

## SECTION 4 - HYDRAULICS

15. Remove and discard the piston o-rings, seal rings, and backup rings.
16. If applicable, remove the piston spacer from the rod.
17. Remove the rod from the holding fixture. Remove the cylinder head gland and retainer plate, if applicable. Discard the o-rings, backup rings, rod seals, and wiper seals.

### Steer Cylinder Piston Removal

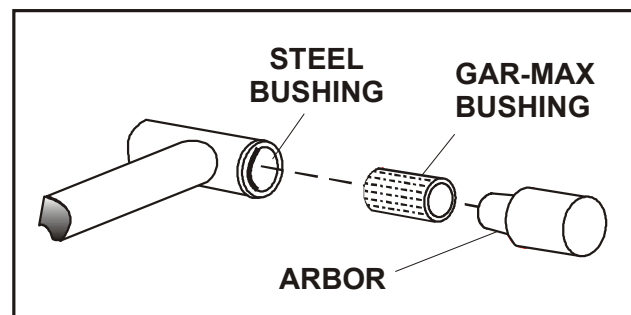
1. Using the spanner holes, rotate the piston until the end of the retaining ring can be seen through the cross-drilled retaining ring hole.
2. Insert a flathead screwdriver (or similar tool) into the cross-drilled retaining ring hole.
3. Using the screwdriver, guide the retaining ring into the cross-drilled retaining ring hole while turning the piston.
4. Continue turning the piston approximately one (1) full turn until the start of the retaining ring is again aligned with the cross-drilled retaining ring hole.
5. Lift up on the retaining ring so that the hook on the start of the retaining ring releases from the hole in the rod.
6. Pull the retraining ring all the way out of the cross-drilled retraining ring hole.
7. Slide the piston over the rod in the direction of the spanner holes to remove.

### 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 threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.

9. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
13. 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 with WD40 prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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



**Figure 4-5. Gar-Max Bearing Installation**

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
17. 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 (3121167).

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.

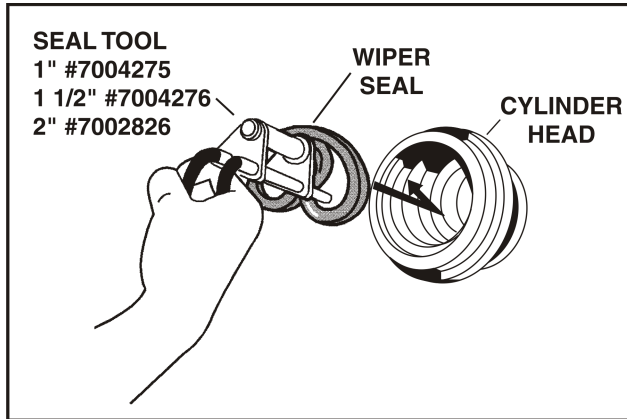


Figure 4-6. Rod Seal Installation

**NOTICE**

**WHEN INSTALLING 'POLY-PAK' PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**

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.

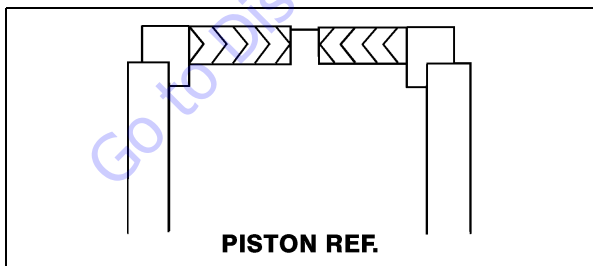


Figure 4-7. Poly-Pak Piston Seal Installation

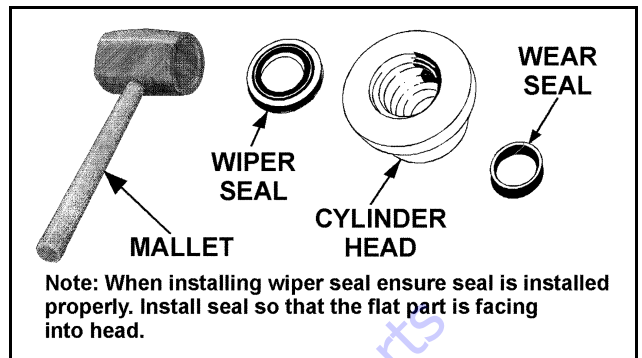


Figure 4-8. Wiper Seal Installation

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

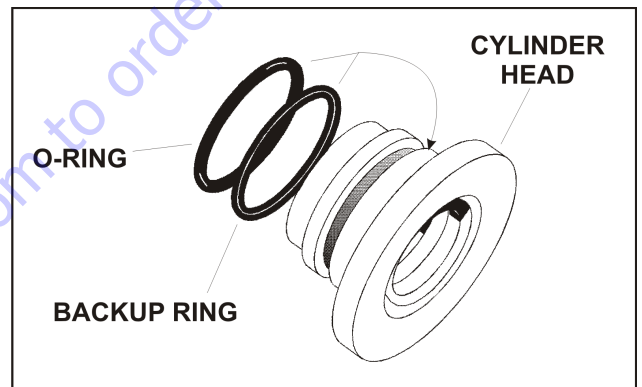


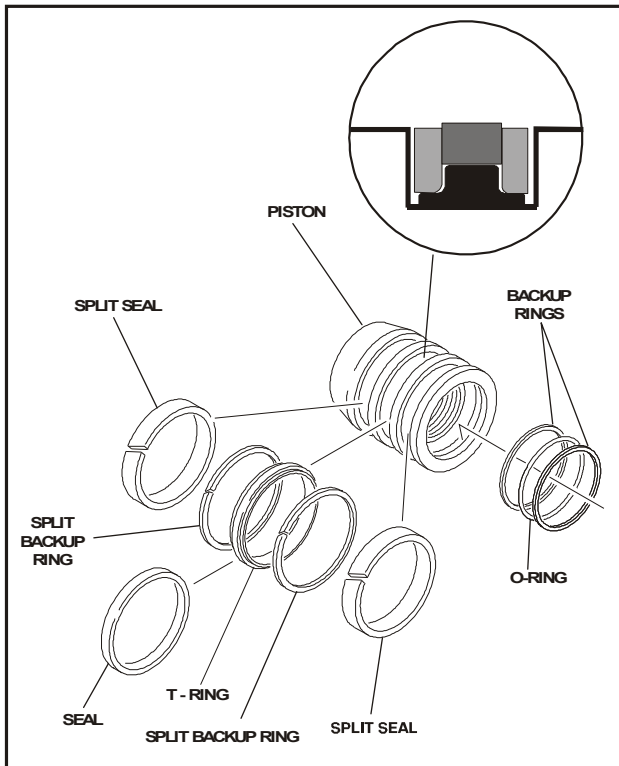
Figure 4-9. Installation of Head Seal Kit

4. Install washer ring 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. Carefully slide the piston spacer on the rod.

**NOTE:** Upper telescope cylinder piston has an o-ring installed inside the spacer.

6. If applicable, correctly place new o-ring in the inner piston diameter groove. (The backup ring side facing the O-ring is grooved.)
7. If applicable, correctly place new seals 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.)

**NOTE:** The backup rings for the solid seal have a radius on one side. This side faces the solid seal. (See magnified insert in Figure 4-9. The split of seals and backup rings are to be positioned so as not to be in alignment with each other.)



**Figure 4-10. Piston Seal Kit Installation**

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

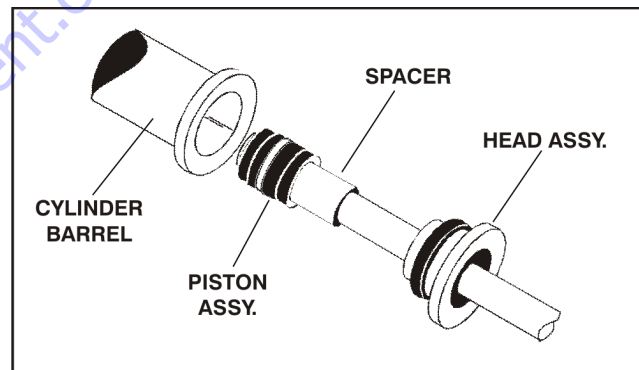
11. Assemble the tapered bushing loosely into the piston and insert JLG capscrews (not vendor capscrews) through the drilled holes in the bushing and into the tapped holes in the piston.
12. Tighten the capscrews evenly and progressively in rotation to the specified torque value.
13. After the screws 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.

14. Retorque the capscrews evenly and progressively in rotation to the specified torque value.
15. Remove the cylinder rod from the holding fixture.
16. Place new guide locks and seals in the applicable outside diameter grooves of the cylinder piston. (See Figure 4-10.)
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 the 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.
20. Secure the cylinder head gland using the washer ring and socket head bolts.



**Figure 4-11. Rod Assembly Installation**

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. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. (See Table 4-3, Holding Valve Torque Specifications).

**Table 4-2. Cylinder Piston Nut Torque Specifications**

Description	Nut Torque Value	Setscrew torque Value
Lift Cylinder	250-300 ft. lbs. (339-407 Nm)	N/A

23. Push the piston onto the rod until it abuts the spacer end and install the attaching nut.

**Table 4-3. Holding Valve Torque Specifications**

Description	Torque Value
Integrated Steer	15 ft. lbs. (20 Nm)
Integrated Proportional Valve	15 ft. lbs. (20 Nm)
Integrated Blocking Valve	15 ft. lbs. (20 Nm)
Relief	33 ft. lbs. (45 Nm)
Coil Nuts	Hand Tighten

**⚠ WARNING**

**WHEN REBUILDING THE CYLINDERS, APPLY MEDIUM STRENGTH THREADLOCKING COMPOUND TO THE PISTON NUT AND SETSCREW, THEN TORQUE PISTON NUT. REFER TO TABLE 4-2, CYLINDER PISTON NUT TORQUE SPECIFICATIONS.**

**NOTE:** Reverse the procedure Steer Cylinder Piston Removal on page 4-8 for installing the steer cylinder piston.

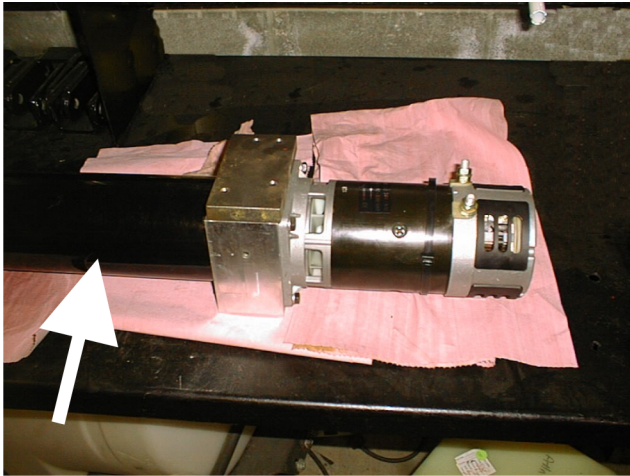
24. Remove the cylinder rod from the holding fixture.
25. Position the cylinder barrel in a suitable holding fixture.

**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.**

26. 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.
27. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
28. If applicable, secure the cylinder head retainer using a suitable chain wrench.
29. 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.
30. If applicable, install the cartridge-type holding valve and fittings in the port block using new o-rings as applicable. Refer to Table 4-3, Holding Valve Torque Specifications.

### Pump Removal



1. Place the pump/motor assembly on a clean workbench.

**NOTE:** Drain the hydraulic oil by carefully removing the oil fill plug located on the left side of the hydraulic reservoir.

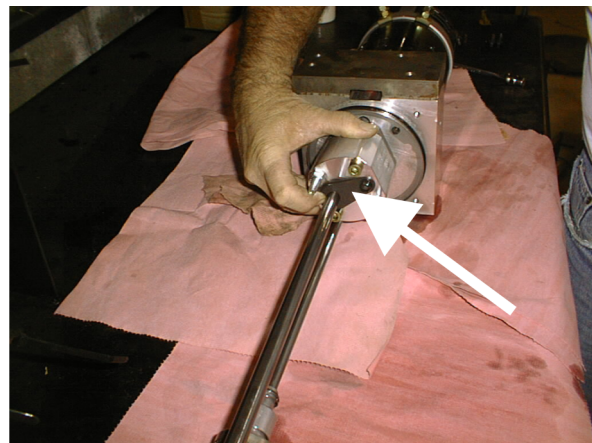


2. Remove the oil tank from the lift cylinder as follows:
  - a. Slowly loosen and remove the four bolts that hold the tank on to the cylinder.
  - b. Carefully remove the tank from the valve body taking care not to damage internal pickup tube or o-ring gasket on tank.
  - c. Place tank on a suitable work bench or work area.

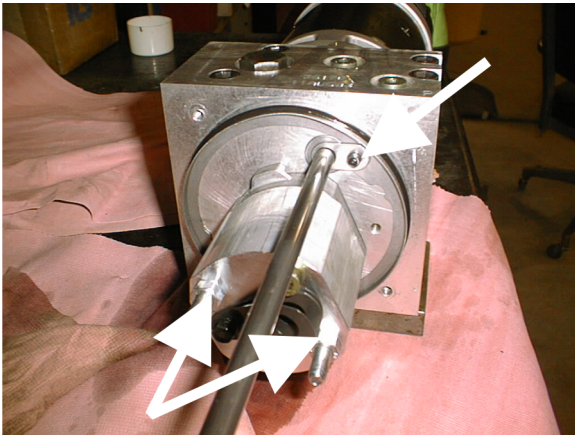
**NOTE:** The filter and bypass are located on the pickup tube inside the tank.

The filter should be changed once a year.

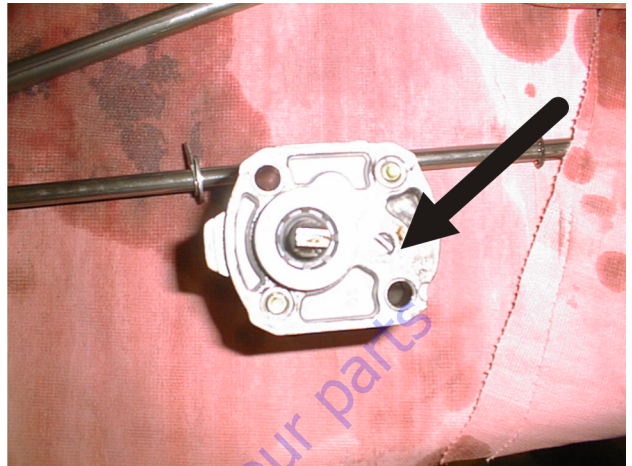
3. If replacing filter, pull old filter off the end of the tube and push new filter onto the end of tube.
4. Thoroughly clean the tank and clean any debris from the magnet.
5. Wipe out tank with clean, lint free rag, taking care not to introduce debris or dirt.
6. Replace the tank. Torque mounting bolts to 20-25 in-lb.
7. If only replacing the oil filter and maintenance is complete, reinstall cylinder assembly on machine, remove fill plug and refill tank with proper grade of oil by using a funnel. Fill until oil weeps out of opening.
8. Replace plug and torque to 40 ft. lbs. (56 Nm).



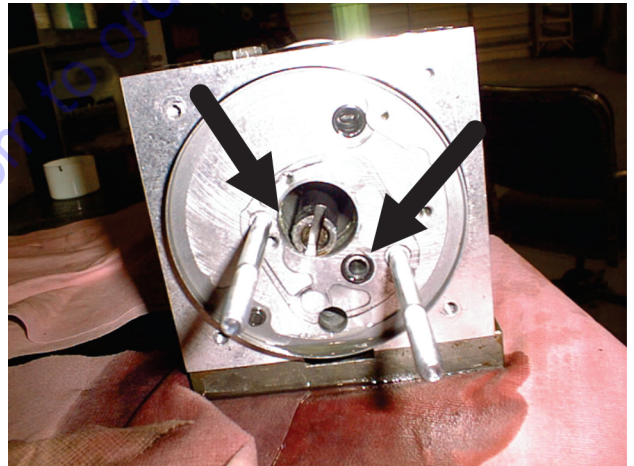
9. To remove the oil pickup line, squeeze retainer and slide outward.
10. Replace the o-ring if necessary.



11. Remove allen nut on the return/filter line and rotate large retainer ring to remove return/filter line.
12. Replace the return/filter line oring if necessary.
13. With the return line and the pickup tube removed, the pump can be removed.
14. Loosen and remove the two hexhead nuts from the pump and block. Remove pump from valve body.



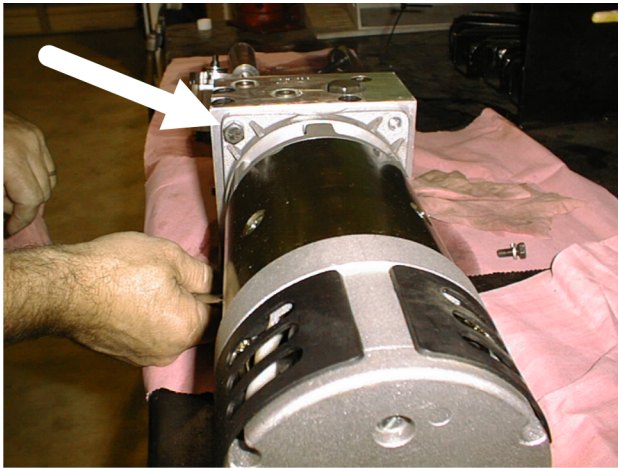
**NOTE:** Be sure to remove and discard the plastic plug at the oil inlet on the new pump before installing.



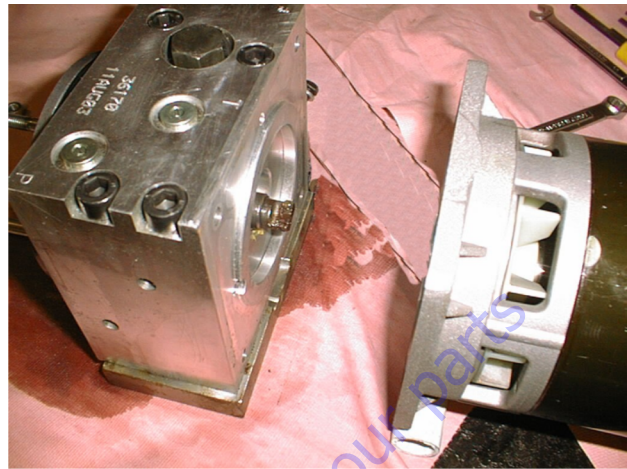
15. Check oring on valve body and replace if necessary before installing the new pump. Lubricate orings before assembling.

**NOTE:** There are two orings used to seal the pump to the valve body, one for the pump inlet (shown above) and one on the pump boss around the drive coupler.

**Motor Removal**



1. Remove the four bolts attaching the motor to the valve body.



2. Pull motor from valve body.
3. Once all maintenance is performed and lift cylinder assembly is reinstalled on the machine, remove fill plug and refill tank with proper grade of oil by using a funnel. Fill until oil weeps out of opening.
4. Replace plug and torque to 40 ft. lbs.

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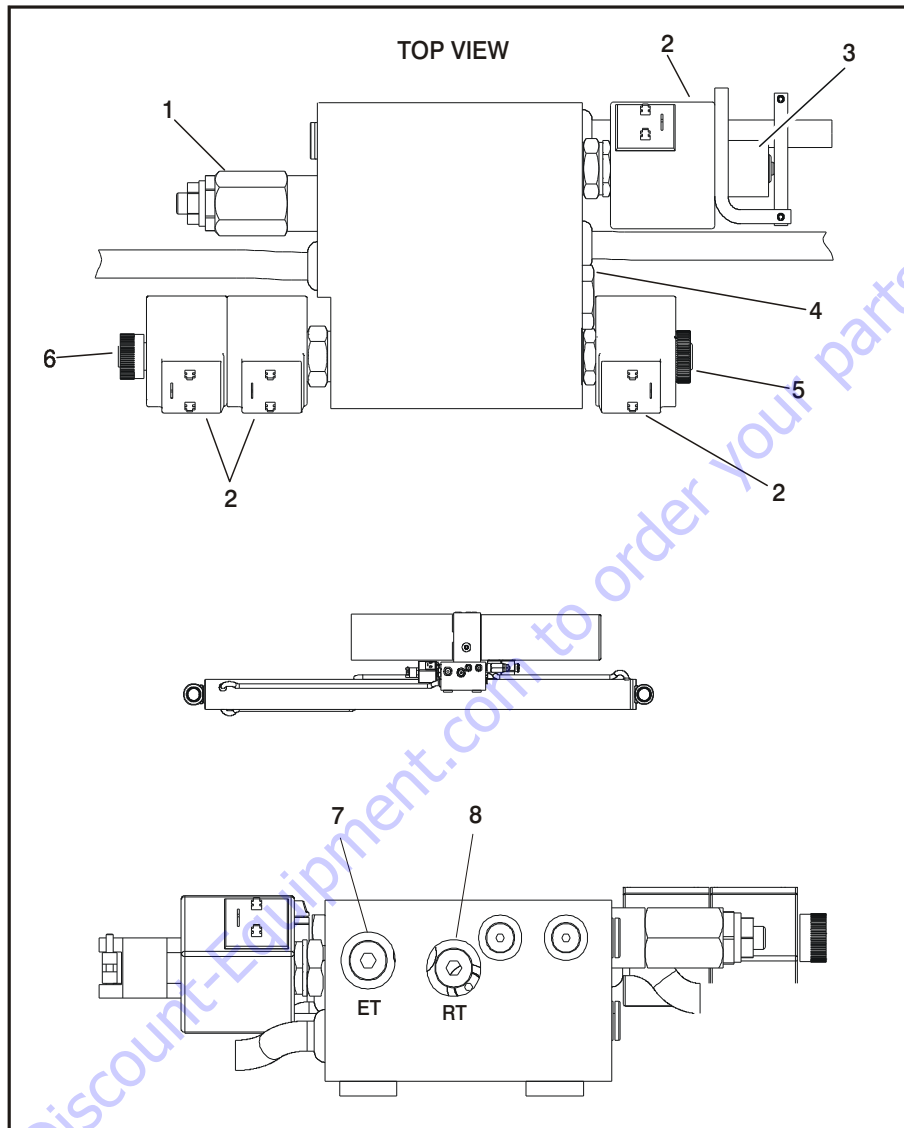


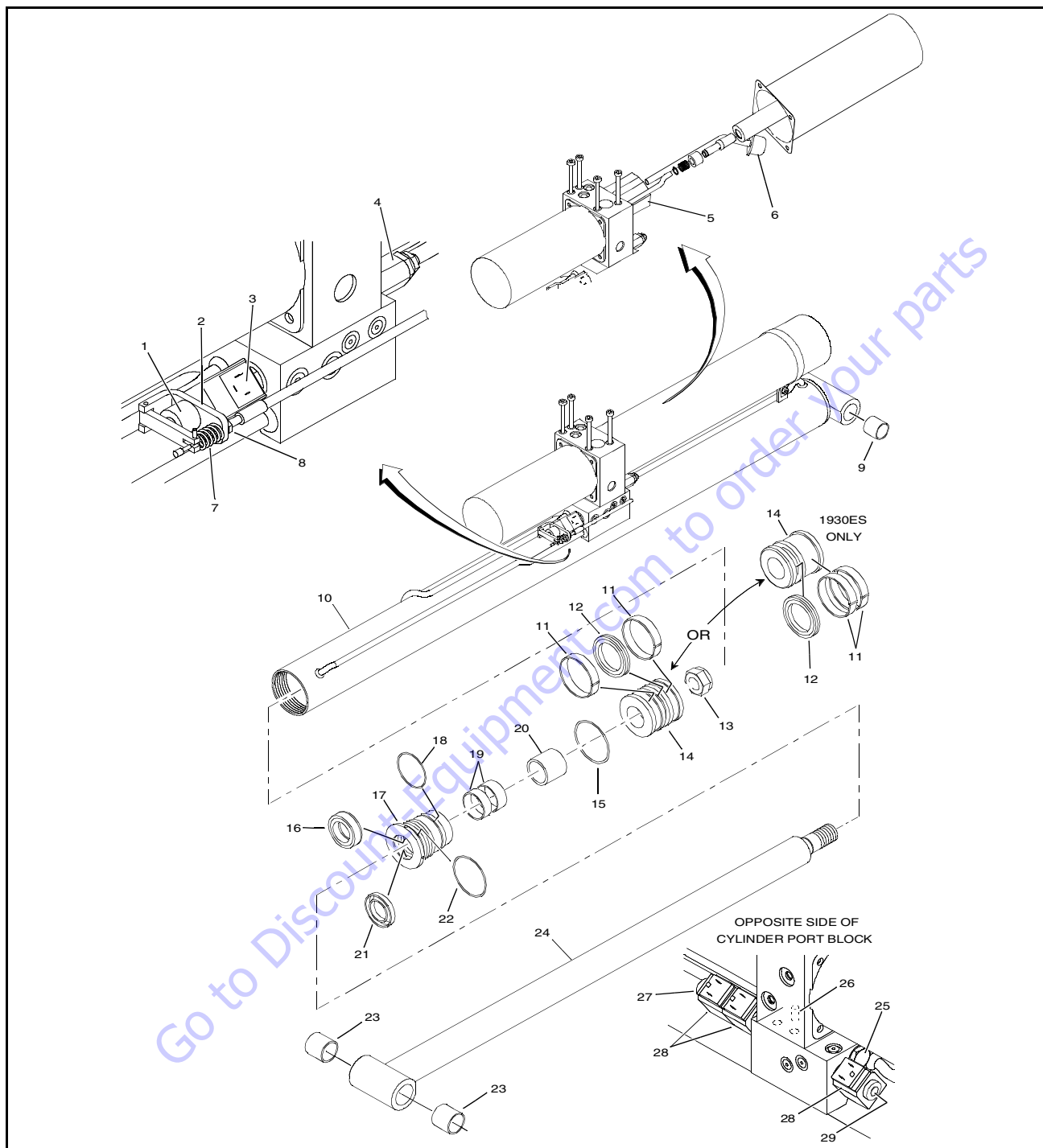
Figure 4-12. Lift Cylinder/Pump/Tank Assembly

Table 4-4. Valve Torque Values

Item	Description	Torque
1	Bi-directional Relief Valve	33 ft. lbs. (45 Nm)
2	Solenoid	NA
3	Proportional Valve	15 ft. lbs. (20 Nm)
4	Check Valve	33 ft. lbs. (45 Nm)
5	Blocking Valve	15 ft. lbs. (20 Nm)
6	4Way Directional Valve	15 ft. lbs. (20 Nm)
7	Extend Port	NA
8	Retract Port	NA

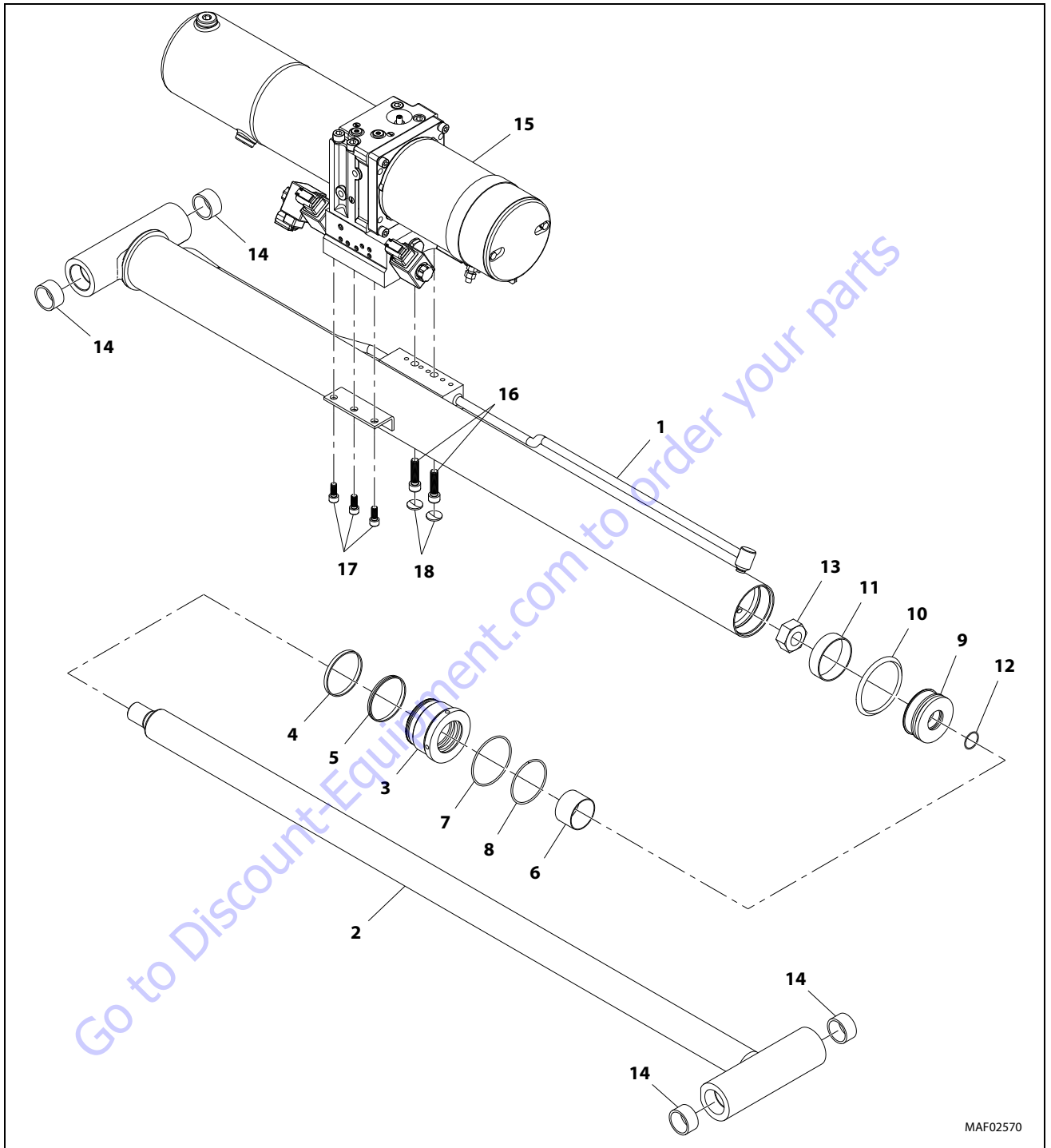


## SECTION 4 - HYDRAULICS



- |                            |               |             |                  |                               |
|----------------------------|---------------|-------------|------------------|-------------------------------|
| 1. Proportional Valve      | 7. Spring     | 13. Locknut | 19. Wear Ring    | 25. Check Valve               |
| 2. Emergency Release Assy. | 8. Jam Nut    | 14. Piston  | 20. Spacer       | 26. Dowel Pin                 |
| 3. Coil                    | 9. Bushing    | 15. O-ring  | 21. Wiper        | 27. Directional Control Valve |
| 4. Relief Valve            | 10. Barrel    | 16. Seal    | 22. O-ring       | 28. Coil                      |
| 5. Pump                    | 11. Wear Ring | 17. Head    | 23. Bushing      | 29. Directional Control Valve |
| 6. Filter                  | 12. Seal      | 18. O-ring  | 24. Cylinder Rod |                               |

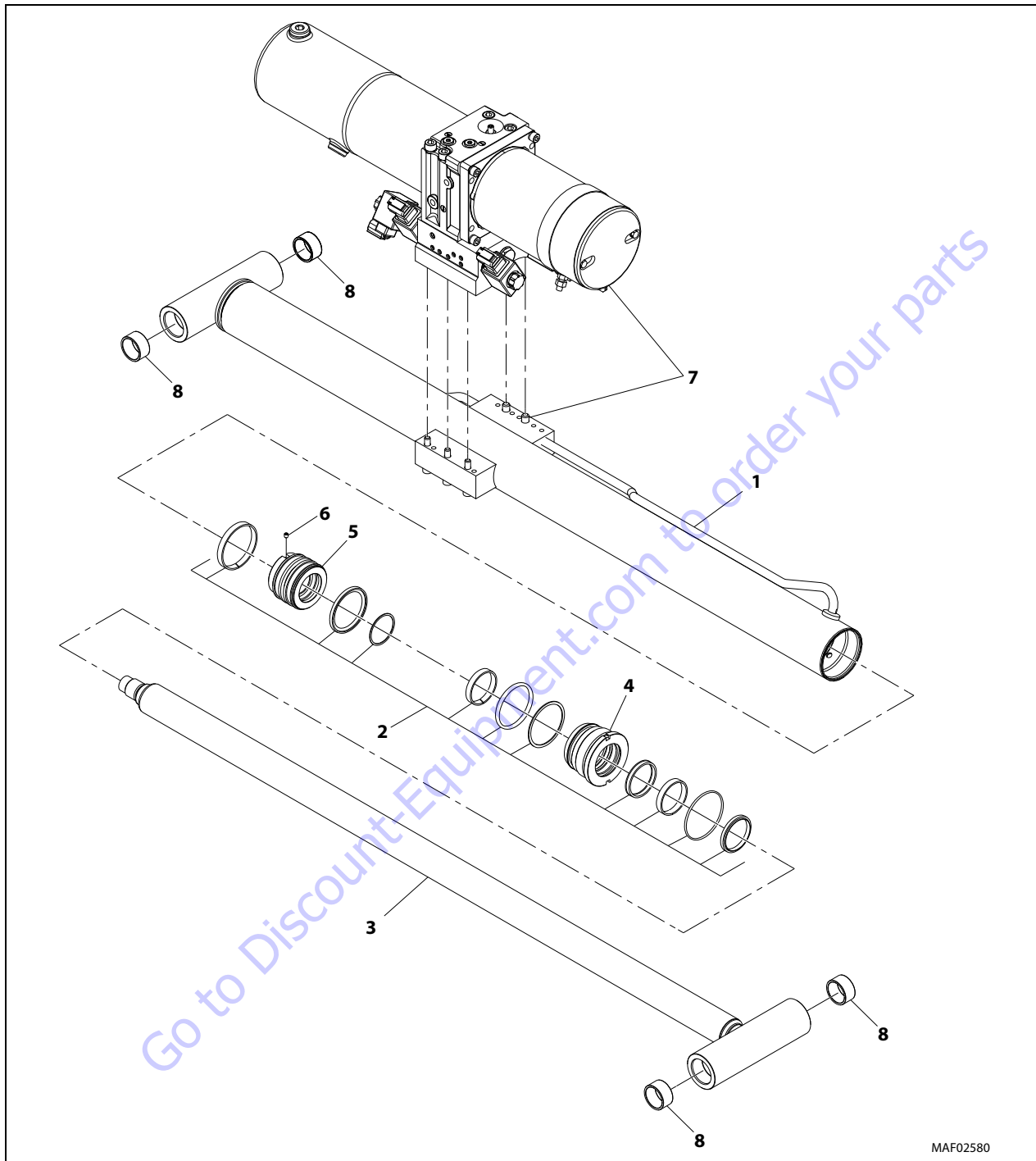
**Figure 4-13. Lift Cylinder Assembly**



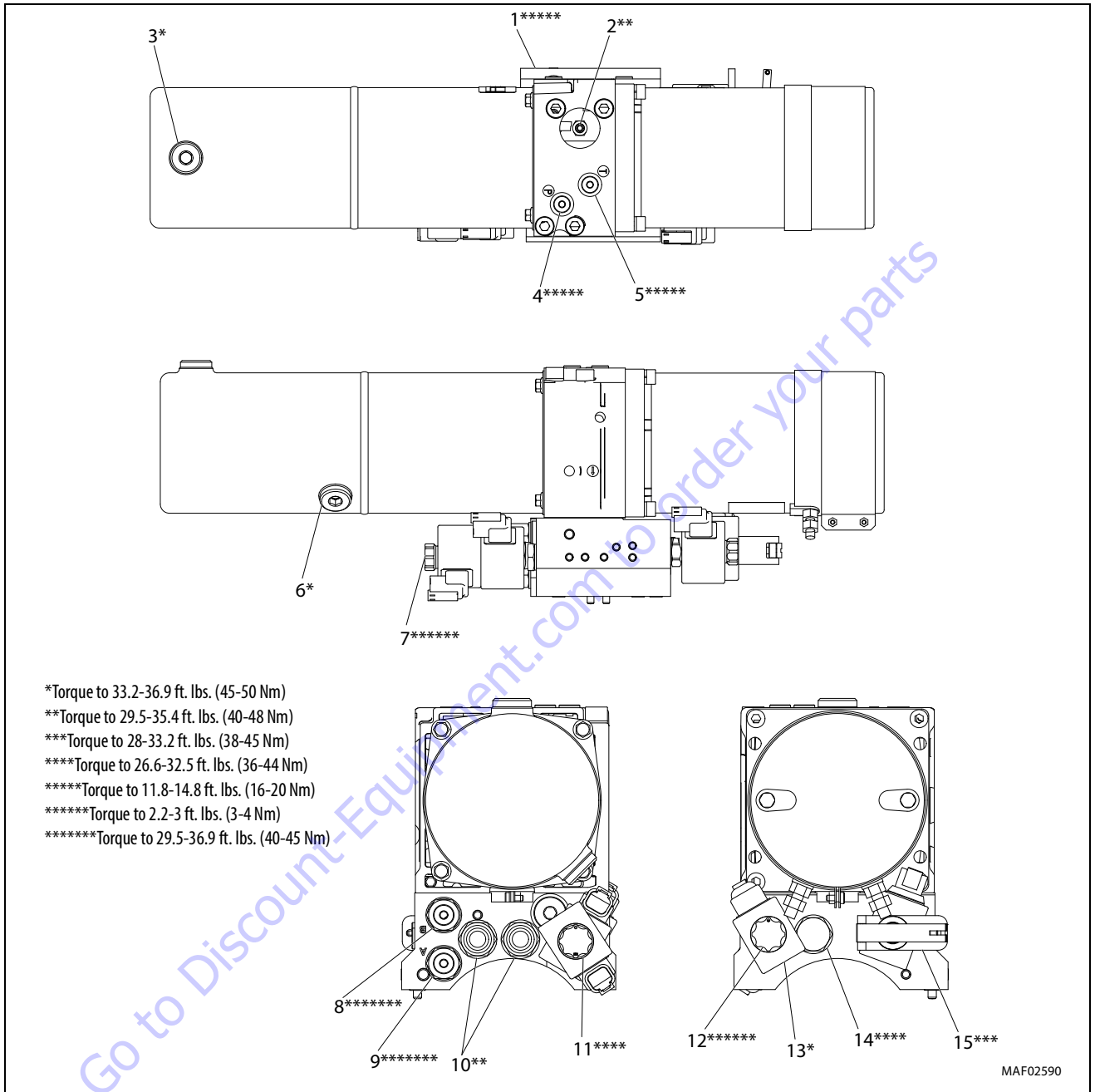
- |                  |            |               |                              |                    |
|------------------|------------|---------------|------------------------------|--------------------|
| 1. Barrel        | 5. Seal    | 9. Piston     | 13. Nut                      | 16. Capscrew       |
| 2. Rod           | 6. Bearing | 10. Seal      | 14. Bushing                  | 17. Capscrew       |
| 3. Cylinder Head | 7. O-Ring  | 11. Wear Ring | 15. Motor/Pump/Tank Assembly | 18. Extension Plug |
| 4. Dust Seal     | 8. O-Ring  | 12. O-Ring    |                              |                    |

Figure 4-14. Lift Cylinder Assembly (1930ES) (SH-PAC)

## SECTION 4 - HYDRAULICS



**Figure 4-15. Lift Cylinder Assembly (1930ES) (Serta)**



- |                 |                |                   |                                  |                            |
|-----------------|----------------|-------------------|----------------------------------|----------------------------|
| 1. TR & TS Port | 4. P Port      | 7. Steer Coil Nut | 10. Steer Relief Valve           | 13. Lift Solenoid Valve    |
| 2. Relief Valve | 5. T Port      | 8. Steer Port B   | 11. Steer Solenoid Valve         | 14. Lift/Steer Check Valve |
| 3. Drain Plug   | 6. Filler Plug | 9. Steer Port A   | 12. Lift Solenoid Valve Coil Nut | 15. Descent Valve          |

Figure 4-16. Lift Cylinder Assembly - Motor/Pump/Tank Assembly

# PARTS FINDER

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by Part Number**



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A screenshot of the "Search Manuals" form. It includes fields for "Brand", "Model", "Serial", "Part Number", "Part Name", and "Quantity". There is a "Search" button at the bottom.

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A screenshot of the "Parts Order Form". It includes fields for "Manufacturer", "Model", "Description", "Part Number", "Part Name", "Quantity", and "Price". There is a "Submit" button at the bottom.

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## SECTION 5. JLG CONTROL SYSTEM

## 5.1 DIAGNOSTIC PORT

The diagnostic port is located behind the battery cover at the near the ground control station as shown below. The MDI (Multifunction Digital Indicator) and the JLG Hand-Held Analyzer can be connected at this port.

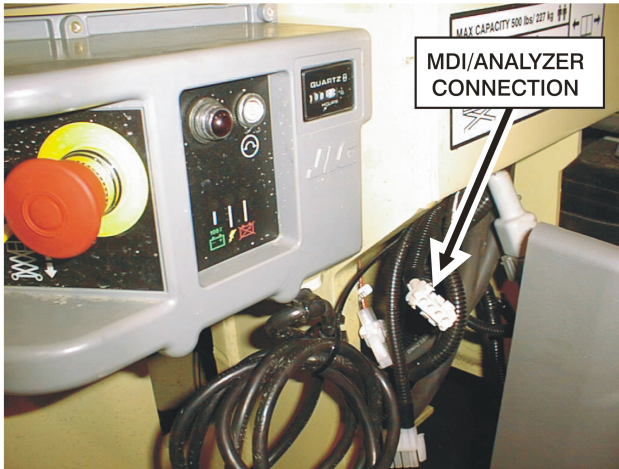


Figure 5-1. Diagnostic Port

## 5.2 HAND HELD ANALYZER

**To Connect the Hand Held Analyzer:**

1. Connect the four pin end of the cable supplied with the analyzer, to the diagnostic port (refer to Figure 5-1.) 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 position and pulling both emergency stop buttons on.

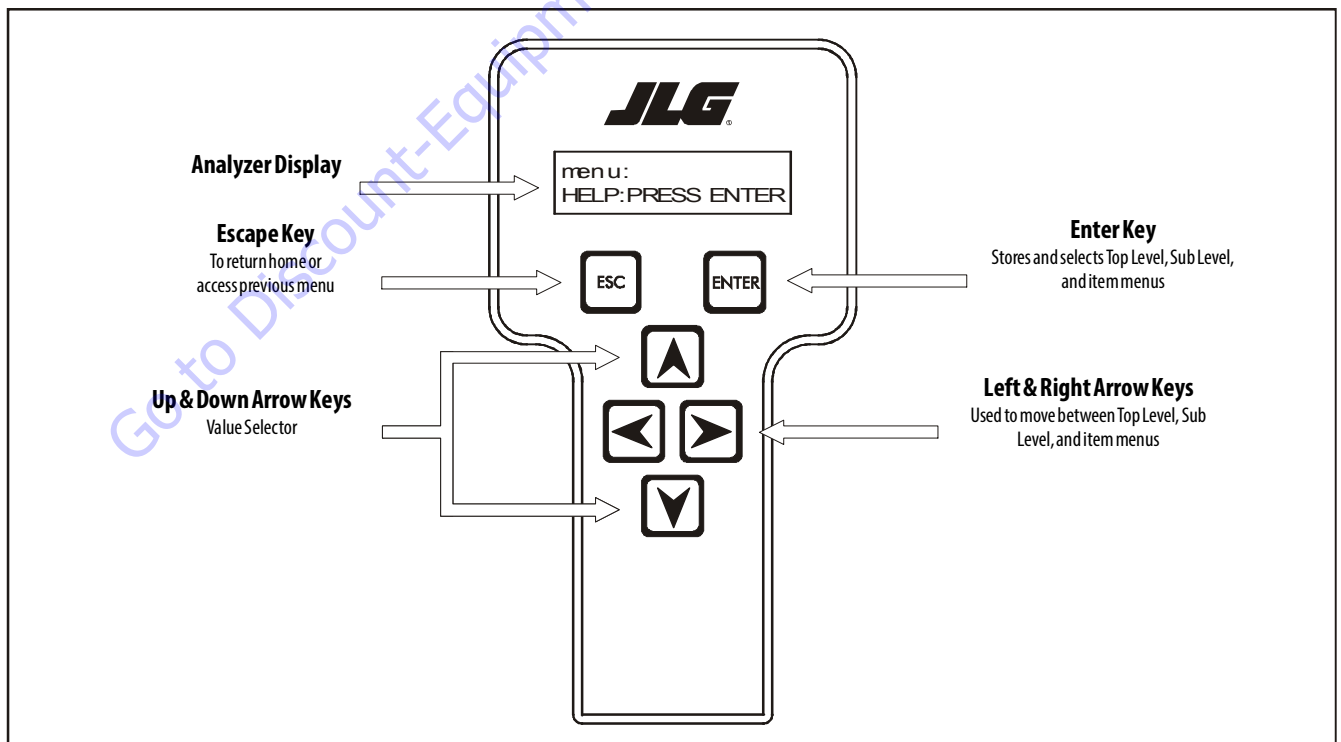
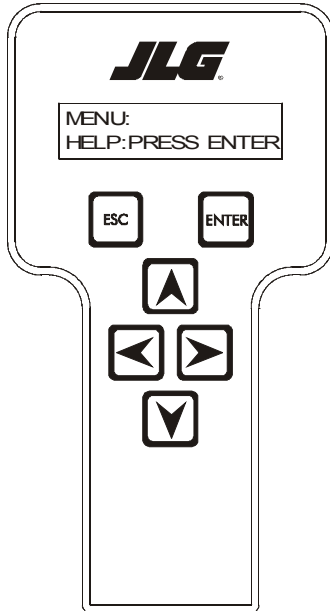


Figure 5-2. Hand Held Analyzer

**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 **ESC**; then you will be able to scroll using the right and left arrow keys to select a different menu item.

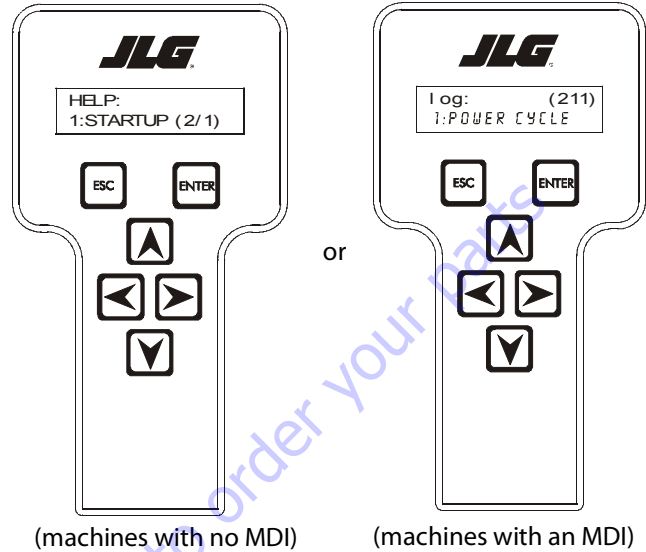
The top level menus are as follows:

- HELP**
- DIAGNOSTICS**
- ACCESS LEVEL**
- PERSONALITIES**
- MACHINE SETUP**
- ACTIVATE TESTS**
- CALIBRATION**

If you press **ENTER**, at the HELP:PRESS ENTER display, and a fault is present, the analyzer display will scroll the fault across the screen. If more than one fault is present only the highest priority fault will show. The other active faults are viewable in Logged Help. If there was no fault detected, the display will read:

- In platform mode,  
**HELP: (001)**  
**EVERYTHING OK,**
- In ground mode,  
**HELP: (002)**  
**GROUND MODE OK**

If **ENTER** is pressed again, the display moves to the following display:



**LOGGED HELP**

- 1: STARTUP (2/1):** (Or last recorded fault)
- LOG: (211)**
- 1: Power Cycle** (Or last recorded fault)

At this point, the analyzer will display the highest priority active fault, if any are present. You may scroll through the fault logs to view what the last fifteen faults were. Use the right and left arrow keys to scroll through the fault logs. The active faults, are listed before the first POWER CYCLE. To return to the top menu, press **ESC** two times.

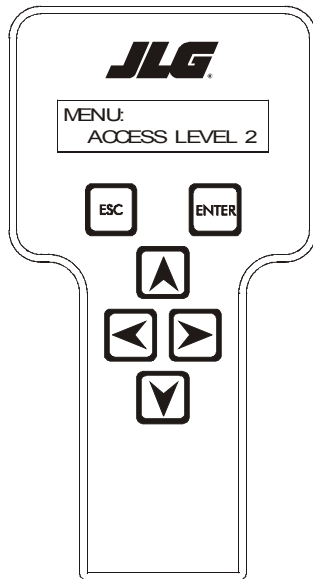
When a top level menu is selected, a new set of menu items may be offered; If for example you choose Personalities:

- DRIVE**
- LIFT**
- STEER**
- GROUND**

Pressing **ENTER** with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases 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 **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 configuration 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:



### MENU: ACCESS LEVEL 2

Press **ENTER** to select the **ACCESS LEVEL** menu.

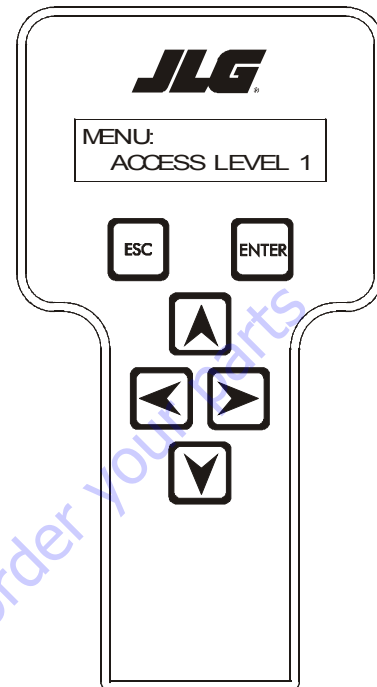
Using the **UP** or **DOWN** arrow keys, enter the first digit of the password, 3.

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 3.

Repeat this process until you have entered all five digits 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:



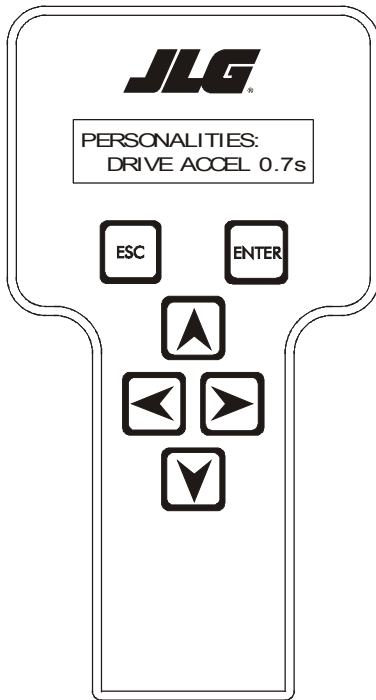
### MENU: ACCESS LEVEL 1

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 0.7s

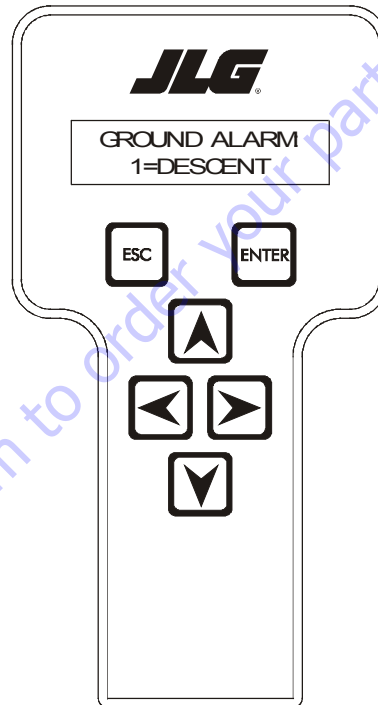
There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the 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:

### **⚠ WARNING**

**FAILURE TO MAKE THE PROPER SETTINGS FOR THE PARTICULAR MACHINE CAN RESULT IN IMPROPER OPERATION.**



### GROUND ALARM: 1=DESCENT

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 selecting the machine model to match the size of the machine, the personality settings will return to default settings.

**NOTE:** Refer to Table 5-3, Machine Model Adjustment - Version P1.14, and Table 5-4, Machine Configuration Programming Information - Version P1.14 for the default settings.

Password 33271 will give you access to level 1, which will permit you to change all machine personality and/or machine setup settings.

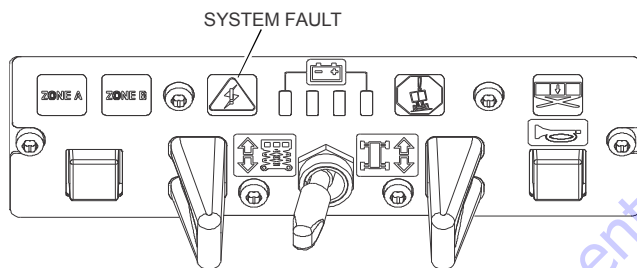
**WARNING**

CHANGING THESE SETTINGS MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.

**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 flash code is indicated on the face of the platform control box as shown:



Diagnostic Trouble Codes are indicated on the MDI for those machines that are equipped with an MDI. (refer to Section 3.7).

**NOTE:** Flash codes and DTC's are also displayed on the handheld analyzer. For descriptions see, Table 5-2, Flash Code Listing.

**5.3 TILT SENSOR CALIBRATION**

Be sure that the machine is parked and stowed on level ground.

**NOTE:** Tilt Sensor Calibration can not be performed if the main contactor switch is open due to an alarm.

1. Enter Access Level 1 and go to the CALIBRATION/TILT SENSOR/LEVEL VEHICLE screen.
2. Choose the right arrow key to view the raw, uncalibrated tilt sensor values. If either raw angle reads  $\pm 5.0$  or more, the machine is too unlevel and the software will prohibit calibration. Therefore, attempt to dissect the three areas of error to find the primary contributor:
  - a. Machine mounting and/or grade:
 

Try to measure the top of the Ground Control box for levelness. If unable to get a good reading, unbolt the Ground Control box and check the box's mounting surface for levelness.
  - b. Tilt sensor mounting on machine or wedged crooked in control box:
 

If the machine mounting/grade appears acceptable, remove and open the Ground Control box carefully. Observe whether the tilt sensor is properly seated.
  - c. Tilt sensor has developed an offset shift:
 

Remove the tilt sensor from the Ground Control box but keep both the tilt sensor and Ground Control box electrically connected. Level one axis of the tilt sensor and observe the raw reading (should be within  $\pm 2.0$ ). Do the same for the other axis. If either axis is greater than  $\pm 2.0$ , replace the tilt sensor.

**NOTE:** Check that the tilt switch is properly set by referring to the Tilt Settings table in Section 1 of this manual.

**Failure Troubleshooting for The Field**

Some possible reasons that the tilt sensor will not calibrate are:

- a. The surface the machine is sitting on is off level by a few degrees (flat doesn't imply level; parking lots are often not level).
- b. The tilt sensor has failed one or both of the channels (X axis and Y axis).
- c. Tilt sensor has moisture intrusion that has shifted its output.
- d. Water and/or corrosion in the box has corrupted electrical connections or caused a tilt sensor or ground control board failure (observe any cracks in the box).
- e. The Ground Control Box, as mounted on the machine, does not allow the tilt sensor to be level.

For the following troubleshooting steps, a bubble level (smaller is better) will be needed and the machine must be on a level surface:

1. On the Analyzer, go to the Diagnostics/System and read the tilt angle. If either angle reports  $+20.0^\circ$ , there is an electrical/electronic failure (tilt sensor, control board, electrical connections).
  - a. Take the Ground Control box off of the machine and open the rear cover.
  - b. Disconnect the sensor and clean any corrosion off of the tilt sensor and control board connections.
  - c. Reassemble and test. If fault persists, replace tilt sensor.
2. If the Analyzer displays angles other than  $+20.0^\circ$ , attempt to calibrate. If machine won't calibrate, note the reason displayed on Analyzer:
  - a. SENSOR FAILURE – tilt sensor internal frequency is out of range (replace sensor).
  - b. NOT LEVEL - tilt sensor has either developed an offset or it is too unlevel as mounted on the machine.

### 5.4 TILT SENSOR ELECTRICAL EVALUATION

This basic check using the JLG Analyzer can be used to test the Tilt Sensor.

- **If angle measurements read  $+20.0$ , then a sensor/wiring/connector fault exists.** If the readings intermittently display expected angles, then there is likely a wiring/connector problem and not a failed sensor. In either case, open the ES Ground box. Disconnect the sensor, check the wire terminations, and clean any corrosion on the tilt sensor and control board connections. Reconnect and test. If the fault persists, replace the tilt sensor and return the faulty tilt sensor to JLG with a detailed description of the diagnostic steps taken.

### 5.5 ELEVATION ANGLE SENSOR ELECTRICAL EVALUATION

These basic checks using the JLG Analyzer can be used to test the Elevation Angle Sensor. If the problem is still occurring, perform the Tilt vs. Allowed Height Evaluation described below.

- **On a level surface, with the Analyzer under DIAGNOSTICS/ELEV SENSOR, verify that the elevation angle sensor voltage increases (ranges from 0.2V-0.8V to 3.6V-4.2V) with platform height.** If not, check the sensor mounting. If necessary, unbolt sensor and rotate by hand while monitoring with the Analyzer to check the integrity of the sensor output.
- **For machines equipped with an elevation proximity switch, if the Elevation Sensor appears satisfactory, verify that the Elevation Prox switch is opening and closing appropriately** by watching the change of state between the stowed and elevated positions (monitor PROX SWITCH under DIAGNOSTICS/ELEV SENSOR). If a change of state is not observed, check prox mounting and operability by placing metal in front of the prox sensor face.

## Tilt vs. Allowed Height Evaluation

First, find a level surface (not just flat like a parking lot; must be level). The surface should be a plane in which the wheels are within  $0^{\circ}\pm 0.2^{\circ}$ . Find this surface by taking a digital level and measuring the areas on which the wheels would rest in both the X and Y directions. Mark the locations and drive the machine to these points. If a level surface can not be found, flat shims or plates may be placed under the wheels to create a level plane for the wheels.

In determining the existing tilt angle, read the angle on the Analyzer under DIAGNOSTICS/SYSTEM. Do not place a hand-held level on the machine to determine whether the machine is level and lifting to the appropriate height. Such a measurement will likely be different than the Ground box/tilt sensor angle reading due to manufacturing and mounting tolerances. The tilt angle in both directions should read within  $\pm 0.5^{\circ}$  while on a level surface. If not, then either the machine has a drifting tilt sensor or has been erroneously re-calibrated since the original factory calibration.

Check the service records to determine whether a re calibration has been performed. If so, re-calibrate on the level surface. If there is no record of an earlier calibration, we must assume that the sensor output has drifted. Therefore, replace the sensor and return to JLG with a detailed troubleshooting description.

**NOTE:** There is a rare case in which an attempted calibration will be unsuccessful for machines with Ground module software version P1.5 or earlier. If this occurs while performing a calibration, the Analyzer will display:

LEVEL VEHICLE  
TILT +20.0 +20.0

and the following fault will also be logged.

TILT SENSOR NOT CALIBRATED (2/3) [DTC 811]

If no other faults have been logged since the last startup, this fault indicates that the software needs to be updated to P1.6 or later. Update the software and continue troubleshooting evaluation before replacing any components.

If the tilt sensor readings are within range for a level machine, compare the allowed Tilt vs. Height in the chart below. Being within 6" of the target height is considered acceptable.

Table 5-1. Tilt Settings

Model	Tilt Setting (front to back)	Tilt Setting (side to side)	Maximum Platform Elevation
1930ES	3°	1.5°	18.75 ft (5.7 m)
		2°	14 ft (4.3 m)
		2.5°	11 ft (3.4 m)
		3°	9 ft (2.7 m)
2032ES	3°	1.5°	20 ft (6 m)
		2°	15 ft (4.5 m)
		2.5°	12 ft (3.7 m)
		3°	10 ft (3 m)
2632ES	3°	1.5°	25.4 ft (7.7 m)
		2°	20 ft (6 m)
		2.5°	16 ft (4.9 m)
		3°	13 ft (4 m)
2646ES	3°	2°	26 ft (7.9 m)
		2.5°	22 ft (6.7 m)
		3°	20 ft (6 m)
3246ES	3°	2°	31.75 ft (9.7 m)
		2.5°	22 ft (6.7 m)
		3°	20 ft (6 m)

**NOTE:** For Japanese specification machines labeled "Ministry of Labor Notification #70," the Tilt Setting is 5 degrees (front to back and side to side) regardless of elevated platform height.

If the machine does not appear to track the lift cutout heights and no fault exists as described above, stow the machine and re calibrate the Elevation Sensor.

### 5.6 ELEVATION SENSOR CALIBRATION

#### NOTICE

**MACHINE MUST BE ON LEVEL GROUND BEFORE ELEVATION SENSOR CAN BE SET.**

1. Be sure that the machine is parked and platform stowed on level ground.
2. Attach the analyzer near the ground control station.
3. Go to Access Level 1 and scroll through to CALIBRATION.
4. Under CALIBRATION, go to SET STOW ELEV.
5. Press ENTER for YES to set the stowed height for the elevation sensor.
6. Fully raise the platform.
7. Under CALIBRATION, go to SET MAX ELEV.
8. Press ENTER for YES to set the maximum height for the elevation sensor.

**NOTE:** Check the elevation sensor by lifting the scissor arms, from the platform, and driving until the drive speed cuts back. Refer to High Drive Speed Cutout for proper speed cut out height.

### 5.7 UPDATING SOFTWARE

Updating the ground module software requires a laptop computer, connecting cable, and software update cd. Contact JLG Industries to acquire the software cd.

Before updating the software, use the Hand-held Analyzer to view the machine's settings (MACHINE SETUP and PERSONALITIES) (refer to Figure 5-3 and Figure 5-4 for Analyzer Flow Chart). It is important to write down the settings to verify they are the same after software update is complete.

**NOTE:** Software update must be done with the machine powered in Ground Mode.

1. Disconnect analyzer from diagnostic port.
2. Using the laptop connector cable, connect the laptop to the diagnostic port.
3. Run the software update cd.
  - a. When the JLG Reprogramming Tool dialogue box appears, click on the Program button.
  - b. Another dialogue box will appear asking if you want to overwrite the current software version. Click YES.
4. After software update is complete, disconnect computer from diagnostic port.
5. Reconnect the hand-held analyzer to the diagnostic port.
  - a. Enter Access Level 1 password; 33271
  - b. Scroll to MACHINE SETUP. Change MODEL NUMBER to a different model, but immediately change it back to the proper setting. Do the same for MARKET. This will ensure the settings are carried over to all parameters.
  - c. Scroll through the settings to verify they are the same as before the software update.
6. Disconnect Analyzer.
7. Software update is complete.

### 5.8 TROUBLESHOOTING

It should be noted that there is no substitute for a thorough knowledge of the equipment and related systems.

It should be recognized that the majority of the problems arising in the machine will be centered in the hydraulic and electrical systems.

The first rule for troubleshooting any circuit that is hydraulically operated and electrically controlled is to determine if the circuit is lacking hydraulic oil and electrical control power. This can be ascertained by overriding the bypass valve (mechanically or electrically) so that oil is available to the function valve, then overriding the function valve mechanically. If the function performs satisfactorily, the problem exists with the control circuit.

**NOTE:** It may also be helpful to do the following for intermittent or difficult problems: run a system test, ANALYZER -> SYSTEM TEST; check the machine personalities, ANALYZER ->PERSONALITIES (refer to Table 5-3, Machine Model Adjustment - Version P1.14); and check the machine setup, ANALYZER -> MACHINE SETUP (refer to Table 5-4, Machine Configuration Programming Information - Version P1.14).

These below flash codes apply only to machines without the MDI (refer to Section 3.7, MDI (Multifunction Digital Indicator) and Brake Release). For machines with the MDI, refer to Section 6.

Anytime a problem is resolved, recycle the EMS.

**Table 5-2. Flash Code Listing**

Flash Code	Help Message	Cause	Possible Resolve
<b>Help Messages with no flash code may occur during normal operation and explain various vehicle interlocks.</b>			
0 0	ALARM SOUNDING--TILTED AND ABOVE ELEVATION	Platform is elevated and the chassis is not level. Platform Position Sensor (PPS) elevation status is elevated and the vehicle is tilted and machine setup's TILT CUTOUT is configured correctly, see Table 5-4, Machine Configuration Programming Information - Version P1.14. No motion restrictions.	
0 0	DRIVING AT CUTBACK-- ABOVE ELEVATION	Platform is elevated and the machine is in the drive mode of operation. In platform mode, Platform Position Sensor (PPS) elevation status is elevated and the vehicle is driving and the drive speed is drive elevated. Driving at elevated speed.	
0 0	DRIVE & LIFT UP PREVENTED -- TILTED & ELEVATED	Driving is not possible since the platform is elevated and the chassis is not level. In Platform Mode, Platform Position Sensor (PPS) elevation status is elevated and the vehicle is tilted and machine setup's TILT CUTOUT is configured correctly, see Table 5-4, Machine Configuration Programming Information - Version P1.14. Drive prevented.	
0 0	LIFT UP PREVENTED-- MAX HEIGHT ZONE A	Applicable to 3246ES configured for the Zone A/B Capacity Selection, and operating on Zone A. The vehicle has reached the maximum height and further lift up motion is not possible. Machine Setup's CAPACITY SELECT is 1=ZONE A/B and Machine Setup's MODEL is 3246ES and Zone A Lift Up=False. Lift up prevented.	

## SECTION 5 - JLG CONTROL SYSTEM

**Table 5-2. Flash Code Listing**

Flash Code	Help Message	Cause	Possible Resolve
0 0	DRIVING AT CUTBACK -- POTHOLE STILL ENGAGED	While stowed, drive speed is reduced (due to lower ground clearance) since the control system detected that the pot-hole protection mechanism is deployed (failed to retract). In platform mode with a healthy elevation sensor, elevation sensor less than 0.15V and the elevation prox closed and pot-hole protection's PHP switches detect down. In platform mode with an unhealthy elevation sensor, the elevation prox is closed <u>AND</u> pot-hole protection's PHP switches detect down.	Clear the obstacle blocking the pot-hole protection mechanism, repair the mechanical problem, re-adjust the pot-hole limit switches, or repair the wiring to correct the problem.
0 0	FUNCTIONS LOCKED OUT -- SYSTEM POWER DOWN	After 2 hours without activity, the control system enters a low-power state to preserve battery charge.	Check batteries charge, condition, etc. Normal operation should resume after a power cycle.
0 0	DRIVE PREVENTED -- ELEVATED AND ABOVE DRIVE CUT-OUT HEIGHT	The Drive Cutout functionality is enabled, and the platform is elevated above the calibrated cutout height. Drive Cutout is set to 1= YES <u>AND</u> the Elevation Sensor is "Healthy" <u>AND</u> the Elevation Sensor's Zeroed Voltage is Greater Than the Calibrated Drive Cutout Voltage. Refer to Drive Cutout Functionality.	Check elevation switches Check pothole switches.
<b>Help messages with the 2-1 flash code occur during after power-up of the vehicle control system.</b>			
2 1	STARTUP	This help message is issued at each power-up. This serves to indicate which messages have been recorded in logged help since the last power-up event. No motion restrictions. No motions restricted.	
2 1	KEYSWITCH FAULTY -- PLATFORM & GROUND ACTIVE TOGETHER	The platform and ground mode inputs from the keyswitch are active at the same time. The control system will default to ground mode when if this happens. The keyswitch and wiring inside the ground control box should be examined / repaired. Platform EMS digital input energized and ground mode select digital input energized. Default to ground mode operation and lift up prevented	Re-cycle power once the problem has been resolved to clear this difficulty.
<b>Help messages with the 2-2 flash code indicate difficulty with the platforms controls.</b>			
2 2	FUNCTION PROBLEM -- HORN PERMANENTLY SELECTED	Horn switch in the platform control box was closed during power-up. In platform mode, the Indoor/Outdoor switch digital input is energized and power-up is active. Retained until either is momentarily de-energized. Previously selected Indoor/Outdoor mode maintained.	Release or repair the switch to clear the message.
2 2	FUNCTION PROBLEM -- INDOOR / OUTDOOR PERMANENTLY SELECTED	Indoor / Outdoor switch in the platform control box was closed during power-up. In Platform Mode, the Indoor / Outdoor Switch Digital Input is Energized and Power-up is Active. Retained until Digital Input is momentarily De-energized. Previously selected Indoor / Outdoor Mode maintained	Release or repair the switch to clear the message.

Table 5-2. Flash Code Listing

Flash Code	Help Message	Cause	Possible Resolve
2 2	FUNCTION PROBLEM -- DRIVE & LIFT ACTIVE TOGETHER	The Drive - Lift selector switch indicates that both functions are selected simultaneously. In Platform Mode, the Drive and Lift Digital Inputs are Energized at the same time. Retained until either is momentarily De-energized. Drive, Steer, & Lift Prevented	Repair the wiring or switch to clear the message.
2 2	FUNCTION PROBLEM -- STEER LEFT PERMANENTLY SELECTED	Steer left switch in the platform control box was closed during power-up. In Platform Mode, the Left Steer Digital Input Switch is Energized AND Power-up is Active. Retained until Digital Input is momentarily De-energized. Steer & Drive Prevented	Release or repair the switch to clear the message.
2 2	FUNCTION PROBLEM -- STEER RIGHT PERMANENTLY SELECTED	Steer right switch in the platform control box was closed during power-up. In Platform Mode, the Right Steer Digital Input Switch is Energized and Power-up is Active. Retained until Digital Input is momentarily De-energized. Steer & Drive Prevented.	Release or repair the switch to clear the message.
2 2	ACCELERATOR FAULTY -- WIPER OUT OF RANGE	The joystick (accelerator) wiper signal input is outside the acceptable voltage range. In Platform Mode, the Joystick (accelerator) Analog Input Switch is $> 4.50V$ OR $< 0.50V$ . Retained until Analog Input is measured within proper range. Drive, Steer, & Lift Prevented.	The wiper wire being off, the wiper wire shorted to +B, or the wiper wire shorted to -B (ground) could cause this difficulty.
2 2	ACCELERATOR FAULTY -- STEER SWITCHES ACTIVE TOGETHER	Both the steer left and steer right inputs are closed as the same time. In Platform Mode, the Steer Left Digital Input is Energized and the Steer Right Digital Input is Energized. Retained until either Digital Input is momentarily De-energized. Drive & Steer Prevented.	A short in the steer switch wiring or a failed steer switch can cause this difficulty.
2 2	FUNCTION LOCKED OUT -- ACCELERATOR NOT CENTERED	Selected function (drive or lift) is not allowed because the joystick (accelerator) was not centered at power-up. In Platform Mode, scaled Joystick (accelerator) position was something other than 0% AND Power-up was Active. Retained until the Joystick is momentarily centered. Drive, Steer, & Lift Prevented.	Return joystick to center momentarily and re-initiate.
2 2	FUNCTION PROBLEM -- TRIGGER PERMANENTLY CLOSED	Trigger switch in the platform control box was closed at power-up. In Platform Mode, the Trigger Digital Input was Energized AND Power-up was Active. Retained until the Trigger Digital Input is momentarily De-energized. Drive, Steer, & Lift Prevented.	Release switch or repair the switch / wiring to clear the difficulty.
2 2	TRIGGER CLOSED TOO LONG WHILE IN NEUTRAL	Trigger switch in the platform control box was closed for more than ten seconds while the joystick (accelerator) was in the neutral position (centered). In Platform Mode, the Trigger Digital Input was Energized for 10,000mS AND Drive was In-Active AND Lift was In-Active. Retained until the Trigger Digital Input is momentarily De-energized. Drive, Steer, & Lift Prevented.	Release switch or repair the switch / wiring to clear the difficulty.



## SECTION 5 - JLG CONTROL SYSTEM

**Table 5-2. Flash Code Listing**

Flash Code	Help Message	Cause	Possible Resolve
<b>Help messages with the 2-3 flash code indicate difficulty with the ground controls.</b>			
2 3	FUNCTION PROBLEM – LIFT PERMANENTLY SELECTED	Lift switch (up or down) in the ground control box was closed during power-up. In Ground Mode, [Lift Up Digital Input is Energized or Lift Down Digital Input is Energized] AND Power-up is Active. Retained until the respective Digital Input is momentarily De-energized. Lift Prevented	Release or repair the switch to clear the message.
2 3	GROUND LIFT UP/DOWN ACTIVE TOGETHER	In ground mode, the control system has detected the lift up and down are active simultaneously. In Ground Mode, Ground Lift Up Digital Input is Energized and Ground Lift Down Digital Input is Energized. Retained until both the Digital Inputs are momentarily De-energized. Lift Prevented	Check the lift switch and associated wiring in the ground control box.
2 3	NO DATA FROM TILT SENSOR – NOT CONNECTED OR FAULTY	No signal from the tilt sensor mounted inside the ground control box. Transitions on the Tilt X OR Tilt Y signals not detected for 2000mS. Retained until transitions on both are sensed. Vehicle assumed Tilted (+20.0°X, +20.0°Y); Drive Stowed Demand limited as in Worst-Case Slope Descent Functionality for both Forward and Reverse Drive will be slow in the Forward direction.	Check wiring and plug connections at the tilt sensor and at the ground control board.
2 3	TILT SENSOR NOT CALIBRATED	The Tilt Sensor's Calibration EEPROM is set to the signature implanted by the In-Circuit Test Fixture. Retained until Calibration EEPROM is over-written by a valid calibration. Vehicle assumed Tilted (+20.0°X, +20.0°Y); Drive Stowed Demand limited as in Worst-Case Slope Descent Functionality for both Forward and Reverse Drive will be slow in the forward direction.	Calibrate the Tilt Sensor using the calibration procedure to clear the message.
2 3	FUNCTION PROBLEM -- BRAKE RELEASE PERMANENTLY SELECTED	The ground control box lift switch was closed up or down, during power-up in ground mode.	Check if the lift switch is obstructed or jammed. Check the lift switch signal and wiring to the ground board. Replace ground board.
<b>Help messages with the 2-5 flash code indicate that a function is prevented due to a cutout.</b>			
2 5	ELEV ANGLE SENSOR FAULTY – NOT MOUNTED OR VOLTAGE OUT OF RANGE	The input voltage from the sensor that measures lower arm motion is outside acceptable range. This may be caused by improper sensor mounting, difficulty with the sensor wiring, or a faulty sensor. The elevation sensor is unhealthy Platform height assumed to be full elevation.	Check mounting, review sensor wiring against the electrical schematic, or replace the sensor to clear the message.

Table 5-2. Flash Code Listing

Flash Code	Help Message	Cause	Possible Resolve
2 5	ELEV ANGLE SENSOR HAS NOT BEEN CALIBRATED	The Elevation Sensor's Calibration EEPROM is set to the signature implanted by the In-Circuit Test Fixture. Retained until Calibration EEPROM is over-written by a valid calibration. Platform Height assumed to be Full Elevation. The Elevation Proximity Switch is Open to indicate that the Platform is Elevated, but the Elevation Sensor's Voltage indicates that the Platform is Stowed. To be conservative, the control system will assume that the Platform is Elevated. Elevation Sensor is "Healthy" AND the Elevation Sensor's Zeroed Voltage is < 0.04V AND the Elevation Prox Switch is Open for 2000mS. Retained until situation changes.	Calibrate the elevation angle sensor using the calibration procedure to clear the message.
2 5	DRIVE PREVENTED – CHARGER CONNECTED	Driving is not possible since the vehicle is charging and it is configured to only allow lifting. In Platform Mode, the Battery Charger is Charging AND the Drive / Lift Select Toggle is set to Lift AND Machine Setup's CHARGE INTERLOC is set to 0=DRIVE ONLY. Drive & Steer Prevented	Disconnect battery charger
2 5	DRIVE & LIFT UP PREVENTED – CHARGER CONNECTED	Driving and lifting are not possible since the vehicle is charging and it is configured to prevent all motion. In Platform Mode, the Battery Charger is Charging AND the Drive / Lift Select Toggle is set to Lift AND Machine Setup's CHARGE INTERLOC is set to 1=DRV & LIFT UP. Drive & Lift Up Prevented.	Disconnect battery charger
2 5	PLATFORM OVERLOADED	While the Load Sensing System is enabled, the platform load measured by the Load Sensing System is excessive. Functions from platform control are prevented, and functions from ground control may be prevented, depending on machine configuration. The Load Sensing System Functionality's Overload is True AND [Machine Setup's LOAD is set to 1=CUTOUT PLT OR 2=CUTOUT ALL]. Drive, Steer, & Lift Prevented (except 3246ES CE, Indoor Mode, Height >24 Ft and < 26Ft, Lift Dn allowed).	Remove excess weight from platform.
2 5	DRIVE PREVENTED – POT-HOLE NOT ENGAGED	While elevated, driving is not possible since the control system detected that the pot-hole protection mechanism failed to deploy. In Platform Mode with a Healthy Elevation Sensor, the Elevation Sensor Voltage > 0.15V AND Pot-Hole Protection's PHP Switches detect Up. In Platform Mode with an Unhealthy Elevation Sensor, the Elevation Prox Sensor is Open (no Arm Detected) AND Pot-Hole Protection's PHP Switches detect Up. Drive & Steer Prevented.	Clear the obstacle blocking the pot-hole protection mechanism, repair the mechanical problem, re-adjust the pot-hole limit switches, or repair the wiring to correct the problem.

## SECTION 5 - JLG CONTROL SYSTEM

**Table 5-2. Flash Code Listing**

Flash Code	Help Message	Cause	Possible Resolve
2 5	ELEV PROX PERMANENTLY CLOSED – CHECK PROX AND ANGLE ADJUSTMENT	The Elevation Proximity Switch is closed to indicate that the platform is stowed, but the elevation sensor's voltage indicates that the platform is elevated. To be conservative, the control system will assume that the platform is elevated, and the drive speed will be restricted to elevated. Elevation Sensor is "Healthy" <u>AND</u> the Elevation Sensor's Zeroed Voltage is > 0.15V <u>AND</u> the Elevation Prox Switch is Closed for 2000mS. Retained until situation changes. Refer to Platform Position Sensor Functionality.	Check elevation switches. Replace if necessary.
2 5	DRIVE & LIFT PREVENTED – BRAKES ELECTRICALLY RELEASED FOR TOWING	The manual brake release has been activated to allow the vehicle to be towed. Brake release digital input is energized Drive and Lift Prevented	Disengage the manual brake release.
2 5	DRIVE PREVENTED – ELEVATED ABOVE DRIVE CUTOUT HEIGHT	The Drive Cutout functionality is enabled, and the platform is elevated above the calibrated cutout height. Drive Cutout is set to 1= YES <u>AND</u> the Elevation Sensor is "Healthy" <u>AND</u> the Elevation Sensor's Zeroed Voltage is Greater Than the Calibrated Drive Cutout Voltage. Refer to Drive Cutout Functionality.	Check elevation switches Check pothole switches.
2 5	MODEL CHANGED -- HYDRAULICS SUSPENDED - CYCLE EMS	The model selection has been changed.	Check ANALYZER -> MACHINE SETUP -> MODEL NUMBER. Replace ground board.
2 5	DRIVE PREVENTED -- BRAKES NOT RELEASING	While driving on a level surface, armature current was > 150A for five seconds. Brakes assumed to not be releasing properly.	Ensure vehicle is not stuck on something preventing movement. Check/repair drive motor wiring, brakes or mechanical issues.
<b>Help messages with the 3-1 flash code indicate that a contactor did not close when energized.</b>			
3 1	OPEN CIRCUIT LINE CONTACTOR	The Power Module's line contactor drive circuitry passed power-up self-tests, but the line contactor did not close when energized. The Power Module is reporting a "Contactor Did Not Close" Fault Code (15d). Drive, Steer, & Lift Up Prevented.	Refer to CANbus documentation for Power Module Message - Status.
3 1	CONTACTOR DRIVER PERMANENTLY OFF	The Power Module's Line Contactor drive circuitry failed to energize during power-up self-tests. The Power Module is reporting a "Contactor Driver 1 Permanently Off" Fault Code (22d). Drive, Steer, & Lift Up Prevented.	Refer to CANbus documentation for Power Module Message - Status.
<b>Help messages with the 3-2 flash code indicate that a contactor did not open when de-energized.</b>			
3 2	LINE CONTACTOR MISWIRED ON OR WELDED	The Power Module's Line Contactor Drive Circuitry passed power-up self-tests, but the line contactor did not open when de-energized. The Power Module is reporting a "Contactor Welded" Fault Code (14d). Drive, Steer, & Lift Up Prevented.	Refer to CANbus documentation for Power Module Message - Status.

Table 5-2. Flash Code Listing

Flash Code	Help Message	Cause	Possible Resolve
3 2	CONTACTOR DRIVER PERMANENTLY ON	The Power Module's Line Contactor Drive Circuitry failed to de-energize during power-up self-tests. The Power Module is reporting a "Contactor Driver 1 Permanently On" Fault Code (23d). Refer to CANbus documentation for Power Module Message – Status. Drive, Steer, & Lift Up Prevented.	Refer to CANbus documentation for Power Module Message – Status.
<b>Help messages with the 3-3 flash code indicate an output driver problem.</b>			
<b>NOTE: Certain output driver problems cannot be detected because stimulation of the load could result in safety concerns or annoyance (brake open circuit, lift down open circuit, ground alarm open circuit). 3-3 help messages shall be latched until the next power cycle.</b>			
3 3	BRAKE SHORT TO BATTERY	Voltage was detected on the brake solenoid when the output driver was commanded off during power-up. Brake INPUT driven Low <u>AND</u> Brake STAT detected Low during power-up. Drive, Steer, & Lift Prevented.	
3 3	BRAKE OPEN CIRCUIT	Current flow to the brake solenoid was not detected during normal brake operation. Brake INPUT driven High (normal operation) <u>AND</u> Brake STAT detected Low. Drive & Steer Prevented	
3 3	LIFT UP SHORT TO BATTERY	Voltage was detected on the lift up solenoid when the output driver was commanded off during power-up. Lift Up INPUT driven Low <u>AND</u> Lift Up STAT detected Low during power-up. Drive, Steer, & Lift Up Prevented.	
3 3	LIFT UP OPEN CIRCUIT	Current flow to the lift up solenoid was not detected during power-up. Lift Up INPUT driven High (momentarily) <u>AND</u> Lift Up STAT detected Low during power-up. No motion interlocks.	
3 3	LIFT DN SHORT TO BATTERY	Voltage was detected on the lift down solenoid when the output driver was commanded off during power-up. Lift Down INPUT driven Low <u>AND</u> Lift Down STAT detected Low during power-up. No motion interlocks.	
3 3	LIFT DN OPEN CIRCUIT	Current flow to the lift down solenoid was not detected during normal lift down motion. Lift Down INPUT driven High (normal operation) <u>AND</u> Lift Down STAT detected Low. Lift Up Prevented.	
3 3	STEER LEFT SHORT TO BATTERY	Voltage was detected on the steer left solenoid when the output driver was commanded off during power-up. Left Turn INPUT driven Low <u>AND</u> Left Turn STAT detected Low during power-up. Drive & Steer Prevented.	

## SECTION 5 - JLG CONTROL SYSTEM

**Table 5-2. Flash Code Listing**

Flash Code	Help Message	Cause	Possible Resolve
3 3	STEER LEFT OPEN CIRCUIT	Current flow to the steer left solenoid was not detected during power-up. Left Turn INPUT driven High (momentarily) <u>AND</u> Left Turn STAT detected Low during power-up. Drive & Steer Prevented.	
3 3	STEER RIGHT SHORT TO BATTERY	Voltage was detected on the steer right solenoid when the output driver was commanded off during power-up. Right Turn INPUT driven Low <u>AND</u> Right Turn STAT detected Low during power-up. Drive & Steer Prevented.	
3 3	STEER RIGHT OPEN CIRCUIT	Current flow to the steer right solenoid was not detected during power-up. Right Turn INPUT driven High (momentarily) <u>AND</u> Right Turn STAT detected Low during power-up. Drive & Steer Prevented.	
3 3	GROUND OVERLOAD LAMP SHORT TO BATTERY	While the load sensing system was enabled, voltage was detected on the ground control box's overload lamp when the output driver was commanded off during power-up. Ground Overload INPUT driven Low <u>AND</u> Ground Overload STAT detected Low during power-up <u>AND</u> [Machine Setup's LOAD set to 1=CUTOOUT PLT QR 2=CUTOOUT ALL]. No motion interlocks.	
3 3	GROUND OVERLOAD LAMP OPEN CIRCUIT	While the Load Sensing System was enabled, current flow to the ground control box's overload lamp was not detected during power-up. Ground Overload INPUT driven High (momentarily) <u>AND</u> Ground Overload STAT detected Low during power-up <u>AND</u> [Machine Setup's LOAD set to 1=CUTOOUT PLT QR 2=CUTOOUT ALL]. No motion interlocks.	
3 3	GROUND ALARM SHORT TO BATTERY	While enabled, voltage was detected on the ground alarm when the output driver was commanded off during power-up. Ground Alarm INPUT driven Low <u>AND</u> Ground Alarm STAT detected Low during power-up <u>AND</u> [Machine Setup's GROUND ALARM set to 1=DECENT QR 2=MOTION]. No motion interlocks.	
3 3	LEFT BRAKE SHORT TO BATTERY	The ground board detected voltage while the left brake was commanded off.	Check for continuity through this circuit. Inspect the wiring for physical damage. Replace ground board.
3 3	LEFT BRAKE OPEN CIRCUIT	Current flow to the left brake solenoid was not detected during normal left brake operation.	Check for continuity through this circuit. Inspect the wiring for physical damage. Replace ground board.
3 3	RIGHT BRAKE SHORT TO BATTERY	Voltage was detected on the right brake solenoid when the ground board output was commanded off during power-up.	Check for continuity through this circuit. Inspect the wiring for physical damage. Replace ground board.

Table 5-2. Flash Code Listing

Flash Code	Help Message	Cause	Possible Resolve
3 3	RIGHT BRAKE OPEN CIRCUIT	The ground board did not detect current flow to the right brake during normal operation.	Check for continuity through this circuit. Inspect the wiring for physical damage. Replace ground board.
<b>Help messages with the 4-2 flash code indicate a thermal problem.</b>			
4 2	POWER MODULE TOO HOT – PLEASE WAIT	The Power Module for drive, steer, and lift up has reached thermal cutout. Allow to cool by powering down. The power Module is reporting a "Unit Too Hot" fault code.	
4 2	DRIVING AT CUTBACK -- POWER MODULE CURRENT LIMIT	The drive portion of the Power Module has reached thermal limit. Allow to cool by waiting for temperature to fall. The Power Module is reporting a "I <sup>2</sup> T Drive Current Limit" fault code.	
4 2	LIFT UP AT CUTBACK -- POWER MODULE CURRENT LIMIT	The lift up portion of the power module has reached thermal limit. Allow to cool by waiting for temperature to fall. The Power Module is reporting "I <sup>2</sup> Pump Current Limit" fault code.	
<b>Help messages with the 4-4 flash code indicate a battery supply problem.</b>			
4 4	BATTERY VOLTAGE TOO LOW – SYSTEM SHUTDOWN	Battery Voltage momentarily dropped below 14.5V. With a low battery charge, this can occur during heavy current demand due to drive, steer, or lift up. The Power Module is reporting a "Low Battery" Fault Code (7d). Drive, Steer, & Lift Up Prevented	Recharge batteries or check for damaged batteries.
4 4	BATTERY VOLTAGE TOO HIGH – SYSTEM SHUTDOWN	The Power Module momentarily measured excessively high battery voltage (>37.0v) and the ground module de-energized the ignition relay to protect system devices. The Power Module is reporting a "High Battery" Fault Code (8d) OR a "High Battery without Line" Fault Code (10d). In response, the Ground Module shall de-energize the Ignition Relay and suppress all Help Messages caused by the lack of Ignition Signal. This fault is latched until the next power-cycle. Drive, Steer, & Lift Prevented.	This may be due to improper battery charging or incorrect voltage batteries being used.
4 4	LSS BATTERY VOLTAGE TOO HIGH	While the Load Sensing System is enabled, the Load Sensing System module measured battery voltage >34.0Vdc, which may compromise ability to predict weight. LSS Module Message – Status Message (0x81) is reporting "BATT TOO HIGH" AND [Machine Setup's LOAD is set to 1=CUT-OUT PLT OR 2=CUTOUT ALL]. Vehicle assumed to be Overloaded.	This may be due to improper battery charging or incorrect voltage batteries being used.
4 4	LSS BATTERY VOLTAGE TOO LOW	While the Load Sensing System is enabled, the Load Sensing System module measured battery voltage <9.0vdc, which may compromise ability to predict weight. With a low battery charge, this can occur during heavy current demand due to drive, steer, or lift up. LSS Module Message – Status Message (0x81) is reporting "BATT TOO LOW" AND [Machine Setup's LOAD is set to 1=CUT-OUT PLT OR 2=CUTOUT ALL]. Vehicle assumed to be Overloaded.	Recharge batteries or check for damaged batteries.

## SECTION 5 - JLG CONTROL SYSTEM

**Table 5-2. Flash Code Listing**

Flash Code	Help Message	Cause	Possible Resolve
<b>Help messages with the 6-6 flash code indicate vehicle communication (CANbus) problems. These faults shall not be latched. Normal operation shall resume if difficulty is resolved.</b>			
6 6	CANBUS FAILURE: POWER MODULE	The control system failed to receive messages from the Power Module. Power Module Message – Status (0x24) not received for 1000mS or Power Module is reported a “CANbus Bus Difficulty” Fault Code (0x09). Drive, Steer, & Lift Up Prevented.	Check wiring at the ground control box and power module. Recycle power to clear difficulty.
6 6	CANBUS FAILURE: PLATFORM MODULE	In Platform Mode, the control system failed to receive messages from the platform module. Digital Input Message – Motion (0x00) not received for 1000mS AND Platform Mode selected. Retained until power is re-cycled. All Platform functions Prevented. Normal operation from Ground Mode.	Check wiring at the platform and ground control boxes. Check wiring along scissor arms leading up to Platform.
6 6	CANBUS FAILURE: LOAD SENSING SYSTEM MODULE	With the Load Sensing System enabled, the control system failed to receive messages from the Load Sensing System Module. LSS Module Message – Load Cell Message (0x80) not received for 1000mS AND [Machine Setup’s LOAD set to 1=CUTOOUT PLT QR 2=CUTOOUT ALL]. Retained until power is re-cycled. Vehicle assumed to be Overloaded.	Check wiring at the Load Sensing System Module and along scissor arms leading up to platform.
6 6	ACCESSORY CAN COMMUNICATION LOST	A JLG Accessory Module has failed to maintain CANbus communications with the ground module. The control system received Accessory Message – Control 1 from an Accessory Module, but failed to receive another within 1000mS. Retained until power is re-cycled. No motion interlocks.	Refer to documentation for the JLG Accessory to clear difficulty.
<b>Help messages with the 6-7 flash code indicate JLG accessory problems. These faults shall not be latched. Normal operation shall resume if difficulty is resolved.</b>			
6 7	ACCESSORY FAULT	A JLG Accessory Module has encountered a fault condition and reported it via the host control system. Accessory Message – Control 1’s Request Accessory Fault flag is set to YES. Retained or cleared based on status of flag. No motion interlocks.	Refer to documentation for the JLG Accessory to clear difficulty.
<b>Help messages with the 7-7 flash code indicate motor problems.</b>			
7 7	OPEN-CIRCUIT DRIVE MOTOR FIELD WIRING	The Power Module detected an error in the power wiring (F1 & F2 Terminals) for the drive motors. The Power Module is reporting a “Field Open Circuit” Fault Code (16d). Retained until power is re-cycled. Drive & Steer Prevented	Check power wiring and re-cycle power to clear difficulty.
<b>Help messages with the 8-x flash codes indicate problems with the platform load sensing system. The second digit of the flash code is used to indicated channel.</b>			
8 1	LSS CELL #1 ERROR	Cell #1’s Bridge <2Vdc, >3Vdc, or could the LSS Module could not read Cell #1’s Internal Memory. 8-1 Flash Code LSS Module Message – Status Message (0x81) is reporting “CELL 1 ERROR” AND [Machine Setup’s LOAD is set to 1=CUTOOUT PLT QR 2=CUTOOUT ALL]. Vehicle assumed to be Overloaded.	This situation indicates that the sensor is unplugged, or the sensor is damaged.

Table 5-2. Flash Code Listing

Flash Code	Help Message	Cause	Possible Resolve
8 2	LSS CELL #2 ERROR	Cell #2's Bridge <2Vdc, >3Vdc, or could the LSS Module could not read Cell #2's Internal Memory. 8-2 Flash Code LSS Module Message – Status Message (0x81) is reporting "CELL 2 ERROR" AND [Machine Setup's LOAD is set to 1=CUT-OUT PLT OR 2=CUTOUT ALL]. Vehicle assumed to be Overloaded.	This situation indicates that the sensor is unplugged, or the sensor is damaged.
8 3	LSS CELL #3 ERROR	Cell #3's Bridge <2Vdc, >3Vdc, or could the LSS Module could not read Cell #3's Internal Memory. 8-3 Flash Code LSS Module Message – Status Message (0x81) is reporting "CELL 3 ERROR" AND [Machine Setup's LOAD is set to 1=CUT-OUT PLT OR 2=CUTOUT ALL]. Vehicle assumed to be Overloaded.	This situation indicates that the sensor is unplugged, or the sensor is damaged.
8 4	LSS CELL #4 ERROR	Cell #4's Bridge <2Vdc, >3Vdc, or could the LSS Module could not read Cell #4's Internal Memory. 8-4 Flash Code LSS Module Message – Status Message (0x81) is reporting "CELL 4 ERROR" AND [Machine Setup's LOAD is set to 1=CUT-OUT PLT OR 2=CUTOUT ALL]. Vehicle assumed to be Overloaded.	This situation indicates that the sensor is unplugged, or the sensor is damaged.
<b>Help messages with the 9-x flash codes indicate controller (module) problems. The second digit of the flash code provides additional information about the difficulty.</b>			
9 1	LSS WATCHDOG RESET	The Watchdog Timer on Load Sensing System Module's micro-processor was triggered by exposure to excessive electrical noise, or by a hardware difficulty. 9-1 Flash Code LSS Module Message – Status Message (0x81) is reporting "WATCHDOG RST" AND [Machine Setup's LOAD is set to 1=CUT-OUT PLT OR 2=CUTOUT ALL]. Retained until power is re-cycled. No motion interlocks.	Re-cycle power to clear difficulty
9 2	LSS EEPROM ERROR	Memory used to retain settings on Load Sensing System Module has been corrupted and must be reset by verifying all entries / re-calibrating. 9-2 Flash Code LSS Module Message – Status Message (0x81) is reporting "EEPROM ERROR" AND [Machine Setup's LOAD is set to 1=CUT-OUT PLT OR 2=CUTOUT ALL]. Retained until power is re-cycled. Vehicle assumed to be Overloaded	After resolution, re-cycle power to clear difficulty.
9 3	LSS HAS NOT BEEN CALIBRATED	9-3 Flash Code The Load Sensing System's Calibration EEPROM for Empty Platform Load is set to Never Set (signature implanted by the In-Circuit Test Fixture) AND [Machine Setup's LOAD is set to 1=CUTOUT PLT OR 2=CUTOUT ALL]. Retained until Calibration EEPROM is over-written by a valid calibration. Vehicle assumed to be Overloaded.	Calibrate the Load Sensing System using the calibration procedure to clear the message.



**Table 5-2. Flash Code Listing**

Flash Code	Help Message	Cause	Possible Resolve
9 9	LSS INTERNAL ERROR – PIN EXCITATION	The Excitation Voltage for the Load Sensors < 4.25V. 9-9 Flash Code LSS Module Message – Status Message (0x81) is reporting “INTERNAL ERROR – PIN EXCITATION < 4.25V” AND [Machine Setup’s LOAD is set to 1=CUTOOUT PLT OR 2=CUTOOUT ALL]. Retained until power is re-cycled. Vehicle assumed to be Overloaded.	The sensors may be excessively loading the Excitation Supply due to wiring damage, or the Load Sensing System Module may have hardware difficulty.
9 9	LSS INTERNAL ERROR – DRDY MISSING FROM A/D	The DRDY Interrupt from the Load Sensing System Module’s A/D Converter is missing. 9-9 Flash Code LSS Module Message – Status Message (0x81) is reporting “INTERNAL ERROR – DRDY INTERRUPT FROM A/D” AND [Machine Setup’s LOAD is set to 1=CUTOOUT PLT OR 2=CUTOOUT ALL]. Retained until power is re-cycled. Vehicle assumed to be Overloaded.	This may indicate Load Sensing System Module hardware difficulty.
9 9	POWER MODULE FAILURE: PERSONALITY RANGE ERROR	The Power Module detected an out-of-range or corrupt personality setting. 9-9 Flash Code The Power Module is reporting a “Configuration Range” Fault Code (11d) OR a “Configuration CRC” Fault Code (12d) OR a “Motor Setup” Fault Code (13d). Retained until power is re-cycled.	Reset control system Personalities to default settings to clear difficulty.
9 9	POWER MODULE FAILURE: INTERNAL ERROR	The Power Module detected an internal error via self-test. 9-9 Flash Code The Power Module is reporting a “Two Direction” Fault Code (4d) OR a “Sequence” Fault Code (5d) OR a “CANbus Input” Fault Code (6d) OR a “12V Supply Detection” Fault Code (18d) OR a “System Monitor Activated” Fault Code (24d). Retained until power is re-cycled.	Re-cycle power to clear difficulty.
9 9	POWER MODULE FAILURE: CHECK POWER CIRCUITS OR MOSFET SHORT CIRCUIT	The Power Module detected an error in the Power Wiring for the Drive or Pump. Alternately, the Power Module has failed a self-test. 9-9 Flash Code The Power Module is reporting an “Armature MOSFET Short Circuit” Fault Code (17d) OR an “Armature MOSFET’s Off” Fault Code (19d) OR an “Armature MOSFET’s On” Fault Code (20d) OR an “Armature Pullup MOSFET Short Circuit” Fault Code (21d). Retained until power is re-cycled.	Check wiring and motors or replace the Power Module. Re-cycle power to clear difficulty.
9 9	POWER MODULE FAILURE: SYSTEM MONITOR	The ground board detected armature, field, or pump current while function was not commanded.	Refer to Drive Motor Electrical Evaluation in Section 3.2. Refer to Pump Motor Electrical Evaluation in Section 4.3. Refer to Power Module Electrical Evaluation in Section 3.6.
9 9	EEPROM FAILURE – CHECK ALL SETTINGS	The control system detected an EEPROM failure. Personalities and Machine Setup settings may be reset to default values. 9-9 Flash Code The control system’s EEPROM checksum indicates corruption. Retained until EEPROM settings are corrected and power is re-cycled.	Check / correct all settings and re-cycle power to clear difficulty.

Table 5-2. Flash Code Listing

Flash Code	Help Message	Cause	Possible Resolve
9 9	FUNCTIONS LOCKED OUT – MACHINE NOT CONFIGURED	The control system has not been configured for the first time. 9-9 Flash Code The control system's EEPROM flag indicates that the vehicle has not been configured (new control system components). Retained until EEPROM flag is cleared and power is re-cycled.	Use the JLG Analyzer to adjust all Machine Setup and Personality settings and re-cycle power to clear difficulty.
9 9	FUNCTIONS LOCKED OUT – PLATFORM MODULE SOFTWARE VERSION IMPROPER	The control system will not function because the Platform Module Software Version is not compatible with the rest of the system. 9-9 Flash Code The Platform Module reported a Software Major Version that was not equal to "1". The control system may resume operation once the difficulty has been corrected.	Re-program or replace with a Version 1.xx module.
9 9	FUNCTIONS LOCKED OUT – POWER MODULE SOFTWARE VERSION IMPROPER	The control system will not function because the Power Module Software Version is not compatible with the rest of the system. 9-9 Flash Code The Power Module reported a Software Major Version that was not equal to "1". The control system may resume operation once the difficulty has been corrected.	Re-program or replace with a Version 1.xx module.
9 9	FUNCTIONS LOCKED OUT – LSS MODULE SOFTWARE VERSION IMPROPER	The control system will not function because the LSS Module Software Version is not compatible with the rest of the system. 9-9 Flash Code Machine Setup's LOAD=1 or 2 AND the LSS Module reported a Software Major Version that was not equal to "7". The control system may resume operation once the difficulty has been corrected.	Re-program or replace with a Version 7.xx module.

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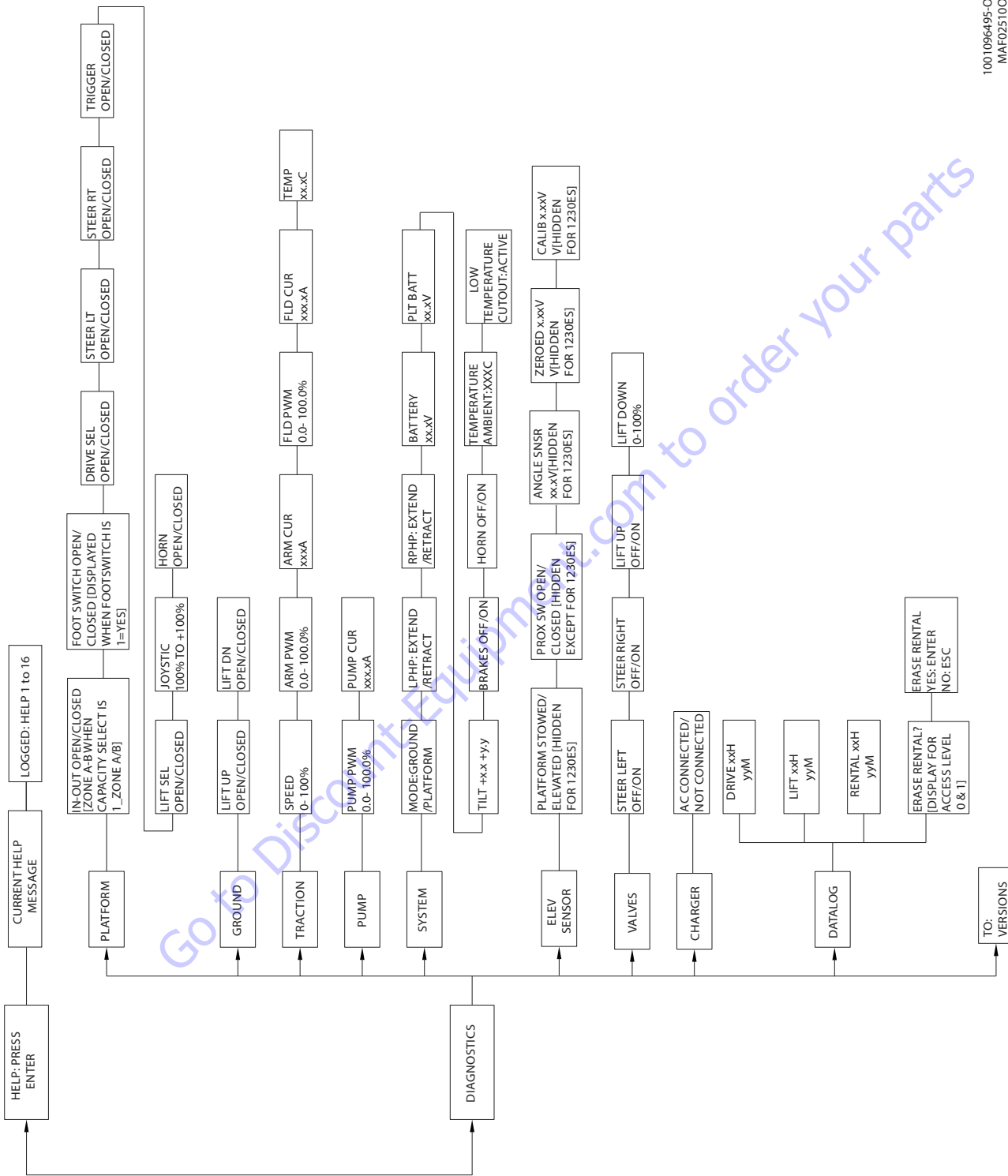
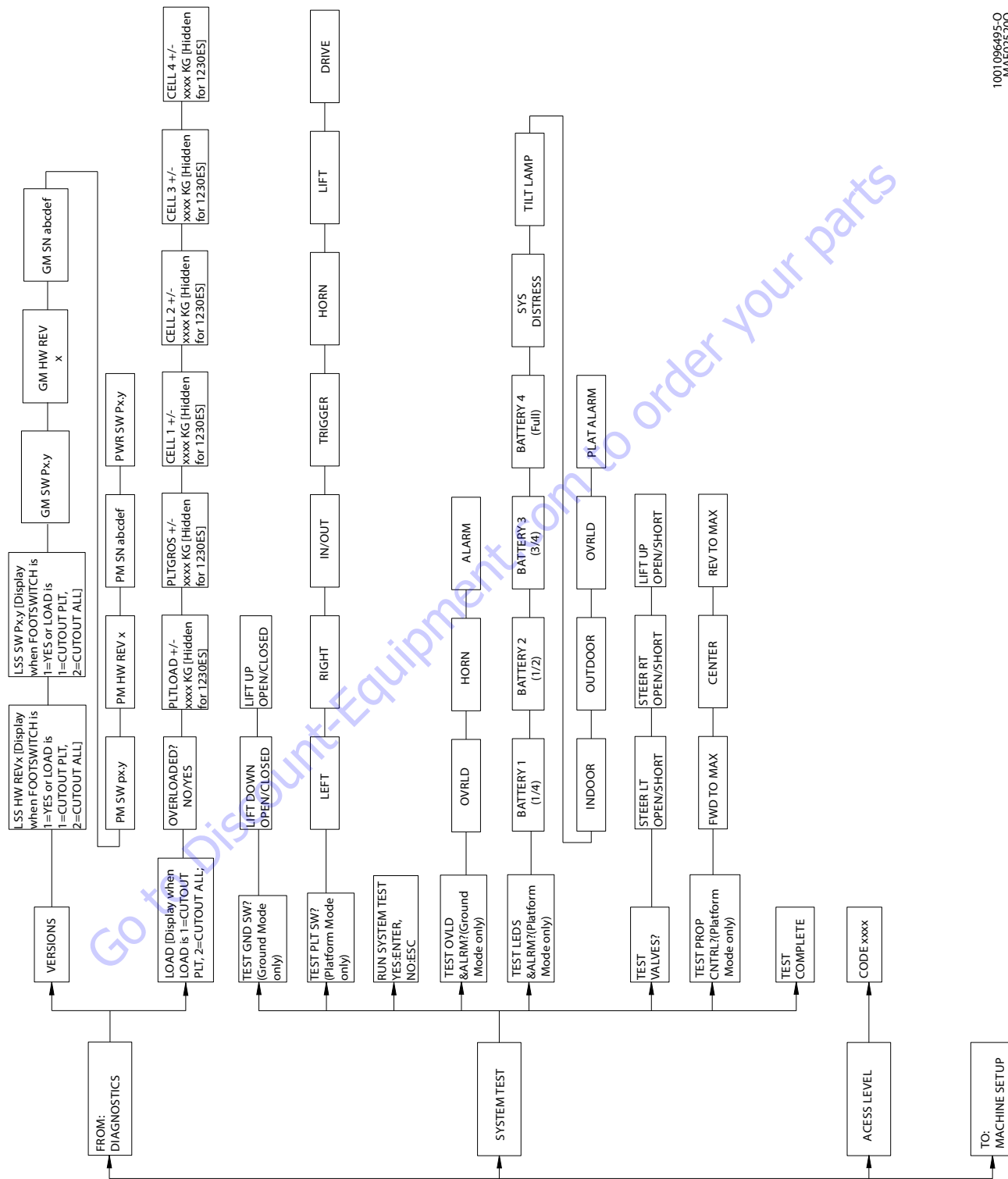


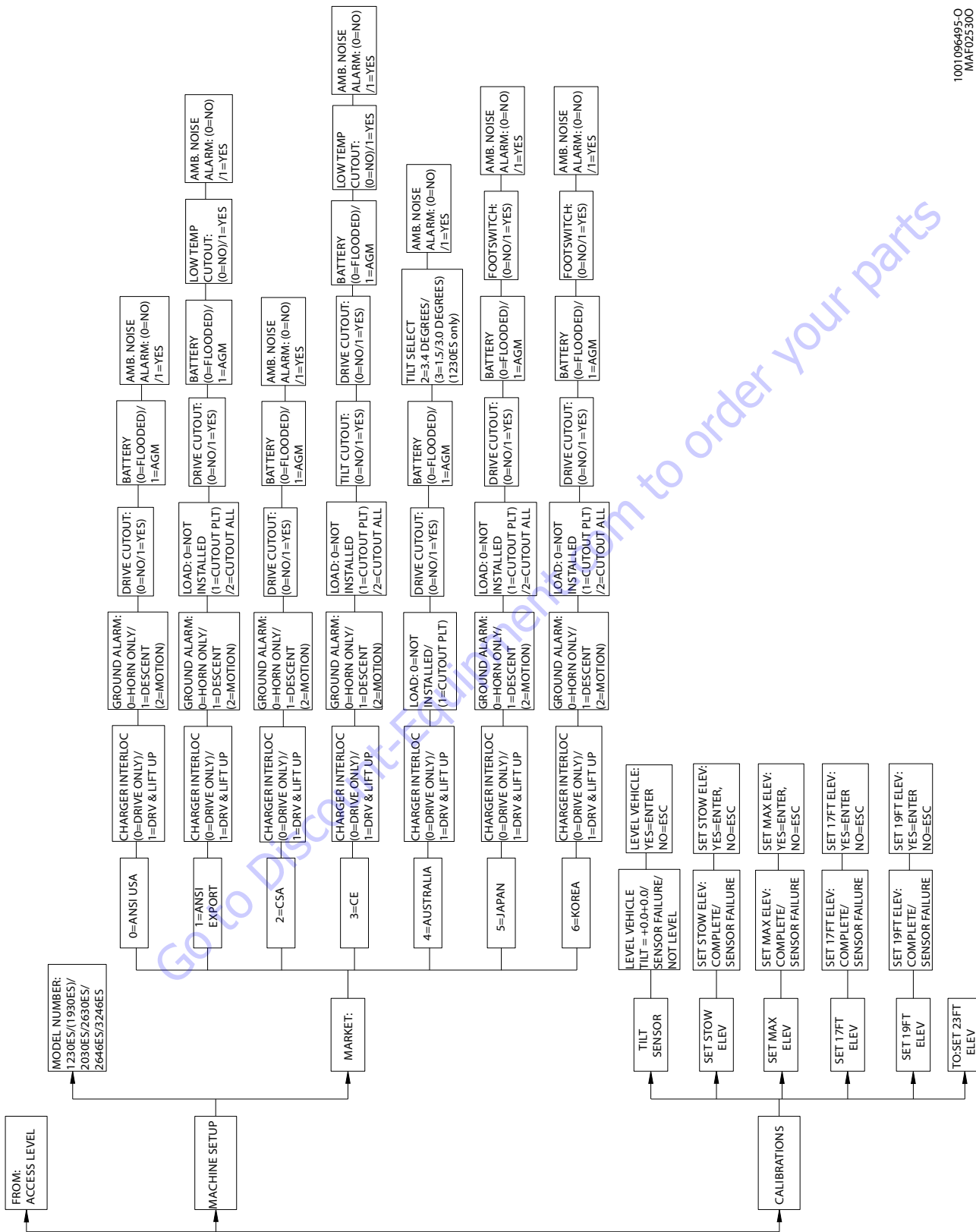
Figure 5-3. Analyzer Flow Chart (Software Version P1.14) - Sheet 1 of 4

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MAF025100



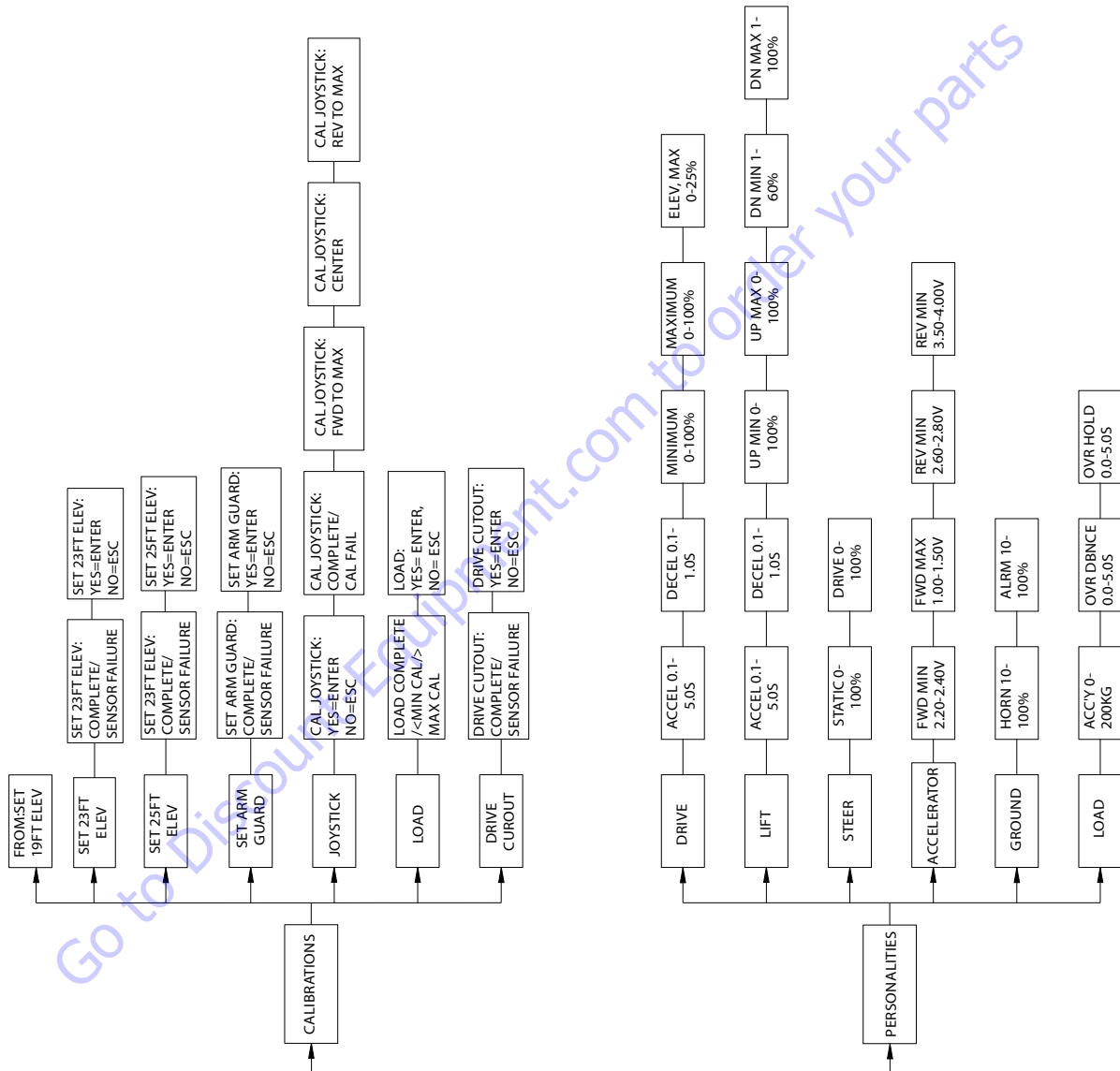
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Figure 5-4. Analyzer Flow Chart (Software Version P1.14) - Sheet 2 of 4



1001096495-O  
MAF025300

Figure 5-5. Analyzer Flow Chart (Software Version P1.14) - Sheet 3 of 4



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MAF025400

Figure 5-6. Analyzer Flow Chart (Software Version P1.14) - Sheet 4 of 4

## SECTION 5 - JLG CONTROL SYSTEM

### 5.9 MACHINE MODEL ADJUSTMENT

Table 5-3. Machine Model Adjustment - Version P1.14

Adjustment	Adjustment Range	1930ES	2032ES	2632ES	2646ES	3246ES
<b>DRIVE</b>						
ACCEL	0.1-5.0(Sec)	0.7	0.7	0.7	0.7	0.7
DECEL	0.1-1.0(Sec)	0.1	0.1	0.1	0.1	0.1
MINIMUM	0-25%	0	0	0	0	0
MAXIMUM	0-100%	100	100	100	100	100
ELEV. MAX.	0-30%	25	25	25	25	25
<b>LIFT</b>						
ACCEL	0.1-5.0(Sec)	0.5	0.5	0.5	0.5	0.5
DECEL	0.1-1.0(Sec)	0.1	0.1	0.1	0.1	0.1
UP MIN	0-50%	20	20	20	20	20
UP MAX	0-100%	100	100	100	100	100
DN MIN	1-60%	45	45	45	45	45
DN MAX	1-100%	75	75	75	75	75
UP LTC	1-100%	50	50	50	50	50
DN LTC	1-100%	77	77	77	77	77
DN Max EARM	1-100%	70	70	70	70	70
<b>STEER</b>						
STATIC	0-100%	70	70	70	70	70
DRIVE	0-100%	30	30	30	30	30
<b>ACCELERATOR</b>						
FWD MIN	2.20-2.40V	2.23	2.23	2.23	2.23	2.23
FWD MAX	1.00-1.50V	1.19	1.19	1.19	1.19	1.19
REV MIN	2.60-2.80V	2.74	2.74	2.74	2.74	2.74
REV MAX	3.50-4.00V	3.78	3.78	3.78	3.78	3.78
<b>GROUND</b>						
HORN	10-100%	94	94	94	94	94
ALARM	10-100%	19	19	19	19	19
<b>LOAD</b>						
ACCY	0-200Kg	0	0	0	0	0
OVR DBNCE	0.0-5.0Sec	3.0	3.0	3.0	3.0	3.0
OVR HOLD	0.0-5.0Sec	5.0	5.0	5.0	5.0	5.0
<b>TEMP CUTOUT</b>						
CUTOUT SET	-30-0C	-30	-30	-30	-30	-30
OVR DBNCE	0-15C	5	5	5	5	5

1001115627-F

**NOTE:** These settings may change in order to achieve optimal performance on a machine by machine basis.

**5.10 MACHINE CONFIGURATION PROGRAMMING INFORMATION**

**NOTE:** When configuring an ES scissors machine, 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. Shaded entries are not available for the selected Market.

**Table 5-4. Machine Configuration Programming Information - Version P1.14**

Configuration Digit	Setting	Description	* Market Default Setting						
			0	1	2	3	4	5	6
1 (Model #)	1	1930ES	(Set to your applicable ES Model 1 through 5)						
	2	2032ES							
	3	2632ES							
	4	2646ES							
	5	3246ES							
2 (Market)	0	ANSI USA	0 - (ANSI USA) (Set to your applicable market)						
	1	ANSI EXPORT							
	2	CSA							
	3	CE							
	4	AUSTRALIA							
	5	JAPAN							
3 (Tilt Cutout)	0	NO - Drive and lift up <u>not</u> prevented while tilted (Ground and Platform Mode).	1	1	1	1	1	1	1
	1	YES - Drive and lift up prevented while tilted (Ground and Platform Mode).							
4 (Drive Cutout)	0	NO - Drive and lift up <u>not</u> prevented while elevated.	0						
	1	YES - Drive and lift up prevented while elevated.							
5 (Charger Interlock)	0	DRIVE ONLY - Drive motion prevented while vehicle is charging.	0	0	0	0	0	0	0
	1	DRIVE AND LIFT UP - Drive and lift up motions are prevented while vehicle is charging. Required for CE.							
6 (Ground Alarm)	0	NOT INSTALLED - Vehicle alarm will function for Arm Guard (if enabled), Overload (if LSS enabled), and as a horn.	2	2	2	0	2	2	2
	1	DESCENT - Vehicle alarm will function for Arm Guard (if enabled), Overload (if LSS enabled, as a horn, and during Lift Down motion.							
	2	MOTION - Vehicle alarm will function for Arm Guard (if enabled), Overload (if LSS enabled, as a horn, and during Drive and Lift motions.							
7 (LSS - Load Sensing System)	0	NOT INSTALLED - Load Sensing System (LSS) is <u>not</u> fitted to the vehicle.	1	1	1	2	1	1	1
	1	CUTOUT PLT - Load Sensing System (LSS) is fitted, and Platform Controls are prevented in the event of an Overload. Ground Controls remain functional. This is the default setting for CE machines.							
	2	CUTOUT ALL - Load Sensing System (LSS) is fitted. Platform and Ground Controls are prevented in the event of an overload.							
8 (Battery)	0	FLOODED - Batteries are conventional lead-acid type.	0						
	1	AGM - Batteries are absorbed glass mat type.							
9 (Footswitch)	0	NO - Vehicle is not fitted with a footswitch	0	0	0	0	0	1	1
	1	YES - Vehicle is fitted with a footswitch							
10 (Wht. Noise Alarm)	0	NO - Vehicle is <u>not</u> fitted with a white noise alarm.	0	0	0	0	1	0	0
	1	YES - Vehicle is fitted with a white noise alarm.							
11 (Low Temp Cutout)	0	NO - Vehicle is <u>not</u> fitted with low temperature cutout.	0	0	0	0	0	0	0
	1	YES - Vehicle is fitted with low temperature cutout.							
12 (Beacon)	0	NO - Vehicle is <u>not</u> configured for the Beacon Option.	0	0	0	0	0	0	0
	1	YES - Vehicle is configured for the Beacon Option.							
	2	NORELAY - Vehicle <u>does not</u> have a beacon relay and is configured to work PRE-EN280.							
13 (PHP Alarm)	0	NO - Vehicle is <u>not</u> configured with PHP Alarm when Pothole bar is blocked.	0	0	0	0	0	0	0
	1	YES - Vehicle is configured with PHP Alarm when Pothole bar is blocked.							

100115626-H



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## SECTION 6. DIAGNOSTIC TROUBLE CODES

### 6.1 INTRODUCTION

This section provides a reference for Diagnostic Trouble Codes (DTC) read from the Multifunction Digital Indicator (MDI). This section should only be used for machines equipped with a MDI and SEVCON Power Module-(ground board software version P1.13 or higher) or ZAPI Power Module-(ground board software version P1.0 or higher). For more information on the MDI or any sensors or indicators, refer to the appropriate section for the machine area. Many of the checks below require configuring and using a multimeter. Refer to Section 7: General Electrical Information & Schematics for multimeter basics. DTCs are sorted in groups by the first two digits, which is also the system distress lamp flash code. To troubleshoot multiple DTCs, start with the DTC with the higher first two digits. The machine is powered by four 6 Volt batteries in series, providing a nominal 24 Volts to the control system. Some procedures below refer to this nominal voltage (VMN) as 24V. Actual voltage measurements may differ based on the charge of the batteries. **If a correction is made during a check, conclude the check by cycling the machine power, using the emergency stop switch.** It may also be helpful to run a system test, ANALYZER -> SYSTEM TEST for intermittent or difficult problems.

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## SECTION 6 - DIAGNOSTIC TROUBLE CODES

### 6.3 DTC CHECK TABLES

#### 0-0 Help Comments

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
ERROR	Error (Displayed on MDI)	The MDI is powered, but cannot communicate with the control system.	<ul style="list-style-type: none"> <li>• Check the MDI connector.</li> <li>• Check the diagnostic connector.</li> <li>• Check continuity between MDI connector socket 6 and ground board connector socket J1-4.</li> <li>• Check continuity between MDI connector socket 4 and ground board connector socket J1-3.</li> <li>• Check that the ground board software version is P1.13 or higher.</li> </ul>
001	EVERYTHING OK	The normal help message in platform mode. Displays on the analyzer only.	
002	GROUND MODE OK	The normal help message in ground mode. Displays on the analyzer only.	
003	ALARM SOUNDING - TILTED & ABOVE ELEVATION	Control system senses that the platform is elevated and the vehicle is tilted, and the machine not configured to cutout.	<ul style="list-style-type: none"> <li>• Check that the machine is tilted. If so, lower the platform and reposition the machine to a level surface.</li> <li>• Fully stow the platform.</li> <li>• The tilt sensor is part of the ground control box. Check that the ground control box is secured to the machine.</li> <li>• Check that the pothole protection switches are securely mounted.</li> <li>• Check that the elevation angle sensor is securely mounted.</li> <li>• Check the ANALYZER -&gt; MACHINE SETUP -&gt; MARKET configuration.</li> <li>• If MARKET is set to CE, ensure ANALYZER -&gt; MACHINE SETUP -&gt; TILT CUTOFF parameter is set as desired.</li> <li>• Backprobing ground board J1-18 should show about 0 volts.</li> <li>• Backprobing ground board J1-10 should show about 0 volts.</li> <li>• Check pothole protection switch adjustment.</li> <li>• Calibrate the elevation sensor, see Section 5.5.</li> <li>• Calibrate the tilt sensor, see Section 5.2.</li> </ul>
004	DRIVING AT CUTBACK - ABOVE ELEVATION	The platform is elevated and the machine is driving.	<ul style="list-style-type: none"> <li>• Fully stow the platform.</li> <li>• Check that the elevation angle sensor is securely mounted.</li> <li>• Check that the pothole protection switches are securely mounted.</li> <li>• Check the lift/drive switch.</li> <li>• Backprobing ground board J1-18 should show about 0 volts.</li> <li>• Backprobing ground board J1-10 should show about 0 volts.</li> <li>• Check function of elevation angle sensor. ANALYZER -&gt; DIAGNOSTICS -&gt; ELEV SENSOR -&gt; ZEROED should be about 0V when stowed and about 0.15V at cutback.</li> </ul>

 **0-0 Help Comments**

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
005	DRIVE & LIFT UP PREVENTED - TILTED & ELEVATED	Driving is not possible since the platform is elevated and the chassis is not level.	<ul style="list-style-type: none"> <li>• Check that the machine is tilted. If so, lower the platform and reposition the machine to a level surface.</li> <li>• Fully stow the platform.</li> <li>• The tilt sensor is part of the ground control box. Check that the ground control box is secured to the machine.</li> <li>• Check that the pothole protection switches are securely mounted.</li> <li>• Check that the elevation angle sensor is securely mounted.</li> <li>• Check the ANALYZER -&gt; MACHINE SETUP -&gt; MARKET configuration.</li> <li>• If MARKET is set to CE, ensure ANALYZER -&gt; MACHINE SETUP -&gt; TILT CUTOFF parameter is set as desired.</li> <li>• Check pothole protection switch adjustment.</li> <li>• Backprobing ground board J1-18 should show about 0 volts.</li> <li>• Backprobing ground board J1-10 should show about 0 volts.</li> <li>• Calibrate the elevation sensor, see Section 5.5.</li> <li>• Calibrate the tilt sensor, see Section 5.2.</li> </ul>
006	LIFT UP PREVENTED - MAX HEIGHT ZONE A	The vehicle has reached the maximum height and further lift up motion is not possible. Applicable to 2632ES or 3246ES.	<ul style="list-style-type: none"> <li>• Check that the zone is set appropriately for the platform load.</li> <li>• Check that the platform height is at the rated maximum height specification (20' for 2632 or 26' for the 3246).</li> <li>• Check that the elevation angle sensor is securely mounted.</li> <li>• If there are any elevation sensor faults (DTC 251, 252, 2511, or 2512), troubleshoot those first.</li> <li>• Check that ANALYZER -&gt; MACHINE SETUP -&gt; MODEL setting is correct.</li> <li>• Check that ANALYZER -&gt; MACHINE SETUP -&gt; MARKET setting is correct.</li> <li>• Check ANALYZER -&gt; DIAGNOSTICS -&gt; ELEV SENSOR -&gt; ZEROED is about 1.53V for the 3246 or about 1.22V for the 2632 when at full height. If not, repair or replace the elevation angle sensor.</li> </ul>
007	DRIVING AT CUTBACK - POT-HOLE STILL ENGAGED	While stowed, drive speed is reduced since the control system detected that the pot-hole protection mechanism failed to retract.	<ul style="list-style-type: none"> <li>• Check for obstructions around the pot-hole protection mechanisms.</li> <li>• Check that the PHP switches are securely mounted.</li> <li>• Check PHP switches wiring from the ground board and for proper operation. The left PHP input (24V) is from J1-9 and its output (24V when deployed) is to J1-10. The right PHP input (24V) is from J1-17 and its output (24V when deployed) is to J1-18.</li> </ul>
008	FUNCTIONS LOCKED OUT - SYSTEM POWERED DOWN	After 2 hours without activity, the control system enters a low-power state to preserve battery charge.	<ul style="list-style-type: none"> <li>• Normal operation should resume after a power cycle.</li> <li>• Check batteries charge, condition, etc.</li> </ul>

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### 0-0 Help Comments

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
009	DRIVE PREVENTED - ELEVATED ABOVE DRIVE CUTOUT HEIGHT	The platform is elevated above the calibrated cutout height.	<ul style="list-style-type: none"> <li>• Check that the elevation angle sensor is securely mounted.</li> <li>• Check the ANALYZER -&gt; MACHINE SETUP -&gt; MARKET configuration.</li> <li>• If MARKET is set to Japan, ensure ANALYZER -&gt; MACHINE SETUP -&gt; DRIVE CUTOUT parameter is set as desired.</li> </ul>

### 2-1 Power-Up

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
211	POWERCYCLE	This help message is issued at each power cycle. Displays on the analyzer only.	Normal operation. No check necessary.
212	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously. Defaults to ground mode.	<ul style="list-style-type: none"> <li>• Check key switch function.</li> <li>• Backprobe J2-3 with the keyswitch in the ground position. Voltage should be under 6V. Otherwise, keyswitch or wiring faulty.</li> <li>• Backprobe J2-4 with the keyswitch in the platform position. Voltage should be under 6V. Otherwise, keyswitch or wiring faulty.</li> <li>• Check key switch wiring to ground board J2-3 and J2-4 and to emergency stop switch.</li> <li>• Replace ground board.</li> </ul>

### 2-2 Platform Controls

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
221	FUNCTION PROBLEM - HORN PERMANENTLY SELECTED	The horn switch was closed during power-up in platform mode.	<ul style="list-style-type: none"> <li>• Check if the horn switch is damaged, obstructed or jammed.</li> <li>• Disconnect the horn switch ribbon cable on the platform board. If DTC still present, replace the platform board. If DTC 221 is no longer present, replace the horn switch or platform board.</li> </ul>
222	FUNCTION PROBLEM - INDOOR / OUTDOOR PERMANENTLY SELECTED	The indoor / outdoor (zone A / zone B) switch was closed during power-up in platform mode.	<ul style="list-style-type: none"> <li>• Check if the indoor/outdoor (zone A / zone B) capacity switch is damaged, obstructed or jammed.</li> <li>• Replace platform board.</li> </ul>
223	FUNCTION PROBLEM - DRIVE & LIFT ACTIVE TOGETHER	The drive and lift inputs are closed simultaneously in platform mode.	<ul style="list-style-type: none"> <li>• Check drive/lift switch for visible damage.</li> <li>• Check switch continuity. There should only be continuity from the center post to one of the outer posts at a time. Otherwise, replace the switch.</li> <li>• Check drive/lift switch signal and wiring to the platform board. Its input (0V) is from platform board terminal J1-11. "Lift" selection output (0V when selected) is to platform board terminal J1-9. "Drive" selection output (0V when closed) is to platform board terminal J1-10.</li> <li>• Replace platform board.</li> </ul>

## 2-2 Platform Controls

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
224	FUNCTION PROBLEM - STEER LEFT PERMANENTLY SELECTED	The steer left switch was closed during power-up in platform mode.	<ul style="list-style-type: none"> <li>Check if the steer left switch is obstructed or jammed.</li> <li>Check steer left switch and its wiring. The steer left switch input (24V) is from platform board terminal J1-1, and its output (24V when closed) is to platform board terminal J1-15.</li> <li>Replace platform board.</li> </ul>
225	FUNCTION PROBLEM - STEER RIGHT PERMANENTLY SELECTED	The steer right switch was closed during power-up in platform mode.	<ul style="list-style-type: none"> <li>Check if the steer right switch is obstructed or jammed.</li> <li>Check steer right switch and its wiring to the platform board. The steer right switch input (24V) is from platform board terminal J1-1, and its output (24V when closed) is to platform board terminal J1-16.</li> <li>Replace platform board.</li> </ul>
226	ACCELERATOR FAULTY - WIPER OUT OF RANGE	The joystick signal is outside the acceptable range of 0.50V - 4.5V, or is unstable.	<ul style="list-style-type: none"> <li>Center joystick and check to see if a power cycle will clear DTC.</li> <li>Check the joystick signal and its wiring. The joystick input (5V) is from the platform board terminal J1-5, its output (2.5V with joystick at center) to the platform board terminal J1-6, and its ground (0V) is to the platform board terminal J1-7. Observe output signal while slowly operating joystick.</li> <li>Replace platform board.</li> </ul>
227	STEER SWITCHES FAULTY	The steer left and steer right inputs were closed simultaneously.	<ul style="list-style-type: none"> <li>Check if the steer switches are damaged, obstructed or jammed.</li> <li>Check the steer switch signals and wiring to the platform board. The steer switch input (24V) is from platform board terminal J1-1, outputs (24V when closed) are to platform board terminals J1-15 and J1-16 (left and right).</li> <li>Replace platform board.</li> </ul>
228	FUNCTION LOCKED OUT - ACCELERATOR NOT CENTERED	The joystick was not centered at power-up.	<ul style="list-style-type: none"> <li>Release joystick and allow to center.</li> <li>Check if the joystick is obstructed or jammed.</li> <li>Check the joystick signal and its wiring. The joystick input (5V) is from the platform board terminal J1-5, its output (2.5V with joystick at center) to the platform board terminal J1-6, and its ground (0V) is to the platform board terminal J1-7. Observe output signal while slowly operating joystick.</li> <li>Replace platform board.</li> </ul>
229	FUNCTION PROBLEM - TRIGGER PERMANENTLY CLOSED	The trigger switch was closed during power-up in platform mode.	<ul style="list-style-type: none"> <li>Check if the trigger switch is obstructed or jammed.</li> <li>Check the trigger switch signal and wiring to the platform board. The trigger input (24V) is from platform board terminal J1-1, and its output (24V when closed) is to platform board terminal J1-8.</li> <li>Replace platform board.</li> </ul>
		(Japanese or Korean Specification Only) The footswitch in the platform and trigger switch were closed during power-up in platform mode.	<ul style="list-style-type: none"> <li>Release one switch.</li> <li>Repair the switches/wiring to clear the difficulty.</li> </ul>



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### 2-2 Platform Controls

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
2210	TRIGGER CLOSED TOO LONG WHILE IN NEUTRAL	The trigger switch was closed for more than five seconds while the joystick was centered.	<ul style="list-style-type: none"> <li>Check if the trigger switch is obstructed or jammed.</li> <li>Check the trigger switch signal and wiring to the platform board. The trigger input (24V) is from platform board terminal J1-1, and its output (24V when closed) is to platform board terminal J1-8.</li> <li>Replace platform board.</li> </ul>
2211	FOOTSWITCH CLOSED TOO LONG WHILE IN NEUTRAL	(Japanese or Korean Specification Only) The footswitch in the platform and trigger switch were closed simultaneously for more than seven seconds while the joystick was centered.	<ul style="list-style-type: none"> <li>Release either switch.</li> <li>Repair switch/wiring to clear the difficulty.</li> </ul>
2232	FUNCTION PROBLEM - DRIVE & LIFT BOTH OPEN	The drive and lift inputs are both de-energized in Platform Mode.	<ul style="list-style-type: none"> <li>Check if either function is active, if Yes;</li> <li>Repair the wiring or switch to clear the message.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>

### 2-3 Ground Controls

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
231	FUNCTION PROBLEM - LIFT PERMANENTLY SELECTED	The ground control box lift switch was closed up or down, during power-up in ground mode.	<ul style="list-style-type: none"> <li>Check if the lift switch is obstructed or jammed.</li> <li>Check the lift switch signal and wiring to the ground board. The lift switch input (24V) is from ground board terminal J2-4, and its outputs (24V when closed) are to ground board terminals J2-6, J2-7 (up and down).</li> <li>Replace ground board.</li> </ul>
232	GROUND LIFT UP / DOWN ACTIVE TOGETHER	The lift up / down inputs are closed simultaneously.	<ul style="list-style-type: none"> <li>Check if the lift switch is obstructed or jammed.</li> <li>Check the lift switch signal and wiring to the ground board. The lift switch input (24V) is from ground board terminal J2-4, and its outputs (24V when closed) are to ground board terminals J2-6 (up), J2-7 (down).</li> <li>Replace ground board.</li> </ul>
233	FUNCTION PROBLEM - BRAKE RELEASE PERMANENTLY SELECTED	The manual brake release switch was closed during power-up.	<ul style="list-style-type: none"> <li>Check if the brake release switch is obstructed or jammed.</li> <li>Check the brake release switch signal and wiring to the ground board. The brake release switch input (24V) is from ground board terminal J1-19, and its output (24V when closed) is to ground board terminal J1-20.</li> <li>If the brakes are released, the machine can be pushed or moved without drive motor power.</li> <li>Replace ground board.</li> </ul>

 **2-5 Function Prevented**

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
251	ELEV ANGLE SENSOR FAULTY - VOLTAGE OUT OF RANGE	The elevation angle sensor input voltage is outside the acceptable range of 0.10V - 4.50V.	<ul style="list-style-type: none"> <li>• Check that the platform elevation sensor is securely mounted and undamaged.</li> <li>• Check voltage as displayed on ANALYZER -&gt; DIAGNOSTICS -&gt; ELEV SENSOR -&gt; ANGLE SNSR. Backprobe ground board J1-15. If this voltage disagrees with the ANGLE SNSR voltage, replace the ground board.</li> <li>• Backprobe the elevation angle sensor connector. Terminal A should be 4.7V, terminal C should be 0V.</li> <li>• Check the elevation angle sensor signal and wiring to the ground board. The elevation angle sensor input is from ground board terminal J1-14 (4.7V), its output (0.1 - 1.2V when stowed) is to ground board terminal J1-15, and its ground is to ground board terminal J1-16.</li> <li>• Replace the ground board.</li> </ul>
252	ELEV ANGLE SENSOR HAS NOT BEEN CALIBRATED	The elevation angle sensor has not been calibrated.	<ul style="list-style-type: none"> <li>• Calibrate the elevation angle sensor to clear fault. See Section 5.5.</li> </ul>
253	DRIVE PREVENTED - CHARGER CONNECTED	Driving is not possible while the vehicle is charging.	<ul style="list-style-type: none"> <li>• Check if the charger is connected to off board power source and disconnect if desired.</li> <li>• Check ANALYZER -&gt; MACHINE SETUP -&gt; CHARGER INTERLOC is set as desired.</li> <li>• Check that charger's red (positive) battery wire connector terminal is receiving power (24V) from batteries.</li> <li>• Check signal from charger interlock connector terminal 2 to ground board terminal J1-29, where 0VDC indicates charging in process.</li> </ul>
254	DRIVE & LIFT UP PREVENTED - CHARGER CONNECTED	Drive or lift is not possible while the vehicle is charging AND is configured to prevent all motion.	<ul style="list-style-type: none"> <li>• Check if the charger is connected to off board power source and disconnect if desired.</li> <li>• Check ANALYZER -&gt; MACHINE SETUP -&gt; CHARGER INTERLOC is set as desired. (Must be in ACCESS LEVEL 1 to change.)</li> <li>• Check that charger's red (positive) battery wire connector terminal is receiving power (24V) from batteries.</li> <li>• Check signal from charger interlock connector terminal 2 to ground board terminal J1-29, where 0VDC indicates charging in process.</li> </ul>
255	PLATFORM OVERLOADED	The load sensing system measured platform load is excessive.	<ul style="list-style-type: none"> <li>• Remove excess weight from the platform.</li> <li>• Check that the platform is not caught on something, preventing up or down movement.</li> <li>• If any CAN bus faults are active, troubleshoot those first.</li> <li>• Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>

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### 2-5 Function Prevented

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
256	DRIVE PREVENTED - POTHOLE NOT ENGAGED	Driving is not possible while elevated since the pot-hole protection system failed to deploy.	<ul style="list-style-type: none"> <li>• Check for obstructions or mechanical problems around the pot-hole protection mechanisms.</li> <li>• Check that the PHP switches are securely mounted.</li> <li>• Adjust pot-hole protection switches.</li> <li>• Check the pothole protection switches signal and wiring to the ground board. The left pot-hole protection switch input (24V) is from ground board terminal J1-9, and its output (24V when deployed) is to ground board terminal J1-10. The right pot-hole protection switch input (24V) is from ground board terminal J1-17, and its output (24V when deployed) is to ground board terminal J1-18.</li> </ul>
257	ELEV PROX PERMANENTLY CLOSED - CHECK PROX AND ANGLE ADJUSTMENT	The elevation proximity switch shows the platform to be stowed, while the elevation angle sensor shows the platform to be raised. The elevation proximity switch is only found on certain older lifts. This switch is not used on current machines so this DTC should not occur.	<ul style="list-style-type: none"> <li>• Verify that an elevation proximity switch is present on the machine. If not, ensure ANALYZER -&gt; MACHINE SETUP -&gt; ELEV PROX is set to NOT INSTALLED. If the switch is present, set ELEV PROX to INSTALLED and check switch continuity. The switch should close when placed in close proximity to ferrous metal.</li> </ul>
258	DRIVE & LIFT PREVENTED - BRAKES ELECTRICALLY RELEASED FOR TOWING	Manual brake release mode is activated with the switch in the battery box near the ground control box. Drive or lift is not possible.	<ul style="list-style-type: none"> <li>• Push manual brake release switch again or cycle power to clear manual brake release mode.</li> <li>• Check if the brake release switch is obstructed or jammed.</li> <li>• Check the brake release switch signal and wiring to the ground board. The switch input (24V) is from ground board terminal J1-19, and its output (24V when closed) is to ground board terminal J1-20.</li> <li>• Replace ground board.</li> </ul>
259	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS	The model selection has been changed.	<ul style="list-style-type: none"> <li>• Check ANALYZER -&gt; MACHINE SETUP -&gt; MODEL NUMBER.</li> <li>• Replace ground board.</li> </ul>
2510	DRIVE PREVENTED - BRAKES NOT RELEASING	While driving on a level surface, armature current was > 150A for five seconds. Brakes assumed to not be releasing properly.	<ul style="list-style-type: none"> <li>• Ensure vehicle is not stuck on something preventing movement.</li> <li>• Check / repair drive motor wiring, brakes or mechanical issues.</li> </ul>
2511	ELEV ANGLE SENSOR FAULTY - NOT MOUNTED	The input voltage from the elevation angle sensor indicates the elevation angle sensor is not mounted.	<ul style="list-style-type: none"> <li>• Check that the elevation angle sensor is securely mounted.</li> <li>• Check that the elevation angle sensor mechanisms are intact.</li> <li>• Replace elevation angle sensor.</li> </ul>
2512	ELEV ANGLE SENSOR NOT DETECTING CHANGE	The input voltage from the elevation angle sensor did not change while vehicle was lifting up.	<ul style="list-style-type: none"> <li>• Check that the elevation angle sensor is securely mounted.</li> <li>• Check elevation angle sensor is not jammed or obstructed.</li> <li>• If there are any other elevation angle sensor, joystick, or lift up faults, troubleshoot them before continuing.</li> <li>• Replace elevation angle sensor.</li> </ul>

### 3-1 Line Contactor Open Circuit

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
311	OPEN CIRCUIT LINE CONTACTOR	The power modules line contactor did not close when energized. Drive, steer and lift up prevented.	<ul style="list-style-type: none"> <li>• Check contactor main contact wiring to battery (+) terminal and power controller terminal B+.</li> <li>• Contactor solenoid resistance should measure about 52 Ohms.</li> <li>• Check contactor solenoid wiring to power module 12 position connector terminal 8 and ground board terminal J1-19.</li> <li>• Check that power module 12 position connector terminal 8 goes from 24V to near 0V while contactor should be closing. If this happens replace contactor.</li> <li>• Replace the line contactor.</li> </ul>
312	CONTACTOR DRIVER PERMANENTLY OFF	The power modules line contactor drive circuitry failed to energize when requested. Drive, steer and lift up prevented.	<ul style="list-style-type: none"> <li>• Check continuity between contactor connector pin 1 and ground board socket J1-19.</li> <li>• Contactor solenoid resistance should measure about 52 Ohms.</li> <li>• Check continuity between contactor connector pin 2 and power module connector socket 8.</li> <li>• Replace power module.</li> </ul>
314	AUXILIARY RELAY - OPEN CIRCUIT	The auxiliary relay did not close when energized.	<ul style="list-style-type: none"> <li>• Check the auxiliary relay coil and associated wiring to J1-13 and J1-32.</li> <li>• No voltage on J1-28.</li> <li>• HEALTH (Status LED) - ON</li> </ul>

### 3-2 Line Contactor Short Circuit

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
321	LINE CONTACTOR MISWIRED ON OR WELDED	Battery voltage was present at the power module B+ terminal at power up. Drive, steer and lift up prevented.	<ul style="list-style-type: none"> <li>• Check wiring of contactor.</li> <li>• Check resistance between the studs of the contactor while disconnected from the machine.</li> <li>• Check contactor main contact wiring to battery (+) terminal and power module terminal B+.</li> <li>• Check continuity between contactor connector pin 1 and ground board socket J1-19.</li> <li>• Check continuity between contactor connector pin 2 and power module 12 position connector terminal 8.</li> <li>• Measure voltage between power model B+ and B- terminals. If 24V is present, replace line contactor.</li> <li>• Replace power module.</li> </ul>
322	CONTACTOR DRIVER PERMANENTLY ON	The power modules line contactor drive circuitry failed to de-energize when requested. Drive, steer and lift up prevented.	<ul style="list-style-type: none"> <li>• Check continuity between contactor connector pin 1 and ground board socket J1-19.</li> <li>• Check continuity between contactor connector pin 2 and power module 12 position connector terminal 8.</li> <li>• Replace power module.</li> </ul>
326	AUXILIARY RELAY SHORT TO BATTERY	The System Module did not activate the Negative Main Contactor driver, but battery voltage was measured on the J1-28 of the controller.	<ul style="list-style-type: none"> <li>• Check contacts and coils of auxiliary relay.</li> <li>• Check if no motion interlocks</li> <li>• Check voltage on J1-28.</li> <li>• HEALTH (Status LED) - ON</li> </ul>

## SECTION 6 - DIAGNOSTIC TROUBLE CODES

### 3-3 Ground Output Driver

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
331	BRAKE SHORT TO BATTERY	The ground board detected voltage while the brake solenoid was commanded off.	<ul style="list-style-type: none"> <li>Ensure ANALYZER -&gt; MACHINE SETUP -&gt; ELEV PROX is set to NOT INSTALLED.</li> </ul>
332	BRAKE OPEN CIRCUIT	The ground board did not detect current flow to the brake solenoid during normal operation.	<ul style="list-style-type: none"> <li>Ensure ANALYZER -&gt; MACHINE SETUP -&gt; ELEV PROX is set to NOT INSTALLED.</li> </ul>
333	LIFT UP SHORT TO BATTERY	The ground board detected voltage while the lift up solenoid was commanded off at power up.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. The lift up solenoid resistance should measure about 30 Ohms. The lift up solenoid is powered with 24V from ground board J1-25, and its ground is to ground board J1-30, 37.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
334	LIFT UP OPEN CIRCUIT	The ground board did not detect current flow to the lift up solenoid during power up.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. The lift up solenoid resistance should measure about 30 Ohms. The lift up solenoid is powered with 24V from ground board J1-25, and its ground is to ground board J1-30, 37.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
335	LIFT DN SHORT TO BATTERY	The ground board detected voltage while the lift down solenoid was commanded off.	<ul style="list-style-type: none"> <li>Check ANALYZER -&gt; MACHINE SETUP -&gt; ELEV PROX is set to NOT INSTALLED</li> <li>Check for continuity through this circuit. The lift down solenoid resistance should measure about 20 Ohms. The lift down solenoid is powered (PWM) by ground board J1-26, and its ground is to ground board J1-27.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
336	LIFT DN OPEN CIRCUIT	The ground board did not detect current flow to the lift down solenoid during normal operation.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. The lift down solenoid resistance should measure about 20 Ohms. The lift down solenoid is powered (PWM) by ground board J1-26, and its ground is to ground board J1-27.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
337	STEER LEFT SHORT TO BATTERY	The ground board detected voltage while the steer left solenoid was commanded off at power up.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. Steer left solenoid resistance should measure about 30 Ohms. The steer left solenoid is powered with 24V from ground board J1-21, and its ground is to ground board J1-30, 37.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
338	STEER LEFT OPEN CIRCUIT	The ground board did not detect current flow to the steer left solenoid during normal operation.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. Steer left solenoid resistance should measure about 30 Ohms. The steer left solenoid is powered with 24V from ground board J1-21, and its ground is to ground board J1-30, 37.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>

### 3-3 Ground Output Driver

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
339	STEER RIGHT SHORT TO BATTERY	The ground board detected voltage while the steer right solenoid was commanded off.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. Steer right solenoid resistance should measure about 30 Ohms. The steer right solenoid is powered with 24V from ground board J1-22, and its ground is to ground board J1-30, 37.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
3310	STEER RIGHT OPEN CIRCUIT	The ground board did not detect current flow to the steer right solenoid during normal operation.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. Steer right solenoid resistance should measure about 30 Ohms. The steer right solenoid is powered with 24V from ground board J1-22, and its ground is to ground board J1-30, 37.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
3311	GROUND ALARM SHORT TO BATTERY	The ground board detected voltage while the ground alarm was commanded off.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. The ground alarm solenoid is powered with 24V from ground board J1-19, its PWM signal is from ground board J1-28, and its ground is to ground board J1-30, 37. There should be about 1500 Ohms between ground alarm connector pin 1 and pin 3.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
3312	LEFT BRAKE SHORT TO BATTERY	The ground board detected voltage while the left brake was commanded off.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. The left brake is powered with 24V from ground board J1-23, and its ground is to ground board J1-30, 37. Brake solenoid resistance should measure about 20 Ohms.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
3313	RIGHT BRAKE SHORT TO BATTERY	Voltage was detected on the right brake solenoid when the ground board output was commanded off during power-up.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. Brake solenoid resistance should measure about 20 Ohms. The right brake is powered with 24V from ground board J1-24, and its ground is to ground board J1-30, 37.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
3314	LEFT BRAKE OPEN CIRCUIT	Current flow to the left brake solenoid was not detected during normal left brake operation.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. The left brake is powered with 24V from ground board J1-23, and its ground is to ground board J1-30, 37. Brake solenoid resistance should measure about 20 Ohms.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
3315	RIGHT BRAKE OPEN CIRCUIT	The ground board did not detect current flow to the right brake during normal operation.	<ul style="list-style-type: none"> <li>Check for continuity through this circuit. Brake solenoid resistance should measure about 20 Ohms. The right brake is powered with 24V from ground board J1-24, and its ground is to ground board J1-30, 37.</li> <li>Inspect the wiring for physical damage.</li> <li>Replace ground board.</li> </ul>
33297	LEFT BRAKE - SHORT TO GROUND	Drive and Steer Prevented	<ul style="list-style-type: none"> <li>Excessive current flow to the Left Brake Solenoid was detected (J1-34 NLB).</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>

## SECTION 6 - DIAGNOSTIC TROUBLE CODES

### 3-3 Ground Output Driver

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
33298	STEER LEFT VALVE - SHORT TO GROUND	Drive, Steer and Lift Up Prevented	<ul style="list-style-type: none"> <li>Excessive current flow to the steer left solenoid detected (J2-9 NLV).</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33299	LINE CONTACTOR COIL - SHORT TO BATTERY	Drive, Lift and Steer Prevented	<ul style="list-style-type: none"> <li>Voltage from an external source was detected on the Negative Main Line Contactor.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33302	NEGATIVE SUPPLY - SHORT TO BATTERY	Drive, Lift, and Steer Prevented	<ul style="list-style-type: none"> <li>At power-up, the system module detected an external short on J1-12, J1-17, J1-23, J2-14 or J2-15. Normally these pins are grounded by the System Module. All functions are prevented to protect the control system.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33303	NEGATIVE SUPPLY - SHORT TO GROUND	Drive, Lift and Steer Prevented	<ul style="list-style-type: none"> <li>At power-up, the System Module detected an external short on J1-12, J1-17, J2-14 or J2-15. Normally these pins are grounded by the System Module. Since the external ground may compromise integrity, all functions will be prevented.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33304	RIGHT BRAKE - SHORT TO GROUND	Drive, and Steer Prevented	<ul style="list-style-type: none"> <li>Excessive current flow to the Right Brake solenoid was detected (J1-33 NRB).</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33305	STEER RIGHT VALVE - SHORT TO GROUND	Drive, Steer, and Lift Up Prevented	<ul style="list-style-type: none"> <li>Excessive current flow to the Steer Right Solenoid was detected (J2-18 NRV).</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33383	BEACON LIGHT - OPEN CIRCUIT	Current flow to the Beacon Output was not detected (J1-35 BEAC)	<ul style="list-style-type: none"> <li>Machine Setup's BEACON is 0=NO OR 1=YES</li> <li>No motion restrictions</li> <li>Latched</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33384	BEACON LIGHT - SHORT TO GROUND	Excessive current flow to the Beacon Output was detected (J1-35 BEAC)	<ul style="list-style-type: none"> <li>Machine Setup's BEACON is 0=NO OR 1=YES</li> <li>No motion restrictions</li> <li>Latched</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33406	LIFT UP VALVE - SHORT TO GROUND	Drive, Steer, and Lift Up Prevented	<ul style="list-style-type: none"> <li>Excessive current flow to the Lift Up Solenoid was detected at (J2-2 PDV or J2-16 NDV).</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33407	LIFT DN VALVE - SHORT TO GROUND	Lift Up and Down Prevented	<ul style="list-style-type: none"> <li>Excessive current flow to the Lift Down Solenoid was detected (J2-16 NDV).</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
33562	BEACON LIGHT - SHORT TO BATTERY	Voltage from an external source was detected on the Beacon Output (J1-35 BEAC)	<ul style="list-style-type: none"> <li>Machine Setup's BEACON is 0=NO OR 1=YES</li> <li>No motion restrictions</li> <li>Latched</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>

### 4-2 Thermal Limit (SOA)

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
421	POWER MODULE TOO HOT - PLEASE WAIT	The power module has reached thermal cutout.	<ul style="list-style-type: none"> <li>Power down and allow to cool.</li> <li>Do not operate in ambients over 140° F (60° C).</li> <li>Check for jammed or obstructed drive motors.</li> <li>Check for excessively high current consumption in the pump, ANALYZER -&gt; DIAGNOSTICS -&gt; PUMP -&gt; PUMP CUR over 130 Amps with an empty platform.</li> <li>Check for excessively high traction current consumption, ANALYZER -&gt; DIAGNOSTICS -&gt; TRACTION -&gt; ARM CUR over 120 Amps while driving on the level.</li> </ul>
422	DRIVING AT CUTBACK - POWER MODULE CURRENT LIMIT	The drive portion of the power module has reached thermal limit.	<ul style="list-style-type: none"> <li>Check for jammed or obstructed drive motors.</li> <li>Check for excessively high traction current consumption, ANALYZER -&gt; DIAGNOSTICS -&gt; TRACTION -&gt; ARM CUR over 120 Amps while driving on the level.</li> </ul>
423	LIFT UP AT CUTBACK - POWER MODULE CURRENT LIMIT	The lift up portion of the power module has reached thermal limit.	<ul style="list-style-type: none"> <li>Check for jammed or obstructed arm stack or pivot bushing.</li> <li>Check for excessively high current consumption in the pump, ANALYZER -&gt; DIAGNOSTICS -&gt; PUMP -&gt; PUMP CUR over 130 Amps with an empty platform.</li> <li>Refer to Pump Motor Electrical Evaluation in Section 4.8.</li> </ul>

### 4-4 Battery Supply

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
441	BATTERY VOLTAGE TOO LOW - SYSTEM SHUT-DOWN	The power module momentarily measured battery voltage under 14.5V between ground board J1-39 and ground board J1-40.	<ul style="list-style-type: none"> <li>Recharge batteries or check for damaged batteries.</li> <li>Check battery charger function.</li> </ul>
442	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUT-DOWN	The power module momentarily measured battery voltage > 37.0V.	<ul style="list-style-type: none"> <li>May be due to improper battery charging or incorrect voltage batteries being used.</li> </ul>
443	LSS BATTERY VOLTAGE TOO HIGH	The load sensing system module momentarily measured battery voltage > 34.0V.	<ul style="list-style-type: none"> <li>May be due to improper battery charging or incorrect voltage batteries being used.</li> <li>Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>
444	LSS BATTERY VOLTAGE TOO LOW	The load sensing system module momentarily measured battery voltage < 9V.	<ul style="list-style-type: none"> <li>Recharge batteries or check for damaged batteries.</li> <li>Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>
446	LOGIC SUPPLY VOLTAGE OUT OF RANGE	The system module logic supply voltage was measured to be out of normal operating range by the interface PCB (<11V).	<ul style="list-style-type: none"> <li>This may be caused by a loose battery terminal, severely discharged batteries, damaged battery, or an improper wire harness connection.</li> <li>Drive, Steer, and Lift Prevented</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
4421	LOGIC SUPPLY VOLTAGE OUT OF RANGE	The system module logic supply voltage was measured by the power PCB to be more than 34V for 10uS.	<ul style="list-style-type: none"> <li>This may be caused by a loose battery terminal, severely discharged batteries, damaged battery, or an improper wire harness connection.</li> <li>Drive, Steer, and Lift Prevented</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>



## SECTION 6 - DIAGNOSTIC TROUBLE CODES

### 4-4 Battery Supply

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
4422	LOGICSUPPLYVOLTAGE OUT OF RANGE	The system module logic supply voltage was measured by the power PCB to be less than 11V for 10uS.	<ul style="list-style-type: none"><li>• This may be caused by a loose battery terminal, severely discharged batteries, damaged battery, or an improper wire harness connection.</li><li>• Drive, Steer, and Lift Prevented</li><li>• ZAPI - HEALTH (Status LED) - ON</li></ul>

### 6-6 Communication

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
661	CANBUS FAILURE- POWER MODULE	The control system failed to receive messages from the power module.	<ul style="list-style-type: none"><li>• Check for 24V between power module 12 position connector terminal 1 and the power module B- terminal. If this is the problem, the line contactor may be cycling on and off, making a clicking noise when the machine is powered.</li><li>• Disconnect ground board J1 and power module connector. Ground board socket J1-31 to power module connector socket 10 should have continuity. Ground board socket J1-32 to power module connector socket 11 should have continuity.</li><li>• Turn on machine in platform mode. If DTC 662 is present, troubleshoot that DTC before continuing.</li></ul>

## 6-6 Communication

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
662	CANBUS FAILURE - PLATFORM MODULE	In platform mode, the control system failed to receive messages from the platform board.	<ul style="list-style-type: none"> <li>• Turn on machine in ground mode. If DTC 661 is not present check for 24V between platform box connector terminals D and A. If not 24V, test continuity from platform box connector socket A to ground board connector socket J1-6 and test continuity from platform box connector socket D to ground board connector socket J1-7.</li> <li>• If DTC 661 was present in the previous check, disconnect armstack passthru connector located near the ladder on the left. Turn on in ground mode. If DTC 661 is not present then there is a problem in armstack harness. Armstack passthru socket 5 to platform box terminal E should have continuity. Armstack passthru socket 6 to platform box connector terminal F should have continuity. Armstack passthru socket 7 to platform box connector terminal G should have continuity. Armstack passthru socket 5 to armstack passthru socket 6 resistance should be 120 Ohms +/- 5%. Armstack passthru socket 5 to armstack passthru socket 7 should measure open circuit. Armstack passthru socket 6 to armstack passthru socket 7 should measure open circuit.</li> <li>• Disconnect armstack passthru and ground board J1. Armstack passthru pin 5 to ground board socket J1-11 should have continuity. Armstack passthru pin 6 to ground board socket J1-12 should have continuity. Armstack passthru pin 7 to ground board socket J1-13 should have continuity. Armstack passthru pin 5 to armstack passthru pin 6 should measure open circuit. Armstack passthru pin 5 to armstack passthru pin 7 should measure open circuit. Armstack passthru pin 6 to armstack passthru pin 7 should measure open circuit.</li> <li>• Disconnect ground board J1 and power module connector. Ground board socket J1-31 to power module connector socket 10 should have continuity. Ground board socket J1-32 to power module connector socket 11 should have continuity. Ground board socket J1-31 to J1-32 should measure open circuit. Ground board socket J1-31 to J1-33 should measure open circuit. Ground board socket J1-32 to J1-33 should measure open circuit.</li> <li>• Ensure all connections opened above are reconnected. Disconnect power module connector. Turn on in platform mode. If DTC 662 is no longer present replace power module.</li> <li>• If DTC 661 and 662 have been present through above steps replace ground board.</li> </ul> <p style="text-align: right;"><i>Continued Next Page</i></p>

## SECTION 6 - DIAGNOSTIC TROUBLE CODES

### 6-6 Communication

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
662 (Cont.)	CANBUS FAILURE - PLATFORM MODULE (Continued)	In platform mode, the control system failed to receive messages from the platform board.	<ul style="list-style-type: none"> <li>Disconnect platform box connector. Open platform box. Disconnect platform board connector. Platform box socket E to platform board J1-3 should have continuity. Platform box socket F to platform board J1-4 should have continuity. Platform box pin E to pin F should measure open circuit. Platform box pin E to pin G should measure open circuit. Platform box pin F to pin G should measure open circuit. If these checks are OK replace platform board.</li> </ul>
663	CANBUS FAILURE - LOAD SENSING SYSTEM MODULE	With load sensing system enabled, the control system failed to receive messages from the load sensing system module.	<ul style="list-style-type: none"> <li>Check ANALYZER -&gt; MACHINE SETUP -&gt; MODEL NUMBER is correct.</li> <li>Check ANALYZER -&gt; MACHINE SETUP -&gt; MARKET is correct.</li> <li>Check ANALYZER -&gt; MACHINE SETUP -&gt; LOAD is correct.</li> <li>Check for 24V between load sense system module connector J1-1 and J1-2.</li> <li>Turn on machine in platform mode. If DTC 662 is present, troubleshoot that DTC before continuing.</li> <li>Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>
664	CANBUS FAILURE - ACCESSORY MODULE	An accessory module has stopped communication.	<ul style="list-style-type: none"> <li>Turn on machine in platform mode. If DTC 662 is present, troubleshoot that DTC before continuing.</li> <li>See accessory module documentation for troubleshooting.</li> </ul>
6635	CANBUS FAILURE - CHASSIS TILT SENSOR	Chassis Tilt Sensor messages not received for 1000 mS while B+ is present on J1-28	<ul style="list-style-type: none"> <li>The control system failed to receive messages from the Chassis Tilt Sensor located inside the Ground Control Box.</li> <li>Ensure that +B is present on pin 1 of the sensor, and -B is present on pin 4. Check the CANbus wiring to pins 2 and 3 of the sensor.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>

### 6-7 Accessory

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
671	ACCESSORY FAULT	An accessory module is reporting a fault.	<ul style="list-style-type: none"> <li>See accessory module documentation for troubleshooting.</li> </ul>

### 7-7 Electric Motor

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
771	OPEN CIRCUIT DRIVE MOTOR WIRING	The power module detected a problem in the drive motors' power circuit wiring.	<ul style="list-style-type: none"> <li>Refer to Drive Motor Electrical Evaluation in Section 3.5.</li> <li>Refer to Power Module Electrical Evaluation in Section 3.6.</li> </ul>
772	STALLED TRACTION MOTOR OR POWER WIRING ERROR	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>The System Module detected armature current feedback &gt; 4.5V or &lt; 0.5V. This is mostly likely caused by a stalled traction motor or power wiring issue. Alternately, it could be an internal fault.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>

## 7-7 Electric Motor

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
773	CAPACITOR BANK FAULT - CHECK POWER CIRCUITS	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>There is an internal or external fault that prevents the System Module's capacitor bank from charging.</li> <li>The System Module detected that the VMN of the pump and traction has not increased more than 1.3V in 1000mS. Alternately, the VMN of the pump or traction is less than 20% of battery voltage.</li> <li>If this message persists after disconnecting the drive and pump wiring, there is an internal fault.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
774	SHORT CIRCUIT FIELD WIRING	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>The field wiring passed System Module power-up diagnostics. However, an external short circuit was detected when current was applied to F1 / F2. This situation is caused by improper field wiring or a damaged motor.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul> <p><b>NOTE:</b> Tilt Sensor Calibration is not available when this condition is present.</p>
775	OPEN CIRCUIT FIELD WIRING	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>The System Module applied field current, but could not regulate the desired current. The situation is caused by improper field wiring or a damaged motor.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
776	STALLED PUMP MOTOR OR POWER WIRING ERROR	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>The System Module measured improper pump current feedback (&gt;4.5V or &lt;0.5V) for 240mS. This is caused by a stalled pump motor, a power wiring issue, or a System Module malfunction.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
777	OPEN CIRCUIT PUMP MOTOR WIRING	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>The System Module measured pump current less than 8A while the motor voltage was greater than 7V for 1200mS. This indicates there is an open-circuit between the System Module's -P terminal and the pump motor.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
778	TRACTION T HIGH - CHECK POWER CIRCUITS	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>While driving, the voltage measured at the System Module's T terminal did not agree with the predicted value for at least 300mS. This issue may be caused by a power wiring error or an internal fault.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
779	TRACTION T LOW - CHECK POWER CIRCUITS	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>While driving, the voltage measured at the System Module's T terminal did not agree with the predicted value for at least 1000mS. This issue may be caused by an open circuit of the armature wiring (+B and -T terminals) or an internal fault.</li> <li>VMN does not increase more than 1.3V</li> <li>VMN is less than 20% Battery Voltage</li> <li>Battery Voltage . VMN is greater than 4V</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>

## SECTION 6 - DIAGNOSTIC TROUBLE CODES

### 7-7 Electric Motor

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
7710	PUMP P HIGH - CHECK POWER CIRCUITS	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>While steering or lifting up, the voltage measured at the System Module's P terminal did not agree with the predicted value for at least 240mS. This issue may be caused by a power wiring error or an internal fault.</li> <li>Pump Feedback . Predicted &gt;7V</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
7711	PUMP P LOW - CHECK POWER CIRCUITS	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>While steering or lifting up, the voltage measured at the System Module's P terminal did not agree with the predicted value for at least 1000mS. This issue may be caused by an open-circuit of the pump wiring (+BF2 and -P terminals) or an internal fault.</li> <li>Pump feedback does not increase more than 1.3V</li> <li>Pump feedback is less than 20% Battery Voltage</li> <li>Battery Voltage - pump feedback is greater than 4V</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
7741	ARMATURE BRAKING CURRENT TOO HIGH	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>The System Module detected excessive braking current for more than 5000mS. This can be caused by transporting an excessive load on a steep grade. Alternately, this may indicate an internal fault.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
7742	FIELD VOLTAGE IMPROPER	Drive, Steer, and Lift Prevented	<ul style="list-style-type: none"> <li>The System Module voltage at the F1 and F2 terminals was improper at power-up (expected to be ½ Battery Voltage). This is caused by an open- or short-circuit in the field wiring or motor. Disconnect the field and motor wiring from the System Module and connect F1 / F2 with a short wire. If the situation persists after a power cycle, it may be an internal issue.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>

### 8-1 Tilt Sensor

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
811	TILT SENSOR NOT CALIBRATED	The tilt sensor calibration has not been performed.	<ul style="list-style-type: none"> <li>Calibrate the tilt sensor, see Section 5.2.</li> <li>Replace then calibrate tilt sensor, see Section 5.2.</li> </ul>
812	NO DATA FROM TILT SENSOR - NOT CONNECTED OR FAULTY	No signal from tilt sensor.	<ul style="list-style-type: none"> <li>Check tilt sensor connections and wiring in ground control box.</li> <li>Calibrate the tilt sensor, see Section 5.2.</li> <li>Replace then calibrate tilt sensor, see Section 5.2.</li> </ul>

**NOTE:** Tilt Sensor cannot be calibrated if main contactor is open due to an alarm.

### 8-2 Platform Load Sense

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
821	LSS CELL #1 ERROR	A problem has been detected with the load sense system.	Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.
822	LSS CELL #2 ERROR	A problem has been detected with the load sense system.	Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.
823	LSS CELL #3 ERROR	A problem has been detected with the load sense system.	Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.

## 8-2 Platform Load Sense

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
824	LSS CELL #4 ERROR	A problem has been detected with the load sense system.	<ul style="list-style-type: none"> <li>Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>
825	LSS HAS NOT BEEN CALIBRATED	The load sensing system module has not been calibrated	<ul style="list-style-type: none"> <li>Empty platform. Calibrate LSS, see Section 2.2: Calibration in the LSS manual, 3124288.</li> <li>Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>

## 9-9 Hardware

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
991	LSS WATCHDOG RESET	A problem has been detected with the load sense system.	<ul style="list-style-type: none"> <li>Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>
992	LSS EEPROM ERROR	A problem has been detected with the load sense system.	<ul style="list-style-type: none"> <li>Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>
993	LSS INTERNAL ERROR - PIN EXCITATION	A problem has been detected with the load sense system.	<ul style="list-style-type: none"> <li>Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>
994	LSS INTERNAL ERROR - DRDY MISSING FROM A/D	A problem has been detected with the load sense system.	<ul style="list-style-type: none"> <li>Refer to Section 2.3: Troubleshooting in the LSS manual, 3124288.</li> </ul>
995	POWER MODULE FAILURE - PERSONALITY RANGE ERROR	The power module detected an out-of-range or corrupt personality setting	<ul style="list-style-type: none"> <li>Record all personality settings in ANALYZER -&gt; PERSONALITIES and ANALYZER -&gt; MACHINE SETUP. Reset control system personalities to default settings by selecting a different model than indicated, cycle power then select proper model. Then, enter personality settings recorded above.</li> </ul>
996	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's analog to digital converter does not respond for the power PCB. This is an internal failure.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
997	POWER MODULE FAILURE - CHECK POWER CIRCUITS OR MOSFET SHORT CIRCUIT	The power module detected an error in the power wiring for the drive or pump.	<ul style="list-style-type: none"> <li>Refer to Drive Motor Electrical Evaluation in Section 3.5.</li> <li>Refer to Pump Motor Electrical Evaluation in Section 4.8.</li> <li>Refer to Power Module Electrical Evaluation in Section 3.6.</li> </ul>
998	EEPROM FAILURE - CHECK ALL SETTINGS	The control system detected an EEPROM failure.	<ul style="list-style-type: none"> <li>Replace ground board.</li> </ul>
999	FUNCTION LOCKED OUT - POWER MODULE SOFTWARE VERSION IMPROPER	The power module software version is not compatible with the rest of the system.	<ul style="list-style-type: none"> <li>Replace power module to clear fault.</li> </ul>
9910	FUNCTION LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	The platform board software version is not compatible with the rest of the system.	<ul style="list-style-type: none"> <li>Reprogram platform board.</li> </ul>

## SECTION 6 - DIAGNOSTIC TROUBLE CODES

### 9-9 Hardware

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
9911	FUNCTION LOCKED OUT - LSS MODULE SOFTWARE VERSION IMPROPER	The load sensing system module software version is not compatible with the rest of the system.	<ul style="list-style-type: none"> <li>Replace LSS module to clear fault.</li> </ul>
9912	POWER MODULE FAILURE - SYSTEM MONITOR	The ground board detected armature, field, or pump current while function was not commanded.	<ul style="list-style-type: none"> <li>Refer to Drive Motor Electrical Evaluation in Section 3.5.</li> <li>Refer to Pump Motor Electrical Evaluation in Section 4.8.</li> <li>Refer to Power Module Electrical Evaluation in Section 3.6.</li> </ul>
9917	HIGH RESOLUTION ANALOG TO DIGITAL FAILURE - INTERRUPT LOST	The ground board detected armature, field, or pump current while function was not commanded.	<ul style="list-style-type: none"> <li>Pump Motor being turned backwards by a faulty check valve in the hydraulic system.</li> <li>Software issue on the controller. Update software.</li> </ul>
9924	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED	The control system's memory indicates that the vehicle has not been configured (new control system components).	<ul style="list-style-type: none"> <li>Use the JLG analyzer to adjust all machine setup and personality settings, refer to 5.7 Machine Configuration Programming Information.</li> </ul>
9950	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's armature power circuitry is driven without PWM command for 100mS.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9951	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's pump power circuitry is driven without enable from the interface PCB for 100mS.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9952	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's pump power circuitry is driven without PWM command for 100mS.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9953	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's field power circuitry is driven without enable from the interface PCB for 100mS.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9954	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's field power circuitry is driven without reverse direction from the power PCB for 100mS.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9955	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's field power circuitry is driven without forward selection from the power PCB for 100mS.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>

**🔧 9-9 Hardware**

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
9956	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's field current control or MOSFET's are malfunctioning.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9957	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's hardware that generates an interrupt at 36V and 12V did not respond properly at power-up.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9958	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's pump current measurement or MOSFET are malfunctioning.</li> <li>Pump current measurement &gt;2.74V or &lt;2.26V for 200mS while idle.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9960	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module detected an issue with the traction current measurement or the MOSFET's.</li> <li>Armature current feedback &gt;2.74V or &lt; 2.26V while idle</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9962	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's temperature feedback is &gt;4.9V or &lt;0.1V.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9963	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module detected a mismatch in the redundant RAM information stored in the power PCB.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
9964	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's analog to digital converter does not respond for the interface PCB.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
9969	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's MC/EB/EV/DV Enable is always on. This is internal fault.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>



## SECTION 6 - DIAGNOSTIC TROUBLE CODES

### 9-9 Hardware

DTC	FAULT MESSAGE	DESCRIPTION	CHECK
9970	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module detected a mismatch in the redundant RAM information stored in the interface PCB.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - ON</li> </ul>
9971	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's MC/EB valve activation pin is shorted. This is an internal fault.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
99143	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's power and interface PCB digital inputs do not agree.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
99144	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's MC feedback from the interface PCB disagrees with the feedback from the power PCB.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
99145	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's enable for the power PCB requested a drive motor or valve activation when not expected.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
99146	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's lift down feedback voltage to the interface and power PCB's disagrees.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
99147	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's VMN feedback voltage to the interface and power PCB's disagrees.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
99148	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module's setpoint request from the interface PCB does not match the input state.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>
99149	POWER MODULE FAILURE - INTERNAL ERROR	Drive, Steer, & Lift Prevented	<ul style="list-style-type: none"> <li>The System Module encountered an unexpected software issue.</li> <li>Cycle machine, if error still exists, replace System Module.</li> <li>ZAPI - HEALTH (Status LED) - FLASHING</li> </ul>

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## SECTION 7. GENERAL ELECTRICAL INFORMATION & SCHEMATICS

### 7.1 GENERAL

This section contains schematics to be used for locating and correcting most of the operating problems which may develop. If a problem should develop which is not presented in this section or which is not corrected by listed corrective actions, technically qualified guidance should be obtained before proceeding with any maintenance.

#### **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.**

### 7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. A digital meter with reasonable accuracy (within 7%) is recommended for the measurements in these procedures. 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**

Finding 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 kΩ = 1200 Ω

Example: 50 mA = 0.05 A

Voltage Measurement

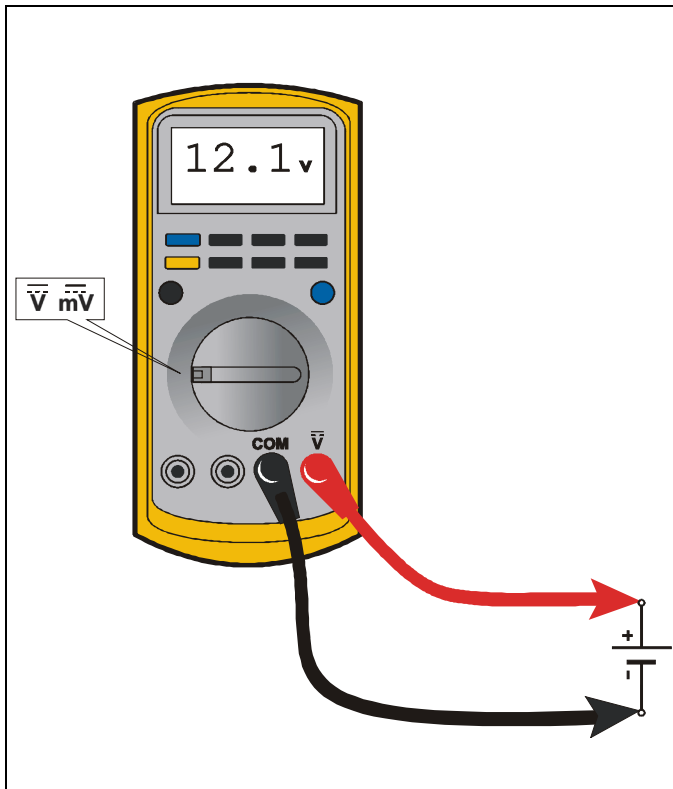


Figure 7-1. Voltage Measurement (DC)

- 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

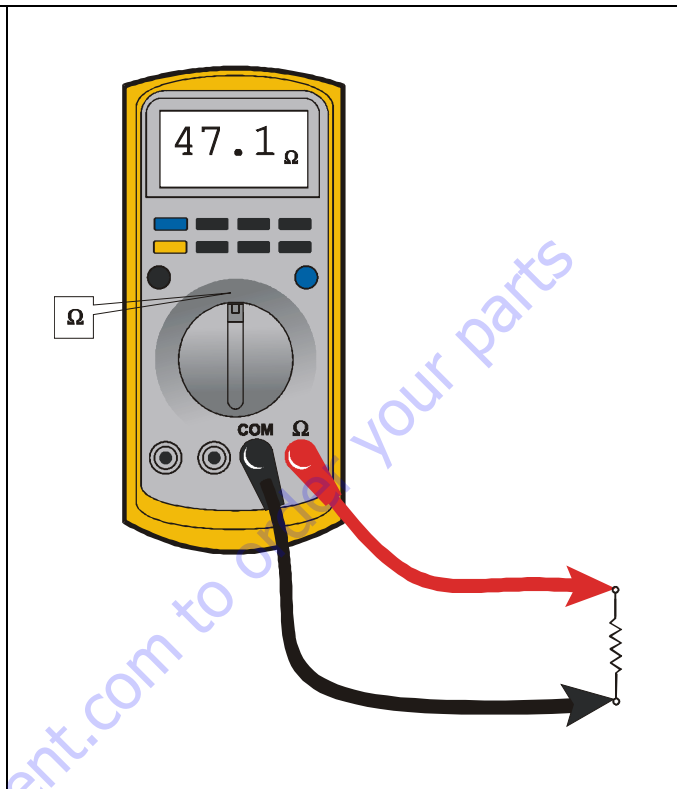


Figure 7-2. Resistance Measurement

- 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

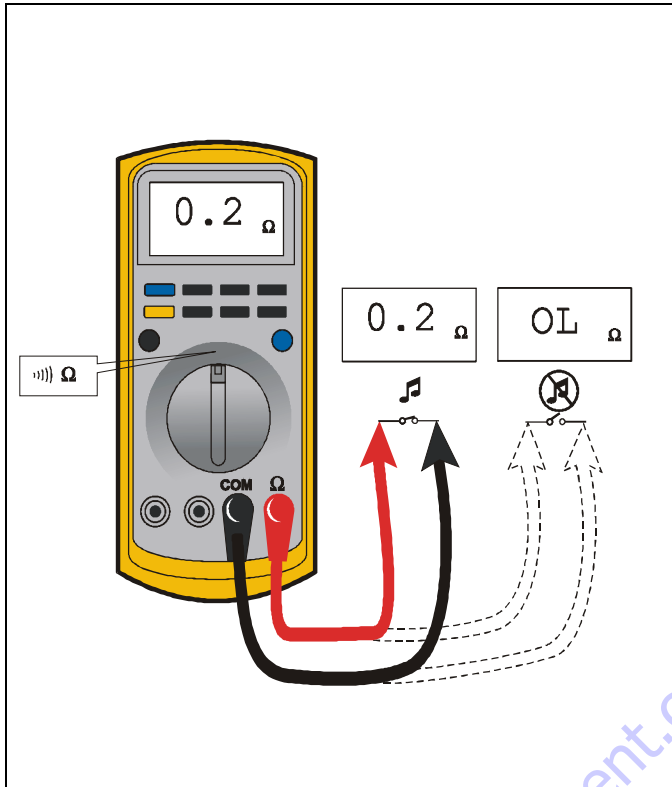


Figure 7-3. Continuity Measurement

- 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

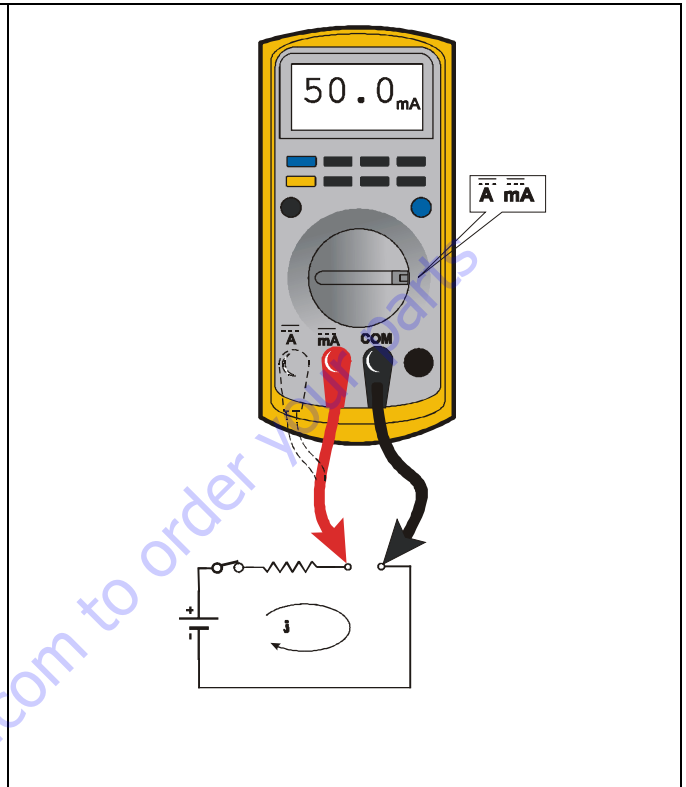


Figure 7-4. Current Measurement (DC)

- 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

### Continuity Measurement Over Long Distances

When trying to determine continuity of a harness or wire, longer than the reach of standard instrument leads, is possible to perform the check without excessively long leads. Using the other wires in the harness one can determine the condition of a particular wire in the harness.

#### Requirements:

- Harness with at least three separate wires including the wire under test.
- These wires must be able to be isolated from other wires, etc.
- Jumper or method to connect contacts on one side of harness.
- Meter that can measure resistance or continuity.

#### Procedure

Test multimeter leads resistance. Subtract this value from the measured resistance of the wires to get a more accurate measurement.

Consult the circuit schematic to determine which wires to use in addition to wire under test, here called wire #1 and wire #2, and how to isolate these wires. These wires should appear in the same connectors as the wire under test or are within reach of the jumper.

1. Disconnect all connections associated with the wire under test and the two additional wires. If harness is not completely isolated disconnect battery terminals also, as a precaution.
2. Measure continuity between all three wires, the wire under test, wire #1 and wire #2. These should be open. If not, repair the shorted wires or replace the harness.
3. On one side, jumper from contact of wire #1 and wire #2.
4. Measure continuity between wire #1 and wire #2. If there is continuity, both wires are good and can be used for this test. If there is not continuity, either wire could be bad. Check connections and measurement setup. Redo measurement. If still no continuity, repair wires or consult schematic for other wires to use for test.
5. Jumper from wire under test to wire #1.
6. Measure continuity. If there is continuity, the wire under test is good. Resistance of a wire increases as the length increases and as the diameter decreases.

One can find the continuity of two wires, here #1 and #2, at once by following steps 1 through 4. If there is a problem the third wire is used to troubleshoot the other wires. To find the problem, start at step 1 and use the entire procedure.

### 7.3 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.

### 7.4 DIELECTRIC GREASE APPLICATION

Dielectric grease helps to prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Non-waterproof connectors benefit from the application of dielectric grease.

#### Installation

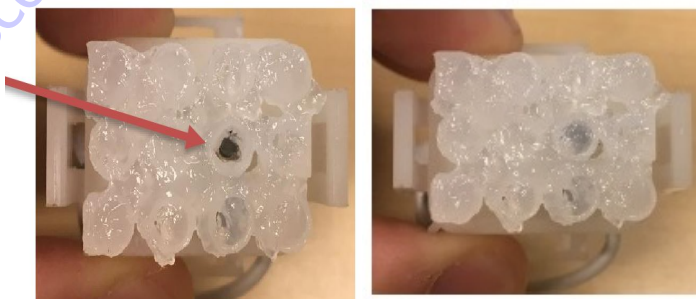
The following is general guidance for the installation of dielectric grease in a connector system.

- Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
- Apply dielectric grease to plug/male connector housing which typically contains sockets contact/female terminals.
- Leave a layer of dielectric grease on the mating face of the connector, completely covering each connector terminal hole. Refer the pictures shown below.
- 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

This connector system is widely used inside enclosures for general-purpose interconnect. Follow the general guidance for installation.



Improper

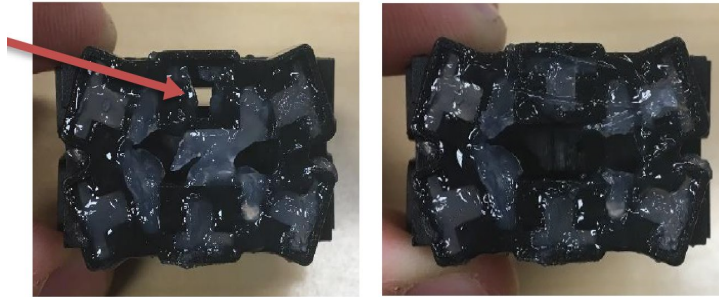
Proper

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### AMP Faston

This connector system is typically used on operator switches at JLG. Follow the general guidance for installation.

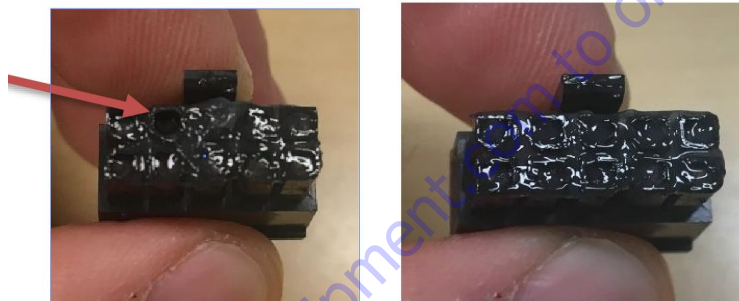


Improper

Proper

### AMP Micro-Fit

This connector system is typically used on control modules at JLG. Follow the general guidance for installation.

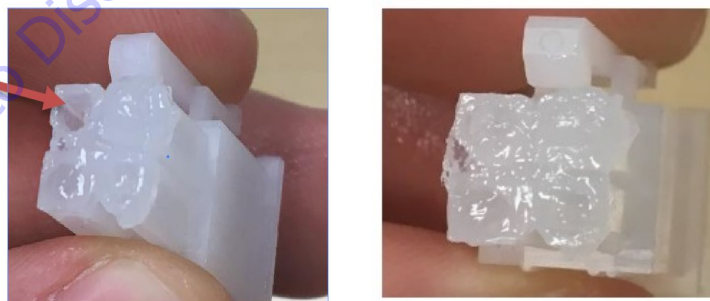


Improper

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.



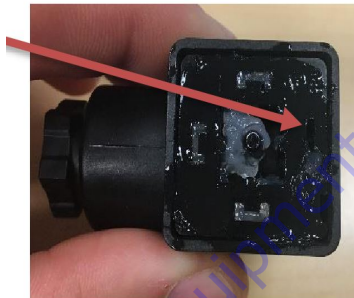
Improper



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**

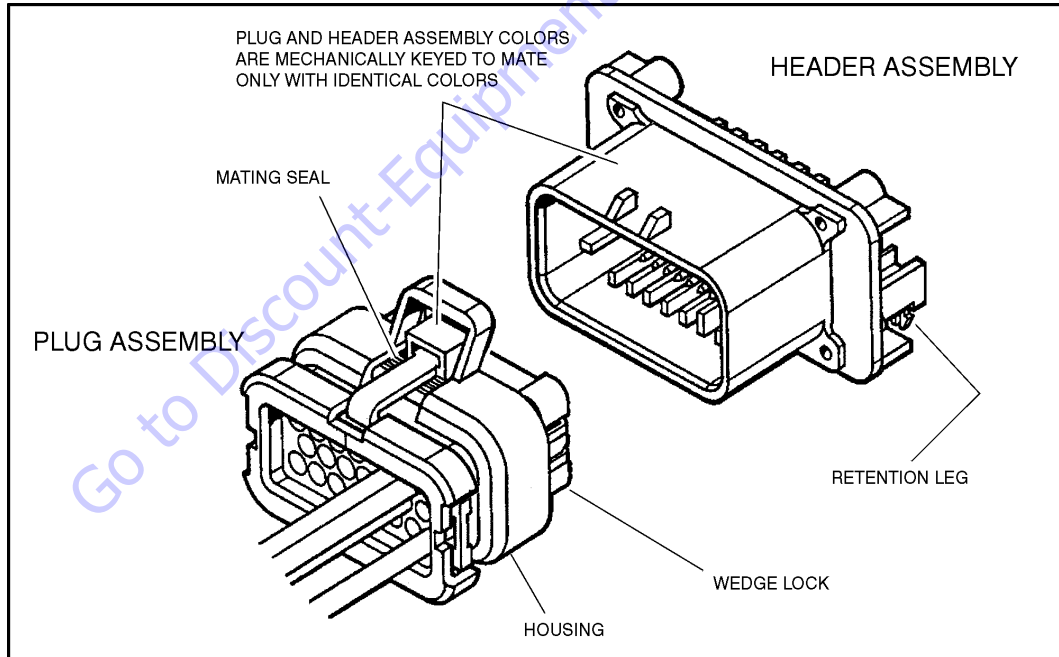
Carling switches may experience high impedance, or discontinuity, due to silicone dielectric grease ingress when switching inductive loads. Therefore, dielectric grease shall not be applied to Carling switch mating connectors unless specifically noted.

**Scissor Platform Cable at the Platform Control**

Some waterproof connectors are exposed to the elements when disconnected by the customer benefit from having protection using dielectric grease.



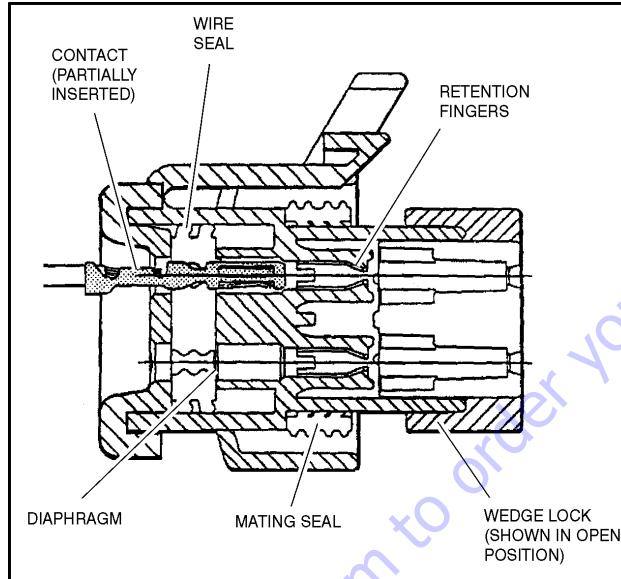
**7.5 AMP CONNECTOR**



**Figure 7-5. AMP Connector**

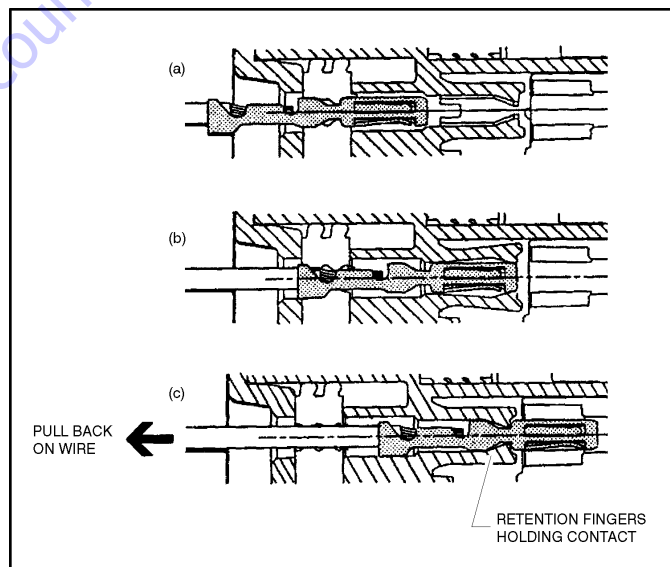
**Assembly**

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 7-6., Connector Assembly (1 of 4)). Proceed as follows:



**Figure 7-6. Connector Assembly (1 of 4)**

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-7., Connector Assembly (2 of 4)).
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., Connector Assembly (2 of 4)).
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., Connector Assembly (3 of 4)).
4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-9., Connector Assembly (4 of 4)).



**Figure 7-7. Connector Assembly (2 of 4)**

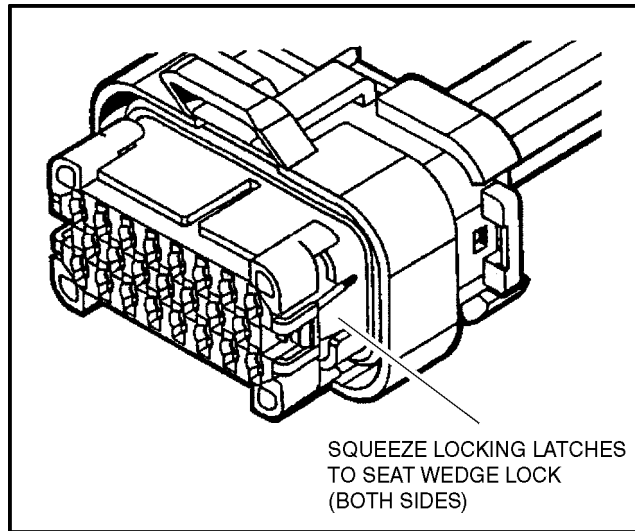


Figure 7-8. Connector Assembly (3 of 4)

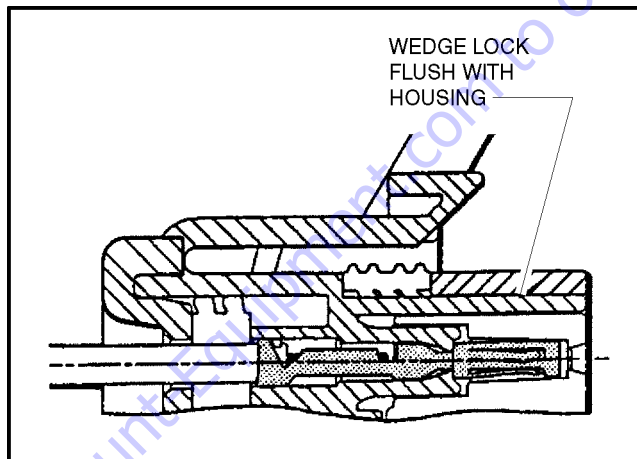


Figure 7-9. Connector Assembly (4 of 4)

## Disassembly

1. Insert a 4.8 mm (3/16") wide screwdriver blade between the mating seal and one of the red wedge lock tabs.
2. Pry open the wedge lock to the open position.
3. 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.

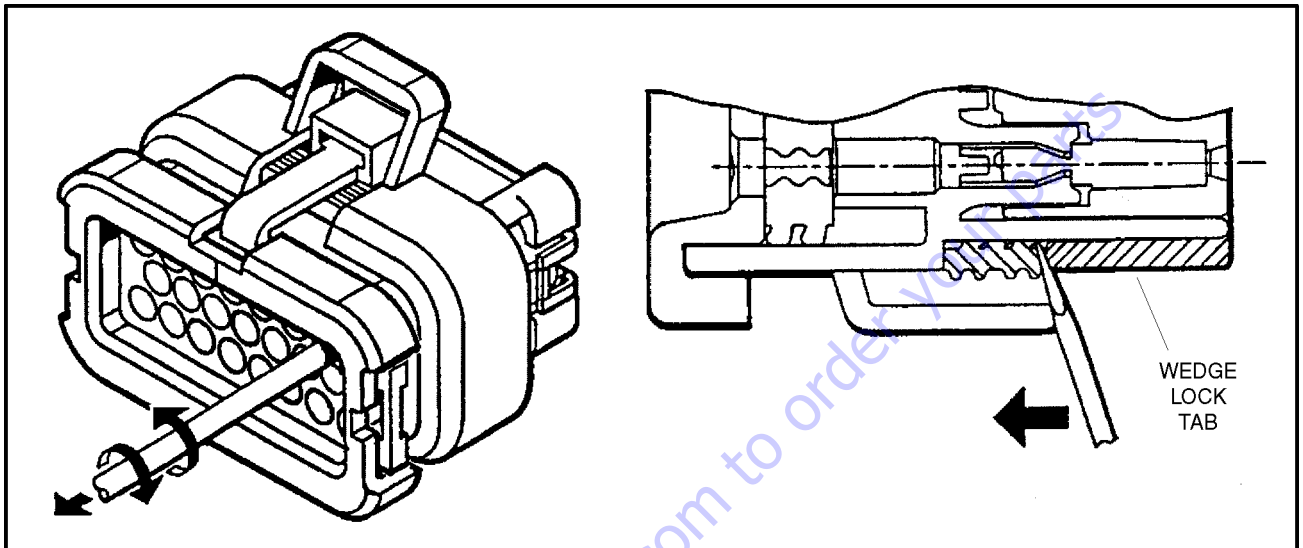


Figure 7-10. Connector Disassembly

**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

**CAUTION**

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.

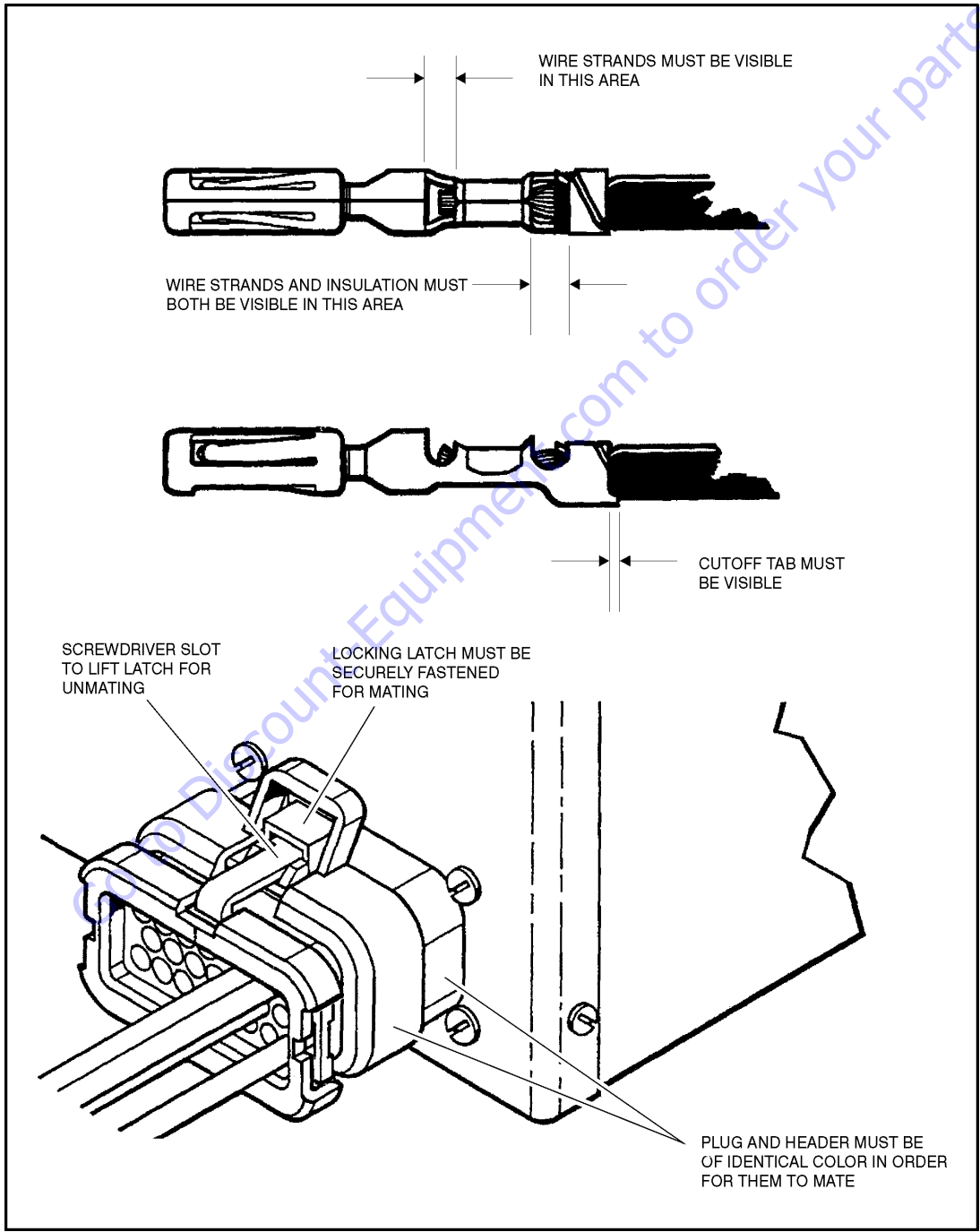


Figure 7-11. Connector Installation

## 7.6 WORKING WITH DEUTSCH CONNECTORS

### DT/DTP Series Assembly



**Figure 7-12. DT/DTP Contact Installation**

1. Grasp crimped contact about 25 mm 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 wedge lock with arrow pointing toward exterior locking mechanism. The wedge lock 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**

1. Remove wedge lock using needle nose pliers or a hook shaped wire to pull wedge straight out.
2. 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.
3. Hold the rear seal in place, as removing the contact may displace the seal.

### HD30/HDP20 Series Assembly

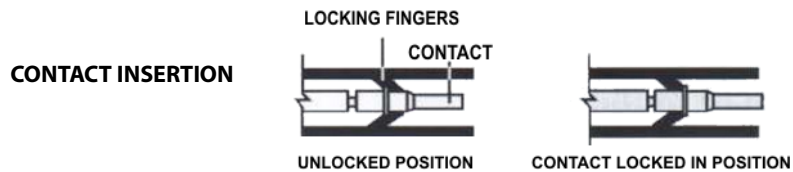


**Figure 7-14. HD/HDP Contact Installation**

1. Grasp contact about 25mm behind the contact crimp barrel.
2. Hold connector with rear grommet facing you.

## SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS

3. 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**

1. With rear insert toward you, snap appropriate size extractor tool over the wire of contact to be removed.
2. Slide tool along into the insert cavity until it engages contact and resistance is felt.
3. Pull contact-wire assembly out of connector.



**Figure 7-17. HD/HDP Unlocking Contacts**

**NOTE:** Do Not twist or insert tool at an angle.



## **7.7 SWITCHES**

### **Basic check**

The following check determines if the switch is functioning properly, not the circuit in which the switch is placed. A switch is functioning properly when there is continuity between the correct terminals or contacts only when selected.

1. De-energize the circuit.
2. Isolate the switch from the rest of the circuit if possible. If not possible, keep in mind it may affect readings.
3. Access the terminals to the switch.
4. If the switch has two terminals:
  - a. Measure resistance across the terminals.
  - b. Change the switch position.
  - c. Measure resistance again with the leads in the same positions. If the meter was reading short, it should read an open. If the meter was reading open it should read short.
5. If the switch has more than two terminals, consult the schematic or switch diagram to determine what terminals will be connected. The test is similar to testing a switch with two terminals.
  - a. Place one meter lead on the common contact and the other on a different contact in the same circuit.
  - b. Cycle through all positions of the switch. The meter should read short only when the switch connects the two terminals and open otherwise.
  - c. If the switch has more than one common contact repeat the process for that circuit.

### **Limit Switches**

Limit switches are used to control movement or indicate position. Mechanical limit switches are just like manually operated switches except that the moving object operates the switch. These switches can be tested the same way as a standard switch by manually operating the sensing arm.

Another type of limit switch used by JLG is the inductive proximity switch, also referred to as a "prox switch". Inductive proximity switches are actuated only by ferrous metal (metal that contains Iron, such as steel) near the switch. They do not require contact, and must be energized to actuate. These types of switches can be used to detect boom or platform position, for example. These switches have a sensing face where the switch can detect ferrous metal close to it. To find the sensing face, take note how the switch is mounted and how the mechanisms meet the switch. Test this type of switch as follows:

1. Remove prox switch from its mount.
2. Reconnect harness if it was disconnected for step a, and turn on machine.
3. Hold switch away from metal and observe switch state in the control system diagnostics using the Analyzer. See vehicle or control system documentation on how to do this.
4. Place sensing face of switch on the object to be sensed by the switch. If that is not available, use a piece of ferrous metal physically similar to it. The switch state in the control system diagnostics should change.
5. When reinstalling or replacing switch be sure to follow mounting instructions and properly set the gap between the switch and object sensed.

### Automatic Switches

If the switch is actuated automatically, by temperature or pressure for example, find a way to manually actuate the switch to test it. Do this either by applying heat or pressure, for example, to the switch. These switches may need to be energized to actuate.

1. Connect instrumentation to monitor and/or control the parameter the switch is measuring.
2. Observe switch state in control system with the Analyzer. See vehicle or control system documentation on how to do this.
3. Operate system such that the switch actuates. This could be going over a certain pressure or temperature, for example. The state indicated in the control system should change.

### Switch Wiring - Low Side, High Side

When controlling a load, a switch can be wired between the positive side of the power source and the load. This switch is called a "high side" switch. The switch supplies the power to the load. When a switch is wired between the negative side of the power source and the load, it is a "low side" switch. The switch provides the ground to the load.

A low side switch will allow voltage to be present on the load. No power is applied because the switch is stopping current flow. This voltage can be seen if the measurement is taken with one test lead on the load and the other on the battery negative side or grounded to the vehicle. What is actually being measured is the voltage drop across the switch. This could mislead a technician into thinking the load is receiving power but not operating. To produce an accurate picture of power or voltage applied to the load, measure voltage across the load's power terminals. Also, the technician can measure the voltage at both power terminals with respect to battery ground. The difference between those two measurements is the voltage applied to the load.

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7.8 ELECTRICAL SCHEMATICS AND LAYOUTS

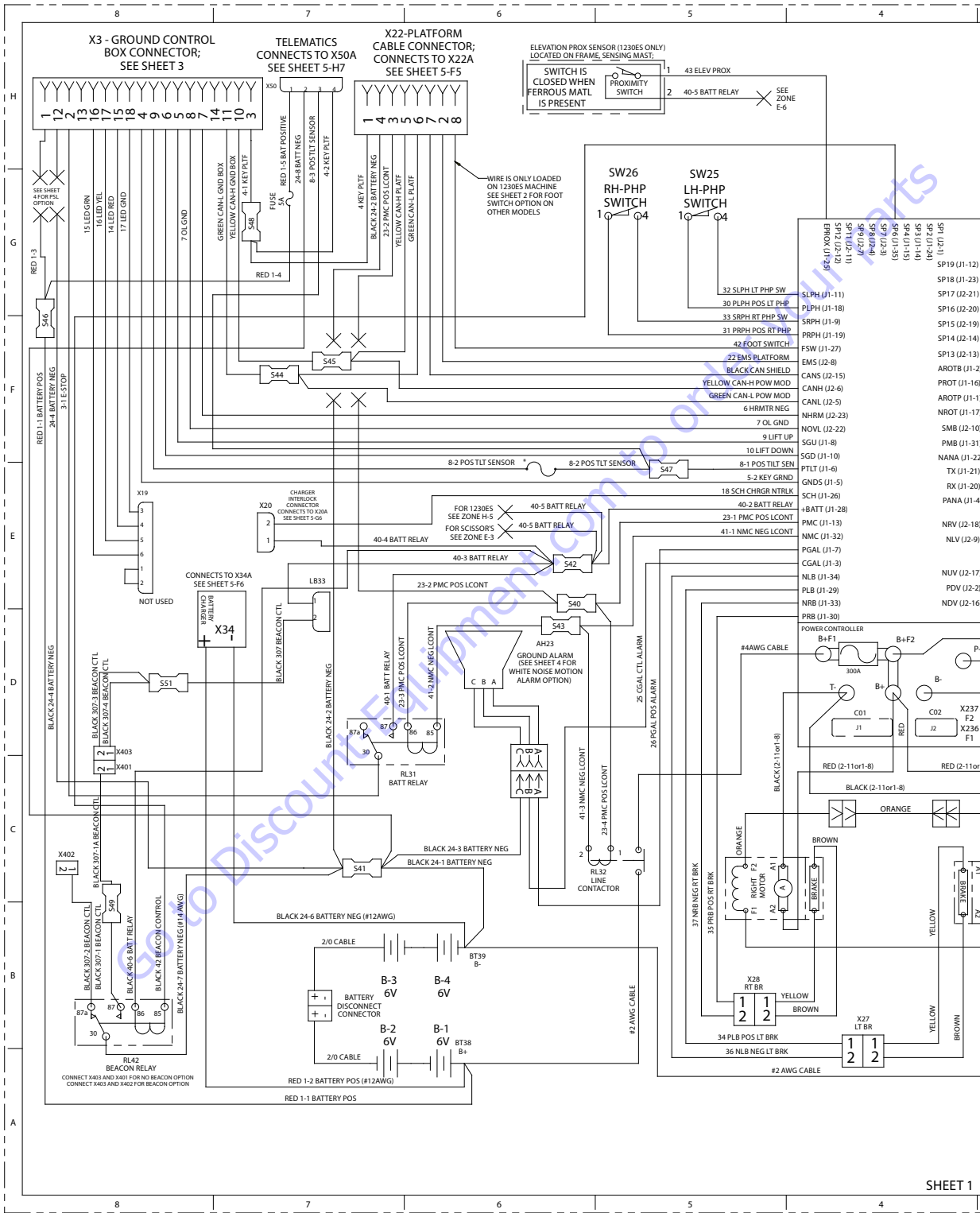
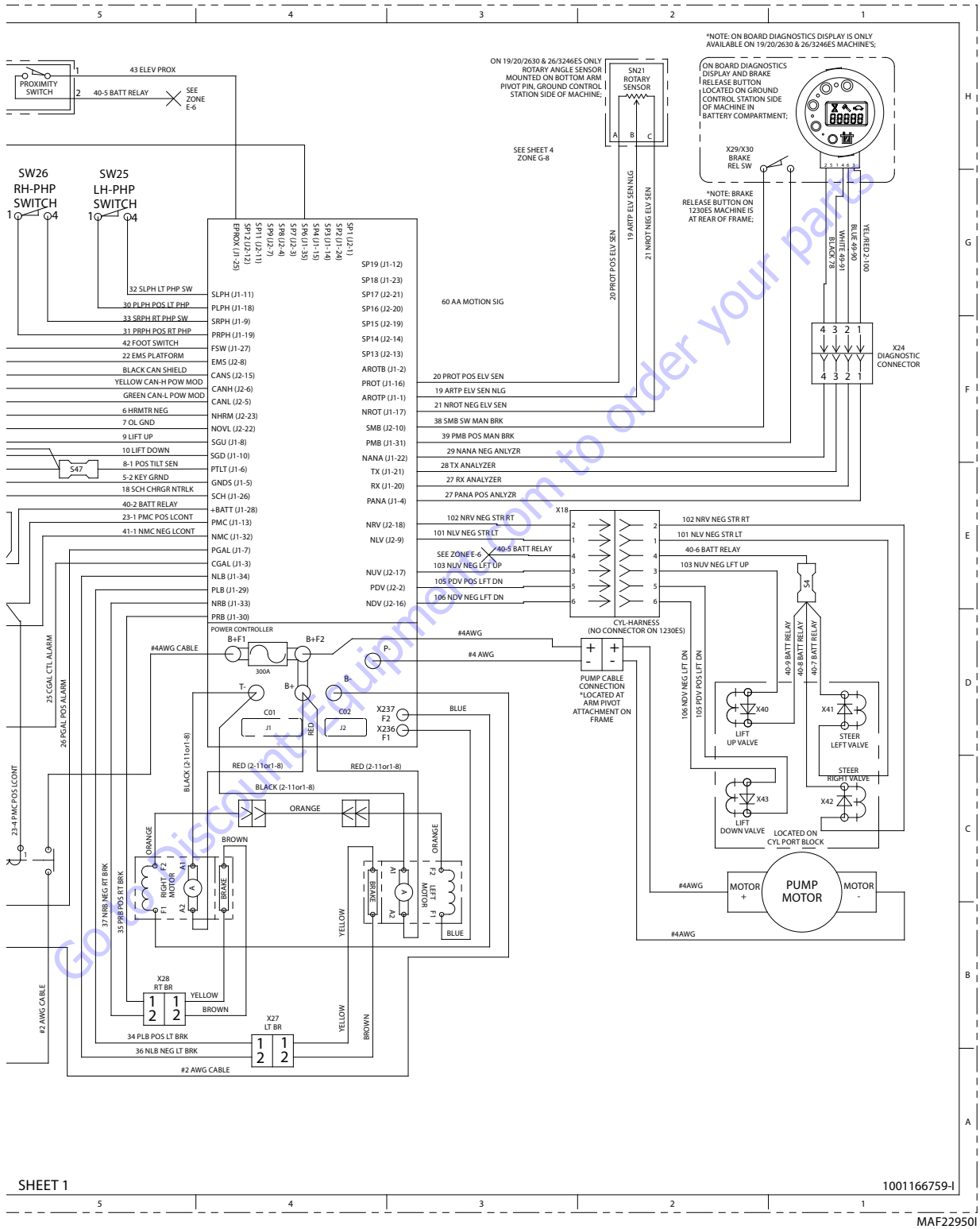


Figure 7-18. Electrical Schematic - Sheet 1 of 10

# SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS



# SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS

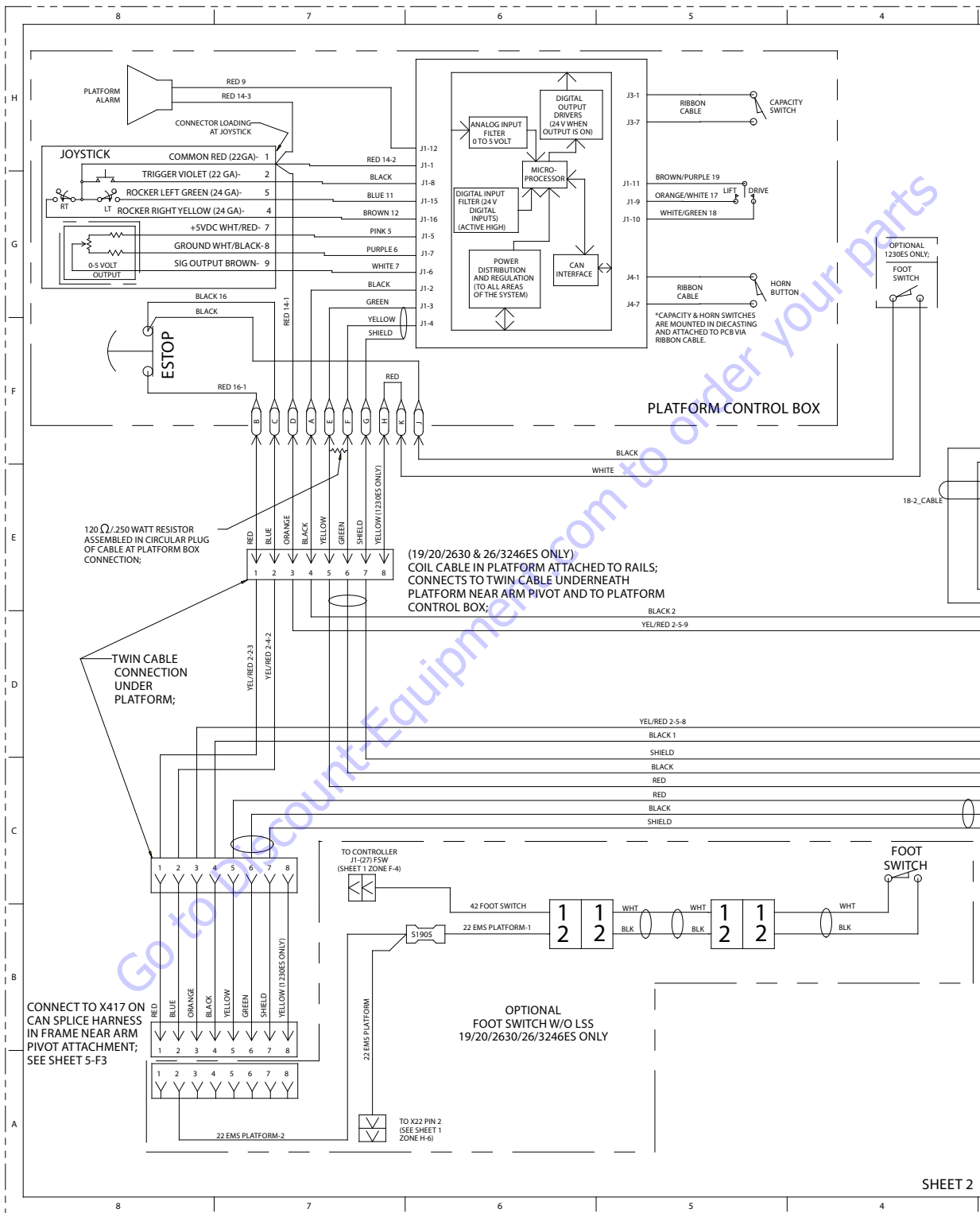


Figure 7-20. Electrical Schematic - Sheet 3 of 10

SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS

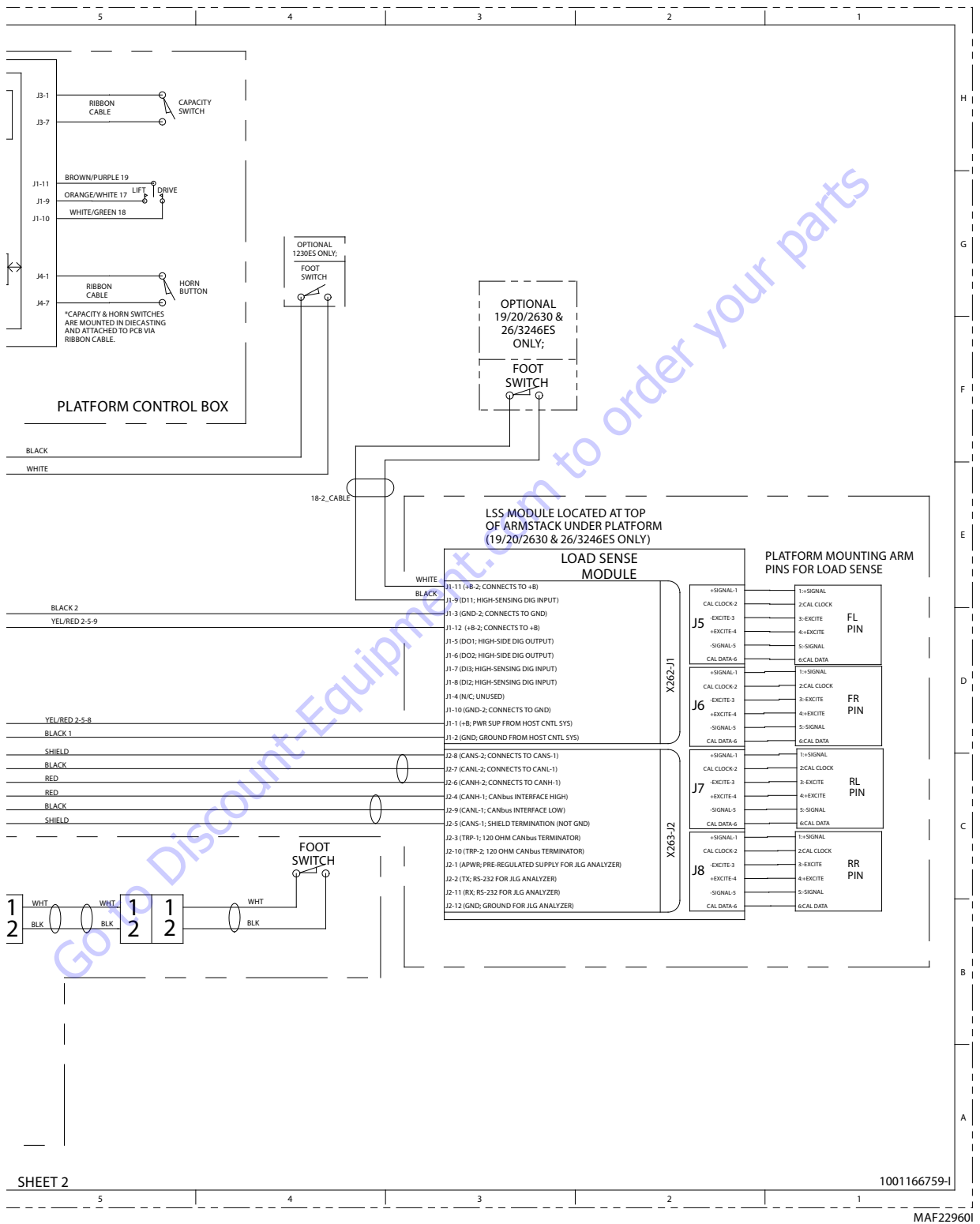
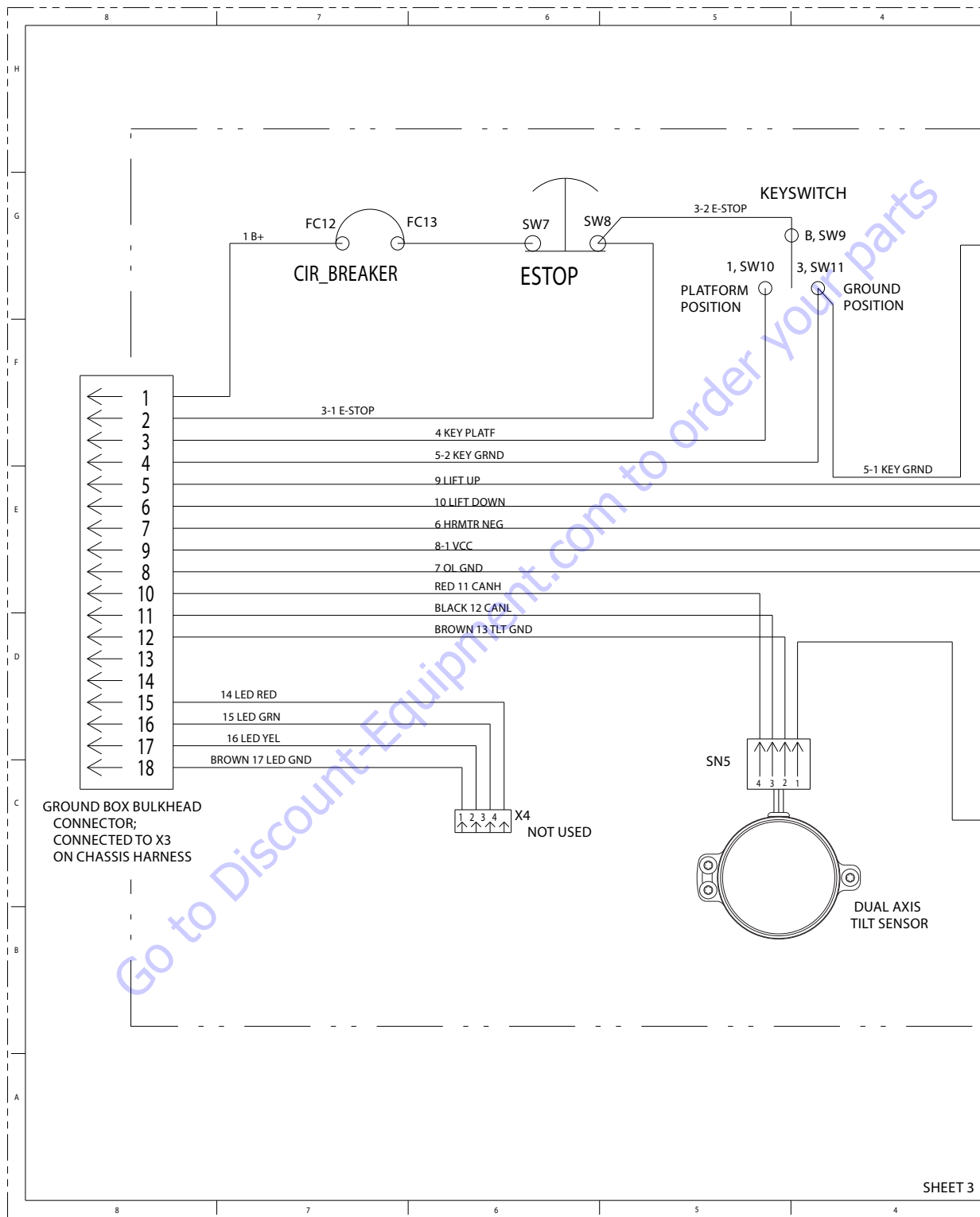


Figure 7-21. Electrical Schematic - Sheet 4 of 10

**SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-22. Electrical Schematic - Sheet 5 of 10**

SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS

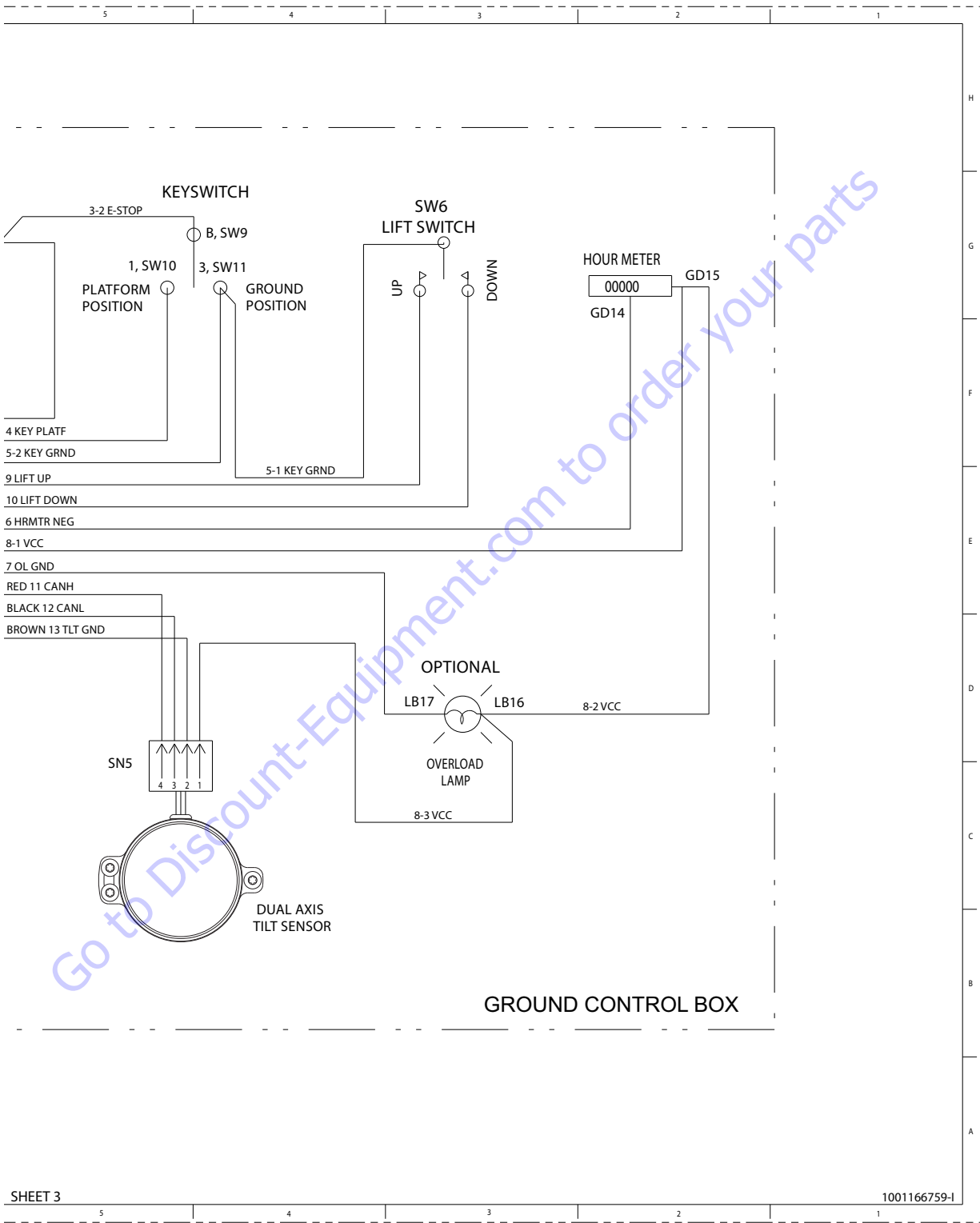
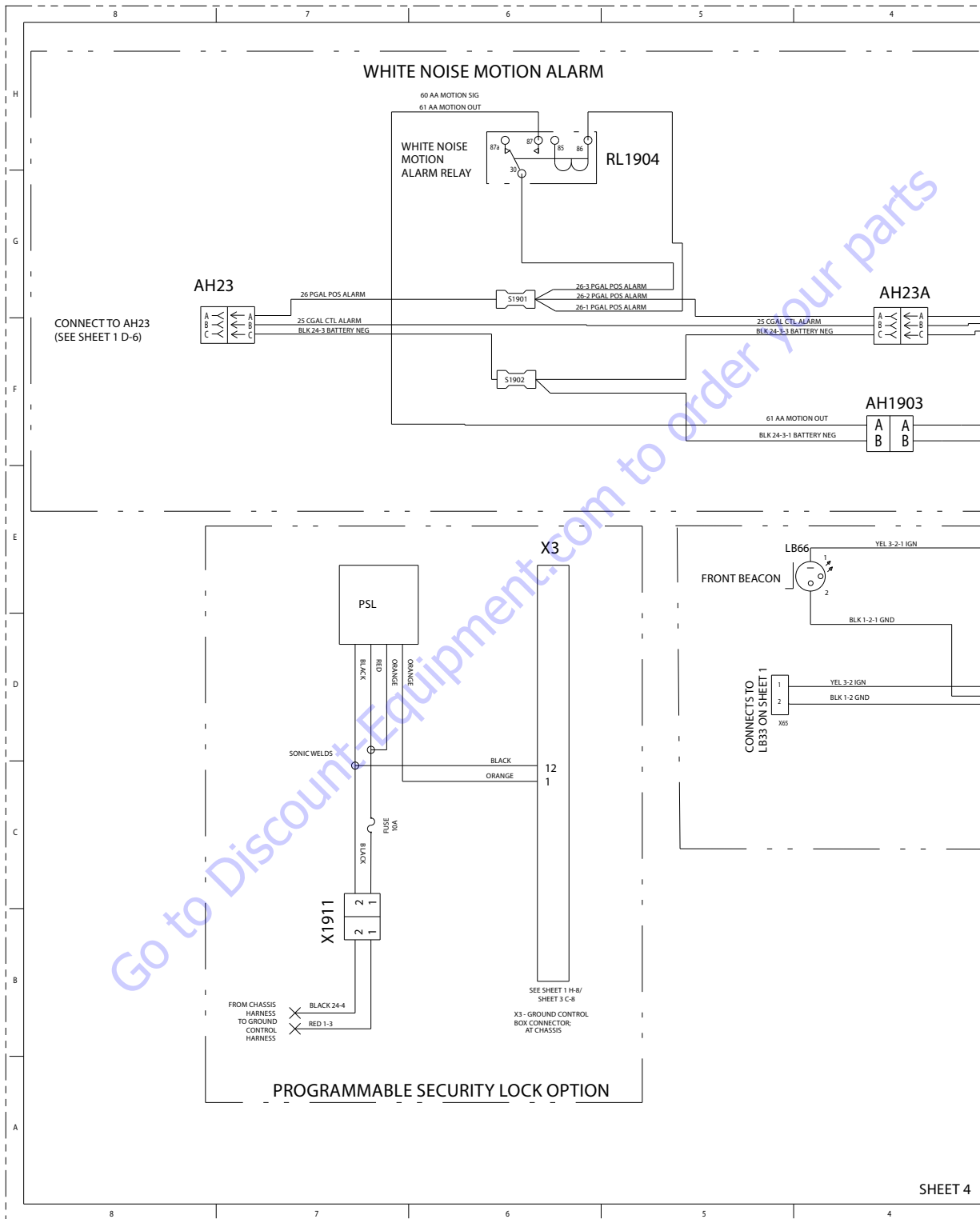


Figure 7-23. Electrical Schematic - Sheet 6 of 10



**SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-24. Electrical Schematic - Sheet 7 of 10**

SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS

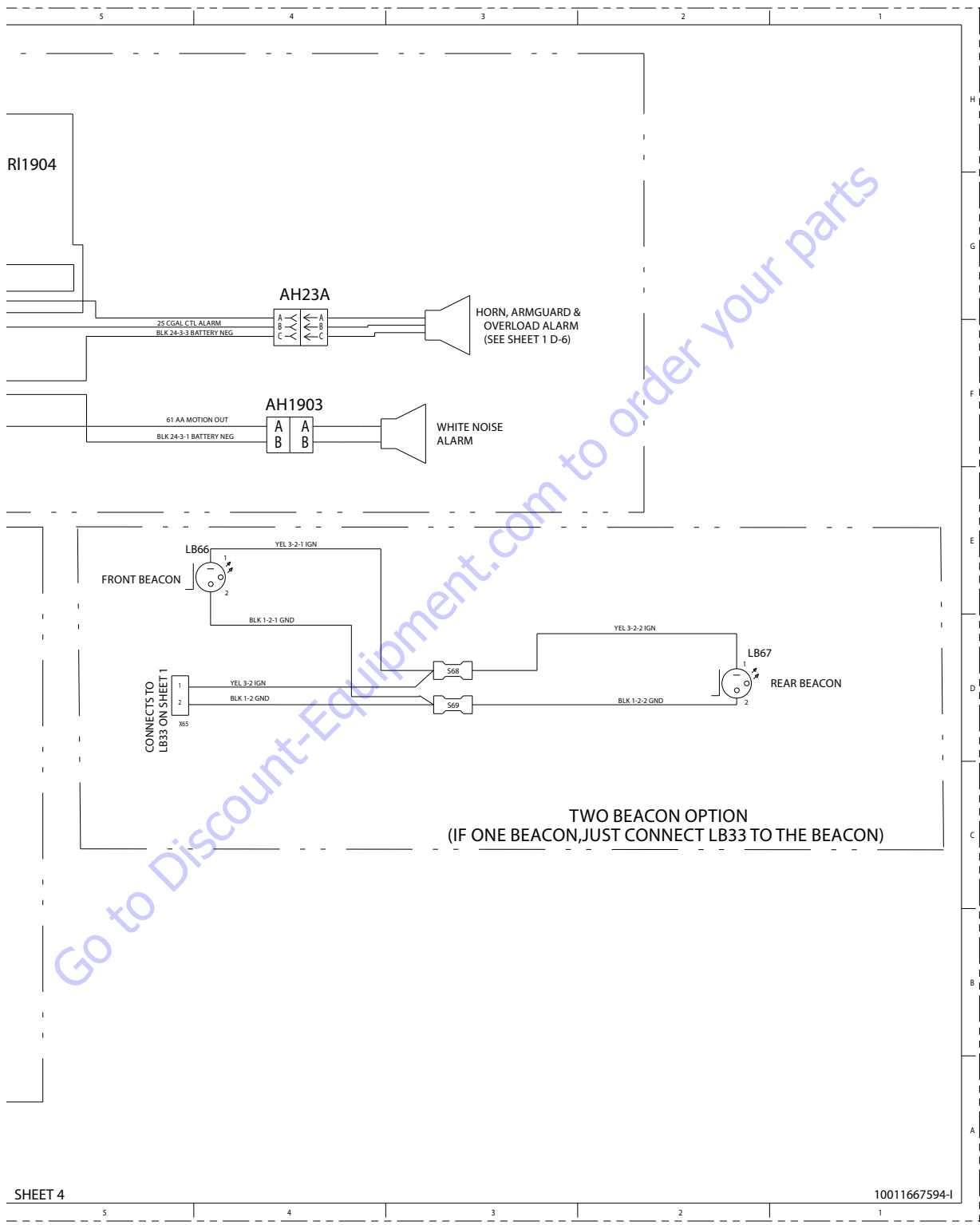


Figure 7-25. Electrical Schematic - Sheet 8 of 10

# SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS

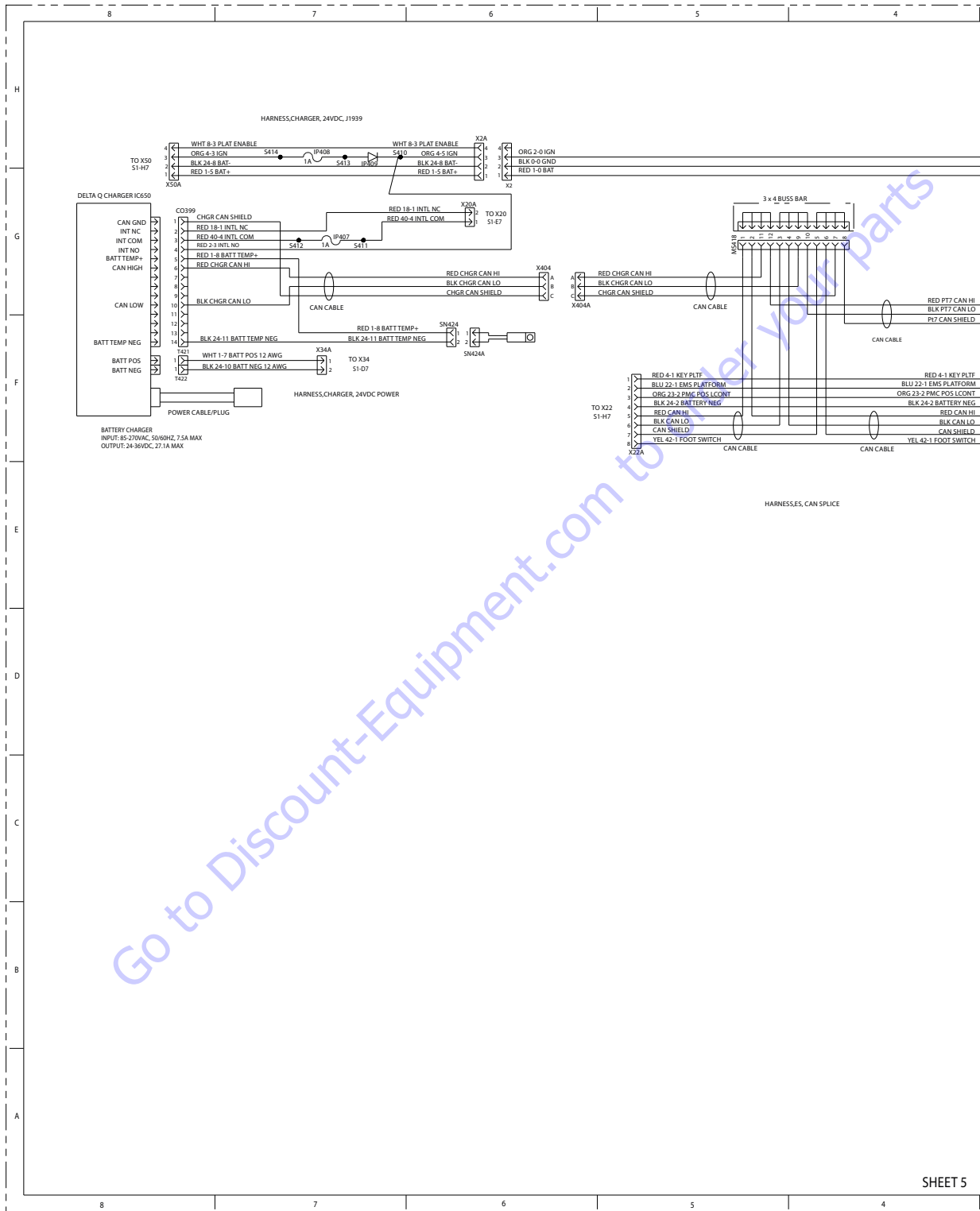
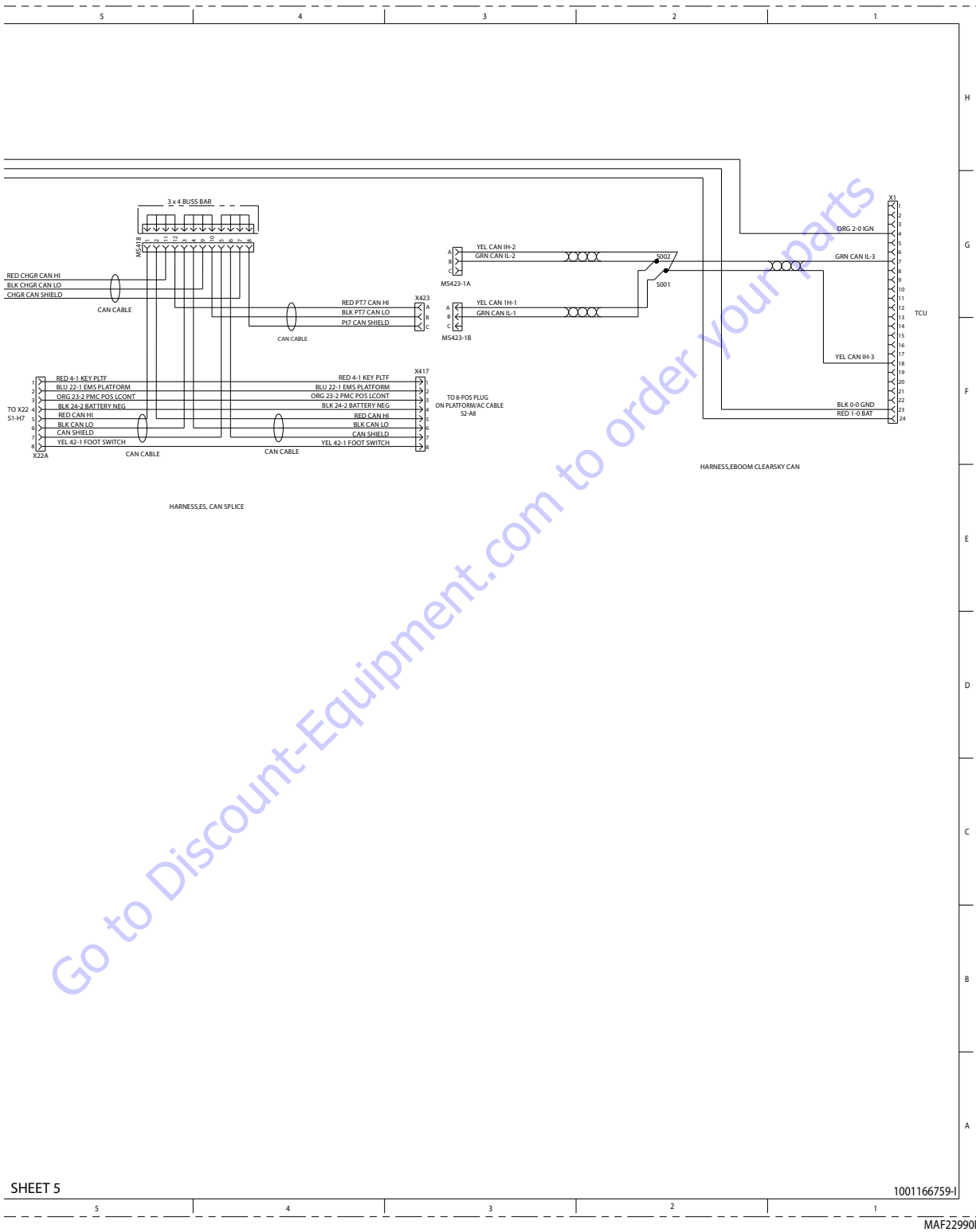


Figure 7-26. Electrical Schematic - Sheet 9 of 10

SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS



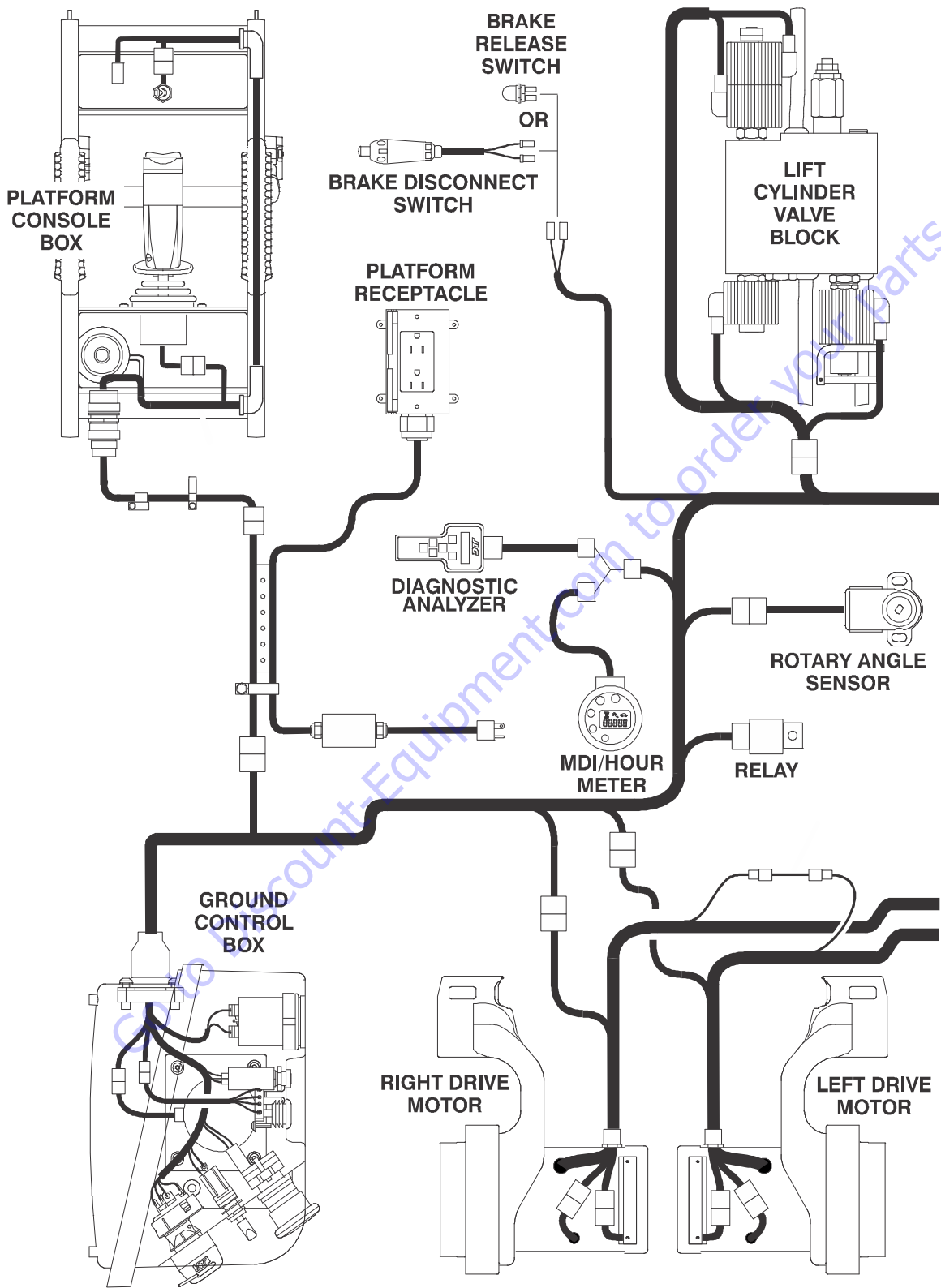
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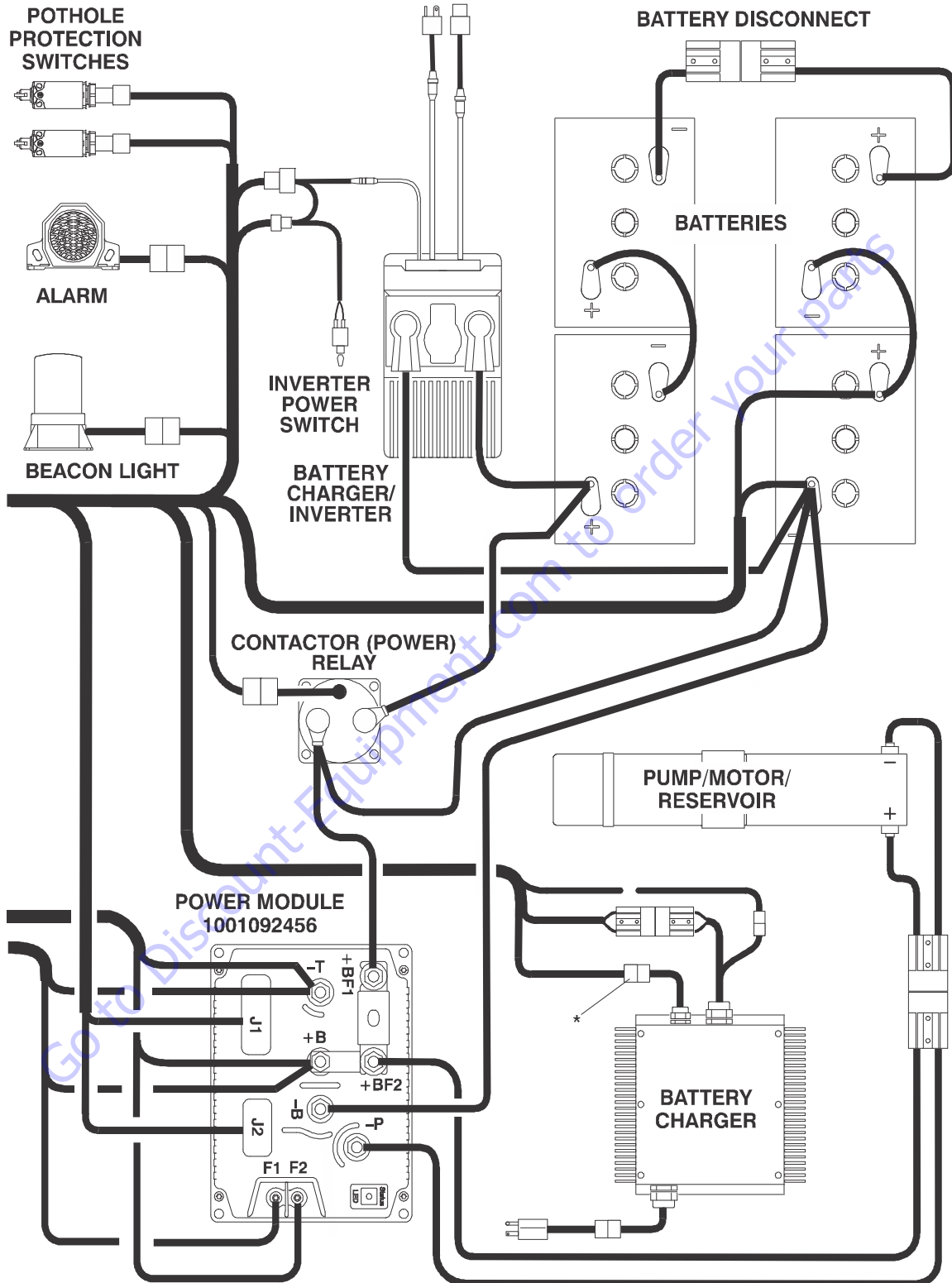
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Figure 7-27. Electrical Schematic - Sheet 10 of 10

**SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-28. Electrical Components Layout**



\* NOTE: THIS CONNECTION USED ONLY WHEN FOOTSWITCH OR BATTERY CHARGER INTERLOCK OPTIONS ARE REQUIRED.

Figure 7-28., Electrical Components Layout

7.9 HYDRAULIC SCHEMATIC

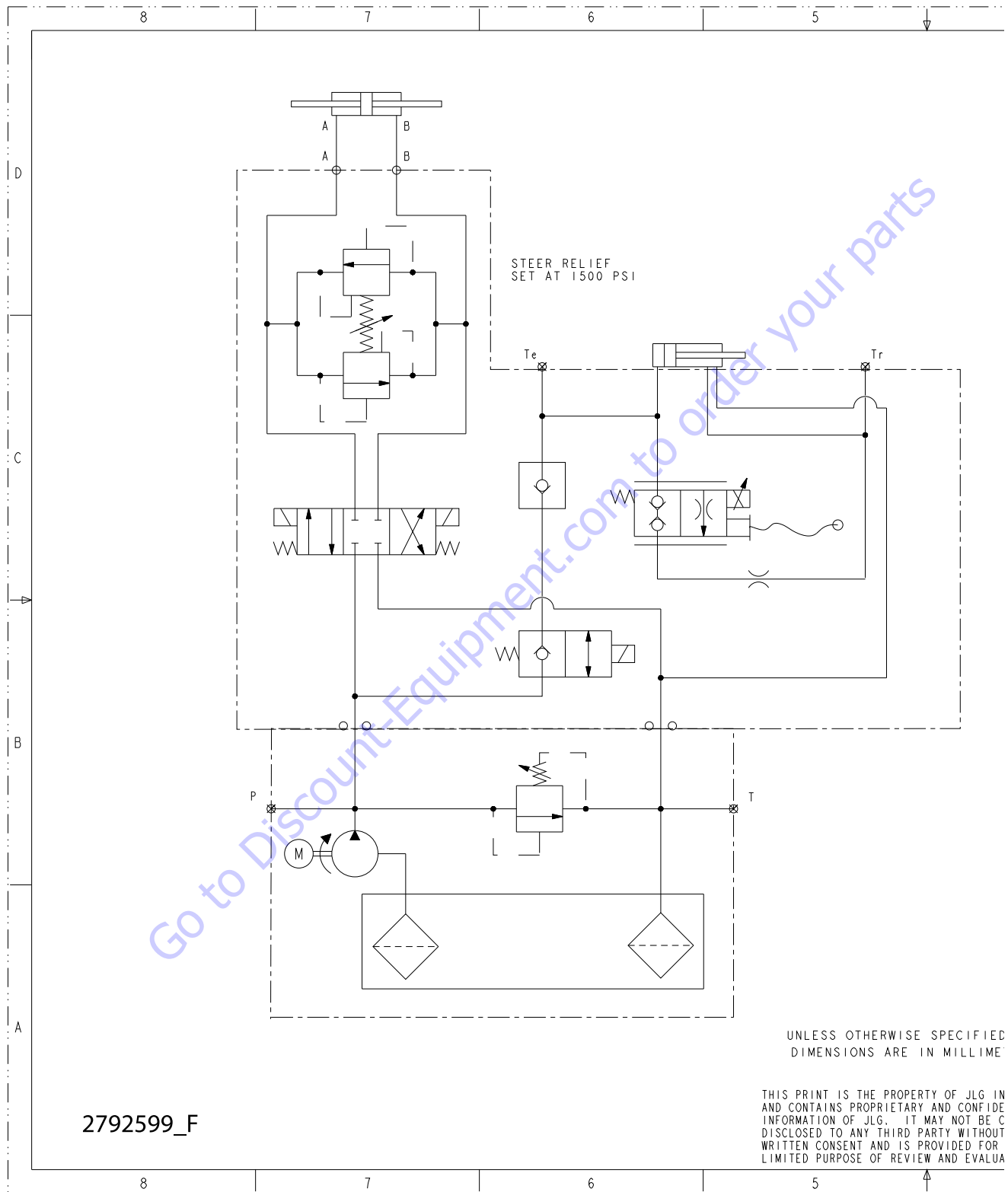
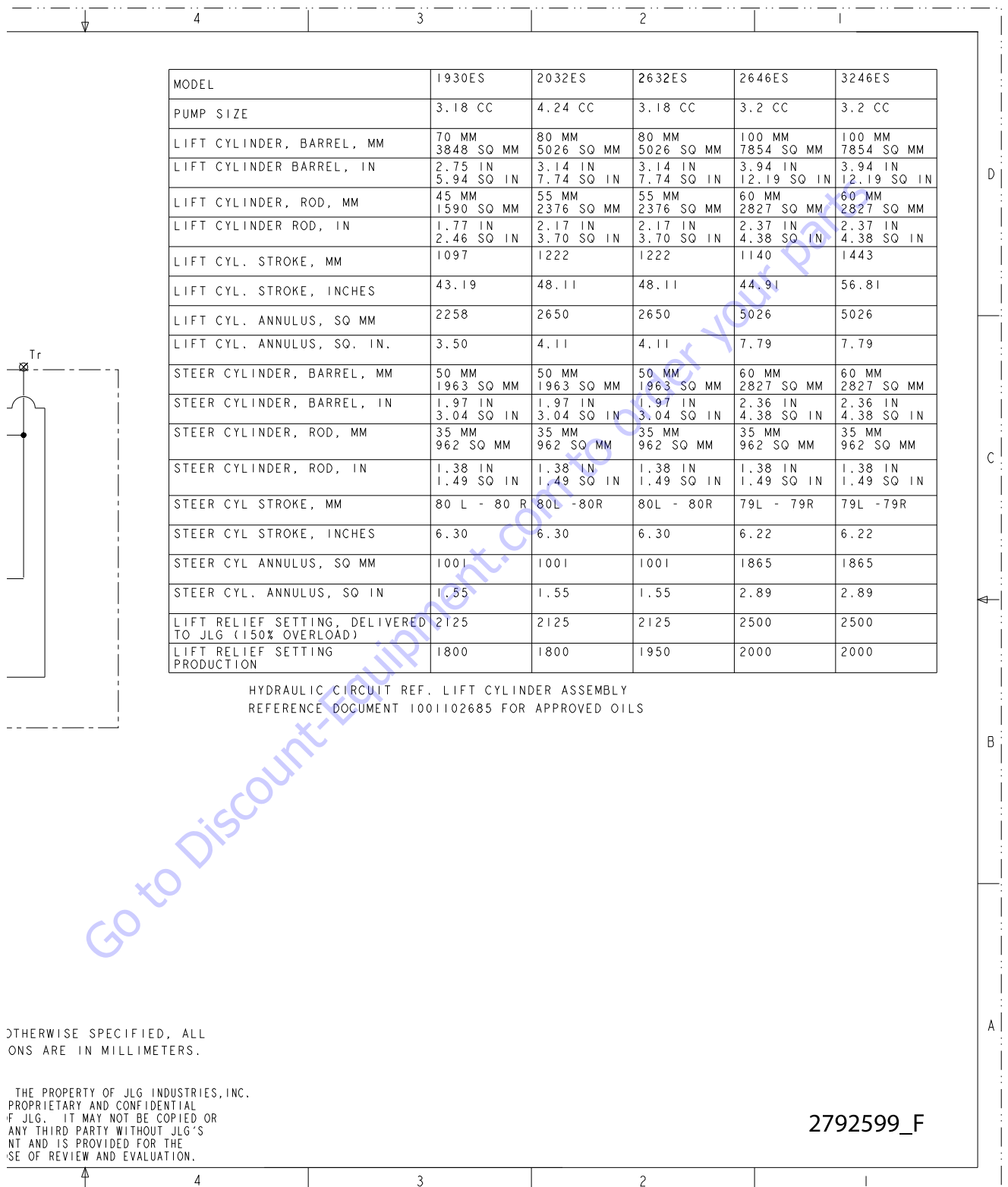


Figure 7-29. Hydraulic Schematic - USA Manufactured

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OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS.

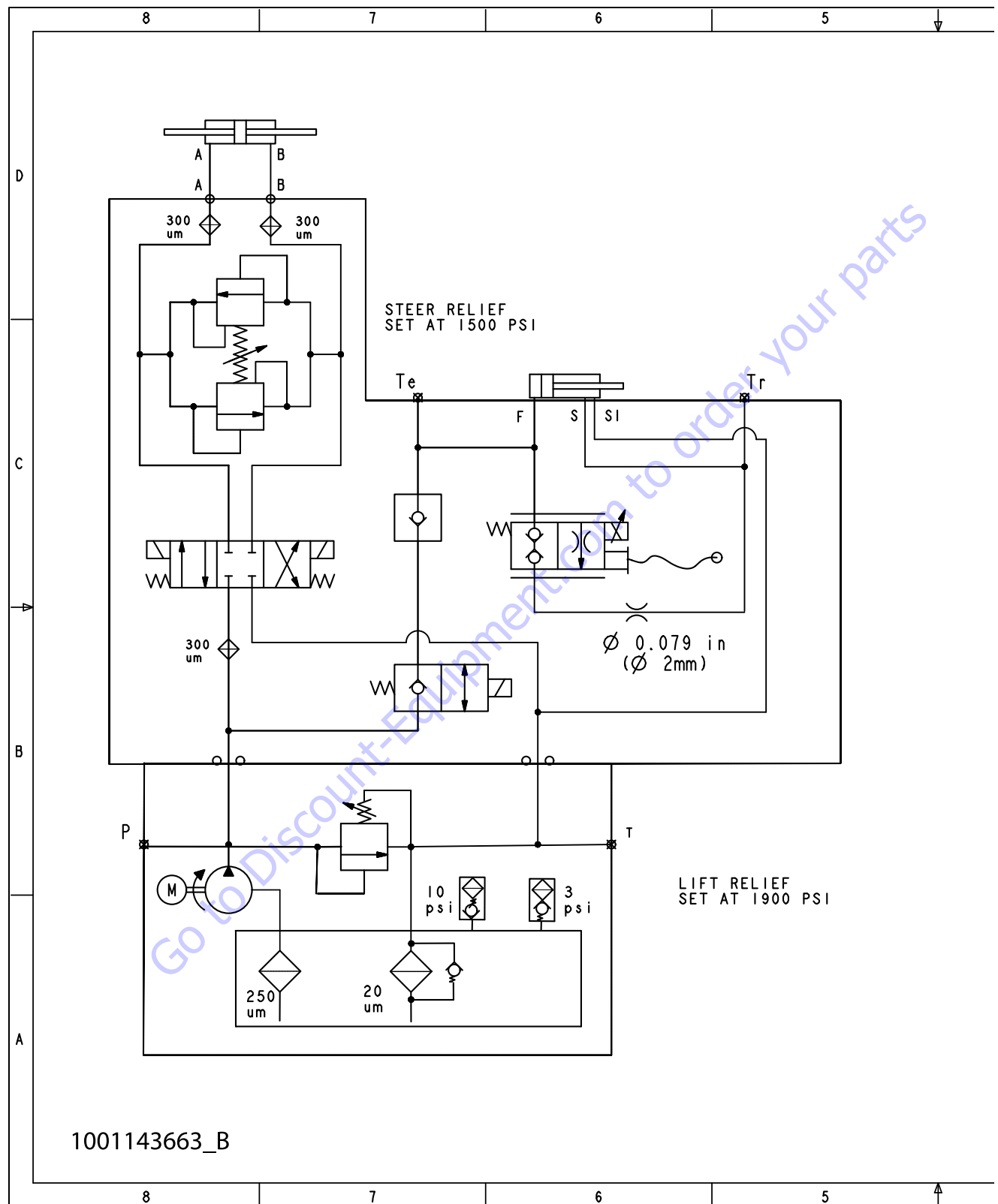
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**Figure 7-29., Hydraulic Schematic - USA Manufactured**



**SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-30. Hydraulic Schematic - China Manufactured**

**SECTION 7 - GENERAL ELECTRICAL INFORMATION & SCHEMATICS**

	4	3	2	1	
MODEL	1930ES	2032ES	2632ES	2646ES	3246ES
PUMP SIZE	3.2 CC	3.2 CC	3.2 CC	3.2 CC	3.2 CC
LIFT CYLINDER, BARREL, MM	70 MM 3848 SQ MM	80 MM 5026 SQ MM	80 MM 5026 SQ MM	100 MM 7854 SQ MM	100 MM 7854 SQ MM
LIFT CYLINDER BARREL, IN	2.75 IN 5.94 SQ IN	3.14 IN 7.74 SQ IN	3.14 IN 7.74 SQ IN	3.94 IN 12.19 SQ IN	3.94 IN 12.19 SQ IN
LIFT CYLINDER, ROD, MM	45 MM 1590 SQ MM	55 MM 2376 SQ MM	55 MM 2376 SQ MM	60 MM 2827 SQ MM	60 MM 2827 SQ MM
LIFT CYLINDER ROD, IN	1.77 IN 2.46 SQ IN	2.17 IN 3.70 SQ IN	2.17 IN 3.70 SQ IN	2.37 IN 4.38 SQ IN	2.37 IN 4.38 SQ IN
LIFT CYL. STROKE, MM	1097	1222	1222	1140	1443
LIFT CYL. STROKE, INCHES	43.19	48.11	48.11	44.91	56.81
LIFT CYL. ANNULUS, SQ MM	2258	2650	2650	5026	5026
LIFT CYL. ANNULUS, SQ. IN.	3.50	4.11	4.11	7.79	7.79
STEER CYLINDER, BARREL, MM	50 MM 1963 SQ MM	50 MM 1963 SQ MM	50 MM 1963 SQ MM	60 MM 2827 SQ MM	60 MM 2827 SQ MM
STEER CYLINDER, BARREL, IN	1.97 IN 3.04 SQ IN	1.97 IN 3.04 SQ IN	1.97 IN 3.04 SQ IN	2.36 IN 4.38 SQ IN	2.36 IN 4.38 SQ IN
STEER CYLINDER, ROD, MM	35 MM 962 SQ MM	35 MM 962 SQ MM	35 MM 962 SQ MM	35 MM 962 SQ MM	35 MM 962 SQ MM
STEER CYLINDER, ROD, IN	1.38 IN 1.49 SQ IN	1.38 IN 1.49 SQ IN	1.38 IN 1.49 SQ IN	1.38 IN 1.49 SQ IN	1.38 IN 1.49 SQ IN
STEER CYL STROKE, MM	80 L - 80 R	80L -80R	80L - 80R	79L - 79R	79L -79R
STEER CYL STROKE, INCHES	6.30	6.30	6.30	6.22	6.22
STEER CYL ANNULUS, SQ MM	1001	1001	1001	1865	1865
STEER CYL. ANNULUS, SQ IN	1.55	1.55	1.55	2.89	2.89
LIFT RELIEF SETTING PRODUCTION	1900	1900	1900	1900	1900

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**Figure 7-30., Hydraulic Schematic - China Manufactured**

# PARTS FINDER

**Search Website  
by Part Number**



**Search Manual  
Library For Parts  
Manual & Lookup Part  
Numbers – Purchase  
or Request Quote**

A screenshot of the "Search Manuals" form. It includes fields for "Brand", "Model", "Serial", "Part Number", and "Quantity". There is a "Search" button at the bottom.

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Manual? Request Help  
by Manufacturer,  
Model & Description**

A screenshot of the "Parts Order Form". It is a table with columns for "Quantity", "Part Number", "Description", "Manufacturer", "Model", "Serial", "Part Name", "Part Description", "Part Category", "Part Location", "Part Status", and "Part Notes".

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