



Service Manual



WF3000 Series

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Overview of Revisions:

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SAFETY

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Safety Symbols used in the Manual

To help guide you through the manual and to highlight particular danger areas, we have used graphic illustrations:

DANGER



This symbol indicates life-threatening risks

- Failure to comply with this notice may result in fatal injuries to yourself or other people.

WARNING



This symbol indicates the risk of serious injury and/or serious material damage.

- Failure to comply with this notice may result in severe injuries to yourself or other people and/or serious material damage.

CAUTION



This symbol indicates the risk of minor injury and/or minor material damage.

- Failure to comply with this notice may result in minor injuries to yourself or other people and/or minor material damage.

INFORMATION



Contains additional information with supplementary notes and hints.

OPTION

Option

These items relate to optional features not supplied with the standard version.

General Maintenance and Repair Safety Notes

DANGER



Read the safety notices in the truck Maintenance and Operator's Manuals.

- Failure to do so could result in severe or fatal injuries to maintenance personnel and/or other persons.

Motorised vehicles can be dangerous if maintenance and service are neglected. For this reason maintenance and inspections must be carried out at regular short intervals by trained personnel working to approved company guidelines.

DANGER



Follow all national/local safety regulations applicable for maintenance work, e.g. for work on higher levels.

- Failure to do so could result in severe or fatal injuries to maintenance personnel and/or other persons.

Maintenance and Repair

1. Maintenance work must only be carried out in accordance with the test and maintenance program contained in the present Maintenance Manual and any applicable service notices.
2. Only qualified and authorised personnel may carry out work on the truck.
3. Always keep fire extinguishers in good working condition. Do not approach fluid levels or leaks with a naked flame.
4. To clean, use a non flammable, non combustible cleaning solution which is groundwater-neutral. Only carry out cleaning with an oil separator. Protect the electrical system from dampness.
5. Keep the service area clean, dry and well-ventilated.
6. Do not allow oil to penetrate the ground or enter the draining system. Used oil must be recycled. Oil filters and desiccants must be treated as special waste products. Relevant applicable regulations must be followed.
7. Neutralise and thoroughly rinse any spilled battery fluid immediately.
8. Keep the truck clean. This will facilitate the location of loose or faulty components.

9. Make sure that capacity and data plates, warnings and labels are legible at all times.
10. Alterations or modifications by the owner or operator are not permitted without the express written authorisation from Crown.
11. Only use original Crown spare parts to ensure the reliability, safety and suitability of the Crown truck.

Before Leaving the Truck

- Stop the truck.
- Lower the fork carriage fully.
- Apply the parking brake.
- Turn off the truck and remove the key.
- Block all wheels when parking on an uneven surface.

Before Carrying out Work on the Truck

- Raise the truck to free the drive wheel. Press the emergency Stop button and disconnect the battery.
- Prevent the truck from rolling away.
- Before carrying out work on the hoist frame, the lift mast or on the fork carriage: Block these parts according to maintenance instructions in order to prevent them from dropping.
- Only carry out operational testing when there is sufficient room to manoeuvre, to avoid the risk of injury to yourself and others.

Before Operating the Truck

- Check the safety devices.
- Get into the driver's seat.
- Check the operation of the lifting device, travel direction switch, speed control, steering, warning devices and brakes.

Warnings and Labels on the Truck

During regular maintenance check that the warnings and labels on the truck are complete and legible.

- Clean any illegible labels.
- Replace any faulty or missing labels.

The order and meaning of the warnings and labels on the truck are described in section 10.9 of the parts manual.



INTRODUCTION

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General

The present manual is designed for Customer Service engineers who wish to familiarise themselves with the maintenance work required for the various truck components.

It also contains troubleshooting sections which can be used to identify and remedy truck faults.

INFORMATION



This book is not an operating manual. It is designed solely for specialist personnel who have been trained and authorised to carry out the work described in the manual.

This manual therefore contains fewer and less detailed warnings than the Operator's Manual, as the latter is aimed at persons who have very little or no prior experience at all.

Operating Instructions

This manual contains no operating instructions. An operating instructions manual is supplied with the vehicle. Additional copies can be ordered as required.

With the help of this manual you and your personnel will be able to ensure the long service life, operational safety and error free functioning of your CROWN vehicle.

Service Training

CROWN offers the appropriate vehicle related training for service personnel. Details on this training can be obtained from CROWN on request.

Ordering Spare Parts

The maintenance manual does not cover spare parts. These are listed in a separate manual.

Spare parts can be ordered by quoting:

- The truck specification number
- The truck model number
- The truck serial number

This information can be found on the truck's data plate. Only if this information is provided can the order be processed quickly, correctly and reliably.

Please refer to the Technical Specifications Sheet for the utilisable loads, technical data and dimensions for this series. Brochures can be obtained from your CROWN dealer or from the following address:

CROWN Gabelstapler GmbH & Co.KG
Moosacher Str. 52
80809 Munich
GERMANY
Tel.: +49 (0)89 / 93 002 -0
Fax: +49 (0)89 / 93 002 -175 or 133

Using the Manual

The manual is divided into sections. The following table shows how the manual is structured.

Sections Maintenance	
Section	Description
IDX	Table of Content
MA	Safety
ITD	Introduction
M1	Lubrication and Adjustment
M2	Hydraulics
M3	Drive Unit
M4	Electrical
M5	Brake
M6	Steering
M7	Mast / Lifting Mechanism
M8	Cylinder
DIA	Electrical Diagrams
HYD	Hydraulic Schematic

A01M-gb

Model-Number

This manual describes the maintenance and repairs for the following truck versions:

WF 3000-1.0

WF 3000-1.2



LUBRICATION AND ADJUSTMENT

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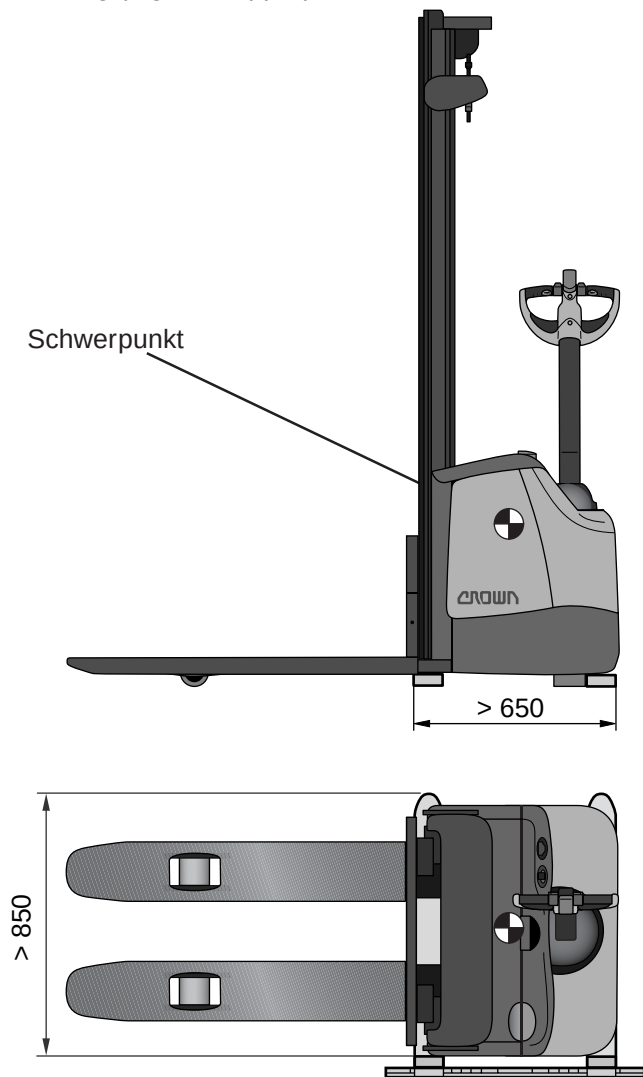
Raising And Towing The Truck

Raising With Another Forklift Truck

DANGER

Failure to read the instructions can cause the truck to tip over or fall from the forks. Fatal accidents could result.

- Position the forks of the truck which is doing the lifting as shown by the diagram below.
- The centre of gravity of the WF 3000 with and without the battery is near the battery compartment. It should always be between the forks of the truck doing the lifting.
- Secure the WF 3000 firmly to the forks of the truck which is doing the lifting (e.g. with appropriate straps).



MO-3300-014

Lifting by Crane

DANGER



Make sure the crane / fork lift and the lifting equipment have sufficient capacity.

If the crane / lift truck crash or a load falls, fatal injuries can result.

Capacity required: 900 kg

Attach lifting gear as shown in the following diagram and prevent the truck from slipping.



MO-3300-013

Towing the Truck

DANGER



Tipovers can result in fatal accidents.

If the towing truck negotiates a bend, a fork will slip under the truck that is being towed. This can cause the towed truck to tip over and result in fatal injuries.

Only travel straight ahead when towing.

When the truck is de-energised, the brake (acting on the drive wheel) is applied. To remove the truck from an aisle, for example, it can be raised and pulled by a forklift truck. The required capacity (WF unladen, with battery, 800 kg): 1100 kg. The load wheels remain on the ground when the truck is towed.

CAUTION

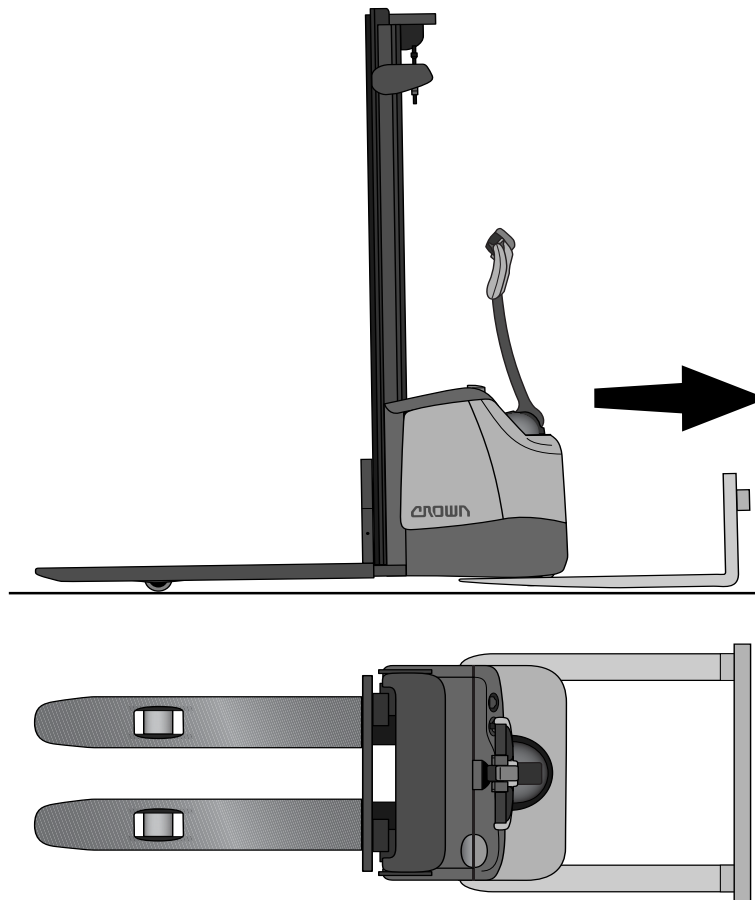


Risk of damage to the drive system.

If the drive wheel is still touching the ground, the drive system will be damaged when the truck is towed.

Only raise the truck so far that the drive wheel is not touching the ground.

- Position the forks as shown in the diagram.
- Raise the truck (at its front) approx. 20 mm, but no higher than necessary as otherwise the bottom of the WF's fork tips will scratch the ground.

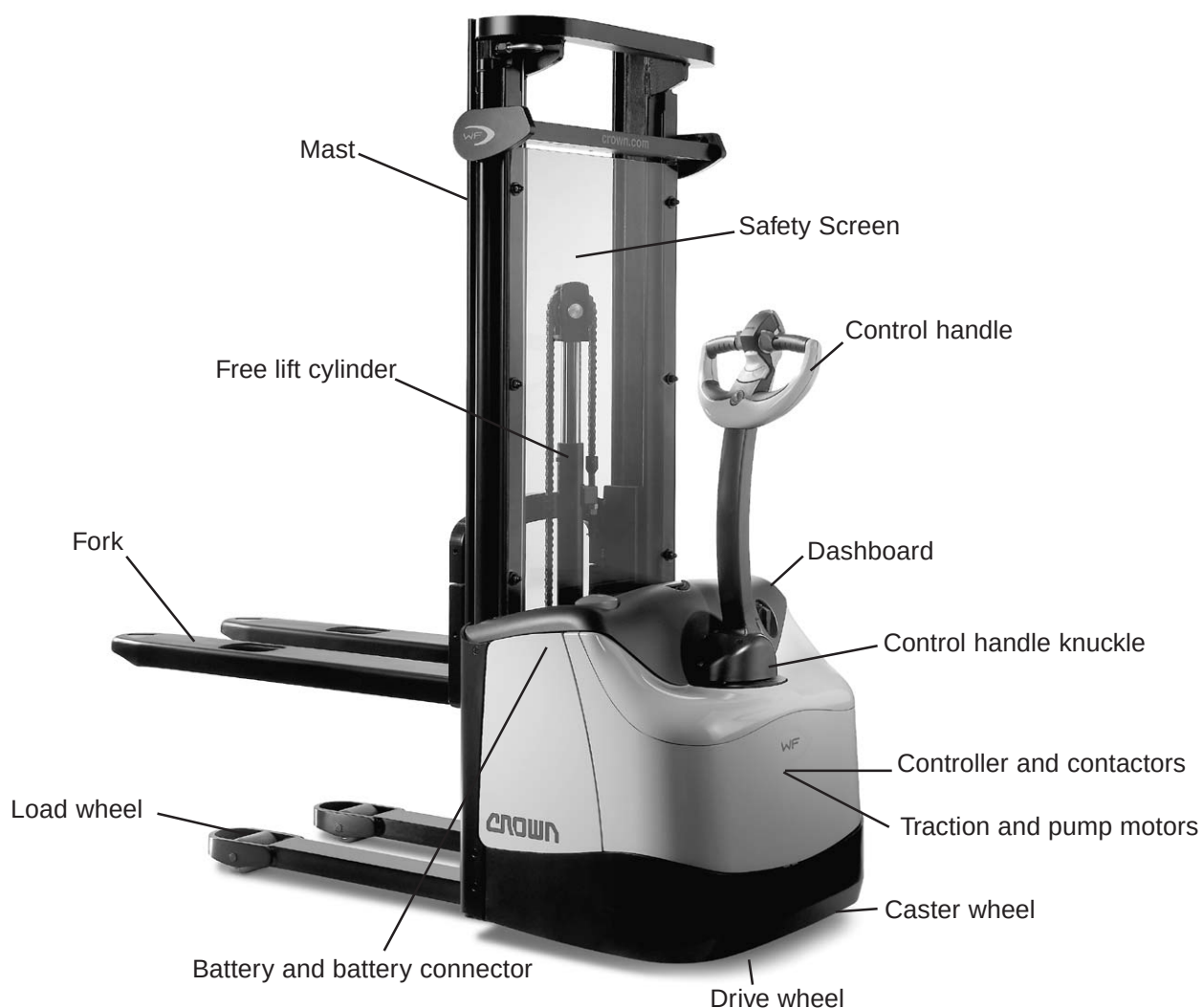


MO-3300-015

Component Access

Undo the 3 screws securing the dashboard. Lift off the dashboard and panel to gain access to the components beneath the panel.

Note: The illustration shows the model with the TT mast.



After disassembling the top panel you will be able to access the:

- Diagnostic LED on the TCM
- Fuse FU1 (travel power fuse)
- Fuse FUS (raise power fuse)
- Combination instrument
- Fuse FU3 (signal)
- Fuse FU4 (cold store versions only)

After lifting off the bottom panel you will be able to access the:

- Traction motor
- Power unit
- Brake
- Pump motor
- Hydraulic unit
- Horn
- Alarm transmitter
- Diode block
- Main contactor
- Relay K2
- Alarm filter block
- TCM (traction control module)
- HCM (hydraulic control module)

The hand grip contains:

- HNS1 & HNS2 (horn switches)
- LOS1 & LOS2 (fork lower switches)
- RAS (raise switch)
- HSS (fast / slow travel switch)
- SAS (safety reverse switch)
- FS, RS, POT (travel switch unit and potentiometer)

The control handle knuckle contains the:

- BRS (brake switch)
- ORS (brake override zone switch)

The mast contains the:

- FLS (flashing light)
- LMS (lift limit switch)

Maintenance

Recommended Lubricants and Oils

Lubricants

The next page shows typical lubricants used by Crown itself in its factories. However, you can use any lubricants provided they meet the same technical criteria.

Cold Store Trucks

Special hydraulic oil, lubrication oil and grease must be used for cold store trucks operating in low temperature conditions (see table on following page). An anticorrosion fluid (Crown no. 805236-004) must be applied to all screws, washers, nuts, pins, retaining rings etc. Carefully protect all electrical connections and components against corrosion. For detailed information, refer to chapter 4.

Service intervals must be adapted to the conditions of use. This means they must be reduced as far as possible to prevent excessive wear.

Taking the truck out of service

If you wish to take the truck out of service for more than 3 months, proceed as follows:

- Disconnect the battery from the truck.
- Decommission the battery in accordance with the manufacturer's instructions.
- Clean the truck*). Lubricate in accordance with the maintenance manual.
- If the truck is to be stored in harsh conditions (e.g. saline atmosphere) treat the surface of the truck with a suitable preservative to prevent corrosion.
- Do not park the truck in the open air or in a humid environment. The ideal place is a dry room where the temperature and air humidity are as constant as possible. If the truck has to be covered, use an air-permeable material. Do not use plastic sheets. Otherwise, condensation may form.
- Jack up the truck. Lower the chassis onto suitable wooden blocks so that the wheels clear the ground (prevents the wheels from flattening from constant pressure).

- Every 3 months connect the battery, carry out a daily inspection and activate all the truck functions. Now disconnect the battery again.

Bringing the truck back into service

- If you wish to bring the truck back into service, proceed as follows:
- Remove any anti-corrosion agents which have been additionally applied (apart from the cold store agents)*.
- Jack up the truck, remove the wooden blocks and lower the truck.
- Charge the battery or fit a charged battery.
- Connect the battery.
- Carry out the daily inspection.

* Do not apply high pressure cleaning agents and/or solvents to the truck. Do not use metallic brushes. Do not wet clean the electrical system and do not use flammable solvents.

Lubricant Table

Lubricant Type	Product Description	Manu- facturer	Crown Part No.	Type
Grease (multi purpose)	Aralube HLP2 LM-Grease Regulus A2 Beacon EP2 EP2 Mobiluxe EP2 Retinax LX LGWMI	Aral Castrol Century Esso Maxol Mobil Shell SKF	053002-001	B
Low temperature grease	Aralube SKL2 Unirex Lotemp EP	Aral Mobil	053002-005	BB
Hydraulic oil	Vitam GF 32 Hyspin AWS-32 Nuto H32 DTE 24 Tellus 32 Hydran LZ 32 B110	Aral Castrol Esso Mobil Shell Finol Fuchs Mineralölwerke GmbH	053001-003	D
Low temperature hydraulic oil	Deutz Oel HVI 32	Klockner	053001-009	DD
Transmission oil	Hyp 85W90 GX - D 85W90 Mobilube HD85/90 Spirax MB90	Aral Esso Mobil Shell	053002-004	A
Low temperature transmission oil	Mobil SHC 624	Mobil	053002-009	AA
Lubrication oil	Kowal 40 Essolube HDX + 40 Delvac 1240	Aral Esso Mobil	053002-007	G
Low temperature lubrication oil	SHC 626	Mobil	053002-008	GG
Rubber and vinyl dressing	---	---	---	H

L01_Lubricants_WF-GB

Adjuvants Table

Adjuvant	Product Description	Application	Crown Part No.
Anti-corrosive agent	Tectyl	Anti-corrosive agent for cold store trucks.	-----
Clearseal paint	2K Klarlack	Acid-resistant clearseal paint for traction controllers used in cold stores.	-----
Jointing compound	Elring Dirko	Jointing compound for gear unit covers (liquid seal).	310ml cartridge: 805236-002 100g tube: 805236-001

L01_Adjuvants_WF_GB

Test and Maintenance Schedule (X = Standard, C = Cold Store)

I = Inspection, L = Lubrication / A, M, ... = Lubricants			Months / Service Hours			
Item		Action	3 100	6 250	12 500	24 1000
I-1		Check the clearance of the load wheel and caster wheel bearings and check for wear	X / C			
I-2		Check the tyres of the load wheels, caster wheels and drive wheel for wear.		X / C		
I-3		Torque the drive wheel nuts on a new truck or 50 hours after removal/assembly. Thereafter, every 500 hours or every 12 months.			X / C	
I-4		Check hydraulic lines and hoses for damage, and check connections are tight.		X / C		
L-1	D/D-D	Check hydraulic oil level, replenish if necessary.		X / C		
L-2	D/D-D	Replace hydraulic oil				X / C
I-5		Check relief valve setting.			X / C	
I-6		Check rubber buffer on hydraulic motor.				X / C
I-7		Check carbon brushes and commutator of pump and traction motors for wear (see chapter 4).			X / C	
I-8		Check pump motor coupling for damage and wear.				X / C
I-9		Torque the traction motor and lift motor attachments.				X / C
I-10		Torque the gear unit attachment, check gear unit oil level.				X / C
I-11		Torque all power cable connections.			X / C	
I-12		Clean battery connector contacts and check contact springs.		X / C		
I-13		Clean battery connector contacts. Check connector housing, contact springs and cables.		X / C		
I-14		Mast cables: Ensure plug connections are tight. Strain relief present? Check cable pre-tension.		X / C		
I-15		Check charger connecting cable for damage.	X / C			
I-16		Check all electrical lines for damage to insulation, and ensure switches and connections are secure and check for corrosion.			X / C	
L-3	B/BB	Lubricate hinges and battery panel lock.		X / C		

L04_WF-GB

Test and Maintenance Schedule (X = Standard, C = Cold Store)						
I = Inspection, L = Lubrication / A, M, ... = Lubricants				Months / Service Hours		
Item		Action	3 100	6 250	12 500	24 1000
I-17		Clean pump contactor contacts and check for wear.		X / C		
I-18		Clean main contactor contacts and check for wear.			X / C	
I-19		Read traction controller error log. Torque traction controller attachment.			X / C	
I-20		Apply pressurised air to abrasion in brake. Check the conical nipple for damage. Check air gap.	X / C			
I-21		Dismantle the brake. Clean all components and check for wear and damage. Replace any worn or damaged components.			X / C	
I-22		Check the restoring force of the control handle springs.			X / C	
I-23		Check the steering chain tension.		X / C		
I-24		Check the lateral axis alignment of the truck.	X / C			
I-25		Check the alignment of the mast to the truck (lowering plumb test).		X / C		
I-26		Check fork carriage for cracks, and check rollers for slack.		X / C		
I-27		Check slack between forks and fork carriage.			X / C	
I-28		Check forks for damage and wear.			X / C	
I-29		Clean mast contact surfaces and check for wear.			X / C	
L-04	B/BB	Lubricate mast contact surfaces.			X / C	
I-30		Clean all lift chains, check for damage, corrosion and wear (elongation).		X / C		
L-05	G/GG	Lubricate lift chains.		X / C		
I-31		Check chain anchors for damage, corrosion and cracks.		X / C		
I-32		Check mast rollers for wear and slack.		X / C		
L-06	B/BB	Lubricate mast rollers and fork carriage rollers.		X / C		
I-33		Check load backrest for damage and ensure it is securely fitted.		X / C		

L05_WF-GB

Test and Maintenance Schedule (X = Standard, C = Cold Store)**I = Inspection, L = Lubrication / A, M, ... = Lubricants****Months / Service Hours**

Item		Action	3 100	6 250	12 500	24 1000
I-34		Check pulleys, pulley yoke, hose rollers and mast limit cushioning for wear, damage and slack.		X / C		
L-07	H	Lubricate hose rollers.		X / C		
L-08	G/GG	Lubricate chain pulleys.		X / C		
L-09	A/AA	Check gear oil level, replenish if necessary.		X / C		
L-10	A/AA	Replace gear oil				X / C
I-35		Check hydraulic cylinder piston rods for damage and ensure cylinder is sealed. Check cylinder attachment fuses.		X / C		
-		Carry out the UVV inspection. (Germany only. For other countries, refer to national regulations).	1 x annually			
-		PMT test (traction controller safety test, see chapter 4)	1 x annually			

L06_WF-GB

Truck Tilt Settings

DANGER



Truck tipovers can result in fatal injuries.

The risk of a tipover is greatly increased by setting the truck tilt angle beyond the tolerance level.

Adjust the truck tilt angle regularly and with care.

The stability of the truck requires the tilt angle to be kept as low as possible.

Maximum stability is achieved by measuring the lateral inclination and carrying out a lowering plumb test on the mast with appropriate adjustment.

The inclination of the truck and therefore the mast changes as the drive wheel and / or the caster wheel increasingly wear.

The inclination of the truck must be checked and if necessary adjusted in the following cases:

- Lateral inclination and lowering plumb test at the intervals given in the maintenance schedule.
- Replacing the drive wheel
- Replacing the caster wheel
- Replacing the mast

Testing and adjustment take place in 2 stages:

Testing and Adjusting the Lateral Inclination

The truck must be parked on a flat, level surface. The max. permissible deviation from the evenness and levelness of the 4 contact points on the truck (the two load wheels, caster wheel and drive wheel) must be less than 1 mm.

- Measure the skirt height off the ground (at the separating joint) on the left and right hand sides. The difference between the left and right hand sides should not exceed +/- 1mm.
- Adjust the height of the caster wheel to correct the lateral inclination of the chassis. To do this, undo the locking screw (3, Fig. MP-3300-007) and adjust the height via the setscrew (1).

- Fix the caster wheel again. Repeat the measurement to check the adjustment.
- If necessary, repeat the adjustment until the difference in height on the two sides is within the tolerance level.
- Now carry out the lowering plumb test.

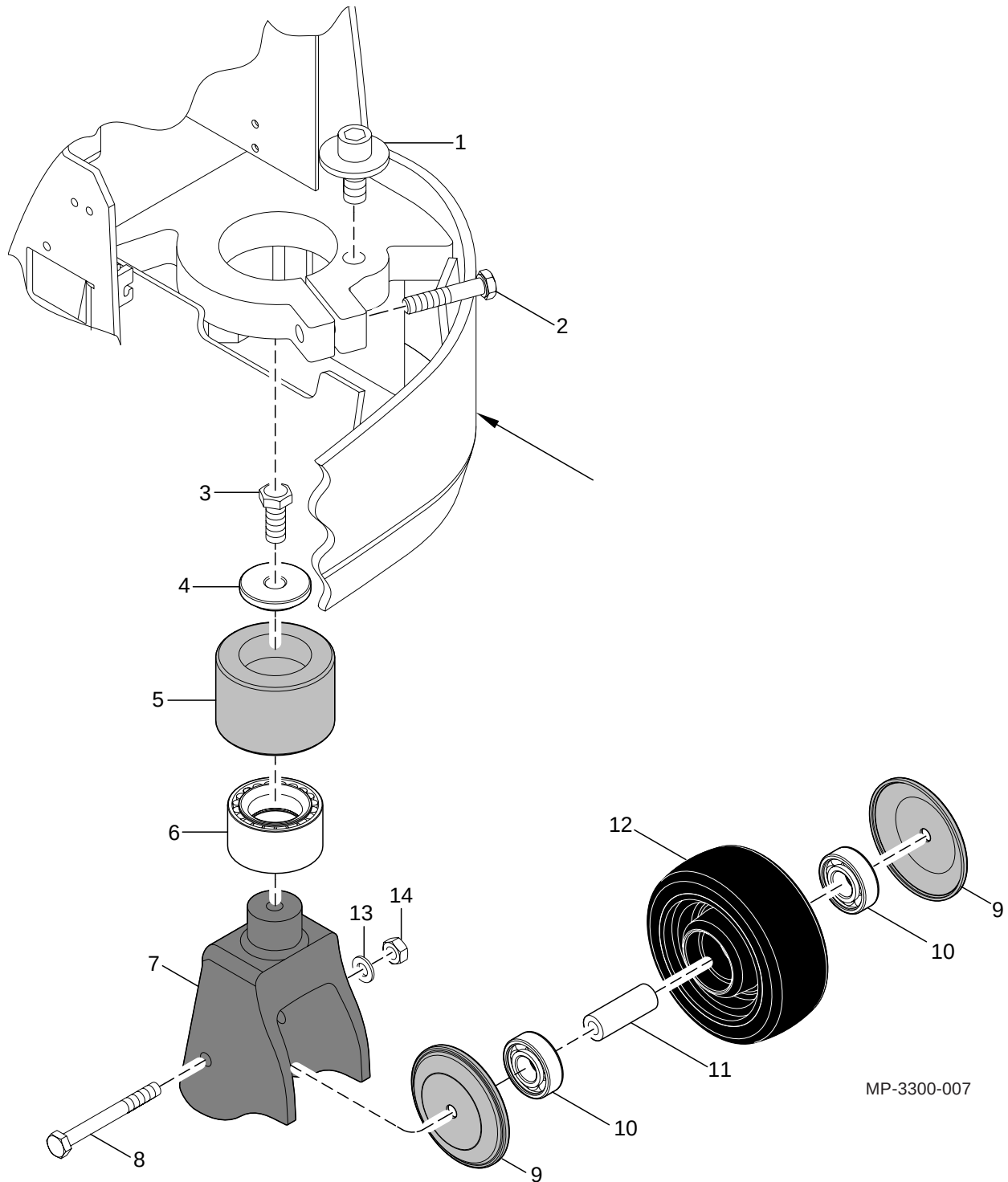
Lowering Plumb Test

Test the lateral inclination before carrying out the lowering plumb test.

The truck must be parked on a flat, level surface. The max. permissible deviation from the evenness and levelness of the 4 contact points on the truck (the two load wheels, caster wheel and drive wheel) must be less than 1 mm.

- Attach a test load (the maximum weight at maximum lift height and with the correct load centre of gravity - see capacity plate).
- Raise the test load approx. 300 mm.
- Attach a lowering plumb to the back of the fork carriage.
- Prepare a paper rectangle: 50 mm long and 20 mm wide. Mark out the middle of the rectangle.
- Wait until the plumb has finished oscillating and stick the previously prepared paper rectangle onto the ground below the plumb. The centre should lie underneath the tip of the plumb. The long side of the rectangle (50 mm) should be perpendicular to the truck's longitudinal axis.
- Now extend the mast as far as the stop and then lower it a few millimetres. It is important that the mast is not tensioned at the limit positions.
- Check the position of the lowering plumb. The plumb should not now be pointing outside the rectangle.
- If the plumb is pointing outside the rectangle in the lateral direction, the lateral mast inclination must be compensated using shims 813875-001/-002. The shims are positioned between the base of the outer mast and the truck base (RH or LH) and screwed to the rear panel of the battery.

- If the plumb is pointing outside the rectangle in the longitudinal direction, either the drive and caster wheels or the load rollers are heavily worn. In this case, check the wheels and rollers for wear and replace any worn wheels and rollers. Now repeat the lateral inclination setting and the vertical plumb test.



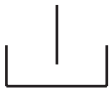
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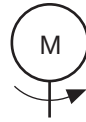
HYDRAULICS

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Hydraulic Symbols



Vented reservoir
with lines above the fluid level



Electric motor
with unidirectional turn and speed



Vented reservoir
with lines below the fluid level



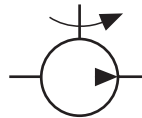
Electric motor
with unidirectional turn
and variable speed



Filter or strainer



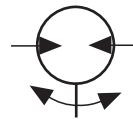
Hydraulic line with full flow
(tubing or hose)



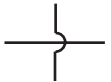
Hydraulic pump
with fixed displacement
and single direction of turn



Pilot or drain line or drainage
with limited flow



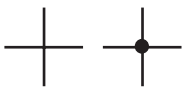
Hydraulic motor,
bi-directional



Lines crossing; not connected



Pressure gauge



Lines crossing and connected



Thermometer



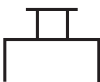
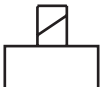
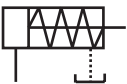
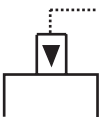
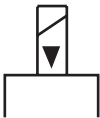
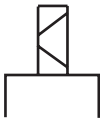
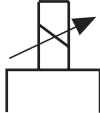
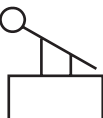
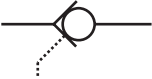
Plugged port (test port)



Accumulator gas charged
diaphragm type



Flow meter

	Pressure switch		Manual actuator
	Double-acting cylinder; unequal area		Spring, (bias to normal de- energised position)
	Double-acting cylinder; equal area		Solenoid single coil or winding
	Single-acting cylinder with spring returned (rod end vented)		Hydraulic pilot operated
	Single-acting cylinder ram type		Solenoid valve, pilot operated
	Single-acting cylinder, with cushion		Dual solenoid
	Assembly housing, manifold block		Proportional solenoid
	Manual lever actuator		Pilot check valve (pilot to open)



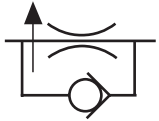
Throttle, fixed



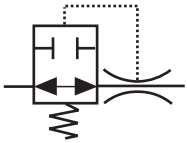
Throttle, adjustable



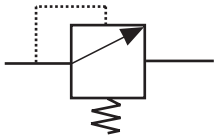
Pressure-compensated flow control, fixed



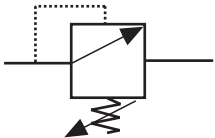
Pressure-compensated flow control with reverse flow bypass; fixed.



Velocity fuse



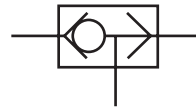
Relief valve, fixed setting



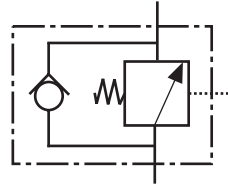
Relief valve, adjustable



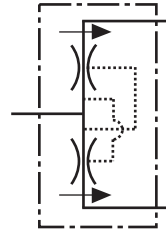
Check valve



Shuttle valve



Single counterbalance valve assembly in manifold



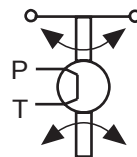
Flow divider/combiner



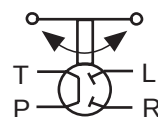
Bypass flow control with controlled flow, pressure-regulated



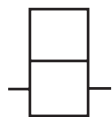
Shut-off valve, manual



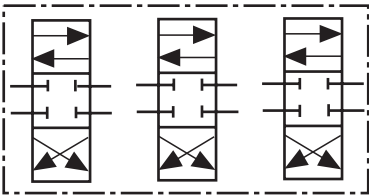
Torque generator



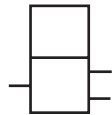
Hydraulic steer unit



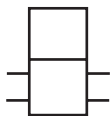
2/2 way valve
(two way, two switch positions)



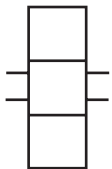
Valve block with
3 operating units



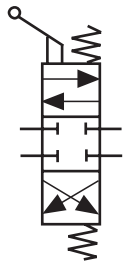
3/2 way valve
(three way, two switch positions)



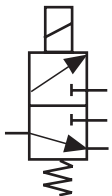
4/2 way valve
(four way, two switch positions)



4/3 way valve
(four way, two switch positions)



4/3 way valve
(four way, two switch positions);
manual activation and spring centered



3/2 way valve
(three way, two switch positions);
Spring bias solenoid control

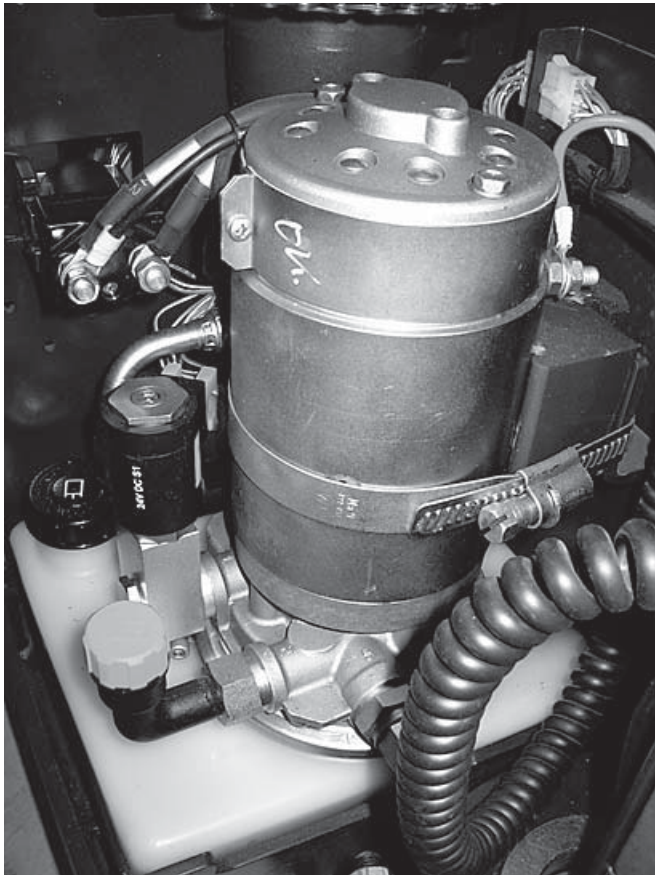
M3562

Hydraulics

Hydraulic Reservoir Capacity

The hydraulic reservoir has a capacity of 5.4 litres up to the max. oil level mark. The marking on the hydraulic reservoir serves to indicate the maximum capacity. When checking the hydraulic oil level, make sure that the cylinders are fully retracted and that the entire hydraulic system is fully bled.

Only start the truck once the reservoir has been filled with the approved hydraulic oil up to the maximum level. For the correct grade, refer to the lubricant table in Chapter 1.



MS-3300-001

The hydraulic oil is filled up to the marking on the hydraulic reservoir. The oil level should not deviate by more than ± 3 mm from this level.

Changing the Hydraulic oil and Hydraulic Filter

WARNING



De-pressurise all components before carrying out maintenance work on the hydraulic system.

High pressure hydraulic oil can cause serious injuries.

Whenever a high pressure fluid enters the skin it must be treated as an emergency, even if the skin initially shows no reaction.

Physical effects may take time to set in.

Secure all connections before re-applying system pressure. Keep hands and body away from any ports as high pressure hydraulic oil can emerge.

Use absorbent paper to trace leaks, never use your hands!

- Fully lower the forks. Retract the mast fully.
- Turn the key switch OFF. Remove the key. Disconnect the battery.
- Attach a warning tag to the control handle to advise others that the truck is being serviced.
- Chock the drive wheel and load wheels.
- Remove the front cover from the drive unit to access the hydraulic reservoir.
- Remove the knuckle cover and the two-part centre cover of the control handle. Rotate the control handle 90° (towards the hydraulic reservoir). This will give you better access to the hydraulic system components.
- Undo the retaining strap which secures the motor to the chassis. Push the strap up to loosen it from the chassis.

- Separate the hydraulic lines from the hydraulic pump. Seal the hydraulic ports immediately to minimize oil loss and prevent hydraulic system contamination.
- Disconnect all electrical wiring from the hydraulic unit. Insulate the wire ends to prevent sparking. Tag out the wire ends and motor terminals to avoid any confusion when you later connect the wires.
- The reservoir and motor/pump assembly can now be moved. Carefully raise the reservoir and pull it forward as far as possible. Remove the reservoir and the motor/pump assembly from the drive unit frame.
- Remove the screw from the clamp securing the motor/pump assembly to the reservoir flange. Open the clamp until it drops off the flange and rests on the top of the reservoir.
- Lift the motor/pump assembly from the reservoir.
- Remove the oil from the reservoir and any remains that have built up in the reservoir. Observe local disposal regulations.
- Remove the retaining ring of the strainer in the filter housing of the suction line below the pump. Replace the filter. Refit the strainer in the filter housing of the suction line. Attach the strainer and the retaining ring.
- Fit the motor/pump assembly onto the reservoir. Centre the pump flange with the flange on the reservoir.
- Refit the clamp and tighten the mounting screw firmly.
- Fit the reservoir and the motor/pump assembly in the drive unit frame.
- Connect the power cables to the pump motor and tighten the connections securely.
- Reconnect the hydraulic supply lines and the electrical connections. Tighten the connections firmly.
- Make sure that the reservoir and motor/pump assembly are against the frame. Now tighten the holding strap to secure the motor/pump assembly to the drive unit frame.
- Fill the reservoir up to the full mark via a filter (at least 10 micron) using the correct hydraulic oil grade according to the operating conditions of the truck (see Chapter 1, Lubricant table).
- Refit the covers of the control handle, and tighten the mounting screws firmly.
- Refit the front cover of the drive unit, and tighten the mounting screws firmly.
- Remove the wedge.
- Connect the battery and remove the warning tag from the control handle.
- Bleed the hydraulic system (see Chapter 8, Cylinder Bleeding and Flushing).

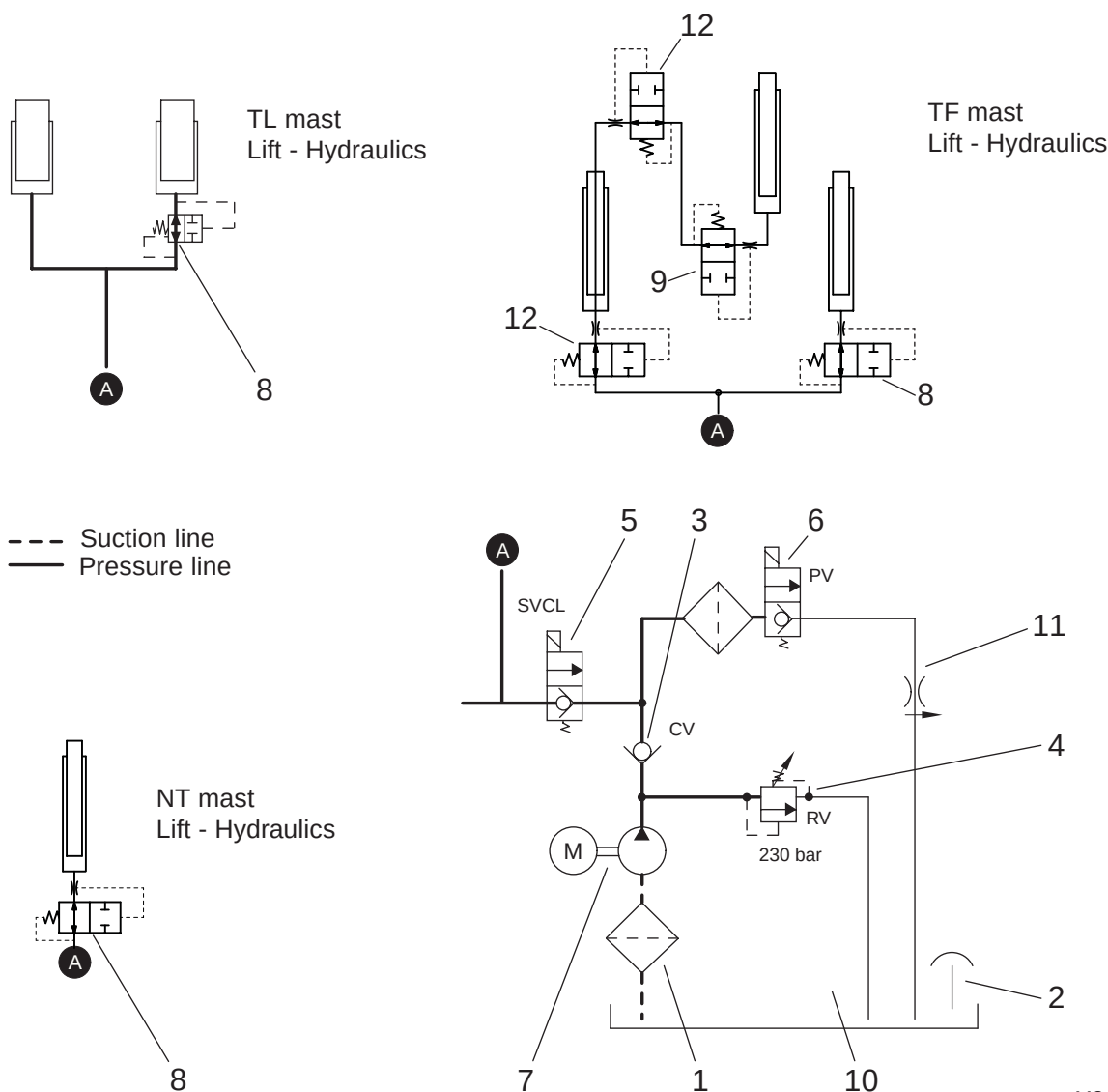
Hydraulic system

Function

Lifting (see diagram)

If the "Raise" switch is pressed down on the control handle, the pump motor is energised and starts to drive the pump. The pump initially draws oil from the reservoir via the suction filter, directing it through the internal check valve and the proportional valve which opens briefly, and back to the oil reservoir. While the proportional valve is fully closed, the operating pressure builds up on the lift cylinder (soft lift). A relief valve in the circuit keeps the pressure to the maximum permissible limit.

- 1 Suction filter
- 2 Reservoir ventilation
- 3 Check valve (CV)
- 4 Overload valve (RV)
- 5 Cylinder shutoff valve (SVCL)
- 6 Proportional valve (PV)
- 7 Pump & motor
- 8 Line break safety device (LH lift cylinder, opposite the fork direction)
- 9 Free lift cylinder line break safety device
- 10 Reservoir
- 11 Flow restrictor
- 12 Line break safety device (RH lift cylinder, opposite the fork direction)

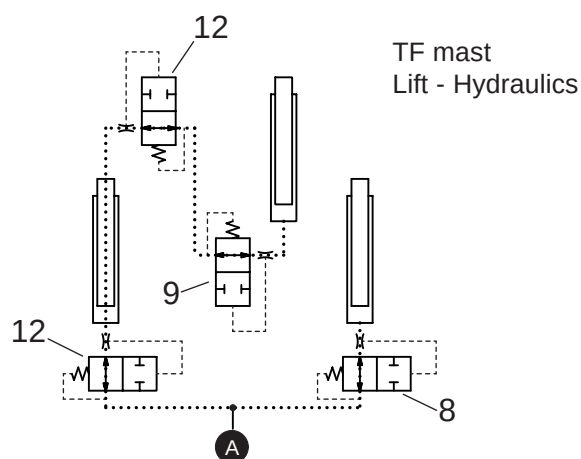
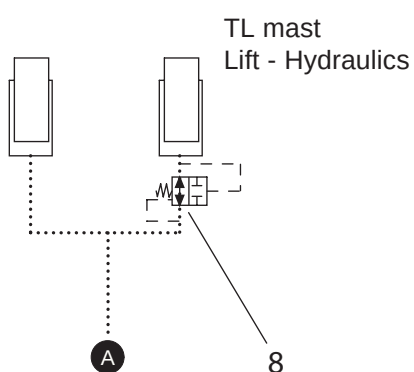


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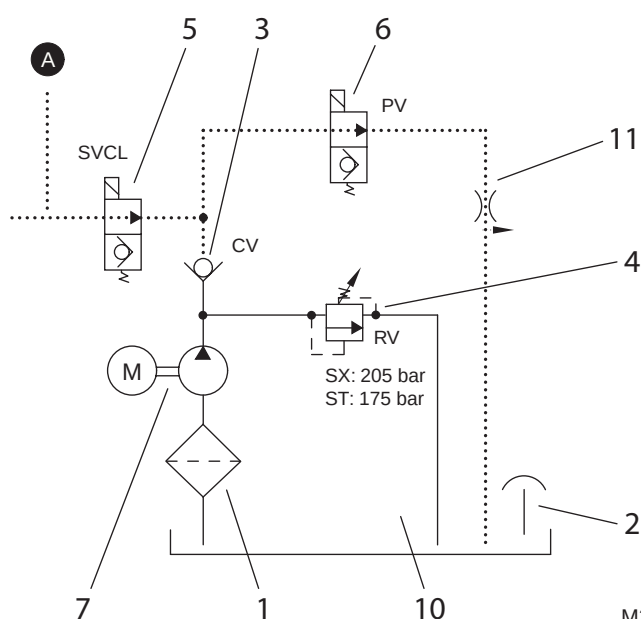
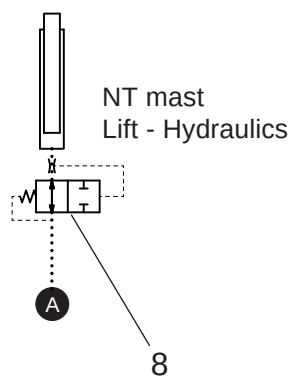
Lowering (see diagram)

If one of the two "Lower" switches (LOS1 or LOS2) is pressed down on the control handle, the shutoff valve opens. At the same time the proportional valve opens according to whether LOS1 or LOS2 has switched fully or partially. The hydraulic oil can now flow from the cylinder(s) via the flow restrictor back to the oil reservoir. If the proportional valve is partially open, lowering is slow. If the proportional valve is fully open, lowering is fast.

- 1 Suction filter
- 2 Reservoir ventilation
- 3 Check valve (CV)
- 4 Overload valve (RV)
- 5 Cylinder shutoff valve (SVCL)
- 6 Proportional valve (PV)
- 7 Pump & motor
- 8 Line break safety device (LH lift cylinder, opposite the fork direction)
- 9 Free lift cylinder line break safety device
- 10 Reservoir
- 11 Flow restrictor
- 12 Line break safety device (RH lift cylinder, opposite the fork direction)



..... Return



M3565a

MOTOR AND PUMP ASSEMBLY

Hydraulic Lines and Fittings

WARNING



De-pressurise all components before carrying out maintenance work on the hydraulic system. High pressure hydraulic oil can cause serious injuries.

Whenever a high pressure fluid enters the skin it must be treated as an emergency, even if the skin initially shows no reaction.

Physical effects may take time to set in.

Secure all connections before re-applying system pressure. Keep hands and body away from any ports as high pressure hydraulic oil can emerge.

Use absorbent paper to trace leaks, never use your hands!

General Rules for Hydraulic Lines and Connections

- Apply pressurised air to all hoses and lines before assembling them, to remove any loose particles. Bent steel or plastic lines will be permanently damaged. These must be replaced even if the damage is not externally visible.
- Any hose which bends during operation in its normal assembly position must also be replaced.
- All hoses and lines must have sufficient clearance from other surfaces or edges that could result in wear or cuts or where the hoses or lines could get caught.
- All connections must be tight and without leaks.

Bleeding the Hydraulic System

Whenever work has been performed on hydraulic components, the hydraulic system must be flushed and bled. The procedure for doing this can be found in Chapter 8 under "Cylinder Bleeding and Flushing".

Drift Test

Whenever work has been performed on hydraulic components a drift test must be carried out to ensure that certain system components are working correctly. The procedure for doing this can be found in Chapter 8 under "Drift Test".

Proportional function:

Whenever maintenance work has been performed on the hydraulic system.

Ensure that the load can start smoothly when the lift motor is switched on and that the load can also brake smoothly when lowering is switched off (subjective test).

The HCM (hydraulic control module) may have to be calibrated (see Electrics chapter).

REMOVAL

WARNING



De-pressurise all components before carrying out maintenance work on the hydraulic system.

High pressure hydraulic oil can cause serious injuries.

Whenever a high pressure fluid enters the skin it must be treated as an emergency, even if the skin initially shows no reaction.

Physical effects may take time to set in.

Secure all connections before re-applying system pressure. Keep hands and body away from any ports as high pressure hydraulic oil can emerge.

Use absorbent paper to trace leaks, never use your hands!

- Fully lower the forks. Retract the mast fully.
- Turn the key switch OFF. Remove the key. Disconnect the battery.

- Attach a warning tag to the control handle to advise others that the truck is being serviced.
- Chock the drive wheel and load wheels.
- Remove the front cover from the drive unit to access the hydraulic components.
- Disconnect the power cables from the pump motor. Insulate the wire ends to prevent sparking.
- Disconnect all the hydraulic supply lines and/or electrical connections that obstruct you when removing the motor/pump unit.
- Remove the strap (and where applicable the spacer) which fixes the pump motor to the chassis. Undo the clamp that fixes the motor/pump assembly to the reservoir.
- Remove the motor/pump assembly from the reservoir and take it to a suitable work area for further dismantling.
- Check the connections again for leaks once the system has reached operating temperature.

MOTOR

Refer to Chapter 4, "Electrics", for pump motor maintenance and repair instructions.

PUMP

The hydraulic pump cannot be serviced and can only be replaced as a complete assembly. Before fitting a new pump, make sure that the pump and all its hydraulic components are clean. Install a new suction filter (see section on changing the hydraulic oil and filter).

After replacing the pump:

- Use clean, filtered hydraulic oil (at least 10 micron) to replenish the reservoir.
- Never run the pump without oil.
- Start the installed pump unladen (pressure side open) and leave it to pump hydraulic fluid for max. 20 seconds. This will ensure the pump is bled and that there is sufficient lubrication. Close the pressure side again as soon as the oil emerges without bubbles. Bleed the entire system (see Chapter 8, Cylinder Bleeding and Flushing).
- If the oil is still foaming after approx. 20 seconds, the system must be checked (see "Hydraulic System Troubleshooting Table" on following page).

Replacing the relief valve

- Remove the locking mechanism (4) and unscrew the relief valve (3),
- Remove the O ring and the strainer from the valve seat if they are still in there.
- Apply a thin coat of hydraulic oil to the new O ring and place it in the valve seat with the strainer.
- Apply hydraulic oil to the relief valve, insert it into the valve seat and tighten. Tap in the new locking mechanism.
- Refit the hydraulic unit and adjust the relief valve.

- Repeat the test. Repeat the setting until the relief valve opens within the tolerance range.

Relief valve test and setting

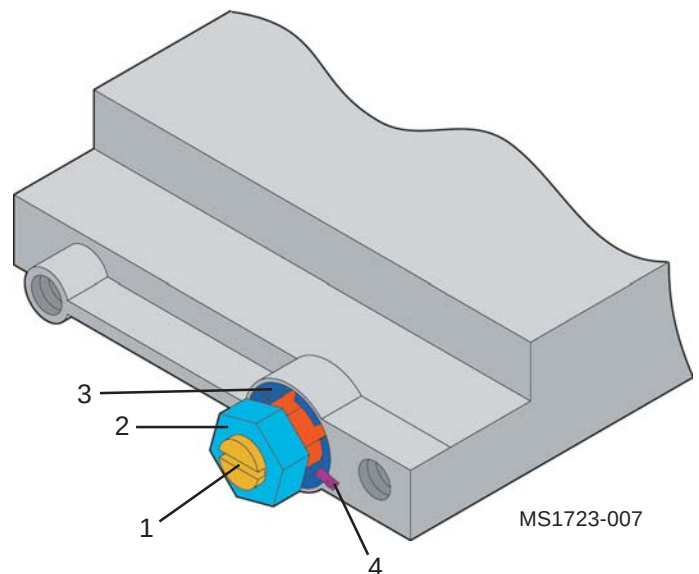
The relief valve protects the hydraulic system and the lifting mechanism from overloading.

WARNING



Do not let the pump unit run unless it is fixed to the chassis.

The amount of torque will twist the unit. This can result in short circuits and damage.



Model	Rated capacity	Minimum load	Maximum load
WF3000-1.0	1,0 t	1,100 kg	1,200 kg
WF3000-1.2	1,2 t	1,320 kg	1,420 kg

H01_GB

- With the truck at operating temperature, raise a test load on the forks that corresponds to 110% of rated capacity (= minimum load). It should be easy to raise the load.
- Now raise a test load that corresponds to 110% of rated capacity + 100 kg (=maximum load). It should not be possible to raise this load. (relief valve opens).

If necessary, adjust the relief valve so that it opens within the above mentioned tolerance range.

- Hold onto the setscrew (1) and loosen the jam nut (2): Turn the setscrew clockwise to increase the limit until the valve opens, turn it anti-clockwise to reduce the limit
- Counter-fix the setscrew (1) again with the nut (2).

Hydraulic System Troubleshooting

Symptom	Probable Cause	Remedy
Noisy Pump	• Low oil level • Incorrect oil viscosity (e.g. standard oil used in cold store) • Inlet hose connection leak (pump suctions air) • Partially blocked suction hose filter	Check oil level, replenish. Use the correct hydraulic oil for the application. Check suction line connection to the pump. Replace filter
Foaming hydraulic oil	• Air in system • Water in oil	Check oil level Check suction line connection to the pump Clean reservoir and replace hydraulic oil.
Pump or oil overheating	• Incorrect oil viscosity (e.g. standard oil used in cold store) • Oil contaminated with water • Air in system • Pressure relief valve permanently open	Fully drain, clean and fill with suitable oil for the application. Fully drain, clean reservoir and add clean oil. Check oil level Check suction line connection to pump (see "Foaming Oil") Check setting and operation of relief valve
Low flow	• Air in system • Relief valve leaking or set too low • Oil too hot	See "Foaming oil". See "Pump or Oil Overheating" Check setting and operation of relief valve, replace if faulty
Failure to build pressure	• Defective relief valve • Low oil level	Check operation of relief valve, replace if faulty. Add oil

H02-GB



DRIVE UNIT

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Gear Unit

Drive unit attached to flange of
control handle support

Discharge filter

Drive motor with drive pinion removed

Drive wheel

MS-3230-100

Gear unit cover

Pinion shaft and gearwheel

Oil refill plug (6 Nm)

Oil level

Driven shaft and gearwheel

Drain plug (6 Nm)

M1472

Drive unit, general

The drive unit consists of the gear unit and the drive motor.

The drive motor can be removed without removing the drive unit or dismantling the gear unit. For a vertical drive system it is not necessary to drain the oil.

WARNING



The drive unit is heavy.

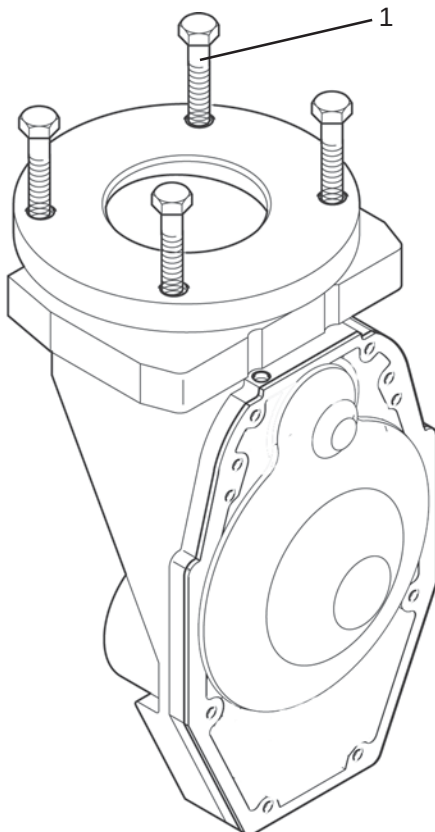
Use a suitable device to prevent the drive unit from tipping over on removal.

The easiest method is to lift the truck away from the loosened drive unit using a crane.

If you have to jack up the truck in order to release the drive unit, firmly secure the truck underneath.

Drive unit removal

- Disconnect the battery and prevent the truck from being switched on again.
- Disconnect the electric wiring from the motor.



MS1723-031

- Prevent the drive unit from tipping over and remove the 4 mounting screws (1, Fig. MS1723-031) which secure the drive unit to the flange of the control handle support.
- Either jack up the truck so that the drive unit can be removed from underneath it, or raise the truck using a crane with sufficient capacity (see chapter 1 for instructions and safety notes).
- Position the drive unit in a secure device.

Drive motor removal

NOTE



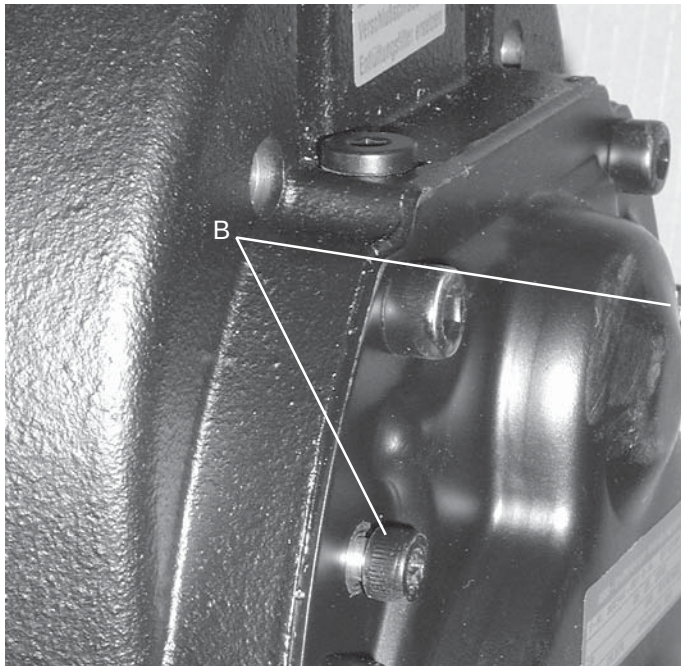
If you are removing the drive motor with the drive unit installed, you must ensure that the motor does not get caught in the bearing cage of the drive unit when it is removed.

Tilt the drive unit so that the motor can be freely removed.

- Disconnect the battery and prevent the truck from being switched on again.
- Disconnect the electric wiring from the motor.
- Unscrew the mounting screws (A, Fig. MS1723-021) approx. 5 mm from out of the housing.

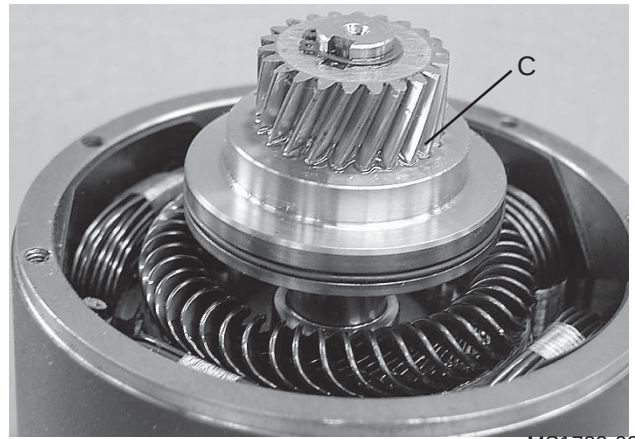


MS1723-021



MS1723-022

- Unscrew both screws (B, Fig. MS1723-022).
- Screw 2 M8 bolts into the thread (B, Fig. MS1723-022) with a minimum length of 35 mm and tighten them on alternate sides until the motor is removed from the centering shoulder.
- **Prevent the motor from falling out!** Unscrew both screws (A, Fig. MS1723-021). **Attention: Take care not to damage the toothing (C, Fig. MS1723-024) and D, Fig. MS1723-023)**



MS1723-024

Motor disassembly

NOTE

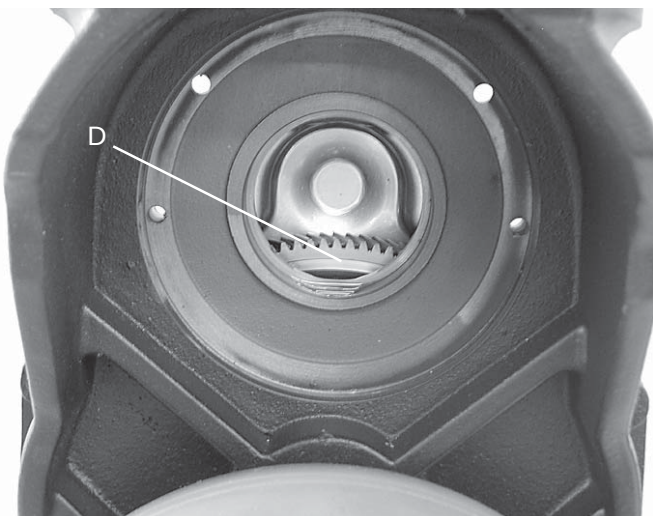


All item numbers in the following sections refer to Figure MS-1723-027-A on the following page unless another figure number is indicated.

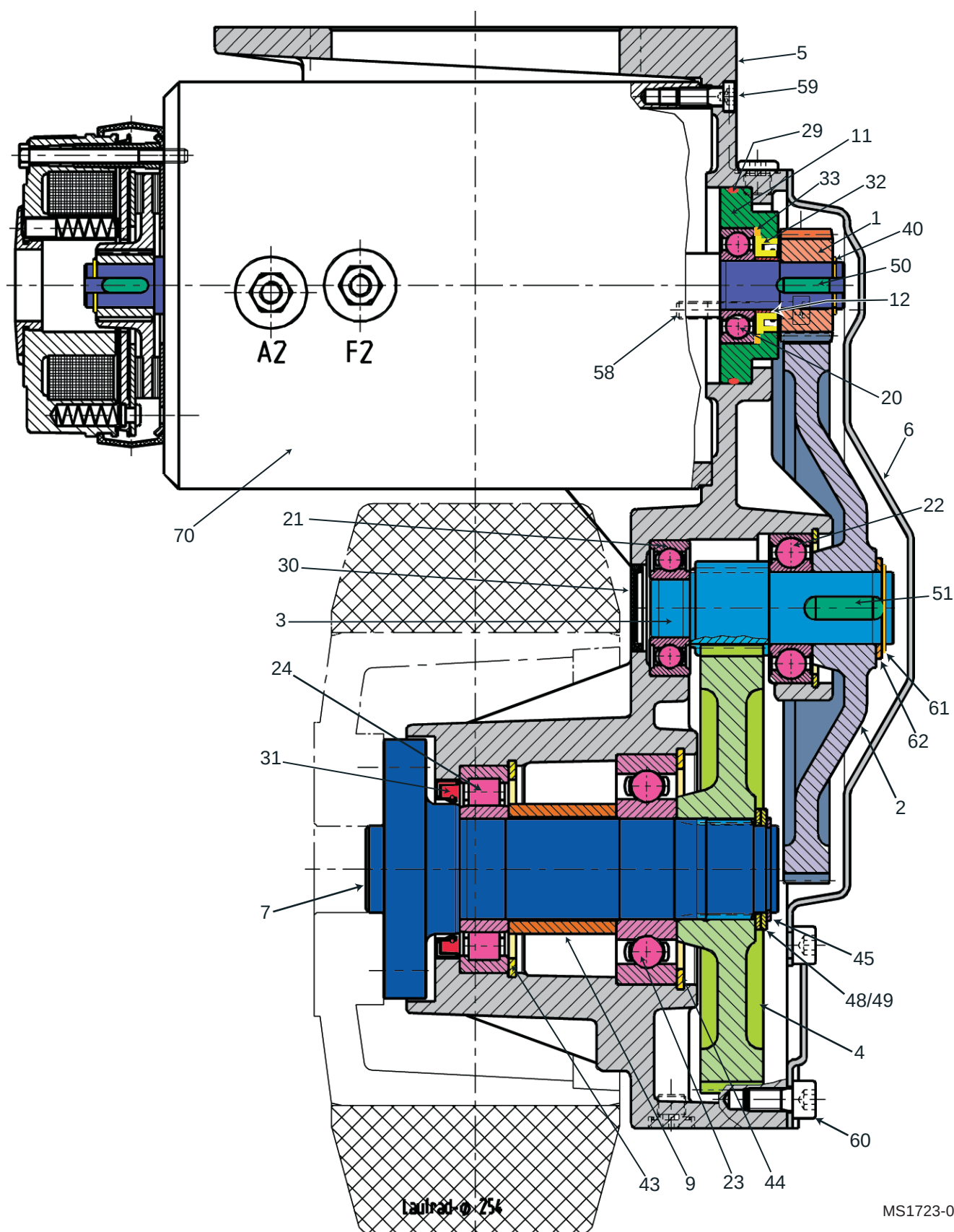
- Remove the motor as described in the previous section.
- Disassemble the brake (see "Brake" chapter).
- Remove the retaining ring (40).
- Remove the pinion (1) via the bushing (11) using an extractor.
- Remove the conical nipple (29).
- Press out the shaft seal (32).
- Extract the bearing (20) and the inner ring (12).

Motor assembly

- Press the bearing (20) onto the rotor shaft. At the same time hold the opposite shaft end securely.
- Seal the inner ring (12) with Loctite® 601.
- Place the conical nipple (29) in the bushing (11) and press in the shaft seal (32). Now insert the ball bearing shim (33) into the bushing (11).
- Fit the complete bushing onto the motor armature.
- Insert the feather key (50) and the pinion (1).



MS1723-023



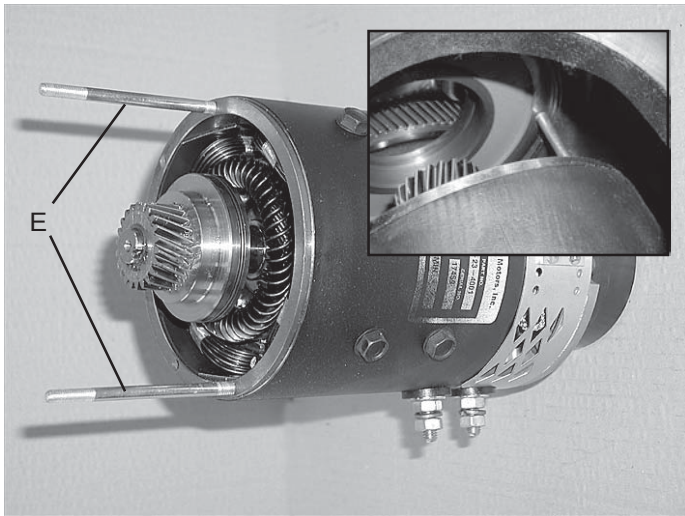
MS1723-027A

- Fit the retaining ring (40).
- Attach the brake (see "Brake" chapter).
- Fit the motor as described below.

Drive motor assembly

Tools required: 2 off M6 threaded rods, approx. 100 mm long.

- To aid the assembly, screw 2 off M6 threaded rods, approx. 100 mm long, into two opposite threaded holes of the motor (E, MS1723-023)

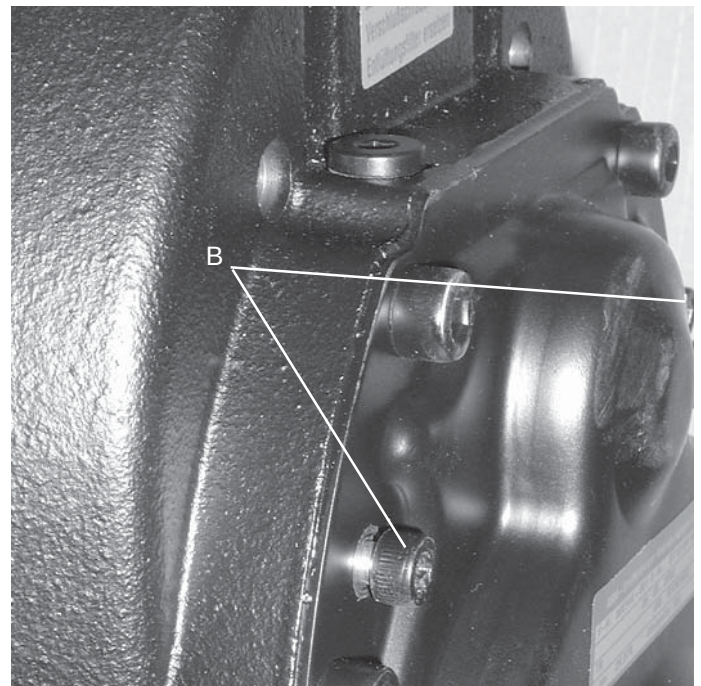


MS1723-023

- Push the motor into the gear unit with the mounting aids ahead, and push it into the locating edge. **Take care not to damage the toothing in the process.**
- Insert the two mounting screws of the motor (A, Fig. MS1723-021) back onto the gear unit. Alternately tighten the two screws in small increments. This will pull the motor completely into the centering shoulder and prevent it from twisting in the centering shoulder.
- Refit the screws (B, Fig. MS1723-022).
- Torque screws A, Fig. MS1723-021 and B, Fig. MS1723-022 to **10 Nm**.
- Refit electrical connections to the motor and the brake.
- Carry out an operational test.



MS1723-021



MS1723-021

Gear unit disassembly

General

NOTE

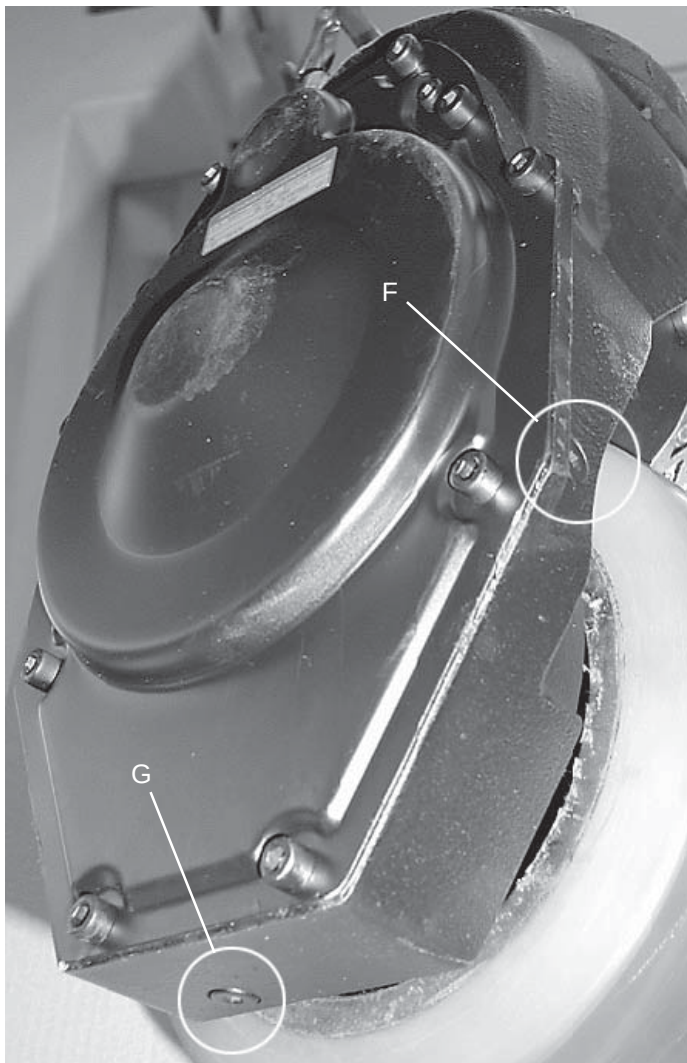


It is not necessary to remove the motor if you are dismantling the gear unit and re-assembling it.

If you are dismantling the gear unit, you must replace all bearings and seals. Used bearings and seals will result in premature failure of the unit.

Preparation

- Disconnect the battery and prevent the truck from being switched on again.
- If necessary, remove the motor as described in the previous section.
- Unscrew and remove the drive wheel.



MS1723-028

Draining the oil

- Place a tray underneath the drain plug (G, Fig. MS1723-029) of the gear unit and drain the oil. Unscrew the control plug (F) to allow the oil to drain faster.

Drive unit removal

- Now remove the drive unit for disassembly. Refer to the "Drive unit removal" section at the start of this chapter.
- Remove both screws (58, Fig. MS1723-027) and the 10 screws (6) which secure the housing lid.

Gear unit cover removal

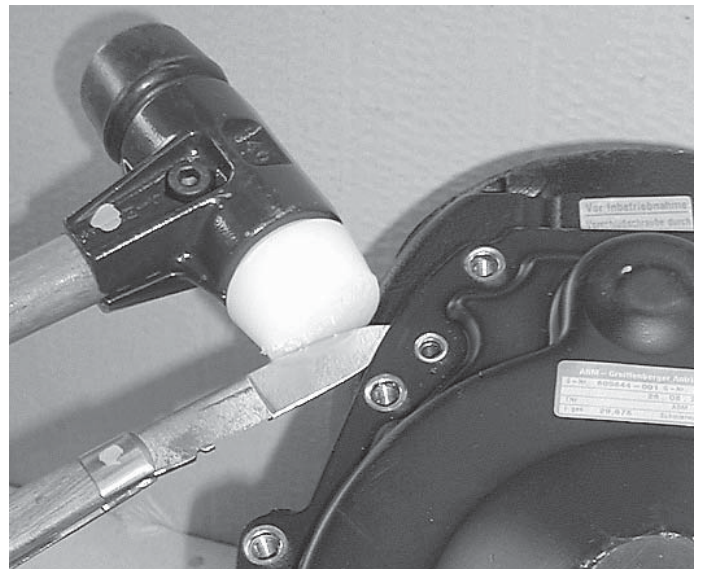
WARNING



Do not damage the contact surfaces of the gear unit housing and the gear unit cover.

Do not use a thick tool (screwdriver or similar). This will damage the contact surfaces.

- Tap a burr-free, thin tool along the circumference of the seal gap until the housing cover can be gently removed (see Fig. MS1723-030).



MS1723-029

- Using a scraper carefully remove the sealant remains from the contact surfaces of the gear unit housing and the gear unit cover. Now thoroughly clean the contact surfaces with a suitable solvent (e.g. Loctite® 7063 Cleaner).

Gear unit disassembly

NOTE



All item numbers in the following sections refer to Figure MS-1723-0027-A on the following page unless another figure number is indicated.

- Remove the retaining ring (61, Fig. MS1723-027A) and the supporting ring (62).
- Using a suitable extractor pull off the wheel (2).
- Remove the retaining ring (45) and the two shims (48, 49).
- Press off the driven shaft (7) in the direction of the drive wheel. **This will inevitably damage the bearing (23).**
- Remove the retaining ring (44) and extract the bearing (23). **The bearing can no longer be used.**
- Remove the retaining ring (43) and extract the bearing (24) via the outer ring.
- Now press out the shaft seal (31).
- Remove the retaining ring (42) and the sealing cover (30).
- Press off the pinion shaft (3) in the direction of the gear unit cover (6). Both bearings (21 and 22) will remain on the pinion shaft.
- Remove the two bearings (21 and 22) from the pinion shaft (3).

NOTE



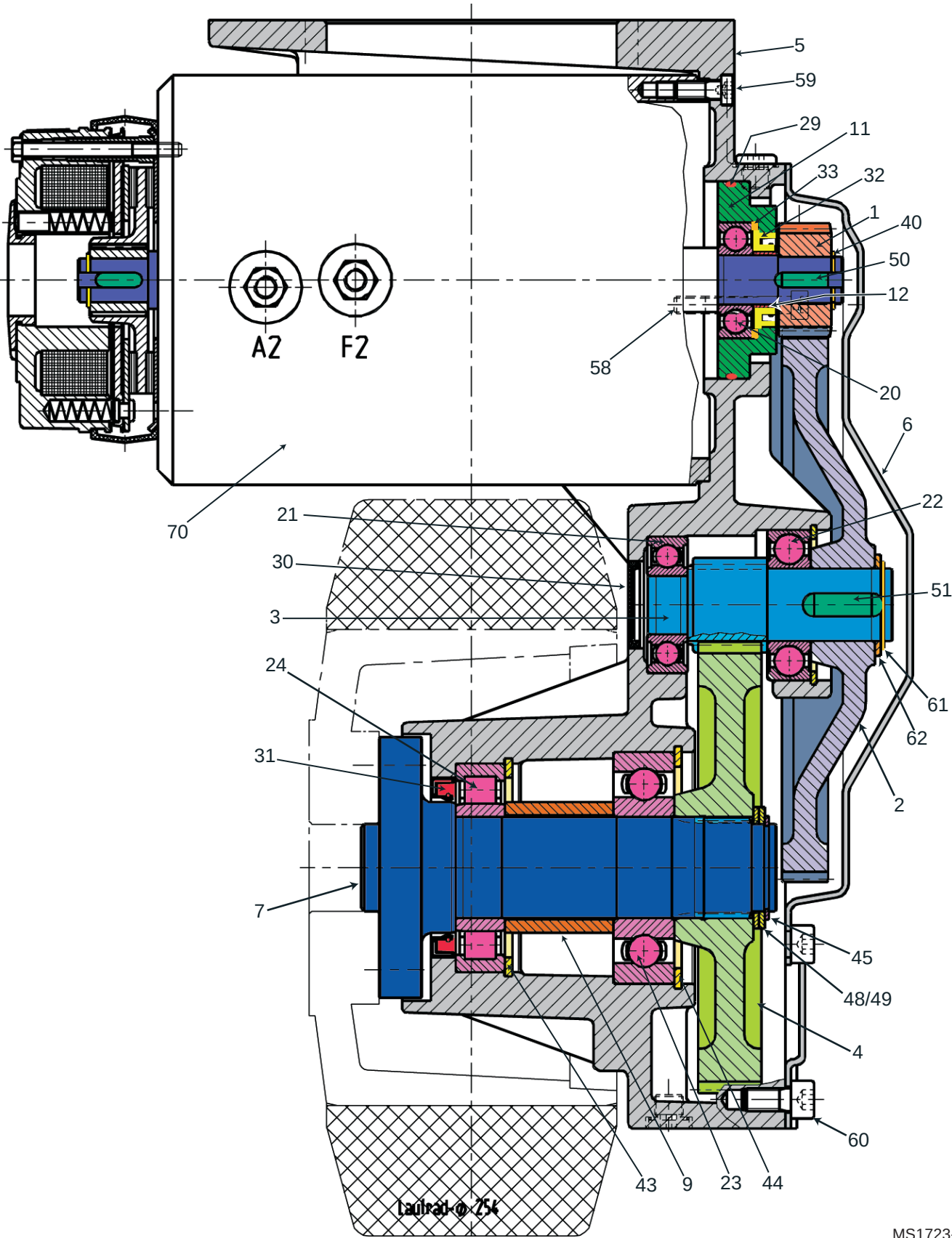
The output gear is part of the motor. The procedure for removing the pinion and the bearings is described in the Drive Motor section on the previous pages.

Gear unit assembly

Replace all bearings and seals. Used bearings and seals will result in premature failure of the unit.

- Press the bearing (21) into the housing via the outer ring.
- Press the inner ring of the roller bearing (24) onto the drive shaft (7).

- Press the shaft seal (31) from the outside into the seat on the gear unit housing.
- Fit the outer ring of the roller bearing (24) and insert the retaining ring (43).
- Place the bushing (9) onto the rollers of the bearing (24) and press the bearing (23) into the gear unit housing and insert the retaining ring (44).
- Place the wheel (4) in position and guide the drive shaft carefully into the shaft seal. Align the bushing in the process.
- Align the wheel (4) with the tooth shaft profile of the drive shaft (7).
- Support the wheel (4) with suitable bushing and press the drive shaft (7) into the wheel (4).
- Using an appropriate number of shims (49), distance the drive shaft (7) between the two shims (48) so that there is no slack and insert the retaining ring (45).
- Press the bearing (22) onto the pinion shaft (3).
- Hold against the inner ring of the bearing (21) and fit the pinion shaft (3). Press in the retaining ring (42).
- The contact surfaces of the cover and gear unit housing must be clean and oil-free. If necessary, clean the surfaces as described in the Gear Unit Cover Removal section.
- Apply a layer of Dirko® sealant (part no. see chapter one, lubricants) all around the contact surfaces of the gear unit cover.
- Insert the feather key (51) into the pinion shaft (3).
- Hold against the inner ring of the bearing (21) and fit the wheel (2) onto the pinion shaft (3).
- Thread the supporting ring (62) onto the pinion shaft (3) and insert the retaining ring (61).
- Press the sealing cover (30) into the housing.



MS1723-027A

Gear unit cover installation

- Place the gear unit cover onto the housing and press on it gently.
- Insert all 10 mounting screws (M8x16 Tuflock A) of the cover and torque them evenly and cross-wise to 25 Nm.
- If you have removed the motor, install it again as described in the Drive Motor Assembly section.

Adding Oil

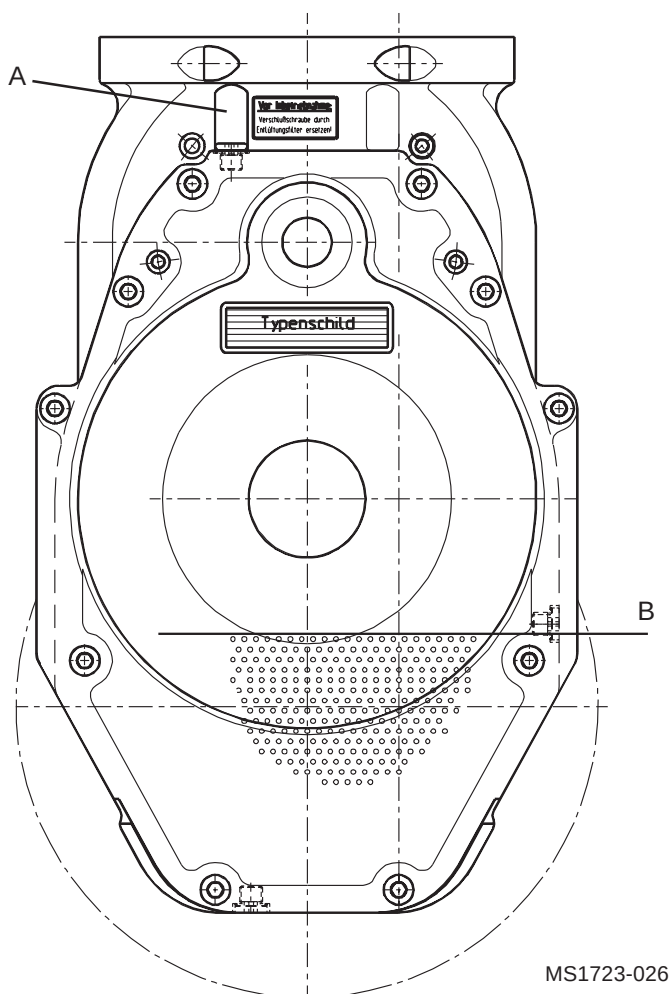
You will require approx. 0.7 litres of gear oil (see Lubricant table in chapter 1 to select an oil appropriate to your operating conditions).

- Unscrew the discharge filter (A, Fig. MS1723-026) and remove the control screw (B). New gear units are fitted with a filler plug instead of a discharge filter. This prevents from escaping during transport. Ensure that a discharge filter is fitted (A, Fig. MS1723-026) if the gear unit is being installed in a truck.

- With the drive unit vertical, fill the specified amount of gear oil up to the bottom edge of the control screw (B) through the hole for the discharge filter (A).
- Screw the discharge filter (A) and the control screw (B) back on once you have reached the correct oil level. The tightening torque for the filter and the control screw is 6 Nm.

Drive unit installation

- Install the drive unit in the reverse order of disassembly (see Drive Unit Removal section in the present chapter).
- Carry out an operational test of the truck and then check the gear unit for leaks.



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ELECTRICS

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Electrics - General

Wire Colour Codes

The wires used in the truck are colour-coded and numbered according to their function. The first digit or the first two digits indicate the wire colour while the last two digits are counter numbers.

Exceptions to this can be component leads supplied by vendors. Each wire is identified by a number on a wiring pictorial (refer to section DIA).

ABBREVIATION	COLOUR	NUMBER	FUNCTION
BLK	Black	0 **	Digital signal
BRN	Brown	1 **	Analog signal
RED	Red	2 **	Positive not connected
ORG	Orange	3 **	+12 V DC converter
YEL	Yellow	4 **	Third DC converter
GRN	Green	5 **	Negative not connected
BLU	Blue	6 **	Insulated negative
VIO	Violet	7 **	+5 V DC converter
GREY	Grey	8 **	Fourth DC converter
WHT	White	9 **	Various
RED/WHT	Red/White	29 **	Positive connected
GRN/WHT	Green/White	59 **	Negative connected

** Numbers 01 to 99

E01-GB

Abbreviations

Switch Symbol Abbreviation List *			
Abbreviation	Component	Abbreviation	Component
K*	Relay	LMS	Limit switch
ACS	Accelerator pedal switch	LOS	Lower switch
AXS	Auxiliary function switch	ORS	Override switch
BRS	Brake switch	POT	Potentiometer
DIS	Direction control switch	RA	Raise potentiometer
DRS	Door switch	RAS	Raise switch
EDS	Emergency Disconnect Switch	REA	Reach potentiometer
EM	Encoder module	RS	Reverse switch
ENC	Encoder	SAS	Reverse safety switch
FS	Forward switch	SDS	Start switch
HBS	Handbrake switch	SES	Seat switch
HSS	Fast / Slow Travel switch	SSS	Sideshifter switch
HNS	Horn switch	THS	Thermo switch
KYS	Key switch	TLT	Tilt switch
LGS	Light switch	WAS	Walk along switch

* If one of the above abbreviations is used more than once, a number extension will be used, e.g . SV1, SV2 etc.

E02-gb

Sundry Abbreviations *

Abbreviation	Description	Abbreviation	Description
BV(AK)	Battery Voltage after key	M2 (PM)	Pump motor
BDI	Battery discharge indicator	MRC	Controller
BR	Brake	OHGD	Overhead guard display
BWI	Brush wear indicator	P	Pump contactor
CA	Cable connection	PC	Plug connector (fitting JC)
F	Connection field coils	PCB	Printed circuit board
FAN	Fan	SF	Shunt field
FU	Fuse	STI	Steering wheel indicator
HN	Horn	SV	Solenoid valve
IFD	Information display	TB	Terminal board
JC	Jack connector (fitting PC)	TMM	Truck management module
LINE	Line contactor	TT	Hourmeter
M1 (TM)	Traction motor	VMN	Chopper (Negative voltage motor)

* If one of the above abbreviations is used more than once, a number extension will be used, e.g . SV1, SV2etc.

E03-gb

Other abbreviations *

Abbreviation	Designation	Abbreviation	Designation
GCSR	Gate closed switch right	GCSL	Gate closed switch left
PLS	Platform switch	TCM	Traction motor
PS	Pressure switch	HR	Heater
HCM	Hydraulic control module	ALM	Travel alarm
RECEIVER	Receiver	TRANS-MITTER	Transmitter
BDI	Combi instrument	CHARGER	Integrated charger
BRK	Electromagnetic brake	DR	Driver
SLS	Sideshift switch left	SRS	Sideshift switch right
ECS	Elevation Control Switch		

* If one of the above abbreviations is used more than once, a number extension will be used, e.g. SV1, SV2, etc.

E12-S1-GB

Electrical Symbols

EUROPE	USA	DESCRIPTION	EUROPE	USA	DESCRIPTION
		Wires joining			Hand operated maintained contact
		Wires crossing			Solenoid valve
		Wire connection			Inductor
		Plug / socket			Resistor
		Wire strap			Capacitor
		Terminal board			Potentiometer
		Fuse			Varistor
		Assembled unit			Thermal protector
		Contact, normally open			Lamp
		Contact, normally closed			Horn
		Contact double throw			Battery
		Operating device			Diode
		Operating devices, slow releasing			Breakdown diode
		Operating device, slow operating			LED
		Hand operated push button			Transistor
		Mechanically actuated			MOSFET
		Hydraulically actuated			Thyristor
		Emergency disconnect			Comparator
		Motor armature			

M0056-gb

Electrical Components

DANGER



Jack up the truck before carrying out repair work or troubleshooting the electrical system.

Traction Pod (POT, FS, RS)

The travel switches are activated via the thumbswitches on the control handle. The traction pod comprises a switch (FS) for forward travel, a switch (RS) for reverse travel, and a potentiometer (POT) which governs the travel speed. For cold store versions the potentiometer is heated.

Fast / Slow Travel Switch (HSS)

The fast / slow travel switch (HSS) is activated via a rotary switch (rabbit / turtle symbol) on the control handle. The switch signal to the traction controller is used to change between the high and slow speed ranges.

The switch is connected in series to the limit switch (LMS).

Safety Reverse Switch (SAS)

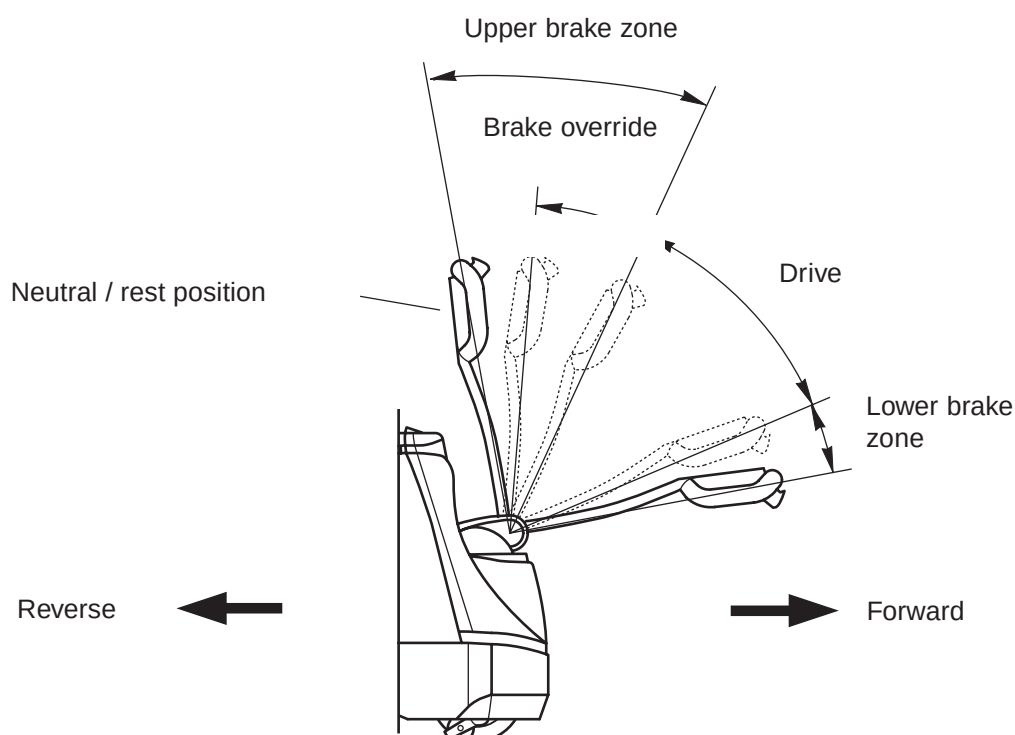
The safety reverse switch (SAS) is activated via the switch cap at the top of the control handle: the traction controller immediately changes from forward to reverse travel when the SAS is activated. The signal for normal travel to the traction controller is simultaneously interrupted. Depending on the traction controller setting the truck either travels for a given time, or provided the switch is pressed, travels in reverse.

Brake Switch (BRS)

The brake switch (BRS) is immediately below the control handle knuckle. As soon as the control handle reaches the upper or lower braking zone (see Fig. M1476) the brake switch is activated. The traction controller interrupts the power supply to the traction motor (TM) and the brake (BR). The brake magnet releases the anchor disk which in turn, spring powered, brakes the truck.

Override Switch (ORS)

The override switch (ORS) is immediately below the control handle knuckle. As soon as the control handle enters the brake override zone (see Fig. M1476) the override switch (ORS) sends a signal to the traction controller with the resulting slow travel option (by pressing the traction pod). This provides better shunt operation in restricted conditions.



M1476

Raise / Lower Switches (RAS, LOS)

The raise (RAS) and lower (LOS1, LOS2) switches are activated via rocker switches in the control handle. The rocker switches act on switches assembled on the hydraulic circuit board of the control handle. The switches are electrically locked in pairs so that they cannot both be pressed at the same time.

The raise (RAS) switch activates the pump contactor (P) which is controlled by the hydraulic control module (HCM): The pump starts.

The lower (LOS) switch applies voltage to the solenoid (SV) via the hydraulic control module (HCM). The solenoid opens.

Limit Switch (LMS)

On reaching a preset height, approx. 0.5m + the free lift range, the limit switch (LMS) interrupts a signal to the traction controller. The switch signal to the traction controller is used to change between the high and slow speed ranges. The switch is connected in series to the Fast/Slow Travel (HSS) switch.

Horn Switch (HNS)

A buzzer sounds when the horn button is pressed.

Key Switch (KYS)

The key switch directs the battery supply to the traction controller and the battery discharge indicator (BDI).

Emergency Disconnect (BD)

Pulling the battery connector on the red knob at the top of the truck completely disconnects the power supply to the truck.

Fuses (FU)

The entire truck circuit is protected by fuses FU1 & FU2, the control circuit by fuse FU3. Cold store trucks OPTION have a fuse FU4 for control handle heating.

- FU1 for the traction circuit and the control lines.
- FU2 for the pump circuit.
- FU3 control circuit and options.
- FU4 heaters.

OPTION Thermal Switch (THS)

This switch is an electronic thermostat for cold store trucks. It is located on the main circuit board of the control handle and switches the heaters on when the temperature falls below 0°C.

Thermal switch (THS2)

This thermal switch is located in the pump motor. When the pump motor temperature reaches 170°C, it disconnects the pump.

After cooling down to 140 °C +/- 15 °C it switches the pump back on.

Hydraulic Control Module (HCM)

Controls the lift contactor P and the valves SVCL & PV as a function of the raise/lower switches RAS /LOS1/ LOS2. A curve is internally stored.

Warning: Make sure you order the correct spare part to avoid damaging system components.

Unigage (BDI)

Contains an adjustable battery discharge indicator with a specific algorithm, an hourmeter and a lift cutout system.

For a detailed description of its operation and adjustment, refer to the appropriate chapter. Standard with some models, otherwise optional.

Integrated Charger

Intelligent charger which disconnects the truck's control circuit when connected to the mains. (See electrical diagrams)

Plug Holder (PC)

To accommodate the mains plug while the truck is in operation.

No electrical function.

Drive motor (M1)

Drive motor for the truck (separately excited motor), governed by the traction controller.

Hydraulic Motor (M2)

Drives the hydraulic pump (compound motor), indirectly via the hydraulic control module, directly via the pump contactor.

Main Contactor (Line/LC)

Activated by the key switch (positive voltage). Connects the positive power supply to the load circuit of the traction circuitry.

Can be deactivated by the traction controller (output A3).

Lift Contactor (P/P1+P2)

Connects the positive power supply to the lift motor of the truck. Governed by the hydraulic control module.

With the remote control option this is a contactor with 2 contacts (in series).

Electromagnetic Brake (BRK)

Activated by the override switch or the brake switch (positive voltage).

Can be deactivated by the traction controller (output A4).

Terminal Board (TB)

This is where the hydraulic control connections are made; lift cutout, pump contactor etc. (see electrical diagrams).

Travel Alarm Driver (DR)

Activates the travel alarm as a function of the travel control signal issued to the traction controller.

See electrical diagrams (travel alarm option).

Aux. Hydraulic Switch (SLS/SRS)

Enables the auxiliary hydraulics to be controlled from the control handle (optional, cannot be combined with remote control).

Remote Control Toggle Switch (ECS)

Switch to activate lift remote control, deactivates travel when activated (optional, cannot be combined with aux. hydraulics).

Aux. Hydraulic Valves (SVA1/SVA2)

Controls the auxiliary hydraulics as a function of the aux. hydraulic switch.

Horn (HN)

Horn: Activated via horn switches HNS1 or HNS2 via the drivers on the main circuit board.

Main Circuit Board (MAIN PCB)

Contains driver connections for switches SAS/FS/RS/POT/HNS1 and HNS2, including the thermostat which switches on the control handle heating on cold store trucks.

Hydraulic Circuit Board (HYD PCB)

Carrier for the raise / lower switches, also acts as a distributor for the positive power supply to the heating unit / thermostat resistors.

Equipped with heating resistors for cold store trucks.

Travel Alarm (ALM)

Alarm transmitter, activated by the driver circuitry and indirectly via the travel switches.

Receiver

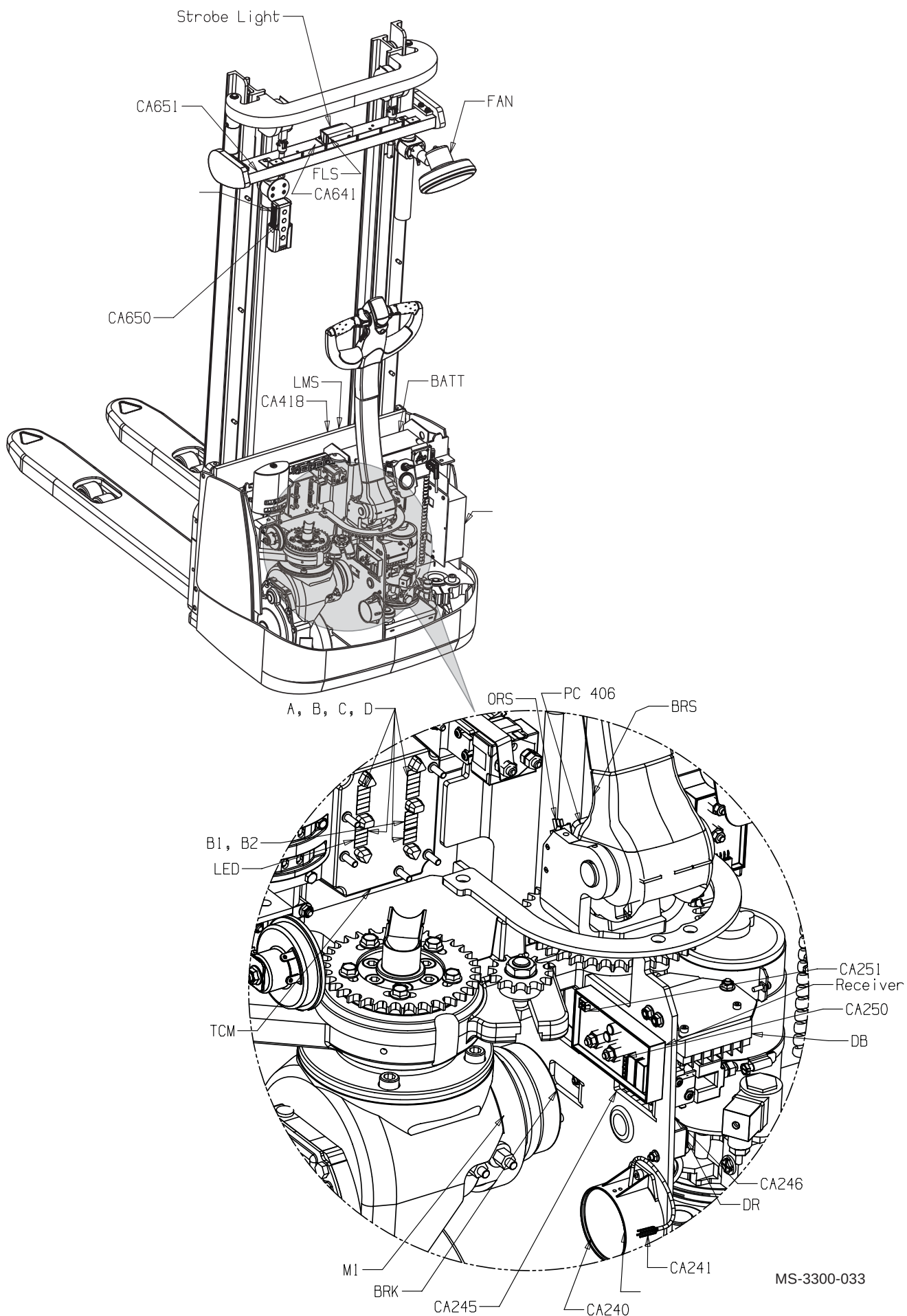
Input / output device for the remote control option.

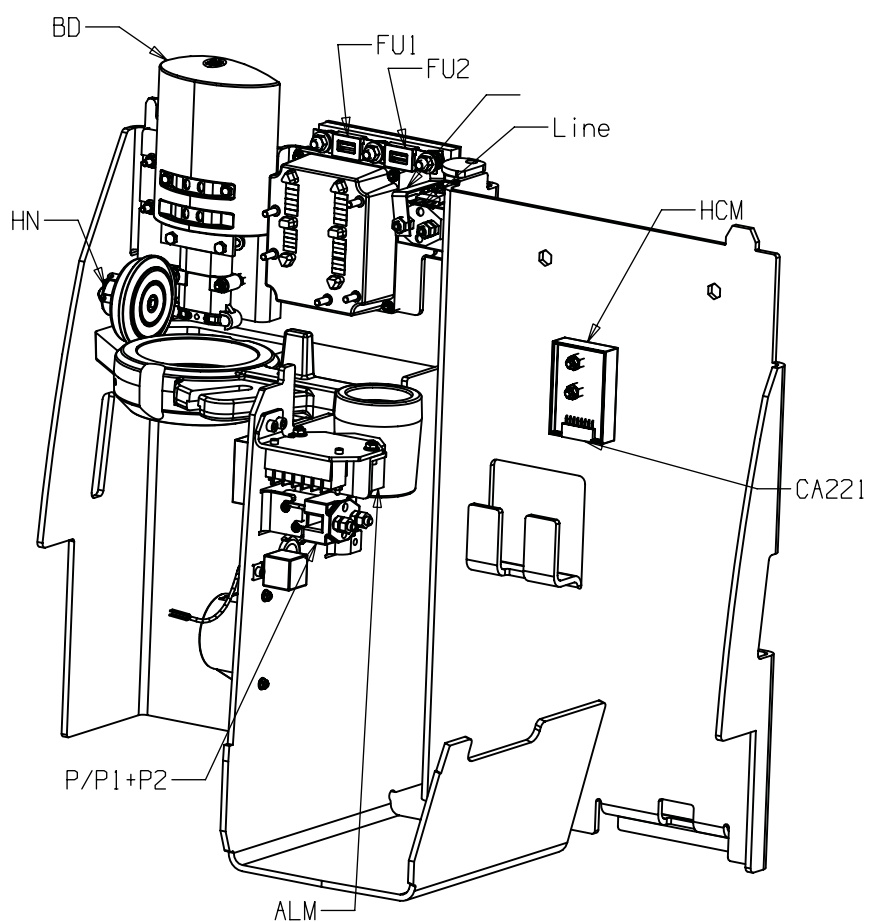
Allows lift/lower to be operated in remote control mode, deactivates travel. Connected to the transmitter via a cable.

Transmitter

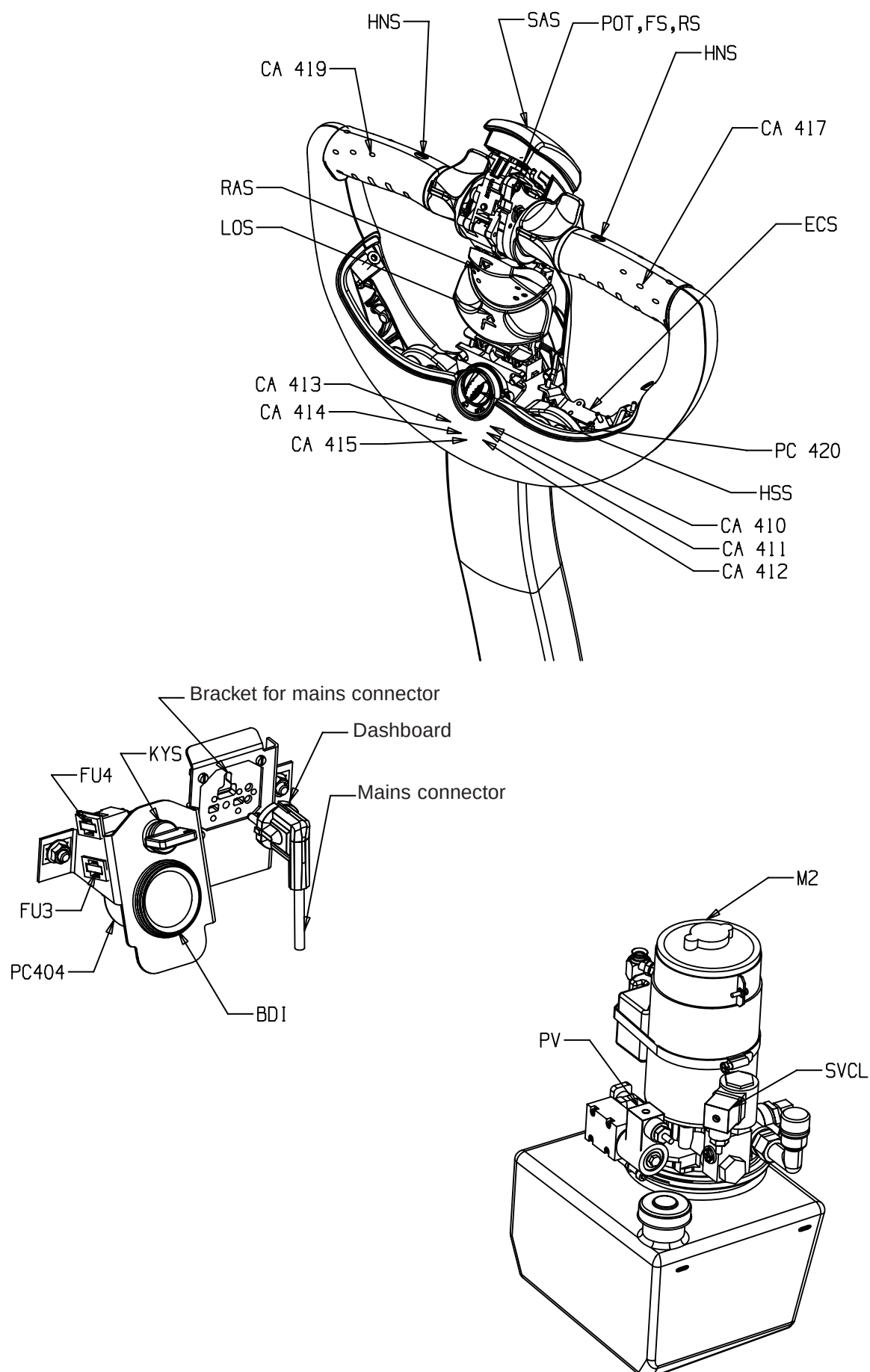
Manual device for the remote control option.

Allows lift/lower to be operated in remote control mode, deactivates travel. Connected to the receiver via a cable.





MS-3300-030



MS-3300-032

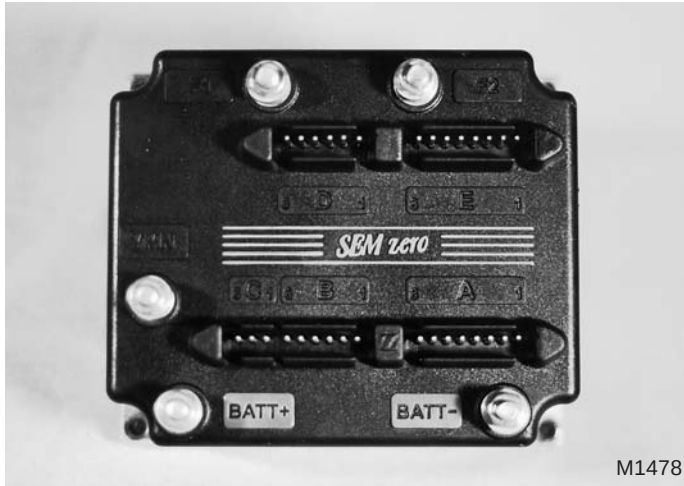
SEM0 Traction Controller

DANGER



The truck must be jacked up prior to carrying out repair work or troubleshooting the electrical system.

General



The programmable SEM 0 impulse controller provides effective control of the truck's travel characteristics.

The truck is powered by an SEM motor (Separate Excited Motor). With this type of motor there are two variables for controlling output: field current and armature voltage.

Precautionary Measures

- Do not connect the controller to any battery that differs from the voltage indicated on the controller (24 - 26 volts DC). Increasing the battery voltage could damage the MOSFETs; while a lower voltage supply would fail to energise the system.
- Only operate the controller with special traction batteries. Do not connect it to rectifiers or the mains network.
- When starting to use the truck, jack it up to prevent it from moving without the driver in the event of possible wiring errors.

- When the key switch has been turned off, the filter capacitors in the controller remain charged for a few minutes longer. When you work on the controller at this time, first isolate the controller from the battery (disconnect the battery). Then discharge the capacitors by shorting the positive and negative leads of the power part with each other over a resistor (10 - 100 Ohm, min. 5 W) for a few seconds.

Functional Characteristics

Speed control

Infinitely variable speed control in both directions, programmable via the handset.

Reduced speed ranges

There are two travel ranges with reduced speed available. Slow travel (via a rotary switch HSS integrated in the control handle grip) and the brake override zone (depending on the control handle position, activated via a microswitch ORS integrated within the control handle).

In addition, slow travel can be activated and fast travel deactivated by pressing the mast switch.

Downhill speed control

When the truck travels downhill, the controller monitors the motor armature speed, comparing it with the travel signal prescribed by the traction potentiometer. If the prescribed speed is exceeded, the truck automatically brakes electrically with energy recovery.

Regenerative braking

There are three ways of regenerative braking:

- Release braking (resetting the accelerator to neutral)
- Inversion braking (setting the accelerator to the opposite direction)
- Braking through speed restriction on inclines: The controller constantly governs the motor speed in accordance with the nominal value prescribed by the accelerator. If the nominal value is exceeded, the truck automatically brakes.

Anti Roll Down Function

This function prevents the truck from rolling down an incline without the driver. When the key switch is switched on, the controller monitors the motor speed. If it detects a rotational movement without a travel command being issued, the truck automatically brakes.

If the truck moves of its own accord on an incline, this ensures that it automatically brakes to a halt after a short time. When the truck is stationary the brake force is removed so that the truck can move again, and again braking is activated. If the brake is not applied, the truck will therefore move only very slowly down a slope.

Hourmeter

An hourmeter integrated within the traction controller can be optionally set with the help of the programmer to "KEY ON" (hourmeter activated when key switch is on) or "RUNNING" (hourmeter activated only when truck is travelling).

Self-Diagnostic System

The traction controller self-diagnostic system lists the five most recent error messages. These error messages can be read with the programmer. In addition to the error, the error frequency, the respective number of service hours and the traction controller temperature at the time of the error are logged and displayed.

A red LED on the traction controller also indicates the most recent error via a flashing code. The display is deleted when the controller is switched off and on again and if the error was only temporary.

Monitored Circuits

The following functions are monitored by the traction controller microprocessor, depending on the operating mode:

- When the truck is switched on: Control logic (hardware) and program functions (software), field current, VMN, contactor drivers, power up sequence, travel and lift switch output signals.
- Truck on standby (key switch on): VMN, field current, contactor drivers.
- During operation: control logic (hardware) and program functions (software), VMN, field current, contactors.
- Permanently monitoring: traction controller temperature, battery voltage.

Safety Mechanisms

Incorrect polarity

A main contactor controlled by the logic system separates the traction controller from the battery and thereby protects the power part from incorrect polarity.

Wiring Errors

All outputs are protected against wiring errors. The outputs for the main contactor and the magnetic brake can be charged to max. 3 amps and are fitted with an overload and short circuit protection.

Temperature protection

When the power part temperature exceeds 80°C, the maximum current is restricted in proportion to the rise in temperature. At 90°C the traction controller automatically cuts out.

If the temperature drops below -10° the maximum current is reduced in proportion to the ongoing battery discharge.

Start sequence

A specific order must be followed for starting up the truck. Otherwise the main contact will not be activated and the truck will not operate.

Protection rating

The traction controller is protected against contamination and spray water (IP 54 protection rating).

Maintenance

Maintenance of the SEM0 traction controller is restricted to external cleaning and checking the torques of the nuts securing the power cable connecting bolts.

You should also take this opportunity to check the errors listed with the help of the programmer.

WARNING



The SEM 0 traction controller operates at high currents. Particular safety measures are therefore required when handling the controller.

- Only use specially trained personnel.
- Use non-fatigue goggles.
- Do not wear loose clothing.
- Do not wear jewelry.
- Only use insulated tools.

- Disconnect the battery (=EMERGENCY DISCONNECT).
- Jack up the truck.
- Discharge the traction controller capacitors by connecting the BATT- and BATT+ connections over a resistance of approx. 10 Ohm, 5 W.
- Remove the power cable: label the cable if necessary. Secure the bottom nuts (2, Fig. MS519) with a fork wrench. Undo the top nut (1, Fig. MS519).

Note:

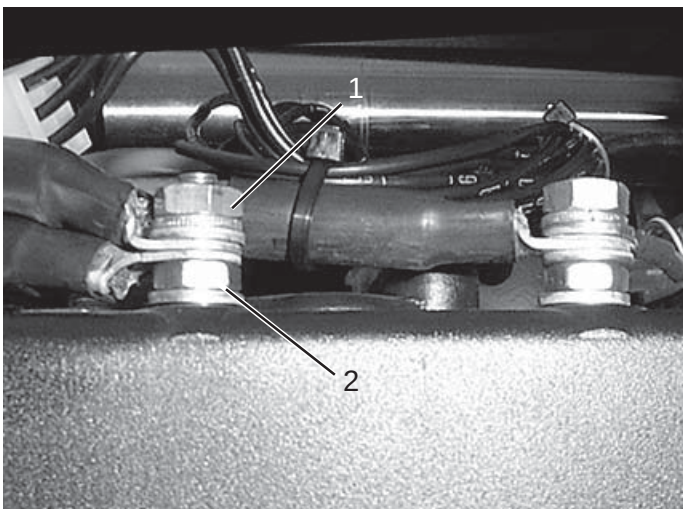
The bottom nut secures the connecting bolt to the power part circuit board and the plastic housing. If this nuts is under-tightened (torque less than 6 Nm), high transition resistances will occur between the circuit board and the bolt. The heat generated can damage the controller and melt the cover near the connecting bolts.

If the bolt is over-tightened (torque greater than 7 Nm), this can result in physical damage to the power part circuit board and the housing.

- Check the torque for the locknuts (2, Fig. MS519) of the connecting bolt with a torque wrench: It should be 6 - 7 Nm.

Important: An incorrect torque can damage the circuit board and the housing of the controller.

- Remove any dirt and corrosion from the contact surfaces.
- Wipe down the traction controller with a clean, damp cloth.
- When everything is dry, re-connect the power cables. To do this, secure the bottom nut (2, Fig. MS519) with a fork wrench and tighten only the top nut (1, Fig. MS519). Fit the control lines.
- **For cold store versions:** Apply a coat of Dow Corning® 4 Compound, part no. 053051-006, to the control line connectors.



MS519

Replacing the SEM0 Traction Controller

WARNING



Make sure you are operating the truck with the correct controller.

The use of SEM0 traction controllers with different part numbers can change the characteristics and result in accidents.

When fitting a new SEM0 traction controller in a truck you must select the right truck model through the appropriate selection in the configuration menu.

If you have changed and stored the standard configuration with the programmer, the stored parameters will be loaded the next time the controller is started.

- Prepare to remove the traction controller as previously described in the **Maintenance** section.
- Remove the 4 mounting screws and remove the traction controller.
- Check the contact pattern left behind by the controller back plate on the heat dissipation sheet. The controller must lie fully flat on the heat dissipation sheet. If there are large areas with no contact to the controller, replace the heat dissipation sheet to avoid thermal problems.
- Clean the contact surface of the traction controller on the truck chassis with a lint-free cloth and use an industry-standard silicon removal agent to remove the residue of the heat conducting paste.
- Apply a **thin and even** layer of Dow Corning® 340 heat conducting paste, part no. 053051-008 to the floorboard (= contact surface of the traction controller on the truck chassis).
- Secure the traction controller again with the 4 screws.
- If necessary clean the contact surfaces and refit the power cable (**you must follow the instructions in the Maintenance section on the previous page**) and refit the connectors for the control lines.
- **For cold store versions:** Apply a coat of Dow Corning® 4 Compound, part no. 053051-006, to

the control line connectors. Apply a layer of acid-resistant clearseal paint to the controller.

Important: After replacing the controller check and adjust the settings. You can adjust the settings to suit the customer's requirements. Follow the order described as follows.

Parameter Setting after Replacing the Traction Controller

Preparatory Measures

- **Power down the truck and jack it up so that the drive wheel is free (see Chapter 1).**
- When the truck is *powered down* connect the programmer to the traction controller.
- Power up the truck.

Adjustment

1. If required, change the options for the safety reverse switch and the internal service hourmeter of the controller. The standard setting is contained in Table 11-GB. If you have made changes, switch the truck off and on again. This will activate the changes.
2. Measure the battery voltage directly at the battery and adjust the reading measured and displayed by the traction controller (see CONFIG MENU section).
3. Using the TEST menu check the wiring and operation of the switches (see TEST menu section).
4. Re-calibrate the traction potentiometer (see "Traction pod – calibrate potentiometer, PROGRAM VACC menu).
5. Test the traction pod starting point at creep speed. The drive wheel should start when the travel switch closes. If necessary increase the value accordingly. Repeat the test for both travel directions (see PARAMETER CHANGE menu section).
6. **Jack down the truck and bring it to a secure area where you can perform test runs without endangering other people.**

7. Set the maximum speed to slow travel if necessary (CUTBACK SPEED). Repeat the test with maximum load (see PARAMETER CHANGE menu).
8. Set the maximum speed to the special range if necessary (OVERRIDE). Repeat the test with maximum load (see PARAMETER CHANGE menu).
9. Set the maximum speed "Forward" (MAX SPEED FORWARD) and "Reverse" (MAX SPEED BACK).
Warning: The maximum permissible speed is 6 km/h unladen.
Set the maximum speed to mast stage slow travel if necessary (CUTBACK 2). Repeat the test with maximum load.
10. Set the release brake characteristics:
Set the unladen truck to maximum speed and release the travel switch. Repeat the test with the maximum permissible load.
If necessary adjust the braking pattern (RELEASE BRAKING).
11. Set the braking pattern for changing direction:
Set the unladen truck to approx. 25% of maximum speed and move the travel switch in the opposite direction until it reaches the stop.
Set the braking pattern so that the delay sets in gently (INVERSION BRAKING).
Now repeat the test at maximum permissible speed. Adjust the setting until the delay sets in gently in both speed ranges and the effect is ideal. Preference should be given to the best setting for when the truck is unladen.
Repeat the process with the maximum permissible load.
12. Adjust, where necessary, the time taken to change direction. To do this change the AUX TIME DELAY parameter.
Both parameters, INVERSION BRAKING and AUX TIME DELAY affect the "feel" of the delay when changing direction.

Important: Power down the truck before disconnecting the programmer. Now reconnect the LEDs.

Status LED

When the truck is powered up the status LED connected to terminal strip E briefly flashes. This indicates that the test program is being booted up by the controller.

The status LED is off during normal travel. When an error occurs it flashes the respective code (see following table) until the error is rectified.

The programmer can be used to define the error more exactly.

N° of Flashes	Console Display	Notes
1	Logic failure #1:	Line contactor voltage control error
1	Watch dog:	Logic or software error
1	EEPROM KO:	EEPROM error
2	INCORRECT STARTS:	Starting sequence for travel not correct
2	FORW + BACK:	Forward and backward simultaneously requested
3	CAPACITOR CHARGE	Problem with power block
3	VMN NOT OK	Problem with chopper; armature voltage not correct
3	VFIELD NOT OK	Field voltage not correct
4	VACC NOT OK	Signal from traction potentiometer not correct
4	PEDAL WIRE KO	Traction pod wiring not correct
5	NO FIELD CUR.	No field current: Field wiring not correct or field current sensor error
5	HIGH FIELD CUR.	High field current: Field wiring not correct or field current sensor error
5	STBY I HIGH	High current: Armature current sensor error
5	I = 0 EVER	No current: Armature current sensor error
6	CONTACTOR DRIVER	Contactor driver error
6	COIL SHORTED	Contactor coil shorted
6	CONTACTOR CLOSED	Line contactor contact faulty
7	TH. PROTECTION	Temperature of control unit too high (> 80°C) or too low (< -10°C)
32	BATTERY LOW	Battery voltage too low

E04-GB

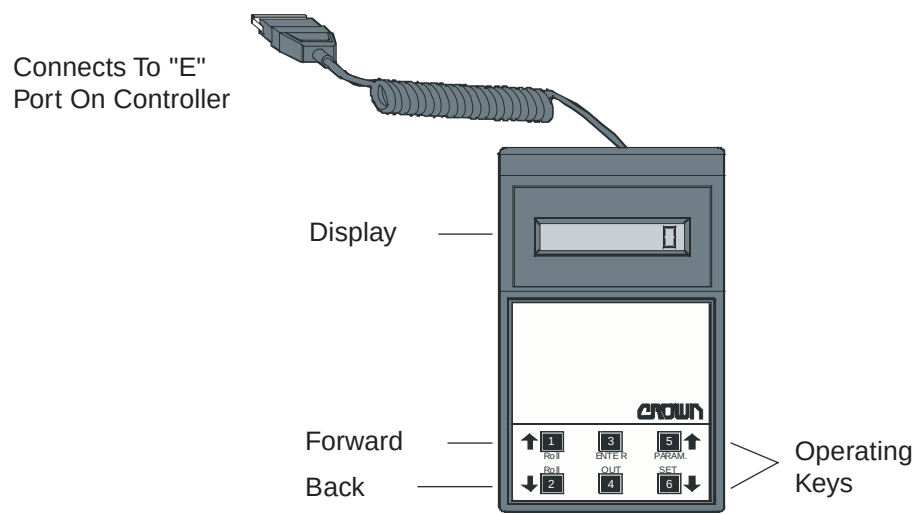
Programmer

General

The optional programmer, Crown P/N 793548, enables programming, testing and diagnostics for the controller.

The programmer is connected to the controller by a cable, thus powered by the controller.

Crown Handset P/N 793548 (Includes Cord)



8084

Description of Keys		
Key	Designation	Explanation
1	ROLL up	Selects the next sub-menu or an option.
2	ROLL down	Selects the previous sub-menu or an option.
3	ENTER	Enters the main menu. Stores the pin configuration.
4	OUT *	Quits a sub-menu or an option. Step by step return to the main menu.
5	PARAM SET UP	Increases setting values or selects configuration.
6	PARAM SET DOWN	Decreases setting values or selects configuration.

* You can undo a change by switching the truck off and on again. The controller will be reset to the output values, as long as you have not saved the settings before.

E05-GB

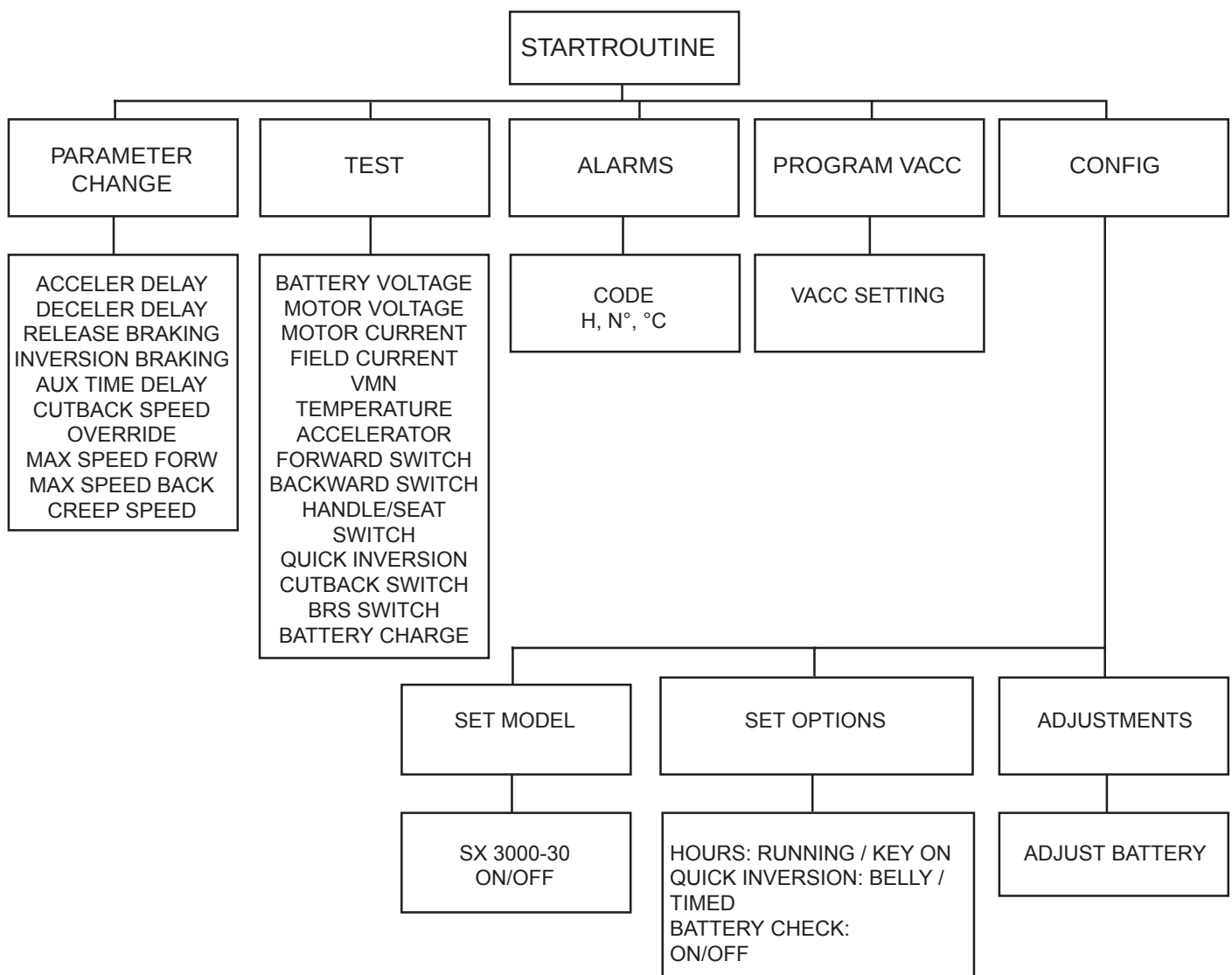
Operating SEM0 Controller Menu

General

When the programmer has been connected a self test start routine is performed. The software version of the controller (e.g. V2.02), the rated voltage and the rated current are now displayed.

When it is complete, use the ROLL up/down and ENTER keys to select the required menu.

Menu structure



Menu Functions

PARAMETER CHANGE

In the PARAMETER CHANGE menu the listed truck parameters can be read and set in real time.

TEST

In the TEST menu the listed truck parameters can be activated, checked and set in real time.

ALARMS

In the ALARMS menu error messages generated and stored during operation can be called up and processed.

PROGRAM VACC

In the PROGRAM VACC menu item the traction potentiometer is calibrated. The traction controller reads and records the potentiometer's minimum and maximum output voltage.

CONFIG

The Configuration menu is used to set the operation of the hourmeter and the safety reverse switch. In addition, the "Adjustments" sub-menu allows for calibration between the battery voltage measured by the controller and the actual battery voltage.

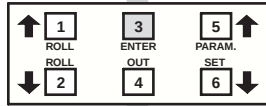
The SX parameter in the SET MODEL submenu is designed to select the truck, for the SX3000 it must be set to ON, for the ST3000 it must be set to OFF, for the WP2300 it should always be OFF.

The BATTERY CHECK parameter must be set OFF with these systems, otherwise with the ON setting and incorrect BATTERY ADJUST setting, it will result in travel failure.

Functions Menu, general

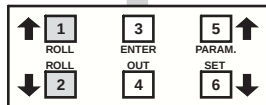
SEM0 CROWN X.XX
24 V 200A 00000

Power Up Menu



Press "Enter" to go to first menu.

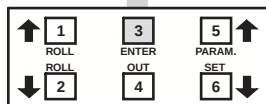
MAIN MENU
PARAMETER CHANGE



Use "roll up" or "roll down" key to scroll through menus.

PARAMETER CHANGE
ALARMS
TESTER
CONFIG MENU
PROGRAM VACC

Menu Listing



When desired menu appears on display, press "Enter" to go to that particular menu.

See chapter Parameter Change Menu.

See chapter Alarms Menu.

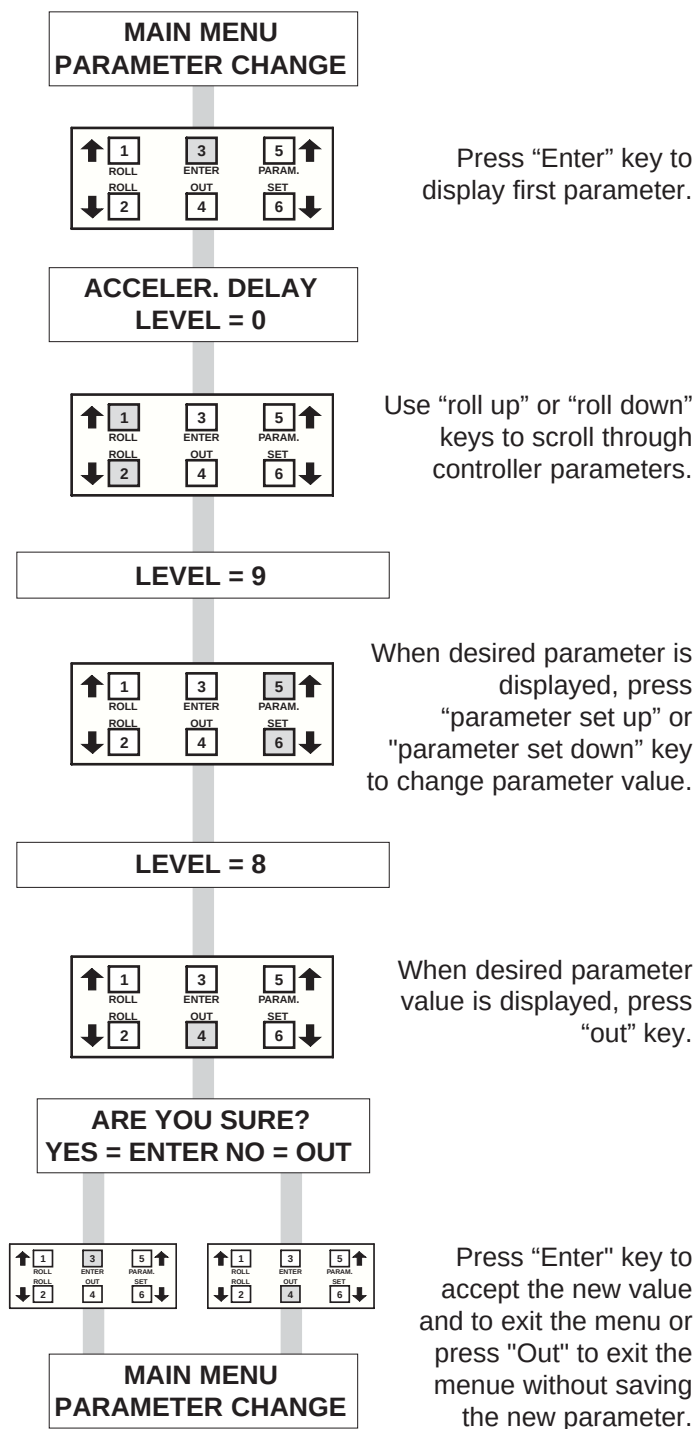
See chapter for the Tester Menu.

See chapter for the Config Menu.

See chapter for the Program VACC Menu.

Parameter Change Menus

In this menu the parameters can be read and adjusted. Parameters can be monitored during truck operation with the handset. Refer to the tune-up section for a complete listing and description of each parameter.



Settings and Error Messages

Parameter CHANGE menu (valid only for WF 1.2 t)

Menu item	Setting range	Recommended setting	Description
ACC DELAY	1.15 - 3.00 sec	0	Acceleration delay: The time taken for the traction controller to increase the output supply to the traction motors from 0 to 100%. (When travel switch suddenly set to limit).
DEC DELAY	9 - 0	0	Time taken to reach the new set value when the set value on the travel switch is changed. Corresponds to the braking intensity when the transmitter is returned.
RELEASE BRAKING	0 - 9	1	Release braking. Activated when the travel switch is released. Time taken for the motor current to fall to zero.
INVERSION BRAKING	0 - 9	9	Inversion braking. Activated when travel switch is set to the opposite direction.
AUX TIME DELAY	0 - 9	3	A lower value reduces the time taken for inversion braking to activate when changing from one direction to the opposite direction.
CUTBACK SPEED 1	30 - 100% ACC	5	Maximum current (=speed) for the low speed range selected by the fast / slow speed switch (HSS) (in % of max. current ACC for fast speed (=normal)). Again, the entire mechanical control range of the transmitter is available. Enables more sensitive travel at reduced speed.
CUTBACK SPEED 2	30 - 100% ACC	6	Max. travel current (= speed) available when you change to the low speed range with mast switch LMS (in % of max. travel current ACC for fast (=normal)). Again, the entire mechanical control range of the transmitter is available. Enables more sensitive travel at reduced speed

E06-01-GB

Parameter CHANGE menu (valid only for WF 1.2 t)

Menu item	Setting range	Recommended setting	Description
OVERRIDE	10 - 50% ACC	6	Max. travel current (=speed) in brake override zone (see section M4.2)
MAX SPEED FORW	100 - 70% FCN	6	Max. forward speed: This value determines the maximum traction motor current during forward travel. When the armature voltage has been fully absorbed by the traction controller, the speed is increased by weakening the field current. If the value is set to 0 the field current will not fall below the nominal value (FCN=field current nominal) when the armature voltage is fully absorbed.
MAX SPEED BACK	100 - 70% FCN	6	Max. reverse current: This value determines the maximum traction motor current during reverse travel. When the armature voltage has been fully absorbed by the traction controller, the speed is increased by weakening the field current. If the value is set to 0 the field current will not fall below the nominal value (FCN=field current nominal) when the armature voltage is fully absorbed.
CREEP SPEED	6,7 - 11% V Batt.	2	Creep speed. Setting for the minimum voltage applied to the traction motor when the travel switch is closed. This function should be set to one level below the value at which the truck begins to travel. This ensures that the empty run of the travel switch is kept to a minimum

E06-02-GB

Parameter CHANGE menu (valid only for WF 1.0 t)

Menu item	Setting range	Recommended setting	Description
ACC DELAY	1.15 - 3.00 sec	0	Acceleration delay: The time taken for the traction controller to increase the output supply to the traction motors from 0 to 100%. (When travel switch suddenly set to limit).
DEC DELAY	9 - 0	0	Time taken to reach the new set value when the set value on the travel switch is changed. Corresponds to the braking intensity when the transmitter is returned.
RELEASE BRAKING	0 - 9	1	Release braking. Activated when the travel switch is released. Time taken for the motor current to fall to zero.
INVERSION BRAKING	0 - 9	9	Inversion braking. Activated when travel switch is set to the opposite direction.
AUX TIME DELAY	0 - 9	3	A lower value reduces the time taken for inversion braking to activate when changing from one direction to the opposite direction.
CUTBACK SPEED 1	30 - 100% ACC	5	Maximum current (=speed) for the low speed range selected by the fast / slow speed switch (HSS) (in % of max. current ACC for fast speed (=normal)). Again, the entire mechanical control range of the transmitter is available. Enables more sensitive travel at reduced speed.
CUTBACK SPEED 2	30 - 100% ACC	3	Max. travel current (= speed) available when you change to the low speed range with mast switch LMS (in % of max. travel current ACC for fast (=normal)). Again, the entire mechanical control range of the transmitter is available. Enables more sensitive travel at reduced speed.

E06-03-GB

Parameter CHANGE menu (valid only for WF 1.0 t)

Menu item	Setting range	Recommended setting	Description
OVERRIDE	10 - 50% ACC	6	Max. travel current (=speed) in brake override zone (see section M4.2)
MAX SPEED FORW	100 - 70% FCN	9	Max. forward speed: This value determines the maximum traction motor current during forward travel. When the armature voltage has been fully absorbed by the traction controller, the speed is increased by weakening the field current. If the value is set to 0 the field current will not fall below the nominal value (FCN=field current nominal) when the armature voltage is fully absorbed.
MAX SPEED BACK	100 - 70% FCN	9	Max. reverse current: This value determines the maximum traction motor current during reverse travel. When the armature voltage has been fully absorbed by the traction controller, the speed is increased by weakening the field current. If the value is set to 0 the field current will not fall below the nominal value (FCN=field current nominal) when the armature voltage is fully absorbed.
CREEP SPEED	6,7 - 11% V Batt.	2	Creep speed. Setting for the minimum voltage applied to the traction motor when the travel switch is closed. This function should be set to one level below the value at which the truck begins to travel. This ensures that the empty run of the travel switch is kept to a minimum

E06-03-GB

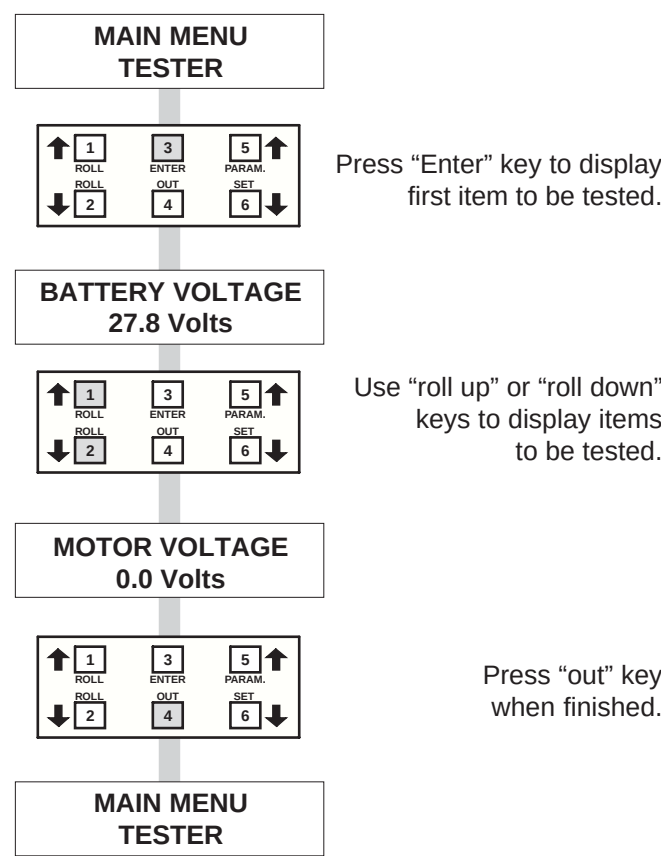
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Tester Menu

In this menu the handset acts as a multimeter reading voltages, current, temperature and switch state.

Listed are the output or input signals that can be measured while in the “Tester” mode. These measurements are to be used for reference as each truck, due to the age of components, may vary slightly.

It should be noted that **no parameter changes can be made in “Tester”**.



TESTER Menu

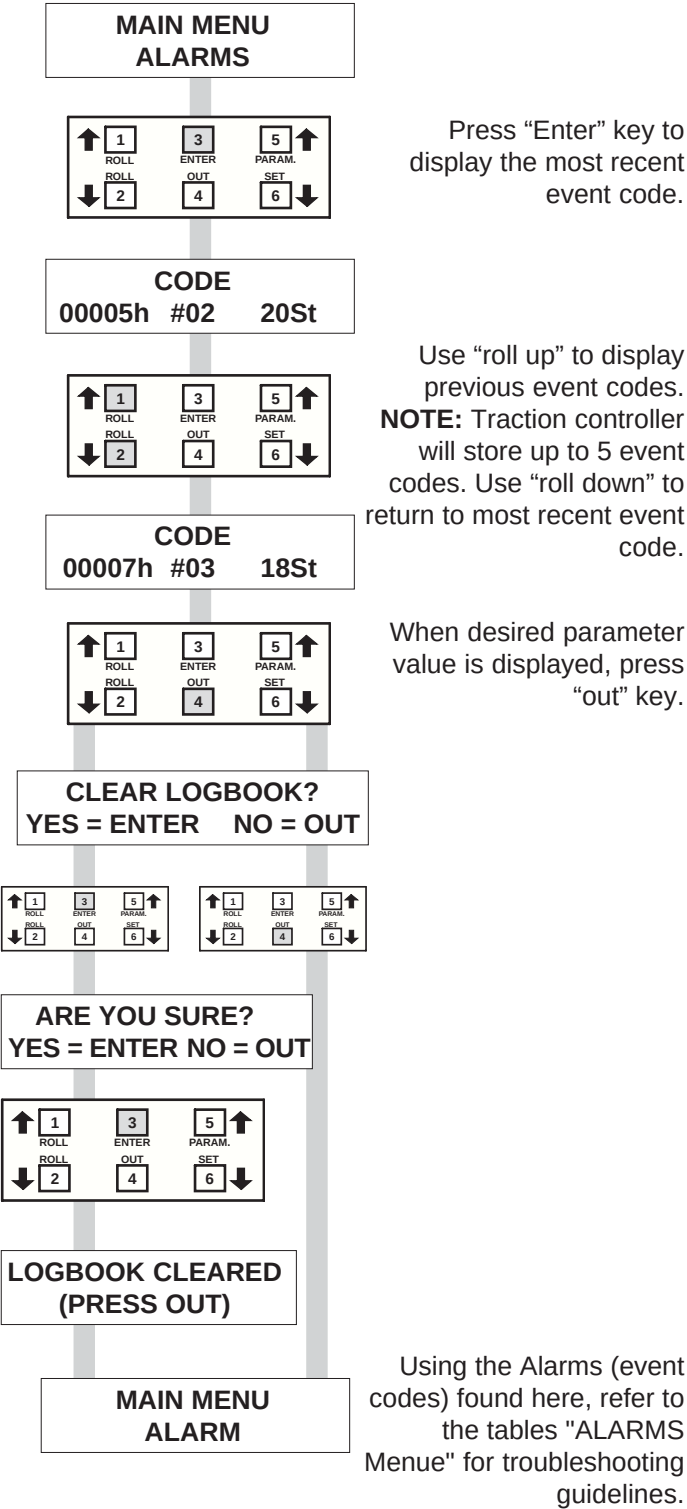
The following table describes the various truck parameters which can be selected and checked in the TESTER menu.

TESTER menu	
Menu item	Description
BATTERY VOLTAGE	Battery voltage measured at key switch input.
Motor VOLTAGE	Current applied to armature, measured between +BATT and VMN.
MOTOR CURRENT	Current received by motor armature.
FIELD CURRENT	Measures the current between VMN (Volt Motor Negativ) and -BATT. The reading indicates the potential difference over the controller power part.
TEMPERATURE	Controller temperature, measured at the aluminium base plate next to the MOSFETs.
ACCELERATOR	Displays the nominal signal of the traction potentiometer. The left hand side displays the voltage reading, the right-hand side the percentage relating to the maximum operating signal calibrated via PROGRAMM VACC
FORWARD SWITCH	Tests the operation of the "Forward" (FS) switch Displays the open (OFF) and closed (ON) status.
BACKWARD SWITCH	Tests the operation of the "Reverse" (RS) switch. Displays the open (OFF) and closed (ON) status.
HANDLE/SEAT SWITCH	Tests the operation of the "Override" (ORS) switch Displays the open (OFF) and closed (ON) status.
QUICK INVERSION	Tests the operation of the "Safety Reverse" (FS) switch and the mast switch (LMS) series connection. Displays the open (OFF) and closed (ON) status.
CUTBACK SWITCH 1	Tests the operation of the "Fast/Slow" (SHS) switch. Displays the open (OFF) and closed (ON) status.
CUTBACK SWITCH 2	Tests the operation of the mast switch (LMS). Displays the open (OFF) and closed (ON) status.
BRS SWITCH	Tests the operation of the brake switch (BRS). Displays the open (OFF) and closed (ON) status.
BATTERY CHARGE	Displays the battery charge status as a percentage.

E07-GB

Alarms Menu

In this menu the traction controller microprocessor remembers the last 5 alarms that have occurred. Items remembered that are associated with each alarm are; the event code, the hour meter reading, the number of times that particular alarm occurred, and the controller temperature.



ALARMS Menu

The traction controller can collect and store operational faults during operation. The last 5 error messages are stored together with the following information:

- Type of error
- Error frequency
- Hourmeter status
- Power part temperature

The ALARMS menu can be used to call up and read the respective fault codes.

ALARMS Menu		
Error Message	Description	Possible Cause
LOGIC FAILURE #1	Main contactor drive test error during auto-diagnostic function on truck power-up.	Control logic error. Replace logic system.
WATCH-DOG	Error in auto-diagnostic function performed during truck power-up, when parked and during travel.	Watchdog circuit (hardware) or program (software) faulty. Replace logic system.
EEPROM KO	Error in non-volatile memory area where hourmeter, error message and truck parameter data is stored.	Turn key switch off and on again. If the error persists, replace the logic system. If the error is removed, make sure that all the stored data is deleted and reset to a default value.
INCORRECT START	Start sequence incorrect. The following sequence must be maintained: Override switch (by moving the multitask handle from idle to travel position), followed by travel switch (by pressing the transmitter).	- Travel direction switch (FS/RS) or multitask handle switch jammed. - Wiring error. - Incorrect start sequence entered by user.
FORW + BACK	Test is performed constantly and checks whether both travel directions are applied simultaneously.	- Wiring error. - Travel direction switch jammed. - Incorrect start sequence entered by user. - Control handle main board faulty.
CAPACITOR CHARGE	Test during auto-diagnostic function on power-up. If the capacitors have not started to charge 500 ms after turning the key switch, an error message appears and the main contactor does not close.	- Armature power cable wiring error - Faulty controller.

E08-GB

ALARMS Menu (Contd.)

Error Message	Description	Possible Cause
VMN NOT OK	Test performed in idle mode with the main contactor closed and during travel. The error message appears when VMN - is below the battery voltage when truck is idle - does not comply with power when truck is travelling	- Motor cable wiring error. - Motor loss to earth. - Power part error.
VFIELD NOT OK	Test performed when truck is idle and main contactor open. The error message appears if approx. 50% of the battery voltage is not applied to the field connections.	- Motor loss to earth. - Motor field connections not connected or incorrectly connected to controller. - Error in power part field controller range.
VACC NOT OK	Test performed during auto-diagnostic function on power-up and when truck is idle. The error message appears if the potentiometer signal deviates by more than 2 volts from the stored minimum value.	- Broken potentiometer cable. - Wiring error. - Potentiometer faulty. - Tiller main board faulty. - PROGRAM VACC not performed or incorrectly performed.
PEDAL WIRE KO	Test performed constantly and monitors the traction potentiometer and its wiring. Error message appears for broken wires.	- Potentiometer connections not wired or interrupted. - Tiller main board faulty.
STBY I HIGH	Test performed during auto-diagnostic function on power-up and when truck is idle. The error message appears if a current flow is detected.	- Faulty current sensor (replace controller). - Back coupling, logic system or power part error (replace component or entire controller).
I = 0 EVER	Test performed during travelling. The error message appears if the traction current does not exceed a given minimum value.	- Insufficient motor contact (check carbon brushes). - Faulty current sensor (replace controller). - Back coupling, logic system or power part error (replace component or entire controller).

E09-GB

ALARMS Menu (contd.)

Error Message	Description	Possible Cause
CONTACTOR CLOSED	Test performed during auto-diagnostic function on power-up. The motor field is energised before the main contactor is applied. The error message appears if the power capacitors do not discharge.	- Main contactor jammed (check contacts, if necessary replace contactor). - Faulty field circuit (check field coil and field cable operation and connections).
TH PROTECTION	- An error message appears if the controller temperature exceeds 80°C. The maximum current is reduced in proportion to the rise in temperature. At 90°C the system automatically cuts out. - If the temperature falls below -10°C, the maximum current is reduced to 80%. - If the error message appears in the normal temperature range, this indicates an error in the controller.	- Excessive ambient temperature. - Temperature sensor faulty (replace controller). - Faulty logic (replace logic system.) - Insufficient heat transfer (check mounting bolts and the rest of the system).
BATTERY LOW	An error message appears if the battery voltage falls below 63% of the nominal value. The current is reduced in proportion to the potential difference. At 43% of the nominal value the system automatically cuts out. - If the error message appears at a battery voltage above 63%, this indicates an error in the controller or the wiring.	- Less than 63 % of the battery voltage is applied to input A2 after the key switch is applied. Wiring problem: poor contact, additional consumer, cable too long, small diameter etc. - Microprocessor error or battery current measurement error (replace logic system).
HIGH FIELD CURR, NO FIELD CURR	Test performed constantly and checks the field current.	- Field current measuring error (replace controller). - Field cable not connected. - Power part error (replace component or entire controller).
CONTACTOR DRIVER; COIL SHORTED	Tests the main contactor circuit.	- Contactor coil short-circuited, not connected or incorrectly connected - Contactor drive opened or short-circuited (replace logic system). - Voltage feedback error to contactor driver (replace logic system).

E10-GB

Calibrating the Traction Pod Potentiometer, PROGRAM VACC menu

It is always necessary to calibrate the traction pod potentiometer when:

- the traction pod potentiometer has been replaced or,
- the traction controller has been replaced.

There is no need to physically adjust the potentiometer and the travel switch.

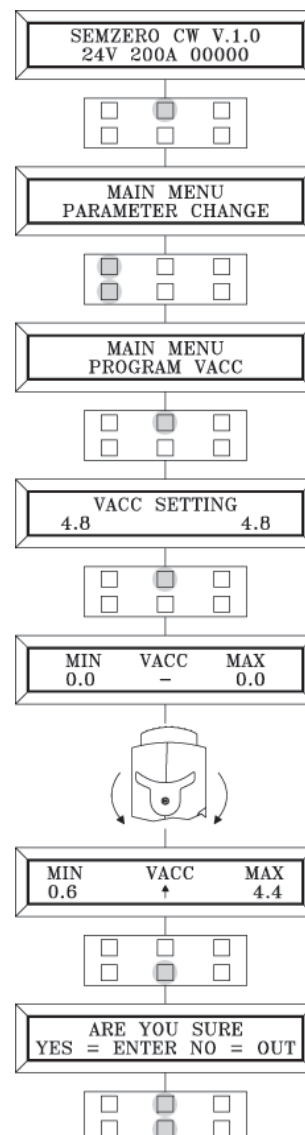
Preparatory Measures

- **Power down the truck and jack it up so that the drive wheel is free (see Chapter 1).**
- Connect the programmer to the traction controller.
- Power up the truck.

Calibration

- Press ENTER on the programmer.
- Using the ROLL UP and ROLL DOWN keys scroll through to the PROGRAM VACC menu.
- Press ENTER. This enables you to select the calibration routine.
- The display shows the stored minimum and maximum voltage of the potentiometer. An arrow in the display indicates the travel direction to which the values are assigned. Arrow up = Forward. Arrow down = Reverse. If you move the travel switch in the corresponding direction you can change the display accordingly.
- Press ENTER to delete the stored values. The display now shows 0.00 for the minimum and maximum values.
- Pull the tiller to the travel range (brake released) and press the travel switch slowly in the forward direction until it reaches the stop.
- The display shows the new minimum and maximum value and an arrow for the selected travel direction.
- Pull the tiller to the travel range (brake released) and press the travel switch slowly in the reverse direction until it reaches the stop.

- The display shows the new minimum and maximum value and an arrow for the selected travel direction.
- Press OUT when you are ready.
- The display asks "Are you sure?". If you wish to save the new levels, press ENTER. If not, press OUT.
- Press OUT to quit the VACC menu.

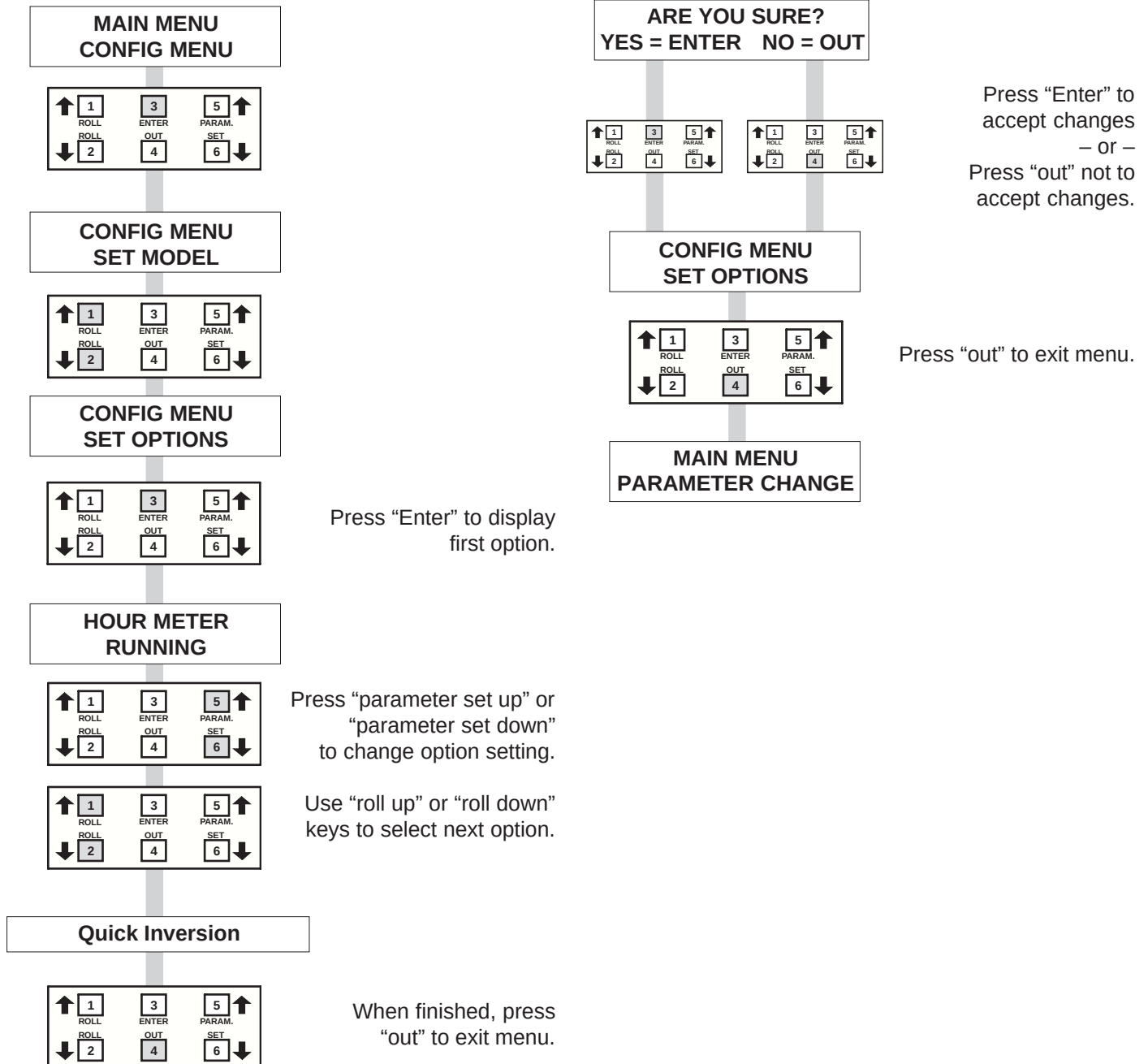


M1610

Config. Menu

In this menu the operation of the hour meter and the safety reverse switch (SAS) can be set.

Config. Menu (continued)



CONFIG Menu

The CONFIG menu provides access to the SET OPTIONS, ADJUSTMENTS and SET MODEL sub-menus.

SET MODEL

WARNING

Make sure that you have made the right setting for the particular truck. See table.

This would result in incorrect standard settings being loaded. This would change the truck operating characteristics and could cause accidents.

SET OPTIONS

See Table E11-GB for a description of the parameters. The standard setting for HOUR COUNTER is "RUNNING". For QUICK INVERSION the "BELLY" setting.

ADJUSTMENTS

In the menu item ADJUST BATTERY you can adjust the battery voltage measured by the controller to give the actual battery voltage.

Using a digital voltmeter measure the battery voltage directly at the battery. Adjust the voltage shown in this menu until it matches the voltage measured directly at the battery.

CONFIG Menu		
Sub-Menu	Option	Description
SET MODEL	WF 1.2 t ON/OFF	ON for WF 1.2 t OFF for WF 1.0 t
SET OPTIONS	HOUR COUNTER: KEY ON / RUNNING	Determines the operation of the hourmeter in the traction controller. The following options are available: - KEY ON: Counts the hours while the truck is switched on - RUNNING: Counts the hours while the traction motor is applied
	QUICK INVERSION: BELLY / TIMED	Determines the operation of the reverse safety switch (belly switch): - BELLY: Truck travels in opposite direction while the safety reverse switch is applied. - TIMED: Truck travels in opposite direction while the safety reverse switch is applied, however, only for 2 seconds.
	BATTERY CHECK ON/OFF	Must be OFF if a Curtis BDI is used (standard on all trucks).
ADJUSTMENTS	ADJUST BATTERY	Adjusts the battery current measured by the controller to the actual battery current. This can be necessary for example in the event of a relatively high voltage potential on the key switch.

E11-GB

On Board Charger

The charger disconnects the truck's control circuit as soon as it identifies voltage on the mains cable.

This occurs through a internal charger connection, see electrical diagrams.

WARNING



The charger cannot be repaired in the field. Attempting to make repairs can result in accidents caused by electric shock and fire.

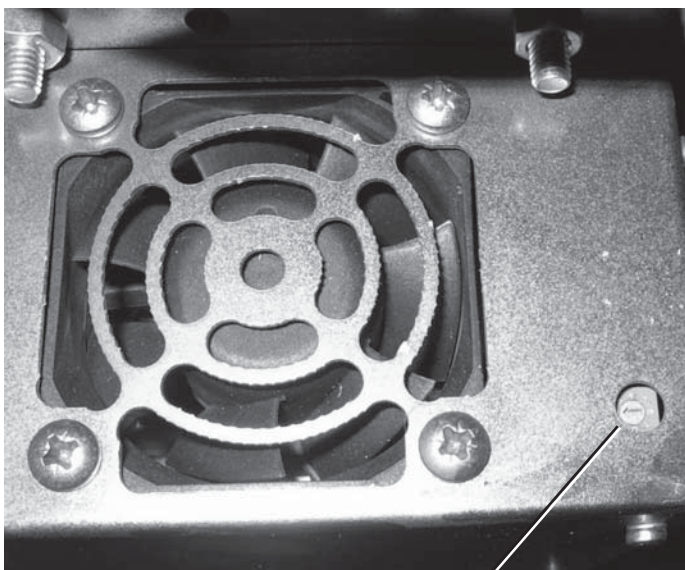
Replace the charger where necessary with an original Crown replacement charger.

General

Please read this paragraph carefully. It contains important information on the operation of the charger. You must understand how the charger operates in order to correctly assess any problems which may occur when charging the battery.

This charger is suitable for a variety of battery types. An eight (0-7) position battery type selector switch *) is located at the fan side of the charger.

Position 1 is for maintenance free, starter and semi industrial batteries. Position 2 is for industrial (open lead acid) batteries. Position 0 and 3-7 are not used. (To avoid material damage, do not use these positions).



Selector switch

M1611

This charger is an „intelligent“ device. A microprocessor controls the charging by taking into account the charge status of the battery.

A complete charge cycle consists of several phases, indicated by a yellow LED. A green LED indicates the presence of the mains supply. Both LEDs are located on the instrument panel next to the socket to protect the mains lead.

Battery Charging Phases

The charge cycle begins with connection to the mains supply. The green LED is permanently lit.

First Phase (I1)

The first phase (I1) is a charge with constant (maximum possible) current. This phase lasts until the battery voltage > 24 volts. (The yellow LED is permanently lit.)

Second Phase (P)

In the second phase (P) the charging capacity (product of charging current and charging voltage) is kept constant. In addition the charging current is reduced in proportion to the increasing battery voltage. This phase ends when the battery voltage reaches a certain level. (The yellow LED is permanently lit.)

Third Phase (U)

In the third phase (U) the charging current is kept constant. The output voltage of the charger is restricted to 29 volts. During this phase the charging current drops increasingly. (The yellow LED flashes rapidly.)

Fourth Phase (I2)

The fourth and for normal charges last phase (I2) is again a charge with constant current until the gassing voltage stage is reached. The amount of constant current used to charge is calculated from the charge consumed by the battery during the first two phases (I1 and P).

**) Reset the microprocessor after setting the selector switch. The procedure for this is described in the section „Faults in the charging unit microprocessor. Reset the microprocessor as follows:“.*

The duration of this phase is set to reach 17% of capacity (= Boost - factor 1.15) consumed by the battery during the first three phases (I1, P and U). The charging voltage is restricted to 34 volts. (The yellow LED flashes slowly.)

End of Normal Charging

Normal charging is completed at the end of the fourth phase. (The yellow LED is off) The battery is now fully charged and the total battery capacity can be used.

Special Charging Phases

Compensating Charge

For instructions on compensating charging, in particular charging intervals, please refer to the battery manufacturer's documentation.

If the charger remains connected to the mains at the end of a normal charge, 15 minutes after Phase I2 a compensating charge will begin with half the constant current used during phase I2. (The yellow LED flashes either regularly or intermittently.)

The compensating charge reduces the problem of sulphating and the cell voltage of the 12 battery cells is compensated to 2 volts / cell.

This phase ends when the battery voltage is stable, i.e. changes by less than 60 mV/h.

Float Charge

If the charger remains connected to the mains after the compensating charge, 48 hours later the charge recommences with the first phase (I1). As the battery however is still full, the individual charging cycles are severely reduced, and the first phase (I1) is even bypassed if the battery voltage has not fallen below 24 volts.

The float charge ensures that the battery can be used even after long periods of inactivity. (The yellow LED flashes regularly or intermittently.)

Partial Charging

The charger is designed to adapt to all discharge conditions of the battery and all typical partial charge cycles. It uses an „occasional charging“ feature. The electronic system takes into account these partial charges and adjusts the current in the fourth phase (I2) accordingly.

If charging is interrupted by the user (mains connector removed) and if the mains connector is re-inserted within 13 minutes, it then continues at the point at which it was interrupted. The charger stores the capacity charged into the battery up to the interruption for 13 minutes and calculates a correction value which ensures that the capacity subsequently removed from the battery is re-charged.

If the mains interruption lasts for more than 13 minutes, the charging process will start again with phase 1.

Charging Phases										
Phases	I1 and P	U1	I2	U2	T _{stop} = 15 Min	Compensating Charge	T _{stop} = 48 h	Float Charge	Error	Stop
Mains	Mains plug connected									Disconnected
Fan	On				Off	On	Off	On	Undefined	Off
Green LED	Permanently on								Flashes	Off
Yellow LED	Permanently on	Rapid flash	Slow flash	Intermittent flash	Off	As for I2 and U2	Off		Undefined	Off

E21-GB

Charging Errors

Green LED is not lit

Possible Causes:

Socket does not conduct mains supply.

Check whether the socket conducts power supply by plugging in an item of equipment (e.g. lamp etc.) which you know is working.

Faulty mains lead to charger.

Temporarily replace the mains lead to the charger with one which you know is ok. When you finally replace the mains lead avoid damaging the lead when fitting the clamp.

With the AC connected, listen for the operation of the cooling fan. This fan will operate when the charger is delivering current to the batteries. A variation in the speed of the fan is considered normal.

The fan is not always active, see table.

Charger faulty.

Replace the charger.

Green LED flashing

In this case an error has occurred during charging. The charging time in phase I1 or P is too long (time limit exceeded).

Possible Causes:

One or more battery cells faulty. Repair the battery in accordance with the battery manufacturer's instructions.

The ambient temperature is too high. The charger automatically reduces the output capacity in order to avoid a thermal overload. When the ambient temperature is too high the charging current is reduced, which can lead to time limits being exceeded. Also check whether the fan starts up when the mains lead is connected. The air inlet and outlet of the charger must not be covered.

Error in charger microprocessor. Reset the microprocessor as follows:

- Remove the mains plug and disconnect the battery.
- Disconnect the charger connections to the earth contact or the pump contactor and fuse F1 and short-circuit the two leads of the charger. Alternatively, wait 10 minutes. Then re-connect the charger lead to the battery.
- Re-connect the mains plug.
- Check that the green LED is permanently lit and the charger fan is running.
- If the green LED is not lit and/or the fan is not running, replace the charger.

Important: Before replacing a charger, always check whether the malfunction is due to a temperature problem or the battery.

Faulty battery cells of poorly serviced batteries or charger ambient temperatures above 40 °C are typical causes of faults.

Take into account the fact that the charger emits heat (the temperature of the airflow extracted by the on-board fan is 20 °C above ambient temperature). This heat loss also heats up the environment if the ventilation is inadequate.

If the temperature and battery can both be safely ruled out as possible causes, reset the microprocessor and check if it is possible to charge.

Important Technical Data

Mains voltage: 230 V +10% / -15%

Mains frequency: 50 - 60 Hz + /-1%

Output capacity: 720 W + /-3%

Can be used for open lead acid batteries with 12 cells and a cell voltage of 2 volts (24 volt battery)

- Minimum battery capacity 160 Ah
- Maximum battery capacity 300 Ah

The maximum charging time at room temperature for an 80% discharged battery is:

- 15 h for a 300 Ah battery
- 12 h for a 240 Ah battery
- 8 h for a 160 Ah battery

Charger safety class: IP20

Ambient temperature: 0 °C to +40 °C

Air humidity: 90% relative, not condensing

Replacing the Charger

WARNING



Do not reverse the battery connection wires

If you reverse connect the charger wires to a battery, the minimum damage you will incur is a blown internal fuse. This fuse can only be replaced by the manufacturer. Replace the charger where necessary with an original Crown replacement charger.

Removal / Installation

- Remove the mains plug and disconnect the battery.
- Undo the mains supply lock on the charger and remove the connector.
- Disconnect the charger connections to the earth contact of the pump contactor and fuse F1.
- Disconnect the plug connection of the 3 wire lead to the LEDs.
- Remove the 4 screws which attach the charger to the retaining plate and remove the charger.
- Installation is the reverse order of removal.

To ensure the charger is properly earthed, check again that the unpainted earth points on the charger sheet are not corroded. If necessary, remove paint or corrosion to create the important earth points.

Electric Motors

General Maintenance Instructions

The following instructions apply to all motors. Details relating to specific models and designs are provided in the sub-sections (traction motor, pump motor etc.).

Preparation

- Disconnect the battery (= EMERGENCY DISCONNECT).
- Secure the truck from rolling away.

Important Maintenance Instructions

- Remove all carbon brushes and check for wear. If one or more carbon brushes need to be replaced, replace all brushes. In addition to the carbon brushes the pressure springs must also be replaced to ensure the correct pressure.

The length of the shortest brush determines whether the brush set needs to be replaced.

Even if the minimum length has not been reached the brushes should be replaced as the remaining useful life could be much shorter than the time until the next inspection:

If a brush is too short the spring will lie on the brush support. The brush sparks during operation and burns the collector with corresponding damage.

- Blast the motor with dry compressed air only.
- Check the armature for unevenness, burning, grooves and cracking of the multi-plate edges. Turn the armature if necessary. A non-oily, evenly distributed layer on the brush surfaces is normal.
- **If oil or grease is found in the motor collector compartment** (usually a paste consisting of oil, oil vapour, dust and carbon particles), **immediately remove the cause** and clean the motor thoroughly:

Oil or grease burns in the brush sparks and leaves behind a highly abrasive oil ash which can very quickly destroy the collector and the brushes.

- The brushes must be able to move freely in the brush support (without spring tension) without tilting. Never modify brushes if one or more brushes cannot move freely. In this case replace all brushes as they will

probably have been thermally overloaded. Thermal overloading (temperatures >160 °C) causes the brushes to swell up. Brushes which jam in the brush support produce intense sparking and destroy the collector.

- The brush edges must not be cracked. Brushes with cracking along the long edge of the surface will have been damaged by a worn collector. If information is provided in the manual, restore the collector to the specified limits. Otherwise, replace the armature in full.
- Loose brush connections are a clear sign of motor overload. In this case inspect the collector for burning and repair or replace as necessary.
- When fitting the brush take care to place the spring gently on the brush. If the contact is too hard the brush will be damaged.
- Make sure that all brushes contact the armature at the same pressure.
- New brushes must be run in with a medium load in the first hours. Never fully charge the motor straight away.

Traction Motor Maintenance (WF 1.0 t)

Access to brushes

- Disconnect the battery
- Prevent the truck from rolling away.
- Remove the tensioning belt from the motor.

Maintenance

- Apply dry compressed air to the motor.
- Remove all carbon brushes and check them with the armature in accordance with the instructions in "Key Maintenance Instructions".
- A new carbon brush is 20 mm long
- Carbon brush wear limit: 9 mm
- Refit the tensioning belt.

Armature

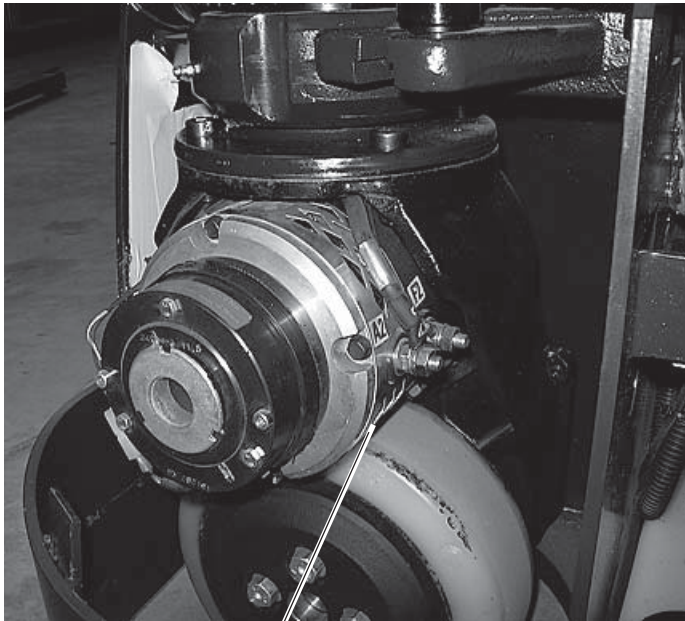
- A new armature has a max. diameter of 48 mm.
- The armature can be overwound provided the diameter is no less than 45 mm.
- The armature must be replaced if the diameter is 44 mm or less.
- After overwinding cut the mica down to at least 0.5 mm below the multi-plates without changing the gap width between the multi-plates.
- The multi-plate edges must be carefully de-burred.

Bearings

- The ball bearings are maintenance-free. If the bearings are removed during repair work they must be replaced, or after 10000 service hours at the latest.
- If a ball bearing which is to be replaced only has one sealing lip, lubricate it with a quality ball bearing grease (Staburags NBU 8EP).

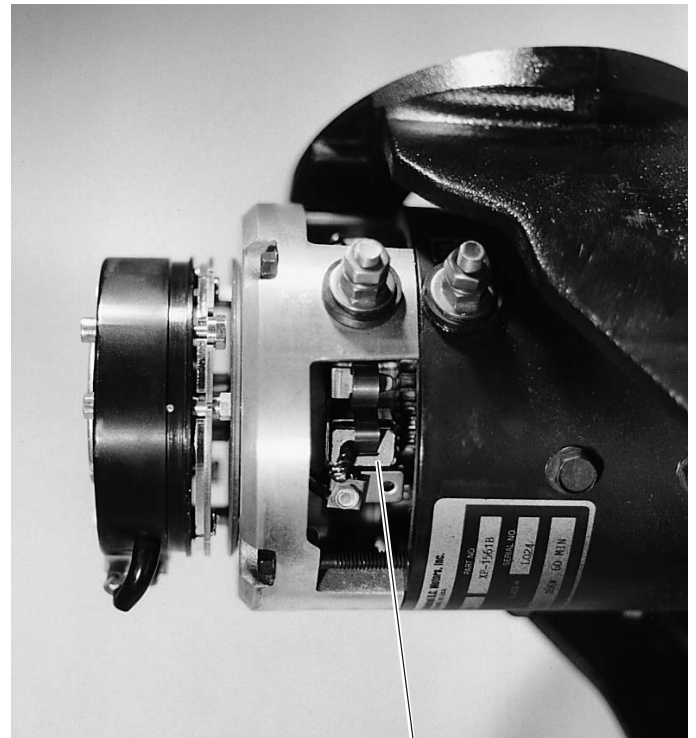
Traction Motor Maintenance (WF 1.2 t)

Access to brushes



Drive motor tensioning belt

MS3300-001



M1460

Carbon brush

- Disconnect the battery
- Prevent the truck from rolling away.
- Remove the tensioning belt from the motor.

Maintenance

- Apply dry compressed air to the motor.
- Remove all carbon brushes and check them with the armature in accordance with the instructions in "Key Maintenance Instructions".
- A new carbon brush is 28 mm long
- Carbon brush wear limit: 15 mm
- Refit the tensioning belt.

Armature

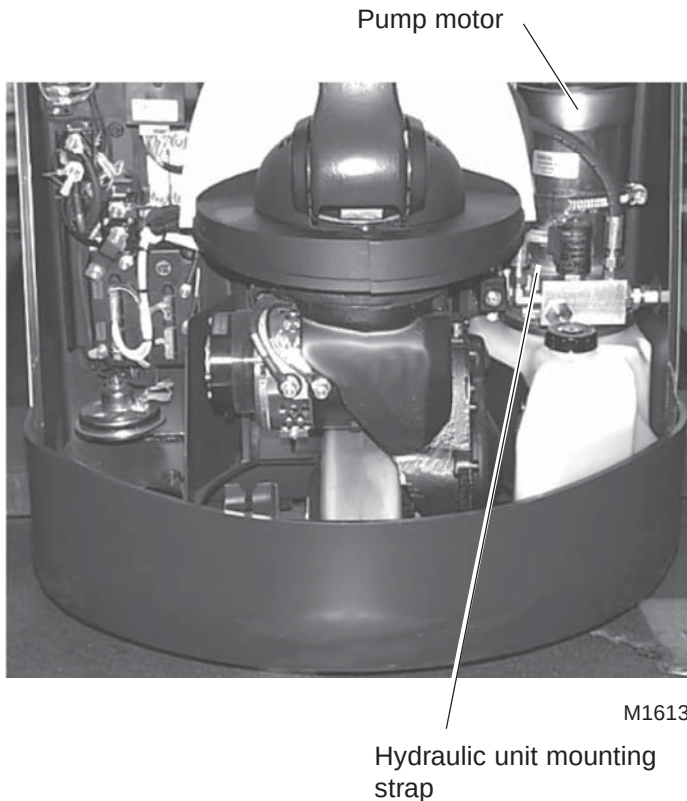
- A new armature has a max. diameter of 53.3 mm.
- The armature can be overwound provided the diameter is no less than 51.8 mm.
- The armature must be replaced if the diameter is 49.5 mm or less.
- After overwinding cut the mica down to at least 0.5 mm below the multi-plates without changing the gap width between the multi-plates.
- The multi-plate edges must be carefully de-burred.

Bearings

- The ball bearings are maintenance-free. If the bearings are removed during repair work they must be replaced.

Pump Motor Maintenance

Access to brushes



- Disconnect the battery
- Prevent the truck from rolling away.

Maintenance

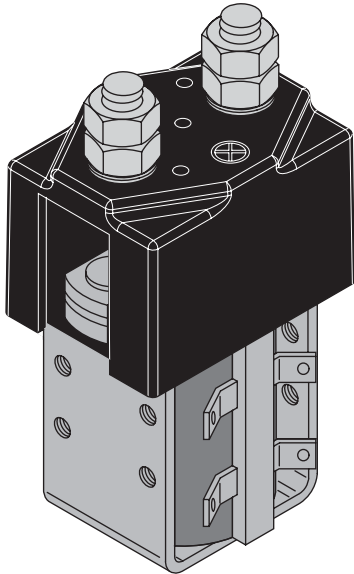
- Remove the tensioning belt from the pump motor.
- Apply low pressurised air to remove dust from the motor.
- Remove all carbon brushes and check them with the armature in accordance with the instructions in "Key Maintenance Instructions".
- A new carbon brush is 23 mm long
- Carbon brush wear limit: 15 mm
- Remove the brushes and dispose of them.
- Remove the springs and dispose of them.
- Fit new springs.
- Fit new brushes.

- Check that the brushes can move freely.
- Check that the contact pressure is the same for all springs.
- Refit the tensioning belt.
- Reconnect the battery.
- Test the pump.
- Remove the mechanism for preventing the truck from rolling away.

Armature

- Turn the armature coil and check for signs of burning or other damage. Replace the armature if necessary.
- A new armature has a diameter of 45 mm. The wear limit is 44 mm.
- The armature must **not** be overwound. Instead it must be replaced when the wear limit is reached.

Contactors



M1480

DANGER

Disconnect the battery before working on the contactors.

Important: Only use original Crown contactors as replacements, or Crown spare parts for repairs. The contactors are specially made for the truck.

Do not change the place or the angle where they are positioned, and do not change the wiring.

If dismantling a contactor for inspection or repairs, you must mark out the position of the contacts with respect to each other. It is important that contacts that are already been worked into each other are reassembled together. Otherwise, excessive wear and premature failure will result.

Inspection

Contacts

The contacts can blacken, swell and roughen during normal operation. This is normal, and there is no need to file or polish them. On the contrary: physically re-worked contacts burn out very rapidly.

Under certain conditions the contact silver coating can wander from one contact to another, where it can build up. This is quite harmless. The contacts must only be replaced if the silver coating has flaked off to such an extent that the supporting metal is visible.

Coils

The coil cannot be repaired. In the event of a defect, replace any coils if no resistance can be measured between the connections using an ohmmeter.

Springs

Replace any springs showing signs of corrosion, or fading through overheating.

Servicing

This contactor has fixed contacts that are connected to the cover. As contacts must always be replaced in pairs, for servicing you need a complete cover, 2 moving contacts and 2 contact springs.

Dismantling

All item numbers refer to the illustration unless stated otherwise.

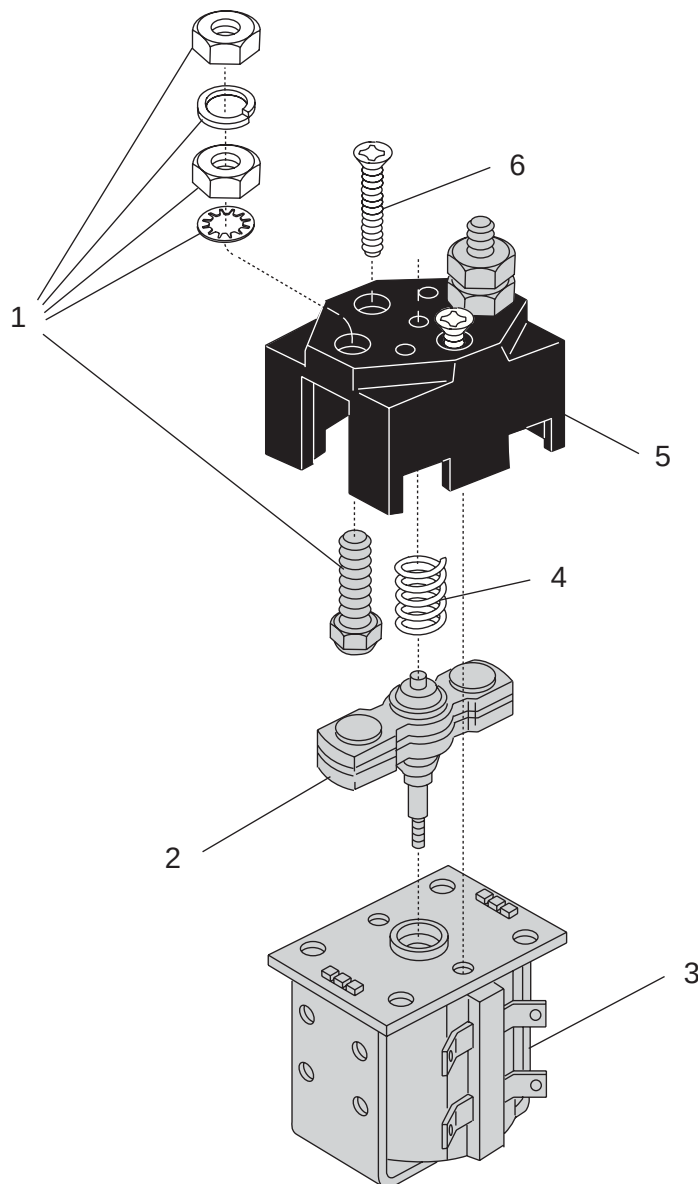
- Unscrew two mounting screws (6) and remove the upper housing section (5).
- Pull out the moving contact (2).
- Unscrew the mounting nuts and take off the fixed contacts (1).
- Clean, check and if necessary replace the components.

Assembly

All item numbers refer to the illustration unless stated otherwise.

Assembly is the reverse order of removal.

- Carefully insert the moving contact into the holes provided.
- Screw in and tighten the mounting screws with sealant 053050-006.



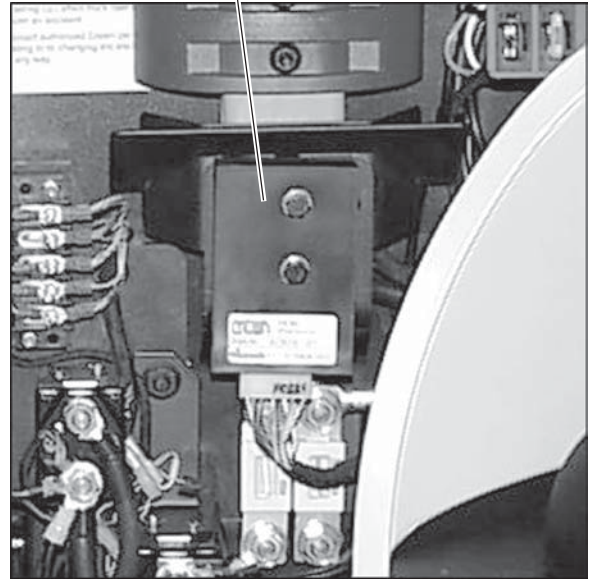
M1481

Hydraulic Control Module (HCM)

Whenever HCM module, proportional valve or hydraulic wiring is changed or disconnected, the system needs to be re-calibrated. Follow procedure listed.

- Connect the battery, if it is not already connected.
- Turn the key switch ON (the raise and lowering functions must be operational).
- Raise the forks to about 1 m above floor.
- Disconnect the battery (use Battery Disconnect).
- Fully press and HOLD the lower button.
- Connect the battery.
- Keep lower button fully depressed for 5 seconds. During this time the forks should not lower.
- Release the lower functions.
- Switch the truck off and on again.
- The procedure is complete, check all functions as per truck specifications.

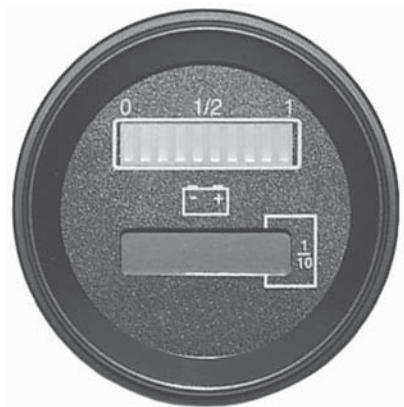
HCM
Hydraulic Control Module



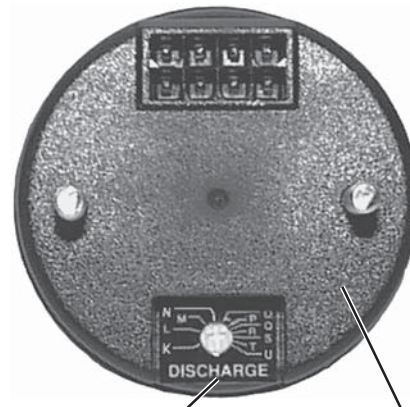
M1617

Battery Discharge Indicator (BDI)

The upper portion of the unigage is a battery discharge indicator with lift interrupt and lower portion is a hour meter.



M1615



M1616

Setting selector

Back of meter

The purpose of the lift interrupt is to monitor and protect the battery as well as electrical components of the truck. To protect the battery, the discharge cycle must not exceed 80% discharge under full current load. For wet cell batteries, an 80% discharge equals 1.73 volts per cell (VPC) [electrolyte temperature at 25°C/77°F] and for maintenance free batteries, an 80% discharge equals 1.86 (VPC) under load or 2.02 VPC (open circuit).

WARNING



Allowing the battery to go deeper into discharge will permanently damage battery and possibly the electrical components on the truck.

OPERATION

The green and yellow LEDs on the battery discharge indicator show how much charge is left in the battery. A flashing red LED is a warning the battery is getting low. When two red LEDs flash, the meter locks out lift and, at this point, the battery must be recharged or exchanged for a fully charged battery to resume full truck operation.

General

WARNING



The following setting and calibration instructions for the BDI apply only to wet batteries.

When maintenance free batteries are being used, set the selector to „P“. No further adjustment is necessary. When wet cell batteries are being used, adjust the setting following the procedure outlined below.

This applies only to battery approved by Crown. For other battery types, contact the battery manufacturer.

A battery from the factory will require approx. 5 - 10 charge and discharge cycles to reach its full capacity.

A battery is considered to be technically discharged when it has reached 20% residual capacity. For example, a battery with a 500 amp hour capacity has an actual available output of 400 amp hours.

In addition, the effective output will depend on the discharge speed, which in turn is affected by the particular truck application.

The battery discharge indicator must therefore be set in accordance with the truck's particular application conditions.

The battery discharge indicator controls the lift cutout system. The lift cutout system is designed to prevent the battery from being operated to the point where it is fully discharged.

If the battery is constantly discharged to below 20% of residual capacity it will be damaged.

If the lift cutout system is activated above 20% of the battery's residual capacity the battery will not be damaged, but the truck's maximum operating time under a single battery charge will not be attained.

The lift cutout system should therefore be activated as close to 20% of the battery's residual capacity as possible. If at all, it may be slightly above 20%, but never below.

NOTE



For new trucks the battery discharge indicator should be set at the latest after ten discharge and charge cycles.

Battery Discharge Indicator Setting (BDI)

The acid density is a very reliable indicator of the charge status of a lead acid battery.

However, since it is unrealistic to continually measure the acid density of a truck battery to an industrial standard, the battery voltage is used to determine the charge status over longer journeys.

To adapt the BDI to the battery used and the truck's specific application profile, you need the battery manufacturer's data sheet. The values you require are the density of the electrolyte for an 80% discharged battery (20% battery residual capacity) and for a fully charged battery (100% battery capacity).

Finally, via the potentiometer on the back of the BDI the display is set to the actual discharge terminal voltage of the battery at 20% residual capacity.

The factory default setting of the battery discharge indicator is „N“ (any setting from K to U is possible).

Calibration for wet batteries

- Fully charge the battery as indicated by the battery manufacturer in the operating instructions. Measure the acid density in accordance with the battery manufacturer's maintenance instructions to check if the battery is actually 100% charged. Faulty battery cells will make calibration impossible.
- Operate the truck as usual under normal operating conditions until the battery is empty: both LEDs of the BDI will flash and the lift cutout system will be triggered.
- Leave the battery for at least 10 to 12 hours (one hour at the very minimum!).
- After this interval measure the acid density on at least three different battery cells. The smallest recorded value is the one you need.
- Compare the recorded density with the density specified by the manufacturer for an 80% discharged battery (20% residual capacity).
- If the battery is more than 80% discharged (less than 20% residual capacity), set the potentiometer on the back of the BDI to direction **K**.
- If the battery is less than 80% discharged (more than 20% residual capacity), set the potentiometer on the back of the BDI to direction **U**.
- Re-charge the battery and check the calibration. If necessary, repeat this process.

Discharge Terminal Voltage Setting (volts/cell)

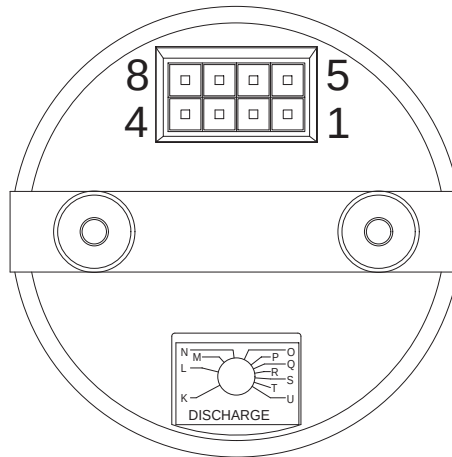
K	L	M	N	O	P	Q	R	S	T	U
1.57	1.63	1.68	1.73	1.78	1.82	1.84	1.86	1.89	1.91	1.93

E20-GB

Wet batteries
(industrial batteries)

Maintenance-free
batteries

TROUBLESHOOTING



M1479

CONNECTOR TERMINAL - 802833	
PIN NO.	RELAY OPTION K
1	No Connection
2	+ Keyswitch
3	Relay ARM (+) Lockout
4	Relay N.C. (-) Lockout
5	Common (B-)
6	Truck Hours
7	B + Low (24V)
8	B + High (48V)

SYMPTOMS:

CHECK:

Gauges will not reset

Check Battery state-of-charge both voltage and specific gravity. The settings equals 2.09 Volts per cell. Batteries charged to 1250 SG with the electrolyte temperature at 25°C / 77°F and battery under full current load or better will have this voltage. If a battery is not able to produce reset, the battery and/or charger must be checked.

Truck comes in too soon for a battery charge

Check specific gravity of battery when the meter's red LED's flash. Do not turn the DISCHARGE setting towards K if the specific gravity of the battery corresponds to more than 80% discharge (1150 SG for most batteries with electrolyte temperature at 25°C / 77°F and under full current load). More running time can be obtained by turning the DISCHARGE setting from N towards K, providing the battery does not show 80% discharge.

E22-GB

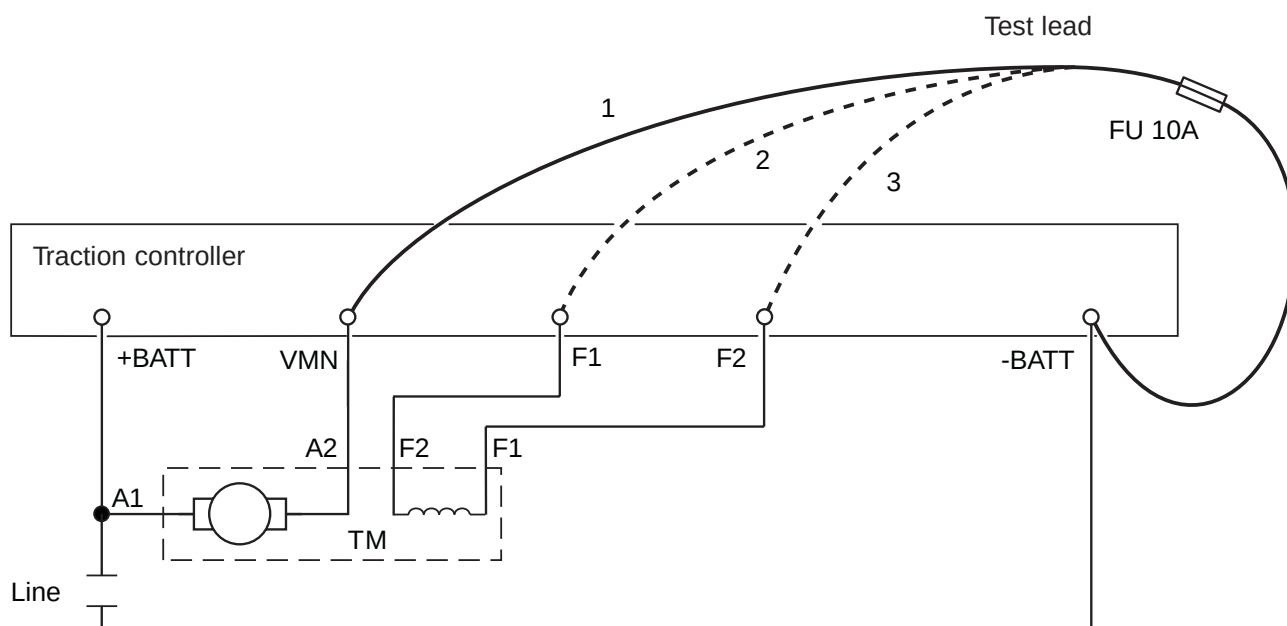
Traction Controller Safety Test

The traction controller safety test takes the form of a Pulse Monitor Trip Test (PMT).

In accordance with EU Norm PREN 1175-1 the following test must be carried out to check the fuse circuit.

The test requires a test lead of approx. 1 mm² diameter and a 10A fuse.

- Switch off the truck and jack it up.
- Connect one end of the test lead to -BATT.
- Connect the other end of the test lead to VMN (see diagram).
- Connect the programmer to the traction controller.
- Power up the truck. The programmer should display CAPACITOR CHARGE. Activating the traction pod should have no effect.
- Switch off the truck and disconnect the test lead from VMN (the other end remains connected to -BATT).
- Attach test lead to F1 (item 2).
- Power up the truck. The programmer should display VFIELD NOT OK. Activating the traction pod should have no effect.
- Switch off the truck, remove the test lead completely, remove the programmer.
- When the truck is switched on again and the traction pod activated, the traction motor should start.
- If the test proves unsuccessful, replace the traction controller.



M1482



BRAKE

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Brake

Function

The drive motor contains the drive wheel brake which is designed as a disk brake.

Its design is shown in Figure 8051-01.

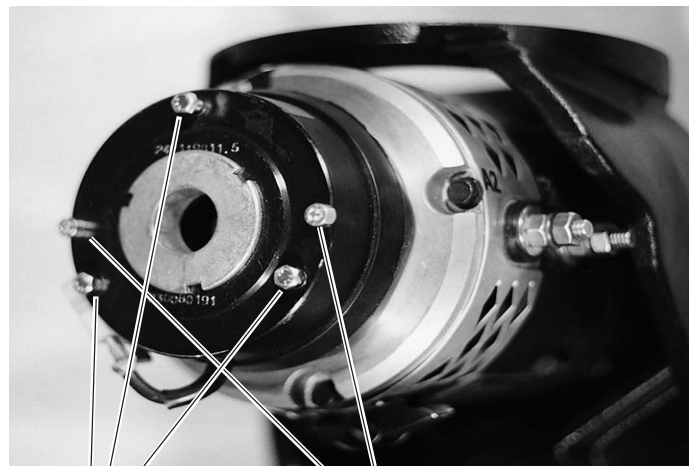
The brake interlocks with the motor shaft. The brake is applied when de-energised. If the truck needs to be moved in this case, the brake can be mechanically released by turning the two cheese head screws. Afterwards, always remember to undo this! Before starting up the truck again, make sure that it cannot move.

The brake is electro-magnetically released. The axial force generated by the compression springs acts on the moving armature disk. The rotor with friction lining on either side also moves axially. The force acting on the armature disk pulls the rotor between the armature disk and the friction plate. When a DC voltage is produced at the coil, a magnetic force acts on the armature disk. The armature disk is pulled against the compression springs. The rotor and hence the brake are released.

Disassembly

The item numbers in brackets refer to Figure MP8051-01 on the following page.

- Disconnect the battery (=EMERGENCY DISCONNECT).
- Jack up the truck.
- Remove the front panel.
- Pull the rubber covering ring (8) out of the groove in the magnetic body.
- Remove the abrasion dust.
- Undo the electric connectors from the magnetic body (3).
- Unscrew the three mounting screws (see Fig. M1462).



Mounting
screws
(hex. head)

Screws for mechanical
brake release
(cheese head screws)

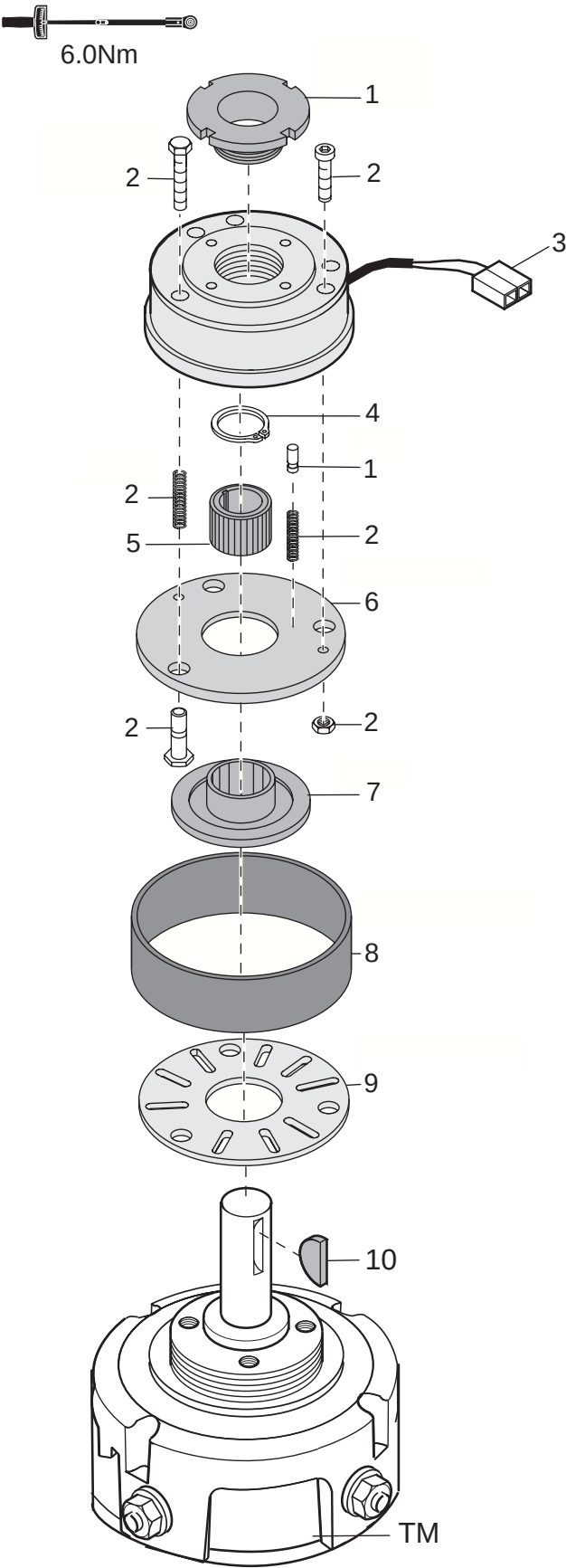
M1462

- Remove the magnetic body (3) from the motor (including everything connected to it).
- Remove the rotor (7) from the hub (5). Take care not to damage the toothing.
- Measure the thickness of the rotor. Replace the rotor if it is less than 5.5mm thick.
- Remove the friction plate (9).
- Unscrew the cheese head screws (see Fig. M1462) from their respective nuts.
- Unscrew the hollow screws (2) from the magnetic body (3 off).
- Remove the armature disk (6).
- Thoroughly clean all components.

CAUTION



Do not allow friction surfaces to come into contact with oil or grease.

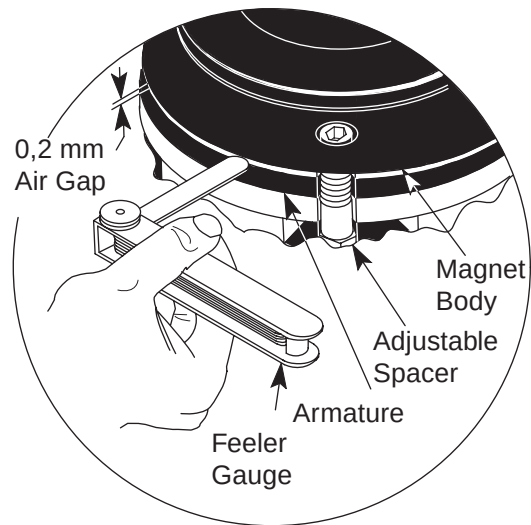


8051-01

Assembly

Installation is the reverse of removal.

- Should any pressure items (with the 3 inner compression springs) have fallen out of the magnetic body, insert them in their correct position: The flat surface must be facing the spring.
- Place the armature disk in the correct position on the magnetic body: The friction plate must be seated on the side facing away from the magnetic body.
- Screw the hollow screws into the magnetic body as far as they will go.
- Screw the cheese head screws into their respective nuts only so far until a gap of at least 1mm remains between the armature disk and the magnetic body.
- Place the friction plate on the motor.
- Push the rotor onto the hub. Avoid damaging the toothing.
- With the Allen screws, attach the magnetic body and everything connected to it to the motor.

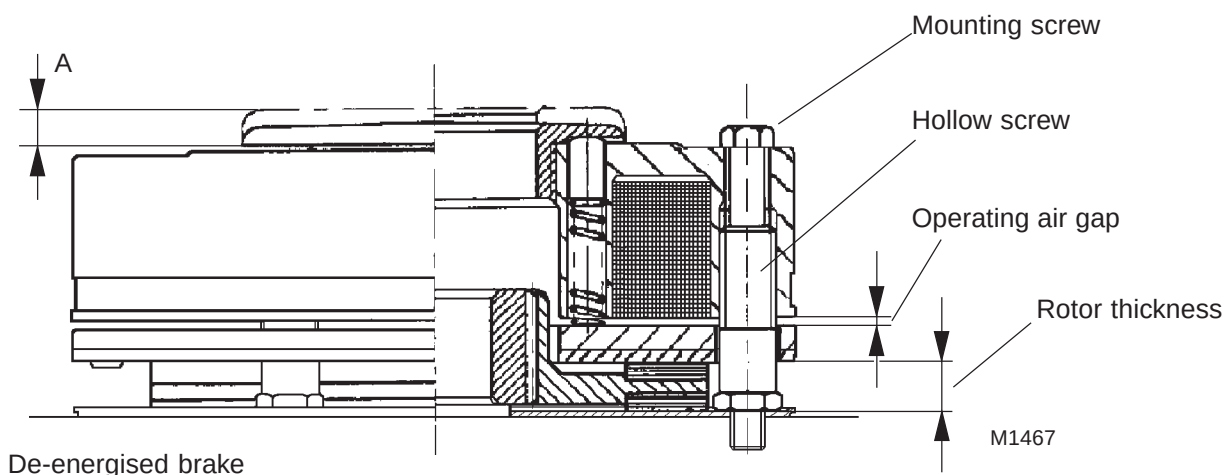


6739-01

Air gap setting

The operating air gap is measured between the magnetic body and the armature disk when the truck is braked. Set the air gap to 0.2 mm. The max. permissible tolerance is 0.55 mm.

- Unscrew the hollow screws until they firmly contact the friction plate.
- Tighten the Allen screws evenly.
- Check the operating air gap along several points using a feeler gauge. The air gap should be even all the way along.
- To increase the air gap unscrew the Allen screws slightly. To reduce the air gap screw the hollow screws into the magnetic body. Then proceed as described above.
- When the air gap has been correctly set, torque the Allen screws to 6 Nm using a torque wrench



Brake moment setting

The basic setting for the brake moment is made by turning in the adjusting ring to dimension A, see following table.

Brake test

- Accelerate the empty truck at operating temperature with a fully charged battery on a level, dry and non-skid concrete surface to maximum speed.
- Set the control handle to the lower braking range.
- Measure the braking distances from the time the brakes are applied to the point where the truck comes to rest.

INFORMATION

 *The braking distance has priority over the default setting.*

Definition of run-in/new rotor

With the brake system it is important to note the run-in status of the rotor. We distinguish between a new and a run-in rotor.

We speak of a new rotor if the brake lining on the rotor has been used for max. 10 full braking processes.

The rotor is run-in after approx. 150 full braking processes. After approx. 150 full braking processes, the brake's coefficient of friction no longer rises.

The permissible braking distances can be found in the following table.

Rated braking distance (without load)		
	New rotor	Used rotor (run-in)
Screw depth A	5 mm	
With rated load	1.0 to 1.1 m	0.95 to 1.05 m
Without load	0.6 to 0.7 m	0.55 to 0.65 m

B01-GB

General Notes

The braking system and caster system are adjusted at the factory to provide nominal brake and stability performance for level, smooth, dry, concrete floors and standard tire and load conditions. Upon installation, the trucks brake and stability performance should be checked to ensure acceptability. It may be necessary to modify the factory settings to properly accommodate the particular operating conditions. When a vehicle is operating over a variety of floor and load conditions, it may be impractical to adjust the brakes and casters to perform optimally for all of the different conditions.

WARNING

 *Increasing caster loading reduces load on the drive tire and therefore reduces braking effectiveness and traction. Reducing caster loading reduces stability.*

Drive tire wear or replacement as well as floor conditions will affect operating characteristics of the truck, mainly: Braking/traction, Stability/Handling, Steer Effort.

Floor conditions in set up area should be consistent generally with floor conditions in the overall facility. Periodic caster adjustments may be required to maintain proper balance of these characteristics and proper operation

Troubleshooting

Symptom	Probable Cause	Remedy
Brakes will not release	● Air gap more than 0.2 mm ● Brake temperature above 140 °C ● Open circuit in brake module circuitry or wiring	Adjust Allow to cool and check air gap Make voltage checks at test points of the brake module
Brakes drag	● Air gap more than 0.2 mm ● Brake pad mounting plates or rotor distorted ● Armatures movement restricted by dirt, foreign material ● Pads soiled with grease	Adjust Replace Clean with low pressure air Replace
Brakes grab	● Incorrect stopping distance adjustment ● Brake pad mounting plates or rotor distorted ● Brake pads loose or soiled with grease	Adjust Replace Replace
Abnormal noise and chatter when brakes applied	● Brake pad mounting plates or rotor distorted ● Brake pads worn out, loose, soiled with grease, foreign material embedded ● Rotor thin, cracked, or spline worn	Replace Replace Replace

B02-GB

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STEERING

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Steering

Live ring bearing

The control handle is connected to the drive unit via the control handle support and a flange. The live bearing, designed as a double taper bearing, moves between the flange and the truck chassis. It is maintenance-free and permanently lubricated.

Figure M1477 shows a cross section of the live ring bearing, with the drive unit disassembled.

Disassembly

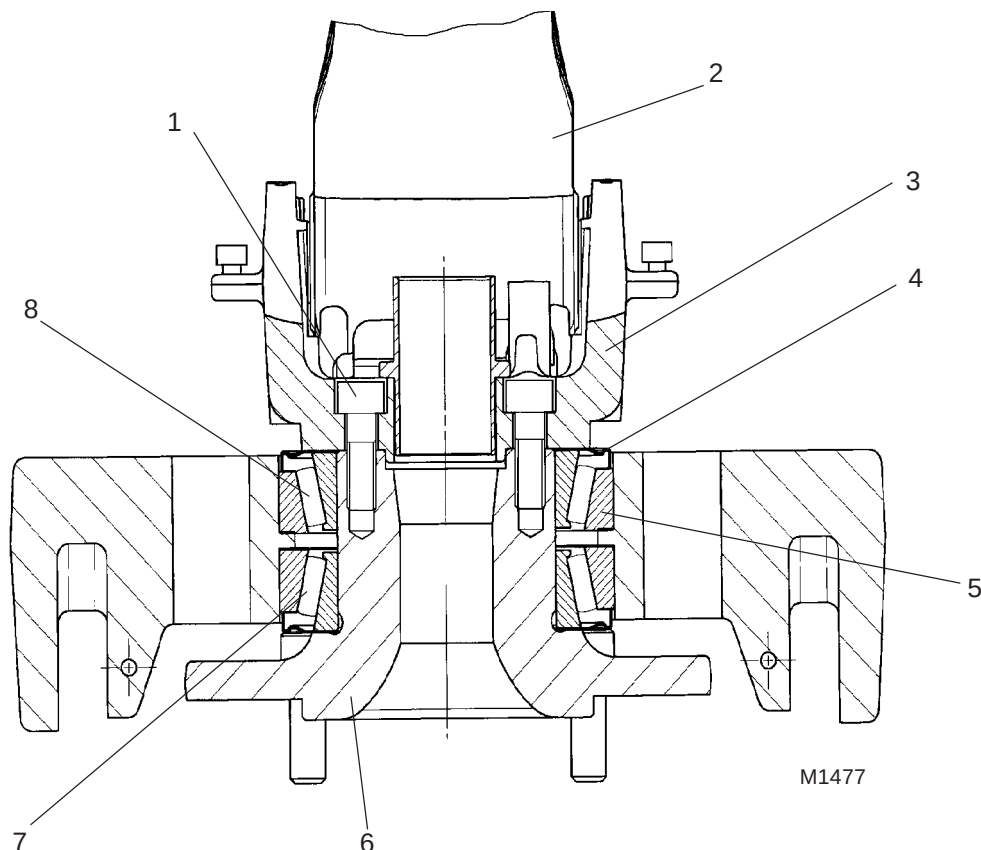
The item numbers in brackets refer to Figure M1477.

- Disconnect the battery (=EMERGENCY DISCONNECT).
- Jack up the truck and secure it (see Chapter 1).
- Remove the front panel and the control handle support.
- Undo all 6 mounting screws (1) from the control handle support (2) and remove the control handle and support. Take care not to damage any wires in the process.

- Undo the drive unit wire connections.
- Using a rubber hammer drive out the flange (6) with the drive unit down out of the truck chassis.
- Remove the inner ring and the Nilos ring of the lower conical roller bearing (5) from the flange (6).
- Pull up the inner ring and the Nilos ring from the upper conical roller bearing (6).
- Drive out the outer rings of both bearings from the truck chassis.

Installation

- Before assembling, make sure the seat surfaces are clean and burr-free.
- Refit all wire connections without twisting them.
- Control handle support mounting screws (12) torque: 49 Nm.



Control handle return springs

The 3 return springs positioned next to each other are located on the rotating axle of the control handle. The inner, angled end of the springs is positioned in the longitudinal slot of the axle. The outer end (also angled) pushes the control handle up. Remove the control handle support panel to access the springs for lubrication purposes.

CAUTION



While the springs are tensioned, do not reach into the control handle near the rotating axle.

To avoid possible injury caused by the truck accidentally starting, before carrying out any work on the control handle attachment:

- Disconnect the battery (=EMERGENCY DISCONNECT).
- Secure the truck to prevent it from rolling away

The item numbers in brackets refer to Figure M1491.

Adjustment

The LH side of the axle (4) is fitted as standard with a dowel pin (5). If the bias spring force reduces over time, the pre-tension of the springs (2) can be increased as follows:

- Leave the control handle (1) in the neutral position (up).
- Drive out the dowel pin on the LH side.
- Drive in the dowel pin on the RH side. To do this, use a face wrench to turn the axle sufficiently far.

Disassembly

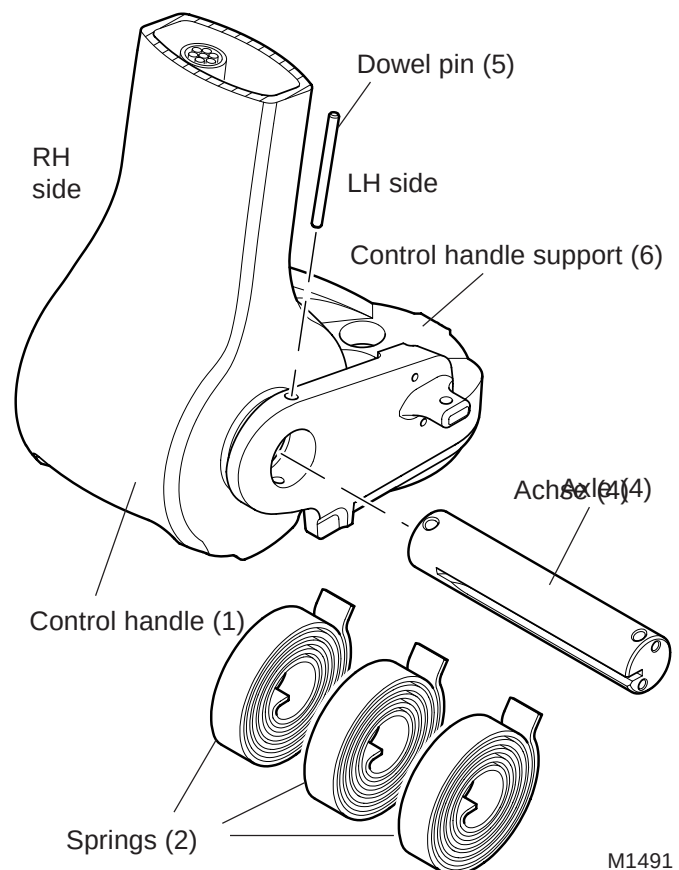
- Control handle in neutral position.
- Mark the axle position.
- Drive out the dowel pin.
- The discharged springs should now turn the axle.
- Tilt the axle fully down.
- If the axle still hasn't turned, it is obviously rigid and must be assisted with the aid of the face wrench. Turn the axle, viewed from the left, anti-

clockwise approximately 20° with respect to the fixed position.

- Drive the axle out to the right so that the 3 springs can be removed.

Installation

- Push the 3 springs onto the axle. The inner, angled end should enter the groove of the axle in the process. It can be useful to attach a belt around the inner end of the first inserted spring, in order to help line up the other springs.
- Drive the axle in fully.
- Tilt the tiller up as far as the stop.
- Attach the axle to the LH side (RH side if necessary) using a dowel pin. To do this, turn the axle sufficiently far.



Steering Chain

DANGER



Your hands could be trapped by the steering chain.

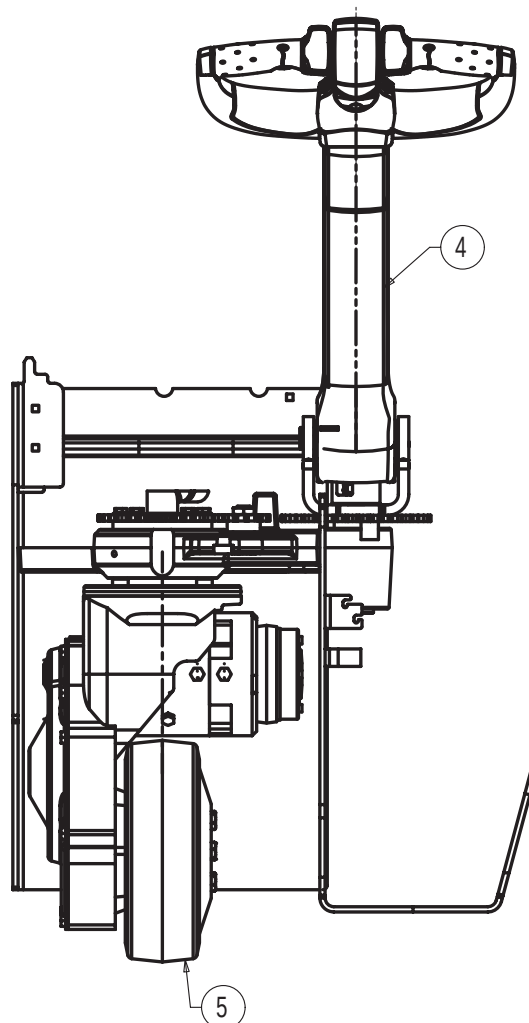
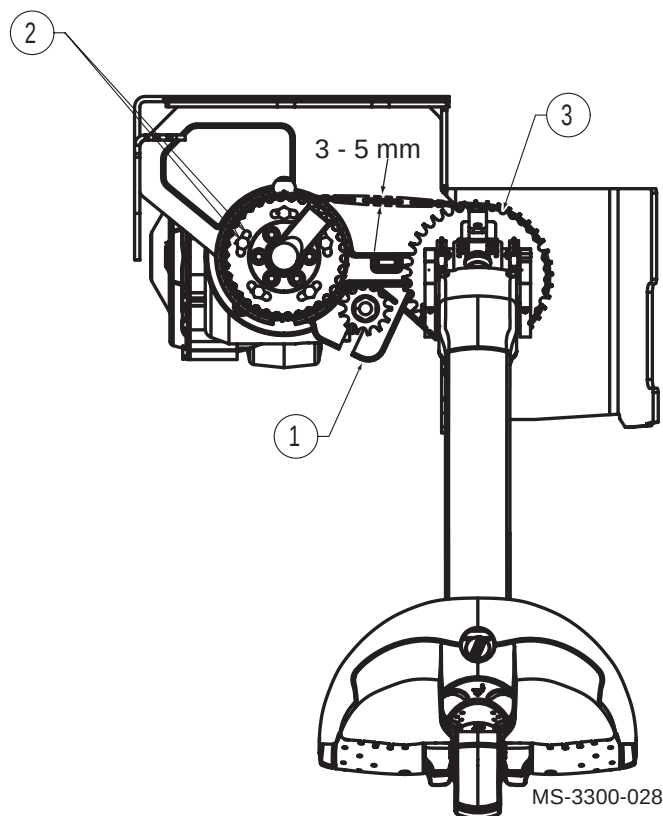
Prevent the truck from being switched on again. The safest way to do this is to disconnect the battery.

Permissible Elongation

New steering chains are 901.7 mm long (71 links with 1/2" x 5/16"). The chain must be replaced if there is a 2% elongation. The chain is connected to a chain lock and half a chain link.

Chain Tension Adjustment

- Switch off the truck and remove the key. Prevent the truck from being switched on again.
- Jack up the truck and prevent it from accidentally lowering if the steering chain can only be reached from below. See chapter 1.
- Remove any chain covers, if applicable. The steering chain is correctly tensioned if, when you apply pressure with both thumbs on the opposite side of the chain tensioner, the chain yields approx. 3 – 5 mm.
- To adjust the chain tension loosen the nut of the chain tensioner and push the chain tensioner (1, Fig. MS-3300-028) in the slotted hole in the corresponding direction. Now tighten the nut again and check the chain tension. If necessary, repeat the adjustment.
- Test forward travel. If this produces a deviation in angle from the control handle (4) to the drive wheel (5), loosen the mounting screws (2) connecting the steering shaft to the chain pinion. Turn the control handle to the forward position. Tighten the screws (2) again and test forward travel once again. Repeat the adjustment if necessary.
- To facilitate future service work, note the position of the chain pinion in relation to the steering shaft using a water-proof pen.

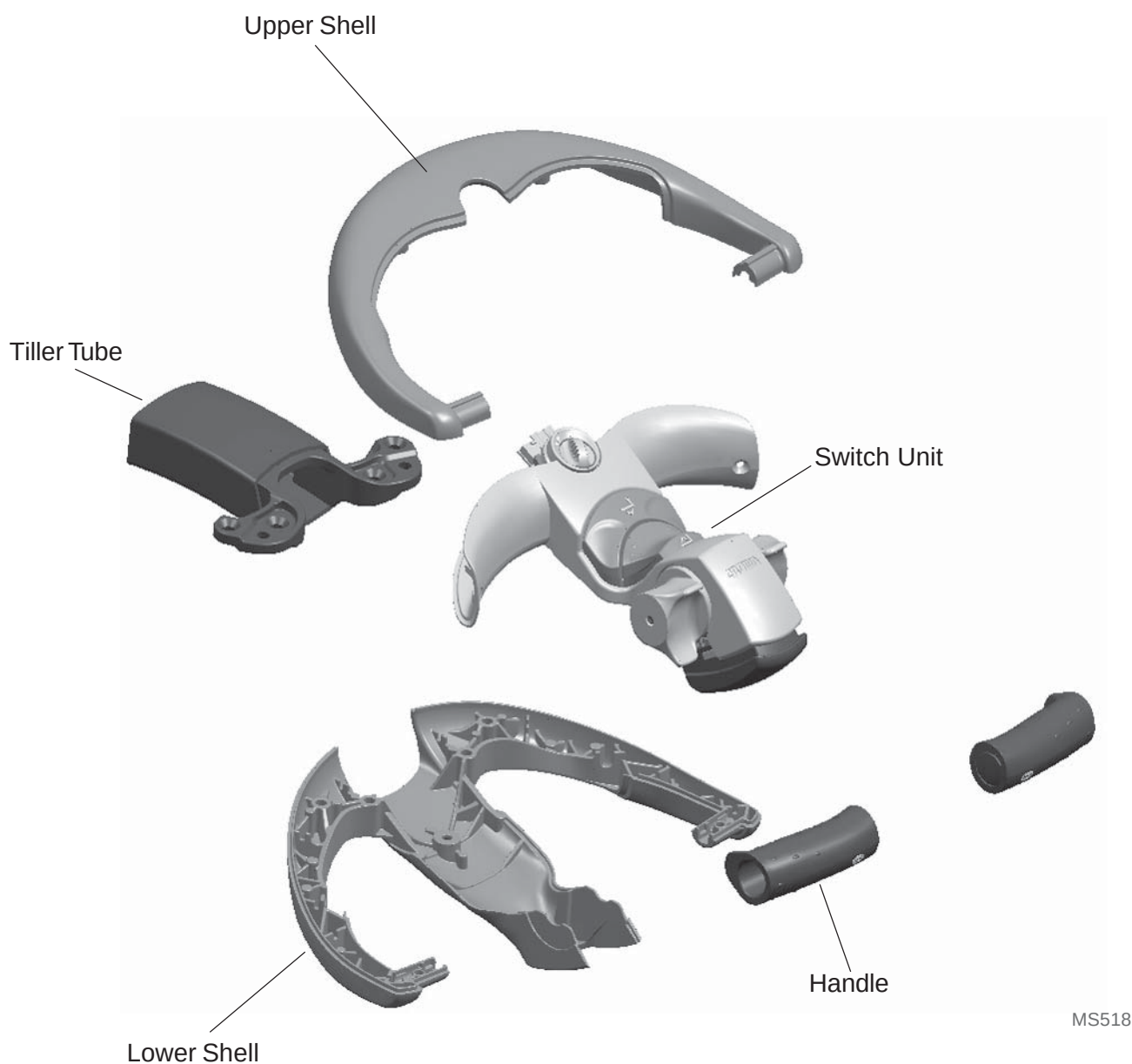


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Tiller Handle

Main Components

This is an overview of the main components and their associated terms:



Tiller Handle Component Removal / Installation

To access the various components of the tiller handle you will need:

A 2, 3, 5, 8 mm Torx® screwdriver and a small screwdriver with a flat blade.

CAUTION



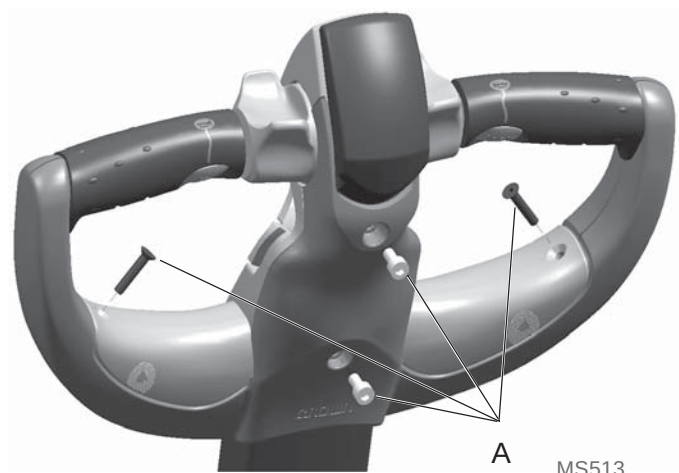
Danger of short circuiting!

De-energise the truck (disconnect the battery) and prevent it from being switched on again.

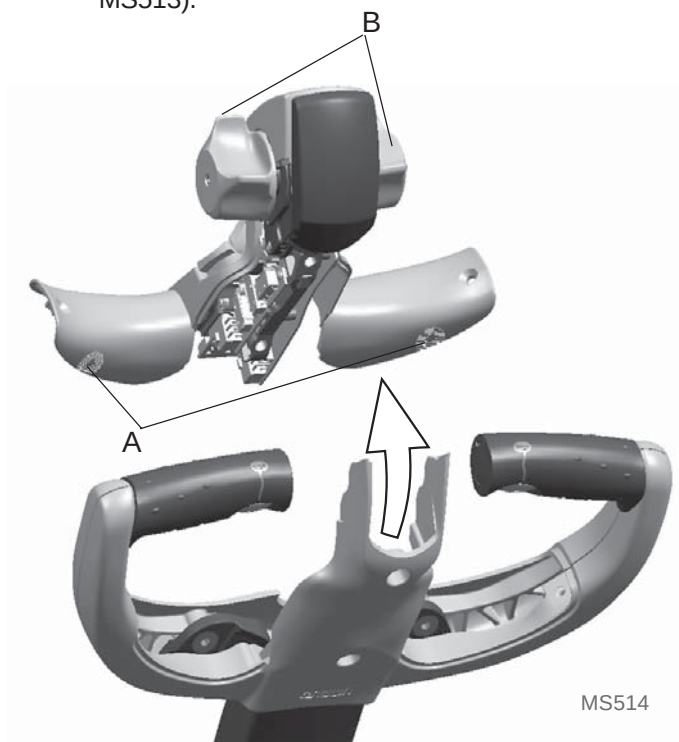
Unless otherwise stated, all screws must be tightened with a standard torque. A torque table can be found in chapter 1 of this manual.

Tiller Handle Shells

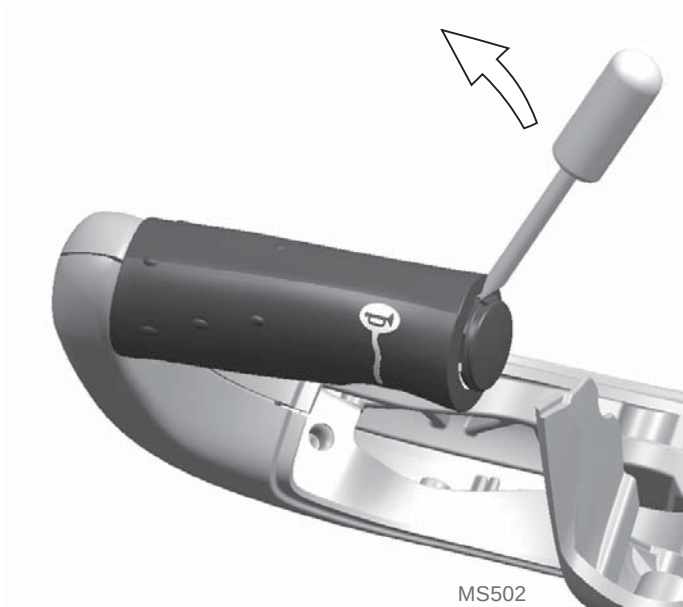
Removing the Upper and Lower Shells



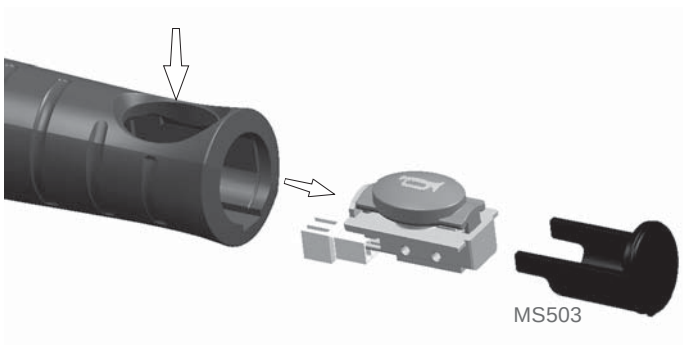
- Remove the four M5 Torx® screws (A, Fig. MS513).



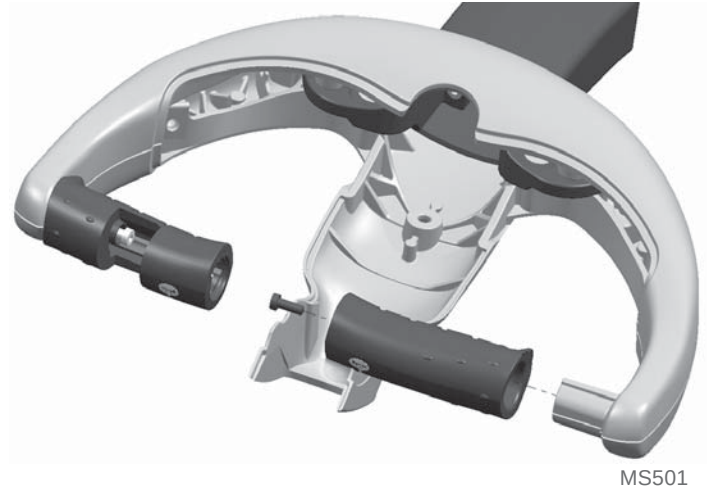
- Press on the thumb markings (A, Fig. MS514) of the switch unit or pull on the butterfly switches (B). The switch unit will slide up out of the lower shell.
- Remove the plug connector of the tiller wire harness and the horn switch from the switch unit boards.



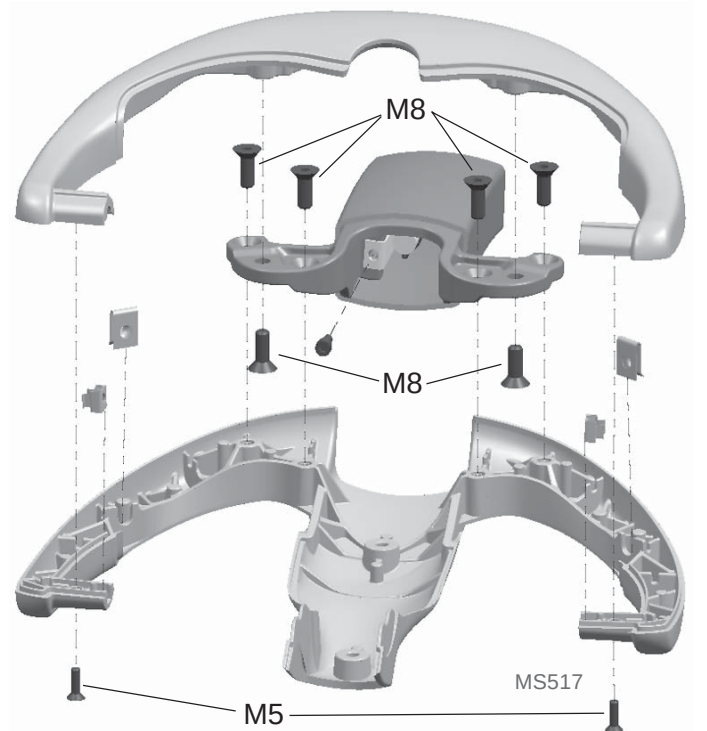
- Using a small flat screwdriver lever out the protective cap from each tiller handle (see Fig. MS502).



- Gently press the horn switch inward and pull it out of the handle (see Fig. MS503). Disconnect the plug connector from the switch.



- Remove the internal M5 Torx® screws and pull the handles off (see Fig. MS501).



- Remove the two M5 Torx® screws and the six M8 Torx® screws (see Fig. MS517). Remove the shells.

Fitting the Upper and Lower Shells

Installation is the reverse of removal. When installing, take care not to damage the wiring.

Switch Unit

Removal

The switch unit contains the safety reverse switch, the travel switch, the "Fast/Slow" toggle switch, the main board and the pump controller board.

To replace any one of these components you have to disassemble the entire switch unit.

- Remove the plug connector of the tiller wire harness and the horn switch from the switch unit boards.

Switch Unit Installation

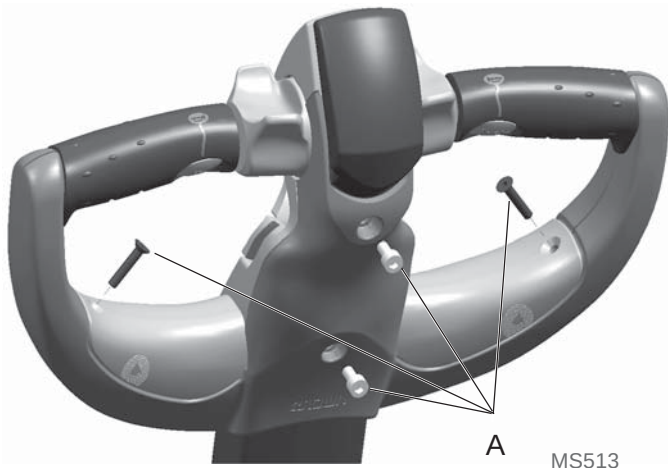
Installation is essentially the reverse order of removal.

Ensure you re-connect the tiller wire harness and the horn wiring. The connectors cannot be interchanged and are reverse battery protected.

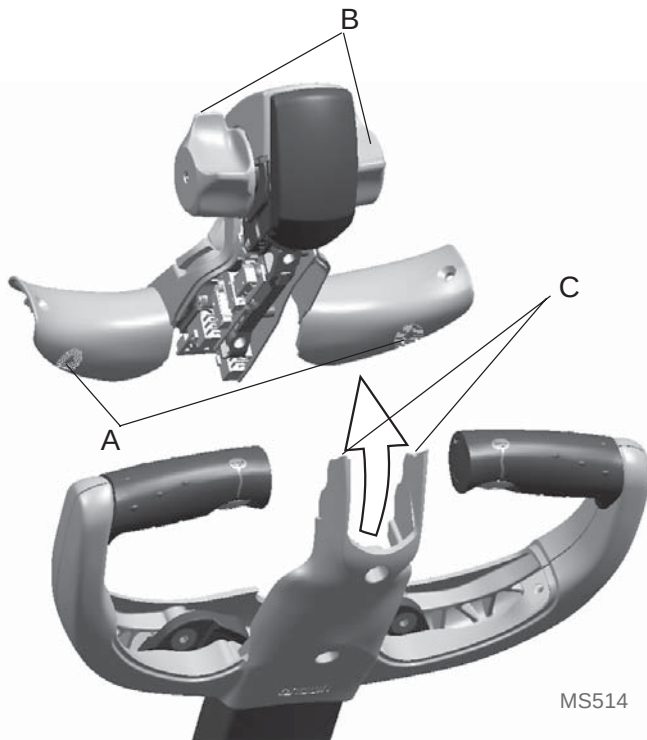
Guide the switch unit over the two side sections (C, Fig. MS514), pushing the switch unit downward and forward in the process.

Tighten the mounting screws (M5).

After re-connecting the battery test all functions.



- Remove the 4 M5 Torx® screws (A, Fig. MS513).



- Press on the thumb markings (A, Fig. MS514) of the switch unit or pull on the butterfly switches (B). The switch unit will slide up out of the lower shell.

"Fast/Slow" Toggle Switch

There are no parts in this switch module which can be repaired. The entire module must be replaced.

The switch module comes in two variants: a standard version (812943-001) and a cold store version (812274-001). Make sure you use the right module!

Removal

- Remove the switch unit (see *SWITCH UNIT* section in this chapter).



- Remove the two M3 Torx® screws (see Fig. MS511) and remove the toggle module.

Installation

- Fit the new toggle module and fix it with two M3 Torx® screws.
- Re-install the switch unit (see *SWITCH UNIT* section in this chapter). Carry out a functional test.

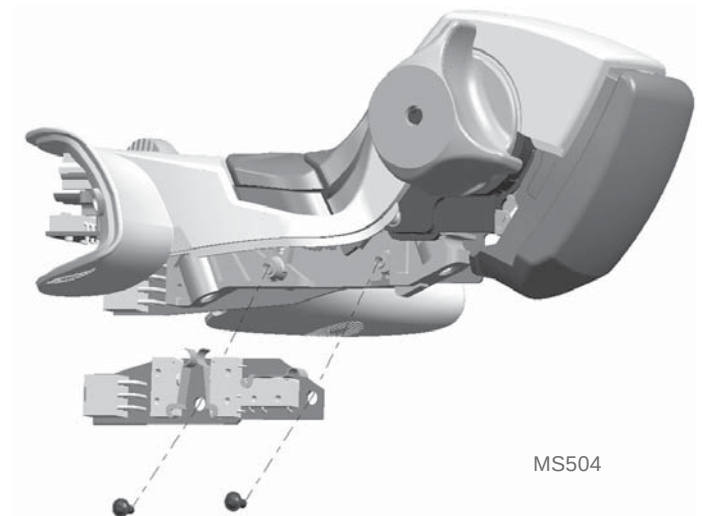
Hydraulic Board

There are no parts in this board which can be repaired. It must be replaced in full.

The board comes in two variants: a standard version and a cold store version. Make sure you use the right board!

Removal

- Remove the switch unit (see *SWITCH UNIT* section in this chapter).



- Remove the two M3 Torx® screws (see Fig. MS504) from the smaller of the two boards (the larger one is the main board). Remove the hydraulic board.

Installation

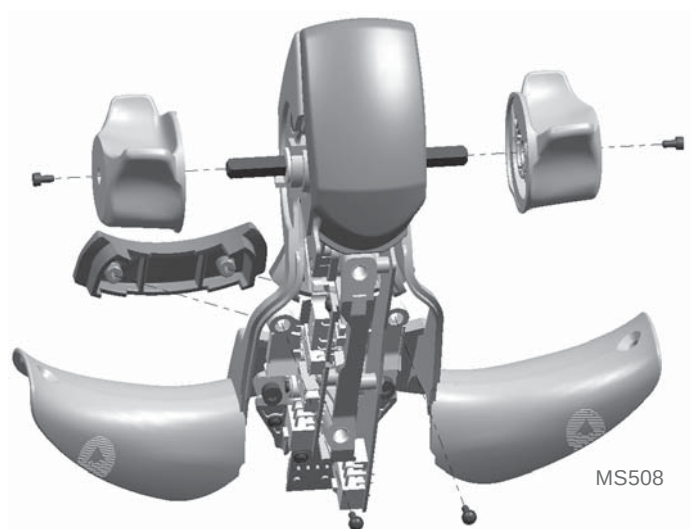
- Fit a new hydraulic board (ensuring it is the right version, cold store or standard!) and fix it with two M3 Torx® screws.
- Re-install the switch unit (see *SWITCH UNIT* section in this chapter). Carry out a functional test.

Potentiometer

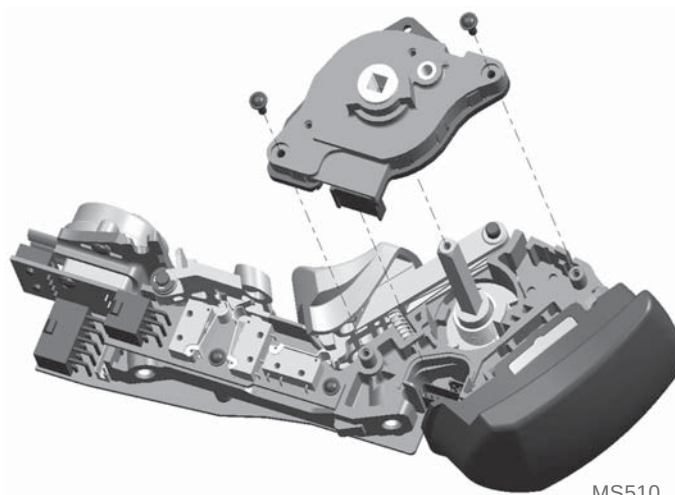
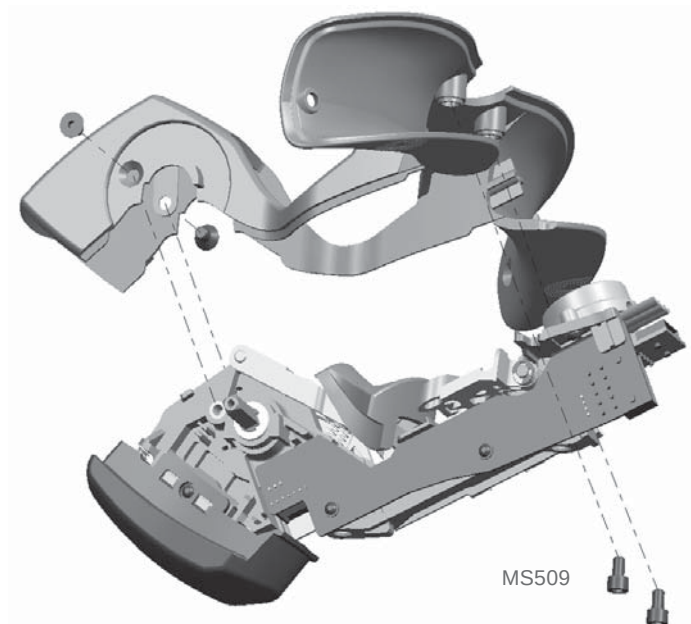
There are no parts in the potentiometer which can be repaired. It must be replaced in full. **The potentiometer comes in two variants: a standard version and a cold store version. Make sure you use the right potentiometer!**

Removal

- Remove the switch unit (see *SWITCH UNIT* section in this chapter).



- Remove the two M3 Torx® screws (see Fig. MS508) from the butterfly switches and pull the butterfly switches off. Take care not to lose the plastic slide bearings (washers).



- Remove the two M3 Torx® screws which secure the orange lower switch cap. Remove the switch cap.
- Remove the four M5 Torx® screws shown in Fig. MS509. Remove the switch unit cover.
- Remove the two M3 Torx® screws shown in Fig. MS510. Remove the connectors from the boards. Remove the potentiometer from the square axle.

Installation

- **Before connecting the wire to the potentiometer, pack the potentiometer bushing with grease (part no. 053002-005). Do not use any other grease.**

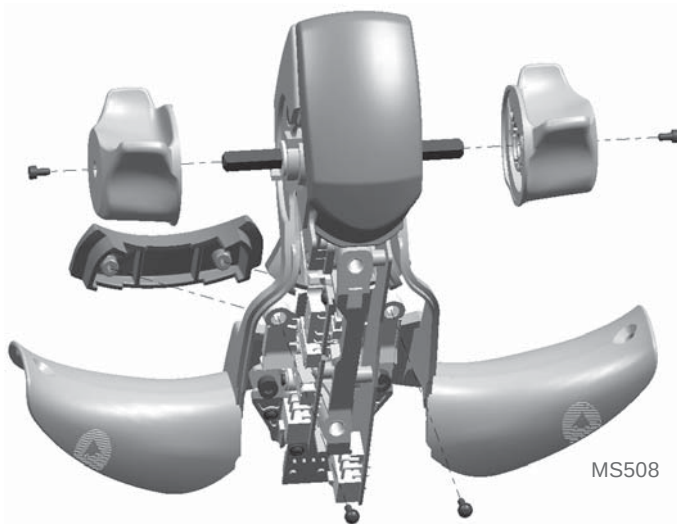
Installation of the potentiometer is the reverse of removal.

Note: The butterfly switches cannot be fitted incorrectly. They will only fit properly in a single position.

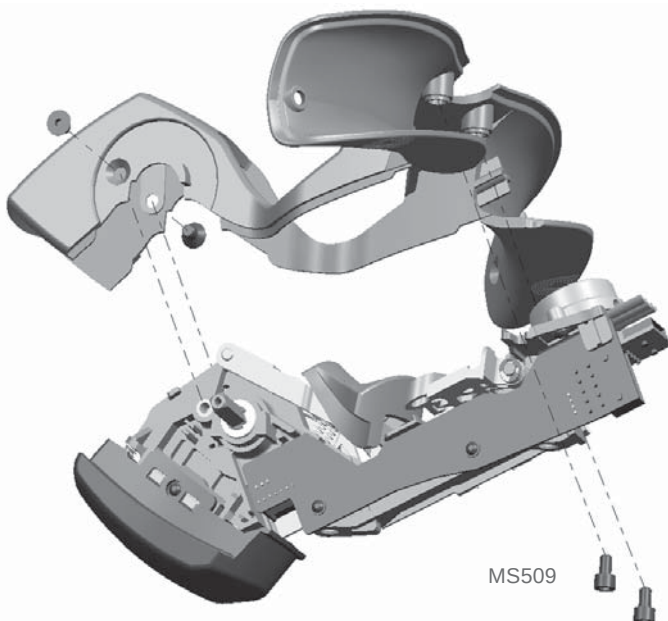
Safety Reverse Switch

Removal

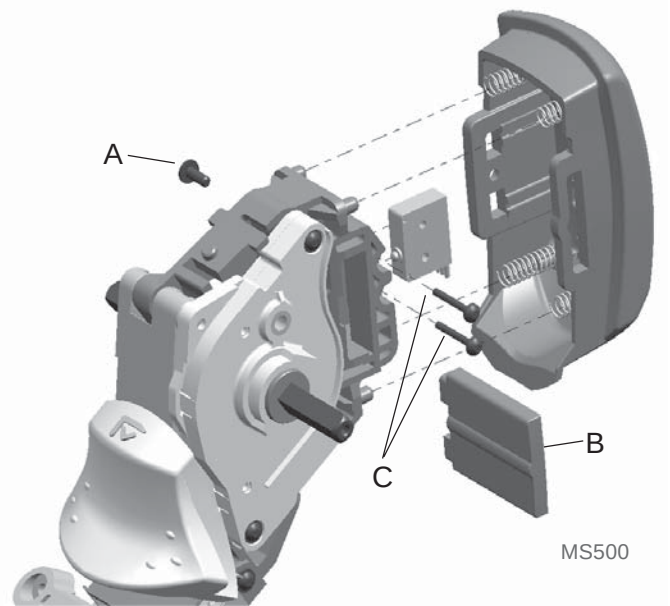
- Remove the switch unit (see *SWITCH UNIT* section in this chapter).



- Remove the two M3 Torx® screws (see Fig. MS508) from the butterfly switches and pull the butterfly switches off. Take care not to lose the plastic slide bearings (washers).
- Remove the two M3 Torx® screws which secure the orange lower switch cap. Remove the switch cap.



- Remove the four M5 Torx® screws shown in Fig. MS509. Remove the switch unit cover.



- Remove the M3 Torx® screw (item A, Fig. MS500) and pull out the switch jumper (item B).
- Remove the two M2 Torx® screws (item C). Remove the microswitch connector from the main board.

Installation

Installation of the safety reverse switch is the reverse of removal.

- **Before connecting the microswitch to the main board, lubricate the microswitch connector with grease (part no. 053002-005). Do not use any other grease.**
- Re-install the switch unit (see *SWITCH UNIT* section in this chapter) and carry out a functional test.

Note: The butterfly switches cannot be fitted incorrectly. They will only fit properly in a single position.

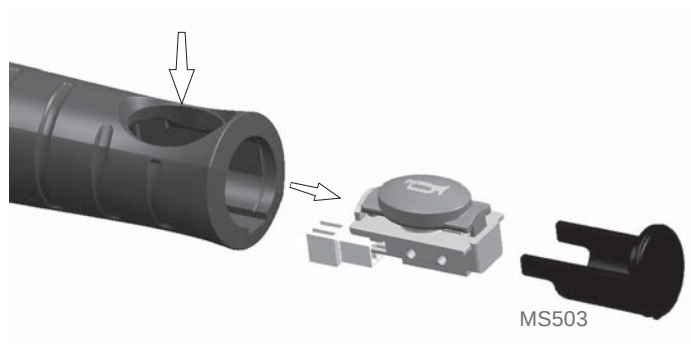
Horn Switch

Removal

- Remove the switch unit (see *SWITCH UNIT* section in this chapter).



- Using a small flat screwdriver lever out the handle protective cap (see Fig. MS502)



- Simply press the horn switch inward and pull it out of the handle (see Fig. MS503). Disconnect the plug connector from the switch.

Installation

Note: The switches for the left and right handles are different. If you fit the switch on the wrong side the horn symbol will be upside down!

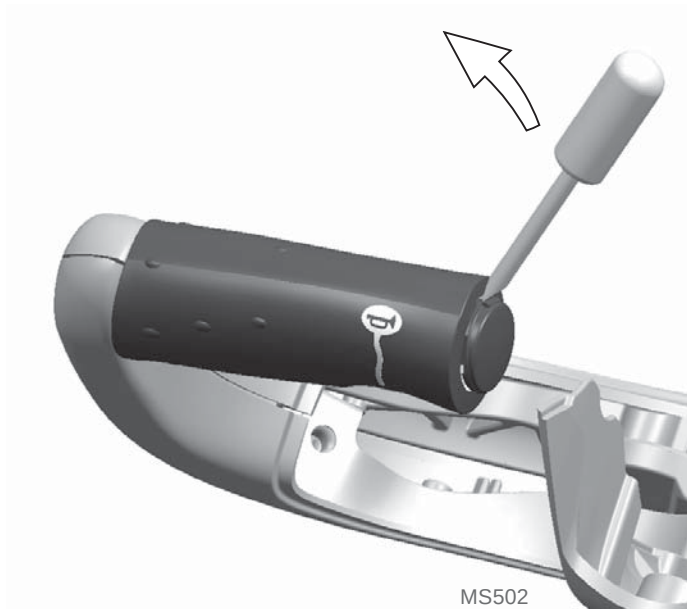
Fit the horn switch in the reverse order of removal.

- Re-install the switch unit (see *SWITCH UNIT* section in this chapter) and carry out a functional test.

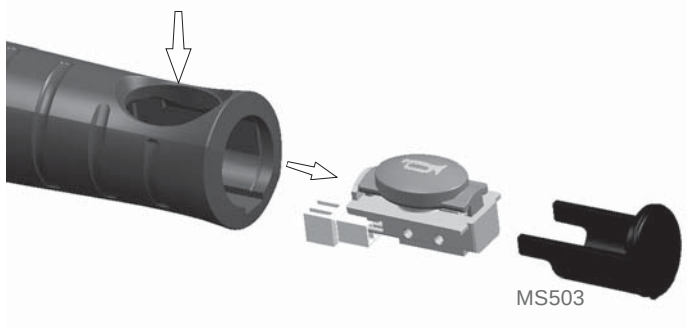
Handle

Removal

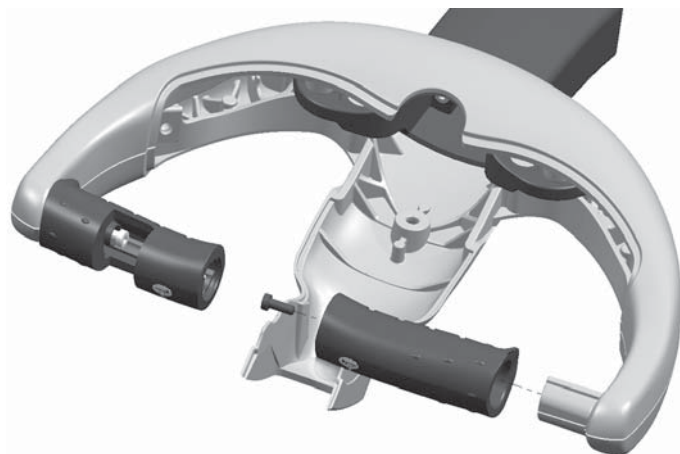
- Remove the switch unit (see *SWITCH UNIT* section in this chapter).



- Using a small flat screwdriver lever out the handle protective cap (see Fig. MS502)



- Simply press the horn switch inward and pull it out of the handle (see Fig. MS503). Disconnect the plug connector from the switch (see Fig. MS503).



- Unscrew the internal M5 Torx® screw (see Fig. MS501) and pull off the handle.

Installation

Note: The switches for the left and right handles are different. If you fit the switch on the wrong side the horn symbol will be upside down!

Fit the horn switch in the reverse order of removal.

- Re-install the switch unit (see *SWITCH UNIT* section in this chapter) and carry out a functional test.

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MAST

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Mast

DANGER



Risk of trapping and severing limbs!
When carrying out work on the mast and the attachments: always block the mast stages and attachments to prevent them from accidentally moving.
Make sure the wooden blocks and lifting gear used have sufficient capacity.

General

Torque Requirements

All screw connections on the mast must be torqued to the standard values. See Chapter 1 for these values.

Please note: The mast screw connections must be torqued to 380 Nm.

Lifting Gear Minimum Capacity

Note the minimum capacity for the lifting gear whenever carrying out work on the mast.

- Mast without fork carriage: 600 kg
- Fork Carriage: 200 kg

Mast Removal

CAUTION



Always block masts when working on masts in an elevated position, even though connected to a hoist.

- Position truck under appropriate lifting device.
- Lower fork carriage completely. Make certain to remove load, if applicable, from forks.
- Turn the key switch OFF. Remove the key and disconnect the battery.
- Attach warning tag to control handle to advise others that the truck is being serviced.
- Chock drive tire and outrigger load wheels.
- Disconnect all electrical connections that may prohibit removal of the mast assembly.
- Remove the cylinder covers located at the bottom of the outer mast — one on each side.
- Disconnect the hydraulic supply lines to the mast lift cylinders. Seal connections to minimize oil loss and prevent hydraulic system contamination.
- Disconnect the remaining hydraulic supply lines that may prohibit the removal of the mast assembly. Seal connections to minimize oil loss and prevent hydraulic system contamination.
- Attach lifting device at top of all sections of the mast assembly. Then raise lifting device just enough to eliminate any slack in lifting chains/slings.
- Remove mast mounting nuts that secure the outer mast to the power unit. The nuts should only be used once and must then be replaced with new ones of the same type.
- Remove mast assembly and fork carriage from truck.

Installation

WARNING



Wear appropriate safety items, such as safety glasses and shoes, whenever performing maintenance work. To avoid injury, do not place fingers, hands, arms or feet through mast or position them at pinch points.

- Attach lifting device at top of all sections of the mast assembly.
- Raise mast assembly and move it into position against the power unit.
- Slide the first cross brace of the mast assembly from the top into the receptacle of the power unit.
- Secure the mast assembly to the power unit using new nuts of the same type.
- **Tighten the nuts to a torque value of 380 Nm.**
- Remove any pipe plugs or caps that were previously used to seal connections. Then connect all hydraulic lines that were previously disconnected.
- Connect electrical connections between power unit and mast assembly.
- Remove lifting device from mast assembly.
- Remove chocks.
- Connect battery and remove warning tag from the control handle.
- Air that may have entered the system must be bled from the system. Follow the procedure outlined under "Cylinder Bleeding and Flushing", section M8, to bleed the hydraulic circuit.
- Carry out a lowering plumb test after attaching the mast. If the test results are outside the tolerance range, re-adjust the mast and repeat the test.

Fork Carriage Removal

WARNING



Wear appropriate safety items, such as safety glasses and shoes, whenever performing maintenance work. To avoid injury, do not place fingers, hands, arms or feet through mast or position them at pinch points.

- Turn the key switch OFF. Remove the key and disconnect the battery.
- Attach warning tag to control handle to advise others that the truck is being serviced.
- Chock drive tire and outrigger load wheels.
- Using a lifting device, raise fork carriage until lift chains are slack.
- Disconnect lift chain(s) from chain anchors or tensioner on fork carriage. Then lower fork carriage completely.
- Attach lifting device to top of inner mast. Then raise inner mast and remove fork carriage. Make certain rollers and shims remain in place on fork carriage.
- Lower mast to collapsed height.

Fork Carriage Installation

- Chock drive tire and outrigger load wheels.
- Make certain rollers are in good condition and installed on fork carriage. Replace a worn or damaged roller.
- Using a lifting device, raise inner mast, install the fork carriage, and lower inner mast to collapsed height.
- Attach lifting device to fork carriage and raise carriage enough to allow chains and hydraulic supply lines, if applicable, to be connected.
- Connect lift chain(s) to chain anchors or tensioner on fork carriage.
- Remove any pipe plugs or caps that were previously used to seal connections. Then connect all hydraulic lines that were previously disconnected.
- Lower fork carriage and remove lifting device.

- Check lift chain tension and adjust if necessary.
- Remove chocks.
- Connect battery and remove warning tag from the control handle.
- Remove chocks.
- Connect battery and remove warning tag from the control handle.

Fork Carriage Adjustment

WARNING



Wear appropriate safety items, such as safety glasses and shoes, whenever performing maintenance work. To avoid injury, do not place fingers, hands, arms or feet through mast or position them at pinch points.

- Turn the key switch OFF. Remove the key and disconnect the battery.
- Attach warning tag to control handle to advise others that the truck is being serviced.
- Chock drive tire and outrigger load wheels.
- Remove forks.
- Using a lifting device, raise fork carriage until the top two rollers extend above the mast channel and carriage meets the carriage stop. Then lower carriage slightly below stop to free carriage.
- Using a feeler gage, measure the distance between top roller and mast and record measurement. If the distance exceeds 0.5 mm, place more shims under the respective roller.
- Now repeat the previous step on the lower roller.

If the roller slack levels are within the tolerance range, remove the chock, connect the battery and remove the warning tag from the control handle.

If the slack is beyond the tolerance levels:

- Remove the fork carriage as described in the previous section.
- Add shims, as necessary, to the appropriate roller locations until clearances are within the acceptable range. If more than one shim is being added at any location, it is recommended that shims be distributed evenly between right and left hand sides of the fork carriage.
- Assemble the fork carriage as described in the previous section.

Mast Maintenance

Lubricating Roller Tracks

- Lower fork carriage completely.
- Turn the key switch OFF. Remove the key and disconnect the battery.
- Attach warning tag to control handle to advise others that the truck is being serviced.
- Chock drive tire and outrigger load wheels.
- Clean roller tracks.
- Lubricate entire roller path with a lubricant designed for the truck application (i.e., freezer/corrosion, etc.). Refer to "Lubricant & Fluid Chart", section M1, for approved lubricants and recommended suppliers.
- Remove chocks.
- Connect battery and remove warning tag from the control handle.

Lowering Plumb Test

Always carry out a lowering plumb test if the mast or fork carriage have been removed.

The lowering plumb test must be performed with rated load (1000 kg).

Preparatory measures

Position the truck for inspection with the above test load on a level surface. The surface is level if the height difference at the wheel contact points < 1mm.

Now raise the forks 300 mm.

Attach a plumb to the back of the fork carriage. Once the plumb has finished oscillating, centre the middle point of the plumb on the middle point of a 20x50 mm square. The 50 mm long side should be facing the truck's longitudinal axis.

Carrying out the vertical plumb test

When the above preparations have been made, extend the mast fully. Make sure that the mast does not extend as far as the stops.

The plumb should not be pointing outside the square when the mast is raised.

Lift chains

General

Lift chains are a major component of a fork lift truck. The chain system on this mast is designed to transmit the lift force from the hydraulic cylinder to the fork reliably and efficiently. Safe, uninterrupted truck operation depends on careful servicing and maintenance of the lift chains.

Most complaints about the chain performance are due to lack of maintenance. Highly stressed precision chains require regular maintenance to ensure a long useful life.

Inspection

The chain must be inspected every 100 hours for any signs of faults or damage. If used in a corrosive or dusty environment, this interval must be reduced to 50 hours. If this cannot be performed on the truck, the lift chains must be removed.

Irrespective of the result of the inspection, the lift chains, detachable chain anchors and anchor bolts must be replaced in the event of 3% chain elongation.

The inspection should include the following:

- Chain wear and elongation.
- Pitting due to rust or corrosion, in particular on the outer surfaces of the connection plates.
- Pins turning in or extruding from the outside plates.
- Loss of freedom of movement.
- Damage to the anchor bolt attachment
- Wear and corrosion to the anchor bolt and anchor.
- Wear between the bolts and the connection plates.

The following sections cover the above items in detail.

Cleaning

WARNING



Never use chemical solvents or steam to clean the chains.

The lubricant applied at the factory will be removed from the inner plate surfaces.

The chain surface should be cleaned with paraffin, a hard bristle brush and lint-free cloth.

After inspection apply another film of chain spray. The oil acts both as a lubricant and as an anti-corrosive protection.

Wear

The chain bends as it passes over the chain rollers. This leads to a gradual wearing of the joints.

Any slack a chain undergoes during its lifetime is due to wear to the links and the chain plate eyelet.

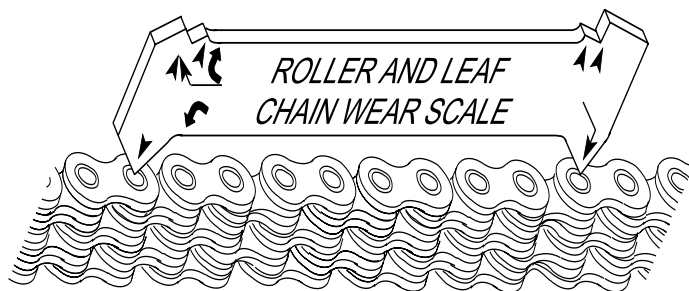
DANGER

When checking for chain wear be sure to measure a part of the chain which passes over the guide pulleys. Never repair chains by cutting out the worn section and replacing it with a new section. If a chain is worn, always replace both lift chains.

Chain wear can be measured with a wear gauge (Crown No. 106440) or a steel tape measure (see Fig. 2271).

Before testing the chain elongation it is important to tension the lift chain if necessary. For non-detachable lift chains the weight of the fork carriage or mast is sufficient. If the lift chain is detached it must be kept taut during measurement.

The chain slack test must cover at least ten links, over at least three different points in a section of the chain which always passes over a pulley during operation.



2271

Chain Dimensions (Dimension C in Fig. 2271).

New: 10 links = 158.75 mm

Wear limit: 10 links = 163.5 mm

Detachable chain anchors, tie bolts and lift chains must be replaced in the event of 3% chain elongation.

DANGER

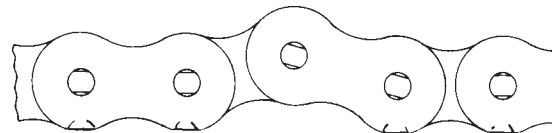
If just one of the faults mentioned in this chapter is detected, both chains together with their chain anchors or bolts must be immediately replaced.

Never repair damaged chains!

This can result in fatal accidents!

Freedom of Movement of Chain Links

Each individual chain link must flex freely. Tight joints (Fig. 2775si) increase friction and the chain tension during lifting. Excessive chain tension in turn accelerates material wear.



2775si

Possible causes of stiff joints are as follows:

- Bent pins or plates
- Rusty joints.
- Peened plate edges.

Plate edge distortion is caused by:

- Ruptured chain pinion.
- Constant overloading of the chain.
- Chain striking the mast components.

Immediately replace any chains with stiff joints.

Chain Tension

When installed, both lift chains should have the same chain tension to ensure even distribution of the load over the two chains when lifting.

When replacing the forks make sure that both forks lie evenly on the surface. If they are not even, compensate the chain length via the chain anchor so that both chains have the same chain tension.

After adjusting, tighten the counternuts of the chain anchor again (for correct torques see Chapter 1, Torque table).

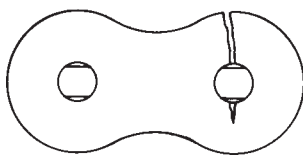
Chain Anchor and Pulleys

In the course of checking the chain system, the chain anchors, chain bolts and pulleys must be checked for wear.

On the chain anchor watch out for wear and cracking of the individual fingers. If one of the above problems occurs replace the chain anchor.

Pulleys with heavily worn flanges and contact surfaces must be replaced. Worn flanges are due to misalignment. The chain tension and mast roller setting must be checked.

Worn Connection Plates



2774si

Generally speaking, material wear is the cause of worn or missing connection plates. The plates near the chain pin hole (Fig. 2774si) can crack after a large number of lifting cycles with heavy loads.

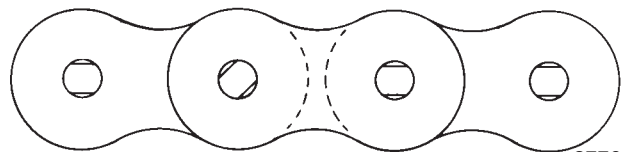
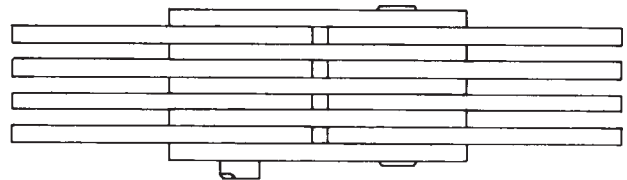
Replace both chains immediately if cracking shows or plates are missing.

Protruding or Turned Chain Pins

DANGER



Never attempt to repair the chain by driving pins back into the chain. This can result in accidents with severe or even fatal injuries if the chain tears. Fit new chains.



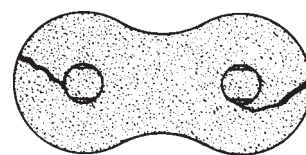
2776si

Considerable frictional forces between the connection plates and the pins occur when lifting heavy loads with an insufficient or non-existent film of oil. In extreme cases the frictional torque in the joints can be such that the pins turn and gradually work out of the chain (Fig. 2776si). This can result in chain failure.

Turned pins can be rapidly identified if the flat ends are not all pointing in the same direction.

Chains with twisted or protruding pins must be replaced immediately.

Corrosion



2773si

The chains used on fork lift trucks are highly stressed precision components. It is particularly important to maintain the original fatigue strength throughout its useful life.

Corrosion considerably reduces the capacity of a lift chain. It results in cracking in the side plates.

Lift chains must therefore be protected from corrosion. The layer of grease applied in the factory hot dip galvanizing process is an excellent protection and fully penetrates the joints.

Do not remove this initial layer! After commissioning the chain supplement the factory lubrication through a regular lubrication schedule.

Rust film on lift chains can be removed and neutralised by cleaning with chain oil. Always replace heavily cor-

roded and rusting chains. The risk of cracking as a result of rust is too great.

Chain Lateral Wear

Wear traces along a stretch of the chain on the pin heads and the outer plates indicate misalignment. This can have one of two causes: uneven chain tension or misalignment between the pulleys and the chain anchors.

Uneven Chain Tension

When fitting or adjusting the chains make sure that they are evenly charged. If for example the fork heel height or the platform height are changed, the chain anchors must be loosened until both forks touch the ground. Both chains must have equal amounts of air or tension at this point. The lower chain anchor nuts must be tightened by the same number of turns. When the required height has been reached, fix the setting with the top (chain side) lock nut and its respective lock washer.

Misaligned Lift Components

Misalignment of the chain pinion and the chain due to the wrong number of washers on the mast or a damaged mast or cylinder components can also contribute to wearing of the chain sides.

To test whether this is the case, proceed as follows: Place the truck on a horizontal surface in the service station. Support the fork carriage and detach both ends of the lift chain from the chain anchor and visually inspect the alignment with the anchor slots.

Lift Chain Lubrication

Lubrication is the most important factor in lift chain maintenance. It considerably affects the chain's useful life.

Highly stressed chains under constant use cannot last sufficiently long if they are not regularly lubricated within a planned maintenance schedule.

As with all contact surfaces, the tensiled steel precision moving parts require a durable lubricant film between the contact surfaces to avoid excessive wear.

Maintaining a lubricant film on all the chain surfaces provides the following benefits:

- Restricts joint wear to a minimum (chain elongation)
- Avoids corrosion
- Reduces the risk of chain bolts turning
- Restricts the danger of chain joints turning in to a minimum
- Ensures an even movement of the chains and thus reduces noise levels
- Reduces the chain tension due to less friction in the chain system

Key factors when considering which lubricant to use are as follows:

- High degree of penetration in the narrowest of gaps
- Maximum tolerance of pressure and shearing forces before the lubricant film comes off.
- Suitability to the operating temperature range, especially important for cold store trucks.

You will find details of Crown approved chain oils in the Lubricant table in Chapter 1 of this manual.

Lubrication intervals depend on the operating conditions and the environment. Trucks parked outdoors, in cold stores or which are subjected to extreme weather conditions must be lubricated more frequently.

Dust will gather on oiled chains in dusty environments. However, even in these conditions, regular lubrication can considerably reduce wear.

A paste mixture of oil and dirt will gather on the chain joints, but they will not wear as fast as they would if they were left to dry, leaving a metal to metal contact between the pins and plates.

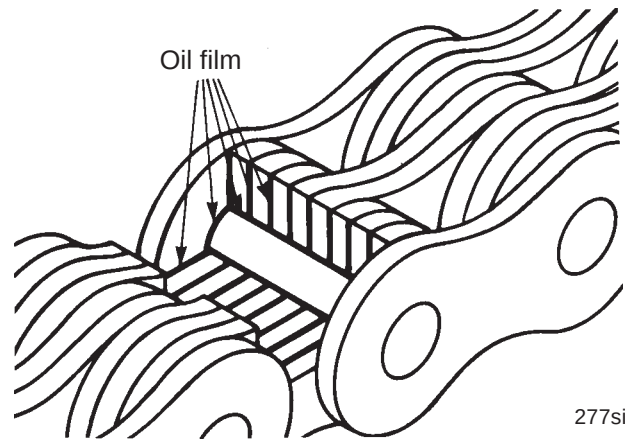
Note: A lift chain must never be allowed to dry.

In dusty operating conditions the multi-plate chains can be more efficiently lubricated than roller chains.

Multi-plate chains consist of several plates. Therefore they provide several paths for the lubricant to reach the chain

bolt (see Fig. 277si) and allow the oil to penetrate to the bearing surface on the chain bolt, even when the chain is dirty.

In normal operating conditions the chains should be cleaned and immediately lubricated every 100 service hours. In extreme conditions this interval must be reduced accordingly.



277si

Separating Lift Chains

Lift chains are supplied by the meter and must be cut to the required length.

Tools and Equipment Required

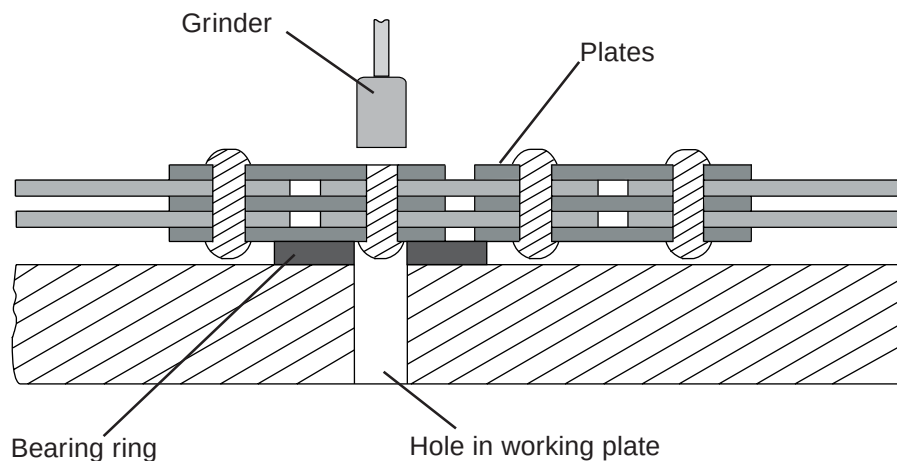
- A secure working plate with a hole slightly larger than the head diameter of a chain bolt. The hole must be deeper than the chain bolt length.
- A bearing ring (washer) with a hole slightly larger than the head diameter of a chain bolt. The bearing ring thickness must be slightly larger than the height of the head of a chain bolt.
- A grinder.
- A hole with a diameter slightly shorter than the chain bolt and a hammer. Or a press with a suitable mandrel.

Detachment

WARNING

Wear protective glasses.

- Carefully grind the head of the chain bolt. The inner plate surface must not be damaged.
- Place the bearing ring onto the hole in the working plate. The bearing ring prevents the inner plate surface from being damaged when you drive out the chain bolt.
- Place the head of the chain bolt to be driven out into the bearing ring.
- Make sure the chain bolt, the bearing ring and the hole are aligned in the working plate and drive the chain bolt out.



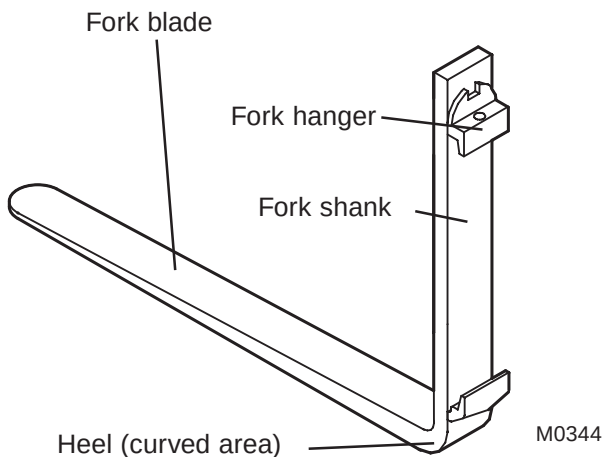
Fork Tines

General

The fork tines (Fig. M0344) must be checked by trained personnel at the specified maintenance intervals (see chapter 1) for cracks, damage and wear.

If the forks are used to transport abrasive loads the inspection must be carried out at shorter intervals.

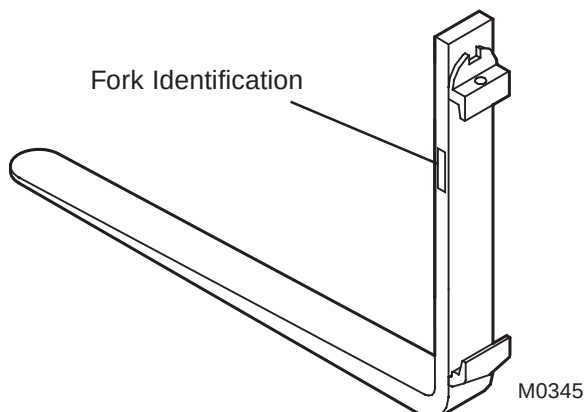
Terms



Fork Identification

The data plate is on the side of the fork back (Fig. 0345) and comprises the following data:

- Capacity
- Load centre of gravity
- Manufacturing Data (Month / Year)
- Company logo
- Manufacturing site



Repairs

DANGER



Never carry out repair welding to surface cracks, damaged or worn parts around the heel of the fork.

Fork repairs must only be carried out by the manufacturer / qualified personnel. When repairing supporting members always carry out a load test and check for signs of cracking.

Fork Inspection

DANGER



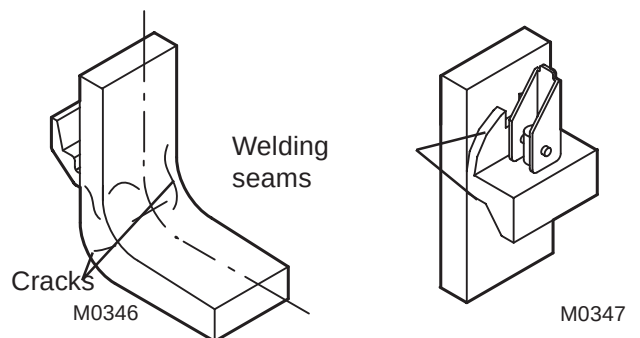
Forks showing signs of cracking, distortion or wear beyond the stated tolerance levels must be de-commissioned. They endanger the life of the operator and other people.

Crack Inspection

Inspect all fork tine surfaces for signs of cracks.

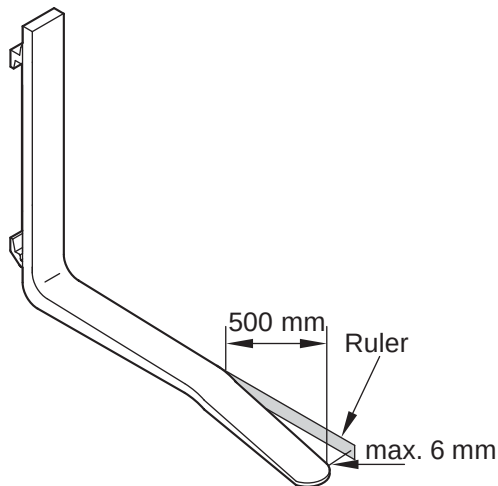
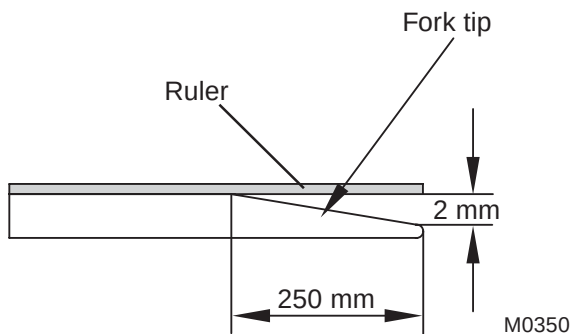
Fatigue cracking tends to occur around the heel of the forks. Check this area with particular care. If necessary carry out a non-rupturing crack test (paint penetration process or Magnaflux).

For upper and lower fork hangers (Fig. M0347) including their fork back attachments check for cracks on the welding seam. If any cracking is discovered which could affect safety remove the relevant fork.



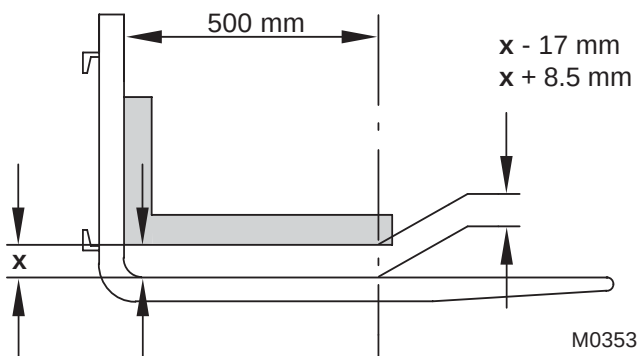
Verticality Test

Check verticality of fork tip (Fig. M0350). If the tolerance level has been exceeded, de-commission the fork.

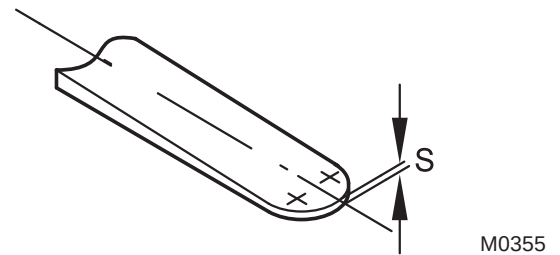


Fork Blade Warping

Measure the angle deflection between the top of the fork blade and the front of the fork shank (Fig. M0353). If dimension x is outside the tolerance range, the fork must be aligned by a specialist and re-checked.



Measuring the Fork Tip Width



If the fork tip width S is less than $a/6$ mm (a = fork back width) do not use the fork (Fig. 0355).

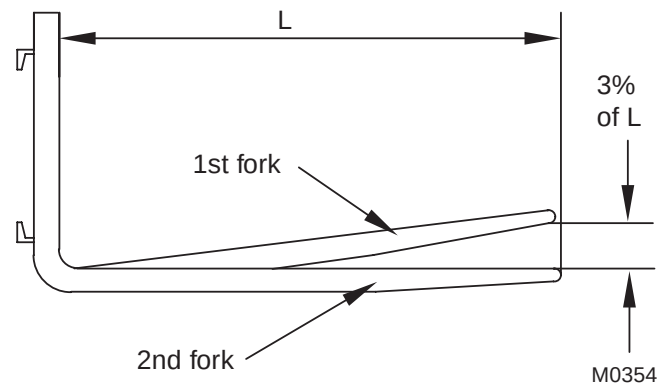
Fork Tine Height Difference

Check the height of the fork tines in relation to each other (Fig. M0354) if the fork is fixed to the fork carriage. If the difference is greater than 3 % of the fork blade length the fork tines must be correctly aligned.

Example: If the length of the fork blade is 1150mm the maximum permissible deviation is approx. 35mm.

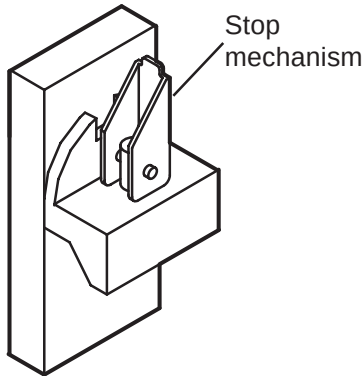
However, this would prevent the fork from working. In practice, forks must be aligned if the deviation is max. 10 mm.

Fork Stop



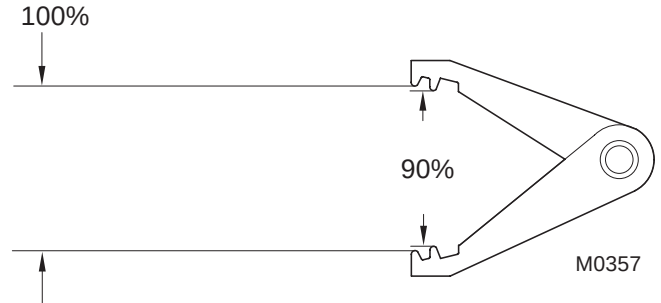
Check the stop mechanism (Fig. M0356) on both fork tines. The mechanism should lock securely, otherwise the fork must be de-commissioned.

Fork Blade Wear



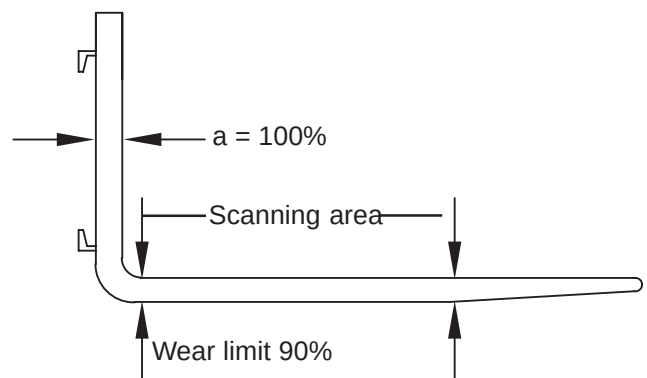
M0356

Check the fork blade for wear. The heel is particularly sensitive to wear. If the width is 90% or less than the original value, the fork must be taken out of service. For the inspection, use the calliper with part no. 107330 (see Fig. 0357).



This calliper has 2 opposite tappets. The outer tappet is used to determine the original fork blade thickness at a section with no wear. This is the fork shank. This determines the 100% value. The inner tappets correspond to 90% of the value previously obtained.

- Scan the thickness of the fork shank using the outer tappets (Point a = 100% in Fig. MS-2232-013). Fix the calliper.
- Now use the inner tappets (90%) to scan the fork blade between the shank and the start of the curved area. If the calliper fits at any point over the fork blade, then the fork is worn. Take the fork out of service.



MS-2232-013



CYLINDERS

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Cylinders

General

Safety when working on hydraulic systems

WARNING



Risk of serious injury from pressurized hydraulic oil.

Pressurized hydraulic oil can penetrate the skin. This is a serious medical emergency which requires immediate medical attention.

The skin will not show any obvious initial damage and the physical effects will not be manifested immediately. Seek medical assistance if your skin has been affected by pressurized hydraulic oil.

For your personal protection:

Depressurise the hydraulic system before starting assembly work on the hydraulic system.

After carrying out assembly work carefully check to see that all ports are tightened before re-pressurising the system.

Wear protective clothing, safety glasses and safety gloves when tracing leaks or bleeding the system.

Use a piece of absorbent paper to trace leaks, never use your hands.

Follow the hydraulic oil manufacturer's safety instructions when handling these oils.

General Instructions for Repairing Hydraulic Components

Hydraulic systems are sensitive to dirt.

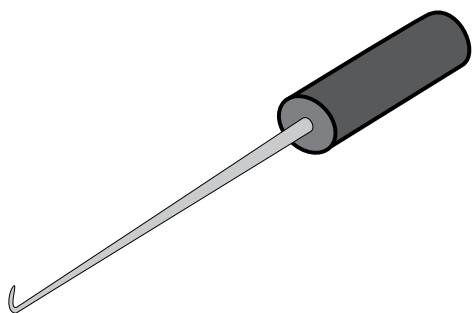
- Thoroughly clean any hydraulic components you have removed before dismantling them and placing them on a workbench.
- Always repair hydraulic components in a clean working environment.
- Immediately protect cleaned and de-greased components with a thin coating of hydraulic oil. Use the same type as is used in the truck.
- Protect all components from re-contaminating until they are installed again.
- Immediately seal any open hydraulic ports on repaired assemblies with filler plugs. This also applies to the open ports and lines on the truck when you remove any hydraulic components.
- Do not refinish any cylinder surfaces! Replace any damaged components.
- **When carrying out repairs always replace all the seals in the assembly.** Never recycle seals which have already been used.

Rod Seal Assembly

General

All tools and equipment used for rod seals must be burr-free and not have sharp edges. The tools should be made either of soft metal (aluminium, brass) or a suitable plastic.

Do not use hooks to remove seals. The same rule applies: Burr-free, rounded tips and made of soft metal to avoid damaging the seal seat.



Screwdrivers or similar tools will damage the seal seats and the seals. This will result in leaks.

To remove rod seals from the lift cylinder and the free-lift cylinder, you will require 2 specially produced tools (see Figure MS-2232-016).

Screwdriver,
Shaft min. 150 mm long, max. 4mm Ø

4 mm self-tapping
screw

Insulating
tape

Hard-soldered screw. Soldering joint sanded.

MS-2232-016

If the seal has to be pushed over sharp edges, cracks or nicks, use appropriate protective devices.

We will now demonstrate 2 procedures – depending on the seal rod diameter – for ensuring safe assembly.

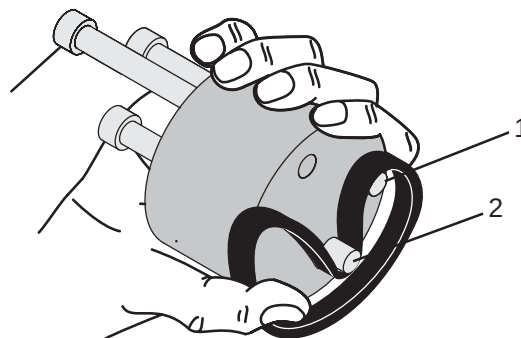
Large Rod Seal Assembly

Tools required:

- Tool body (outer diameter must fit the internal diameter of the cylinder cap).
- Three pins (1, 2 and 3). Pin (1) is fixed; pins (2) and (3) are moveable.

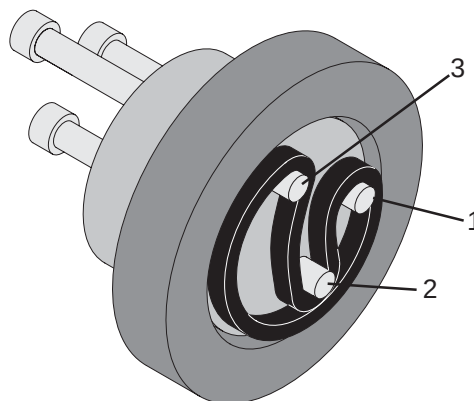
Assembly:

- Apply a thin coating of hydraulic oil to the rod seal and the seal seat in the cylinder cap.
- Place the rod seal over the fixed pin (1).
- Bend the rod seal under pin (2) (see Fig. MS-2232-019).



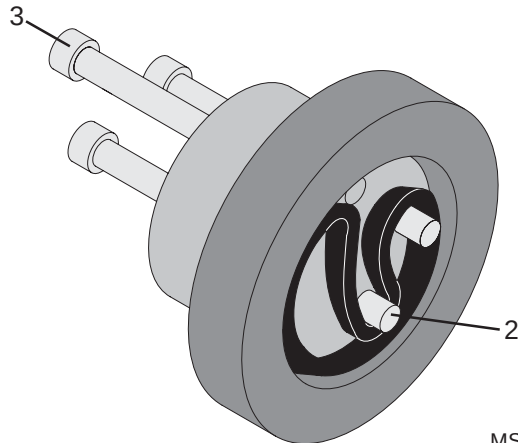
MS-2232-019

- Bend the loop created in this way so far up that pin (3) can be pushed into the loop.
- Now push the tool body into the cylinder cap until the rod seal is aligned with the seal seat (see Fig. MS-2232-020).



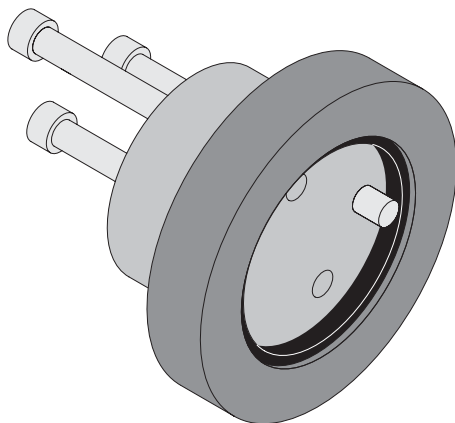
MS-2232-020

- Pull back pin (3). A section of the rod seal jumps into the seal seat (Fig. MS-2232-022).



MS-2232-022

- Now pull back pin (2). The rod seal is now fully seated in the seal seat.
- Pull the tool body out of the cylinder cap.



MS-2232-021

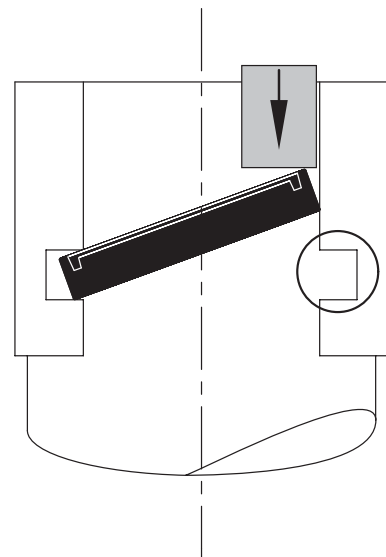
Small Seal Rod Assembly

Tools required:

Groove aligning arbor. The outer diameter must fit the internal diameter of the cylinder cap. The arbor should end at the bottom of the seal seat.

Arbor to drive in the seal.

- Apply a thin coating of hydraulic oil to the rod seal and the seal seat in the cylinder cap.
- Place the cylinder cap onto the groove aligning arbor.
- Gently squeeze the rod seal together.
- Place the rod seal at one point of the seal seat.
- Press the rod seal and the arbor into the seal seat.

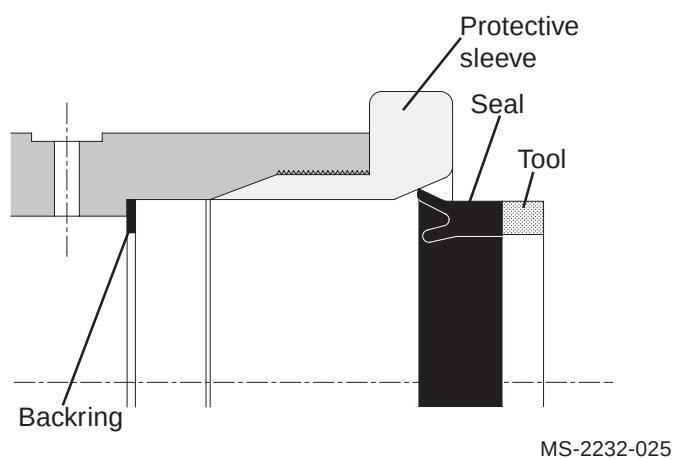


MS-2232-024

Rod Seal Assembly, Sealing Lip First

The sealing lip is sensitive and must not be damaged. You therefore require special protective sleeves when pushing the seal over the thread and holes.

Sealing lip assembly direction: Always to the pressure side!



Cylinders

Great care and cleanliness should be exercised in disassembly and assembly of any hydraulic cylinder. Wipe all surfaces clean of dirt and oil before attempting disassembly. Care should be taken when removing the ram from the cylinder. Once disassembly is complete, wash all metallic parts in solvent and blow dry with clean compressed air. Carefully inspect the ram assembly and cylinder bore. Replace if scored, grooved, pitted, or worn. Minor damage to the cylinder bore can be removed with the use of a cylindrical honing tool. Place washed components in a clean container until assembly.

WARNING



High pressure hydraulic oil can cause serious injuries.

De-pressurise all components before carrying out maintenance work on the hydraulic system.

When repairing the hydraulic system always wear protective clothing, goggles and gloves.

Whenever a high pressure fluid enters the skin it must be treated as an emergency, even if the skin initially shows no reaction.

Physical effects may take time to set in.

Secure all connections before re-applying system pressure. Keep hands and body away from any ports as high pressure hydraulic oil can emerge.

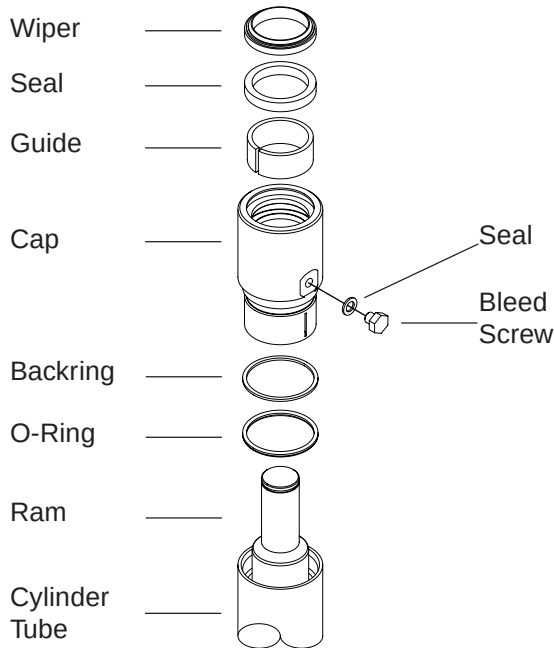
Use absorbent paper to trace leaks, never use your hands!

TL Mast Lift Cylinder

Seal Replacement

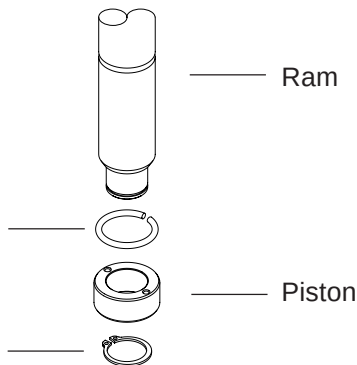
When excessive hydraulic oil is evident on the cylinder, where the ram exits the cap, one or more of the seals are bad and need replaced. It is recommended that all the seals in the cylinder be replaced whenever a cylinder is removed and disassembled for seal replacement. Follow the procedure outlined below to remove cylinders and replace seals.

- Place key switch in the OFF position, remove key and disconnect the battery.
- Attach warning tag to control handle to advise others that the truck is being serviced.
- Chock drive tire and outrigger load wheels.
- Remove R.H. cylinder cover from bottom of outer mast.
- Disconnect the hydraulic supply line to the R.H. mast lift cylinder. Seal connections to minimize oil loss and prevent hydraulic system contamination.
- Remove retaining ring and shims from the top of the R.H. mast lift cylinder.
- Before removing the R.H. cylinder bracket from outer mast, secure the cylinder to the mast to prevent it from falling when the bracket is removed and the mast is raised. Make certain the device used to secure the cylinder is capable of withstanding the weight of the cylinder. Then remove the R.H. cylinder bracket from the outer mast.
- Repeat the previous steps on the L.H. side, if that cylinder is being removed for seal replacement.
- Attach a lifting device to the appropriate mast (inner on TL mast trucks, middle on TT mast trucks), raise the mast and remove the mast lift cylinder(s).
- Lower mast to collapsed height.
- Remove cap from cylinder tube.



11103

- Remove bleed screw from cap. Then remove seal from bleed screw and discard seal.
- Remove wiper, seal, guide, backring and o-ring from cap and discard.



11104

- Carefully remove ram from cylinder tube. Do not allow ram to come in contact with any sharp edges.
- Remove retaining rings and piston from ram. Discard piston.
- Inspect contact surfaces on the ram and cylinder cap. If slight scoring is present, sand with fine emery paper until all high surfaces have been removed. Heavily scored components must be replaced. After all parts have been disassembled and inspected, thoroughly wash all metal parts and blow dry with clean compressed air.

- Apply a thin layer of hydraulic oil to all the seals to be fitted.
- Install retaining ring in groove on ram. Then install new piston on bottom of ram and secure it with retaining ring previously removed.
- Install ram in cylinder tube. Use care when installing ram to avoid contact with sharp edges. Make certain ram is properly seated in tube.
- Install new wiper, seal, guide, backring and o-ring in cap. Use care when installing to avoid nicking the components.
- Install new seal on bleed screw. Then install bleed screw in cap and tighten securely.
- Install cap on cylinder tube and tighten securely. Use care when installing cap to prevent sharp edges from damaging the new seals.
- Install mast lift cylinders following procedure outlined under "Installing TL Mast Lift Cylinders."

Installing TL Mast Lift Cylinders

- Attach lifting device to the inside of the mast. Now raise the mast and install the R.H. lift cylinder. Install R.H. cylinder bracket and tighten screws securely to secure cylinder to mast. Repeat this step, if necessary, on L.H. cylinder.
- Carefully lower mast and align ram(s) with mounting hole(s) in mast. Continue lowering mast to collapsed height.

INFORMATION



1 shim must always be fitted on TL masts. Otherwise the mast will drop too far.

- Install shims and retaining rings at top of ram(s). Make certain the shims are installed in their original location. For correct shimming see "Secondary Cylinder Shim".
- Connect hydraulic line(s) to mast lift cylinder(s) and tighten securely.
- Install cylinder cover(s) on mast and tighten mounting screws securely.
- Remove lifting device from mast.

- Remove chocks.
- Connect battery and remove warning tag from the control handle.

TF Mast Lift Cylinders

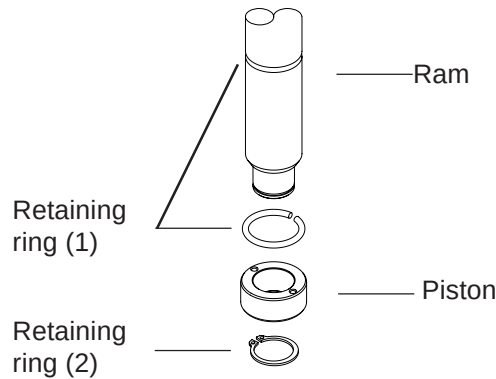
Removing the TF Mast Lift Cylinders

When excessive hydraulic oil is evident on the cylinder, where the ram exits the cap, one or more of the seals are bad and need to be replaced. The small rod diameter means that individual seals cannot be replaced in the field. For this reason, only pre-assembled caps are available as a spare part.

- Turn the key switch OFF. Remove the key and disconnect the battery.
- Attach warning tag to control handle to advise others that the truck is being serviced.
- Chock drive tire and outrigger load wheels.
- Remove R.H. cylinder cover from bottom of outer mast.
- Disconnect the hydraulic supply line to the R.H. mast lift cylinder. Seal connections to minimize oil loss and prevent hydraulic system contamination.
- Remove retaining ring and shims from the top of the R.H. mast lift cylinder.
- Before removing the R.H. cylinder bracket from outer mast, secure the cylinder to the mast to prevent it from falling when the bracket is removed and the mast is raised. Make certain the device used to secure the cylinder is capable of withstanding the weight of the cylinder. Then remove the R.H. cylinder bracket from the outer mast.
- Repeat the previous steps on the L.H. side, if that cylinder is being removed for seal replacement.
- Attach lifting device to the mast. Now raise the mast and install the lift cylinder(s).
- Lower mast to collapsed height.

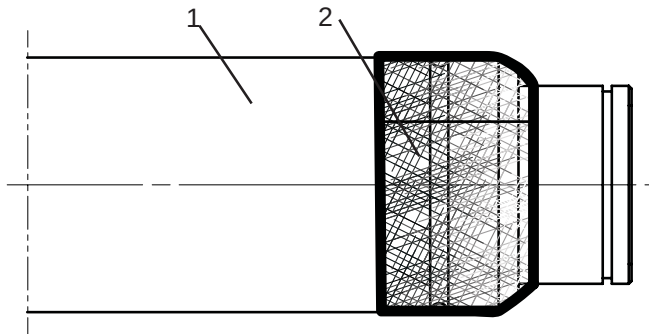
- Follow the appropriate procedure outlined under "Cylinder Bleeding and Flushing".
- Carry out a drift test. See "Drift Test".

Seal Replacement



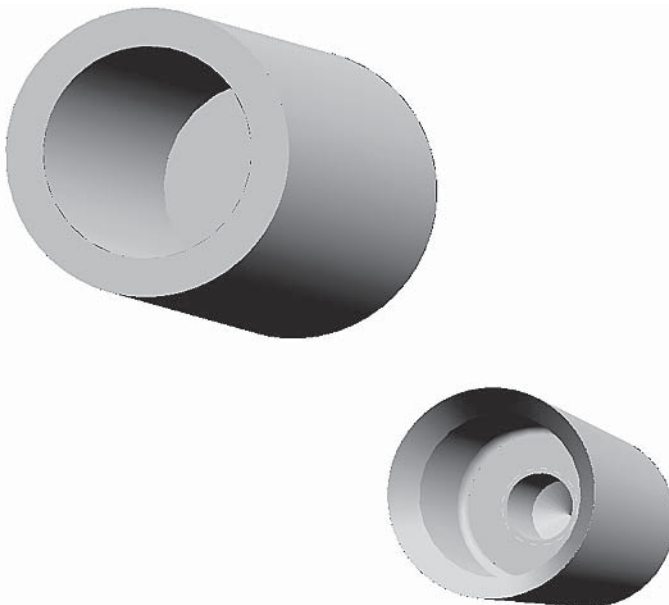
11104

- Loosen the cap and unscrew it from the cylinder tube.
- Pull the cylinder pipe down from off the ram.
- Remove the retaining ring (1) from the piston rod and discard it. The retaining ring must be replaced on assembly.
- Pull down the cap over the ram.
- Remove bleed screw from cap. Then remove seal from bleed screw and discard seal.
- Remove wiper, seal, guide, backring and o-ring from cap and discard.
- Remove the retaining ring (2) and piston from ram. Discard piston.
- Inspect contact surfaces on the ram and cylinder cap. If scoring is present, the ram must be replaced. Wash all metal components with a suitable solvent and dry them with dry, clean compressed air.
- Apply a thin layer of hydraulic oil to all the seals to be fitted.
- Install new wiper, seal, guide, backring and o-ring in cap. Use care when installing to avoid damaging the components.
- Install new seal on bleed screw. Then install bleed screw in cap and torque to **5 – 6 Nm**.



MS-3300-034

- Secure the groove in the ram (1) with wide PVC insulating tape. The tap must overlap the neck.
- Apply a thin layer of hydraulic oil to the ram and carefully push the cap up onto the ram.
- Remove the insulating tape without any remains.



MS-3300-035

INFORMATION

The retaining ring (1, Fig. 11104) must only be fitted with special tool, part no. 814743. The use of any other tools such as pliers etc. will permanently damage the retaining ring as well as damaging the cylinder pipe wall.

- Using the special tool part number 814743 (Fig. MS-3300-035) install a **new** retaining ring part number 811267 in the groove of the ram.

- Then install a new piston on the bottom of the ram and secure it with the retaining ring previously removed (2, Fig. 11104).
- Apply a thin layer of hydraulic oil to the ram.
- Carefully push the cylinder tube over the piston onto the ram.
- Screw the cap onto the cylinder tube and torque to **120 - 140 Nm**.
- Install mast lift cylinders following procedure outlined under "Installing TF Mast Lift Cylinders."

Installing TF Mast Lift Cylinders

- Attach lifting device to the mast. Now raise the mast and install the R.H. lift cylinder. Install R.H. cylinder bracket and tighten screws securely to secure cylinder to mast. Repeat this step, if necessary, on L.H. cylinder.
- Carefully lower mast and align ram(s) with mounting hole(s) in mast. Continue lowering mast to collapsed height.
- Install shims and retaining rings at top of ram(s). Make certain the shims are installed in their original location. For correct shimming see "Secondary Cylinder Shim".
- Connect hydraulic line(s) to mast lift cylinder(s) and tighten securely.
- The cylinder covers also act as the buckle supports for the cylinders. It is therefore essential to observe the following installation procedure.
 - Mount the cylinder covers and manually tighten the screws.
 - Extend the lift cylinder by approx. 50mm to ensure good positioning in the receptacles.
 - Bring the cylinder covers into contact with the cylinder pipes.
 - Tighten the mounting screws.
- Remove lifting device from mast.
- Remove chocks.
- Connect battery and remove warning tag from the control handle.

- Air that may have entered the system must be bled from the system. Follow the appropriate procedure outlined under "Cylinder Bleeding and Flushing".
- Carry out a drift test. Siehe „Drift - Test“.

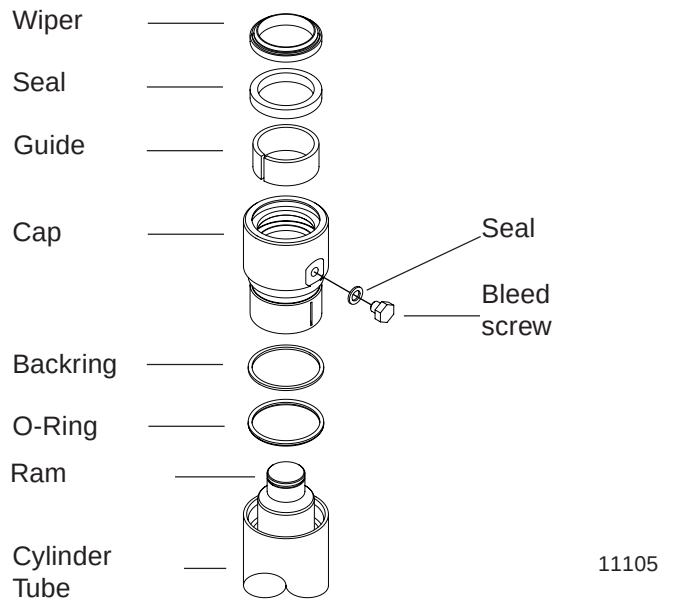
Free Lift Cylinder TF and Mono Mast

Seal Replacement

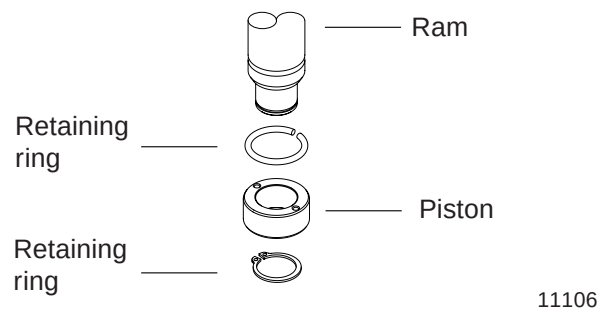
When excessive hydraulic oil is evident on the cylinder, where the ram exits the cap, one or more of the seals are bad and need to be replaced. It is recommended that all the seals in the cylinder be replaced whenever the cylinder is removed and disassembled for seal replacement. Follow the procedure outlined below to remove cylinder and replace seals.

- Turn the key switch OFF. Remove the key and disconnect the battery.
- Attach warning tag to control handle to advise others that the truck is being serviced.
- Chock drive tire and outrigger load wheels.
- Remove forks.
- Using a lifting device, raise fork carriage until lift chains are slack. Then place wood blocks under each side of carriage and lower carriage onto blocks.
- Disconnect hydraulic line to fork carriage cylinder. Seal connections to minimize oil loss and prevent hydraulic system contamination.
- Disconnect lift chain from tensioner on fork carriage and pull chain through yoke assembly.
- Remove screws that secure the free lift cylinder to inner mast and carefully remove the cylinder. Make certain to save shims that were between mast and free lift cylinder.
- Remove retaining ring used to secure yoke assembly to the free lift cylinder ram. Then remove yoke assembly.
- Remove cap from cylinder tube.
- Remove bleed screw from cap. Then remove seal from bleed screw and discard seal.
- Remove wiper, seal, guide, backring and o-ring from cap and discard.

- Carefully remove ram from cylinder tube. Do not allow ram to come in contact with any sharp edges.
- Remove retaining rings and piston from ram. Discard piston.
- Inspect contact surfaces on the ram and cylinder cap. Heavily scored components must be replaced. After all parts have been disassembled and inspected, thoroughly wash all metal parts and blow dry with clean compressed air.



- Apply a thin layer of hydraulic oil to all the seals to be fitted.



- Install retaining ring in groove on ram. Then install new piston on bottom of ram and secure it with retaining ring previously removed.
- Install ram in cylinder tube. Use care when installing ram to avoid contact with sharp edges. Make certain ram is properly seated in tube.

- Install new wiper, seal, guide, backring and o-ring in cap. Use care when installing to avoid nicking the components.
- Install new seal on bleed screw. Then install bleed screw in cap and tighten securely.
- Install cap on cylinder tube and tighten securely. Use care when installing cap to prevent sharp edges from damaging the new seals.

Installing Free Lift Cylinder

- Install free lift cylinder and secure it to inner mast using screws and shims previously removed. Tighten screws securely. For correct shimming see „Free Lift Cylinder Shims“.
- Install yoke assembly on ram and secure it with retaining ring previously removed.
- Insert lifting chain through yoke assembly and connect chain to tensioner in fork carriage. Make certain chain is not twisted.
- Connect hydraulic supply line to free lift cylinder and tighten connections securely.
- Using lifting device, raise fork carriage and remove blocks from under carriage. Then lower carriage completely and remove lifting device.
- Install forks.
- Remove chocks.
- Connect battery and remove warning tag from the control handle.
- Air that may have entered the system must be bled from the system. Follow the appropriate procedure outlined under “Cylinder Bleeding and Flushing”.
- Carry out a drift test. See “Drift Test”.

Cylinder Bleeding and Flushing

Hydraulic circuits need to be flushed after repair of lift cylinders and bled of all air. Before bleeding and flushing, all hydraulic ports must be checked for leaks. In addition you must ensure that all filters, where applicable, are fitted and that there is sufficient hydraulic fluid in the reservoir for flushing and bleeding. Hydraulic system must be pressurized during the flushing and bleeding procedures.

Bleeding — Mast Lift Cylinders

- Slowly raise forks to approximately 1220 mm (4 ft.).
- Slowly open R.H. mast lift cylinder bleed screw and bleed air from cylinder until a solid stream of hydraulic fluid flows out of bleed screw hole. Tighten bleed screw securely.
- Repeat steps 1 and 2 on the L.H. mast lift cylinder.
- Flush cylinders following procedure outlined below.

Bleeding — Free Lift Cylinder (if applicable)

- Slowly elevate carriage in free lift to approximately 1220 mm (4 ft.).
- Slowly open fork carriage cylinder bleed screw and bleed air from cylinder until a solid stream of hydraulic fluid flows out of bleed screw hole.
- Tighten bleed screw securely.
- Flush cylinder following procedure outlined below.

Flushing – Mast Lift Cylinders and Free Lift Cylinders (if applicable)

- Actuate control valve to raise carriage through free and stage lift and stop to hold in position.
- With carriage raised, visually inspect cylinders for any leaks.
- Actuate control valve to lower carriage through stage and free lift while visually checking operation and staging.
- Raise and lower carriage rapidly for a minimum of 10 cycles to flush system.

Drift Test

All drift tests should be conducted with a capacity load (refer to capacity plate for the rated capacity of your truck). The material used for the load test must be evenly stacked within the limits of a 1.2 m x 1.2 m square pallet and must be secured to the fork carriage with the forks spread to their maximum width.

CAUTION



Never stand or work under a suspended load

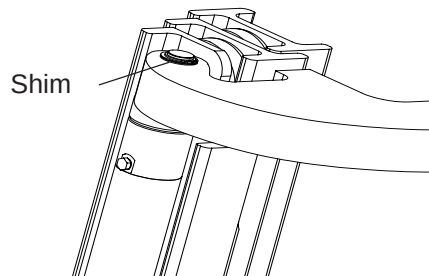
Fully extend the mast with maximum rated load. The load may not drift down more than 50 mm within 5 minutes.

Occasionally internal leaks in the cylinder may cause the fork assembly to lower slowly. However, this may also be due to leaks in the check valves, pilot valves etc. In this case flush the system by raising and lowering the fork carriage several times to remove any foreign bodies from the valve seats. Then repeat the drift test.

Cylinder Shimming

Lift Cylinder Shims

- Add as many shims (Fig. M8 3130-001) between the retaining ring on the top of the lift cylinder and top brace of the inner mast as possible. At fully extended mast the cylinder bottom shall not lift up



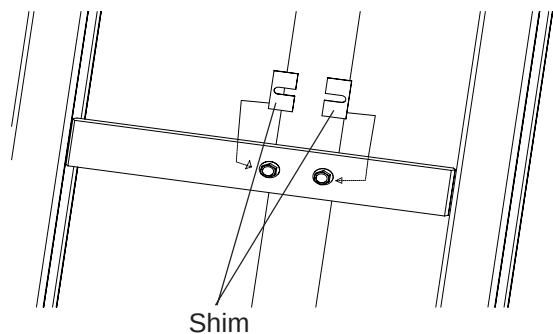
M8-3130-001

from its seat. Should this happen, remove a equivalent quantity of shims.

- Adjust side plates so, that there is no rattling of the side cylinders during driving/lifting.

Free Lift Cylinder Shims

- The free lift cylinder can be adjusted so that its installation angle can be set correctly. This is done by adding shims between the cylinder and the middle cross brace of the inner mast. (Figure M8-3130-002)
- In general, 2 shims 811812 must be used. Add or remove shims as required so that the free lift cylinder is vertically aligned. The chain should have a min. distance to the fork carriage of 3mm when passing the yoke.



M8-3130-002

- The cylinder bottom always must have fully contact with the lower cylinder mount of the inner mast. This can be adjusted with the cylinder fixing screws and the slotted holes of the mid cross brace of the inner mast.

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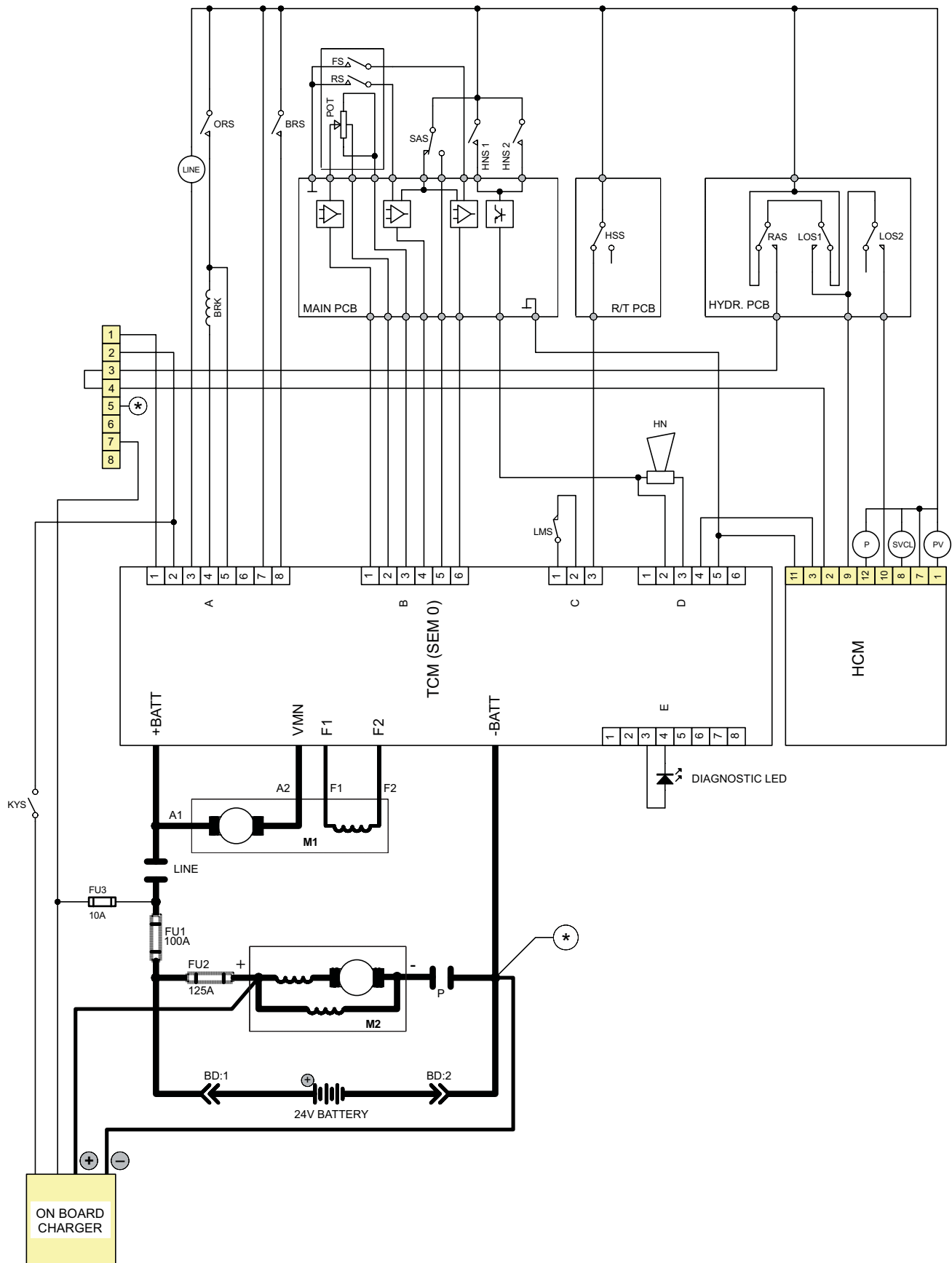


ELECTRICAL DIAGRAMS

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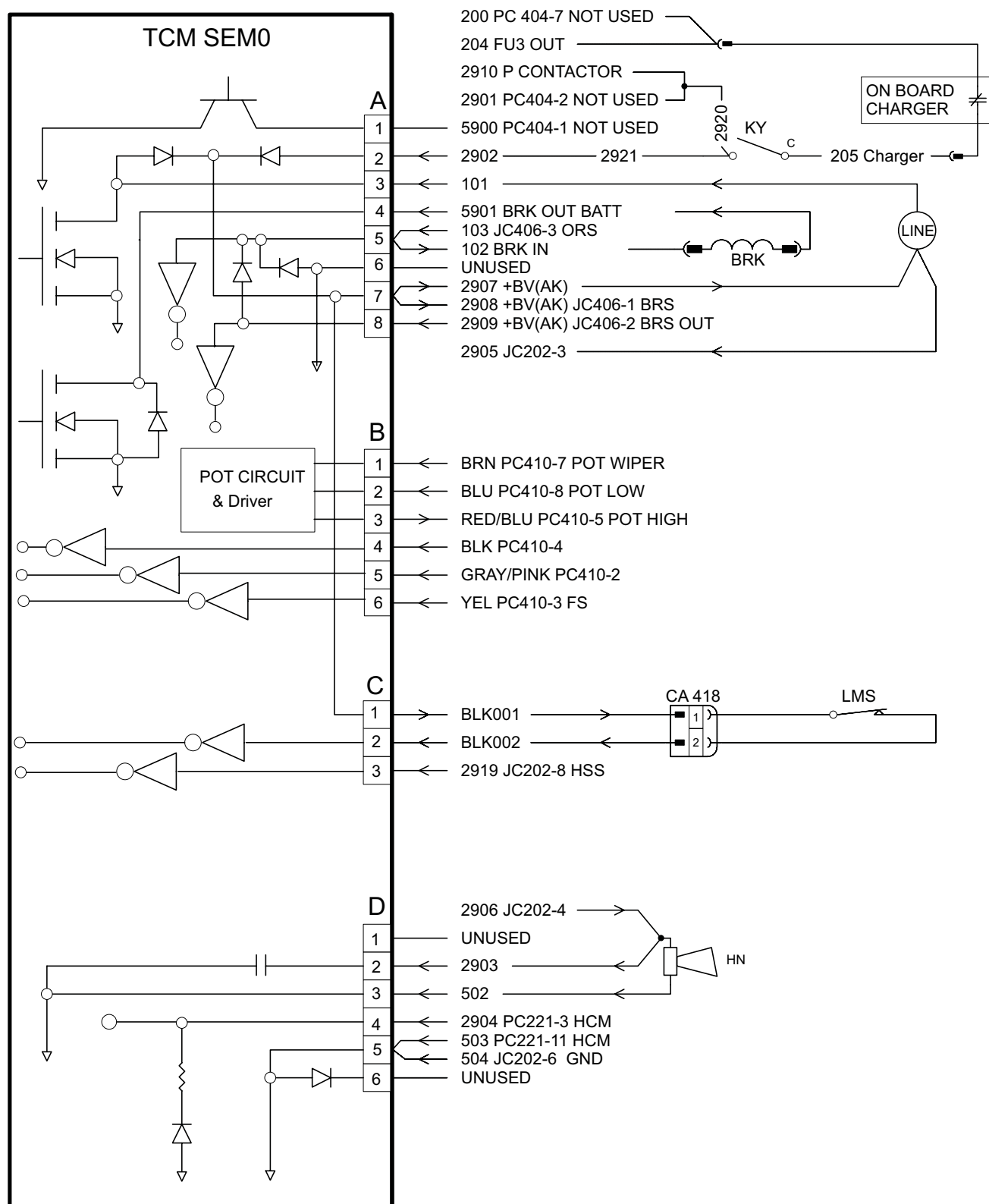
WF 3000-10 Standard

Overview



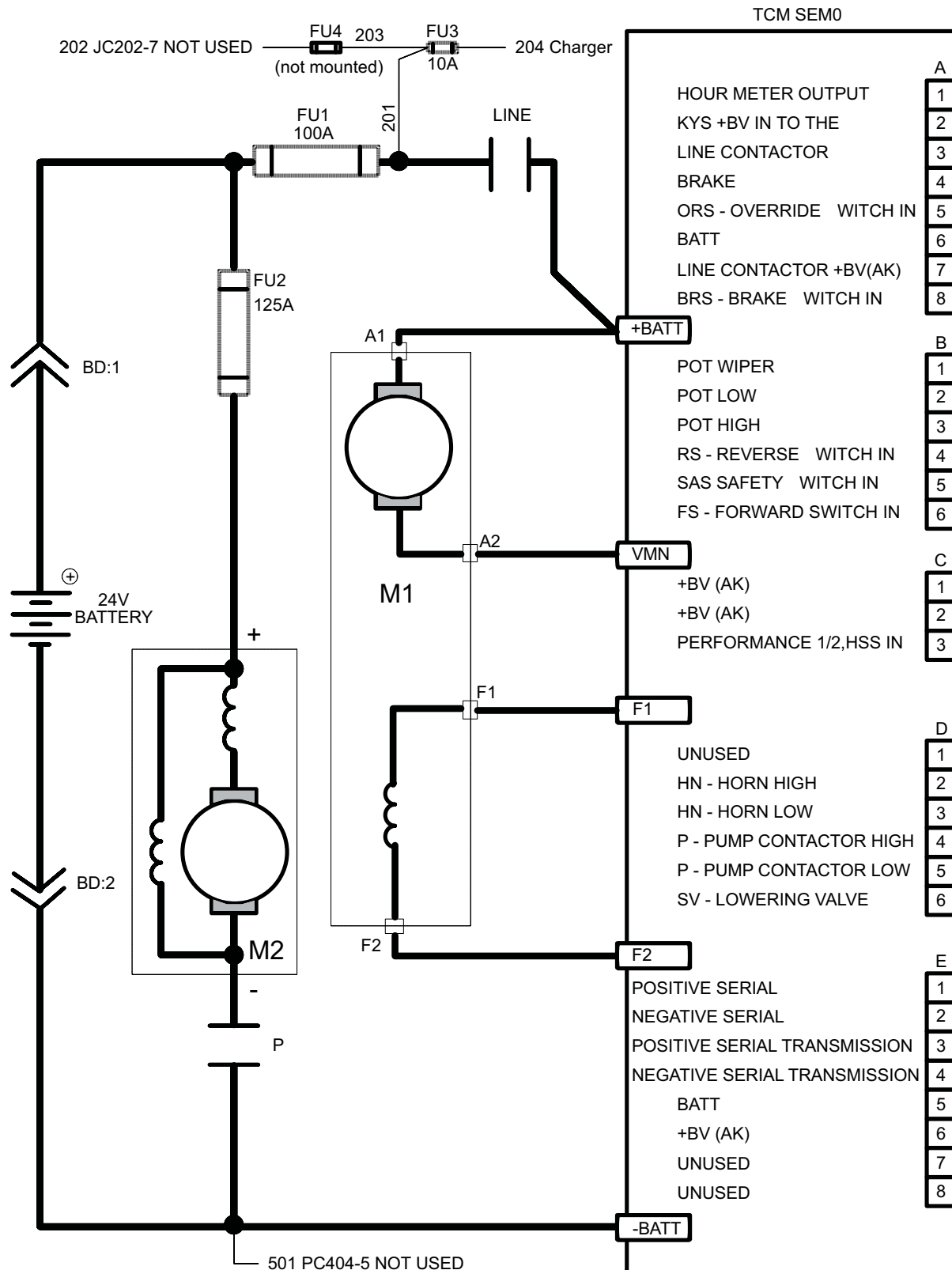
813706-1-2B

WF3000-10 Standard, Traction Controller - SEM0 Logic



813706-2-2B

WF3000-10 Standard, Traction Controller - SEM0 Power Circuit

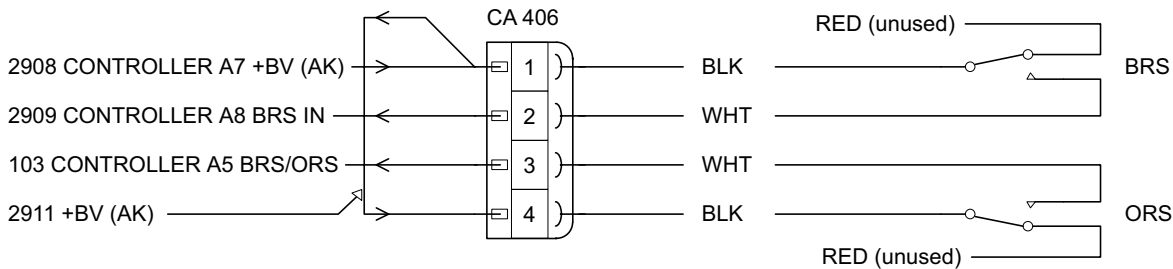
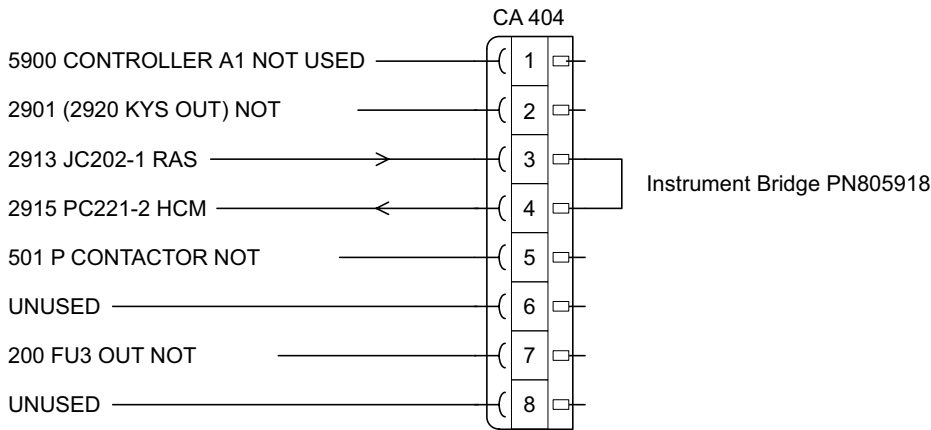
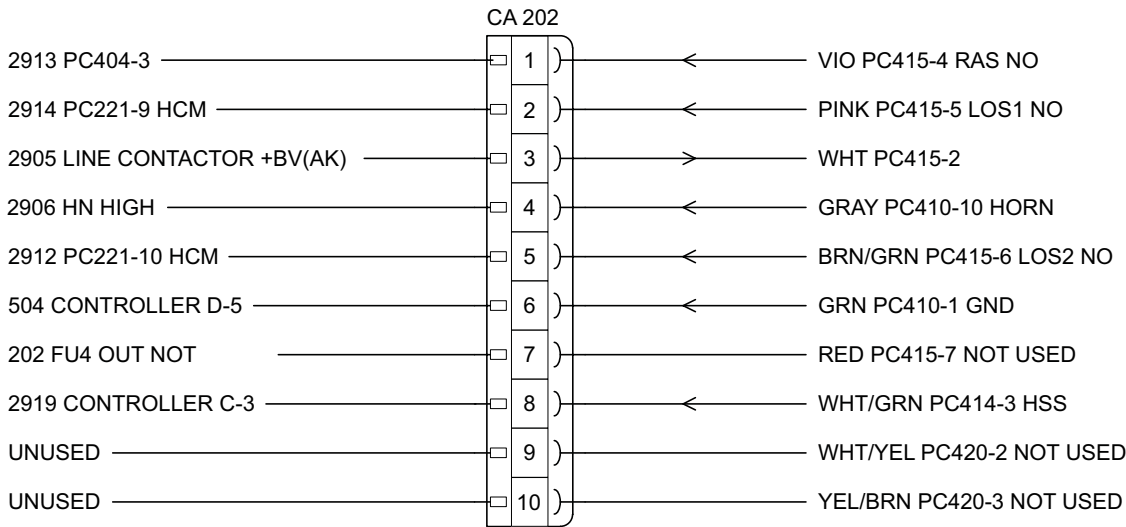


Note:

- 1) Voltage between B1 & B2:
10V = Max. speed
0V = No drive command

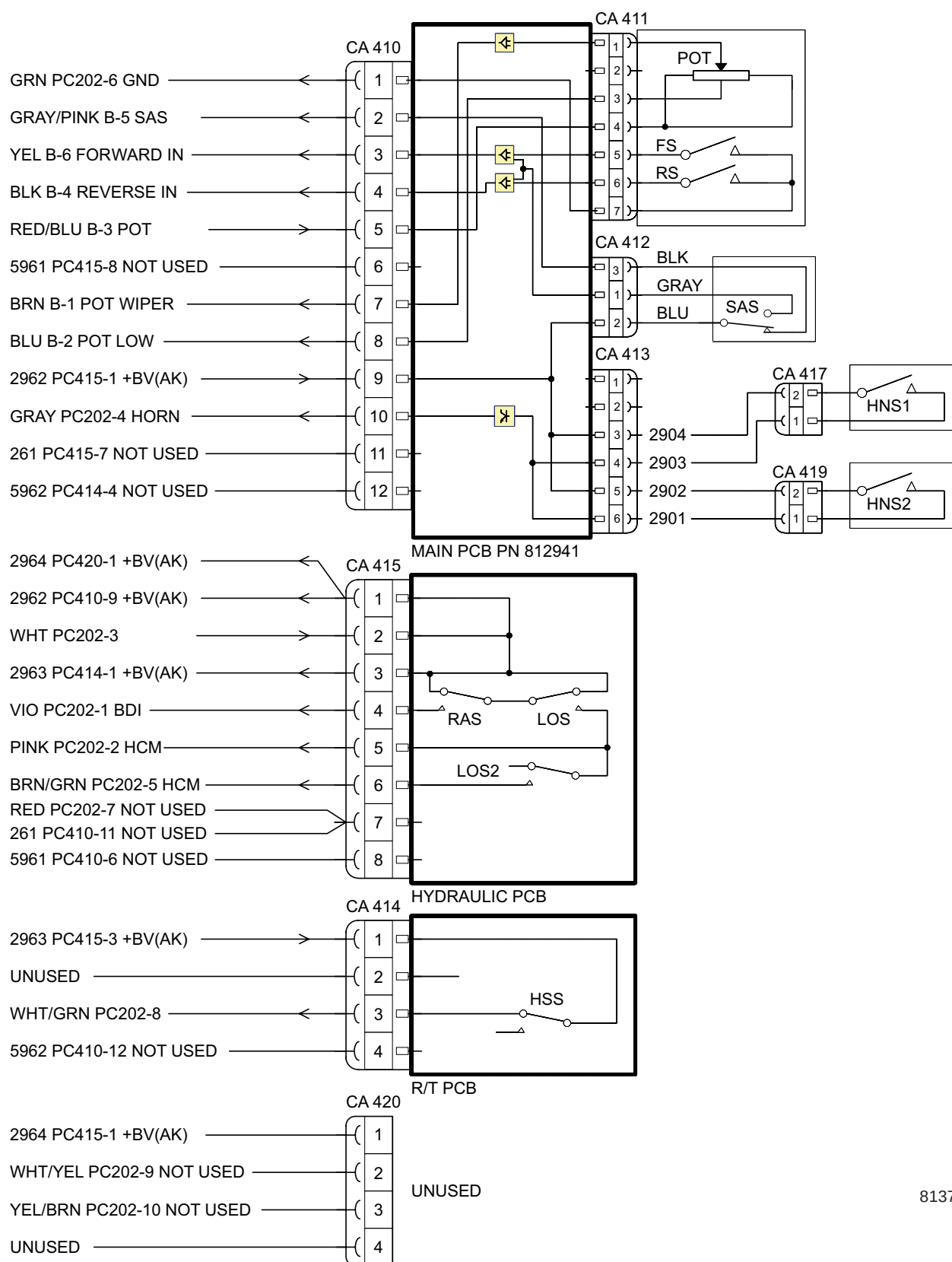
813706-3-2B

WF3000-10 Standard, Power Unit Control Circuit



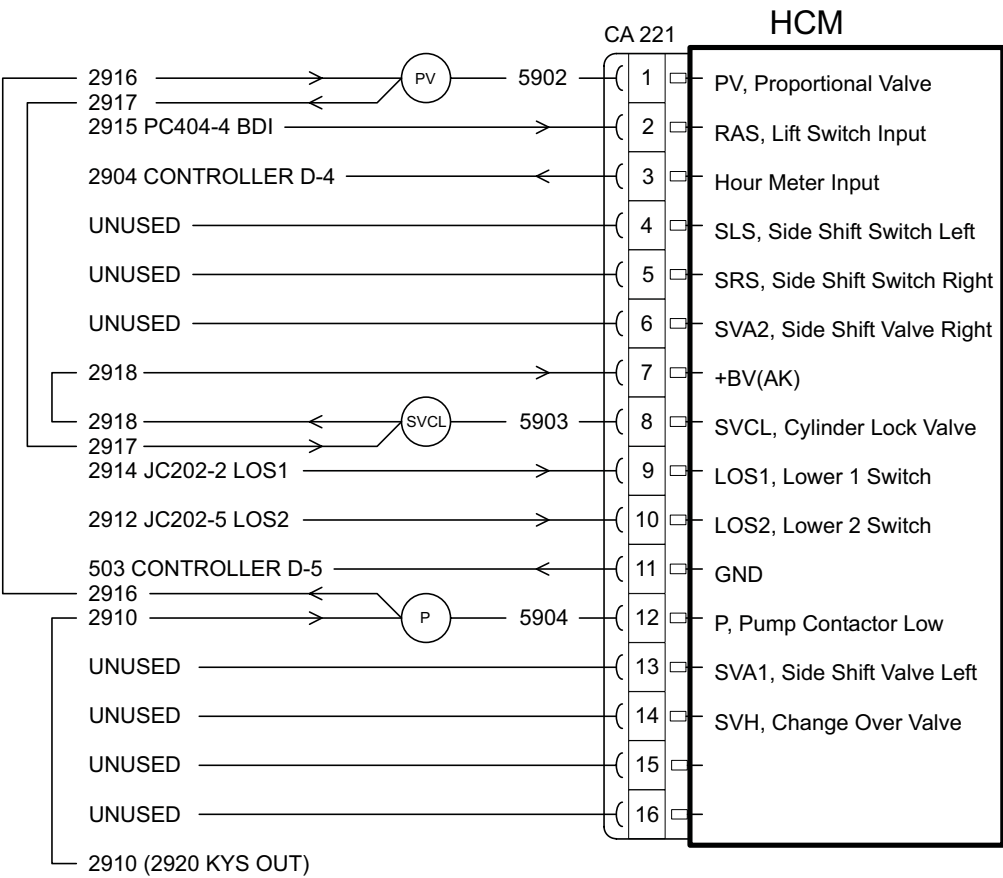
813706-4-2B

WF3000-10 Standard, Control Handle - Control Circuit



813706-5-2B

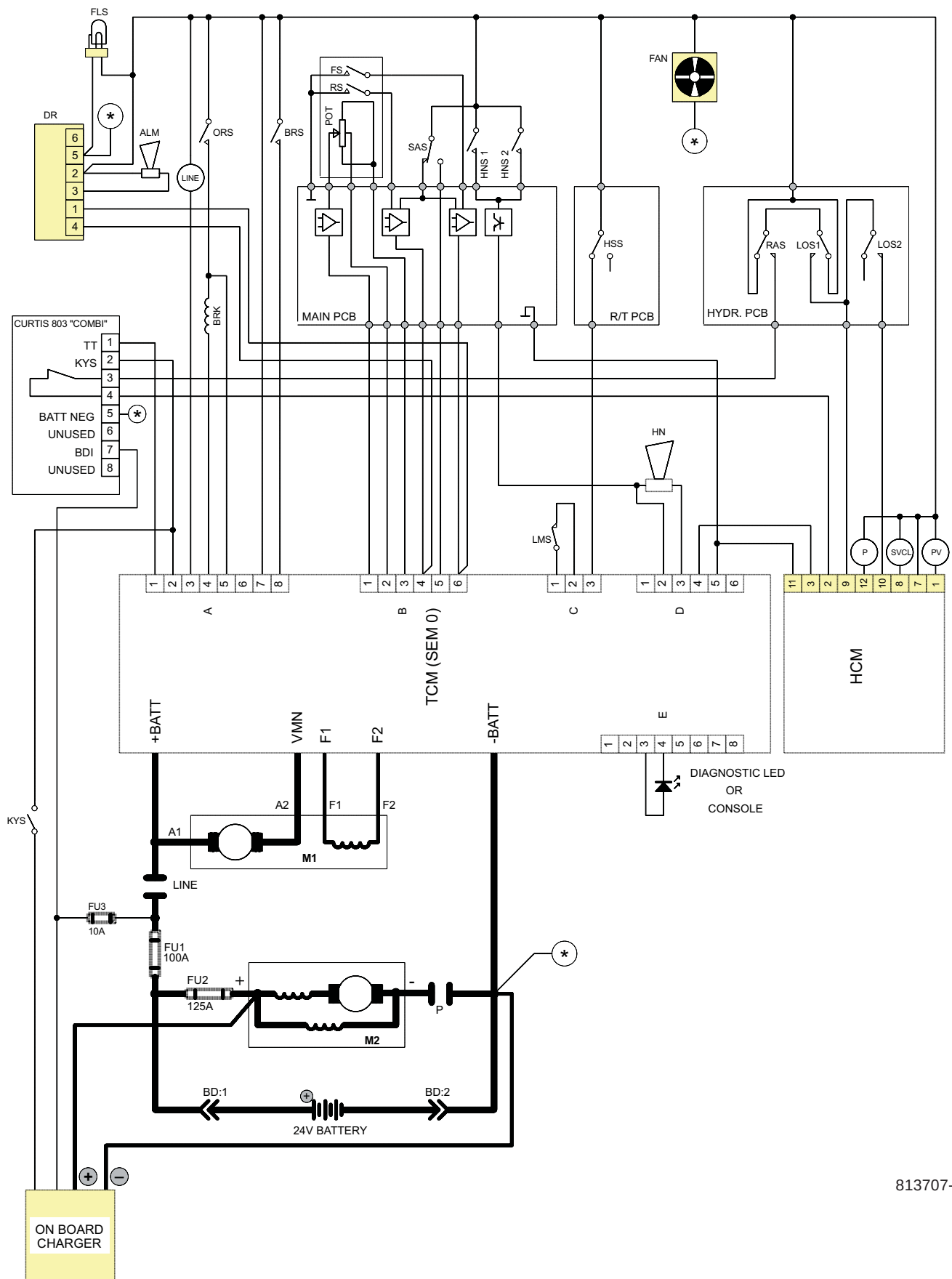
WF3000-10 Standard,Hydraulic Control Module (HCM)



813706-6-2B

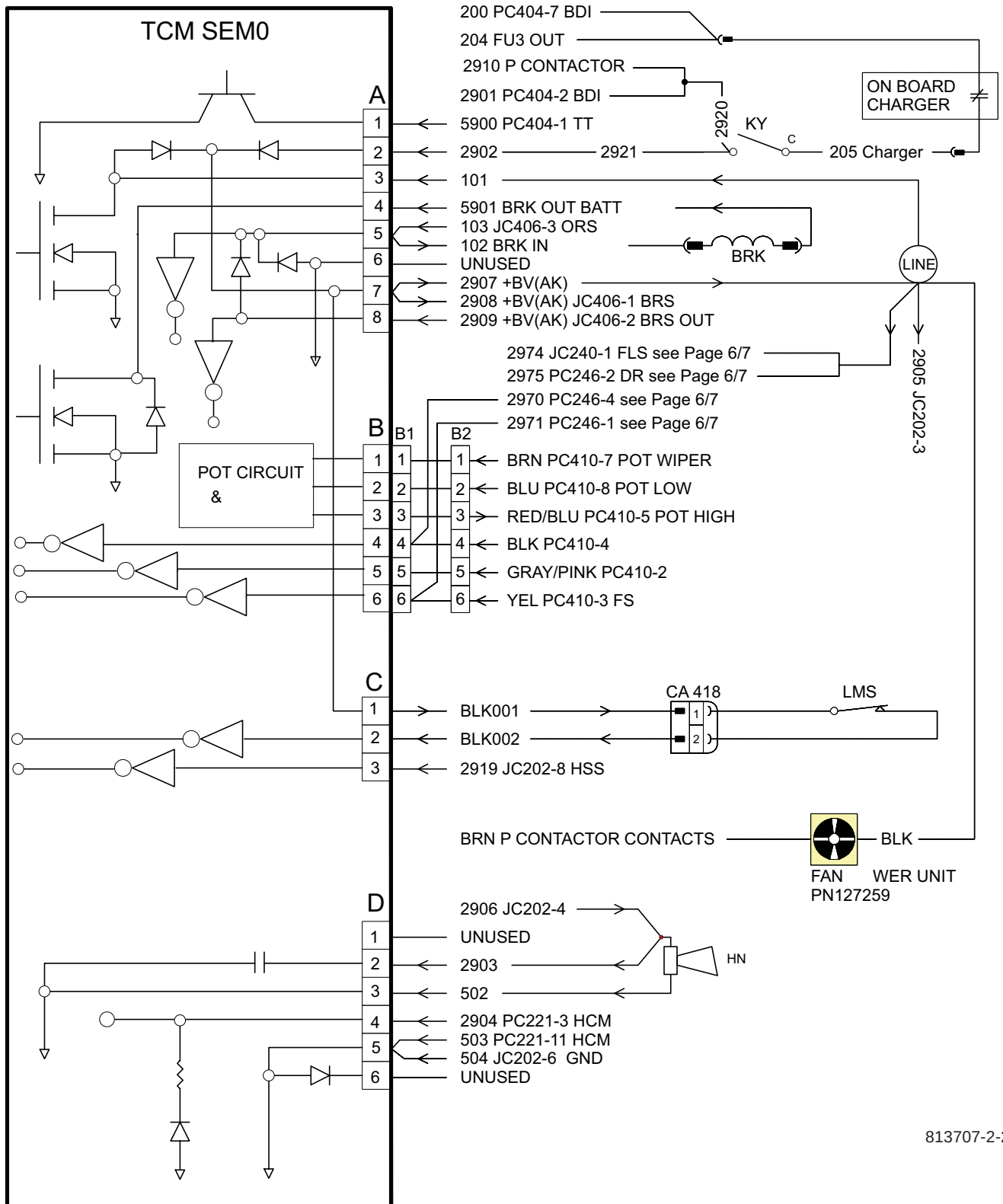
WF3000-10 with Options

Overview



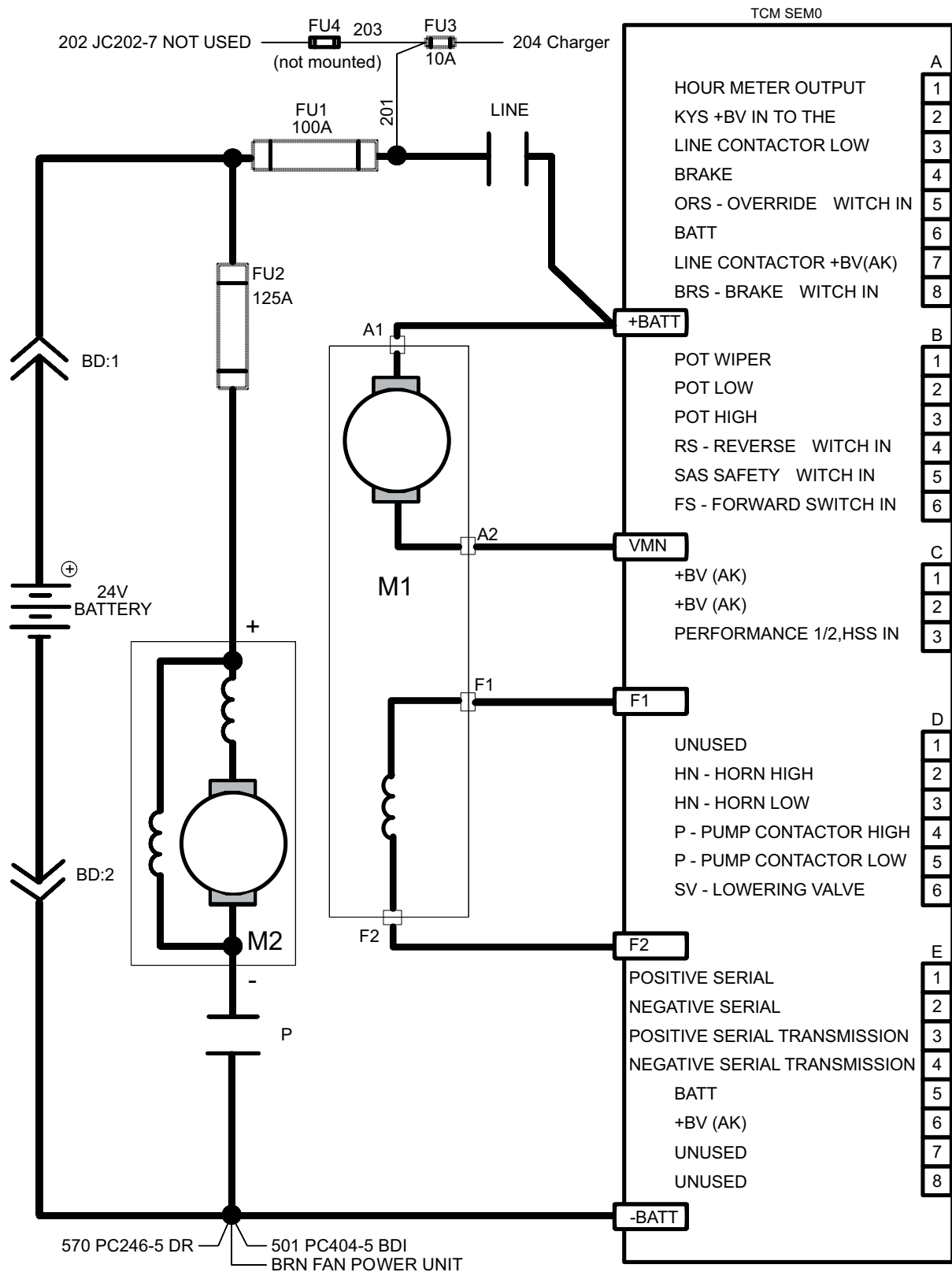
813707-1-2B

WF3000-10 with Options, Traction Controller - SEM0 Logic



813707-2-2B

WF3000-10 with Options, Traction Controller - SEM0 Power Circuit

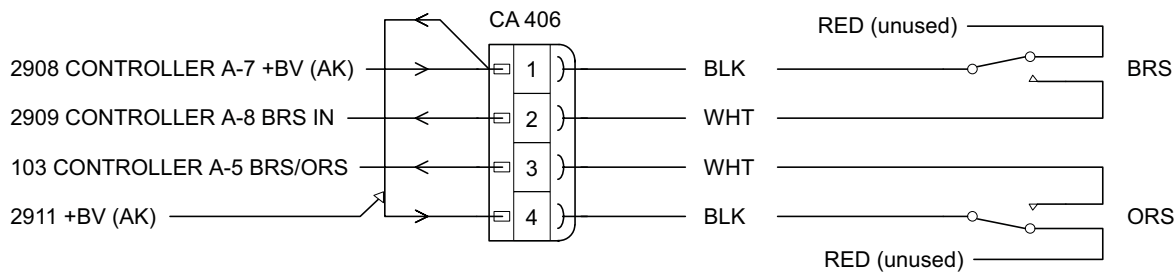
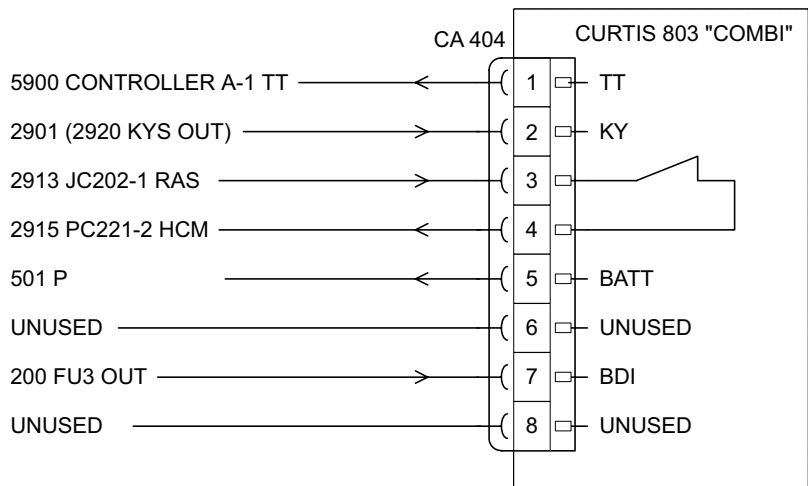
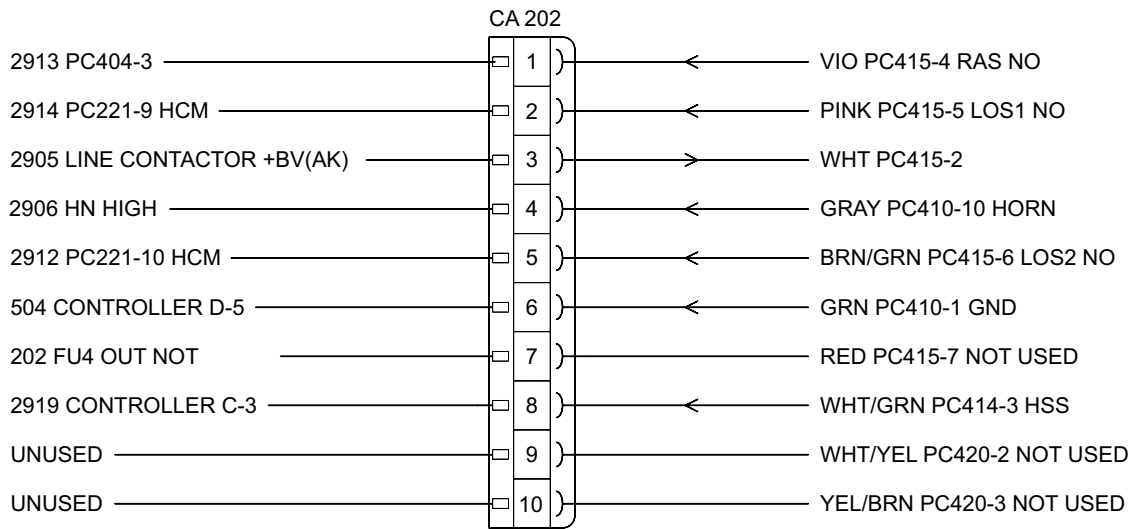


Note:

- 1) Voltage between B1 & B2:
 10V = Max.speed
 0V = No drive command

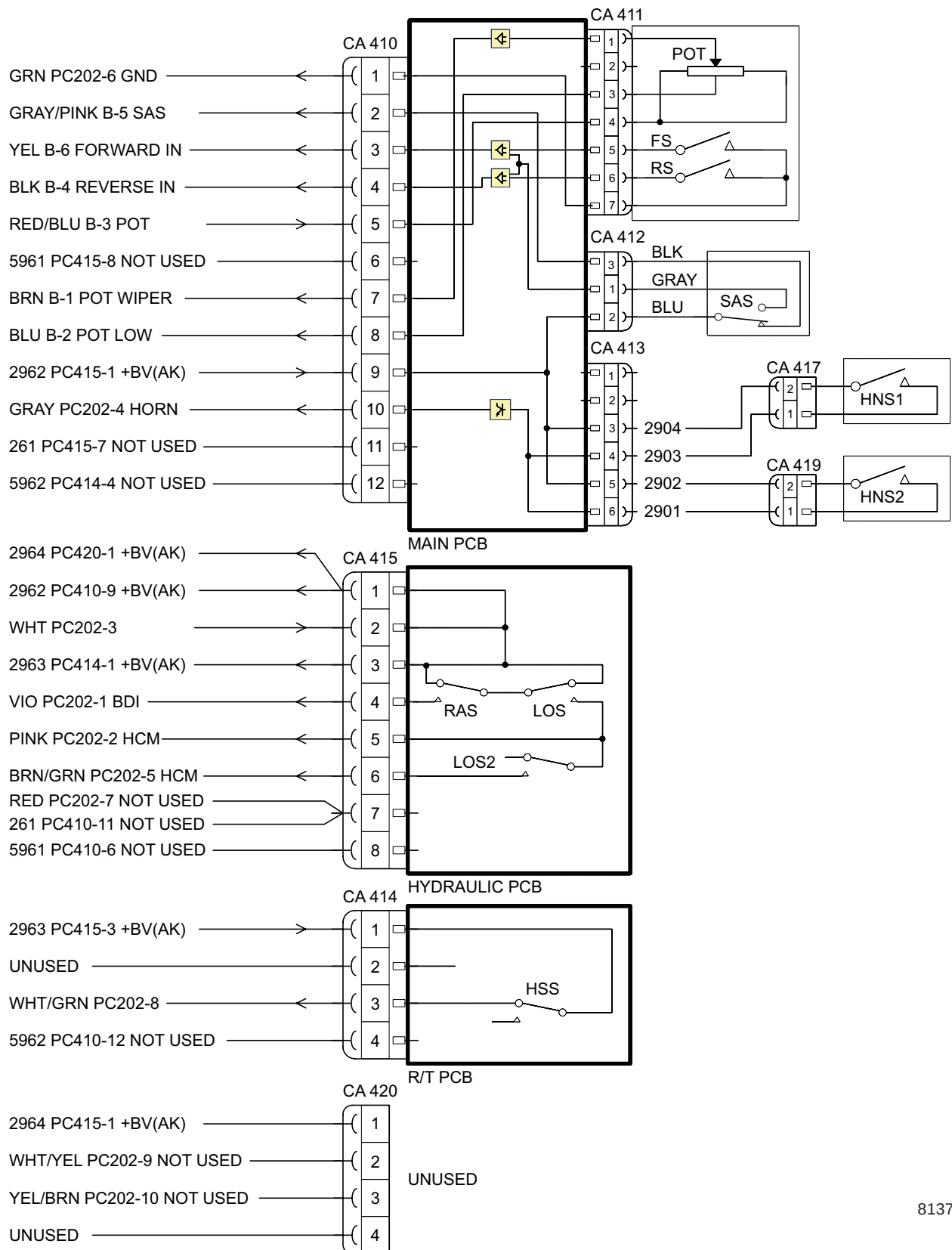
813707-3-2B

WF3000-10 with Options, Power Unit - Control Circuit



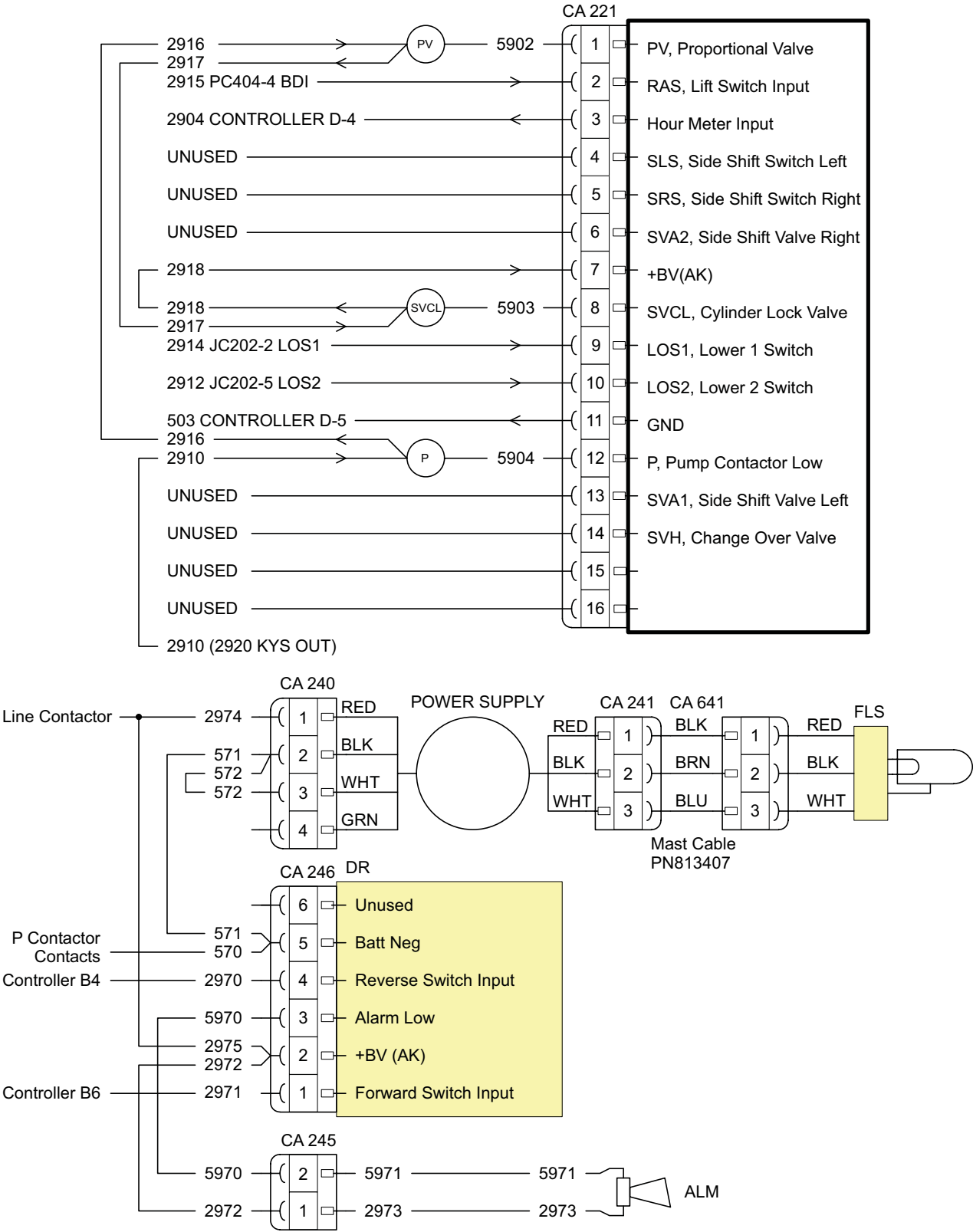
813707-4-2B

WF3000-10 with Options, Control Handle - Control Circuit



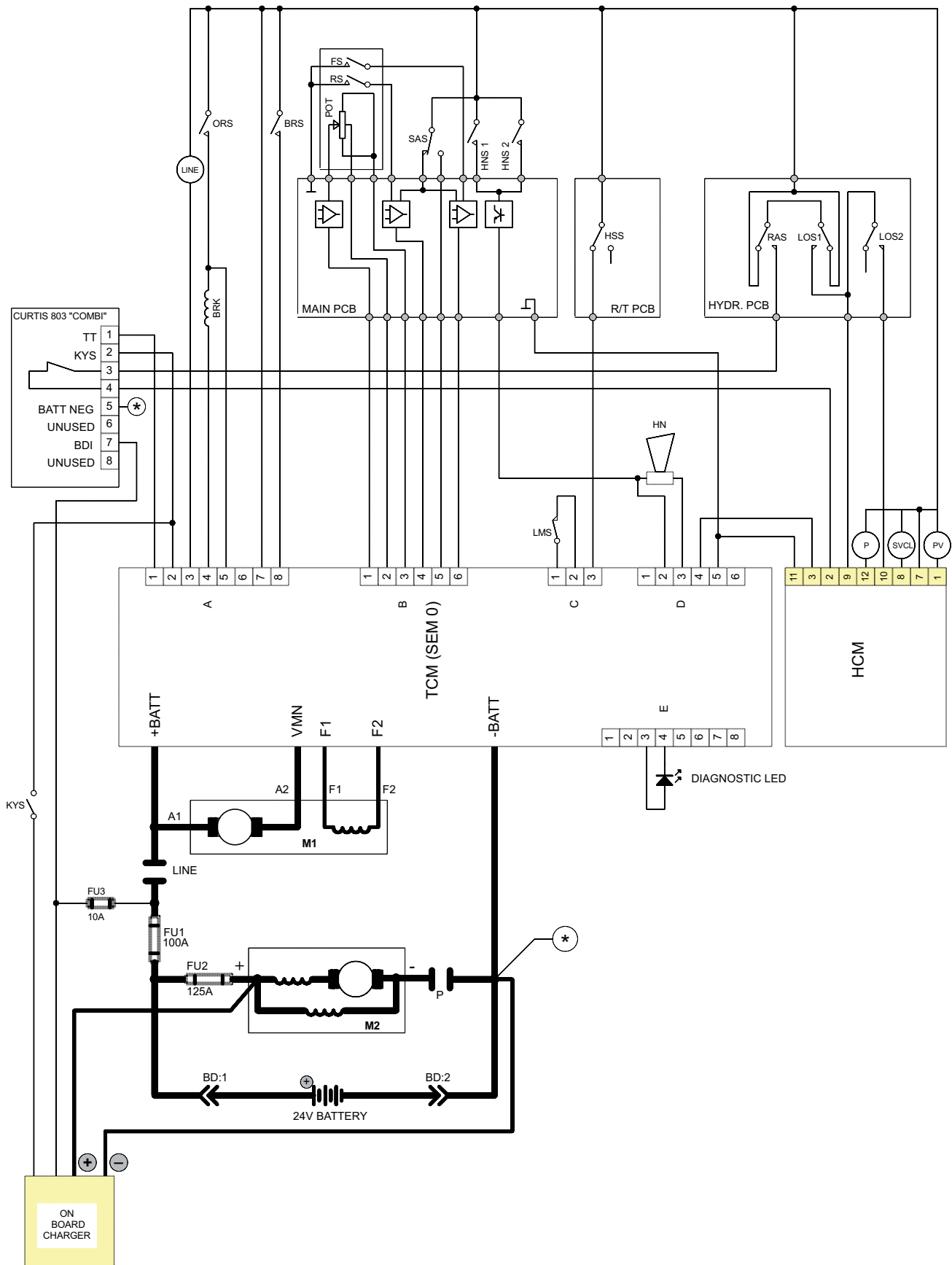
813707-5-2B

WF3000-10 with Options, Hydraulic Control Module (HCM) - Travel Alarm and Flashing Beacon



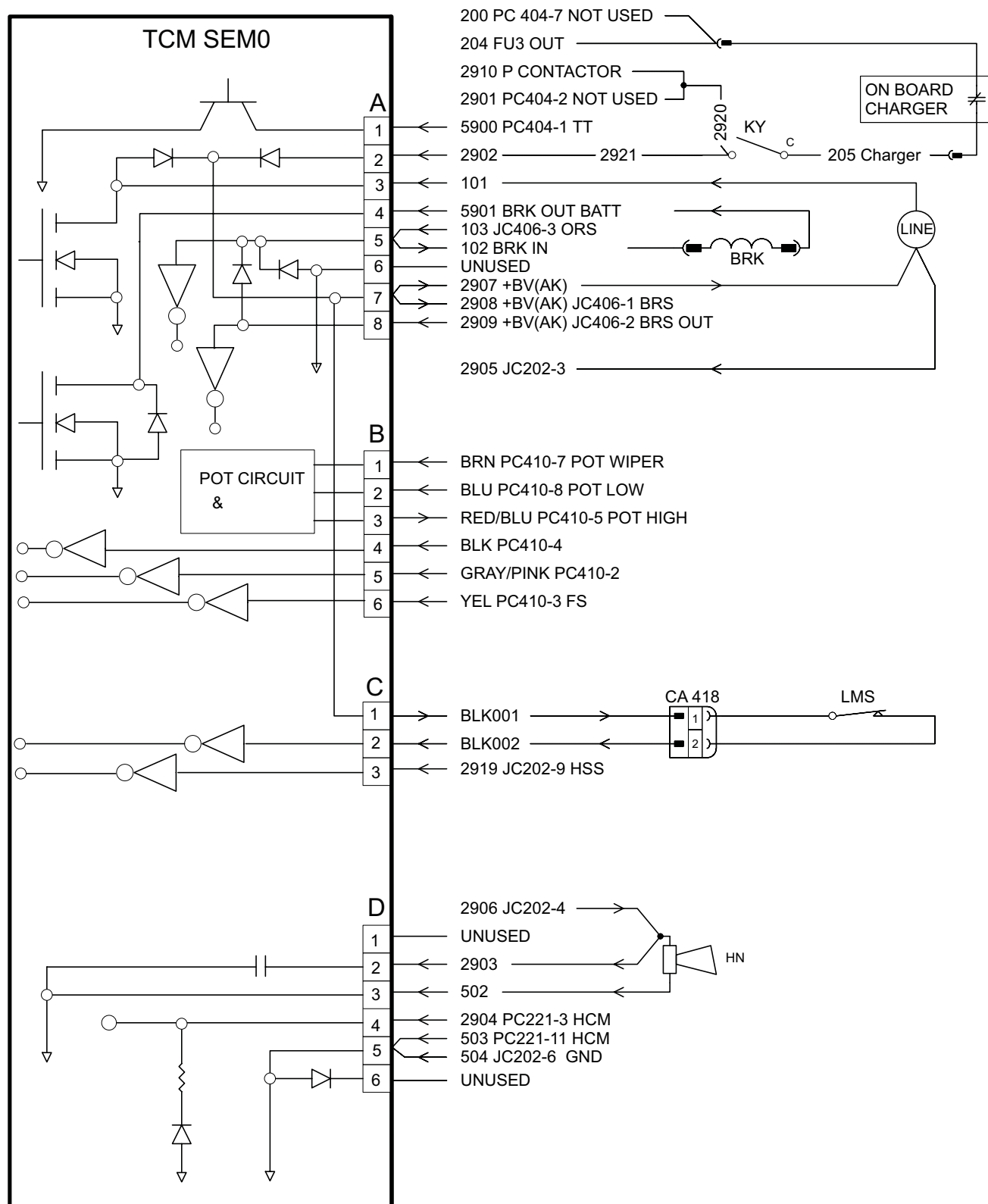
WF 3000-12 Standard

Overview



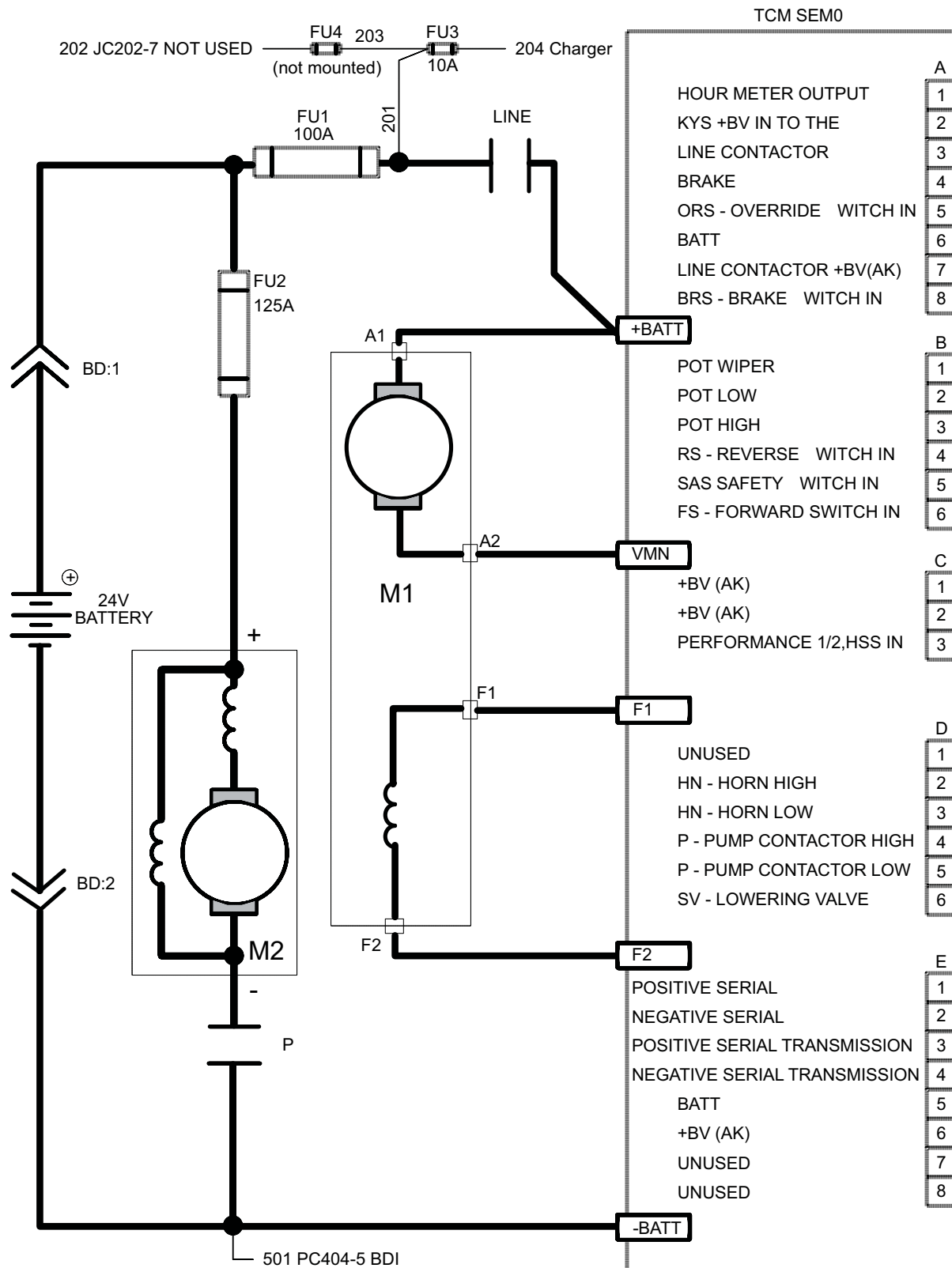
814374-1-2B

WF3000-12 Standard, Traction Controller - SEM0 Logic



814374-2-2B

WF3000-12 Standard, Traction Controller - SEM0 Power Circuit

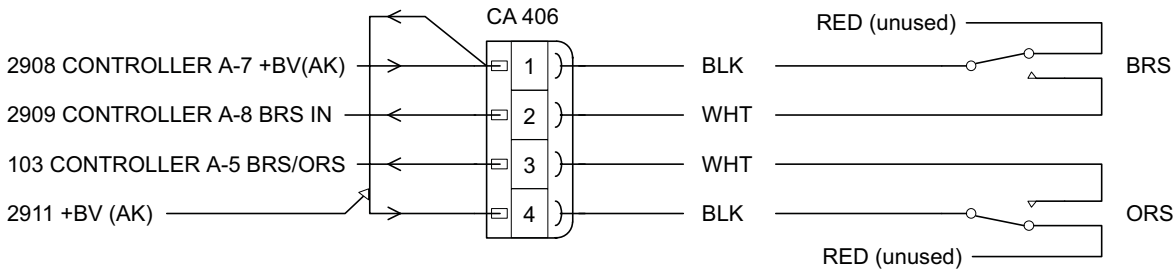
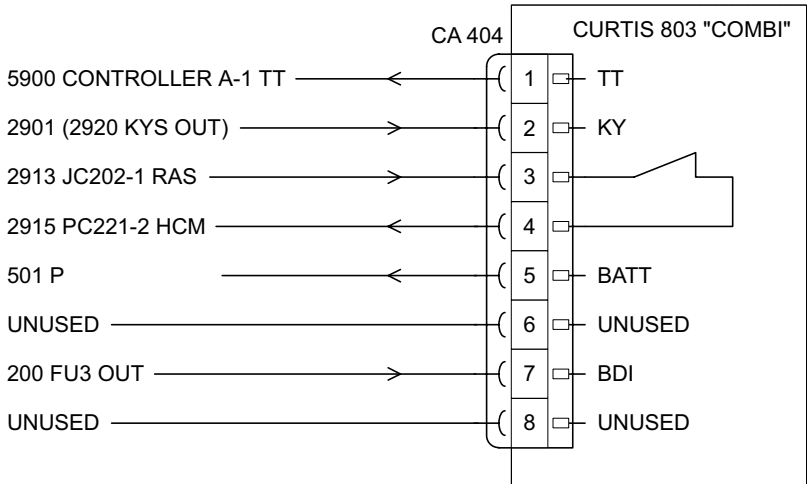
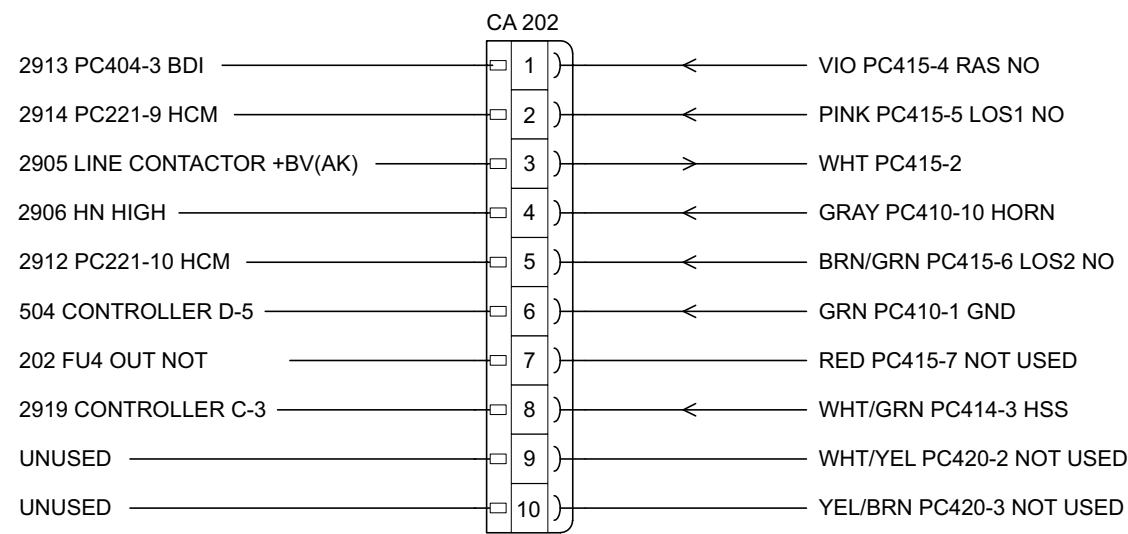


Note:

- 1) Voltage between B1 & B2:
10V = Max. speed
0V = No drive command

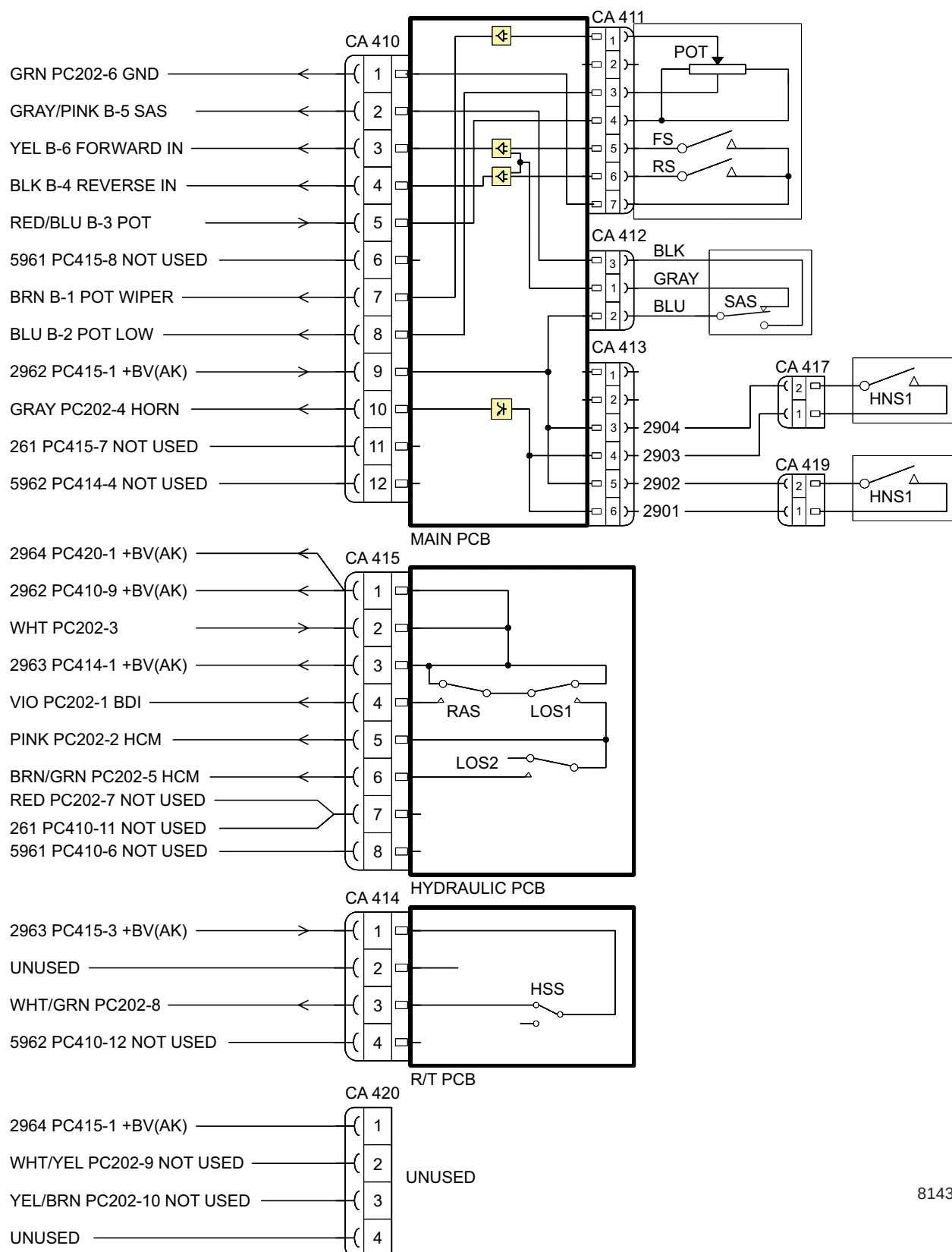
814374-3-2B

WF3000-12 Standard, Power Unit Control Circuit



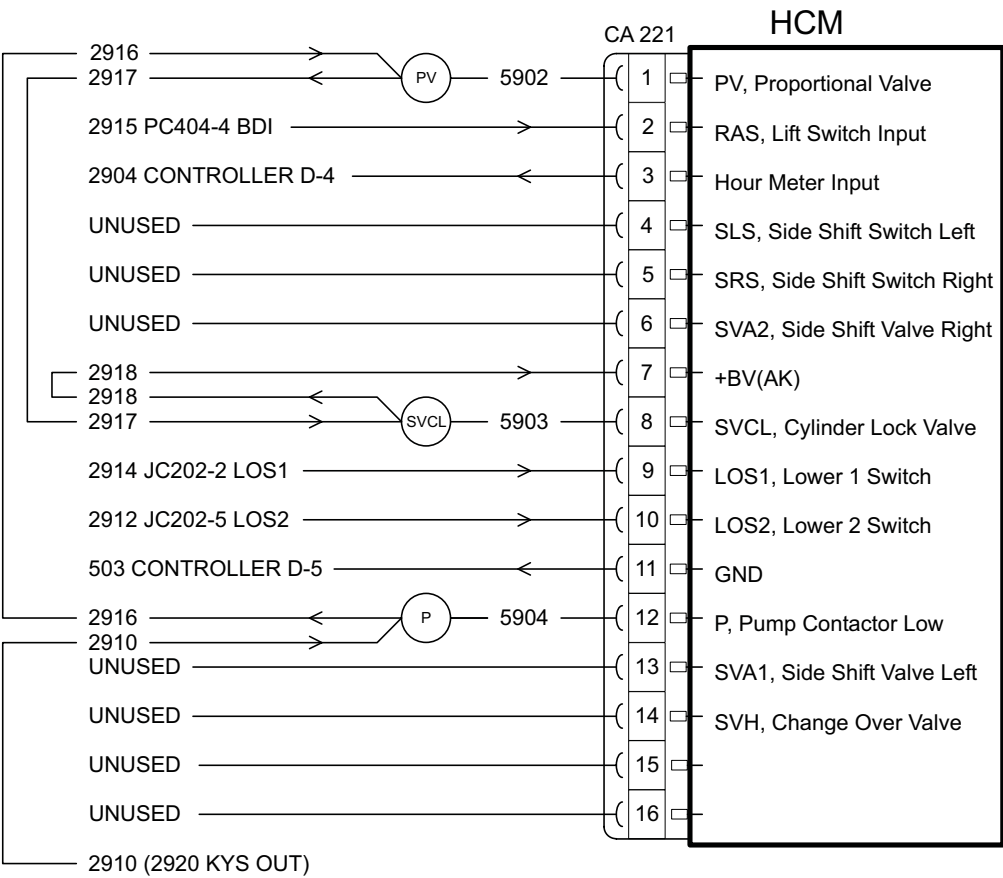
814374-4-2B

WF3000-12 Standard, Control Handle - Control Circuit



814374-5-2B

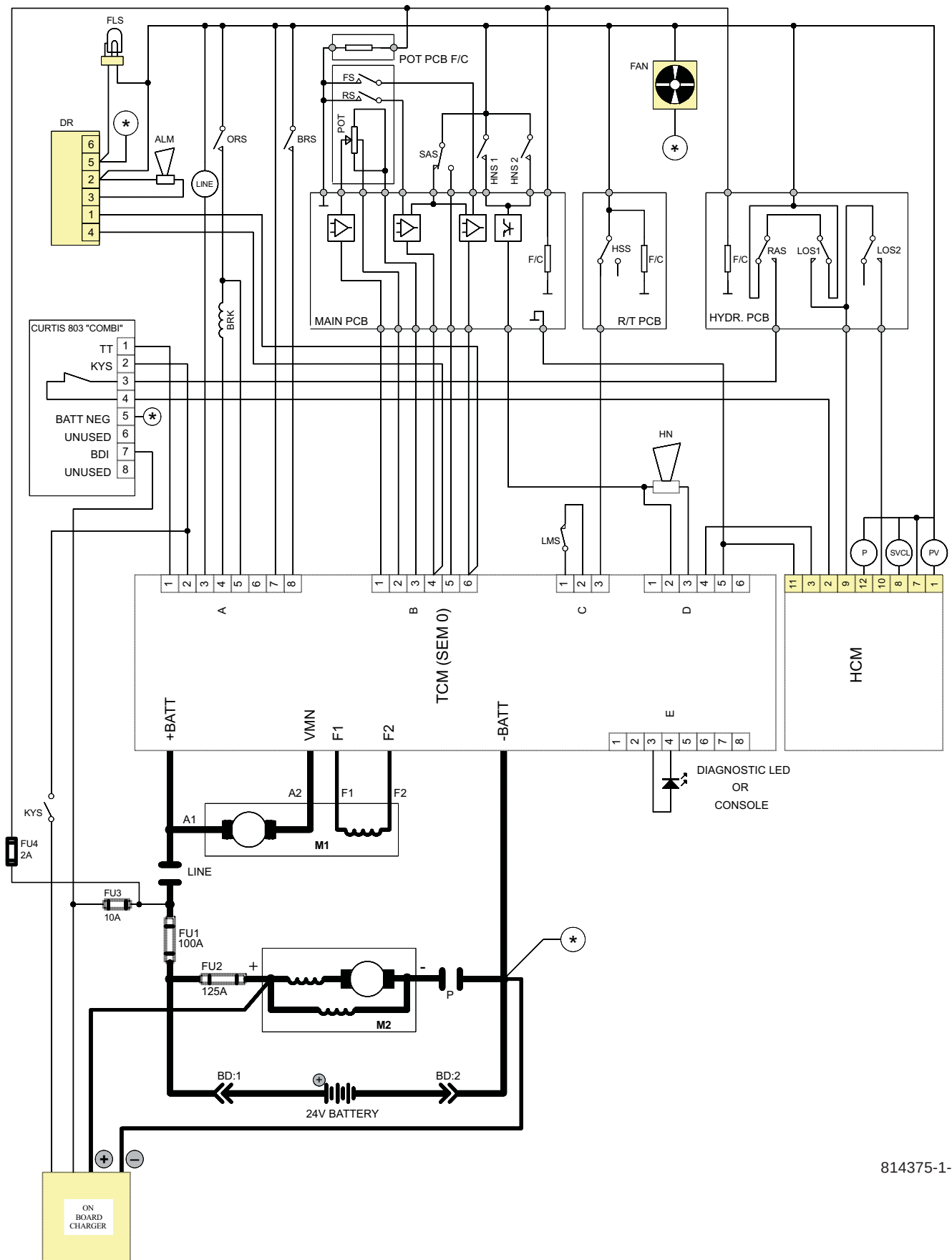
WF3000-12 Standard, Hydraulic Control Module (HCM)



814374-6-2B

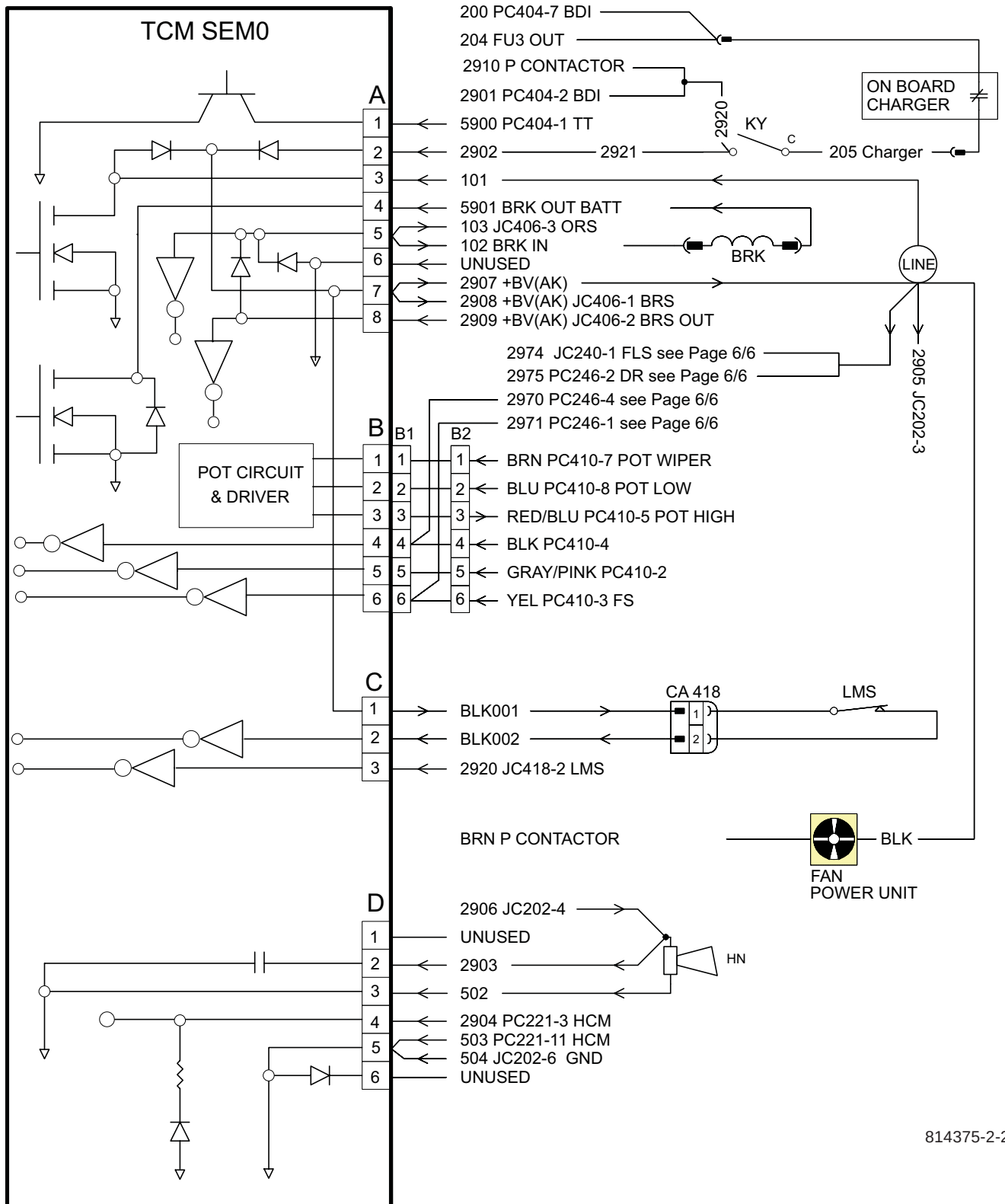
WF3000-12 with Options

Overview



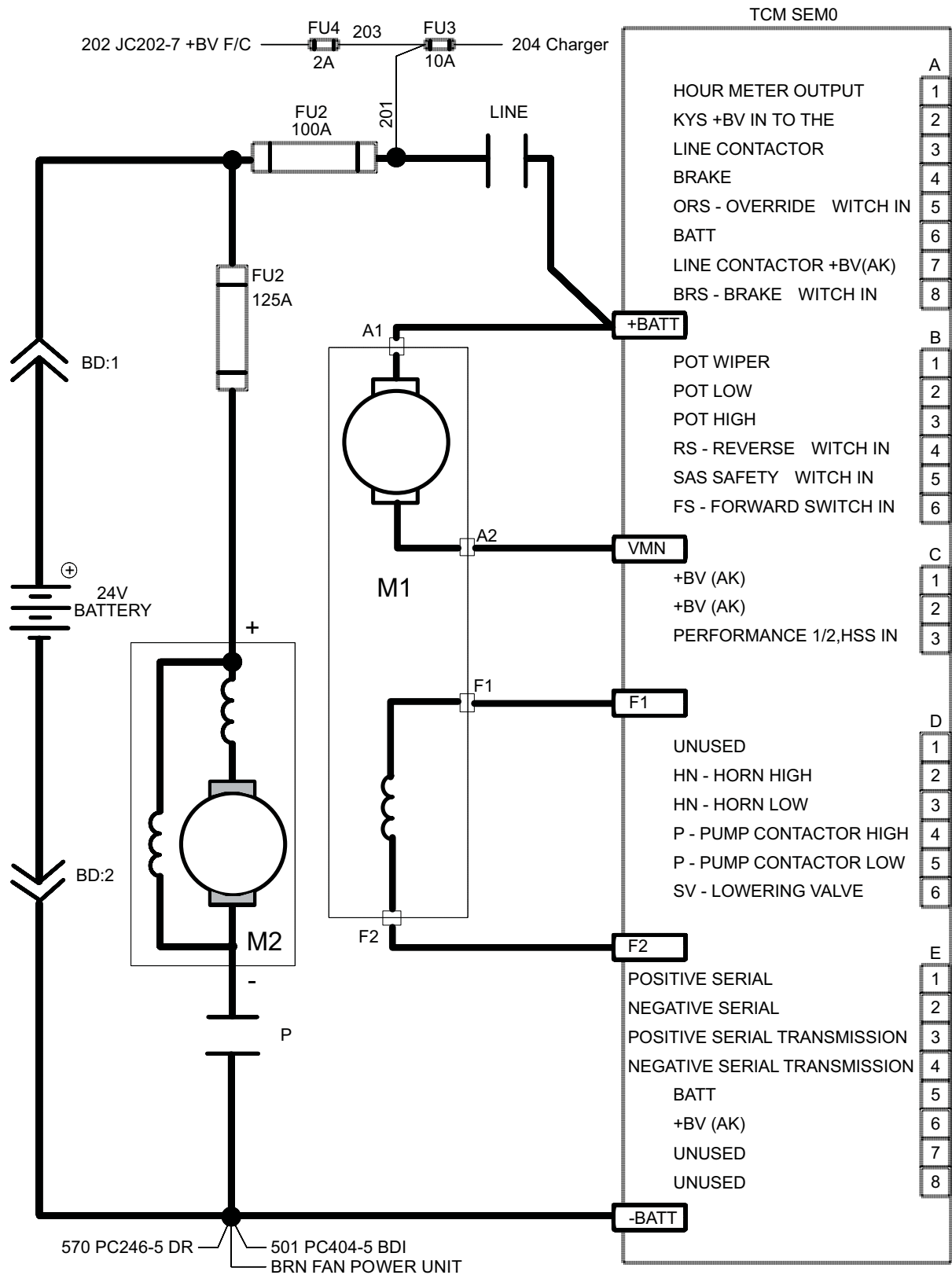
814375-1-2B

WF3000-12 Swith Options, Traction Controller - SEM0 Logic



814375-2-2B

WF3000-12 with Options, Traction Controller - SEM0 Power Circuit

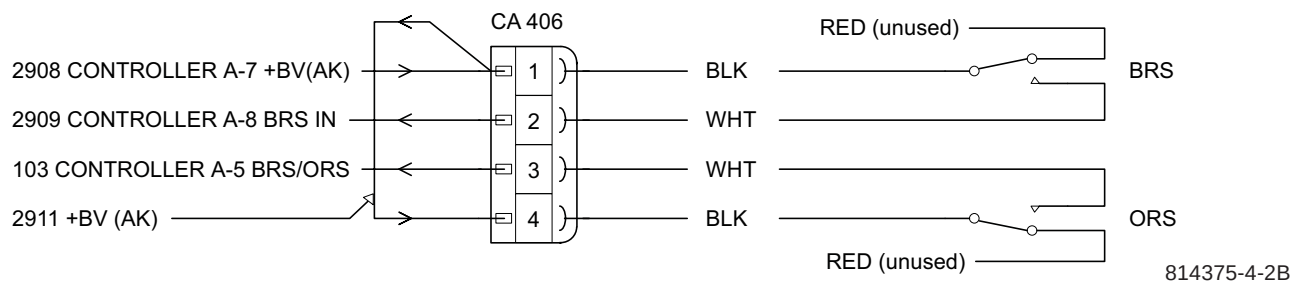
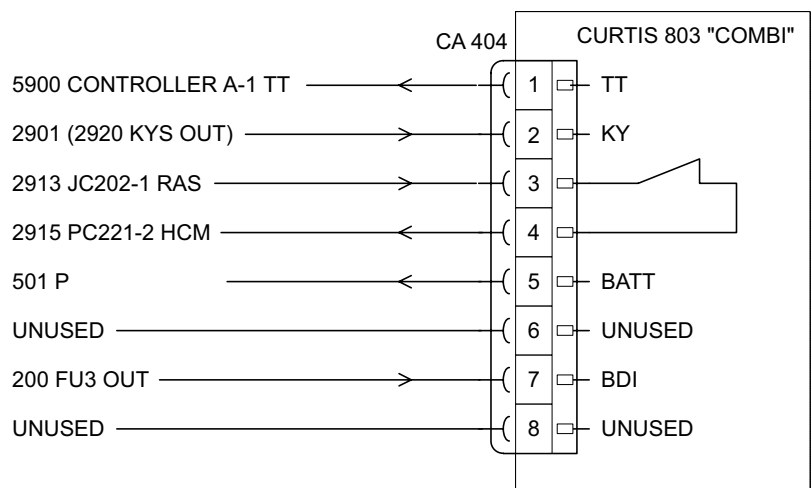
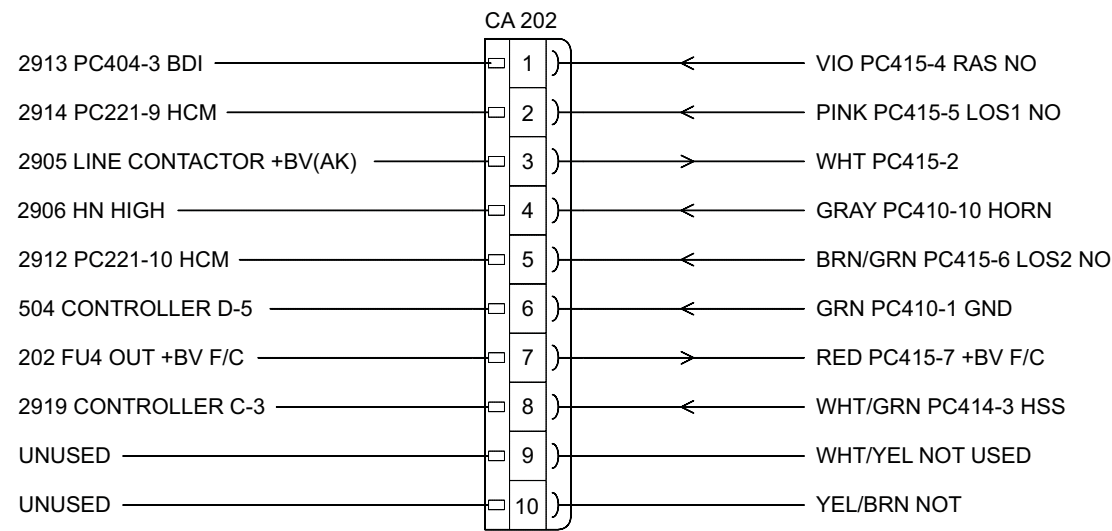


Note:

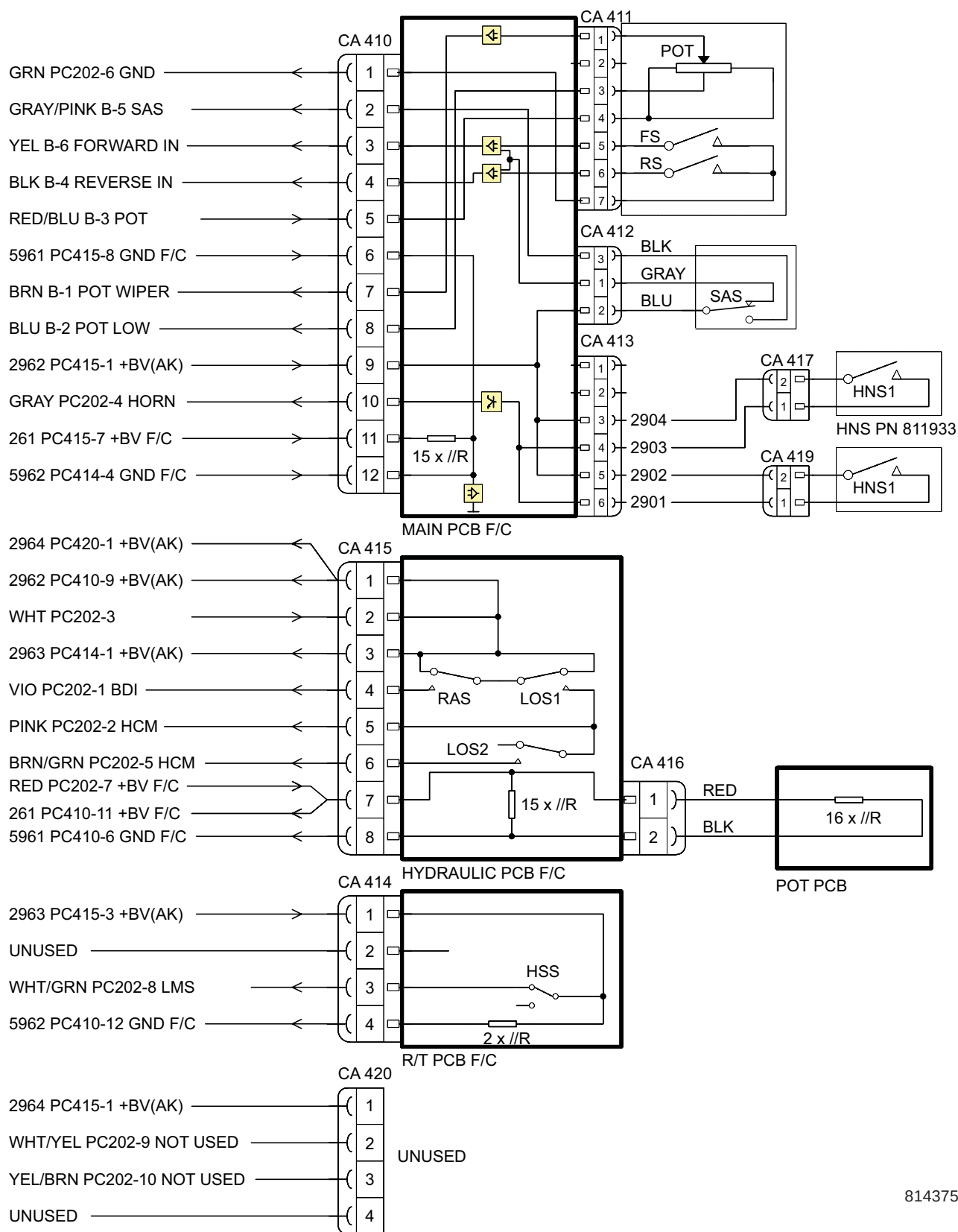
- 1) Voltage between B1 & B2:
 10V = Max.speed
 0V = No drive command

813707-3-2B

WF3000-12 with Options, Power Unit - Control Circuit

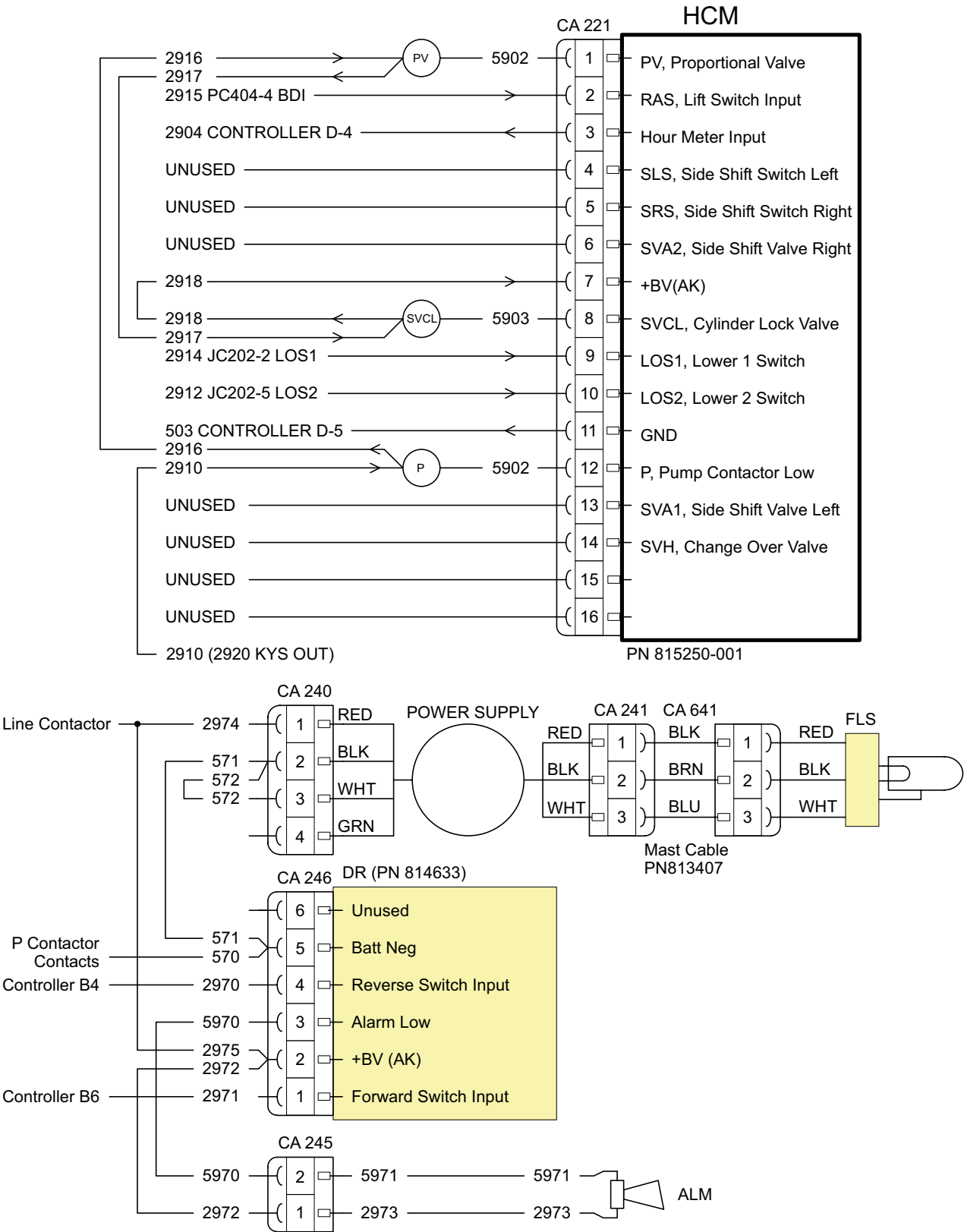


WF3000-12 with Options, Control Handle - Control Circuit

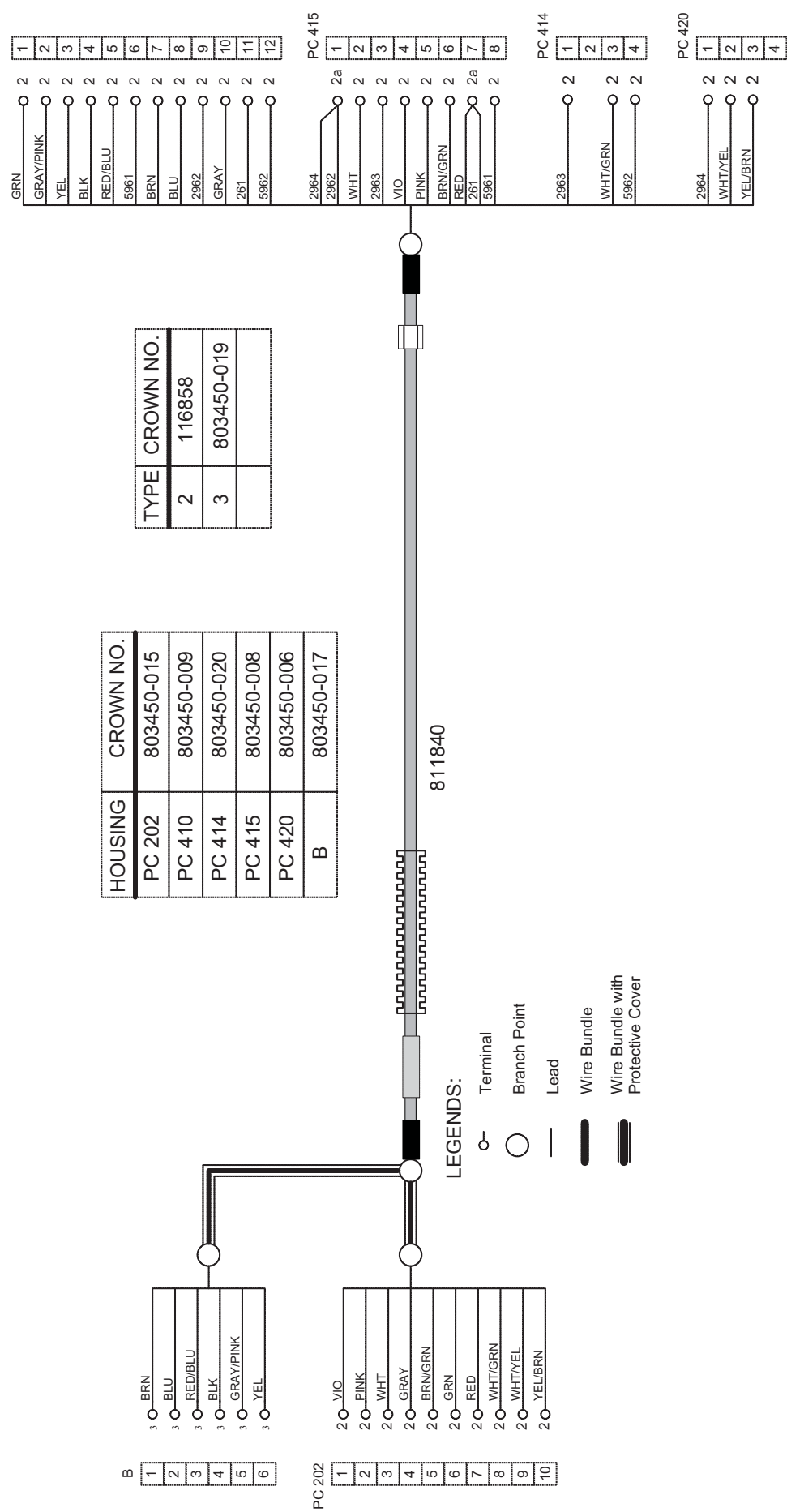


814375-5-2B

WF3000-12 with Options,
Hydraulic Control Module (HCM) - Travel Alarm and Flashing Beacon

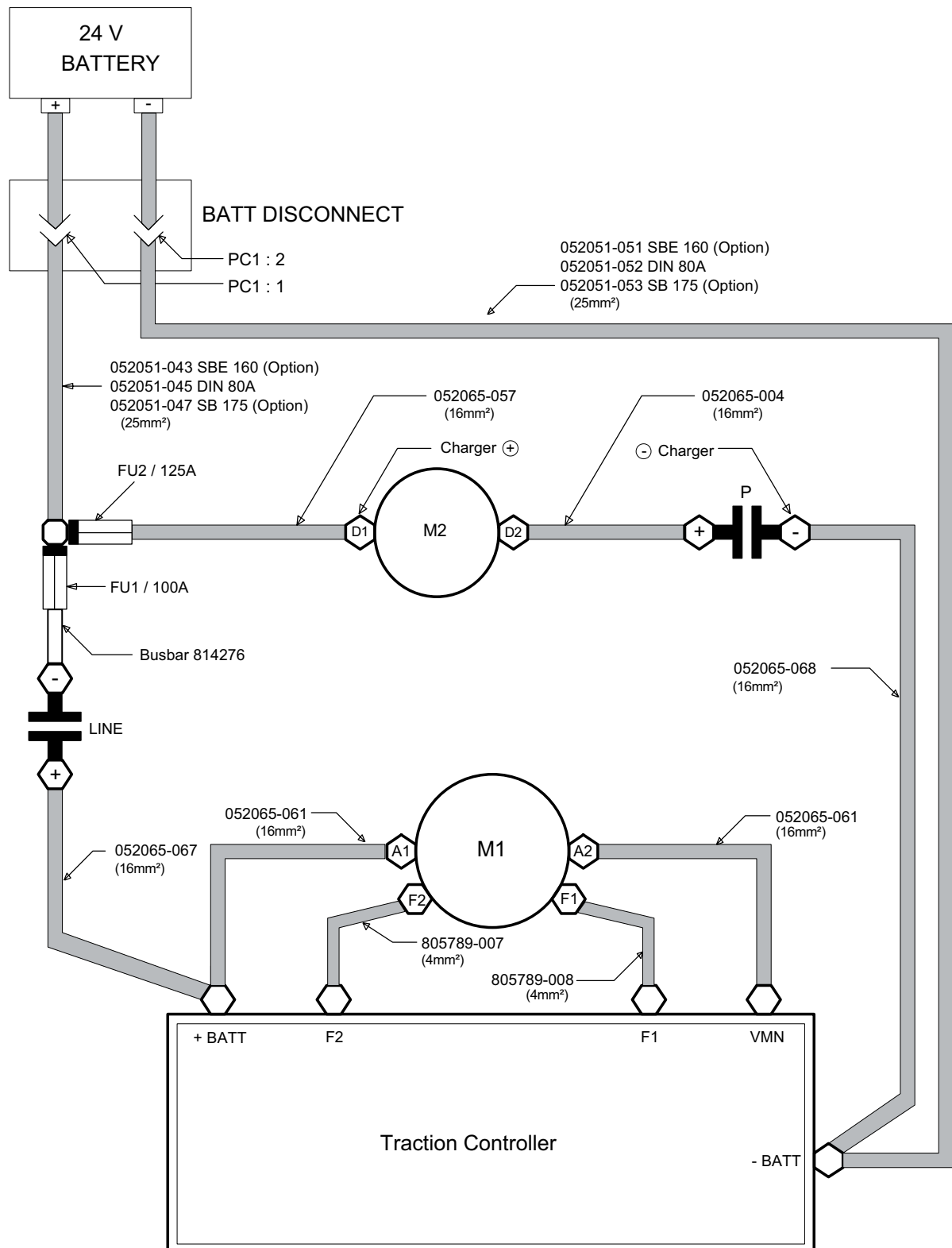


Control Handle Wiring



811840_2C

Power Cables



813708_2C

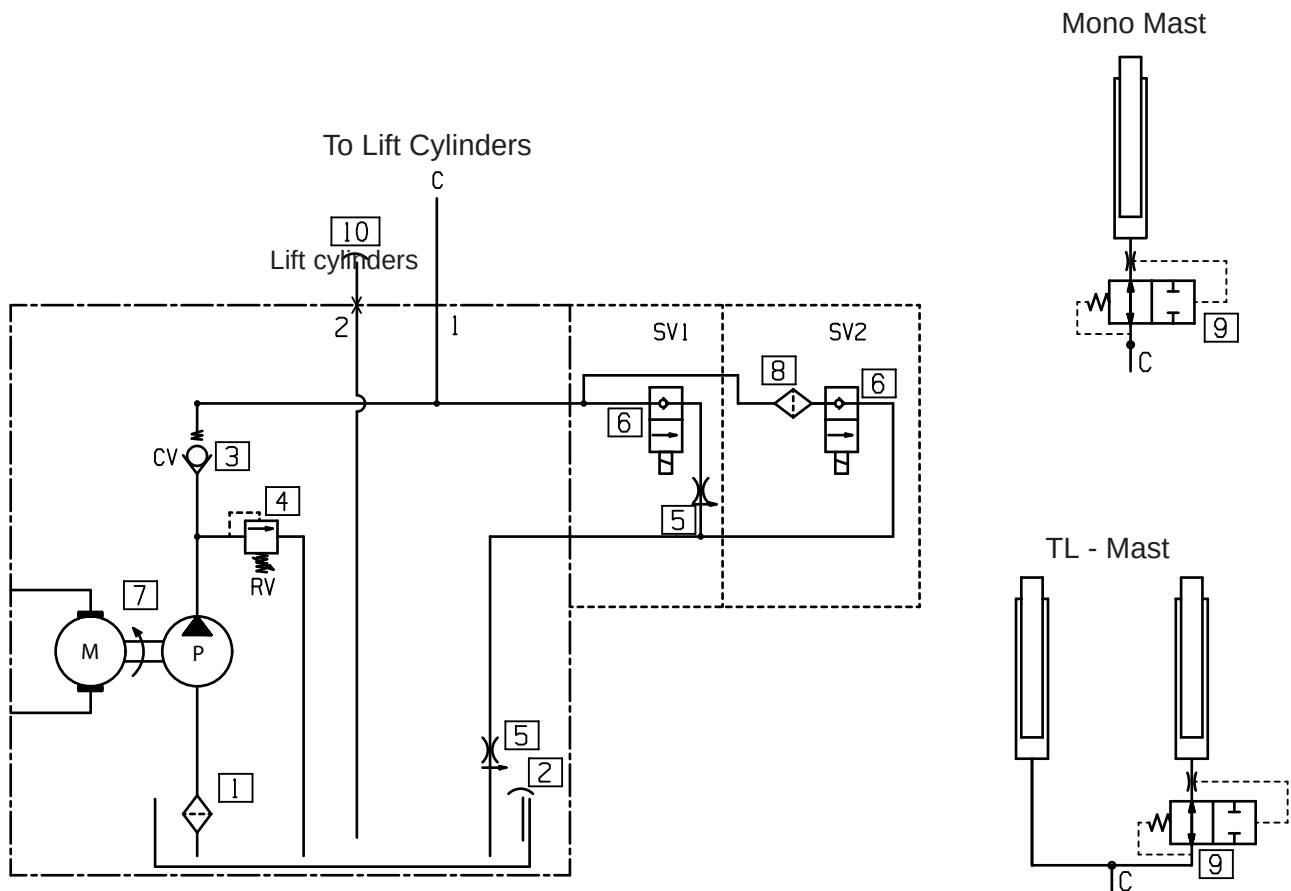
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HYDRAULIC SCHEMATIC

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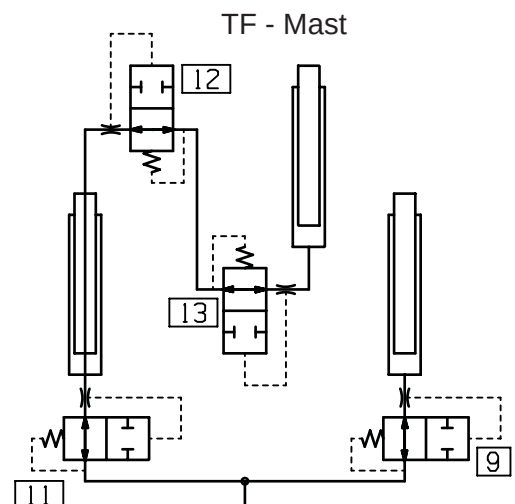
Hydraulik Schematic Standard Lift



- 1 Suction Filter
- 2 Reservoir Breather
- 3 Check Valve (CV)
- 4 Relief Valve (RV)
- 5 Flow Control, Pressure Comp.
- 6 Two-Way Valve (SVCL)
- 7 Pump & Motor
- 8 Filter
- 9 Velocity Fuse (Lift Cylinder)
- 10 Add. Breather
- 11 Velocity Fuse (Lift Cylinder)
- 12 Velocity Fuse (Lift Cylinder Output)
- 13 Carriage Cylinder Velocity Fuse

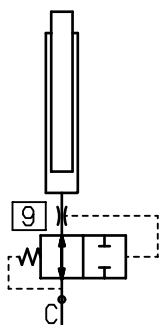
Abbreviations:

SVCL	Solenoid Valve Cylinder Lock
PV	Proportional Valve
RV	Relief Valve
CV	Check Valve

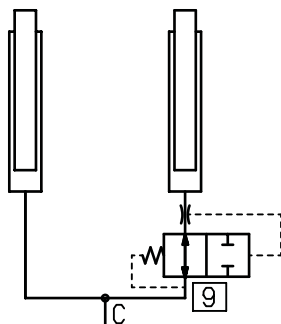


Hydraulik Schematic Soft Lift

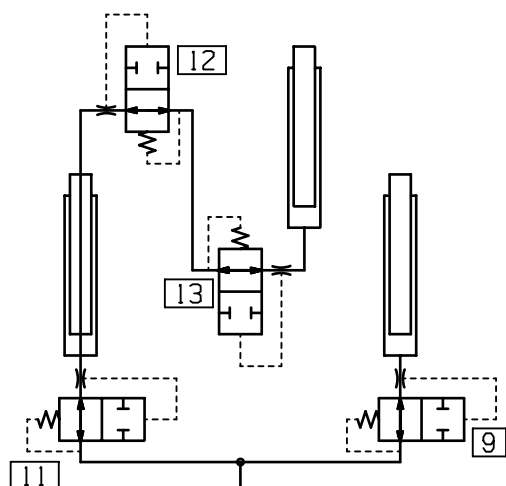
Mono Mast



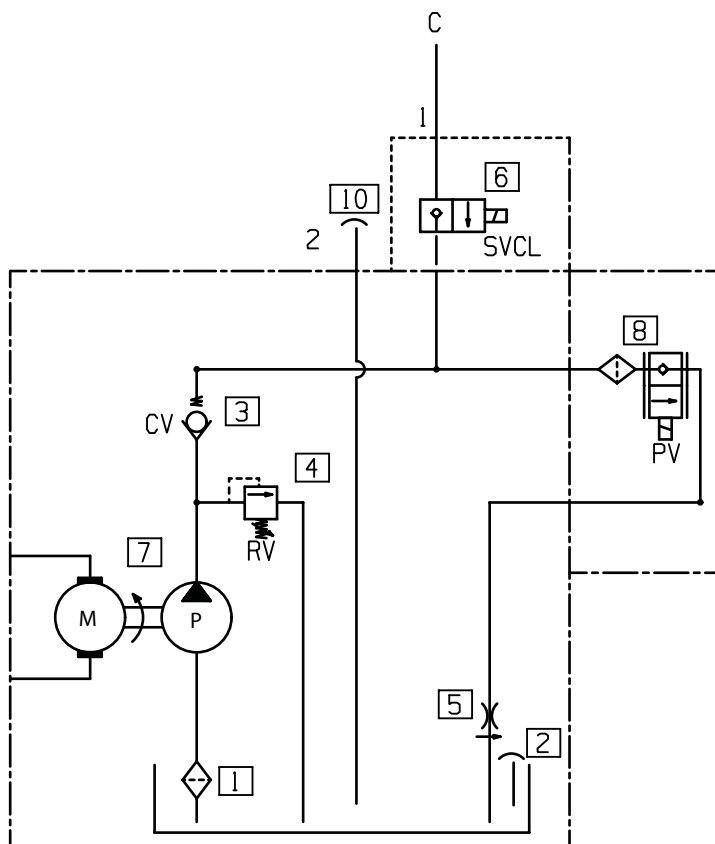
TL - Mast



TF - Mast



To Lift Cylinders



- 1 Suction Filter
- 2 Reservoir Breather
- 3 Check Valve (CV)
- 4 Relief Valve (RV)
- 5 Flow Control, Pressure Comp.
- 6 Two-Way Valve (SVCL)
- 7 Pump & Motor
- 8 Filter
- 9 Velocity Fuse (Lift Cylinder)
- 10 Add. Breather
- 11 Velocity Fuse (Lift Cylinder)
- 12 Velocity Fuse (Lift Cylinder Output)
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