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# Maintenance Manual

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**Models 9300/9400 Sideloader Lift Trucks With  
The ACR System™**



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**Models**  
9300  
9400

**Serial No.**  
00100 and Up

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## Abbreviations and Symbols

<b>Term/Symbol</b>	<b>Definition</b>	<b>Term/Symbol</b>	<b>Definition</b>
NVM	Non Volatile Memory	temp	Temperature
OACH	Over All Collapsed Height	TPA	Traction Power Amplifier
OD	Operator Display	T/S	Troubleshoot
opt.	optional		
OTM	over-the-mast	UL	Underwriters Laboratories, Inc.
PC	Power disconnect Contactor	V	Volt or Volts
PM	Pump Motor	VDC	Volts Direct Current
PME	Pump Motor Encoder	VM	Vehicle Manager
PMT	Pump Motor Temp sensor or Programmable Maintenance Tool	wrt	with respect to
pot	potentiometer	w/	with
PPA	Pump Power Amplifier		
psi	pounds per square inch	™	trademark
P/N	Part Number	©	copyright
		+	plus or positive
qty.	quantity	-	minus or negative
RPM	Revolutions Per Minute	±	plus or minus
R/R	Remove or Replace	°	degrees
RTME	Right Traction Motor Encoder	°F	degrees Fahrenheit
RTMT	Right Traction Motor Temperature sensor	°C	degrees Celsius
RTM	Right Traction Motor	%	percent
RTPA	Right Traction Power Amplifier	=	equals
SAE	Society of Automotive Engineers		
SOL	Solenoid		
S/W	software		



## Welding Safety

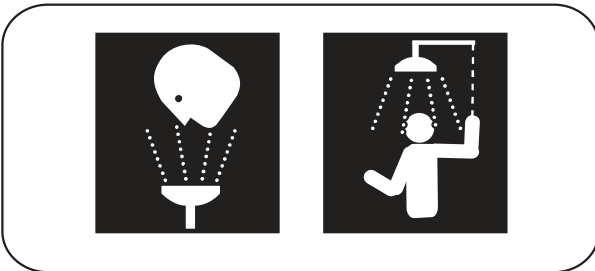
### ⚠ WARNING

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

Coating removal may be by mechanical methods, chemical methods, or a combination of methods. Perform flame cutting and/or welding operations only in well ventilated areas. Use local exhaust if necessary.

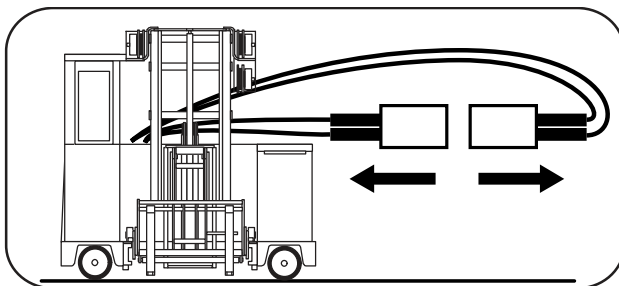
Before working on this lift truck, make sure:

- fire protection equipment is nearby
- you know the location of the nearest eyewash station.



### ⚠ CAUTION

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



### ⚠ WARNING

Before removing a power amplifier, discharge the amplifier's internal capacitor by jumpering the + and - terminals with a 100 ohm 25W resistor.

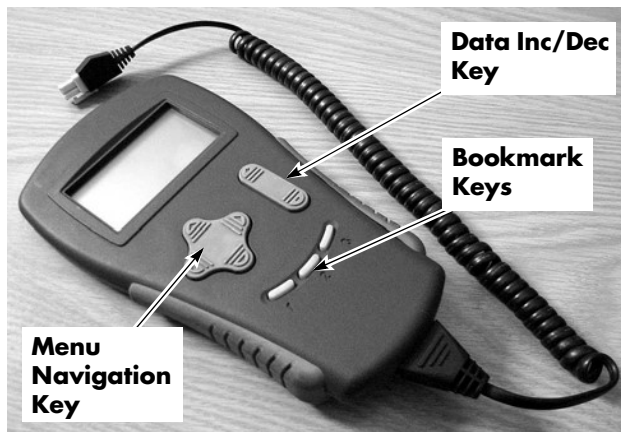
- Check for shorts to frame as described in "Shorts to Frame" on page 5-2. If you detect any shorts, correct them before you proceed with the welding operation.
- Clean the area to be welded.
- Protect all lift truck components from heat, weld spatter, and debris.
- Attach the ground cable as close to the weld area as possible.
- Disconnect all electrical circuit cards before doing any type of electric resistance welding.
- Do not perform any welding operations near the electrical components.
- If you must do welding near the battery compartment, remove the battery from the lift truck.
- When you are finished welding, re-install circuit cards and perform all ground tests and electrical inspections before operating the lift truck.

# Programmable Maintenance Tool

The Programmable Maintenance Tool (PMT) (P/N 950-185/XXX) permits you to test and diagnose the power amplifiers. See Figure 3-8.

**NOTE:** PMT S/W Version 1.39 or higher is required for correct functionality with the Raymond Model 9300/9400 Sideloaders.

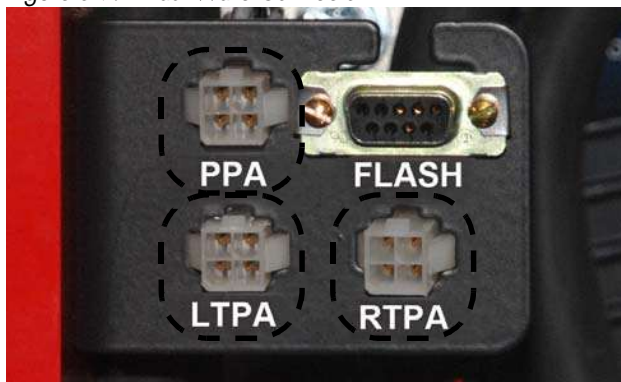
Figure 3-8. Programmable Maintenance Tool



## PMT Connection to Truck

The PMT connects to one of three connectors located on the communications connector bracket inside the electrical/hydraulic compartment. See Figure 3-9.

Figure 3-9. FlashWare Connector



**NOTE:** Some PMT functions require activation of controls in the operator compartment. An PMT extension cable can be made with the following components:

- P/N 1-012-340/002 socket - qty. 4
- P/N 1-012-430/001 pin - qty. 4
- P/N 1-012-339/002 connector - qty. 1
- P/N 1-012-429/003 connector - qty. 1

1. Turn the key switch OFF.
2. Open the electrical/hydraulic compartment door and connect the PMT to the LTPA, RTPA, or PPA connector.

**NOTE:** The PMT must be connected to the amp that receives the input or creates the output for correct readings.

3. Turn the key switch ON. Wait for the PMT to “boot up” before proceeding to the next step.
4. Use the Menu Navigation Key up and down button to scroll to the desired menu.
5. Press the right arrow on the Menu Navigation Key to enter the sub-menu.
6. Use the Menu Navigation Key up and down button arrows to scroll through the sub-menu list.
7. Use the right arrow to select and view a single variable.
8. To change the value of the parameter use the Data Inc/Dec Key. Alternately, you can press the right arrow Menu Navigation Key once more and enter the detail screen. A bar graph appears as well as minimum and maximum data points. Change the parameter value by pressing the Data Inc/Dec Key. The new value is set as soon as the Data Inc/Dec Key is released.

To close a menu, sub-menu, or detail screen, press the left arrow on the Menu Navigation Key.



## Operator Display

The Operator Display contains a Battery Discharge Indicator (BDI) bar graph and an LED alpha-numerical information window. The alpha-numerical information window can display the Battery State-of-Charge percentage, hour meter functions, fault codes, and truck parameters. The display is also equipped with four warning icons on the left and crab steer position indicators on the right. See [Figure 3-10](#).

Figure 3-10. Operator Display

### Over Temperature Indicator

### Error Code Indicator

### Crab Steer Center Indicator

### Crab Steer Left Indicator



### Not Used

### Crab Steer Right Indicator

### Battery Discharge Indicator

### Numerical Field

### Battery Charge Required Indicator

### Maintenance Required/Fault Indicator

## Hour Meter (H)

Total traction hours are displayed while the truck is traveling.

Total lift hours are displayed during lift/lower functions and aux functions.

Total deadman hours are displayed at power-up.

## Fault Codes

When a fault occurs, a three character code is displayed. Fault Codes are displayed as a single alpha character followed by 2 numeric characters. The alpha character identifies the power amplifier from which the code originated.

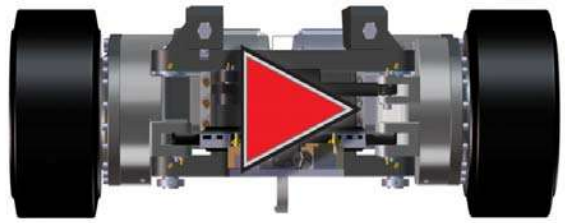
- L = Left Traction Power Amplifier
- r = Right Traction Power Amplifier
- P = Pump Power Amplifier

See "Fault Codes" on page 6-9.



# Lubrication Points

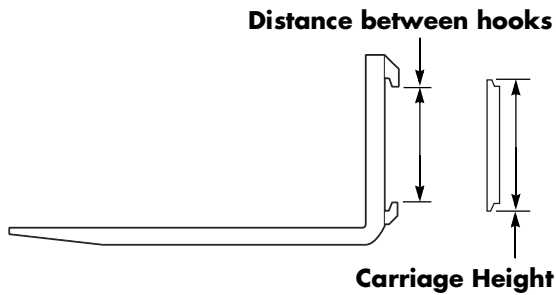
Click on arrow to launch video.





## Fork Inspection

Figure 4-9. Determining Fork Mounting Class

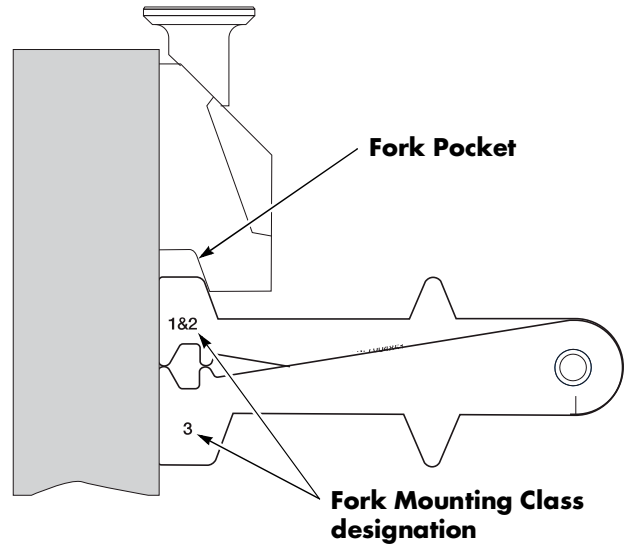


- b. Compare this measurement to the table below.

Fork Mounting Class	Distance Between Hooks in. (mm)	Carriage Height in. (mm)
1	12.05 (306)	13 (331)
2	15.04 (382)	16 (407)
3	18.78 (477)	20 (508)

3. Locate the correct extruded edge on the caliper for the fork mounting class. See [Figure 4-10](#).
4. Slide the extruded edge up into the hook pocket. See [Figure 4-10](#).
5. If the caliper's extruded edge *completely slides up into the fork pocket*, remove the fork from service. See [Figure 4-10](#).

Figure 4-10. Fork Hook Inspection

**Markings**

Make sure the fork's marking (individual load rating) is legible (typically located on side of fork). If fork marking is not legible, remove the fork from service.



## Battery Discharge Indicator Operation

## Battery Discharge Indicator Operation

The Battery Discharge Indicator (BDI) algorithm continuously calculates the Battery State-of-Charge (BSOC) when the key switch is turned ON. The result of the BDI algorithm is the Variable BDI Percentage, which is viewable in the PMT menu *Monitor >> Battery* (refer to “[Monitor Menu](#)” on page 3-10). When the key switch is turned OFF, the present BDI Percentage is stored in Non-Volatile Memory (NVM). The reset voltage level is checked only once when the key switch is first turned ON. Note that the BDI Reset Percent parameter also influences the algorithm that determines whether BDI Percentage is reset to 100%.

The parameter Reset Volts Per Cell (the voltage that must be seen to reset to 100%) should always be set higher than the parameter Full Volts Per Cell (voltage of the fully charged and stabilized battery). The full voltage level sets the key switch voltage that is considered to be 100% state-of-charge. When a battery drops below this voltage, it is considered to begin losing charge.

The parameter Empty Voltage Level sets the Key Switch Voltage that is considered to be 0% state-of-charge.

When a battery has a high BDI percentage, its float voltage when the key switch is turned ON can sometimes cause false resets. The BDI Reset Percent parameter addresses this problem by allowing the user to define a BDI Percentage value above which the BDI Percentage variable does not reset. When the key switch is first turned ON, the BDI Percentage variable will reset to 100% only if Key Switch Voltage is greater than Reset Voltage Level and BDI Percentage is less than BDI Reset Percent.

The parameter Discharge Time sets the minimum time for the BDI algorithm to count down the BDI Percentage from 100% to 0%. The BDI algorithm integrates the time the filtered key switch voltage is below the state-of-charge voltage level. When that cumulative time

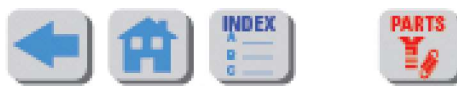
exceeds the Discharge Time/100, the BDI Percentage is decremented by one percentage point and a new state-of-charge voltage level is calculated. The recommended setting for this parameter is 160 minutes for the Model 9300 and 300 minutes for the Model 9400. This setting does not mean that the battery will only last the number of minutes that the parameter is set for. It is a number that is used in the calculations of the displayed BDI percentage. Entering a lower number decreases the number of operating hours the battery will last. Increasing the number lengthens the time.

The standard values for volts per cell parameters are as follows for flooded lead acid and sealed maintenance-free batteries. These values are set in the Programmable Parameter Menu under the Battery Menu.

Parameter	Battery Type	
	Flooded	Sealed
Reset Volts Per Cell	2.09	2.09
Full Volts Per Cell	2.04	2.04
Empty Volts Per Cell	1.88	1.90
<b>NOTE:</b> Use the standard values for your type of batteries as the starting point in setting the reset, full, and empty volts-per-cell parameters.		

### Adjusting BDI Operation

1. Fill, charge, and install a battery that is typical of the batteries normally used in this application.
2. Have a customer operator use the lift truck in normal application until cutout occurs. Allow the battery to cool and stabilize for at least two hours.
3. Before filling the battery, either take specific gravity readings for lead acid batteries or measure open circuit voltage of the battery cells for sealed batteries.
4. Compare the measurements with the battery manufacturer's recommendations for maximum discharge.
5. Adjust the Discharge Time value as needed and repeat the previous steps until battery cutout occurs at the desired discharge level.



Symptom Tables

## Symptom Tables: Hydraulic Functions

Refer to electrical and hydraulic schematics.

### Lift/Lower

#### No Lift - Pump Motor Does Not Run

Step	Action/ Meter Setting	(+) Lead	(-) Lead	Expected Results	Step Passed	Step Failed
1	Connect PMT to the PPA at the Serial Port connector (DP3) and measure PS1 input	N/A	N/A	0 to 100 and 0 to -100	Perform step 2	Check PS1 per Pinout Matrix
2	Check PS1 input	JP3-16	JP3-7	Lift: 0.80 to 1.2V Neutral: 2.4 to 2.6V Lower: 3.77 to 4.23V	Perform step 3	R/R pot
3	Check input from the Lift CutOut switch	JP3-10	JP3-7	B+	Perform step 4	R/R wires or switch
4	If configured to 0 with FlashWare, check the input from the Height Limit Switch	JP3-9			Check inputs from other optional devices	

#### No Lift - Pump Motor Does Run

Step	Action/ Meter Setting	(+) Lead	(-) Lead	Expected Results	Step Passed	Step Failed
<b>Note:</b> Make sure the Emergency Lower Valve is closed.						
1	Connect PMT to the PPA at the Serial Port connector (DP3) and measure PS1 input	N/A	N/A	0 to 100 and 0 to -100	Perform step 3	Perform step 2
2	Check PS1 input	JP3-16	JP3-7	Lift: 0.80 to 1.2V Neutral: 2.4 to 2.6V Lower: 3.77 to 4.23V	Perform step 3	R/R pot
3	If configured to 0 with FlashWare, check input from the Height Limit switch	JP3-9		B+	Perform step 4	Repair wires or switch





## Power Amplifier LED Diagnostics


Flash Code	Fault Code: Reason	Refer to...
3,1	"Code L31: TPC Contactor Open/Shorted"	Page 6-18
	"Code r31: SOL9 (Fork Tilt) Contactor Open/Shorted"	Page 6-19
	"Code P31: LPC Contactor Open/Shorted"	Page 6-19
3,2	"Code L32: SOL14 (Brake Dump) Open/Shorted"	Page 6-19
	"Code P32: SOL6 (Directional Valve) Open/Shorted"	Page 6-19
3,3	"Code L33: STR Contactor Open/Shorted"	Page 6-19
	"Code r33: SOL7 (Mast Traverse) Open/Shorted"	Page 6-20
	"Code P33: SOL10 (Mast Tilt) Open/Shorted"	Page 6-20
3,4	"Code L34: SOL13 (Crab Steer Left) Open/Shorted"	Page 6-20
	"Code P34: SOL1 (Load Hold) Open/Shorted"	Page 6-20
3,5	"Code L35: SOL12 (Crab Steer Right) Open/Shorted"	Page 6-20
	"Code r35: SOL4 (Lift/Aux) Open/Shorted"	Page 6-21
	"Code P35: SOL2 (Proportional Lower) Open/Shorted"	Page 6-21
3,6	"Code r36: RTME Bad"	page 6-21
	"Code r36: RTME Bad"	Page 6-21
	"Code P36: PME Bad"	Page 6-21
3,7	"Code L37: LTM Phase Detected Open"	Page 6-22
	"Code r37: RTM Phase Detected Open"	Page 6-22
	"Code P37: PM Phase Detected Open"	Page 6-22
3,8	"Code L38: TPC Contactor Welded"	Page 6-22
	"Code P38: LPC Contactor Welded"	Page 6-22
3,9	"Code L39: TPC Contactor Did Not Close"	Page 6-23
	"Code P39: LPC Contactor Did Not Close"	Page 6-23
4,1	"Code L41: Traction Pot (VR1) Voltage Too High"	Page 6-23
	"Code r41: Fork Tilt/Reach Pot Voltage Too High"	Page 6-23
	"Code P41: Lift/Lower Pot Voltage Too High"	Page 6-24
4,2	"Code L42: Traction Pot (VR1) Voltage Too Low"	Page 6-24
	"Code r42: Fork Tilt/Reach Pot Voltage Too Low"	Page 6-24
	"Code P42: Lift/Lower Pot Voltage Too Low"	Page 6-25
4,3	"Code r43: Steer Pot Voltage Too High"	Page 6-25
	"Code P43: Mast Traverse/Tilt Pot Voltage Too High"	Page 6-25
4,4	"Code r44: Steer Pot Voltage Too Low"	Page 6-26
	"Code P44: Mast Traverse/Tilt Pot Voltage Too Low"	Page 6-26
4,5	"Code r45: Brake Pot Low"	Page 6-26
4,6	"Code L46: LTPA EEPROM Failure"	Page 6-26
	"Code r46: RTPA EEPROM Failure"	Page 6-27
	"Code P46: PPA EEPROM Failure"	Page 6-27
4,7	"Code L47: High Pedal Disable or Sequencing Fault"	Page 6-27
	"Code r47: High Pedal Disable or Sequencing Fault"	Page 6-27
	"Code P47: PPA High Pedal Disable or Sequencing Fault"	Page 6-28
4,9	"Code L49: Parameter Change Fault"	Page 6-28
	"Code P49: Parameter Change Fault"	Page 6-28
5,1	"Code L51: LTPA CAN Communications Fault"	Page 6-28
5,2	"Code L52: LTPA PDO Fault Traction Slave"	Page 6-29
5,3	"Code L53: LTPA PDO Fault Pump"	Page 6-29
5,4	"Code P54: Lift/Lower Pot Out-of-Range"	Page 6-30
5,5	"Code P55: Mast Traverse/Tilt Pot Out-of-Range"	Page 6-30
5,6	"Code r56: Fork Tilt/Reach Pot Out-of-Range"	Page 6-30




## Fault Codes

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: r22</b>		
	<p><b>Code r22: RTPA Overtemp Cutback</b></p> <p>RTPA internal heatsink temperature is above 185°F/85°C. Operation in extreme hot environment, excessive load on truck, or incorrect TPA installation.</p>	<p>Use an accurate temperature measuring device (or PMT) to verify temperature reading. If temperature is within operating range, replace the RTPA. If temperature is above 185°F/85°C, refer to Slow Travel <a href="#">“Symptom Tables: Travel Functions”</a> on page 5-18.</p>

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: P22</b>		
	<p><b>Code P22: PPA Overtemp Cutback</b></p> <p>PPA internal heatsink temperature is above 185°F/85°C. Operation in extreme hot environment, excessive load on truck, or incorrect TPA installation.</p>	<p>Use an accurate temperature measuring device (or PMT) to verify temperature reading. If motor is hot, allow motor to cool. Check mast for binding. If motor is not hot, check resistance of temp sensor (PMT) at JP12-1 and 2. Resistance should be between 550 and 600 ohms at room temp. If not, replace PMT. If OK, check wiring back to PPA. If OK, replace PPA.</p>

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: L23</b>		
	<p><b>Code L23: LTPA Battery Undervoltage Cutback</b></p> <p>LTPA senses battery voltage &lt;33.6V. Battery discharged or excessive load on battery.</p>	<p>Cycle key switch to clear. If code does not clear, measure B+ at the LTPA and specific gravity of battery. Replace battery with fully charged battery if necessary. Check for shorted devices connected to B+ cable (for example: RF Unit or Scanner). Check battery connector.</p>

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: r23</b>		
	<p><b>Code r23: RTPA Battery Undervoltage Cutback</b></p> <p>RTPA senses battery voltage &lt;33.6V. Battery discharged or excessive load on battery.</p>	<p>Cycle key switch to clear. If code does not clear, measure B+ at the RTPA and specific gravity of battery. Replace battery with fully charged battery if necessary. Check for shorted devices connected to B+ cable (for example: RF Unit or Scanner). Check battery connector.</p>



## Fault Codes

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: P41</b>		
	<b>Code P41: Lift/Lower Pot Voltage Too High</b> Voltage at JP3-16 is >4.5V.	Check continuity of wires between the PPA and PS1. Measure approximately 5V between PS1-5 and B-. If not, measure approximately 5V between JP3-26 and B-. If not, replace PPA. Measure approximately 48V between PS1-4 and B+. If not, measure approximately 48V between JP3-7 and B+. If not, replace PPA. Measure approximately 2.5V between PS1-3 and B- in neutral position. If not, replace PS1. If correct, measure 2.5V at JP3-16. If not, check wire from PPA to PS1. If voltage at JP3-16 is correct, replace PPA.

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: L42</b>		
	<b>Code L42: Traction Pot (VR1) Voltage Too Low</b> Voltage at JP1-16 is <0.5V.	Check continuity of wires between the LTPA and VR1. Measure approximately 5V between VR1-5 and B-. If not, measure approximately 5V between JP1-26 and B-. If not, replace LTPA. Measure approximately 48V between VR1-4 and B+. If not, measure approximately 48V between JP1-7 and B+. If not, replace LTPA. Measure approximately 1.2V between VR1-3 and B- in neutral position. If not, replace VR1. If correct, measure 1.2V at JP1-16. If not, check wire from LTPA to VR1. If voltage at JP1-16 is correct, replace LTPA.

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: r42</b>		
	<b>Code r42: Fork Tilt/Reach Pot Voltage Too Low</b> Voltage at JP2-16 is <0.5V.	Check continuity of wires between the RTPA and PS3. Measure approximately 5V between PS3-5 and B-. If not, measure approximately 5V between JP2-26 and B-. If not, replace RTPA. Measure approximately 48V between PS3-4 and B+. If not, measure approximately 48V between JP2-7 and B+. If not, replace RTPA. Measure approximately 2.5V between PS3-3 and B- in neutral position. If not, replace PS3. If correct, measure 2.4 to 2.6V at JP2-16. If not, check wire from RTPA to PS3. If voltage at JP2-16 is correct, replace RTPA.



## Fault Codes

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: P69</b>		
	<p><b>Code P69: PPA Power Supply Load Out-of-Range</b></p> <p>Internal supply current out-of-range (+12V, +5V). Devices connected to these outputs on the PPA are drawing too much or too little current.</p>	Cycle key switch to clear. If not cleared, check for opens or shorts in wiring harness from JP3-25 and JP3-26.

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: L71</b>		
	<p><b>Code L71: LTPA OS General Fault</b></p> <p>LTPA internal fault.</p>	Cycle key switch to clear. Replace LTPA if code continues.

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: r71</b>		
	<p><b>Code r71: RTPA OS General Fault</b></p> <p>RTPA internal fault.</p>	Cycle key switch to clear. Replace RTPA if code continues.

Icon	Code Title/Reason	Notes/Corrective Action
<b>Message Displayed: P71</b>		
	<p><b>Code P71: PPA OS General Fault</b></p> <p>PPA internal fault.</p>	Cycle key switch to clear. Replace PPA if code continues.



## List of Component Procedures

**List of Component Procedures**

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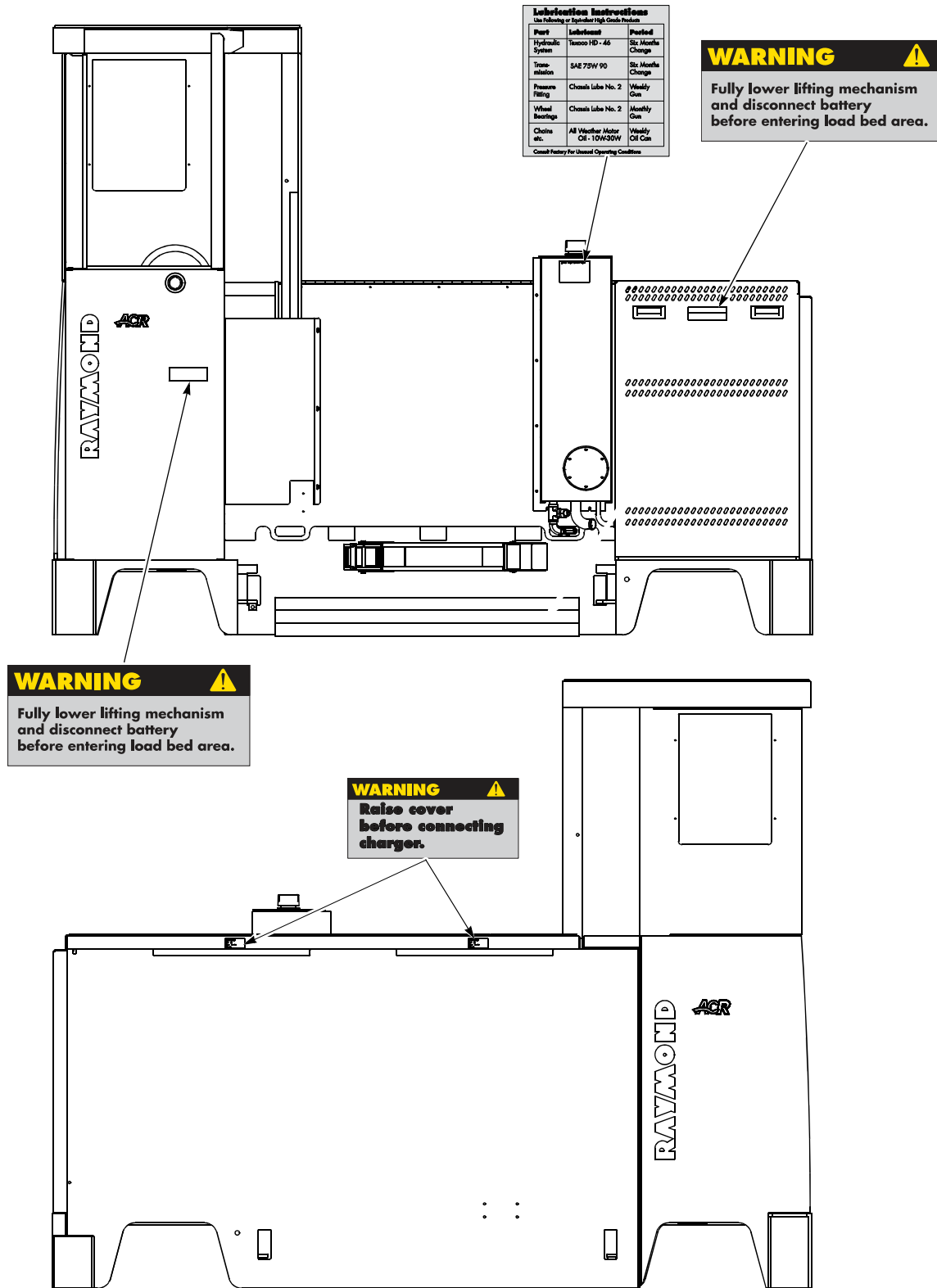
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Figure 7-10. Decal Locations





## Steer Feedback Pot Belt Installation

1. Install the **belt** on the pulleys and adjust just tight enough to keep it on the pulleys.
2. Rotate the steering fully left and fully right stopping every couple of inches and check belt tension to find the tightest and loosest positions.
3. At the tightest location, adjust the belt to have approximately 0.06 in. (1.5 mm) deflection when pushed by hand. Return the steering to the location where the belt was the loosest and check deflection. It should be between 0.06 and 0.18 in. (1.5 and 4.5 mm).
4. Set load-bed width and Steer Feedback Pot voltages. Refer to [page 3-18](#).



## Drive Wheel Removal/Installation

### Removal

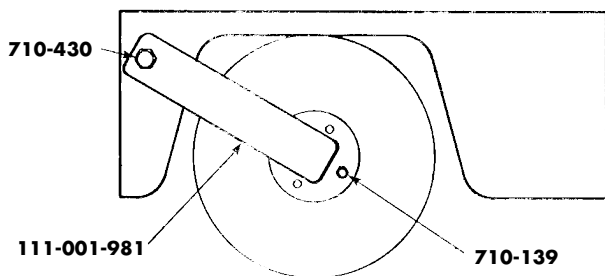
1. Turn the key switch OFF, lift the battery cover and disconnect the battery connector.

### **⚠ WARNING**

**Use extreme care when the lift truck is jacked up. Never block the lift truck between the telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from vehicle while jacking the lift truck. After the lift truck is jacked, install solid blocks or jack stands beneath it to support it. Do NOT rely on the jack alone to support the lift truck. See "Jacking Safety" on page 2-8.**

2. Jack and block the drive end of the truck so the wheels are approximately 1/4 in. (6.35 mm) off the floor.
3. Attach special wrench (P/N 111-001-981) to the wheel nut with a 3/8-16 x 1.5 in. screw (P/N 710-139) and to the chassis with a 3/4-16 x 2.75 in. screw (P/N 710-430). See Figure 7-27.

Figure 7-27. Drive Wheel Removal



4. Reconnect the battery connector and turn the key switch ON.
5. With the deadman pedal depressed, activate the directional speed control handle in the direction that loosens the nut.

6. Turn the key switch OFF, lift the battery cover and disconnect the battery connector. Remove the nut.
7. Attach a wheel puller to the 1/2-20 holes in the wheel hub and pull the wheel assembly.
8. If the **tire** needs to be replaced, see "Tire Pressing" on page 7-33.
9. Examine and replace any bearings showing signs of wear. Repack the bearings with grease. See "Lubrication Specification Chart" on page A-2.

### Installation

1. Mount the wheel on the drive shaft and hand tighten the wheel nut.
2. Attach the special wrench, as in Step 3 of the removal instructions.
3. Reconnect the battery connector and turn the key switch ON.
4. Depress the deadman pedal and activate the control handle in the direction that tightens the nut. Apply full stall torque of the traction motor for 0.5 to 1.0 second. Remove the wrench.
5. Turn the key switch OFF, lift the battery cover and disconnect the battery connector.
6. Mark an indication point on the wheel and perform the torquing procedure after 8 hours, 1 week, 1 month, and 6 months of operation.



## Battery Procedures

### CAUTION

**Before working on the battery, review "Battery Safety" on page 2-5. Batteries for this lift truck weigh between 2900 and 3700 lb. (1317 to 1680 kg). Use extreme care during replacement. Use a suitable battery moving device or hoist for lifting. DO NOT extend a battery more than 1/3 of its length outside the battery compartment without being attached to a battery-moving device.**

## Battery Connector/Cables

### Inspection

1. Turn the key switch OFF and disconnect the battery connector.
2. Check the battery connector for damaged cables.
3. Check to see if battery cables are pulling out of the connector.
4. Check the cables at the battery terminals. Connections should be tight, with no corrosion.
5. Look inside the connector. Check all internal contacts for damage, dirt, or corrosion. Do not use a metal object to clean the connector.

**NOTE:** Some degreasers and parts cleaners cause the connector shell to disintegrate. Avoid contacting battery connectors with solvents.

## Removal, Replacement, and Installation

The cables to either half of the connector have a lip on their forward end. This lip snaps over a spring-loaded retainer that is part of the connector.

**NOTE:** When replacing battery cable ends, remove only one end at a time from the connector, to avoid the cable ends touching and causing a short circuit.

DO NOT allow the metal cable end to touch the battery. Use insulated tools and avoid contact with battery case or cable ends.

1. To remove a cable from the connector, push the retainer down while pulling the battery cable towards the rear and out of the connector. See Figure 7-33 and Figure 7-34.

Figure 7-33. Battery Cable and Connector



Figure 7-34. Battery Cable Removal from Connector



2. Do not attempt to repair battery cables by crimping new terminals. Replace the cable.

## Battery Exterior Cleaning

1. Read, understand, and follow procedures, recommendations and specifications in the



## Power Amplifiers

### **WARNING**

**The power amplifiers self-discharge at key OFF. Wait at least one full minute after key OFF before applying any tools to wired circuits.**

After replacing any **power amplifier**, verify that the software in all three amplifiers is the same version.

After replacing the Left Traction Power Amplifier (LTPA - Master), perform the following:

- Learn Traction Pot - refer to page [3-17](#).
- Set Steer Feedback Pot Voltages - refer to page [3-18](#).
- Set Load-Bed Width - refer to page [3-18](#).

# Manifolds

## Main Manifold

The main manifold, located in the electrical/hydraulic compartment, controls all lift/lower and aux functions.

Figure 7-55. Main Manifold (1 of 3)

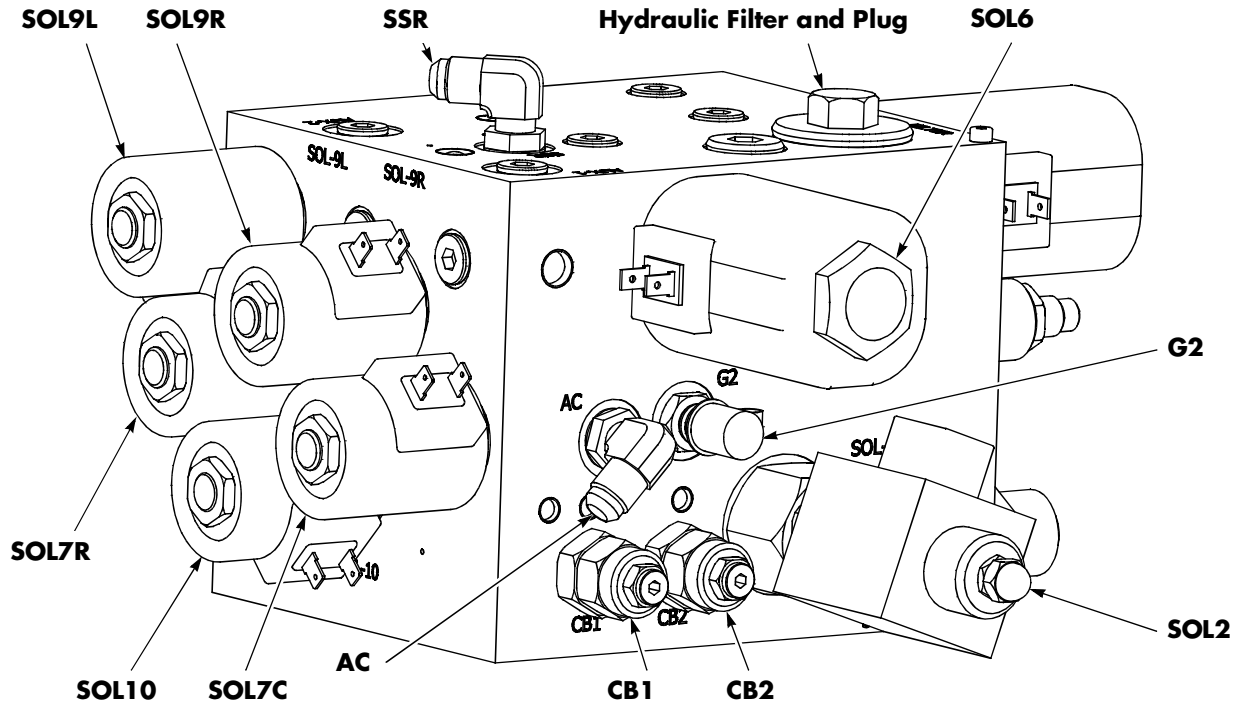
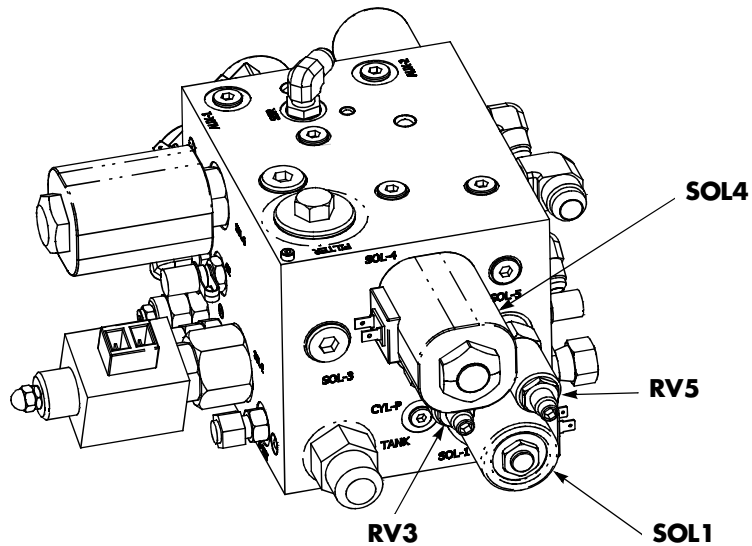


Figure 7-56. Main Manifold (2 of 3)





## Lift Cylinder Bleeding

Bleed the lift cylinders when lift truck operation indicates that air has entered the system.

1. Raise the carriage approximately 6 in. (152.4 mm). Loosen the bleed screw on top of the cylinder.

**NOTE:** Loosen the bleed screw only enough to permit air to escape.

2. When only oil flows from the cylinder, tighten the bleed screw.

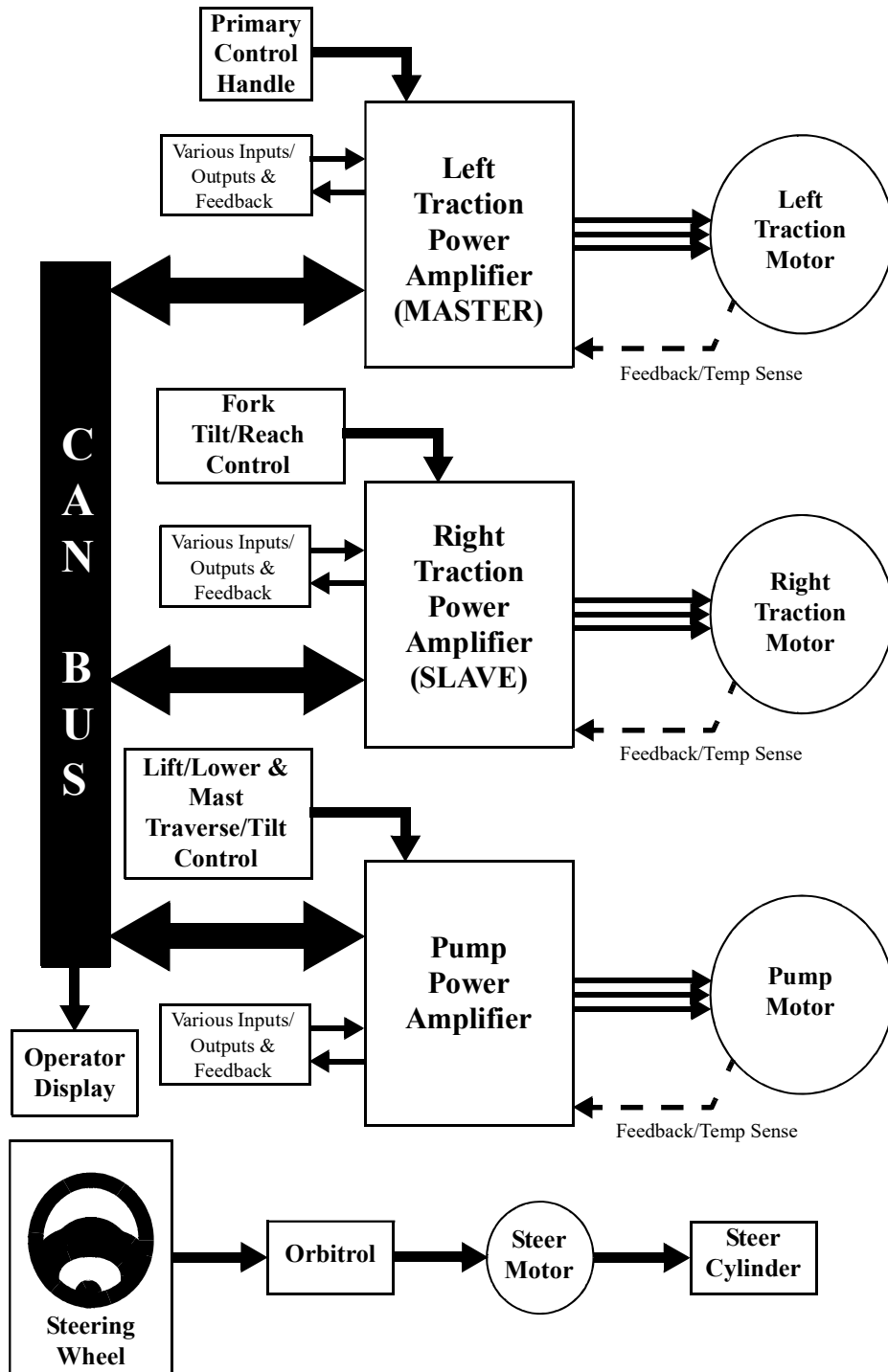
System Architecture

# System Architecture

Area Network (CAN) Bus. The Operator Display receives information via the CAN Bus. See [Figure 8-1](#).

Two traction power amplifiers and a pump power amplifier communicate via a Control

Figure 8-1. System Architecture Diagram





## Functional Operation

## Functional Operation

At Start-up, the following is performed by the LTPA, RTPA, and PPA:

- Communications are verified at start up or CAN Bus time-out error codes occur.
- Display Comm verified and Display LED are flashed for visual check. There is no code if a segment of the display does not work, Operator must verify visually.
- Software Version Number Compare – all amps must have the same software version numbers or Software Mismatch error code 52 occurs. Truck does not function.
- Check Hour Meters – in the case an amplifier is replaced or swapped from another truck, hour meters are compared and changed if inconsistencies are found.
- Anti-Tie Down test occurs at start and prevents truck functions if the Lift/Lower Bypass switch (S24) is stuck in the closed position (Error Code 61 is displayed).
- On-Deadman at Start-up conditions are tested and SRO fault is displayed if condition occurs (Error Code 58 is displayed).

## Emergency Power Off

The Power Contactor (PC) coil is powered through FU5, the Key Switch (S1), and the EPO (S21). The Ground side goes through FU6 and TP4. Depressing the EPO directly removes B+ from the PC coil on the Contactor Panel. With B+ to the coil interrupted, all power is removed to the Amplifiers and the Steer Motor.

## Current Sensing

The LTPA and RTPA monitor traction motor current internally. If current exceeds 450A, current limit is activated and voltage to the traction motor that has exceeded the current limit is reduced by the respective amplifier to maintain current at 450A, preventing damage to the system.

The PPA monitors pump motor current internally. If current exceeds 650A, current limit is activated and voltage to the pump motor is reduced by the amplifier to maintain current at 650A, preventing damage to the system.

## Temperature Sensing

The PPA monitors its internal heat sink temperature sensor and Pump Motor temperature sensor. At 185°F (85°C), the PPA goes into thermal limiting. At 203°F (95°C), the PPA shuts down.

Pump motor temperature limit (start current limit): 293°F (145°C)

Pump motor temperature Max. (Stop lift & aux): 320°F (160°C)

The RTPA and LTPA monitor their internal heat sink temperature sensors and respective Traction Motor temperature sensors. At 185°F (85°C), the TPA goes into thermal limiting. At 203°F (95°C), the TPA shuts down.

Traction Motor - At 293°F (145°C), the TPA linearly reduces travel speed. At 320°F (160°C), the TPA limits travel to 1.0 mph.

## Hydraulic Components

### Main Hydraulic Manifold

The main hydraulic manifold, located in the electrical/hydraulic compartment, controls lift, lower, and aux functions. The following components are installed on the manifold:

- RV3 (Lift Relief Valve) - Adjustable pressure relief valve to port oil back to the reservoir if pressure in the lift system exceeds the setting of the valve to prevent component damage.
- RV5 (Aux Relief Valve) - Adjustable pressure relief valve to port oil back to the reservoir if pressure in the aux system exceeds the setting of the valve to prevent component damage.



Pinout Matrix

Item	Connector	Functional Description	Theory of Operation	Normal Level	Signal Source	Signal User
61	JP3-8	Analog 2	Input to the PPA from the Pump Motor Temp sensor (PMT). At 293°F (145°C), the amp begins to reduce lift speed. At 320°F (160°C), lift is not allowed.	Approx. 1.22V and between 550-600 ohms @ room temp	PMT	PPA
62	JP3-9	Height Limit	Input to the PPA from the Height Limit switch (S40). The amp reduces lift speed by the value set in FlashWare (0 to 50%) when the switch opens.	Switch open: 0V Closed: B+	S40	PPA
63	JP3-10	Lift Cutout	Input to the PPA from the optional Lift Cutout switch (S41A). The amp disables lift when the switch opens.	Switch open: 0V Closed: B+	S41A	PPA
64	JP3-11	1/4 Speed Limit	Input to the PPA from the 1/4 Speed Limit switch (S45). The amp limits travel speed to 1/4 of full speed when the switch opens.	Switch open: 0V Closed: B+	S45	PPA
65	JP3-12	Mast Tilt	Input to the PPA from the Mast Tilt switch (S23). When the switch is closed and the Mast Traverse/Tilt pot (PS2) is moved, the amp energizes the mast tilt solenoid (SOL10) and directional valve solenoid (SOL6).	Switch open: 0V Closed: B+	S23	PPA
66	JP3-13	Coil Return (B+)	B+ supply from the PPA to the Lift Pump Contactor (LPC) and the solenoid coils.	B+	PPA	LPC, SOL6, SOL10, SOL1, SOL2
67	JP3-16	Lift/Lower	Input to the PPA from the Lift/Lower pot (PS1).	Full lower: 0.94 to 1.2V Neutral: 2.4 to 2.6V Full lift: 3.77 to 4.23V	PS1	PPA
68	JP3-17	Mast Traverse/Tilt	Input to the PPA from the Mast Traverse/Tilt pot (PS2).	Traverse back: 0.94 to 1.2V Neutral: 2.4 to 2.6V Traverse forward: 3.77 to 4.23V	PS2	PPA
69	JP3-19	Lower Cutout	Input to the PPA from the Lower Cutout switch (S41B). The amp disables lower when the switch opens.	Switch open: 0V Closed: B+	S41B	PPA
70	JP3-21	CAN Term H	CAN BUS termination jumper. Reduces the effect of noise interfering with communication between the amps and display. If missing, intermittent communication codes may be displayed.	N/A	LTPA, RTPA, PPA, OD	LTPA, RTPA, PPA, OD



## Decimal Equivalent Chart

**Decimal Equivalent Chart**

4ths	8ths	16ths	32nds	64ths	To 3 Places	To 2 Places	MM Equivalent
				1/64	.016	.02	0.397
			1/32	3/64	.031	.03	0.794
				5/64	.047	.05	1.191
		1/16		7/64	.062	.06	1.587
				9/64	.078	.08	1.984
			3/32	11/64	.094	.09	2.381
				13/64	.109	.11	2.778
	1/8			15/64	.125	.12	3.175
				17/64	.141	.14	3.572
			5/32	19/64	.156	.16	3.969
				21/64	.172	.17	4.366
		3/16		23/64	.188	.19	4.762
				25/64	.203	.20	5.159
			7/32	27/64	.219	.22	5.556
				29/64	.234	.23	5.593
1/4				31/64	.250	.25	6.350
				33/64	.266	.27	6.747
			9/32	35/64	.281	.28	7.144
				37/64	.297	.30	7.540
		5/16		39/64	.312	.31	7.937
				41/64	.328	.33	8.334
			11/32	43/64	.344	.34	8.731
				45/64	.359	.36	9.128
	3/8			47/64	.375	.38	9.525
				49/64	.391	.39	9.922
			13/32	51/64	.406	.41	10.319
				53/64	.422	.42	10.716
		7/16		55/64	.438	.44	11.112
				57/64	.453	.45	11.509
			15/32	59/64	.469	.47	11.906
				61/64	.484	.48	12.303
1/2				63/64	.499	.50	12.700



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# RAYMOND SERVICE INFORMATION

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Greene, New York 13778-0130



**RSI MUL-18-002**  
**March 9, 2018**

**Model(s)**  
**FlashWare**

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**SUBJECT:** FlashWare 7.8 Functionality and Enhancements

**GENERAL INFORMATION:** Highlights of FlashWare 7.8

1. New OPR Carriage Control Card P/N 1275051/001 load/upload functionality.
2. New Guidance Manager P/N 1268588/001 support.
3. Correct "Flash Erase Error" message when trying to connect to a VM with a Boot Block version of 1.0.
4. New Windows 10 compatible Drivers for Silver Box P/N 230489-001 USB/CAN Interface Module.

**SERVICE INFORMATION:** Download the current version from the Raymond Portal.

1. There are two separate selections:
  - "FlashWare Application Package" includes FlashWare and all truck files.
  - "FlashWare Application" includes the FlashWare application only.
2. The user will have the ability to select "Run" or "Save."
  - Choose "Run" to automatically extract the file into the C:\Download folder.
  - Choose "Save" to launch the application at a later time.
3. After the version downloads, launch the self-extracting Zip file. This will install the files into the C:\Download folder. Open the Readme.txt file located in the C:\Download folder and follow the instructions.

Customers must contact their local Raymond Sales and Service Center to obtain the current FlashWare version.

**PARTS AVAILABILITY:** Now available through the Parts Distribution Center.

**FILING INSTRUCTIONS:** File this notice in the Appendix of all applicable maintenance manuals.



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# RAYMOND SERVICE INFORMATION

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Greene, New York 13778-0130



**RSI MUL-15-010**  
**November 17, 2015**

**Models**  
**Multi Product**

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**SUBJECT:** Fork Eye Wear Inspection

**GENERAL INFORMATION:** The fork inspection procedures do not have information for checking wear of fork eyes. This information should be used to inspect forks on trucks that use a fork bar inserted through a round fork eye to connect the forks to the carriage.

**SERVICE INFORMATION:**

**Inspection Procedures**

1. Measure the length of the fork blade. Multiply the length of the fork blade by 0.04. Example if you are checking a 42 in. fork;  $42 \times 0.04 = 1.68$  (1 11/16 in.). This is the maximum allowable deflection at the tip of the fork, in either direction horizontally.
2. Move both forks 2 in. inward from the carriage on the fork bar so the carriage does not interfere with fork movement.
3. Measure the distance between the inside edges of the forks at the tips.
4. Without moving the fork eye, push the right fork tip inward as far as possible.
5. Measure the distance between the inside edges of the forks at the same locations used in step 3.
6. Compare the measurement to the maximum allowable deflection calculated in step 1.
7. Verify the measurement taken in step 3 is still the same. Without moving the fork eye, pull the right fork tip outward as far as possible.
8. Measure the distance between the inside edges of the forks at the same locations used in step 3.
9. Compare the measurement to the maximum allowable deflection calculated in step 1.

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