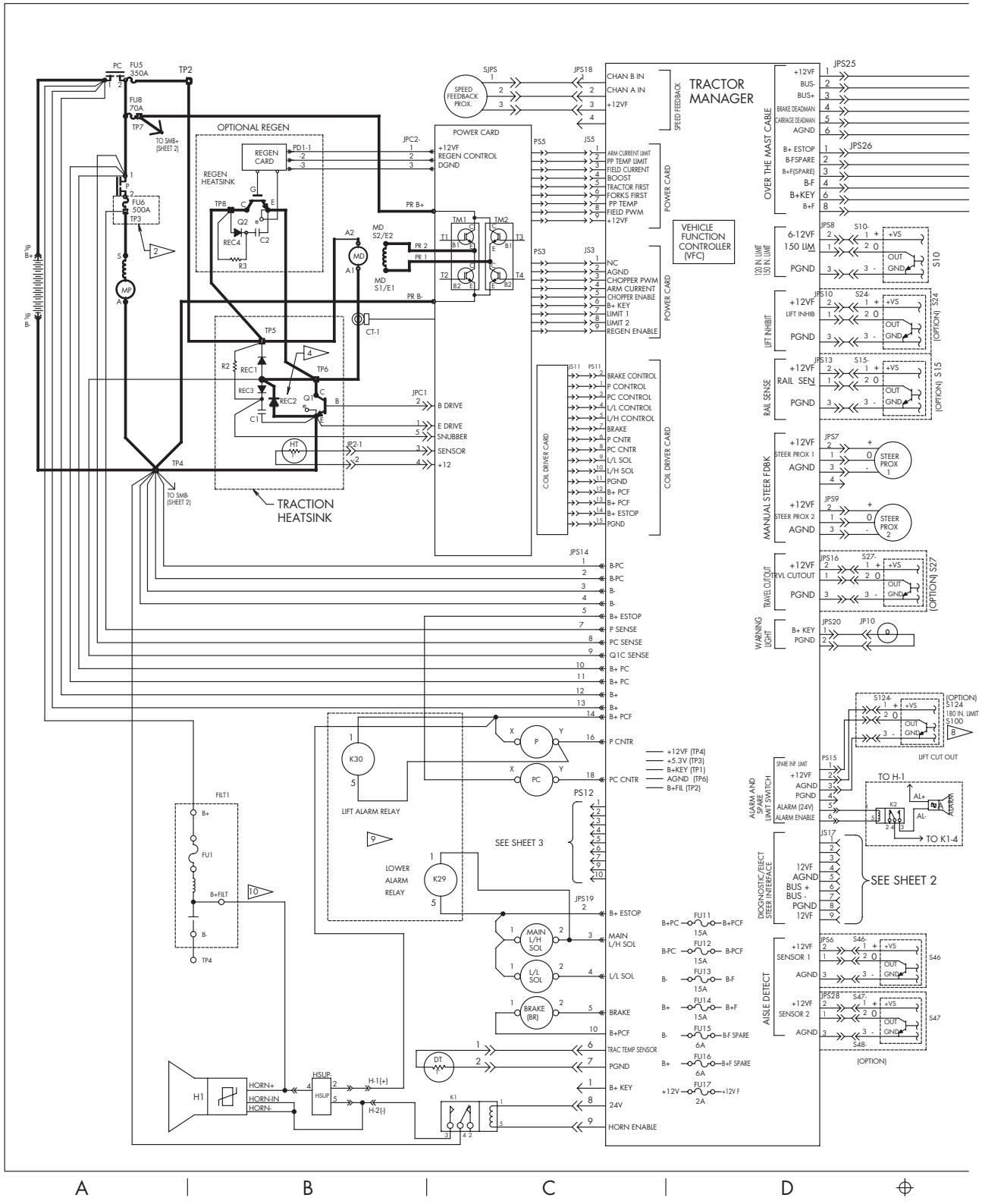


Figure A-1. EASi™ Orderpicker Electrical Schematic Sheet 1

https://truckmanualshub.com/

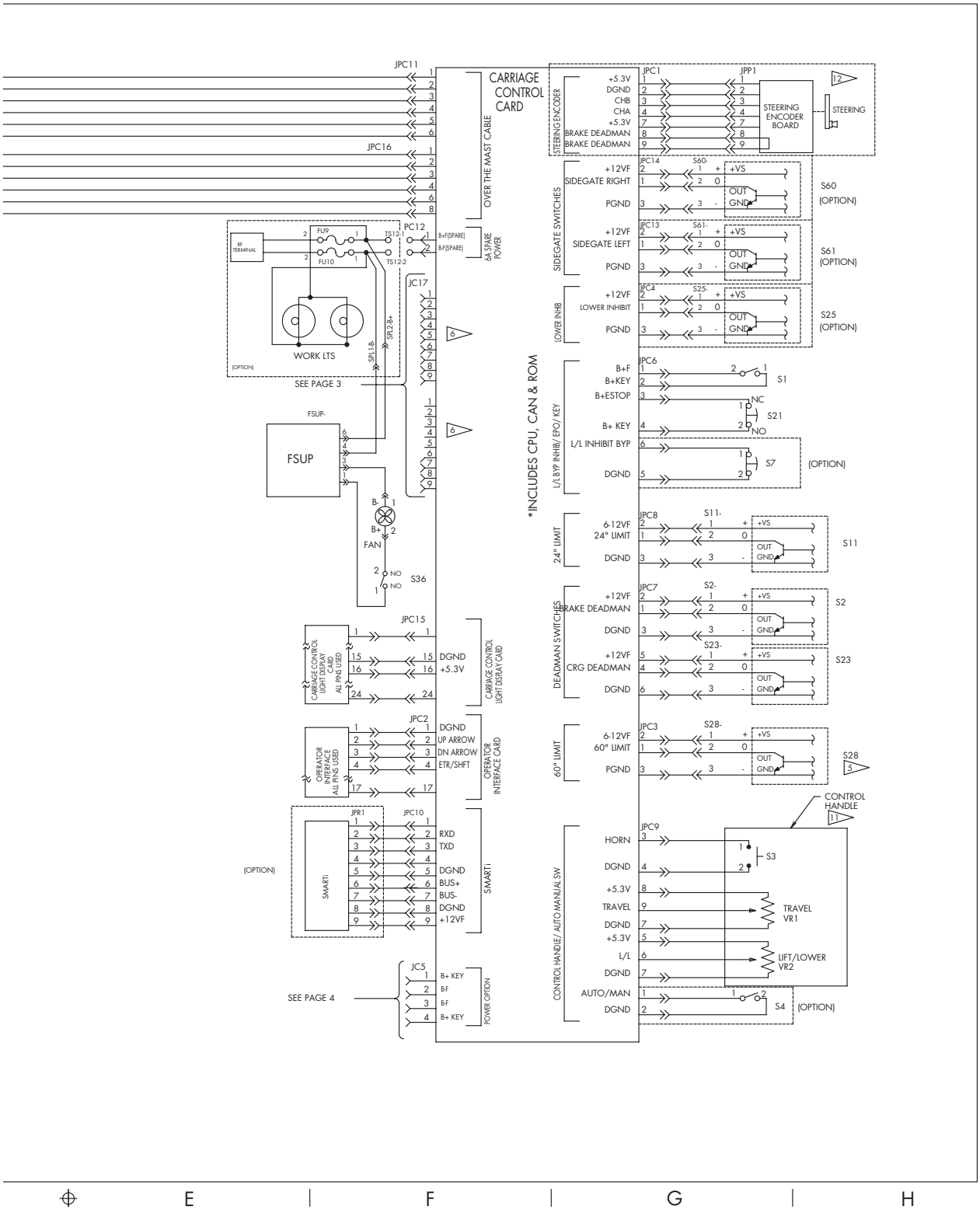


Figure A-1 (Cont.).

https://truckmanualshub.com/

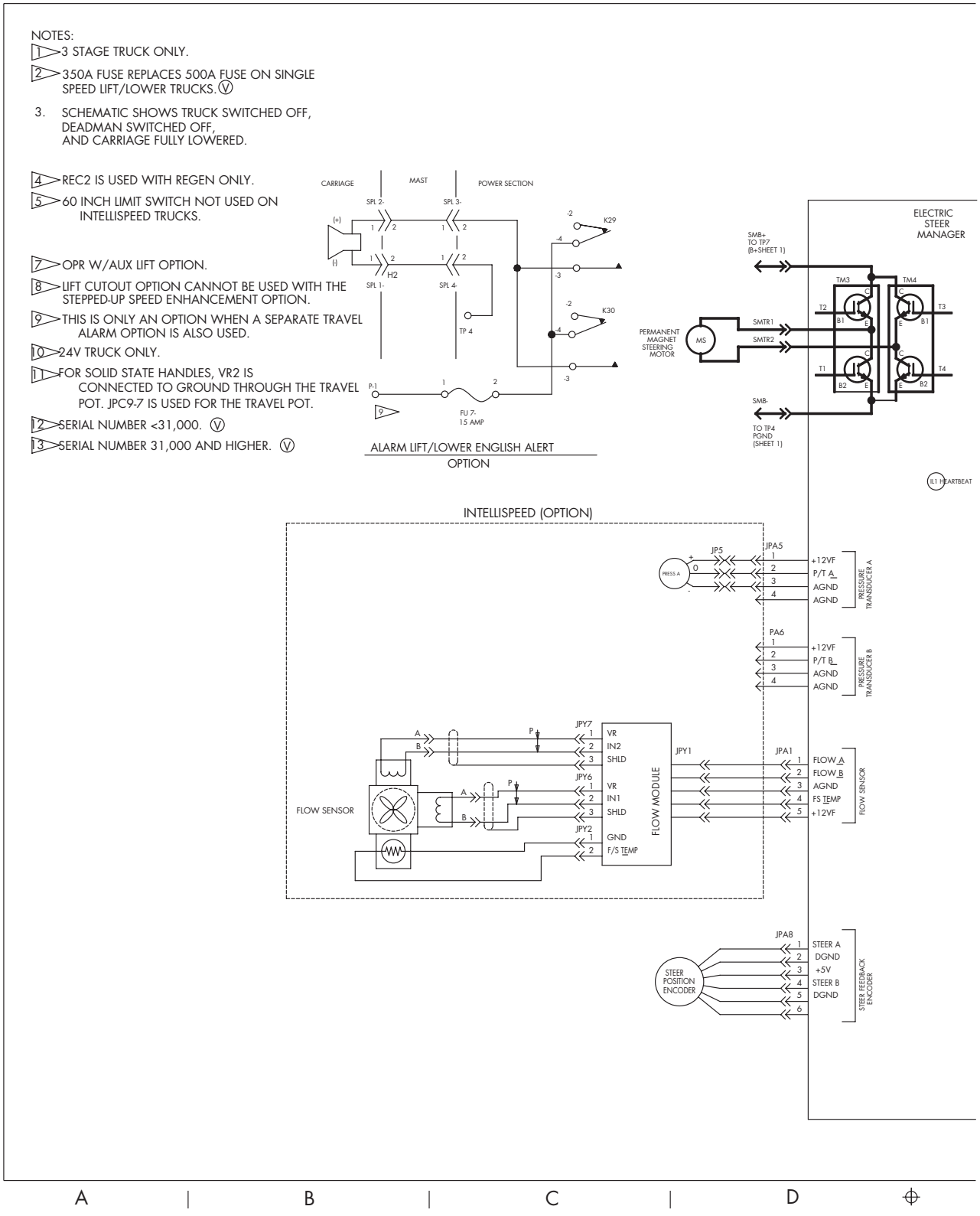


Figure A-2. EASi™ Orderpicker Electrical Schematic Sheet 2

https://truckmanualshub.com/

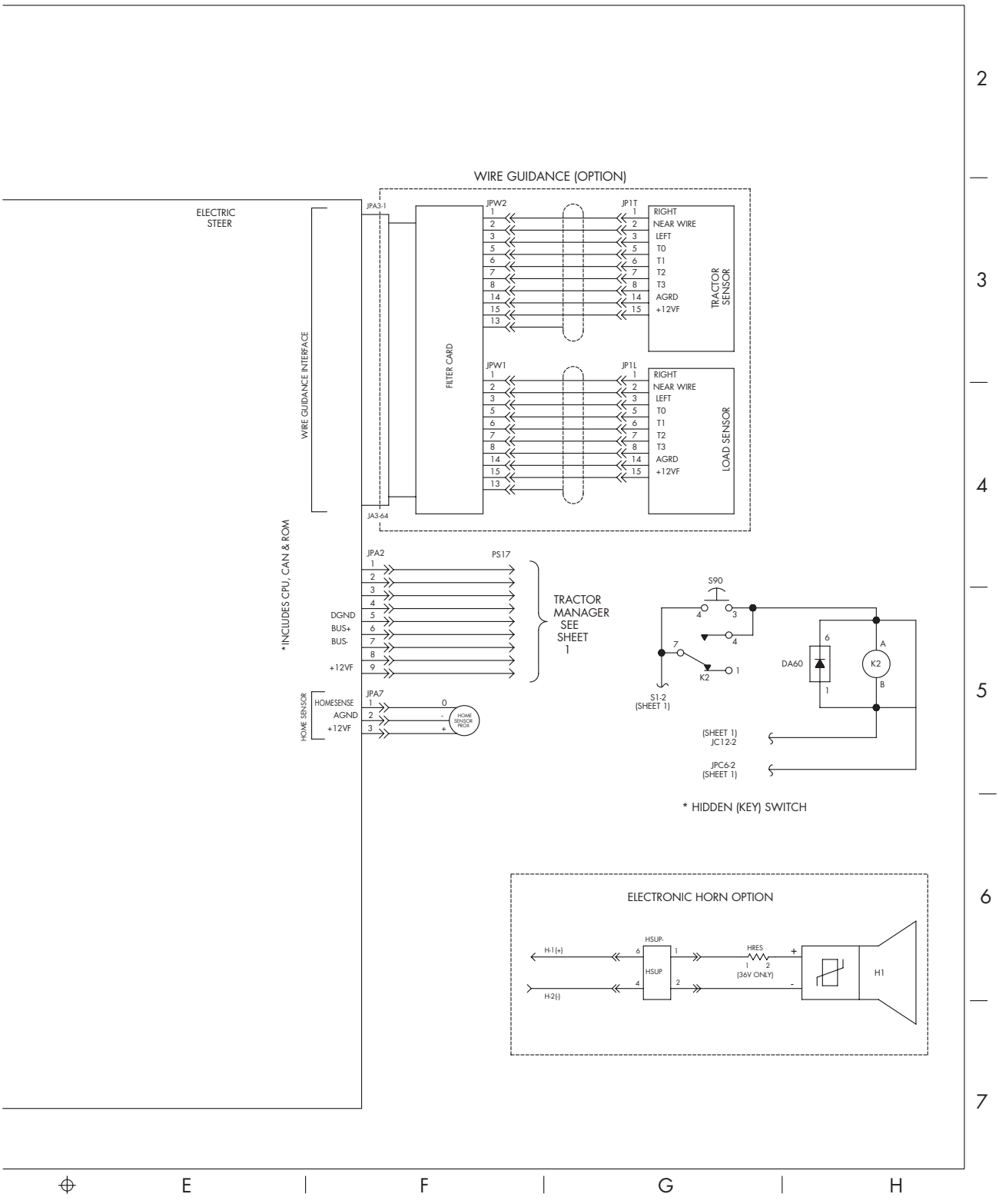


Figure A-2 (Cont.).

https://truckmanualshub.com/

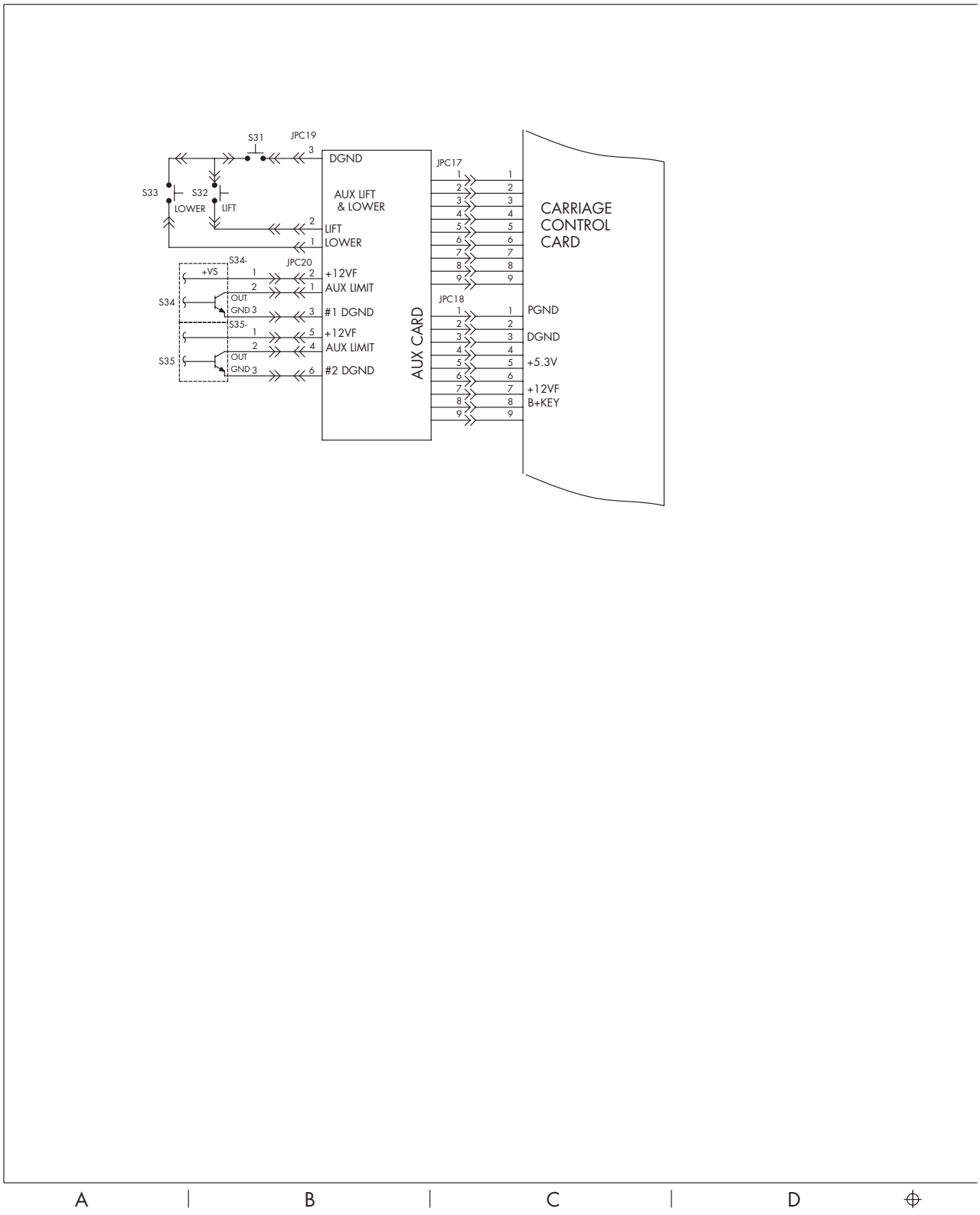


Figure A-3. EASi™ Orderpicker Electrical Schematic Sheet 3

https://truckmanualshub.com/

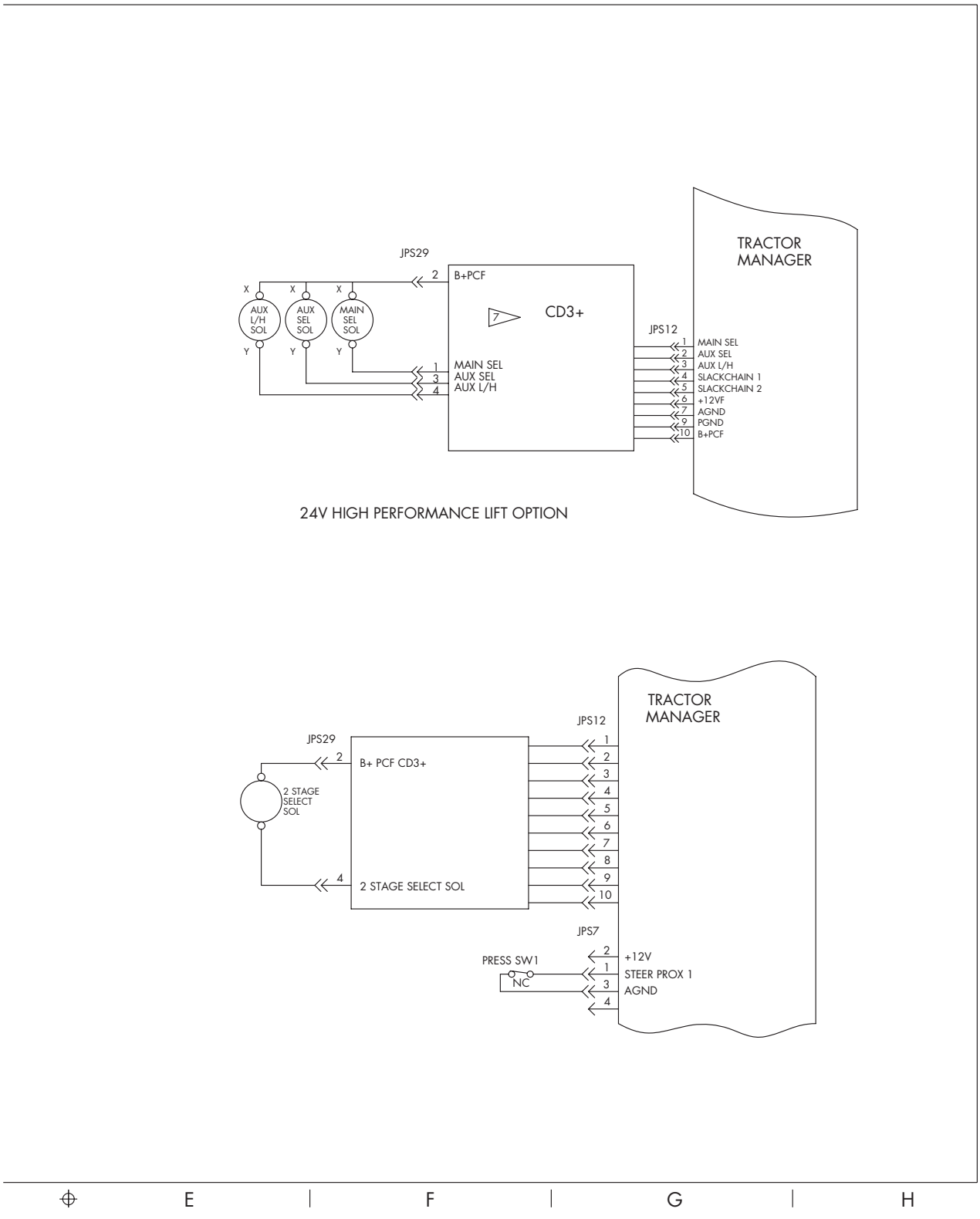


Figure A-3 (Cont.).

https://truckmanualshub.com/

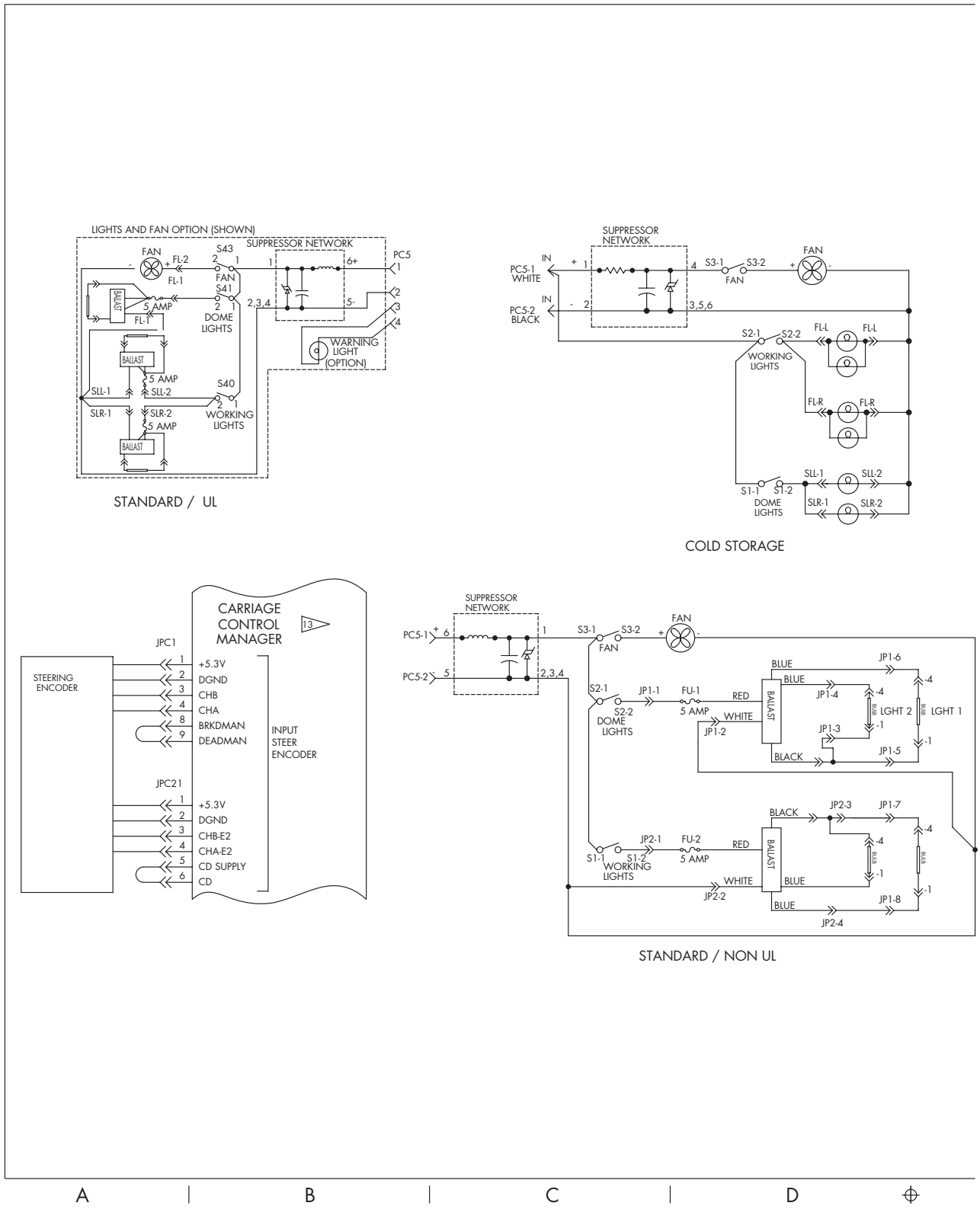


Figure A-4. EASi™ Orderpicker Electrical Schematic Sheet 4

https://truckmanualshub.com/

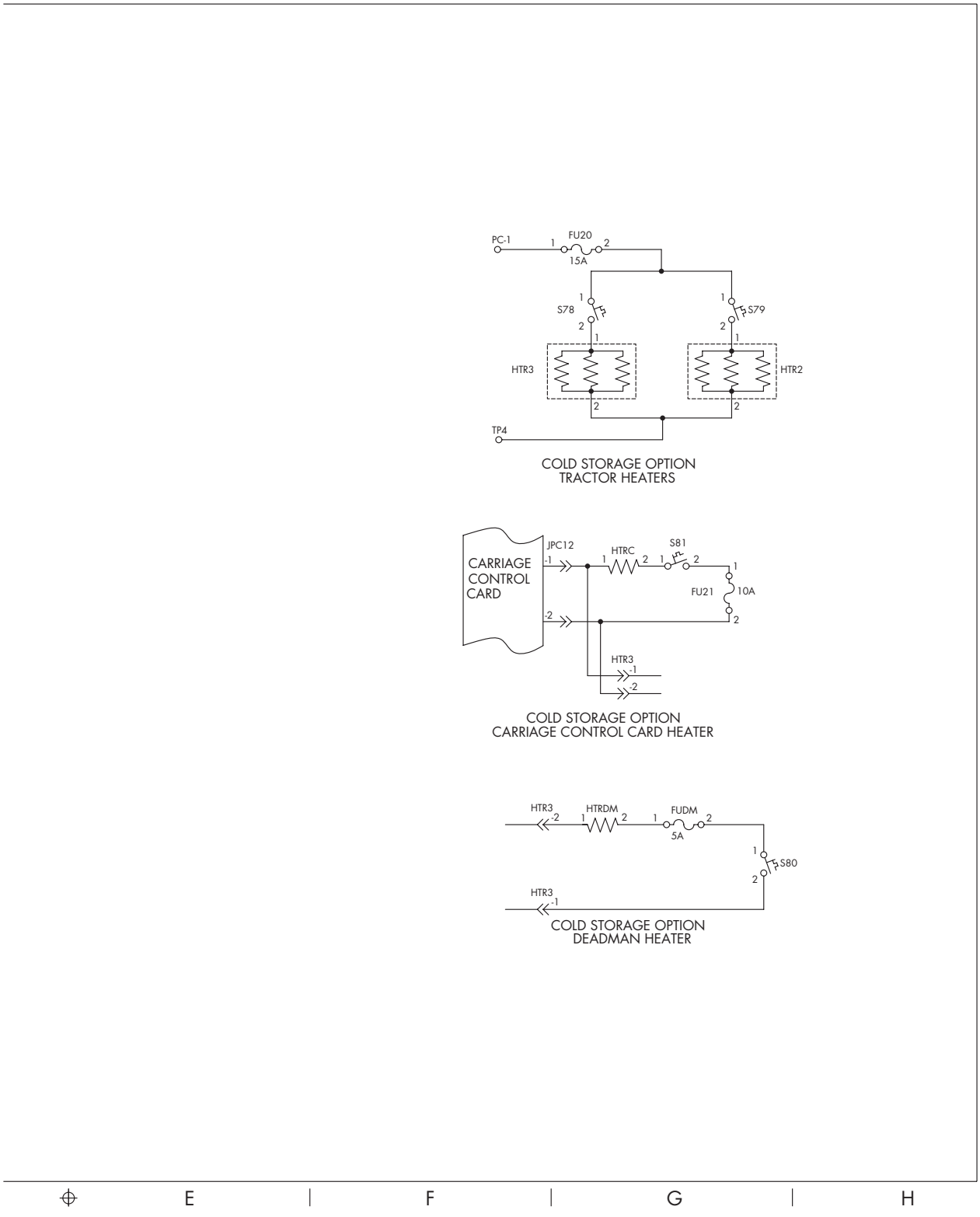


Figure A-4 (Cont.).

https://truckmanualshub.com/

LEGEND

IDENT.	SHEET	DESCRIPTION
AL+	1	POSITIVE SIDE OF ALARM (OPTION)
AL-	1	NEGATIVE SIDE OF ALARM (OPTION)
C1	1	MAIN TRANSISTOR SNUBBER CAP
C2	1	REGEN TRANSISTOR SNUBBER CAP
CT-1	1	CURRENT SENSOR (ARMATURE)
DT	1	TEMPERATURE SENSOR (DRIVE MOTOR)
FILT1	1	LINE FILTER FOR HORN NOTE 10
FU1	1	CONTROL FUSE FOR FILT1, 15A NOTE 10
FU5	1	POWER FUSE FOR TRAVEL, 350A
FU6	1	POWER FUSE FOR LIFT, 450A (350A FOR SINGLE SPEED LIFT OPTION)
FU7	2	FUSE FOR LIFT/LOWER ALARM
FU8	1	POWER FUSE FOR FIELD MOTOR AND ELECTRIC STEERING (70A)
FU9	1	CONTROL FUSE FOR RF TERMINAL B+ 2A
FU10	1	CONTROL FUSE FOR RF TERMINAL B- 2A
FU11	1	CONTROL FUSE FOR B+PCF, 15A
FU12	1	CONTROL FUSE FOR B-PCF, 15A
FU13	1	CONTROL FUSE FOR B-FUSED, 15A
FU14	1	CONTROL FUSE FOR B+FUSED, 15A
FU15	1	CONTROL FUSE FOR B-F (SPARE) ON TRACTOR MANAGER, 6A
FU16	1	CONTROL FUSE FOR B+F (SPARE) ON TRACTOR MANAGER, 6A
FU17	1	CONTROL FUSE FOR +12V FUSED, 2A
FU20	4	CONTROL FUSE FOR COLD STORAGE TRACTOR HEATERS (OPTION), 15A
FU21	4	CONTROL FUSE FOR COLD STORAGE CCC HEATER (OPTION), 10A
FUDM	4	CONTROL FUSE FOR COLD STORAGE DEADMAN HEATER (OPTION), 5A
H	1	HORN
H2	2	HORN FOR LIFT/LOWER ALARM
HRES	2	ELECTRONIC HORN RESISTOR (OPT)
HSUP	1	HORN SUPPRESSOR
HTR2	4	TRACTOR HEATER (OPTION)
HTR3	4	TRACTOR HEATER(OPTION)
HTRC	4	CCC HEATER (OPTION)
HTRDM	4	DEADMAN HEATER (OPTION)
IL1	2	LED FOR HEARTBEAT ON STEER MANAGER
JPA3	2	CONNECTOR FROM ELECTRIC STEER MANAGER TO W.G. FILTER CARD
JP1T	2	CONNECTOR FROM TRACTOR W.G. ANTENNA TO FILTER CARD
JP1L	2	CONNECTOR FROM LOAD W.G. ANTENNA TO FILTER CARD
JP2	1	TEMP SENSOR POWER PANEL CONNECTOR
JP5	2	CONNECTOR FROM PRESSURE TRANSDUCER A TO ELECTRIC STEER MANAGER
JP10	1	CONNECTOR FROM TRACTOR MANAGER TO WARNING LIGHT
JPA1	2	CONNECTOR FROM ELECTRIC STEER TO FLOW SENSOR MODULE
JPA2	2	CONNECTOR FROM ELECTRIC STEER MANAGER TO TRACTOR MANAGER
JPA5	2	CONNECTOR FROM ELECTRIC STEER MANAGER TO PRESSURE TRANSDUCER A
JPA7	2	HOME SENSOR PROX CONNECTOR TO STEER MANAGER
JPA8	2	STEER POSITION FEEDBACK ENCODER
JPB-	1	BATTERY CONNECTOR B-
JPB+	1	BATTERY CONNECTOR B+
JPC1	1,2,&4	CONNECTOR ON POWER CARD FOR Q1//CONN. ON CARRIAGE C.C. FOR STEERING ENCODER BD (PRIMARY)
JPC2	1&2	CONNECTOR ON POWER CARD FOR REGEN//CONN. ON C.C.C. FOR DISPLAY CARD
JPC3	1	CONN. ON C.C.C. FOR 60" LIMIT SWITCH
JPC4	1	CONN. ON C.C.C. FOR LOWER INHIB.
JPC6	1	CONN. ON C.C.C. FOR LIFT/LOWER BYPASS SWITCH
JPC7	1	CONN. ON C.C.C. FOR DEADMAN SWITCHES
JPC8	1	CONN. ON C.C.C. FOR 24" LIMIT
JPC9	1	CONN. ON C.C.C. FOR CONTROL HANDLE
JPC10	1	CONN. ON C.C.C. FOR SMARTI
JPC11	1	CONN. ON C.C.C. FOR OVER THE MAST CABLE #1
JPC13	1	CONN. ON C.C.C. FOR SIDEGATE SWITCHES
JPC14	1	CONN. ON C.C.C. FOR SIDEGATE SWITCHES
JPC15	1	CONN. ON C.C.C. FOR LIGHT DISPLAY CARD
JPC16	1	CONN. ON C.C.C. FOR OVERMAST CABLE #2
JPC17	3	CONNECTOR FOR C.C.C. FOR AUX CARD
JPC18	3	CONNECTOR FOR C.C.C. FOR AUX CARD
JPC19	3	CONNECTOR FOR SWITCHES (S31, S32, S33) ON AUX LIFT OPTION
JPC20	3	CONNECTOR FOR SWITCHES (S34 AND S35) ON AUX LIFT OPTION
JPC21	4	CONNECTOR FOR SECONDARY STEER INPUT ENCODER
JPP1	1	STEERING ENCODER BOARD CONNECTOR
JPR1	1	CONNECTOR ON SMARTI FOR CARRIAGE CONTROL CARD
JPS6	1	CONNECTOR ON TRACTOR MANAGER FOR AISLE DETECT
JPS7	1	CONNECTOR ON TRACTOR MANAGER FOR STEER PROX 1
JPS8	1	CONNECTOR ON TRACTOR MANAGER FOR 150" LIMIT
JPS9	1	CONNECTOR ON TRACTOR MANAGER FOR STEER PROX 2
JPS10	1	CONNECTOR ON TRACTOR MANAGER FOR LIFT INHIB.
JPS12	3	CONNECTOR ON TRACTOR MANAGER FOR CD3 + SOL. CARD
JPS13	1	CONNECTOR ON TRACTOR MANAGER FOR RAIL SENSE
JPS14	1	CONNECTOR ON TRACTOR MANAGER FOR CONTACTOR ASSY
JPS16	1	CONNECTOR ON TRACTOR MANAGER FOR TRAVEL CUTOUT
JPS18	1	CONNECTOR ON TRACTOR MANAGER FOR SPEED FEEDBACK PROX.
JPS19	1	CONNECTOR ON TRACTOR MANAGER FOR EMERGENCY STOP
JPS25	1	CONNECTOR ON TRACTOR MANAGER FOR OVER THE MAST CABLE #1
JPS26	1	CONNECTOR ON TRACTOR MANAGER FOR OVER THE MAST CABLE #2
JPS29	3	CONNECTOR ON CD3 + SOL. CARD FOR AUX SOL.
JPS30	3	CONNECTOR FOR SWITCH - LIMIT JUMPER. (MAIN 1)
JPS31	3	CONNECTOR FOR SWITCH - LIMIT JUMPER. (MAIN 2)
JS3	1	CONNECTOR ON TRACTOR MANAGER TO POWER CARD
JS4	1	CONNECTOR ON TRACTOR MANAGER TO TRACTION ENCODER
JS5	1	CONNECTOR ON TRACTOR MANAGER TO POWER CARD
JS11	1	CONNECTOR ON COIL DRIVER TO TRACTOR MANAGER
JS17	1	CONNECTOR ON TRACTOR MANAGER TO DIAGNOSTIC/ELECT. STEER INTERFACE
JPW1	2	CONNECTOR ON FILTER CARD FOR LOAD SENSOR
JPW2	2	CONNECTOR ON FILTER CARD FOR TRACTOR SENSOR
JPY1	2	CONNECTOR ON FLOW MODULE TO ELECRIC STEER MANAGER
JPY2	2	CONNECTOR ON FLOW MODULE TO FLOW SENSOR TEMPERATURE SENSOR
JPY6	2	CONNECTOR ON FLOW MODULE TO FLOW SENSOR CHANNEL 1
JPY7	2	CONNECTOR ON FLOW MODULE TO FLOW SENSOR CHANNEL 2

A | B | C | D

Figure A-5. EASi™ Orderpicker Electrical Schematic Sheet 5

https://truckmanualshub.com/

IDENT.	SHEET	DESCRIPTION
K1	1	RELAY (HORN)
K2	1	RELAY (ALARM) OPTION
K29	1&2	RELAY FOR LOWER ALARM
K30	1&2	RELAY FOR LIFT ALARM
MD-A1	1	DRIVE MOTOR TERMINAL (ARMATURE)
MD-A2	1	DRIVE MOTOR TERMINAL (ARMATURE)
MD-S1	1	DRIVE MOTOR TERMINAL (FIELD)
MD-S2	1	DRIVE MOTOR TERMINAL (FIELD)
MS	1	STEER MOTOR
P	1	LIFT PUMP CONTACTOR
PC	1	POWER DISCONNECT CONTACTOR
PC5	1	CONNECTOR ON C.C.C. FOR LIGHTS/FAN OPTION
PC12	1	CONNECTOR ON C.C.C. FOR SPARE POWER
PD1	1	CONNECTOR ON REGEN CARD TO POWER CARD
PR1	1	CABLE FROM POWER CARD TO DRIVE MOTOR FIELD
PR2	1	CABLE FROM POWER CARD TO DRIVE MOTOR FIELD
PRB-	1	CABLE FROM POWER CARD TO TP4
PRB+	1	CABLE FROM POWER CARD TO TP7
PRESS SW1	3	PRESS SWITCH FOR 24V HI PERF LIFT
PS3	1	CONNECTOR FROM POWER CARD TO TRACTOR MANAGER
PS5	1	CONNECTOR FROM POWER CARD TO TRACTOR MANAGER
PS11	1	CONNECTOR FROM TRACTOR MANAGER TO COIL DRIVER
PS15	1	CONNECTOR FROM TRACTOR MANAGER TO ALARM & SPARE LIMIT SWITCH
Q1	1	MAIN TRANSISTOR
Q2	1	REGENERATION BRAKING TRANSISTOR
R2	1	POWER TRANSISTOR SNUBBER RESISTOR
R3	1	REGEN TRANSISTOR SNUBBER RESISTOR
REC1	1	FREE WHEELING RECTIFIER
REC2	1	REGENERATION BRAKING RECTIFIER
REC3	1	SNUBBER RECTIFIER - Q1
REC4	1	SNUBBER RECTIFIER - Q2
S1	1	KEY SWITCH
S2	1	DEADMAN SWITCH (BRAKE DEADMAN)
S3	1	HORN SWITCH
S4	1	AUTO/MANUAL SWITCH
S7	1	LIFT/LOWER INHIBIT BYPASS SWITCH
S10	1	150" LIMIT SWITCH OR 120" LIMIT SWITCH
S15	1	RAIL SENSING SWITCH
S21	1	EPO SWITCH
S23	1	CARRIAGE DEADMAN SWITCH
S24	1	LIFT INHIBIT SWITCH
S25	1	LOWER INHIBIT SWITCH
S27	1	TRAVEL CUTOUT SWITCH
S28	1	60" LIMIT SWITCH
S31	3	AUX LIFT LEFTHAND DEADMAN
S32	3	AUX LIFT
S33	3	AUX LOWER
S34	3	AUX LIFT LIMIT SWITCH #1/ REARGATE #1
S35	3	AUX LIFT LIMIT SWITCH #2/ REARGATE #2
S46	1	AISLE DETECT SENSOR 1
S47	1	AISLE DETECT SENSOR 2
S60	1	SIDEGATE RIGHT SWITCH
S61	1	SIDEGATE LEFT SWITCH
S78	4	TRACTOR HEATER THERMOSTAT (OPTION)
S79	4	TRACTOR HEATER THERMOSTAT (OPTION)
S80	4	DEADMAN HEATER THERMOSTAT (OPTION)
S81	4	CCC HEATER THERMOSTAT (OPTION)
S100	1	180" LIMIT SWITCH
S124	1	LIFT CUT OUT (OPTION)
SMB-	1	B- TO ELECTRIC STEER POWER COMPONENTS
SMB+	1	B+ TO ELECTRIC STEER POWER COMPONENTS
SMTR1	2	STEER MOTOR TO ELECTRIC STEER MANAGER
SMTR2	2	STEER MOTOR TO ELECTRIC STEER MANAGER
SOL, AUX L/H	3	AUX LIFT LOAD HOLD SOLENOID] EASI OPR W/AUX
SOL, AUX SEL	3	AUX LIFT SELECT SOLENOID] EASI OPR W/AUX
SOL, L/L	1	PROPORTIONAL LIFT/LOWER SOLENOID(VARIABLE SPEED LIFT/LOWER ONLY)
SOL, MAIN SEL	3	MAIN LIFT SELECT SOLENOID (EASI OPR W/AUX)
SOL, MAIN L/H	1	MAIN LIFT LOAD HOLD SOLENOID
2 STAGE SEL SOL	3	TWO STAGE LIFT PUMP SOLENOID
SJPS	1	CONNECTOR FOR SPEED SENSOR
TM1	1	H-BRIDGE TRANSISTOR FOR DRIVE MOTOR (FIELD)
TM2	1	H-BRIDGE TRANSISTOR FOR DRIVE MOTOR (FIELD)
TM3	2	H-BRIDGE TRANSISTOR FOR STEER MOTOR
TM4	2	H-BRIDGE TRANSISTOR FOR STEER MOTOR
TP2	1	TIE POINT ON FU5
TP3	1	TIE POINT ON FU6
TP4	1	TIE POINT ON B-
TP5	1	TIE POINT ON REC1
TP6	1	TIE POINT ON REC2
TP7	1	TIE POINT ON FU8
TP8	1	TIE POINT ON REC4 (REGEN)
VR1	1	VARIABLE RESISTOR FOR THROTTLE
VR2	1	VARIABLE RESISTOR FOR LIFT/LOWER

2 3 4 5 6 7

E F G H

Figure A-5 (Cont.).

https://truckmanualshub.com/

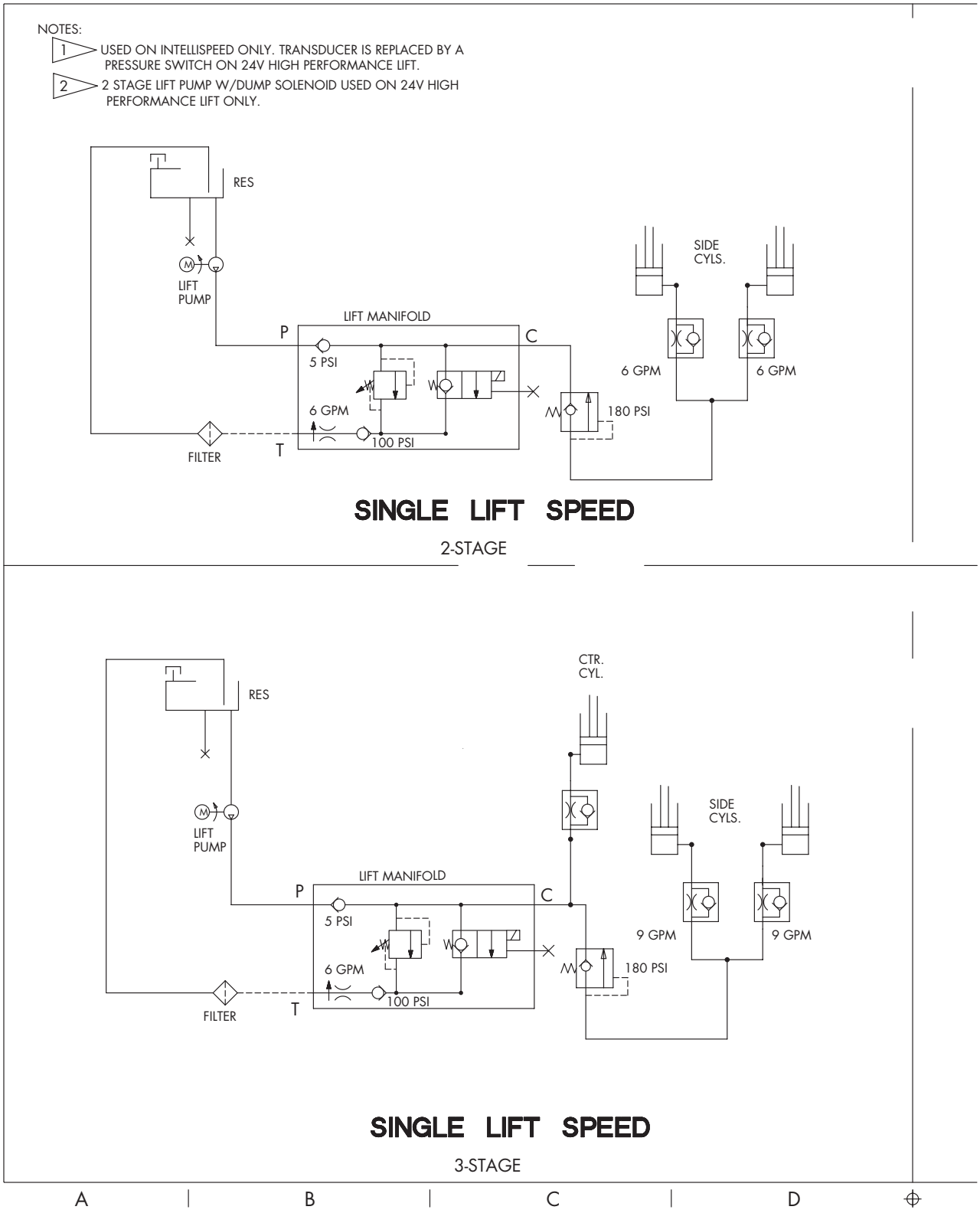


Figure A-6. EASi™ Orderpicker Hydraulic Schematic Sheet 1

https://truckmanualshub.com/

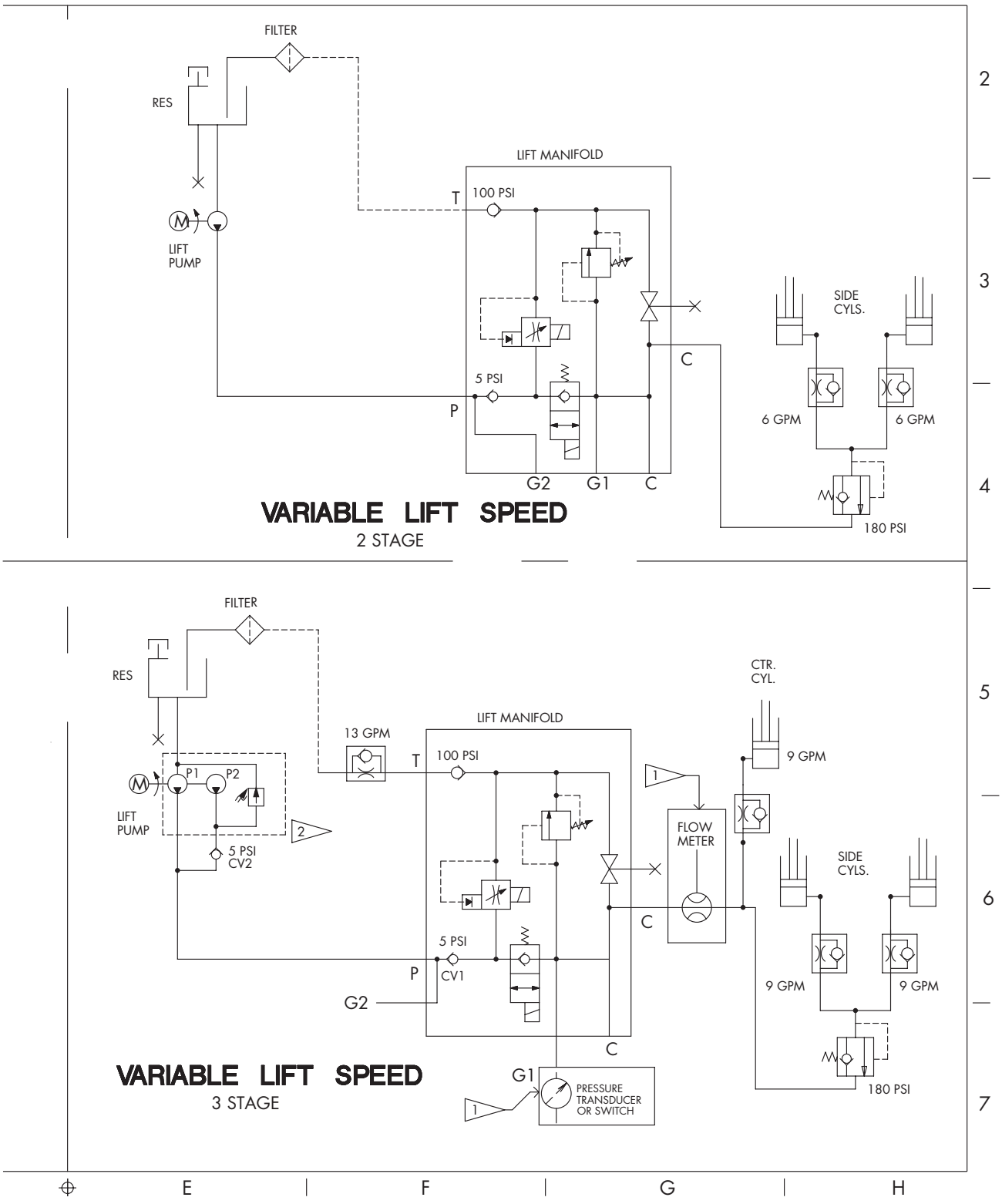


Figure A-6 (Cont.).

https://truckmanualshub.com/

RAYMOND

https://truckmanualshub.com/

Index

Section I. Index

A

Active Maintenance Mode 3-6, 3-20
Analog Input Tests . . . . . .6-115 to 6-145
Antistatic Kit 2-10
Audible Alarms 3-5
Auto Steer Center 8-58
AUTO/MANUAL Switch (S4), Theory . 8-60
Auto/Manual Switch Test 6-157

B

Battery
- Adding Water 7-49
- BSOC 5-2
- Charging 7-48
- Checks 4-9
- Cleaning 7-48
- Connector 4-9
- Cutout Adjustment 7-50
- History Record 7-50
- Hydrometer Use 7-49
- Low Voltage 5-5
- Plugged In, Theory 8-33
- Procedures . . . . . 7-48 to 7-50
- Safety 2-6
- Tests
  - Leakage to Frame 7-48

Bearings
- Mast, Shimming . . . . . 7-82 to 7-87
- Motor 5-5

Brake
- Assembly/Installation 7-43
- Deadman, Theory 8-31
- Gap 4-9
- Pads 4-9
- Stopping Distance 4-9

C

Carriage Control Card
- Connectors 5-19
- Replacement 7-58
- Theory of Ops 8-28

Carriage Deadman, Theory 8-31
CCC
- Connectors 5-19

Charging Battery 7-48
Charts
- Connector Locator 5-15
- Decimal Equivalent A-8
- Torque
  - Component Specific A-4
  - Metric A-6
  - Standard - Brass A-7
  - Standard (Ferrous) A-5

Checklists
- Operator's Daily 4-8

Circuit Card
- Connectors . . . . . 5-17 to 5-21
- Theory of Operation 8-28

Circuit Card Replacement
- Carriage Control Card 7-58
- ESM 7-60
- Filter Card 7-60
- Power Card 7-59
- Tractor Manager 7-59
- VFC 7-59

Codes
- Communication . . . . . 6-41 to 6-49
- Configuration 3-26
- Steering . . . . . 6-100 to 6-109

Codes and Messages . . . . . 6-9 to 6-113
Cold Storage 3-25
- Heater Assemblies 3-25

Communication
- Error Codes . . . . . 6-41 to 6-49

Communication Error Code
- Diagnosis and Repair 5-25
- Troubleshooting 5-23

Component Locator Photos . . . . 7-3 to 7-12
Configuration Codes 3-26
Configure Mode 3-6
- Menu 3-10

Connector Locator Chart 5-15
Connectors
- Carriage Control Card 5-19
- Electric Steer Manager 5-20
- Filter Card 5-21
- Power Card 5-17
- Tractor Manager 5-18
- VFC 5-17

Contactor Coils, Theory 8-44
Contactor Test
- PC 6-192

Contactor Test, P 6-193
Contactors, Inspection 4-9

https://truckmanualshub.com/

Control Handle
Cleaning 7-29
Inspection 7-29
Installation 7-30
Lift/Lower Knob 7-28
Removal 7-24
Repair/Replacement Procedures 7-24 to 7-30
Soldering Procedures 7-30
Travel Pot Repair/Replace 7-26
Conversions, Standard/Metric A-10 to A-11
Current Limiting, Theory 8-46
Cutout Adjustment 7-50

D

Daily Checklist 4-8
Deadman Pedal
Depressed, Theory 8-39
Rectangular 7-32
Round 7-32
Decals 4-5
Decimal to Fraction Conversion A-8
Digital Input Tests . . . . . 6-147 to 6-190
Digital Output Tests . . . . . 6-191 to 6-213
Display Messages 6-2
Drive Mode, Theory 8-53
Drive Motor
Remove/Install 7-36
Temperature Sensor
Installation 7-55
Removal 7-55
Drive Tire Replacement 7-41
Drive Unit
Assembly 7-39
Axle Seal Replacement 7-38
Checks 4-10
Disassembly 7-38
Installation 7-40
Removal 7-37
Troubleshooting Guide 5-22

E

Electric Motor Tests 5-6
Electric Steer Manager
Connectors 5-20
Replacement 7-60
Theory 8-29, 8-56
Electric Steer Motor, Theory 8-57
Electric Steering Functional Operation 8-58
Elevated Height Limits, Theory 8-44
Emergency Lower Valve 2-12
Emergency Lower Valve, Theory 8-67
Encoder
Steering Card, Theory 8-56
Steering Position Feedback
Theory 8-57
EPO Switch 7-33
EPROM
Location
CCC 5-19
ESM 5-20
VFC 5-17
Removal/Replacement 7-63
ESD 5-4
Precautions 2-9
ESM
Connectors 5-20

F

Field Transistors 7-62
Filter Card
Connectors 5-21
Replacement 7-60
Theory 8-60
Theory of Ops 8-30
Flow Sensor 7-66
Assembly 7-67
Disassembly 7-66
O-Ring Replacement 7-66
Forks
Checks 4-10
Installation 7-14
Removal 7-14
Fraction to Decimal Conversion A-8

G

G Series Error Code Troubleshooting . 5-26
Grounded Motor Test 5-7

H

Hall Effect Switches, *see* Switches
Heater Assemblies 3-25
High Pressure Relief Valve Adjustment 7-69
Horn Switch
Replacement 7-24

https://truckmanualshub.com/

Index

Hydraulic
Cylinder Storage Preparation 3-28
Flow Sensor Service Notes 7-66
System Storage Preparation 3-28
Hydrometer Use 7-49

I

Installation 3-21
Cold Storage Conditioning 3-23
Greasing Mast 3-22
Warranty 3-22

K

Key Switch On, Theory 8-33
Kit, Antistatic 2-10

L

LEARN
Controls 3-13
Guide Wire Offsets 3-17
Guide Wire Offsets, Theory 8-62
Ht/Wt 3-13
Mode 3-6
Speed Sensor 3-18
Steer 3-15
When to Run 3-13
Wire Frequency 3-16
Wire Frequency, Theory 8-61
LEDs
Location . . . . . 5-17 to 5-21
Wire Guidance 6-2
Lift Chain Storage Preparation 3-28
Lift Cylinder
Bleeding 7-71
Three-Stage Center 7-76
Cleaning 7-77
Installation 7-79
Removal 7-76
Three-Stage Center w/Cushions
Service 7-78
Cushion Replacement 7-78
Seal Replacement 7-79
Three-Stage Center w/o Cushions
Disassembly 7-76
Reassembly 7-77
Service 7-76
Two-Stage 7-74
Cleaning 7-75
Disassembly 7-74
Installation 7-75
Reassembly 7-75
Removal 7-74
Lift, Variable Speed 8-75
Lift/Lower
Knob Installation/Adjustment 7-28
Pot (VR2) Replacement 7-24
System Theory 8-67
Valve 7-70
Lights
Steering Indicator 6-2
Wire Guidance LEDs 6-2
Load Holding Valve 7-70
Locator Photos . . . . . 7-3 to 7-12
Lower
Variable Speed 8-79
Lubricants A-3
See also Oil
Lubrication
Specification Chart A-2
Lubrication Equivalency Chart A-2

M

Maintenance Minder 4-3
Disabling 4-4
Enabling 4-3
Maintenance Mode 3-6, 3-19
Active 3-6, 3-20
Static 3-6, 3-20
Manual Design 1-4
Map of the Manual 1-2
Mast
Bearing
Shimming . . . . . 7-82 to 7-87
Inner Tele to Carriage 7-86
Main Frame to Outer Telescopic 7-84
Outer Tele to Inner Tele . . . 7-85
Bearing Replacement
Upper 7-82
Checks 4-10
Disassembly 7-84

https://truckmanualshub.com/

Menus
Configure Mode 3-10
Program Mode 3-9
Messages and Codes . . . . . 6-9 to 6-113
Microprocessor Removal/Replacement 7-63
Modes of Operation
Program Mode 3-6
Run Mode 3-5
Motor
Bearings 5-5
Brush
Length 4-11
Spring Tension 4-11
Brushes 7-51
Inspection 7-51
Replacement 7-52
Checks 4-11
Drive, Remove/Install 7-36
Electric Steer 8-57
General 7-51
Grounded Test 5-7
Maximum Amp Draw 5-7
Open Circuit Test 5-6
Overheating 5-5
Storage Preparation 3-28
Stud Terminals 7-52
Tests 5-6

O

Operator Display 6-2
Steering Indicator Lights 6-2
Operator Interface Card, Theory 8-28
Operator's Daily Checklist 4-8

P

Password 3-6
Changing Access Codes 3-10
Photos, Locator . . . . . 7-3 to 7-12
Pin-Out Matrix . . . . . 8-3 to 8-24
Navigation Instructions 8-2
Power Card
Connectors 5-17
Replacement 7-59
Theory of Ops 8-30
Pressure Switch Adjustment 7-73
Printed Circuit Board Removal/Replacement
7-58 to 7-60
Program Mode 3-6
Configure Mode 3-6
LEARN 3-6
Maintenance Mode 3-6
Menu 3-9
Proportional Lift/Lower Solenoid, Theory 8-79
Proportional Plugging, Theory 8-47
Prox Sensor
Steering Home Reference, Theory . 8-57
Proximity Sensor Adjustment 7-23
PS15 Test 6-183

Q

Q1
Replacement 7-56
Test 5-11
Q2 Test 5-12

R

REC1 Replacement 7-57
Records
Battery History 7-50
Regenerative Braking, Theory 8-50
Run Mode 3-5

S

S10 Test 6-149
S11 Test 6-148
S15 Test 6-155
S2 Test 6-150
S21 (EPO) Test 6-151
S23 Test 6-175
S24 Test 6-160
S25 Test 6-179
S27 Test 6-161
S28 Test 6-163
S3 (Horn Switch) Test 6-158
S32 Test 6-184
S33 Test 6-185
S34 Test 6-186
S35 Test 6-187
S46 Test 6-172
S47 Test 6-171
S60 & 61 (Sidegate Switches) Test . . 6-159
S7 Test 6-162

https://truckmanualshub.com/

Index

Safety
- Battery 2-6
- Definitions 2-2
- Emergency Lower Valve 2-12
- General . . . . . 2-3 to 2-5
- Static Precautions 2-9

Scheduled Maintenance
- 360 Day 4-13
- 60 Day 4-9
- Guidelines . . . . . 4-2 to 4-13
- Initial 90 Day 4-12

Sealants A-3

SelfTest
- ESM, Theory 8-39
- Power ON, Theory 8-33
- TM, Theory 8-38

Sensors
- Steer Prox Adjust 7-23
- Steering Home Reference Prox, Theory 8-57
- Temperature
  - Installation 7-55
  - Removal 7-55

Shimming Mast Bearings . . . 7-82 to 7-87
- Inner Tele to Carriage 7-86
- Main Frame to Outer Telescopic . . 7-84
- Outer Tele to Inner Tele 7-85

Skid Pad
- Inspection 7-15
- Location 7-15
- Replacement 7-15

Solenoid
- Main Load Hold
  - Test 6-196

Solenoids
- Lift/Lower Proportional 8-79

Specification Plate 3-4

Specifications, Vehicle 3-4

Speed Limits
- Advanced intellispeed 8-45
- Without Advanced intellispeed . . . 8-45

Standard/Metric Conversions A-10 to A-11

Static Maintenance Mode 3-6, 3-20

Static Precautions 2-9

Steer Motor 8-57

Steering
- Auto Steer Center 8-58
- Cable 8-54
- Electric 8-55
- Electric, Functional Operation . . . 8-58
- Electric, Service Notes 7-22
- Encoder Card, Theory 8-56
- Error Codes . . . . . 6-100 to 6-109
- Home Reference Proximity Sensor, Theory 8-57
- Indicator Lights 6-2
- Manager,Theory 8-56
- Position Encoder, Theory 8-57
- Transistors 7-61
- Wire Rope
  - Adjustment 7-18
  - Replacement 7-19

Stopping Distance 4-9

Storage
- Hydraulic Cylinders 3-28
- Hydraulic System 3-28
- Lift Chains 3-28
- Motors 3-28
- Warranty Issues 3-28

SuperWord 3-6

Switches
- Brake Deadman, Theory 8-31
- Carriage Deadman, Theory 8-31
- Deadman Replacement 7-32
- Emergency Power Off 7-33
- Hall Effect 8-31
- Pressure Switch Adjustment 7-73

System Data 3-2

https://truckmanualshub.com/

T

Tests
- Analog Inputs . . . . . 6-115 to 6-145
- Auto/Manual Switch 6-157
- Digital Inputs . . . . . 6-147 to 6-190
- Digital Output . . . . . 6-191 to 6-213
- Electrical Components 5-14
- Grounded Motor 5-7
- Main Load Hold Solenoid 6-196
- Open Motor Circuit 5-6
- P Contactor 6-193
- PC Contactor 6-192
- PS15 6-183
- Q1 Power Transistor 5-11
- Q2 REGEN Transistor 5-12
- S10 6-149
- S11 6-148
- S15 6-155
- S2 6-150
- S21 (EPO) 6-151
- S23 6-175
- S24 6-160
- S25 6-179
- S27 6-161
- S28 6-163
- S3 (Horn Switch) 6-158
- S32 6-184
- S33 6-185
- S34 6-186
- S35 6-187
- S46 6-172
- S47 6-171
- S60 & 61 (Sidegate Switches) . . . 6-159
- S7 6-162
- TM 12V Power Supply 6-116
- TM1/2 5-13
- TM3/4 5-13
- VR1 6-119
- VR2 6-120
- Wire Guidance . . . . . 6-130 to 6-135

Theory of Operation
- Battery Plugged In 8-33
- Brake Deadman (S2) 8-31
- Carriage Control Card 8-28
- Carriage Deadman (S23) 8-31
- Contactor Coils 8-44
- Current Limiting 8-46
- Drive Mode 8-53
- Electric Steer Manager 8-29, 8-56
- Electric Steering 8-55
- Elevated Height Limits 8-44
- Emergency Lower Valve 8-67
- Filter Card 8-30
- Hall Effect Switches 8-31
- Learn Guide Wire Offsets 8-62
- LEARN Wire Frequency 8-61
- Lift/Lower System 8-67
  - Single Speed 8-67
  - Variable Speed
    - Lift 8-75
    - Lower 8-79
- Manual Cable Steering 8-54
- Operator Interface Card 8-28
- Pin-Out Matrix . . . . . 8-3 to 8-24
- Power Card 8-30
- Proportional Plugging 8-47
- Regenerative Braking 8-50
- Steer Encoder Card 8-56
- Steer Home Proximity Sensor 8-57
- Steer Position Encoder 8-57
- Tractor Manager 8-29
- Vehicle Function Controller 8-29
- Wire Guidance 8-59
- Wire Guidance Sensors 8-60

Thread Adhesives A-3
Tie-Down for Transport 2-13
Tire Replacement 7-41
TM Connectors 5-18
TM1/TM2 Replacement 7-62
TM3/TM4 Replacement 7-61
Torque Chart
- Component Specific A-4
- Metric A-6
- Standard (Brass) A-7
- Standard (Ferrous) A-5

Torque Specs
- Motor Terminals 7-52

Towing 2-15
Traction System
- Architecture . . . . . 8-25 to 8-31
- Functional Operation . . . . 8-33 to 8-53

https://truckmanualshub.com/

Index

Tractor Manager
Card Replacement 7-59
Connectors 5-18
Theory of Ops 8-29
VFC Connectors 5-17
Transistors
Field 7-62
Q1 Replacement 7-56
Steering 7-61
TM1/TM2 Replacement 7-62
TM3/TM4 Replacement 7-61
Travel Pot (VR1)
Disassembly 7-26
Travel, Theory 8-39
Troubleshooting
BSOC 5-2
Communication Error Codes 5-23
Connector Locator Chart 5-15
Drive Unit 5-22
Electrical 5-2
Electrical Component Tests 5-14
Electrical Symptoms . . . . 5-35 to 5-36
ESD 5-4
G Series Error Codes 5-26
Hydraulic Functions . . . . 5-31 to 5-33
Low Voltage 5-5
Motor Overheating 5-5
Motors 5-5
Open or Short 5-5
Pin-Out Matrix . . . . . 8-3 to 8-24
Q1 5-11
Q2 5-12
TM1/2 5-13
TM3/4 5-13
Travel Functions 5-34

V

Valves
Emergency Lower 2-12
High Pressure Relief Adjustment . 7-69
Lift/Lower 7-70
Load Holding 7-70
Variable Speed
Lower, Theory 8-79
Variable Speed Lift
Theory 8-75
Vehicle
Operation 3-22
Specifications 3-4
Vehicle Function Controller
Card Replacement 7-59
Connectors 5-17
Theory of Ops 8-29
VR1 Test 6-119
VR2 Test 6-120

W

Warranty 3-22
Storage Issues 3-28
Wire Guidance 3-24
AUTO/MANUAL Switch 8-60
End-of-Aisle Configurations 8-62
End-of-Aisle Control, Theory 8-62
End-of-Aisle Magnet Installation . . 8-64
End-of-Aisle Slow Down, Theory . . 8-65
Filter Card, Theory 8-60
Functional Operation . . . . 8-61 to 8-64
LEARN Mode 8-61
LEDs 6-2, 8-60
Operation, Theory 8-61
Sensor Adjustment 8-60
Sensor Assemblies 8-60
Setup 3-24
Tests . . . . . 6-130 to 6-135
Theory of Operation 8-59

https://truckmanualshub.com/

https://truckmanualshub.com/

https://truckmanualshub.com/

!PDMM-0101!

PDMM-0101