4.12 UPRIGHT MONITORING SYSTEM (UMS)

The UMS provides a visual and audible warning to the operator when the limits of the upright assembly alignment have been reached. In addition, the UMS will not allow the tower boom to be lowered when the upright assembly is misaligned in a direction oriented away from the work platform.

Re-Synchronizing Upright

A pull type control valve allows the operator to adjust the upright level cylinder if the upright is not 90° (vertical) relative to the chassis (Refer to Figure 4-16.). This valve is located in the tank compartment area.

Referencing the corrective action listed on decal 1001096141 located on the oil tank, perform the following steps with the aid of an assistant:

1. Turn the key switch to the ground control position.
2. Start the engine.
3. Pull and hold the red relevel knob located next to the main control valve. Refer to Figure 4-16.
4. Raise the tower boom 6 feet (1.8 m).
5. Release the red relevel knob.
6. Lower the tower boom fully and continue to hold down the switch to Tower Down for an additional 20 seconds.
7. Repeat steps 3 thru 6 if necessary until the upright is 90° (vertical) relative to the chassis.

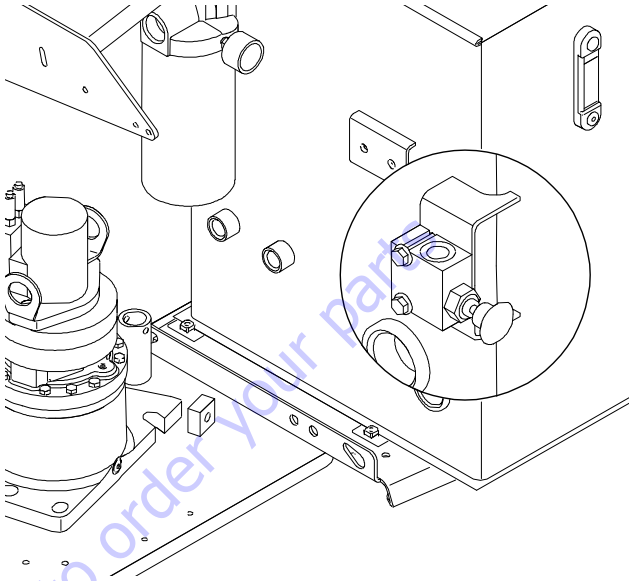


Figure 4-16. Releveling Valve

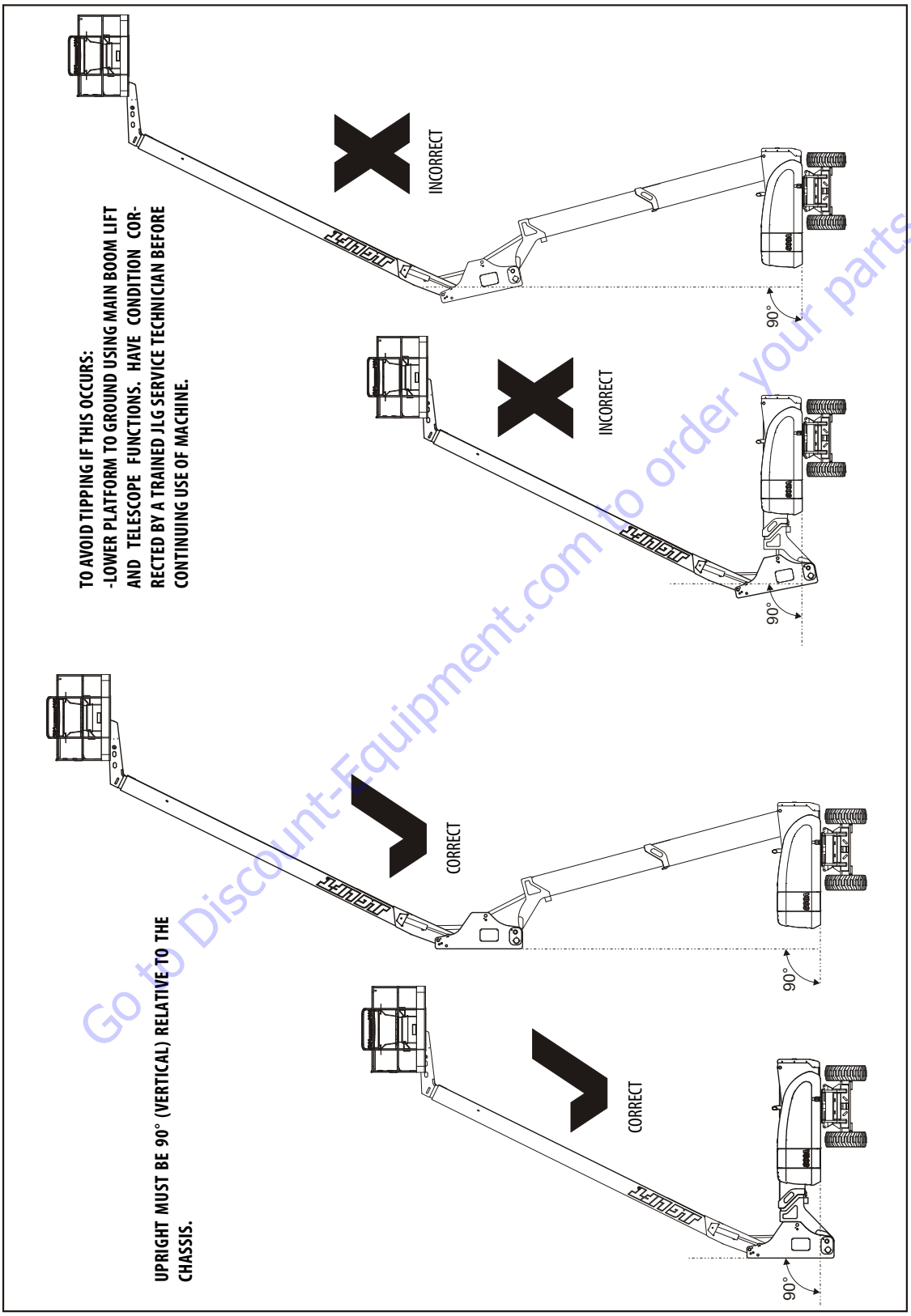


Figure 4-17. Boom Upright Positioning

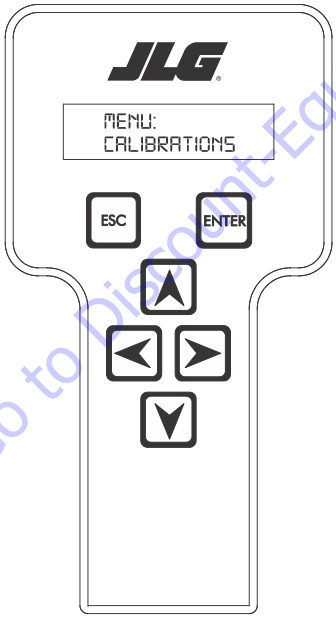
Calibration

1. Connect the JLG Hand-held analyzer to the original analyzer connection in the ground box.

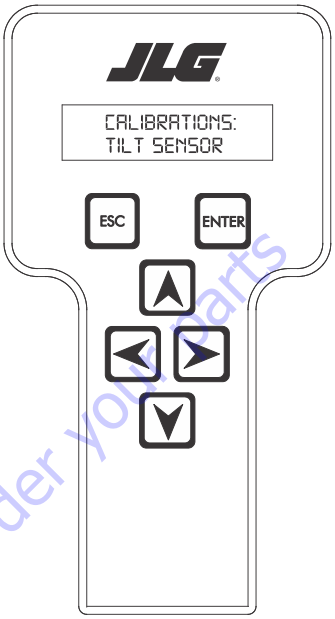
NOTICE

DO NOT CONNECT TO THE ANALYZER CONNECTION PORT INSTALLED WITH THE UPRIGHT MONITORING SYSTEM MODULE.

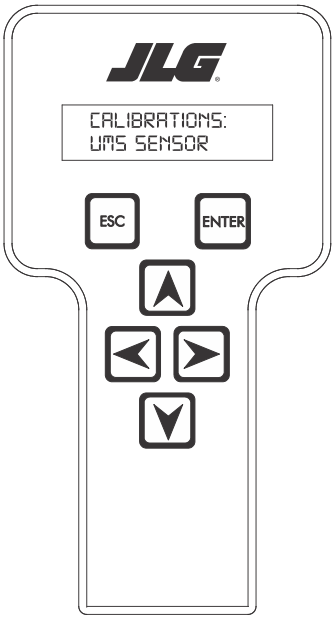
2. Pull out the emergency stop button at the ground control station and start the engine from the ground controls.
3. To calibrate the Upright Monitoring System through the hand-held analyzer, you must be in access level 1. To advance to access level 1, scroll to the ACCESS LEVEL menu and press "ENTER" (ENTER). Using the arrows on the keypad, enter the password "33271" and press "ENTER" (ENTER).
4. Calibrate the upright monitoring system sensor by the following procedure:
   a. In access level 1, scroll through the menu items until "CALIBRATIONS" is displayed on the second line of the analyzer screen. The screen will display the following:



   b. After pressing 'ENTER" one of the following screens will be displayed:



Or

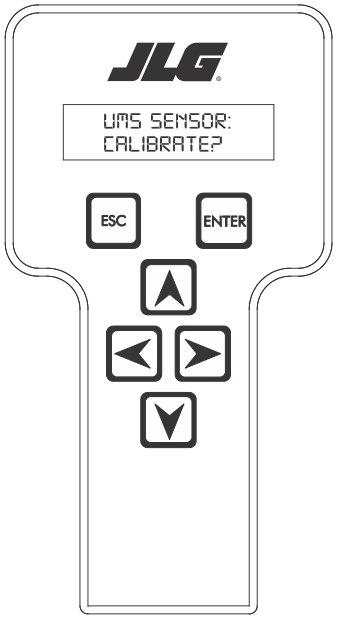


   c. Scroll left to right through the above menu items until "UMS SENSOR" sub menu appears on the bottom line of the analyzer display. Press the "ENTER" (ENTER) key.

NOTICE

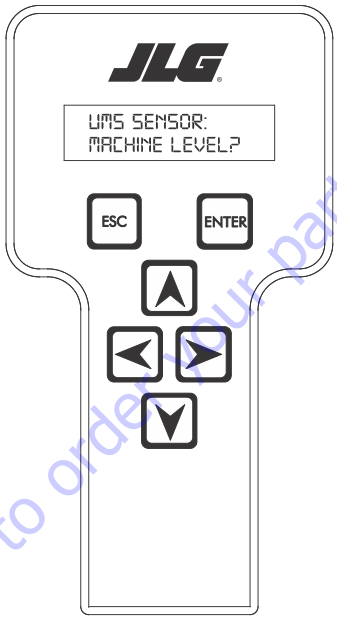
IT IS NOT NECESSARY TO CALIBRATE THE TILT SENSOR IN THE GROUND CONTROL MODULE AT THIS TIME. HOWEVER, WHEN THE TILT SENSOR IN THE GROUND CONTROL MODULE IS RECALIBRATED, THE UPRIGHT MONITORING SYSTEM TILT SENSOR MUST BE RECALIBRATED AS WELL.

d. After selecting "UMS SENSOR", the following screen will appear:



NOTE: *By pressing the left or right arrow keys in this screen, you may view the output of the sensor.*

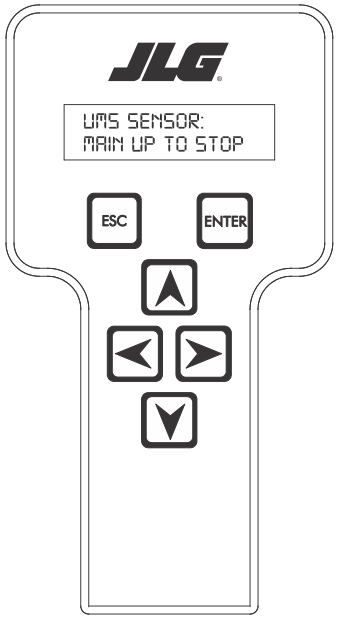
e. Press "ENTER" (ENTER) and the next screen will display the following, asking if the machine is on a level surface:



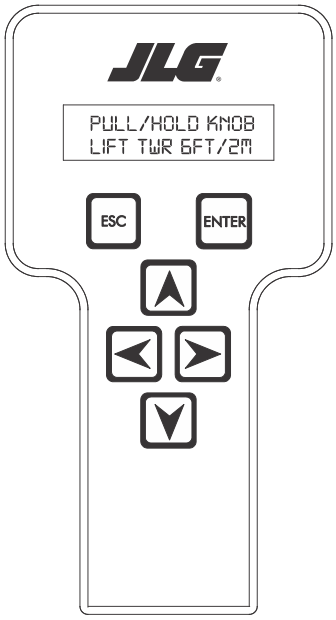
NOTICE

THE MACHINE MUST BE LEVEL FOR PROPER CALIBRATION.

f. Verify the machine is level and press "ENTER" (ENTER). The screen will display the following, asking you to fully elevate the main boom:



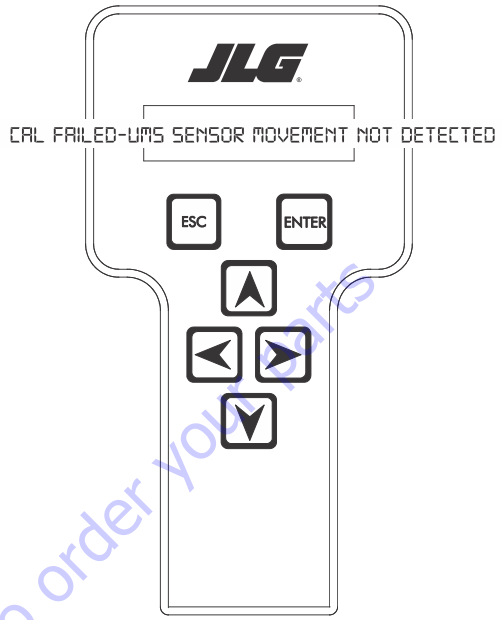
g. After the main boom has been fully elevated, press "ENTER" (ENTER). The analyzer will display the following:



NOTE: *By pressing the left or right arrows in this screen, you may view the output of each sensor.*

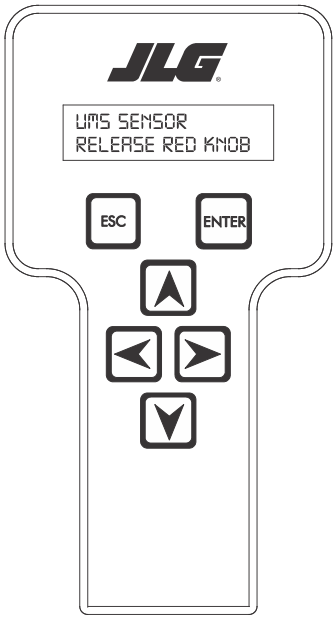
h. With the aid of an assistant, pull and hold the red re-leveling knob on the hydraulic tank while lifting the tower boom. Raise the tower boom six (6) feet or two (2) meters. After elevating the tower the required distance, press "ENTER" (ENTER).

If the upright monitoring system did not detect adequate sensor activity, the screen will display:

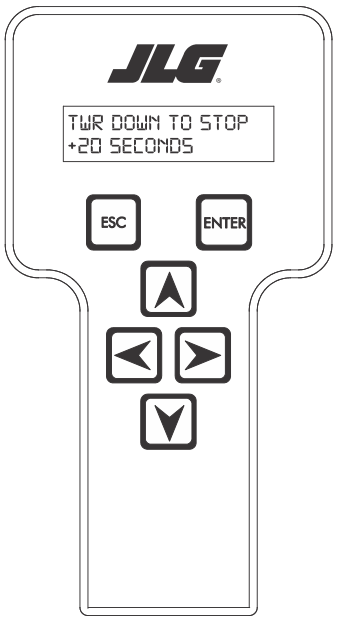


Should you get the above message, verify that the sensor is installed correctly and verify the sensor connection to the sensor harness is secure. Also, ensure the red knob is held fully open for the required time.

If the calibration is executing properly, you shall see the following display:

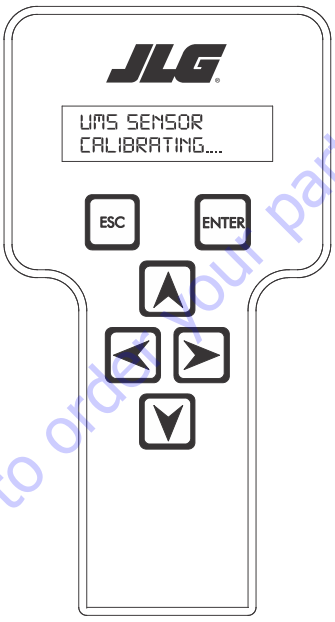


i. When viewing the above display, press "ENTER" (ENTER). The screen will display the following:

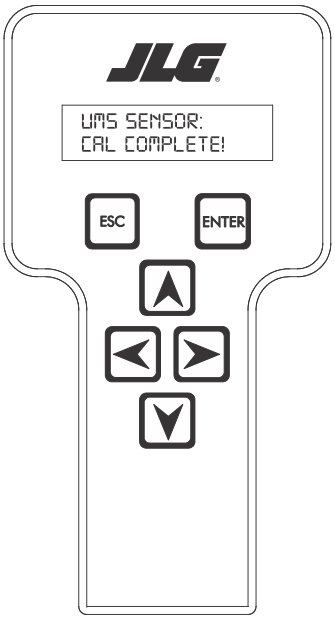


j. Lower the tower boom onto the boom stop. Continue to hold the tower boom down function for at least twenty (20) seconds **WITHOUT RELEASING THE FUNCTION SWITCH**. The calibration must recognize continuous activation of the tower down function switch for the required time.

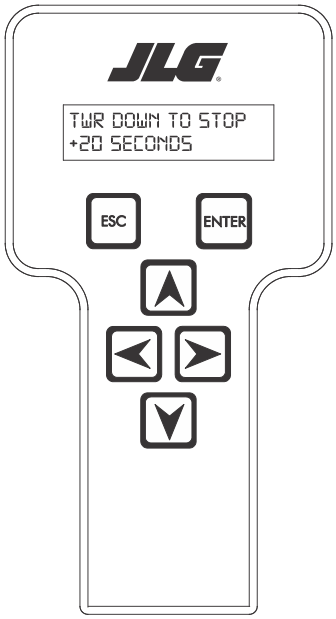
After the required activation time has passed, release the function switch and press "ENTER" (ENTER). The analyzer will display the following message:



If the calibration has been completed successfully, the screen will automatically change to:



If the calibration has not been completed successfully, the display will automatically change to:



Repeat step j until the calibration time requirement has been satisfied.

⚠ WARNING

DO NOT RAISE THE TOWER BOOM AGAIN DURING CALIBRATION.

k. To correctly complete the calibration process, fully retract and fully lower the main boom. Once the machine is in the stowed position, turn off the machine and disconnect the analyzer.

Calibration Faults

CAL Failed-Chassis Not Level

In the event the turntable tilt switch input is logic low indicating that the machine is not level the UMS calibration screens shall display this fault.

CAL Failed-UMS Sensor Raw Output Out Of Range

The control system shall display a fault in the event the raw sensor output is greater then ±5° for the UMS sensor.

CAL Failed-Turntable Sensor Raw Output Out Of Range

The control system shall display a fault in the event the raw sensor output is greater then ±5° for the turntable sensor.

CAL Failed-Calibration Disrupted

If calibration is disrupted, the control system shall display this fault.

CAL Failed- UMS Sensor Movement Not Detected

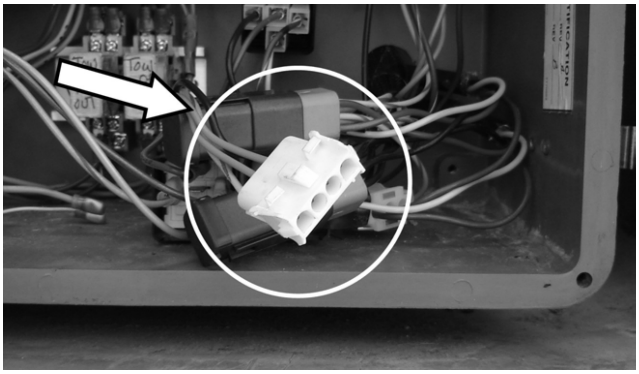
The UMS angle has not detected the required amount of movement during calibration.

Function Check

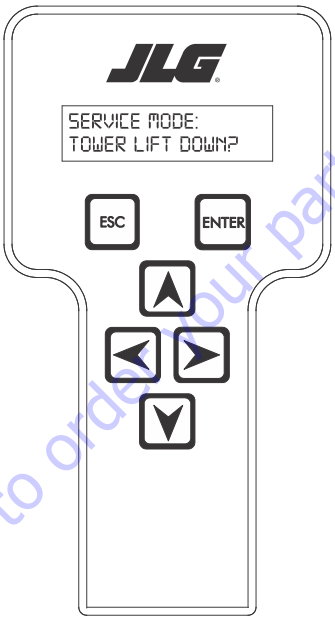
NOTICE

ON ADE EQUIPPED MACHINES, DO NOT CONNECT TO THE ANALYZER CONNECTION PORT INSTALLED WITH THE UPRIGHT MONITORING SYSTEM MODULE.

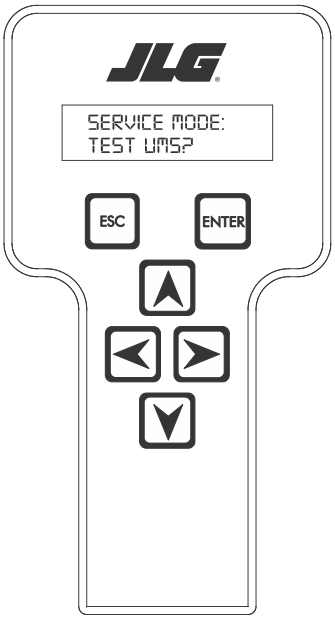
1. Connect the hand-held analyzer at the ground control station using the four-pin connector.



2. Pull out the emergency stop button at the ground control station and turn the key switch to ground controls. Start the engine.
3. Advance to access level 1 by scrolling to the ACCESS LEVEL menu and press "ENTER" ENTER. Using the arrows on the keypad, enter the password "33271" and press "ENTER" ENTER.
4. Scroll through the top level menu until SERVICE MODE appears. Press "ENTER" ENTER to select this menu item. After pressing "ENTER" one of the following screens will be displayed:

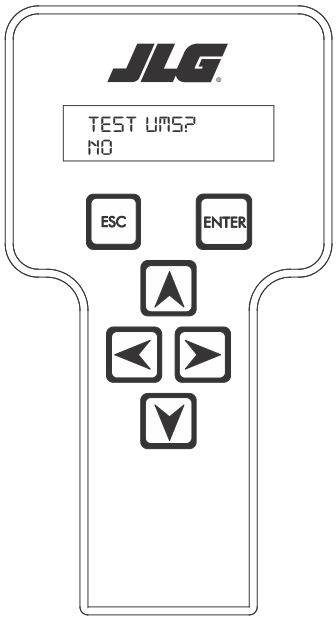


Or

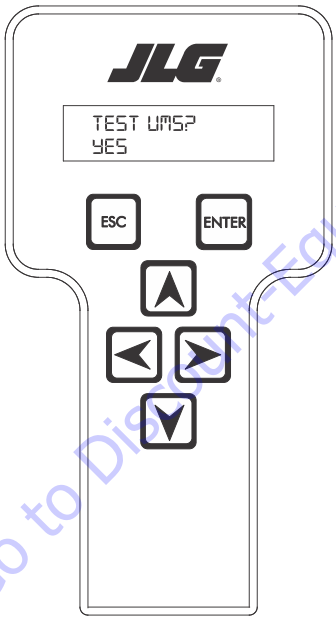


5. Scroll left to right through the above menu items until "TEST UMS?" sub menu appears on the bottom line of the analyzer display. Press the "ENTER" ENTER key.

6. The controller will now display the following:



or, by pressing the up and down arrow keys:



7. When the "YES" message is displayed, press the "ENTER" ENTER key to automatically perform a function test. Upon the function test, the system will activate the Upright Monitoring System, warning lights, and alarm. Verify that the alarm sounds, the boom malfunction indicator lights (platform and ground) are illuminated.

8. From the ground controls, raise the tower boom several feet. Verify that the tower boom will not lower.

9. To end the system test, press the Emergency Stop Switch (EMS) at the ground controls. Upon loss of power (pressing the EMS) to the system, the upright monitoring system will reset and all functionality will be restored to the machine.

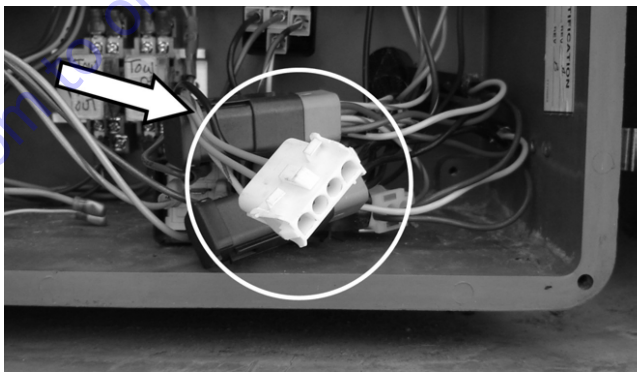
Service Mode/Tower Boom Retrieval

The UMS software incorporates a service mode to temporarily disengage the UMS and allow a tower lift down operation when the UMS has detected a backward stability concern.

NOTICE

ON ADE EQUIPPED MACHINES, DO NOT CONNECT TO THE ANALYZER CONNECTION PORT INSTALLED WITH THE UPRIGHT MONITORING SYSTEM MODULE.

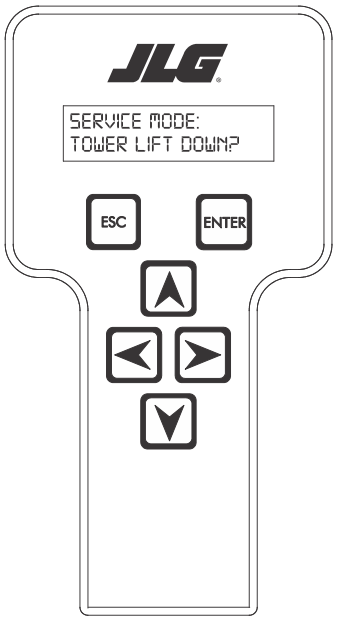
1. Connect the hand-held analyzer at the ground control station using the four-pin connector.



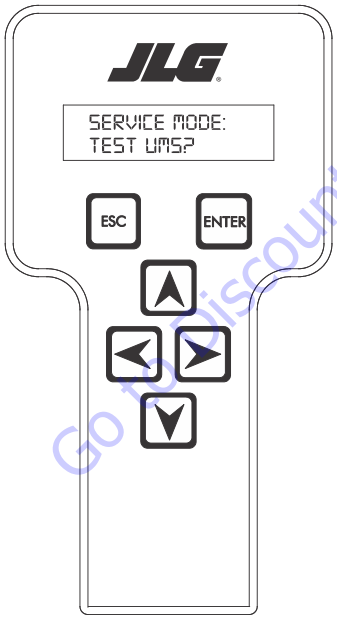
2. Pull out the emergency stop button at the ground control station and turn the key switch to ground controls. Start the engine.

3. Advance to access level 1 by scrolling to the ACCESS LEVEL menu and press "ENTER" ENTER. Using the arrows on the keypad, enter the password "33271" and press "ENTER" ENTER.

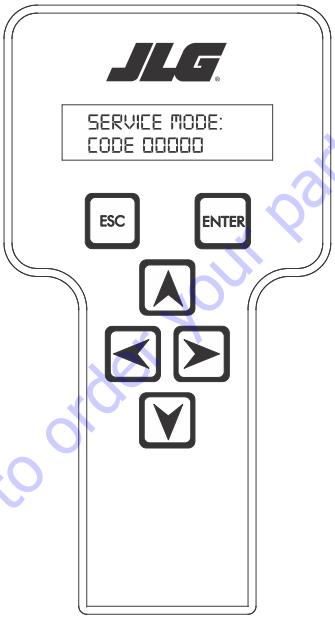
4. Scroll through the top level menu until SERVICE MODE appears. Press "ENTER" (ENTER) to select this menu item. After pressing "ENTER" one of the following screens will be displayed:



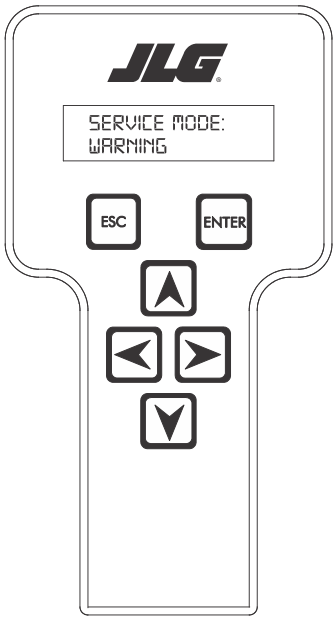
Or



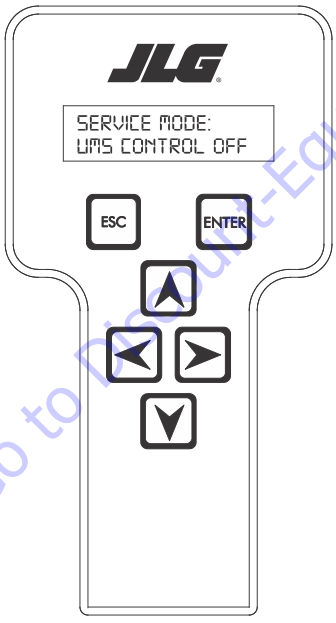
5. Scroll left to right through the above menu items until "TOWER LIFT DOWN?" sub menu appears on the bottom line of the analyzer display. Press the "ENTER" (ENTER) key.
6. The controller will now display the following:



7. Enter the service code "**81075**" and press the "ENTER" ENTER key. The controller display will now display the following,

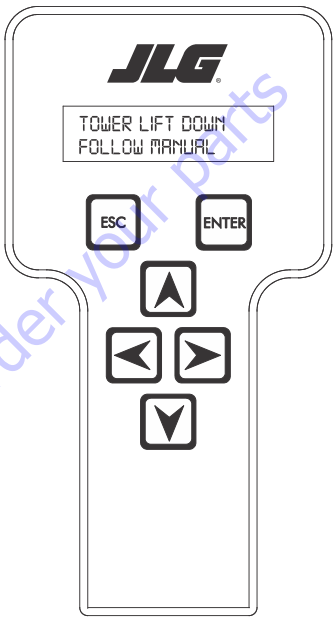


followed by:



The flashing and scrolling messages will repeat until the "ENTER" ENTER key is pressed.

8. When the "ENTER" ENTER key is pressed, the UMS will be disabled and the display will read:



9. Before using tower lift down adhere to the following:

- Make sure the main boom is fully retracted.
- Make sure the tower boom is fully retracted.
- Slowly lower the tower boom.

10. When the platform has been safely lowered to the ground, exit the service mode by pressing the Emergency Stop Switch (EMS) at the ground controls. Upon loss of power (pressing the EMS) to the system, the upright monitoring system will reset and all functionality will be restored to the machine.

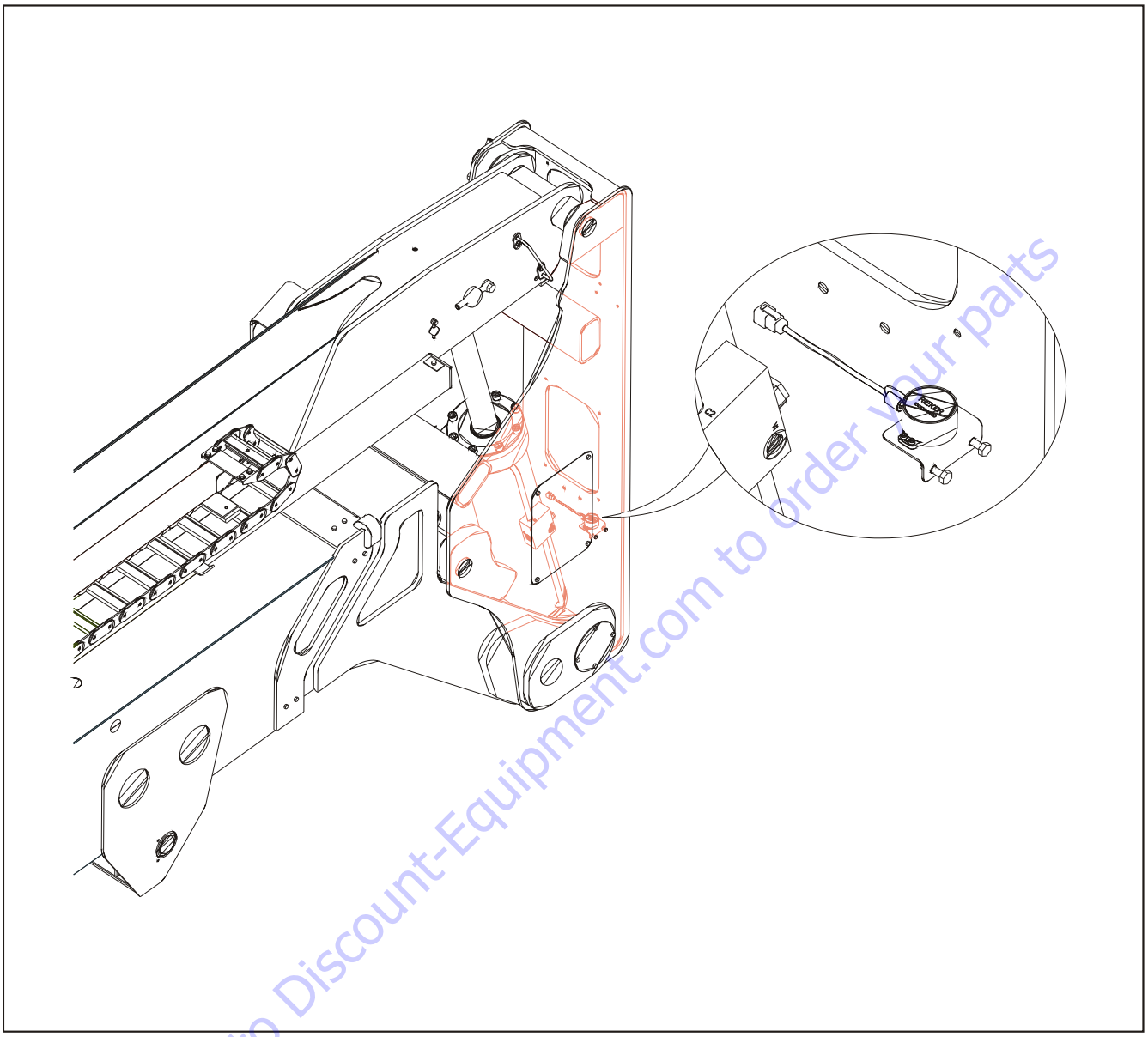


Figure 4-18. UMS Sensor Location

4.13 UMS TROUBLESHOOTING AND DIAGNOSTIC TROUBLE CODES (DTC)

Backward Stability Concern DTC (2532)

UMS SENSOR BACKWARD LIMIT REACHED

When the upright angle relative to the turntable is higher than +2.5° (away from the work platform), tower lift down will be disallowed immediately. Tower Lift Down will be re-allowed when the upright angle relative to the turntable is less than 2.0°. If Tower Lift Down is disabled for more than 1.5 seconds, the ground boom malfunction indicator lamp, upright tilted lamp and platform alarm will light/sound continually and a fault shall be raised. These conditions will be latched along with Tower Lift Down until the upright angle is less than 2.0° for 2 seconds and the Tower Lift Down command is returned to neutral.

Solution:

- Inspect sensor mounting for obvious damage and excessive corrosion.
- Verify sensor calibration according to Section , Calibration.
- Follow the corrective action listed in Section , Re-Synchronizing Upright on decal 1001096141 located near the red knob of the machine.
- Inspect machine hydraulics. Refer to Holding Valve Checks in Section , Tower Out of Sync for other possible causes.

Forward Stability Concern DTC (2530)

UMS SENSOR FORWARD LIMIT REACHED

When the upright angle relative to the turntable is less than –4.0° for longer than 1.5 seconds, the ground control boom malfunction indicator lamp, the platform malfunction indicator lamp, and platform alarm will light/sound continually and a fault will be raised. The light/alarm signal will stop only when the upright angle reaches values greater than –3.0° for 2 seconds.

Solution:

- Inspect sensor mounting for obvious damage or excessive corrosion.
- Verify sensor calibration according to Section , Calibration.
- Command tower lift down function until fully stored..
- Inspect machine hydraulics. Refer to Holding Valve Checks in Section , Tower Out of Sync for other possible causes.

Out of Usable Range DTC (2531)

UMS SENSOR OUT OF USABLE RANGE

When both the Chassis tilt sensor and the UMS sensor read greater than 10° in the same direction the UMS will be disengaged until the condition no longer exists and a fault shall be raised.

Solution:

- Verify the message clears when operating the machine on grade less than 10°.
- Inspect sensor mounting for obvious damage or excess corrosion.
- Verify sensor calibration according to Section , Calibration.

UMS Sensor Not Calibrated DTC (816)

UMS SENSOR NOT CALIBRATED

If the control system detects a sensor out of range condition or a not calibrated fault with the UMS angle sensor, the control system shall report a fault and disable Tower Lift Down and activate the ground boom malfunction indicator lamp, upright tilted lamp and platform alarm continually

If the control system detects that the UMS angle sensor has not been calibrated, the ground boom malfunction lamp will flash at a 3 Hz rate until the system is calibrated or disabled.

Solution:

- Calibrate sensor according to Section , Calibration.

UMS Sensor Faulted DTC (817)

UMS SENSOR FAULT

If the system detects that the UMS sensor frequency outside the 100Hz +/- 5Hz range or the duty cycle is outside 50% +/- 21% range the control system shall report a fault.

Solution:

- Inspect wire harness going to the sensor and UMS module for damage and proper continuity.
- Inspect sensor mounting for obvious dense and excessive corrosion.
- Replace sensor.

Calibration Faults

See Section , Calibration

4.14 ARTICULATING JIB AND JIB LIFT CYLINDER

NOTE: *Pin numbers listed in the following procedures are referenced in Figure 4-19., Location of Components-Articulating Jib.*

NOTE: *Using a suitable lifting device, support the jib.*

NOTE: *The Jib assembly weighs approximately 269 lb (122 kg).*

Removal

1. For platform/support removal see platform/support removal diagram. (See Section 4.3, Platform).
2. Position the articulating jib boom level with the ground.
3. Tag and disconnect hydraulic lines from platform cylinder and jib lift cylinder. Use suitable container to retain any residual hydraulic fluid. Cap or plug all openings of hydraulic lines and ports.
4. Remove mounting hardware from slave cylinder pin (1). Using a suitable brass drift and hammer, remove the cylinder pin from articulating jib boom.
5. Remove mounting hardware from articulating jib boom pivot pin (2). Using a suitable brass drift and hammer, remove the pivot pin from boom assembly. Remove the jib assembly from the machine.

Disassembly

1. Remove mounting hardware from articulating jib boom pivot pins (3) and (4). Using a suitable brass drift and hammer, remove the pins from articulating jib boom pivot weldment.
2. Remove mounting hardware from rotator support pins (5) and (6). Using a suitable brass drift and hammer, remove the pins from rotator support.
3. Remove mounting hardware from lift cylinder pin (7). Using a suitable brass drift and hammer, remove the cylinder pin from articulating jib boom.

Inspection

NOTE: *When inspecting pins and bearings Refer to Pins and Composite Bearing Repair Guidelines in Section 2.*

1. Inspect articulating fly boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
2. Inspect articulating fly boom pivot attach points for scoring, tapering and ovality, or other damage. Replace pins as necessary.
3. Inspect inner diameter of articulating fly boom pivot bearings for scoring, distortion, wear, or other damage. Replace bearings as necessary.

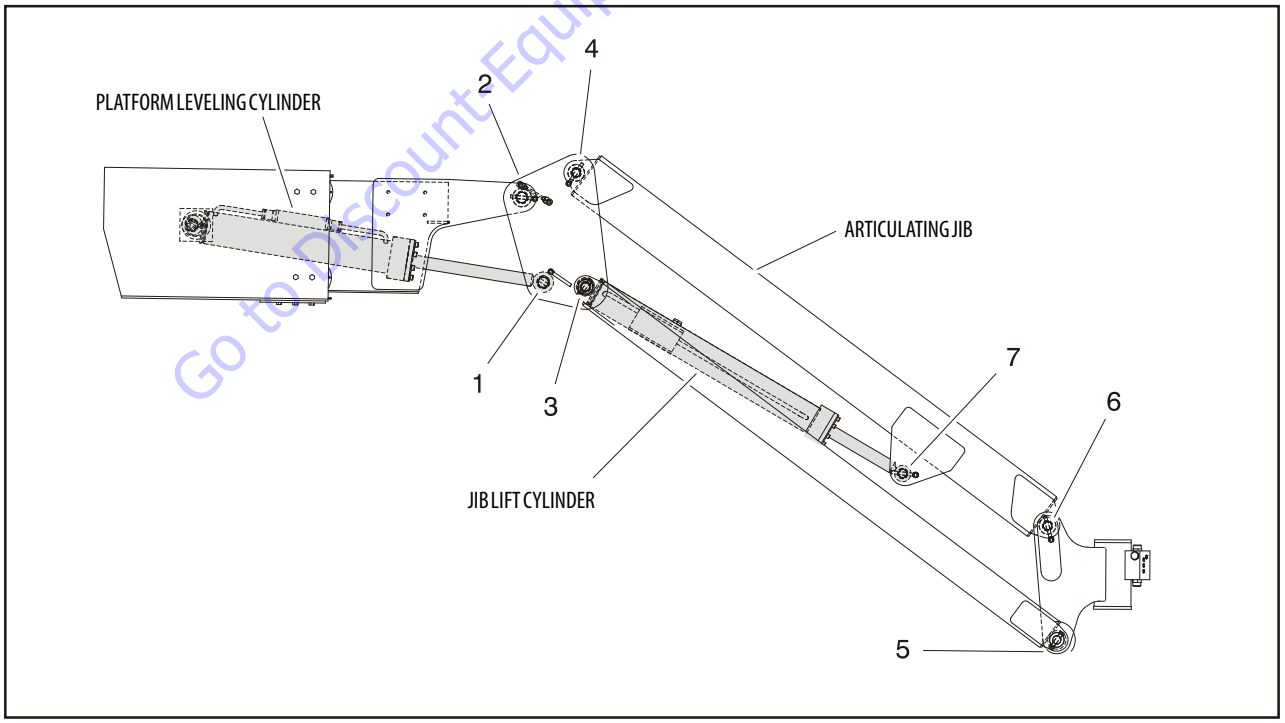


Figure 4-19. Location of Components-Articulating Jib

4. Inspect lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
5. Inspect inner diameter of rotator attach point bearings for scoring, distortion, wear, or other damage.
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of articulating jib boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Assembly

1. Align lift cylinder with attach holes in articulating jib boom. Using a soft head mallet, install cylinder pin (7) into articulating jib boom and secure with mounting hardware.
2. Align bottom tubes with attach holes in articulating jib boom pivot weldment. Using a soft head mallet, install rotator support pin (3) into articulating jib boom pivot weldment and secure with mounting hardware.
3. Align rotator support with attach hole in articulating jib boom. Using a soft head mallet, install rotator support pin (6) into articulating jib boom and secure with mounting hardware.
4. Align bottom tubes with attach holes in rotator support. Using a soft head mallet, install rotator support pin (5) into articulating jib boom and secure with mounting hardware.
5. Align articulating jib boom with attach hole in articulating jib boom pivot weldment. Using a soft head mallet, install rotator support pin (4) into articulating jib boom and secure with mounting hardware.

Installation

NOTE: *The Jib assembly weighs approximately 332 lb (151 kg).*

NOTE: *Using a suitable lifting device, support the Jib assembly.*

1. Align articulating jib boom pivot weldment with attach holes in fly boom assembly. Using a soft head mallet, install pivot pin #2 into fly boom assembly and secure with mounting hardware.
2. Align the platform leveling cylinder with attach holes in articulating jib boom pivot weldment. Using a soft head mallet, install platform leveling cylinder pin #1 into articulating jib boom pivot weldment and secure with mounting hardware.
3. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to platform level cylinder and jib lift cylinder as tagged during removal.

4.15 SEQUENCE FOR HOSE REPLACEMENT IN THE TOWER BOOM

1. Remove the tower boom front cover bolts, exposing the Powertrack.
2. Remove bolts to disconnect the top bar of the Powertrack
3. Pull the Powertrack out of base boom. (as far as hoses will allow)
4. At left side rear of upright, remove access cover plate (4) bolts. (others if necessary)
5. Remove access cover plate, (4) bolts, from bottom front of fly boom.
6. Cut cable ties that attach hose to be replaced.
7. Disconnect hose that is to be replaced, and cap the male fitting.
8. Attach the new hose to the end of the hose to be replaced.
9. Pull these lines thru the upright and out the bottom, then feed back into the fly boom.
10. At the Powertrack, in front of the tower boom, open the Powertrack links to expose the hose to be replaced.
11. Pull hose to be replaced, attached to the new hose, thru the fly boom and thru the Powertrack links.
12. Disconnect new hose from the replaced hose and connect to fitting where the damaged hose was connected.
13. Roll Powertrack back into base, and attach the top bar of the Powertrack (2) bolts to the inside top of the fly boom section.
14. Check for leaks and hardware tightened securely.
15. Replace access cover plates and front cover.

4.16 LIMIT SWITCHES ADJUSTMENT

Main Boom Horizontal Limit Switch

1. Place machine on level surface.
2. Raise main boom 5 to 10 degrees above horizontal. limit switch should activate before this point.
3. Lower main boom until limit switch resets. This should be 1 degree above to 4 degrees below horizontal.

NOTE: *Angle indicator should be placed approx. 2 ft. from the main boom pivot pin and the attach point on the main boom. Tower angle switch must be reset before main boom angle switch can be activated.*

Tower Boom Horizontal Limit Switch

1. Place machine on level surface.
2. Raise Tower Boom 8 to 13 degrees above horizontal. The tower angle limit switch should activate at this point.
3. Lower the tower boom until the limit switch resets. This should be 2 to 7 degrees below where the switch was activated. (See Figure 4-20. and Figure 4-21. for adjustments).

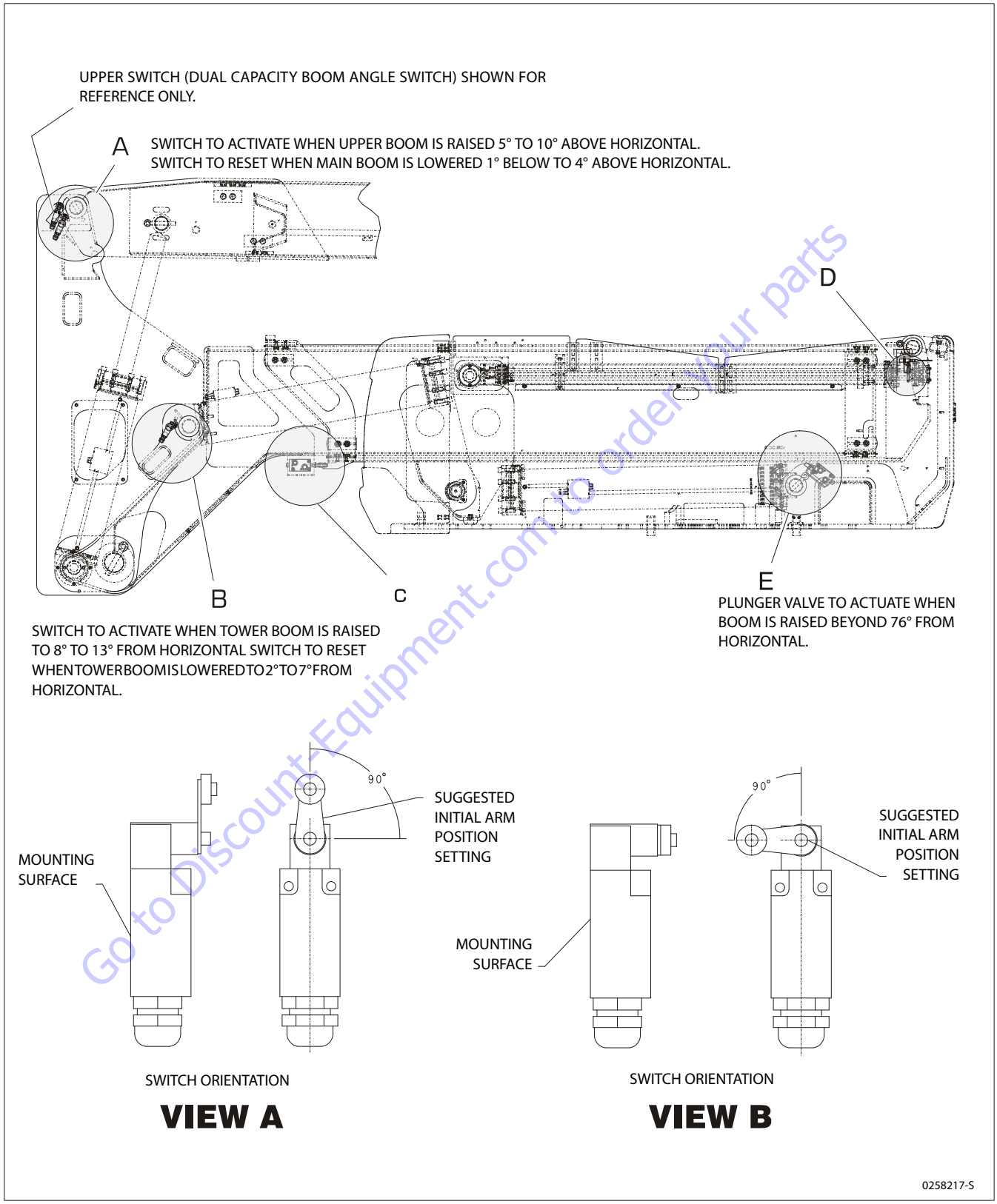


Figure 4-20. Boom Valve and Limit Switches Location (Sheet 1 of 3)

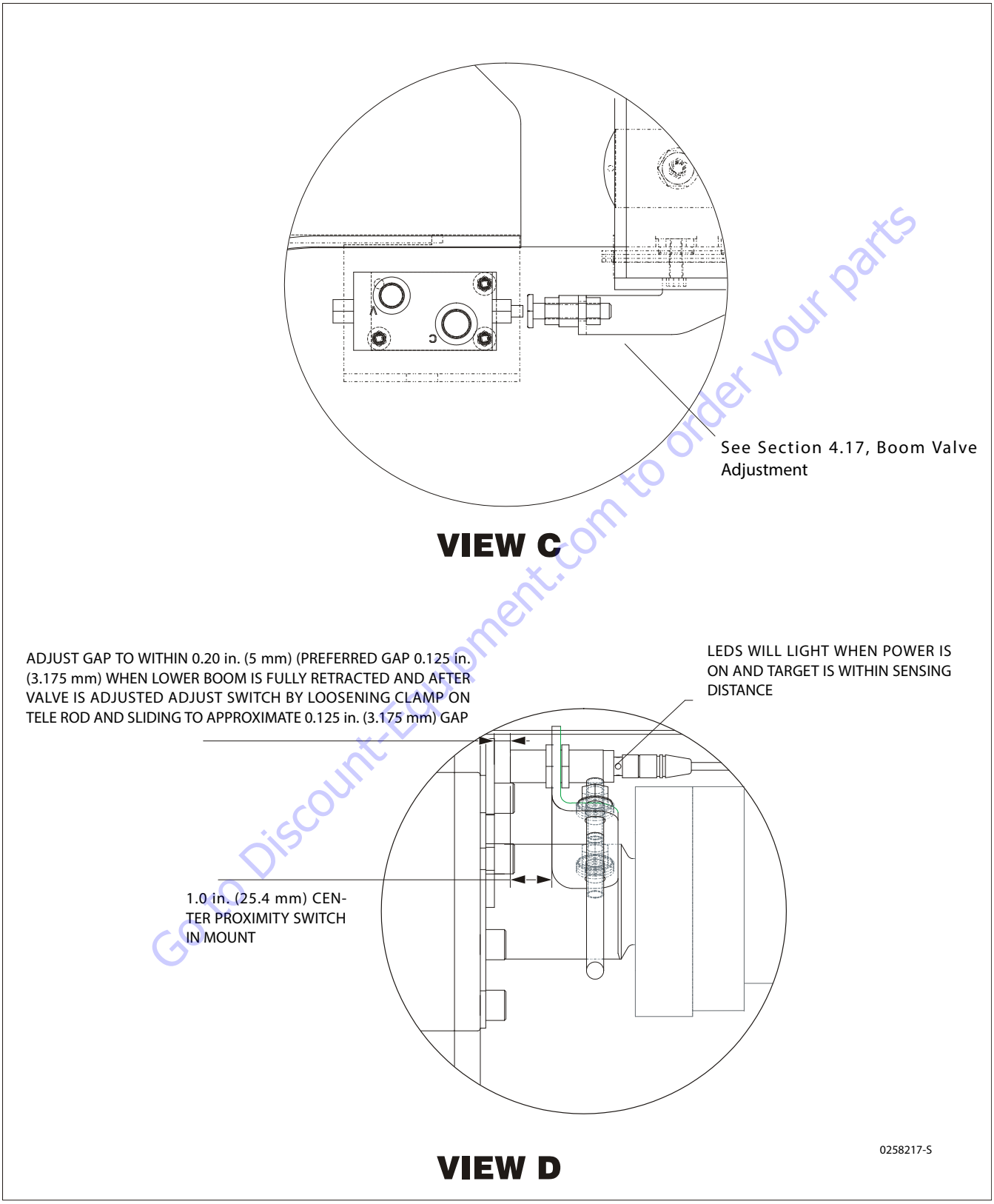


Figure 4-21. Boom Valve and Limit Switches Location (Sheet 2 of 3)

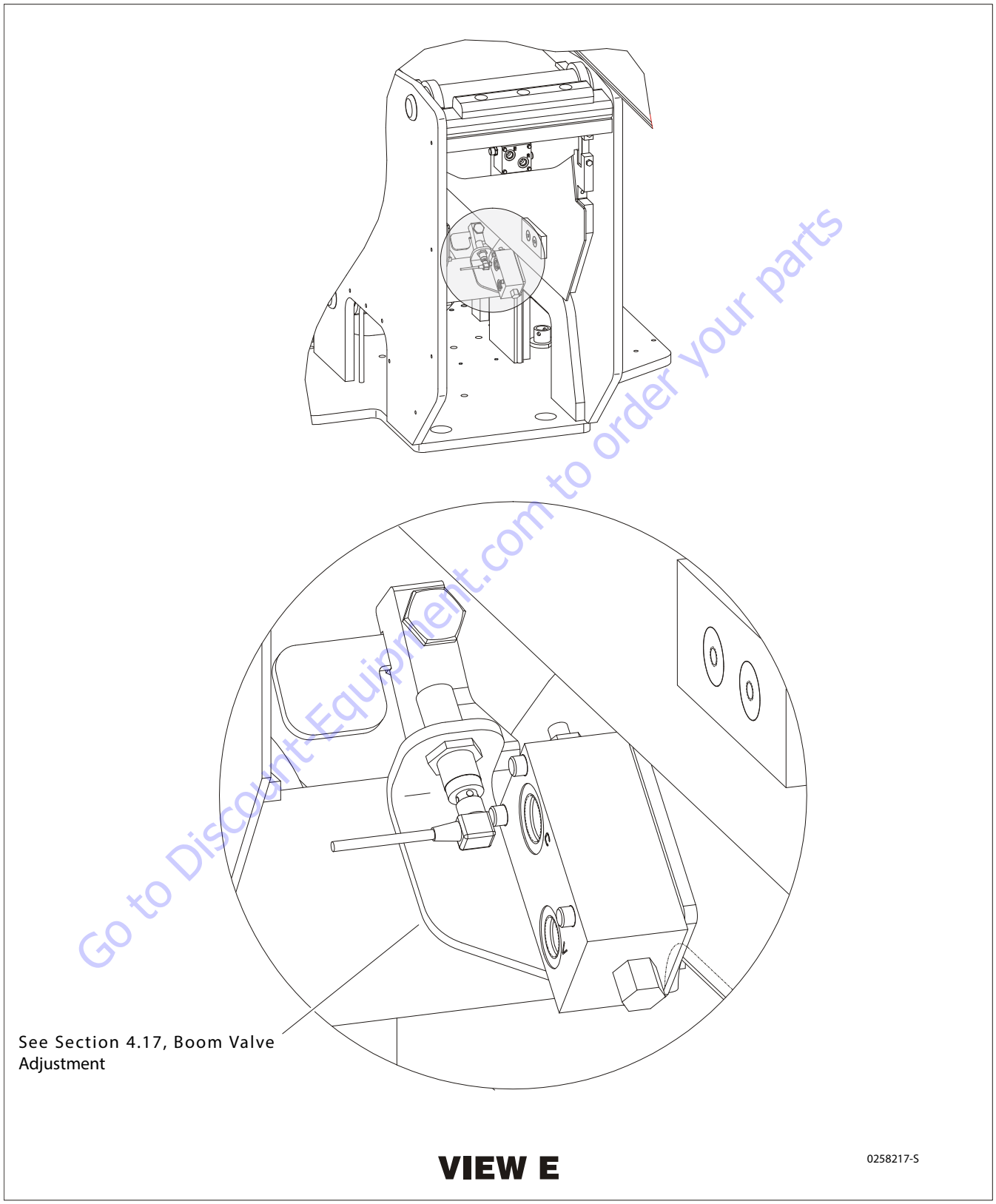


Figure 4-22. Boom Valve and Limit Switches Location (Sheet 3 of 3)

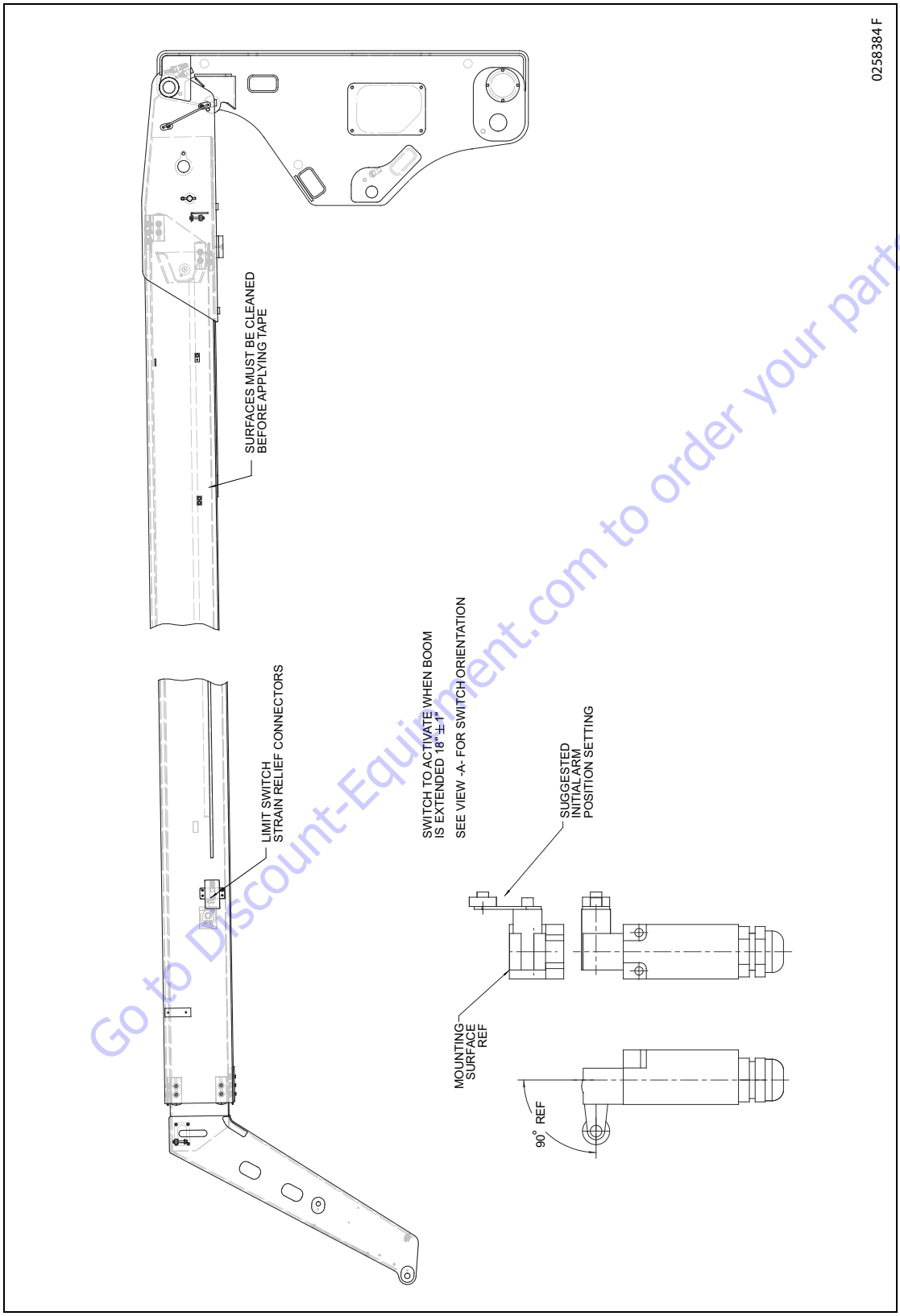


Figure 4-23. Transportation Switch Installation (CE only)

4.17 BOOM VALVE ADJUSTMENT

1. Adjust the screws so the plunger on the valves has 0.250 in. (6.35 mm) travel remaining when the lower boom is fully raised and retracted.
2. After the valves are adjusted, adjust the proximity switches to within 0.20 in. (5 mm) of their target. The LED's on the proximity switches will light when the power is on and the switch is within 0.20 in. (5 mm) of the target. There is a proximity switch to backup both valves.

NOTE: *The cam valve under the boom requires the tower boom to be completely lowered and the cam valve mounted on T/T requires the tower boom to be fully elevated prior to adjustment.*

Tower Boom

1. Shim up wear pads until 1/32 inch (0.8 mm) clearance to adjacent surface.
2. When adjusting wear pads, removing or adding shims, bolt length must also be changed.
   - **a.** When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   - **b.** When shims are removed, shorter bolts must be used so bolt does not protrude from insert and come into contact with boom surface.

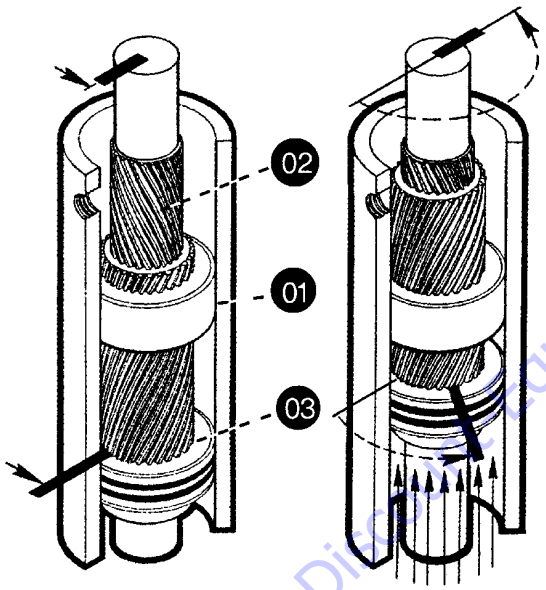
Main Boom

1. Shim up wear pads to within 1/32 inch (0.8 mm) clearance between wear pad and adjacent surface.
2. Adjusting wear pads, removing or adding shims, bolt length must also be changed.
   - **a.** When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   - **b.** When shims are removed, shorter bolts must be used so bolt does not protrude from insert and Sheaves and wire rope must be replaced as sets.

4.18 ROTATOR ASSEMBLY

Theory of Operation

The L20 Series rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert linear piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear teeth (01) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (02), and the annular piston sleeve (03). Helical spline teeth machined on the shaft engage matching splines on the in- side diameter of the piston. The outside diameter of the piston carries a second set of splines, of opposite hand, which engage with matching splines in the housing. As hydraulic pressure is applied, the piston is displaced axially within the housing - similar to the operation of a hydraulic cylinder - while the splines cause the shaft to rotate. When the control valve is closed, oil is trapped inside the actuator, preventing piston movement and locking the shaft in position.



Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.

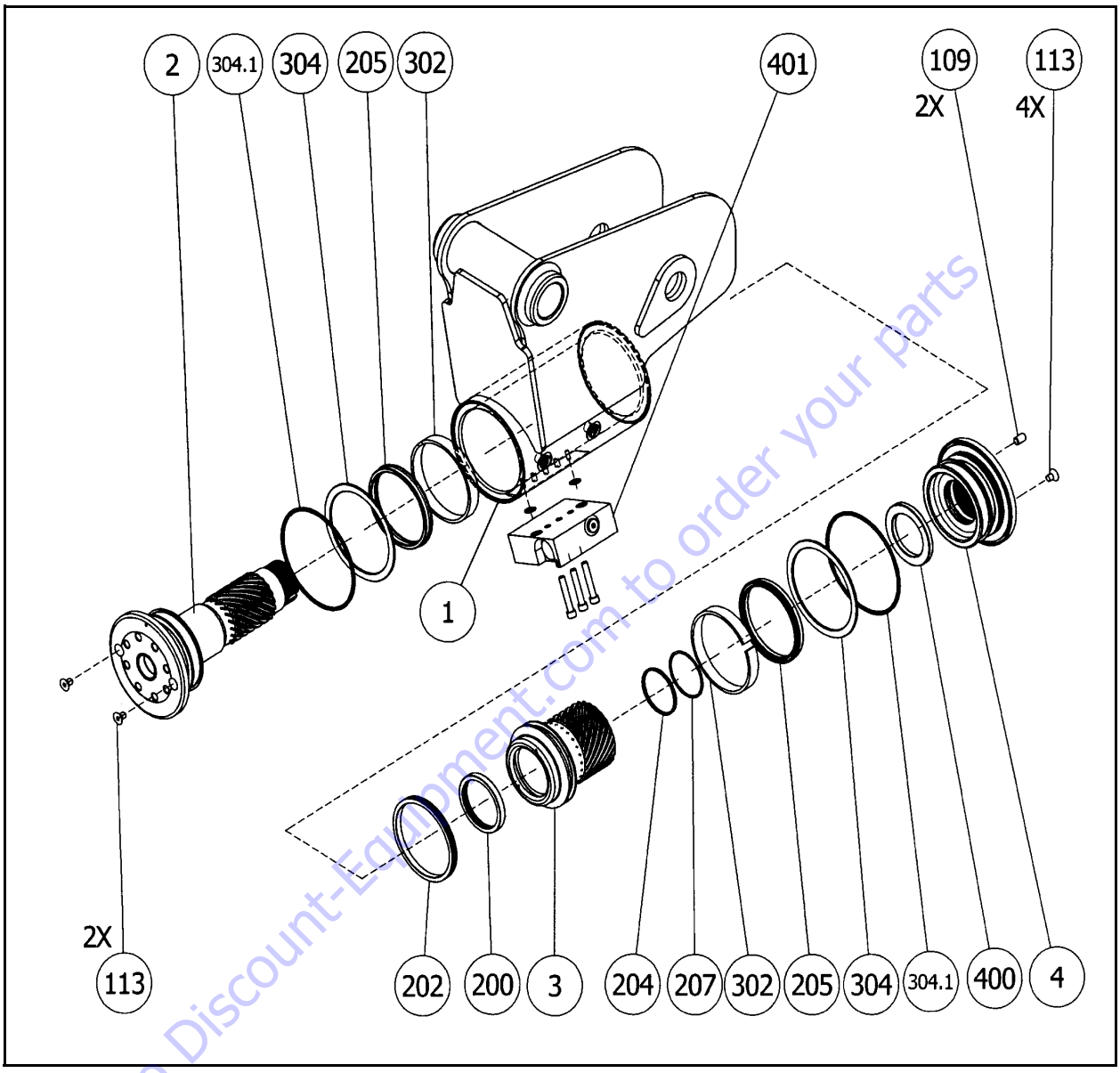
As fluid pressure is applied, the piston is displaced axially while the helical gearing causes the piston and shaft to rotate simultaneously. The double helix design compounds rotation: shaft rotation is about twice that of the piston.

The shaft is supported radially by the large main radial bearing and the lower radial bearing. Axially, the shaft is separated from the housing by the main and lower thrust washers. The end cap is adjusted for axial clearance and locked in position by set screws or pins.

Required Tools

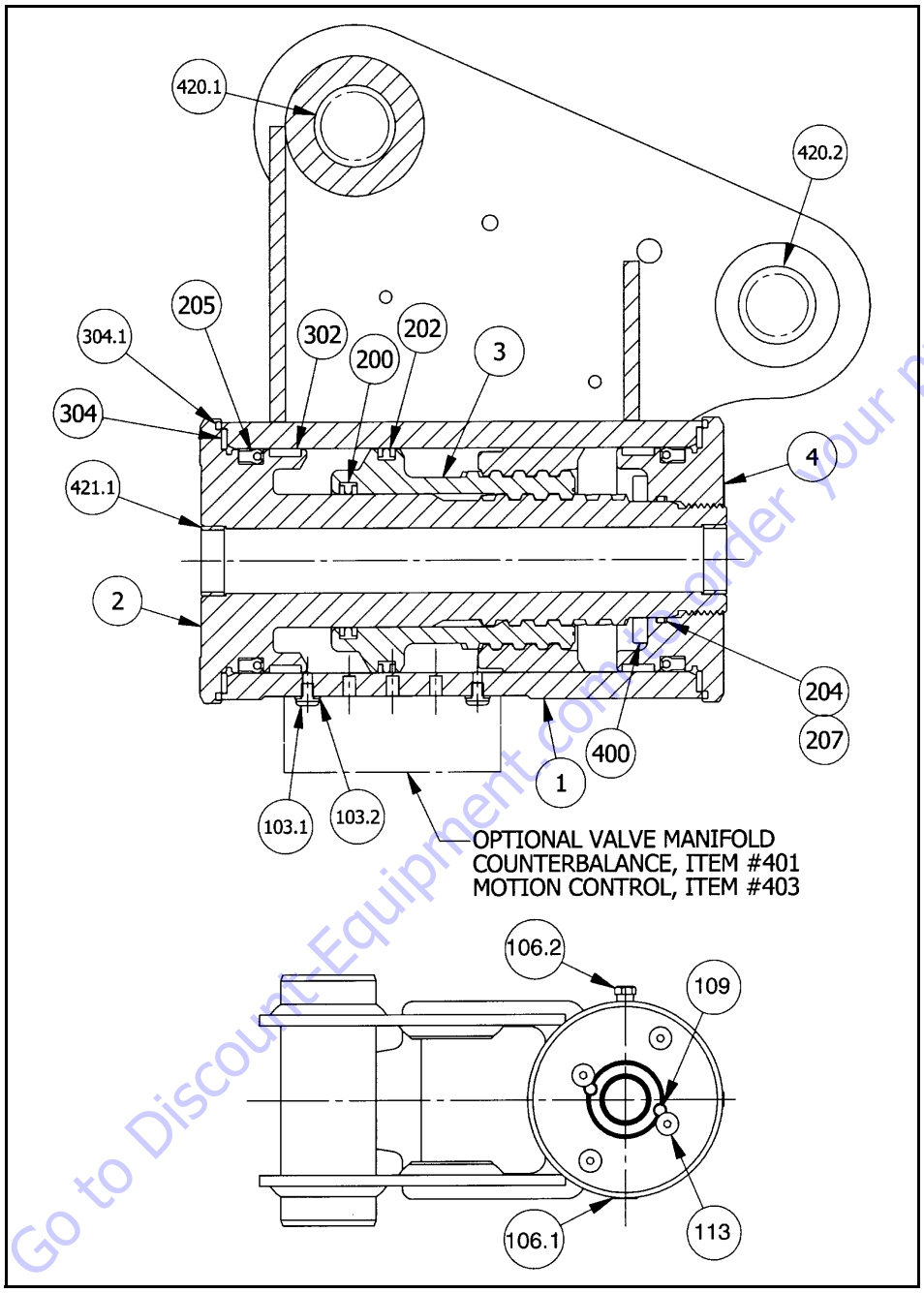
Upon assembly and disassembly of the actuator there are basic tools required. The tools and their intended functions are as follows:

1. Flashlight - helps examine timing marks, component failure and overall condition.
2. Felt Marker - match mark the timing marks and outline troubled areas.
3. Allen wrench - removal of port plugs and set screws.
4. Box knife - removal of seals.
5. Seal tool - assembly and disassembly of seals and wear guides.
6. Pry bar - removal of end cap and manual rotation of shaft.
7. Rubber mallet- removal and installation of shaft and piston sleeve assembly.
8. Nylon drift - installation of piston sleeve
9. End cap dowel pins - removal and installation of end cap (sold with Helac seal kit).



PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109. Lock Pin	207. Backup Ring		
	113. Capscrew	304.1. Wiper Seal		

Figure 4-24. Rotator - Exploded View



PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109. Lock Pin	207. Backup Ring		
	113. Capscrew	304.1. Wiper Seal		

Figure 4-25. Rotator- Assembly Drawing

Disassembly

⚠ CAUTION

SECURE PRODUCT TO SLOTTED TABLE OR VISE.

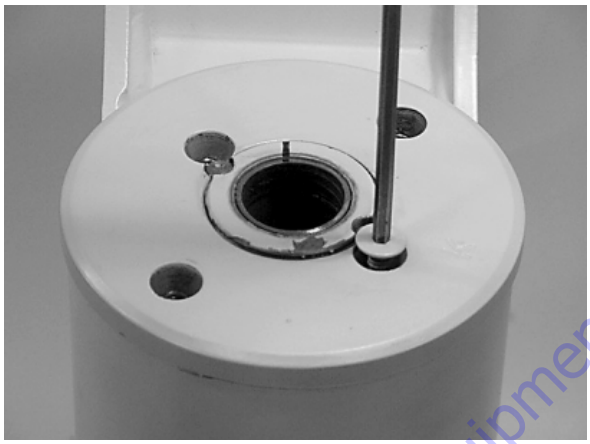
⚠ CAUTION

CONTENTS UNDER PRESSURE. WEAR APPROVED EYE PROTECTION. USE CAUTION WHEN REMOVING PORT PLUGS AND FITTINGS.

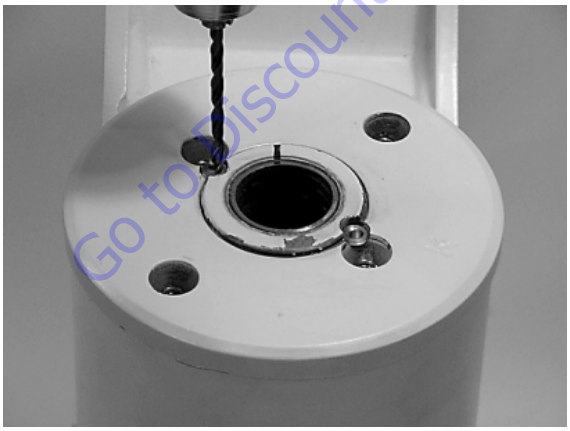
NOTICE

MAKE SURE WORK AREA IS CLEAN.

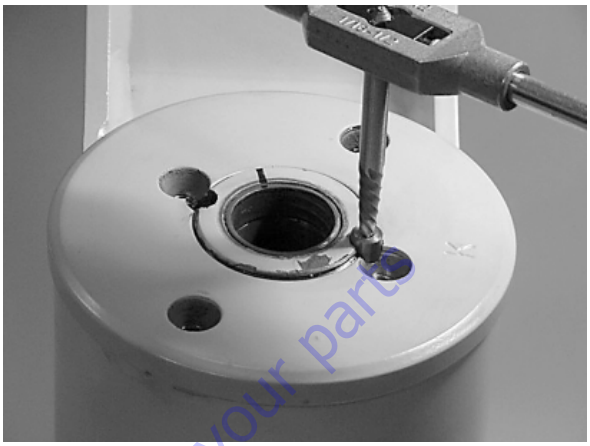
1. Remove the capscrews (113) over end cap lock pins (109).



2. Using a 1/8" (3.18mm) drill bit, drill a hole in the center of each lock pin to a depth of approximately 3/16" (4.76mm).

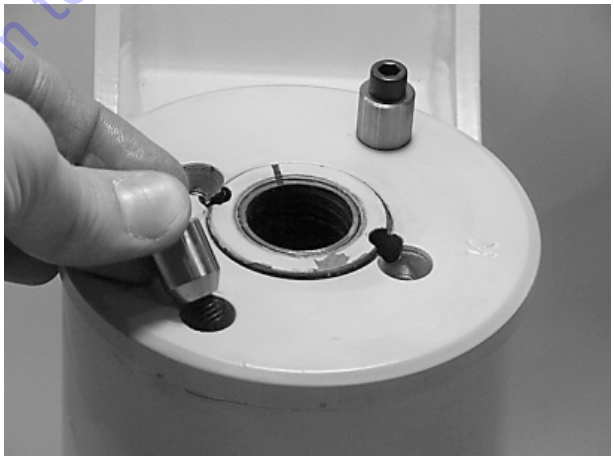


3. Remove the lock pins using an "Easy Out" (a size #2 is shown).



If the pin will not come out with the "Easy Out", use 5/16" drill bit to a depth of 1/2" (12.7mm) to drill out the entire pin.

4. Install the end cap (4) removal tools provided with the Helac seal kit.

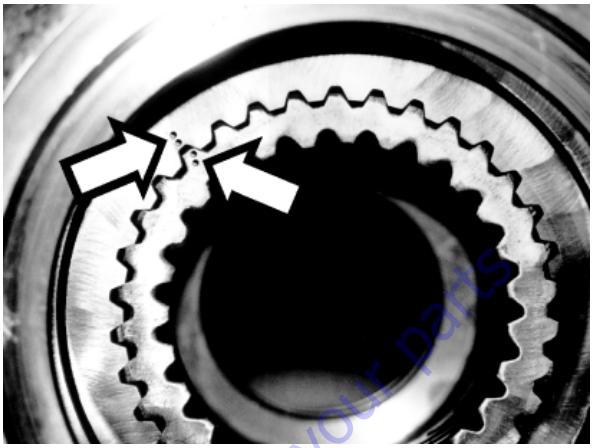


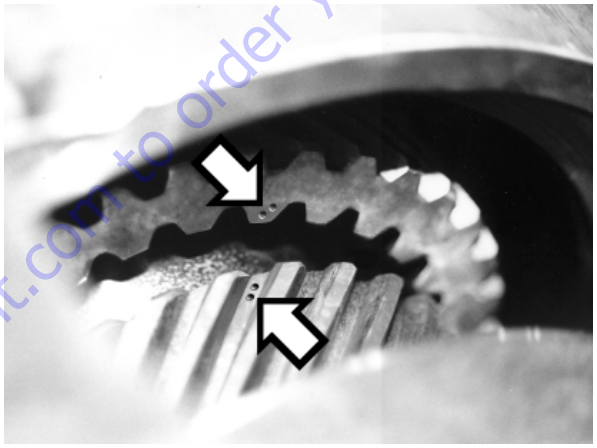
5. Using a metal bar, or similar tool, unscrew the end cap (4) by turning it counterclockwise.

6. Remove the end cap (4) and set aside for later inspection.

7. Remove the stop tube if equipped. The stop tube is an available option to limit the rotation of the actuator.

8. Every actuator has timing marks for proper engagement.





9. Prior to removing the shaft, (2), use a felt marker to clearly indicate the timing marks between shaft and piston. This will greatly simplify timing during assembly.

10. Remove the shaft (2). It may be necessary to strike the threaded end of the shaft with a rubber mallet.

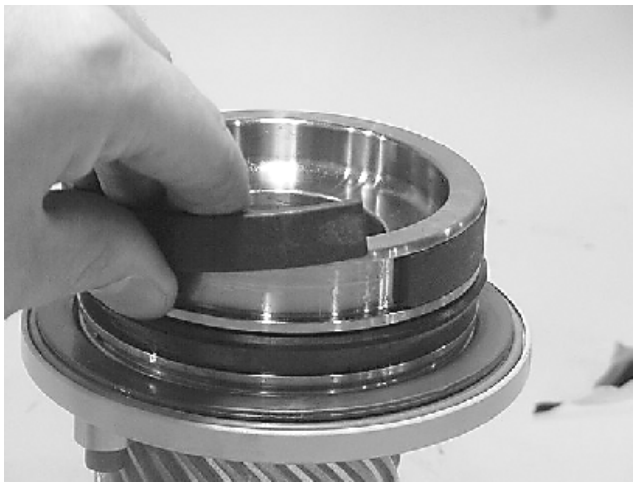
11. Before removing the piston (3), mark the housing (1) ring gear in relation to the piston O.D. gear. There should now be timing marks on the housing (1) ring gear, the piston (3) and the shaft (2).

12. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is not damaged.

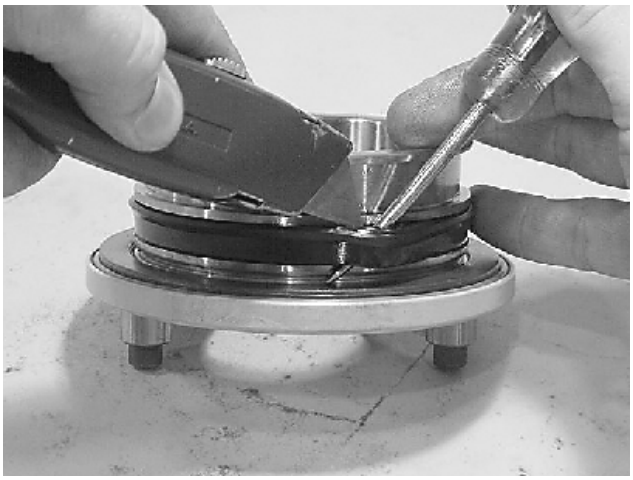
13. At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.

14. Remove the o-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.

15. Remove the wear guides (302) from the end cap (4) and shaft (2).



16. To remove the main pressure seals (205), it is easiest to cut them using a sharp razor blade being careful not to damage the seal groove.



17. Remove the thrust washers (304), from the end cap (4) and shaft (2).

18. Remove the wiper seal (304.1) from its groove in the end cap (4) and shaft (2).

19. Remove the piston O.D. seal (202) from the piston.

20. Remove the piston I.D. seal (200). You may now proceed to the inspection process.

Inspection

NOTICE

SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.

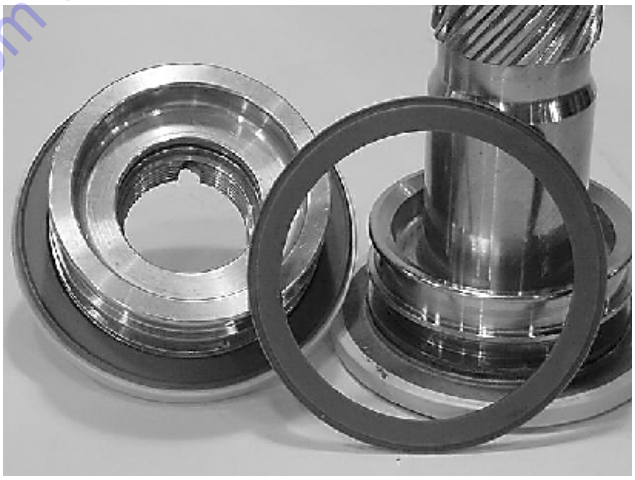
1. Clean all parts in a solvent tank and dry with compressed air prior to inspecting. Carefully inspect all critical areas for any surface finish abnormalities: Seal grooves, bearing grooves, thrust surfaces, rod surface, housing bore and gear teeth.

2. Inspect the thrust washers (304) for rough or worn edges and surfaces. Measure it's thickness to make sure it is within specifications (Not less than 0.092" or 2.34 mm).

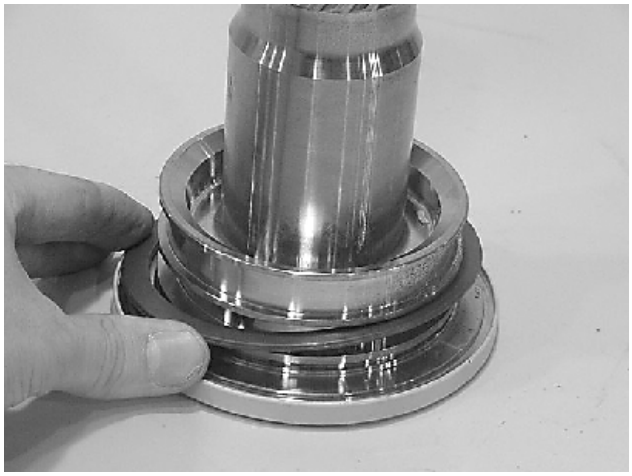
3. Inspect the wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).

Assembly

1. Gather all the components and tools into one location prior to re-assembly. Use the cut away drawing to reference the seal orientations.

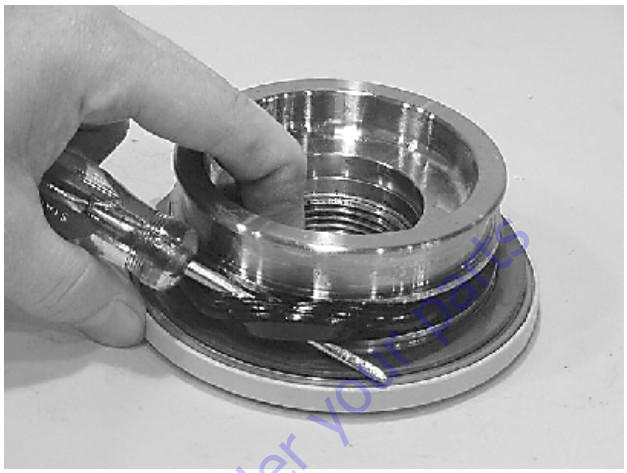


2. Install the thrust washer (304) onto shaft (2) and end cap (4).



3. Install the wiper seal (304.1/green 0-ring) into the groove on the shaft (2) and end cap (4) around the outside edge of the thrust washer (304).

4. Using a seal tool install the main pressure seal (205) onto shaft (2) and end cap (4). Use the seal tool in a circular motion.



5. Install the wear guide (302) on the end cap (4) and shaft (2).

6. Install the O-ring (204) and backup ring (207) into the inner seal groove on the end cap (4).

7. Install the inner T-seal (200) into the piston (3) using a circular motion.

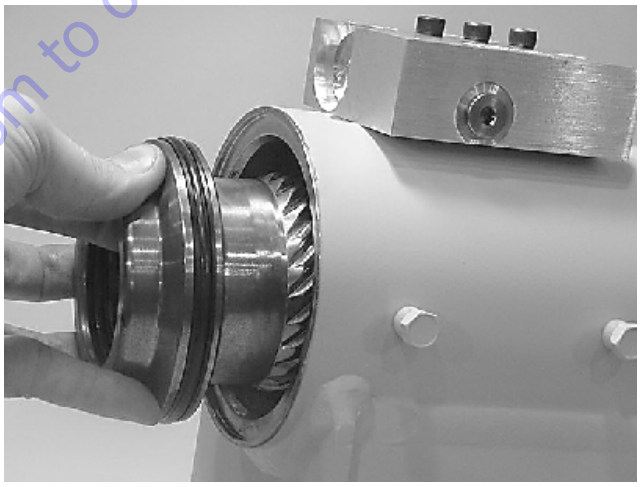
   Install the outer T-seal (202) by stretching it around the groove in a circular motion.

   Each T-seal has 2 backup rings (see drawing for orientation).

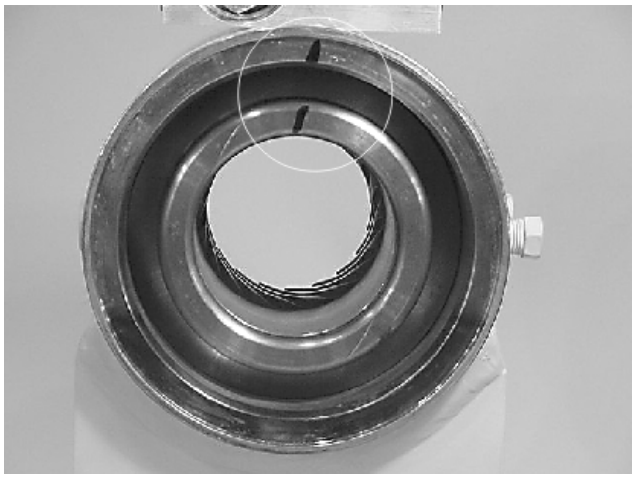
   Beginning with the inner seal (200) insert one end of b/u ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly.

   Repeat this step for the outer seal (202).

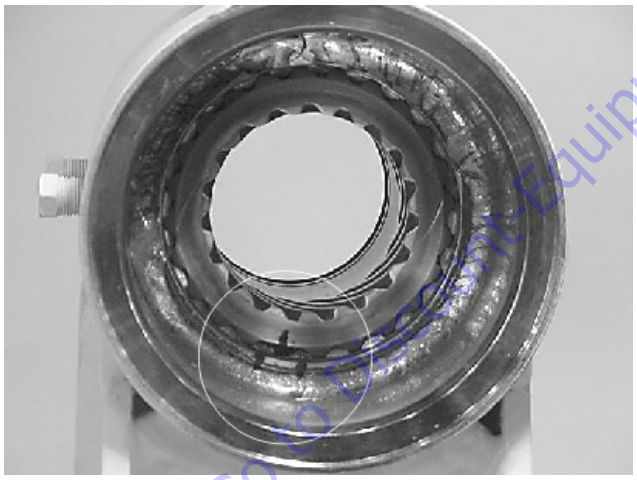
8. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) is touching inside the housing bore.



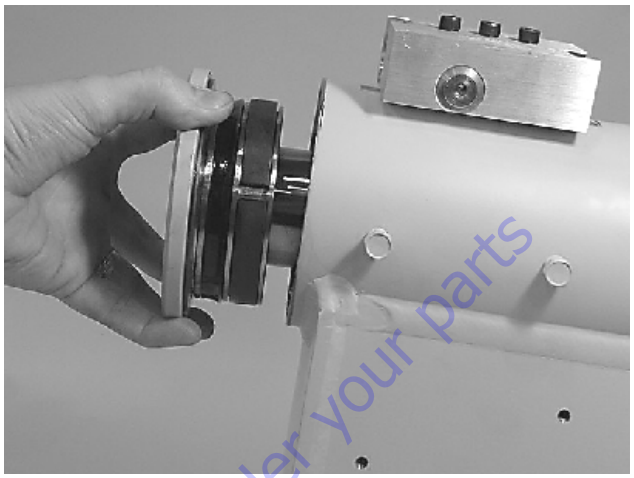
9. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.



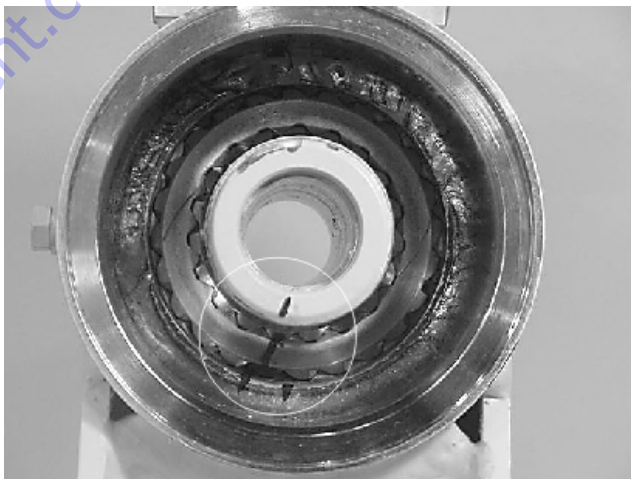
10. Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.



11. Install the shaft (2) into the piston (3). Be careful not to damage the seals. Do not engage the piston gear teeth yet.



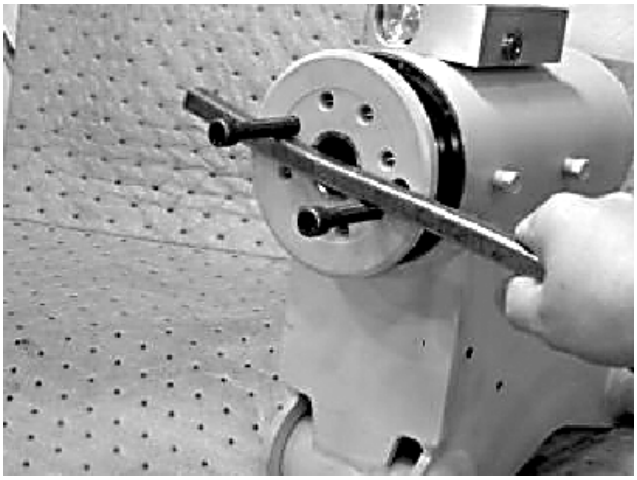
12. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.



13. Install 2 bolts in the threaded holes in the flange. Using a bar, rotate the shaft in a clockwise direction until the wear guides are seated inside the housing bore.

NOTICE

AS THE SHAFT IS ROTATED, BE CAREFUL NOT TO DISENGAGE THE PISTON AND HOUSE GEARING.

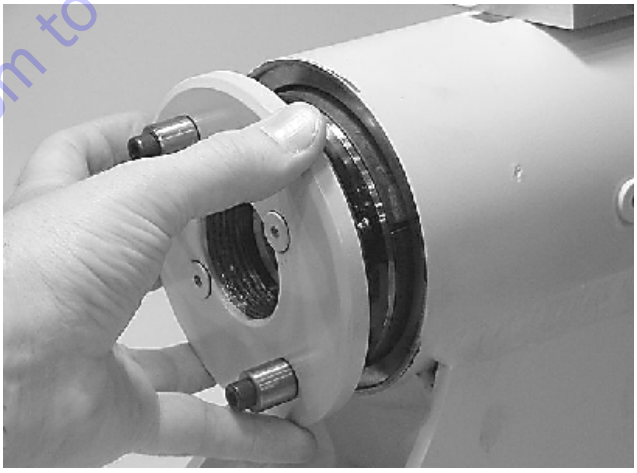


14. Install the stop tube onto the shaft end, if equipped. Stop tube is an available option to limit the rotation of an actuator.

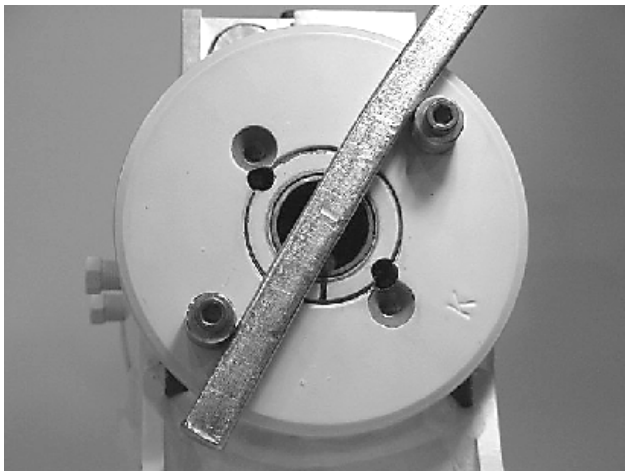
15. Coat the threads on the end of the shaft with anti-seize grease to prevent galling.

16. Install the 0-ring (204) and backup ring (207) into the inner seal groove on the end cap (4).

17. Thread the end cap (4) onto the shaft (2) end. Make sure the wear guide remains in place on the end cap as it is threaded into the housing (1).

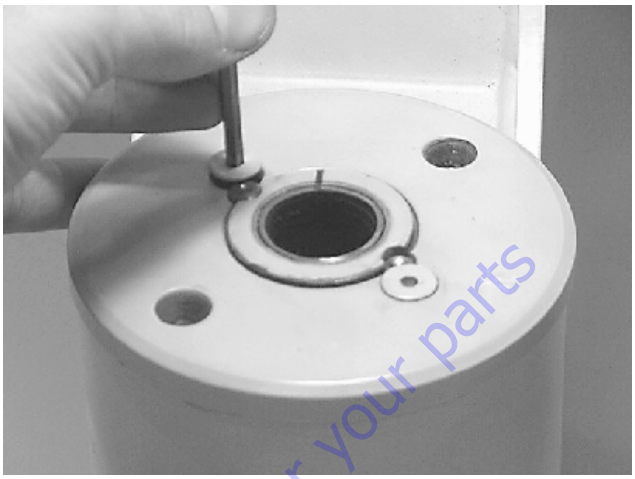


18. Tighten the end cap (4). In most cases the original holes for the lock pins will line up.



19. Place the lock pins (109) provided in the Helac seal kit in the holes with the dimple side up. Then, using a punch, tap the lock pins to the bottom of the hole.

20. Insert the set screws (113) over the lock pins. Tighten them to 25 in. lbs. (2.825 Nm).



Installing Counterbalance Valve

Refer to Figure 4-26., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old Medium Strength Threadlocking Compound.
2. Make sure the new valve has the O-rings in the counterbores of the valve to seal it to the actuator housing.
3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. Medium Strength Threadlocking Compound should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4-inch bolts 110 to 120 in.lbs. (12.4 to 13.5 Nm). Do not torque over 125 in.lbs. (14.1 Nm). Torque the 5/16-inch bolts 140 in.lbs. (15.8 Nm). Do not torque over 145 in.lbs. (16.3 Nm).
5. Make sure the valve is seated against the housing valve flat. If it is raised up on any side or corner, remove the valve to determine what the obstruction is. If possible, test this using a hydraulic hand pump or electric test.

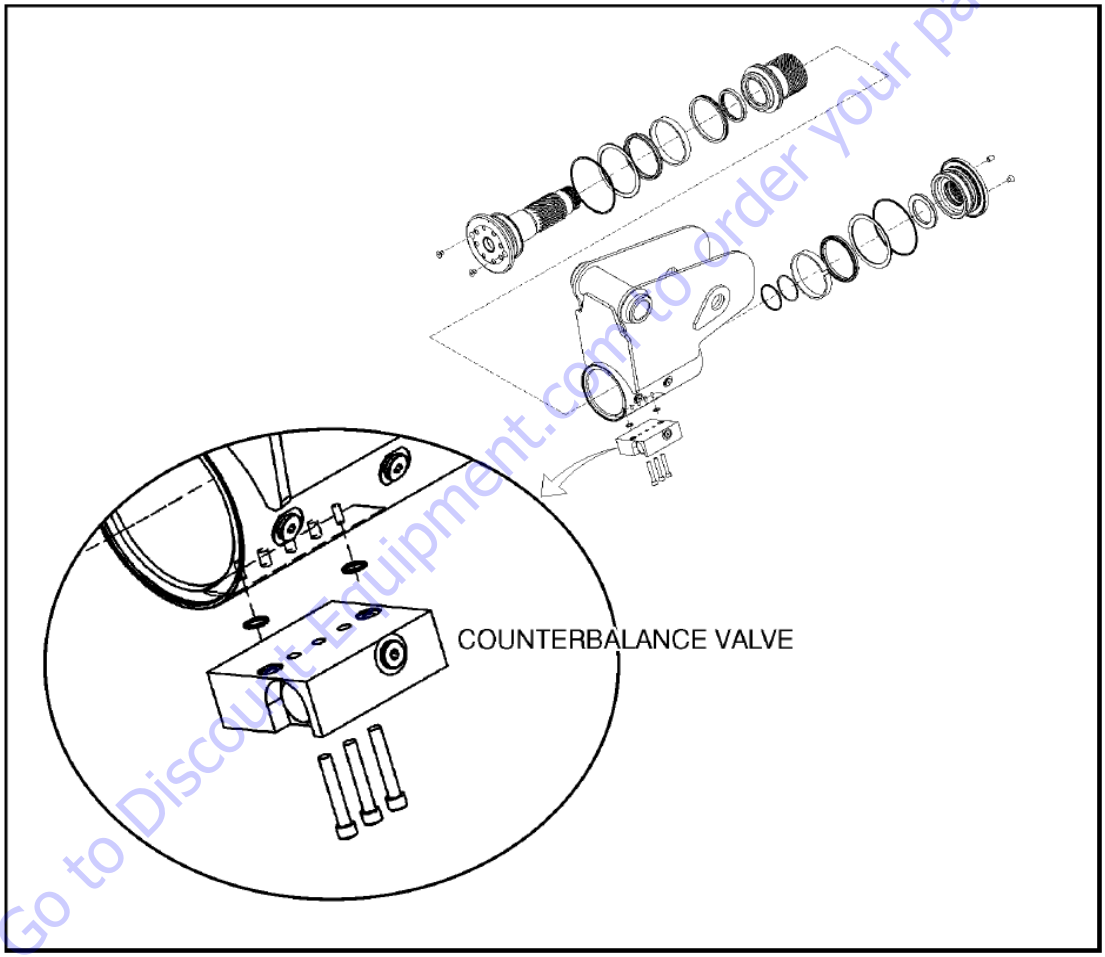


Figure 4-26. Rotator Counterbalance Valve

Greasing Thrust Washers

1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.

2. There are two grease ports located on both the shaft flange and the end cap. They are plugged with capscrews (113) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view)

NOTICE

IF A HYDRAULIC TEST BENCH IS NOT AVAILABLE, THE ACTUATOR CAN BE ROTATED BY HAND, OPEN THE PRESSURE PORTS AND USE A PRY BAR WITH CAPSCREWS INSERTED INTO THE SHAFT FLANGE TO TURN THE SHAFT IN THE DESIRED DIRECTION.

3. Insert the tip of a grease gun into one port and apply grease to the shaft flange. Continue applying until grease flows from the opposite port. Cycle the actuator five times and apply grease again. Repeat this process on the end cap. Insert the capscrews into the grease ports and tighten to 25 in-lbs. (2.8 Nm).

Testing the Actuator

If the equipment is available, the actuator should be tested on a hydraulic test bench. The breakaway pressure — the pressure at which the shaft begins to rotate — should be approximately 400 psi (28 bar). Cycle the actuator at least 25 times at 3000 psi (210 bar) pressure. After the 25 rotations, increase the pressure to 4500 psi (315 bar) to check for leaks and cracks. Perform the test again at the end of the rotation in the opposite direction.

TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

If the actuator is equipped with a counterbalance valve, plug the valve ports. Connect the hydraulic lines to the housing ports. Bleed all air from the actuator (see Installation and Bleeding) Rotate the shaft to the end of rotation at 3000 psi (210 bar) and maintain pressure. Remove the hydraulic line from the non-pressurized side.

Continuous oil flow from the open housing port indicates internal leakage across the piston. Replace the line and rotate the shaft to the end of rotation in the opposite direction. Repeat the test procedure outlined above for the other port. If there is an internal leak, disassemble, inspect and repair.

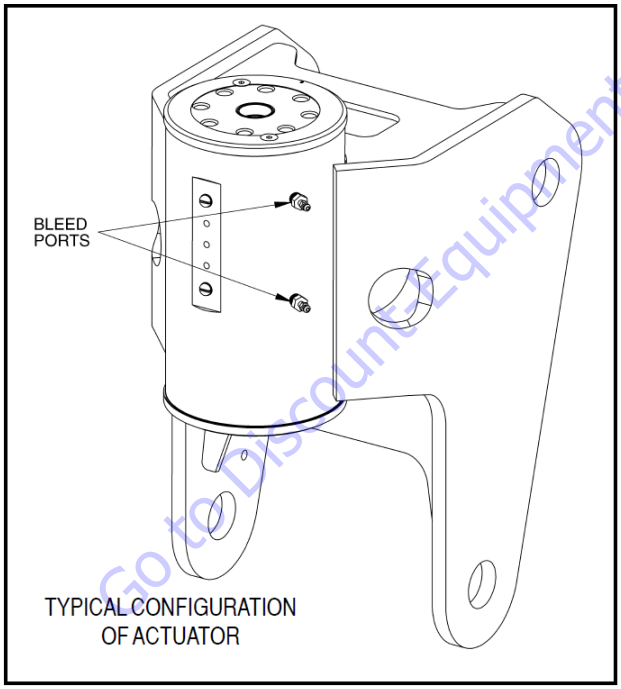
Installation and Bleeding

After installation of the actuator on the equipment, it is important that all safety devices such as tie rods or safety cables are properly reattached.

To purge air from the hydraulic lines, connect them together to create a closed loop and pump hydraulic fluid through them. Review the hydraulic schematic to determine which hydraulic lines to connect. The linear feet and inside diameter of the hydraulic supply lines together with pump capacity will determine the amount of pumping time required to fully purge the hydraulic system.

Bleeding may be necessary if excessive backlash is exhibited after the actuator is connected to the hydraulic system. The following steps are recommended when a minimum of two gallons (8 liters) is purged.

1. Connect a 3/16" inside diameter x 5/16" outside diameter x 5 foot clear, vinyl drain tube to each of the two bleed nipples. Secure them with hose clamps. Place the vinyl tubes in a clean 5-gallon container to collect the purged oil. The oil can be returned to the reservoir after this procedure is completed.



TYPICAL CONFIGURATION
OF ACTUATOR

2. With an operator in the platform, open both bleed nipples 1/4 turn. Hydraulically rotate the platform to the end of rotation (either clockwise or counterclockwise), and maintain hydraulic pressure. Oil with small air bubbles will be seen flowing through the tubes. Allow a 1/2 gallon of fluid to be purged from the actuator.
3. Keep the fittings open and rotate the platform in the opposite direction to the end position. Maintain hydraulic pressure until an additional 1/4 gallon of fluid is pumped into the container.
4. Repeat steps 2 & 3. After the last 1/2 gallon is purged, close both bleed nipples before rotating away from the end position.

4.19 FOOT SWITCH ADJUSTMENT

Adjust so that functions will operate when pedal is at center of travel. If switch operates within last 1/4 in. (6.35 mm) of travel, top or bottom, it should be adjusted.

Troubleshooting

Table 4-1. Troubleshooting

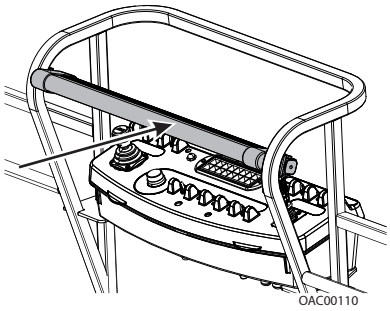
Problem	Cause	Solution
1. Shaft rotates slowly or not at all	a. Insufficient torque output	a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.
	b. Low rate of fluid flow	b. Inspect ports for obstructions and hydraulic lines for restrictions and leaks.
	c. Control or counterbalance valve has internal leak	c. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.
	d. Piston and/or shaft seal leak	d. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test.
	e. Corrosion build-up on the thrust surfaces	e. Re-build the actuator. Remove all rust then polish. Replacement parts may be needed.
	f. Swollen seals and composite bearings caused by incompatible hydraulic fluid	f. Re-build the actuator. Use fluid that is compatible with seals and bearings.
2. Operation is erratic or not responsive	a. Air in actuator	a. Purge air from actuator. See bleeding procedures.
3. Shaft will not fully rotate	a. Twisted or chipped gear teeth	a. Check for gear binding. Actuator may not be able to be re-built and may need to be replaced. Damage could be a result of overload or shock.
	b. Port fittings are obstructing the piston	b. Check thread length of port fittings. Fittings should during stroke not reach inside the housing bore.
4. Selected position cannot be maintained	a. Control or counterbalance valve has internal leak	a. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.
	b. Piston and/or shaft seal leak	b. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test.
	c. Air in actuator	c. Purge air from actuator. See bleeding procedures

4.20 SKYGUARD®

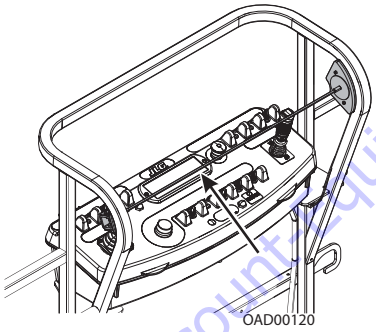
Operation

SkyGuard provides enhanced control panel protection. When the SkyGuard sensor is activated, functions in use at the time of actuation will reverse or cutout. The SkyGuard Function Table provides more details on these functions.

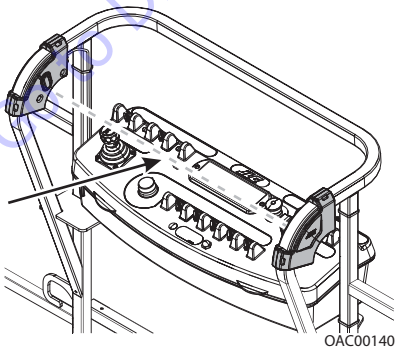
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



SkyGuard



SkyGuard SkyLine™



SkyGuard SkyEye™

⚠ WARNING

THE MACHINE OPERATOR IS REQUIRED TO PERFORM A DAILY FUNCTION TEST TO ENSURE PROPER OPERATION OF THE SKYGUARD SYSTEM.

Function Test

SKYGUARD ONLY

Perform this function test if **SkyGuard only** is selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops then telescope in function operates for a short duration. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure normal operation available.

In Ground Mode:

1. Operation is allowed regardless of SkyGuard activation.

BOTH SKYGUARD AND SOFT TOUCH

*Perform this procedure if **both SkyGuard and Soft Touch** are selected in machine setup* (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

NOTE: *Machine will treat Soft Touch/SkyGuard override switch as if it is a Soft Touch and SkyGuard switch.*

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure sure normal operation is available.

In Ground Mode:

1. Operation is allowed regardless of SkyGuard activation.

SOFT TOUCH ONLY

If **Soft Touch only** is selected in machine setup (refer to Table 6-2), machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch.

SKYGUARD NOT SELECTED IN MACHINE SETUP

If the SkyGuard system is installed on the machine, but no option is selected in the machine setup (refer to Table 6-2), SkyGuard sensor status will be ignored. No function cutout or reversal will be implemented.

Diagnostics & Troubleshooting

If SkyGuard does not function when the sensor is engaged, first verify the configuration under the
MACHINE SETUP: SKYGUARD OPTION menu using the handheld Analyzer. Ensure the selected configuration matches the actual system installed on the machine. If not, select the correct configuration, then verify operation.

Additionally, use the handheld analyzer to navigate to the DIAGNOSTICS: FEATURES → SKYGUARD INPUTS menu to determine additional SkyGuard fault information.

Engage the SkyGuard sensor and observe the Analyzer to determine if the switch/relay closes.

If the status of the switch/relay remains OPEN while the SkyGuard sensor is actively engaged, it is possible the sensor has failed and should be replaced immediately.

If the status of the switch/relay remains CLOSED while the SkyGuard sensor is actively engaged, a power or ground wire may not be making good contact or may be loose or broken. Additionally, there is a low probability that both relays may have failed.

If the switch/relay status is in disagreement, then one may have failed or is not installed correctly. In this case, the machine will be inoperable.

FAULT CODES

Refer to Table 6-13 for more fault code information

- **0039 -** SkyGuard switch activation fault
- **2563 -** switch disagreement fault

Table 4-2. SkyGuard Function Table

Drive Forward	Drive Reverse	Steer	Swing	Tower Lift Up	Tower Tele Out	Tower Lift Down	Boom Tele In	Boom Lift Up	Boom Lift Down	Boom Tele In	Boom Tele Out	Jib Lift	Basket Level	Basket Rotate
R*/C**	R	C	R	R	C	C	C	R	R	R	C	C	C	C
R = Indicates Reversal is Activated														
C = Indicates Cutout is Activated														
* DOS (Drive Orientation System) Enabled														
** DOS Not Enabled, machine is driving straight without steering, and any other hydraulic function is active														
Note: If SkyGuard is enabled with the SOft Touch system, functions will cutout instead of reversing.														

4.21 BOLT-ON EXTERNAL FALL ARREST

The Bolt-On External Fall Arrest system is designed to provide a lanyard attach point while allowing the operator to access areas outside the platform. Exit/Enter the platform through the gate area only. The system is designed for use by one person.

Personnel must use fall protection at all times. A full body harness is required with lanyard not to exceed 6 ft. (1.8 M) in length, that limits the maximum arrest force to 900 lb (408 kg).

Bolt-On External Fall Arrest System capacity is 310 lb (140 kg) - one (1) person maximum.

Do not move the platform during use of the Bolt-On External Fall Arrest system.

⚠ WARNING

DO NOT OPERATE ANY MACHINE FUNCTIONS WHILE OUTSIDE OF PLATFORM. BE CAREFUL WHEN ENTERING/EXITING THE PLATFORM AT ELEVATION.

⚠ WARNING

IF THE BOLT-ON EXTERNAL FALL ARREST SYSTEM IS USED TO ARREST A FALL OR IS OTHERWISE DAMAGED, THE ENTIRE SYSTEM MUST BE REPLACED AND THE PLATFORM FULLY INSPECTED BEFORE RETURNING TO SERVICE. REFER TO THE SERVICE MANUAL FOR REMOVAL AND INSTALLATION PROCEDURES.

THE BOLT-ON EXTERNAL FALL ARREST SYSTEM REQUIRES AN ANNUAL INSPECTION AND CERTIFICATION. THE ANNUAL INSPECTION AND CERTIFICATION MUST BE PERFORMED BY A QUALIFIED PERSON OTHER THAN THE USER.

Inspection Before Use

The Bolt-On External Fall Arrest system must be inspected before each use of the mobile elevating work platform. Replace components if there are any signs of wear or damage.

Before each use, perform a visual inspection of the following components:

- Cable: Inspect cable for proper tension, broken strands, kinks, or any signs of corrosion.

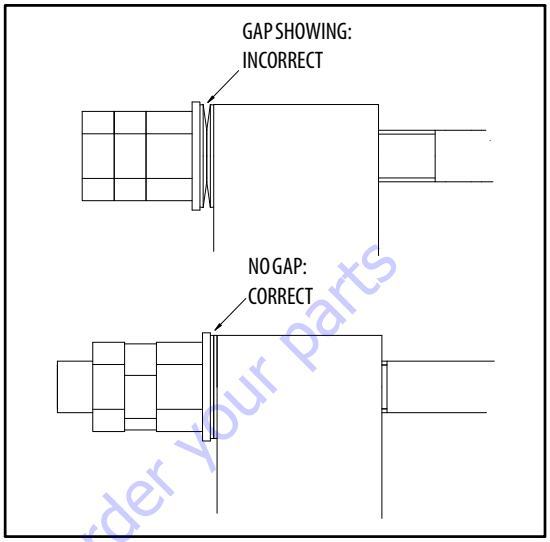
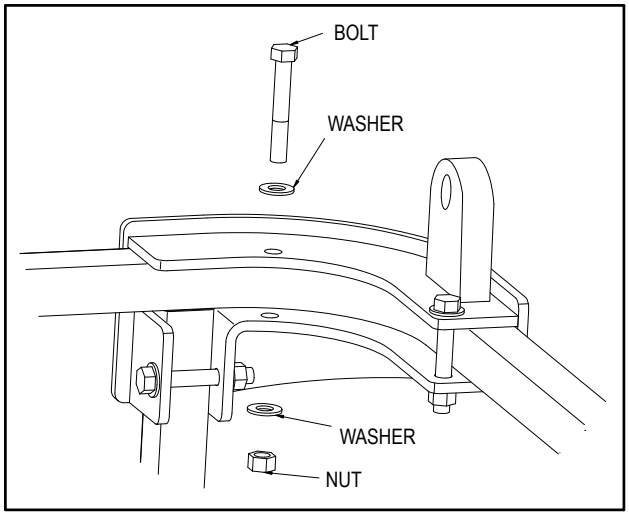


Figure 4-27. Bolt-On External Fall Arrest Cable Tension

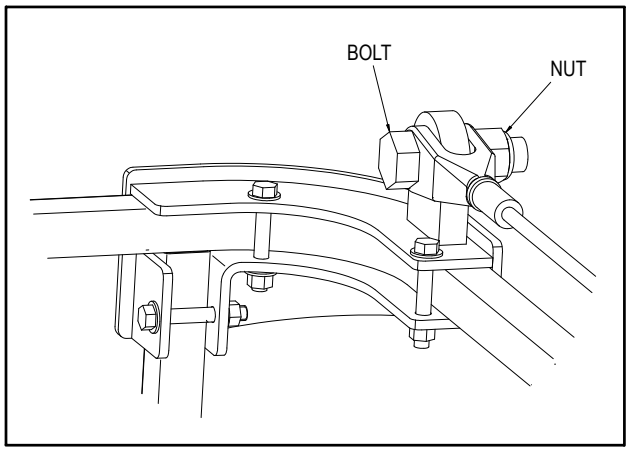
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are no missing components and hardware is properly tightened.
- Platform Rails: No visible damage is acceptable.

Installation

1. Install the retaining hardware (bolts, nuts, and washers) and secure the brackets to the platform rail. Tighten the nuts but do not torque them yet.

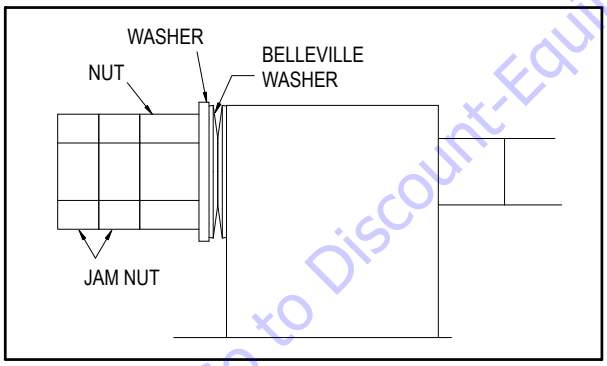


2. Attach the fall arrest cable to the right hand bracket Using the attaching bolt and nut. Orient the bolt as shown below. Do not tighten the nut so cable can still rotate.

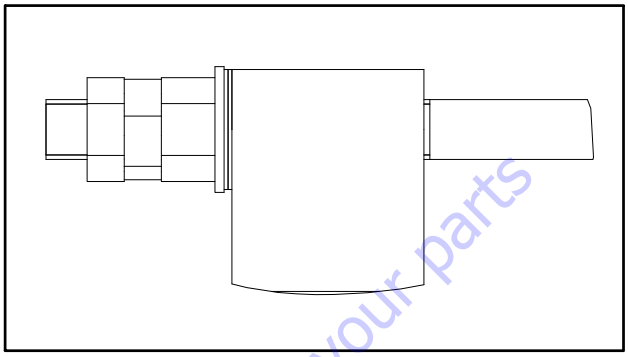


3. Install the Attachment Ring onto the cable.

4. Without twisting the fall arrest cable, pull it thru the left hand bracket and mark the top of the swaged cable end. Install the fall arrest cable through the left hand bracket and secure it using the belleville washers, washer, retaining nut, and jam nuts. Orient the hardware as shown below and with the belleville washers so the gap is present at the outside diameter of the washers. install the nuts onto the cable finger tight so the mark on the cable does not move.

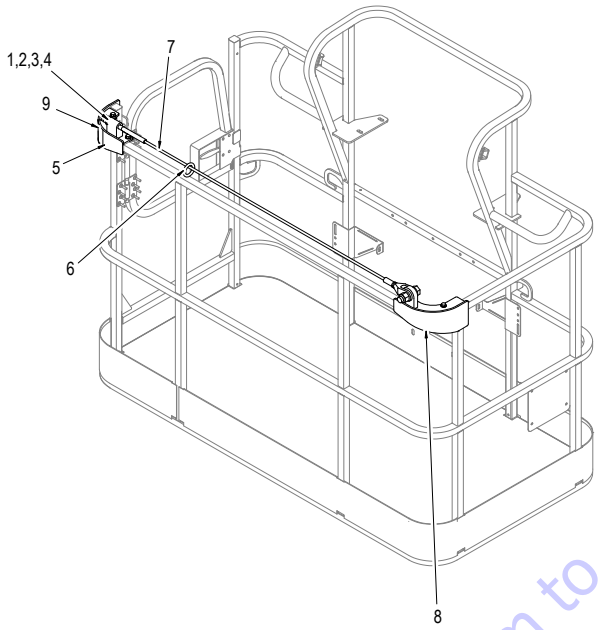


5. Use the two jam nuts to prevent the cable from rotating while the nut is tightened. Tighten the nut until the belleville washers are fully compressed and no gap is present at the outside diameter of the washers. Ensure the cable has not rotated during tightening.



6. Tighten the first jam nut against the retaining nut to keep the nut from loosening. Tighten the remaining jam nut against the first jam nut.

7. Torque the nuts and bolts securing the brackets to 15 ft.lbs. (20 Nm).



1. Belleville Washer
2. Washer
3. Hex Nut
4. Jam Nut
5. LH Bracket
6. Attachment Ring
7. Cable
8. RH Bracket
9. Decal

Figure 4-28. Bolt-On External Fall Arrest System

PARTS FINDER

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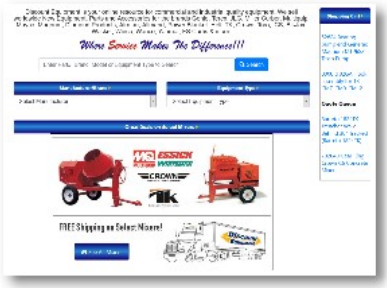

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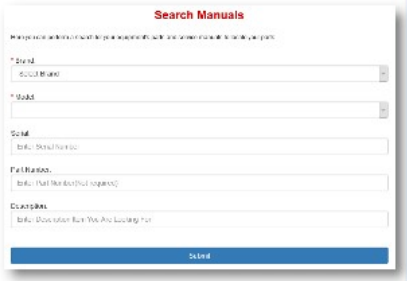

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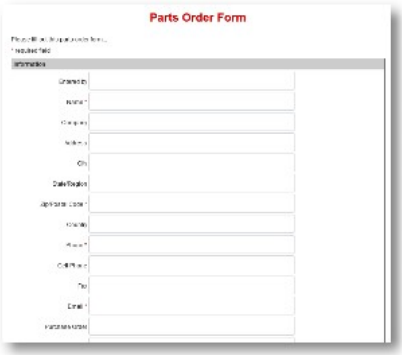

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SECTION 5. BASIC HYDRAULICS INFORMATION & SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

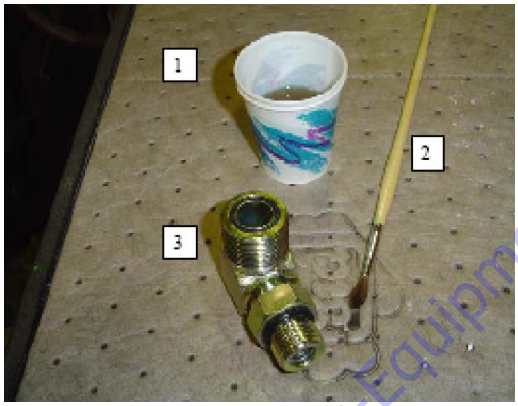
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

NOTE: *All O-ring fittings must be pre-lubricated with hydraulic oil prior to assembly.*

Cup and Brush

The following is needed to correctly oil the o-ring in this manner:

- A small container for hydraulic oil
- Small paint brush



1. Hold the fitting in one hand while using the brush with the other hand to dip into the container. Remove excess hydraulic oil from the brush so an even film of oil is applied on the o-ring.

2. Holding the fitting over the hydraulic oil container, brush an even film of oil around the entire o-ring in the fitting, making sure the entire o-ring is completely saturated.

3. Turn the o-ring on the other side of the fitting and repeat the previous step, ensuring the entire o-ring is coated with hydraulic oil.

Dip Method

NOTE: *This method works best with Face Seal o-rings, but will work for all o-ring fitting types.*

The following is needed to correctly oil the o-ring in this manner:

- A small leak proof container
- Sponge cut to fit inside the container
- A small amount of hydraulic oil to saturate the sponge.

1. Place the sponge inside the container and add hydraulic oil to the sponge until it is fully saturated.
2. Dip the fitting into the sponge using firm pressure. Upon lifting the fitting, a small droplet will form and drip from the bottom of the fitting. This should signify an even coating of oil on the fitting.

3. O-ring Boss type fittings will require more pressure in able to immerse more of the fitting into the saturated sponge. This will also cause more oil to be dispersed from the sponge.

Spray Method

This method requires a pump or trigger spray bottle.

1. Fill the spray bottle with hydraulic oil.
2. Hold the fitting over a suitable catch can.
3. Spray the entire o-ring surface with a medium coat of oil.

Brush-on Method

This method requires a sealed bottle brush.

1. Fill the bottle with hydraulic oil.
2. Using slight pressure to the body of the spray bottle, invert the bottle so the brush end is in the downward position.
3. Brush hydraulic oil on the entire o-ring, applying an even coat of oil.

5.2 HYDRAULIC CONNECTION ASSEMBLY AND TORQUE SPECIFICATION

Tapered Thread Types

NPTF = national tapered fuel (Dry Seal) per SAE J476/J512

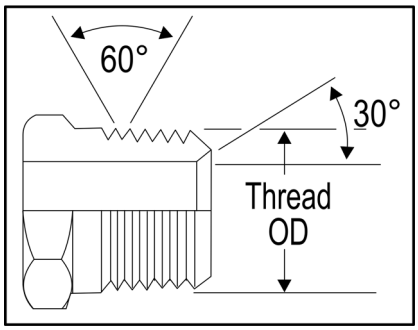


Figure 5-1. NPTF Thread

BSPT = British standard pipe tapered per ISO7-1

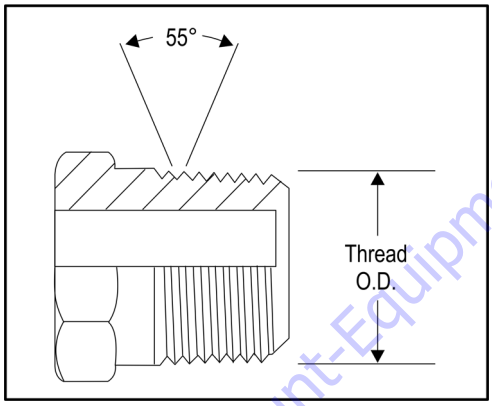


Figure 5-2. BSPT Thread

Straight Thread Types, Tube and Hose Connections

JIC = 37° flare per SAE J514

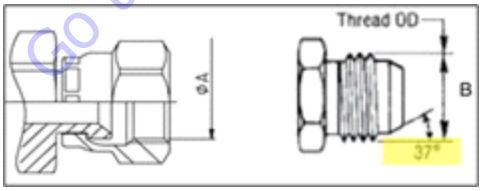


Figure 5-3. JIC Thread

SAE = 45° flare per SAE J512

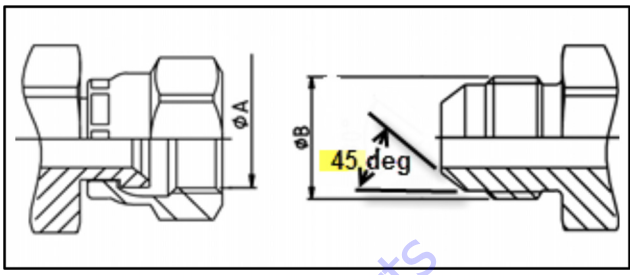


Figure 5-4. SAE Thread

ORFS = o-ring face seal per SAE J1453

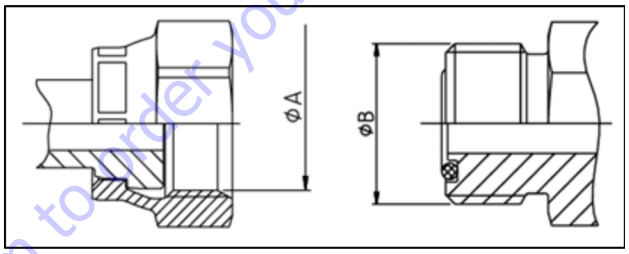


Figure 5-5. ORFS Thread

MBTL = metric flareless bite type fitting, pressure rating L (medium) per ISO 8434, DIN 2353

MBTS = metric flareless bite type fitting, pressure rating S (high) per ISO 8434, DIN 2353

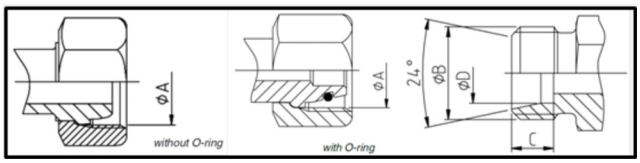


Figure 5-6. MTBL-MBTS Thread

BH = bulkhead connection – JIC, ORFS, MBTL, or MBTS types

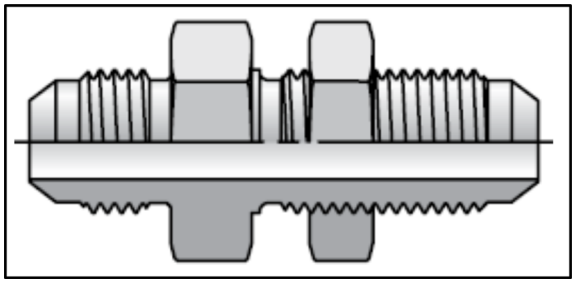


Figure 5-7. Bulkhead Thread

Straight Thread Types, Port Connections

ORB = o-ring boss per SAE J1926, ISO 11926

MPP = metric pipe parallel o-ring boss per SAE J2244, ISO 6149, DIN 3852

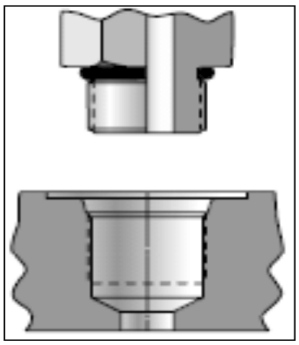


Figure 5-8. ORB-MPP Thread

MFF = metric flat face port per ISO 9974-1

BSPP = British standard parallel pipe per ISO 1179-1, DIN 3852-2

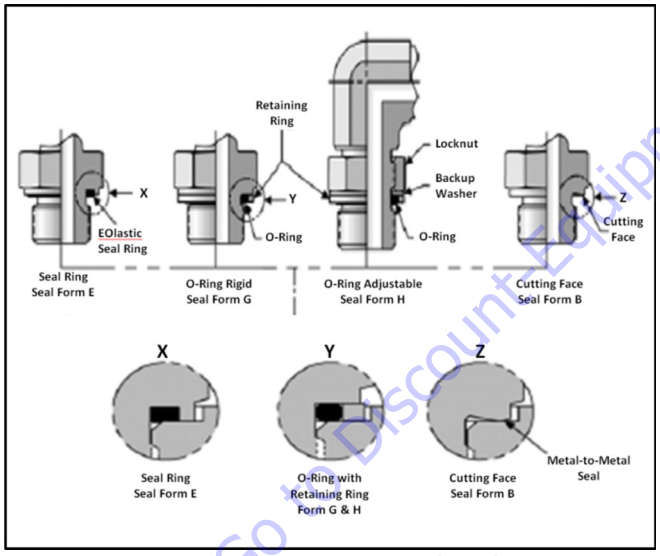


Figure 5-9. MFF-BSPP Thread

Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

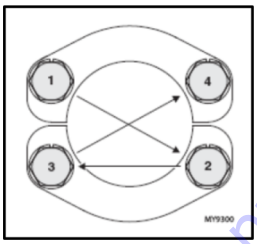


Figure 5-10. ORB-MPP Thread

Tightening Methods

Torque = Application of a twisting force to the applicable connection by use of a precise measurement instrument (i.e. torque wrench).

Finger Tight = The point where the connector will no longer thread onto the mating part when tightened by hand or fingers. Finger Tight is relative to user strength and will have some variance. The average torque applied by this method is 3 ft-lbs [4 N-m] Also referred to as 'Hand Tight.'

TFFT = Turns From Finger Tight; Application of a preload to a connection by first tightening the connection by hand (fingers) and applying an additional rotation counted by a defined number of turns by use of a tool.

FFWR = Flats from Wrench Resistance; Application of a preload to a connection by tightening to the point of initial wrench resistance and turning the nut a described number of 'flats'. A 'flat' is one side of the hexagonal tube nut and equates to 1/6 of a turn. Also referred to as the 'Flats Method.'

Assembly and Torque Specifications

Prior to selecting the appropriate torque from the tables within this section, it is necessary to properly identify the connector being installed. Refer to the Figures and Tables in this section.

GENERAL TUBE TYPE FITTING ASSEMBLY INSTRUCTIONS

1. Take precautions to ensure that fittings and mating components are not damaged during storage, handling or assembly. Nicks and scratches in sealing surfaces can create a path for leaks which could lead to component contamination and/or failure.
2. When making a connection to tubing, compression or flare, inspect the tube in the area of the fitting attachment to ensure that the tube has not been damaged.
3. The assembly process is one of the leading causes for contamination in air and hydraulic systems. Contamination can prevent proper tightening of fittings and adapters from occurring.
   - **a.** Avoid using dirty or oily rags when handling fittings.
   - **b.** If fittings are disassembled, they should be cleaned and inspected for damage. Replace fittings as necessary before re-installing.
   - **c.** Sealing compounds should be applied where specified; however, care should be taken not to introduce sealant into the system.
   - **d.** Avoid applying sealant to the area of the threads where the sealant will be forced into the system. This is generally the first two threads of a fitting.
   - **e.** Sealant should only be applied to the male threads.
   - **f.** Straight thread fittings do not require sealants. O-rings or washers are provided for sealing.
   - **g.** When replacing or installing an O-ring, care is to be taken while transferring the O-ring over the threads as it may become nicked or torn. When replacing an O-ring on a fitting, the use of a thread protector is recommended.
   - **h.** When installing fittings with O-rings, lubrication shall be used to prevent scuffing or tearing of the O-ring. See O-ring Installation (Replacement) in this section.
4. Take care to identify the material of parts to apply the correct torque values.
   - **a.** Verify the material designation in the table headings.
   - **b.** If specifications are given only for steel fittings and components, the values for alternate materials shall be as follows: Aluminum and Brass- reduce steel values by 35%; Stainless Steel- Use the main limit for steel.
5. To achieve the specified torque, the torque wrench is to be held perpendicular to the axis of rotation.

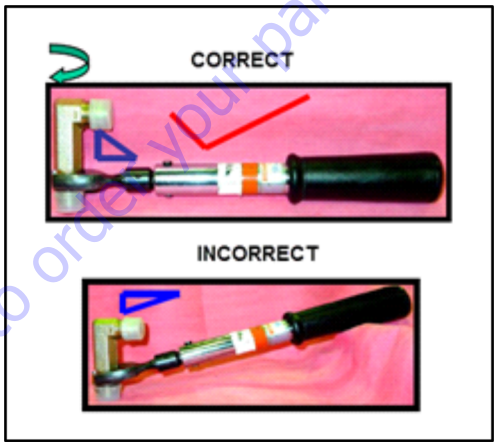


Figure 5-11. Torque Wrench Angle

6. Refer to the appropriate section in this manual for more specific instructions and procedures for each type of fitting connection

Assembly Instructions for American Standard Pipe Thread Tapered (NPTF) Connections.

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as High Strength Threadlocking compound to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

⚠ CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

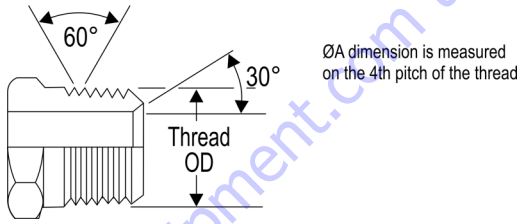
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-1, NPTF Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: *TFFT values provided in Table 5-1, NPTF Pipe Thread are applicable for the following material configurations:*

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-1. NPTF Pipe Thread



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
Material	Dash Size	Thread Size (UNF)	ØA* (in)	ØA* (mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-27	0.40	10.24	2 to 3
	4	1/4-18	0.54	13.61	2 to 3
	6	3/8-18	0.67	17.05	2 to 3
	8	1/2-14	0.84	21.22	2 to 3
	12	3/4-14	1.05	26.56	2 to 3
	16	1-11 1/2	1.31	33.22	1.5 to 2.5
	20	1 1/4-11 1/2	1.65	41.98	1.5 to 2.5
	24	1 1/2-11 1/2	1.89	48.05	1.5 to 2.5
	32	2-11 1/2	2.37	60.09	1.5 to 2.5

* ØA thread dimension for reference only.

** See FFWR and TFFT Methods subsection for TFFT procedure requirements.

Assembly Instructions for British Standard Pipe Thread Tapered (BSPT) Connections

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as High Strength Threadlocking compound, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

⚠ CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

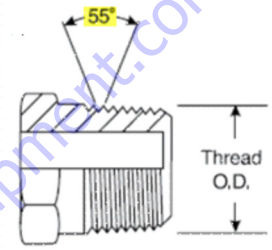
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-2, BSPT Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: *TFFT values provided in Table 5-2, BSPT Pipe Thread are applicable for the following material configurations:*

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-2. BSPT Pipe Thread



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
MATERIAL	Dash Size	Thread Size (BSPT)	ØA* (in)	ØA* (mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-28	0.38	9.73	2 to 3
	4	1/4-19	0.52	13.16	2 to 3
	6	3/8-19	0.66	16.66	2 to 3
	8	1/2-14	0.83	20.96	2 to 3
	12	3/4-14	1.04	26.44	2 to 3
	16	1-11	1.31	33.25	1.5 to 2.5
	20	1 1/4-11	1.65	41.91	1.5 to 2.5
	24	1 1/2-11	1.88	47.80	1.5 to 2.5
	32	2-11	2.35	59.61	1.5 to 2.5

* ØA thread dimension for reference only.

** See Appendix B for TFFT procedure requirements.

Assembly Instructions for 37° (JIC) Flare Fittings

1. Inspect the flare for obvious visual square ness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting and start threads by hand.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

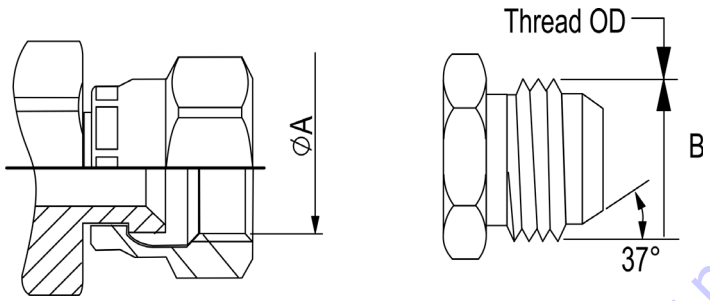
3. Torque assembly to value listed in Table Table 5-3, 37° Flare (JIC) Thread - Steel or Table 5-4, 37° Flare (JIC) Thread - Aluminum/Brass while using the Double Wrench Method per Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

NOTE: *Torque values provided in Table Table 5-3, 37° Flare (JIC) Thread - Steel and Table 5-4, 37° Flare (JIC) Thread - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-3. 37° Flare (JIC) Thread - Steel

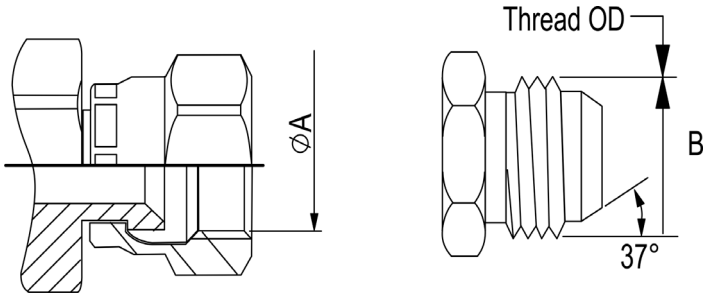


Type/Fitting Identification							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	7	8	9	10	--
	3	3/8-24	0.34	8.60	0.37	9.50	8	9	10	11	12	14	--
	4	7/16-20	0.39	10.00	0.44	11.10	13	14	14	18	19	19	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	14	15	15	19	20	21	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	22	23	24	30	31	33	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	42	44	46	57	60	63	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	60	63	66	81	85	89	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	84	88	92	114	120	125	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	100	105	110	136	142	149	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	118	124	130	160	168	176	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	168	176	185	228	239	251	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	195	205	215	264	278	291	3/4 to 1
	32	2 1/2-12	2.42	61.50	2.50	63.50	265	278	292	359	377	395	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

Table 5-4. 37° Flare (JIC) Thread - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	4	4	5	5	6	7	--
	3	3/8-24	0.34	8.60	0.37	9.50	5	6	7	7	8	9	--
	4	7/16-20	0.39	10.00	0.44	11.10	8	9	9	11	12	13	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	9	10	10	12	13	14	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	14	15	16	19	20	21	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	27	29	30	37	39	41	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	39	41	43	53	56	58	1 to 1-1/2
	12	11/16-12	0.97	24.60	1.06	27.00	55	57	60	74	78	81	1 to 1-1/2
	14	13/16-12	1.11	28.30	1.19	30.10	65	68	72	88	93	97	1 to 1-1/2
	16	15/16-12	1.23	31.30	1.31	33.30	77	81	84	104	109	114	3/4 to 1
	20	15/8-12	1.54	39.20	1.63	41.30	109	115	120	148	155	163	3/4 to 1
	24	17/8-12	1.80	45.60	1.87	47.60	127	133	139	172	180	189	3/4 to 1
	32	21/2-12	2.42	61.50	2.50	63.50	172	181	189	234	245	257	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

Assembly Instructions for 45° SAE Flare Fittings

1. Inspect the flare for obvious visual square ness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting.
3. Tighten fitting by hand until hand tight.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

Torque fitting to value listed in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass while using the Double Wrench Method outlined in this section. Refer to FFWR and TFFT Methods for procedure requirements if using the TFFT method.

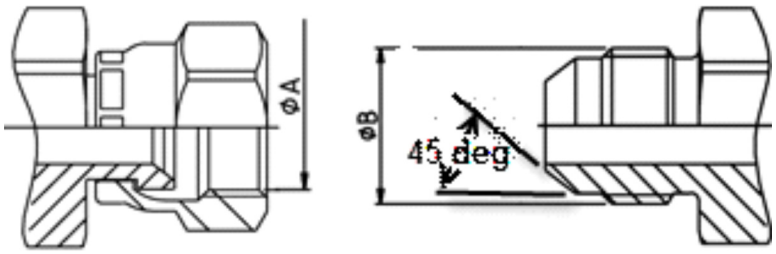
NOTE: *Torque values provided in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS

mating components.

Table 5-5. 45° Flare (SAE) - Steel

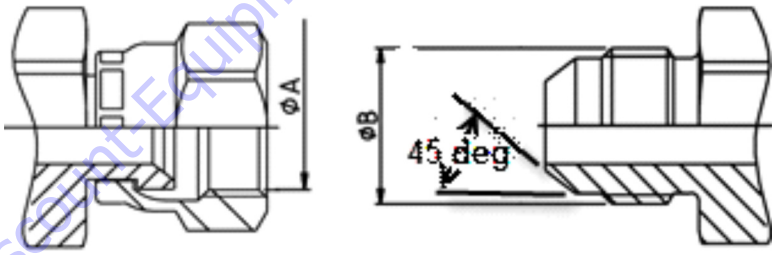


TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	13	14	14	18	19	19
	6	5/8-18	0.56	14.30	0.63	15.90	22	23	24	30	31	33
	8	3/4-16	0.69	17.50	0.75	19.10	42	44	46	57	60	62
	10	7/8-14	0.81	20.60	0.87	22.20	60	63	66	81	85	89
	12	11/16-14	0.98	25.00	1.06	27.00	84	88	92	114	119	125

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methodsfor FFWR procedure requirements.

Table 5-6. 45° Flare (SAE) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	8	9	9	11	12	12
	6	5/8-18	0.56	14.30	0.63	15.90	14	15	15	19	20	20
	8	3/4-16	0.69	17.50	0.75	19.10	27	29	30	37	39	41
	10	7/8-14	0.81	20.60	0.87	22.20	39	41	43	53	56	58
	12	11/16-14	0.98	25.00	1.06	27.00	55	58	61	75	79	83

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for TFFT procedure requirements.

Assembly Instructions for O-Ring Face Seal (ORFS) Fittings

1. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).
2. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Place the tube assembly against the fitting body so that the flat face comes in contact with the O-ring. Hand thread the nut onto the fitting body.
5. Torque nut to value listed in Table 5-7, O-ring Face Seal (ORFS) - Steel or Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass while using the Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

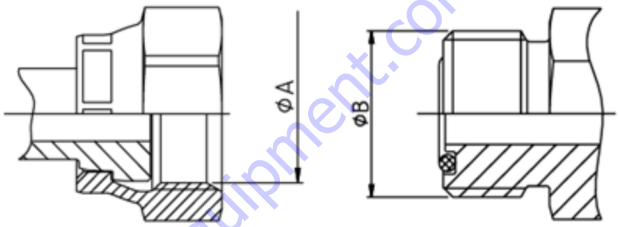
NOTE: *Torque values provided in Table 5-7, O-ring Face Seal (ORFS) - Steel and Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or

BRASS mating components

Table 5-7. O-ring Face Seal (ORFS) - Steel

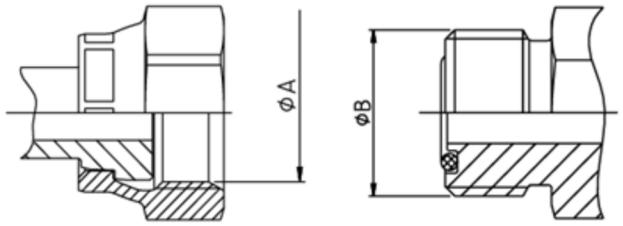


TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	18	19	20	25	26	27	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	30	32	33	40	43	45	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	40	42	44	55	57	60	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	60	63	66	81	85	89	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	85	90	94	115	122	127	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	110	116	121	149	157	164	1/4 to 1/2	1/2 to 3/4
	20	111/16-12	1.59	40.50	1.69	42.90	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	230	242	253	312	328	343	1/4 to 1/2	1/2 to 3/4
	32	21/2-12	2.43	61.67	2.50	63.50	375	394	413	508	534	560	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methodsfor FFWR procedure requirements.

Table 5-8. O-ring Face Seal (ORFS) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	26	28	29	35	38	39	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	39	41	43	53	56	58	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	55	58	61	75	79	83	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	72	76	79	98	103	107	1/4 to 1/2	1/2 to 3/4
	20	111/16-12	1.59	40.50	1.69	42.90	98	103	108	133	140	146	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	32	21/2-12	2.43	61.67	2.50	63.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

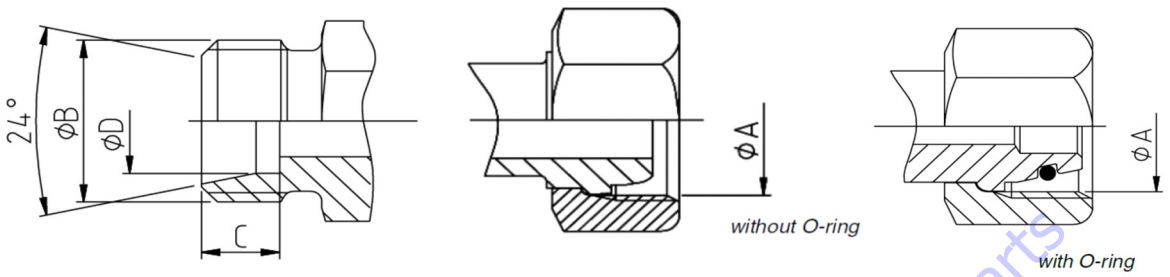
Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

⚠ CAUTION

A NON-SQUARE TUBE END CAN CAUSE IMPROPERLY SEATED FITTINGS AND LEAKAGE.

1. Inspect the components to ensure free of contamination, external damage, rust, splits, dirt, foreign matter, or burrs. Ensure tube end is visibly square. If necessary replace fitting or tube.
2. Lubricate thread and cone of fitting body or hardened pre-assembly tool, as well as the progressive ring and nut threads.
3. Slip nut and progressive ring over tube, assuring that they are in the proper orientation.
4. Push the tube end into the coupling body.
5. Slide collect into position and tighten until finger tight. Mark nut and tube in the finger-tight position. Tighten nut to the number of flats listed in Table Table 5-9, DIN 24°Cone (MBTL & MBTS) while using the Double Wrench Method. The tube must not turn with the nut.

Table 5-9. DIN 24°Cone (MBTL & MBTS)



TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)						
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Torque [Ft-Lb] Nom	Torque [Ft-Lb] Max	Torque [N-m] Min	Torque [N-m] Nom	Torque [N-m] Max	Flats from Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12x1.5	10.50	12.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the						1.5 to 1.75
		8	M14x1.5	12.50	14.00	7.00	8.20							1.5 to 1.75
		10	M16x1.5	14.50	16.00	7.00	10.20							1.5 to 1.75
		12	M18x1.5	16.50	18.00	7.00	12.20							1.5 to 1.75
		15	M22x1.5	20.50	22.00	7.00	15.20							1.5 to 1.75
		18	M26x1.5	24.50	26.00	7.50	18.20							1.5 to 1.75
		22	M30x2	27.90	30.00	7.50	22.20							1.5 to 1.75
		28	M36x2	33.90	36.00	7.50	28.20							1.5 to 1.75
		35	M45x2	42.90	45.00	10.50	35.30							1.5 to 1.75
		42	M52x2	49.90	52.00	11.00	42.30							1.5 to 1.75
	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Torque [Ft-Lb] Nom	Torque [Ft-Lb] Max	Torque [N-m] Min	Torque [N-m] Nom	Torque [N-m] Max	Flats from Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14x1.5	12.50	14.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the						1.5 to 1.75
		8	M16x1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
		10	M18x1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
		12	M20x1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
		14	M22x1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
		16	M24x1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
		20	M30x2	27.90	30.00	10.50	20.20							1.5 to 1.75
		25	M36x2	33.90	36.00	12.00	25.20							1.5 to 1.75
		30	M42x2	39.90	42.00	13.50	30.20							1.5 to 1.75
		38	M52x2	49.90	52.00	16.00	38.30							1.5 to 1.75

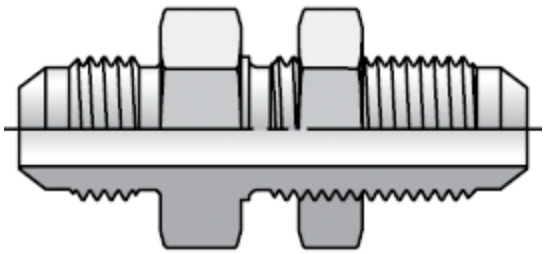
* ØA, ØB, C, & ØD thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

Assembly Instructions for Bulkhead (BH) Fittings

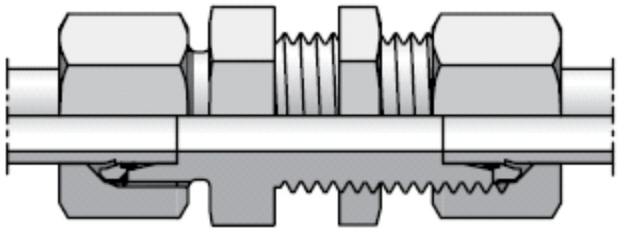
1. Ensure threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary replace fitting or adapter.
2. Remove the locknut from the bulkhead assembly.
3. Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
4. Hand thread the locknut onto the bulkhead end of the fitting body.
5. Torque nut onto fitting per Table 5-10 and Table 5-11 while using the Double Wrench Method.

Table 5-10. Bulkhead Fittings (BH) - INCH



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	O-RING FACE SEAL (ORFS) BULKHEAD FITTING	4	9/16-18	15	16	17	20	22	23
		6	11/16-16	25	27	28	34	37	38
		8	13/16-16	55	58	61	75	79	83
		10	1-14	85	90	94	115	122	127
		12	13/16-12	135	142	149	183	193	202
		14	15/16-12	170	179	187	230	243	254
		16	17/16-12	200	210	220	271	285	298
		20	111/16-12	245	258	270	332	350	366
		24	2-12	270	284	297	366	385	403
	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
	37° FLARE (JIC) BULKHEAD FITTING	3	3/8-24	8	9	9	11	12	12
		4	7/16-20	13	14	14	18	19	19
		5	1/2-20	20	21	22	27	28	30
		6	9/16-18	25	27	28	34	37	38
		8	3/4-16	50	53	55	68	72	75
		10	7/8-14	85	90	94	115	122	127
		12	11/16-12	135	142	149	183	193	202
		14	13/16-12	170	179	187	230	243	254
		16	15/16-12	200	210	220	271	285	298
		20	15/8-12	245	258	270	332	350	366
		24	17/8-12	270	284	297	366	385	403
		32	21/2-12	310	326	341	420	442	462

Table 5-11. Bulkhead Fittings (BH) - METRIC



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTL) BULKHEAD FITTING	6	M12x1.5	14	15	16	19	20	22
		8	M14x1.5	17	18	19	23	24	26
		10	M16x1.5	22	23	24	30	31	33
		12	M18x1.5	35	37	39	47	50	53
		15	M22x1.5	44	47	50	60	64	68
		18	M26x1.5	70	75	80	95	102	108
		22	M30x2	115	120	125	156	163	169
		28	M36x2	150	157	164	203	213	222
		35	M45x2	155	162	169	210	220	229
		42	M52x2	220	230	240	298	312	325
	DIN 24° CONE FLARELESS BITE (MBTS) BULKHEAD FITTING	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
		6	M14x1.5	17	15	16	23	20	22
		8	M16x1.5	22	18	19	30	24	26
		10	M18x1.5	35	23	24	47	31	33
		12	M20x1.5	40	35	37	54	47	50
		14	M22x1.5	44	47	50	60	64	68
		16	M24x1.5	70	75	80	95	102	108
		20	M30x2	115	120	125	156	163	169
		25	M36x2	150	157	164	203	213	222
		30	M42x2	155	162	169	210	220	229
		38	M52x2	220	230	240	298	312	325

Assembly Instructions for O-Ring Boss (ORB) Fittings

1. Inspect components to ensure that male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).

⚠ CAUTION

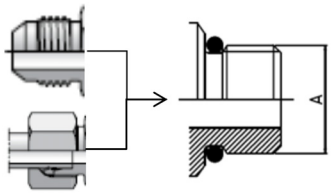
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-12 thru Table 5-17 while using the Double Wrench Method.
   a. The table headings identify the straight thread O-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread O-ring port.
   b. Torque values provided in Table 5-12 thru Table 5-17 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-12. O-ring Boss (ORB) - Table 1 of 6



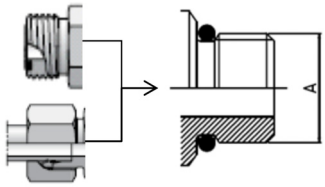
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-13. O-ring Boss (ORB) - Table 2 of 6

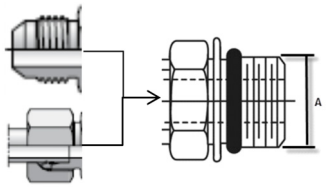


TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	26	27	28	35	37	38
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	17	18	18	23	24	24
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-14. O-ring Boss (ORB) - Table 3 of 6



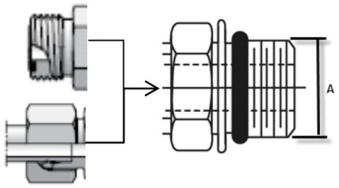
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	7	7
	3	3/8-24	0.37	9.52	(100)	(105)	(110)	11	12	12
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	21	22	23	28	30	31
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(39)	(41)	(43)	4	5	5
	3	3/8-24	0.37	9.52	(65)	(69)	(72)	7	8	8
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	15	19	20	20
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-15. O-ring Boss (ORB) - Table 4 of 6



TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

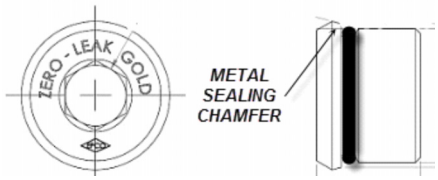
Table 5-16. O-ring Boss (ORB) - Table 5 of 6

TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	16	19	20	22
	6	9/16-18	0.56	14.28	34	36	38	46	49	52
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(20)	(21)	(21)	2	2	2
	3	3/8-24	0.37	9.52	(36)	(38)	(40)	4	4	5
	4	7/16-20	0.44	11.11	6	7	7	8	9	9
	5	1/2-20	0.50	12.70	9	10	10	12	14	14
	6	9/16-18	0.56	14.28	22	24	25	30	33	34
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-17. O-ring Boss (ORB) - Table 6 of 6



TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
	32	2 1/2-12	2.50	63.50						

TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
	32	2 1/2-12	2.50	63.50						

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Assembly Instructions for Adjustable Port End Metric (MFF) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

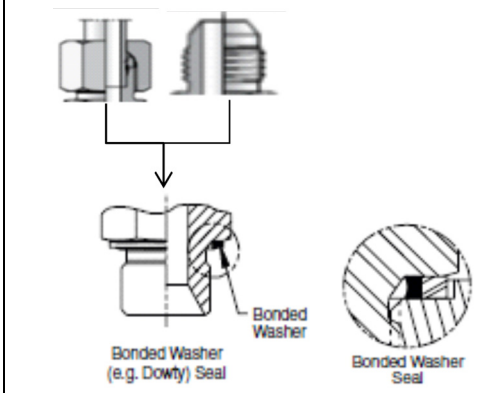
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

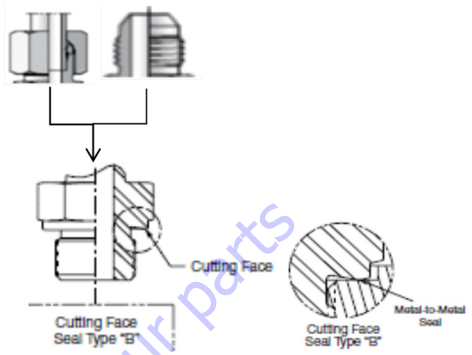
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, or Table 5-23 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, and Table 5-23 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

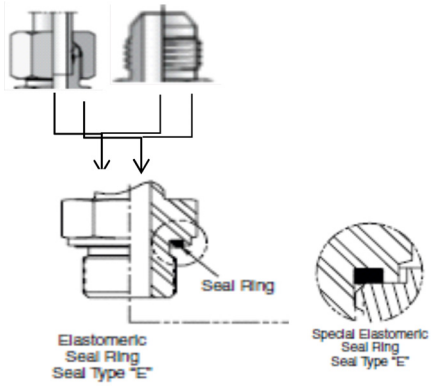
Table 5-18. Metric Flat Face Port (MFF) - L Series - Table 1 of 3

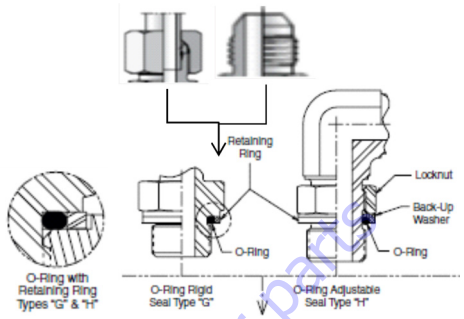




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	7	8	8	9	11	11	13	14	14	18	19	19
	M12x1.5	8	15	16	17	20	22	23	22	23	24	30	31	33
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	33	35	36	45	47	49	48	51	53	65	69	72
	M18x1.5	15	41	43	45	55	58	61	59	62	65	80	84	88
	M22x1.5	18	48	51	53	65	69	72	103	108	113	140	146	153
	M27x2	22	66	70	73	90	95	99	140	147	154	190	199	209
	M33x2	28	111	117	122	150	159	165	251	264	276	340	358	374
	M42x2	35	177	186	195	240	252	264	369	388	406	500	526	550
	M48x2	42	214	225	235	290	305	319	465	489	512	630	663	694
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	4	5	5	5	7	7	8	9	9	11	12	12
	M12x1.5	8	10	11	11	14	15	15	14	15	16	19	20	22
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	21	22	23	28	30	31	31	33	34	42	45	46
	M18x1.5	15	27	28	29	37	38	39	38	40	42	52	54	57
	M22x1.5	18	31	33	34	42	45	46	67	70	73	91	95	99
	M27x2	22	43	45	47	58	61	64	91	96	100	123	130	136
	M33x2	28	72	76	79	98	103	107	163	171	179	221	232	243
	M42x2	35	115	121	127	156	164	172	240	252	264	325	342	358
	M48x2	42	139	146	153	188	198	207	302	318	332	409	431	450

Table 5-19. Metric Flat Face Port (MFF) - L Series - Table 2 of 3





TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	15	18	19	20
	M12x1.5	8	18	19	20	25	26	27	18	19	20	25	26	28
	M14x1.5	10	33	35	36	45	47	49	30	31	32	40	42	44
	M16x1.5	12	41	43	45	55	58	61	41	43	45	55	58	61
	M18x1.5	15	52	55	57	70	75	77	52	54	57	70	74	77
	M22x1.5	18	92	97	101	125	132	137	66	70	73	90	95	99
	M27x2	22	133	140	146	180	190	198	133	139	146	180	189	198
	M33x2	28	229	241	252	310	327	342	229	240	252	310	326	341
	M42x2	35	332	349	365	450	473	495	332	348	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12
	M12x1.5	8	12	13	13	16	18	18	12	13	13	16	18	18
	M14x1.5	10	21	22	23	28	30	31	19	20	21	26	27	29
	M16x1.5	12	27	28	29	37	38	39	26	28	29	36	38	39
	M18x1.5	15	34	36	37	46	49	50	34	35	37	46	48	50
	M22x1.5	18	60	63	66	81	85	89	43	45	47	59	61	64
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 5-20. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

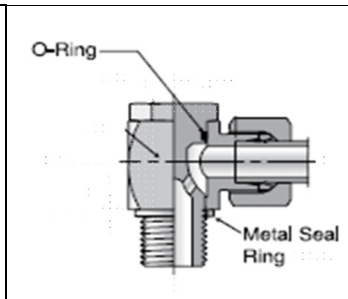
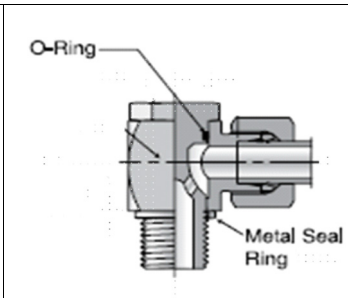
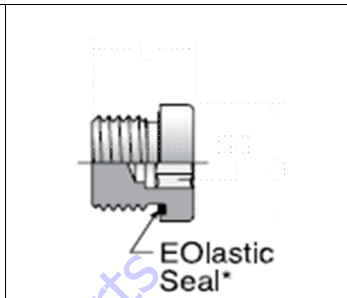
																				
TYPE/FITTING IDENTIFICATION			**BANJO FITTINGS with L series DIN (MBTL) opposite end**						**HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end**						**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**					
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	14	18	19	19	9	10	10	12	14	14
	M12x1.5	8	26	28	29	35	38	39	33	35	36	45	47	49	18	19	20	25	26	27
	M14x1.5	10	37	39	41	50	53	56	41	43	45	55	58	61	26	28	29	35	38	39
	M16x1.5	12	44	46	48	60	62	65	59	62	65	80	84	88	41	43	45	55	58	61
	M18x1.5	15	59	62	65	80	84	88	74	78	81	100	106	110	48	51	53	65	69	72
	M22x1.5	18	89	94	98	120	127	133	103	108	113	140	146	153	66	70	73	90	95	99
	M27x2	22	96	101	106	130	137	144	236	248	260	320	336	353	100	105	110	135	142	149
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	166	175	183	225	237	248
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	266	280	293	360	380	397
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	266	280	293	360	380	397
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	M12x1.5	8	17	18	19	23	24	26	21	22	23	28	30	31	12	13	13	16	18	18
	M14x1.5	10	24	26	27	33	35	37	27	28	29	37	38	39	17	18	19	23	24	26
	M16x1.5	12	29	30	31	39	41	42	38	40	42	52	54	57	27	28	29	37	38	39
	M18x1.5	15	38	40	42	52	54	57	48	51	53	65	69	72	31	33	34	42	45	46
	M22x1.5	18	58	61	64	79	83	87	67	70	73	91	95	99	43	45	47	58	61	64
	M27x2	22	62	66	69	84	89	94	153	161	169	207	218	229	65	69	72	88	94	98
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	108	114	119	146	155	161
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	173	182	190	235	247	258
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	173	182	190	235	247	258

Table 5-21. Metric Flat Face Port (MFF) - S Series - Table 1 of 3

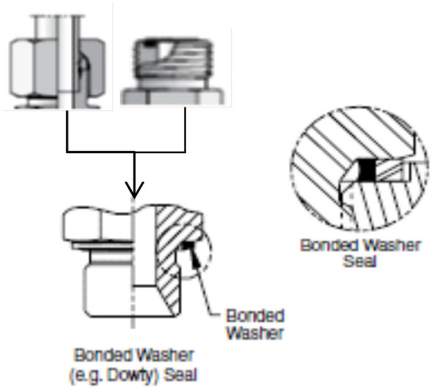
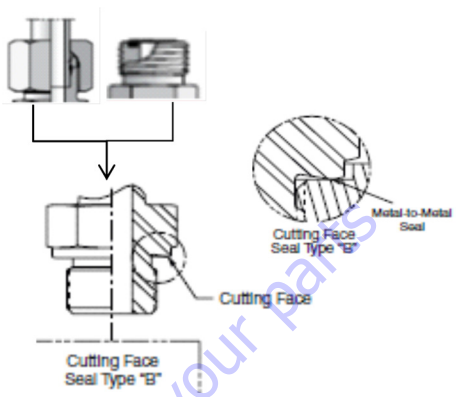
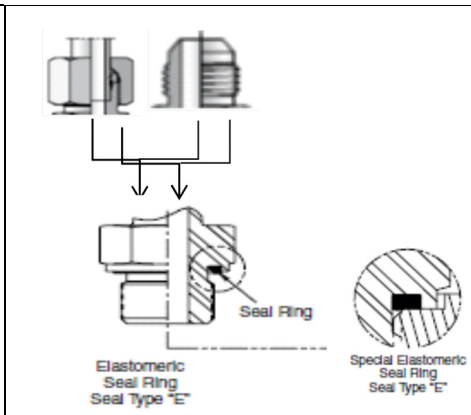
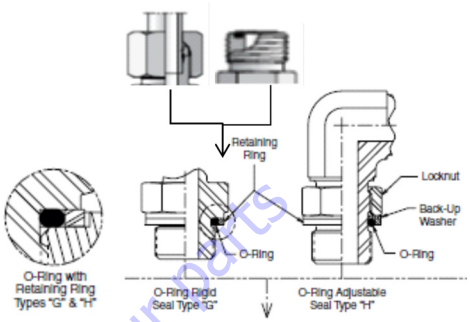
														
TYPE/FITTING IDENTIFICATION			**FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end**						**FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end**					
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	15	16	17	20	22	23	26	28	29	35	38	39
	M14x1.5	8	26	28	29	35	38	39	41	43	45	55	58	61
	M16x1.5	10	33	35	36	45	47	49	52	55	57	70	75	77
	M18x1.5	12	41	43	45	55	58	61	81	85	89	110	115	121
	M20x1.5	14	41	43	45	55	58	61	111	117	122	150	159	165
	M22x1.5	16	48	51	53	65	69	72	125	132	138	170	179	187
	M27x2	20	66	70	73	89	95	99	199	209	219	270	283	297
	M33x2	25	111	117	122	150	159	165	302	317	332	410	430	450
	M42x2	30	177	186	195	240	252	264	398	418	438	540	567	594
	M48x2	38	214	225	235	290	305	319	516	542	568	700	735	770
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	10	11	11	14	15	15	17	18	19	23	24	26
	M14x1.5	8	17	18	19	23	24	26	27	28	29	37	38	39
	M16x1.5	10	21	22	23	28	30	31	34	36	37	46	49	50
	M18x1.5	12	27	28	29	37	38	39	53	56	58	72	76	79
	M20x1.5	14	27	28	29	37	38	39	72	76	79	98	103	107
	M22x1.5	16	31	33	34	42	45	46	81	86	90	110	117	122
	M27x2	20	43	45	47	58	61	64	129	136	142	175	184	193
	M33x2	25	72	76	79	98	103	107	196	206	216	266	279	293
	M42x2	30	115	121	127	156	164	172	259	272	285	351	369	386
	M48x2	38	139	146	153	188	198	207	335	352	369	454	477	500

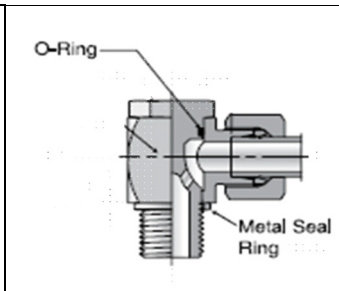
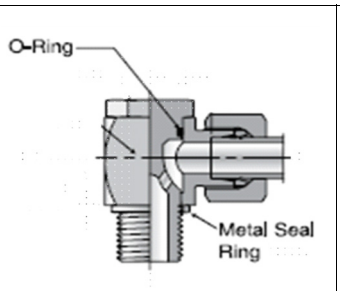
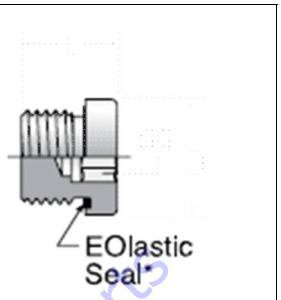
Table 5-22. Metric Flat Face Port (MFF) - S Series - Table 2 of 3





TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	26	28	29	35	38	39
	M12x1.5	8	33	35	36	45	47	49	41	43	45	55	58	61
	M14x1.5	10	52	55	57	70	75	77	52	55	57	70	75	77
	M16x1.5	12	66	70	73	90	95	99	66	70	73	90	95	99
	M18x1.5	15	92	97	101	125	132	137	92	97	101	125	132	137
	M22x1.5	18	100	105	110	135	142	149	100	105	110	135	142	149
	M27x2	22	133	140	146	180	190	198	133	140	146	180	190	198
	M33x2	28	229	241	252	310	327	342	229	241	252	310	327	342
	M42x2	35	332	349	365	450	473	495	332	349	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	17	18	19	23	24	26
	M12x1.5	8	21	23	23	29	31	32	27	28	29	37	38	39
	M14x1.5	10	34	36	37	46	49	50	34	36	37	46	49	50
	M16x1.5	12	43	45	47	58	61	64	43	45	47	58	61	64
	M18x1.5	15	60	63	66	81	85	89	60	63	66	81	85	89
	M22x1.5	18	65	69	72	88	94	98	65	69	72	88	94	98
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 5-23. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

			
TYPE/FITTING IDENTIFICATION	**BANJO FITTINGS with S series DIN (MBTS) opposite end**	**HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end**	**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**

MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	33	35	36	45	47	49	--	--	--	--	--	--
	M12x1.5	8	37	39	41	50	53	56	41	43	45	55	58	61	--	--	--	--	--	--
	M14x1.5	10	44	46	48	60	62	65	59	62	65	80	84	88	--	--	--	--	--	--
	M16x1.5	12	59	62	65	80	84	88	74	78	81	100	106	110	--	--	--	--	--	--
	M18x1.5	15	81	85	89	110	115	121	92	97	101	125	132	137	59	62	65	80	84	88
	M22x1.5	18	89	94	98	120	127	133	100	105	110	135	142	149	--	--	--	--	--	--
	M27x2	22	100	105	110	135	142	149	236	248	260	320	336	353	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	--	--	--	--	--	--

MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	21	22	23	28	30	31	--	--	--	--	--	--
	M12x1.5	8	24	26	27	33	35	37	27	28	29	37	38	39	--	--	--	--	--	--
	M14x1.5	10	29	30	31	39	41	42	38	40	42	52	54	57	--	--	--	--	--	--
	M16x1.5	12	38	40	42	52	54	57	48	51	53	65	69	72	--	--	--	--	--	--
	M18x1.5	15	53	56	58	72	76	79	60	63	66	81	85	89	38	40	42	52	54	57
	M22x1.5	18	58	61	64	79	83	87	65	69	72	88	94	98	--	--	--	--	--	--
	M27x2	22	65	69	72	88	94	98	153	161	169	207	218	229	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	--	--	--	--	--	--

Assembly Instructions for Metric ISO 6149 (MPP) Port Assembly Stud Ends

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not pre installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

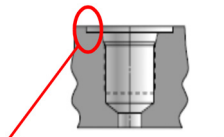
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-24 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-24 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

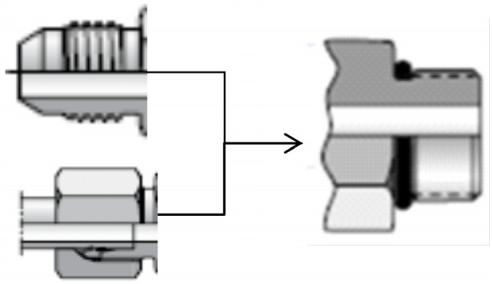
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

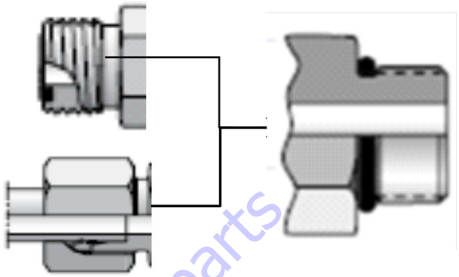
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)



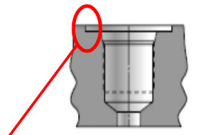
Note: Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB),**but is not interchangeable.**



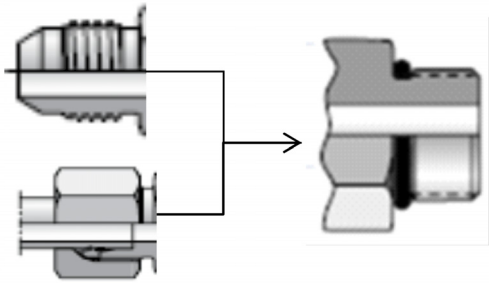


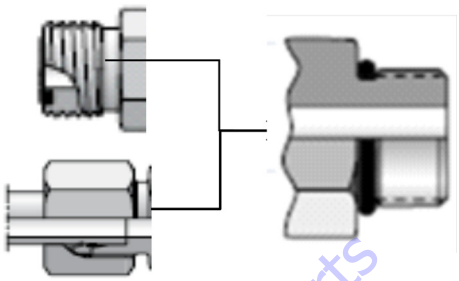
TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10x1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12x1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18x1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20x1.5	--	--	--	--	--	--	--	59	62	65	80	84	88
	M22x1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27x2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30x2	--	95	100	105	130	136	142	175	184	193	237	249	262
	M33x2	25	120	126	132	160	171	179	230	242	253	310	328	343
	M38x2	--	135	142	149	183	193	202	235	247	259	319	335	351
	M42x2	30	155	163	171	210	221	232	245	258	270	330	350	366
	M48x2	38	190	200	209	260	271	283	310	326	341	420	442	462
	M60x2	50	230	242	253	315	328	343	370	389	407	500	527	552

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)



Note: Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB),**but is not interchangeable.**





TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10x1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12x1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18x1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20x1.5	--	--	--	--	--	--	--	30	40	42	41	54	57
	M22x1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27x2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30x2	--	62	65	68	84	88	92	114	120	125	155	163	169
	M33x2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38x2	--	88	93	97	119	126	132	153	161	168	207	218	228
	M42x2	30	101	106	111	137	144	150	159	168	176	216	228	239
	M48x2	38	124	130	136	168	176	184	202	212	222	274	287	301
	M60x2	50	150	157	164	203	213	222	241	253	265	327	343	359

Assembly Instructions for Adjustable Port End (BSPP) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

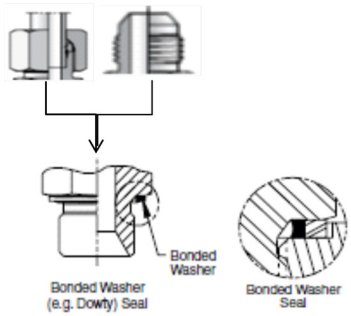
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

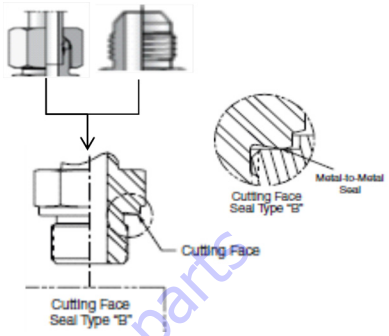
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, or Table 5-30 while using the Double Wrench Method.
   a. The table headings identify the BSPP port and the type on the other side of the fitting. The torque will be applied to the BSPP port.
   b. Torque values provided in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, and Table 5-30 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-25. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3





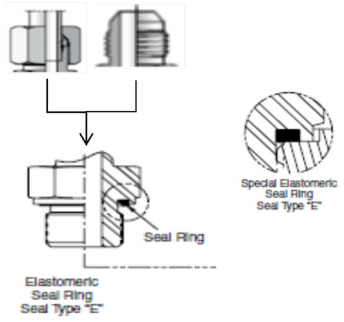
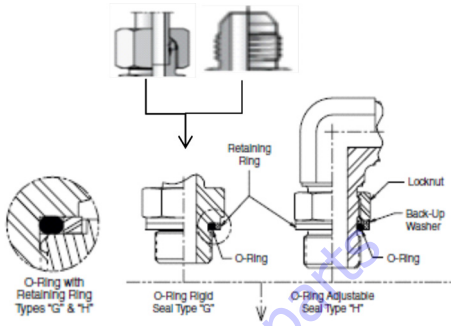
TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B** (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G 1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G 1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G 3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G 1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G 1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G 1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G 1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G 3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G 1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G 1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	42	139	146	153	188	198	207	302	318	333	409	431	451

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-26. British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3

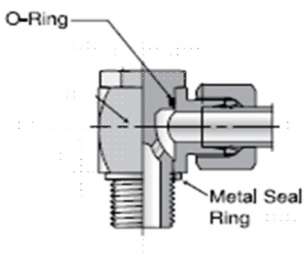
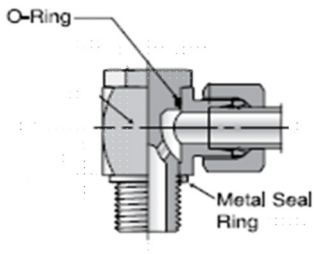
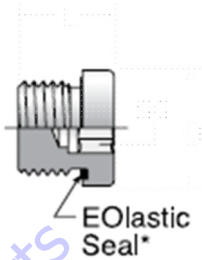
														
TYPE/FITTING IDENTIFICATION			**FORM E* (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end**						**FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end**					
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	52	55	57	70	75	77	52	55	57	70	75	77
	G 1/2A	15	66	70	73	90	95	99	66	70	73	90	95	99
	G 1/2A	18	66	70	73	90	95	99	66	70	73	90	95	99
	G 3/4A	22	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	28	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	35	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	34	36	37	46	49	50	34	36	37	46	49	50
	G 1/2A	15	43	45	47	58	61	64	43	45	47	58	61	64
	G 1/2A	18	43	45	47	58	61	64	43	45	47	58	61	64
	G 3/4A	22	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	28	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	35	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	42	259	272	285	351	369	386	259	272	285	351	369	386

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-27. British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3

			
TYPE/FITTING IDENTIFICATION	**BANJO FITTINGS with L series DIN (MBTL) opposite end**	**HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end**	**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**

MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15
	G1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65
	G1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153
	G1A	28	--	--	--	--	--	--	236	248	260	320	336	353	148	156	163	200	212	221
	G1-1/4A	35	--	--	--	--	--	--	398	418	438	540	567	594	295	313.5	332	400	425	450
	G1-1/2A	42	--	--	--	--	--	--	516	542	568	700	735	770	332	349	365	450	473	495

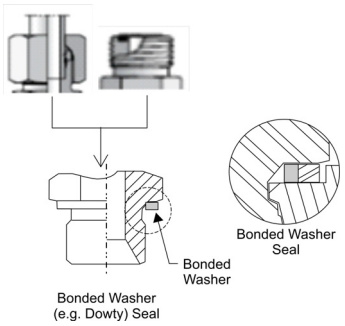
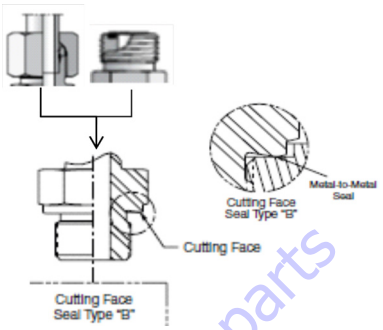
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	G1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42
	G1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99
	G1A	28	--	--	--	--	--	--	153	161	169	207	218	229	96	101	106	130	137	144
	G1-1/4A	35	--	--	--	--	--	--	259	272	285	351	369	386	216	227	237	293	308	321
	G1-1/2A	42	--	--	--	--	--	--	335	352	369	454	477	500	216	227	237	293	308	321

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-28. British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3

														
TYPE/FITTING IDENTIFICATION			**FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end**						**FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end**					
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	26	28	29	35	38	39	41	43	45	55	58	61
	G 1/4A	8	26	28	29	35	38	39	41	43	45	55	58	61
	G 3/8A	10	33	35	36	45	47	49	66	70	73	90	95	99
	G 3/8A	12	33	35	36	45	47	49	66	70	73	90	95	99
	G 1/2A	14	48	51	53	65	69	72	111	117	122	150	159	165
	G 1/2A	16	48	51	53	65	69	72	96	101	106	130	137	144
	G 3/4A	20	66	70	73	90	95	99	199	209	219	270	283	297
	G 1A	25	111	117	122	150	159	165	251	264	276	340	358	374
	G 1-1/4A	30	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	38	214	225	235	290	305	319	516	542	568	700	735	770
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	17	18	19	23	24	26	27	28	29	37	38	39
	G 1/4A	8	17	18	19	23	24	26	27	28	29	37	38	39
	G 3/8A	10	21	22	23	28	30	31	43	45	47	58	61	64
	G 3/8A	12	21	22	23	28	30	31	43	45	47	58	61	64
	G 1/2A	14	31	33	34	42	45	46	72	76	79	98	103	107
	G 1/2A	16	31	33	34	42	45	46	62	66	69	84	89	94
	G 3/4A	20	43	45	47	58	61	64	129	136	142	175	184	193
	G 1A	25	72	76	79	98	103	107	163	171	179	221	232	243
	G 1-1/4A	30	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	38	139	146	153	188	198	207	335	352	369	454	477	500

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-29. British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3

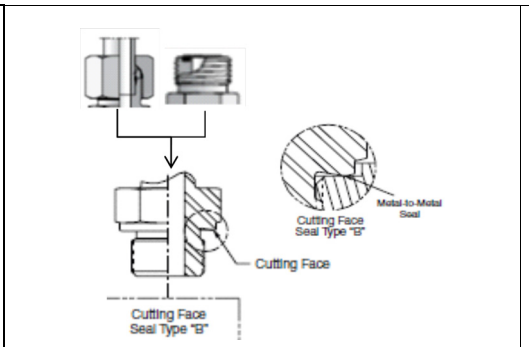
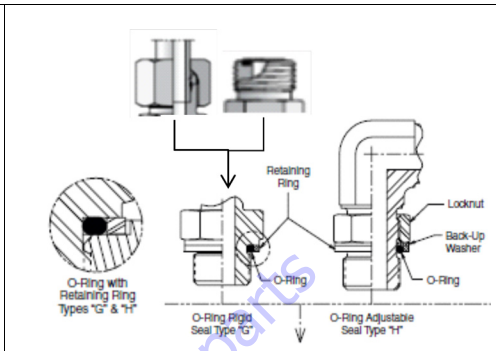
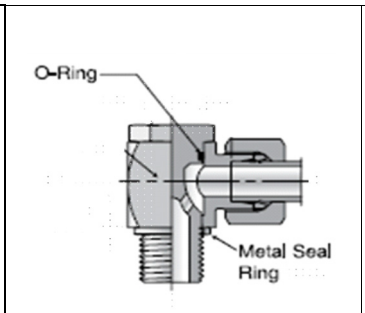
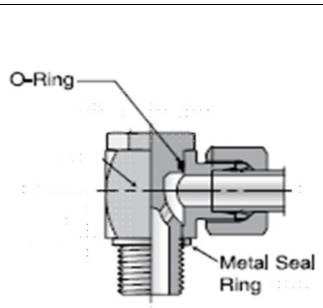
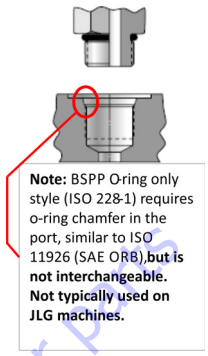
														
TYPE/FITTING IDENTIFICATION			**FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end**						**FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end**					
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	41	43	45	55	58	61	26	28	29	35	38	39
	G 1/4A	8	41	43	45	55	58	61	26	28	29	35	38	39
	G 3/8A	10	59	62	65	80	84	88	52	55	57	70	75	77
	G 3/8A	12	59	62	65	80	84	88	52	55	57	70	75	77
	G 1/2A	14	85	90	94	115	122	127	66	70	73	90	95	99
	G 1/2A	16	85	90	94	115	122	127	66	70	73	90	95	99
	G 3/4A	20	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	25	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	30	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	38	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	27	28	29	37	38	39	17	18	19	23	24	26
	G 1/4A	8	27	28	29	37	38	39	17	18	19	23	24	26
	G 3/8A	10	38	40	42	52	54	57	34	36	37	46	49	50
	G 3/8A	12	38	40	42	52	54	57	34	36	37	46	49	50
	G 1/2A	14	55	58	61	75	79	83	43	45	47	58	61	64
	G 1/2A	16	55	58	61	75	79	83	43	45	47	58	61	64
	G 3/4A	20	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	25	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	30	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	38	259	272	285	351	369	386	259	272	285	351	369	386
* Typical for JLG Straight Male Stud Fittings														
** Non typical for JLG Straight Male Stud Fittings, reference only.														
*** Typical for JLG Adjustable Fittings														

Table 5-30. British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						JIS/BSPP O-RING ONLY					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	30	32	33	40	43	45	33	35	36	45	47	49	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G 3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G 1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G 1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						
	G 3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254						
	G 1A	25	--	--	--	--	--	--	236	248	260	320	336	353						
	G 1-1/4A	30	--	--	--	--	--	--	398	418	438	540	567	594						
	G 1-1/2A	38	--	--	--	--	--	--	516	542	568	700	735	770						
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	20	21	21	27	28	28	22	22	23	30	30	31	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G 3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G 1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G 1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G 3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G 1A	25	--	--	--	--	--	--	153	161	169	207	218	229						
	G 1-1/4A	30	--	--	--	--	--	--	259	272	285	351	369	386						
	G 1-1/2A	38	--	--	--	--	--	--	335	352	368	454	477	499						

* Typical for JLG Straight Male Stud Fittings

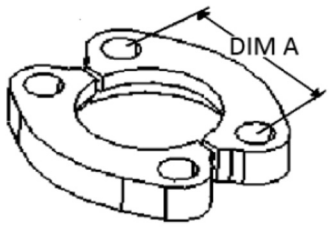
** Non typical for JLG Straight Male Stud Fittings, reference only.

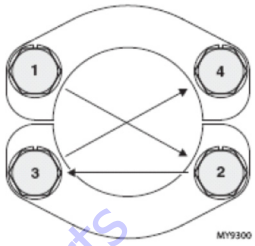
*** Typical for JLG Adjustable Fittings

Assembly Instructions for Flange Connections: (FL61 and FL62)

1. Make sure sealing surfaces are free of rust, splits, scratches, dirt, foreign matter, or burrs.
2. See Figure for O-ring installation instructions.
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Position flange and clamp halves.
5. Place lock washers on bolt and bolt through clamp halves.
6. Tighten all bolts by hand.
7. Torque bolts in diagonal sequence in two or more increments to the torque listed on Table Table 5-31and Table 5-32.

Table 5-31. Flange Code (FL61 & FL62) -Inch Fasteners

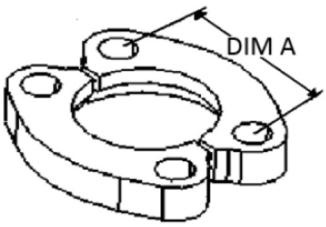


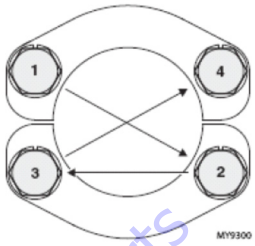


TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)													
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws						
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	5/16-18	18	19	19	24	25	26	24	25	26	32	34	35
	12	0.75	19	1.88	47.75	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	16	1.00	25	2.06	52.32	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	20	1.25	32	2.31	58.67	7/16-14	52	54	57	70	74	77	68	71	75	92	97	101
	24	1.50	38	2.75	69.85	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	32	2.00	51	3.06	77.72	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	40	2.50	64	3.50	88.90	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	48	3.00	76	4.19	106.43	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	56	3.50	89	4.75	120.65	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	64	4.00	102	5.13	130.30	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	80	5.00	127	6.00	152.40	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws						
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	5/16-18	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	3/8-16	--	--	--	--	--	--	44	46	49	60	63	66
	16	1.00	25	2.25	57.15	7/16-14	--	--	--	--	--	--	68	71	75	92	97	101
	20	1.25	32	2.62	66.55	1/2-13	--	--	--	--	--	--	111	116	122	150	158	165
	20	1.25	32	2.62	66.55	--	--	--	--	--	--	--	--	--	--	--	--	--
	24	1.50	38	3.12	79.25	5/8-11	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	3/4-10	--	--	--	--	--	--	332	348	365	450	473	495

* A dimension for reference only.

Table 5-32. Flange Code (FL61 & FL62) - Metric Fasteners





TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)													
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
	12	0.75	19	1.88	47.75	M8x1.25	18	19	19	24	25	26	18	19	19	24	25	26
	16	1.00	25	2.06	52.32	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	20	1.25	32	2.31	58.67	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	24	1.50	38	2.75	69.85	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	32	2.00	51	3.06	77.72	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	40	2.50	64	3.50	88.90	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	48	3.00	76	4.19	106.43	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	56	3.50	89	4.75	120.65	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	64	4.00	102	5.13	130.30	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	80	5.00	127	6.00	152.40	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	M8x1.25	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	M10x1.5	--	--	--	--	--	--	52	54	57	70	74	77
	16	1.00	25	2.25	57.15	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M14x2	--	--	--	--	--	--	133	139	146	180	189	198
	24	1.50	38	3.12	79.25	M16x2	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	M20x2.5	--	--	--	--	--	--	406	426	446	550	578	605

* A dimension for reference only.

Double Wrench Method

To prevent undesired hose or connector rotation, two wrenches must be used; one torque wrench and one backup wrench. If two wrenches are not used, inadvertent component rotation may occur which absorbs torque and causes improper joint load and leads to leaks. For hose connections, the 'lay line' printed on the hose is a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted. See Figure 5-12. for double wrench method requirements.

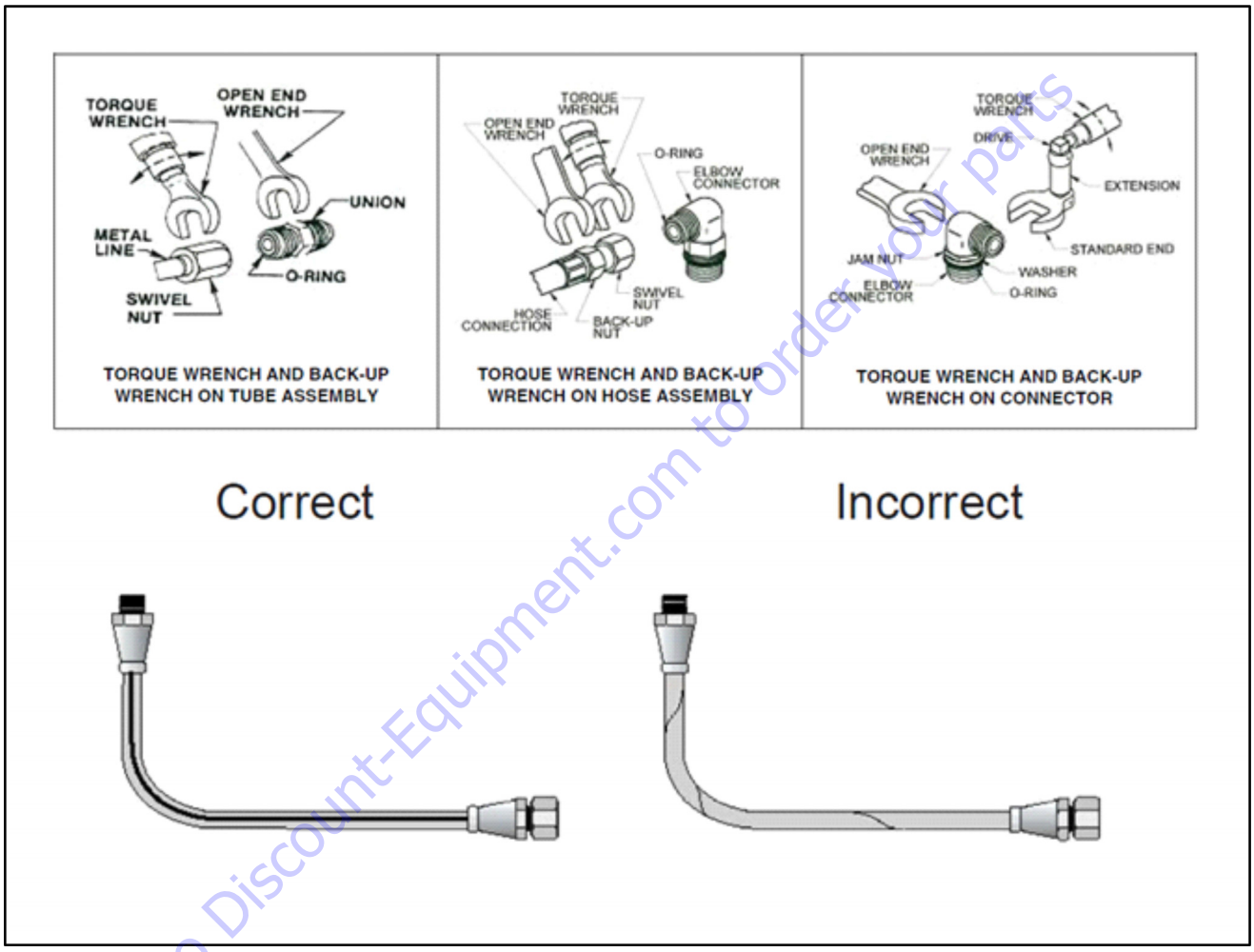


Figure 5-12. Double Wrench Method

FFWR and TFFT Methods

FFWR (FLATS FROM WRENCH RESISTANCE METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter. See Figure B.1.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten as shown in Figure B.1. The nut is to be rotated clockwise the number of hex flats as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened. See Figure 5-13.

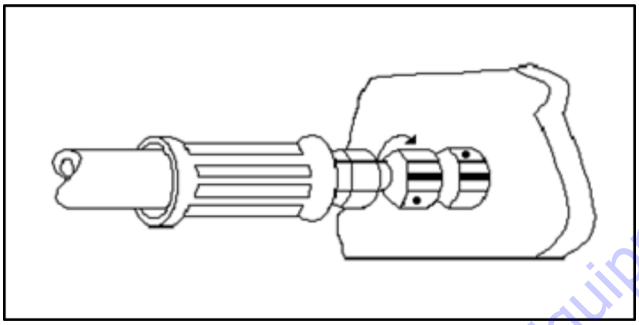


Figure 5-13. FFWR Method

TFFT (TURNS FROM FINGER TIGHT METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of turns as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

Adjustable Stud End Assembly

For Adjustable Stud End Connections; the following assembly steps are to be performed:

1. Lubricate the o-ring with a light coat of hydraulic oil.
2. Position #1 – The o-ring should be located in the groove adjacent to the face of the backup washer. The washer and o-ring should be positioned at the extreme top end of the groove as shown.
3. Position #2 – Position the locknut to just touch the backup washer as shown. The locknut in this position will eliminate potential backup washer damage during the next step.
4. Position #3 – Install the connector into the straight thread box port until the metal backup washer contacts the face of the port as shown.
5. Position #4 – Adjust the connector to the proper position by turning out (counterclockwise) up to a maximum of one turn as shown to provide proper alignment with the mating connector, tube assembly, or hose assembly.
6. Position #5 – Using two wrenches, use the backup wrench to hold the connector in the desired position and then use the torque wrench to tighten the locknut to the appropriate torque.
7. Visually inspect, where possible, the joint to ensure the o-ring is not pinched or bulging out from under the washer and that the backup washer is properly seated flat against the face of the port.

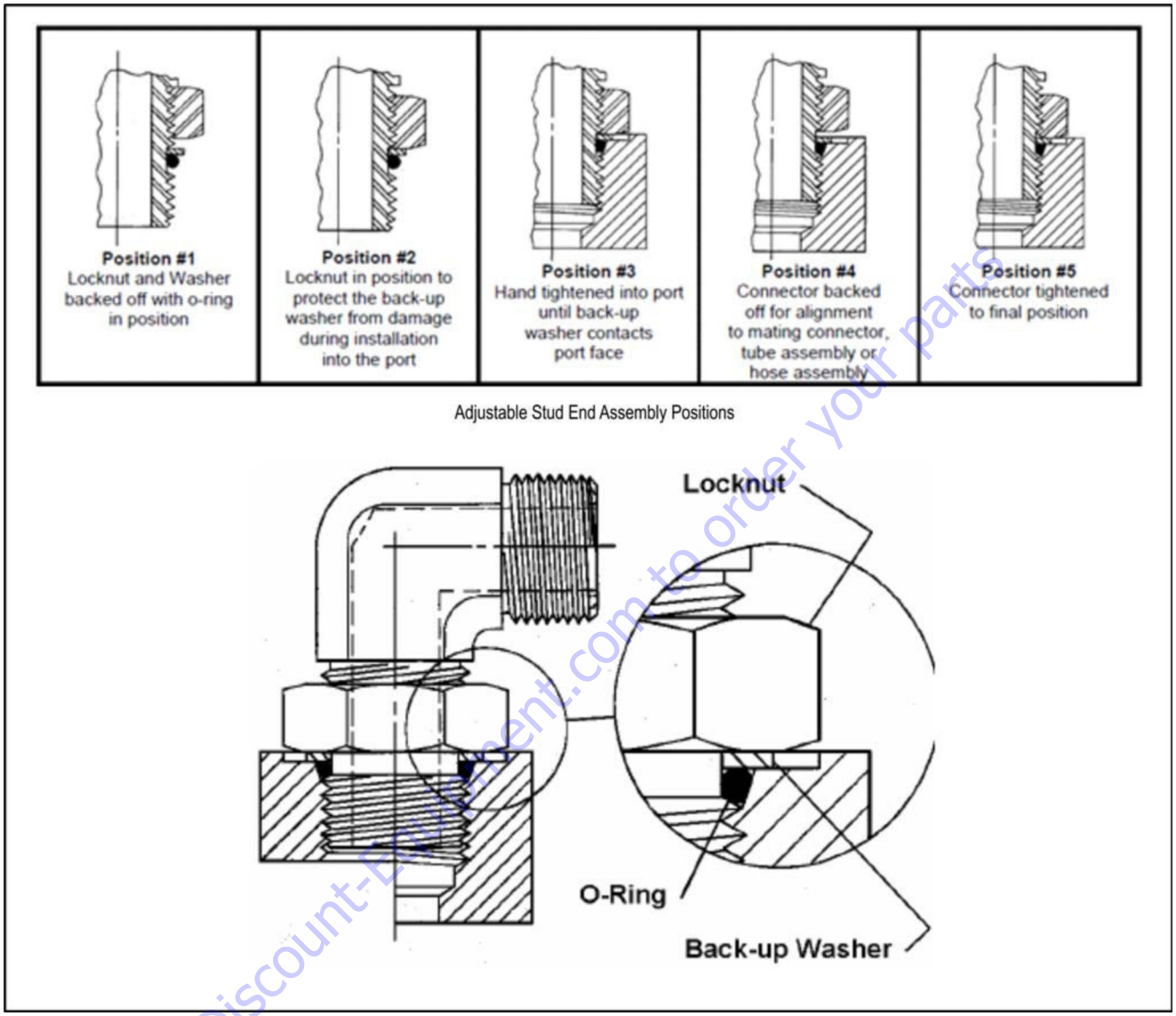


Figure 5-14. Adjustable Stud End Assembly

O-ring Installation (Replacement)

Care must be taken when installing O-rings over threads during replacement or installation. O-rings could become nicked or torn. A damaged O-ring could lead to leakage problems.

1. Inspect O-ring for tears or nicks. If any are found replace O-ring.
2. Ensure proper O-ring to be installed. Many O-rings look the same but are of different material, different hardness, or are slightly different diameters or widths.
3. Use a thread protector when replacing O-rings on fittings.
4. In ORB; ensure O-ring is properly seated in groove. On straight threads, ensure O-ring is seated all the way past the threads prior to installation.
5. Inspect O-ring for any visible nicks or tears. Replace if found.

5.3 HYDRAULIC CYLINDERS

Axle Lockout Cylinder

DISASSEMBLY

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

⚠ WARNING

ROD CAN FALL OUT OF BARREL AND CAUSE INJURY OR DAMAGE TO THE EQUIPMENT. BE CAREFUL WHEN REMOVING AXLE CYLINDER. OPENING BLEED VALVE CAN CAUSE ROD TO FALL OUT OF BARREL.

1. Open bleeder valve. Rotate rod and remove from barrel.
2. Remove wiper. Do not scratch barrel bore.
3. Remove two wear rings and rod seal from grooves of rod bore. Do not scratch barrel bore.
4. Remove counterbalance valve.

CLEANING AND INSPECTION

1. Inspect bore and rod for scoring, pitting, or excessive wear.
2. Remove minor surface blemishes with wet sandpaper. Pitting requires replacement of barrel and rod.
3. Clean all parts with approved solvent and dry with compressed air.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

NOTE: *Apply a light film of hydraulic oil to all components prior to assembly.*

NOTICE

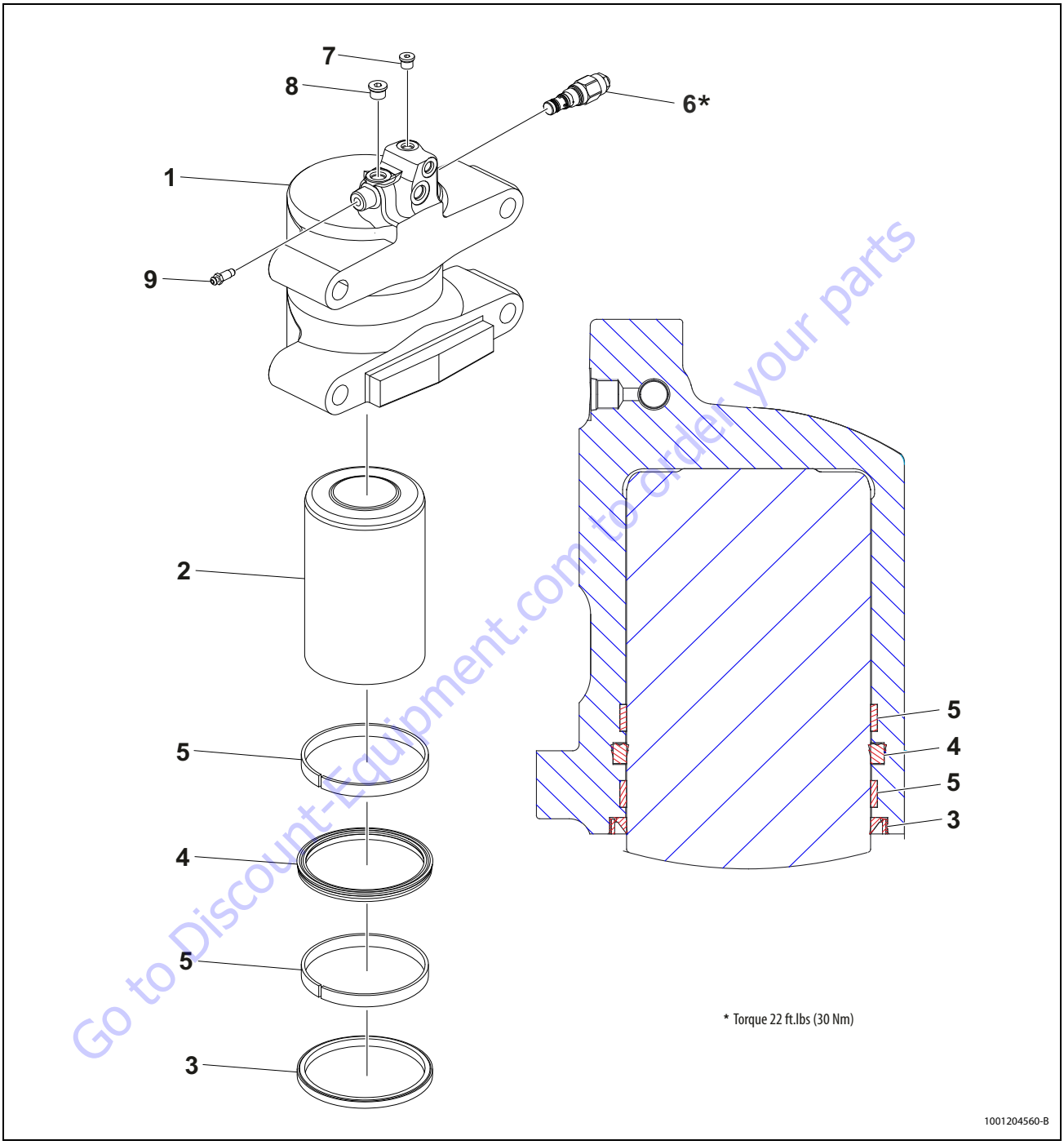
WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

1. Install two new wear rings and rod seal in rod bore grooves. Make sure they are not twisted.
2. Install new wiper in barrel.
3. Lubricate rod bore with clean hydraulic fluid.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE ROD. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE ROD AND CYLINDER BARREL SURFACES.

4. Install rod in bore and push to top of the bore.
5. Install counterbalance valve. Torque to 22 ft.lbs. (30 Nm).
6. Bleed system.



1. Barrel
2. Rod
3. Wiper
4. Rod Seal
5. Wear Ring
6. Counterbalance Valve
7. O-ring Plug
8. O-ring Plug
9. Bleeder Valve

Figure 5-15. Axle Lockout Cylinder

Platform Level Cylinder

DISASSEMBLY

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove cartridge valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

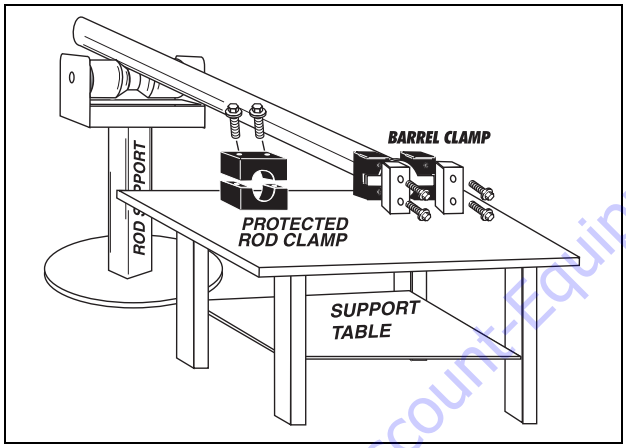


Figure 5-16. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

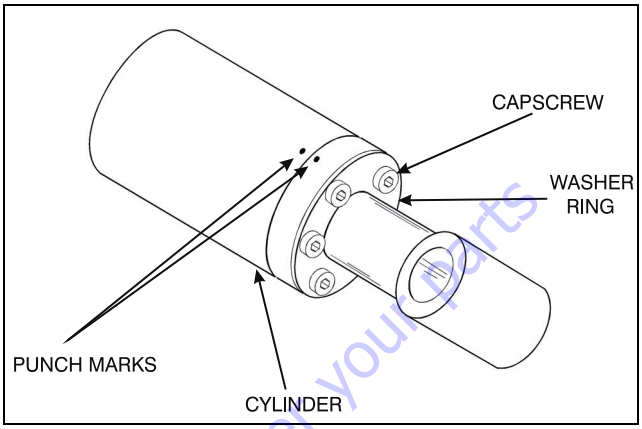


Figure 5-17. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

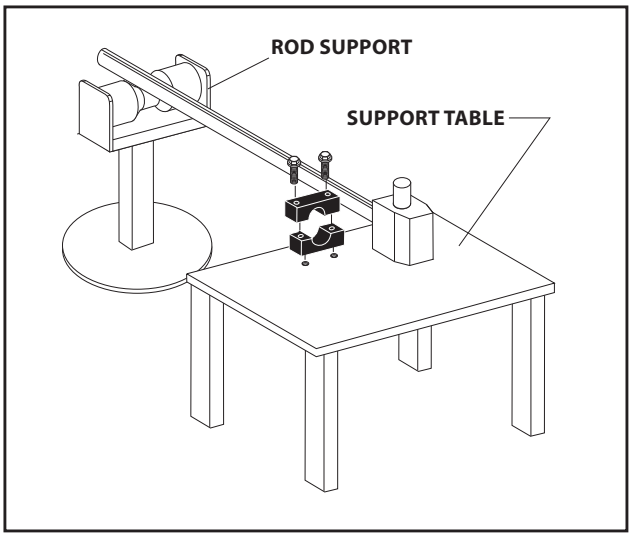
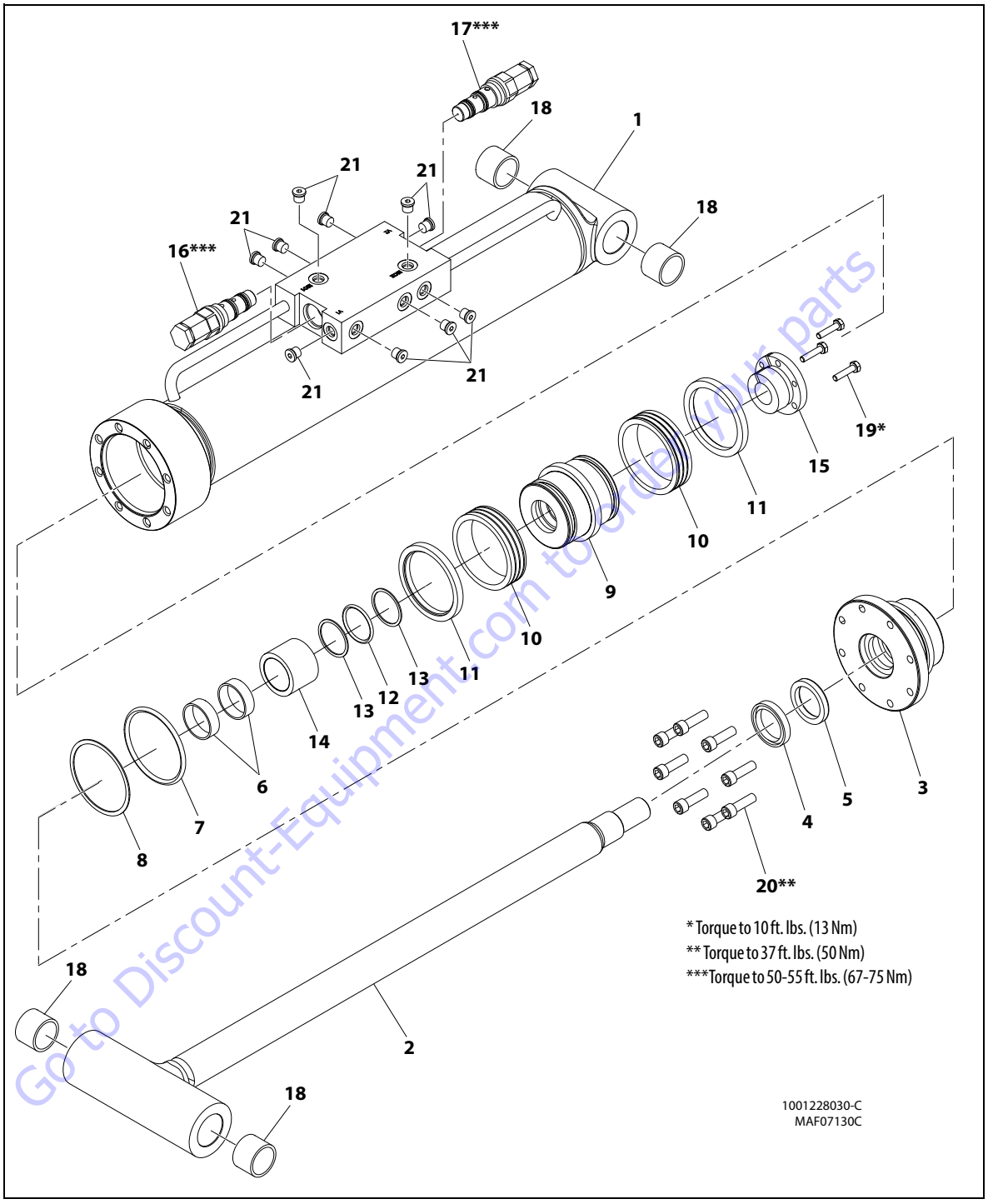


Figure 5-18. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Wiper
5. Seal
6. Wear Ring
7. O-ring
8. Backup Ring
9. Piston
10. seal
11. Lock Ring
12. O-ring
13. Backup Ring
14. Tube Spacer
15. Tapered Bushing
16. Cartridge Valve
17. Cartridge Valve
18. Bushing
19. Capscrew
20. Capscrew
21. Plug

Figure 5-19. Platform Level Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

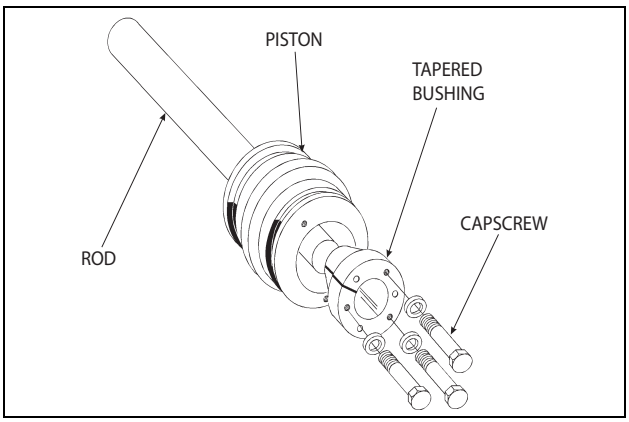


Figure 5-20. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove piston spacer, if applicable, from the rod.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, and wiper seals.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*

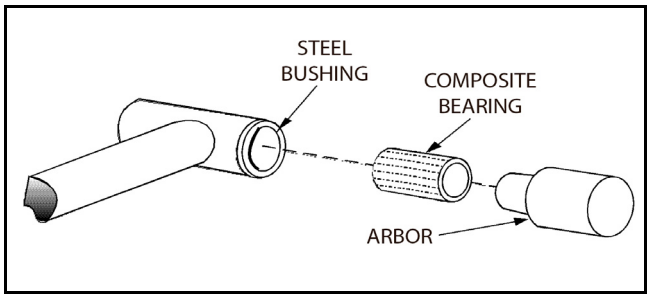


Figure 5-21. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

NOTE: *Apply a light film of hydraulic oil to all components prior to assembly.*

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

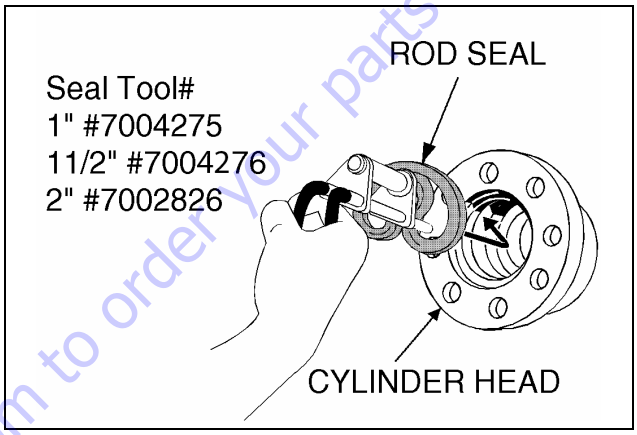


Figure 5-22. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

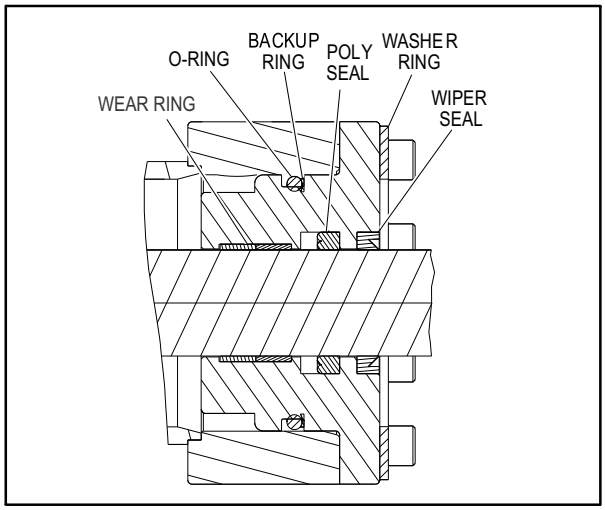


Figure 5-23. Cylinder Head Seal Installation

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

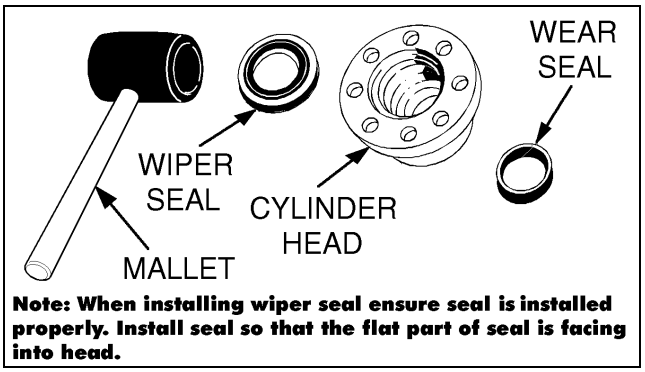


Figure 5-24. Wiper Seal Installation

3. Place a new o-ring and backup seal in the applicable outside diameter groove of the cylinder head.

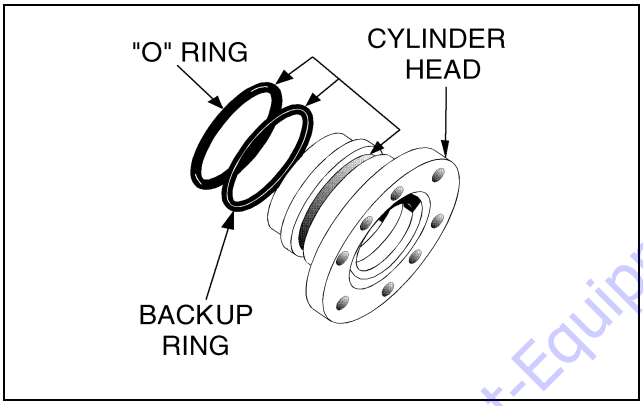


Figure 5-25. Installation of Head Seal Kit

4. Install washer ring onto rod if applicable, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.

5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

6. Place a new o-ring and backup rings in the inner piston diameter groove.

7. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

8. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

NOTE: *When installing the tapered bushing, piston and mating end of rod must be free of oil.*

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

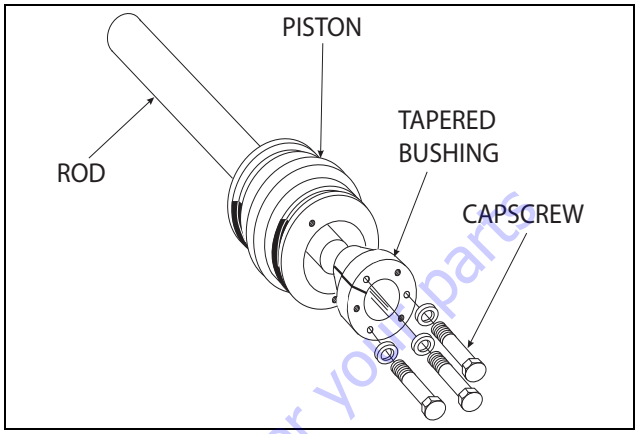


Figure 5-26. Tapered Bushing Installation

10. Tighten the capscrews evenly and progressively and torque capscrews as shown in Figure 5-19.

11. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

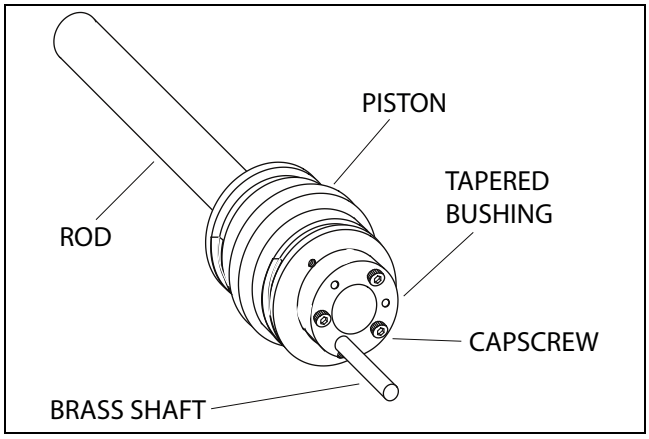


Figure 5-27. Seating the Tapered Bearing

12. Rotate the capscrews evenly and progressively in rotation to torque as shown in Figure 5-19.

13. Remove the cylinder rod from the holding fixture.

NOTICE

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCKK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

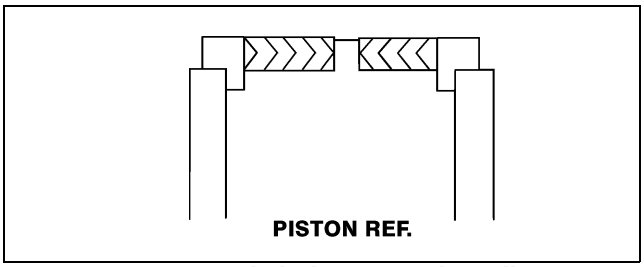


Figure 5-28. Hydrolock Piston Seal Installation

14. Place new hydrolock seal and guide lock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

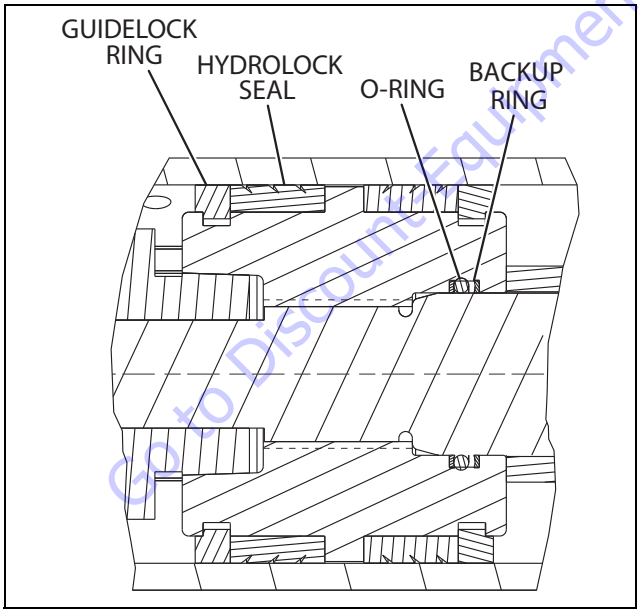


Figure 5-29. Piston Seal Kit Installation

15. Position the cylinder barrel in a suitable holding fixture.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

16. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

17. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

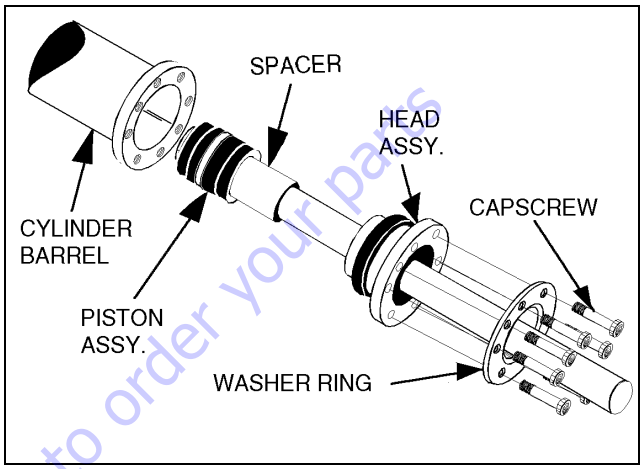


Figure 5-30. Rod Assembly Installation

18. Apply Medium Strength Threadlocking Compound if applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 37 ft.lbs. (50 Nm).

19. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.

20. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valve to 50-55 ft.lbs. (68-75 Nm).

Upright Level Cylinder

NOTE: *SERVICE INFORMATION NOT AVAILABLE AT TIME OF PUBLICATION.*

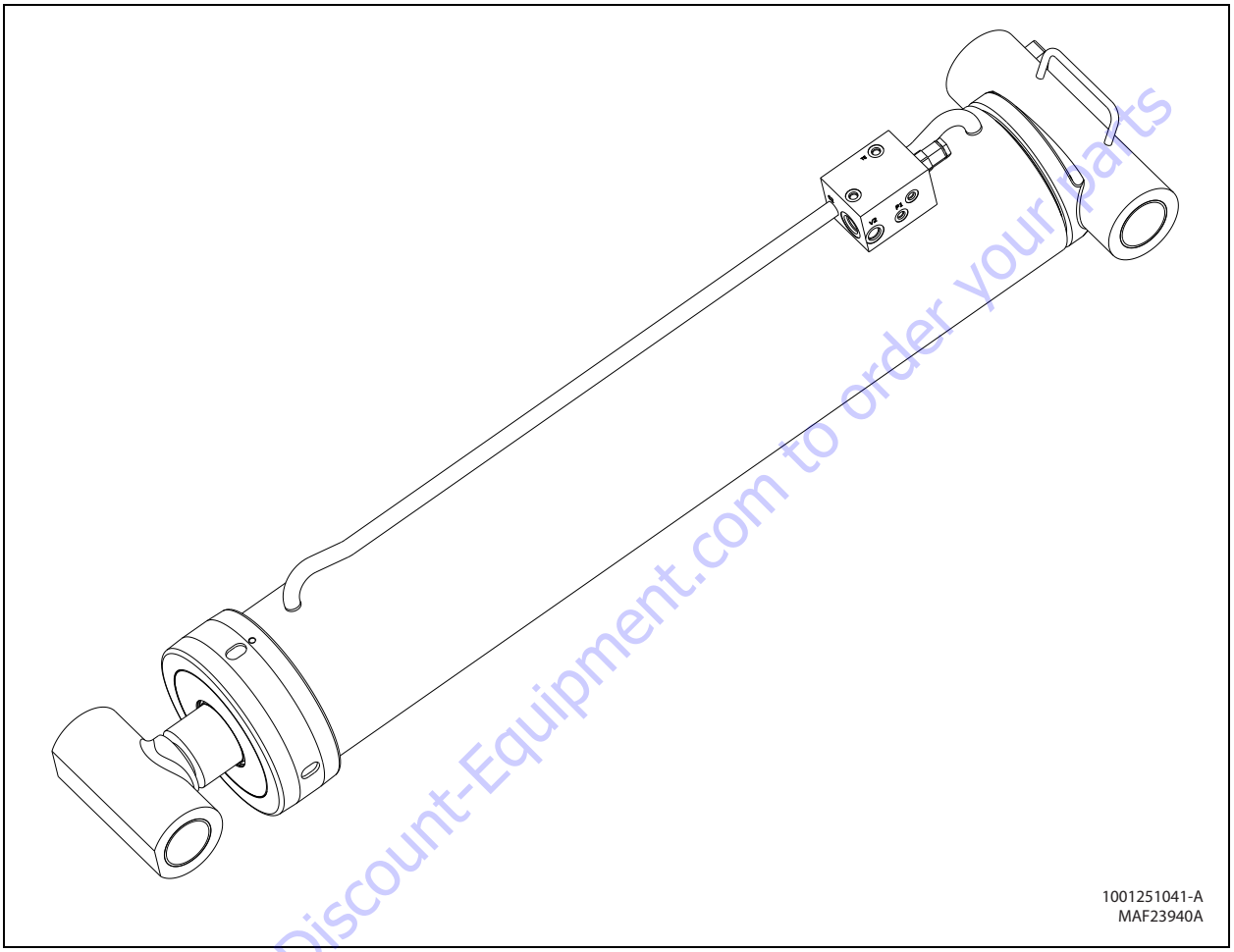


Figure 5-31. Upright Level Cylinder

Jib Lift Cylinder

DISASSEMBLY

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the counterbalance holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

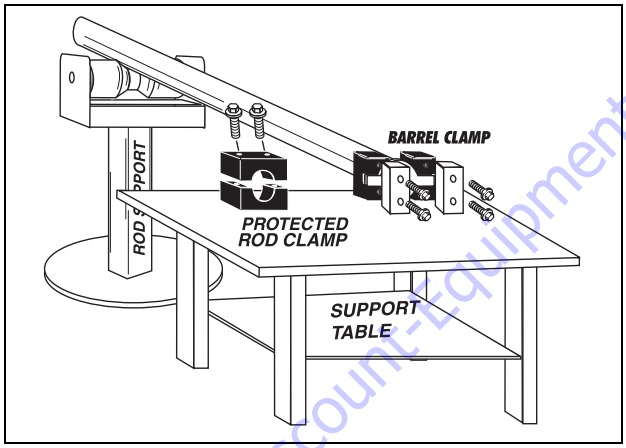


Figure 5-32. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

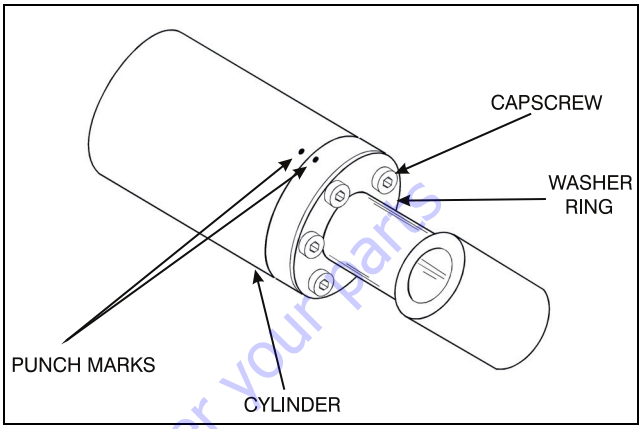


Figure 5-33. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

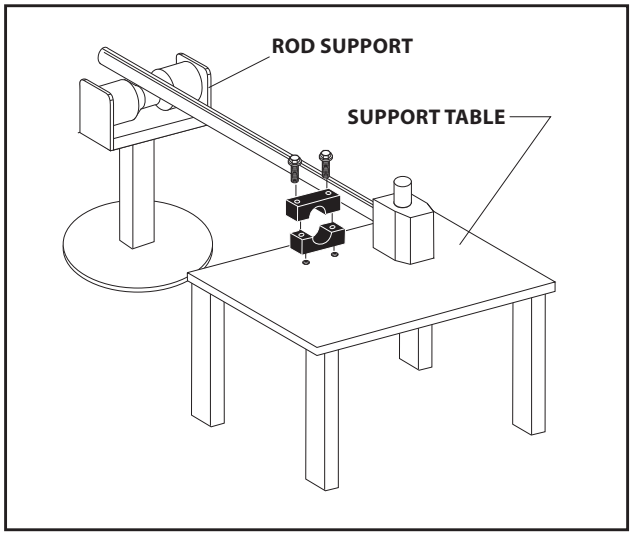
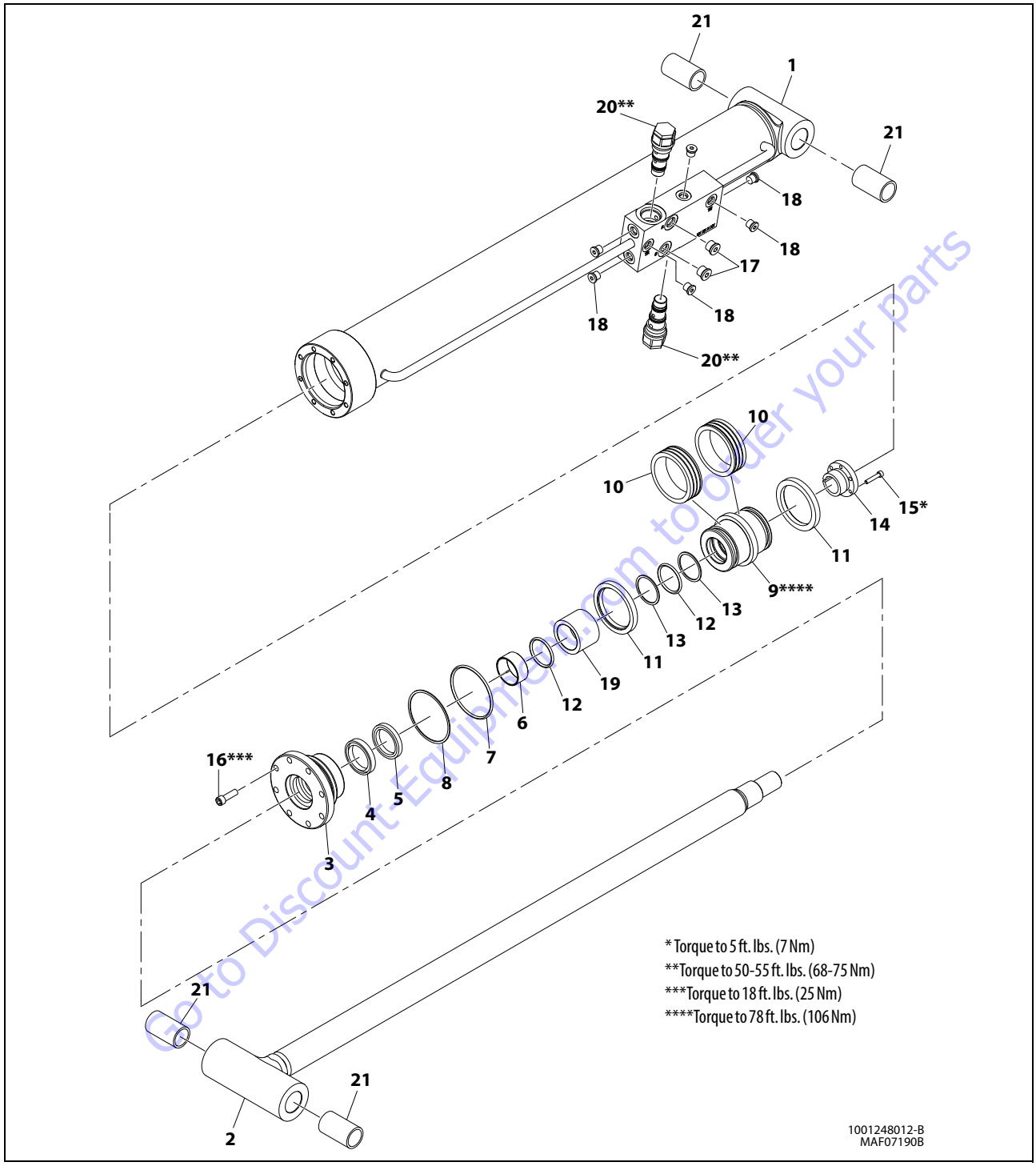


Figure 5-34. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Wiper Seal
5. Rod Seal
6. Wear Ring
7. O-ring
8. Backup Ring
9. Piston
10. Piston Seal
11. Lock Ring
12. O-ring
13. Backup Ring
14. Tapered Bushing
15. Capscrew
16. Capscrew
17. O-ring Plug
18. O-ring Plug
19. Tube Spacer
20. Counterbalance Valve
21. Bushing

Figure 5-35. Jib Lift Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

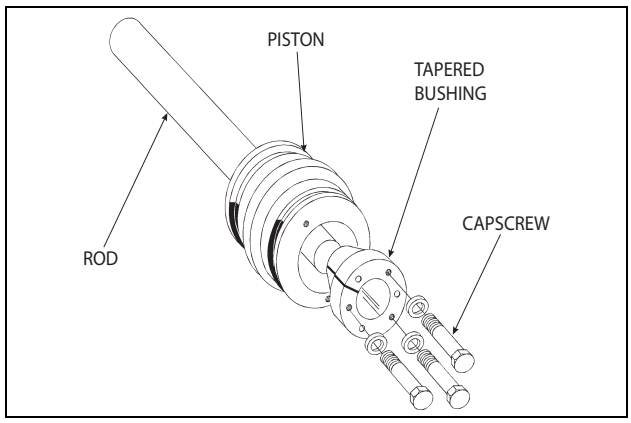


Figure 5-36. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove piston spacer, if applicable, from the rod.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, and wiper seals.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*

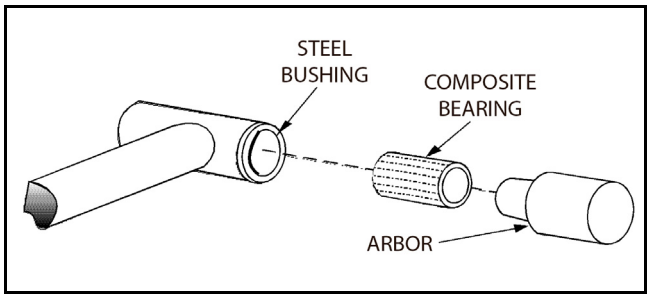


Figure 5-37. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

NOTE: *Apply a light film of hydraulic oil to all components prior to assembly.*

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

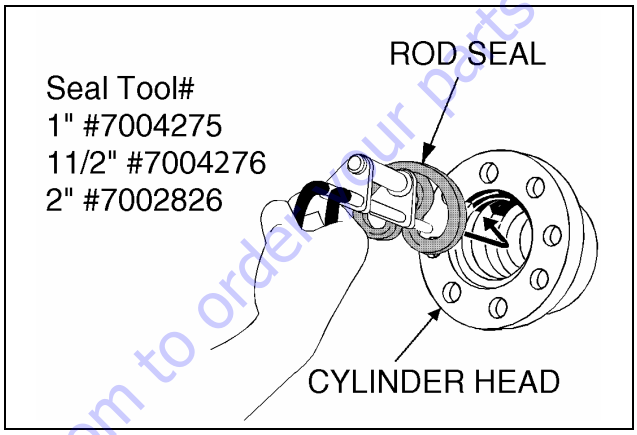


Figure 5-38. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

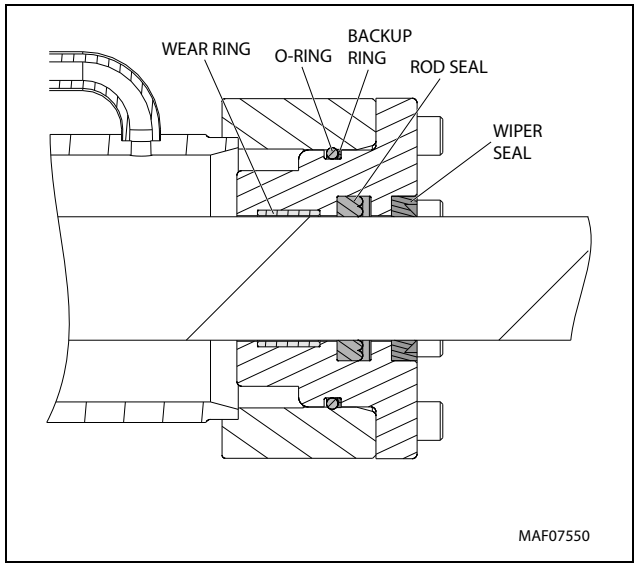


Figure 5-39. Cylinder Head Seal Installation

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

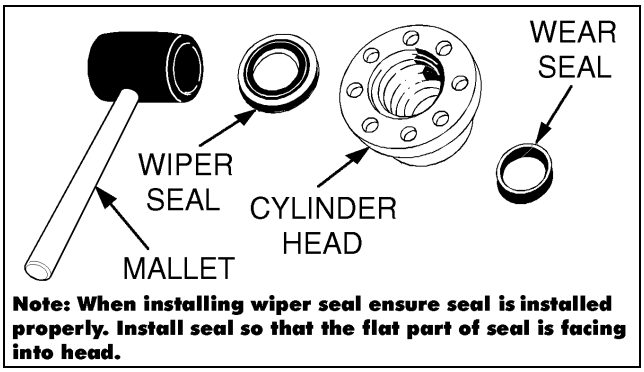


Figure 5-40. Wiper Seal Installation

3. Place a new o-ring and backup ring in the applicable outside diameter groove of the cylinder head.

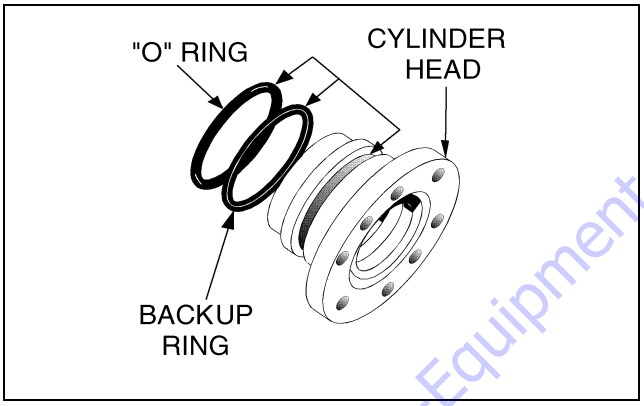


Figure 5-41. Installation of Head Seal Kit

4. Install washer ring onto rod if applicable. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Carefully slide the piston spacer on the rod.
6. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
7. Place a new o-ring and backup rings in the inner piston diameter groove.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.
9. Thread piston onto rod until it abuts the spacer end. Torque piston as shown in Figure 5-35. Install the tapered bushing.

NOTE: *When installing the tapered bushing, piston and mating end of rod must be free of oil.*

10. Install the bolts in tapered bushing.
11. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

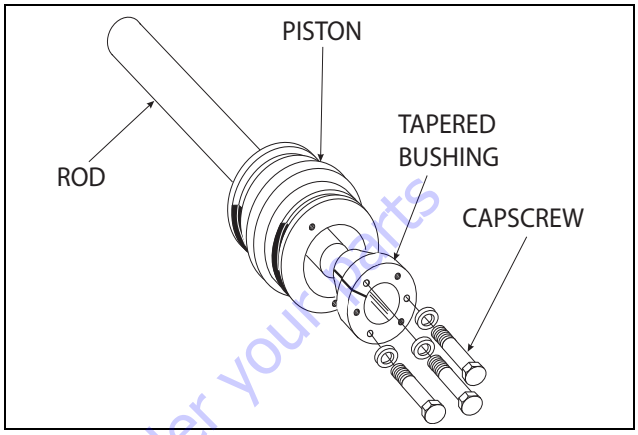


Figure 5-42. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation and torque as shown in Figure 5-35.
13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

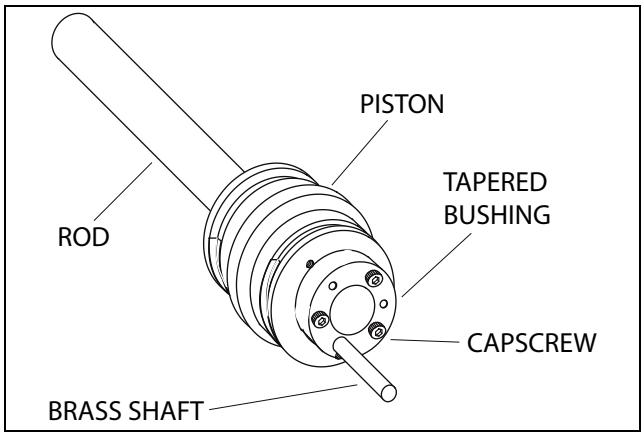


Figure 5-43. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation and torque as shown in Figure 5-35.

15. Remove the cylinder rod from the holding fixture.

NOTICE

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCKK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

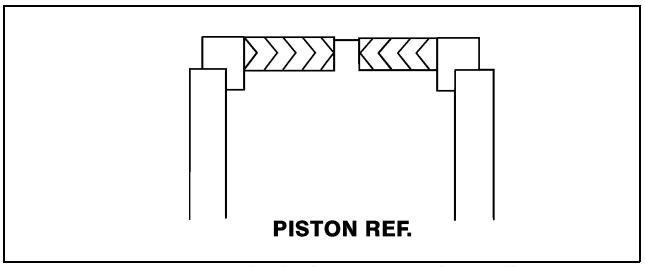


Figure 5-44. Hydrolock Piston Seal Installation

16. Place new hydrolock seal and guide lock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

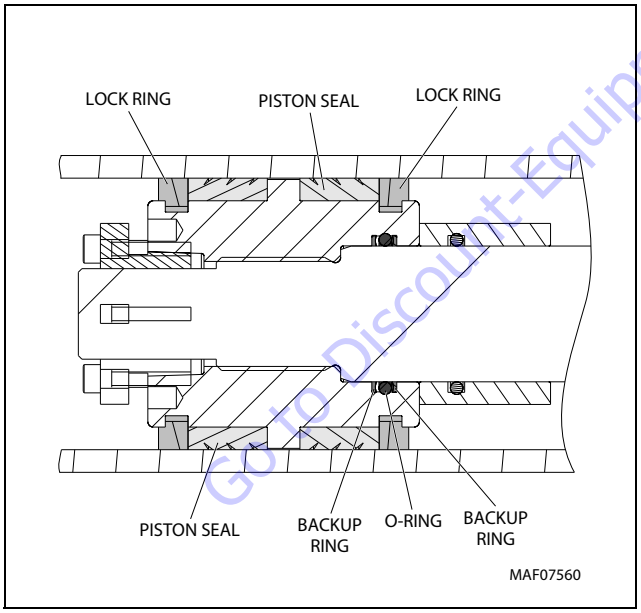


Figure 5-45. Piston Seal Kit Installation

17. Position the cylinder barrel in a suitable holding fixture.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

19. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

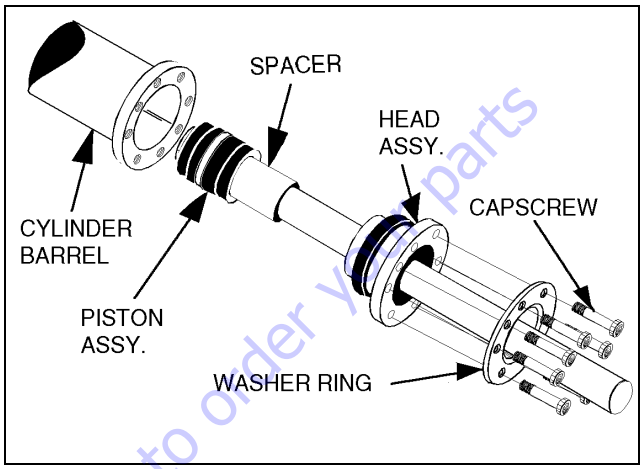


Figure 5-46. Rod Assembly Installation

20. Apply Medium Strength Threadlocking Compound to the socket head bolts and secure the cylinder head gland using the capscrews. Torque capscrews to 18 ft. lbs. (25 Nm).

21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.

22. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft.lbs. (68-75 Nm).

Main Boom Lift Cylinder

NOTE: *SERVICE INFORMATION NOT AVAILABLE AT TIME OF PUBLICATION.*

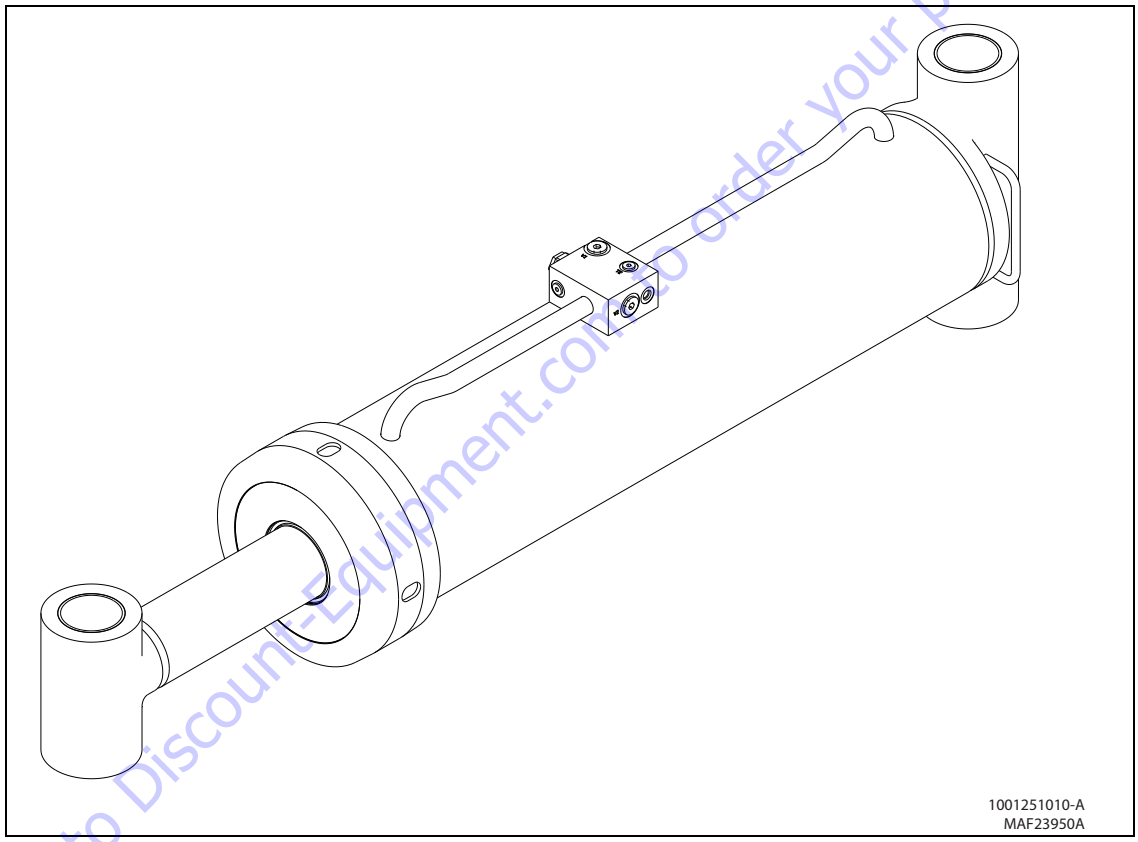


Figure 5-47. Main Boom Lift Cylinder

Tower Boom Lift Cylinder

NOTE: *SERVICE INFORMATION NOT AVAILABLE AT TIME OF PUBLICATION.*

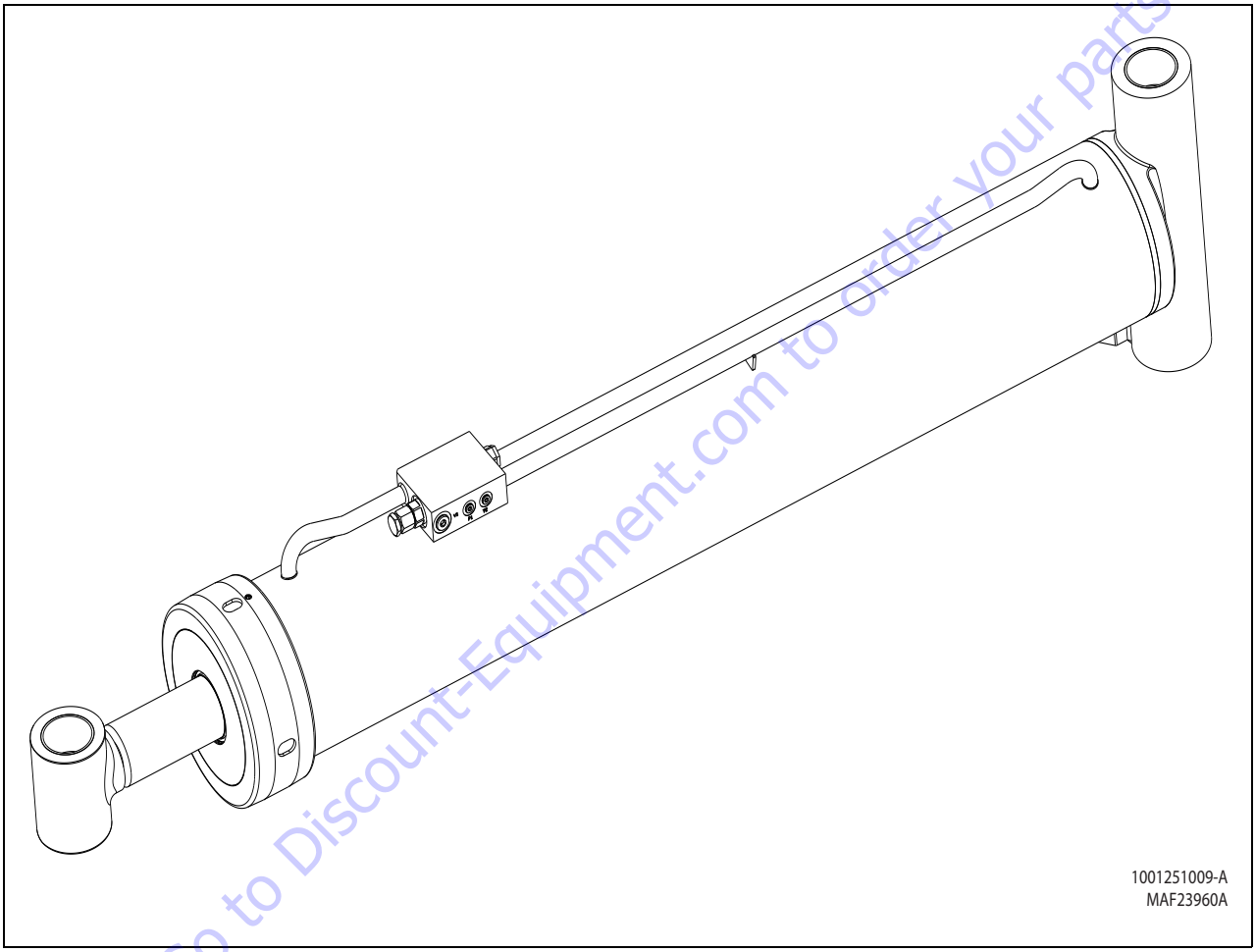


Figure 5-48. Tower Boom Lift Cylinder

Master Cylinder

DISASSEMBLY

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place the cylinder barrel into a suitable holding fixture.

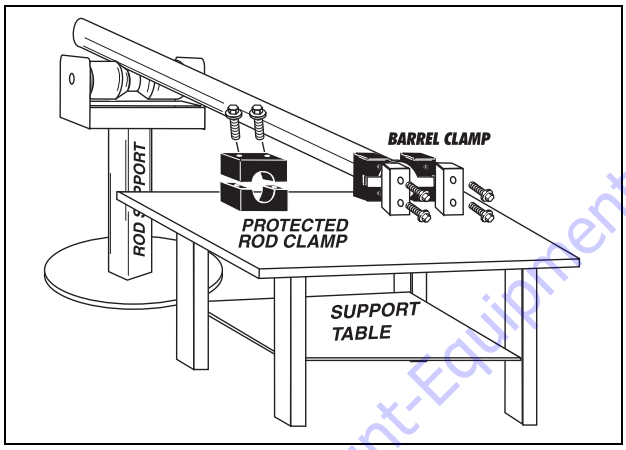


Figure 5-49. Cylinder Barrel Support

4. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

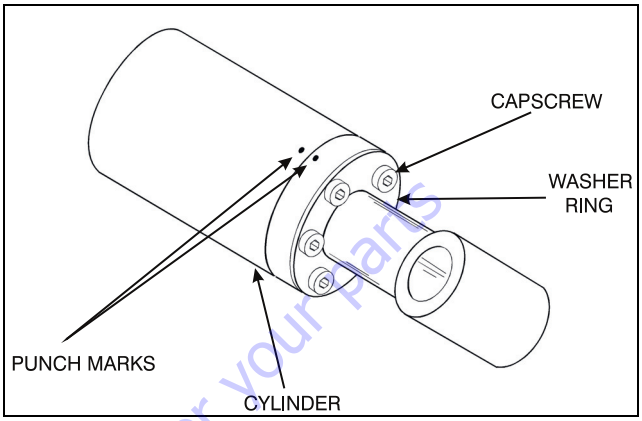


Figure 5-50. Capscrew Removal

5. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

6. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

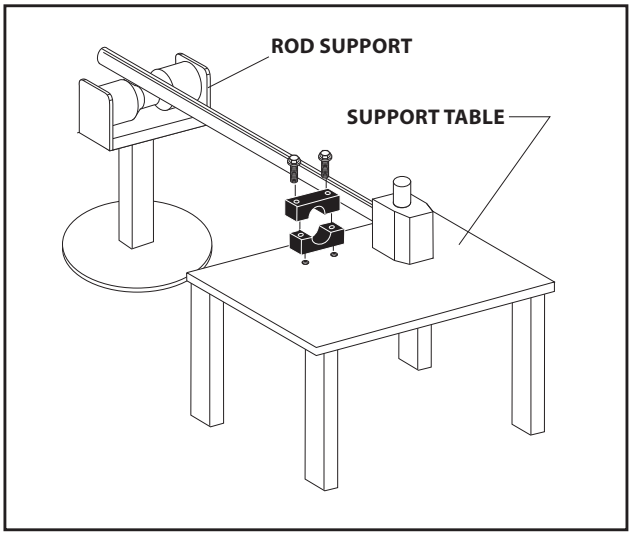
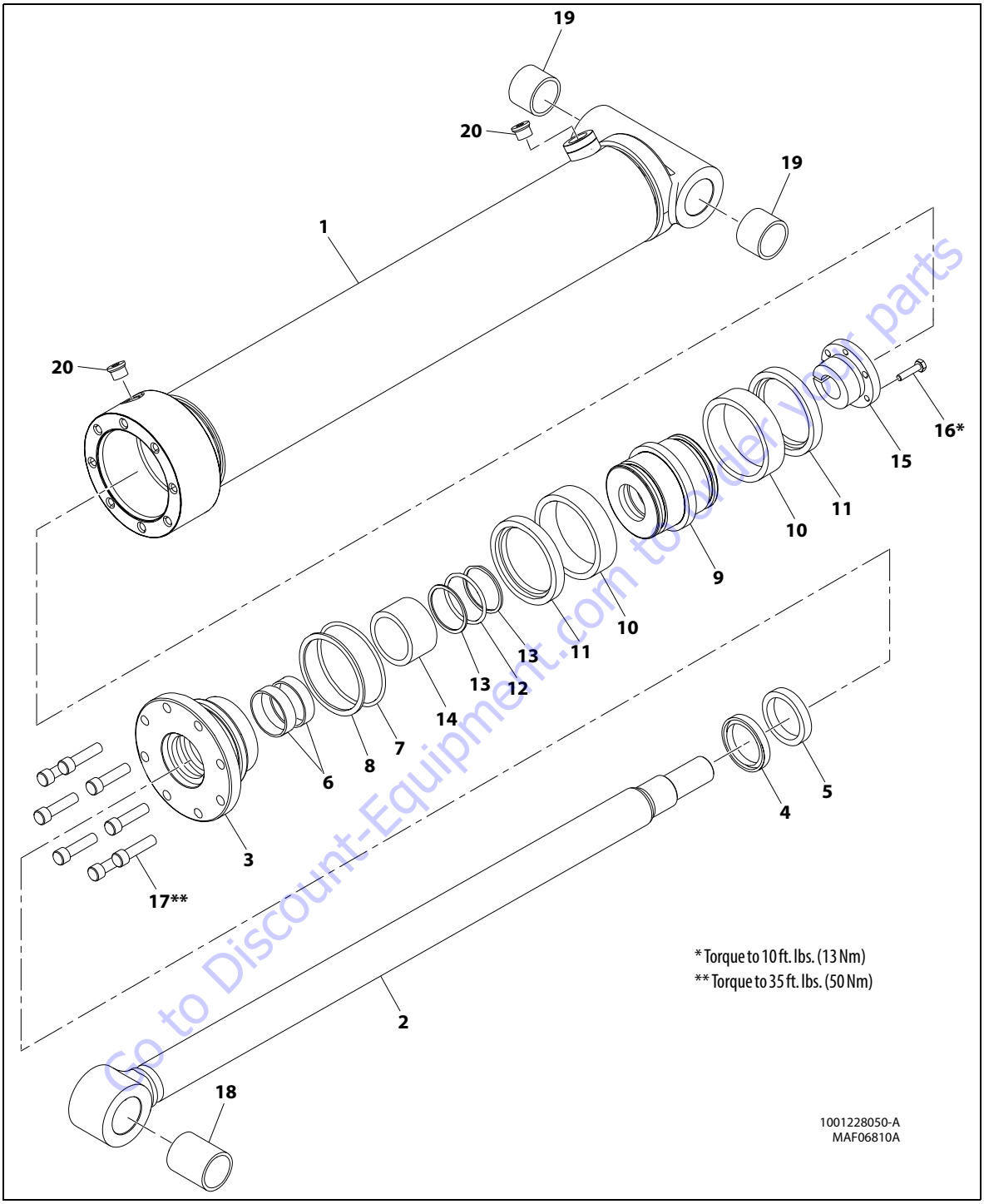


Figure 5-51. Cylinder Rod Support



1. Barrel	5. Rod Seal	9. Piston	13. Backup Ring	17. Capscrew
2. Rod	6. Wear Ring	10. Wear Ring	14. Tube Spacer	18. Bushing
3. Head	7. O-ring	11. Lock Ring	15. Tapered Bushing	19. Bushing
4. Wiper	8. Backup Ring	12. O-ring	16. Capscrew	20. Plug

Figure 5-52. Master Cylinder

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
9. Remove the bushing from the piston.

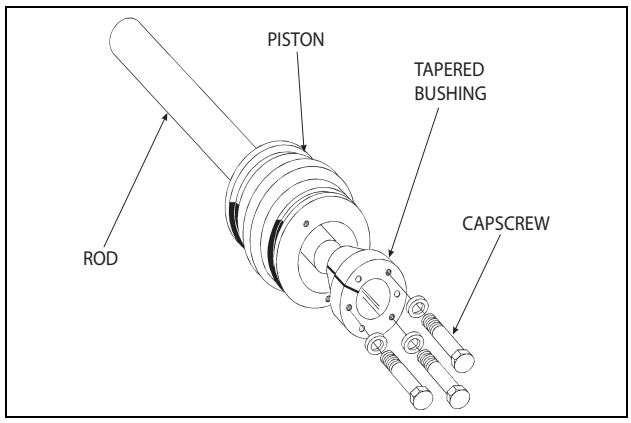


Figure 5-53. Tapered Bushing Removal

10. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
11. Remove and discard the piston o-rings, seal rings, and backup rings.
12. Remove piston spacer from the rod.
13. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, and wiper seals.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*

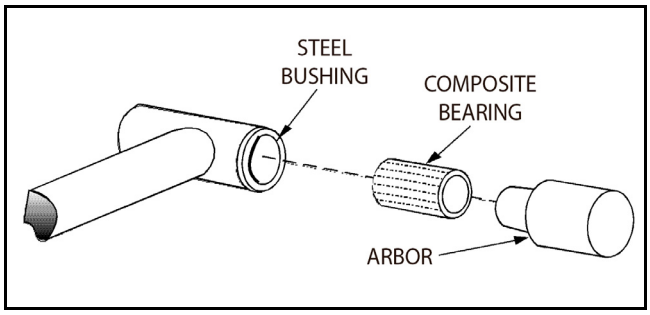


Figure 5-54. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

NOTE: *Apply a light film of hydraulic oil to all components prior to assembly.*

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

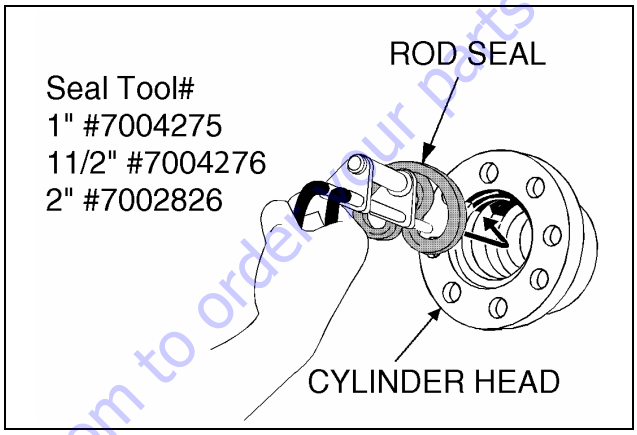


Figure 5-55. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

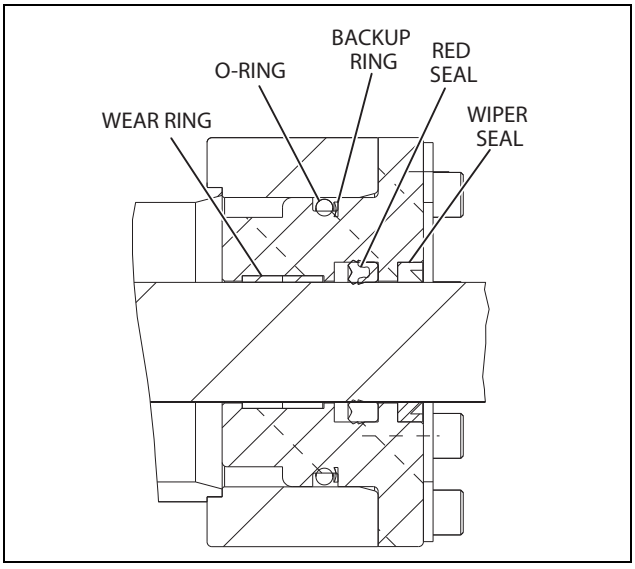


Figure 5-56. Cylinder Head Seal Installation

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

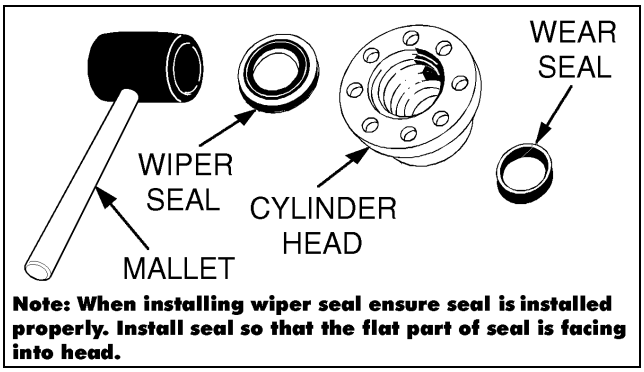


Figure 5-57. Wiper Seal Installation

3. Place a new o-ring and backup seal in the applicable outside diameter groove of the cylinder head.

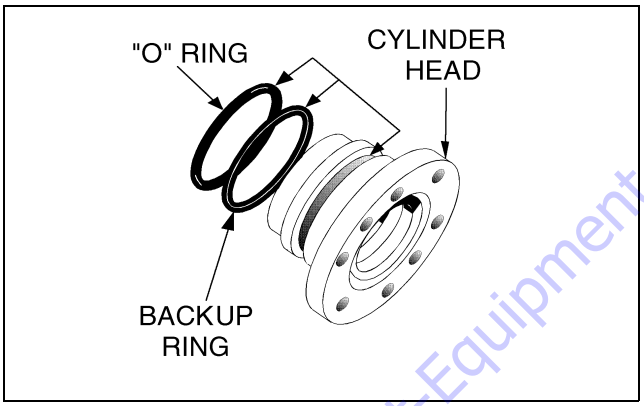


Figure 5-58. Installation of Head Seal Kit

4. Install washer ring onto rod if applicable, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.

5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

6. Place a new o-ring and backup rings in the inner piston diameter groove.

7. Install piston spacer onto the cylinder rod.

8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

9. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

NOTE: *When installing the tapered bushing, piston and mating end of rod must be free of oil.*

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

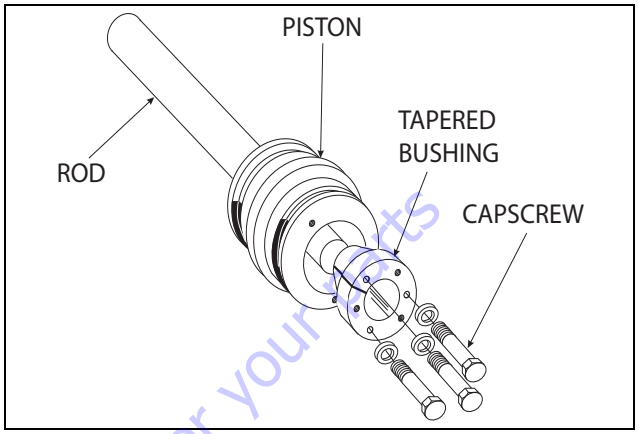


Figure 5-59. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation and torque as shown in Figure 5-52.

12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

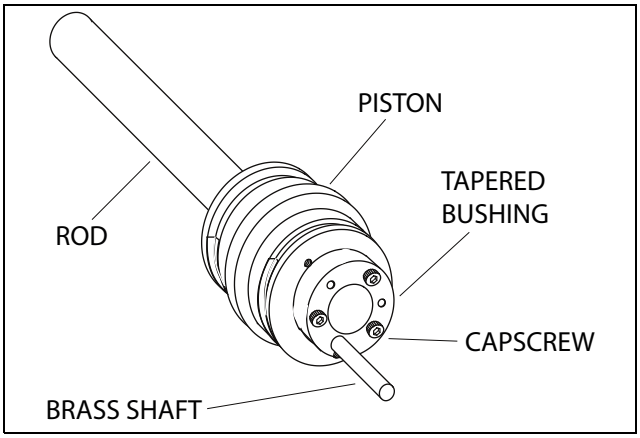


Figure 5-60. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation and torque as shown in Figure 5-52.

14. Remove the cylinder rod from the holding fixture.

NOTICE

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCKK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

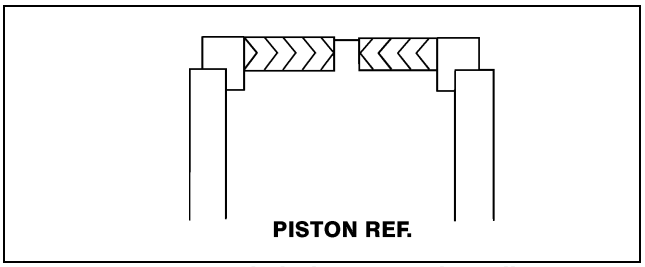


Figure 5-61. Hydrolock Piston Seal Installation

15. Place new guidelock rings and hydrolock seal or wear ring as applicable in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

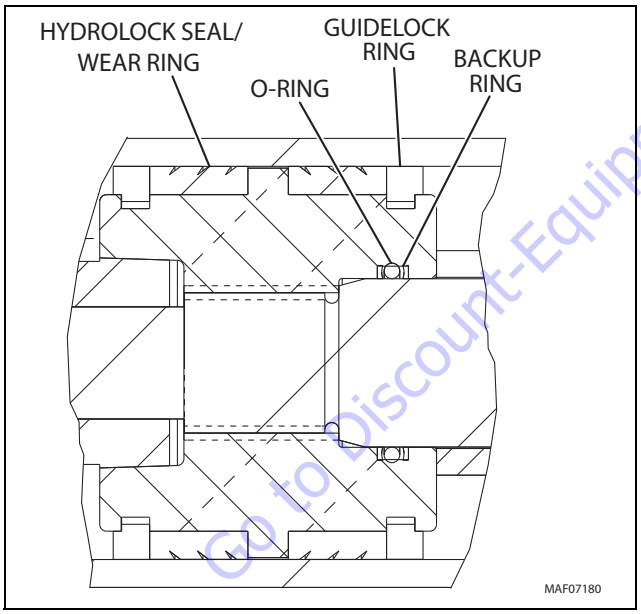


Figure 5-62. Piston Seal Kit Installation

16. Position the cylinder barrel in a suitable holding fixture.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

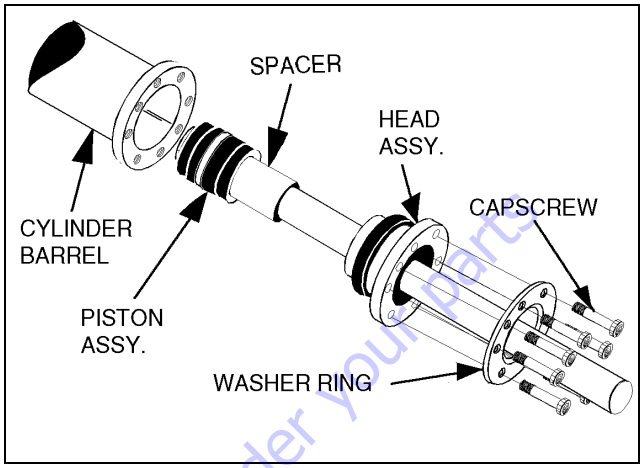


Figure 5-63. Rod Assembly Installation

19. Apply Medium Strength Threadlocking Compound if applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 35 ft.lbs. (50 Nm).

Steer Cylinder

DISASSEMBLY

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place the cylinder barrel into a suitable holding fixture.

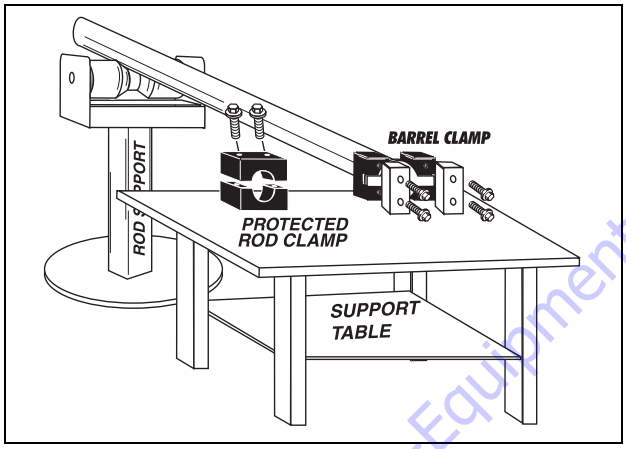


Figure 5-64. Cylinder Barrel Support

4. Using a hook spanner, loosen the spanner nut retainer and remove spanner nut from cylinder barrel.

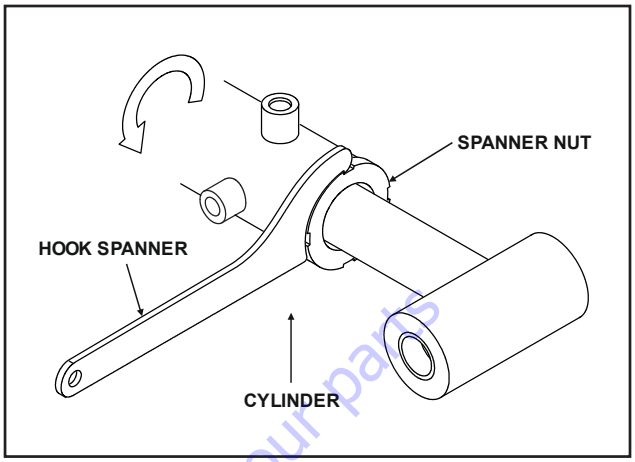


Figure 5-65. Spanner Nut Removal

5. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

6. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

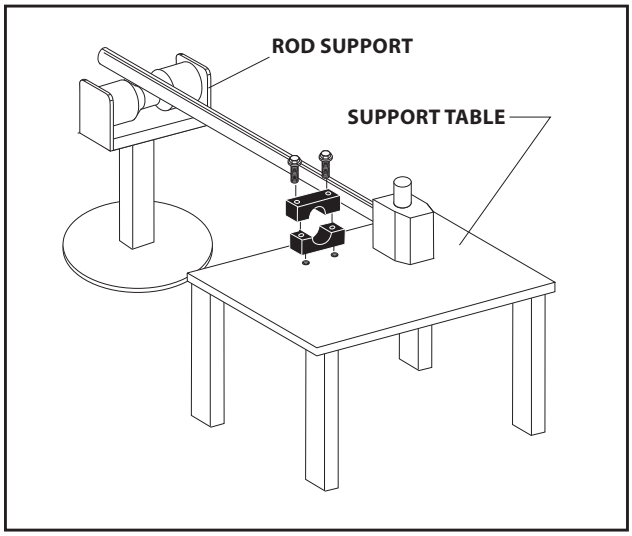
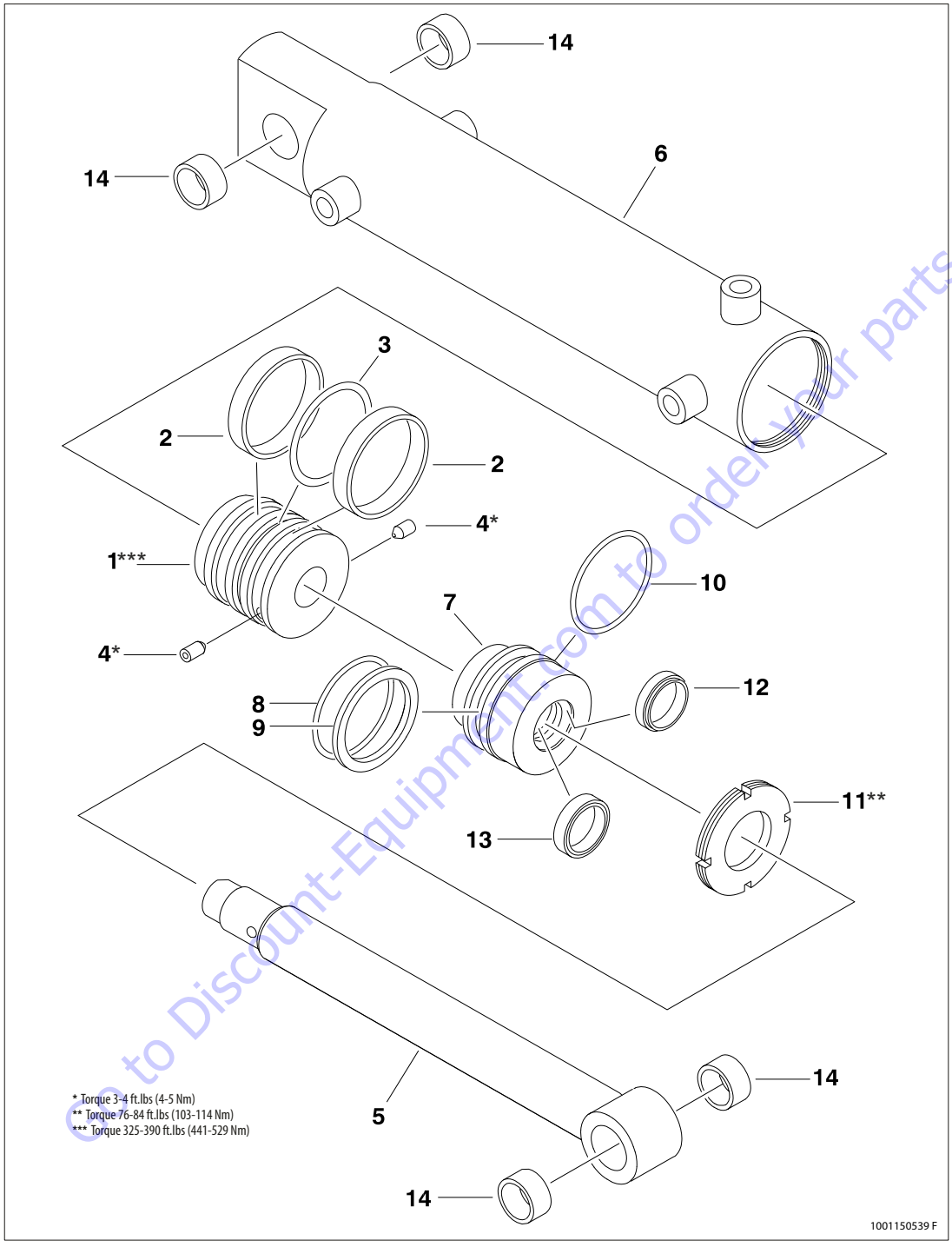


Figure 5-66. Cylinder Rod Support



1. Piston
2. Wear Ring
3. Seal
4. Setscrew
5. Rod
6. Barrel
7. Head
8. O-ring
9. Backup Ring
10. C-Ring
11. Spanner Nut
12. Wiper Seal
13. Rod Seal
14. Bushing

Figure 5-67. Steer Cylinder

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Remove the setscrews from the piston.
9. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
10. Remove and discard the piston seal and wear rings.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, c-ring, rod seal, and wiper seal.

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of barrel for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*

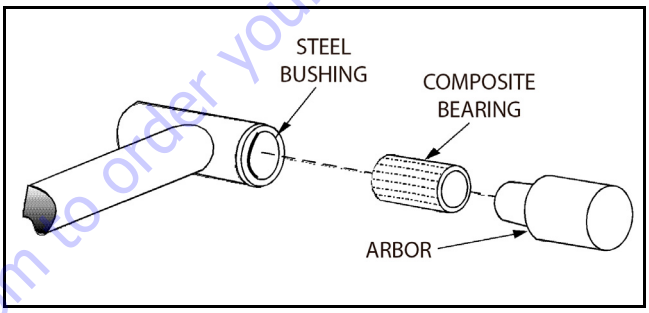


Figure 5-68. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

NOTE: *Apply a light film of hydraulic oil to all components prior to assembly.*

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

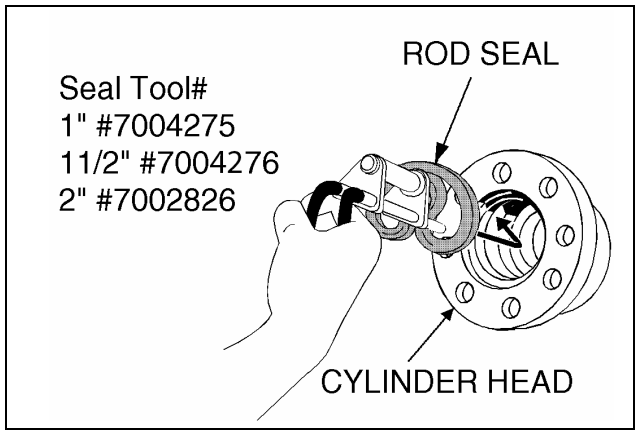


Figure 5-69. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

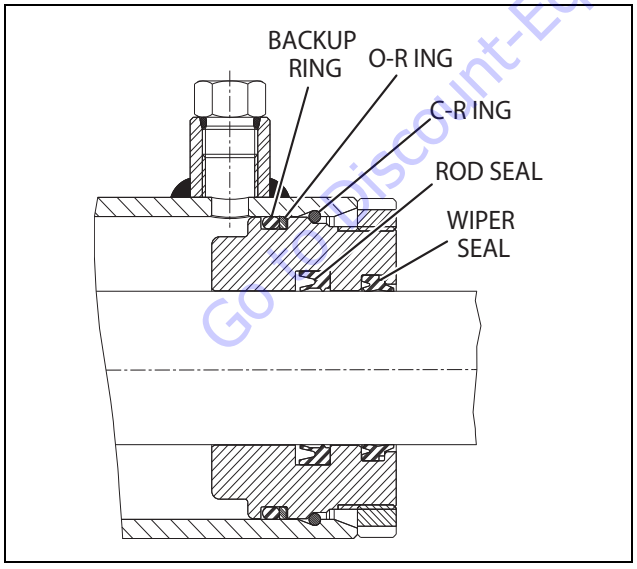


Figure 5-70. Cylinder Head Seal Installation

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

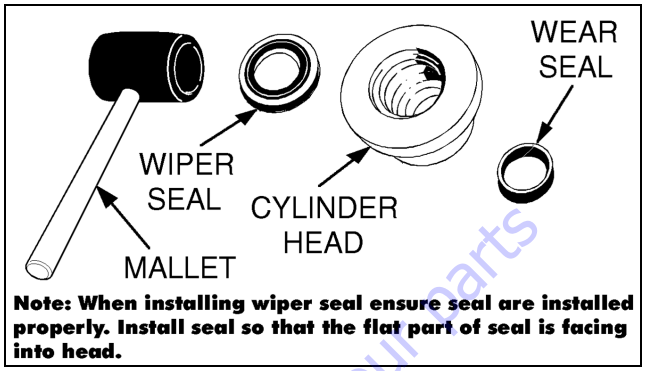


Figure 5-71. Wiper Seal Installation

3. Place a new o-ring, backup ring and c-ring in the applicable outside diameter groove of the cylinder head.

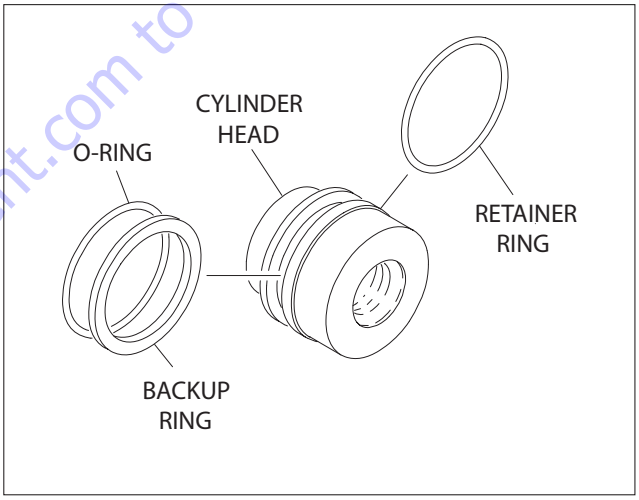


Figure 5-72. Installation of Head Seal Kit

4. Install spanner nut onto rod. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.

5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

6. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

7. Install the setscrews on the piston.

8. Remove the cylinder rod from the holding fixture.

9. Place new seal and wear ring in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

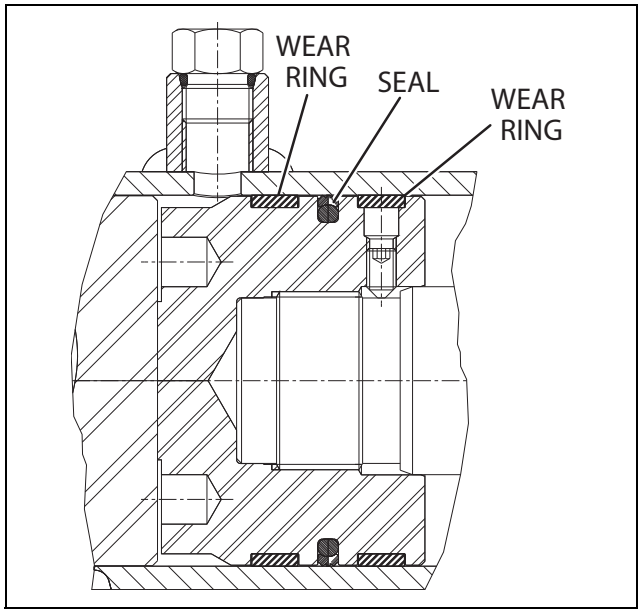


Figure 5-73. Piston Seal Kit Installation

10. Position the cylinder barrel in a suitable holding fixture.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

11. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

12. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

13. Secure spanner nut into the cylinder barrel. Torque nut to 325-390 ft.lbs. (441-529 Nm).

14. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves, if applicable.

Main Boom Telescope Cylinder

DISASSEMBLY

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove capscrews and valve assembly from the barrel end. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

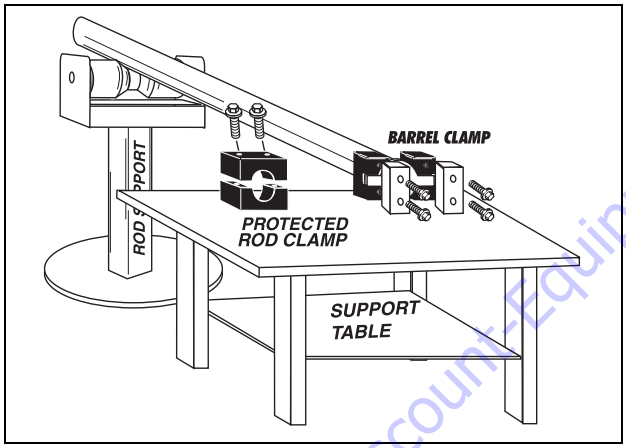


Figure 5-74. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

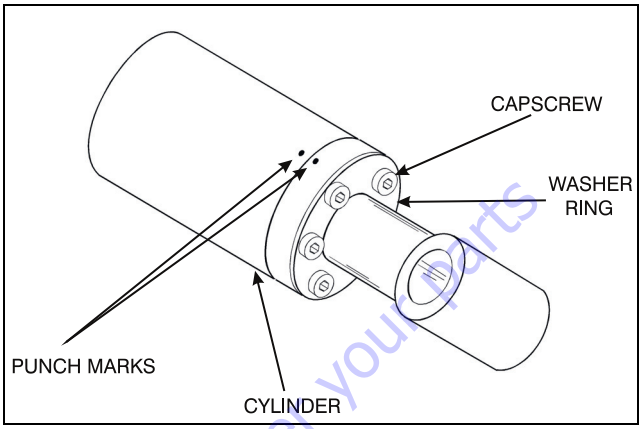


Figure 5-75. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

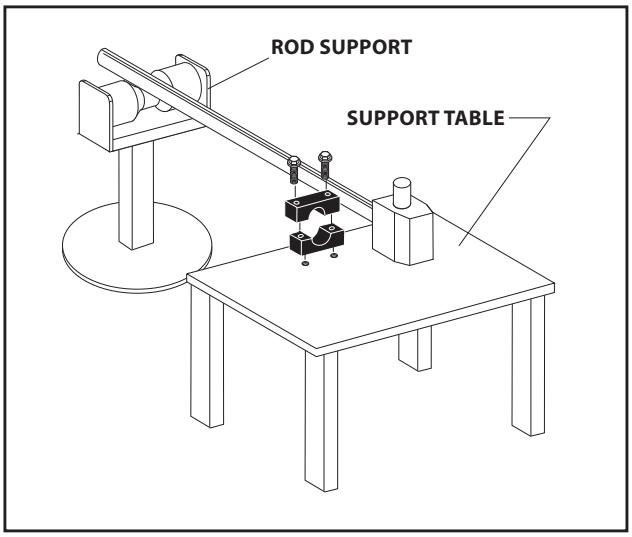
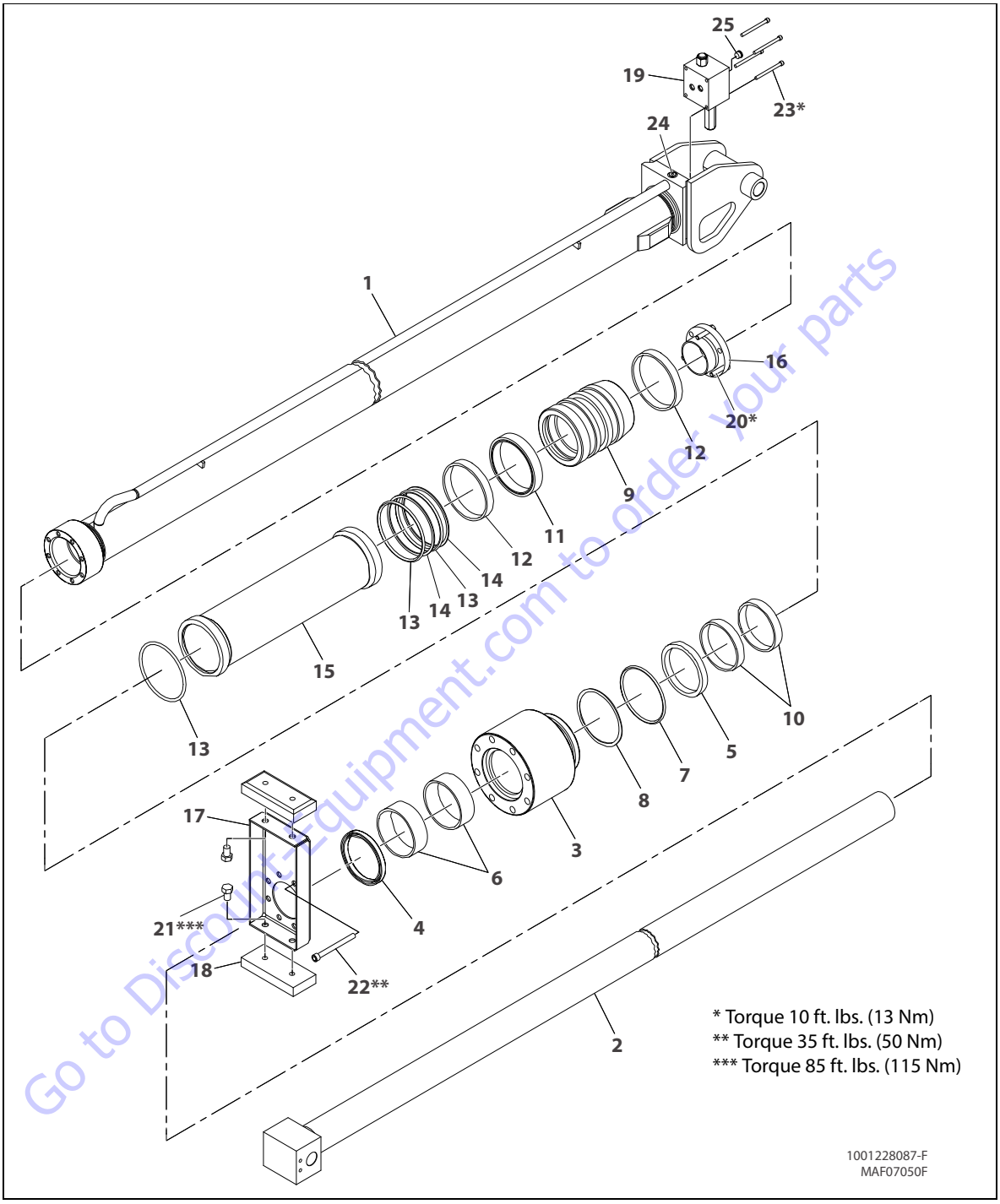


Figure 5-76. Cylinder Rod Support



1.	Barrel	6.	Wear Ring	11.	Piston Seal	16.	Tapered Bushing	21.	Capscrew
2.	Rod	7.	O-ring	12.	Wear Ring	17.	Plate	22.	Capscrew
3.	Head	8.	Backup Ring	13.	O-ring	18.	Wear Pad	23.	Capscrew
4.	Wiper Seal	9.	Piston	14.	Backup Ring	19.	Valve Assembly	24.	O-ring Plug
5.	Rod Seal	10.	Wear Ring	15.	Spacer	20.	Capscrew	25.	O-ring Plug

Figure 5-77. Main Boom Telescopic Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

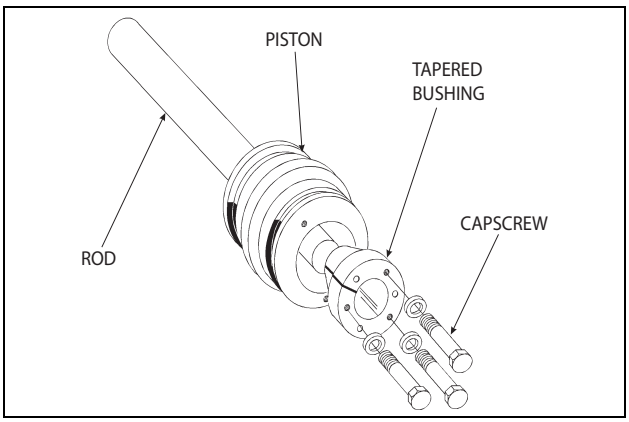


Figure 5-78. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove o-rings from piston spacer. Remove piston spacer from the rod.
14. Remove capscrews to remove plate and wear pads.
15. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, and wiper seals.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*

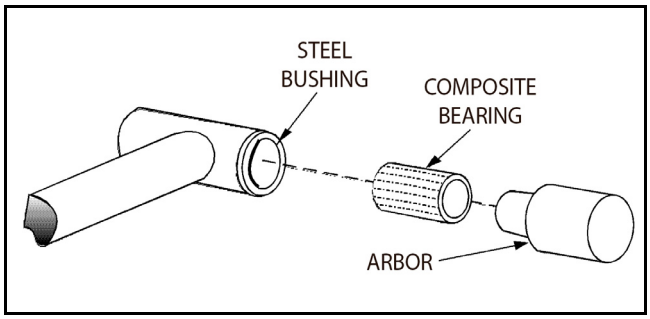


Figure 5-79. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

NOTE: *Apply a light film of hydraulic oil to all components prior to assembly.*

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

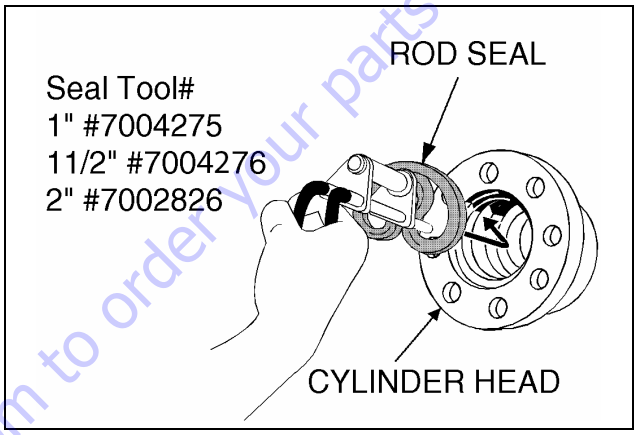


Figure 5-80. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

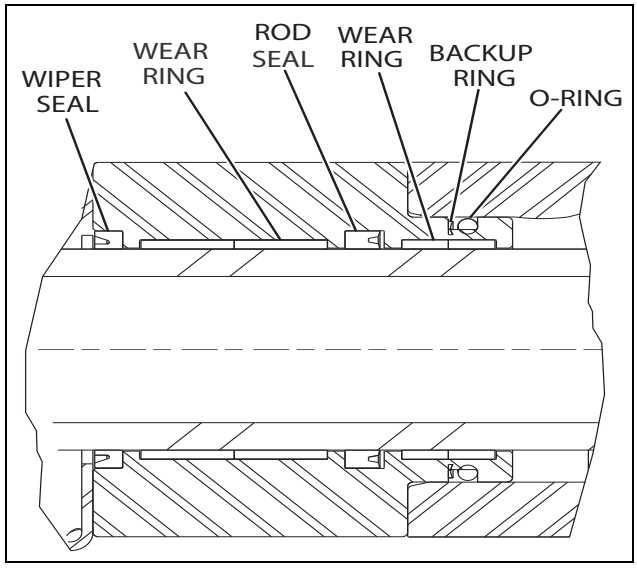


Figure 5-81. Cylinder Head Seal Installation

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

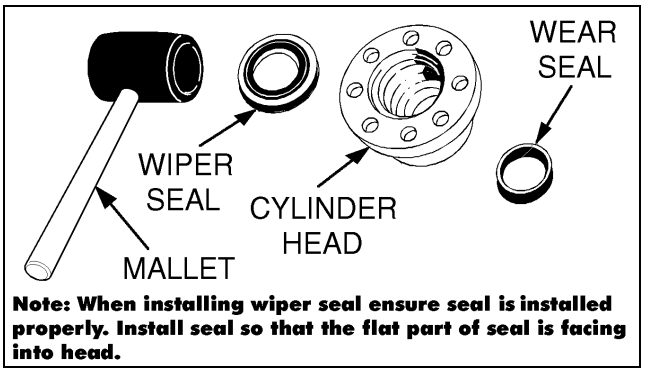


Figure 5-82. Wiper Seal Installation

3. Place a new o-ring and backup seal in the applicable outside diameter groove of the cylinder head.

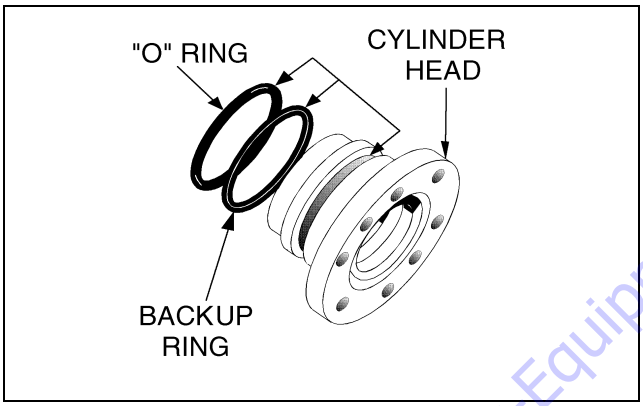


Figure 5-83. Installation of Head Seal Kit

4. Install plate on to the rod. Use capscrews to attach wear pads on the plate.
5. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
6. Install o-rings inside grooves of the piston spacer. Carefully slide the spacer on the rod.
7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
8. Place a new o-ring and backup rings in the inner piston diameter groove.
9. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.
10. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

NOTE: *When installing the tapered bushing, piston and mating end of rod must be free of oil.*

11. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

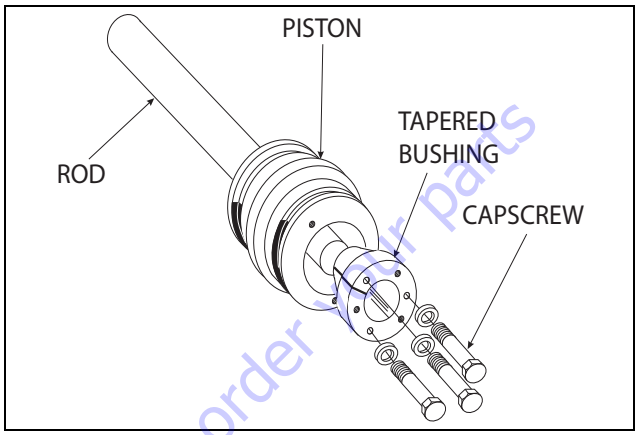


Figure 5-84. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation and torque as shown in Figure 5-77.
13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

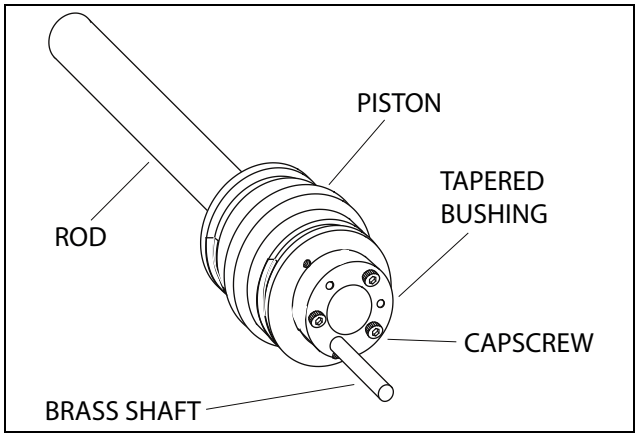


Figure 5-85. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation and torque as shown in Figure 5-77.

15. Remove the cylinder rod from the holding fixture.

16. Place new hydrolock seal and guide lock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

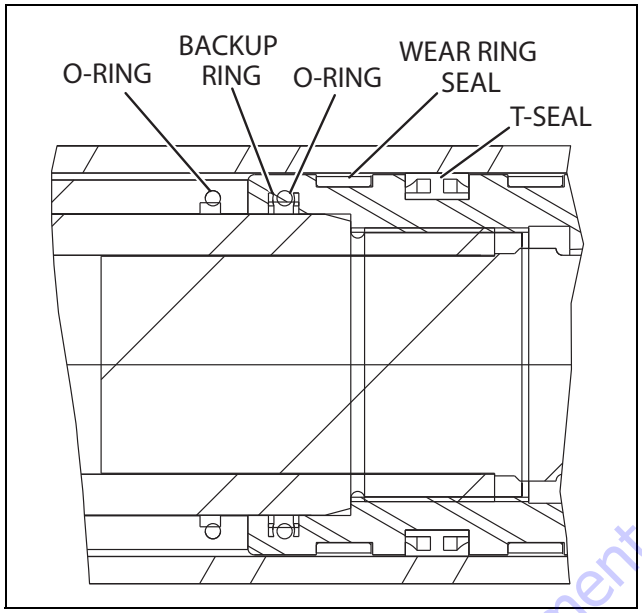


Figure 5-86. Piston Seal Kit Installation

17. Position the cylinder barrel in a suitable holding fixture.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

19. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

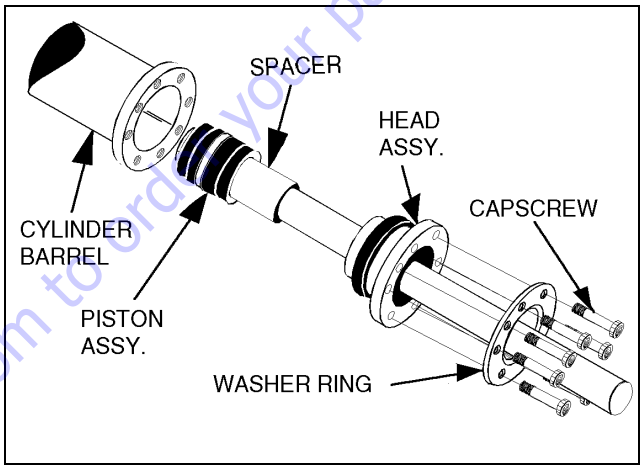


Figure 5-87. Rod Assembly Installation

20. Apply Medium Strength Threadlocking Compound to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 35 ft.lbs. (50 Nm).

21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.

22. Install the valve assembly. Torque capscrews to 10 ft.lbs. (13 Nm).

Tower Boom Telescope Cylinder

DISASSEMBLY

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. If applicable, remove the cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

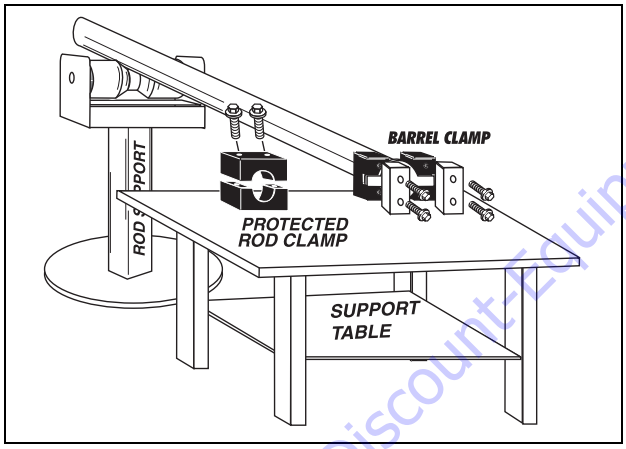


Figure 5-88. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

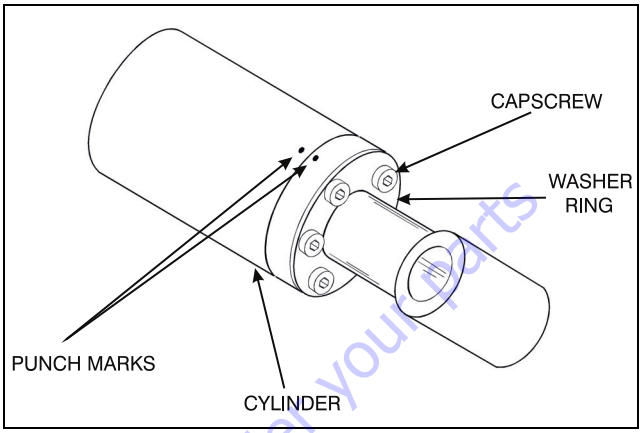


Figure 5-89. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

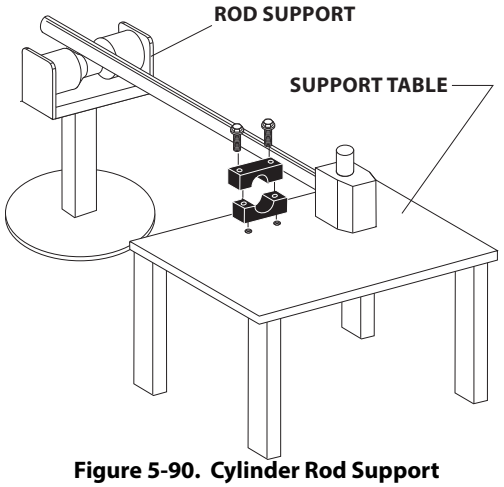
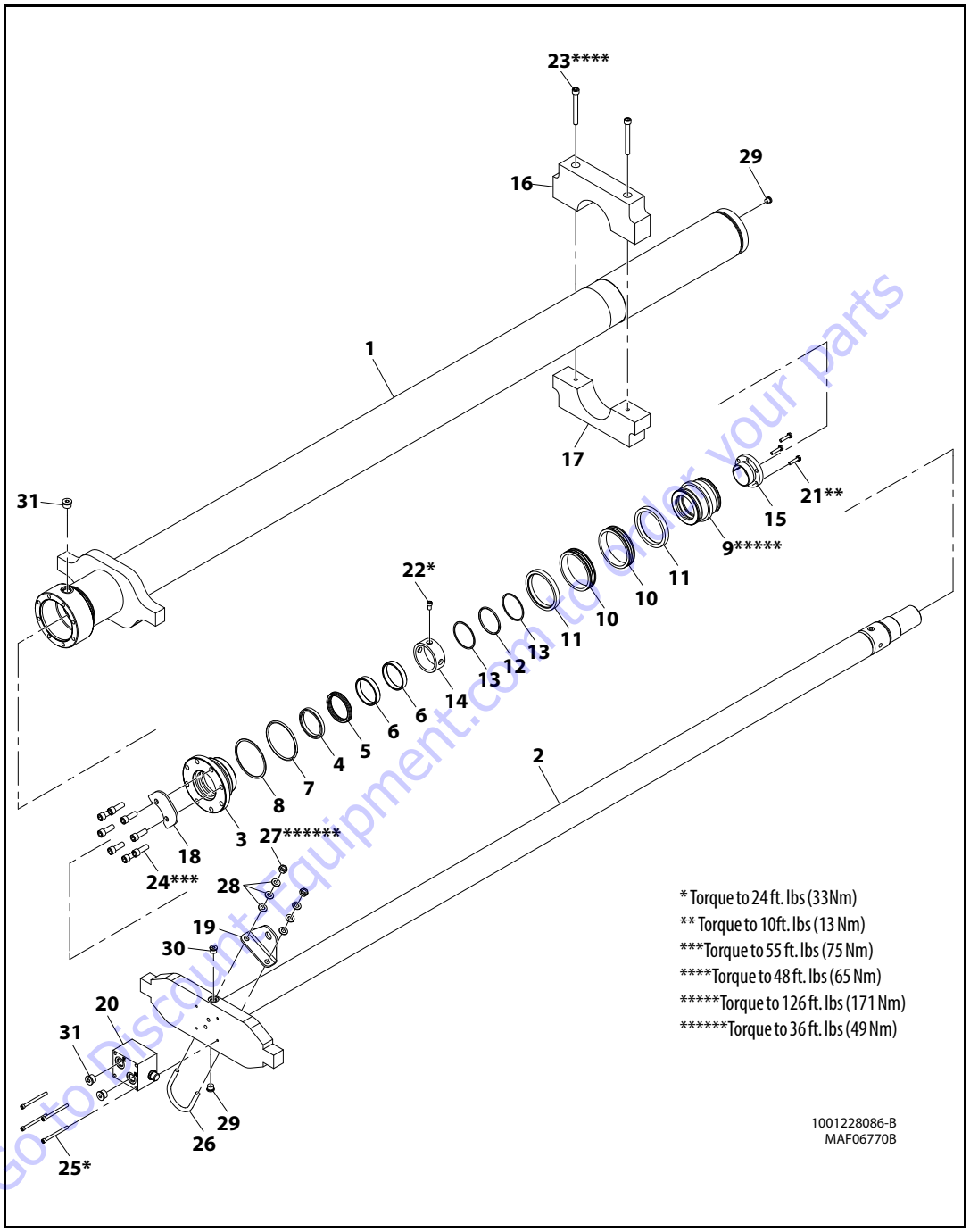


Figure 5-90. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Wiper
5. Rod Seal
6. Wear Ring
7. O-ring
8. Backup Ring
9. Piston
10. Seal
11. Lock Ring
12. O-ring
13. Backup Ring
14. Tube Spacer
15. Tapered Bushing
16. Support Pad
17. Support Pad
18. Target Plate
19. Mount Plate
20. Valve Assembly
21. Bolt
22. Setscrew
23. Bolt
24. Capscrew
25. Capscrew
26. U Bolt
27. Nut
28. Flatwasher
29. Plug
30. Plug
31. Plug

Figure 5-91. Tower Boom Telescopic Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

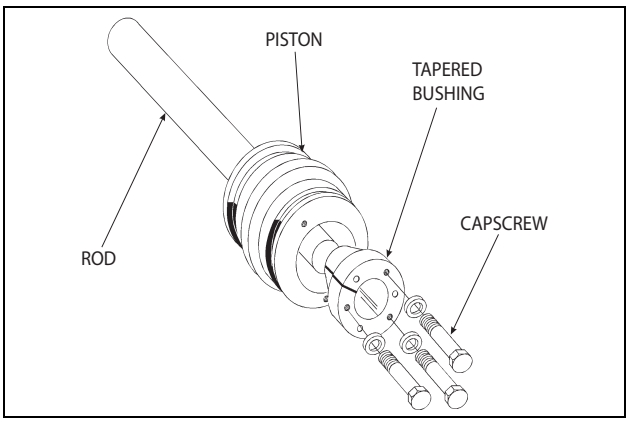


Figure 5-92. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove setscrew from the piston spacer. Remove spacer from the rod.
14. Remove the rod from the holding fixture. Remove capscrews, target plate and washer ring if available. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, and wiper seals.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*

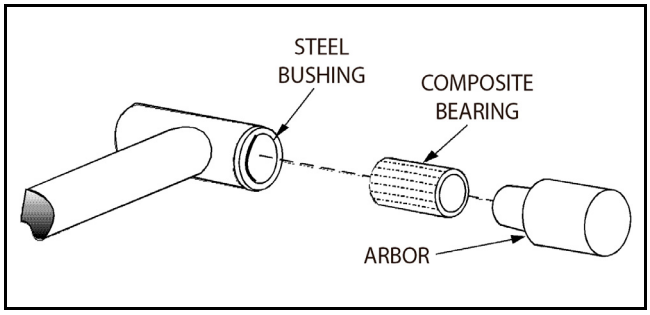


Figure 5-93. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

NOTE: *Apply a light film of hydraulic oil to all components prior to assembly.*

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

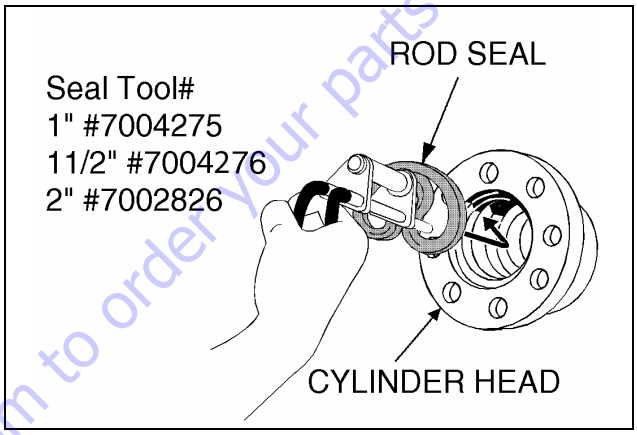


Figure 5-94. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

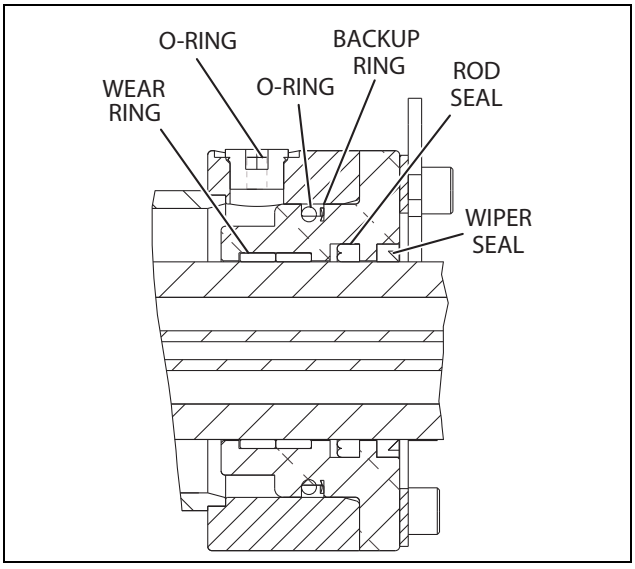


Figure 5-95. Cylinder Head Seal Installation

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

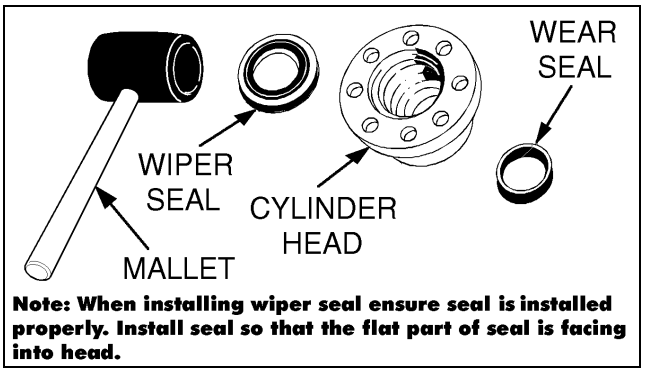


Figure 5-96. Wiper Seal Installation

3. Place a new o-ring and backup seal in the applicable outside diameter groove of the cylinder head.

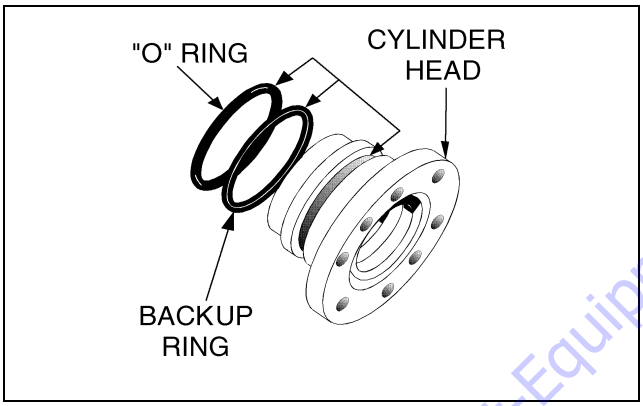


Figure 5-97. Installation of Head Seal Kit

4. Install washer ring onto rod if applicable, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.

5. Carefully slide the piston spacer on the rod. Install setscrew on the spacer. Torque setscrew as shown in Figure 5-91.

6. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

7. Place a new o-ring and backup rings in the inner piston diameter groove.

8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

9. Thread piston onto rod until it abuts the spacer end and torque piston as shown in Figure 5-101. and Figure 5-91. Install the tapered bushing.

NOTE: *When installing the tapered bushing, piston and mating end of rod must be free of oil.*

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

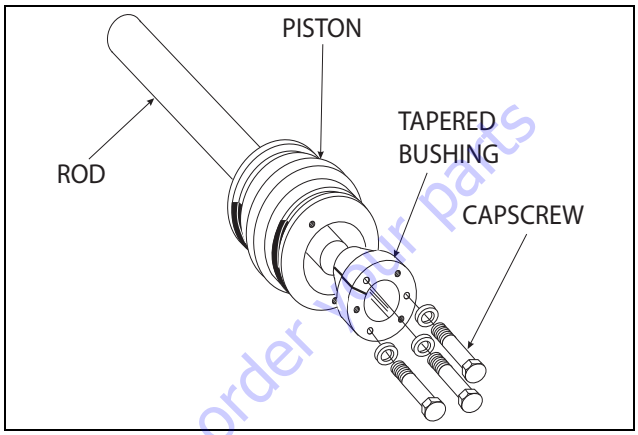


Figure 5-98. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation and torque capscrews as shown in Figure 5-91.

12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

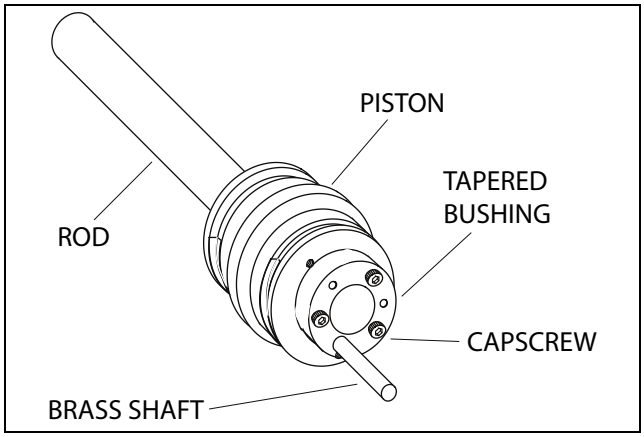


Figure 5-99. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation and torque capscrews as shown in Figure 5-91.

14. Remove the cylinder rod from the holding fixture.

NOTICE

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCKK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

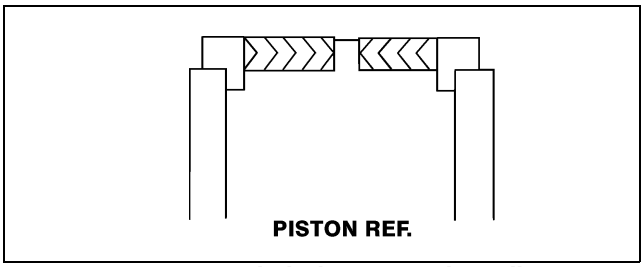


Figure 5-100. Hydrolock Piston Seal Installation

15. Place new hydrolock seal and guidelock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

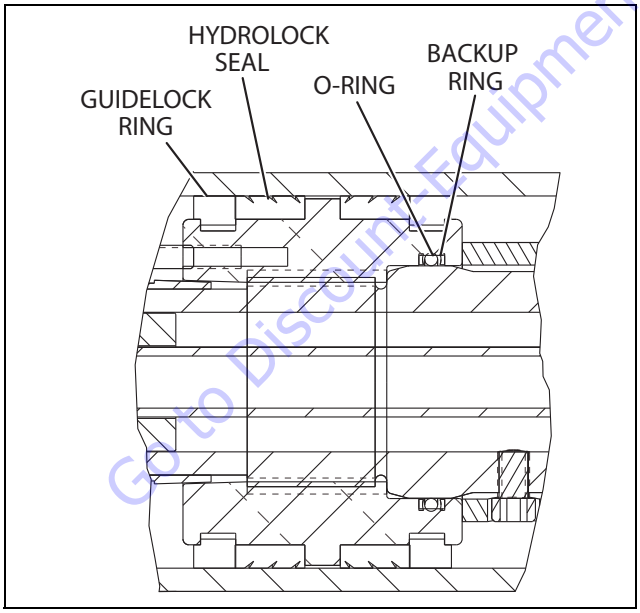


Figure 5-101. Piston Seal Kit Installation

16. Position the cylinder barrel in a suitable holding fixture.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

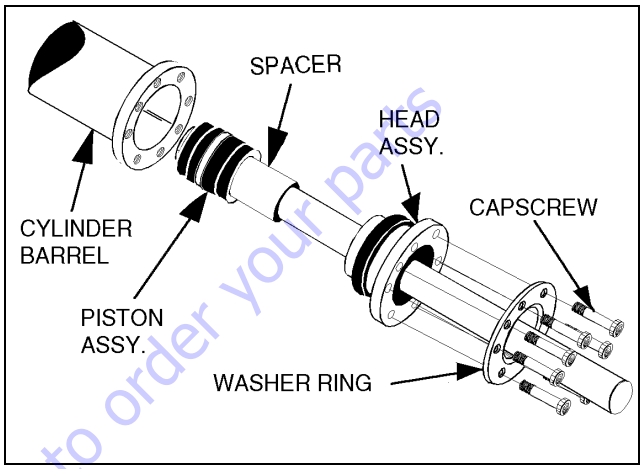


Figure 5-102. Rod Assembly Installation

19. Apply Medium Strength Threadlocking Compound to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 55 ft.lbs. (75 Nm).

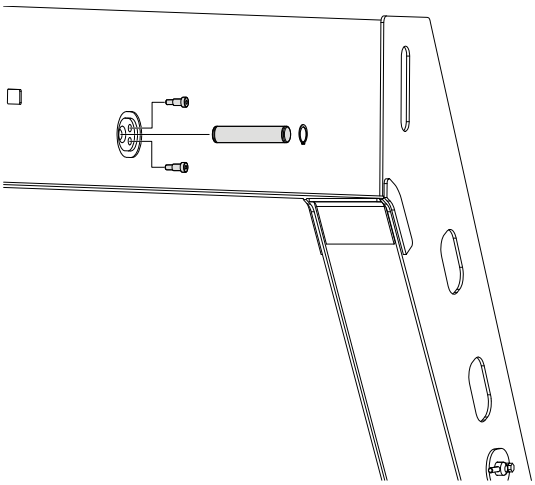
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.

21. Install the valve assembly. Torque capscrews to 24 ft.lbs. (33 Nm).

5.4 CYLINDER REMOVAL AND INSTALLATION

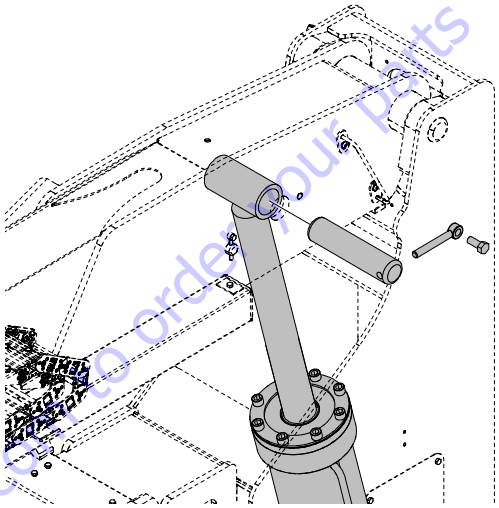
Removal

1. Place machine on a flat and level surface, with main boom in the horizontal position.
2. Extend the boom to gain access to main fly boom telescope cylinder rod end pin.
3. Remove the hardware securing the telescope cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.



NOTE: *The Main Boom weighs approximately 2226 lb (1010 kg).*

4. Using a suitable sling and lifting device, secure the platform end of the boom.
5. Place blocking under the main lift cylinder to prevent it from falling when the attaching hardware is removed.
6. Remove the hardware securing the main lift cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.



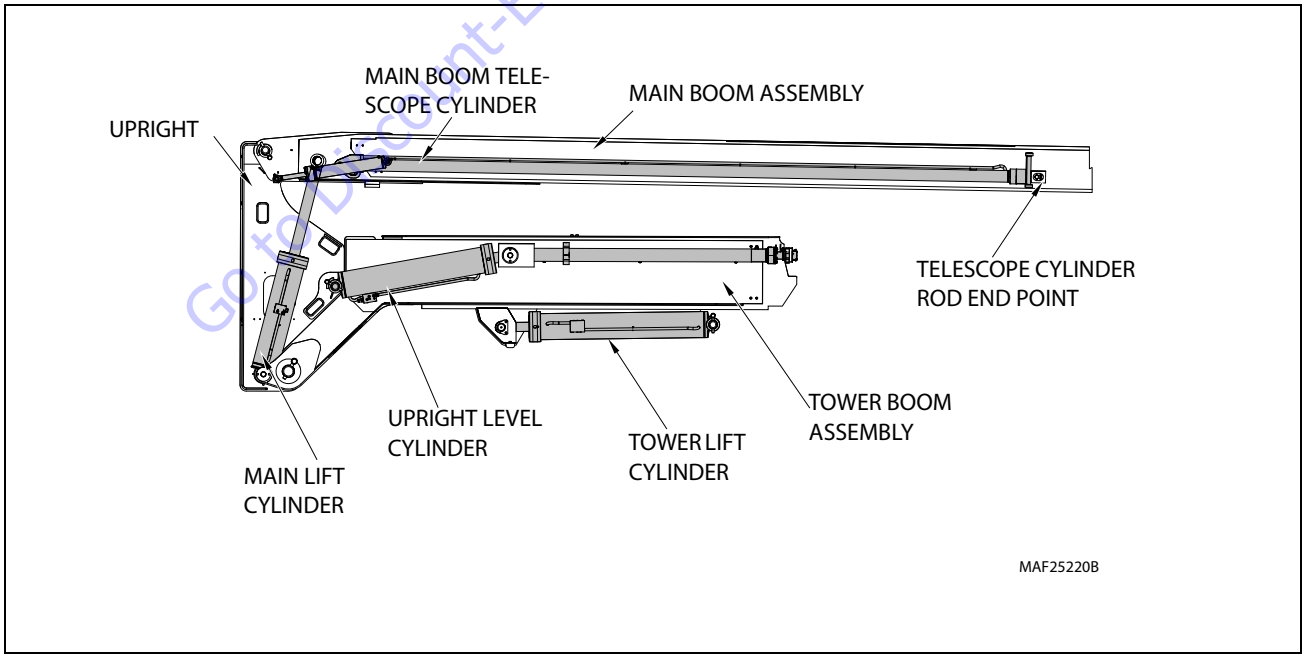
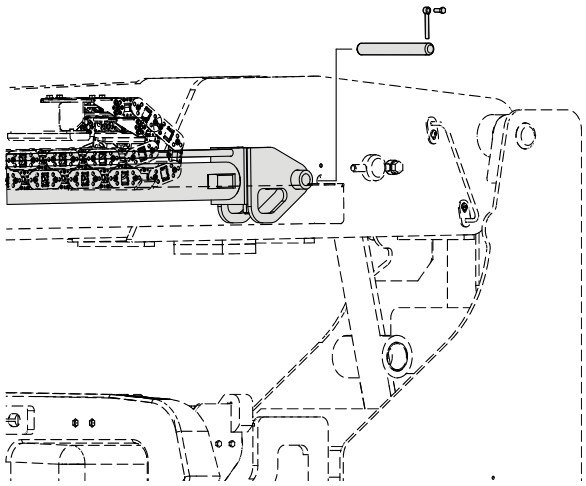


Figure 5-103. Components Main Boom and Tower Boom

7. Using auxiliary power from ground controls, retract the lift cylinder rod completely.
8. Remove hardware securing cover plate on the rear of the main boom. Remove cover plate.
9. Remove mounting hardware securing the telescope cylinder barrel to the main base boom.



10. Using an external pump, extend the cylinder as far as the hydraulic lines will allow to enable a lifting device to be attached to the telescope cylinder.

NOTICE

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID THE ENTRY OF CONTAMINANTS INTO THE SYSTEM

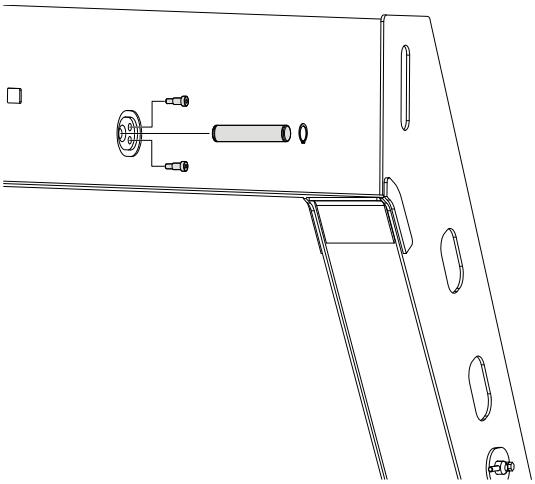
11. Tag and disconnect hydraulic lines from telescope cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.

NOTE: *The Telescope Cylinder weighs approximately 477.8 lb (216.7 kg).*

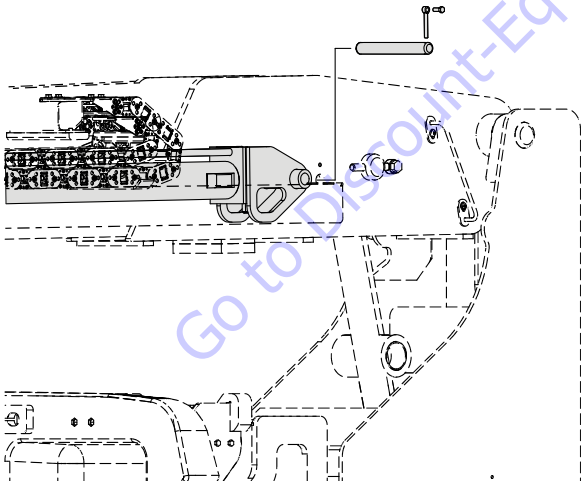
12. Secure the telescope cylinder with a suitable sling and lifting device.
13. Carefully remove the telescope cylinder from the main boom assembly and place in a suitable work area.

Main Boom Telescope Cylinder Installation

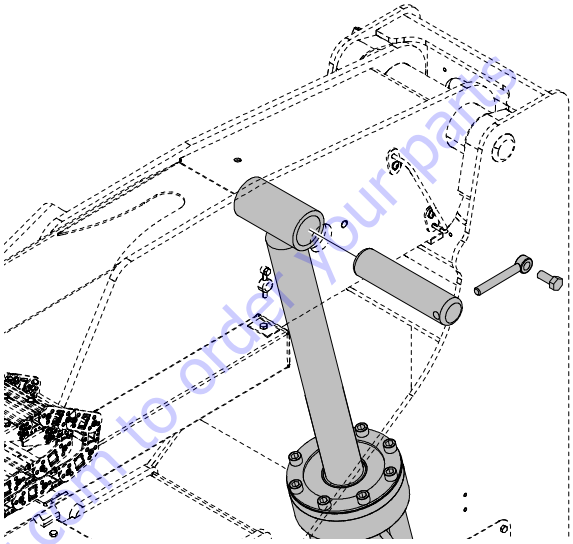
1. Using suitable lifting equipment, carefully insert the cylinder into the boom assembly.
2. Carefully install main telescope cylinder rod pin through the fly boom and secure it with the retaining rings.



3. Remove applicable hydraulic line and port caps and properly connect the hydraulic lines to the telescope cylinder. Ensure all hoses are correctly routed.
4. Carefully install the telescope cylinder barrel end support into mounting block in base boom and secure with blocks and torque the bolts to 35 ft.lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts. Shim as necessary.



5. Remove the lifting device from the main telescope cylinder and retract the main telescope cylinder.
6. Extend the main lift cylinder using the auxiliary control from the ground controls to align with rod end hole in main base boom.
7. Carefully insert the main lift cylinder rod end pin through the base boom and install the mounting hardware.

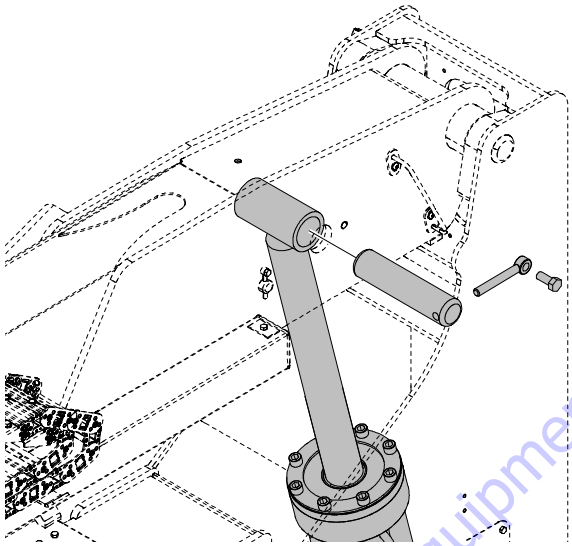


8. Using all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks. Secure as necessary.
9. Check fluid level of hydraulic tank and adjust as necessary.

Main Lift Cylinder Removal

NOTE: *The Main Boom weighs approximately 2226 lb (1010 kg).*

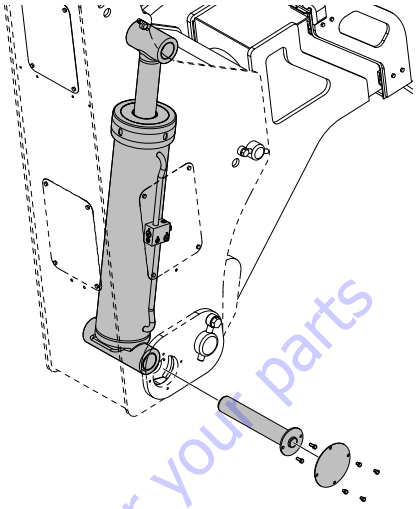
1. Place the machine on a flat and level surface. Attach a suitable lifting device and sling, sufficient to lift the main boom assembly, to the approximate center of the main boom assembly.
2. Place blocking under the cylinder to prevent it from falling when the attaching hardware is removed.
3. Remove the hardware securing the main lift cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.



4. Using auxiliary power from ground controls, retract the lift cylinder rod completely.
5. Disconnect, cap, and tag the main boom lift cylinder hydraulic lines and ports.
6. Attach a suitable lifting device and sling to the main lift cylinder.
7. Remove hardware securing cover plate on the bottom of the upright. Remove cover plate.

NOTE: *The Main Lift Cylinder weighs approximately 493 lb (224 kg).*

8. Use a suitable brass drift and hammer to remove main lift cylinder barrel end pin from Upright.



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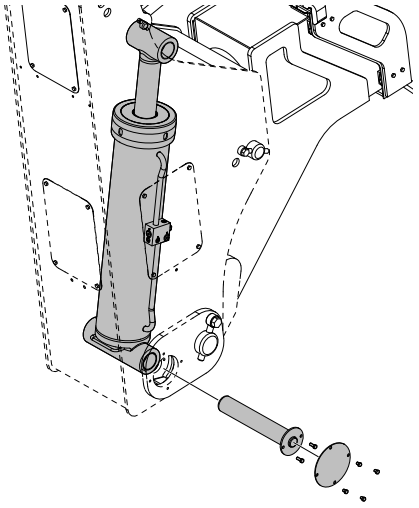
9. Using a suitable brass drift drive out the barrel end attach pin from the tower upright. Raise the main boom assembly with the lifting device and sling to allow enough space to remove the main lift cylinder from the upright top.
10. Carefully lift the cylinder clear of the boom assembly and lower to the ground or suitably supported work area.
11. Lower the boom assembly to the stowed position.

Main Lift Cylinder Installation

1. Lift the main boom to allow enough space to lower the main boom lift cylinder to align with pin mounting holes of the tower fly boom and barrel end of main lift cylinder.
2. Using a suitable brass drift, drive barrel end attach pin through the mounting holes in the lift cylinder and the tower fly boom. Secure in place with the pin and torque the bolts to 35 ft. lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts.



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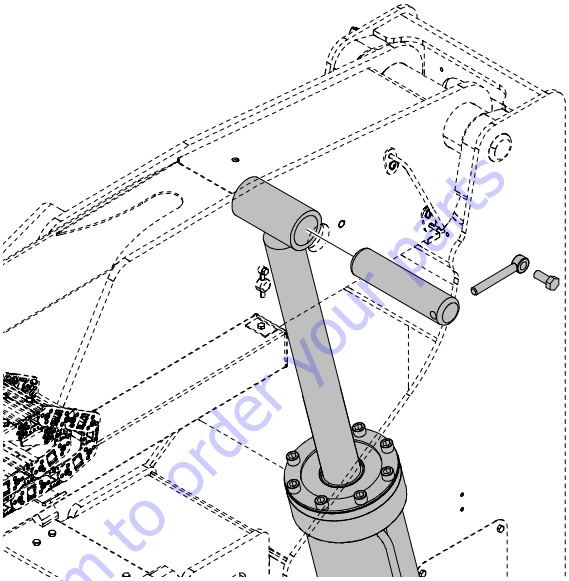
3. Remove cylinder port plugs and hydraulic line caps and attach lines to cylinder ports as tagged during removal.
4. Using auxiliary power extend the cylinder rod until the attach pin hole aligns with those in the main boom.
5. Using a suitable drift drive cylinder rod attach pin through the aligned holes, taking care to align the grooved pin holes. Secure the pin in place and torque the bolt to 285 ft. lbs. (388 Nm). Use JLG Medium Strength Threadlocking Compound on bolts.



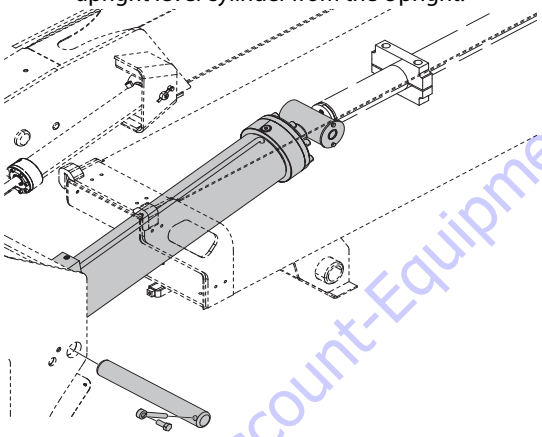
6. Remove lifting device and sling. Activate hydraulic system.
7. Using all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks. Secure as necessary.
8. Check fluid level of hydraulic tank and adjust as necessary.

Upright Level Cylinder Removal

NOTICE

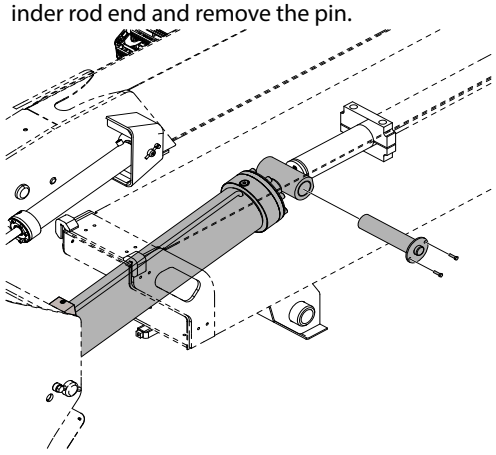
HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

1. Remove the Main Boom. Refer to Main Boom removal.
2. Tag and disconnect hydraulic lines to the main lift cylinder. Use suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove mounting hardware from the main boom lift cylinder barrel end. Use a suitable brass drift and hammer to remove main lift cylinder barrel end pin from Upright and remove main lift cylinder.
4. Disconnect the Upright Level Cylinder as follows:
   a. Use a suitable lifting device to support the Upright.
   b. Remove mounting hardware securing the Upright Level Cylinder to the upright. Use a suitable brass drift and hammer to remove upright level cylinder barrel end pin from upright and disconnect the upright level cylinder from the Upright.



NOTE: *The Upright weighs approximately 1167 lb (529.3 kg).*

5. Before extending the tower boom, support the tower boom from the bottom.
6. Extend the tower boom to get access to the Upright level cylinder rod end pin by using an external auxiliary pump.
7. Tag, disconnect and cap the hydraulic lines of the Upright level Cylinder barrel.
8. Attach a suitable lifting device to support the Upright Level Cylinder.
9. Remove mounting hardware from the upright level cylinder rod end and remove the pin.



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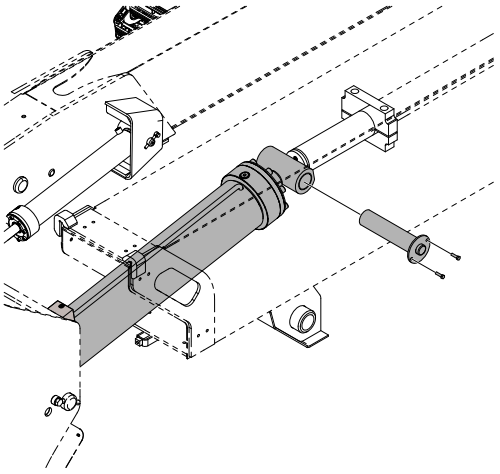
10. Remove the Upright Level Cylinder from the Tower Fly Boom. Place the Upright level Cylinder in a suitable work area.

Upright Level Cylinder Installation

1. Put the leveling cylinder in position in the tower boom, align holes in the tower boom and leveling cylinder rod end.
2. Secure the leveling cylinder rod end pin to tower boom and torque the bolts to 35 ft. lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts.



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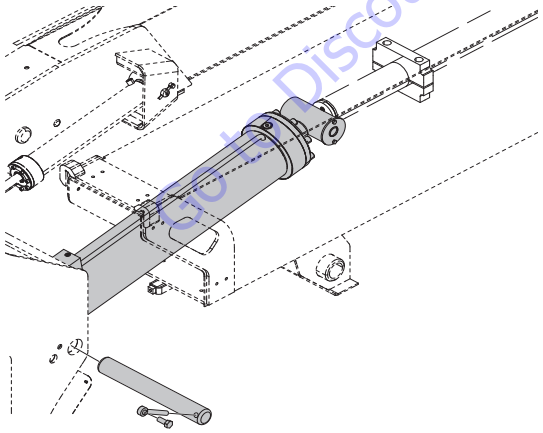
3. Remove Cylinder Port plugs and hydraulic line caps. Properly attach lines to Cylinder ports as tagged during removal.
4. Use all applicable safety precautions, operate the lifting device to move upright assembly into proper position.
5. Align holes in upright and barrel end of level cylinder. Use a suitable rubber mallet to install level barrel end pin. Secure pin and torque the bolt 285 ft. lbs. (388 Nm). Use Medium Strength Threadlocking Compound on bolts.



6. Install Main Lift Cylinder.
7. Install Main Boom. Refer to Main Boom installation.
8. Remove hydraulic line caps and attach all the hydraulic and electrical lines as tagged during removal.
9. Use all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks.
10. Check fluid level of hydraulic tank and add fluid, if required.

Tower Boom Lift Cylinder Removal

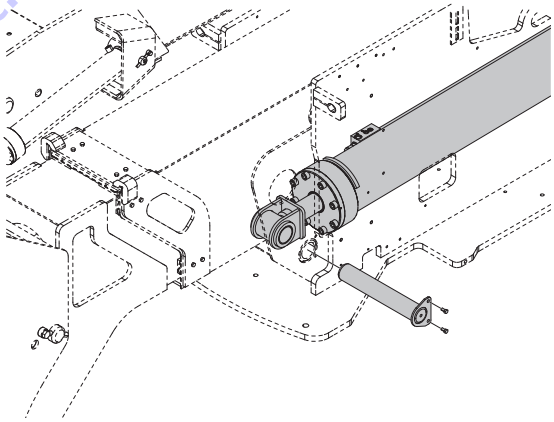
1. Place machine on a flat and level surface. Place the main boom in a horizontal position with the telescope cylinder fully retracted. Place the tower boom in a fully elevated and fully retracted position.

NOTE: *The Main Boom weighs approximately 2226 lb (1010 kg), Upright weighs approximately 1167 lb (529.3 kg) & Tower Boom weighs approximately 2944 lb (1335 kg).*

2. Support the main boom, upright and tower boom with adequate overhead crane.

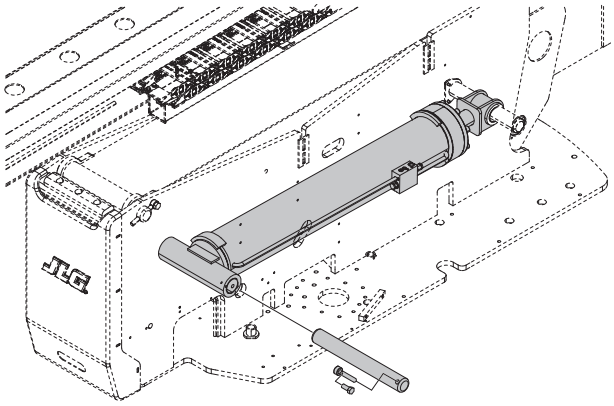
NOTE: *The Tower lift cylinder weighs approximately 597 lb (271 kg).*

3. Adequately support the tower lift cylinder.
4. Remove mounting hardware securing the lift cylinder rod pin to the tower boom. Using a suitable brass drift, drive out the tower lift cylinder rod attach pin.



5. Using all applicable safety precautions, operate auxiliary power, activate tower lift down and fully retract lift cylinder.
6. Tag, disconnect, and cap the tower lift cylinder hydraulic lines and ports.

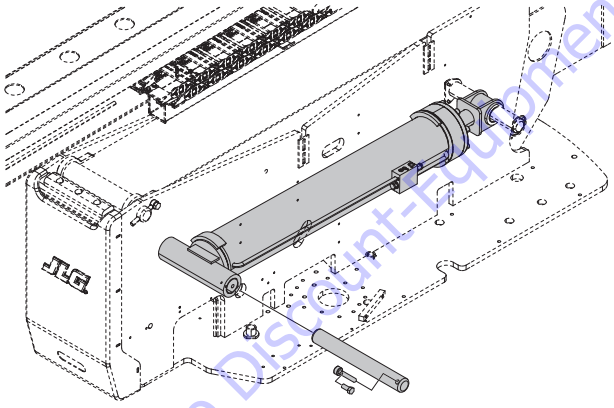
7. Remove mounting hardware securing the tower lift cylinder barrel pin to the turntable. Using a suitable brass drift, drive out the tower lift cylinder barrel pin.



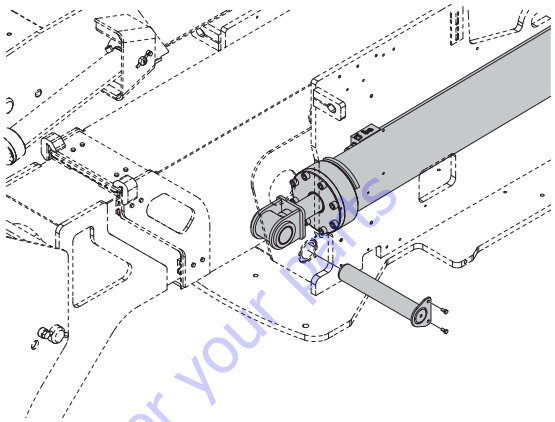
8. Carefully remove the tower lift cylinder from turntable. Place in a suitable work area.

Tower Boom Lift Cylinder Installation

1. Support the main boom and tower boom, place the tower lift cylinder on the turntable and align the holes. Install the cylinder barrel pin and torque the bolt to 285 ft. lbs. (388 Nm). Use Medium Strength Threadlocking Compound on bolts.



2. Remove caps from cylinder hydraulic lines properly and install lines to cylinder as previously tagged.
3. Using auxiliary power, activate tower lift function and extend cylinder rod until the cylinder rod bushing aligns with bushings on boom.
4. Using an appropriate brass drift, drive the tower lift cylinder rod end attach pin through the aligned bushings. Secure pin and torque the bolt 35 ft. lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts.



5. Remove main boom support and lifting device supporting the upright.
6. Using all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks. Secure as necessary.
7. Check fluid level of hydraulic tank and add fluid, if required.

Tower Telescope Cylinder Removal

1. Place machine on flat and level surface.
2. Remove the tower telescope cylinder rod end trunion hardware.
3. Using an external pump, extend the tower telescope cylinder as far enough to attach the lifting device.
4. Tag, disconnect and cap hydraulic hoses to Tower Telescope Cylinder. Plug cylinder ports. Remove the hoses.

NOTE: *The Tower Telescope Cylinder weighs approximately 238.3 lb (108.1 kg).*

5. Properly secure the Tower Telescope Cylinder by using a suitable sling or support.
6. Remove the tower telescope cylinder barrel end trunion hardware.
7. Carefully remove the Tower Telescope Cylinder from the Boom. Place cylinder on a suitable work area.

Tower Telescope Cylinder Installation

1. Slide the telescope cylinder into the boom, aligning the cylinder port block end with slotted holes in Base Boom.
2. Secure the telescope cylinder barrel end to the fly boom by using retaining plate and torque the bolts 35 ft. lbs. (48Nm). Use Medium Strength Threadlocking Compound on bolts.
3. Secure telescope cylinder rod end and torque the bolts to 35 ft. lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts.
4. Remove caps and plugs from hydraulic lines and ports. Properly connect hydraulic lines to cylinder. Reinstall cover plate.
5. Using all applicable safety precautions, operate the boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
6. Check fluid level of hydraulic tank and add fluid, if required.

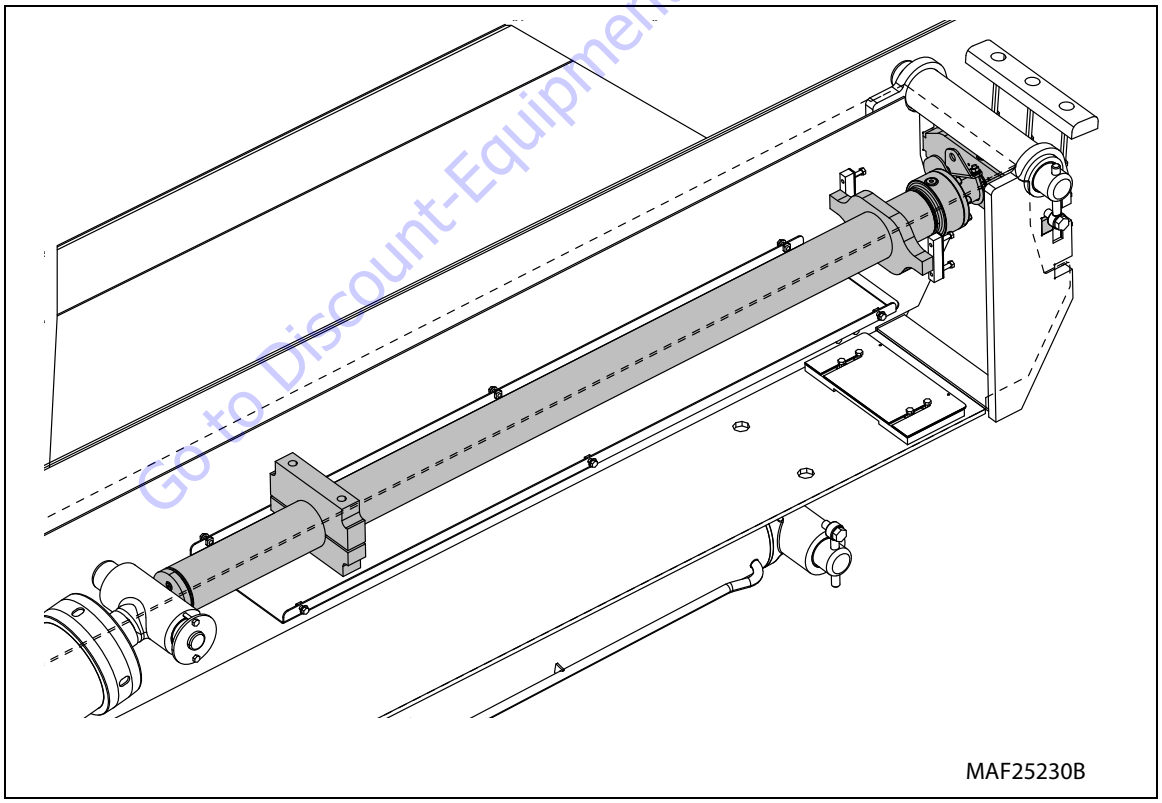


Figure 5-104. Removal/Installation of Tower Telescope Cylinder

Master Cylinder Removal

NOTE: *The Master Cylinder weighs approximately 63 lb (28.6 kg).*

1. Tag and disconnect hydraulic lines to the main boom lift cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Properly secure the master cylinder by using a suitable sling or support.
3. Remove the master cylinder pin retaining hardware. Using a suitable brass drift, remove the master cylinder pins from the rod and barrel ends.
4. Carefully remove the master cylinder.
5. Clean and inspect the cylinder pins and retaining hardware for reuse. Replace if necessary.

Master Cylinder Installation

1. Remove caps from the hydraulic hoses and attach hoses to the proper cylinder ports.

NOTE: *The Master Cylinder weighs approximately 63 lb (28.6 kg).*

2. Use suitable slings or support to position the master cylinder in place. Align barrel end mounting holes with the holes in main boom.
3. Use suitable mallet and keeper to install the barrel end attach pin and torque the bolts to 35 ft. lbs. (48 Nm).
4. Extend the master cylinder rod until the rod attach pin hole aligns with holes in the upright pivot. Use suitable mallet and keeper to install the rod end pin.
5. Remove any support or sling used to lift the master cylinder.
6. Use all applicable safety precautions, operate the boom functions.
7. Check for proper operation and hydraulic leaks.
8. Check the fluid level of hydraulic tank. Fill the tank, if required.

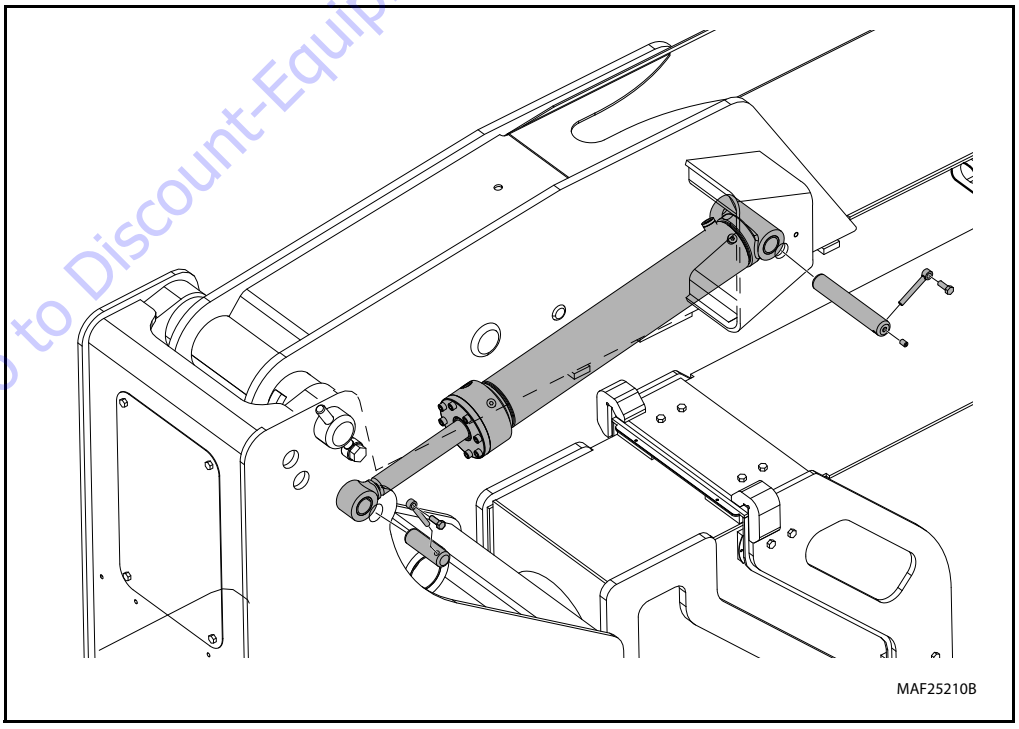


Figure 5-105. Removal/Installation of Master Cylinder

5.5 HYDRAULIC PUMP W/HAYES PUMP DRIVE COUPLING LUBRICATION

Any time pump or pump drive coupling is removed coat, pump and drive coupling splines with Lithium Soap Base Grease (TEXACO CODE 1912 OR EQUIVALENT) coupling is greased prior to assembly.

5.6 PRESSURE SETTING PROCEDURES

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within ± 5% of specified pressures.

To ensure all pressures are set correctly, the following procedures must be followed in order.

1. All applicable steps must be followed.
2. Set up of the function pump.
3. Adjustments Made at the Main Valve Block.
4. Adjustments Made at the Platform Valve Block

Set Up the Function Pump

(the pump that is mounted on the back of the drive pump).

1. **Set Stand by pressure or load sense pressure**

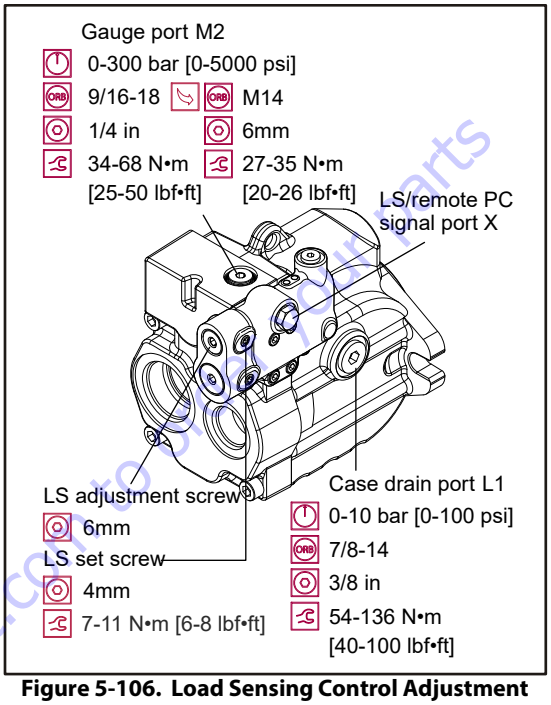


Figure 5-106. Load Sensing Control Adjustment

   a. Install a low pressure gauge at port **"MP"** of the main valve block. A gauge capable of reading **400 psi (28 bar)**.

   b. Start the engine and let it idle. The gauge should be reading between **400-440 psi (28-30 bar)**.

   c. To make an adjustment to this pressure, go to the engine compartment, locate the function pump. There are (2) adjustments at the top of the pump. They are located on the pump compensator which has (4) bolts mounting it to the pump. The stand by adjustment is at the top.

   d. To adjust this, a 4 mm and 6 mm Allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine. First, using the 4 mm wrench, loosen the setscrew on the side of the compensator which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it by 1 turn.

   e. Using a 6 mm wrench adjust clockwise to increase or counterclockwise to decrease the pressure. The pressure should read between **400-440 psi (28-30 bar)**.

2. Set High pressure relief

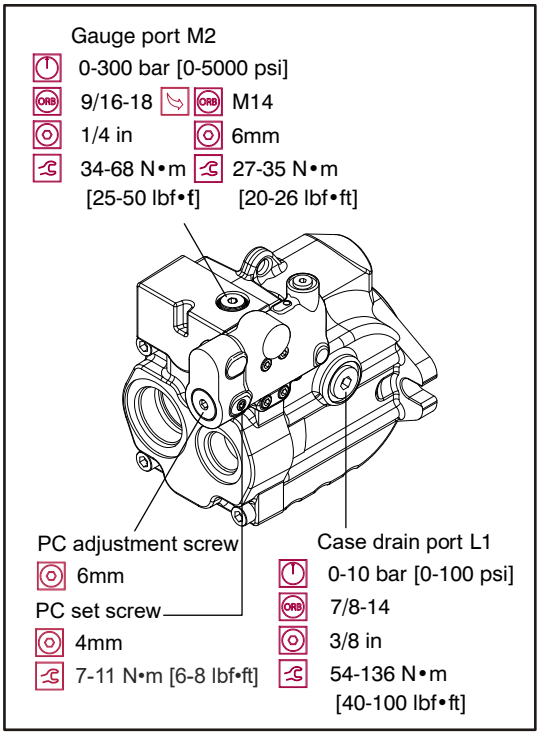


Figure 5-107. Pressure Compensation Control Adjustment

a. Install a high pressure gauge at the **"MP"** port of the main valve block.

b. Activate main boom telescope in. The gauge should read **2600-2700 psi (179-186 bar)**.

c. To make an adjustment to this pressure, go to the engine compartment to the function pump. The high pressure relief adjustment is the lower one of the (2) on the compensator. To adjust this, a 4 mm and 6 mm Allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine.

d. Using the 4 mm wrench, loosen the setscrew on the side of the compensator which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it by 1 turn.

e. Using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. This is the **maximum** relief pressure for all functions governed by this pump.

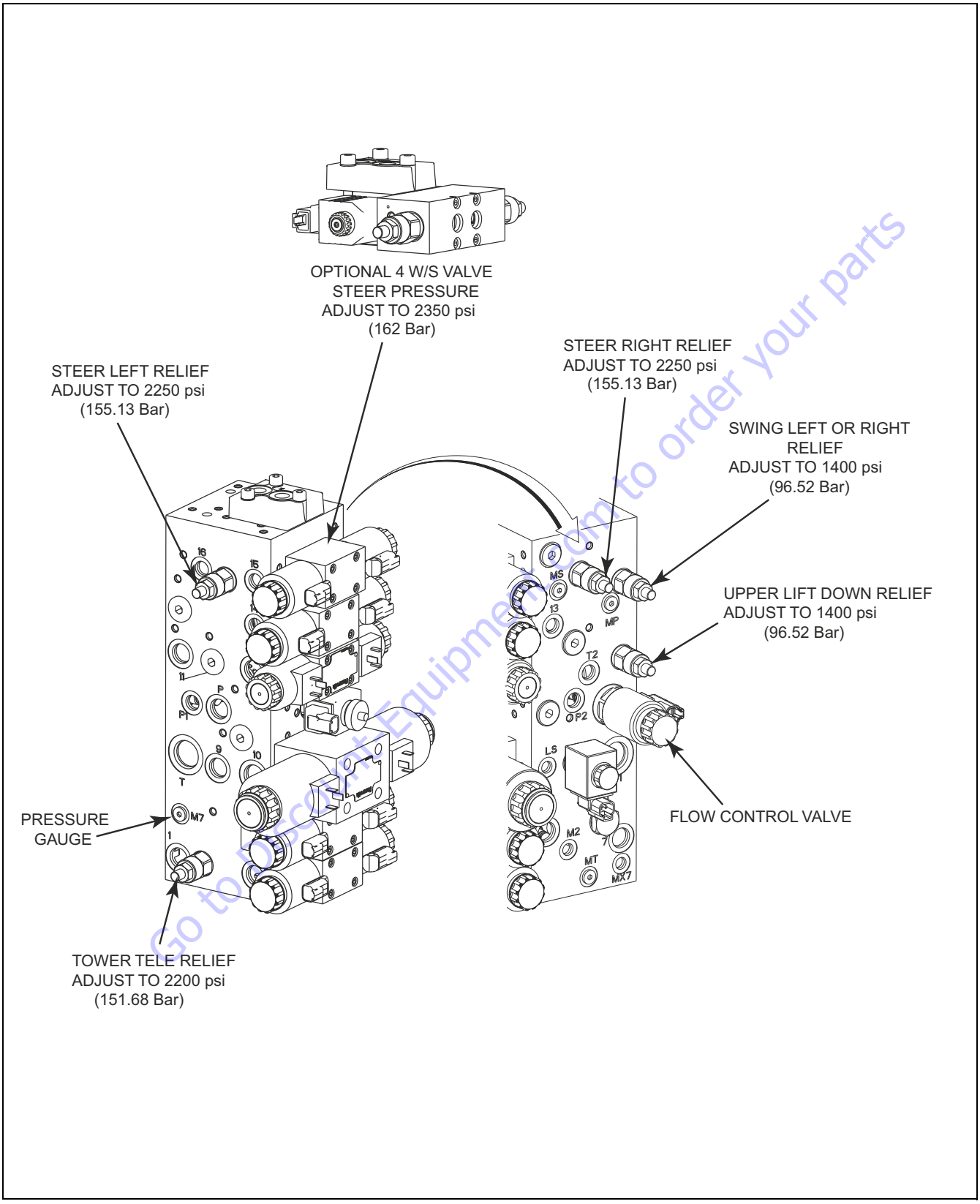


Figure 5-108. Main Control Valve Pressure Adjustments

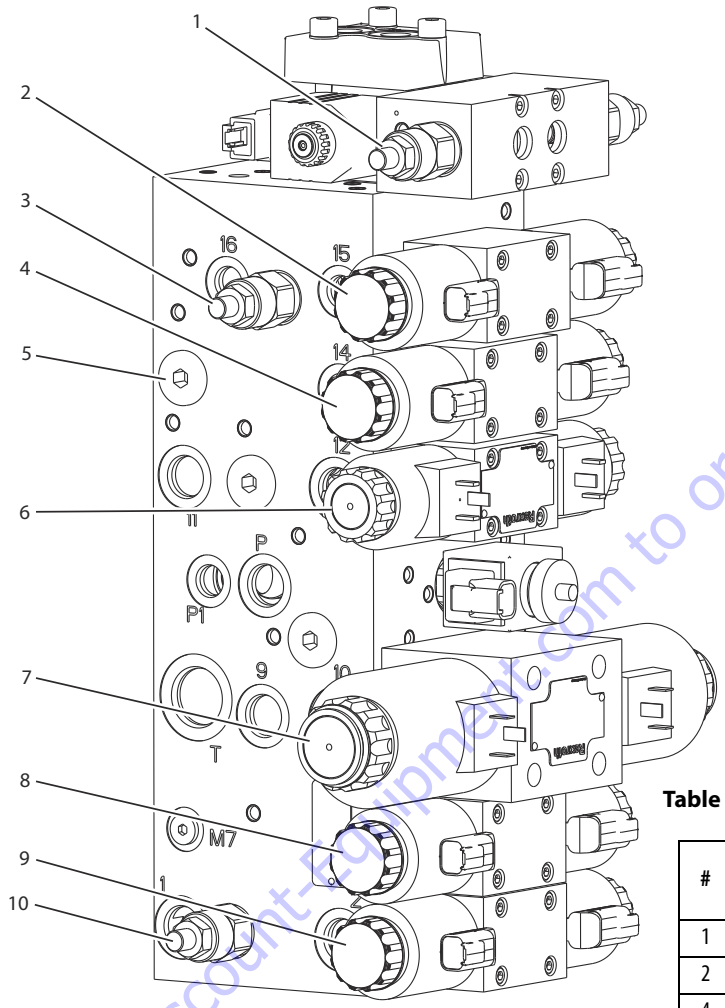
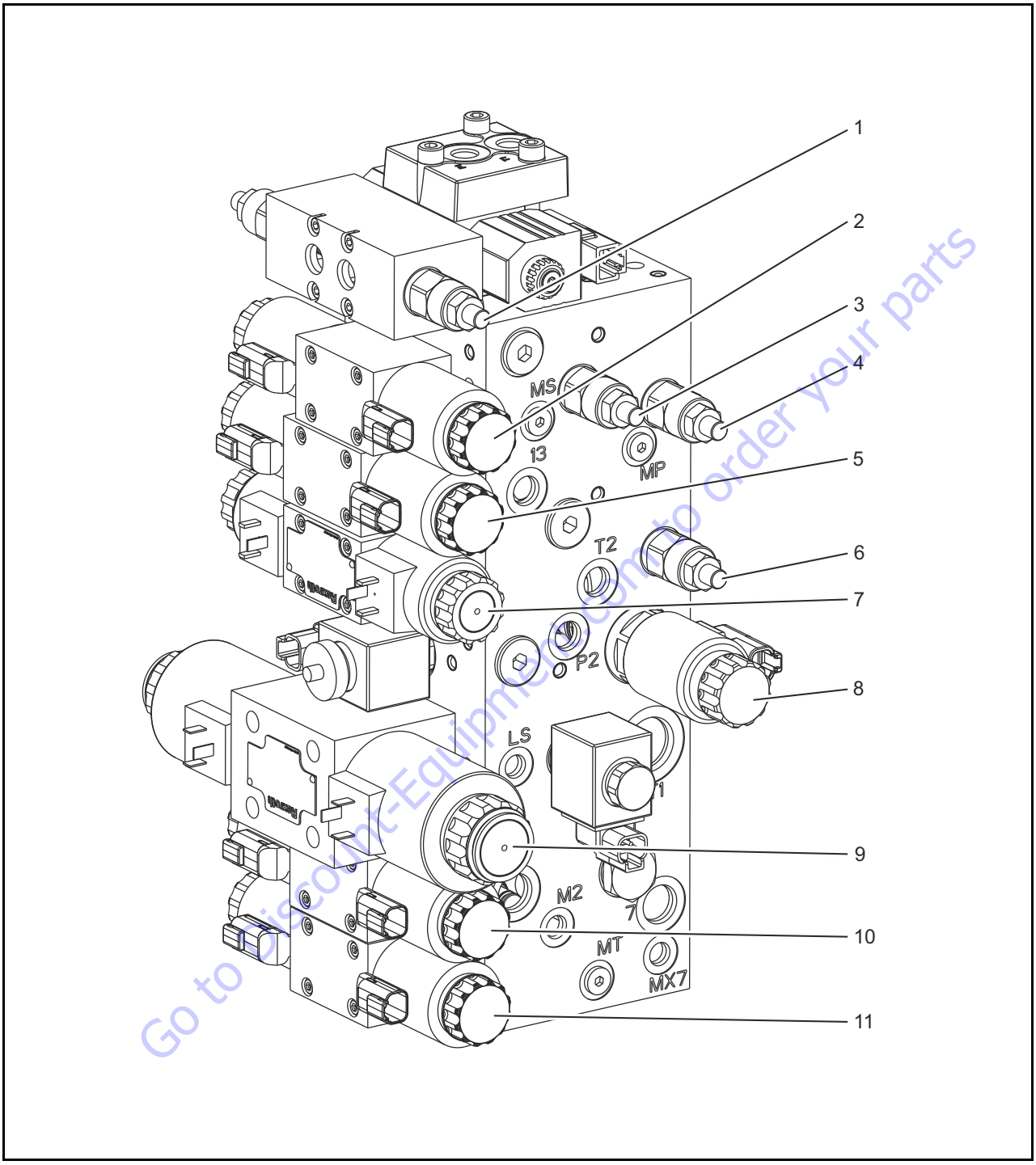


Table 5-33. Main Control valve Coil Resistance

#	Item	Coil Resistance @20^{0}C (Ohms)
1	Rear Steer Right Solenoid	5.3
2	Front Steer Right Solenoid	5.3
4	Shuttle Valve	5.3
6	Main Lift Down Solenoid	2
7	Main Tele In Solenoid	5.3
8	Tower Lift Up Solenoid	4.1
9	Tower Tele In Solenoid	4.1

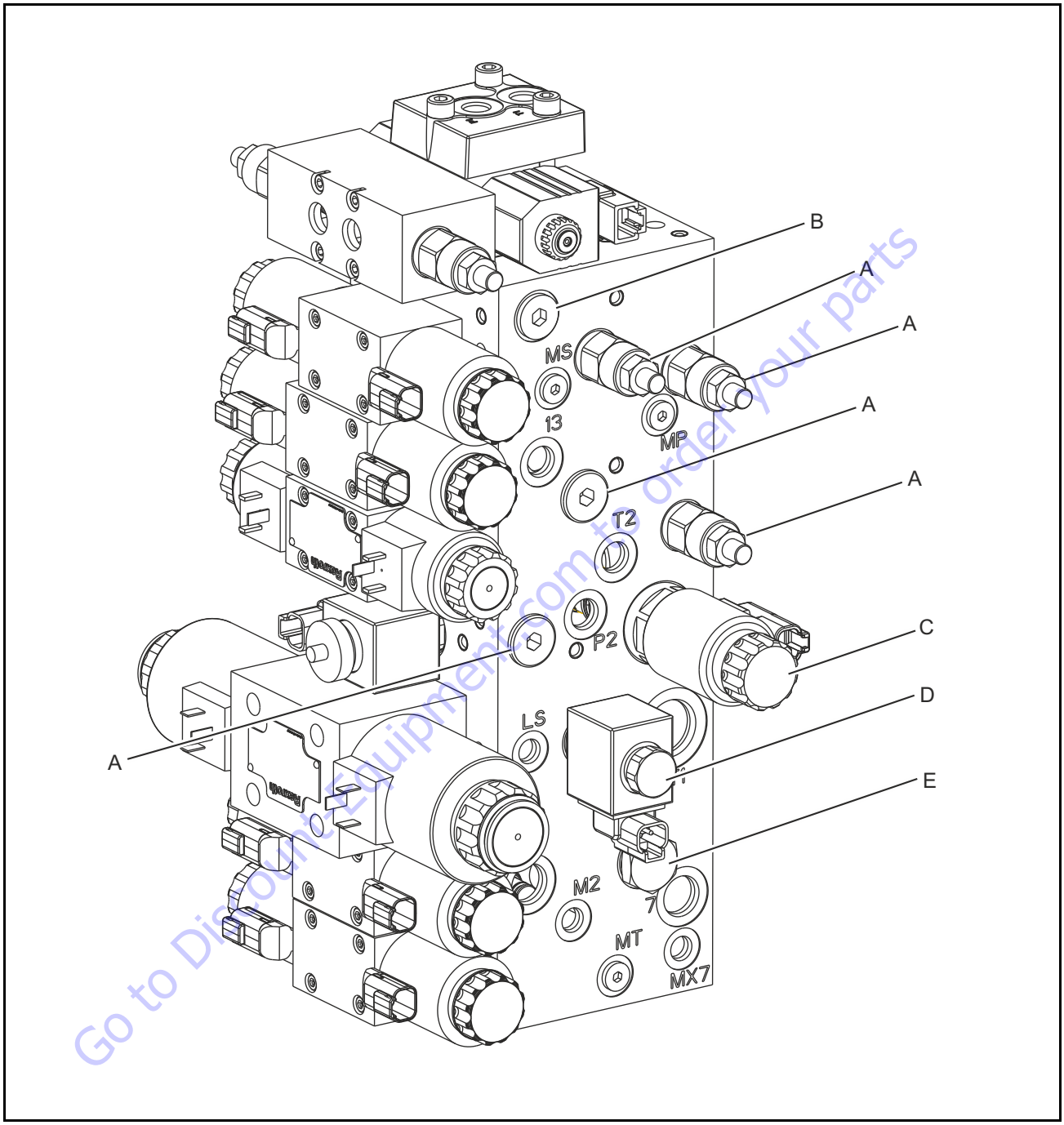
1. Rear Steer Right Solenoid
2. Front Steer Right Solenoid
3. Front Steer left Solenoid
4. Shuttle Valve
5. Swing left Solenoid
6. Main Lift Down Solenoid
7. Main Tele In Solenoid
8. Tower Lift Up Solenoid
9. Tower Tele In Solenoid
10. Tower Tele Relief

Figure 5-109. Main Valve Components - Sheet 1 of 2



1. Rear Steer Left Solenoid
2. Front Steer Left Solenoid
3. Front Steer Right Relief
4. Main Boom Lift Down Solenoid
5. Swing Left or Right Relief
6. Swing Right Solenoid
7. Main Lift Down Solenoid
8. Flow Control Valve
9. Main Tele Out Solenoid
10. Tower Lift Down Solenoid
11. Tower Tele Out Solenoid

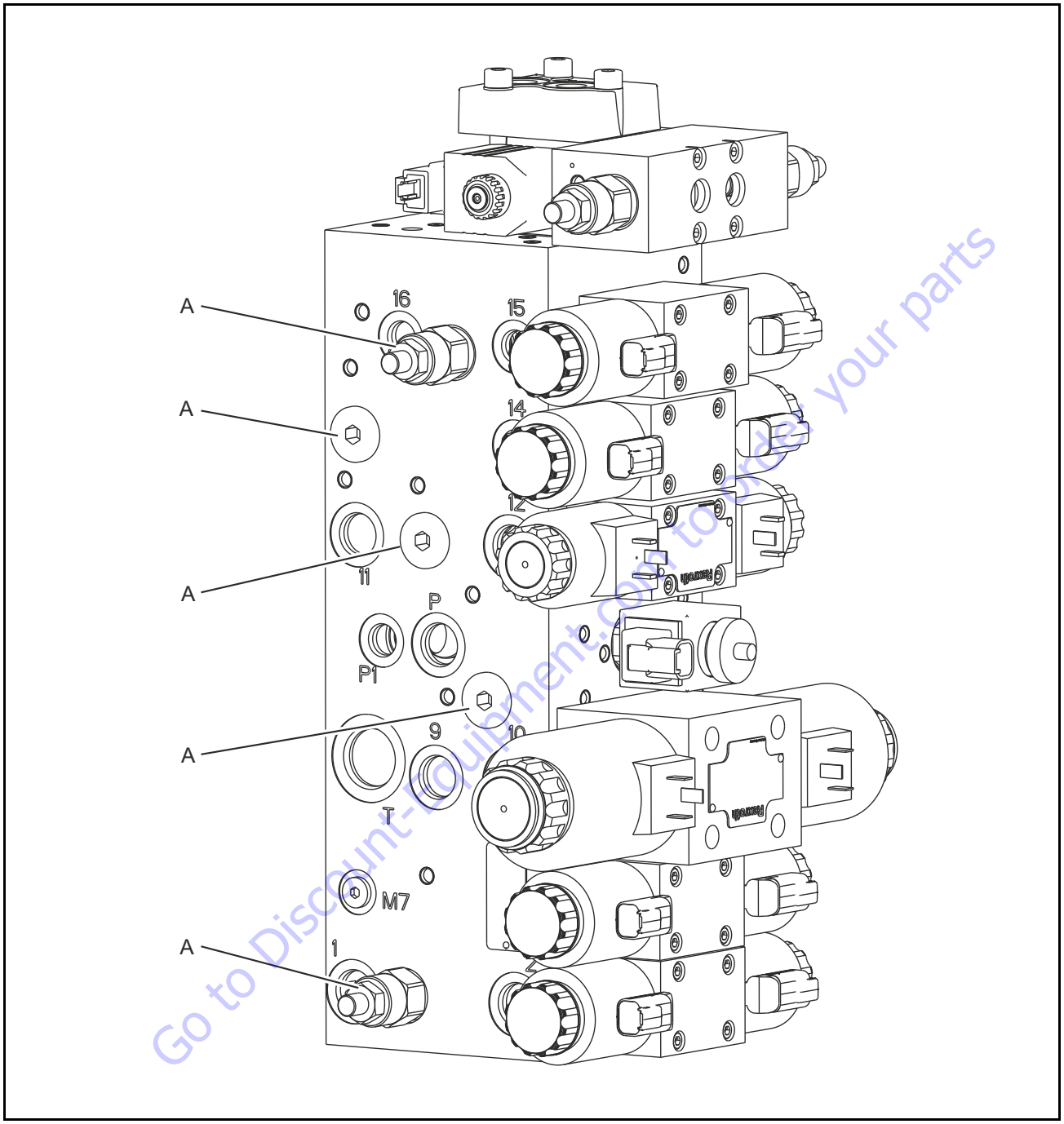
Figure 5-110. Main Valve Components - Sheet 2 of 2



	Ft. Lbs.	Nm
A	25-30	33.8-40.6
B	25.1-30.2	34-41
C	121.1-132.8	164.2-180
D	28.8-37.6	39-51
E	30-35	40.6-47.5

NOTE: *When removing control valves from the manifold, it is important to observe the tag on the face of the valve, as the new valve must be installed with the tag facing the same way as the tag on the valve that was removed. The bolt pattern on the control valves is not symmetrical, so if the bolts seem difficult to turn when installing, it would indicate the valve is upside down and forcing the bolts will result in cross-threading. Check the tag, and if necessary, rotate the valve 180 degrees.*

Figure 5-111. Valve Component Torque - Sheet 1 of 2



	Ft. Lbs.	Nm
A	25-30	33.8-40.6

NOTE: *When removing control valves from the manifold, it is important to observe the tag on the face of the valve, as the new valve must be installed with the tag facing the same way as the tag on the valve that was removed. The bolt pattern on the control valves is not symmetrical, so if the bolts seem difficult to turn when installing, it would indicate the valve is upside down and forcing the bolts will result in cross-threading. Check the tag, and if necessary, rotate the valve 180 degrees.*

Figure 5-112. Valve Component Torque - Sheet 2 of 2

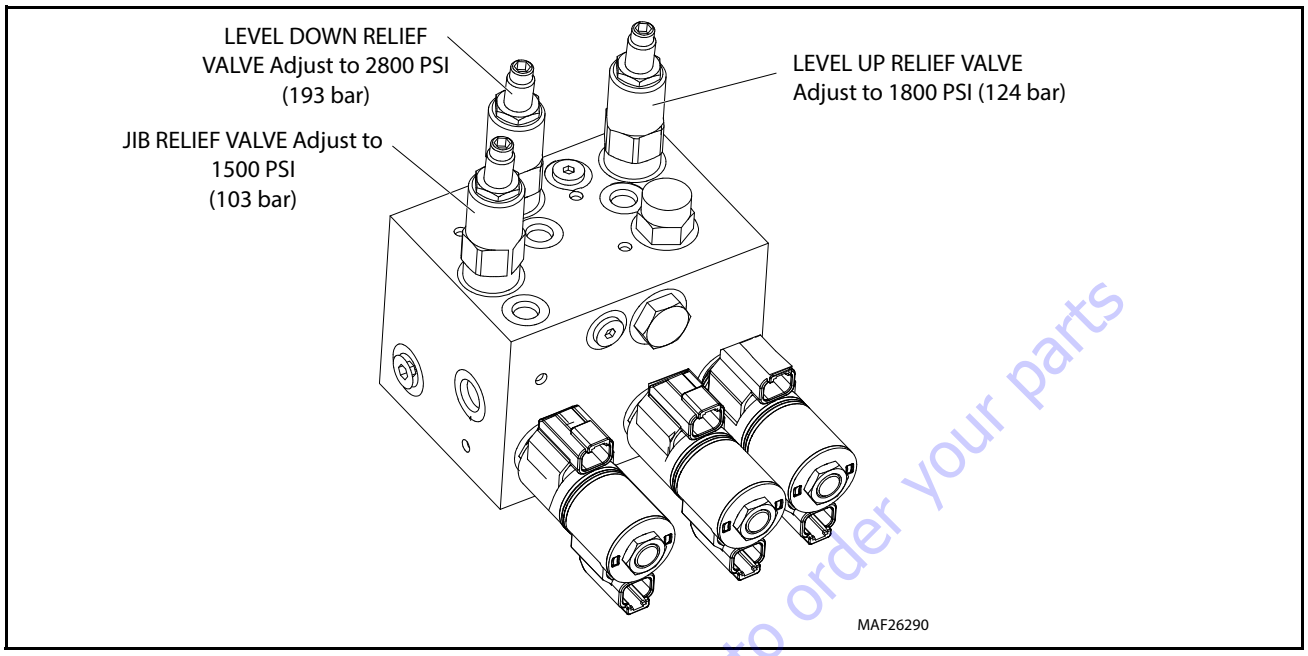


Figure 5-113. Platform Control Valve Pressure Adjustments

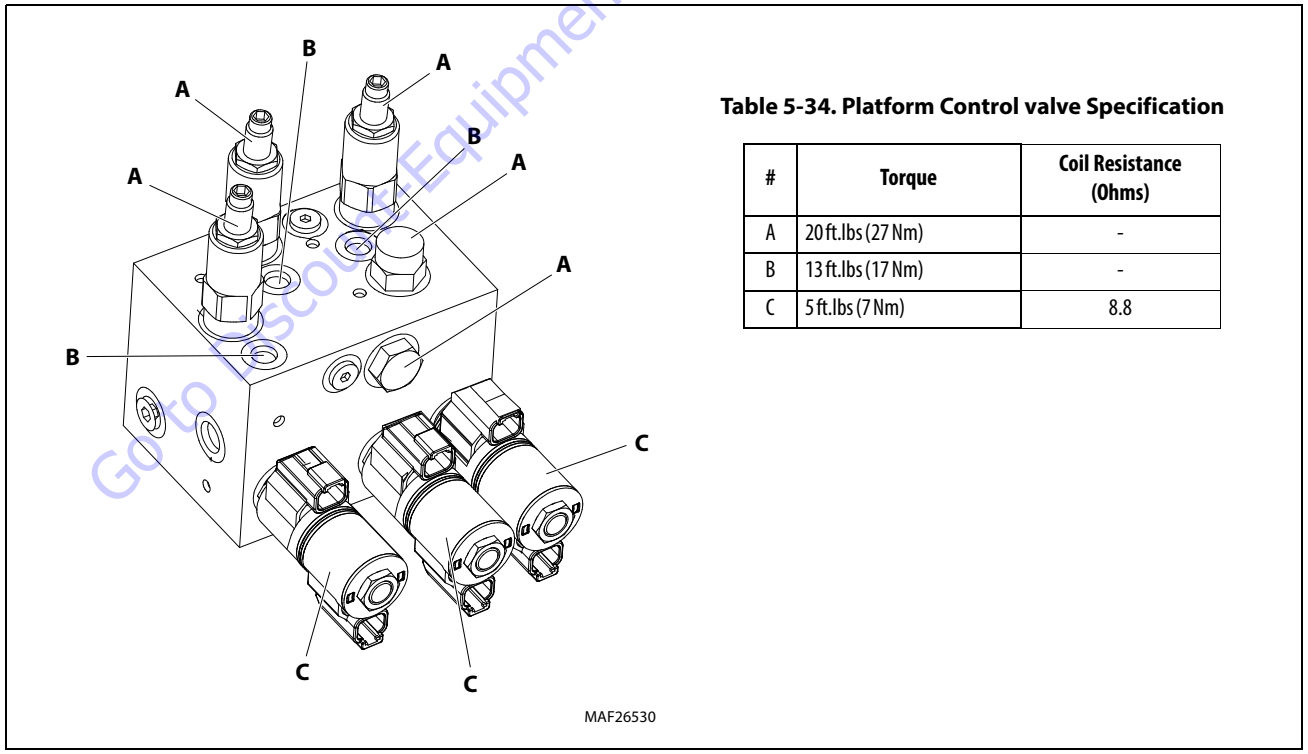


Table 5-34. Platform Control valve Specification

#	Torque	Coil Resistance (Ohms)
A	20 ft.lbs (27 Nm)	-
B	13 ft.lbs (17 Nm)	-
C	5 ft.lbs (7 Nm)	8.8

Figure 5-114. Platform Control Valve Component Torque

Adjustments Made at the Main Valve Block

MAIN LIFT DOWN

1. Install a high pressure gauge capable of reading **3000 psi** into the external pressure tap at the tee fitting in port "**L.S**" of main control valve, right side of manifold.
2. Activate main boom lift down. The gauge should read **2100 psi (145 bar)**.
3. The adjustment cartridge is located to the right of port #T2. Turn clockwise to increase, counterclockwise to decrease.

SWING

NOTE: *left and right are done with one adjustment.*

4. Install a high pressure gauge at the "**MP**" port of the main valve block. Lock the turntable lock pin.
5. Activate swing, the gauge should read **1400 psi (97 bar)**. The adjustment cartridge is located on the right side of the block, right above port "**MP**".
6. Turn clockwise to increase, and counterclockwise to decrease.

2 WHEEL STEER

1. Install a high pressure gauge at the "**MS**" port of the main valve block. Activate steer left or right. The gauge should read **1800 psi (124 bar)** (2-wheel steer) both directions.
2. One relief cartridge is located on the right side of the block, above port "**MS**". The other one is located on the left side next to port #15.
3. Turn clockwise to increase, and counterclockwise to decrease.

4 WHEEL STEER

1. Install a high pressure gauge at the "**MS**" port of the main valve block.
2. Activate front wheel steer left or right. One relief cartridge is located on the right side of the block, above port "**MS**". The other one is located on the left side next to port #15. Turn clockwise to increase, counterclocwise to decrease.
3. Adjust to **2350 psi (162 bar)** front steer. Remove the coil from the front wheel steer directional valve.
4. Activate 4 wheel steer. Adjust the rear wheel steer reliefs to **2250 psi (155 bar)**. Those reliefs are located on the both sides of the 4-wheel steer block bolted on the top of the main control valve.
5. There must be a minimum of 100 psi difference between the front axle relief pressure and rear axle relief pressure.

TOWER TELESCOPE OUT

1. Install a high pressure gauge at gauge port **"M2"** located on the right side of the valve block, at the bottom.
2. Activate tower telescope out, the gauge should read **2200 psi (152 bar)**. This can be done with the tower lift down or up. If the tower lift is up, run the tower telescope out to the end of stroke.
3. The tower telescope out relief valve is located on the left side, at the bottom next to port #1. Turn clockwise to increase, counterclockwise to decrease.

Adjustments Made at the Platform Valve Block

PLATFORM LEVEL UP

1. Install a high pressure gauge at the gauge port **"M1"** of the platform valve. There is pressure trapped at this test port.
2. To release this Pressure, activate level down to the end of stroke (the pressure in the up side goes to 0). This will allow to snap a gauge on at this port.
3. Activate level up to the end of stroke, the gauge should read **2600-2700 psi (179-186 bar)**. The level up relief valve is located next to the port **"M1"**.
4. Turn clockwise to increase, and counterclockwise to decrease.

PLATFORM LEVEL DOWN

1. Install a high pressure gauge at the gauge port **"M2"** of the platform valve.
2. To get a gauge on this point activate level up to the end of stroke (the pressure in the down side will go to 0, allowing to snap a gauge on). Activate level down to the end of stroke, the gauge should read **1800psi. (124 bar).**
3. The level down relief valve is located next to port "M2". Turn clockwise to increase and counterclockwise to decrease.

ARTICULATING JIB DOWN

1. Install a high pressure gauge on port "**M3**" of the platform valve.
2. Activate jib down, the gauge should read **1500 psi. (103 bar).**
3. The down relief valve is located next to port "**M3**". Turn clockwise to increase and counterclockwise to decrease.

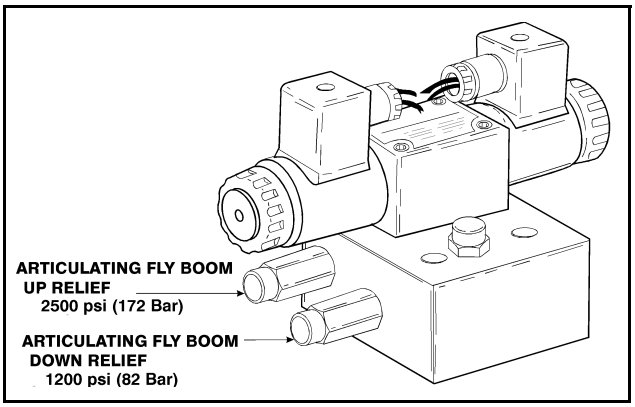


Figure 5-115. Articulating Jib Boom Pressure adjust.

4 WHEEL STEER (IF EQUIPPED)

1. At the platform console using the steer select switch activate “4 wheel steer”.
2. Install a pressure gauge in port **"G"** on the control valve.
3. With the aid of an assistant, activate steer left and right, adjust front steer relief valve to **2500 psi (172.4 bar)**. This pressure only affects the front axle.
4. At the platform console using the steer select switch activate “crab” or “coordinated” steer.
5. At the main control valve block disconnect the wire din connectors on the front steer valve. When steer is activated only the rear steer will work.
6. Install a pressure gauge in port **"G"** on the control valve.
7. With the aid of an assistant, activate steer left and right, adjust rear steer relief valve to **2500 psi (172 bar)** Reading at the valve bank. **2500 psi (172 bar)** will give you **2000 psi (138 bar)** at the cylinders.
8. Re-connect the front steer din connectors at the valve bank.

5.7 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

From a hydrostatic component standpoint, the goal at system start up is to put into functional operation, the hydrostatic system in such a way as to preserve the designed life span of the system. The following start-up procedure should be adhered to whenever a new pump or motor is initially installed into a machine, or a system is restarted after either a pump or motor has been removed and/or replaced.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTIONS DISCONNECTED, ETC.). WHILE PERFORMING THE PROCEDURE IN ORDER TO PREVENT INJURY. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING THE VEHICLE/MACHINE.

Prior to installing the pump and/or motor, inspect the unit(s) for damage that may have been incurred during shipping and handling. Make certain that all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

NOTE: *If a pump or motor is being replaced due to internal damage, the remaining units (pump or motors) need to be inspected for damage and contamination, and the entire hydraulic system will need to be flushed and the fluid replaced. Failure to do so may cause considerable damage to the entire system.*

The inlet line leading from the reservoir to the pump must be filled prior to start-up. Check the inlet line for property tightened fittings and make sure it is free of restrictions and air leaks.

NOTE: *In most cases, the reservoir is above the pump inlet so that the pressure head created by the higher oil level helps to keep the inlet pressures within an acceptable range and prevent high vacuum levels. However, due to hose routing or low reservoir locations, there may be air trapped within this line. It is important to assure that the air is bled from this line. This can be accomplished by loosening the hose at the fitting closest the pump. When oil begins to flow, the line is full, the air has been purged, and the fitting can be retightened to its specified torque. If the tank needs to be pressurized in order to start the flow of oil, a vacuum reading should be taken at the inlet of the pump during operation in order to verify that the pump is not being asked to draw an inlet vacuum higher than it is capable of.*

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the main case drain port.

NOTE: *It is highly recommended to use the highest possible case drain port, this ensures that the housing contains as much oil as possible and offers the greatest amount of lubrication to the internal components.*

NOTE: *In initial start-up conditions, it may be convenient to fill the housing, just prior to installing the case drain line. Component, (especially motor), location may be such that access to the case drain port after installation is not realistic.*

NOTE: *Make certain that the oil being used to fill the component housing is as clean as possible, and store the fill container in such a way as to prevent it from becoming contaminated.*

Install a 60 bar (or 1000 psi) pressure gauge in the charge pressure gauge port in order to monitor the charge pressure during start-up.

It is recommended that the external control input signal, (electrical connections for EDC), be disconnected at the pump control until after initial start-up. This will ensure that the pump remains in its neutral position.

⚠ WARNING

DO NOT START THE ENGINE UNLESS PUMP IS IN THE NEUTRAL POSITION (0 DEGREES SWASHPLATE ANGLE). TAKE PRECAUTIONS TO PREVENT MACHINE MOVEMENT IN CASE PUMP IS ACTUATED DURING INITIAL START-UP.

"Jog" or slowly rotate the engine until charge pressure starts to rise. Start the engine and run at the lowest possible RPM until charge pressure has been established. Excess air should be bled from the system lines as close to the motors as possible.

NOTE: *With the engine on low idle, "crack", (loosen-don't remove), the system lines at the motor(s). Continue to run the engine at low idle and tighten the system lines as soon as oil is observed to leak from them. When oil is observed to "leak" at the motor the line is full, the air has been purged, and the system hoses should be retightened to their specified torque.*

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code. If charge pressure is inadequate, shut down and determine the cause for improper pressure.

⚠ WARNING

INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATOR'S ABILITY TO CONTROL THE MACHINE.

Shut down the engine and connect the external control input signal. Also reconnect the machine function(s), if disconnected earlier. Start the engine, checking to be certain the pump remains in neutral. With the engine at normal operating RPM, slowly check for forward and reverse machine operation.

Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

Shut down engine, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

The machine is now ready for operation.

5.8 HYDRAULIC DRIVE PUMP PRE-FILL PROCEDURE

⚠ CAUTION

HYDRAULIC DRIVE PUMP MUST BE PRE-FILLED BEFORE STARTING THE ENGINE. FAILURE TO DO SO CAN CAUSE PREMATURE FAILURE OF THE PUMP.

1. Fill the hydraulic reservoir.
2. Determine if the hydraulic oil tank sight level gauge is higher than other hydraulic components.
   a. Determine if the hydraulic oil tank sight level gauge is higher than the hydraulic drive pump assembly.
   b. Determine if the hydraulic oil tank sight level gauge is higher than all hydraulic hope loops and the routings between the hydraulic tanks and the hydraulic drive pump assembly.
   c. If sight level gauge is the highest hydraulic oil level point, proceed to step 3.
   d. if sight level gauge is NOT the highest oil level point, low pressure air may need to applied to the hydraulic oil tank (fill cap via air regulator) in conjunction with step 4 to get hydraulic oil to move over the air locks created by these high spots.
3. If the machine is to be equipped with a hydraulic oil cooler option.
   a. Determine if there is hydraulic “tee” fittings installed at the hydraulic drive pump that has a “cap” fittings attached to it. (this will generally be at or near the top of the hydraulic drive pump body). This “cap” fitting is to be used to manually fill the hydraulic drive pump case.
   b. Remove “cap” fitting.
   c. Fill hydraulic drive pump case with hydraulic oil.
   d. Attach and torque “cap” fitting.
   e. Pre-filling of hydraulic drive pump w/oil cooler option is complete. (Step #4 can be omitted at this point).
4. If machine is NOT equipped with a hydraulic oil cooler option.
   a. Locate a case access port on the hydraulic drive pump. Preferably one located on at or near the top or under sides of the pump.
   b. Using the proper wrench, Remove the O-ring plug to allow air to escape from the hydraulic drive pump case.
   c. Hydraulic oil will flow by gravity from the hydraulic tank to the drive pump.
   d. The pump is full, when hydraulic oil starts to flow out of this port.
   e. Install the O-ring plug and torque.
5. Pre-filling of the hydraulic drive pump is complete.

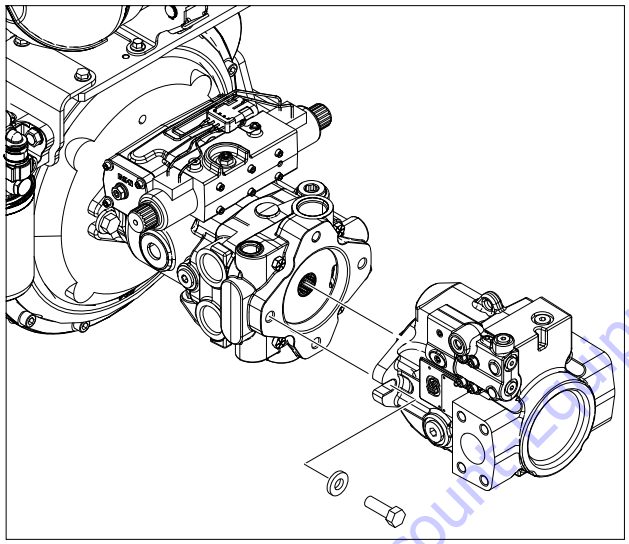
5.9 FUNCTION PUMP

Removal

1. Place machine on level surface and allow the engine and system fluids to cool.
2. Properly relieve any pressure in hydraulic system.
3. Tag and disconnect the hydraulic lines and fittings from the function pump. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

NOTE: *The function pump weighs approximately 35 lb (16 kg).*

4. Use a suitable device to support the function pump.
5. Remove two bolts and washers attaching the function pump to the drive pump. Remove function pump from the machine as shown.



6. Remove and discard o-ring, if applicable.
7. Place function pump in the clean work area.

Installation

NOTE: *The function pump weighs approximately 35 lb (16 kg).*

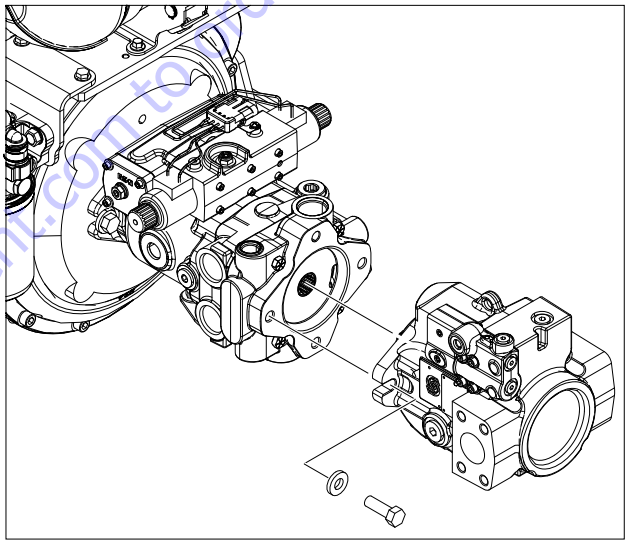
1. Use a suitable device to support the function pump.
2. If applicable, install the o-ring on to the function pump.
3. Align and install the function pump to the drive pump.

NOTE: *Make sure that the pump shaft is properly aligned.*

⚠ CAUTION

INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.

4. Secure function pump with two bolts and washers as shown. Apply Medium Strength Threadlocking Compound to the bolts before installation. Torque bolts to 85 ft. lbs. (116Nm).



5. Remove tag and reconnect the hydraulic lines to the function pump.
6. Reconnect the battery power and make sure for proper working of the function pump.

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Table 5-35. Symbols Used

Symbol	Meaning	Symbol	Meaning
	Non-reusable part, use a new part		Inspect for wear or damage
	Option - either part may exist		Note correct orientation
	Internal hex head		Torque specification
ORB	O-ring boss port		Pull out with tool - press fit
	Lubricate with hydraulic fluid		Cover splines with installation sleeve
	Apply grease /petroleum jelly		Pressure measurement / gauge location or specification
The symbols above can be found in the pump illustrations. The legend above is provided to define each symbol and explain its purpose.			

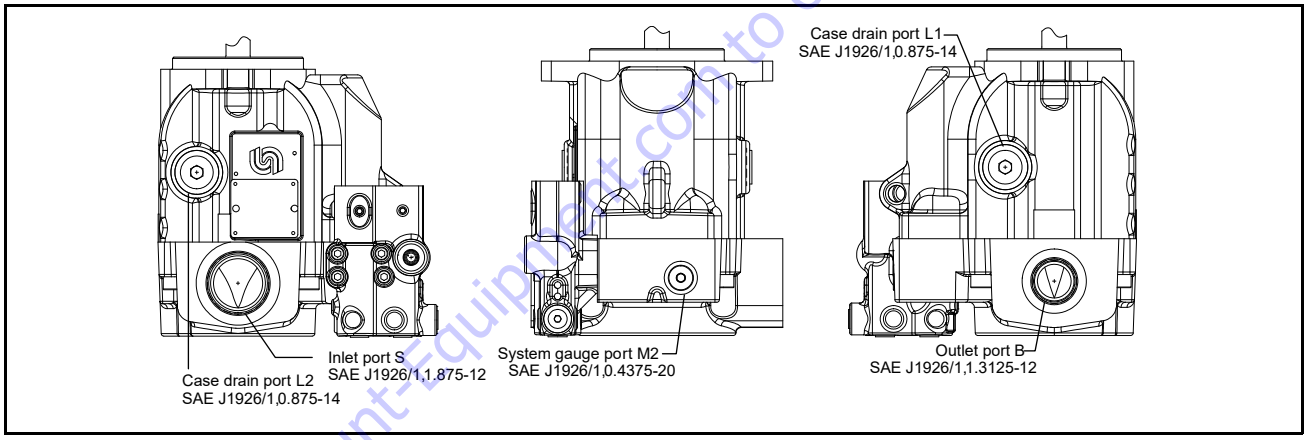


Figure 5-116. Gauge Port Locations

Table 5-36. Gauge and Port information

Port	Purpose	Range of Pump	Fitting
M2	System pressure	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting
M4	Servo pressure	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting
L1,L2	Case pressure	0-100 psi [0-10 bar]	7/8 - 14 o-ring fitting
X1	Load Sense signal	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting (tee into Load Sense signal line)

Initial Start-up Procedures

Follow this procedure when starting-up a new pump or when the pump has been removed.

1. Install the pump on the engine. Ensure the pump shaft is properly aligned.

⚠ CAUTION

INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.

2. Fill the main pump housing with clean hydraulic fluid. Pour filtered oil directly into the main most case drain port.
3. Fill the inlet line leading from the pump to the reservoir. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
4. To ensure the pump stays filled with oil, install the case drain line in the main most case drain port.
5. Install a gauge at port M2 to monitor system pressure during start up.
6. While watching the pressure gauge installed at M2, jog the engine or run at the lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shutdown the engine, determine cause, and take corrective action. Refer to Troubleshooting.
7. Operate the hydraulic system for at least fifteen minutes under light load conditions.
8. Check and adjust control settings as necessary after installation. Refer to Adjustments.
9. Shut down the engine and remove the pressure gauge. Replace plug at port M2.
10. Check the fluid level in the reservoir; add clean filtered fluid if necessary. The pump is now ready for operation.

Troubleshooting

Table 5-37. Excessive Noise and/ or Vibration

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will cause cavitation.	Fill the reservoir to proper level.
Check for air in system.	Air in system will cause noisy, erratic control.	Purge air and tighten fittings. Check inlet for leaks.
Check pump inlet pressure / vacuum.	Improper inlet conditions will cause erratic behavior and low output flow.	Correct pump inlet pressure / vacuum conditions. Refer to Hydraulic parameters.
Inspect shaft couplings.	A loose or incorrect shaft coupling will cause excessive noise and/or vibration.	Repair or replace coupling and ensure that correct coupling is being used.
Check shaft alignment.	Misaligned shafts will create excessive noise and/or vibration.	Correct shaft misalignment.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.

Table 5-38. Actuator Response Is Sluggish

Item	Description	Action
Check external system relief valve setting.	Low external relief valve setting will slow down system.	Adjust external relief valve setting per manufacturer's recommendations. External relief setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and LS control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check Load Sense control signal pressures.	Incorrect Load Sense signal will not allow pump to operate correctly.	Inspect system, ensure that proper Load Sense signal is transmitted to the pump.
Internal system leaks.	Worn internal parts will not allow the pump to operate properly.	Refer to Authorized Service Center for repairs as required.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system valving.	Malfunctioning valving may not allow system to respond properly.	Repair or replace system valving as required.
Check pump case pressure.	High case pressure will cause the system to be sluggish.	Correct case drain line restrictions.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.

Table 5-39. System Operating Hot

Item	Description	Action
Check fluid level in reservoir.	Insufficient volume of hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level. Verify proper size of reservoir.
Inspect heat exchanger. Check air flow and input air temperature for the heat exchanger.	Insufficient air flow, high input air temperature, or undersized heat exchanger will not meet cooling demands of the system.	Clean, repair, or replace heat exchanger as required. Verify proper size of heat exchanger.
Check external system relief valve setting.	Fluid passing through relief valve adds heat to system.	Adjust external system relief valve setting per manufacturer's recommendations. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check pump inlet pressure / vacuum.	High inlet vacuum adds heat to system.	Correct inlet pressure / vacuum conditions.

Table 5-40. Low Pump Output Flow

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will limit output flow and cause internal damage to pump.	Fill the reservoir to proper level.
Hydraulic fluid viscosity above acceptable limits.	Fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system relief valve setting.	External relief valve set below Pressure Compensator setting will cause low output flow.	Adjust external relief valve per manufacturer's recommendation. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and Load Sense control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.
Check input speed.	Low input speeds decrease flow.	Adjust input speed.
Check pump rotation.	Incorrect rotational configuration will cause low flow.	Use pump with appropriate rotational configuration.

Table 5-41. Pressure or Flow Instability

Item	Description	Action
Check for air in system.	Air in system will cause erratic operation.	Activate Pressure Compensator, allowing system to bleed air. Check inlet line for leaks and eliminate source of air ingression.
Check control spools.	Sticking control spools will cause erratic operation.	Inspect spools for free movement in bore. Clean or replace as needed.
Check Load Sense setting.	Low Load Sense setting may cause instability.	Adjust Load Sense setting to proper level. See Adjustments.
Check Load Sense signal line.	Blocked Load Sense signal line will interfere with proper Load Sense operation.	Remove blockage.
Check external relief valve and Pressure Compensator setting.	Insufficient pressure differential between Pressure Compensator Pressure Compensator setting and external relief valve.	Adjust external relief valve or Pressure Compensator control settings to appropriate level. Relief valve setting must be above Pressure Compensator setting for proper operation.
Check external relief valve.	Chattering external relief valve may cause unstable feedback to pump control.	Adjust or replace relief valve.

Table 5-42. System Pressure Not Reaching Pressure Compensator Setting

Item	Description	Action
Check Pressure Compensator control setting.	System pressure will not rise above Pressure Compensator setting.	Adjust Pressure Compensator to appropriate setting.
Check external relief valve.	External relief valve setting below Pressure Compensator setting will prevent pressure compensation.	Adjust external relief valve per manufacturer's recommendations. External relief valve must be set above Pressure Compensator setting for proper operation.
Inspect Pressure Compensator control spring.	Broken, damaged, or missing spring will cause erratic operation.	Replace spring as required.
Inspect Pressure Compensator spool for wear.	Wear of the Pressure Compensator spool will cause internal leakage in the control.	Replace the spool as required.
Inspect Pressure Compensator spool for proper orientation.	Improper orientation will result in poor operation.	Correct orientation of spool.
Check Pressure Compensator control for contamination.	Contamination may interfere with movement of the Pressure Compensator Spool.	Clean Pressure Compensator control components, take appropriate action to eliminate contamination.

Table 5-43. High Inlet Vacuum

Item	Description	Action
⚠ CAUTION **HIGH INLET VACUUM CAUSES CAVITATION WHICH CAN DAMAGE INTERNAL PUMP COMPONENTS.**		
Check fluid temperature.	Low temperature increases viscosity. High fluid viscosity causes high inlet vacuum.	Allow system to warm up before operation.
Inspect inlet screen.	Blocked or restricted inlet screen will cause high inlet vacuum.	Clean screen / remove blockage.
Check inlet piping.	Too many fittings, bends, or long piping will cause high inlet vacuum.	Eliminate fittings to make path more direct.
Hydraulic fluid viscosity above acceptable limits.	High fluid viscosity causes high inlet vacuum.	Select fluid with appropriate viscosity for expected operating temperature.

Shaft Seal Replacement

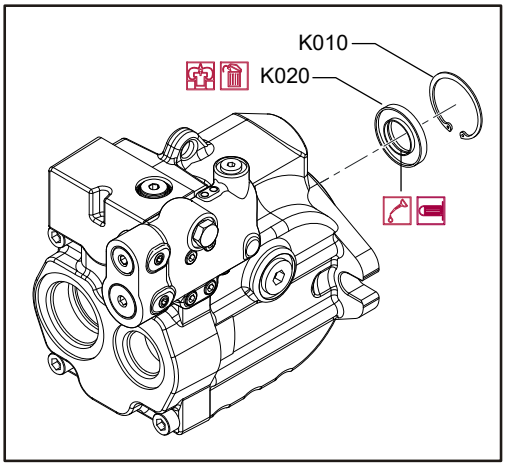


Figure 5-117. Shaft Seal and Retaining Ring

A lip type shaft seal is used in the pump and can be replaced without major disassembly of the unit. Replacement of the shaft seal requires removal of the pump from the machine.

REMOVAL

1. Using the appropriate snap-ring pliers, remove the retaining ring (K010) from the housing.
2. Remove the shaft seal (K020) from the bore in the pump housing and discard. Avoid damaging the pump housing or shaft. Puncture the face of the seal with a packing hook, or use a slide-hammer type puller to remove the seal.

INSTALLATION

1. Inspect the pump housing and new seal for damage. Inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.
2. Lubricate the lip of the new shaft seal with clean hydraulic fluid. Place a protective sleeve over the shaft end to prevent damage to the seal during installation.

⚠ CAUTION

PREMATURE BEARING FAILURE CAN RESULT IF THE SHAFT SEAL CONTACTS THE SHAFT BEARING. PRESS THE SEAL INTO THE HOUSING ONLY FAR ENOUGH TO CLEAR THE RETAINING RING GROOVE.

3. Keeping the seal perpendicular to the shaft, press the new seal into the housing just far enough to clear the retaining ring groove. Install seal with the cupped side toward the shaft bearing. Do not damage the seal during installation.
4. Using the appropriate snap ring pliers, install the seal retaining ring.
5. Remove the installation sleeve.

Control Assembly

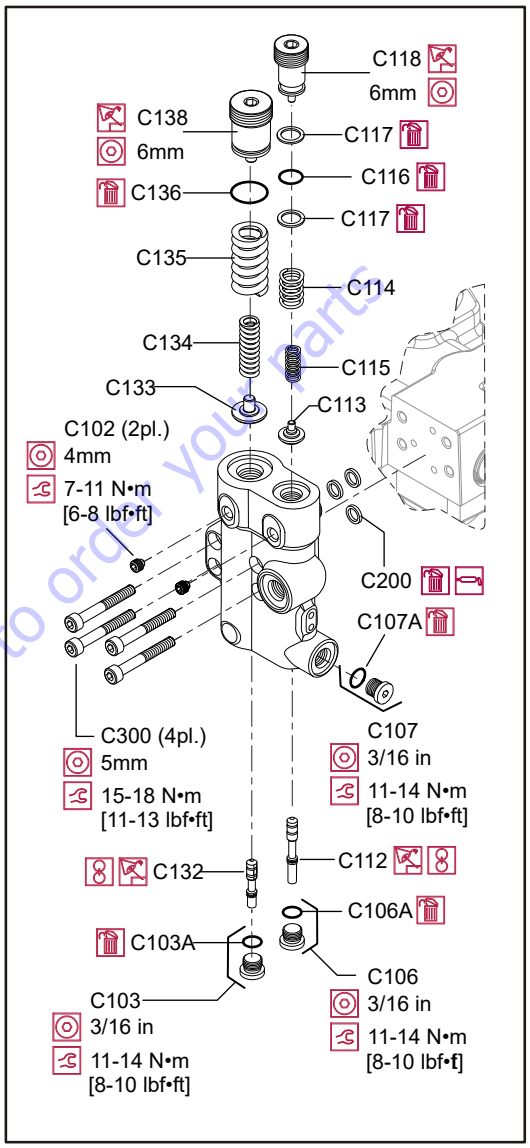


Figure 5-118. Control Assembly

DISASSEMBLY

1. Remove the four screws (C300) holding the control housing onto the end cap.
2. Remove the control and discard the three interface o-rings (C200).
3. Remove the Pressure Compensator set screw (C102), Pressure Compensator adjustment screw (C138), o-ring (C136), springs (C135, C134), and seat (C133). Discard the o-ring.
4. Remove the plug (C103), o-ring (C103A),and Pressure Compensator spool (C132) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.
5. Remove the plug (C107) and o-ring (C107A); discard the o-ring.

NOTE: *For Pressure Compensator only controls, skip steps 6 and 7.*

6. Remove the Load Sense set screw (C102), Load Sense adjustment screw (C118), o-ring (C116), backup rings (C117), springs (C114, C115), and seat (C113); discard the o-ring.
7. Remove the plug (C106), o-ring (C106A), and Load Sense spool (C112) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.

INSPECTION

1. Inspect the adjustment screws for wear at the tips and where they contact the springs; replace as necessary.
2. Inspect the springs and spring guides for wear or damage; replace as necessary.
3. Carefully inspect the spools. Ensure the sealing lands are free of nicks and scratches. Check the ends that contact the spring guides for wear. Replace spools as necessary.
4. Inspect the control housing for damage. Check the spool bores for excessive wear.
5. Clean all parts and lubricate spools, springs, guides and new o-rings with clean hydraulic fluid.

REASSEMBLY

1. Install the Pressure Compensator spool, spherical end first, into the Pressure Compensator bore. The Pressure Compensator spool is the shorter of the two. Using a new o-ring, install the plug (C103). Torque to 8-10 ft.lb. [11-14 Nm].
2. Place the two Pressure Compensator springs onto the spring guide and install into the Pressure Compensator bore. Place a new o-ring onto the Pressure Compensator adjustment screw and thread it into the Pressure Compensator bore until flush, then make another full turn. Install and torque the set screw to 6-8 ft.lb. [7-11 Nm].

NOTE: *For Pressure Compensator only controls, skip steps 15 and 16.*

3. Install the Load Sense spool, spherical end first, into the Load Sense bore. The Load Sense spool is the longer of the two. Using a new o-ring, install the plug (C106). Torque to 8-10 ft.lb. [11-14 Nm].
4. Place the two Load Sense springs onto the spring guide and install into the Load Sense bore. Place a new o-ring and backup rings onto the Load Sense adjustment screw and thread it into the Load Sense bore until flush, then make another full turn. Install and torque the set screw to 6-8 ft.lb. [7-11 Nm].
5. Using a new o-ring, install the plug (C107). Torque to 8-10 ft.lb. [11-14 Nm].
6. Using petroleum jelly to retain them, install the three interface o-rings (C200) in the recesses on the control housing.
7. Install the control assembly onto the endcap using the four screws (C300). Torque to 11-13 ft.lb. [15-18 Nm]. Torque screws in a criss-cross pattern and re-torque the first screw to ensure proper torque retention.

Plug and Fitting Sizes and Torques

If any plugs or fittings are removed from the unit during service, install and torque as indicated here. This drawing is a composite. Your configuration may differ but the appropriate wrench size and torque can be found here.

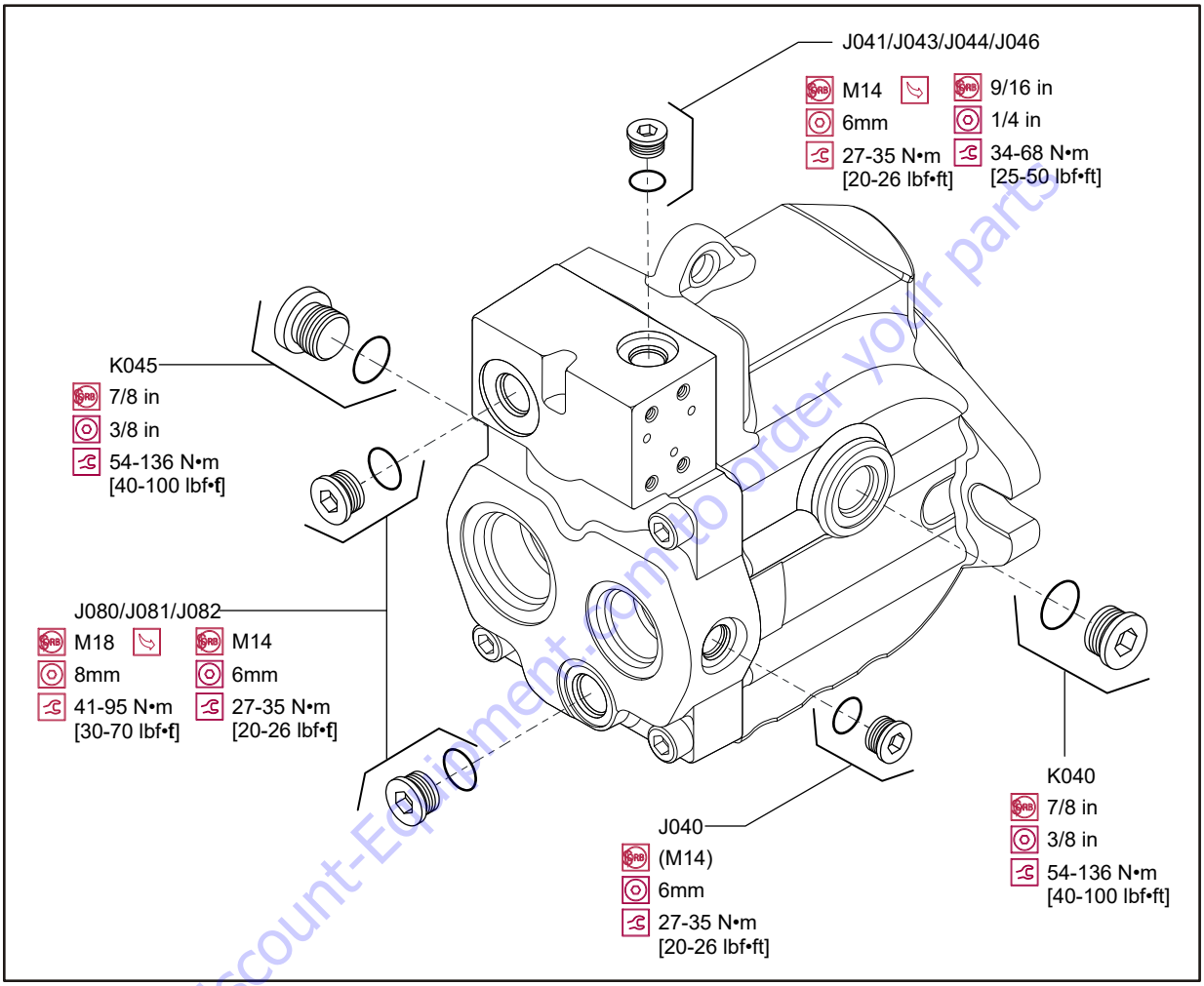


Figure 5-119. Plug Locations, Sizes, and Torques

5.10 DRIVE PUMP

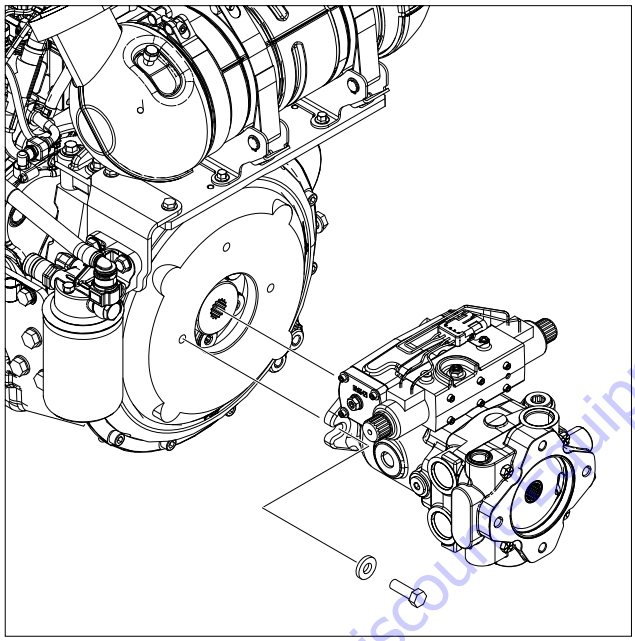
Removal

NOTE: *Remove the function pump from the machine first, refer Section 5.9, Function Pump.*

1. Tag and disconnect the hydraulic lines and fittings from the drive pump. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

NOTE: *The drive pump weighs approximately 62 lb (28 kg).*

2. Use a suitable device to support the drive pump.
3. Remove two bolts and washers attaching the drive pump to the engine assembly. Remove drive pump from the machine as shown.



4. Remove and discard o-ring from the drive pump groove.
5. Place drive pump in the clean work area.

Installation

NOTE: *The drive pump weighs approximately 62 lb (28 kg).*

1. Use a suitable device to support the drive pump.
2. Install the new o-ring in to the drive pump groove.
3. Align and install the drive pump to the engine assembly.

NOTE: *Make sure that the pump shaft is properly aligned.*

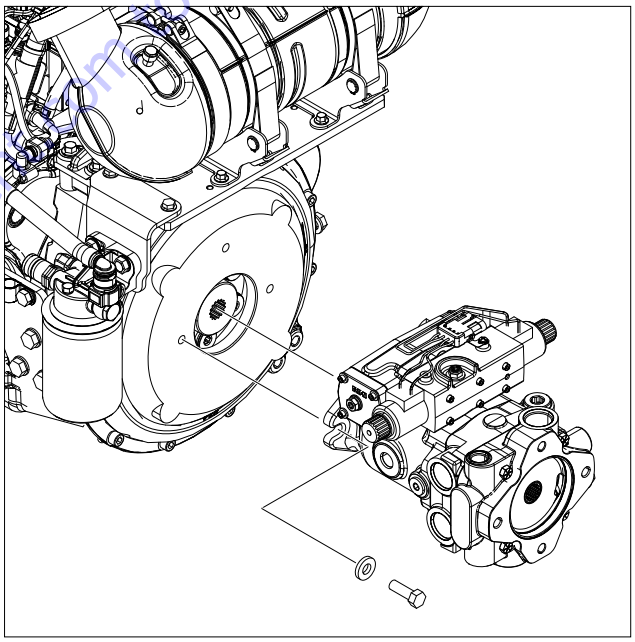
⚠ CAUTION

INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.

4. Secure drive pump with two bolts and washers as shown.

NOTE: *Apply Medium Strength Threadlocking Compound to the bolts before installation.*

5. Torque bolt to 50 ft. lbs. (68Nm).



6. Remove tag and reconnect the hydraulic lines and fittings to the drive pump.

Servo Controlled Piston Pump

DISASSEMBLY

The following instructions apply to a single servo controlled piston pump with or without a gerotor charge pump. A tandem pump assembly should be separated into individual pumps before disassembly.

1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the capscrews up. Mark the relationship of the working ports (for assembly identification) to the servo control assembly with a scribe. Remove the four capscrews retaining endcover.
2. Lift the charge pump adapter assembly straight up off endcover, shaft and gerotor. Gerotor may stay in adapter or on endcover.
3.
4. Remove o-ring from charge pump adapter.
5. Remove outer gerotor ring from either the charge pump adapter or the inner gerotor ring.

NOTE: *Refer to "Charge Pump Adapter Assembly" for disassembly and inspection of charge pump adapter assembly.*

6. Remove the inner gerotor ring and key from drive shaft or inner gerotor ring and coupler assembly from shaft.
7. Lift endcover straight up off shaft and housing. Remove valve plate from endcover or from rotating kit assembly, still in housing.
8. From endcover, remove bypass valve or plug, and relief valve assemblies. Note: Mark the relief valve in relationship to the cavity it was removed, for reassembly purposes.

Endcover Inspection

- Check the bearing (press fit) in endcover. If needles remain in cage, move freely, and setting is at the dimension shown in Figure 5-120. removal not required.
- Check roll pin in endcover. If tight and set to the dimension shown in Figure 5-120. removal not required.

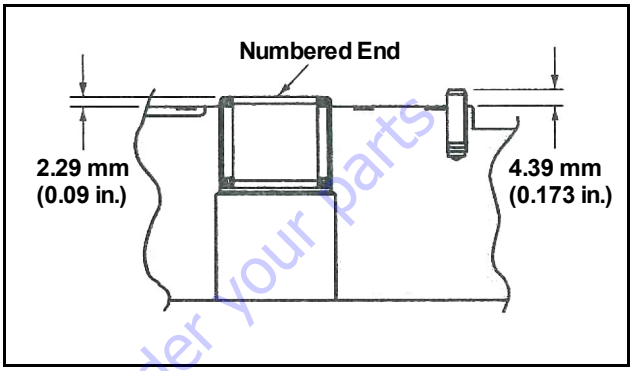


Figure 5-120. Endcover Inspection

1. Remove housing gasket from housing or endcover.
2. With pump still in vise, remove the six capscrews retaining the manual servo control assembly. Remove the control assembly and control housing gasket from the housing. Remove orifice plates, noting location for reassembly. Remove nut and lock washer from control arm, remove arm. Note position of control arm for reassembly.

NOTE: *Refer to "Manual Servo Control Basic Assembly" for disassembly and Inspection of control assembly.*

3. To remove rotating kit assembly from housing, first remove pump from vise holding the rotating kit assembly in position. Lower pump so that the shaft end (flange end) is up. Set the rear of housing onto table with housing flat and rotating kit assembly at rest on table. (Hole in table, for protruding shaft, is required.) Lift and remove the housing and shaft from rotating kit assembly, and swashplate.
4. Remove swashplate from rotating kit assembly and servo piston follower from swashplate.

NOTE: *Refer to "Rotating Kit Assembly" for disassembly and Inspection of rotating kit.*

Swashplate Inspection

- The finish on the piston shoe surfaces of the swashplate should show no signs of scoring.
- Inspect swashplate bushing surface for wear and surface for coating transfer from bushing.

1. To remove servo piston assembly from housing, start with the four each capscrews and washers retaining each cover plate.
2. In removing the cover plate from the servo piston bolt, remove jam nut, washer, and seal washer. Hold the servo piston bolt with hex key and unscrew cover plate off of bolt.
3. Remove servo piston assembly and seal sub-assemblies (two sets) from housing.

NOTE: *Disassembly of servo piston assembly is not required.*

4. Remove retaining ring from the front of housing. Press the shaft, shaft seal or spacer, and washer from housing. Remove retaining ring, thrust washer, thrust bearing, second thrust washer, and second retaining ring from shaft.

Housing Inspection

- Check the bearing (press fit) in housing. If needles remain in cage, move freely, and setting at the dimension shown in Figure 5-121., removal not required.

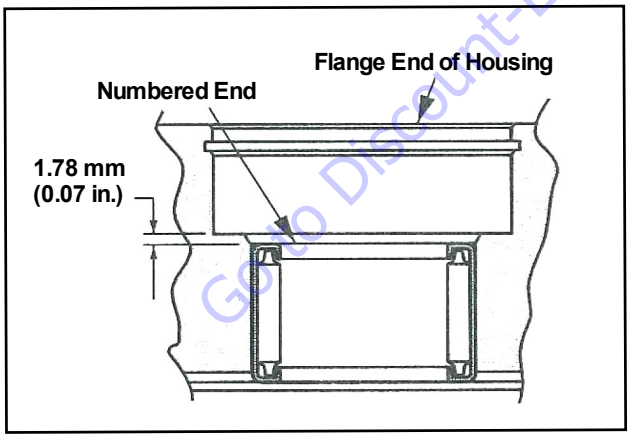


Figure 5-121. Housing Inspection

1. To remove cradle sub-assembly, remove the two capscrews retaining cradle inside housing. Removing cradle subassembly from housing.
2. Remove button head capscrews (2 Qty.) to remove bushing from cradle.

Bushing Inspection

- Inspect bushing for contamination embedment within coating of bushing surface coming in contact with swashplate.

1. Remove all plugs from housing.
2. Discard the shaft seal, gaskets, and o-rings from all assemblies. Replace with new seals upon reassembly.

ASSEMBLY

1. All parts should be cleaned and critical moving parts lubricated before reassembly.
2. If necessary, press new bearing in housing to dimension shown in Figure 5-121. with the numbered end of bearing outward.
3. Install the two new seal sub-assemblies into the servo piston cavity of housing.
4. Screw the cover plate onto the servo piston assembly. Install new cover plate gasket in place on housing. Install servo piston assembly and cover plate into servo piston bore in right side of housing (as shown in Figure 5-122. Retain cover plate with four each washers and capscrews. Torque capscrews 40 to 48 in.lbs (4.5 to 5.4 Nm). To obtain neutral, centering the servo piston assembly is required. Measure in from the left side and set servo piston 0.5 in. (12.7 mm) from surface of housing servo bore as shown in Figure 5-122..

NOTE: *Re-adjustment may be required for neutral at unit start-up.*

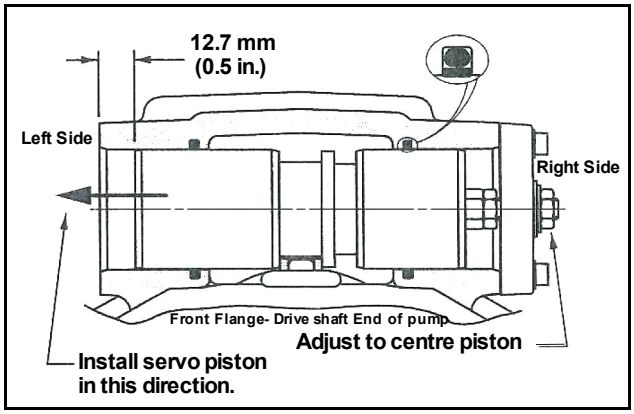


Figure 5-122. Servo Piston Installation

5. Install new seal washer, washer, and jam nut to servo piston bolt. Holding servo piston bolt with hex key wrench Torque jam nut (150 to 160 in.lbs) 17 to 18 Nm. Check the centering of servo piston assembly. Install new cover plate gasket and cover plate to left side of servo piston and retain with four each washers and #10-24 capscrews. Torque capscrews 40 to 48 in.lbs (4.5 to 5.4 Nm).

6. To assemble cradle sub-assembly, install bushing onto cradle retaining with button head capscrews. Torque button head capscrew 14 to 16 in.lbs (1.6 to 1.8 Nm).

7. Place cradle sub-assembly into housing making sure cradle is completely seated into housing. Retain cradle sub-assembly with two capscrews. Torque capscrews 20 to 24 ft.lbs (27 to 33 Nm).

8. To install shaft, place exterior retaining ring, thrust race, thrust bearing, second thrust race, and second retaining ring onto shaft. Position washer and shaft seal or spacer onto shaft.

9. Install shaft assembly into front of housing for units with spacer, retain with interior retaining ring and go on to step 10. For units with shaft seal. seat seal into position with seal driver and retain with interior retaining ring.

10. Install servo piston follower onto swashplate dowel pin. Install swashplate carefully onto bushing (coat bushing surface with hydraulic oil), aligning servo piston follower with slot in servo piston assembly.

NOTE: *Refer to "Rotating Kit Assembly" for reassembly of rotating kit assembly.*

11. To install rotating kit assembly, leave housing and shaft in the horizontal position. Holding swashplate into position with screw driver thru controller linkage passageway at the top of housing. place rotating kit assembly over shaft and into housing until pistons are in against swashplate. Make sure all parts are in housing completely and properly positioned. Return the pump to the vise with open end of housing up. clamping housing on the outer portion of the flange.

12. Install gasket on to housing.

13. If necessary, press new bearing and roll pin in endcover to dimension shown in figure 1-3. Bearing installed with the numbered end outward. Roll pin installed with split oriented away from bearing.

14. Install new o-ring on relief valves. Install relief valve in its original cavity in endcover that it was removed. Torque 100 to 110 ft.lbs (136 to 149 Nm).

15. Install new o-ring on bypass valve or plug. Install bypass valve or plug into endcover. Note: Make sure paddle of bypass valve is perpendicular to relief valve axis prior to installing or damage could result.

16. Apply a small amount of petroleum jelly to the steel side of valve plate to hold in place for installation. Aligning the index pin, place the valve plate in position onto the endcover, with steel side against endcover.

17. Install endcover assembly onto housing assembly. Make sure ports are positioned correctly, valve plate and gasket stay in place.

18. Install key and inner ring gerotor onto shaft or coupler assembly. Lubricate inner ring gerotor.

NOTE: *Refer to "Charge Pump Adapter Assembly" for assembly of charge relief valve in adapter plate.*

19. Install o-ring and outer ring gerotor onto adapter plate. Lubricate both a-ring and outer ring to hold in position during assembly of adapter plate. Install adapter plate onto endcover. Make sure o-ring and gerotor ring stay in place.

20. Retain endcover and adapter plate (when used) with four capscrews, Torque 27 to 31 ft.lbs (37 to 42 Nm).

NOTE: *Refer to "Manual Servo Control Basic Assembly" for reassembly of manual servo control assembly.*

21. Install control housing gasket onto housing. Install orifices into control assembly and retain in position with petroleum jelly. Position the feedback link at 90 degrees from control housing. Install manual servo control assembly onto housing making sure feedback link entered small groove in servo piston assembly.

22. Retain control assembly with six capscrews, torque 40 to 48 in.lbs (4.5 to 5.4 Nm).

23. Install control arm onto control assembly input arm. Retain with lock washer and nut, torque 4 to 6 ft.lbs (5 to 8 Nm).

24. Install new o-rings on all plugs. Install plugs into housing. Torque 3/4 in. plug 21 to 24 ft.lbs (28 to 32 Nm). Torque 1-1/4 in. plug 40 to 45 ft.lbs (54 to 61 Nm).

25. Refer to "Start-up Procedure".

Charge Pump Adapter Assembly

DISASSEMBLY

1. Remove plug, shims, spring, and poppet from adapter assembly as shown in Figure 5-124.

Inspection

- Inspect the charge pump relief valve seat inside the charge pump adapter. Check to insure that seat is smooth and free of burrs or other defects.
- Inspect the charge pump relief valve spring.
- Inspect the bearing or bushing inside the charge pump adapter. The bearing needles must remain in the bearing cage and bearing at dimension shown in Figure 5-123. The bushing must have no excessive scoring.
- Inspect the gerotor pocket inside the charge pump adapter assembly. It should not be scored excessively.

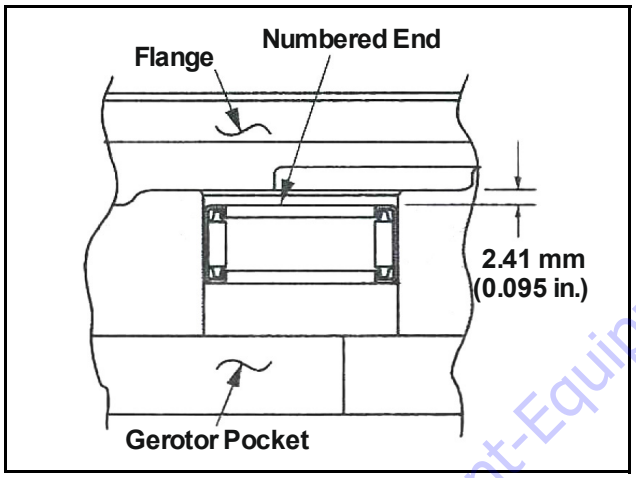
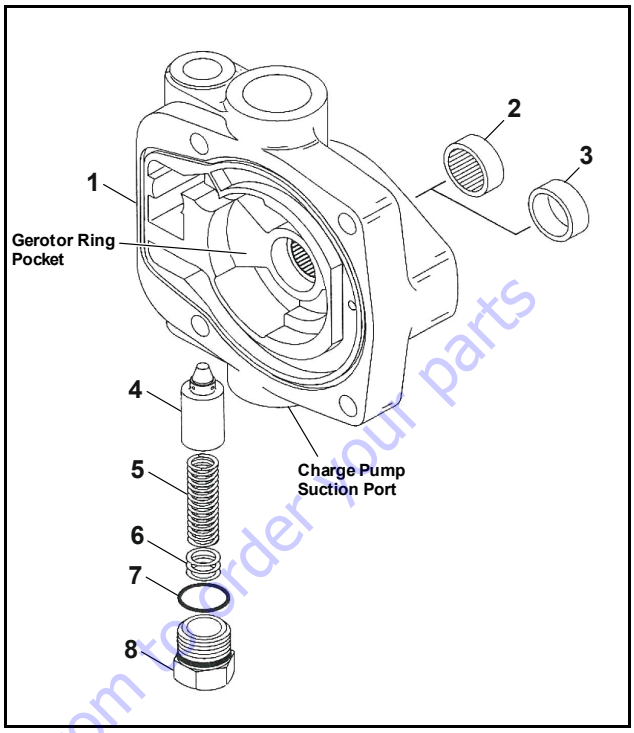


Figure 5-123. bearing or bushing Inspection

ASSEMBLY

1. If necessary, press new bearing or bushing in adapter assembly. The bearing to dimension shown in Figure 5-123. with the numbered end of bearing outward and closest to mounting flange. The bushing is to be pressed flush to 0.254 mm [0.010 in.) recessed.
2. Install poppet. spring, shims, new o-ring on plug, and plug into adapter assembly. Torque plug 30 to 27 ft.lbs. (40.7 to 36.6 Nm).



1. Charge Pump Adapter
2. Bearing
3. Bushing
4. Poppet
5. Spring
6. Shims
7. O-ring
8. Plug

Figure 5-124. Charge Pump Adapter Assembly

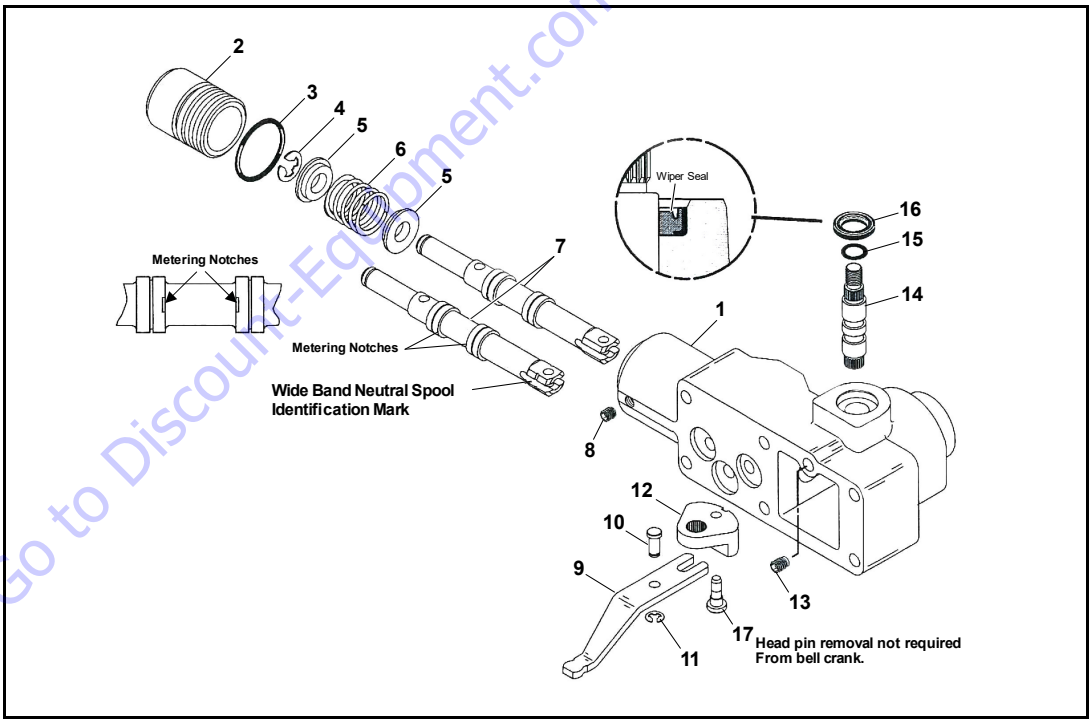
Manual Servo Control Basic Assembly

DISASSEMBLY

1. Remove wiper seal with screw driver. Remove set screw retaining input shaft and remove input shaft from control housing.
2. Remove set screw from plug retaining valve spool and remove plug.
3. Remove E-ring from pin retaining feedback link and valve spool. Remove pin, feedback link, valve spool and bell crank from control housing.
4. Compress spring and remove E-ring. spring retainer, spring and second spring retainer from valve spool.
5. Remove o-rings from plug and input shaft. Clean all parts and lubricate in prep for reassembly.

ASSEMBLY

1. Install spring retainer, spring. and second spring retainer onto spool. Compress spring with retainer and retain with E-ring onto valve spool.
2. Install valve spool into control housing making sure that metering notches on valve spool can be seen in the metering ports. Notches shown in Figure 5-125.
3. Position bell crank in housing. Slide feedback link into position between clevis on valve spool. aligning holes, and install dowel pin retaining with E-ring.
4. Install new o-ring onto input shaft. Hold bell crank in position with feedback link slot and align splined hole of bell crank with input shaft cavity. Install input shaft into control housing and bell crank.
5. Medium Strength Threadlocking Compound or equivalent to set screw and install, retaining input shaft. Adjust set screw until it bottoms out on input shaft and back out one-quarter turn.
6. Install wiper seal on input shaft as shown in Figure 5-125. Install new o-ring onto plug. retaining valve spool, and install plug. Adjust plug until there is no play in the valve spool with input shaft held stationary. Lock in place with set screw. Torque set screw 17 to 25 in.lbs (2 to 3 Nm).



1. Control Housing
2. Plug
3. O-ring
4. Retaining Ring
5. Spring Retainer
6. Spool Centering Spring
7. Valve Spool
8. Set Screw
9. Feedback Link
10. Dowel Pin
11. Retaining Ring
12. Bell Crank
13. Set Screw
14. Input Shaft
15. O-ring
16. Wiper Seal
17. Head Pin

Figure 5-125. Manual Servo Control Basic Assembly

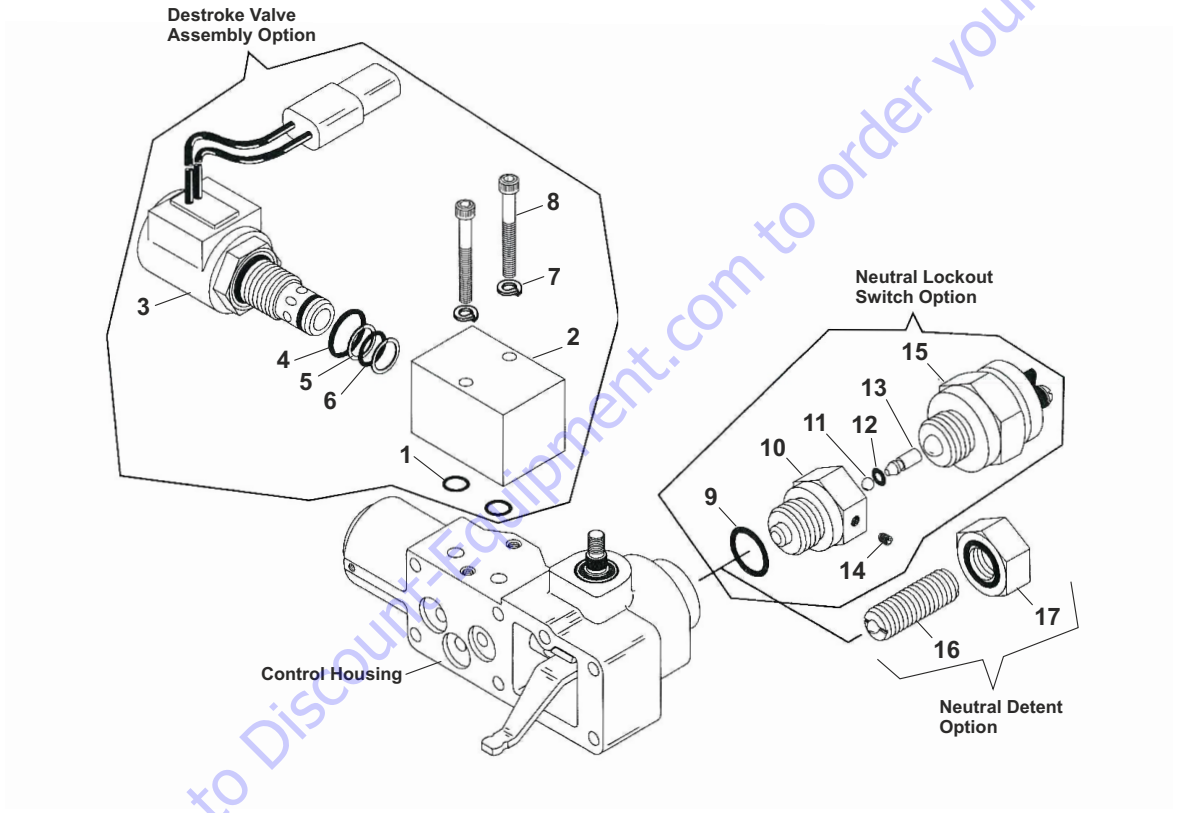
Manual Servo Control Assembly Options

DISASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Remove the two capscrews and lock washers from manifold. Removing destroke valve assembly and two a-rings.
2. Remove destroke valve from manifold in order to remove o-rings and backup washers. Note: in order to remove destroke valve the solenoid may need to be removed from core first (not shown).

ASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Install new o-rings and backup washers onto destroke valve.
2. Install destroke valve into manifold by hand until top o-ring is met by manifold. Then wrench tighten to 25 ft.lbs. (34 Nm) max. Loosen Nut retaining coil to reposition if necessary and re-torque 4 to 5 ft.lbs. (5.4 to 7 Nm).
3. Lubricate the two o-rings and install onto manifold. Install destroke valve assembly onto control assembly. Retain with lock washers and capscrews. Torque 2.2 to 2.6 ft.lbs. (3 to 3.5 Nm).



1. O-ring
2. manifold
3. Destroke Valve
4. O-ring
5. Backup Washer
6. O-ring
7. Lock Washer
8. Capscrew
9. O-ring
10. Neutral Lockout Adapter
11. Ball
12. O-ring
13. Pin
14. Set Screw
15. Neutral Lockout Switch
16. Ball Plunger
17. Nut Seal

Figure 5-126. Manual Servo Control Basic Assembly Option

DISASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION

1. Loosen set screw in adapter and remove neutral lockout switch from adapter.
2. Remove neutral lockout adapter from control assembly.
3. Remove pin, ball. and a-rings from adapter.

ASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION

1. Install new a-ring onto adapter and new o-ring onto pin.
2. Install ball and pin into adapter. Lubricate with petroleum jelly to hold in place during installation.
3. Install adapter into control assembly. Torque 44 to 53 ft.lbs. (60 to 70 Nm).
4. Apply Medium strength threadlocking compound or equivalent to threads of switch and install neutral lockout switch into adapter. The adjustment procedures for the switch are as follows.
   a. Install switch, while moving control arm back and forth, until “detent” action is detected. Back out the switch until the “detent” action is very slight.
   b. Obtain a test light or use a multimeter. Attach the leads from the test light to the switch or the wiring connector.
   c. Move the control arm out of the detent position. The test light will go on. Screw in the switch until the light goes off. Mark this as position “A”. See Figure 5-127. Move the control arm to the detent position and the test light should come back on.
   d. Leaving the control arm in the detent position, the light will remain on. Screw in the switch until the light goes off. Mark this position "B".
   e. Unscrew the switch one third of the distance between "B" and "A". Install and tighten the hex socket head set screw in one of the main quadrants of the hex of the switch adapter. See Figure 5-127. Torque set screw 2.3 to 2.8 in.lbs (3.2 to 3.8 Nm).
5. Test the switch by moving the control arm to the detent position, the light should be on. Move the control arm out of detent, the light should go off.
6. Remove test light and put servo control assembly into operation.

DISASSEMBLY - NEUTRAL DETENT OPTION

1. Loosen seal nut and remove ball plunger from control housing.

ASSEMBLY- NEUTRAL DETENT OPTION

1. Install ball plunger into control housing until contact with bell crank detent is detected. After contact screw in 1/2 turn and retain with seal nut. Torque nut 10 to 22 ft.lbs. (14 to 30 Nm).

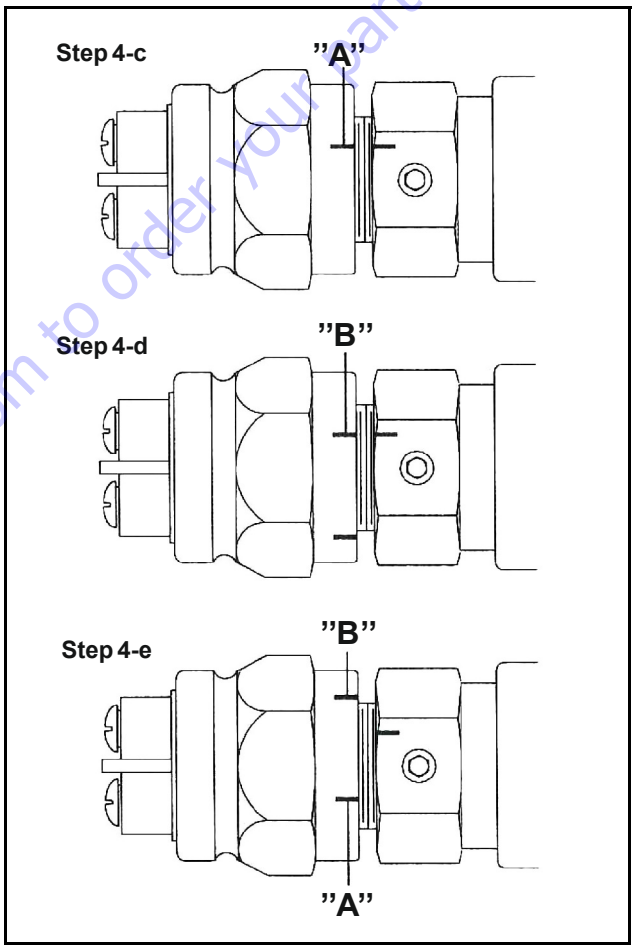


Figure 5-127. Neutral Lockout Switch Assembly

Rotating Kit Assembly

DISASSEMBLY

Disassembly of rotating assembly is required for inspection only.

1. Remove the nine piston assemblies, shoe retainer, and shoe retainer pivot from cylinder barrel.

Inspection

- Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the swashplate. **Do not lap piston shoes.**
- Examine the shoe retainer for wear in the pivot area.
- Examine the pivot to insure smoothness and no signs of wear.
- Inspect the cylinder barrel surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. Do not lap piston block.
- The pistons should move freely in the cylinder barrel bore. If they are sticky in the bore, examine the bore for scoring or contamination.

2. To inspect pins and spring caution should be taken in removing spring. The spring is highly compressed and the retaining ring should not be removed without compressing the spring safely.

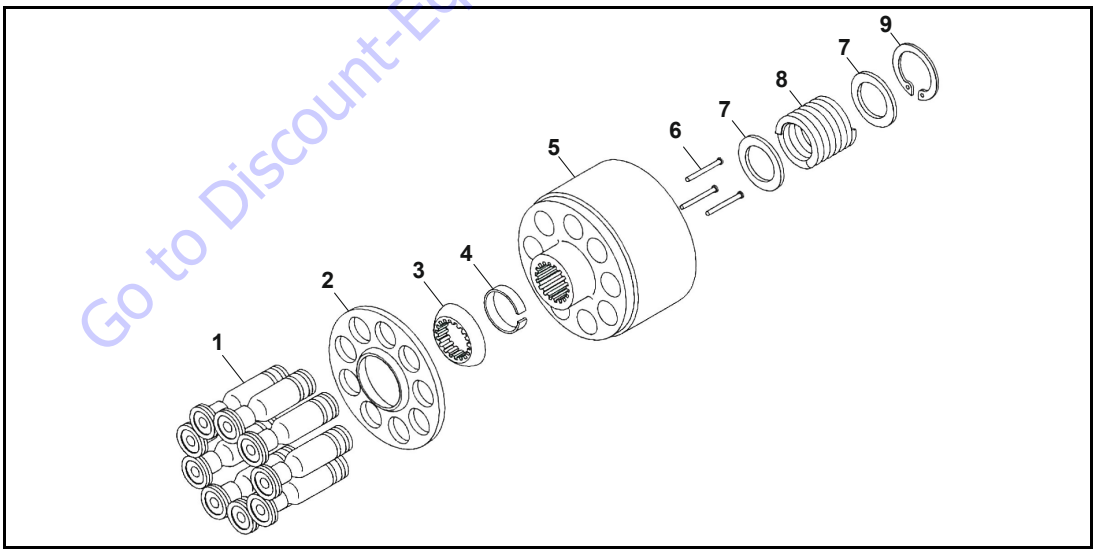
The following parts are required to disassemble the cylinder barrel:

2 ea.	3/8 in. I.D. x 1-1/8 in. O.D. flat washers
1 ea.	3/8 in. x 3-1/4 in. N.C. capscrew and
1 ea.	3/8 in. N.C. nut

To remove spring, place one of the flat washers over the 3/8 in. x 3-1/4 in. capscrew. Put capscrew through the center of the cylinder barrel and apply the second washer. Let washer rest on the three pins and retain with nut. Turning nut and compressing spring inside the barrel. Use a pair of retaining ring pliers and remove the internal retaining ring. Remove nut, bolt, and the two washers from barrel. Remove the washer, spring, second washer, three pins, and pin keeper at the same time.

ASSEMBLY

1. To reassemble the rotating kit assembly complete the following: Compress the pin keeper and install in the spline of the cylinder barrel. Install three pins with head end to the inside of the barrel and position in the special grooves of the cylinder barrel spline.
2. Install the washer, spring, and second washer into the cylinder barrel. Use the two 3/8 in. I. D. washers, nut, and 3/8 in. x 3-1/4 in. capscrew to compress the spring and retain with retaining ring. Remove the nut. capscrew, and the two washers.
3. Install the pivot onto the three pins, shoe retainer on the pivot, and piston assemblies thru the shoe retainer and into cylinder barrel. resting on shoe retainer.



1. Piston assemblies
2. Shoe Retainer
3. Shoe Retainer Pivot
4. Retainer
5. Cylinder Barrel
6. Pins
7. Washer
8. Spring
9. Retaining Ring

Figure 5-128. Rotating Kit Assembly

Fault- logic Trouble Shooting

Match the transmission symptoms with the problem statements and follow the action steps shown in the box diagrams. This will give expedient aid in correcting minor problems eliminating unnecessary machine down time.

Following the fault - logic diagrams are diagram action comments of the action steps shown in the diagrams. Where applicable, the comment number of the statement appears in the action block of the diagrams.

RECOMMENDED GAUGE LOCATIONS

Gauges Recommended

Inlet vacuum gauge: 30 PSI to 14.8 PSI (2 bar to 1 bar)

System pressure gauge: 10,000 PSI (700 bar)

Charge pressure gauge: 0 to 600 PSI (0 to 50 bar)

Case pressure gauge: 0 to 300 PSI (0 to 25 bar)

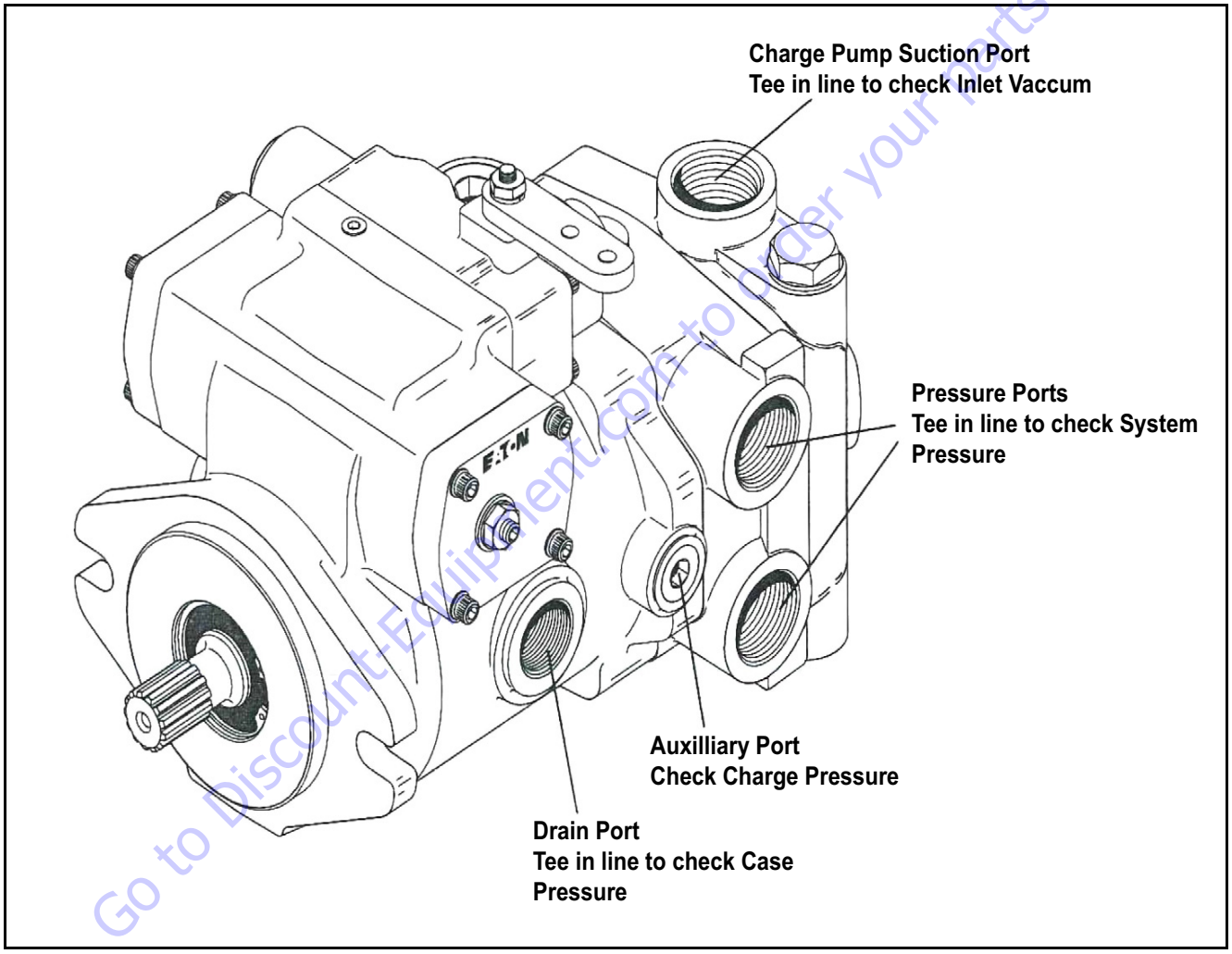


Figure 5-129. Gauge Locations

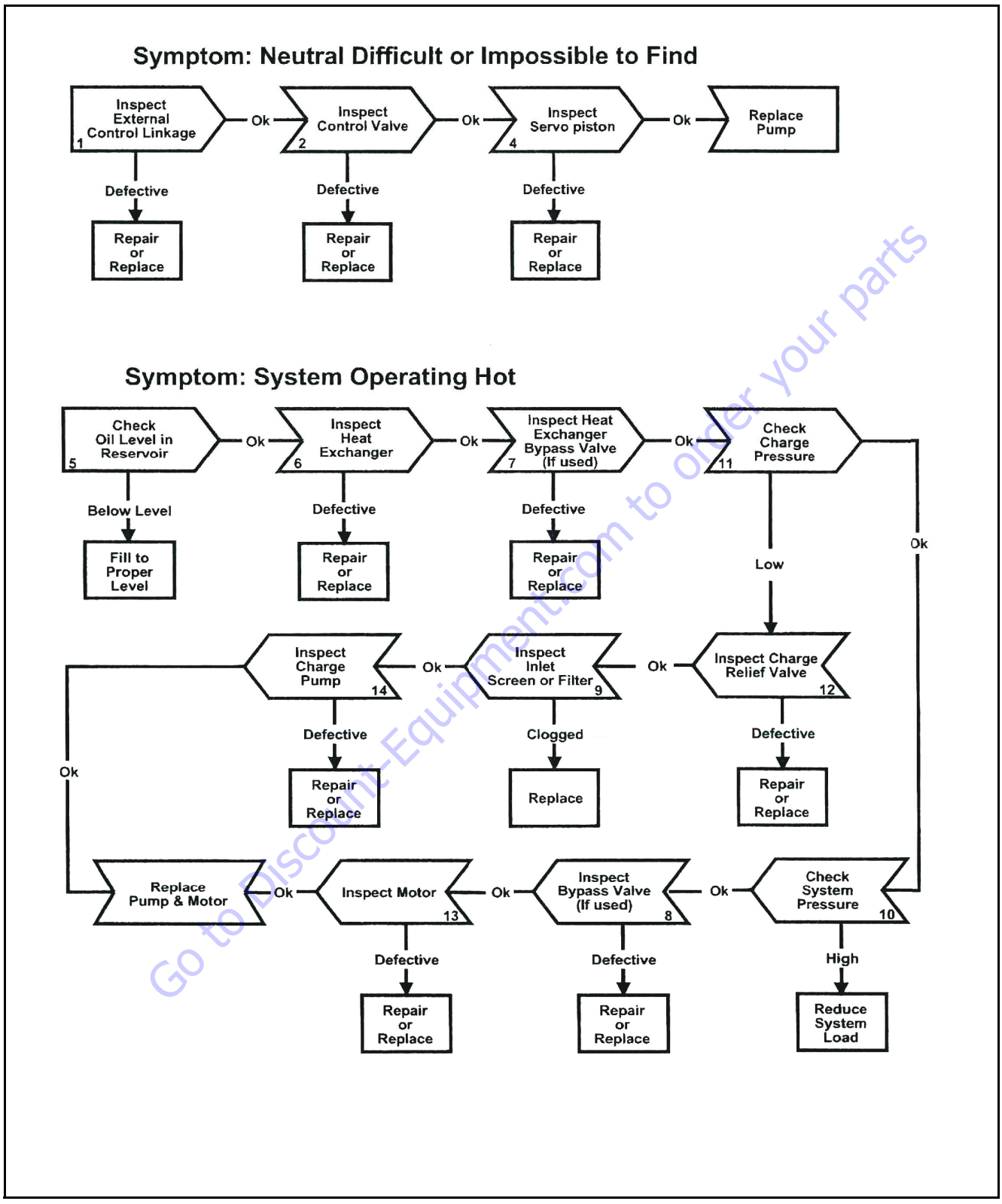


Figure 5-130. Fault- logic Troubleshooting

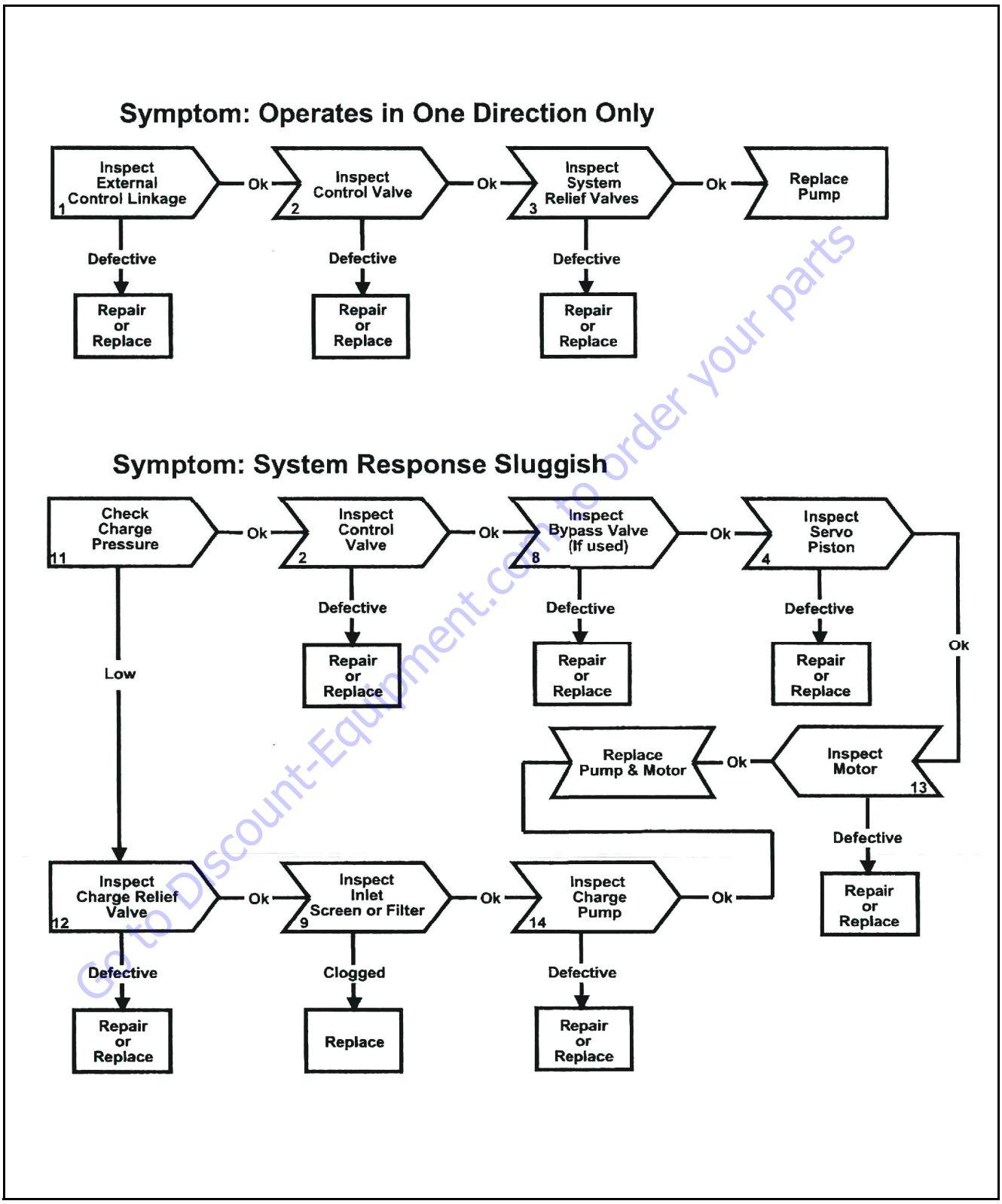


Figure 5-131. Fault- logic Troubleshooting

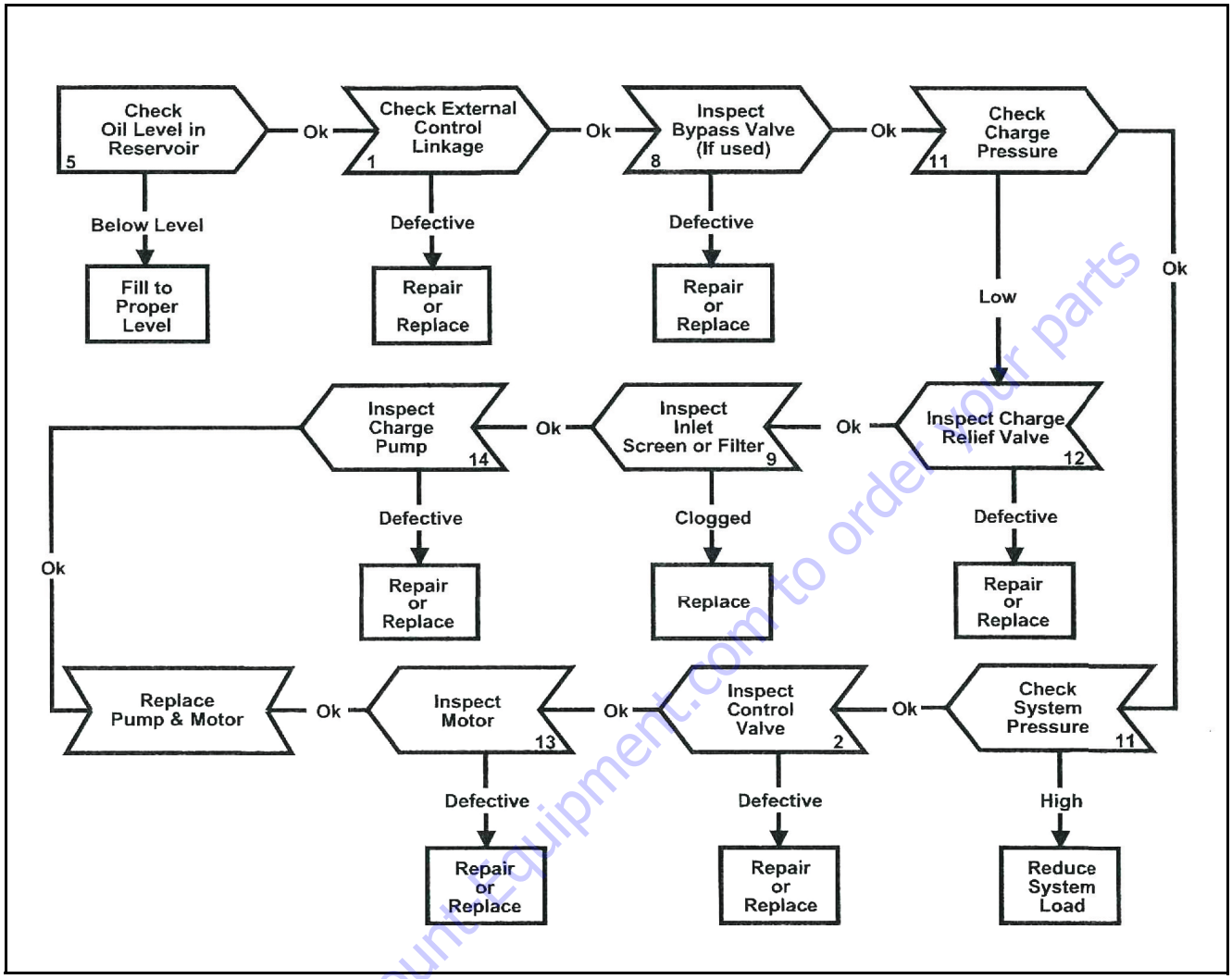


Figure 5-132. Fault- logic Troubleshooting

DIAGRAM ACTION STEP COMMENTS

1. **Inspect External Control Linkage for:**
   - **a.** Misadjusted or disconnected
   - **b.** Binding, bent or broken
2. **Inspect Control Valve for:**
   - **a.** Plugged control orifice(s)
   - **b.** Damaged mounting gasket
   - **c.** Misadjusted, damaged or broken neutral return spring
   - **d.** Broken control connector pin
   - **e.** Faulty destroke valve (if used)
   - **f.** Galled or stuck control spool
   - **g.** Neutral detent or lockout switch misadjusted (if used)
3. **Inspect System Relief Valves for:**
   - **a.** Improper pressure relief setting
   - **b.** Damaged or broken spring
   - **c.** Valve held off seat
   - **d.** Damaged valve seat
4. **Inspect Servo Piston for:**
   - **a.** Misadjusted, damaged or broken neutral return spring assembly
   - **b.** Galled or stuck servo piston
   - **c.** Damaged or missing o-ring and/or backup ring
5. **Check Oil Level in Reservoir:**
   - **a.** Consult owner/operators manual for the proper type fluid and level
6. **Inspect Heat Exchanger for:**
   - **a.** Obstructed air flow (air cooled)
   - **b.** Obstructed water flow (water cooled)
   - **c.** Improper plumbing (inlet to outlet)
   - **d.** Obstructed fluid flow
7. **Inspect Heat Exchanger Bypass Valve for:**
   - **a.** Improper pressure adjustment
   - **b.** Stuck or broken valve
8. **Inspect Bypass Valve for: {if used)**
   - **a.** Held in a partial or full open position
9. **Inspect Inlet Screen or Filter for:**
   - **a.** Plugged or clogged screen or filter element
   - **b.** Obstructed inlet or outlet
   - **c.** Open inlet to charge pump
10. **Check System Pressure:**
    - **a.** See Figure 5-125. for location of pressure gauge installation
    - **b.** Consult owner/operators manual for maximum system relief valve settings
11. **Check Charge Pressure:**
    - **a.** See Figure 5-125. for location of charge pressure gauge installation
    - **b.** Consult owner/operators manual for maximum charge relief valve settings
12. **Inspect Charge Relief Valve for:**
    - **a.** Improper charge relief pressure setting
    - **b.** Damaged or broken spring
    - **c.** Poppet valve held off seat
13. **Inspect Motor for:**
    - **a.** Consult owner/operator manual for motor operation and trouble shooting
14. **Inspect Charge Pump for:**
    - **a.** Broken or missing drive key
    - **b.** Damaged or missing o-ring
    - **c.** Excessive gerotor clearance
    - **d.** Galled or broken gerotor set

System/Charge Relief Valve Pressure Settings

Inlet Vacuum	2.94 PSI (0.203 bar) max.
Case Pressure	25 PSI (1.7 bar) maximum
Charge Pressure	250 to 300 PSI (17.24 to 20.68 bar)
System Pressure	5000 PSI (345 bar) maximum
	3000 PSI (207 bar) continuous

The high pressure relief valves are all factory preset and cannot be readjusted.

The pressure setting is stamped on each valve with a three digit number. To identify, multiply the noted number by 10 to get the valves pressure setting.

Example: 10 x 500 = 5000 PSI (345 bar)

Start-up Procedure

When initially starting a new or a rebuilt transmission system. it is extremely important that the start-up procedure be followed. It prevents the chance of damaging the unit which might occur if the system was not properly purged of air before start-up.

1. After the transmission components have been properly installed, fill the servo pump housing at least half full with filtered system oil. Connect all hydraulic lines and check to be sure they are tight.
2. Install and adjust all control linkage.
3. Fill the reservoir with an approved oil that has been filtered through a 10 micron filter. Refer to Eaton Hydraulics Technical Data sheet number 3-401 titled Hydraulic Fluid Recommendations.
4. Gasoline or L.P. engines: remove the coil wire and turn the engine over for 15 seconds. Diesel engines: shut off the fuel flow to the injectors and turn the engine over for 15 seconds.
5. Replace the coil wire or return the fuel flow to the injectors. Place the transmission unit in the neutral position, start the engine and run it at a low idle. The charge pump should immediately pick up oil and fill the system. If there is no indication of fill in 30 seconds, stop engine and determine the cause.
6. After the system starts to show signs of fill, slowly move pump swashplate to a slight cam angle. Continue to operate system slowly with no load on motors until system responds fully.
7. Check fluid level in the reservoir and refill if necessary to the proper level with an approved filtered oil.
8. Check all line connections for leaks and tighten if necessary.
9. The machine is now ready to be put into operation.
10. Frequent filter changes are recommended for the first two changes after placing the machine back into operation. Change the first filter in 3-5 hours and the second at approximately 50 hours. Routinely scheduled filter changes are recommended for maximum life of the hydraulic system.

5.11 UPRIGHT LEVEL SYSTEM HOLDING VALVE CHECKS

1. Start the machine and warm the hydraulic system to operating temperature.

NOTICE

PERFORM ALL HOLDING VALVE CHECKS FROM THE GROUND CONTROL STATION WITH AN EMPTY PLATFORM.

2. Check the Upright level cylinder rod side holding valve as follows:
   a. Fully retract and fully lower the main boom and tower boom assemblies.
   b. Power the main boom lift down function into the turntable boom rest by holding the function switch down between 10 and 20 seconds.
   c. Verify the upright remains perpendicular to the turntable and that the Upright Monitoring System alarms have not been activated.
3. Check the Upright level cylinder barrel side holding valve function as follows:
   a. Fully retract and fully lower the main boom and tower boom assemblies. Raise the tower boom between 2 ft. and 5 ft. (0.6 m and 1.5 m).
   b. Pull and hold the re-leveling knob between 20 and 30 seconds.
   c. Verify the upright remains perpendicular to the turntable and that the Upright Monitoring System alarms have not been activated.
4. Check the Tower lift cylinder barrel side holding valve function as follows:
   a. Fully raise and fully retract the tower boom. Fully raise and fully extend the main boom.
   b. Using auxiliary power, fully lower the tower boom.
   c. Verify the upright remains perpendicular to the turntable and that the Upright Monitoring System alarms have not been activated.
5. Check the Tower lift up holding valve function as follows:
   a. Fully retract and fully lower the main boom and tower boom assemblies.
   b. Install a 5000 psi (345 bar) pressure gauge to the pressure tap connection installed on port #7 or port MX7 of the main control valve block. This pressure test connection was installed in earlier steps.
   c. Hold the tower boom lift up function between 2 and 5 seconds, and then release the function.
   d. Verify that the gauge reads and maintains the pressure above 1000 psi (68395 bar) for one minute.

NOTE: *If pressure does not remain above the stated pressure for one minute, replace the tower lift check valve (#7017474).*

   e. Activate tower lift down to release any trapped pressure and remove pressure gauge from the test port.
6. Load the platform with the rated capacity and cycle all functions a minimum of five (5) times to confirm safe and proper operational characteristics.
7. The machine may be returned to service once proper operation is confirmed.

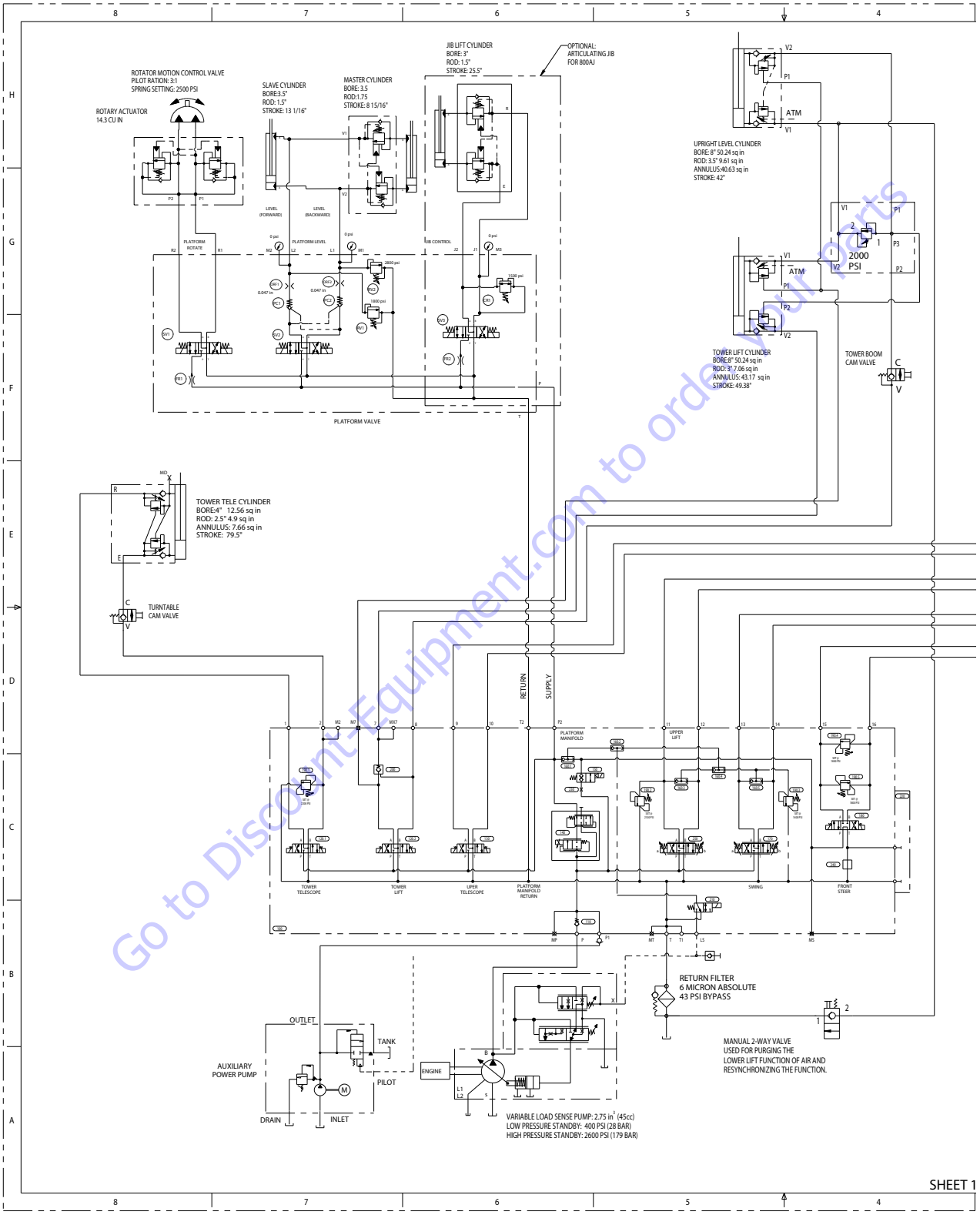


Figure 5-133. Hydraulic Schematic - Sheet 1 of 6

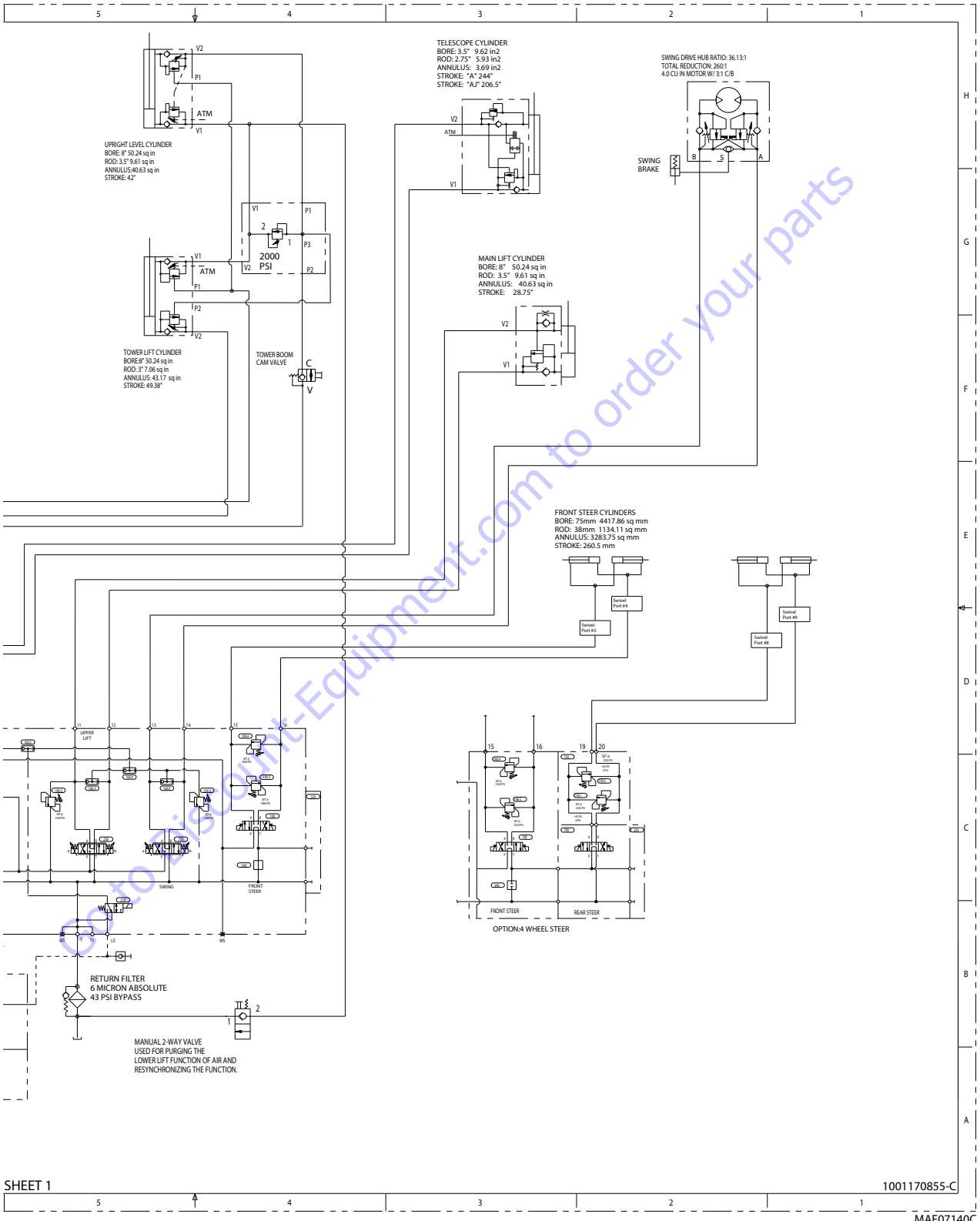


Figure 5-134. Hydraulic Schematic - Sheet 2 of 6

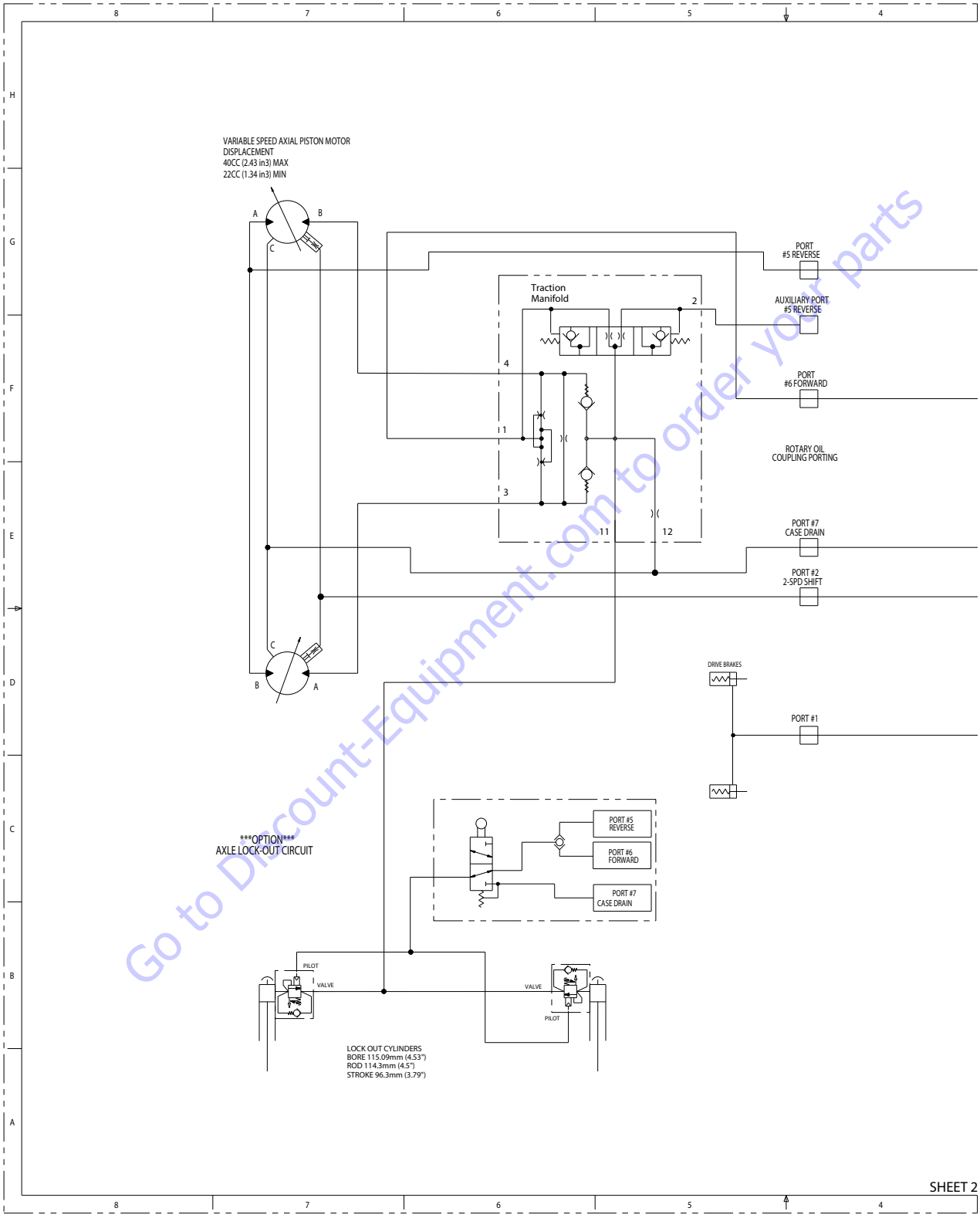


Figure 5-135. Hydraulic Schematic - Sheet 3 of 6

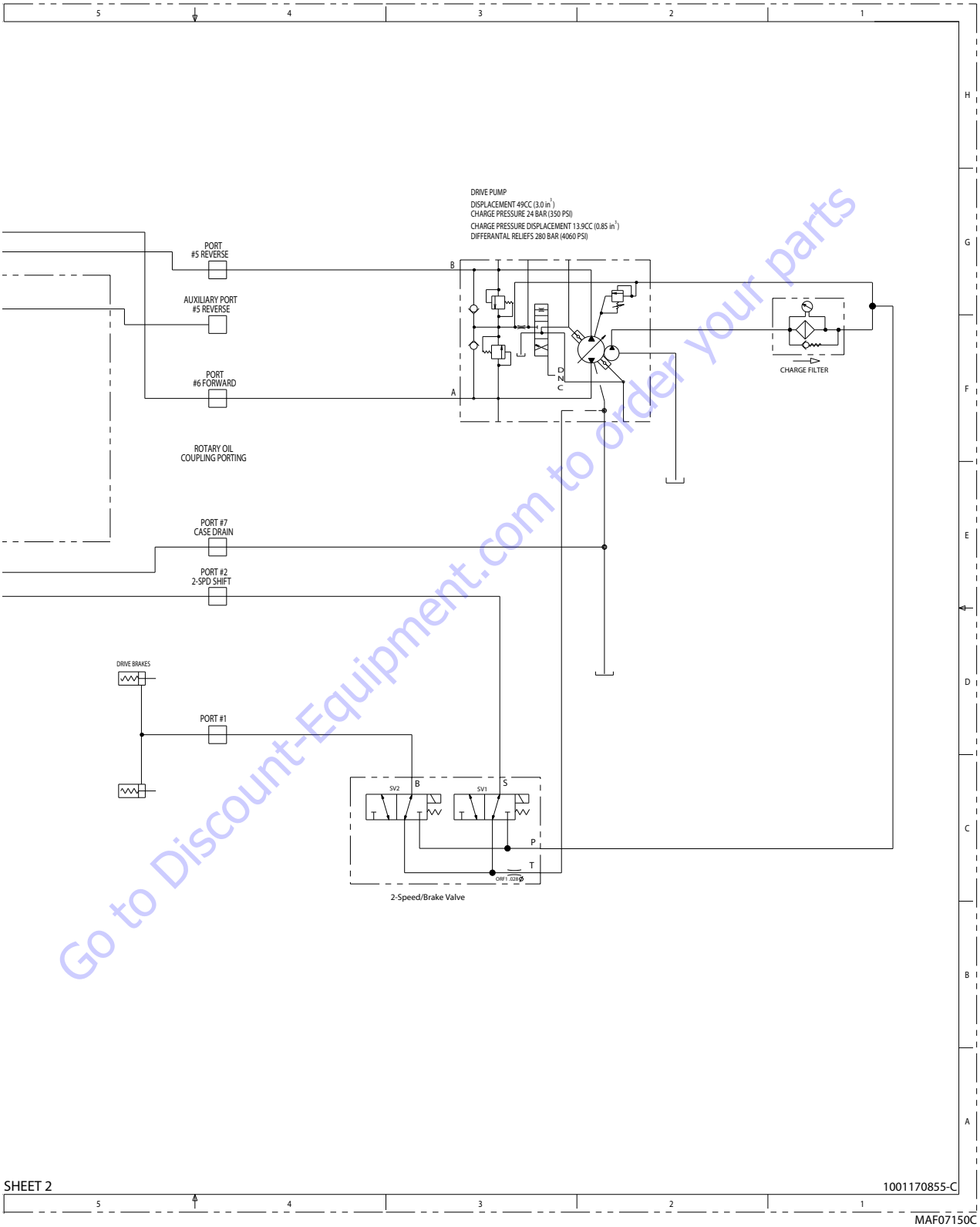


Figure 5-136. Hydraulic Schematic - Sheet 4 of 6

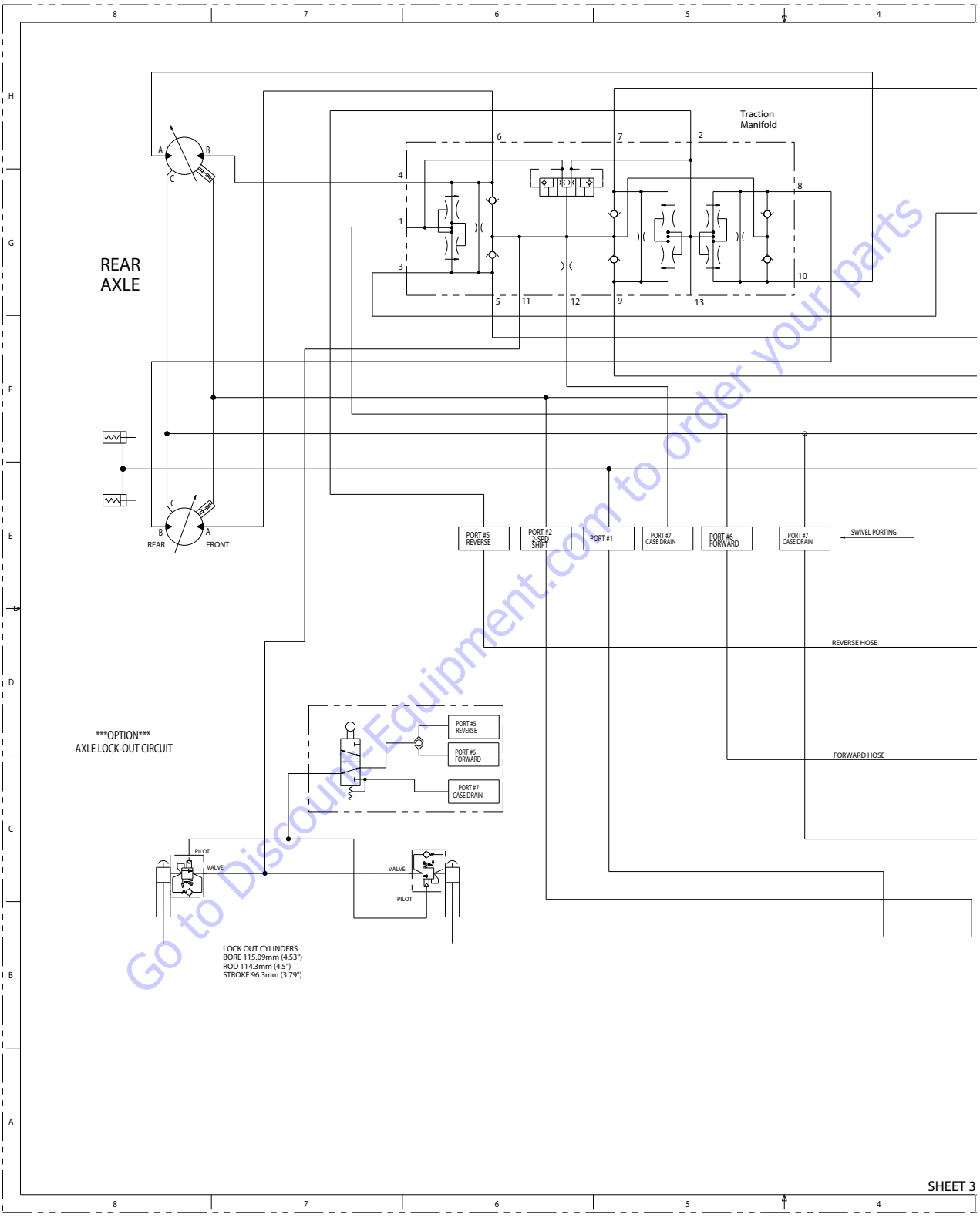


Figure 5-137. Hydraulic Schematic - Sheet 5 of 6

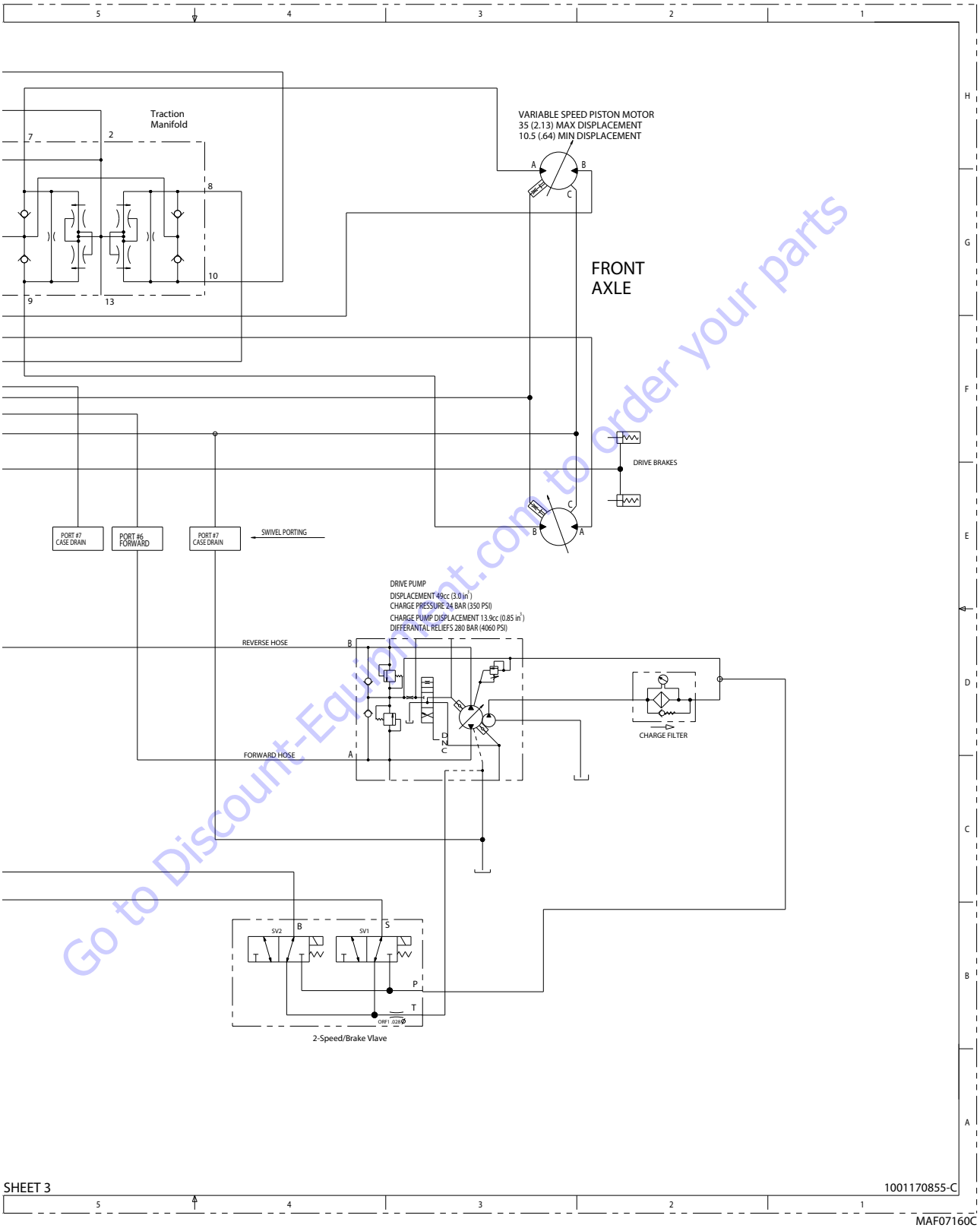
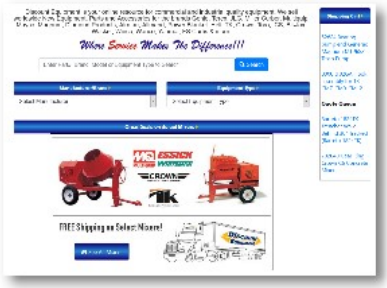


Figure 5-138. Hydraulic Schematic - Sheet 6 of 6

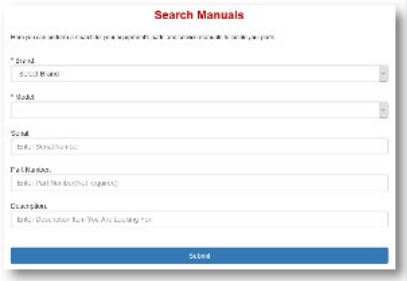
PARTS FINDER

Search Website by Part Number

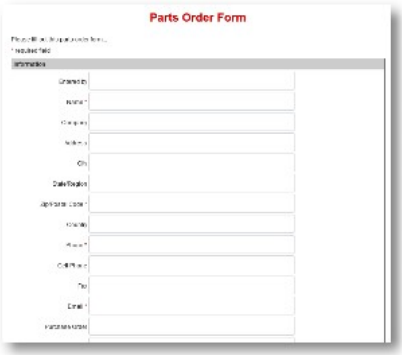
Discount Equipment



Search Manual Library For Parts Manual & Lookup Part Numbers – Purchase or Request Quote



Can't Find Part or Manual? Request Help by Manufacturer, Model & Description



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Click on this link: http://www.discount-equipment.com/category/5443-parts/ and choose one of the options to help get the right parts and equipment you are looking for. Please have the machine model and serial number available in order to help us get you the correct parts. If you don't find the part on the website or on once of the online manuals, please fill out the request form and one of our experienced staff members will get back to you with a quote for the right part that your machine needs.

We sell worldwide for the brands: Genie, Terex, JLG, MultiQuip, Mikasa, Essick, Whiteman, Mayco, Toro Stone, Diamond Products, Generac Magnum, Airman, Haulotte, Barreto, Power Blanket, Nifty Lift, Atlas Copco, Chicago Pneumatic, Allmand, Miller Curber, Skyjack, Lull, Skytrak, Tsurumi, Husquvarna Target, , Stow, Wacker, Sakai, Mi-T- M, Sullair, Basic, Dynapac, MBW, Weber, Bartell, Bennar Newman, Haulotte, Ditch Runner, Menegotti, Morrison, Contec, Buddy, Crown, Edco, Wyco, Bomag, Laymor, Barreto, EZ Trench, Bil-Jax, F.S. Curtis, Gehl Pavers, Heli, Honda, ICS/PowerGrit, IHI, Partner, Imer, Clipper, MMD, Koshin, Rice, CH&E, General Equipment, ,AMida, Coleman, NAC, Gradall, Square Shooter, Kent, Stanley, Tamco, Toku, Hatz, Kohler, Robin, Wisconsin, Northrock, Oztec, Toker TK, Rol-Air, Small Line, Wanco, Yanmar

SECTION 6. JLG CONTROL SYSTEM

6.1 JLG CONTROL SYSTEM ANALYZER KIT INSTRUCTIONS

Introduction

NOTICE

WHEN INSTALLING A NEW POWER MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

NOTICE

IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

The main lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer Kit, JLG part no. 2901443) which will display two lines of information at a time, by scrolling through the program.

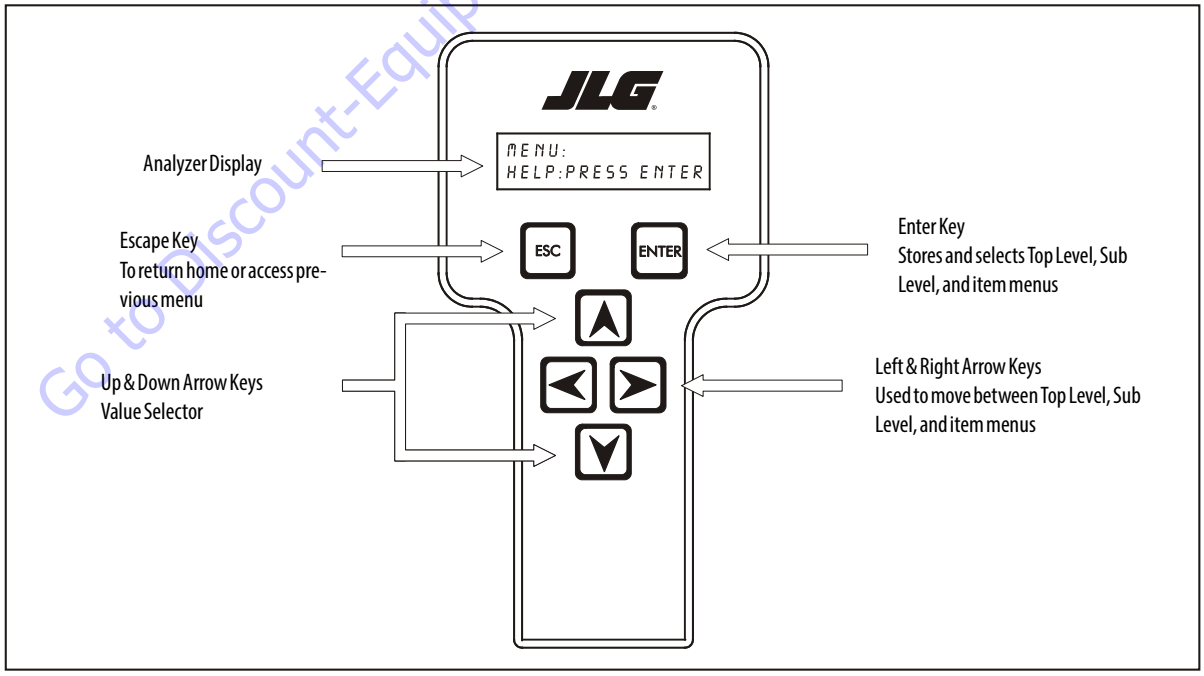


Figure 6-1. Hand Held Analyzer

To Connect the JLG Control System Analyzer

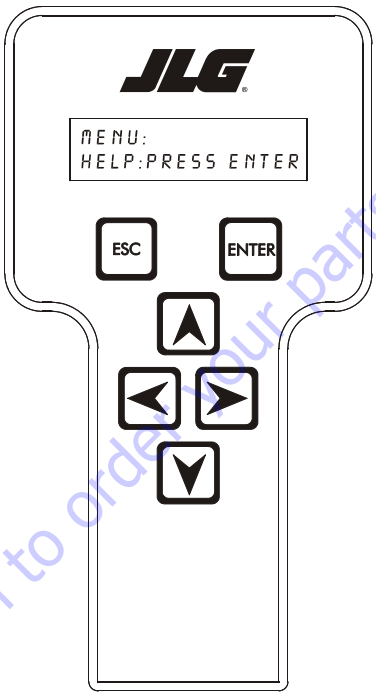
1. Connect the four pin end of the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

NOTE: *The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.*

2. Power up the Control System by turning the lower key to the platform or ground position and pulling both emergency stop buttons on.

Using the Analyzer

With the machine power on and the analyzer connected properly, the analyzer will display the following:



HELP:
PRESS ENTER

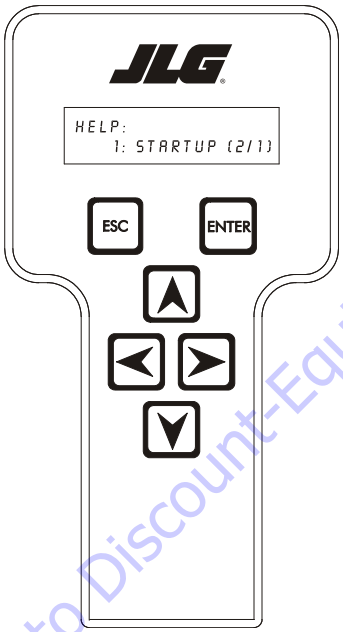
At this point, using the RIGHT  and LEFT  arrow keys, you can move between the top level menu items. To select a displayed menu item, press ENTER  . To cancel a selected menu item, press Escape  ; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

HELP
DIAGNOSTICS
ACTIVATE TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
LEVEL VEHICLE (level 1 only)
CALIBRATIONS (view only)

If you press **ENTER** ENTER, at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display will scroll the fault across the screen. If there was no fault detected, the display will read: **HELP: EVERYTHING OK.** If powered up at the ground station, the display will read: **GROUND OK.**

If **ENTER** ENTER is pressed again, the display moves to the following display:



LOGGED HELP
1: STARTUP (2/1)

At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESCAPE** ESC two times. **STARTUP (2/1)** indicates a power up.

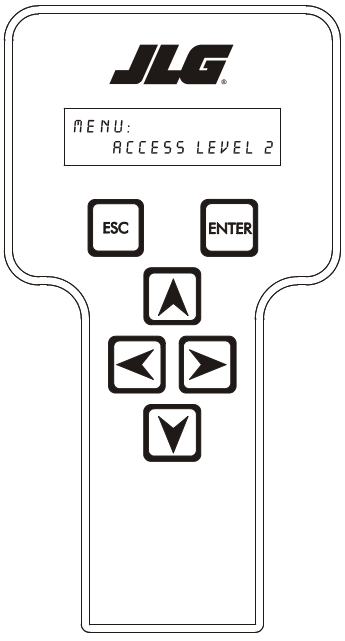
When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

Pressing **ENTER** ENTER with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected menu item by pressing the **ESCAPE** ESC key.

Changing the Access Level of the Hand Held Analyzer

When the analyzer is first connected, you will be in access level 2 which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change the access level, the correct password must be entered. To enter the password, scroll to the **ACCESS LEVEL** menu. For example:



ACCESS LEVEL:
CODE 00000

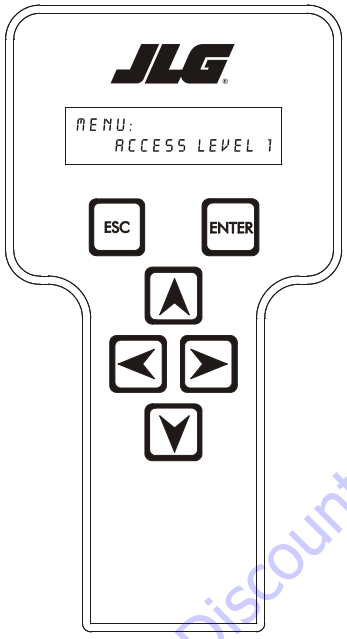
Press **ENTER** to select the **ACCESS LEVEL** menu.

Using the **UP** or **DOWN** arrow keys, enter the first digit of the password, 3.

Then using the **RIGHT** arrow key, position the cursor to the right one space to enter the second digit of the password.

Use the **UP** or **DOWN** arrow key to enter the second digit of the password which is 33271.

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:

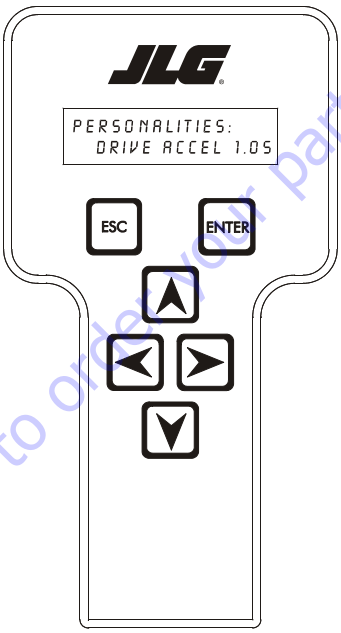


MENU:
ACCESS LEVEL 1

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

Adjusting Parameters Using the Hand Held Analyzer

Once you have gained access to level 1, and a personality item is selected, press the **UP** or **DOWN** arrow keys to adjust its value, for example:

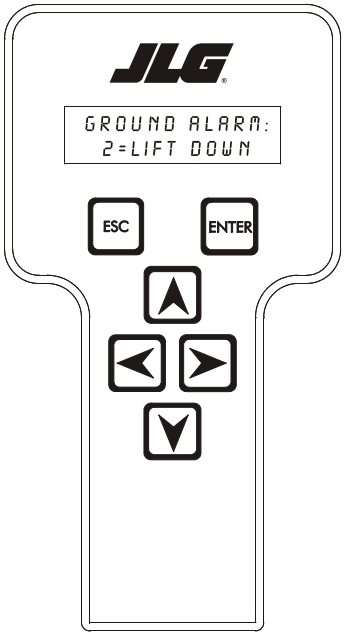


PERSONALITIES:
DRIVE ACCEL 1.5s

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at access level 1.

Machine Setup

When a machine digit item is selected, press the **UP** or **DOWN** arrow keys to adjust its value, for example:



GROUND ALARM:
2 = LIFT DOWN

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when driving. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

NOTE: *Refer to Personality Ranges/Defaults for the recommended factory settings.*

NOTE: *Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.*

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

ELEVATION CUTBACK

⚠ WARNING

CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.

NOTICE

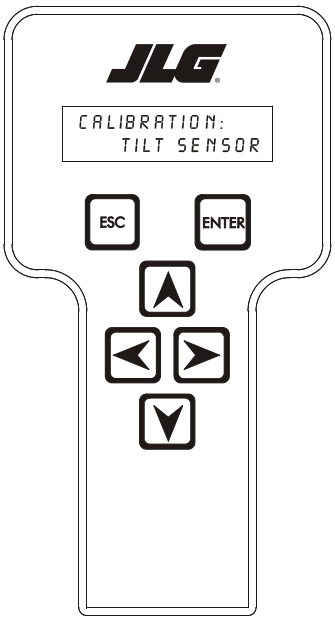
ITS IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

Level Vehicle Description

A NEW TILT MODULE WILL ACT AS IF IT IS TILTED ALL OF THE TIME UNTIL THE FOLLOWING PROCEDURE IS PERFORMED.

⚠ WARNING

DO NOT CALIBRATE THE LEVEL SENSOR EXCEPT ON A LEVEL SURFACE.



Place machine in stowed position with the boom between the rear wheels.

To level machine chose:

CALIBRATION:
TILT SENSOR

Press ENTER.

When prompted, swing machine 180°

Press ENTER.

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
ACCEL	ACCELERATE
ACT	ACTIVE
A/D	ANALOG DIGITAL CONVERTER COUNT
AMB.	AMBIENT
ANG	ANGLE
AUX	AUXILIARY
BCS	BOOM CONTROL SYSTEM
BM	BOOM LENGTH ANGLE MODULE
BLAM	BOOM LENGTH ANGLE MODULE
BR	BROKEN
BSK	BASKET
CAL	CALIBRATION
CL	CLOSED
CM	CHASSIS MODULE
CNTL	CONTROL
CNTRL	CONTROL
C/O	CUT OUT
CONT(S)	CONTRACTOR(S)
COOR	COORDINATED
CRK PT	CRACK POINT
CRP	CREEP
CUT	CUTOUT
CYL	CYLINDER
DECEL	DECELERATE
D	DOWN
DN	DOWN
DWN	DOWN
DEG.	DEGREE
DOS	DRIVE ORIENTATION SYSTEM
DRV	DRIVE
E	ERROR
E&T	ELEVATED & TILTED
ELEV	ELEVATION
ENG	ENGINE
EXT	EXTEND
F	FRONT
FL	FLOW
FNT	FRONT
FOR	FORWARD
FWD	FORWARD
FSW	FOOT SWITCH
FUNC	FUNCTION
G	GROUND

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
GND	GROUND
GRN	GREEN
GM	GROUND MODULE
H	HOURS
HW	HARDWARE
HWFS	HARDWARE FAILSAFE
I	IN or CURRENT
JOY	JOYSTICK
L	LEFT
LB	POUND
LEN	LENGTH
LIM	LIMIT
LT	LEFT
LVL	LEVEL
M	MINUTES
MIN	MINIMUM
MAX	MAXIMUM
M	MAIN
MN	MAIN
NO	NORMALLY OPEN or NO
NC	NORMALLY CLOSED
O	OUT
O/C	OPEN CIRCUIT
OP	OPEN
O/R	OVERRIDE or OUTRIGGER
O//R	OVERRIDE
OSC	OSCILLATING
OVRD	OVERRIDE
P	PLATFORM
P	PRESSURE
PCV	PROPORTIONAL CONTROL VALVE
PLAT	PLATFORM
PLT	PLATFORM
PM	PLATFORM MODULE
POT	POTENTIOMETER
PRES	PRESSURE
PRS	PRESSURE
PT	POINT
R	REAR or RIGHT
REV	REVERSE or REVISION
RET	RETRACT
ROT.	ROTATE
RT	RIGHT

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
S/C	SHORT CIRCUIT
SEL	SELECTOR
SN	SERIAL NUMBER
SPD	SPEED
STOW	STOWED
STOWD	STOWED
SW	SWITCH or SOFTWARE
TELE	TELESCOPE
TEMP	TEMPERATURE
TORQ.	TORQUE
TRN	TRANSPORT
T/T	TURNTABLE
T	TOWER
TURNTBL	TURNTABLE
TWR	TOWER
U	main or UP
V	VOLT
VER	VERSION
VLV	VALVE
WIT	WITNESS
YEL	YELLOW

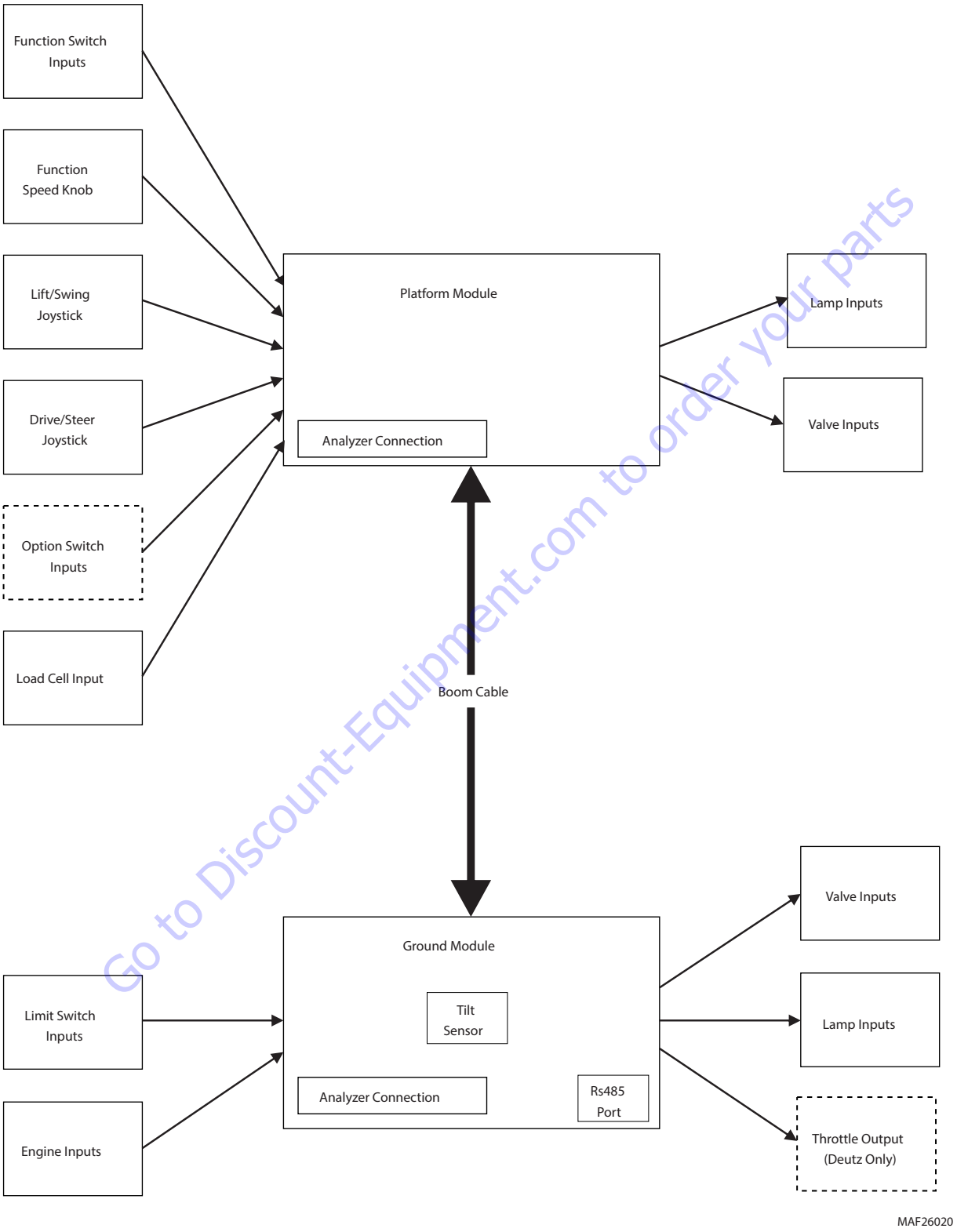


Figure 6-2. ADE Block Diagram

6.2 MACHINE CONFIGURATION PROGRAMMING INFORMATION

Table 6-2. Machine Configuration Programming Information (Software Version P6.30)

Configuration Digit	Number	Description	Default Number
NOTE: *The machine configuration must be completed before any personality settings can be changed. Changing the personality settings first and then changing the model number of the machine configuration will cause the personality settings to return to default values.*			
MODEL NUMBER: 1	**1**	**600A**	**1**
	2	740A	
	3	800A	
	4	800S	
	5	H800A	
MARKET: 2*	**1**	**ANSI USA**	**1**
	2	ANSI EXPORT	
	3	CSA	
	4	CE	
	5	AUSTRALIA	
	6	JAPAN	
	7	GB	
* Certain model selections will limit market options.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.30)

Configuration Digit	Number	Description	Default Number
ENGINE: 3*	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	PERKINS 804C	
	9	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	10	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	11	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	12	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	13	**DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)**	**13**
	14	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	15	PERKINS ECM	
	16	CAT ECM T4I	
	17	CAT ECM T4F	
	18	DEUTZ EMR4: Deutz Engine Control Module (Tier 4 Final)	
	19	FORD DUAL FUEL	
	20	KUBOTA D1305	
* Certain model selections will limit engine options. * Certain market selections will limit engine options.			
GLOW PLUG: 4*	1	NO GLOW PLUGS: No glow plugs installed.	
	2	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	3	**IN-CYLINDER: Glow plugs installed in each cylinder.**	**3**
* Only visible for diesel engine selections.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.30)

Configuration Digit	Number	Description	Default Number
STARTER LOCKOUT: 5*	**1**	**DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.**	**1**
	2	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	
* Only visible for diesel engine selections.			
ENGINE SHUTDOWN: 6	1	DISABLED: No engine shutdown.	
	2	**ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.**	**2**
FUEL CUTOUT: 7*	**1**	**RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached**	**1**
	2	ONE RESTART: Engine allowed to be restarted once for 2 minutes when very low fuel level is reached	
	3	ENGINE STOP: Engine not able to restart when very low fuel level is reached	
* Only visible for diesel engine selections.			
TILT: 8*	1	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.	
	2	4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep.	
	3	3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep.	
	4	4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	5	3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	6	5 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	7	5 DEG + DRV CUT Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
	8	**4 DEG + DRV CUT Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.**	**8**
	9	3 DEG + DRV CUT Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
* Certain market selections will limit tilt options and alter default setting.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.30)

Configuration Digit	Number	Description	Default Number
JIB: 9*	**1**	**NO: No Jib installed.**	**1**
	2	YES: Jib installed which has up and down movements only.	
* Only visible under certain model selections.			
4 WHEEL STEER: 10*	**1**	**NO: No four-wheel steer installed.**	**1**
	2	YES: Four-wheel steer installed.	
* Only visible under certain model selections.			
SOFT TOUCH: 11*	**1**	**NO: No soft touch installed.**	**1**
	2	YES: Soft touch installed	
* Only visible under certain model selections.			
SKYGUARD: 12	1	NO: No SkyGuard installed.	
	2	**BAR/SKYLINE: SkyGuard system installed.**	**2**
	3	SKYEYE: SkyGuard system installed.	
GEN SET/WELDER: 13	**1**	**NO: No generator installed.**	**1**
	2	BELT DRIVE: Belt driven setup.	
GEN SET CUTOUT: 14*	**1**	**MOTION ENABLED: Motion enabled when generator is ON.**	**1**
	2	MOTION CUTOUT: Motion cutout in platform mode only.	
* Only visible if gen set / welder selection is not NO.			
H & T LIGHTS: 15	**1**	**NO: No head and tail lights installed.**	**1**
	2	YES: Head and tail lights installed.	
CABLE SWITCH: 16*	**1**	**NO: No broken cable switch installed.**	**1**
	2	YES: Broken cable switch installed.	
* Only visible under certain model selections.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.30)

Configuration Digit	Number	Description	Default Number
LOAD SYSTEM: 17*	1	NO: No load sensor installed.	
	2	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	**CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).**	**3**
	4	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
* Certain market selections will limit load system options or alter default setting.			
FUNCTION CUTOUT: 18*	**1**	**NO: No drive cutout.**	**1**
	2	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	3	DRIVE CUTOUT: Drive & steer cutout above elevation.	
* Certain market selections will limit function cutout options or alter default setting.			
GROUND ALARM: 19	1	NO: No ground alarm installed.	
	2	DRIVE: Travel alarm sounds when the drive function is active (Option).	
	3	DESCENT: Descent alarm sounds when lift down is active (Option).	
	4	**MOTION: Motion alarm sounds when any function is active (Option).**	**4**
DRIVE: 20	**1**	**4WD: Four wheel drive.**	**1**
	2	2WD: Two wheel drive	
	3	2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	
DISPLAY UNITS: 21*	**1**	**IMPERIAL: DEG F, PSI, LBS.**	**1**
	2	METRIC: DEG C, KPA, KGS.	
* Certain market selections will alter default setting.			
LEVELING MODE: 22*	**1**	**ALL FUNCTIONS: Platform level with all functions.**	**1**
	2	LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	
* Only visible under certain model selections.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.30)

Configuration Digit	Number	Description	Default Number
DRIVE PUMP: 23*	**1**	**SAUER DANFOSS: Machine equipped with Sauer Danfoss drive pump.**	**1**
	2	EATON: Machine equipped with Eaton drive pump.	
	3	M46-XXXX: Machine equipped with M46-XXXX drive pump.	
	4	830XXXXX: Machine equipped with 830XXXXX: drive pump	
* Only visible under certain model selections.			
CLEARSKY: 24	**1**	**NO: ClearSky (Telematics) options is disabled.**	**1**
	2	YES: ClearSky (Telematics) option is enabled.	
CRIBBING OPTION: 25*	**1**	**NO: Cribbing Option is disabled.**	**1**
	2	YES: Cribbing Option is enabled.	
* Only visible under certain model selections.			
FUEL TANK SIZE: 26*	**0**	**31 Gallon Tank**	**0**
	1	52 Gallon Tank	
* Only visible under certain model selections.			
ALARM / HORN: 27	**0**	**SEPARATE: Separate alarm and horn.**	**0**
	1	COMBINED: Combination alarm / horn.	
ALERT BEACON: 28	**0**	**OFF FOR CREEP: Alert beacon will not flash while in Creep**	**0**
	1	20FPS FOR CREEP: Alert beacon will flash at 20FPS while in Creep	
TEMP CUTOUT: 29*	**0**	**NO: Temp Cutout is Disabled**	**0**
	1	YES: Temp Cutout is Enabled	
* Certain model selections will limit temp cutout options.			
PLAT LVL OVR CUT 30	**0**	**NO: Platform Level Override will always be functional**	**0**
	1	YES: Platform Level Override will only be functional when In Transport	
WATER IN FUEL SENSOR: 31*	**0**	**NO: Water in Fuel Sensor Disabled**	**0**
	1	YES: Water in Fuel Sensor Enabled	
* Only visible if engine selection is Deutz EMR4.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.30)

Configuration Digit	Number	Description	Default Number
DUAL CAPACITY 32*	**0**	**NO: Dual Capacity is disabled.**	**0**
	1	YES: Dual Capacity is enabled.	
* Only visible under certain model selections.			

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Table 6-3. 800AJ Machine Configuration Programming Settings (Software Version P6.30)

800 AJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	**9**	**9**	**9**	**9**	**9**	**9**	**9**
Market	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Engine	**13**	**13**	**13**	**13**	**13**	**13**	**13**
Glow Plugs	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	**3**	**3**	**3**	**3**	**3**	**3**
Starter Lockout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Engine Shutdown	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
Fuel Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Tilt	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	X	X	X	X	X	6	X
	X	X	X	X	X	**7**	X
	8	**8**	**8**	**8**	**8**	8	**8**
	9	9	9	9	9	9	9
Jib	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
4 Wheel Steer	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Soft Touch	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Skyguard	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
	3	3	3	3	3	3	3
Gen Set / Welder	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Gen Set Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Head & Taillights	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Cable Switch	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	X	X	X	X	X	X	X
Load System	X	1	X	X	X	X	X
	X	X	X	X	X	X	X
	3	**3**	**3**	X	**3**	**3**	**3**
	4	4	4	**4**	X	4	4

Table 6-3. 800AJ Machine Configuration Programming Settings (Software Version P6.30)

800 AJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Function Cutout	**1**	**1**	**1**	1	**1**	**1**	1
	X	2	2	**2**	2	2	**2**
	3	3	3	X	3	3	3
Ground Alarm	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
	4	**4**	**4**	**4**	**4**	**4**	**4**
Drive Type	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Display Units	**1**	**1**	1	1	1	1	1
	2	2	**2**	**2**	**2**	**2**	**2**
Leveling Mode	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	X	X	X	X	X	X	X
Drive Pump	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
ClearSky	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Cribbing Option	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Fuel Tank Size	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	X	X	X	X	X	X	X
Alarm / Horn	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Alert Beacon	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Temp Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	X	2	X	2	X	X	2
Plat Lvl Ovr Cut	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Water in Fuel Sensor	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Dual Capacity	1	1	1	**1**	**1**	1	**1**
	2	**2**	**2**	2	2	**2**	2

BOLD TEXT indicates the default setting. Plain text indicates another available selection. ***RED ITALIC*** text indicates the required selection for a machine with a Jib. SHADED CELLS indicate hidden menu or selection.

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6.3 MACHINE PERSONALITY SETTINGS AND FUNCTION SPEEDS

NOTE: *Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.*

Table 6-4. Machine Personality Settings

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PERSONALITY	RANGE	DEFAULTS (Danfoss)	DEFAULTS (Eaton)
DRIVE:	ACCELeration	0.0 to 5.0s	2.0	2.0
	DECELeration	0.0 to 3.0s	2.0	2.0
	FORward MINimum speed	1 to 35%	4	15
	FORward MAXimum speed	1 to 100%	30	55
	REVerse MINimum speed	1 to 35%	4	15
	REVerse MAXimum speed	1 to 100%	34	55
	ELEVATED MAXimum speed	1 to 100%	15	28
	CREEP MAXimum speed	1 to 90%	15	32
STEER:	MAXimum speed	1 to 100%	100	100
MAIN LIFT:	ACCELeration	0.0 to 5.0s	2.9	2.9
	DECELeration	0.0 to 3.0s	1.0	1.0
	MINimum UP speed	1 to 60%	26	26
	MAXimum UP speed	1 to 100%	88	88
	CREEP maximum UP speed	1 to 65%	62	62
	MINimum DOWN speed	1 to 60%	25	25
	MAXimum DOWN speed	1 to 100%	95	95
	CREEP maximum DOWN speed	1 to 75%	69	69
TOWER LIFT:	ACCELeration	0.0 to 5.0s	2.8	2.8
	DECELeration	0.0 to 3.0s	0.8	0.8
	MINimum UP speed	1 to 60%	53	53
	MAXimum UP speed	1 to 100%	90	90
	MINimum DOWN speed	1 to 60%	53	53
	MAXimum DOWN speed	1 to 100%	90	90
SWING	ACCELeration	0.0 to 5.0s	2.8	2.8
	DECELeration	0.0 to 3.0s	2.5	2.5
	MINimum LEFT speed	1 to 50%	25	25
	MAXimum LEFT speed	1 to 100%	70	70
	CREEP maximum LEFT speed	1 to 65%	62	62
	MINimum RIGHT speed	1 to 50%	25	25
	MAXimum RIGHT speed	1 to 100%	73	73
	CREEP maximum RIGHT speed	1 to 65%	62	62

Table 6-4. Machine Personality Settings

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PERSONALITY	RANGE	DEFAULTS (Danfoss)	DEFAULTS (Eaton)
MAIN TELESCOPE:	ACCELeration	0.0 to 5.0s	3.5	3.5
	DECELeration	0.0 to 3.0s	0.8	0.8
	MINimum IN speed	1 to 65%	40	40
	MAXimum IN speed	1 to 100%	75	75
	MINimum OUT speed	1 to 65%	40	40
	MAXimum OUT speed	1 to 100%	70	70
TOWER TELESCOPE:	ACCELeration	0.0 to 5.0s	1.0	1.0
	DECELeration	0.0 to 3.0s	0.5	0.5
	MINimum IN speed	1 to 65%	45	45
	MAXimum IN speed	1 to 100%	90	90
	MINimum OUT speed	1 to 65%	55	55
	MAXimum OUT speed	1 to 100%	90	90
PLATFORM LEVEL:	ACCELeration	0.0 to 5.0s	2.5	2.5
	DECELeration	0.0 to 3.0s	1.0	1.0
	MINimum UP speed	1 to 65%	45	45
	MAXimum UP speed	1 to 100%	55	55
	MINimum DOWN speed	1 to 65%	45	45
	MAXimum DOWN speed	1 to 100%	55	55
PLATFORM ROTATE:	ACCELeration	0.0 to 5.0s	1.8	1.8
	DECELeration	0.0 to 3.0s	0.5	0.5
	MINimum LEFT speed	1 to 100%	25	25
	MAXimum LEFT speed	1 to 100%	60	60
	MINimum RIGHT speed	1 to 100%	25	25
	MAXimum RIGHT speed	1 to 100%	60	60
JIB LIFT	Lift ACCELeration	0.0 to 5.0s	2.5	2.5
	Lift DECELeration	0.0 to 3.0s	1.0	1.0
	MINimum UP speed	1 to 65%	27	27
	MAXimum UP speed	1 to 100%	50	50
	MINimum down	1 to 65%	26	26
	Max Down	1 to 100%	45	45

Table 6-4. Machine Personality Settings

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PERSONALITY	RANGE	DEFAULTS (Danfoss)	DEFAULTS (Eaton)
GROUND MODE	Tower UP speed	1 to 100%	89	89
	Tower DOWN speed	1 to 100%		
	Main LIFT UP speed	1 to 100%	87	87
	Main LIFT DOWN speed	1 to 100%	94	94
	SWING speed	1 to 100%	65	65
	Main TELEscope speed	1 to 100%	69	69
	Tower TELEscope speed	1 to 100%	89	89
	PLATFORM ROTATE speed	1 to 100%	59	59
	PLATFORM LEVEL speed	1 to 100%	54	54
	JIB LIFT speed	1 to 100%	44	44

NOTE: *Ground Mode speed are automatically limited to being lower than platform speed for a given function.*

NOTE: *Set personalities in the following order: creep speeds, platform speeds, and then ground speeds.*

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6.4 MACHINE ORIENTATION WHEN SETTING FUNCTION SPEEDS

Tower Lift: main Boom Horizontal, Telescoped In. Tower Lift Up, Record Time. Tower Lift Down, Record Time.

Tower Telescope: Tower Lift Fully Elevated, main Boom Horizontal, Telescoped In. Tower Tele Out, Record Time. Tower Tele In, Record Time.

Lift: Tower Lift Fully Elevated, Tower Telescope Fully Extended, Main Telescope Fully Retracted.

Swing: Boom at Full Elevation. Telescope Retracted. Swing the Turntable off center and stop. Swing the opposite direction and start the test when the turntable is centered up. This eliminates ramp up and down on the controller affecting times.

Telescope: Boom at Full Elevation; Telescope Retracted; Telescope Out, Record Time. Telescope In, Record Time.

Drive (Forward/Reverse): Test should be done on a smooth level surface. Drive Select Switch should be set to high speed. Start approximately 25 ft. (7.62 m) from the starting point so that the unit is at maximum speed when starting the test. Results should be recorded for a 200 ft. (60.96 m) course. Drive Forward, Record Time. Drive Reverse, Record Time.

Drive (Above Horizontal): Test should be done on a smooth, level surface. Drive Select Switch should be set to Low Engine, Low Drive. The Platform Speed Control Knob should be positioned to Creep Speed. This simulates machine speed when the boom is above horizontal. Results should be recorded for a 50 ft. (15.2 m) course. Drive Forward, Record Time. Drive Reverse, Record Time.

Platform Rotate: Platform level and completely rotated one direction. Rotate the opposite direction, Record Time. Rotate the other direction, Record Time.

Articulating Jib: Platform level and centered with the boom. Start with the Jib down. Jib Up, Record Time. Jib Down, Record Time.

Test Notes

1. Stop watch should be started with the function, not with the controller or switch.
2. Drive test results reflect 15x19.5 or 18x19.5 tires, pneumatic or foam filled.
3. All speed tests are run from the platform. These speeds do not reflect the ground control operation.
4. The platform speed knob control must be at full speed (turned clockwise completely).
5. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).
6. Some flow control functions may not work with the speed knob clicked into the creep position.

Table 6-5. Function Speeds

Function	Speed (In Seconds)
Main Lift Up	45 - 50
Main Lift Down	45 - 50
Swing Right & Left	79 - 101
NOTE: *Max 10% difference between swing left and swing right.*	
Main Telescope In	24-34
Main Telescope Out	30-40
Platform Rotate Right & Left	19 - 30
NOTE: *Max 15% difference between rotator left and rotator right.*	
Jib Lift Up	20-30
Jib Lift Down	30-40
Tower Lift Up	57 - 70
Tower Lift Down	44 - 53
Tower Telescope Out	24 - 32
Tower Telescope In	15-25
Drive (2WD) Forward	33-45
Drive (4WD) Forward	33-45
Drive Elevated Max (CE) Drive Elevated Max (ANSI)	122 Min 122 Min

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6.5 CANBUS COMMUNICATIONS

CANbus: CAN (Control Area Network) is a two wire differential serial link between the Platform Module, Jib Module, Ground Module, Boom Length Angle Module and the Chassis Module providing bi-directional communications.

Two-wire: One wire (red) is driven high (5v) and the other low (black) (0v) to send a signal; both wires "float" (2.5v) when no signal is being sent.

Differential: Any electrical line noise can affect the high or the low wires but never both, so communications is not corrupted.

Serial Link: Messages are being sent bit by bit along the wires; the high bus speed allow all modules to be constantly updated around 20 times per second. Typical traffic is 300 - 500 messages per second.

A complete CANbus circuit is approximately 60 ohms, which can be verified at the "T" fitting inside the ground station or below the BLAM. Each individual circuit from the modules is approximately 120 ohms.

The GROUND MODULE (UGM) is the master system controller. Most functions are dispatched and coordinated from this module, The PLATFORM MODULE handle sub-tasks. All characterized information (values) are stored into the ground module (i.e., Personalities or Calibrations).

Interlocks: Any device that sends an electrical input. (For an example a limit switch, proximity switch, etc;)

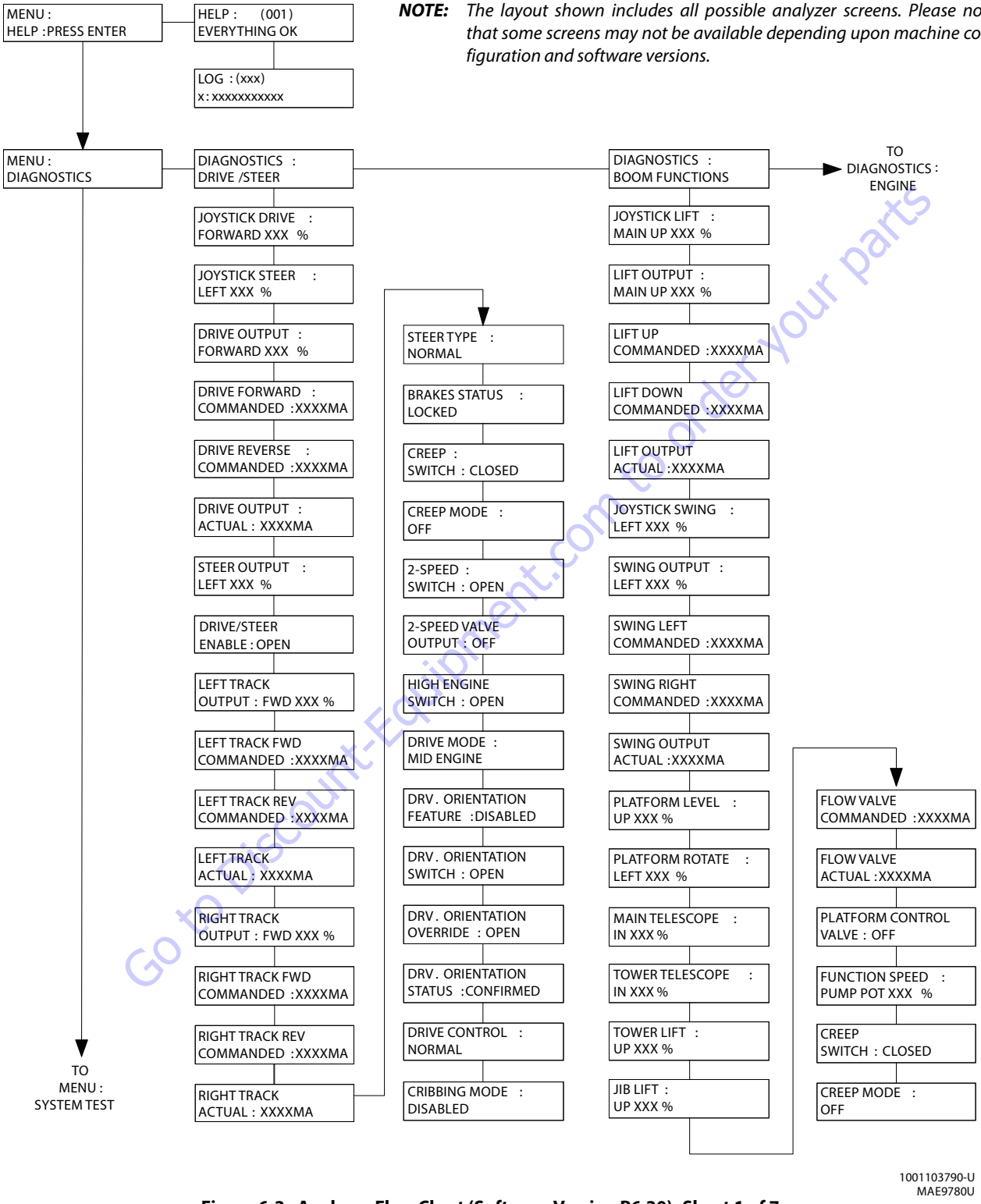
Platform Level: The GROUND MODULE stores the default values and handles interlocks. The PLATFORM MODULE reads the sensors mounted on the platform assembly and controls the Level Up / Down valves to maintain set point sent from the GROUND MODULE.

Steer: The GROUND MODULE stores crack points and sends desired drive direction, steering mode and axle extend/retract commands. The PLATFORM MODULE reports the steering switch position to the GROUND MODULE.

Drive: The GROUND MODULE stores crack points, sends commands for each drive pump. (Command is computed from drive joystick input, interlocks, wheel angle, etc).

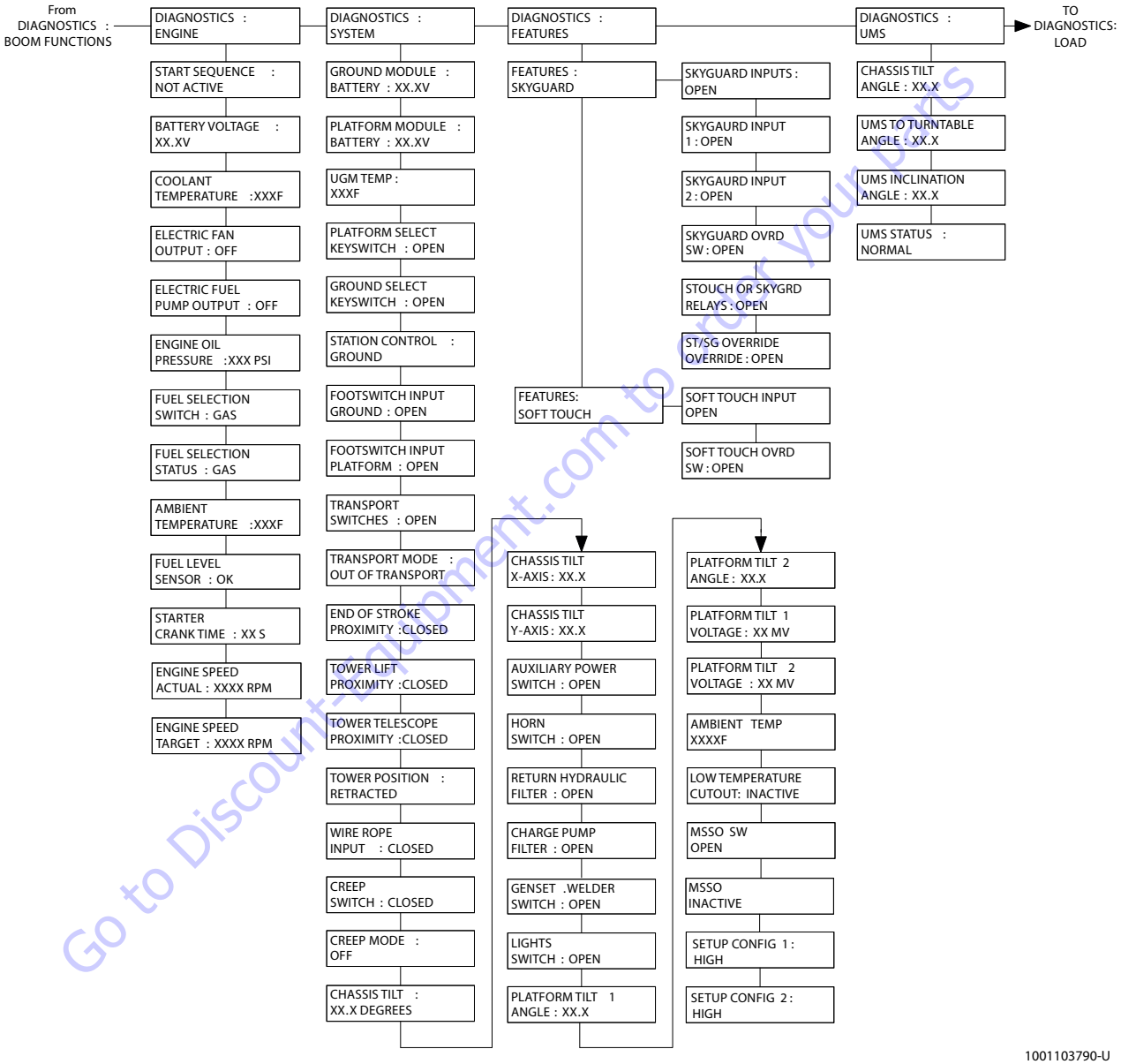
Lift, Tele, & Swing: The GROUND MODULE stores default values and handles interlocks and calibration information. Lift, Telescope and Swing commands are dependent upon interlocks through out the machine. Boom angle, length and swing are controlled by the GROUND MODULE.

NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*



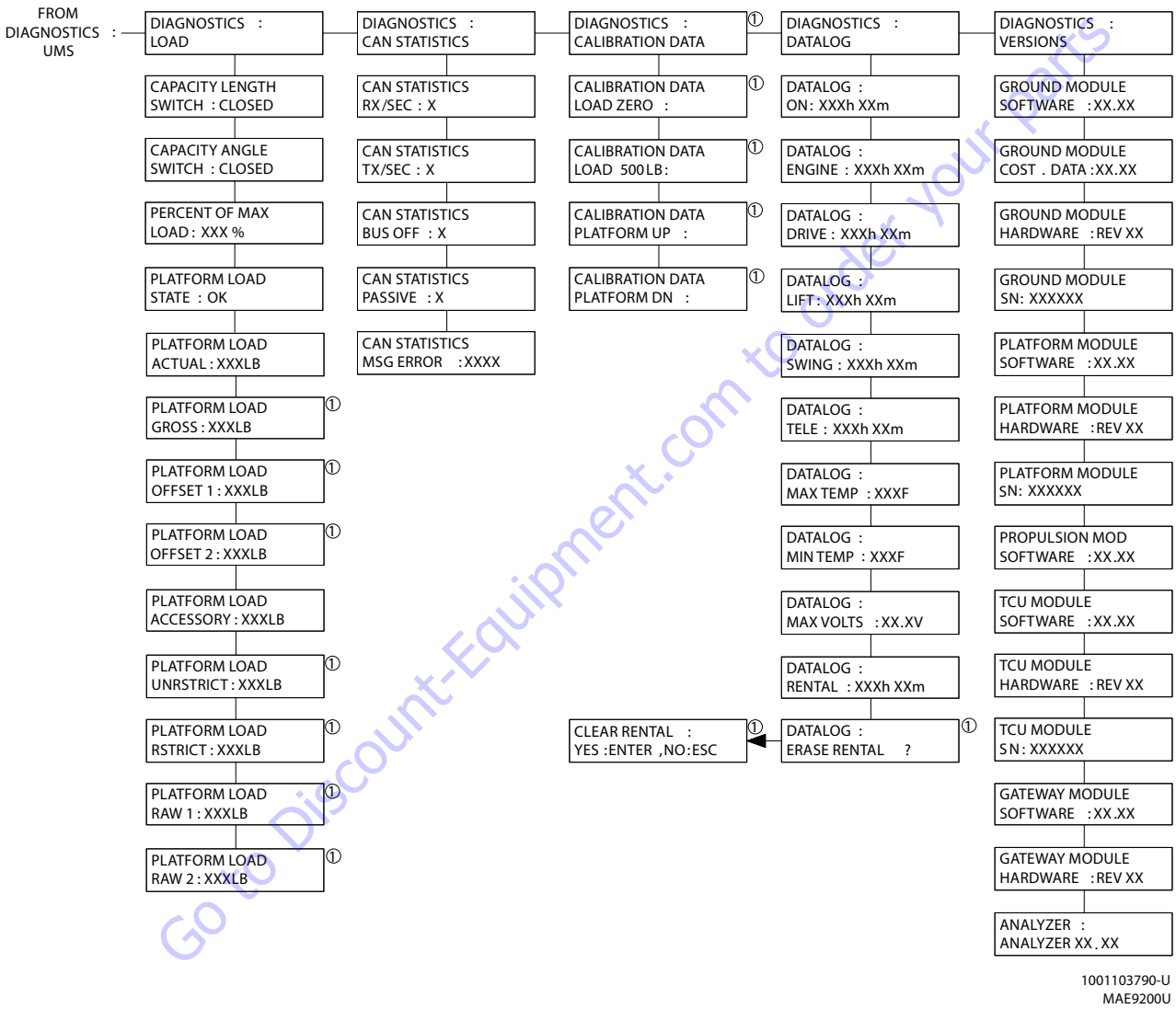
1001103790-U
MAE9780U

Figure 6-3. Analyzer Flow Chart (Software Version P6.30) -Sheet 1 of 7



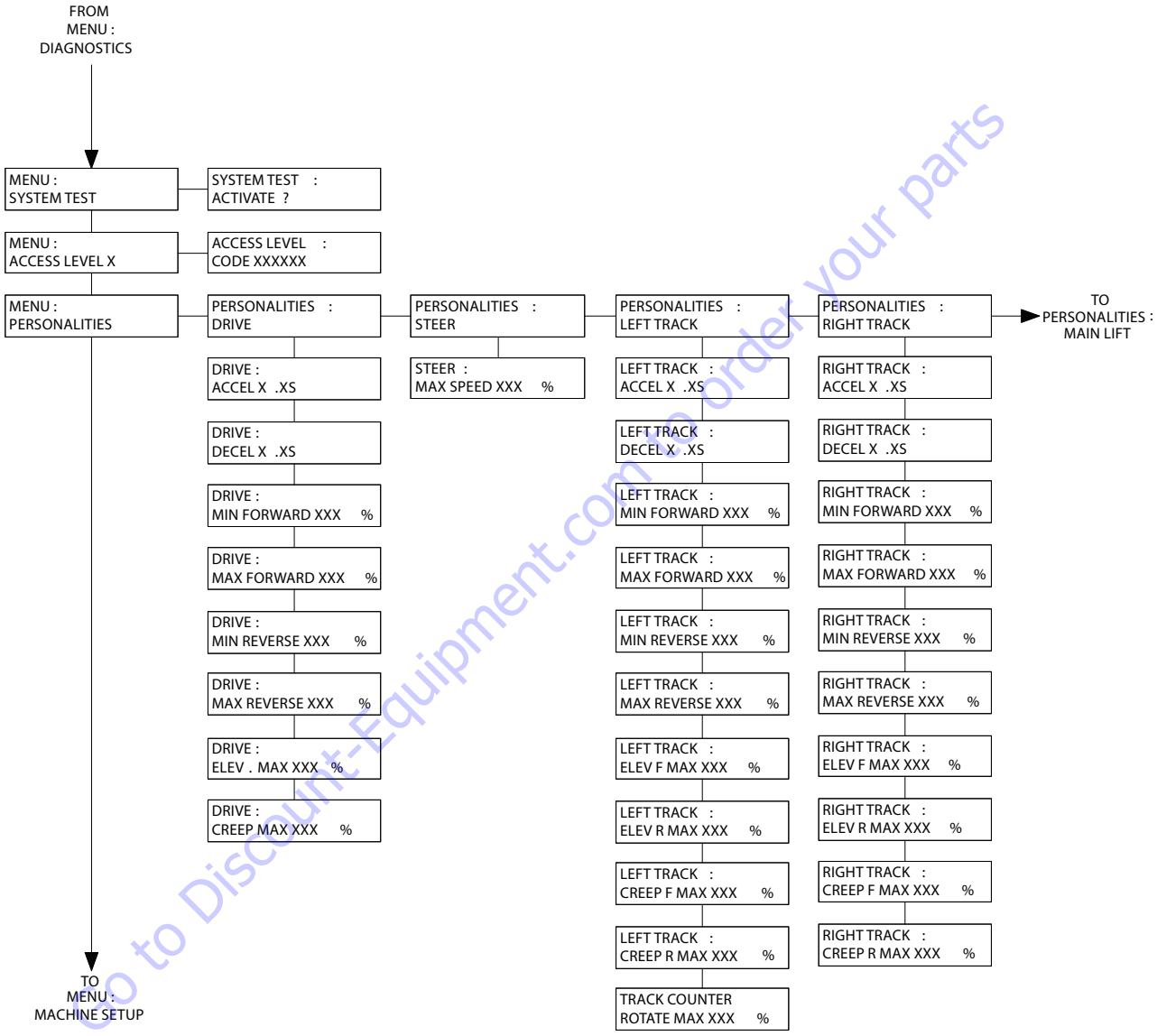
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-4. Analyzer Flow Chart (Software Version P6.30) -Sheet 2 of 7



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

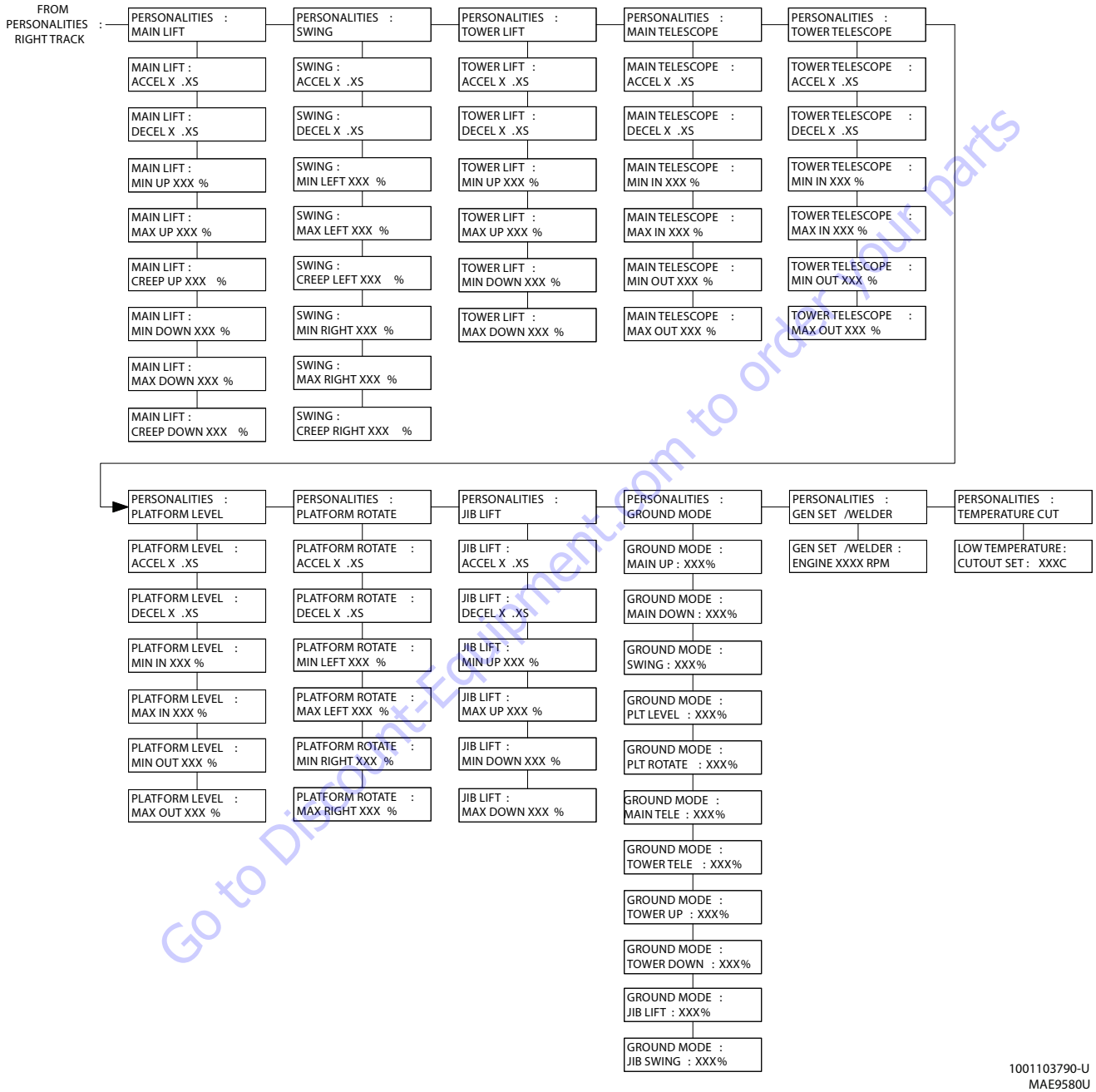
Figure 6-5. Analyzer Flow Chart (Software Version P6.30) -Sheet 3 of 7



1001103790-U
MAE9510U

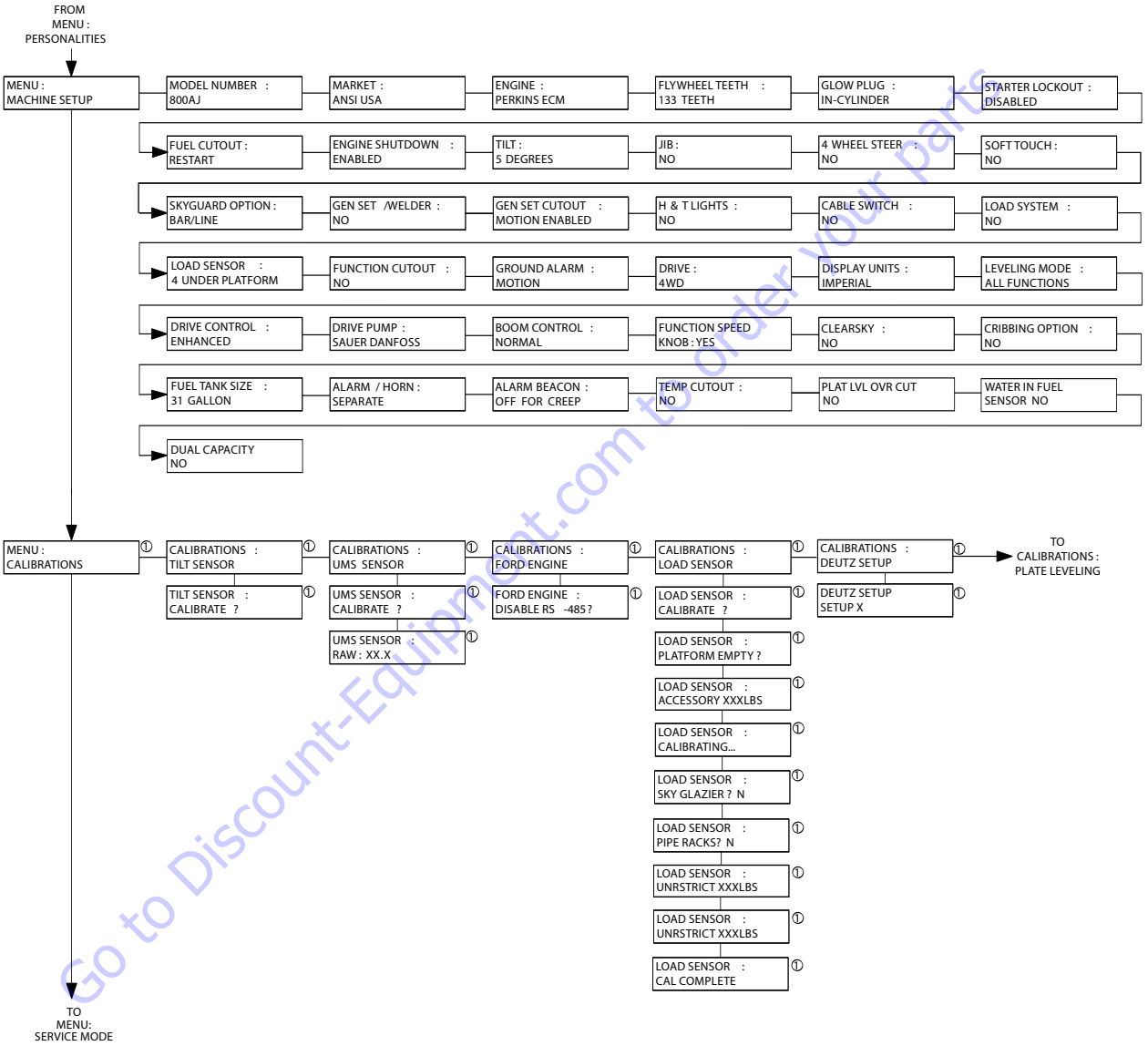
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-6. Analyzer Flow Chart (Software Version P6.30) -Sheet 4 of 7



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

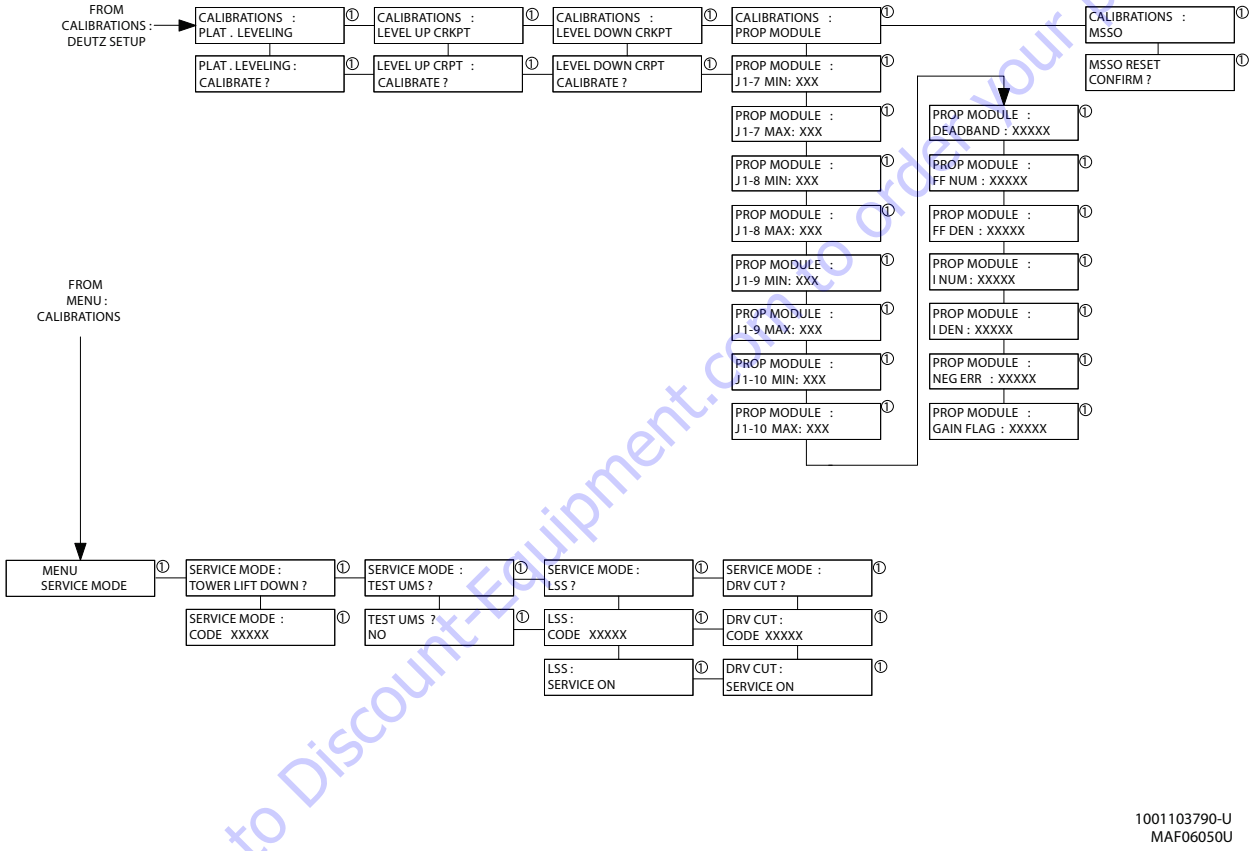
Figure 6-7. Analyzer Flow Chart (Software Version P6.30) -Sheet 5 of 7



1001103790-U
MAE9660U

NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-8. Analyzer Flow Chart (Software Version P6.30) -Sheet 6 of 7



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-9. Analyzer Flow Chart (Software Version P6.30) -Sheet 7 of 7

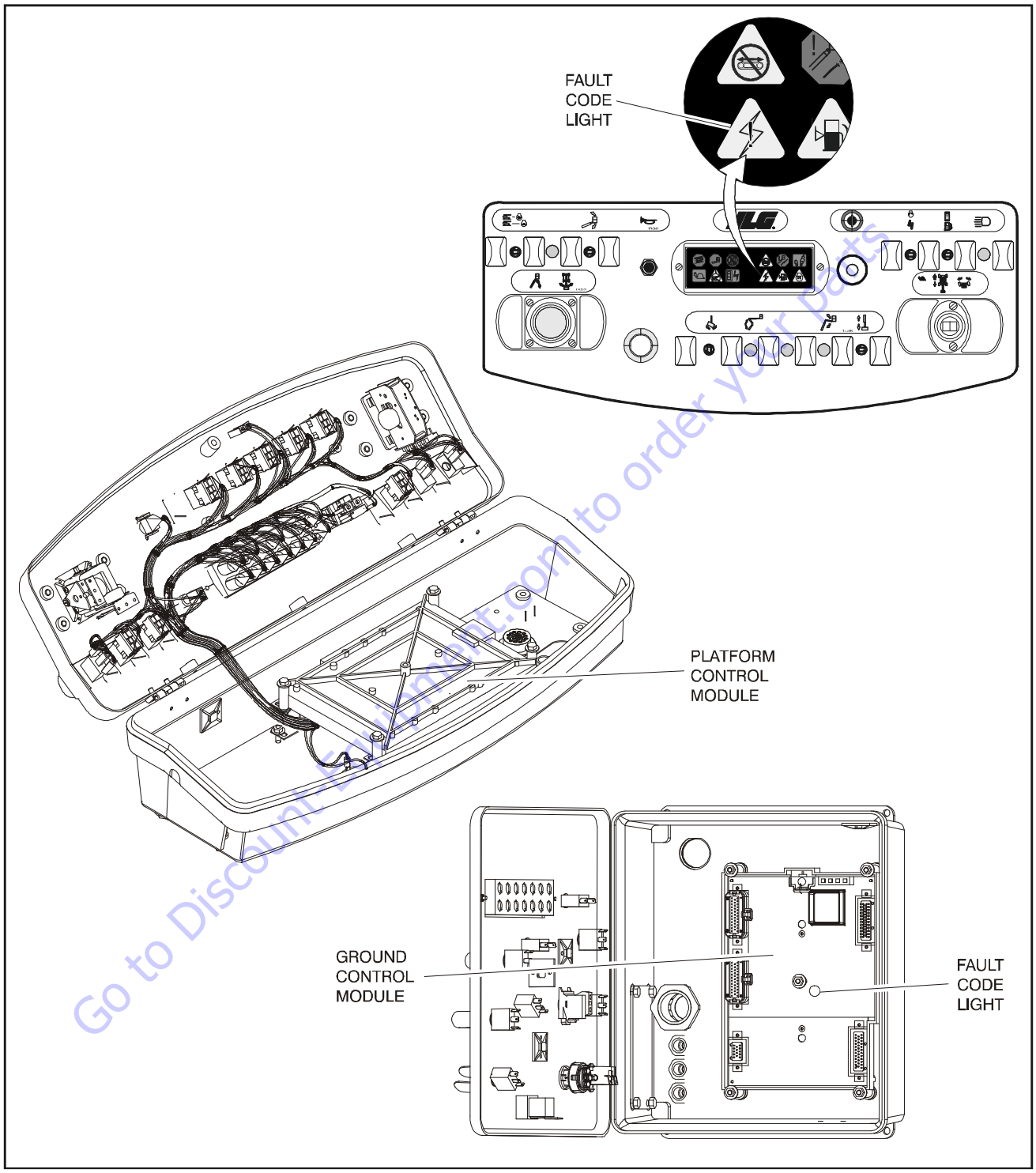
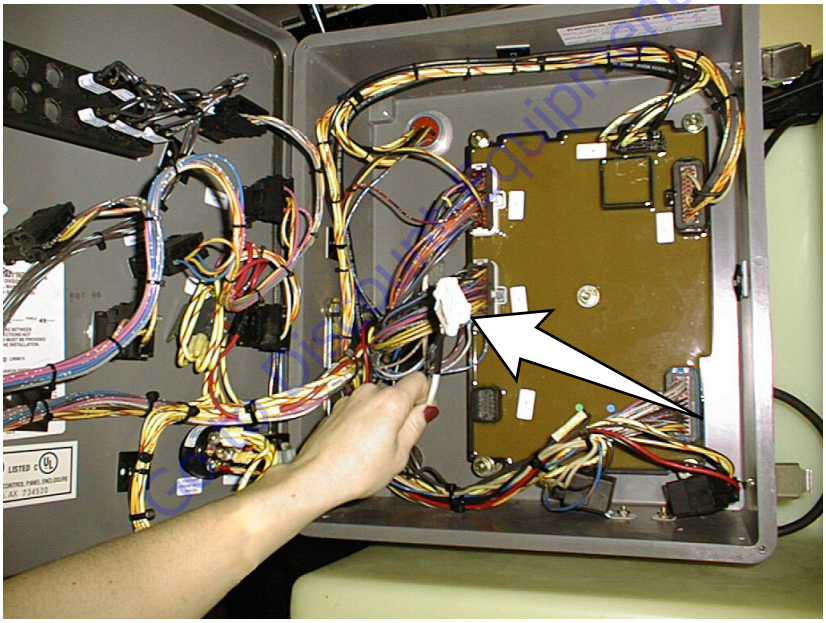


Figure 6-10. Fault Code Light Location

PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 6-11. Analyzer Connecting Points

Connector	Pin	Function	Type	
J1 (Natural)	1	ENGINE THROTTLE ACTUATOR	DIGITAL	OUTPUT
	2	LP START ASSIST	DIGITAL	OUTPUT
	3	DRIVE / LEFT TRACK FORWARD COIL	DIGITAL	OUTPUT
	4	GROUND	GROUND	INPUT
	5	GROUND	GROUND	INPUT
	6	DRIVE / LEFT TRACK REVERSE COIL	DIGITAL	OUTPUT
	7	LP LOCK / ELECTRIC FAN DRIVE	DIGITAL	OUTPUT
	8	GROUND	GROUND	INPUT
	9	GROUND	GROUND	INPUT
	10	IGNITION ON RELAY / ALTERNATOR EXCITATION / FUEL ON SOLENOID	DIGITAL	OUTPUT
	11	START SOLENOID	DIGITAL	OUTPUT
	12	ENGAGE GLOW PLUGS	DIGITAL	OUTPUT
	13	APU ENABLE RELAY	DIGITAL	OUTPUT
	14	ENGINE COOLANT TEMPERATURE	ANALOG	INPUT
	15	ENGINE OIL PRESSURE	ANALOG	INPUT
	16	ENGINE SPEED	FREQUENCY	INPUT
	17	GROUND	GROUND	INPUT
	18	GROUND	GROUND	INPUT
	19	GROUND	GROUND	INPUT
	20	2-SPEED VALVE	DIGITAL	OUTPUT
	21	CHARGE PUMP FILTER BY-PASS	DIGITAL	INPUT
	22	GENERATOR ENABLE RELAY	DIGITAL	OUTPUT
	23	BRAKE VALVE	DIGITAL	OUTPUT
	24	NOT CONNECTED	N/C	N/C
	25	RS-485 HIGH	SERIAL	I/O
	26	RS-485 LOW	SERIAL	I/O
	27	GROUND	GROUND	INPUT
	28	ANALYZER POWER	VOLTAGE	OUTPUT
	29	ANALYZER RS-232 RX	SERIAL	INPUT
	30	ANALYZER RS-232 TX	SERIAL	OUTPUT
	31	ANALYZER GROUND	GROUND	INPUT
	32	ALTERNATOR EXCITATION	DIGITAL	OUTPUT
	33	RS-485 GROUND	GROUND	INPUT
	34	AIR FILTER BY-PASS	DIGITAL	INPUT
	35	NOT CONNECTED	DIGITAL	INPUT

Connector	Pin	Function	Type	
J2 (Gray)	1	STEER DUMP VALVE	DIGITAL	OUTPUT
	2	HORN OUTPUT	DIGITAL	OUTPUT
	3	TOWER TELESCOPE IN SOLENOID	DIGITAL	OUTPUT
	4	MAIN TELESCOPE IN SOLENOID	DIGITAL	OUTPUT
	5	PLATFORM LEVEL UP SOLENOID	DIGITAL	OUTPUT
	6	GROUND	GROUND	INPUT
	7	PLATFORM LEVEL DOWN SOLENOID	DIGITAL	OUTPUT
	8	RIGHT TRACK REVERSE COIL	DIGITAL	OUTPUT
	9	NOT ALLOCATED	DIGITAL	OUTPUT
	10	PLATFORM ROTATE LEFT SOLENOID	DIGITAL	OUTPUT
	11	MAIN LIFT UP SOLENOID	DIGITAL	OUTPUT
	12	JIB UP SOLENOID	DIGITAL	OUTPUT
	13	MAIN DUMP VALVE	DIGITAL	OUTPUT
	14	GROUND	GROUND	INPUT
	15	TOWER TELESCOPE OUT SOLENOID	DIGITAL	OUTPUT
	16	MAIN TELESCOPE OUT SOLENOID	DIGITAL	OUTPUT
	17	GROUND	GROUND	INPUT
	18	GROUND	GROUND	INPUT
	19	RIGHT TRACK FORWARD COIL	DIGITAL	OUTPUT
	20	NOT ALLOCATED	DIGITAL	OUTPUT
	21	PLATFORM ROTATE RIGHT SOLENOID	DIGITAL	OUTPUT
	22	MAIN LIFT DOWN SOLENOID	DIGITAL	OUTPUT
	23	JIB DOWN SOLENOID	DIGITAL	OUTPUT
	24	RETURN FILTER BY-PASS	DIGITAL	INPUT
	25	FUEL LEVEL SENSOR	ANALOG	INPUT
	26	HEAD / TAIL LIGHT ENABLE RELAY	DIGITAL	OUTPUT
	27	ALARM OUTPUT	DIGITAL	OUTPUT
	28	GROUND	GROUND	INPUT
	29	GROUND	GROUND	INPUT
	30	GROUND	GROUND	INPUT
	31	FLOW CONTROL VALVE	DIGITAL	OUTPUT
	32	TOWER LIFT DOWN SOLENOID	DIGITAL	OUTPUT
	33	TOWER LIFT UP SOLENOID	DIGITAL	OUTPUT
	34	SWING LEFT SOLENOID	DIGITAL	OUTPUT
	35	SWING RIGHT SOLENOID	DIGITAL	OUTPUT

Connector	Pin	Function	Type	
J3 (Black)	1	DRIVE / LEFT TRACK CURRENT FEEDBACK	GROUND	INPUT
	2	RIGHT TRACK CURRENT FEEDBACK	GROUND	INPUT
	3	GROUND	GROUND	INPUT
	4	SWING CURRENT FEEDBACK	GROUND	INPUT
	5	NOT CONNECTED	GROUND	INPUT
	6	FLOW CONTROL CURRENT FEEDBACK	GROUND	INPUT
	7	BATTERY VOLTAGE	VBAT	OUTPUT
	8	UMS ANGLE SENSOR	DIGITAL	INPUT
	9	CRIBBING ENGAGE SWITCH	DIGITAL	INPUT
	10	NOT CONNECTED	DIGITAL	INPUT
	11	CONFIGURATION #1	DIGITAL	INPUT
	12	NOT CONNECTED	VOLTAGE	OUTPUT
	13	NOT CONNECTED	ANALOG	INPUT
	14	LIFT CURRENT FEEDBACK	GROUND	INPUT

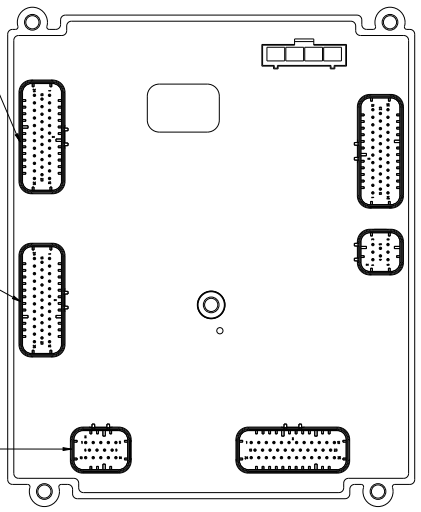


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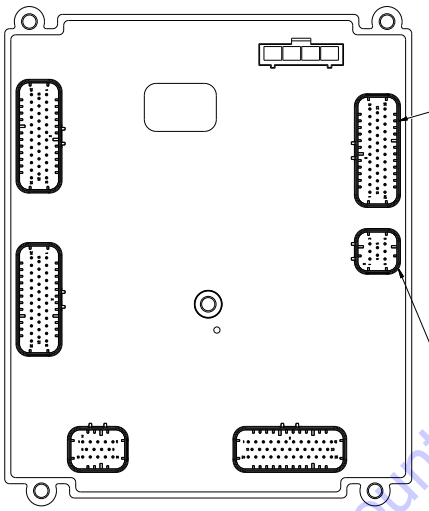
Figure 6-12. Ground Control Module - Sheet 1 of 3



Connector	Pin	Function	Type	
J7 (Black)	1	PLATFORM EMS	DIGITAL	INPUT
	2	PLATFORM MODE	DIGITAL	INPUT
	3	GROUND MODE	DIGITAL	INPUT
	4	CAPACITY ANGLE SWITCH	ANALOG	INPUT
	5	+5 VOLTS	VOLTAGE	OUTPUT
	6	CAN1 TERMINATOR	TERM	I/O
	7	CAPACITY LENGTH SWITCH	ANALOG	INPUT
	8	NOT CONNECTED	ANALOG	INPUT
	9	GROUND	GROUND	INPUT
	10	GROUND	GROUND	INPUT
	11	IN/OUT OF TRANSPORT SWITCHES	DIGITAL	INPUT
	12	BROKEN CABLE SWITCH	DIGITAL	INPUT
	13	CAN1 HIGH	SERIAL	I/O
	14	GROUND MODE POWER TO PLATFORM	DIGITAL	INPUT
	15	FOOTSWITCH	DIGITAL	INPUT
	16	+5 VOLTS	VOLTAGE	OUTPUT
	17	CAN1 TERMINATOR	TERM	I/O
	18	CAN1 SHEILD	GROUND	INPUT
	19	GROUND	GROUND	INPUT
	20	NOT CONNECTED	ANALOG	INPUT
	21	TOWER TELESCOPE PROXIMITY (800A ONLY)/DRIVE ORIENTATION SWITCH	DIGITAL	INPUT
	22	TOWER LIFT PROXIMITY (800A ONLY)	DIGITAL	INPUT
	23	GROUND FUNCTION ENABLE AVAILABLE	DIGITAL	INPUT
	24	CAN1 LOW	SERIAL	I/O
	25	GROUND	GROUND	INPUT
	26	+5 VOLTS	VOLTAGE	OUTPUT
	27	+5 VOLTS	VOLTAGE	OUTPUT
	28	GROUND	GROUND	INPUT
	29	BATTERY VOLTAGE	VBAT	OUTPUT
	30	BATTERY VOLTAGE	VBAT	OUTPUT
	31	BATTERY VOLTAGE	VBAT	OUTPUT
	32	BATTERY VOLTAGE	VBAT	OUTPUT
	33	BATTERY VOLTAGE	VBAT	OUTPUT
	34	BATTERY VOLTAGE (PROPULSION MODULE)	VBAT	OUTPUT
	35	BOOM ANGLE PROXIMITY SWITCH (800S ONLY)/DRIVE ORIENTATION SWITCH	DIGITAL	INPUT

Connector	Pin	Function	Type	
J12 (Black)	1	NOT CONNECTED	FREQUENCY	INPUT
	2	NOT CONNECTED	FREQUENCY	INPUT
	3	CAN2 HIGH (TELEMATICS)	SERIAL	I/O
	4	CAN2 LOW (TELEMATICS)	SERIAL	I/O
	5	CAN2 SHIELD (TELEMATICS)	GROUND	INPUT
	6	CAN2 TERMINATOR	TERM	I/O
	7	CAN2 TERMINATOR	TERM	I/O
	8	MSSO	DIGITAL	INPUT

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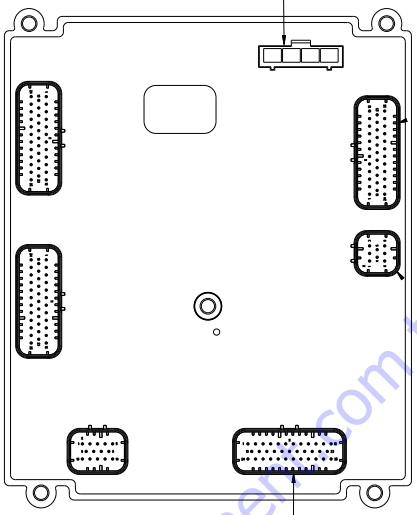
Figure 6-13. Ground Control Module - Sheet 2 of 3

Connector	Pin	Function	Type	
J8 (Black)	1	MODULE GROUND	GROUND	OUTPUT
	2	MODULE POWER	VBAT	INPUT
	3	GROUND TO PLATFORM MODULE	GROUND	INPUT
	4	POWER TO PLATFORM MODULE	VBAT	OUTPUT



Connector	Pin	Function	Type	
J4 (Blue)	1	CRIBBING ENGAGED INDICATOR	DIGITAL	OUTPUT
	2	500 LB CAPACITY LAMP	DIGITAL	OUTPUT
	3	GLOWPLUG INDICATOR	DIGITAL	OUTPUT
	4	ENGINE START	DIGITAL	INPUT
	5	PLATFORM LEVEL DOWN	DIGITAL	INPUT
	6	PLATFORM ROTATE LEFT	DIGITAL	INPUT
	7	MAIN TELESCOPE IN	DIGITAL	INPUT
	8	JIB DOWN	DIGITAL	INPUT
	9	JIB LEFT	DIGITAL	INPUT
	10	TOWER LIFT UP	DIGITAL	INPUT
	11	TOWER TELESCOPE IN	DIGITAL	INPUT
	12	HOURMETER	DIGITAL	OUTPUT
	13	RETURN FILTER BY-PASS LAMP	DIGITAL	OUTPUT
	14	PLATFORM OVERLOADED INDICATOR	DIGITAL	OUTPUT
	15	BOOM MALFUNCTION INDICATOR	DIGITAL	OUTPUT
	16	AUXILIARY POWER / FUNCTION ENABLE	DIGITAL	INPUT
	17	PLATFORM LEVEL UP	DIGITAL	INPUT
	18	PLATFORM ROTATE RIGHT	DIGITAL	INPUT
	19	JIB UP	DIGITAL	INPUT
	20	JIB RIGHT	DIGITAL	INPUT
	21	TOWER LIFT DOWN	DIGITAL	INPUT
	22	TOWER TELESCOPE OUT	DIGITAL	INPUT
	23	MAIN LIFT UP	DIGITAL	INPUT
	24	BATTERY VOLTAGE	VBAT	OUTPUT
	25	BATTERY VOLTAGE - (GROUND ENABLE PRESENT)	VBAT	OUTPUT
	26	BATTERY LOW / NOT CHARGING INDICATOR	DIGITAL	OUTPUT
	27	CHARGE PUMP FILTER BY-PASS LAMP	DIGITAL	OUTPUT
	28	ENGINE HIGH COOLANT TEMPERATURE INDICATOR	DIGITAL	OUTPUT
	29	ENGINE LOW OIL PRESSURE INDICATOR	DIGITAL	OUTPUT
	30	MAIN TELESCOPE OUT	DIGITAL	INPUT
	31	GROUND	GROUND	INPUT
	32	GROUND	GROUND	INPUT
	33	MAIN LIFT DOWN	DIGITAL	INPUT
	34	SWING LEFT	DIGITAL	INPUT
	35	SWING RIGHT	DIGITAL	INPUT

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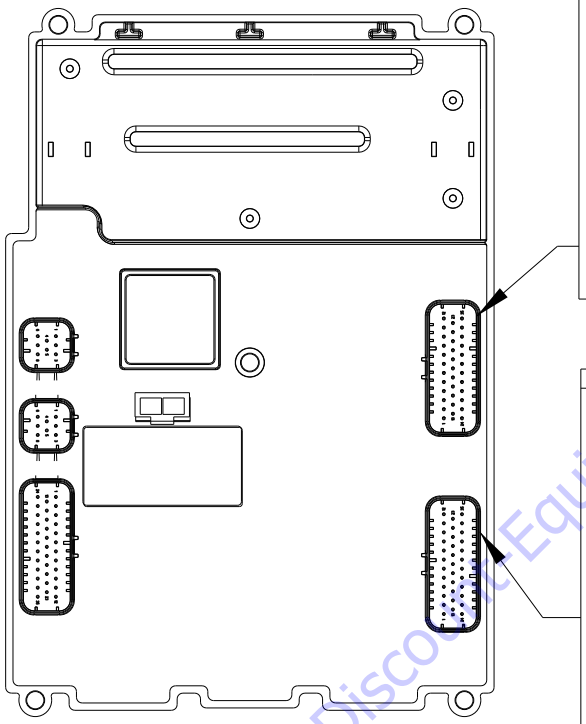
Figure 6-14. Ground Control Module - Sheet 3 of 3



CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J2 GRAY	1	UNALLOCATED	DIGITAL INPUT
	2	UNALLOCATED	DIGITAL INPUT
	3	BATTERY VOLTAGE	HS DIGITAL INPUT
	4	DRIVE ORIENTATION SYSTEM OVERRIDE SWITCH	HS DIGITAL INPUT
	5	UNALLOCATED	LAMP OUTPUT
	6	CHASSIS TILTED INDICATOR	LAMP OUTPUT
	7	FUNCTION ENABLE INDICATOR	LAMP OUTPUT
	8	VEHICLE SYSTEM DISTRESS INDICATOR	LAMP OUTPUT
	9	CREEP SPEED INDICATOR	LAMP OUTPUT
	10	BROKEN CABLE INDICATOR	LAMP OUTPUT
	11	PLATFORM OVERLOADED INDICATOR	LAMP OUTPUT
	12	500 LB CAPACITY INDICATOR	LAMP OUTPUT
	13	1000 LB CAPACITY INDICATOR	LAMP OUTPUT
	14	DRIVE ORIENTATION SYSTEM INDICATOR	LAMP OUTPUT
	15	GENERATOR ON INDICATOR	LAMP OUTPUT
	16	SOFT TOUCH TRIGGERED INDICATOR	LAMP OUTPUT
	17	GLOW PLUG ENGAGED INDICATOR	LAMP OUTPUT
	18	LAMP RETURN	GROUND
	19	DRIVE DISABLED INDICATOR	LAMP OUTPUT
	20	UPRIGHT TILTED INDICATOR	LAMP OUTPUT
	21	LOW FUEL INDICATOR	LAMP OUTPUT
	22	1/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	23	3/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	24	1/2 FUEL LEVEL INDICATOR	LAMP OUTPUT
	25	FUEL LEVEL INDICATORS RETURN	GROUND
	26	ANALYZER POWER	ANALYZER POWER
	27	ANALYZER GROUND	ANALYZER GROUND
	28	ANALYZER RX	ANALYZER RX
	29	ANALYZER TX	ANALYZER TX
	30	BATTERY VOLTAGE	BATTERY VOLTAGE
	31	BATTERY VOLTAGE	BATTERY VOLTAGE
	32	BATTERY VOLTAGE	BATTERY VOLTAGE
	33	BATTERY VOLTAGE	BATTERY VOLTAGE
	34	SWITCH POWER	BATTERY VOLTAGE
	35	FULL FUEL LEVEL INDICATOR	LAMP OUTPUT

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J1 NATURAL	1	TOWER LIFT UP	DIGITAL INPUT
	2	TOWER LIFT DOWN	DIGITAL INPUT
	3	TOWER TELESCOPE IN	DIGITAL INPUT
	4	TOWER TELESCOPE OUT	DIGITAL INPUT
	5	MAIN TELESCOPE IN	DIGITAL INPUT
	6	MAIN TELESCOPE OUT	DIGITAL INPUT
	7	PLATFORM ROTATE RIGHT	DIGITAL INPUT
	8	PLATFORM ROTATE LEFT	DIGITAL INPUT
	9	PLATFORM LEVEL UP	DIGITAL INPUT
	10	PLATFORM LEVEL DOWN	DIGITAL INPUT
	11	JIB UP	DIGITAL INPUT
	12	JIB DOWN	DIGITAL INPUT
	13	SPEED PUMP POTENTIOMETER GROUND	GROUND
	14	ENGINE START	DIGITAL INPUT
	15	AUXILIARY POWER	DIGITAL INPUT
	16	CRAB STEER SELECT	DIGITAL INPUT
	17	COORDINATED STEER SELECT	DIGITAL INPUT
	18	SWITCH POWER	BATTERY VOLTAGE
	19	UNALLOCATED	DIGITAL INPUT
	20	UNALLOCATED	DIGITAL INPUT
	21	UNALLOCATED	DIGITAL INPUT
	22	DRIVE ORIENTATION SYSTEM FEATURE ENABLE	DIGITAL INPUT
	23	UNALLOCATED	DIGITAL INPUT
	24	UNALLOCATED	DIGITAL INPUT
	25	UNALLOCATED	DIGITAL INPUT
	26	UNALLOCATED	DIGITAL INPUT
	27	TWO SPEED VALVE (HIGH ENGINE)	DIGITAL INPUT
	28	TORQUE MODE	DIGITAL INPUT
	29	SOFT TOUCH OVERRIDE	DIGITAL INPUT
	30	HEAD/TAIL LIGHT	DIGITAL INPUT
	31	HORN	DIGITAL INPUT
	32	CREEP MODE	DIGITAL INPUT
	33	DUAL-FUEL SELECT	DIGITAL INPUT
	34	SPEED PUMP POTENTIOMETER REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	35	SPEED PUMP POTENTIOMETER	DIGITAL INPUT

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Figure 6-15. Platform Control Module - Sheet 1 of 2

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J8	1	MODULE GROUND	GROUND
	2	MODULE POWER	BATTERY VOLTAGE

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J5 NATURAL	1	LIFT / SWING JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	LIFT CENTER TAP	INPUT
	3	LIFT SIGNAL	INPUT
	4	SWING SIGNAL	INPUT
	5	SWING CENTER TAP	INPUT
	6	NOT CONNECTED	INPUT
	7	LIFT / SWING JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J6 BLACK	1	DRIVE / STEER JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	DRIVE CENTER TAP	INPUT
	3	DRIVE SIGNAL	INPUT
	4	STEER SIGNAL	INPUT
	5	STEER LEFT	INPUT
	6	STEER RIGHT	INPUT
	7	DRIVE / STEER JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J7 BLACK	1	GROUND MODE	GROUND MODE
	2	PLATFORM EMS	PLATFORM EMS
	3	PLATFORM EMS TO GROUND MODULE	PLATFORM MODE
	4	FOOTSWITCH (FUNCTION ENABLE SWITCH) POWER	BATTERY VOLTAGE
	5	GENERATOR SWITCH POWER	BATTERY VOLTAGE
	6	JIB BLOCK LIMIT SWITCH POWER	BATTERY VOLTAGE
	7	SOFT TOUCH LIMIT SWITCH POWER	BATTERY VOLTAGE
	8	FOOTSWITCH SIGNAL	DIGITAL INPUT
	9	GENERATOR ON SIGNAL	DIGITAL INPUT
	10	+7 REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	11	LOAD CELL INPUT 1	ANALOG INPUT
	12	LOAD CELL INPUT 2	ANALOG INPUT
	13	UNALLOCATED	ANALOG INPUT
	14	GROUND RETURN	GROUND
	15	LOAD CELL REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	16	LOAD CELL RETURN	GROUND
	17	JIB BLOCK LIMIT SWITCH	HS DIGITAL INPUT
	18	SOFT TOUCH LIMIT SWITCH	HS DIGITAL INPUT
	19	PLATFORM ALARM	LAMP OUTPUT
	20	ALARM RETURN	GROUND
	21	PLATFORM LEVEL UP	ME DIGITAL OUTPUT
	22	PLATFORM LEVEL DOWN	ME DIGITAL OUTPUT
	23	GROUND RETURN	GROUND
	24	GROUND RETURN	GROUND
	25	JIB UP	ME DIGITAL OUTPUT
	26	JIB DOWN	ME DIGITAL OUTPUT
	27	UNALLOCATED	ME DIGITAL OUTPUT
	28	UNALLOCATED	ME DIGITAL OUTPUT
	29	GROUND RETURN	GROUND
	30	CAN LOW	CAN LOW
	31	CAN HIGH	CAN HIGH
	32	CAN SHIELD	CAN SHIELD
	33	PLATFORM ROTATE LEFT	ME DIGITAL OUTPUT
	34	PLATFORM ROTATE RIGHT	ME DIGITAL OUTPUT
	35	GROUND RETURN	GROUND

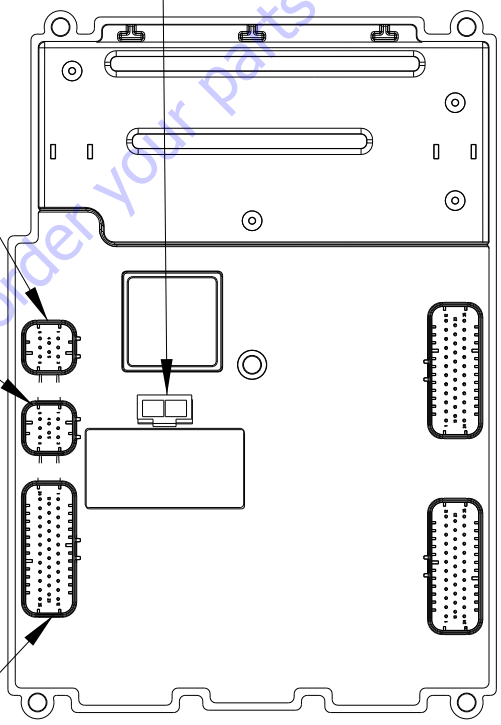

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Figure 6-16. Platform Control Module - Sheet 2 of 2

Analyzer Diagnostics Menu Structure

In the following structure descriptions, an intended item is selected by pressing ENTER; pressing ESC steps back to the next outer level. The LEFT/RIGHT arrow keys move between items in the same level. The UP or DOWN arrow keys alter a value if allowed

Table 6-6. Adjustments - Personality Descriptions

DRIVE	
ACCEL	Displays/adjusts drive acceleration
DECEL	Displays/adjusts drive deceleration
MIN FORWARD	Displays/adjusts minimum forward drive speed
MAX FORWARD	Displays/adjusts maximum forward drive speed
MIN REVERSE	Displays/adjusts minimum reverse drive speed
MAX REVERSE	Displays/adjusts maximum reverse drive speed
ELEVATED MAX	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed
CREEP MAX	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active
STEER MAX	Displays/adjusts the maximum steer speed
LIFT	
ACCEL	Displays/adjusts main lift acceleration
DECEL	Displays/adjusts main lift deceleration
MIN UP	Displays/adjusts minimum main lift up speed
MAX UP	Displays/adjusts maximum main lift up speed
CREEP UP	Displays/adjusts maximum main lift up speed NOTE: used when creep switch on pump pot is active
MIN DOWN	Displays/adjusts minimum main lift down speed
MAX DOWN	Displays/adjusts maximum main lift down speed
CREEP DOWN	Displays/adjusts maximum main lift down speed NOTE: used when creep switch on pump pot is active
SWING	
ACCEL	Displays/adjusts swing acceleration
DECEL	Displays/adjusts swing deceleration
MIN LEFT	Displays/adjusts minimum swing left speed
MAX LEFT	Displays/adjusts maximum swing left speed

Table 6-6. Adjustments - Personality Descriptions

CREEP LEFT	Displays/adjusts maximum swing left speed NOTE: used when creep switch on pump pot is active
MIN RIGHT	Displays/adjusts minimum swing right speed
MAX RIGHT	Displays/adjusts maximum swing right speed
CREEP RIGHT	Displays/adjusts maximum swing right speed NOTE: used when creep switch on pump pot is active
MAIN TELESCOPE	
ACCEL	Displays/adjusts telescope acceleration
DECEL	Displays/adjusts telescope deceleration
MIN IN	Displays/adjusts minimum telescope in speed
MAX IN	Displays/adjusts maximum telescope in speed
MIN OUT	Displays/adjusts minimum telescope out speed
MAX OUT	Displays/adjusts maximum telescope out speed
BASKET LEVEL	
ACCEL	Displays/adjusts basket level acceleration
DECEL	Displays/adjusts basket level deceleration
MIN UP	Displays/adjusts minimum basket level up speed
MAX UP	Displays/adjusts maximum basket level up speed
MIN DOWN	Displays/adjusts minimum basket level down speed
MAX DOWN	Displays/adjusts maximum basket level down speed
BASKET ROTATE	
ACCEL	Displays/adjusts basket rotate acceleration
DECEL	Displays/adjusts basket rotate deceleration
MIN LEFT	Displays/adjusts minimum basket rotate left speed
MAX LEFT	Displays/adjusts maximum basket rotate left speed
MIN RIGHT	Displays/adjusts minimum basket rotate right speed
MAX RIGHT	Displays/adjusts maximum basket rotate right speed
JIB LIFT	Not displayed if JIB = NO
ACCEL	Displays/adjusts jib acceleration
DECEL	Displays/adjusts jib deceleration
MIN UP	Displays/adjusts minimum jib up speed
MAX UP	Displays/adjusts maximum jib up speed
MIN DOWN	Displays/adjusts minimum jib down speed

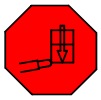
Table 6-6. Adjustments - Personality Descriptions

MAX DOWN	Displays/adjusts maximum jib down speed
MIN LEFT	Displays/adjusts minimum jib left speed
MAX LEFT	Displays/adjusts maximum jib left speed
MIN RIGHT	Displays/adjusts minimum jib right speed
MAX RIGHT	Displays/adjusts maximum jib right speed
STEER	
MAX SPEED	Displays/adjusts maximum steer speed, which applies when vehicle speed is at minimum
GROUND MODE	
LIFT UP	Displays/adjusts fixed lift up speed
LIFT DOWN	Displays/adjusts fixed lift down speed
SWING	Displays/adjusts fixed swing speed
TELE	Displays/adjusts fixed telescope speed
BASKETLEVEL	Displays/adjusts fixed basket level speed
BASKETROTATE	Displays/adjusts fixed basket rotate speed
JIB (U/D)	Displays/adjusts jib lift speed Not displayed if JIB = NO
JIB (L/R)	Displays/adjusts jib swing speed Not displayed if JIB = NO

6.6 LSS SYSTEM

The JLG-designed Load Sensing System (LSS) measures platform load via a sensor mounted in the platform support structure. If the actual platform load exceeds the selected Rated Load, the following will occur:

1. The Overload Visual Warning Indicator will flash at the selected control position (platform or ground).



2. The Platform and Ground Alarms will sound 5 seconds On, and 2 seconds Off.
3. All normal movement will be prevented from the platform control position (optional - ground control functions may be prevented).
4. Further movement is permitted by:
   - **a.** Removing the excess platform load until actual platform load is less than Rated Load.
   - **b.** Operation of the overriding emergency system (Auxiliary Power Unit).
   - **c.** By an authorized person at the ground control position (optional - ground control functions may be prevented).

NOTICE

THE LOAD SENSING SYSTEM MUST BE CALIBRATED WHEN ONE OR MORE OF THE FOLLOWING CONDITIONS OCCUR:

- **a.** LSS Sensor removal or replacement
- **b.** Addition or removal of certain platform mounted accessories. (Refer to Calibration)
- **c.** Platform is removed, replaced, repaired or shows evidence of impact.

NOTICE

THE LOAD SENSING SYSTEM REQUIRES PERIODIC FUNCTION VERIFICATION NOT TO EXCEED 6 MONTHS FROM PREVIOUS VERIFICATION. REFER TO TESTING & EVALUATION.

All calibration procedures are menu driven through the use of a JLG Analyzer.

Diagnostic Menu

The Diagnostic Menu is another troubleshooting tool for the Load Sensing System. Sensor and status information is presented in real-time for the technician. Several sub-menus exist to organize the data.

To access the Diagnostic Menu, use the LEFT and RIGHT Arrow keys to select DIAGNOSTICS from the Top Level Menu. Press the ENTER key to view the menu.

Press the LEFT and RIGHT Arrow keys to view the displays and select the various sub-menus. To access a sub-menu, press the ENTER key. Once in a sub-menu, press the LEFT and RIGHT Arrow keys to view the various displays (just like a Top Level menu). To exit a sub-menu, press the ESC key.

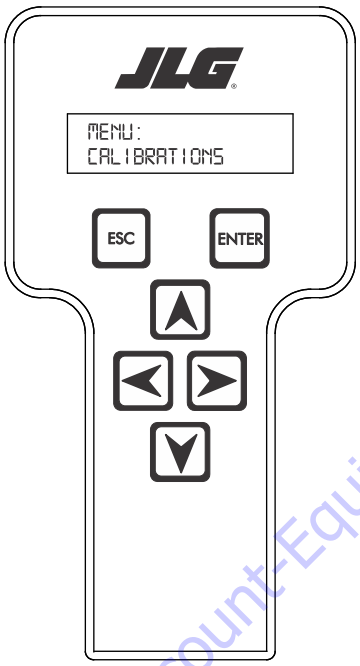
Table 6-7, Diagnostic Menu Descriptions details the structure of the Diagnostic Menu, and describes the meaning of each piece of information presented.

Table 6-7. Diagnostic Menu Descriptions

Diagnostics Menu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
PLATFORM LOAD	STATE:	OK / OVERLOAD	LSS Status.
PLATFORM LOAD	ACTUAL:	XXX.X KG	Calibrated weight of the platform. ??? if Platform Load is Unhealthy**.
PLATFORM LOAD (service*)	GROSS:	XXX.X KG	Gross weight of the platform. ??? if both Cells are Unhealthy**.
PLATFORM LOAD (service*)	OFFSET 1:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	OFFSET 2:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	ACCESSORY	XXX.X KG	Stored accessory weight. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	UNRESTRICT	XXX.X KG	UGM will set Unrestricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RESTRICT	XXX.X KG	UGM will set Restricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RAW 1:	XXX.X KG	Gross value from Cell 1. ??? if Unhealthy**.
PLATFORM LOAD (service*)	RAW 2:	XXX.X KG	Gross value from Cell 2. ??? if Unhealthy**.
* Indicates only visible in service view mode ** Typically indicates a DTC is active			

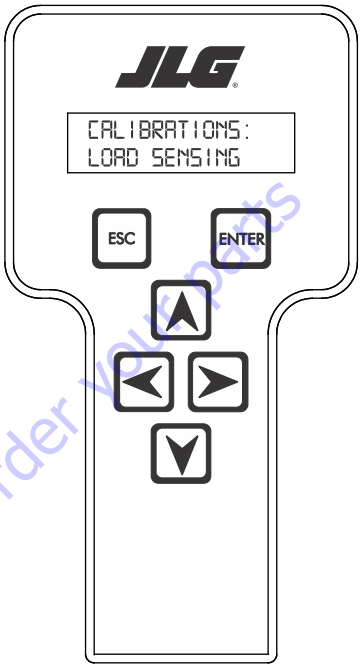
Calibration Procedure

1. Remove everything from the platform, except permanently fixed JLG Accessories, to allow the Load Sensing System to record its' weight during calibration. This includes all tools, debris, and customer-installed devices.
2. Plug the JLG Analyzer into the Machine at the Ground Station and enter Service Access Password 33271.
3. The platform should be approximately level for calibration. Level the platform from ground control (if necessary) to within +/- 5°.
4. To access the Calibration Menu, use the LEFT and RIGHT Arrow keys to select CALIBRATION from the Top Level Menu. The screen will read:

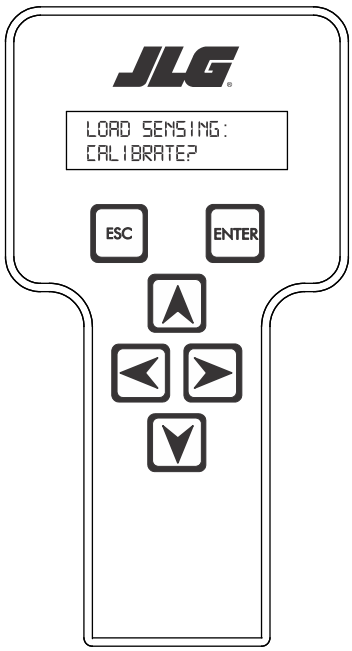


NOTE: *The Calibration Menu is not available in OPERATOR ACCESS.*

5. Press the ENTER key ENTER to view the menu. Upon entry to the Calibration Menu, the JLG Control System will link to the Analyzer and the screen will read:



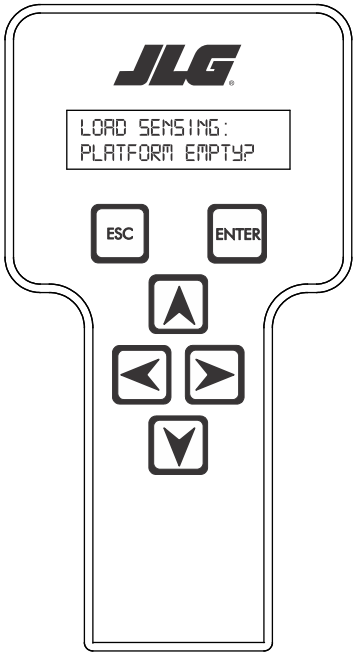
6. Press Enter ENTER. The Screen will read:



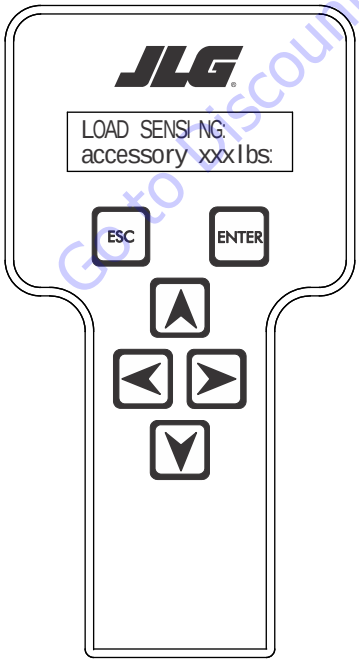
NOTE: *Calibration will auto fail if LSS DTC's are active (443, 444, 4479, 4480, 663, 821, 822, 823, 824, 8218, 8222 -> 8238, 991, 992, 993, 994 or 99285).*

Pressing the ESC key [ESC] after starting calibration and before calibration is complete will display the CAL FAILED message. This will not disturb the prior calibration information.

7. Press ENTER [ENTER]. The analyzer screen will read:



8. If the platform is empty, press ENTER [ENTER]. The screen will read:



NOTE: *Accessory weight will reset to 0 lb each time the machine is re-calibrated and will need to be re-entered.*

NOTE: *The Accessory weight will be temporarily stored in the Control System until calibration has been completed successfully.*

Refer to Table 6-8, Accessory Weights. Use the up and down analyzer keys to enter the accessory weight(s) (in lbs). When all the accessory weights are entered, press ENTER [ENTER]. The screen will read:

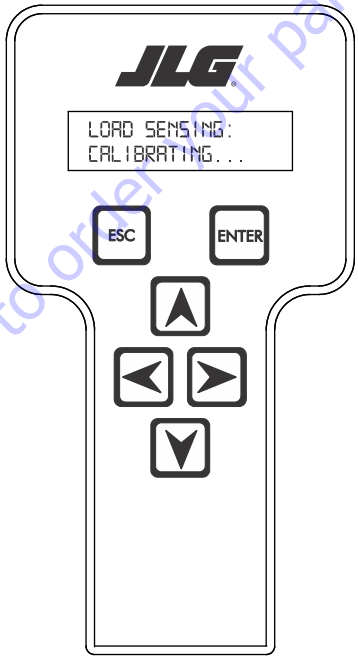


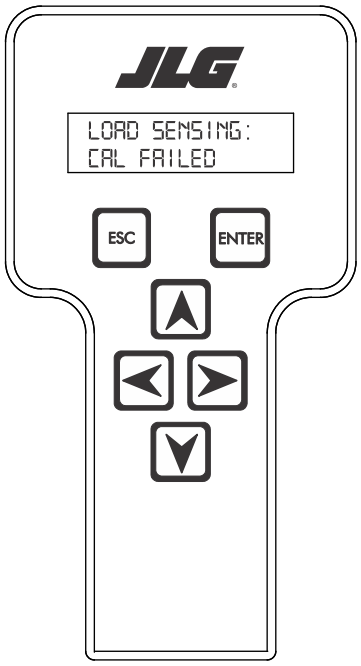
Table 6-8. Accessory Weights

Accessory	Weight
SkyWelder (stick welder)	70 lb (32 kg)
SkyWelder Prep	Prep only = 15 lb (7 kg) Full install = 70 lb (32 kg)
SkyCutter (plasma cutter)	70 lb (32 kg)
SkCutter / SkyWelder Combo	140 lb (64 kg)
Fire Extinguisher	45 lb (20 kg)
Overhead SoftTouch	80 lb (36 kg)
Work Surface	20 lb (9 kg)

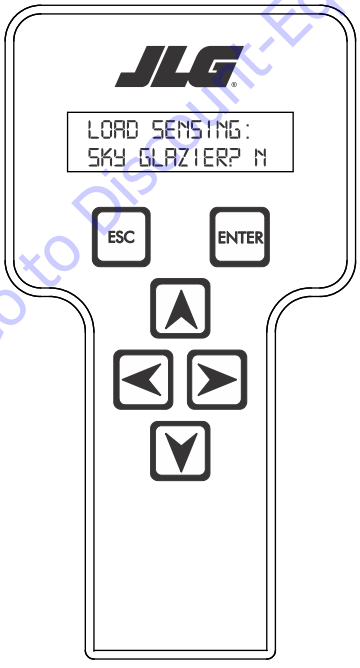
NOTE: *Not all Accessories are available on every JLG model. Some Accessory combinations are prohibited due to excessive weight and/or load restriction. If any installed JLG Accessories are labeled with weight decals but are not listed in the table above, include their weight when entering the ACC WEIGHT value.*

9. The control system will calculate the load cell readings and ensure it is greater than 130 lb (59 kg), but less than 575 lb (261 kg).

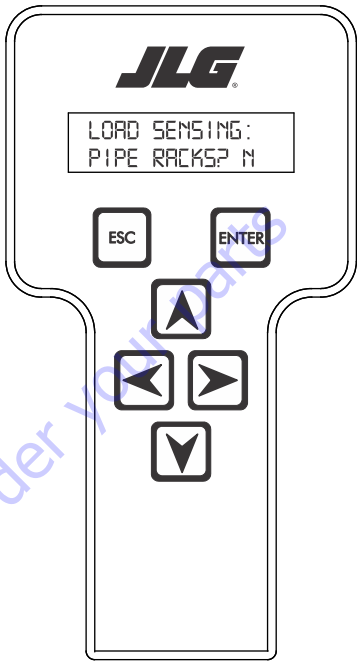
If the platform weight is not within the allowed range, the calibration attempt will be unsuccessful and the Analyzer will show the following:



10. Press ENTER (ENTER). The control system will ask for installed accessories. The screen will show the following:



11. Use the analyzer keys to select N for no or Y for yes. Press ENTER (ENTER). The screen will read:



12. Use the analyzer keys to select N for no or Y for yes. Press ENTER (ENTER). The control system will default to an estimate of unrestricted capacity, which can be adjusted if necessary. Refer to Table 6-9, SkyGlazier Capacity Reductions and Table 6-10, Pipe Rack Capacity Reductions.

The screen will read:

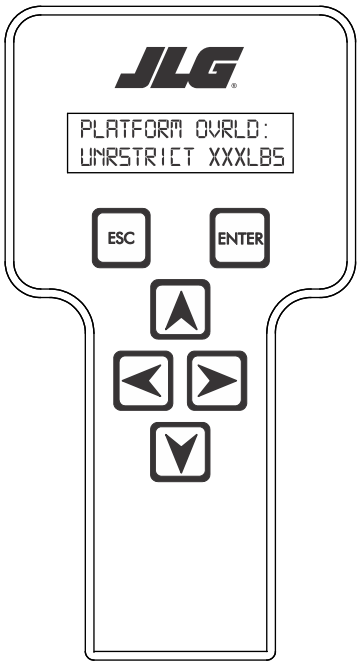


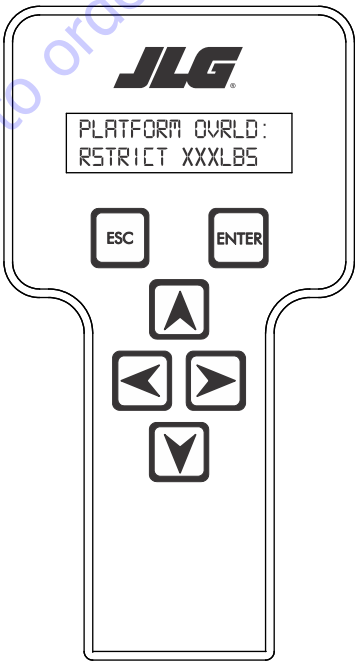
Table 6-9. SkyGlazier Capacity Reductions

Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	400 lb (181 kg)	n/a
600 lb (272 kg)	400 lb (181 kg)	n/a
750 lb (340 kg)	n/a	590 lb (268 kg)
1000 lb (454 kg)	n/a	750 lb (340 kg)
Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.		

Table 6-10. Pipe Rack Capacity Reductions

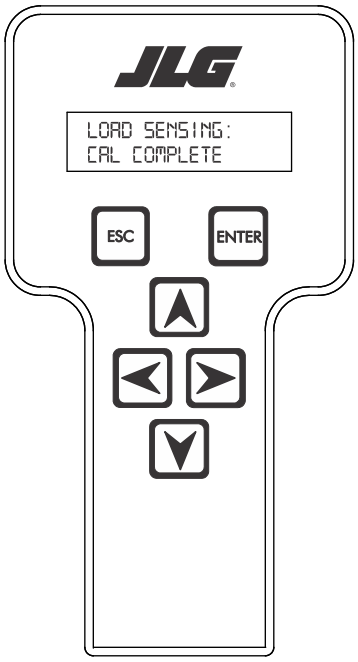
Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	450 lb (204 kg)	n/a
600 lb (272 kg)	500 lb (227 kg)	n/a
750 lb (340 kg)	n/a	650 lb (295 kg)
1000 lb (454 kg)	n/a	900 lb (408 kg)
Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.		

13. Press ENTER (ENTER). The following screen will be displayed for restricted capacity, which can be adjusted if necessary. Refer to Table 6-9, SkyGlazier Capacity Reductions and Table 6-10, Pipe Rack Capacity Reductions.



14. Press ENTER 

. If calibration is successful, the screen will read:



Testing & Evaluation

Refer to Troubleshooting if the Load Sensing System fails to meet these guidelines.

1. Connect the JLG Analyzer.
2. Level the Platform. The platform should be approximately level for analysis, or the guidelines below will not be applicable. Level the platform from Ground Control (if necessary) to within ±5 degrees.
3. Observe the Empty Platform Weight. Proceed to the DIAGNOSTICS, PLTLOAD sub-menu and observe the measured platform load. All tools, debris, and customer-installed devices shall be removed during evaluation. Ideally, the PLTLOAD should be zero but can vary ±15lb (± 7kg). Further, the reading should be stable and should not vary by more than ±2lb (±1kg) (unless there is heavy influence from wind or vibration).
4. Use the Technician's Weight to Evaluate. The technician should enter the platform and record the PLTLOAD reading while standing in the center of the platform.
5. Confirm Control System Warnings and Interlocks. Using the keyswitch, select Platform Mode and power-up. Start the vehicle's engine and ensure that all controls are functional and the Load Sensing System's Overload Visual and Audible Warnings are not active. Simulate an Overload by unplugging the Shear Beam Load Cell. The Overload Visual Warning should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, and 2 seconds Off. With the engine running, all control should be prevented. Cycle the Platform EMS to stop the engine and then power-up again. The Overload Visual and Audible Warning should continue. Confirm that controls are responsive when using the Auxiliary Power Unit for emergency movement. Reconnect the Load Cell. The Overload Visual and Audible Warnings should cease and normal control function should return. Switch the vehicle's keyswitch to Ground Mode and repeat the above procedure. The Overload Visual Warning at the Ground Controls should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, 2 seconds Off. However, the controls should remain functional when using the engine and the Auxiliary Power Unit (if the Control System's MACHINE SETUP, LOAD is set to "2=CUTOUT PLT". If set to "3=CUTOUT ALL", then Ground Controls will be prevented when using the engine as in the platform).
6. Confirm Control System Capacity Indication (optional for vehicles with Dual Capacity Ratings). For vehicles equipped with a Capacity Select switch on the Platform Console Box, it is necessary to examine an additional interface between the Load Sensing System and the Control System. Using the keyswitch, select Platform Mode and power-up. If necessary, put the boom in the transport position (completely stowed) and center the Jib Plus (if equipped). Place the Capacity Select switch in the unrestricted position and ensure that the proper indicator illuminates on the Platform Console Box. Plug the JLG Analyzer into the Analyzer connection and proceed to the DIAGNOSTICS, SYSTEM submenu. Ensure that the CAPACITY displays indicate OFF. Place the Capacity Select switch in the unrestricted position (if so equipped) and ensure that the proper indicator illuminates on the Platform Console Box (but does not flash). For vehicles with unrestricted capacity, ensure that the unrestricted CAPACITY display indicates ON but the restricted CAPACITY indicates OFF. For vehicles with restricted capacity, ensure that the unrestricted CAPACITY display indicates OFF but the restricted CAPACITY indicates ON.
7. Confirm Load Sensing System Performance with Calibrated Weights. Operate the vehicle from Ground Control and place the boom in the transport position (fully stowed) for safety. Plug the JLG Analyzer into the control system connection and proceed to the DIAGNOSTICS, PLTLOAD display. Place 500lb (230kg) in the platform and ensure that PLTLOAD is with ±5% of the actual weight. For Dual Capacity vehicles, do the same for the alternate capacity (unrestricted or restricted).

Troubleshooting

The following tables are furnished to provide possible resolutions for common difficulties. Difficulties are classified as General, Calibration, Measurement Performance, and Host System Functionality.

Table 6-11. LSS Troubleshooting Chart

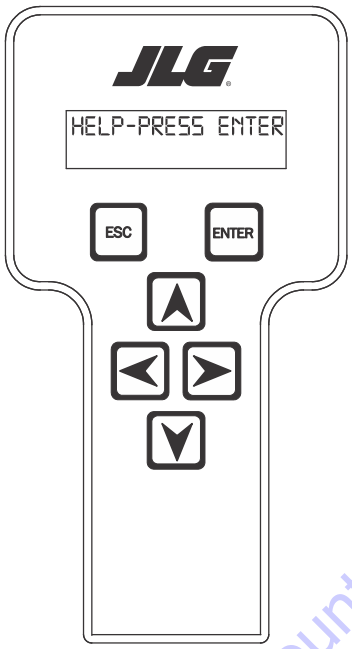
Difficulty	Possible Resolution
Empty Platform Weight (DIAGNOSTICS, PLATFORM LOAD) is not within ±15lb (±7kg) of zero. or Platform Load readings (DIAGNOTICS, PLTLOAD) are unstable by more than ±2lb (±1kg) (without the influence of vibration or wind). or There are large variations in Platform Load (DIAGNOSTICS, PLTLOAD) based on the location of the load. Tolerance to variations is 20lb for an evaluation using the technician's weight, and ±5% of Rated Load when using calibrated weights.	The LSS System is unable to properly measure the platform weight. 1. The Load Cell is not properly plugged into the LSS Harness. It is possible poor electrical contact is made. 2. Wiring leading to the Load Cell is damaged. Carefully inspect sensor wiring where it passes through cable clamps for signs of damage. Inspect wiring where damage to the channel is apparent. 3. The Load Cell was not assembled properly during installation. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable. It is often helpful to apply slight downward pressure above the sensor and observe that its output increases (increasing force measurement; decreasing means the sensor is mounted upside-down). 4. The Load Cell is contaminated by debris or moisture. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable and stable (not changing by more than ±2lb (±1kg) (without the influence of vibration or wind). Lack of measurement stability is a key indication of contamination. Unplug the connector and inspect for dirt or moisture. Look carefully into the female connector on the sensor's cordset for evidence of contamination. Debris should be brushed away with a soft bristle brush (do not introduce any cleaners as they will leave conductive residue). Moisture should be allowed to evaporate or accelerated with a heat-gun (use low heat and be carefully to not melt connector materials). Moisture intrusion into the molded portion of the connector (capillary action into the wire bundle) or the Shear Beam Load Cell itself will require replacement of the sensor. 5. The Load Cell has been mechanically damaged. If the Load Cell is physically deformed or has damage to the cover it should be replaced immediately. It is also possible to have invisible mechanical damage resulting from an extreme overload (>6000lb [>2722kg]).
The Visual and Audible Overload Warnings fail to sound when platform is loaded beyond Rated Load, or when simulated by unplugging the Load Cell. Controls remain functional at Platform and Ground Control positions.	The Control System is failing to regard the overload signal from the LSS System, or the signal is shorted. 1. The Load Sensing System must be enabled within the Control System. Plug the JLG Analyzer into the Control System, enter the Access Level 1 password (33271), and examine the MACHINE SETUP, LOAD sub-menu. The selection "2=CUTOUT PLT" should be displayed (platform controls prevented during overload, ground controls remain operational). In country- or customer-specific circumstance, the selection "3=CUTOUT ALL" is used (platform and ground controls prevented during overload).
The Ground Audible Warning fails to sound, but the Platform Audible Warning sounds properly.	The Ground Alarm is missing or improperly installed. Verify that the device is mounted. Verify wiring from the Main Terminal Box and Ground Module.
Controls remain functional at the Ground Control position during an overload, or when simulated by unplugging the Load Cell. The Controls at the Platform Control position are prevented when using the engine, but not when using the Auxiliary Power Unit.	The JLG Control System is configured to prevent platform controls only in the event of overload. Alternately, the Host Control System can be configured to prevent ground and platform controls for country- or customer-specific circumstances. Using the JLG Analyzer, enter the Access Level 1 password (33271). Proceed to the MACHINE SETUP, LOAD sub-menu. Set this parameter to "2=CUTOUT PLT" to prevent platform controls in the event of overload. Set this parameter to "3=CUTOUT ALL" to prevent platform and ground controls in the event of overload.

6.7 RESETTING THE MSSO SYSTEM

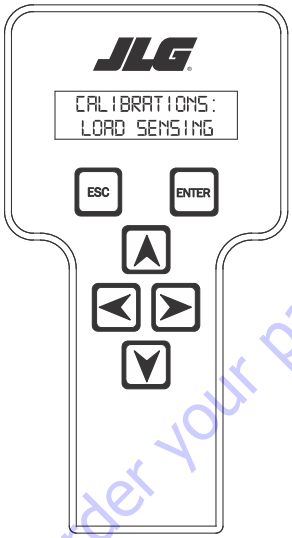
1. Use the following procedure to reset the MSSO system.
2. Position the Platform/Ground select switch to the desired position.
3. Plug the analyzer into the connector coming from the ground control module or from the platform console.

NOTE: *If performing the procedure from the platform console, the Emergency Stop switch on the ground console must also be pulled out.*

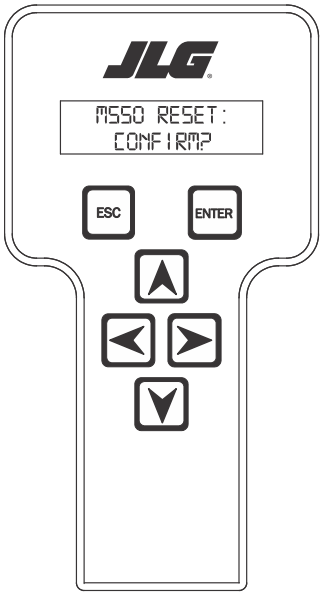
4. Pull out the Emergency Stop switch.
5. The analyzer screen should read:



6. Use the arrow button to reach OPERATOR ACCESS. Press Enter ENTER.
7. Enter the Access Code, 33271.
8. Use the right Arrow key to reach MENU: CALIBRATIONS. Press Enter ENTER.
9. Use the arrow keys to reach the LOAD SENSING menu. The screen should read:



10. Press ENTER ENTER.
11. Use the Down arrow to reach MSSO RESET.Press Enter ENTER. The screen will read:



12. Press Enter ENTER. The JLG Control System will reset an active 873 DTC and the MSSO System will be reset. Press Escape ESC to return to the CALIBRATIONS menu.

6.8 DIAGNOSTIC TROUBLE CODES (DTC)

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
001	00	1	EVERYTHING OK	The normal help message in Platform Mode.	No response required for this DTC.
002	00	2	GROUND MODE OK	The normal help message in Platform Mode.	No response required for this DTC.
0010	00	10	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION	Drive speed is limited to "ELEVATED MAX" while the vehicle is out of transport position.The normal help message in Ground Mode.	Response described in Drive Modes section.
000	**00**	**0**	**<<< HELP COMMENT >>>**		
0011	00	11	FSW OPEN (Foot switch open)	A drive / boom function was selected with the Footswitch open.	The UGM shall not Enable the Machine.
0012	00	12	RUNNING AT CREEP - CREEP SWITCH OPEN	All functions at creep while the Creep Switch is open.	The UGM shall limit the machine to Creep speed.
0013	00	13	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	All functions at creep while the Platform is elevated and the Chassis is tilted.	
0014	00	14	CHASSIS TILT SENSOR OUT OF RANGE	The Chassis is tilted > 19 degrees for more then 4 seconds.	Not reported during power-up.
0015	00	15	LOAD SENSOR READING UNDER WEIGHT	The Load Sensing System indicates > 20% under calibrated zero point.	
0031	00	31	FUEL LEVEL LOW - ENGINE SHUTDOWN	Engine Shutdown has occurred due to Fuel Level = EMPTY condition.	Response described in Fuel Shutdown section.
0035	00	35	APU ACTIVE	Auxiliary Power/Emergency Descent Mode is active.	Response described in Auxiliary Power/Emergency Descent Mode section.
0039	00	39	SKYGUARD ACTIVE - FUNCTIONS CUTOUT	Response described in Auxiliary Power/ Emergency Descent Mode section.	Response described in Sky-Guard section.
0040	00	40	RUNNING AT CREEP - CREEP SWITCH CLOSED	All Function speeds are limited to creep because the creep switch is closed.	
210	**21**	**0**	**<<< POWER-UP >>>**		
211	21	1	POWER CYCLE	The normal help message is issued at each power cycle.	
212	21	2	KEYSWITCH FAULTY	Both Platform and Ground modes are selected simultaneously.	The UGM shall assume a station selection of Ground.
213	21	3	FSW FAULTY	Both Footswitches are closed for more then one second.	The UGM shall not Enable the Machine.
220	**22**	**0**	**<<< PLATFORM CONTROLS >>>**		
227	22	7	STEER SWITCHES FAULTY	Both Steer Left and Steer Right inputs are closed simultaneously.	The UGM shall prohibit Steer; The UGM shall limit Drive to Creep The Steer Left switch input = Low; The Steer Right switch input = Low; Steer and full Drive speed permitted after controls are initialized

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
2211	22	11	FSW INTERLOCK TRIPPED	The Footswitch was closed for more then seven seconds.	Can be reported during power- up.
2212	22	12	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A drive function was selected with Foot-switch open.	Can be reported during power- up.
2213	22	13	STEER LOCKED - SELECTED BEFORE FOOTSWITCH	A steer function was selected with Foot-switch open.	The UGM shall not Enable the Machine.
2214	22	14	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE	Drive/Steer was selected before Enable switch activated.	
2216	22	16	D/S JOY. OUT OF RANGE HIGH	The D/S Joystick reference voltage is > 8.1V.	Resistive joysticks. If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2217	22	17	D/S JOY. CENTER TAP BAD	The D/S Joystick center tap voltage is < 3.08V or > 3.83V.	Resistive joysticks. - There is a +/-.1V range. around these values due to resistor tolerances.
2219	22	19	L/S JOY. OUT OF RANGE HIGH	The L/S Joystick reference voltage is > 8.1V.	Resistive joysticks. - If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2220	22	20	L/S JOY. CENTER TAP BAD	The L/S Joystick center tap voltage is < 3.08V or > 3.83V.	Resistive joysticks. - There is a +/- .1V range. around these values due to resistor tolerances.
2221	22	21	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A lift / swing function was selected with Footswitch open.	If triggered by the Lift and/or Swing joystick not being in the neutral position at Startup, the UGM shall pro-hibit Lift and Swing. If triggered by Lift and/or Swing joystick is not in the neutral position when Foot-switch becomes active or while DTC 2212, 2213 or 2223 is active, the UGM shall not Enable the Machine.
2222	22	22	WAITING FOR FSW TO BE OPEN	The Footswitch was closed during Platform selection.	Can be reported during power- up.
2223	22	23	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE	A boom function was selected with Foot-switch open.	The UGM shall not Enable the Machine.
2224	22	24	FOOTSWITCH SELECTED BEFORE START	The Footswitch was closed during engine start.	The UGM shall prohibit Engine Start.
2269	22	69	FUNCTION PROBLEM - HIGH SPEED & CREEP ACTIVE TOGETHER		

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
234	23	4	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	A boom function has both directions selected together.	Disable whichever boom functions whose boom control inputs are triggering the fault. If Engine Start/Aux at fault, disable Engine Start but permit Auxiliary Power/ Emergency Descent.
235	23	5	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER	A boom function was selected before aux power.	
236	23	6	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH	A boom function was selected before engine start.	
237	23	7	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH	The Start Switch was closed during power-up.	The UGM shall prohibit Engine Start.
23163	23	163	FUNCTION PROBLEM - MSSO PERMANENTLY SELECTED	The MSSO switch input = Low at Startup.	No response required for this DTC Power Cycled.
240	**24**	**0**	**<<< OTHER CONTROLS >>>**		
241	24	1	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE LOW	MACHINE SETUP > TEMP CUTOUT = YES; Ambient Temperature sensor reading - 50C.	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; If the Machine is in Ground Mode; No response required for this DTC.
242	24	2	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE HIGH	Ambient Temperature sensor reading ≥ 85C.	Check Ambient Temperature sensor reading < 85C.
250	**25**	**0**	**<<< FUNCTION PREVENTED >>>**		
259	25	9	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS	The model selection has been changed.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
2513	25	13	GENERATOR MOTION CUTOUT ACTIVE	Driving is not possible while the vehicle generator is running AND is configured to prevent drive.	The UGM shall not Enable the Machine.
2514	25	14	BOOM PREVENTED - DRIVE SELECTED	Boom functions are not possible while the vehicle is being driven AND is configured to not allow simultaneous drive & boom operation.	The UGM shall prohibit all boom functions.
2516	25	16	DRIVE PREVENTED - ABOVE ELEVATION	Driving is not possible while Boom functions are selected AND is configured to not allow simultaneous drive & boom operation.	The UGM shall prohibit Drive and Steer.
2517	25	17	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	Driving is not possible while the vehicle is tilted and above elevation AND is configured to prevent drive while tilted and above elevation.	The UGM shall prohibit Drive and Steer.

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
2518	25	18	DRIVE PREVENTED - BOOM SELECTED	MACHINE SETUP > FUNCTION CUTOUT = BOOM CUTOUT The boom is Above Elevation Any boom function is already active The operator attempts to activate Drive or Steer.	The UGM shall prohibit Drive and Steer.
2519	25	19	DRIVE PREVENTED - TILTED & EXTENDED OR HIGH ANGLE	Drive Selected while tilted and extended and tilt is configured to cutout drive.	
2520	25	20	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER		
2530	25	30	UMS SENSOR FORWARD LIMIT REACHED	The Upright angle relative to the turntable is less than -4.0 degree.	See Section 4.13 "Ums Troubleshooting and Diagnostic Trouble Codes (DTC)"
2531	25	31	UMS SENSOR OUT OF USABLE RANGE	Both the turntable tilt sensor and the UMS sensor read greater then +/-10 degree in the same direction.	See Section 4.13 "Ums Troubleshooting and Diagnostic Trouble Codes (DTC)"
2532	25	32	UMS SENSOR BACKWARD LIMIT REACHED	The Upright angle relative to the turntable is greater than +2.5 degree.	See Section 4.13 "Ums Troubleshooting and Diagnostic Trouble Codes (DTC)"
2563	25	63	SKYGUARD SWITCH - DISAGREEMENT	MACHINE SETUP > SKYGUARD = YES; Machine is in Platform Mode; [(SkyGuard input #1 Platform Module J7-18) ≠ (SkyGuard input #2 Platform Module J1-23)] > 160ms	Response detailed in Sky-Guard section.
2568	25	68	TEMPERATURE CUTOUT ACTIVE - AMBIENT TEMPERATURE TOO LOW	Low Temperature Cutout = Active	If the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
2576	25	76	PLATFORM LEVEL PREVENTED - ABOVE ELEVATION	Platform Level Override Cutout = Enabled; The Platform Level Up or Down switch input = High; Footswitch is active.	The UGM shall suspend Platform Level Up and Down commands; The UGM shall prohibit Platform Level Up and Down
2577	25	77	DRIVE PREVENTED - START BATTERY CONNECTED	Start battery is connected	Check the battery.
330	**33**	**0**	**<<< GROUND OUTPUT DRIVER >>>**		
331	33	1	BRAKE - SHORT TO BATTERY	There is a Short to Battery to the Brake Valve.	Check Harness for damage.
332	33	2	BRAKE - OPEN CIRCUIT	There is an Open Circuit to the Brake Valve.	Check Harness for damage.
3311	33	11	GROUND ALARM - SHORT TO BATTERY	There is a Short to Battery to the Ground Alarm.	Ground Alarm equipped vehicles only.
3336	33	36	ALTERNATOR POWER - SHORT TO GROUND	There is a Short to Ground to the Alternator/ECM.	Check Harness for damage.
3340	33	40	AUX POWER - SHORT TO GROUND	There is a Short to Ground to the Auxiliary Power Pump Relay.	Check Harness for damage.
3341	33	41	AUX POWER - OPEN CIRCUIT	There is an Open Circuit to the Auxiliary Power Pump Relay.	Check Harness for damage.

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3342	33	42	AUX POWER - SHORT TO BATTERY	There is a Short to Battery to the Auxiliary Power Pump Relay.	Check Harness for damage.
3346	33	46	ELECTRIC FAN - SHORT TO GROUND	There is a short to ground to the Electric Fan.	Check Harness for damage.
3347	33	47	ELECTRIC FAN - OPEN CIRCUIT	There is an Open Circuit to the Electric Fan.	Check Harness for damage.
3348	33	48	ELECTRIC FAN - SHORT TO BATTERY	There is a Short to Battery to the Electric Pump.	Check Harness for damage.
3349	33	49	ELECTRIC PUMP - SHORT TO GROUND	There is a Short to Ground to the Pump Relay.	Check Harness for damage.
3350	33	50	ELECTRIC PUMP - OPEN CIRCUIT	There is an Open Circuit to the Pump Relay.	Check Harness for damage.
3351	33	51	ELECTRIC PUMP - SHORT TO BATTERY	There is a Short to Battery to the Pump Relay.	Check Harness for damage.
3352	33	52	LP LOCK - SHORT TO GROUND	There is an Open Circuit to the LP Lock.	Check Harness for damage.
3353	33	53	LP LOCK - OPEN CIRCUIT	There is an Open Circuit to the LP Lock.	Check Harness for damage.
3354	33	54	LP LOCK - SHORT TO BATTERY	There is a short to Battery to the LP Lock.	Check Harness for damage.
3355	33	55	LP START ASSIST - SHORT TO GROUND	There is a short to ground to the LP Start Assist.	Check Harness for damage.
3356	33	56	LP START ASSIST - OPEN CIRCUIT	There is an Open Circuit to the LP Start Assist.	Check Harness for damage.
3357	33	57	LP START ASSIST - SHORT TO BATTERY	There is a short to battery to the LP Start Assist.	Check Harness for damage.
3358	33	58	MAIN DUMP VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Dump Valve.	Check Harness for damage.
3359	33	59	MAIN DUMP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Dump Valve.	Check Harness for damage.
3360	33	60	MAIN DUMP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Dump Valve.	Check Harness for damage.
3361	33	61	BRAKE - SHORT TO GROUND	There is a Short to Ground to the Brake Valve.	Check Harness for damage.
3362	33	62	START SOLENOID - SHORT TO GROUND	There is a Short to Ground to the Start Relay.	Check Harness for damage.
3363	33	63	START SOLENOID - OPEN CIRCUIT	There is an Open Circuit to the Start Relay.	Check Harness for damage.
3364	33	64	START SOLENOID - SHORT TO BATTERY	There is a Short to Battery to the Start Relay.	Check Harness for damage.
3365	33	65	STEER DUMP VALVE - SHORT TO GROUND	There is a Short to Ground to the Steer Dump Valve.	Check Harness for damage.
3366	33	66	STEER DUMP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Steer Dump Valve.	Check Harness for damage.
3367	33	67	STEER DUMP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Steer Dump Valve.	Check Harness for damage.
3368	33	68	TWO SPEED VALVE - SHORT TO GROUND	There is a Short to Ground to the Two Speed Valve.	Check Harness for damage.
3369	33	69	TWO SPEED VALVE - OPEN CIRCUIT	There is an Open Circuit to the Two Speed Valve.	Check Harness for damage.

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3370	33	70	TWO SPEED VALVE - SHORT TO BATTERY	There is a Short to Battery to the Two Speed Valve.	Check Harness for damage.
3371	33	71	GROUND ALARM - SHORT TO GROUND	There is a Short to Ground to the Ground Alarm.	Check Harness for damage.
3372	33	72	GROUND ALARM - OPEN CIRCUIT	There is an Open Circuit to the Ground Alarm.	Check Harness for damage.
3373	33	73	GEN SET/WELDER - SHORT TO GROUND	There is a Short to Ground to the Generator Relay.	Check Harness for damage.
3374	33	74	GEN SET/WELDER - OPEN CIRCUIT	There is an Open Circuit to the Generator Relay.	Check Harness for damage.
3375	33	75	GEN SET/WELDER - SHORT TO BATTERY	There is a Short to Battery to the Generator Relay.	Check Harness for damage.
3376	33	76	HEAD TAIL LIGHT - SHORT TO GROUND	There is a Short to Ground to the Head Light Relay.	Check Harness for damage.
3377	33	77	HEAD TAIL LIGHT - OPEN CIRCUIT	There is an Open Circuit to the Head Light Relay.	Check Harness for damage.
3378	33	78	HEAD TAIL LIGHT - SHORT TO BATTERY	There is a Short to Battery to the Head Light Relay.	Check Harness for damage.
3379	33	79	HOUR METER - SHORT TO GROUND	There is a Short to Ground to the Hour Meter.	Check Harness for damage.
3382	33	82	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Valve	Check Harness for damage.
3383	33	83	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
3384	33	84	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Up Valve	Check Harness for damage.
3388	33	88	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Down Valve	Check Harness for damage.
3389	33	89	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
3390	33	90	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Down Valve	Check Harness for damage.
3394	33	94	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Left Valve.	Check Harness for damage.
3395	33	95	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Left Valve.	Check Harness for damage.
3396	33	96	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Left Valve.	Check Harness for damage.
3397	33	97	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Right Valve.	Check Harness for damage.
3398	33	98	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Right Valve.	Check Harness for damage.
3399	33	99	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Right Valve.	Check Harness for damage.
33100	33	100	JIB LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Up Valve.	Check Harness for damage.
33101	33	101	JIB LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Up Valve.	Check Harness for damage.

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33102	33	102	JIB LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Up Valve.	Check Harness for damage.
33103	33	103	JIB LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Down Valve.	Check Harness for damage.
33104	33	104	JIB LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Down Valve.	Check Harness for damage.
33105	33	105	JIB LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Down Valve.	Check Harness for damage.
33106	33	106	TOWER LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift Up Valve.	Check Harness for damage.
33107	33	107	TOWER LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift Up Valve.	Check Harness for damage.
33108	33	108	TOWER LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift Up Valve.	Check Harness for damage.
33109	33	109	TOWER LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift Down Valve.	Check Harness for damage.
33110	33	110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift Down Valve.	Check Harness for damage.
33111	33	111	TOWER LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift Down Valve.	Check Harness for damage.
33112	33	112	TOWER TELESCOPE IN VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope In Valve.	Check Harness for damage.
33113	33	113	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Telescope In Valve.	Check Harness for damage.
33114	33	114	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope In Valve.	Check Harness for damage.
33115	33	115	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope Out Valve.	Check Harness for damage.
33116	33	116	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Telescope Out Valve.	Check Harness for damage.
33117	33	117	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope Out Valve.	Check Harness for damage.
33118	33	118	SWING RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Right Valve.	Check Harness for damage.
33119	33	119	SWING RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Right Valve.	Check Harness for damage.
33120	33	120	TELESCOPE IN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Telescope In Valve.	Check Harness for damage.
33121	33	121	SWING RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Swing Right Valve.	Check Harness for damage.
33122	33	122	SWING LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Left Valve.	Check Harness for damage.
33123	33	123	TELESCOPE OUT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Telescope Out Valve.	Check Harness for damage.
33130	33	130	THROTTLE ACTUATOR - SHORT TO GROUND	There is a Short to Ground to the Throttle Actuator.	Check Harness for damage.
33131	33	131	THROTTLE ACTUATOR - OPEN CIRCUIT	There is an Open Circuit to the Throttle Actuator.	Check Harness for damage.

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33132	33	132	THROTTLE ACTUATOR - SHORT TO BATTERY	There is a Short to Battery to the Throttle Actuator.	Check Harness for damage.
33170	33	170	LIFT DOWN VALVE - OPEN CIRCUIT	There is a Short to Ground to the Lift Down Valve.	Check Harness for damage.
33171	33	171	LIFT DOWN VALVE - SHORT TO BATTERY	There is an Open Circuit to the Lift Down Valve.	Check Harness for damage.
33172	33	172	LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Battery to the Lift Down Valve.	Check Harness for damage.
33175	33	175	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Left Valve.	Check Harness for damage.
33176	33	176	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Left Valve.	Check Harness for damage.
33177	33	177	JIB ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Left Valve.	Check Harness for damage.
33178	33	178	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Right Valve.	Check Harness for damage.
33179	33	179	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Right Valve.	Check Harness for damage.
33180	33	180	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Right Valve.	Check Harness for damage.
33182	33	182	LIFT VALVES - SHORT TO BATTERY	There is a Short to Battery to the Lift Valves.	Check Harness for damage.
33186	33	186	TELESCOPE OUT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope Out Valve.	Check Harness for damage.
33188	33	188	TELESCOPE OUT VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope Out Valve.	Check Harness for damage.
33189	33	189	TELESCOPE IN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope In Valve.	Check Harness for damage.
33190	33	190	TELESCOPE IN VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope In Valve.	Check Harness for damage.
33207	33	207	HORN - OPEN CIRCUIT	There is an Open Circuit to the Horn.	Check Harness for damage.
33208	33	208	HORN - SHORT TO BATTERY	There is a Short to Battery to the Horn.	Check Harness for damage.
33209	33	209	HORN - SHORT TO GROUND	There is a Short to Ground to the Horn.	Check Harness for damage.
33279	33	279	GLOWPLUG - OPEN CIRCUIT	There is an Open Circuit to the Glow Plugs.	Check Harness for damage.
33280	33	280	GLOWPLUG - SHORT TO BATTERY	There is a Short to Battery to the Glow Plugs.	Check Harness for damage.
33281	33	281	GLOWPLUG - SHORT TO GROUND	There is a Short to Ground to the Glow Plugs.	Check Harness for damage.
33287	33	287	LIFT - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33295	33	295	SWING LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Left Valve.	Check Harness for damage.
33306	33	306	SWING LEFT VALVE - SHORT TO BATTERY	There is short to Battery to the Swing Left Valve.	Check Harness for damage.
33314	33	314	FLOW CONTROL VALVE - OPEN CIRCUIT	There is an Open Circuit to the Flow Control Valve.	Check Harness for damage.
33315	33	315	FLOW CONTROL VALVE - SHORT TO BATTERY	There is short to Battery to the Flow Control Valve	Check Harness for damage.
33316	33	316	FLOW CONTROL VALVE - SHORT TO GROUND	There is short to Ground to the Flow Control Valve	Check Harness for damage.
33317	33	317	DRIVE FORWARD VALVE - OPEN CIRCUIT	There is an Open Circuit to the Drive Forward Valve.	Check Harness for damage.
33318	33	318	DRIVE FORWARD VALVE - SHORT TO BATTER	There is short to Battery to the Drive Forward Valve.	Check Harness for damage.
33319	33	319	DRIVE FORWARD VALVE - SHORT TO GROUND	There is short to Gropund to the Drive Forward Valve.	Check Harness for damage.
33320	33	320	DRIVE REVERSE VALVE - OPEN CIRCUIT	There is an Open Circuit to the Drive Reverse Valve.	Check Harness for damage.
33321	33	321	DRIVE REVERSE VALVE - SHORT TO BATTERY	There is a short to Battery to the Drive Reverse Valve.	Check Harness for damage.
33322	33	322	DRIVE REVERSE VALVE - SHORT TO GROUND	There is a short to Ground to the Drive Reverse Valve.	Check Harness for damage.
33323	33	323	LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Lift Up Valve.	Check Harness for damage.
33324	33	324	LIFT UP VALVE - SHORT TO BATTERY	There is a short to Battery to the Lift Up Valve.	Check Harness for damage.
33325	33	325	LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Lift Up Valve.	Check Harness for damage.
33331	33	331	DRIVE - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33410	33	410	DRIVE - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33412	33	412	SWING VALVES - SHORT TO BATTERY	There is a short to Battery to the Swing Valves.	Check Harness for damage.
33414	33	414	SWING - CURRENT FEEDBACK READING TOO LOW	Current feedback into controller is below threshold value.	Check wiring and coil.

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33415	33	415	FLOW CONTROL VALVE - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second.	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33417	33	417	LIFT - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized.
33418	33	418	SWING - CURRENT FEEDBACK READING LOST	Current feedback into controller not detected.	Check wiring and coil.
33419	33	419	FLOW CONTROL VALVE - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output >40% for a period of 100ms.	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33488	33	488	SWING FLOW CONTROL VALVE - SHORT TO GROUND	There is a short to the Ground to the Swing Flow Control Valve.	Check Harness for damage.
33575	33	575	ECM PULL DOWN RESISTOR - OPEN CIRCUIT	There is an Open Circuit to the ECM Pull Down Resistor.	Check Harness for damage.
340	**34**	**0**	**<<< PLATFORM OUTPUT DRIVER >>>**		
341	34	1	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
342	34	2	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Up Valve.	Check Harness for damage.
343	34	3	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Valve.	Check Harness for damage.
344	34	4	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
345	34	5	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
346	34	6	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Level Down Valve.	Check Harness for damage.
347	34	7	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	There is a short to the Ground to the Platform Level Down Valve.	Check Harness for damage.
348	34	8	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
349	34	9	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Left Valve.	Check Harness for damage.
3410	34	10	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Rotate Left Valve.	Check Harness for damage.
3411	34	11	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	There is a short to Ground to the Platform Rotate Left Valve.	Check Harness for damage.
3412	34	12	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Right Valve.	Check Harness for damage.

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3413	34	13	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Rotate Right Valve.	Check Harness for damage.
3414	34	14	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	There is a short to Ground to the Platform Rotate Right Valve.	Check Harness for damage.
3415	34	15	JIB LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Up Valve.	Check Harness for damage.
3416	34	16	JIB LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Up Valve.	Check Harness for damage.
3417	34	17	JIB LIFT UP VALVE - SHORT TO GROUND	There is a short to Ground to the JIB Lift Up Valve.	Check Harness for damage.
3418	34	18	JIB LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Down Valve.	Check Harness for damage.
3419	34	19	JIB LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Down Valve.	Check Harness for damage.
3420	34	20	JIB LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Down Valve.	Check Harness for damage.
3421	34	21	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Left Valve.	Check Harness for damage.
3422	34	22	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Left Valve.	Check Harness for damage.
3423	34	23	JIB ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Left Valve.	Check Harness for damage.
3424	34	24	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Right Valve.	Check Harness for damage.
3425	34	25	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Right Valve.	Check Harness for damage.
3426	34	26	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Right Valve.	Check Harness for damage.
430	**43**	**0**	**<<< ENGINE >>>**		
431	43	1	FUEL SENSOR - SHORT TO BATTERY OR OPEN CIRCUIT	The Fuel Sensor reading is > 4.3V.	Energize fuel sensor per System Indicators
432	43	2	FUEL SENSOR - SHORT TO GROUND	The Fuel Sensor reading is < 0.2V.	Energize fuel sensor per System Indicators
433	43	3	OIL PRESSURE - SHORT TO BATTERY	The Oil Pressure Sensor reading is > 6.6V.	Deutz engine only.
434	43	4	OIL PRESSURE - SHORT TO GROUND	The Oil Pressure Sensor reading is < 0.1V for more then 5 seconds.	Deutz engine only. - Not reported during engine start.
435	43	5	COOLANT TEMPERATURE - SHORT TO GROUND	The Coolant Temperature Sensor reading is < 0.1V.	Deutz engine only.
436	43	6	FORD FAULT CODE ##	All ford fault codes except 63 are simply passed through from the Ford ECM. They only occur if a Ford Engine is selected in the machine configuration digits. Can be reported during power-up sequence.	

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
437	43	7	ENGINE TROUBLE CODE	Displays engine SPN FMI code.	Report and log in Help If [(MACHINE SETUP > DEUTZ EMR2) or (MACHINE SETUP > DEUTZ EMR4) and SPN:FMI = 535:7], prohibit engine cranking.
438	43	8	HIGH ENGINE TEMP	(Ford engine only) The engine temperature is > 117 C. (Deutz engine only) The engine temperature is > 130 C.	Ford / Deutz engine only.
439	43	9	AIR FILTER BYPASSED	The Air Filter is clogged.	Check Airfilter for clogging
4310	43	10	NO ALTERNATOR OUTPUT	Battery voltage is < 11.5 volts for more then 15 seconds after engine start.	Activate the No Charge indicator J4-26 per System Indicators.
4311	43	11	LOW OIL PRESSURE	(Ford engine only) The ECM has reported a low oil pressure fault. (Deutz engine only) Oil pressure is < 8 PSI for more then 10 seconds after engine start.	Ford / Deutz engine only.
4312	43	12	485 COMMUNICATIONS LOST	This fault only occurs with a Ford Engine. It occures when no response are received from the ECM for 2.5 seconds. Can be reported during power-up sequence.	
4313	43	13	THROTTLE ACTUATOR FAILURE	The engine RPM is > XXX for more then XX seconds.	
4314	43	14	WRONG ENGINE SELECTED - ECM DETECTED	A ECM was detected with a non- ECM type engine selected.	
4322	43	22	LOSS OF ENGINE SPEED SENSOR	The engine RPM sensor indicates 0 RPM AND the Oil Pressure Sensor indicates > 8 PSI for three seconds.	Diesel engine only.
4323	43	23	SPEED SENSOR READING INVALID SPEED	The engine RPM sensor indicates > 4000 RPM.	Diesel engine only.
4331	43	31	SOOT LOAD WARNING - LOW	SPN/FMI 3719 / 16 3703 / 31	Check Engine.
4332	43	32	SOOT LOAD WARNING - HIGH	SPN/FMI 3719 / 0 3714 / 31	Check Engine.
4333	43	33	SOOT LOAD WARNING - SEVERE	SPN/FMI 3715 / 31	Check Engine.
4334	43	34	ENGINE COOLANT - LOW LEVEL	MACHINE SETUP > ENGINE = DEUTZ EMR4; ECM transmits a J1939 DM1 message for an engine coolant low level fault (SPN:FMI 111:1) on CAN2 or uses the J1939 Transport Protocol every one second to send this information if multiple engine faults exist.	MACHINE SETUP > ENGINE SHUTDOWN = ENABLED then shutdown the engine; Activate High Engine Temperature indicator J4-28.
440	**44**	**0**	**<<< BATTERY SUPPLY >>>**		
441	44	1	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN	Battery voltage is < 9V.	
442	44	2	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN	Battery voltage is > 16V.	
445	44	5	BATTERY VOLTAGE LOW	Battery voltage is < 11V for more then 5 seconds.	

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
660	**66**	**0**	**<<< COMMUNICATION >>>**		
662	66	2	CANBUS FAILURE - PLATFORM MODULE	Platform Module CAN communication lost.	
664	66	4	CANBUS FAILURE - ACCESSORY MODULE	The accessory module is not receiving CAN messages. This is probably due to wiring problem.	Check the Wiring.
666	66	6	CANBUS FAILURE - ENGINE CONTROLLER	Engine Control Module CAN	ECM equipped engine only.
6620	66	20	CANBUS FAILURE - UMS SENSOR	communication lost.	
6622	66	22	CANBUS FAILURE - TCU MODULE	Machine Setup/ Telematics = YES, No device heartbeat for 30 sec	
6623	66	23	CANBUS FAILURE - GATEWAY MODULE	Machine Setup/ Telematics = YES, No device heartbeat for 30 sec	
6629	66	29	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH		
6657	66	57	CANBUS FAILURE - TEMPERATURE SENSOR	MACHINE SETUP > TEMP CUTOUT = YES; UGM does not receive any CAN messages from the Ambient Temperature sensor in 250ms	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
671	67	1	ACCESSORY FAULT		
680	**68**	**0**	**<<< TELEMATICS >>>**		
681	68	1	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP		
810	**81**	**0**	**<<< TILT SENSOR >>>**		
813	81	3	CHASSIS TILT SENSOR NOT CALIBRATED	The Chassis Tilt Sensor has not been calibrated.	
815	81	5	CHASSIS TILT SENSOR DISAGREEMENT		
816	81	6	UMS SENSOR NOT CALIBRATED	The Control System detects a sensor out of range condition or a not calibrated fault with UMS angle sensor	
817	81	7	UMS SENSOR FAULT	The system detects that the UMS sensor frequency outside the 100Hz+/- 5Hz range or the duty cycle is outside 50% +/- 21% Range	
820	**82**	**0**	**<<< PLATFORM LOAD SENSE >>>**		
825	82	5	LSS HAS NOT BEEN CALIBRATED	The Load Sensing System Module has not been calibrated.	UGM to set Platform Load State = Overloaded

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
826	82	6	RUNNING AT CREEP - PLATFORM OVERLOADED	All functions at creep, the Load Sensing System indicates the Platform is overloaded AND is configured to warn only while the Platform is overloaded.	
827	82	7	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED	Driving and boom functions are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent drive and boom functions while the Platform is overloaded.	
828	82	8	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED	Lift up and telescope out are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent Lift up and telescope out while the Platform is overloaded.	
8639	86	39	FRONT LEFT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Front Left Steer Valve	Check Harness for damage.
8640	86	40	FRONT LEFT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Front Left Steer Valve	Check Harness for damage.
8641	86	41	FRONT LEFT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Front Left Steer Valve	Check Harness for damage.
8642	86	42	FRONT RIGHT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Front Right Steer Valve	Check Harness for damage.
8643	86	43	FRONT RIGHT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Front Right Steer Valve	Check Harness for damage.
8644	86	44	FRONT RIGHT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Front Right Steer Valve	Check Harness for damage.
8645	86	45	REAR LEFT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Rear Left Steer Valve	Check Harness for damage.
8646	86	46	REAR LEFT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Rear Left Steer Valve	Check Harness for damage.
8647	86	47	REAR LEFT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Rear Left Steer Valve	Check Harness for damage.
8648	86	48	REAR RIGHT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Rear Right Steer Valve	Check Harness for damage.
8649	86	49	REAR RIGHT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Rear Right Steer Valve	Check Harness for damage.
8650	86	50	REAR RIGHT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Rear Right Steer Valve	Check Harness for damage.
871	87	1	RETURN FILTER BYPASSED	Hydraulic Return Filter Clogged	Check Hydraulic Return Filter.
872	87	2	CHARGE PUMP FILTER BYPASSED	Charge Pump Filter Clogged	Check Charge Pump Filter.
873	87	3	MACHINE SAFETY SYSTEM OVERRIDE OCCURRED	MSSO = Active	Response described in MSSO Influence on Machine Operation section.

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
998	99	8	EEPROM FAILURE - CHECK ALL SETTINGS	The Ground Module has reported an EEPROM failure.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start); reset the section of EEPROM where the failure occurred to defaults.
9910	99	10	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	The Platform Module software version is not compatible with the rest of the system.	Activate the platform alarm continuously Creep mode is active If Platform Mode is active, disable all Drive, Steer, and Boom functions and do not permit Machine Enable.
9914	99	14	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	The Platform Module software requires an update.	
9915	99	15	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	The Chassis Tilt Sensor gain calibration has been lost.	
9916	99	16	CHASSIS TILT SENSOR GAIN OUT OF RANGE	The Chassis Tilt Sensor gain calibration has become corrupted.	
9919	99	19	GROUND SENSOR REF VOLTAGE OUT OF RANGE	The Ground Module has reported that its sensor reference voltage is outside acceptable range.	Not reported during power-up.
9920	99	20	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	The Platform Module has reported that its sensor reference voltage is outside acceptable range.	Not reported during power-up.
9921	99	21	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY	The Ground Module has reported that its high side driver cutout failed.	
9922	99	22	PLATFORM MODULE FAILURE - HWFS CODE 1	The Platform Module has reported that the V(Low) FET has failed.	
9923	99	23	GROUND MODULE FAILURE - HWFS CODE 1	The Ground Module has reported that the V(Low) FET has failed.	
9924	99	24	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED	The machine is powered up and no model has been selected yet in the MACHINE SETUP menu	Display ??? or NO MODEL at Analyzer MACHINE SETUP menu MACHINE SETUP->MODEL NUMBER Do not report any other faults Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
9944	99	44	CURRENT FEEDBACK GAINS OUT OF RANGE	The factory set current feedback gains are out of range.	A gain of 1 is used for the factory gain(s) that was out of range; all functions shall be placed in Creep mode.

Table 6-12. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
9945	99	45	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	The factory set current feedback checksum is not correct.	
9979	99	79	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER	Temporary fault for the telematics project. The model needs to be a 600S or 1350S if not this fault will be generated and Platform controls will be prevented. This fault was to ensure that the software will only work for these two models.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).

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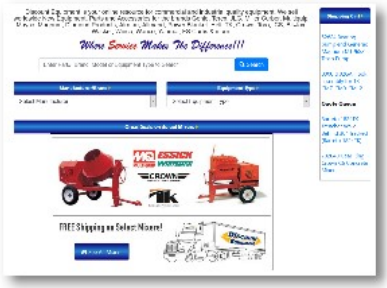

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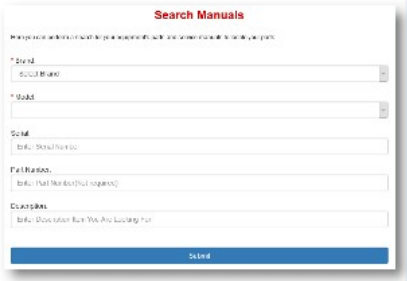

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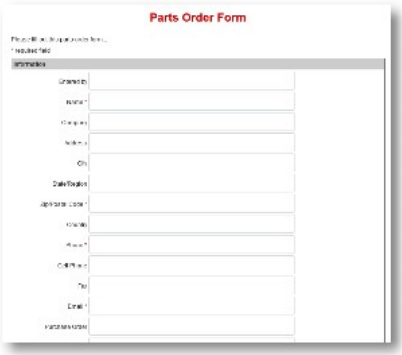

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SECTION 7. BASIC ELECTRICAL INFORMATION & SCHEMATICS

7.1 GENERAL

This section contains basic electrical information and schematics to be used for locating and correcting most of the operating problems which may develop.

NOTE: *Some of the procedures/connectors shown in this section may not be applicable to all models.*

7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

Min/Max

Use of the "Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read the Voltage applied to a solenoid when it is only operational while a switch, far from the solenoid and meter, is held down.

Polarity

Getting a negative Voltage or current reading when expecting a positive reading frequently means the leads are reversed. Check what reading is expected, the location of the signal and that the leads are connected to the device under test correctly. Also check that the lead on the "COM" port goes to the Ground or negative side of the signal and the lead on the other port goes to the positive side of the signal.

Scale

M = Mega = 1,000,000 * (Displayed Number)

k = kilo = 1,000 * (Displayed Number)

m = milli = (Displayed Number) / 1,000

µ = micro = (Displayed Number) / 1,000,000

Example: 1.2 kW = 1200 W
Example: 50 mA = 0.05 A

Voltage Measurement

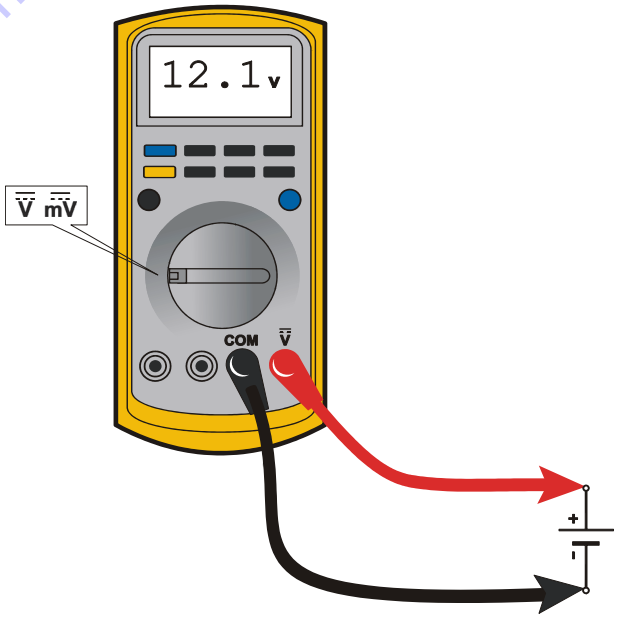


Figure 7-1. Voltage Measurement (DC)

- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual).
- Use firm contact with meter leads.

Resistance Measurement

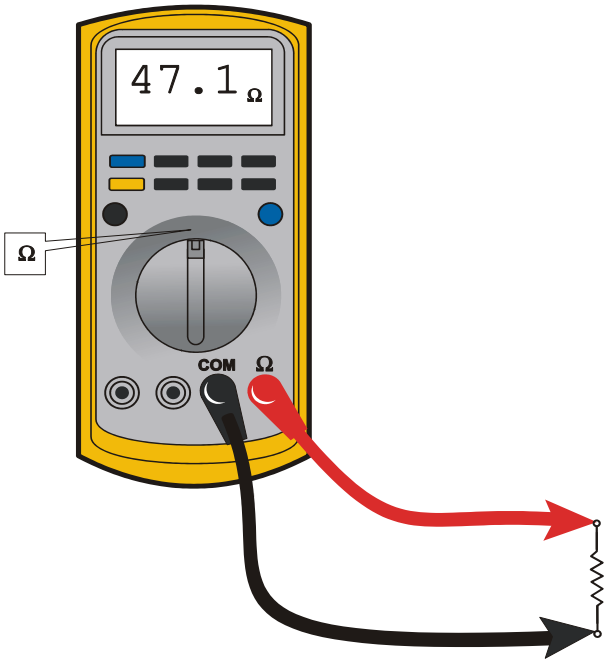


Figure 7-2. Resistance Measurement

- First test meter and leads by touching leads together. Resistance should read a short circuit (very low resistance).
- Circuit power must be turned OFF before testing resistance.
- Disconnect component from circuit before testing.
- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual).
- Use firm contact with meter leads.

Continuity Measurement

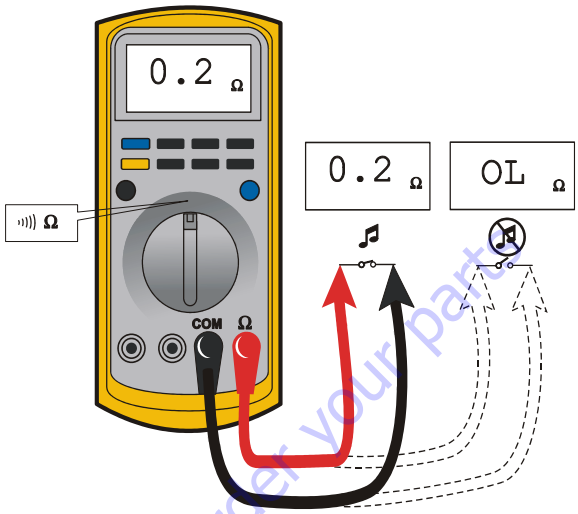


Figure 7-3. Continuity Measurement

- Some meters require a separate button press to enable audible continuity testing.
- Circuit power must be turned OFF before testing continuity.
- Disconnect component from circuit before testing.
- Use firm contact with meter leads.
- First test meter and leads by touching leads together. Meter should produce an audible alarm, indicating continuity.

Current Measurement

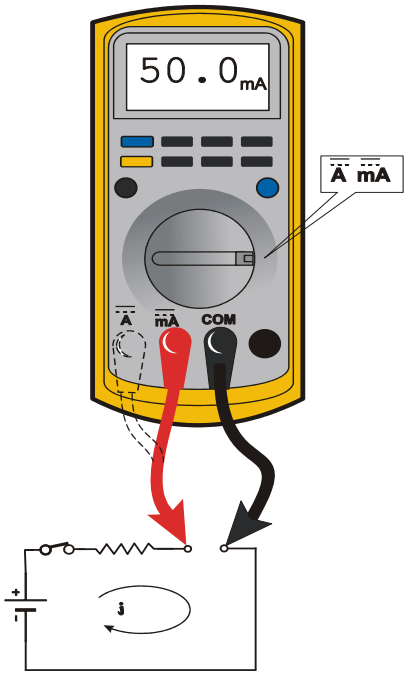


Figure 7-4. Current Measurement (DC)

- Set up the meter for the expected current range.
- Be sure to connect the meter leads to the correct jacks for the current range you have selected.
- If meter is not auto ranging, set it to the correct range (See multi meter's operation manual).
- Use firm contact with meter leads.

7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

NOTE: *This section is not applicable for battery terminals.*

NOTICE

JLG PN 0100048 DIELECTRIC GREASE (NOVAGARD G661) IS THE ONLY MATERIAL APPROVED FOR USE AS A DIELECTRIC GREASE.

NOTE: *Do NOT apply dielectric grease to the following connections:*

- Main Boom Rotary sensor connections (on Celesco Sensor),
- LSS Modules connections,
- Deutz EMR 2 ECM connection.

Silicone Dielectric Compound must be used on all electrical connections except for those mentioned above for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors. This procedure applies to all plug connections not enclosed in a box. Silicone grease should not be applied to connectors with external seals.

1. To prevent oxidation, silicone grease must be packed completely around male and female pins on the inside of the connector prior to assembly. This is most easily achieved by using a syringe.

NOTE: *Over a period of time, oxidation increases electrical resistance at the connection, eventually causing circuit failure.*

2. To prevent shorting, silicone grease must be packed around each wire where they enter the outside of the connector housing. Also, silicone grease must be applied at the joint where the male and female connectors come together. Any other joints (around strain reliefs, etc.) where water could enter the connector should also be sealed.

NOTE: *This condition is especially common when machines are pressure washed since the washing solution is much more conductive than water.*

3. Anderson connectors for the battery boxes and battery chargers should have silicone grease applied to the contacts only.

NOTE: *Curing-type sealants might also be used to prevent shorting and would be less messy, but would make future pin removal more difficult.*

When applied to electrical connections, dielectric grease helps to prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from the application of dielectric grease.

Dielectric grease could be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

Installation of Dielectric Grease

Before following these instructions, refer to excluded connector types (See Exclusions below).

1. Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
2. Apply dielectric grease to plug/male connector housing which typically contains sockets contact/female terminals (fill it approximately ½ full; see example below).
3. Leave a thin layer of dielectric grease on the face of the connector
4. Assemble the connector system immediately to prevent moisture ingress or dust contamination

The following connector systems are specifically addressed because of their widespread use at JLG. However, this guidance may be applied to similar devices.

AMP Mate-N-Lok

Improper Proper

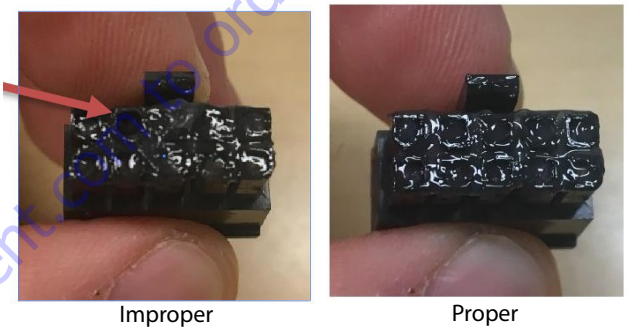
AMP Faston

This connector system is typically used on operator switches at JLG. Follow the general guidance for installation.

Improper Proper

AMP Micro-Fit

This connector system is typically used on control modules at JLG. Follow the general guidance for installation.



Improper Proper

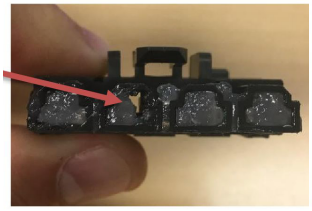
AMP Mini Fit Jr

This connector system is typically used on control modules at JLG. Follow the general guidance for installation.

Improper Proper

Mini Fit Sr

This connector system is typically used on control modules at JLG. Follow the general guidance for installation.

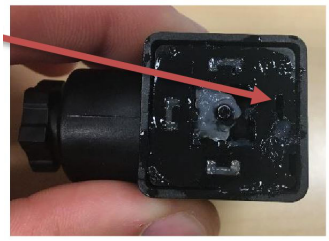


Improper

Proper

DIN Connectors

This connector is typically used on hydraulic valves. Follow the installation instructions.



Improper

Proper

Exceptions

Some waterproof connector applications do benefit from dielectric grease, and some non waterproof connectors do not benefit from dielectric grease.

In the exceptions below, we have found dielectric grease is not needed for some applications, and in some cases can interfere with the intended connection. Dielectric grease shall be used as an exception in other applications.

Enclosures

Application of dielectric grease is not required in properly sealed enclosures. To meet criteria, the enclosure must be rated to at least IP56 (dust protected; protected from powerful jets of water).

Carling Switch Connectors

Carling switches may experience high impedance, or discontinuity, due to silicone dielectric grease ingress when switching inductive loads. Therefore, dielectric grease shall not be applied to Carling switch mating connectors unless specifically noted.

7.4 AMP CONNECTOR

Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on the inside of the connector after the mating of the housing to the header. This is easily achieved by using a syringe to fill the header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling the housing to the header, it is possible that the housing will become air locked, thus preventing the housing latch from engaging.
2. Pierce one of the unused wire seals to allow the trapped air inside the housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 7-5.). Proceed as follows:

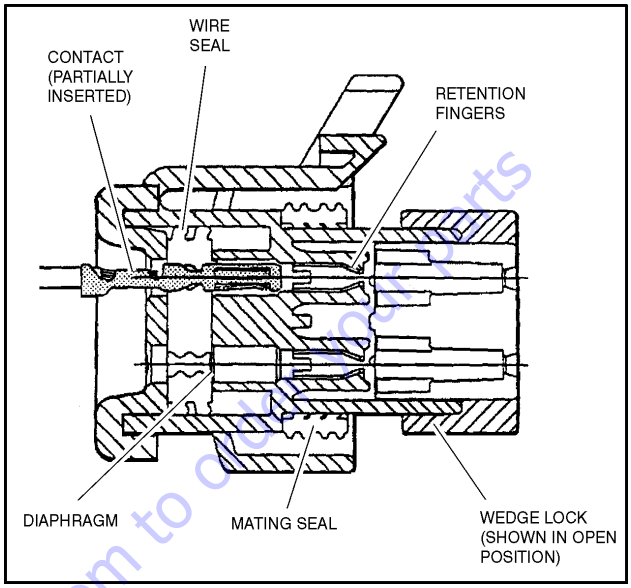


Figure 7-5. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-7.).
2. Pull back on the contact wire with a force of 1 or 2 lb to be sure the retention fingers are holding the contact (See Figure 7-7.).

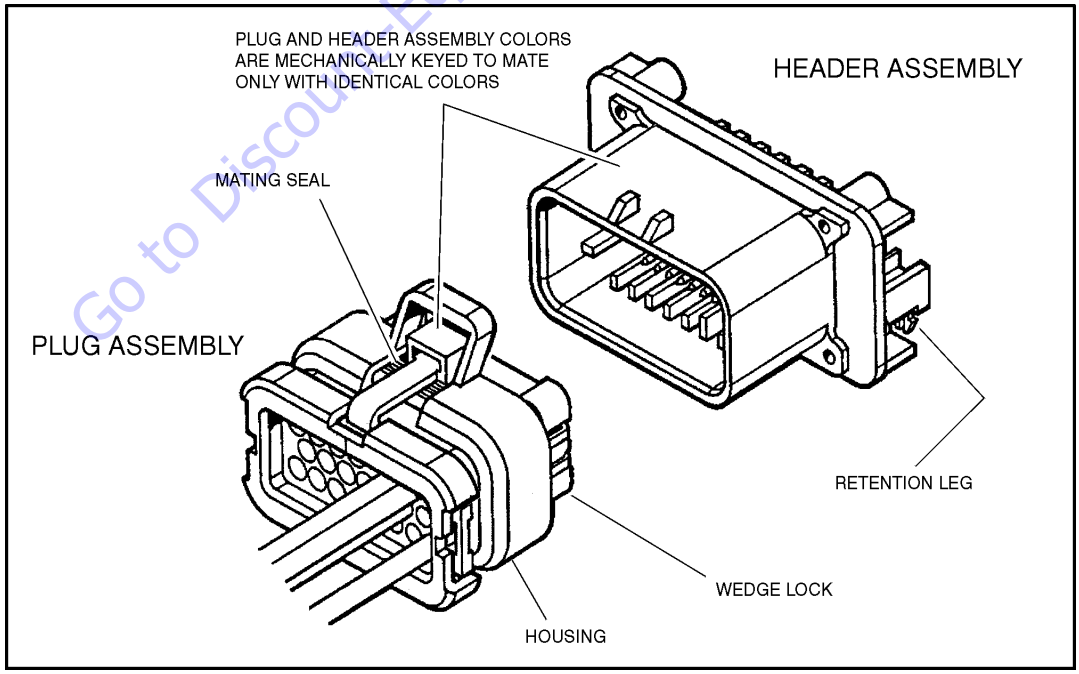


Figure 7-6. AMP Connector

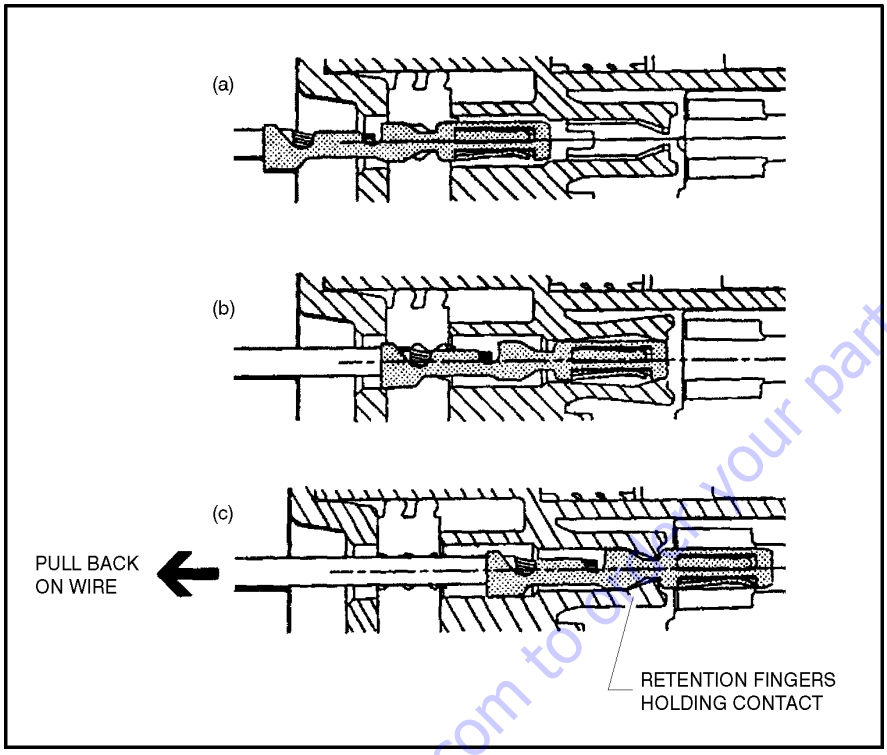


Figure 7-7. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (See Figure 7-8.).

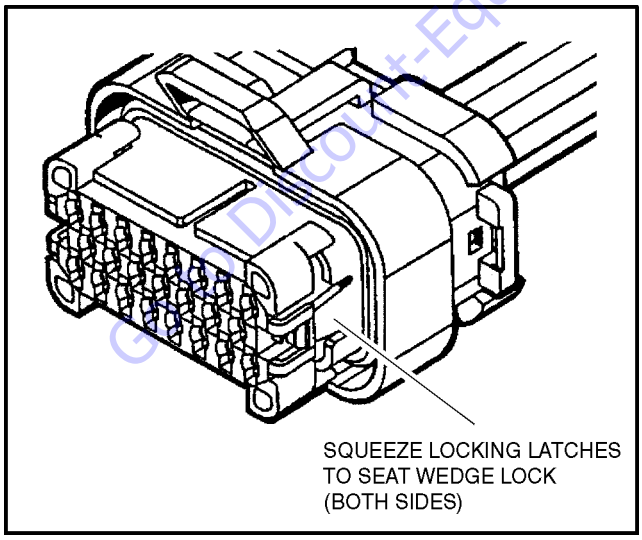


Figure 7-8. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-9.).

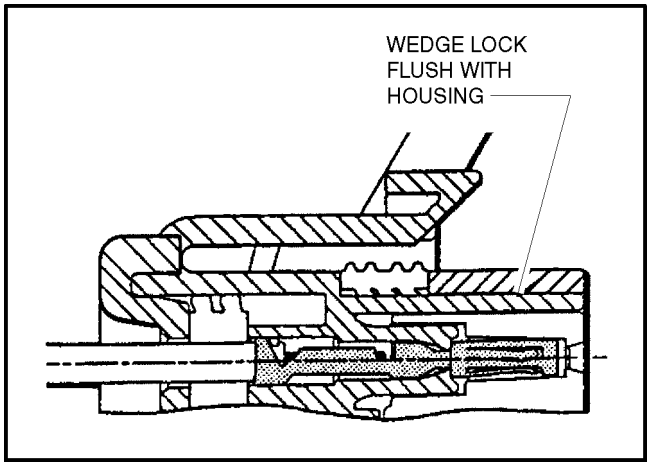


Figure 7-9. Connector Assembly Figure 4

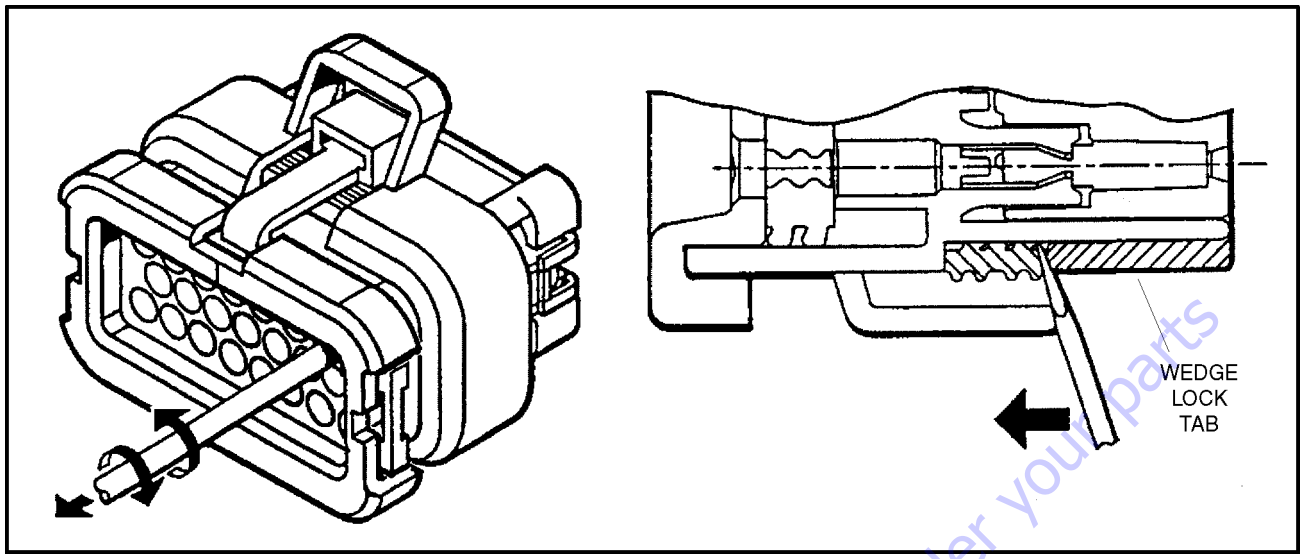


Figure 7-10. Connector Disassembly

Disassembly

5. Insert a 4.8 mm (3/16") wide screwdriver blade between the mating seal and one of the red wedge lock tabs.
6. Pry open the wedge lock to the open position.
7. While rotating the wire back and forth over a half turn (1/4 turn in each direction), gently pull the wire until the contact is removed.

NOTE: *The wedge lock should never be removed from the housing for insertion or removal of the contacts.*

Wedge Lock

The wedge lock has slotted openings in the forward, or mating end. These slots accommodate circuit testing in the field, by using a flat probe such as a pocket knife. DO NOT use a sharp point such as an ice pick.

Service - Voltage Reading

NOTICE

DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

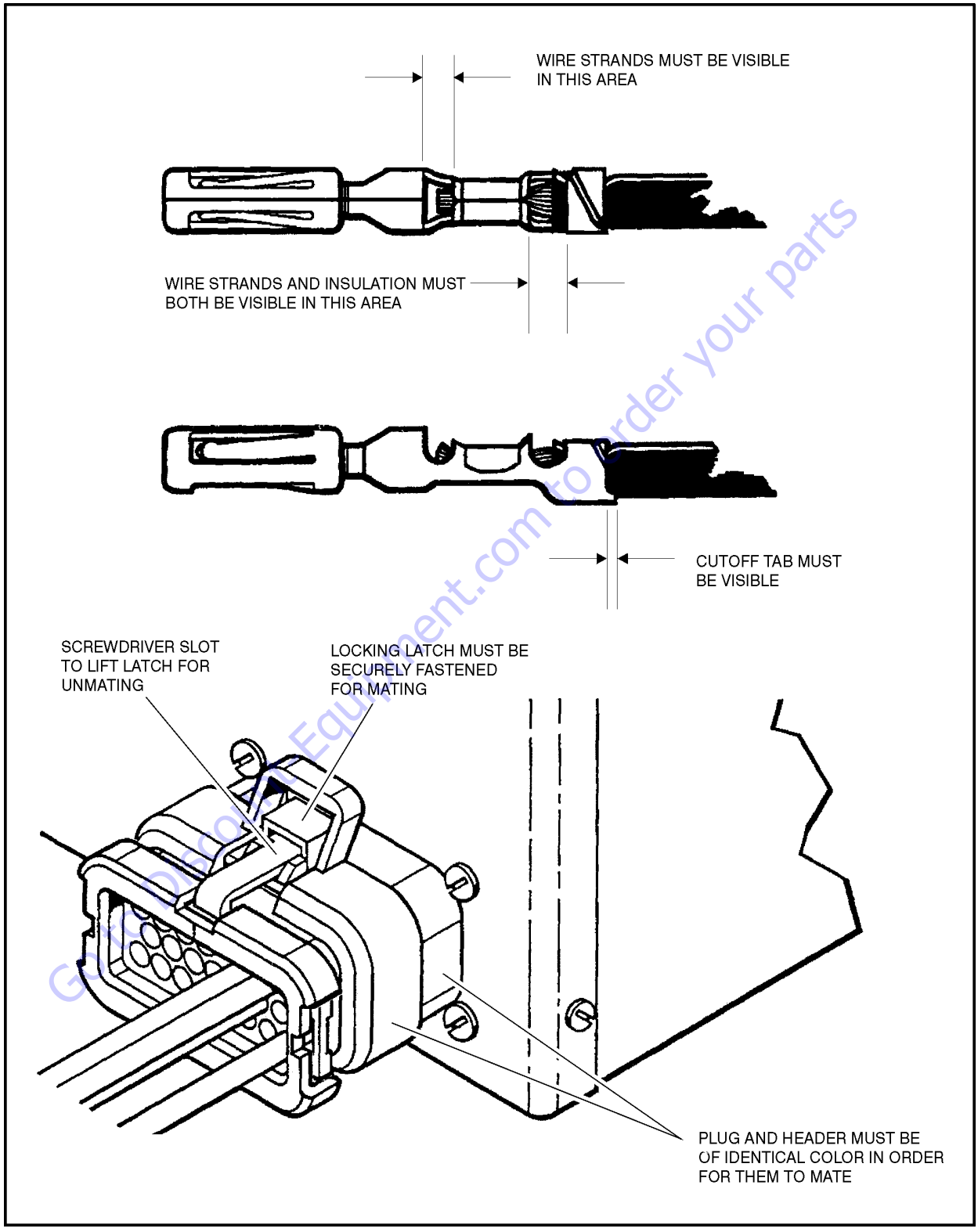


Figure 7-11. Connector Installation

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

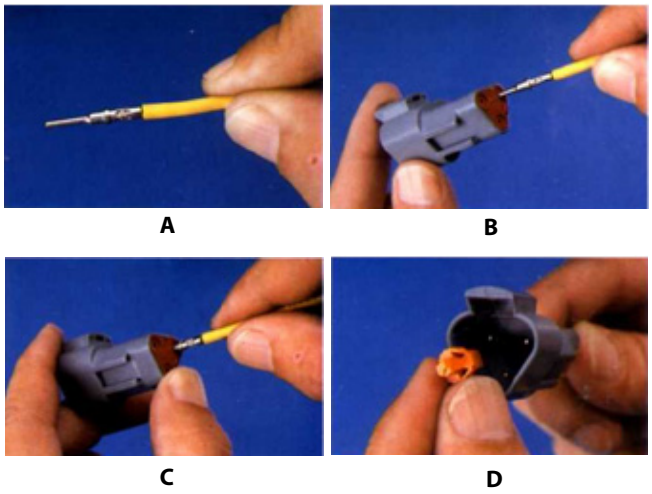


Figure 7-12. DT/DTP Contact Installation

1. Grasp crimped contact about 25mm behind the contact barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that it is properly locked in place.
4. Once all contacts are in place, insert wedgelock with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. They may go in either way.

NOTE: *The receptacle is shown - use the same procedure for plug.*

DT/DTP Series Disassembly

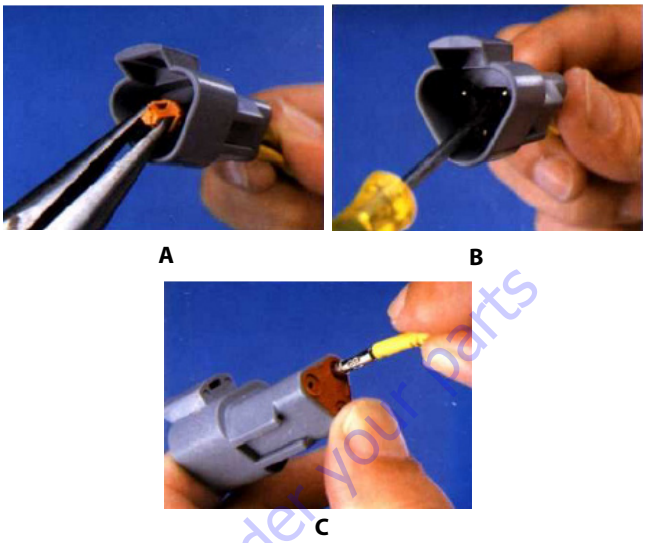


Figure 7-13. DT/DTP Contact Removal

5. Remove wedgelock using needle nose pliers or a hook shaped wire to pull wedge straight out.
6. To remove the contacts, gently pull wire backwards, while at the same time releasing the locking finger by moving it away from the contact with a screwdriver.
7. Hold the rear seal in place, as removing the contact may displace the seal.

HD30/HDP20 Series Assembly

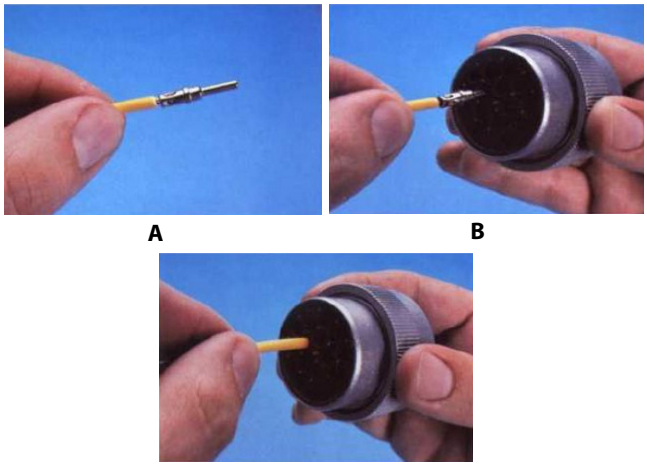


Figure 7-14. HD/HDP Contact Installation

8. Grasp contact about 25mm behind the contact crimp barrel.
9. Hold connector with rear grommet facing you.
10. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm that it is properly locked in place.

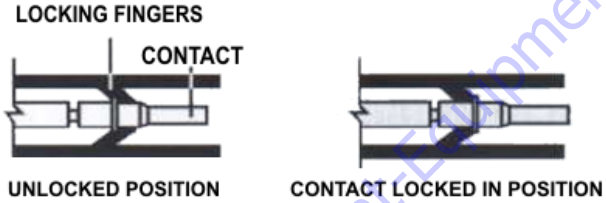


Figure 7-15. HD/HDP Locking Contacts Into Position

NOTE: *For unused wire cavities, insert sealing plugs for full environmental sealing.*

HD30/HDP20 Series Disassembly

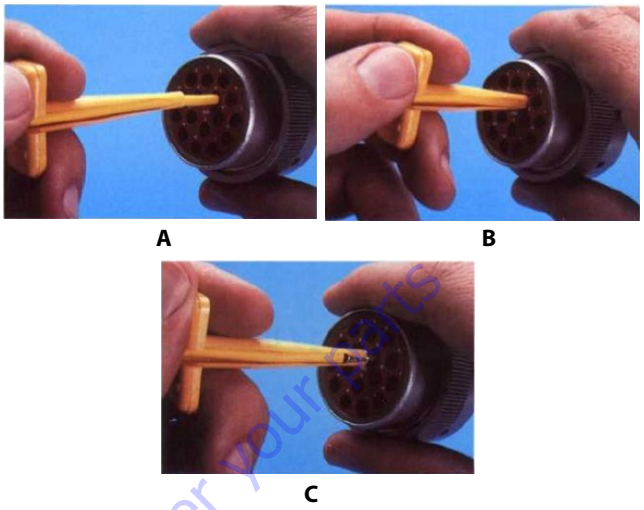


Figure 7-16. HD/HDP Contact Removal

11. With rear insert toward you, snap appropriate size extractor tool over the wire of contact to be removed.
12. Slide tool along into the insert cavity until it engages contact and resistance is felt.
13. Pull contact-wire assembly out of connector.

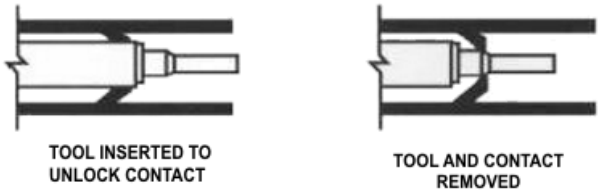


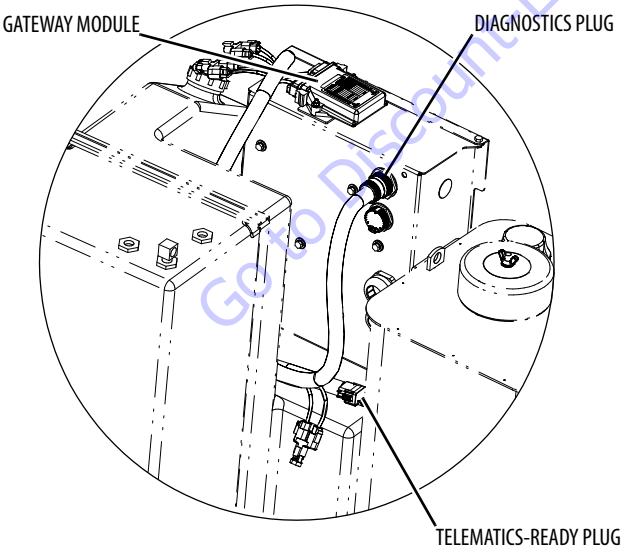
Figure 7-17. HD/HDP Unlocking Contacts

NOTE: *Do Not twist or insert tool at an angle.*

7.6 TELEMATICS GATEWAY

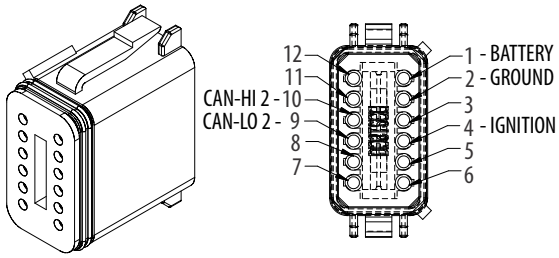
Personnel using machines equipped with an optional telematics gateway will be able to view the following data through their telematics device:

JLG LABEL	DESCRIPTION	UNIT
Engine Speed	Actual engine speed.	RPM
DEF Tank Level (If Equipped)	Indicates the level of DEF (diesel exhaust fluid) within the DEF tank if the machine is equipped with DEF tank. • 0% = Empty • 100% = Full	Percentage (%)
JLG Machine Faults: Active / Not-Active	• 00 - No Machine Faults • 01 - Active Machine Fault • 10 - Error • 11 - Not available	Bit
Total Idle Fuel Used	Total amount of fuel used during vehicle operation during idle conditions.	Liters
Total Idle Hours	Total time of engine operation during idle conditions.	Seconds
Total Engine Hours	Total time of engine operation.	Seconds
Total Fuel Used	Total amount of fuel used during vehicle operation.	Liters
Fuel Rate	Amount of fuel consumed by engine per unit of time.	Liters/Hour
Fuel Level	Ratio of fuel volume to the total volume of the fuel storage container. When a low fuel limit switch is present, the fuel level will indicate "full" until the switch opens, which will then indicate 10% fuel remaining. When Fuel Level 2 (SPN 38) is not used, Fuel Level 1 represents the total fuel in all fuel storage containers. When Fuel Level 2 is used, Fuel Level 1 represents the fuel level in the primary or left side fuel storage container.	Percentage (%)
DM1 Engine Faults	Shows actual engine fault codes.	N/A



Telematics-Ready (TCU) Plug

The telematics-ready (TCU) plug is a standard 12-pin Deutsch connector. Pin-out locations are shown below:



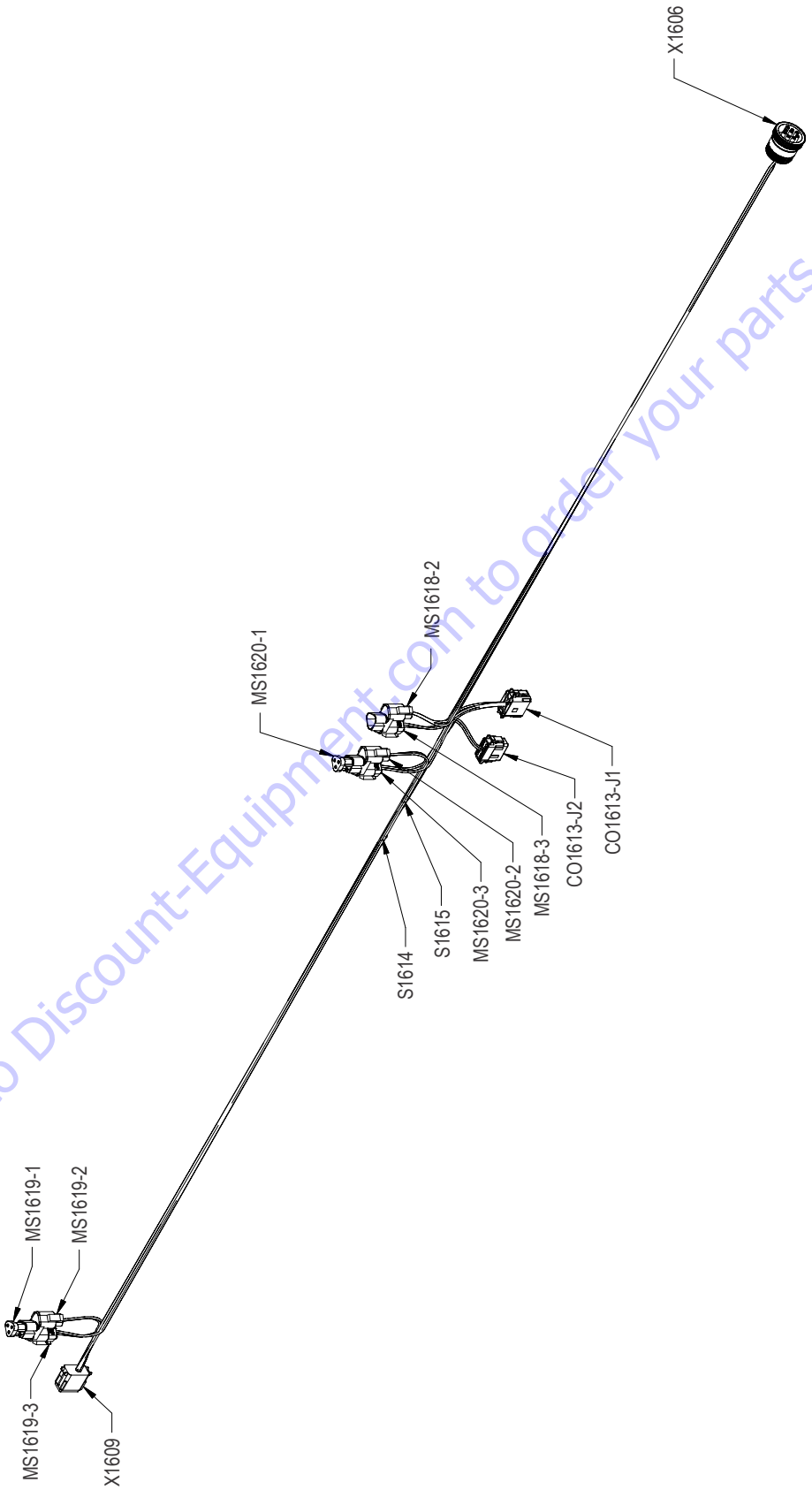


Figure 7-18. Telematics Gateway Harness - Sheet 1 of 3

X1609 (TCU)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-0 BAT	16 AWG	GXL	X1606 (B)
2	BLK	0-0 GND	16 AWG	GXL	S1615 (1)
4	ORN	2-0 IGN	16 AWG	GXL	S1614 (1)
9	GRN	CANL2	18 AWG	GXL	MS1619-2 (B)
10	YEL	CANH2	18 AWG	GXL	MS1619-2 (A)

MS1619-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	X1609 (10)
B	GRN	CANL2	18 AWG	GXL	X1609 (9)

MS1619-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1620-2 (A)
B	GRN	CANL2	18 AWG	GXL	MS1620-2 (B)

CO1613-J1 (GATEWAY 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CAN1	18 AWG	GXL	MS1618-2 (B)
10	YEL	CANH1	18 AWG	GXL	MS1618-2 (A)
11	BLK	0-2 GND	16 AWG	GXL	S1615 (2)
12	ORN	2-2 IGN	16 AWG	GXL	S1614 (2)

CO1613-J2 (GATEWAY 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CANL2	18 AWG	GXL	MS1620-3 (B)
10	YEL	CANH2	18 AWG	GXL	MS1620-3 (A)

MS1620-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1619-3 (A)
B	GRN	CANL2	18 AWG	GXL	MS1619-3 (B)

MS1620-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	CO1613-J2 (10)
B	GRN	CANL2	18 AWG	GXL	CO1613-J2 (9)

S1614					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORN	2-0 IGN	16 AWG	GXL	X1609 (4)
2	ORN	2-1 IGN	16 AWG	GXL	X1606 (H)
2	ORN	2-2 IGN	16 AWG	GXL	CO1613-J1 (12)

S1615					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-0 GND	16 AWG	GXL	X1609 (2)
2	BLK	0-1 GND	16 AWG	GXL	X1606 (A)
2	BLK	0-2 GND	16 AWG	GXL	CO1613-J1 (11)

MS1618-2 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	CO1613-J1 (10)
B	GRN	CANL1	18 AWG	GXL	CO1613-J1 (9)

MS1618-3 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	X1606 (C)
B	GRN	CANL1	18 AWG	GXL	X1606 (D)

X1606 (DIAG)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	0-1 GND	16 AWG	GXL	S1615 (2)
B	RED	1-0 BAT	16 AWG	GXL	X1609 (1)
C	YEL	CANH1	18 AWG	GXL	MS1618-3 (A)
D	GRN	CANL1	18 AWG	GXL	MS1618-3 (B)
H	ORN	2-1 IGN	16 AWG	GXL	S1614 (2)

Figure 7-19. Telematics Gateway Harness - Sheet 2 of 3

					FROM		TO	
WIRE NO.	COLOR	WIRE GAUGE	LENGTH (mm)	JACKET	REFERENCE	PIN	REFERENCE	PIN
CAN L2	GRN	18 AWG	1151	GXL	MS1619-3	B	MS1620-2	B
CAN L2	GRN	18 AWG	151	GXL	X1609	9	MS1619-2	B
CAN L1	GRN	18 AWG	157	GXL	MS1618-2	B	CO1613-J1	9
CAN L2	GRN	18 AWG	225	GXL	MS1620-3	B	CO1613-J2	9
CAN L1	GRN	18 AWG	1076	GXL	MS1618-3	B	X1606	D
CAN H2	YEL	18 AWG	155	GXL	X1609	10	MS1619-2	A
CAN H2	YEL	18 AWG	233	GXL	MS1620-3	A	CO1613-J2	10
CAN H1	YEL	18 AWG	157	GXL	MS1618-2	A	CO1613-J1	10
CAN H2	YEL	18 AWG	1150	GXL	MS1619-3	A	MS1620-2	A
CAN H1	YEL	18 AWG	1079	GXL	MS1618-3	A	X1606	C
0-0 GND	BLK	16 AWG	1006	GXL	X1609	2	S1615	1
0-1 GND	BLK	16 AWG	1145	GXL	X1606	A	S1615	2
0-2 GND	BLK	16 AWG	223	GXL	CO1613-J1	11	S1615	2
1-0 BAT	RED	16 AWG	2150	GXL	X1609	1	X1606	B
2-0 IGN	ORN	16 AWG	939	GXL	X1609	4	S1614	1
2-1 IGN	ORN	16 AWG	1212	GXL	S1614	2	X1606	H
2-2 IGN	ORN	16 AWG	287	GXL	CO1613-J1	12	S1614	2

Figure 7-20. Telematics Gateway Harness - Sheet 3 of 3

7.7 ELECTRICAL SCHEMATIC

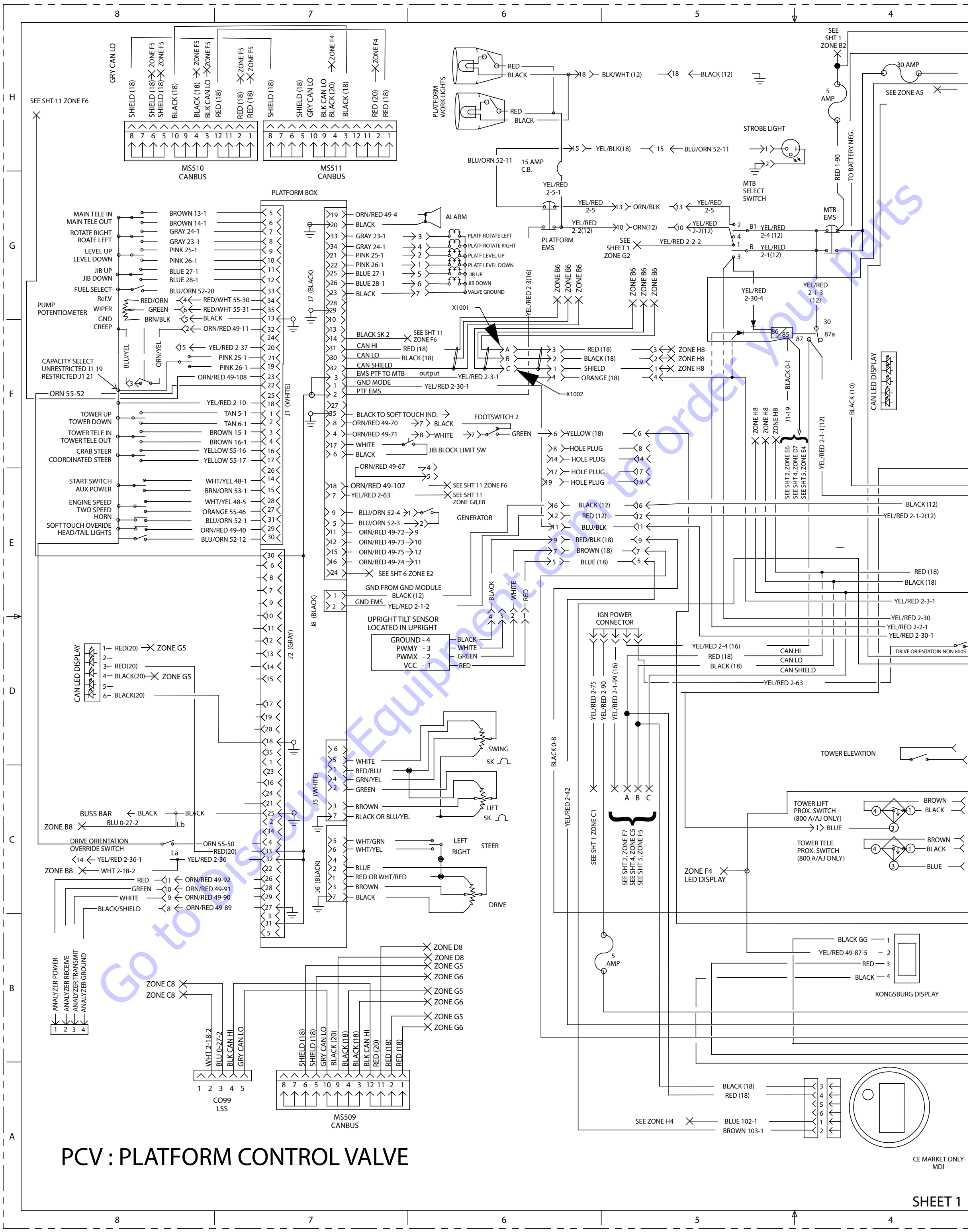


Figure 7-21. Electrical Schematic - Sheet 1 of 17

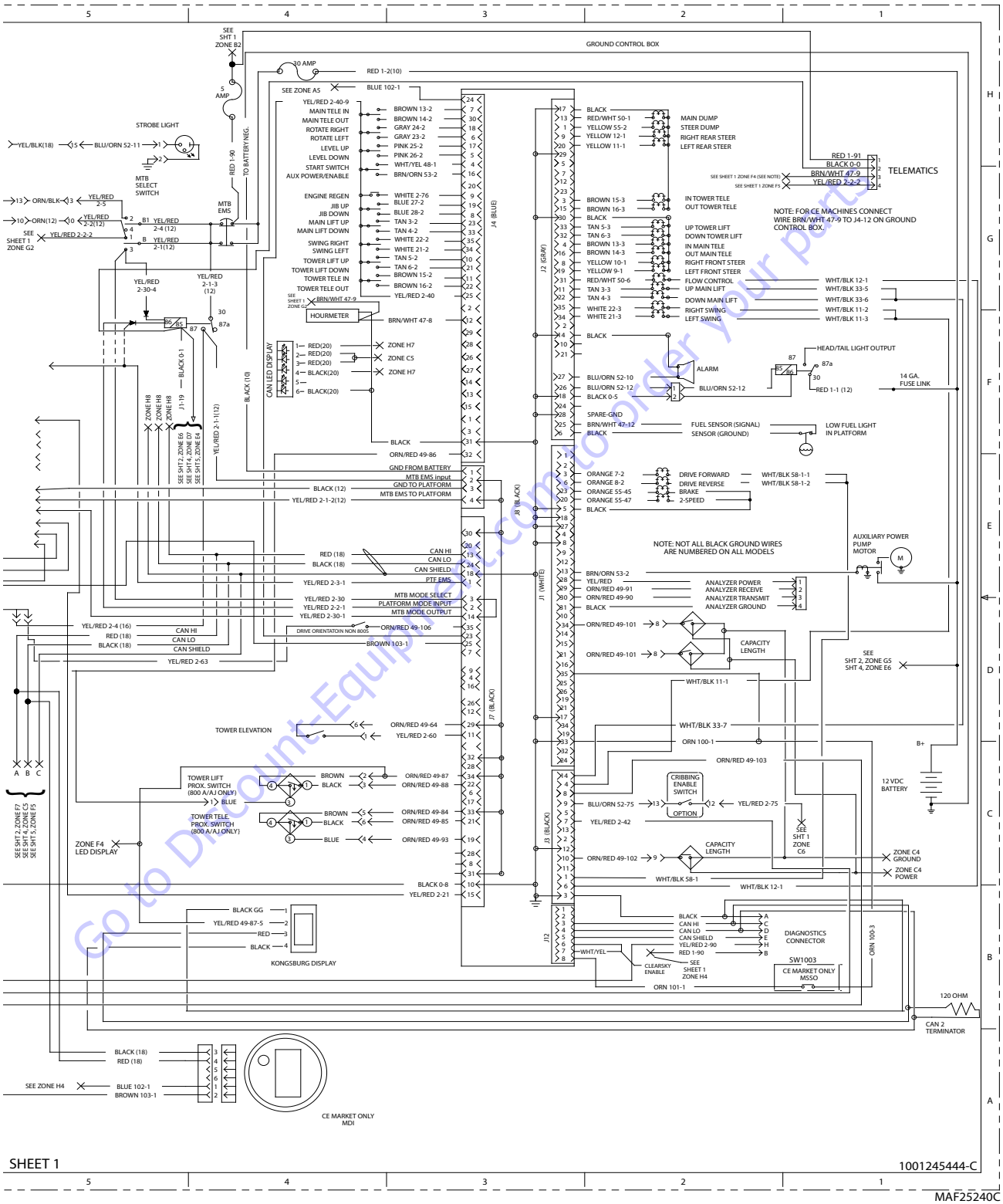
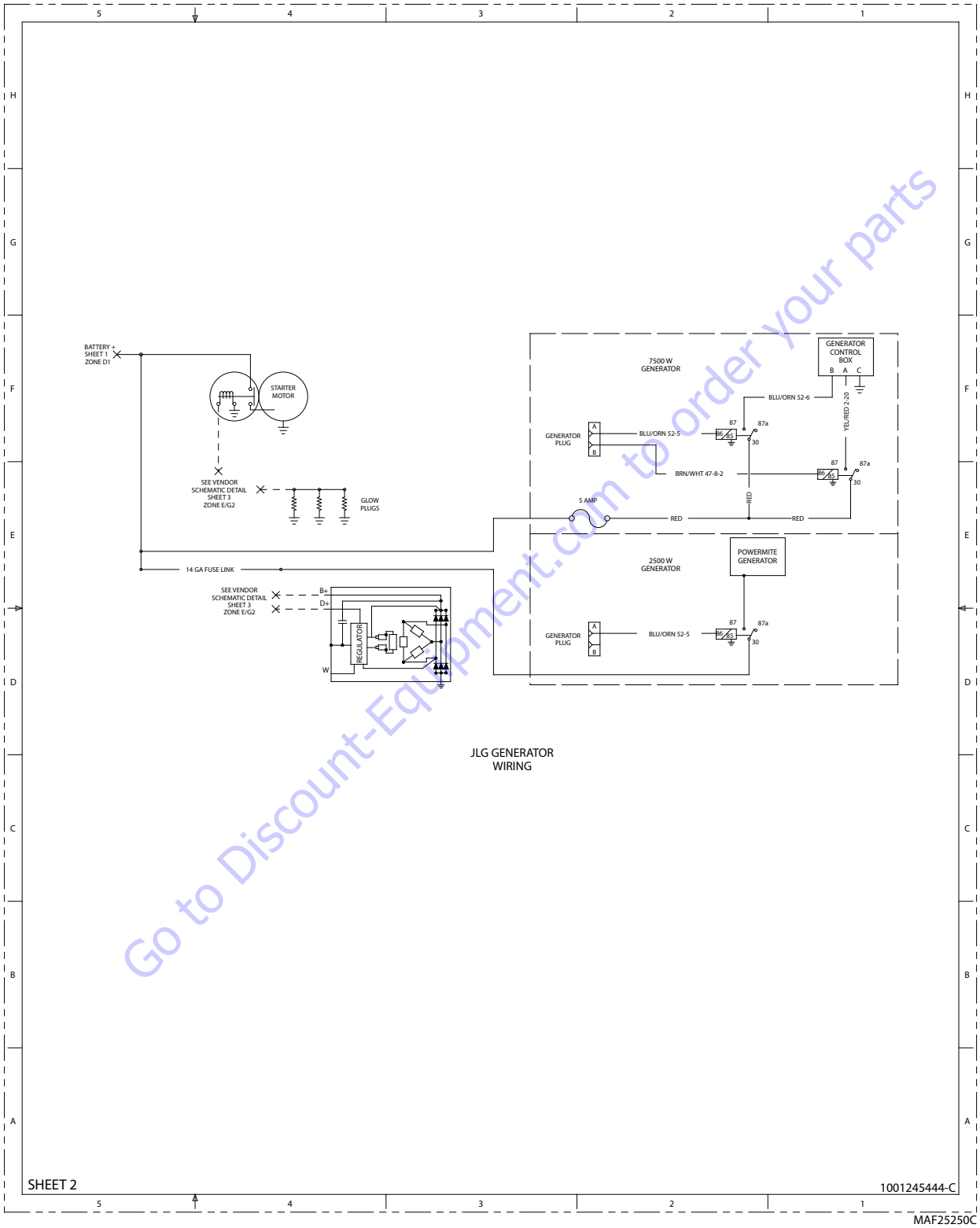


Figure 7-22. Electrical Schematic - Sheet 2 of 17



JLG GENERATOR
WIRING

Figure 7-23. Electrical Schematic - Sheet 3 of 17

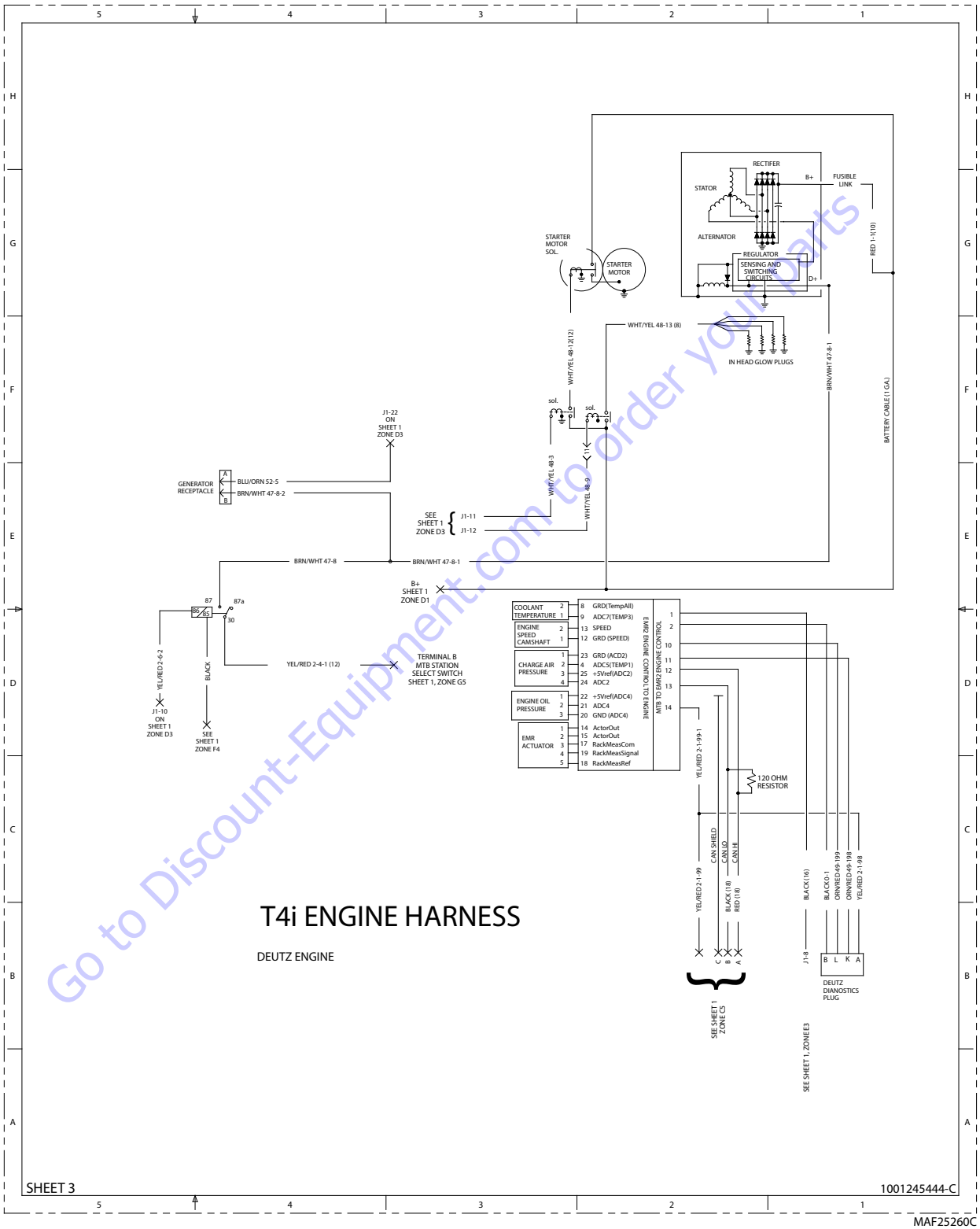


Figure 7-24. Electrical Schematic - Sheet 4 of 17

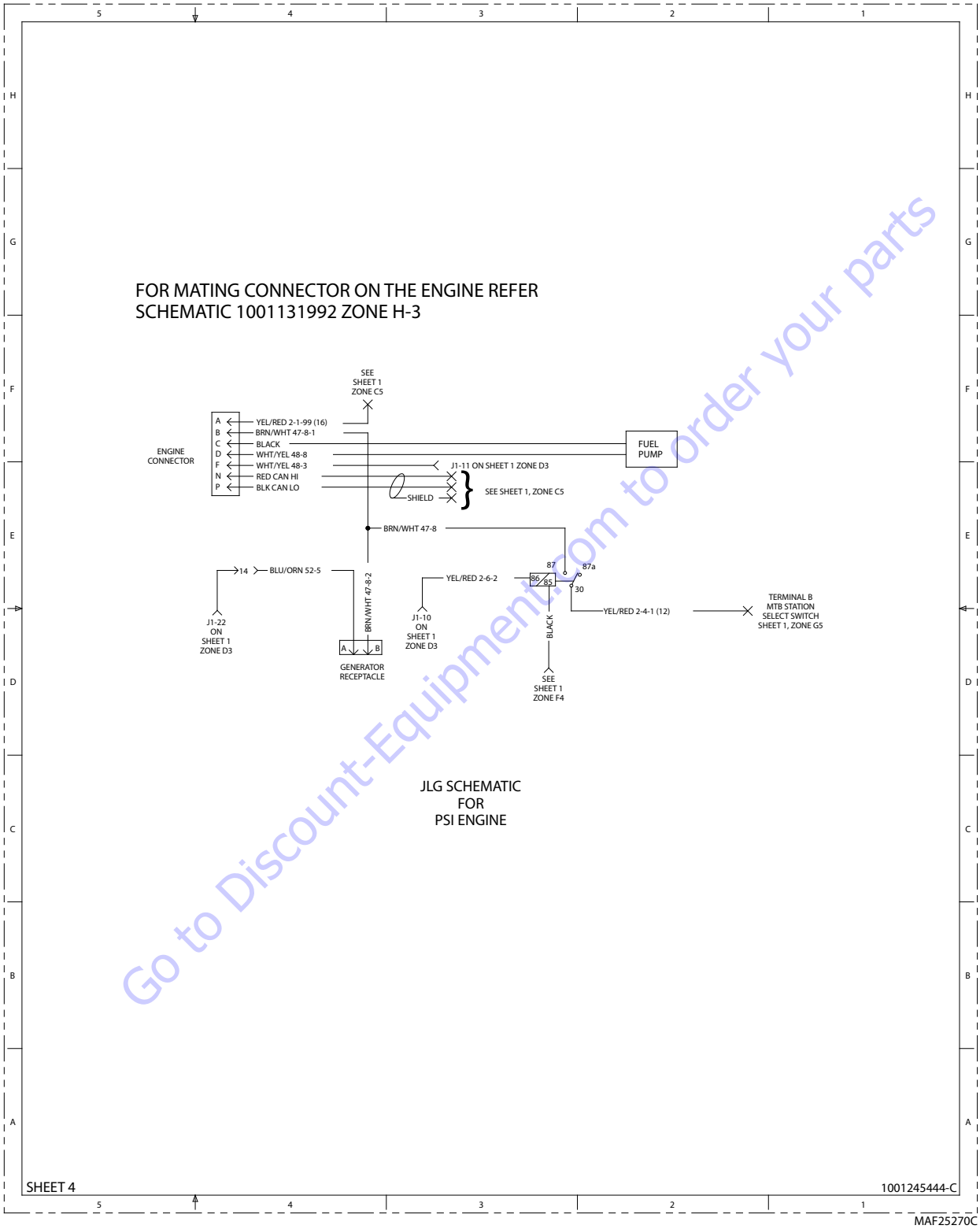


Figure 7-25. Electrical Schematic - Sheet 5 of 17

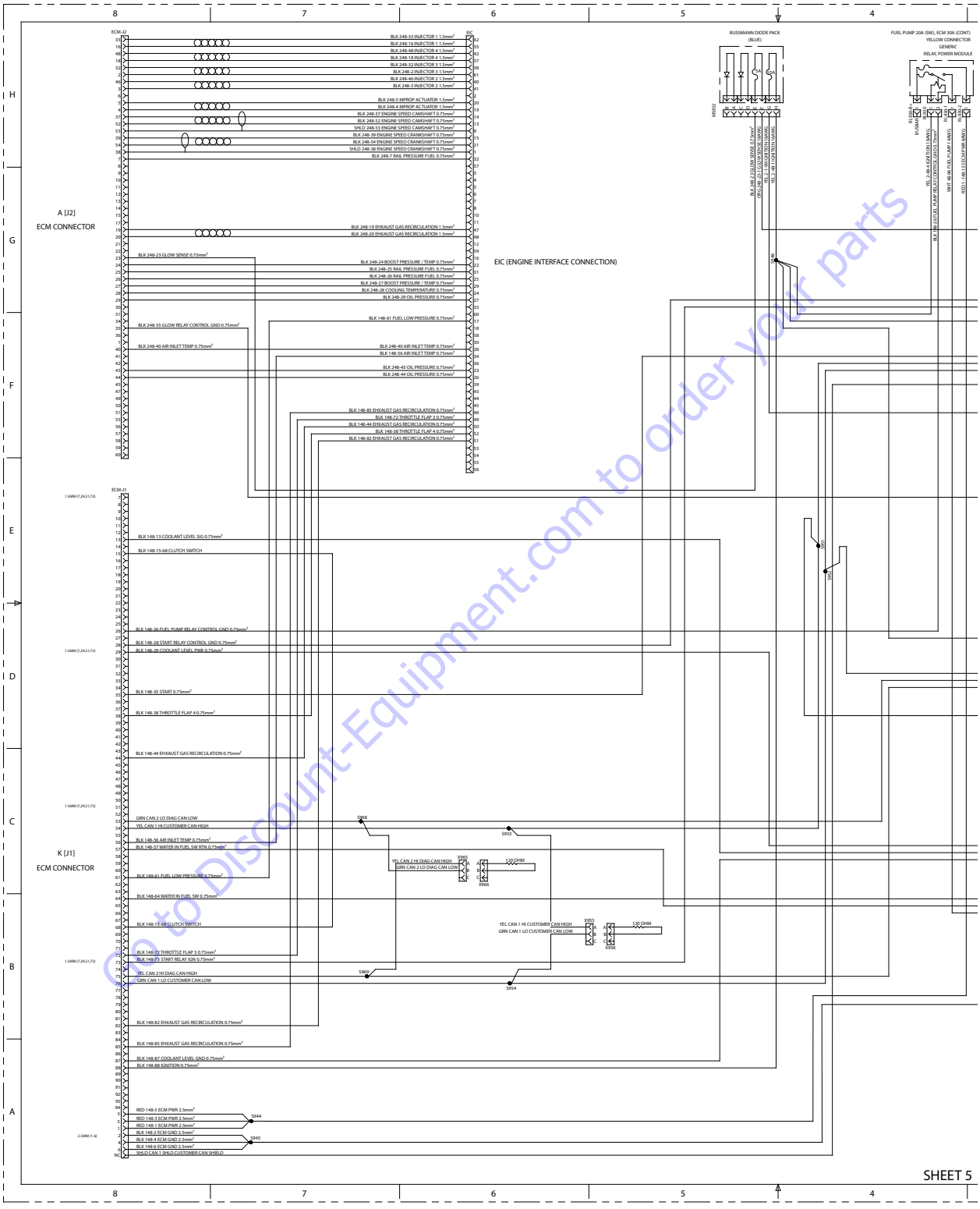


Figure 7-26. Electrical Schematic - Sheet 6 of 17

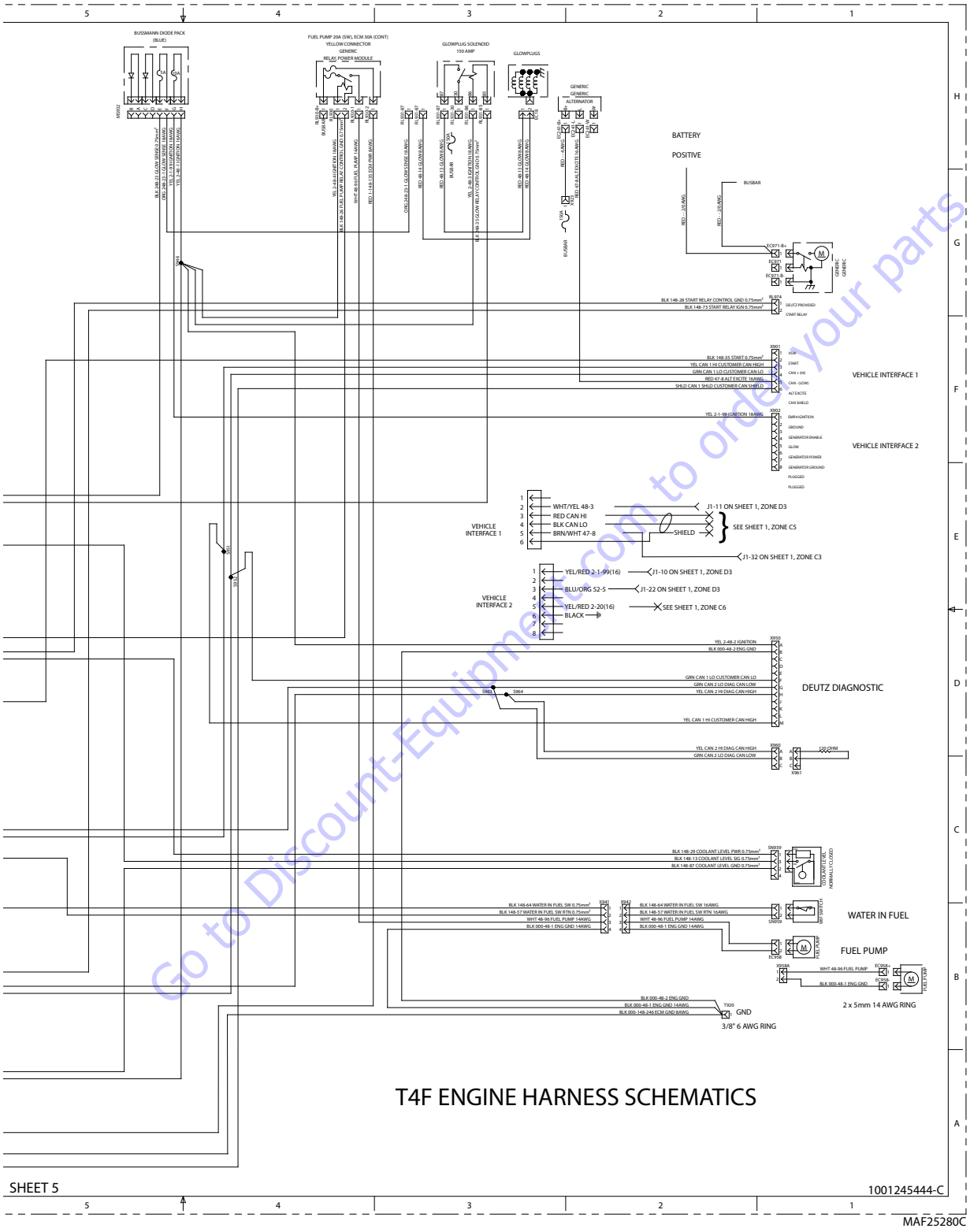


Figure 7-27. Electrical Schematic - Sheet 7 of 17

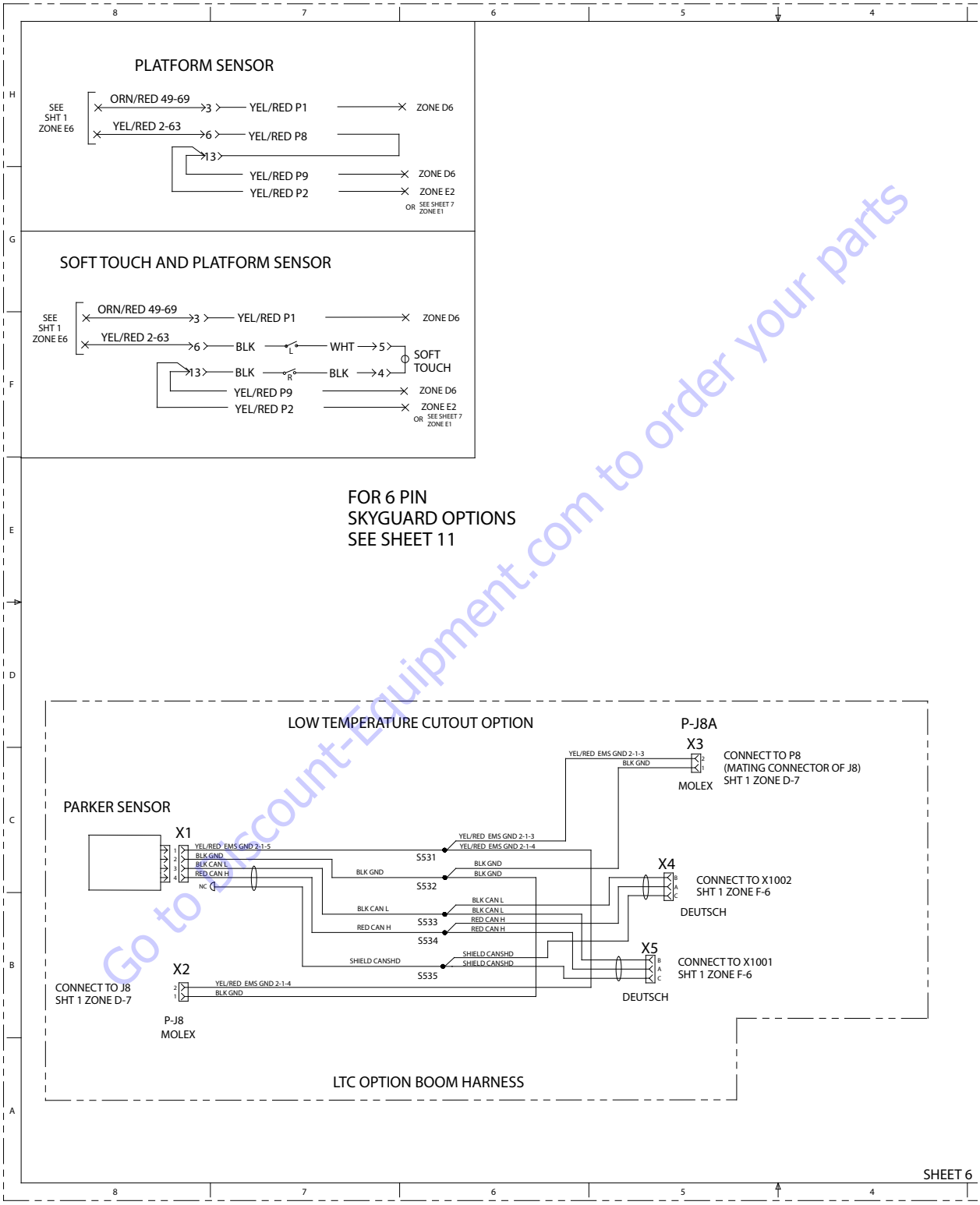


Figure 7-28. Electrical Schematic - Sheet 8 of 17

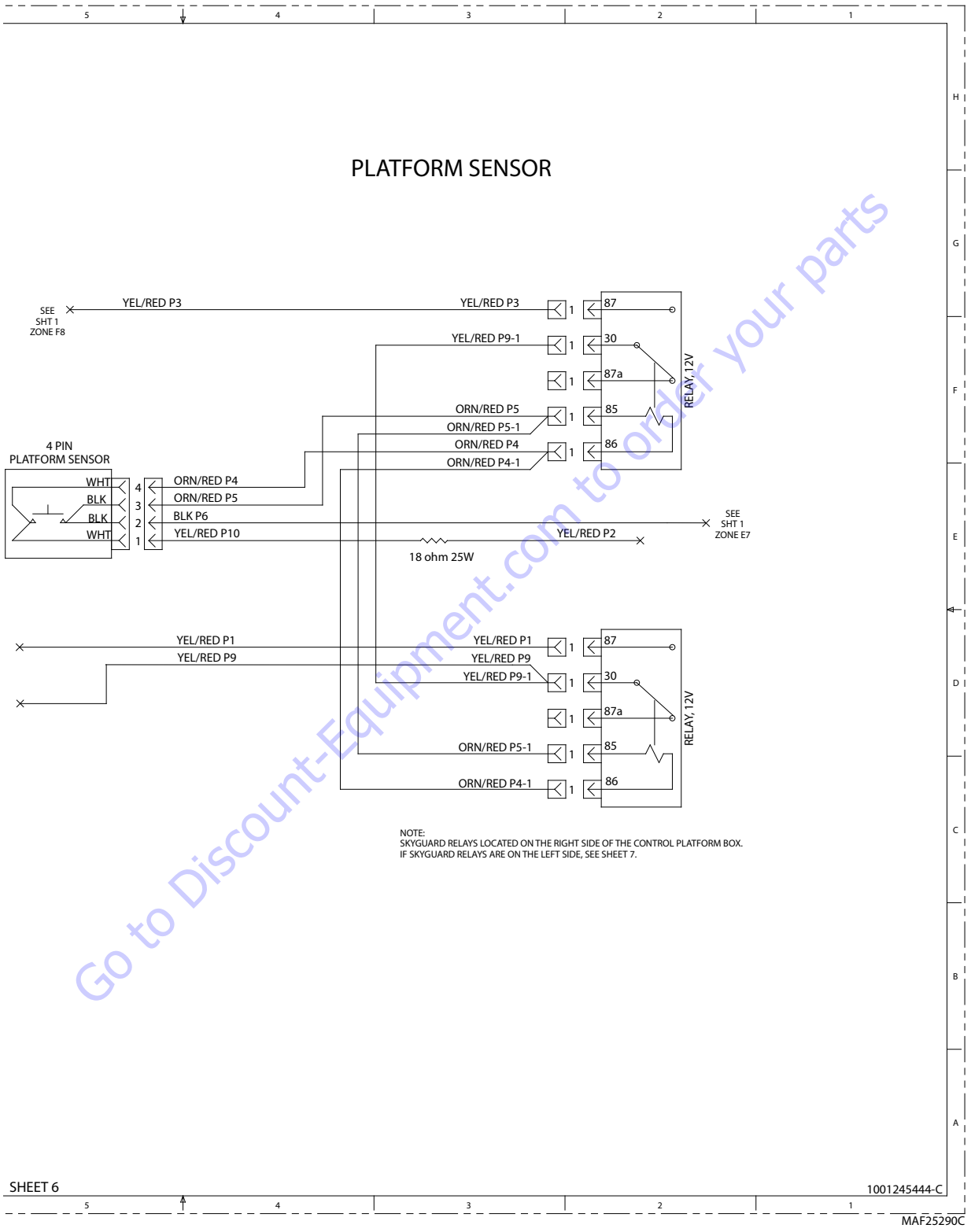


Figure 7-29. Electrical Schematic - Sheet 9 of 17

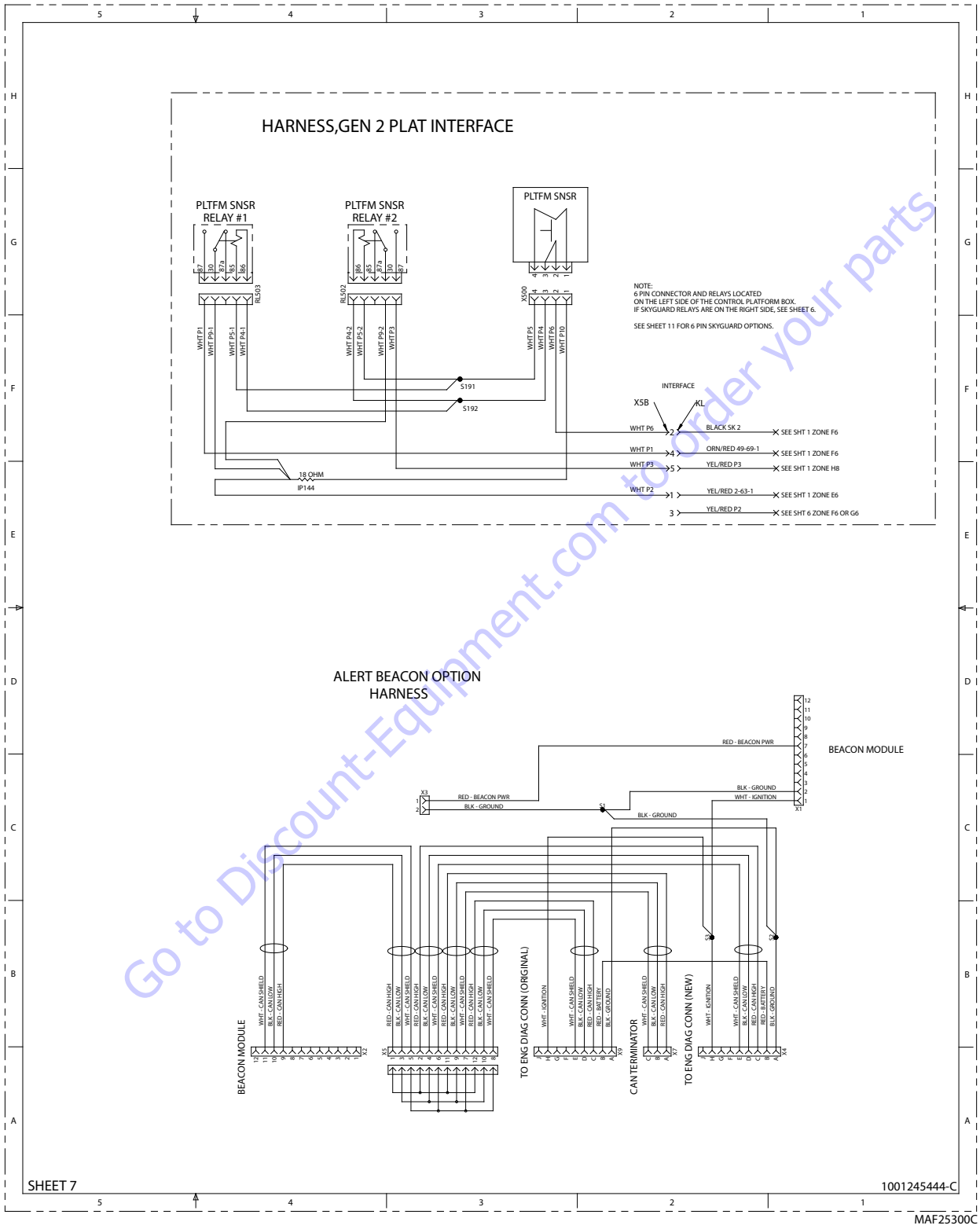


Figure 7-30. Electrical Schematic - Sheet 10 of 17

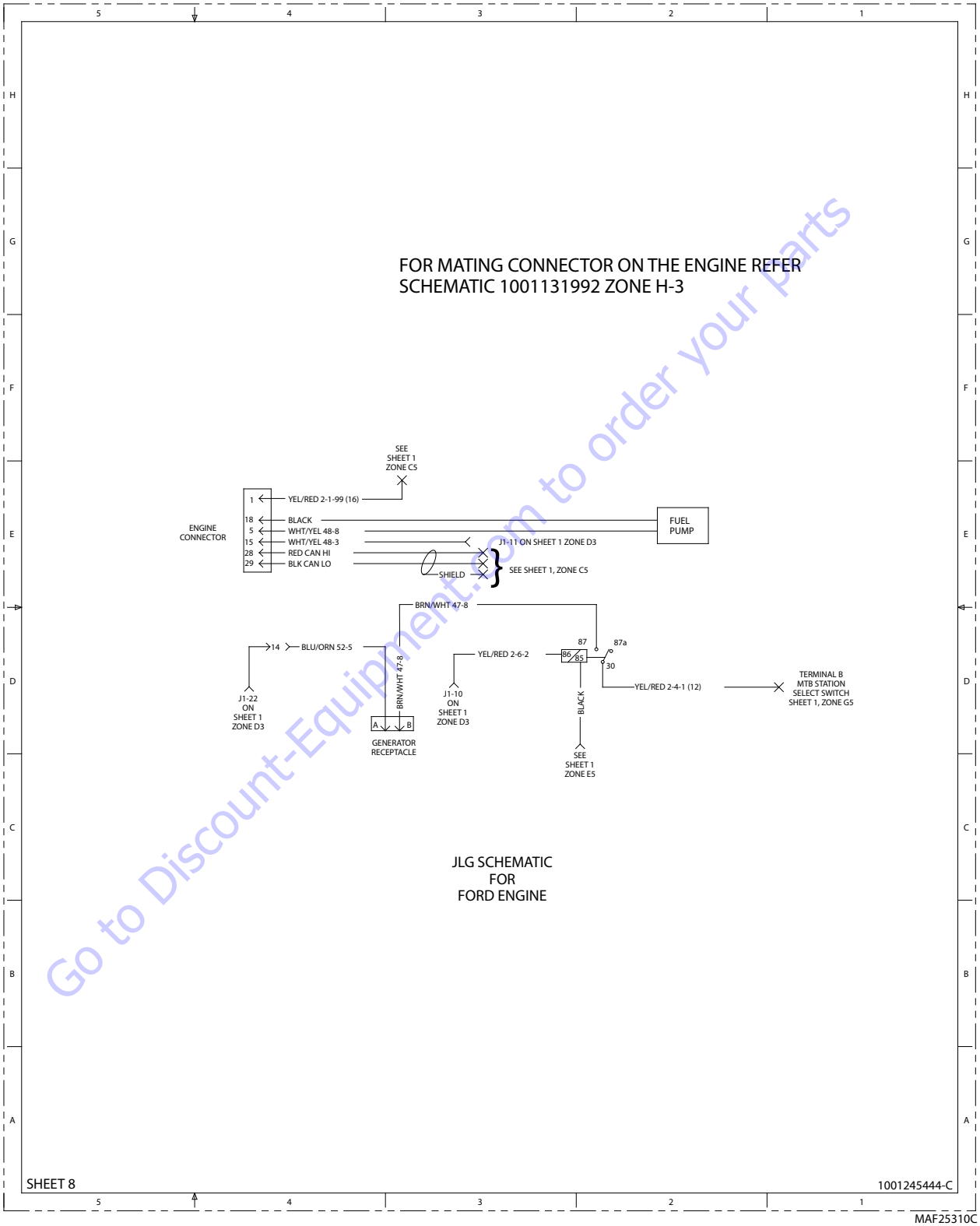


Figure 7-31. Electrical Schematic - Sheet 11 of 17

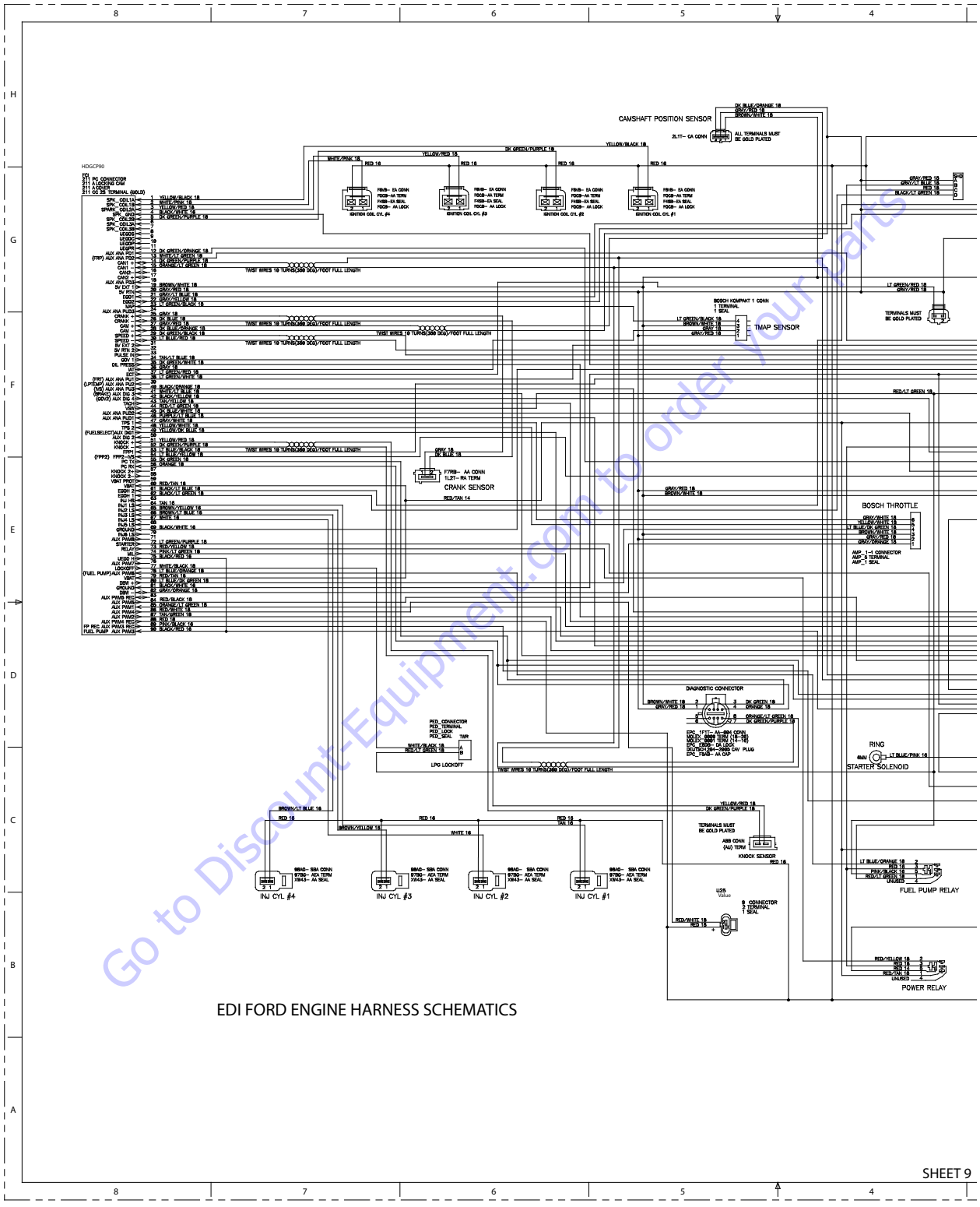


Figure 7-32. Electrical Schematic - Sheet 12 of 17

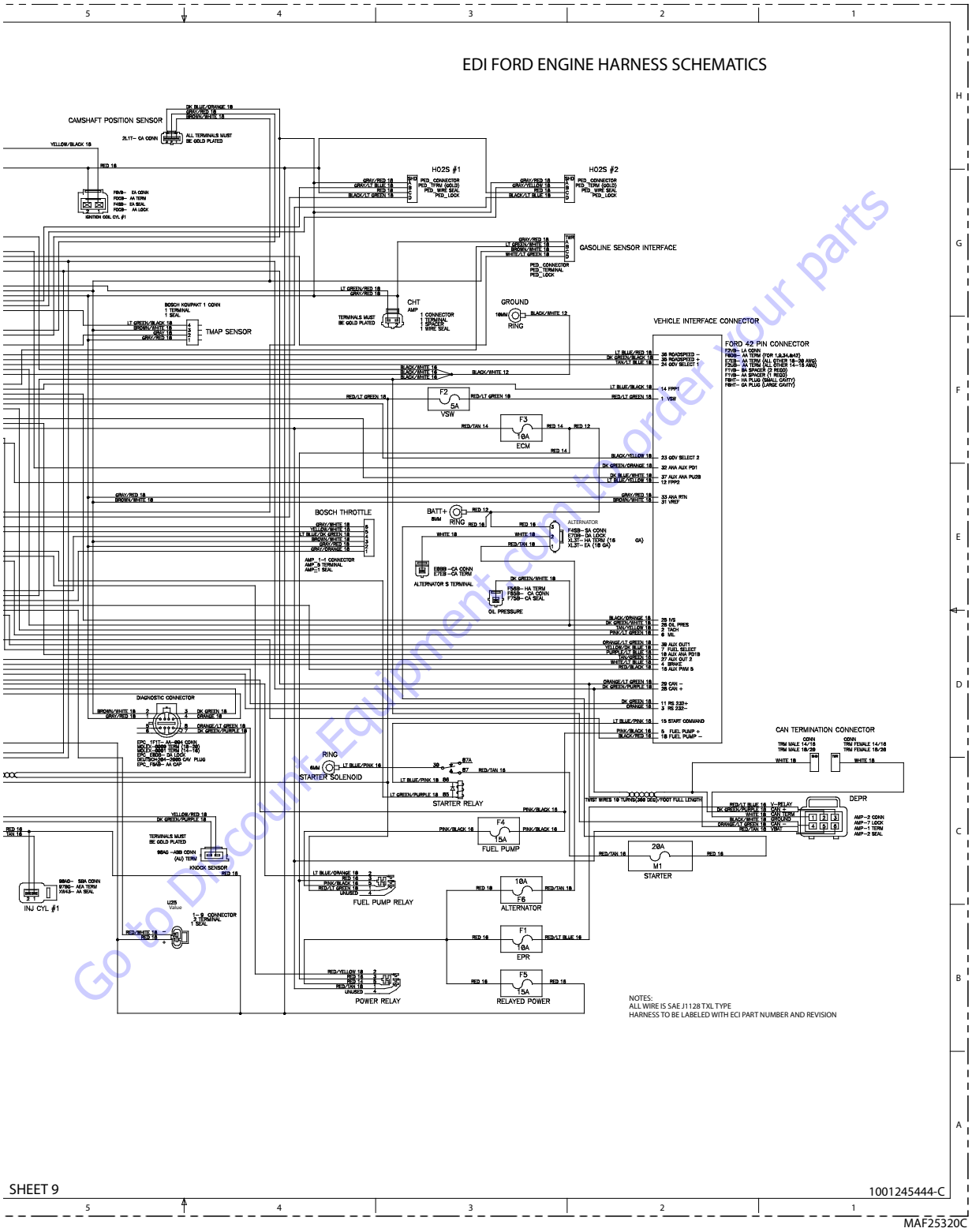


Figure 7-33. Electrical Schematic - Sheet 13 of 17

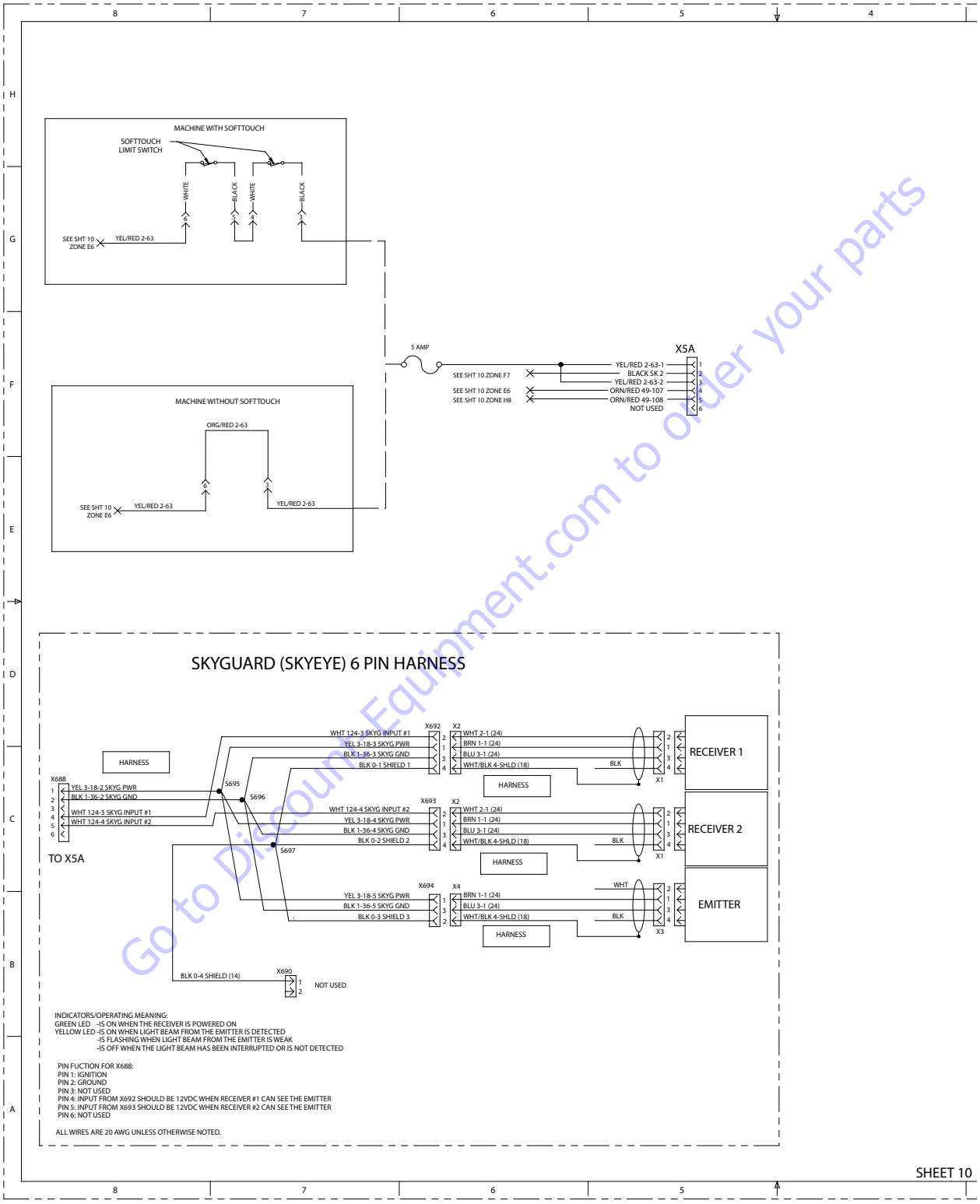


Figure 7-34. Electrical Schematic - Sheet 14 of 17

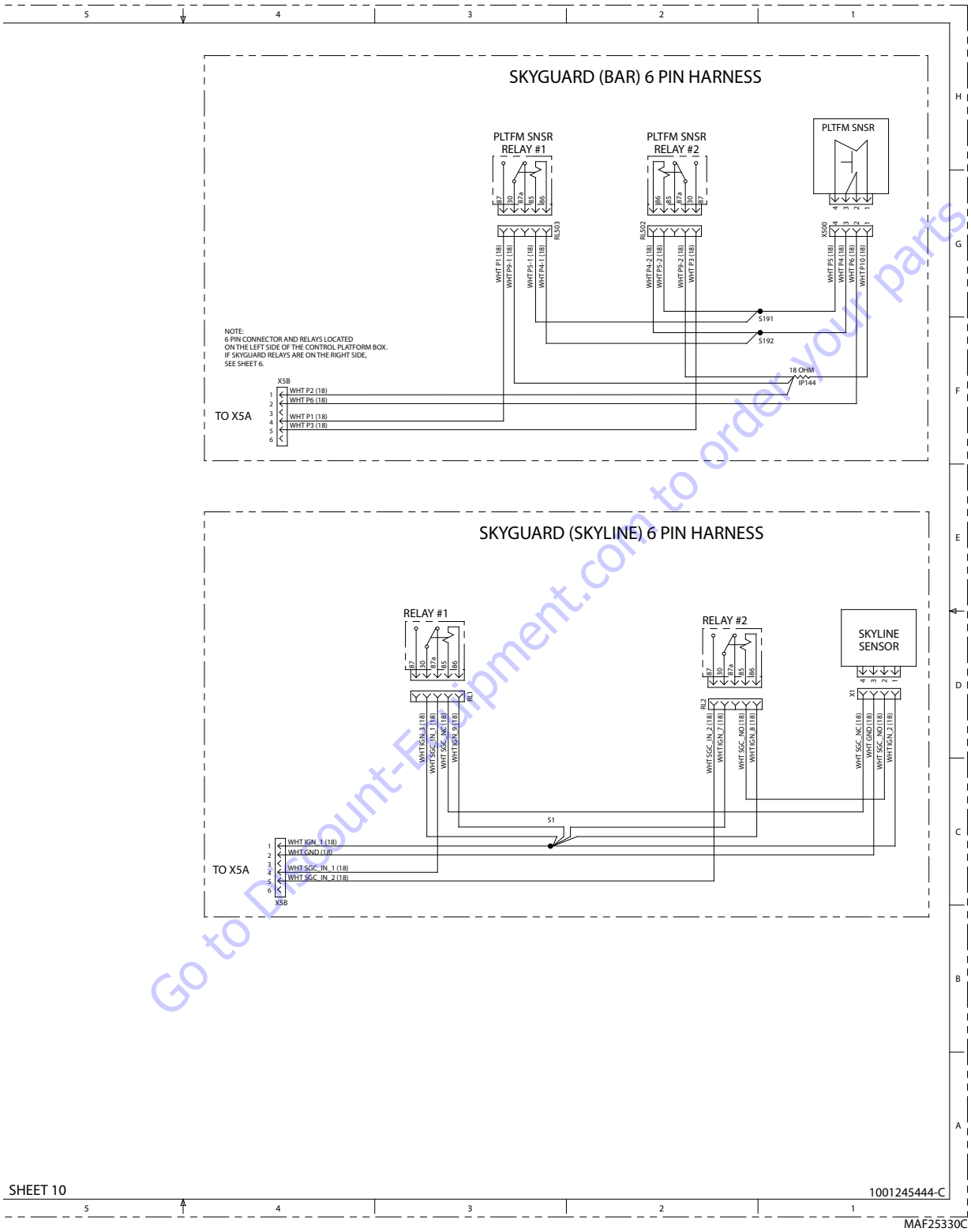


Figure 7-35. Electrical Schematic - Sheet 15 of 17

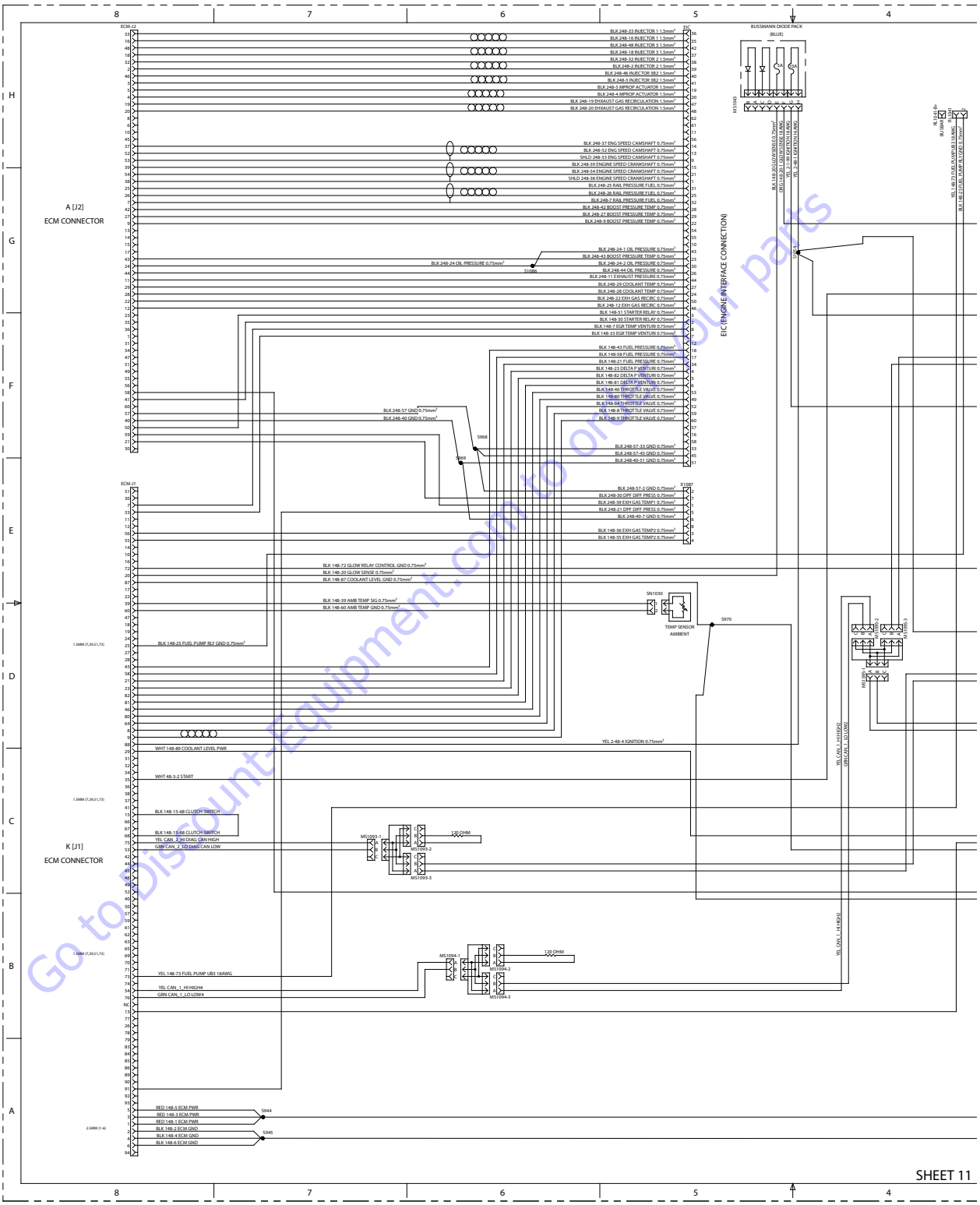


Figure 7-36. Electrical Schematic - Sheet 16 of 17

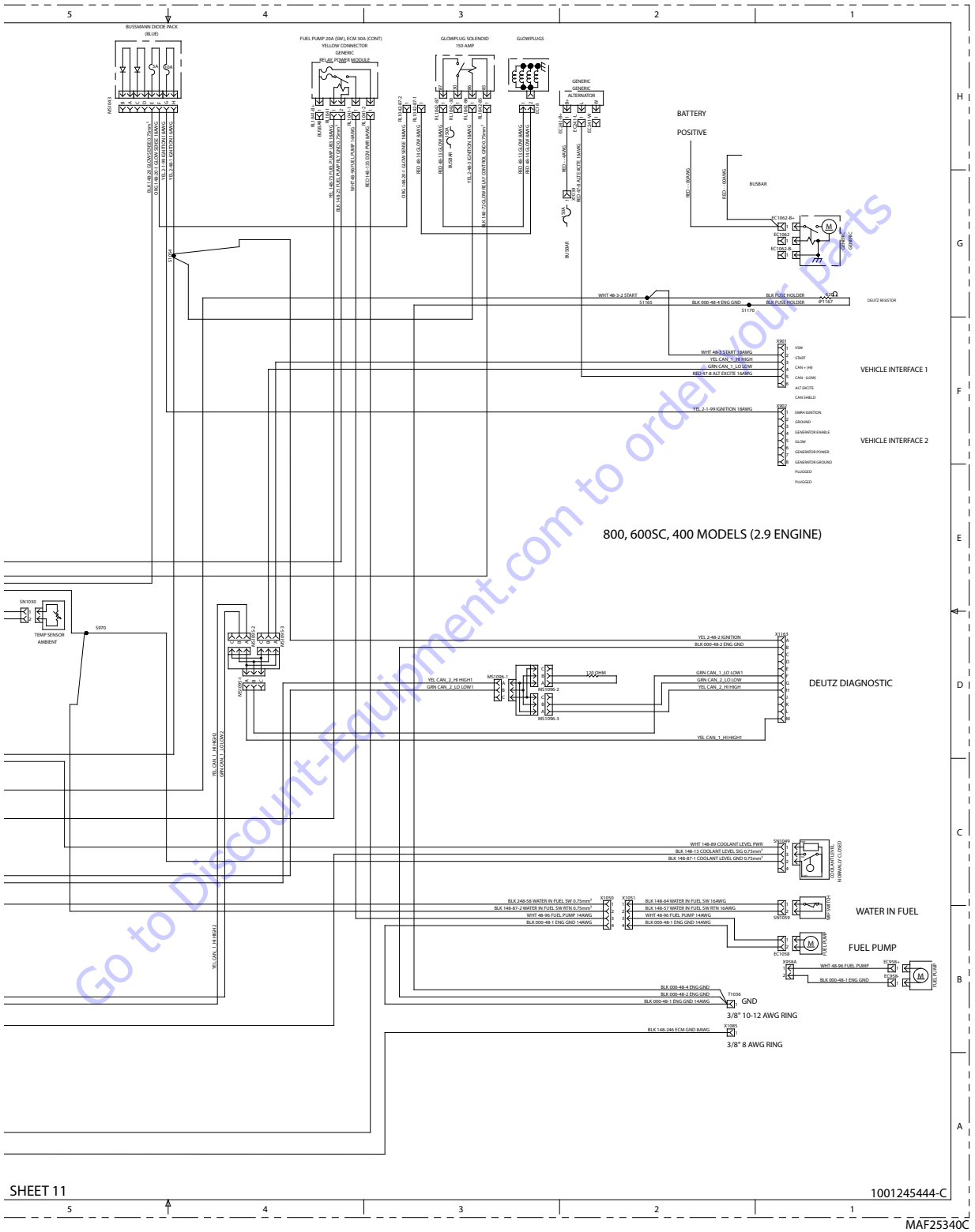


Figure 7-37. Electrical Schematic - Sheet 17 of 17

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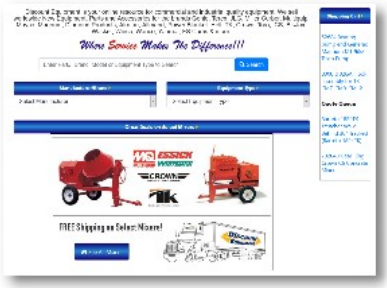

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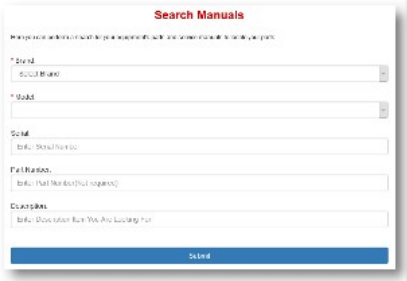

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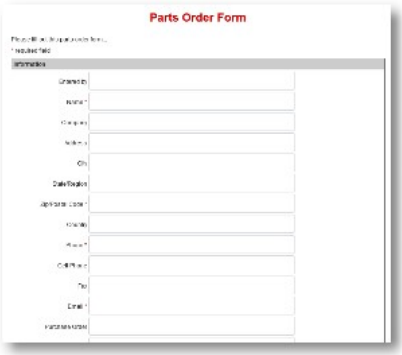

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