



An Oshkosh Corporation Company

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# Service and Maintenance Manual

**Models**  
**400S**  
**460SJ**

**P/N - 3120788**

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**ANSI**



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An Oshkosh Corporation Company



## SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

### A GENERAL

This section contains the general safety precautions which must be observed during maintenance of the aerial platform. It is of utmost importance that maintenance personnel pay strict attention to these warnings and precautions to avoid possible injury to themselves or others, or damage to the equipment. A maintenance program must be followed to ensure that the machine is safe to operate.

#### **⚠ WARNING**

**MODIFICATION OR ALTERATION OF AN AERIAL WORK PLATFORM SHALL BE MADE ONLY WITH WRITTEN PERMISSION FROM THE MANUFACTURER.**

The specific precautions to be observed during maintenance are inserted at the appropriate point in the manual. These precautions are, for the most part, those that apply when servicing hydraulic and larger machine component parts.

Your safety, and that of others, is the first consideration when engaging in the maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without the aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. When raising a portion of the equipment, ensure that adequate support is provided.

#### **⚠ WARNING**

**SINCE THE MACHINE MANUFACTURER HAS NO DIRECT CONTROL OVER THE FIELD INSPECTION AND MAINTENANCE, SAFETY IN THIS AREA RESPONSIBILITY OF THE OWNER/OPERATOR.**

### B HYDRAULIC SYSTEM SAFETY

It should be noted that the machines hydraulic systems operate at extremely high potentially dangerous pressures. Every effort should be made to relieve any system pressure prior to disconnecting or removing any portion of the system.

Relieve system pressure by cycling the applicable control several times with the engine stopped and ignition on, to direct any line pressure back into the reservoir. Pressure feed lines to system components can then be disconnected with minimal fluid loss.

### C MAINTENANCE

#### **⚠ WARNING**

**FAILURE TO COMPLY WITH SAFETY PRECAUTIONS LISTED IN THIS SECTION COULD RESULT IN MACHINE DAMAGE, PERSONNEL INJURY OR DEATH AND IS A SAFETY VIOLATION.**

- ENSURE REPLACEMENT PARTS OR COMPONENTS ARE IDENTICAL OR EQUIVALENT TO ORIGINAL PARTS OR COMPONENTS.
- NO SMOKING IS MANDATORY. NEVER REFUEL DURING ELECTRICAL STORMS. ENSURE THAT FUEL CAP IS CLOSED AND SECURE AT ALL OTHER TIMES.
- REMOVE ALL RINGS, WATCHES AND JEWELRY WHEN PERFORMING ANY MAINTENANCE.
- DO NOT WEAR LONG HAIR UNRESTRAINED, OR LOOSE-FITTING CLOTHING AND NECKTIES WHICH ARE APT TO BECOME CAUGHT ON OR ENTANGLED IN EQUIPMENT.
- OBSERVE AND OBEY ALL WARNINGS AND CAUTIONS ON MACHINE AND IN SERVICEMANUAL.
- KEEP OIL, GREASE, WATER, ETC. WIPED FROM STANDING SURFACES AND HAND HOLDS.
- USE CAUTION WHEN CHECKING A HOT, PRESSURIZED COOLANT SYSTEM.
- NEVER WORK UNDER AN ELEVATED BOOM UNTIL BOOM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR BOOM SAFETY PROP HAS BEEN ENGAGED.
- BEFORE MAKING ADJUSTMENTS, LUBRICATING OR PERFORMING ANY OTHER MAINTENANCE, SHUT OFF ALL POWER CONTROLS.
- BATTERY SHOULD ALWAYS BE DISCONNECTED DURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

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## SECTION 1. SPECIFICATIONS

### 1.1 CAPACITIES

**Table 1-1. Capacities**

Fuel Tank	26 gallons (98.4 liters)
Hydraulic Tank	40.0 gallons (152 liters)
Hydraulic System (Including Tank)	52 gallons (196.8 liters)
Drive Hub	17 ounces (0.5 liters)
Engine Oil Capacity	
Ford	4.5 Quarts (4.25 L) w/Filter
Deutz	6.3 qts. (6 L) w/Filter
Caterpillar	3.8 quarts (3.6 L) crankcase only
GM	4.5 qts. (4.25 L) w/Filter

### 1.2 ENGINE SPECIFICATIONS

**NOTE:** RPM Tolerances are  $\pm 100$ .

**Table 1-2. Ford LRG-425 (Gas or Dual Fuel)**

Type	4 cylinder, 4 stroke, spark ignition
Fuel	Gasoline or Gasoline/LP Gas
Bore	3 in. (96 mm)
Stroke	3.4 in. (86.4 mm)
Displacement	153 cu. in. (2.5 L)
Firing Order	1-3-4-2
BHP at Max. RPM	82
Oil Capacity	4.5 quarts (4.26 L)
Low RPM	1000
Mid RPM	1800
High RPM	3000
Fuel Consumption: Gasoline	
Intermittent	6 gal. hr.
Continuous	5 gal. hr.
Fuel Consumption: LPG	
Intermittent	26 lbs. hr.
Continuous	23 lbs. hr.
Spark Plug	AWSF-52-C
Spark Plug Gap	0.044 in. (1.117 mm)

**Table 1-3. Deutz F3M1011F/F3M2011F**

Fuel	Diesel
No. of Cylinders	3
Bore	3.6 in. (91 mm)
Stroke	4.4 in. (112 mm)
Displacement	133 cu. in. (2184 cm <sup>3</sup> )
BHP at Max. RPM	48
Oil Capacity	
crankcase	6.3 quarts (6 L)
cooler	4.75 quarts (4.5 L)
total capacity	11 quarts (10.5 L)
Low RPM	1200
Mid RPM	1800
High RPM	2800

**Table 1-4. Isuzu 4LE1**

Fuel	Diesel
No. of Cylinders	4
BHP at Max. RPM	45
Low RPM	1000
Mid RPM	1500
High RPM	2800

**Table 1-5. Caterpillar 3024/C2.2**

Fuel	Diesel
No. of Cylinders	4
BHP	46.5 hp (34 kW)
Bore	3.307 in. (84 mm)
Stroke	3.9370 in. (112 mm)
Displacement	134.3 cu. in. (2.2L)
Oil Capacity w/filter	10 qt. (9.4 L)
Compression Ratio	19:1
Firing Order	1-3-4-2
Max. RPM	2800

## SECTION 1 - SPECIFICATIONS

**Table 1-6. GM 3.0L**

Fuel	Gasoline or Gasoline/LP Gas
No. of Cylinders	4
BHP	83 hp @ 3000 rpm 75 hp @ 3000 rpm
Bore	4.0 in. (101.6 mm)
Stroke	3.6 in. (91.44 mm)
Displacement	181 cu.in. (3.0 L, 2966 cc)
Oil Capacity w/filter	4.5 qts. (4.25 L)
Minimum Oil Pressure at idle Hot	6 psi (0.4 Bar) @ 1000 rpm 18 psi (1.2 Bar) @ 2000 rpm
Compression Ratio	9.2:1
Firing Order	1-3-4-2
Max. RPM	2800

**Table 1-7. Perkins 404C-22**

Fuel	Diesel
No. of Cylinders	4
BHP	50 HP (37.3 kW)
Bore	3.3 in. (84 mm)
Stroke	3.9 in. (100 mm)
Firing Order	1-3-4-2
Displacement	135 cu.in. (2.2 L)
Oil Capacity w/filter	10 qt. (9.4 L)
Compression Ratio	23.3:1

## 1.3 TIRES

**Table 1-8. Tires**

Size	Type	Pressure	Weight
12x16.5	Pneumatic	90 psi (6.2 Bar)	128 lbs. (58 kg)
12x16.5	Foam-filled	N/A	328 lbs. (149kg)
14x17.5	Pneumatic	90 psi (6 Bar)	128 lbs. (58 kg)
14x17.5	Foam-filled	N/A	440 lbs. (200kg)
33/16LLx16.1- Sand	Pneumatic	90 psi (2.75 bar)	119.5 lbs. (54 kg)
33/16LLx16.1- Sand	Foam Filled	N/A	426 lbs. (193 kg)
Semitrack Tires			
24x12x 12	Pneumatic	20 psi (1.4 bar)	20.7 lbs. (9.38 kg)

**1.4 SPECIFICATIONS AND PERFORMANCE DATA**

**Table 1-9. Specifications and Performance Data - 400S**

Maximum Work Load (Capacity): Unrestricted: Restricted: Optional:	standard 500 lbs. (230 kg.) 1000 lbs. (230 kg) 750 lbs. (340 kg)
Maximum Travel Grade, Stowed Position (Gradeability)	2 W/D-30% 4 W/D-45%
Maximum Travel Grade, Stowed Position (Side Slope)	5°
Maximum Vertical Platform Height:	40 ft. (12 m)
Maximum Horizontal Platform Reach:	34 ft. (10 m.)
Turning Radius (Outside)	16 ft. (5 m.)
Turning Radius (Inside)	6 ft.-8 in. (2 m.)
Overall Width	6ft.- 6in. (1.98 m)
Tail swing	Zero
Stowed Height	7ft. 4in. (2.24 m)
Stowed Length	20ft. 2in. (6.15 m)
Wheelbase	7ft. 10in. (2,3 m)
Ground Clearance	12in. (30 cm)
Max. Tire Load (400S-500 lbs. Cap.) Max. Tire Load (400S-750 lbs. Cap.)	8200 lbs. (3720 kg) 7200 lbs. (3266 kg)
Ground Bearing Pressure 12x16.5 FF Tires 14x17.5 pneumatic tires	58 psi (4.07 kg/cm <sup>2</sup> ) 45 psi (3.16 kg/cm <sup>2</sup> )
Travel Speed, boom stowed. (2WD/4WD)	4.5 m.p.h. (7.24 kmh) (27-32 sec/ 200ft.)
Travel Speed, boom elevated. (2WD/4WD)	0.75 m.p.h. (1.20 kmh) (46-115 sec/ 50 ft.)
Gross Machine Weight Std. 2wd Machine (Platform Empty, Pneumatic Tires) 500 lb. (230 kg) Capacity 750 lb. (340 kg) Capacity	12,525 lbs. (5681kg) 13,525 lbs. (6135 kg)
Maximum System Voltage	12 VDC
Max. Hydraulic System Operating Pressure	4060 psi (280 bar)
Manual Force	400 N maximum
Maximum Wind Speed	28 mph (12.5 m/s)

**Table 1-10. Specifications and Performance Data - 460SJ**

Maximum Work Load (Capacity): Unrestricted:	500 lbs. (230 kg.)
Maximum Travel Grade, Stowed Position (Gradeability)	2 W/D - 30% 4 W/D - 45%
Maximum Travel Grade, Stowed Position (Side Slope)	5°
Maximum Vertical Platform Height:	46 ft. (14 m.)
Maximum Horizontal Platform Reach:	40 ft. (12 m.)
Turning Radius (Outside)	16 ft. (5 m.)
Turning Radius (Inside)	6 ft.-8 in. (2 m.)
Overall Width	6ft.- 6in. (1.98 m)
Tail swing	Zero
Stowed Height	7ft. 4in. (2.24 m)
Stowed Length	20ft. 2in. (6.15 m)
Wheelbase	7ft. 10in. (2,3 m)
Ground Clearance	12in. (30 cm)
Max. Tire Load	8350 lbs. (3788 kg)
Ground Bearing Pressure	58 psi (4.07 kg/cm <sup>2</sup> )
Travel Speed, boom stowed. (2WD/4WD)	4.5 m.p.h. (7.24 kmh) (27-32 sec/ 200ft.)
Travel Speed, boom elevated. (2WD/4WD)	0.75 m.p.h. (1.20 kmh) (46-115 sec/ 50 ft.)
Gross Machine Weight Std. 2wd Machine (Platform Empty, Pneumatic Tires)	15,855 lb. (7192 kg)
Maximum System Voltage	12 VDC
Max. Hydraulic System Operating Pressure	4060 psi (280 bar)
Maximum Manual Force	400 N
Maximum Wind Speed	28 mph (12.5 m/s)

## SECTION 1 - SPECIFICATIONS

### 1.5 TORQUE REQUIREMENTS

Table 1-11. Torque Requirements

Description	Torque Value	Interval Hours
Wheel Lugs	170 ft. lbs. (231 Nm)	150
Swing Bearing (Loctite)	190 ft. lbs. (260 Nm)	50/600*

\* Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter.

### 1.6 CRITICAL STABILITY WEIGHTS

Table 1-12. Critical Stability Weights

Component	LB.	KG
Ford Engine	339	154
Deutz Engine	441	200
8 ft Platform (x 30")	205	93
6 ft. Platform (x 30")	160	73
5 ft. Platform (x 30")	145	66
4ft. Platform (x 30")	130	59
8 ft. Platform (x 36")	230	105
Bolt-on T/T Cwt. (SJ)	487	221
12x16.5 pneu. Tire & Wheel	128	58
12x16.5 F/F Tire & Wheel	440	200
12x21.5 (NHS)pneu. Tire & Wheel	55	97
12x21.5 (NHS)F/F Tire & Wheel	224	102
14x16.1 Sand pneu. Tire & Wheel	91.5	42
14x16.1 Sand F/F Tire & Wheel	440	200

### 1.7 MAJOR COMPONENT WEIGHTS

Table 1-13. Major Component Weights

Component	LB.	KG
8 ft Platform	230	105
6ft. Platform	160	73
5 ft. Platform	145	66
4 ft. platform	130	59
Extend-A-Reach	230	104
Boom (400S)	985	447
Boom (460SJ)	1250	567
Turntable	3560	1615
Engine Tray	890	404
Hydraulic Tray	225	102
Tail Counterweight (460SJ)	3410	1547
Chassis (12x16.5 pneu. tires)	4200	1905
12x16.5 pneu. Tire & Wheel	128	58
12x16.5 F/F, Tire & Wheel	440	200
12x21.5 (NHS)pneu. Tire & Wheel	55	97
12x21.5 (NHS) F/F, Tire & Wheel	224	102
14x16.1 Sand pneu. Tire & Wheel	91.5	42
14x16.1 Sand F/F Tire & Wheel	440	200
Jib	320	145
Hydraulic Welder	140	64



## 1.8 FUNCTION SPEEDS

Table 1-14. Function Speeds (In Seconds)

Function	Speed
Main Boom Lift Up	26-32
Main Boom Lift Down	19-25
Swing - (10% max diff.)	70-90
Telescope Out	18-23
Telescope In	23-29
Platform Rotate (Left & Right) - (15% max diff.)	9-15
Jib Up - (460SJ)	17-23
Jib Down - (460SJ)	13-20
Drive Forward & Reverse (200 ft.)	27-32 (4.5 MPH)
Drive Above Horizontal, Fwd. & Rev.	46-115 (0.75-0.33 MPH)

## 1.9 PRESSURE SETTINGS - PSI (BAR)

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until hydraulic systems have warmed to normal operating temperatures prior to checking pressures. It is also recommended using a calibrated gauge. Pressure readings are accepted if within +/-5% of specified pressures.

Table 1-15. Relief Settings

Circuit	PSI	Bar
Main Relief - (Bang-Bang Valve)	2500	172
Main Relief (Proportional Valve)	2750	189
Lift Up	N/A	N/A
Lift Down	1600	110
Level Down	1800	124
Level Up	2800	193
Swing (Right & Left)	1600	110
Steer	2500	172
Jib Up (460SJ Only)	2500	172
Jib Down (460SJ Only)	1200	83
Drive - (Pre-Set)	4500	310

## 1.10 CYLINDER SPECIFICATIONS

Table 1-16. Cylinder Specifications

Cylinder	Bore	Stroke	Rod Dia.
Oscillation	2.5 in. (63.5 mm)	4.125 in. (104.8 mm)	1.75 in. (44.45 mm)
Main Lift	5.0 in. (127.0 mm)	39.0 in. (990.0 mm)	2.5 in. (63.5 mm)
Telescope	3.0 in. (76.2 mm)	181.0 in. (459.74 cm)	2.0 in. (50.8 mm)
Slave	2.5 in. (63.5 mm)	14.9 in. (37.9 cm)	1.25 in. (31.75 mm)
Master	2.5 in. (63.5 mm)	15.13 in. (38.4 cm)	1.25 in. (31.75 mm)
Jib	3.0 in. (76.2 mm)	18.4 in. (46.7 cm)	1.5 in. (38.1 mm)
steer	2.5 in. (63.5 mm)	9.2 in. (233.6 mm)	1.75 in. (44.58 mm)

## 1.11 LUBRICATION

### Hydraulic Oil

Table 1-17. Hydraulic Oil

Hydraulic System Operating Temperature Range	S.A.E. Viscosity Grade
+0° to +180° F (-18° to +83° C)	10W
+0° to +210° F (-18° to +99° C)	10W-20, 10W30
+50° to +210° F (+10° to +99° C)	20W-20

**NOTE:** Hydraulic oils must have anti-wear qualities at least to API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service. JLG Ind. recommends Mobilfluid 424 hydraulic oil, which has an SAE viscosity index of 152.

**NOTE:** When temperatures remain consistently below 20 degrees F. (-7 degrees C.), JLG Industries recommends the use of Mobil DTE-13.

**NOTE:** Machines may be equipped with Mobil EAL224H bio-degradable and non-toxic hydraulic oil. This is Vegetable oil based and possesses the same anti-wear and rust protection characteristics as mineral oils, but will not adversely affect the ground water or the environment when spilled or leaked in small amounts. Mobil EAL224H has a viscosity of 34 cSt at 40° C. and viscosity index of 213. The operating temperature range of this oil is -18° C. to +83° C.

## SECTION 1 - SPECIFICATIONS

Aside from JLG recommendations, it is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. If use of hydraulic oil other than Mobilfluid 424 is desired, contact JLG Industries for proper recommendations.

**Table 1-18. Mobilfluid 424 Specs**

SAE Grade	10W30
Gravity, API	29.0
Density, Lb/Gal. 60°F	7.35
Pour Point, Max	-46°F (-43°C)
Flash Point, Min.	442°F (228°C)
Viscosity	
Brookfield, cP at -18°C	2700
at 40° C	55 cSt
at 100° C	9.3 cSt
Viscosity Index	152

**Table 1-19. Mobil EAL H 46 Specs**

Type	Synthetic Biodegradable
ISO Viscosity Grade	46
Specific Gravity	.910
Pour Point	-44°F (-42°C)
Flash Point	500°F (260°C)
Operating Temp.	0 to 180°F (-17 to 162°C)
Weight	7.64 lb. per gal. (0.9 kg per liter)
Viscosity	
at 40° C	45 cSt
at 100° C	8.0 cSt
Viscosity Index	153

**Table 1-20. Exxon Univil HVI 26 Specs**

Specific Gravity	32.1
Pour Point	-76°F (-60°C)
Flash Point	217°F (103°C)
Viscosity	
at 40° C	25.8 cSt
at 100° C	9.3 cSt
Viscosity Index	376
<b>NOTE:</b> Mobil/Exxon recommends that this oil be checked on a yearly basis for viscosity.	

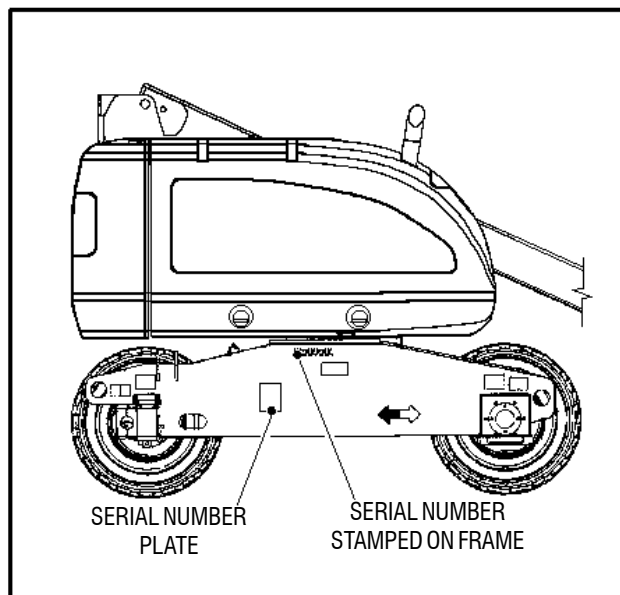
## 1.12 WELDER, HYDRAULIC (OPTION)

**Table 1-21. Welder Specifications - Model 225-4**

Description	Specification
Weld Amps	225
Strike Weld	75
Weld Voltage	21.6 - 28 DC
Frequency	60 Hz, KVA - 4.2 Kw, Single Phase
Oil Flow	18.8 Gpm, 2000 Psi.

## 1.13 SERIAL NUMBER LOCATION

A serial number plate is affixed to the left rear side of the frame. If the serial number plate is damaged or missing, the machine serial number is stamped on the left side of the frame.



**Figure 1-1. Serial Number Location**

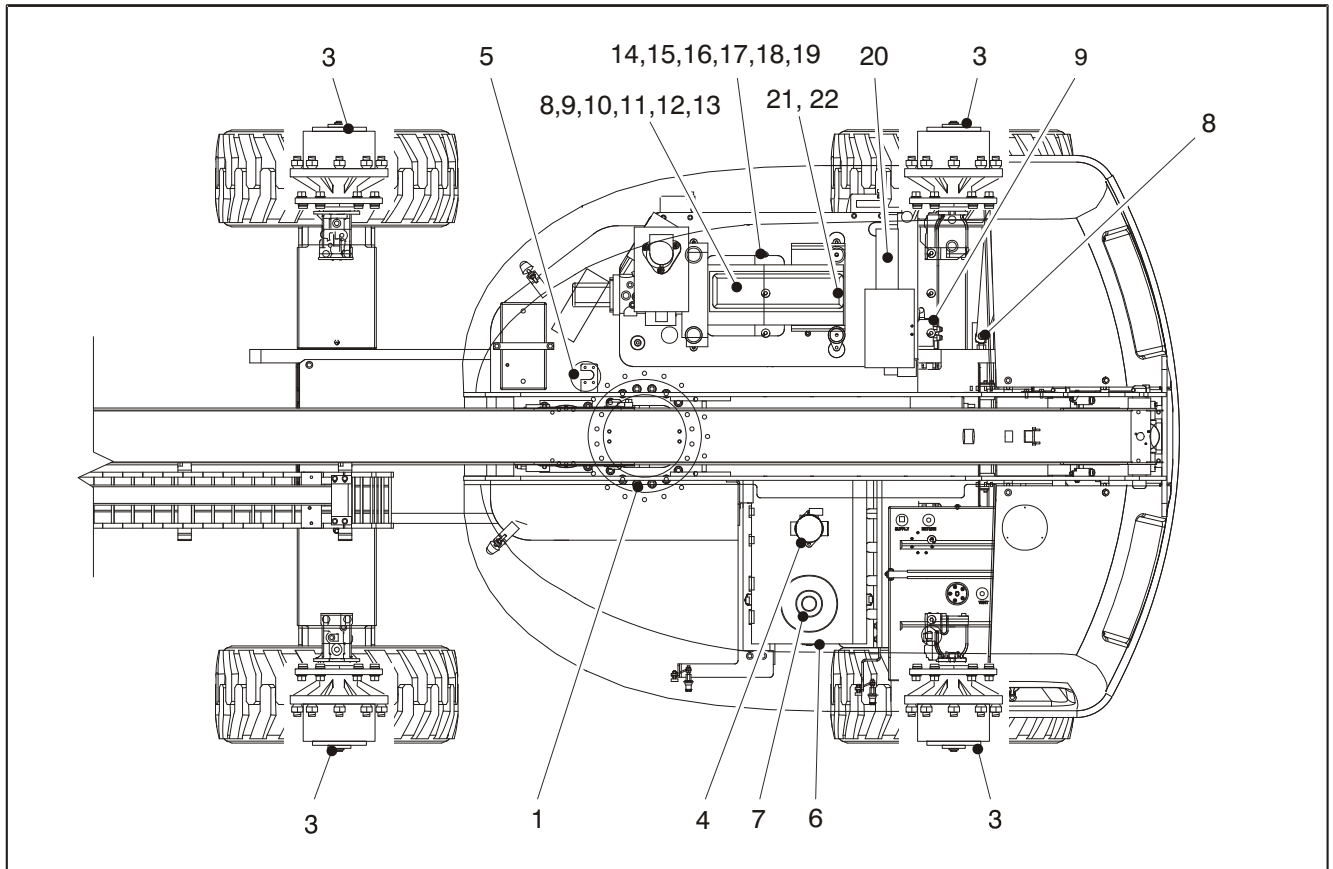


Figure 1-2. Operator Maintenance and Lubrication Diagram

## 1.14 OPERATOR MAINTENANCE AND LUBRICATION

Table 1-22. Lubrication Specifications

KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350° F (177° C). Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec MIL-L-2105
HO	Hydraulic Oil. API service classification GL-3, e.g. Mobilfluid 424.
EO	Engine (crankcase) Oil. Gas - API SF, SH, SG class, MIL-L-2104. Diesel - API CC/CD class, MIL-L-2104B/MIL-L-2104C.
OGL	Open Gear Lubricant - Mobiltac 375 or equivalent.

### NOTICE

LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

**NOTE:** The following numbers correspond to those in Figure 1-2., Operator Maintenance and Lubrication Diagram.

**NOTE:** It is recommended as a good practice to replace all filters at the same time.

#### 1. Swing Bearing - Internal Ball Bearing

Lube Point(s) - 2 Grease Fittings

Capacity - A/R

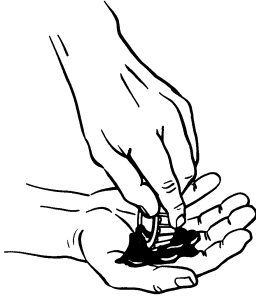
Lube - MPG

Interval - Every 3 months or 150 hrs of operation

Comments - Fittings in center of bearing: Remote Access is optional

## SECTION 1 - SPECIFICATIONS

### 2. Wheel Bearings (2WD Only)



Lube Point(s) - Repack  
Capacity - A/R  
Lube - MPG  
Interval - Every 2 years or 1200 hours of operation

### 3. Wheel Drive Hub

Lube Point(s) - Level/Fill Plug  
Capacity - 17 oz. (0.5 L) - 1/2 Full  
Lube - EPGL  
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation

### 4. Hydraulic Return Filter

Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or whenever Charge Filter is replaced.

### 5. Hydraulic Charge Filter

Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

### 6. Hydraulic Tank

Lube Point(s) - Fill Cap  
Capacity - 40.0 gal. tank (151L) 52.0 gal. system (196.8L)  
Lube - HO  
Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

### 7. Suction Strainers

Lube Point(s) - 2  
Interval - Every 2 years or 1200 hours of operation, remove and clean at time of hydraulic oil change.

### 8. Oil Change w/Filter - Ford

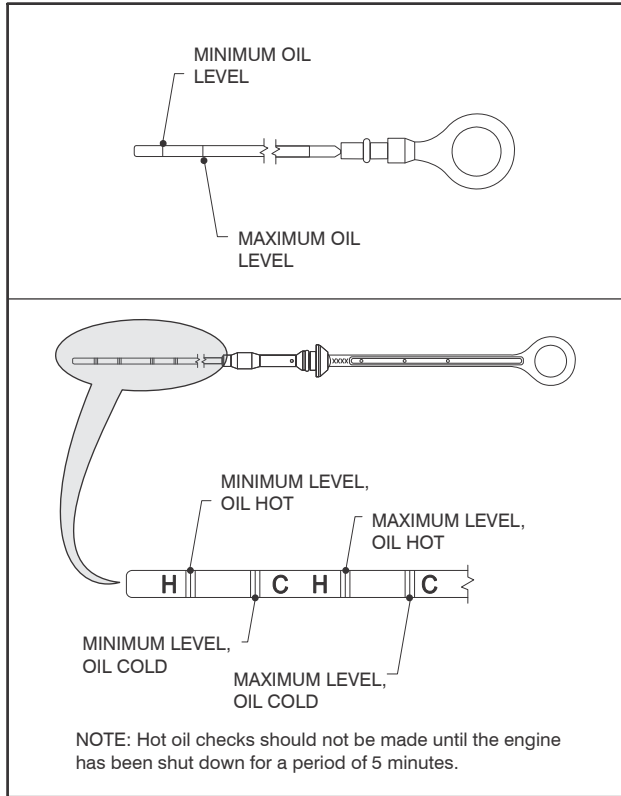


Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7014501)  
Capacity - 4.5 Quarts  
Lube - EO  
Interval - 3 Months or 150 hours of operation  
Comments - Check level daily/Change in accordance with engine manual.

### 9. Oil Change w/Filter - Deutz



Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7016331)  
Capacity - 6.3 qt. (5.9) engine  
Lube - EO  
Interval - Every Year or 1200 hours of operation  
Comments - Check level daily/Change in accordance with engine manual. Refer to Figure 1-3., Deutz Engine Dipstick.



**Figure 1-3. Deutz Engine Dipstick**

**10. Oil Change w/Filter - Isuzu**

Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7022111)  
 Capacity - 6 qt. (5.6L) engine; 6.5 qt. (6.1L) w/cooler  
 Lube - EO  
 Interval - 3 Months or 150 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.

**11. Oil Change w/Filter - Caterpillar**

Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7026855)  
 Capacity - 10 Quarts (9.4 L)  
 Lube - EO  
 Interval - Every Year or 600 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.

**12. Oil Change w/Filter - GM**

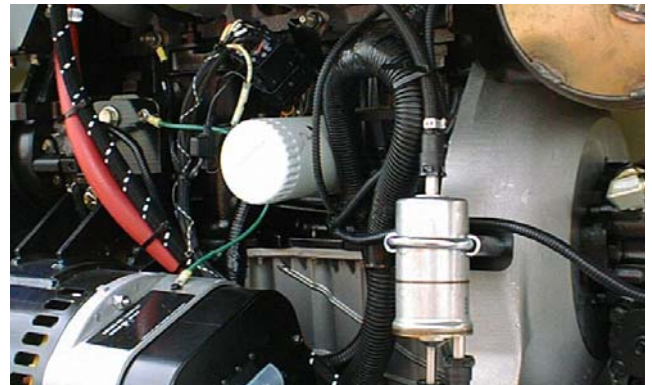


Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7027965)  
 Capacity - 4.5 qt. (4.25 L) w/filter  
 Lube - EO  
 Interval - 3 Months or 150 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.

**13. Oil Change w/Filter - Perkins**

Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7026855)  
 Capacity - 10 Quarts (9.4 L)  
 Lube - EO  
 Interval - Every Year or 600 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.

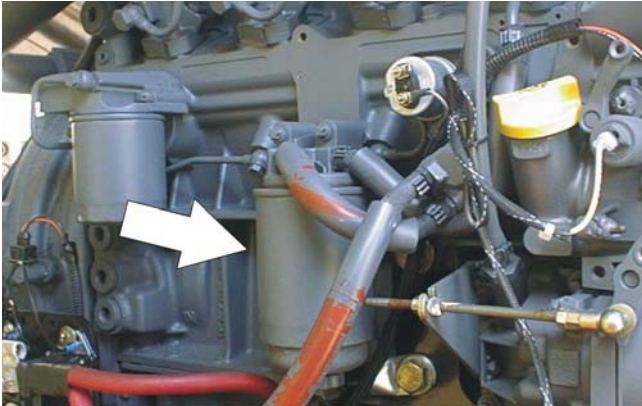
**14. Fuel Filter - Ford**



Lube Point(s) - Replaceable Element  
 Interval - Every Year or 600 hours of operation

## SECTION 1 - SPECIFICATIONS

### 15. Fuel Filter - Deutz



Lube Point(s) - Replaceable Element  
Interval - Every Year or 600 hours of operation

### 16. Fuel Filter - Isuzu

Lube Point(s) - Replaceable Element  
Interval - Every Year or 600 hours of operation

### 17. Fuel Filter - Caterpillar

Lube Point(s) - Replaceable Element  
Interval - Every Year or 600 hours of operation

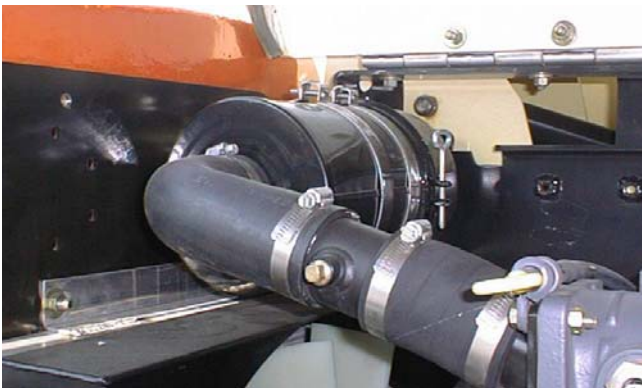
### 18. Fuel Filter (Gasoline) - GM

Lube Point(s) - Replaceable Element  
Interval - Every 6 months or 300 hours of operation

### 19. Fuel Filter - Perkins

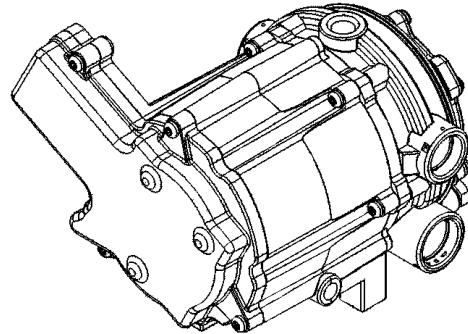
Lube Point(s) - Replaceable Element  
Interval - Every Year or 600 hours of operation

### 20. Air Filter



Lube Point(s) - Replaceable Element  
Interval - Every 6 months or 300 hours of operation  
or as indicated by the condition indicator

### 21. Electronic Pressure Regulator (LP only)



Interval - 3 Months or 150 hours of operation  
Comments - Drain oil build up. Refer to Draining Oil Build Up From The Propane Regulator

### 22. Fuel Filter (Propane) - GM Engine



Interval - 3 Months or 150 hours of operation  
Comments - Replace filter. Refer to Propane Fuel Filter Replacement

## Draining Oil Build Up From The Propane Regulator

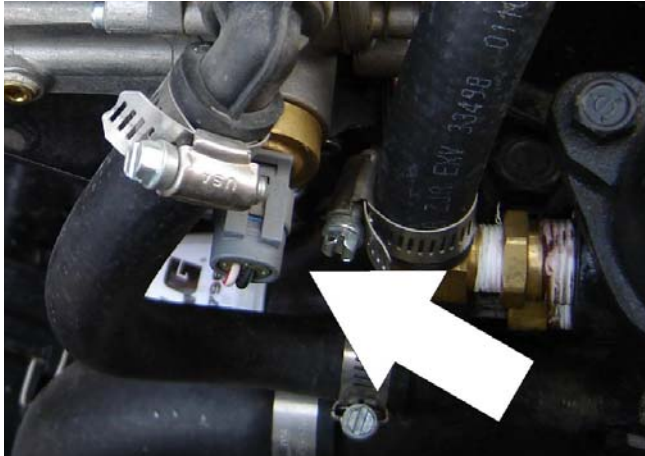
During the course of normal operation oils may build inside the primary and secondary chambers of the propane pressure regulator. These oils may be a result of poor fuel quality, contamination of the fuel supply chain, or regional variation in the make up of the fuel. If the build up of the oil is significant this can effect the operation of the fuel control system. Refer to Section 1.14, Operator Maintenance and Lubrication for maintenance intervals. More frequent draining may be required if the fuel supply has been contaminated.

### **NOTICE**

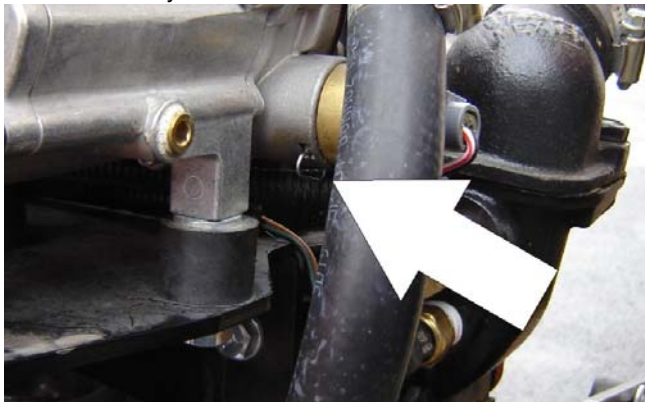
**FOR BEST RESULTS WARM THE ENGINE TO OPERATING TEMPERATURE BEFORE DRAINING. THIS WILL ALLOW THE OILS TO BE LIQUID AND FLOW FREELY FROM THE REGULATOR.**

1. Move the equipment to a well ventilated area. Ensure there are no external ignition sources.

2. Start the engine and bring to operating temperature.
3. With the engine running, close the manual tank valve and run the engine out of fuel.
4. Push in the Emergency Switch once the engine stops.
5. Disconnect the electrical connection to the LPG fuel temperature sensor in the auxiliary fuel port of the EPR.



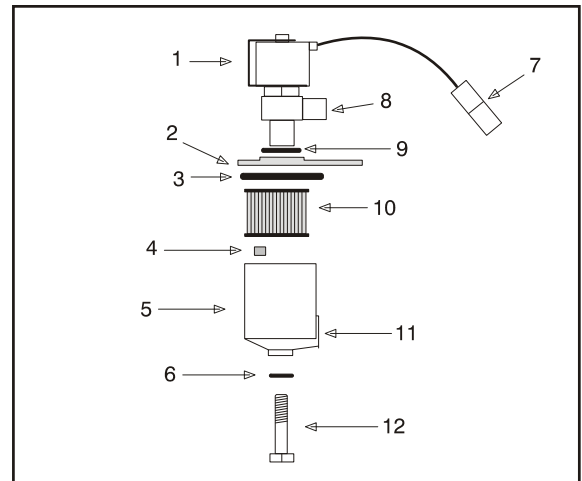
6. Remove the retainer clip for the LPG fuel temperature sensor and remove the sensor from the regulator body.



**NOTE:** Have a small container ready to collect oil that will drain freely from the regulator at this point.

7. Once all of the oil has been drained, reinstall the LPG fuel temperature sensor and reconnect the electrical connector.
8. Open the fuel tank manual valve.
9. Start the engine and verify all connections are secure.
10. Dispose of any drained oil in a safe and proper fashion.

## Propane Fuel Filter Replacement



- |                               |                         |
|-------------------------------|-------------------------|
| 1. Electric Lock Off Solenoid | 7. Electrical Connector |
| 2. Mounting Plate             | 8. Fuel Outlet          |
| 3. Housing Seal               | 9. O-ring               |
| 4. Filter Magnet              | 10. Filter              |
| 5. Filter Housing             | 11. Fuel Inlet          |
| 6. Seal                       | 12. Retaining Bolt      |

**Figure 1-4. Filter Lock Assembly**

### REMOVAL

1. Relieve the propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slowly loosen the Filter housing retaining bolt and remove it.
4. Pull the filter housing from the Electric lock off assembly.
5. Locate Filter magnet and remove it.
6. Remove the filter from the housing.
7. Remove and discard the housing seal.
8. Remove and discard the retaining bolt seal.
9. Remove and discard mounting plate to lock off O-ring seal.

### INSTALLATION

#### **NOTICE**

**BE SURE TO REINSTALL THE FILTER MAGNET INTO THE HOUSING BEFORE INSTALLING NEW SEAL**

1. Install the mounting plate to lock off O-ring seal.
2. Install the retaining bolt seal.
3. Install the housing seal.
4. Drop the magnet into the bottom of the filter housing.
5. Install the filter into the housing.
6. Install the retaining bolt into the filter housing.
7. Install the filter up to the bottom of the electric lock off.
8. Tighten the filter retaining bolt to 106 in lbs (12 Nm).
9. Open manual shut-off valve. Start the vehicle and leak check the propane fuel system at each serviced fitting. Refer to Propane Fuel System Leak Test.

### Propane Fuel System Pressure Relief

#### **⚠ CAUTION**

**THE PROPANE FUEL SYSTEM OPERATES AT PRESSURES UP TO 312 PSI (21.5 BAR). TO MINIMIZE THE RISK OF FIRE AND PERSONAL INJURY, RELIEVE THE PROPANE FUEL SYSTEM PRESSURE (WHERE APPLICABLE) BEFORE SERVICING THE PROPANE FUEL SYSTEM COMPONENTS.**

To relieve propane fuel system pressure:

1. Close the manual shut-off valve on the propane fuel tank.
2. Start and run the vehicle until the engine stalls.
3. Turn the ignition switch OFF.

#### **⚠ CAUTION**

**RESIDUAL VAPOR PRESSURE WILL BE PRESENT IN THE FUEL SYSTEM. ENSURE THE WORK AREA IS WELL VENTILATED BEFORE DISCONNECTING ANY FUEL LINE.**



Values for Zinc Yellow Chromate Fasteners (Ref 4150707)												
SAE GRADE 5 BOLTS & GRADE 2 NUTS												
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry)		Torque Lubricated		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or Vibra-TITE™ 131)	
					IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
		In	Sq In	LB								
4	40	0.1120	0.00604	380	8	0.9	6	0.7				
	48	0.1120	0.00661	420	9	1.0	7	0.8				
6	32	0.1380	0.00909	580	16	1.8	12	1.4				
	40	0.1380	0.01015	610	18	2.0	13	1.5				
8	32	0.1640	0.01400	900	30	3.4	22	2.5				
	36	0.1640	0.01474	940	31	3.5	23	2.6				
10	24	0.1900	0.01750	1120	43	4.8	32	3.5				
	32	0.1900	0.02000	1285	49	5.5	36	4				
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12		
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	17	23	13	18	19	26	16	22
	24	0.3125	0.0580	3700	19	26	14	19	21	29	17	23
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48	28	38
	24	0.3750	0.0878	5600	35	47	25	34	40	54	32	43
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75	45	61
	20	0.4375	0.1187	7550	55	75	40	54	60	82	50	68
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116	68	92
	20	0.5000	0.1599	10700	90	122	65	88	100	136	80	108
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163	98	133
	18	0.5625	0.2030	12950	120	163	90	122	135	184	109	148
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224	135	183
	18	0.6250	0.2560	16300	170	230	130	176	190	258	153	207
3/4	10	0.7500	0.3340	21300	260	353	200	271	285	388	240	325
	16	0.7500	0.3730	23800	300	407	220	298	330	449	268	363
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646	386	523
	14	0.8750	0.5090	32400	470	637	350	475	520	707	425	576
1	8	1.0000	0.6060	38600	640	868	480	651	675	918	579	785
	12	1.0000	0.6630	42200	700	949	530	719	735	1000	633	858
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142	714	968
	12	1.1250	0.8560	47500	880	1193	660	895	925	1258	802	1087
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175	1598	1009	1368
	12	1.2500	1.0730	59600	1240	1681	920	1247	1300	1768	1118	1516
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074	1322	1792
	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750	2380	1506	2042
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754	1755	2379
	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300	3128	1974	2676

NO. 500059 REV. J

- NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 3. \* ASSEMBLY USES HARDENED WASHER

REFERENCE JLG ANEROBIC THREAD LOCKING COMPOUND				
JLG P/N	Loctite® P/N		ND Industries P/N	Description
0100011	242™		Vibra-TITE™ 121	Medium Strength (Blue)
0100019	271™		Vibra-TITE™ 140	High Strength (Red)
0100071	262™		Vibra-TITE™ 131	Medium - High Strength (Red)

Figure 1-5. Torque Chart (SAE Fasteners - Sheet 1 of 7)

**SECTION 1 - SPECIFICATIONS**

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) K= 0.20		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
					IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474	1320	43	5				
10	24	0.1900	0.01750	1580	60	7				
	32	0.1900	0.02000	1800	68	8				
1/4	20	0.2500	0.0318	2860	143	16	129	15		
	28	0.2500	0.0364	3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	25	35	20	25	20	25
	24	0.3125	0.0580	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	7000	45	60	40	55	35	50
	24	0.3750	0.0878	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	9550	70	95	65	90	50	70
	20	0.4375	0.1187	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	12750	105	145	95	130	80	110
	20	0.5000	0.1599	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	16400	155	210	140	190	115	155
	18	0.5625	0.2030	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	20350	210	285	190	260	160	220
	18	0.6250	0.2560	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	30100	375	510	340	460	280	380
	16	0.7500	0.3730	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	41600	605	825	545	740	455	620
	14	0.8750	0.5090	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	51500	860	1170	770	1045	645	875
	12	1.0000	0.6630	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	142200	3555	4835	3200	4350	2665	3625

NO. 500059 REV. J

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 3. \* ASSEMBLY USES HARDENED WASHER

Figure 1-6. Torque Chart (SAE Fasteners - Sheet 2 of 7)

SOCKET HEAD CAP SCREWS										
Magni Coating (Ref 4150701)*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K = .17		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85® K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
					IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
		In	Sq In	LB						
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474							
10	24	0.1900	0.01750							
	32	0.1900	0.02000							
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	410	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625

NO. 5000059 REV. J

- NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 \*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM  
 4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

Figure 1-7. Torque Chart (SAE Fasteners - Sheet 3 of 7)

**SECTION 1 - SPECIFICATIONS**

**SOCKET HEAD CAP SCREWS**  
**Zinc Yellow Chromate Fasteners (Ref 4150707)\***

Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K = .20		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85® K=0.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
					IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
		In	Sq In	LB						
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474							
10	24	0.1900	0.01750							
	32	0.1900	0.02000							
1/4	20	0.2500	0.0318	2860	143	16	129	15		
	28	0.2500	0.0364	3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	25	35	20	25	20	25
	24	0.3125	0.0580	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	7000	45	60	40	55	35	50
	24	0.3750	0.0878	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	9550	70	95	65	90	50	70
	20	0.4375	0.1187	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	12750	105	145	95	130	80	110
	20	0.5000	0.1599	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	16400	155	210	140	190	115	155
	18	0.5625	0.2030	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	20350	210	285	190	260	160	220
	18	0.6250	0.2560	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	30100	375	510	340	460	280	380
	16	0.7500	0.3730	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	41600	605	825	545	740	455	620
	14	0.8750	0.5090	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	51500	860	1170	775	1055	645	875
	12	1.0000	0.6630	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	142200	3555	4835	3200	4350	2665	3625

**NO. 500059 REV. J**

- NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
\*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM  
4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

**Figure 1-8. Torque Chart (SAE Fasteners - Sheet 4 of 7)**

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)							
CLASS 8.8 METRIC BOLTS CLASS 8 METRIC NUTS							
Size	PITCH	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263™)	Torque (Lub)	Torque (Loctite® 262™ OR Vibra-TITE™ 131)	Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)
		Sq mm	KN	[N.m]	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.3	1.0	1.2	1.4
3.5	0.6	6.78	2.95	2.1	1.6	1.9	2.3
4	0.7	8.78	3.82	3.1	2.3	2.8	3.4
5	0.8	14.20	6.18	6.2	4.6	5.6	6.8
6	1	20.10	8.74	11	7.9	9.4	12
7	1	28.90	12.6	18	13	16	19
8	1.25	36.60	15.9	26	19	23	28
10	1.5	58.00	25.2	50	38	45	55
12	1.75	84.30	36.7	88	66	79	97
14	2	115	50.0	140	105	126	154
16	2	157	68.3	219	164	197	241
18	2.5	192	83.5	301	226	271	331
20	2.5	245	106.5	426	320	383	469
22	2.5	303	132.0	581	436	523	639
24	3	353	153.5	737	553	663	811
27	3	459	199.5	1080	810	970	1130
30	3.5	561	244.0	1460	1100	1320	1530
33	3.5	694	302.0	1990	1490	1790	2090
36	4	817	355.5	2560	1920	2300	2690
42	4.5	1120	487.0	4090	3070	3680	4290

**NO. 500059 REV. J**

- NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 \*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM  
 4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

**Figure 1-9. Torque Chart (METRIC Fasteners - Sheet 5 of 7)**

**SECTION 1 - SPECIFICATIONS**

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)						
CLASS 10.9 METRIC BOLTS CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M3 - M5*						
Size	PITCH	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263™) K = 0.20	Torque (Lub OR Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K= 0.18	Torque (Loctite® 262™ OR Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	3.13			
3.5	0.6	6.78	4.22			
4	0.7	8.78	5.47			
5	0.8	14.20	8.85			
6	1	20.10	12.5			
7	1	28.90	18.0	25.2	22.7	18.9
8	1.25	36.60	22.8	36.5	32.8	27.4
10	1.5	58.00	36.1	70	65	55
12	1.75	84.30	52.5	125	115	95
14	2	115	71.6	200	180	150
16	2	157	97.8	315	280	235
18	2.5	192	119.5	430	385	325
20	2.5	245	152.5	610	550	460
22	2.5	303	189.0	830	750	625
24	3	353	222.0	1065	960	800
27	3	459	286.0	1545	1390	1160
30	3.5	561	349.5	2095	1885	1575
33	3.5	694	432.5	2855	2570	2140
36	4	817	509.0	3665	3300	2750
42	4.5	1120	698.0	5865	5275	4395

NO. 500059 REV. J

- NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 \*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM  
 4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

Figure 1-10. Torque Chart (METRIC Fasteners - Sheet 6 of 7)

Magni Coating (Ref 4150701)*						
CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE*						
Size	PITCH	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K = .17	Torque (Lub OR Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K = .16	Torque (Loctite® 262™ OR Vibra-TITE™ 131) K = .15
		Sq mm	kN	[N.m]	[N.m]	[N.m]
3	0.5	5.03				
3.5	0.6	6.78				
4	0.7	8.78				
5	0.8	14.20				
6	1	20.10	12.5	13	12	11
7	1	28.90	18.0	21	20	19
8	1.25	36.60	22.8	31	29	27
10	1.5	58.00	36.1	61	58	54
12	1.75	84.30	52.5	105	100	95
14	2	115	71.6	170	160	150
16	2	157	97.8	265	250	235
18	2.5	192	119.5	365	345	325
20	2.5	245	152.5	520	490	460
22	2.5	303	189.0	705	665	625
24	3	353	220.0	900	845	790
27	3	459	286.0	1315	1235	1160
30	3.5	561	349.5	1780	1680	1575
33	3.5	694	432.5	2425	2285	2140
36	4	817	509.0	3115	2930	2750
42	4.5	1120	698.0	4985	4690	4395

NO. 500059 REV. J

- NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 \*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM  
 4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

Figure 1-11. Torque Chart (METRIC Fasteners - Sheet 7 of 7)





## SECTION 2. GENERAL

### 2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

#### General

This section provides the necessary information needed by those personnel that are responsible to place the machine in operation readiness and maintain its safe operating condition. For maximum service life and safe operation, ensure that all the necessary inspections and maintenance have been completed before placing the machine into service.

#### Preparation, Inspection, and Maintenance

It is important to establish and conform to a comprehensive inspection and preventive maintenance program. The following table outlines the periodic machine inspections and maintenance recommended by JLG Industries, Inc. Consult your national, regional, or local regulations for further requirements for aerial work platforms. The frequency of inspections and maintenance must be increased as environment, severity and frequency of usage requires.

#### Pre-Start Inspection

It is the User's or Operator's primary responsibility to perform a Pre-Start Inspection of the machine prior to use daily or at each change of operator. Reference the Operator's and Safety Manual for completion procedures for the Pre-Start Inspection. The Operator and Safety Manual must be read in its entirety and understood prior to performing the Pre-Start Inspection.

#### Pre-Delivery Inspection and Frequent Inspection

The Pre-Delivery Inspection and Frequent Inspection shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

The Pre-Delivery Inspection and Frequent Inspection procedures are performed in the same manner, but at different times. The Pre-Delivery Inspection shall be performed prior to each sale, lease, or rental delivery. The Frequent Inspection shall be accomplished for each machine in service for 3 months or 150 hours (whichever comes first); out of service for a period of more than 3 months; or when purchased used. The frequency of this inspection must be

increased as environment, severity and frequency of usage requires.

Reference the JLG Pre-Delivery and Frequent Inspection Form and the Inspection and Preventative Maintenance Schedule for items requiring inspection during the performance of these inspections. Reference the appropriate areas of this manual for servicing and maintenance procedures.

#### Annual Machine Inspection

The Annual Machine Inspection must be performed by a Factory-Certified Service Technician on an annual basis, no later than thirteen (13) months from the date of the prior Annual Machine Inspection. JLG Industries, Inc. recognizes a Factory-Certified Service Technician as a person who has successfully completed the JLG Service Training School for the subject JLG product model. Reference the machine Service and Maintenance Manual and appropriate JLG inspection form for performance of this inspection.

Reference the JLG Annual Machine Inspection Form and the Inspection and Preventative Maintenance Schedule for items requiring inspection during the performance of this inspection. Reference the appropriate areas of this manual for servicing and maintenance procedures.

For the purpose of receiving safety-related bulletins, it is important that JLG Industries, Inc. has updated ownership information for each machine. When performing each Annual Machine Inspection, notify JLG Industries, Inc. of the current machine ownership.

#### Preventative Maintenance

In conjunction with the specified inspections, maintenance shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

Reference the Preventative Maintenance Schedule and the appropriate areas of this manual for servicing and maintenance procedures. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.

**Table 2-1. Inspection and Maintenance**

Type	Frequency	Primary Responsibility	Service Qualification	Reference
Pre-Start Inspection	Prior to use each day; or At each Operator change.	User or Operator	User or Operator	Operator and Safety Manual
Pre-Delivery Inspection	Prior to each sale, lease, or rental delivery.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Frequent Inspection	In service for 3 months or 150 hours, whichever comes first; or Out of service for a period of more than 3 months; or Purchased used.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Annual Machine Inspection	Annually, no later than 13 months from the date of the prior inspection.	Owner, Dealer, or User	Factory-Certified Service Technician	Service and Maintenance Manual and applicable JLG inspection form.
Preventative Maintenance	At intervals as specified in the Service and Maintenance Manual.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual

## 2.2 SERVICE AND GUIDELINES

### General

The following information is provided to assist you in the use and application of servicing and maintenance procedures contained in this book.

### Safety and Workmanship

Your safety, and that of others, is the first consideration when engaging in the maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without the aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. When raising a portion of the equipment, ensure that adequate support is provided.

### Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and foreign materials out of the vital components. Precautions have been taken to safeguard against this. Shields, covers, seals, and filters are provided to keep air, fuel, and oil supplies clean; however, these items must be maintained on a scheduled basis in order to function properly.

2. At any time when air, fuel, or oil lines are disconnected, clear adjacent areas as well as the openings and fittings themselves. As soon as a line or component is disconnected, cap or cover all openings to prevent entry of foreign matter.
3. Clean and inspect all parts during servicing or maintenance, and assure that all passages and openings are unobstructed. Cover all parts to keep them clean. Be sure all parts are clean before they are installed. New parts should remain in their containers until they are ready to be used.

### Components Removal and Installation

1. Use adjustable lifting devices, whenever possible, if mechanical assistance is required. All slings (chains, cables, etc.) should be parallel to each other and as near perpendicular as possible to top of part being lifted.
2. Should it be necessary to remove a component on an angle, keep in mind that the capacity of an eye-bolt or similar bracket lessens, as the angle between the supporting structure and the component becomes less than 90 degrees.
3. If a part resists removal, check to see whether all nuts, bolts, cables, brackets, wiring, etc., have been removed and that no adjacent parts are interfering.

## Component Disassembly and Reassembly

When disassembling or reassembling a component, complete the procedural steps in sequence. Do not partially disassemble or assemble one part, then start on another. Always recheck your work to assure that nothing has been overlooked. Do not make any adjustments, other than those recommended, without obtaining proper approval.

## Pressure-Fit Parts

When assembling pressure-fit parts, use an anti-seize or molybdenum disulfide base compound to lubricate the mating surface.

## Bearings

1. When a bearing is removed, cover it to keep out dirt and abrasives. Clean bearings in nonflammable cleaning solvent and allow to drip dry. Compressed air can be used but do not spin the bearing.
2. Discard bearings if the races and balls (or rollers) are pitted, scored, or burned.
3. If bearing is found to be serviceable, apply a light coat of oil and wrap it in clean (waxed) paper. Do not unwrap reusable or new bearings until they are ready to install.
4. Lubricate new or used serviceable bearings before installation. When pressing a bearing into a retainer or bore, apply pressure to the outer race. If the bearing is to be installed on a shaft, apply pressure to the inner race.

## Gaskets

Check that holes in gaskets align with openings in the mating parts. If it becomes necessary to hand-fabricate a gasket, use gasket material or stock of equivalent material and thickness. Be sure to cut holes in the right location, as blank gaskets can cause serious system damage.

## Bolt Usage and Torque Application

1. Use bolts of proper length. A bolt which is too long will bottom before the head is tight against its related part. If a bolt is too short, there will not be enough thread area to engage and hold the part properly. When replacing bolts, use only those having the same specifications of the original, or one which is equivalent.
2. Unless specific torque requirements are given within the text, standard torque values should be used on heat-treated bolts, studs, and steel nuts, in accordance with recommended shop practices. (See Torque Chart Section 1.)

## Hydraulic Lines and Electrical Wiring

Clearly mark or tag hydraulic lines and electrical wiring, as well as their receptacles, when disconnecting or removing them from the unit. This will assure that they are correctly reinstalled.

## Hydraulic System

1. Keep the system clean. If evidence of metal or rubber particles are found in the hydraulic system, drain and flush the entire system.
2. Disassemble and reassemble parts on clean work surface. Clean all metal parts with non-flammable cleaning solvent. Lubricate components, as required, to aid assembly.

## Lubrication

Service applicable components with the amount, type, and grade of lubricant recommended in this manual, at the specified intervals. When recommended lubricants are not available, consult your local supplier for an equivalent that meets or exceeds the specifications listed.

## Battery

Clean battery, using a non-metallic brush and a solution of baking soda and water. Rinse with clean water. After cleaning, thoroughly dry battery and coat terminals with an anti corrosion compound.

## Lubrication and Servicing

Components and assemblies requiring lubrication and servicing are shown in the Lubrication Chart in Section 1.

## 2.3 LUBRICATION AND INFORMATION

### Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g., using inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up or leaks in the pump supply (suction) lines.
2. The design and manufacturing tolerances of the component working parts are very close, therefore, even the smallest amount of dirt or foreign matter entering a system can cause wear or damage to the components and generally results in faulty operation. Every precaution must be taken to keep hydraulic oil clean, including reserve oil in storage. Hydraulic system filters should be checked,

## SECTION 2 - GENERAL

cleaned, and/or replaced as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.

3. Cloudy oils indicate a high moisture content which permits organic growth, resulting in oxidation or corrosion. If this condition occurs, the system must be drained, flushed, and refilled with clean oil.
4. It is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. Good grade mineral oils, with viscosities suited to the ambient temperatures in which the machine is operating, are recommended for use.

**NOTE:** Metal particles may appear in the oil or filters of new machines due to the wear-in of meshing components.

### Hydraulic Oil

1. Refer to Section 1 for recommendations for viscosity ranges.
2. JLG recommends Mobilfluid 424 hydraulic oil, which has an SAE viscosity of 10W-30 and a viscosity index of 152.

**NOTE:** Start-up of hydraulic system with oil temperatures below -15 degrees F (-26 degrees C) is not recommended. If it is necessary to start the system in a sub-zero environment, it will be necessary to heat the oil with a low density, 100VAC heater to a minimum temperature of -15 degrees F (-26 degrees C).

3. The only exception to the above is to drain and fill the system with Mobil DTE 13 oil or its equivalent. This will allow start up at temperatures down to -20 degrees F (-29 degrees C). However, use of this oil will give poor performance at temperatures above 120 degrees F (49 degrees C). Systems using DTE 13 oil should not be operated at temperatures above 200 degrees F (94 degrees C) under any condition.

### Changing Hydraulic Oil

1. Use of any of the recommended crankcase or hydraulic oils eliminates the need for changing the oil on a regular basis. However, filter elements must be changed after the first 50 hours of operation and every 300 hours thereafter. If it is necessary to change the oil, use only those oils meeting or exceeding the specifications appearing in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils. JLG

Industries recommends changing the hydraulic oil annually.

2. Use every precaution to keep the hydraulic oil clean. If the oil must be poured from the original container into another, be sure to clean all possible contaminants from the service container. Always clean the mesh element of the filter and replace the cartridge any time the system oil is changed.
3. While the unit is shut down, a good preventive maintenance measure is to make a thorough inspection of all hydraulic components, lines, fittings, etc., as well as a functional check of each system, before placing the machine back in service.

### Lubrication Specifications

Specified lubricants, as recommended by the component manufacturers, are always the best choice, however, multi-purpose greases usually have the qualities which meet a variety of single purpose grease requirements. Should any question arise, regarding the use of greases in maintenance stock, consult your local supplier for evaluation. Refer to Section 1 for an explanation of the lubricant key designations appearing in the Lubrication Chart.

### 2.4 CYLINDER DRIFT TEST

Maximum acceptable cylinder drift is to be measured using the following methods.

#### Platform Drift

Measure the drift of the platform to the ground. Lower booms (if equipped) slightly elevated, upper boom fully extended with the rated load in the platform and power off. Maximum allowable drift is 2 inches (5 cm) in 10 minutes. If the machine does not pass this test, proceed with the following.

#### Cylinder Drift

Table 2-2. Cylinder Drift

Cylinder Bore Diameter		Max. Acceptable Drift in 10 Minutes	
inches	mm	inches	mm
3	76.2	0.026	0.66
3.5	89	0.019	0.48
4	101.6	0.015	0.38
5	127	0.009	0.22
6	152.4	0.006	0.15
7	177.8	0.005	0.13

Drift is to be measured at the cylinder rod with a calibrated dial indicator. The cylinder oil must be at ambient temperature and temperature stabilized.

The cylinder must have the normal load, which is the normal platform load applied.

If the cylinder passes this test, it is acceptable.

**NOTE:** This information is based on 6 drops per minute cylinder leakage.

## 2.5 PINS AND COMPOSITE BEARING REPAIR GUIDELINES

Filament wound bearings.

1. Pinned joints should be disassembled and inspected if the following occurs:
  - a. Excessive sloppiness in joints.
  - b. Noise originating from the joint during operation.
2. Filament wound bearings should be replaced if any of the following is observed:
  - a. Frayed or separated fibers on the liner surface.
  - b. Cracked or damaged liner backing.
  - c. Bearings that have moved or spun in their housing.
  - d. Debris embedded in liner surface.
3. Pins should be replaced if any of the following is observed (pin should be properly cleaned prior to inspection):
  - a. Detectable wear in the bearing area.
  - b. Flaking, peeling, scoring, or scratches on the pin surface.
  - c. Rusting of the pin in the bearing area.
4. Re-assembly of pinned joints using filament wound bearings.
  - a. Housing should be blown out to remove all dirt and debris...bearings and bearing housings must be free of all contamination.
  - b. Bearing / pins should be cleaned with a solvent to remove all grease and oil...filament wound bearing are a dry joint and should not be lubricated.
  - c. Pins should be inspected to ensure it is free of burrs, nicks, and scratches which would damage the bearing during installation and operation.

## 2.6 WELDING ON JLG EQUIPMENT

**NOTE:** This instruction applies to repairs, or modifications to the machine and to welding performed from the machine on an external structure, or component,

### Do the Following When Welding on JLG Equipment

- Disconnect the battery.
- Ground only to structure being welded.

### Do NOT Do the Following When Welding on JLG Equipment

- Ground on frame and weld on any other area than the chassis.
- Ground on turntable and weld on any other area than the turntable.
- Ground on the platform/support and weld on any other area than the platform/support.
- Ground on a specific boom section and weld on any other area than that specific boom section.
- Allow pins, wear pads, wire ropes, bearings, gearing, seals, valves, electrical wiring, or hoses to be between the grounding position and the welded area.

### CAUTION

**FAILURE TO COMPLY WITH THE ABOVE REQUIREMENTS MAY RESULT IN COMPONENT DAMAGE (I.E. ELECTRONIC MODULES, SWING BEARING, COLLECTOR RING, BOOM WIRE ROPES ETC.)**

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**Table 2-3. Inspection and Preventive Maintenance Schedule**

AREA	INTERVAL					
	Pre-Start <sup>1</sup> Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery <sup>2</sup> or Frequent <sup>3</sup> Inspection	Annual <sup>4</sup> (Yearly) Inspection	Every 2 Years
<b>Boom Assembly</b>	9					
Boom Weldments				1,2,4	1,2,4	
Hose/Cable Carrier Installations				1,2,9,12	1,2,9,12	
Pivot Pins and Pin Retainers				1,2	1,2	
Sheaves, Sheave Pins				1,2	1,2	
Bearings				1,2	1,2	
Wear Pads				1,2	1,2	
Covers or Shields				1,2	1,2	
Extend/Retract Chain or Cable Systems				1,2,3	1,2,3	
<b>Platform Assembly</b>	9					
Platform	1,2				1,2	
Railing	1,2			1	1,2	
Gate			5	1	1,5	
Floor	1,2			1	1,2	
Rotator		9,5				
Lanyard Anchorage Point	2			1,2,10	1,2,10	
<b>Turntable Assembly</b>	9					
Swing Bearing or Worm Gear				1,2,14	1,2,3,13,14	
Oil Coupling		9				
Swing Drive System						
Turntable Lock				1,2,5	1,2,5	
Hood, Hood Props, Hood Latches				5	1,2,5	
<b>Chassis Assembly</b>	9					
Tires	1	16,17		16,17,18	16,17,18	
Wheel Nuts/Bolts	1	15		15	15	
Wheel Bearings						14,24
Oscillating Axle/Lockout Cylinder Systems					5,8	
Outrigger or Extendable Axle Systems				5,8	5,8	
Steer Components						
Drive Motors						
Torque Hubs				11	11	
<b>Functions/Controls</b>	9					
Platform Controls	5	5		6	6	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start <sup>1</sup> Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery <sup>2</sup> or Frequent <sup>3</sup> Inspection	Annual <sup>4</sup> (Yearly) Inspection	Every 2 Years
Ground Controls	5	5		6	6	
Function Control Locks, Guards, or Detents	1,5	1,5		5	5	
Footswitch	1,5			5	5	
Emergency Stop Switches (Ground & Platform)	5			5	5	
Function Limit or Cutout Switch Systems				5	5	
Capacity Indicator					5	
Drive Brakes				5		
Swing Brakes				5		
Boom Synchronization/Sequencing Systems					5	
Manual Descent or Auxiliary Power				5	5	
<b>Power System</b>	9					
Engine Idle, Throttle, and RPM				3	3	
Engine Fluids (Oil, Coolant, Fuel)	11	9,11		11	11	
Air/Fuel Filter		1,7		7	7	
Exhaust System			1,9	9	9	
Batteries	5	1,9			19	
Battery Fluid		11		11	11	
Battery Charger		5			5	
Fuel Reservoir, Cap, and Breather	11,9		2	1,5	1,5	
<b>Hydraulic/Electric System</b>	9					
Hydraulic Pumps		1,9		1,2,9		
Hydraulic Cylinders		1,9,7	2	1,2,9	1,2,9	
Cylinder Attachment Pins and Pin Retainers		1,9		1,2	1,2	
Hydraulic Hoses, Lines, and Fittings		1,9	12	1,2,9,12	1,2,9,12	
Hydraulic Reservoir, Cap, and Breather	11	1,9	2	1,5	1,5	24
Hydraulic Filter		1,9		7	7	
Hydraulic Fluid	11			7,11	7,11	
Electrical Connections		1		20	20	
Instruments, Gauges, Switches, Lights, Horn		1			5,23	
<b>General</b>						
Operators and Safety Manuals in Storage Box	21			21	21	
ANSI and EMI Manuals/Handbooks Installed					21	
Capacity Decals Installed, Secure, Legible	21			21	21	
All Decals/Placards Installed, Secure, Legible	21			21	21	

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**Table 2-3. Inspection and Preventive Maintenance Schedule**

AREA	INTERVAL					
	Pre-Start <sup>1</sup> Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery <sup>2</sup> or Frequent <sup>3</sup> Inspection	Annual <sup>4</sup> (Yearly) Inspection	Every 2 Years
Walk-Around Inspection Performed	21					
Annual Machine Inspection Due				21		
No Unauthorized Modifications or Additions				21	21	
All Relevant Safety Publications Incorporated				21	21	
General Structural Condition and Welds				2,4	2,4	
All Fasteners, Pins, Shields, and Covers				1,2	1,2	
Grease and Lubricate to Specifications				22	22	
Function Test of All Systems	21			21	21, 22	
Paint and Appearance				7	7	
Stamp Inspection Date on Frame					22	
Notify JLG of Machine Ownership					22	

**Footnotes:**

<sup>1</sup> Prior to use each day; or at each Operator change

<sup>2</sup> Prior to each sale, lease, or delivery

<sup>3</sup> In service for 3 months or 150 Hours; or Out of service for 3 months or more; or Purchased used

<sup>4</sup> Annually, no later than 13 months from the date of the prior inspection

**Performance Codes:**

- 1 - Check for proper and secure installation
- 2 - Visual inspection for damage, cracks, distortion or excessive wear
- 3 - Check for proper adjustment
- 4 - Check for cracked or broken welds
- 5 - Operates Properly
- 6 - Returns to neutral or "off" position when released
- 7 - Clean and free of debris
- 8 - Interlocks function properly
- 9 - Check for signs of leakage
- 10 - Decals installed and legible
- 11 - Check for proper fluid level
- 12 - Check for chafing and proper routing
- 13 - Check for proper tolerances
- 14 - Properly lubricated
- 15 - Torqued to proper specification
- 16 - No gouges, excessive wear, or cords showing
- 17 - Properly inflated and seated around rim
- 18 - Proper and authorized components
- 19 - Fully charged
- 20 - No loose connections, corrosion, or abrasions
- 21 - Verify
- 22 - Perform
- 23 - Sealed Properly
- 24 - Drain, Clean, Refill



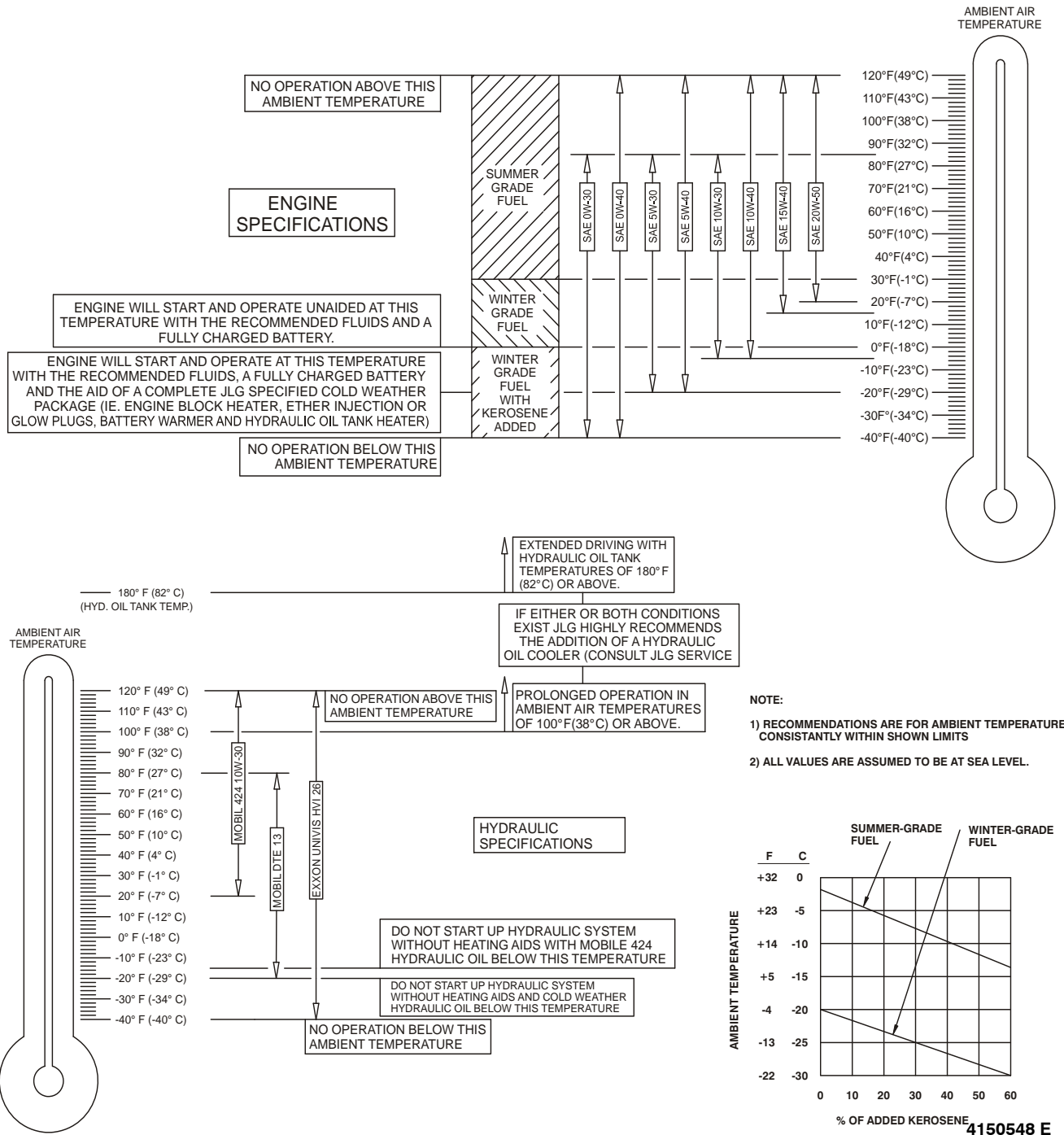


Figure 2-1. Engine Operating Temperature Specifications - Deutz

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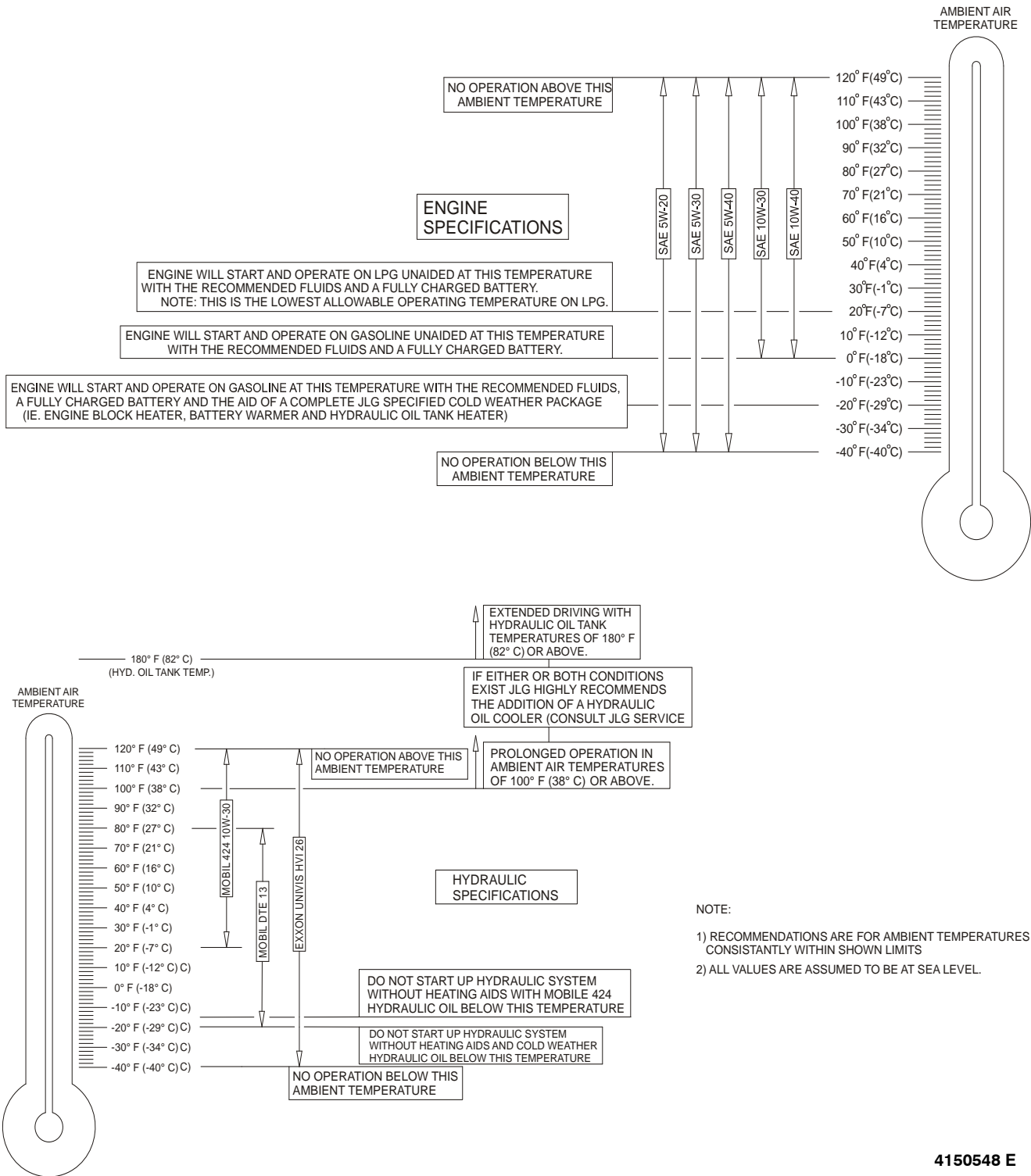
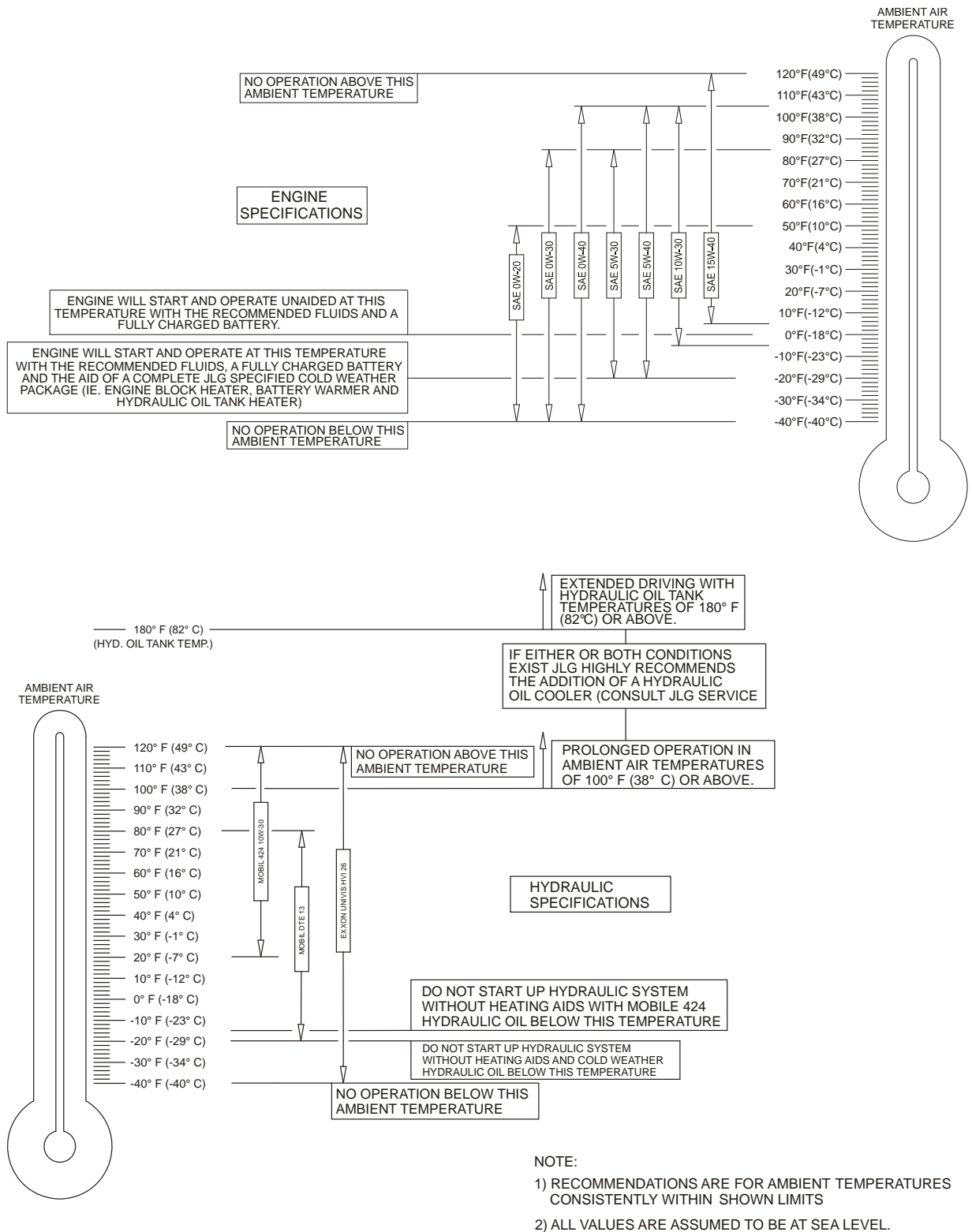


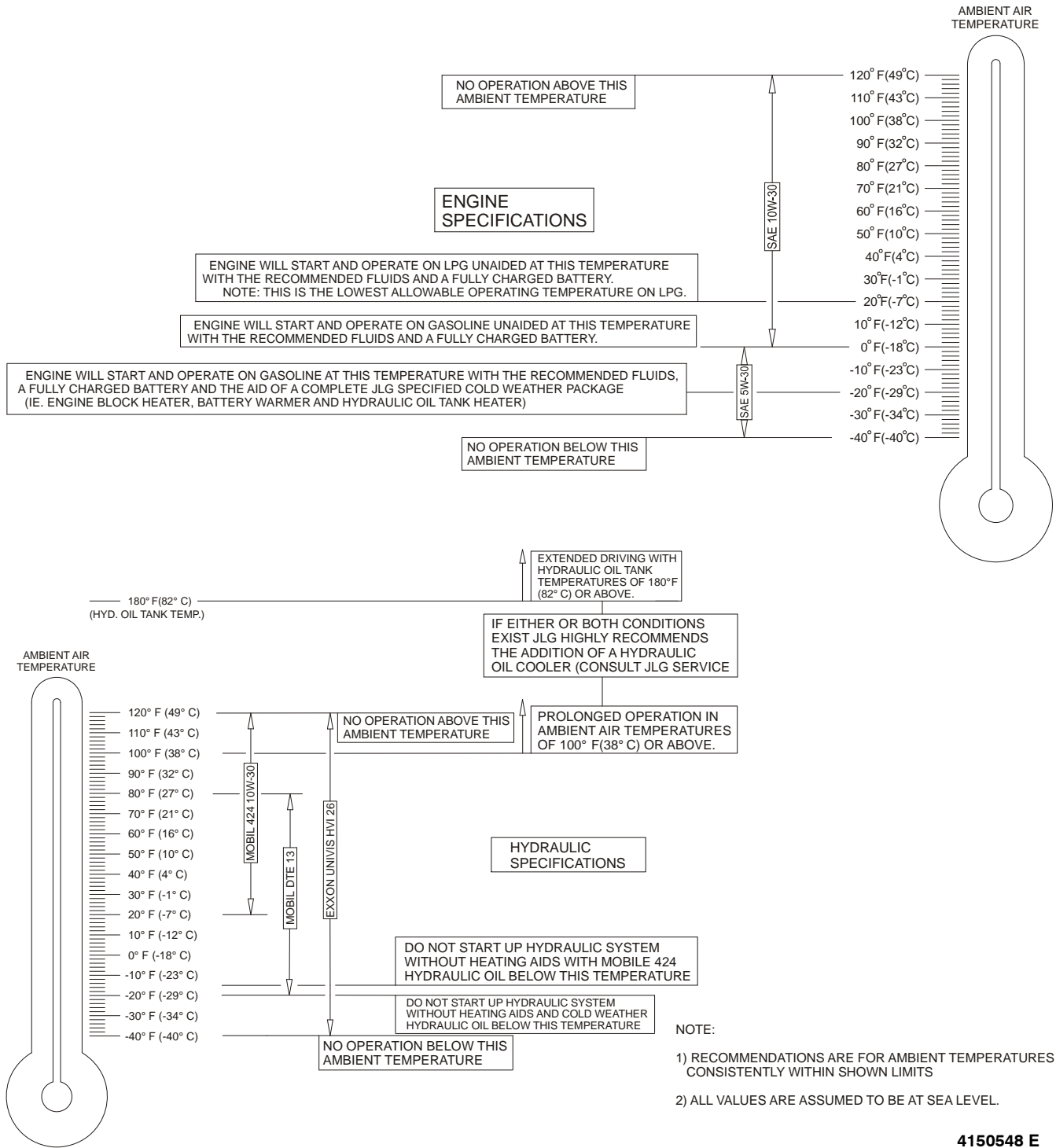
Figure 2-2. Engine Operating Temperature Specifications - Ford



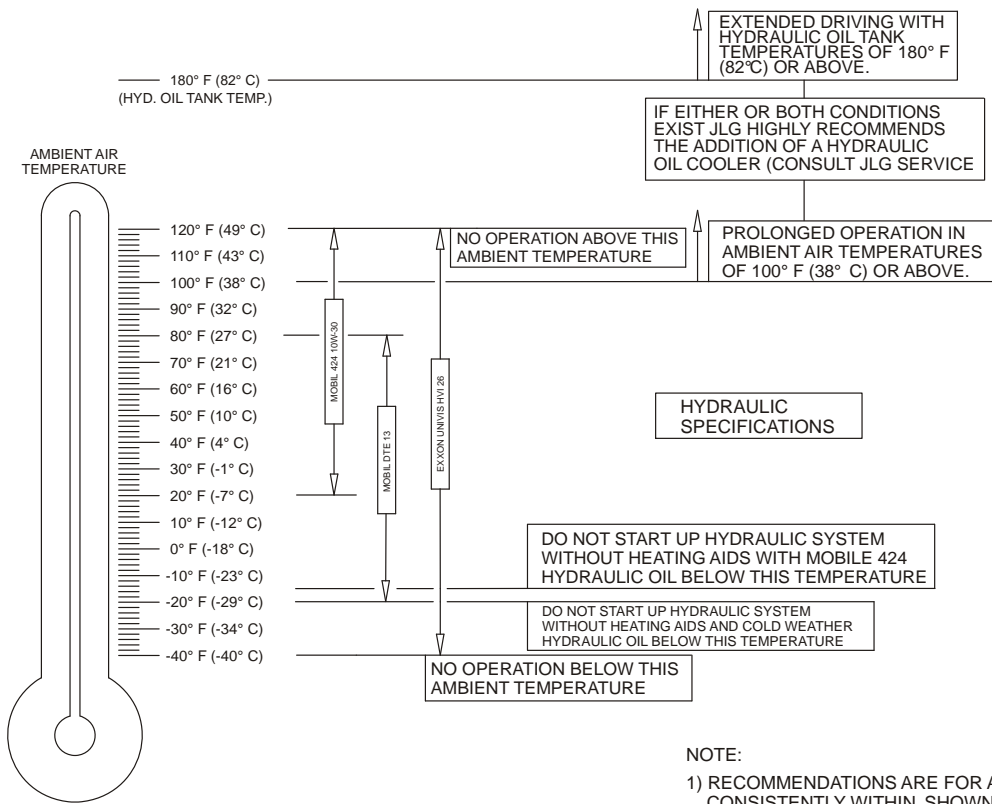
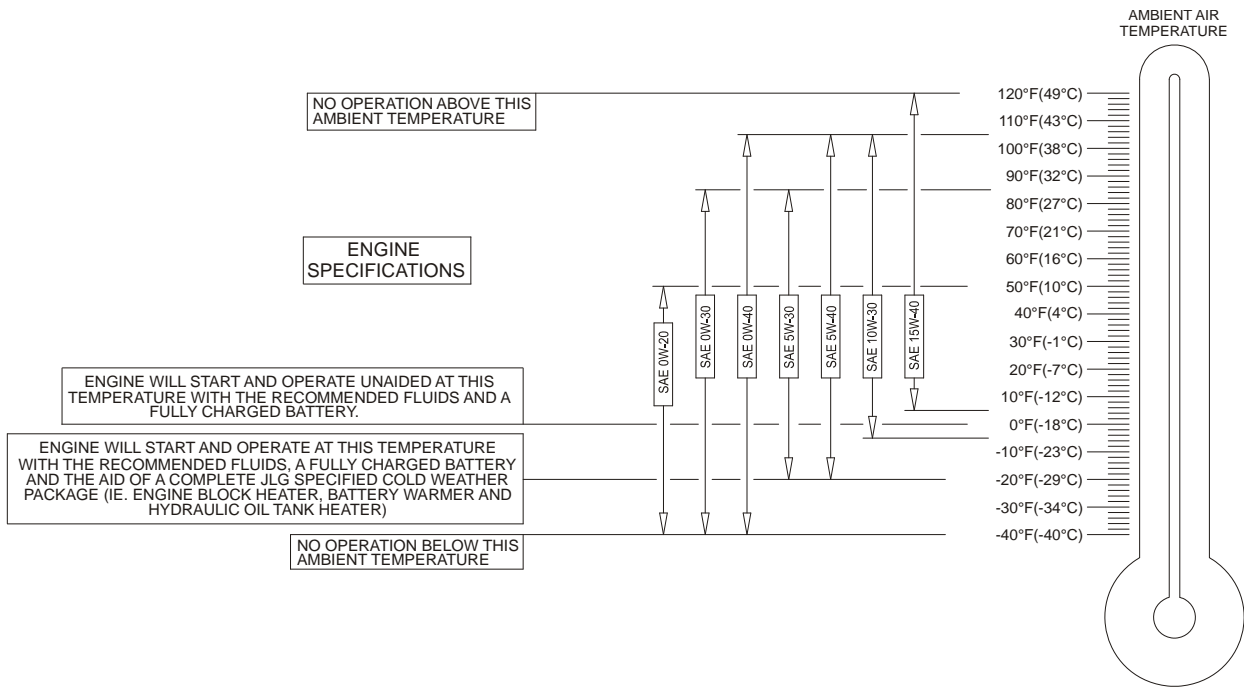
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Figure 2-3. Engine Operating Temperature Specifications - Caterpillar

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**Figure 2-4. Engine Operating Temperature Specifications - GM**



NOTE:  
 1) RECOMMENDATIONS ARE FOR AMBIENT TEMPERATURES CONSISTENTLY WITHIN SHOWN LIMITS  
 2) ALL VALUES ARE ASSUMED TO BE AT SEA LEVEL.

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Figure 2-5. Engine Operating Temperature Specifications - Perkins

**SECTION 2 - GENERAL**

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**NOTES:**

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## SECTION 3. CHASSIS & TURNTABLE

### 3.1 TIRES & WHEELS

#### Tire Inflation

The air pressure for pneumatic tires must be equal to the air pressure that is stenciled on the side of the JLG product or rim decal for safe and proper operational characteristics.

#### Tire Damage

For pneumatic tires, JLG Industries, Inc. recommends that when any cut, rip, or tear is discovered that exposes sidewall or tread area cords in the tire, measures must be taken to remove the JLG product from service immediately. Arrangements must be made for replacement of the tire or tire assembly.

For polyurethane foam filled tires, JLG Industries, Inc. recommends that when any of the following are discovered, measures must be taken to remove the JLG product from service immediately and arrangements must be made for replacement of the tire or tire assembly.

- a smooth, even cut through the cord plies which exceeds 3 inches (7.5 cm) in total length
- any tears or rips (ragged edges) in the cord plies which exceeds 1 inch (2.5 cm) in any direction
- any punctures which exceed 1 inch in diameter
- any damage to the bead area cords of the tire

If a tire is damaged but is within the above noted criteria, the tire must be inspected on a daily basis to insure the damage has not propagated beyond the allowable criteria.

#### Tire Replacement

JLG recommends a replacement tire be the same size, ply and brand as originally installed on the machine. Please refer to the JLG Parts Manual for the part number of the approved tires for a particular machine model. If not using a JLG approved replacement tire, we recommend that replacement tires have the following characteristics:

- Equal or greater ply/load rating and size of original
- Tire tread contact width equal or greater than original
- Wheel diameter, width, and offset dimensions equal to the original
- Approved for the application by the tire manufacturer (including inflation pressure and maximum tire load)

Unless specifically approved by JLG Industries Inc. do not replace a foam filled or ballast filled tire assembly with a pneumatic tire. When selecting and installing a replacement tire, ensure that all tires are inflated to the pressure

recommended by JLG. Due to size variations between tire brands, both tires on the same axle should be the same.

#### Wheel Replacement

The rims installed on each product model have been designed for stability requirements which consist of track width, tire pressure, and load capacity. Size changes such as rim width, center piece location, larger or smaller diameter, etc., without written factory recommendations, may result in an unsafe condition regarding stability.

#### Wheel Installation

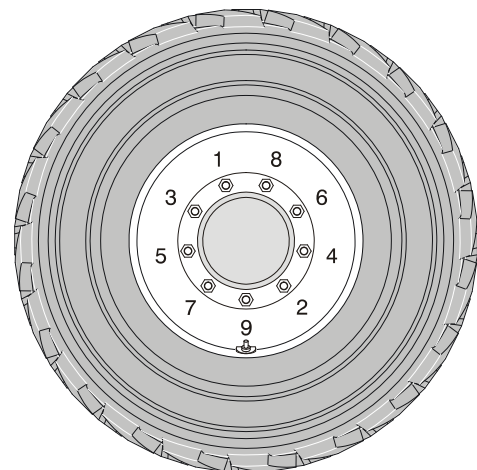
It is extremely important to apply and maintain proper wheel mounting torque.

#### **⚠ WARNING**

**WHEEL NUTS MUST BE INSTALLED AND MAINTAINED AT THE PROPER TORQUE TO PREVENT LOOSE WHEELS, BROKEN STUDS, AND POSSIBLE DANGEROUS SEPARATION OF WHEEL FROM THE AXLE. BE SURE TO USE ONLY THE NUTS MATCHED TO THE CONE ANGLE OF THE WHEEL.**

Tighten the lug nuts to the proper torque to prevent wheels from coming loose. Use a torque wrench to tighten the fasteners. If you do not have a torque wrench, tighten the fasteners with a lug wrench, then immediately have a service garage or dealer tighten the lug nuts to the proper torque. Over-tightening will result in breaking the studs or permanently deforming the mounting stud holes in the wheels. The proper procedure for attaching wheels is as follows:

1. Start all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.
2. Tighten nuts in the following sequence:



- The tightening of the nuts should be done in stages. Following the recommended sequence, tighten nuts per wheel torque chart.

**Table 3-1. Wheel Torque Chart**

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
40 ft. lbs. (55 Nm)	100 ft. lbs. (130 Nm)	170 ft. lbs. (255 Nm)

- Wheel nuts should be torqued after first 50 hours of operation and after each wheel removal. Check torque every 3 months or 150 hours of operation.

### **3.2 DRIVE HUB PART NO. 2780243 (2WD REAR) PART NO. 2780244 (4WD REAR)**

The final drive consists of two stages with an integrated disconnect mechanism. Each stage incorporates a set of matched planetary gears, which provide an equal load of distribution. All torque transmitting components are made of forged, quenched and tempered high-alloy steels. External gears are carburized. Precision roller bearings are used exclusively. Two large, tapered roller bearings support the sprocket or wheel loads. A shaft seal protects the unit against contamination.

#### **Disassembly**

- Position drive so that one of the fill holes is at the bottom of the end cover and drain the gear oil.
- Remove all bolts holding motor and remove motor from drive.
- Press out seal ring (85) together with O-ring (84) from the drive.
- Compress the disc (65) using a simple fixture or other suitable device.
- Remove snap ring (67) from groove of spindle and release pressure on disc until loose. Remove tool and disc (65).
- Remove the springs (74) from the piston (61)
- Remove plug (71).
- Supply air pressure through air channel actually closed by plug (71) to remove piston (61).

**NOTE:** Be careful when supplying air pressure. piston (61) may unexpectedly come out quickly.

- Remove back-up rings (75), piston seal (76), back-up rings (77), and piston seal (78).

- Compress the disk (59) using a simple fixture or other suitable device.
- Remove snap ring (66) and release pressure on disk until loose.
- Remove tool and disk (59).
- Remove the spring (55) from the input shaft (44) and turn the unit so that cover (8) is in the up position.
- Remove screw plugs (22) and seal rings (21).
- Remove snap ring (34), cover unit (8) from drive and O-ring (33).
- Remove first stage planetary assembly (7).
- Remove hex. hd. bolts (23) to remove gear (30) and O-ring (19).
- Remove Snap rings (15) to pull off planet gears (1) together with cylindrical roller bearings (11) from spindle (60).

**NOTE:** Further disassembly of the hub is discouraged. Reinstallation of the shaft nut (4) requires a special tool and a torque of 626 ft lbs (876 Nm) for proper reassembly. These components WILL fail if not properly reassembled.

- Inspect the planetary stage assemblies as complete units. Thoroughly clean and check both the gearing and the bearings for damage and apply new oil. If gears or bearings need replacing, they must be replaced as complete units.

**NOTE:** The first stage planetary bearings (10) **must** be replaced in sets of three pieces.

**NOTE:** The first stage planetary gears (11) **must** be changed as a complete set of four and the manufacturer recommends changing the sun gear shaft (43) along with this set of planets.

**NOTE:** The second stage planetary bearings (11) **must** be replaced in sets of four pieces.



**Disassembly of Cover Unit (8)**

1. Loosen and remove hex. hd. bolts (53) and remove cover (51).
2. Remove Shaft rod (56), O-ring (54), and sleeve (52)

**Disassembly of First Stage Planetary Assembly**

1. Push the sun gear shaft (43) out of the first stage.
2. Remove snap rings (14) and press planet pins (5) out of planet carrier (7) and planet gears (2).
3. Pull cylindrical roller bearing (10) out of planet gears (2).
4. Remove snap ring (16) from sun gear (3) and remove the thrust washer (49).

**Disassembly of the Second Stage Planet Gears (1)**

Press cylindrical roller bearings out of planet gears (1).

**Assembly of First Stage Planetary Assembly (7)**

1. Pre-freeze planet pins (5) and install into planet carrier (7).
2. Install planet carrier (7) together with planet pins (5) on sun gear (3), and snap ring (16).
3. Pre-heat thrust washer (49) and install onto sun gear shaft (43).
4. put sun gear shaft (43) into sun gear (3).
5. Pre-heat stay rings (17) and install onto planet pins (5).
6. Pre-heat cylindrical roller bearings (10) and install onto planet pins (5) and fix bearings with snap rings (14).

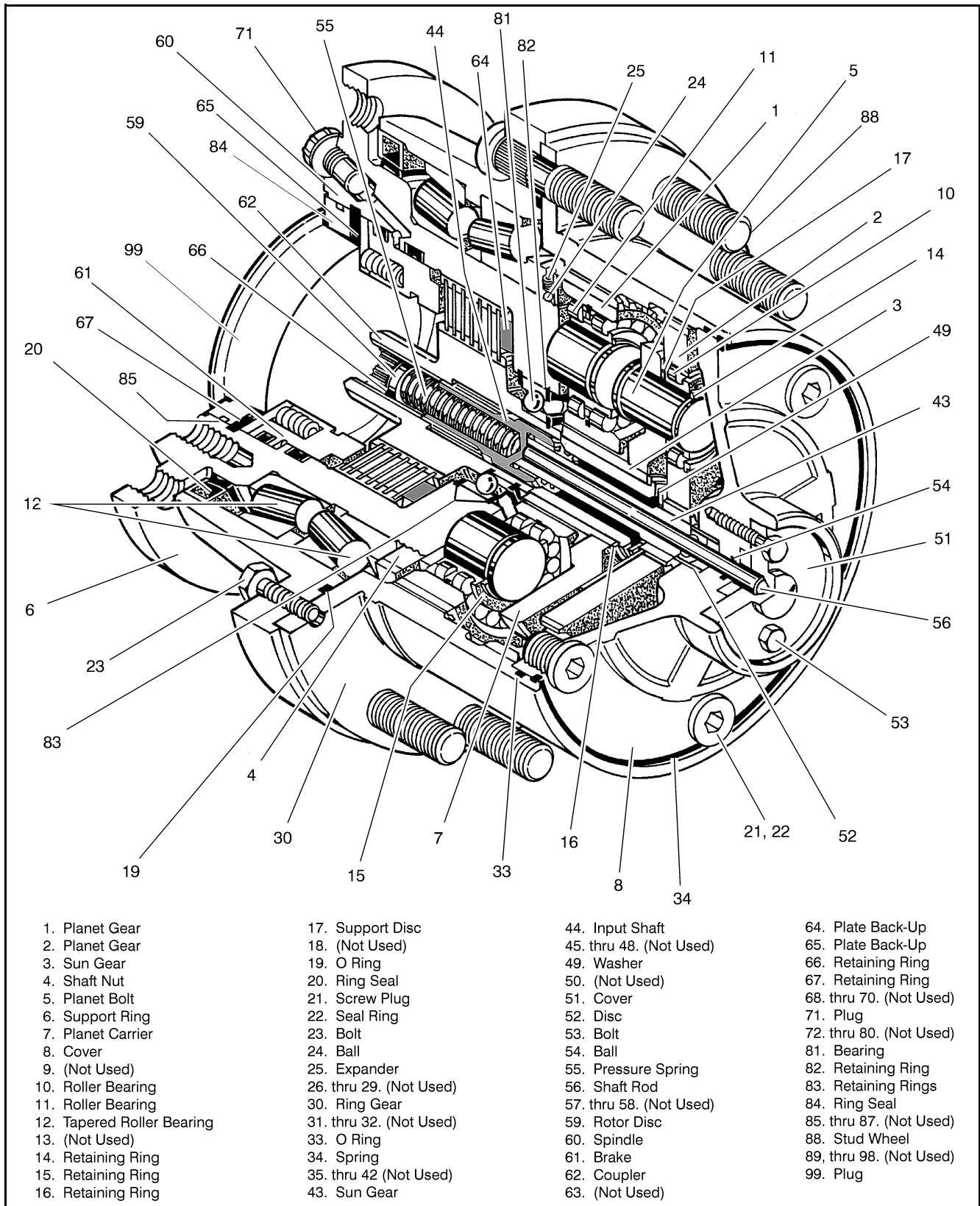
**Assembly Of End Cover Unit (8)**

1. Press sleeve (52) and install O-ring into cover (8).
2. Install shaft rod into cover (8).
3. Install cover into cover (8) and fix cover (51) with hex. hd. bolts (53). Torque bolts to 6.3 ft. lbs.(8.5 Nm).

**Final Assembly**

1. Install thrust washer (29) in spindle (60).
2. Install O-ring (19) into groove of support ring (6).
3. Install planet gears (1) onto planet pins which are part of spindle (60).
4. Install snap rings (15) on planet pins of spindle (60) in order to fix the planet gears (1).
5. Put ring gear (30) onto support ring (6) and fix ring gear (30) with hex. hd. bolts (23). Torque bolts to 15.5 ft. lbs.(21.1 Nm).
6. Insert first stage planetary assembly (7) into drive.
7. Install O-ring (33) in groove of ring gear (30).
8. Install end cover unit (8) on shoulder ring gear (30) and fix with snap ring (34).
9. Install seal rings (21) and screw plugs(22).
10. Before installation of the motor CHECK THAT THERE IS 1-2 MM. OF CLEARANCE BETWEEN THE MOTOR SPLINE SHAFT SHOULDER AND THE COUPLER (62).
11. Install motor and reconnect hydraulic lines.
12. Roll motor so that one fill plug hole is at 12 o'clock position and the other is a 3 o'clock. Fill hub to bottom of 3 o'clock hole with gear oil. Reinstall plugs.
13. After four hours of operation, recheck oil level.

## SECTION 3 - CHASSIS & TURNTABLE



**Figure 3-1. Drive Hub (Part No. 2780243-2WD Rear & Part No. 2780244-4WD Rear)**

### 3.3 DRIVE HUB PART NO. 2780246 (4WD STEER AXLE PRIOR TO S/N 0300076633)

The final drive consists of two stages with an integrated disconnect mechanism. Each stage incorporates a set of matched planetary gears, which provide an equal load of distribution. All torque transmitting components are made of forged, quenched and tempered high-alloy steels. External gears are carburized. Precision roller bearings are used exclusively. Two large, tapered roller bearings support the sprocket or wheel loads. A shaft seal protects the unit against contamination.

#### Disassembly

1. Position drive so that one of the fill holes is at the bottom of the end cover and drain the gear oil.
2. Remove all bolts holding motor and remove motor from drive.
3. Compress the disc (59) using a simple fixture or other suitable device.
4. Remove snap ring (66) and release pressure on disc until loose. Remove tool and disc (59).
5. Remove the spring (55) from the input shaft (44) and turn the unit so that cover (8) is in the up position.
6. Remove screw plugs (22) and seal rings (21).
7. Remove snap ring (34), cover unit (8) from drive and O-ring (33).
8. Remove first stage planetary assembly (7).
9. Remove hex. hd. bolts (23) to remove gear (33) and O-ring (19).
10. Remove Snap rings (15) to pull off planet gears (1) together with cylindrical roller bearings (11) from spindle (60).

**NOTE:** Further disassembly of the hub is discouraged. Reinstallation of the shaft nut (4) requires a special tool and a torque of 626 ft lbs (876 Nm) for proper reassembly. These components WILL fail if not properly reassembled.

11. Inspect the planetary stage assemblies as complete units. Thoroughly clean and check both the gearing and the bearings for damage and apply new oil. If gears or bearings need replacing, they must be replaced as complete units.

**NOTE:** The first stage planetary bearings (10) **must** be replaced in sets of three pieces.

**NOTE:** The first stage planetary gears (11) **must** be changed as a complete set of four and the manufacturer recommends changing the sun gear shaft (43) along with this set of planets.

**NOTE:** The second stage planetary bearings (11) **must** be replaced in sets of four pieces.

#### Disassembly of Cover Unit (8)

12. Loosen and remove hex. hd. bolts (53) and remove cover (51).
13. Remove Shaft rod (56), O-ring (54), and sleeve (52)

#### Disassembly of First Stage Planetary Assembly

1. Push the sun gear shaft (43) out of the first stage.
2. Remove snap rings (14) and press planet pins (5) out of planet carrier (7) and planet gears (2).
3. Pull cylindrical roller bearing (10) out of planet gears (2).
4. Remove snap ring (16) from sun gear (3) and remove the thrust washer (49).

#### Disassembly of the Second Stage Planet Gears (1)

Press cylindrical roller bearings out of planet gears (1).

### Assembly of First Stage Planetary Assembly (7)

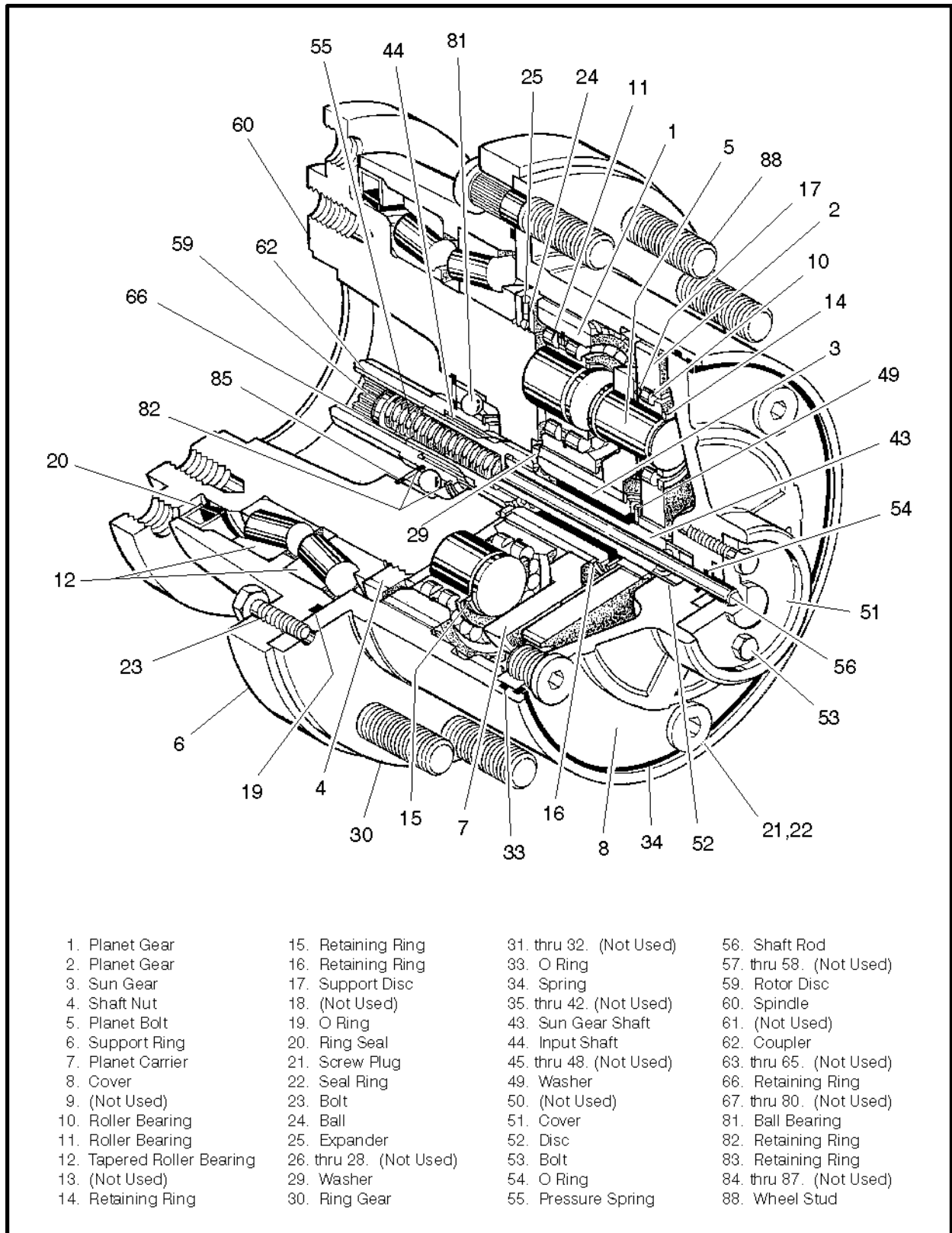
1. Pre-freeze planet pins (5) and install into planet carrier (7).
2. Install planet carrier (7) together with planet pins (5) on sun gear (3), and snap ring (16).
3. Pre-heat thrust washer (49) and install onto sun gear shaft (43).
4. put sun gear shaft (43) into sun gear (3).
5. Pre-heat stay rings (17) and install onto planet pins (5).
6. Pre-heat cylindrical roller bearings (10) and install onto planet pins (5) and fix bearings with snap rings (14).

### Assembly of End Cover Unit (8)

7. Press sleeve (52) and install O-ring into cover (8).
8. Install shaft rod into cover (8).
9. Install cover into cover (8) and fix cover (51) with hex. hd. bolts (53). Torque bolts to 6.3 ft. lbs.(8.5 Nm).

### Final Assembly

1. Install thrust washer (29) in spindle (60).
2. Install O-ring (19) into groove of support ring (6).
3. Install planet gears (1) onto planet pins which are part of spindle (60).
4. Install snap rings (15) on planet pins of spindle (60) in order to fix the planet gears (1).
5. Put ring gear (30) onto support ring (6) and fix ring gear (30) with hex. hd. bolts (23). Torque bolts to 15.5 ft. lbs.(21.1 Nm).
6. Insert first stage planetary assembly (7) into drive.
7. Install O-ring (33) in groove of ring gear (30).
8. Install end cover unit (8) on shoulder ring gear (30) and fix with snap ring (34).
9. Install seal rings (21) and screw plugs(22).
10. Before installation of the motor CHECK THAT THERE IS 1-2 MM. OF CLEARANCE BETWEEN THE MOTOR SPLINE SHAFT SHOULDER AND THE COUPLER (62).
11. Install motor and reconnect hydraulic lines.
12. Roll motor so that one fill plug hole is at 12 o'clock position and the other is a 3 o'clock. Fill hub to bottom of 3 o'clock hole with gear oil. Reinstall plugs.
13. After four hours of operation, recheck oil level.



- |                            |                         |                         |                         |
|----------------------------|-------------------------|-------------------------|-------------------------|
| 1. Planet Gear             | 15. Retaining Ring      | 31. thru 32. (Not Used) | 56. Shaft Rod           |
| 2. Planet Gear             | 16. Retaining Ring      | 33. O Ring              | 57. thru 58. (Not Used) |
| 3. Sun Gear                | 17. Support Disc        | 34. Spring              | 59. Rotor Disc          |
| 4. Shaft Nut               | 18. (Not Used)          | 35. thru 42. (Not Used) | 60. Spindle             |
| 5. Planet Bolt             | 19. O Ring              | 43. Sun Gear Shaft      | 61. (Not Used)          |
| 6. Support Ring            | 20. Ring Seal           | 44. Input Shaft         | 62. Coupler             |
| 7. Planet Carrier          | 21. Screw Plug          | 45. thru 48. (Not Used) | 63. thru 65. (Not Used) |
| 8. Cover                   | 22. Seal Ring           | 49. Washer              | 66. Retaining Ring      |
| 9. (Not Used)              | 23. Bolt                | 50. (Not Used)          | 67. thru 80. (Not Used) |
| 10. Roller Bearing         | 24. Ball                | 51. Cover               | 81. Ball Bearing        |
| 11. Roller Bearing         | 25. Expander            | 52. Disc                | 82. Retaining Ring      |
| 12. Tapered Roller Bearing | 26. thru 28. (Not Used) | 53. Bolt                | 83. Retaining Ring      |
| 13. (Not Used)             | 29. Washer              | 54. O Ring              | 84. thru 87. (Not Used) |
| 14. Retaining Ring         | 30. Ring Gear           | 55. Pressure Spring     | 88. Wheel Stud          |

Figure 3-2. Drive Hub (Part No. 2780246-4WD Steer)

### 3.4 TORQUE HUB - 4WD (MACHINES BUILT AFTER S/N 0300076633)

#### Roll and Leak Testing

Always roll and leak test Torque-Hubs after assembly to make sure that the unit's gears and sealants are working properly. The following information briefly outlines what to look for when performing these tests.

##### THE ROLL TEST

The purpose of a roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying a constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and you should examine them for improper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency.

##### THE LEAK TEST

The purpose of a leak test is to make sure the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall once you have pressurized the unit. Leaks will most likely occur at the main seal or wherever o-rings or gaskets are located. Usually you can detect the exact location of a leak by brushing a soap and water solution around the main seal and where o-rings or gaskets meet the exterior of the unit, then checking for air bubbles. If you detect a leak in a seal, o-ring, or gasket, replace the part immediately.

#### Tightening and Torquing Bolts

If you use an air impact wrench to tighten bolts, take extreme care to insure that you do NOT tighten the bolts beyond their indicated torque specification. Never use an impact wrench to tighten shoulder bolts. Always tighten a11 shoulder bolts by hand.

The following steps describe the proper procedure for tightening and torquing bolts or socket head **cap screws** in a bolt circle.

1. Tighten (but do not torque) bolt "A" until snug.
2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.
3. Continue around the bolt circle and tighten the remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt "A".
5. Continue around the bolt circle and apply an equal torque to the remaining bolts.

#### Oil Information

1. TYPE – EP90  
On normal applications, use EP90. On applications where the lubricant must meet special requirements, the O.E.M should be able to recommend a suitable substitute.
2. OIL TEMPERATURE  
Continuous – 160° F [70° C] Intermittent – 200° F [95° C]
3. OIL CHANGE  
Initial – After 50 hours or 50,000 revolutions of operation. Subsequent – After 1000 hours or (1) year, whichever comes first.

**NOTE:** *Higher temperatures make it necessary to change oil more frequently.*

4. OIL FILL LEVEL AND VOLUME  
Unit mounted horizontal – half full. (See Diagram A.)  
Approximate volume - 17 oz. [0.5 ltr]

#### Main Disassembly for "B" Drives

1. Turn hub (1G) over onto its side, Remove coupling (14) from the wide end of spindle (1A).
2. Mark location of shoulder bolt holes on out- side of ring gear and hub for easy re-alignment when rebuilding. Remove the four shoulder bolts (13) and twelve bolts (12) from cover (6).
3. Remove the sixteen flat washers (16) from cover (6).
4. Lift cover sub-assembly (6) off of ring gear (4), and set cover on table, interior side facing up.

#### CAUTION

**CAUTION: BEWARE OF SHARP EDGES IN THE COUNTERBORE WHEN YOU REMOVE THE O-RING.**

5. Remove o-ring (5) from the counterbore around the edge of cover (6A). Discard the o-ring.

**NOTE:** *If o-ring is not in the cover counter- bore, it is in the ring gear counterbore. Remove it from the hub and discard it.*

6. Remove thrust washer (11) from the counter- bore in top of carrier (3A).
7. Remove input gear (8) from the middle of carrier sub-assembly (3).
8. Lift ring gear (4) off of hub (1G).
9. Lift carrier sub-assembly (3) out of hub (1G).
10. Remove thrust spacer (9) from input shaft (7) in the middle of spindle (1A).

11. Lift input shaft sub-assembly (7) out of middle of spindle (1A), and stand input shaft (7A) on its splined end.

**⚠ CAUTION**

**WEAR SAFETY GLASSES DURING THIS STEP, AND BE AWARE THAT SPRING AND SPACERS COMPRESSED BY RETAINING RING MAY POP SUDDENLY OFF SHAFT WHEN YOU REMOVE THE RETAINING RING.**

12. Using retaining ring pliers, remove retaining ring (7B) from the groove on input shaft (7A).
13. Remove one spacer (7D), one spring (7C), and other spacer (7D) from input shaft (7A).
14. Remove thrust washer (11) from around spindle (1A).
15. Lift internal gear (2) out of hub (1G).

**⚠ CAUTION**

**BEWARE OF SHARP EDGES IN COUNTERBORE WHEN YOU REMOVE THE O-RING.**

16. Remove o-ring (5) from the counterbore in hub (1G). Discard the o-ring.
17. At this point the main disassembly for "B" drives is complete.

### Hub-Spindle Disassembly

**NOTE:** Start with large end of hub facing up, large end of spindle facing down.

**⚠ CAUTION**

**WEAR SAFETY GLASSES DURING THIS STEP.**

1. Remove retaining ring (1I) from around spindle (1A) in hub (1G).
2. Remove spacer (1H) from around spindle (1A) in hub (1G).
3. Set hub (1G), small end/spindle facing down, up on something that will support the hub's flange while it lifts hub up so spindle is not resting on anything. Carefully press or hammer spindle (1A) down out of hub (1G).

**NOTE:** If seal (1B) and bearing cone (1D) come out of hub and rest on spindle, remove these parts from the spindle and set them aside. Discard the seal.

4. If seal and bearing cone did not come out of the small end of hub (1G) when you pressed spindle out of hub, remove seal (1B) and bearing cone (1D) from the small end of hub (1G). Discard the seal.

5. Bearing cone (1F) should be lying loose in wide end of hub (1G). Remove bearing cone (1F) from inside hub (1G).

**NOTE:** If you use a punch and hammer, make sure you do not strike the counterbore with the punch when you remove the bearing cup.

6. Remove bearing cup (1C) from the counterbore in the small end of hub (1G).

**NOTE:** If you use a punch and hammer, make sure you do not strike the counterbore with the punch when you remove the bearing cup.

7. Turn hub (1G) over and lift it out of the flange-support. Remove bearing cup (1E) from the counterbore in the wide end of hub (1G).
8. Turn hub (1G) over onto its small end. Remove two pipe plugs (1J) from the two pipe plug holes in the side of hub (1G).

**NOTE:** If your unit does not have studs, skip this step:

9. Press the nine studs (1N) out of the stud holes in hub (1G).
10. At this point the hub-spindle disassembly is complete.

### Cover Disassembly

1. Remove the two bolts (6C) holding disconnect cap (6D) to cover (6A).
2. Remove disconnect cap (6D) from on top of cover cap (6B) and cover (6A).
3. Remove the two bolts (6C) holding cover cap (6B) to cover (6A).
4. Remove cover cap (6B) from cover (6A).
5. Remove disconnect rod (6K) from cover cap (6B).
6. Pry o-ring (6F) out of the groove inside cover cap (6B). Discard the o-ring.
7. Remove o-ring (6G) from the flange of cover cap (6B). Discard the o-ring.
8. Remove pipe plug (6H) from cover (6A).
9. At this point the cover disassembly is complete.

### Carrier Disassembly

**NOTE:** When you remove the needle rollers from the cluster gears, discard the old needle rollers and use new ones during re-assembly.

1. Using a punch and hammer, drive roll pin (3G) into planet shaft (3E).

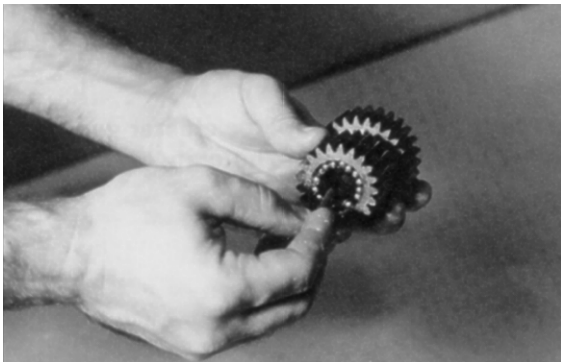
## SECTION 3 - CHASSIS & TURNTABLE

**NOTE:** If you don't drive the roll pin all the way into the planet shaft, you could damage the carrier when you remove the planet shaft from the carrier.

2. Using a punch and hammer, drive planet shaft (3E) out of the planet shaft hole in carrier housing (3A).
3. When you remove planet shaft (3E) from the carrier housing, one thrust washer (38), one cluster gear (3F), and one more thrust washer (3B) will come off of the planet shaft and come to rest inside the carrier. Remove these parts from inside the carrier.
4. Remove 16 needle rollers (3C) from inside one end of cluster gear (3F). Discard the needle rollers.
5. Remove one spacer (3D) from inside cluster gear (3F).
6. Remove the remaining 16 needle rollers (3C) from the other side of cluster gear (3F). Discard the needle rollers.
7. Repeat steps 1-6 to remove and disassemble the two remaining cluster gears.
8. At this point the carrier disassembly is complete.

### Assembly of the Carrier

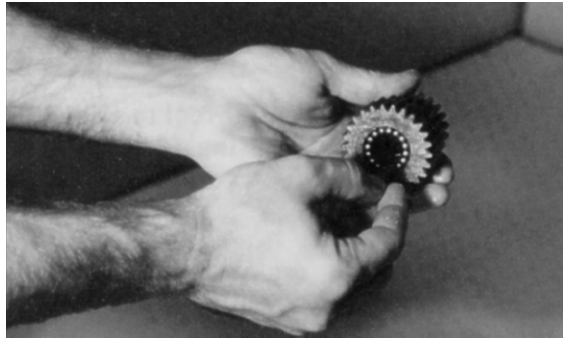
1. Apply grease to the inside of one cluster gear (3F) and line one half of cluster gear with 16 needle rollers (3C).



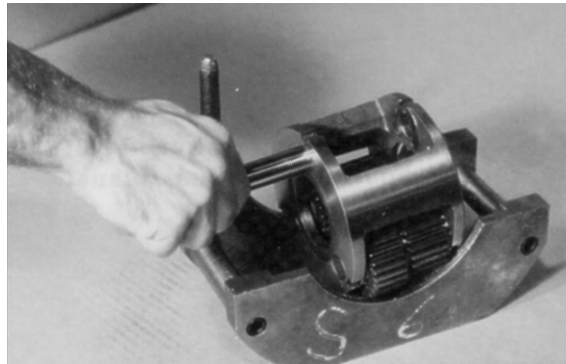
2. Place one spacer (3D) inside cluster gear (3F) so that it rests on top of the needle rollers.



3. Line the remaining half of cluster gear (3F) with 16 needle rollers.

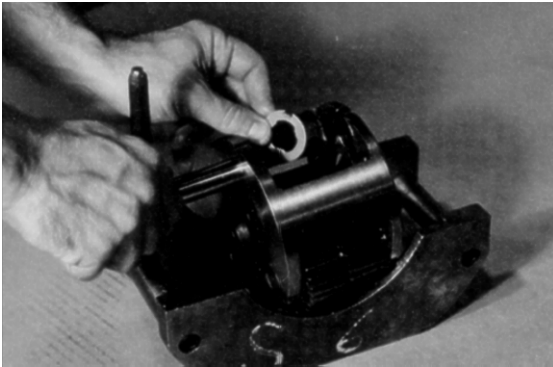


4. Set carrier housing (3A) on table, sideways. Insert a planet shaft (3E), roll pin hole last, into one of the planet shaft holes from roll-pin-holed side of carrier housing (3A).





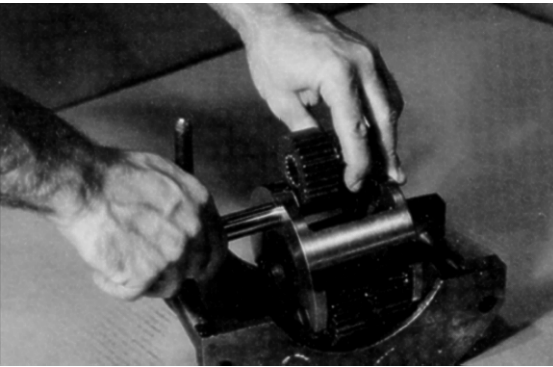
5. Place one thrust washer (3B) onto the end of planet shaft (3E) inside carrier. Fit tang of thrust washer into the slot on the inside edge of the planet shaft hole.



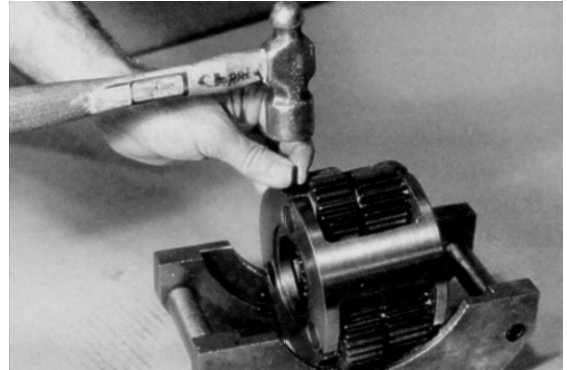
8. Use an alignment punch or similar tool to align the roll pin holes in carrier housing (3A) and planet shaft (3E).



6. Following the thrust washer, place the cluster gear (3F), large end toward roll pin hole in carrier housing, onto the planet shaft (3E).



9. Drive roll pin (3G) down into the aligned roll pin holes in carrier housing (3A) and planet shaft (3E).



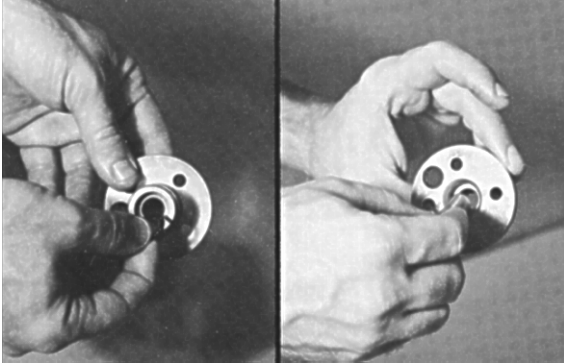
7. Following the cluster gear, place one more thrust washer (3B) onto planet shaft (3E) through the opposite planet shaft hole in carrier housing (3A).



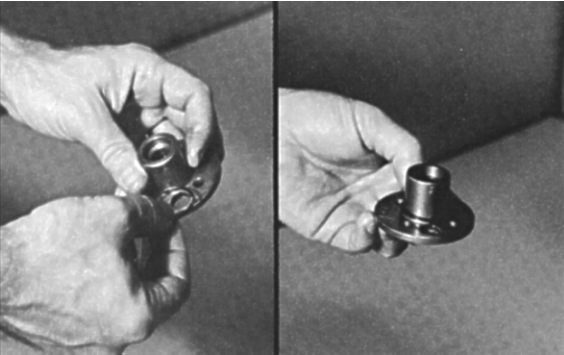
10. Repeat steps 1 thru 9 to assemble and install the two remaining cluster gears.
11. At this point the carrier sub-assembly is complete.

**Cover Sub-Assembly**

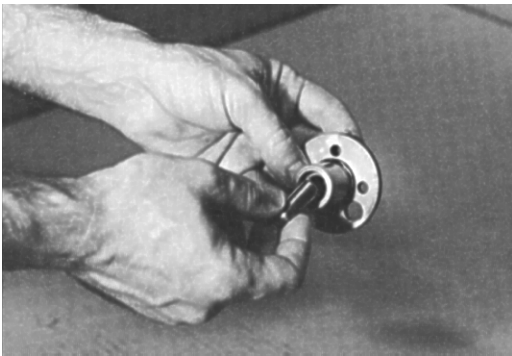
1. Using the disconnect rod, push o-ring (6F) into the groove inside the cover cap (6B).



2. Place the o-ring (6G) onto the cover cap (6B) so that it rests against the flange of the cover cap.



3. Insert disconnect rod (6E) into cover cap (6B).



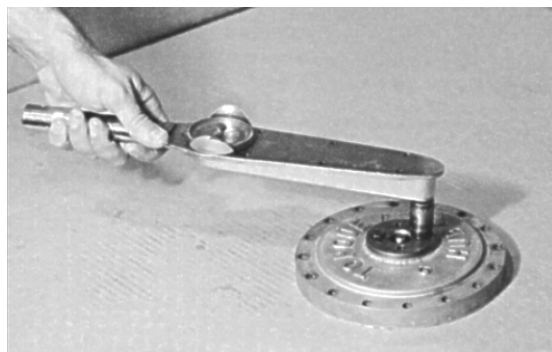
4. Set cover (6A) on table, exterior side up. Place cover cap (6B) onto cover (6A), aligning the pipe plug hole in the cover cap over the pipe plug hole in the cover.



5. Place two of the cover cap bolts (6C) into any two bolt holes that are 180° apart on the cover cap (6B) and tighten bolts.



6. Using a torque wrench, apply 36 to 49 in. lbs. (4 to 5 Nm) of torque to both bolts (6C).



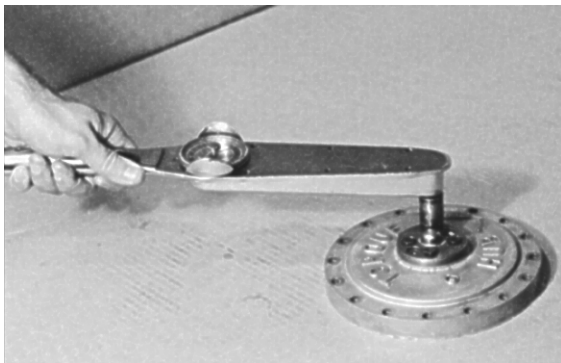
7. With the large end down, place the disconnect cap (6D) onto the cover cap (6B), aligning the pipe plug hole in the disconnect cap over the pipe plug hole in the cover cap.



8. Place the two remaining bolts (6C) into the bolt holes in the disconnect cap (6D), and tighten the bolts.



9. Using a torque wrench, apply 36 to 49 in. lbs. (4 to 5 Nm) of torque to both bolts (6C).



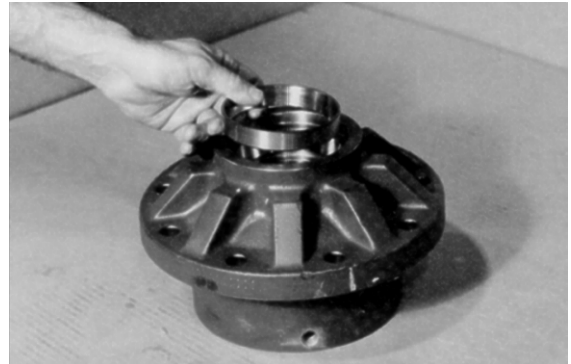
10. Apply a light coat of "Never-Seize" to pipe plug (6H) and tighten it into the pipe plug hole in the cover (6A).



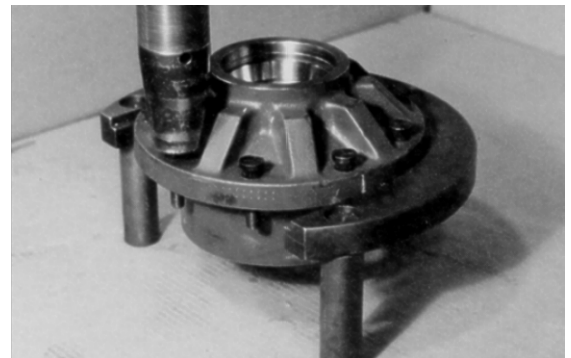
### **Hub-Spindle Sub-Assembly**

**NOTE:** Make sure the cup sits square with the counterbore before pressing.

1. Set hub (1G) onto its large end. Press bearing cup (1C) into the counterbore in the small end of the hub (1G).

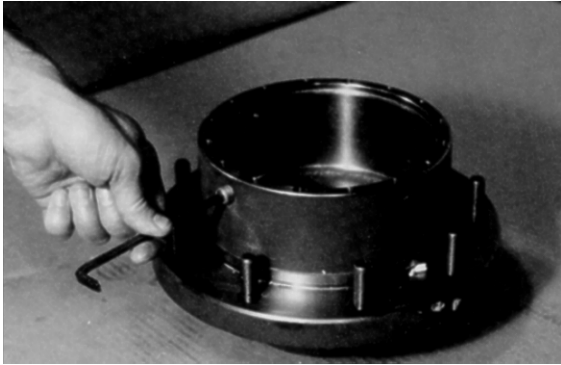


2. Press the nine studs (1N) into the stud holes in hub (1G).



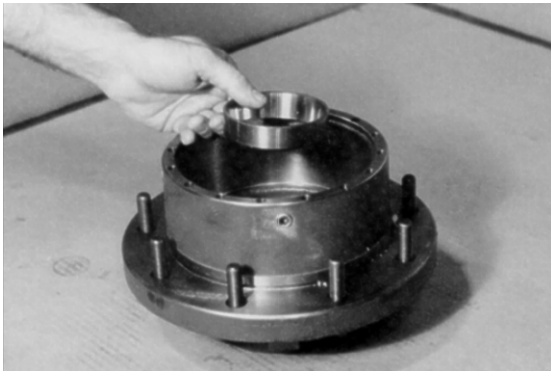
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3. Apply a light coat of "Never-Seize" to two pipe plugs (1J) and tighten them into the two pipe plug holes in the side of the hub (1G).

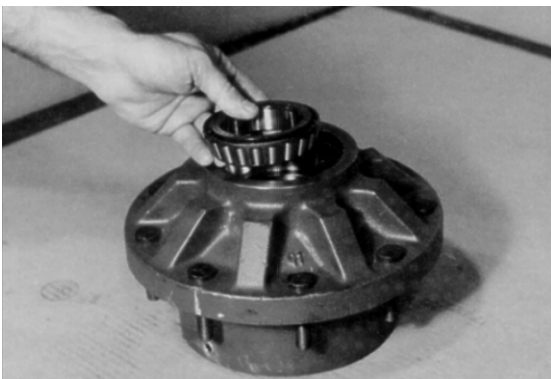


**NOTE:** Make sure the cup sits square with the counterbore before pressing.

4. Turn hub (1G) over onto its small end. Press bearing cup (1E) down into the counterbore in the deep end of the hub (1G).



5. Set hub (1G) onto its large end. Place bearing cone (1D) into bearing cup (1C).



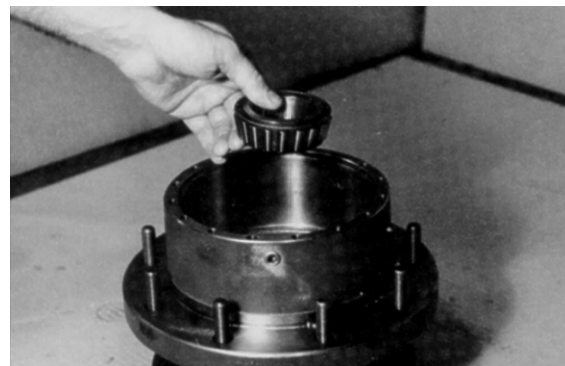
6. Press seal (1B) into the small end of hub (1G).



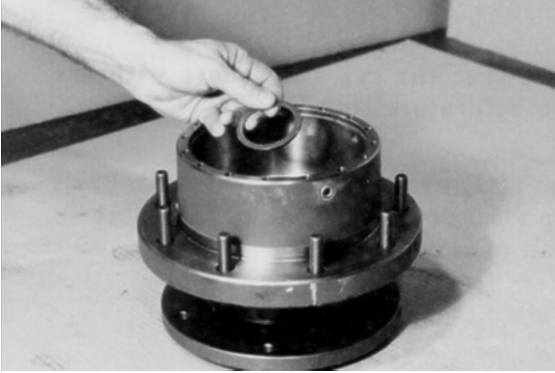
7. Oil spindle, then lower hub (1G), small end down, onto spindle (1A).



8. Press bearing cone (1F) onto spindle (1A) in hub (1G).



9. Place spacer (1H) onto spindle (1A) in hub (1G).



**NOTE:** Make sure the retaining ring is securely seated in the groove.

10. Place retaining ring (1I) over the spacer onto spindle (1A) in hub (1G).



11. At this point the hub-spindle sub-assembly is complete.

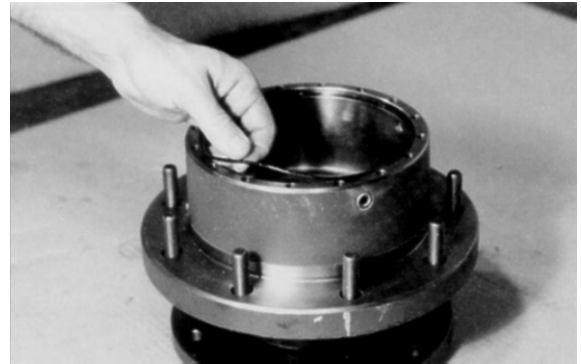
## Main Assembly

### **⚠ WARNING**

**BEWARE OF SHARP EDGES IN COUNTERBORE WHEN INSTALLING THE O-RING**

1. Grease o-ring (5) and place it into the counterbore in hub (1G).

**NOTE:** O-ring may be stretched or pinched together to make it fit the counterbore exactly.

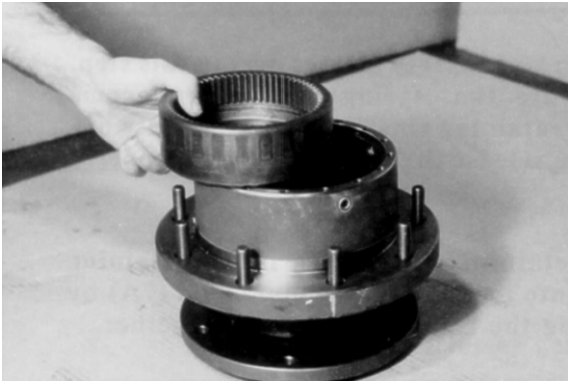


2. Oil all exposed surfaces inside hub (1G).

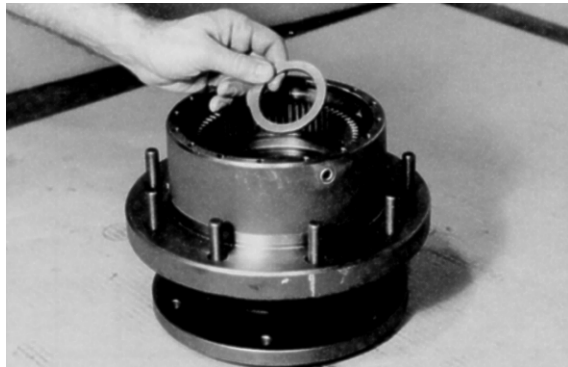


## SECTION 3 - CHASSIS & TURNTABLE

3. Place internal gear (2) into hub (1G) so that its internal splines mesh with the external splines of spindle (1A). Oil internal gear (2).



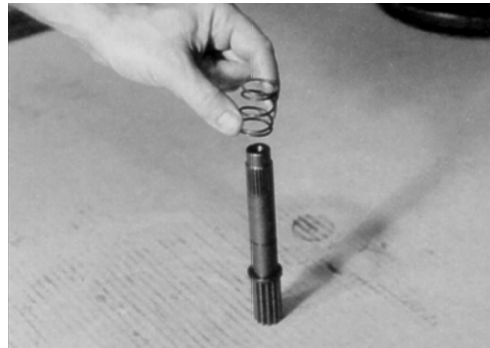
4. Place thrust washer (11) around spindle (1A) so it rests on the bottom of the internal gear (2).



5. Stand input shaft (7A) on its splined end. Place one spacer (7D) onto the smooth end of input shaft (7A).



6. Place one spring (7C) onto the smooth end of input shaft (7A).



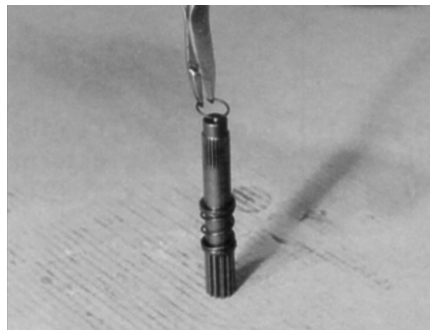
7. Place other spacer (7D) onto the smooth end of input shaft (7A).



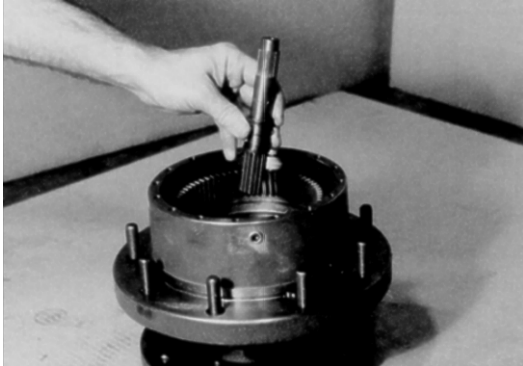
### **⚠ WARNING**

**WEAR SAFETY GLASSES DURING THIS STEP, AND BE AWARE THAT SPRING AND SPACERS, COMPRESSED BY RETAINING RING, MAY POP SUDDENLY OFF SHAFT IF THE RING IS RELEASED BEFORE IT IS PROPERLY IN PLACE.**

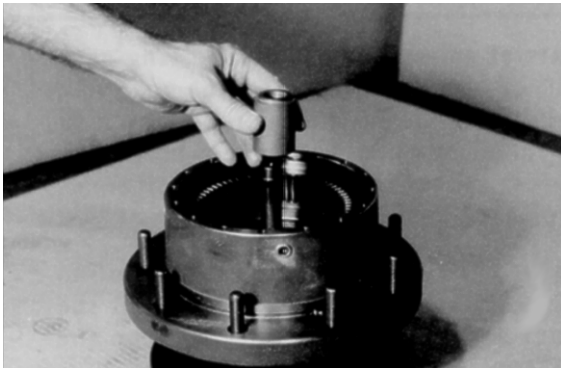
8. Using retaining ring pliers, insert retaining ring (7B) into the groove on input shaft (7A) by compressing the spring and spacers together.



9. With large splined end down, place input shaft sub-assembly (7) into spindle (1A).



10. Place thrust spacer (9) onto input shaft (7).



11. Set carrier sub-assembly (3) on a flat work surface so the large ends of cluster gears (3F) face up. Locate the punch marks on the face of each cluster gear (3F) and position them at 12 o'clock.

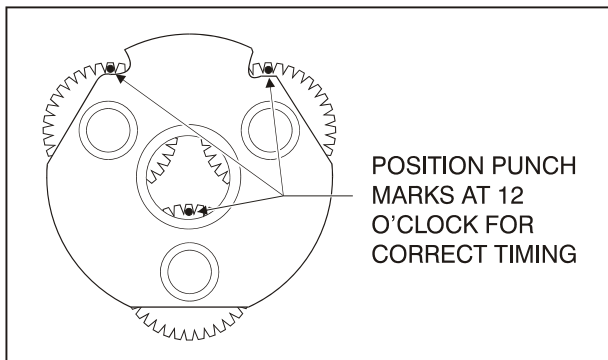
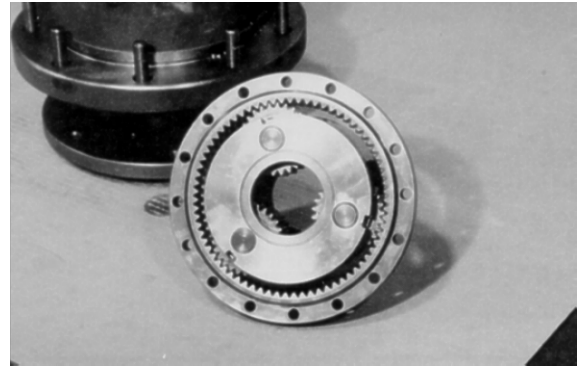


Figure 3-3. Cluster Gear Punch Marks

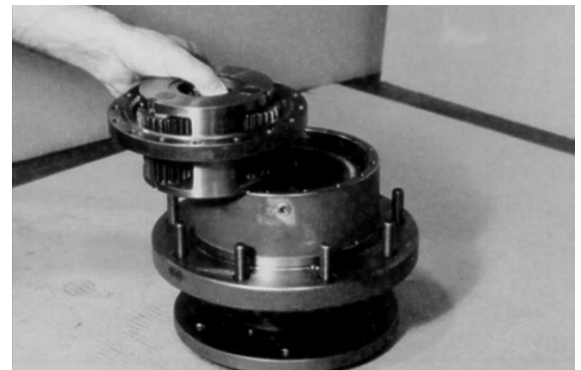
12. With "X" marked side facing up, place the ring gear (4) around cluster gears (3F).

**NOTE:** This will hold the punch marks in position while installing the carrier into the hub.

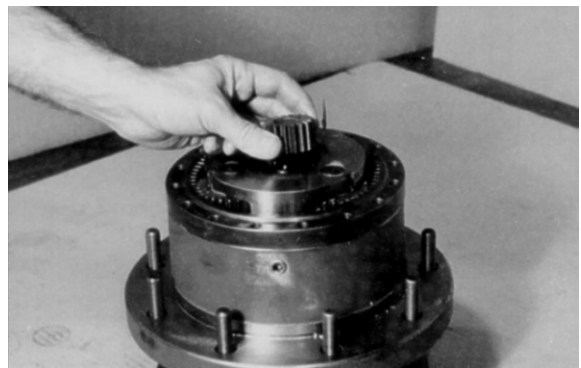


13. Place the carrier sub assembly (3) and ring gear (4) together into mesh with internal gear (2), aligning the "X" marked shoulder bolt hole in the ring gear (4) over one of the shoulder bolt holes in the hub. Mark the location of shoulder bolt holes on the outside of ring gear and hub.

**NOTE:** You may lift the ring gear off the hub to align the shoulder bolt holes. The ring gear and carrier are installed together only to keep the punch marks on the carrier in place.

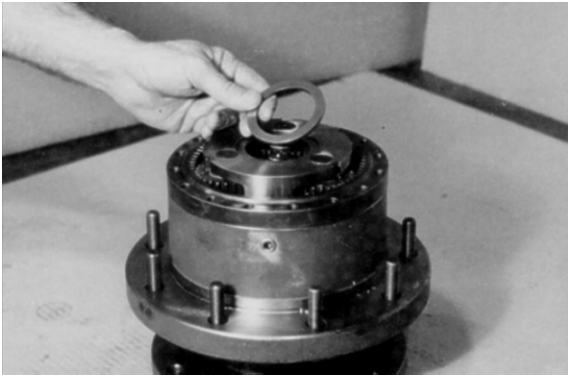


14. With the internal splines facing up (counterbore end facing down), place input gear (8) into mesh with carrier sub-assembly (3).



## SECTION 3 - CHASSIS & TURNTABLE

15. Oil all exposed surfaces inside the hub (1G). Place thrust washer (11) into the counterbore in top of the carrier.



17. Place cover sub-assembly (6) onto ring gear (4), aligning the pipe plug holes according to the alignment prior to disassembly.



### **⚠ WARNING**

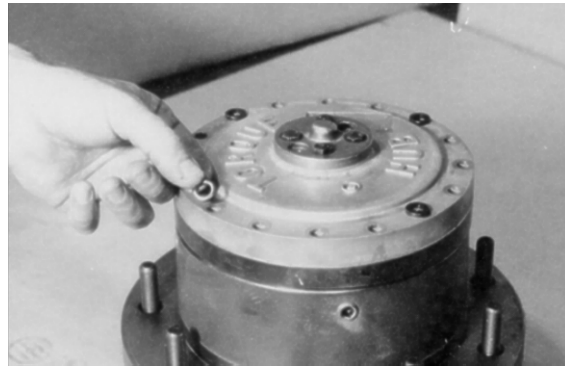
**BEWARE OF SHARP EDGES IN THE COUNTERBORE WHEN YOU INSTALL THE O-RING.**

16. Set the cover (6A) on table, interior side up. Grease o-ring (5) and place it into the counterbore around the edge of cover (6A).

**NOTE:** *The o-ring may be stretched or pinched together to make it fit the counterbore exactly.*



18. Place four flatwashers (16) on top of the bolt holes in the cover sub-assembly.





- 19.** Place shoulder bolts (13) into the four shoulder bolt holes in cover (6) and tighten by hand.



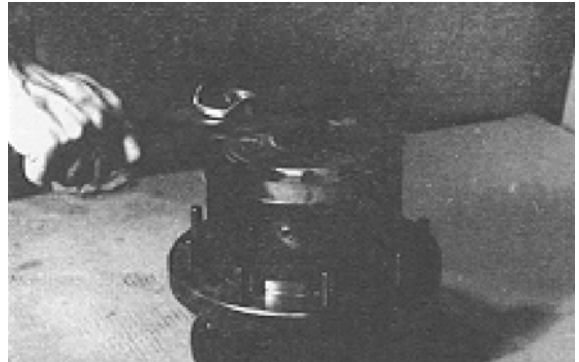
- 21.** Place the 12 bolts into the remaining bolt holes in cover (6) and tighten.



- 20.** Place the remaining 12 flatwashers (16) onto the remaining bolt holes in cover (6).

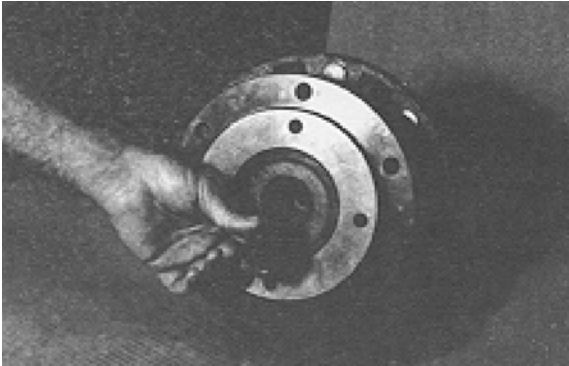


- 22.** Torque the shoulder bolts (13) 18 to 25 ft.lbs. (25 to 34 Nm). Torque bolts (12) 18 to 25 ft.lbs. (25 to 34 Nm).

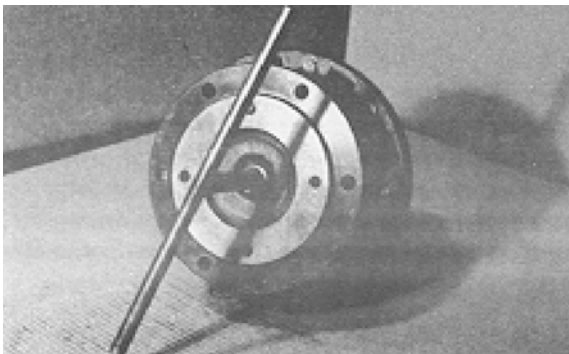


## SECTION 3 - CHASSIS & TURNTABLE

23. Turn hub (1G) over onto its side. Insert coupling (14) into the end of the spindle (1A).



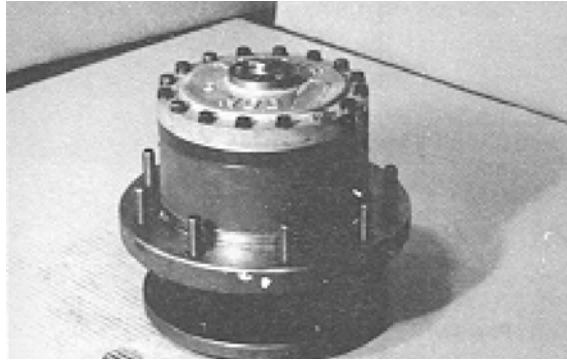
24. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns in each direction as the ratio of the unit. The ratio is the last two digits of the model number on the unit's ID tag.



25. Leak test the unit at a pressure of 5 psi for 2 to 3 minutes.



26. At this point the main assembly is complete.

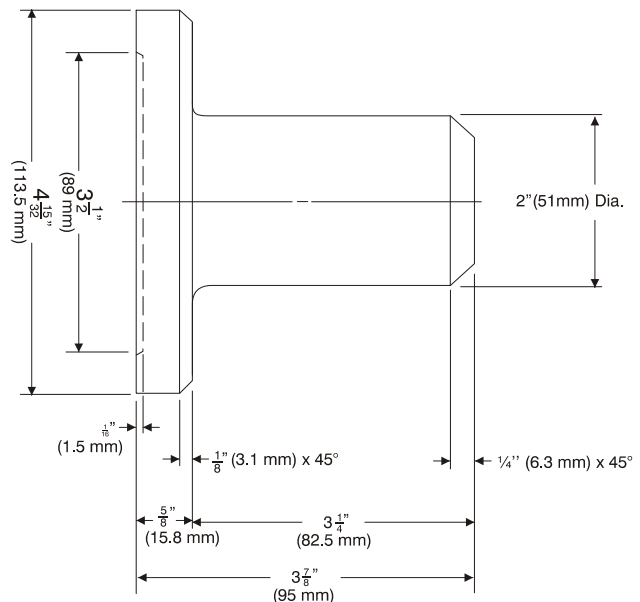


### Tool List

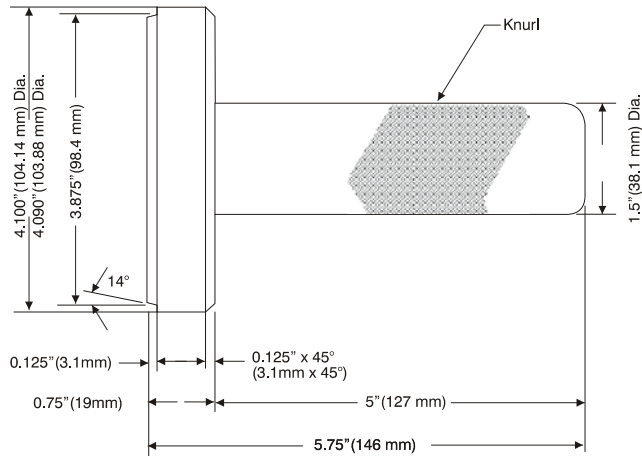
The following specialized tools are used to assemble this unit. The tool diagrams included in this manual are intended for the customer who may wish to have a tool made. All tools exist as one piece and must be made from mild steel. All dimensions are given in inches.

**NOTE:** In order to improve tool life, tools may be carburized and hardened. If this is done, however, the tools must be ground on all surfaces labeled with a "G" on the tool diagram.

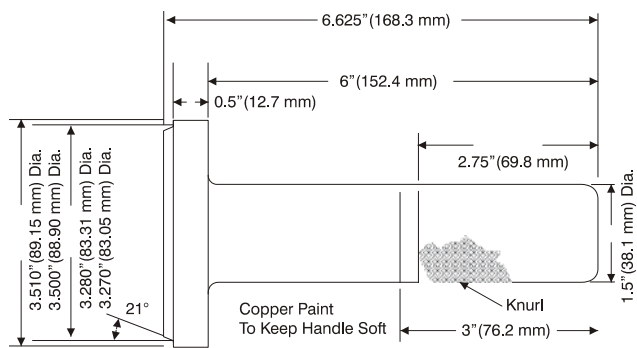
1. T-118126 SEAL PRESSING TOOL for SEAL (1B).



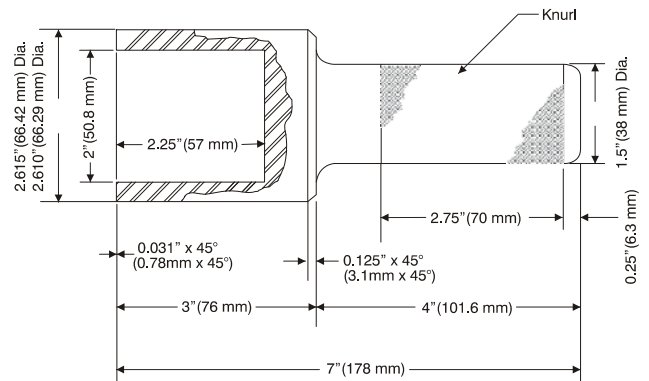
2. T-138903 ASSEMBLY PRESSING TOOL for CUP (1C)



3. T-140433 ASSEMBLY PRESSING TOOL for CUP (1E)



4. T-109691 ASSEMBLY PRESSING TOOL for CONE (1F)



\* These tools are for specific seals, cups or cones. There is a specific tool for each cup and cone.

3.5 RE-ALIGNING TORQUE HUB INPUT COUPLING

The following procedure applies to torque hubs with integral brakes.

Equipment Required

1. Hydraulic power supply (hand pump) capable of producing 200 psi (13.8 bar).
2. Hydraulic fittings to adapt hydraulic supply to brake release port on hub.

Procedure

1. Using appropriate fittings, connect a line from the hydraulic power supply to the brake port.
2. Pressurize the brake release port 155 to 200 psi (10.6 to 13.8 bar) to release the brake.
3. Verify that the brake is released by rotating the input coupling or hub spindle.
4. Once the brake is released, the input coupling will be free to re-align with the drive motor.
5. Install the drive motor on the hub, then release the hydraulic pressure at the brake release port. The coupling will remain in position.
6. Disconnect the hydraulic power supply and reconnect the line going into the brake release port.

### 3.6 DRIVE BRAKE

#### Pre-Installation Checks

##### MECHANICAL

Check, That in the handling prior to assembly, the mounting features and other parts of the brake are undamaged. Ensure that the shaft to which the brake is mounted are clean and free from burrs and swellings.

##### HYDRAULIC/MECHANICAL

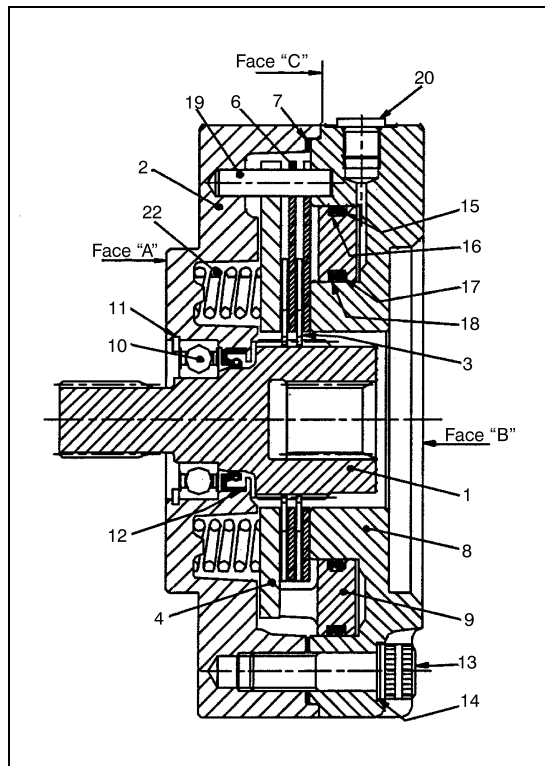
To check brake release, connect an appropriate hydraulic pressure supply set to the required level up to a maximum

of 3000 psi (200bar) and check that brake shaft (1) is free to rotate.

Remove hydraulic supply from brake, checking to ensure that the friction plates (3 & 6) have engaged thus preventing rotation of brake shaft (1)

**NOTICE**

**RELEASE PRESSURE DURING BENCH TESTING SHOULD BE LIMITED TO 2000 PSI (138 BAR) UNLESS BRAKE IS FULLY INSTALLED USING 2-OFF 1/2" UNC MOUNTING BOLTS IN THE THROUGH (MOUNTING) HOLES.**



- |                         |                              |                           |
|-------------------------|------------------------------|---------------------------|
| 1. Brake Shaft          | 9. Piston                    | 17. O-Ring                |
| 2. Housing              | 10. Deep Groove Ball Bearing | 18. Backing Ring          |
| 3. Inner Friction Plate | 11. Internal Retaining Ring  | 19. Dowel Pin             |
| 4. Pressure Plate       | 12. Rotary Shaft Seal        | 20. Hexagon Plug          |
| 5. Gasket               | 13. Socket Head Cap Screw    | 21. Plastic Plug          |
| 6. Outer Plate          | 14. Shakeproof Washer        | 21A. Socket Pressure Plug |
| 7. Gasket               | 15. O-Ring                   | 22. Spring (Natural)      |
| 8. Cylinder             | 16. Backing Ring             | 23. Spring (Blue)         |

Figure 3-4. Drive Brake

## Installation

Position 1-off gasket (5) over male pilot on brake housing (4).

Locate brake shaft (1) and secure brake in position using 2-off 1/2" UNC mounting bolts in the through mounting (fixing) holes provided.

Connect hydraulic pressure supply to brake pressure inlet port. Ensure that the hydraulic pressure is set to the required level up to a maximum of 3000 psi (200 bar) and check that the brake disengages and re-engages correctly.

## Maintenance

The brake is required to be kept in good working order and must be included in the planned maintenance program for the equipment to which the brake is installed.

This must include torque testing together with inspection and replacement of the working parts such as friction plates (3 & 6) and, springs (22 & 23). The frequency of inspection depends on the duty demanded of the brake.

## Disassembly

To remove brake from its installed position, reverse procedure previously described in the installation instructions. Place the complete brake assembly on a clean, dry work bench.

Remove external gasket (5) as necessary.

**NOTE:** Refer to Diagrams for the following.

1. Supporting brake face "A", remove the six socket head cap screws and washers (items 13 & 14) in equal increments to ensure the spring pressure within the brake is reduced gradually and evenly. Alternatively, if press is available, the cylinder housing (8) can be restrained on face "B" while removing the six socket head cap screws and washers (13 & 14). The brake assembly can now be fully dismantled and parts examined.
2. Remove cylinder housing (8) and piston (9) sub-assembly and dismantle if required, removing O-ring seals (15 & 17) and backing rings (16 & 18) as necessary.
3. Remove gasket (7) from housing (2).
4. Remove friction plates (3 & 6) and pressure plate (4).
5. Remove 2-off dowel pins (19).
6. Remove springs (22 & 23).

7. Should it be necessary to replace ball bearing (10) or shaft seal (12), reverse remainder of brake sub-assembly, supporting on face "c" of housing (2).
8. Remove internal retaining ring (11).
9. Using arbor press or similar to break Loctite seal, remove brake shaft (1) from housing (2) and lay aside.
10. Reverse housing (2) and press out ball bearing (10). Shaft seal (12) can also be removed if necessary.

## Examination

All components can now be examined and inspected, paying particular attention to the following.

1. Inspect friction plates (3 & 6) and friction surface on pressure plate (4) for wear or damage.
2. Examine friction plates (3) and brake shaft (1) for wear or damage to splines.
3. Examine input and output splines of brake shaft (1) for wear or damage.
4. Examine compression springs (22 & 23) for damage or fatigue.
5. Check ball bearing (10) for axial float or wear.
6. Examine O-ring seals (15 & 17) and backing rings (16 & 18) for damage.
7. Obtain replacement parts as required.

## Assembly

Clean all parts thoroughly.

Reverse procedure previously outlined in Dismantling instructions taking particular care with.

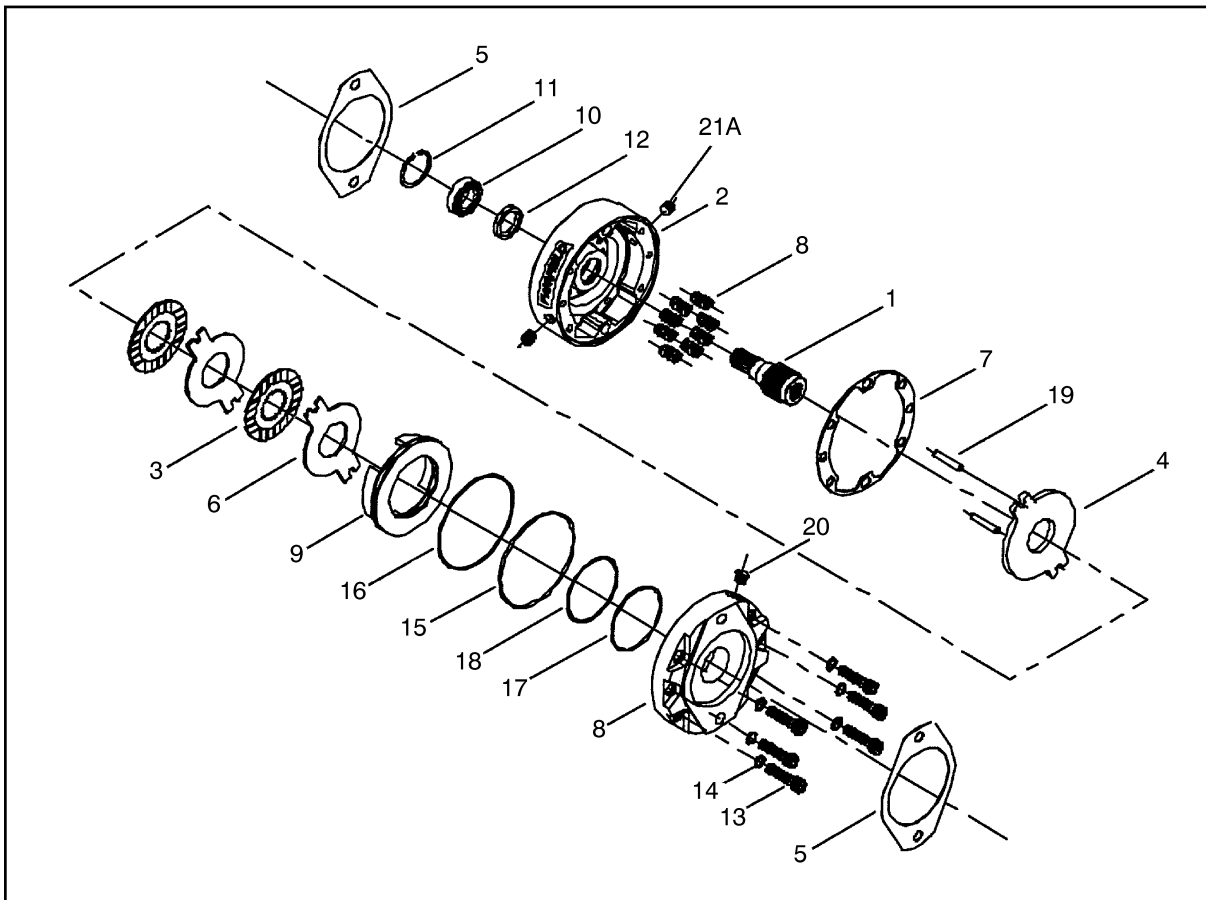
- a. Assembly of shaft seal (12).
- b. Assembly of bearing (10).
- c. Quantity and orientation of springs (22 & 23).
- d. Assembly sequence of friction plates (3 & 6).
1. Lightly lubricate rotary shaft seal (12) and assemble to housing (2) taking care not to damage seal lip.
2. Apply ring of Loctite 641 or equivalent adhesive to full circumference of housing (2) bearing recess adjacent to shoulder. Apply complete coverage of Loctite 641 to outside diameter of bearing (10) and assemble fully in housing (2), retaining with internal retaining ring (11). Remove excess adhesive with clean cloth. Press shaft (1) through bearing (10), ensuring bearing inner ring is adequately supported.
3. Assemble correct quantity of springs (22 & 23) in orientation required.

## SECTION 3 - CHASSIS & TURNTABLE

4. Lubricate O-ring seals (15 & 17) with Molykote 55M (or equivalent) silicone grease and assemble together with backing rings (16 & 18) to piston (9). To ensure correct brake operation, it is important that the backing rings are assembled opposite to the pressurized side of piston (9).
5. Correctly orientate piston (9) aligning spaces with the two dowel pin holes and, assemble into cylinder housing (8) taking care not to damage seals and carefully lay aside.
6. Loctite 2-off pins (19) in housing (2) followed by pressure plate (4) and friction plates i.e. an inner (3) followed by an outer (6) in correct sequence.

7. Position gasket (7) in correct orientation.
8. Align two holes in cylinder with dowel pins (19) and assemble piston & cylinder sub-assembly to remainder of brake securing with 6-off socket head cap screws and washers (13 & 14). Torque to 55ft/lbs. (75 Nm).

**NOTE:** The use of a suitable press (hydraulic or arbor) Pressing down on cylinder end face "B" will ease assembly of the socket head cap screws (13).



- |                         |                              |                           |
|-------------------------|------------------------------|---------------------------|
| 1. Brake Shaft          | 8. Cylinder                  | 15. O-Ring                |
| 2. Housing              | 9. Piston                    | 16. Backing Ring          |
| 3. Inner Friction Plate | 10. Deep Groove Ball Bearing | 17. O-Ring                |
| 4. Pressure Plate       | 11. Internal Retaining Ring  | 18. Backing Ring          |
| 5. Gasket               | 12. Rotary Shaft Seal        | 19. Dowel Pin             |
| 6. Outer Plate          | 13. Socket Head Cap Screw    | 20. Hexagon Plug          |
| 7. Gasket               | 14. Shakeproof Washer        | 21. Plastic Plug          |
|                         |                              | 21A. Socket Pressure Plug |

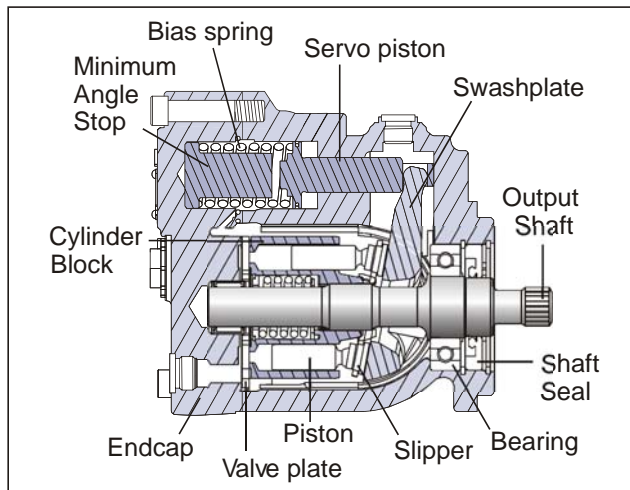
**Figure 3-5. Swing Brake Assembly**

## 3.7 DRIVE MOTOR

### Description

The drive motors are low to medium power, two-position axial piston motors incorporating an integral servo piston. They are designed for operation in both open and closed circuit applications. The standard control is a direct acting single line hydraulic control. The integral servo piston controls motor displacement.

The motors are spring biased to maximum displacement and hydraulically shifted to minimum displacement. Minimum and maximum displacement can be set with fixed internal stops. The large diameter servo piston allows smooth acceleration and deceleration with relatively large circuit orificing.

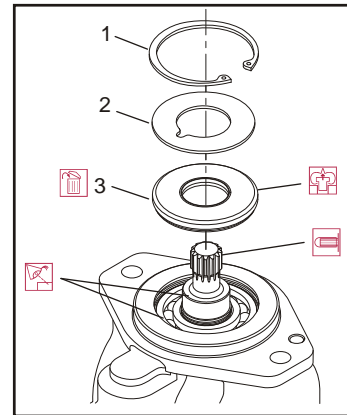


**Figure 3-6. Drive Motor Cross Section**

## Shaft Seal Replacement

### REMOVAL

1. Remove the snap ring (1) retaining the shaft seal and support washer.



1. Snap Ring
2. Support Washer
3. Shaft Seal

**Figure 3-7. Removing the Shaft Seal**

2. Remove the support washer (2).
3. Carefully pry out the shaft seal (3).

To avoid damaging the shaft during removal, install a large sheet metal screw into the chuck of a slide hammer. Drive the screw into the seal surface and use the slide hammer to pull the seal.

4. Discard the seal.

### INSPECT THE COMPONENTS

Inspect the new seal, the motor housing seal bore, and the sealing area on the shaft for rust, wear, and contamination. Polish the shaft and clean the housing if necessary.

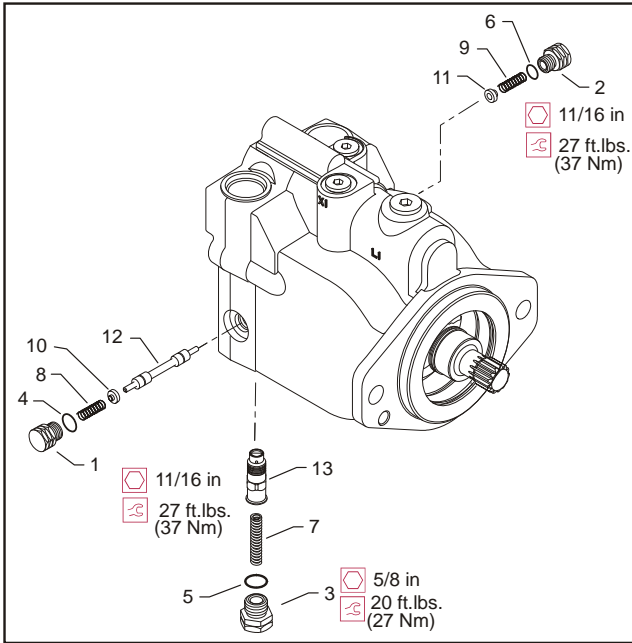
### INSTALLATION

1. Cover the shaft splines with an installation sleeve to protect the shaft seal during installation.
2. Install a new shaft seal with the cupped side facing the motor. Press seal into housing until it bottoms out. Press evenly to avoid binding and damaging the seal.
3. Install seal support washer.
4. Install snap ring.
5. Remove the installation sleeve.

**Loop Flushing Valve**

**REMOVAL**

1. Using a 11/16 in internal hex wrench remove plug (1) and (2).



- |           |            |                    |
|-----------|------------|--------------------|
| 1. Plug   | 6. O-ring  | 11. Washer         |
| 2. Plug   | 7. Spring  | 12. Shift Spool    |
| 3. Plug   | 8. Spring  | 13. Orifice Poppet |
| 4. O-ring | 9. Spring  |                    |
| 5. O-ring | 10. Washer |                    |

**Figure 3-8. Loop Flushing Spool**

2. Using a 1/4 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).

**INSPECT THE COMPONENTS**

Inspect new O-rings and the sealing area for rust, wear, or contamination. Also check springs and poppet for wear.

**INSTALLATION**

1. Install orifice poppet (13).
2. Install shift spool (12).
3. Install spring retaining washers onto springs (10 and 11).
4. Carefully install centering springs (7, 8, and 9).
5. Install new O-rings (6, 4, and 5).
6. Using a 1/4 in hex wrench torque plug (3) to 20 ft.lbs. (27 Nm).
7. Using a 11/16 in internal hex, torque plugs (2 and 1) to 27 ft.lbs. (37 Nm).



## Troubleshooting

**Table 3-2. Excessive Noise and/or Vibration**

Item	Description	Action
Check oil level in reservoir and oil supply to the motor.	Insufficient hydraulic fluid could lead to cavitation that would cause system noise.	Fill the reservoir to the proper level and ensure that oil supply to the motor is adequate and the lines are unobstructed.
Check for air in the system.	Air trapped within the system lines, or the motor itself, could result in cavitation that would cause system noise.	Ensure that all of the system lines and components are purged of air.
Inspect the output shaft couplings.	A loose or incorrect shaft coupling will produce vibrations that could result in system noise.	Ensure that the correct coupling is used and that it fits properly onto the shaft.
Inspect the output shaft alignment.	Misaligned shafts create excessive frictional vibration that could result in system noise.	Ensure that the shafts are properly aligned.
Hydraulic oil viscosity above limits.	Viscosity above acceptable limits will result in cavitation that would lead to system noise.	Replace hydraulic oil with appropriate fluid for operating conditions.

**Table 3-3. System Operating Hot**

Item	Description	Action
Check oil level in reservoir and oil supply to the pump.	Insufficient amount of hydraulic fluid will not meet the cooling demands of the system.	Fill the reservoir to the proper level.
Inspect the heat exchanger, (if so equipped).	If the heat exchanger fails, or becomes obstructed, it may not meet the cooling demands of the system.	Ensure that heat exchanger is receiving adequate air flow and that the heat exchanger is in good operating condition. Repair or replace as necessary.
Check the system relief valves.	If a system relief valve becomes unseated for an extended period of time or fails for any other reason, the system could become overheated.	Repair or replace any malfunctioning relief valves as applicable and verify that the loads on the machine are not excessive.

**Table 3-4. Won't Shift or Slow to Start**

Item	Description	Action
Check the signal line to the servo control port.	Obstructed or restricted flow through the servo control signal lines could result in slow shift or no shift conditions within the motor.	Ensure that the signal lines are not obstructed or restricted and that signal pressure is adequate to shift the motor.
Check that the correct supply and drain orifices are properly installed, and are not obstructed.	Supply and drain orifices determine the shift rate of the motor. The smaller the orifice, the longer the time it takes to shift the motor. Obstruction will also increase shift times.	Ensure that the proper control orifices are installed in the motor and verify that they are not obstructed. Clean or replace as necessary.

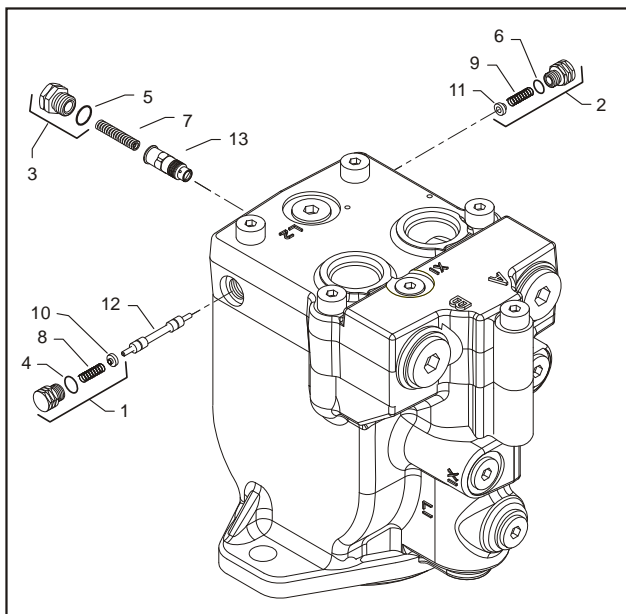
**Disassembly**

**NOTE:** Removal of the endcap voids warranty.

During assembly, coat all moving parts with a film of clean hydraulic oil. This assures that these parts will be lubricated during start-up.

Replace all O-Rings and gaskets.

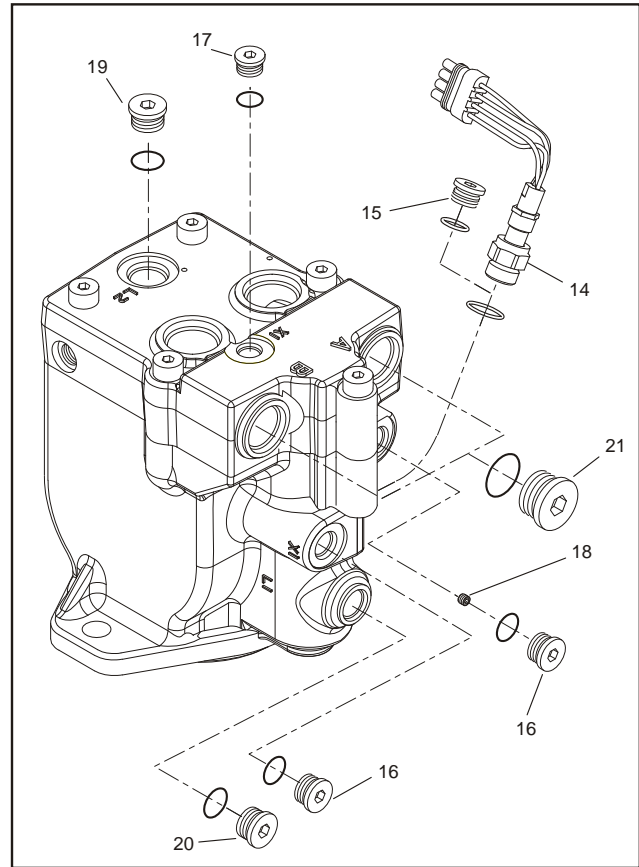
It is recommended that all O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



- |           |           |            |                    |
|-----------|-----------|------------|--------------------|
| 1. Plug   | 5. O-ring | 9. Spring  | 12. Shift Spool    |
| 2. Plug   | 6. O-ring | 10. Washer | 13. Orifice Poppet |
| 3. Plug   | 7. Spring | 11. Washer |                    |
| 4. O-ring | 8. Spring |            |                    |

**Figure 3-9. Loop Flushing Spool**

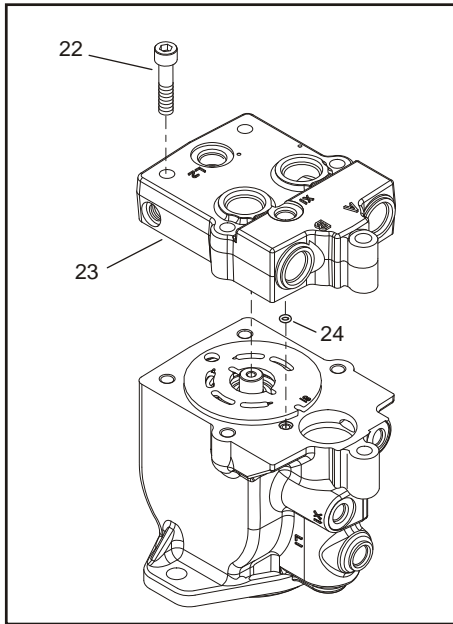
1. Using a 11/16 in wrench remove plug (1) and (2).
2. Using a 5/8 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



- |                       |                    |
|-----------------------|--------------------|
| 14. Lock Nut          | 18. Cavity Plug    |
| 15. O-ring Plug       | 19. Drain Plug     |
| 16. Control Line Plug | 20. Drain Plug     |
| 17. Control Line Plug | 21. Work Port Plug |

**Figure 3-10. Plugs, Fittings, and Speed Sensor**

8. Remove all fittings from the unit. Discard any O-rings on the fittings.
9. Using an 11/16 inch hex wrench, loosen the speed sensor lock nut (14) if equipped. Then remove the speed sensor using a Vi inch hex wrench. Units without speed sensor have an O-ring plug (15) installed in that location; remove it with a Va inch internal hex wrench.
10. Using a 1/4 inch internal hex wrench, remove control line plugs (16, 17). Discard O-rings. Using a 3 mm hex wrench, remove cavity plug (18, if equipped with two-line control) from X2 cavity.
11. Using a 5/16 inch internal hex wrench, remove drain plugs (19, 20). Discard O-rings.
12. Using a 9/16 inch internal hex wrench, remove work port plugs (21, if equipped with axial ports). Discard O-rings.

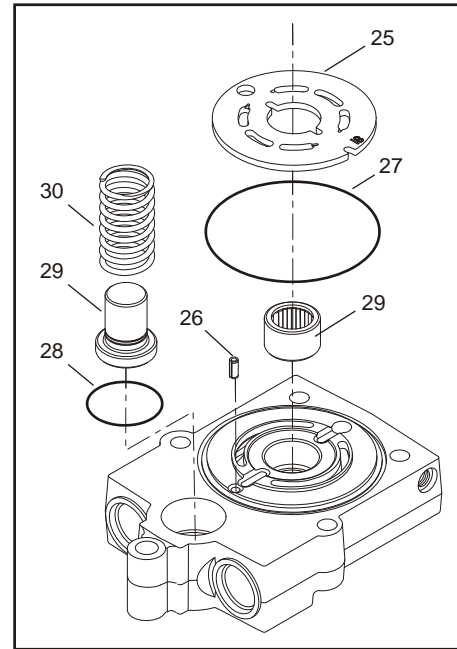


- 22. Screw
- 23. End Cap
- 24. O-ring

Figure 3-11. End Cap

13. Using an 8 mm internal hex wrench, remove the endcap screws (22).
14. Remove the endcap (23). Remove O-ring (24) from the housing or endcap.

When the endcap screws are removed, pressure from the servo spring will cause the endcap to bind on the shaft. Press down on the portion of the endcap covering the servo piston and hold the endcap level while removing.



- 25. Valve Plate
- 26. End Cap
- 27. O-ring
- 28. O-ring
- 29. Angle Stop
- 30. Servo Spring

Figure 3-12. Valve Plate & Rear Shaft Bearing

**CAUTION**

**TAKE CARE NOT TO SCRATCH THE SURFACE OF THE VALVE PLATE.**

15. Remove the valve plate (25) and timing pin (26) from the endcap.

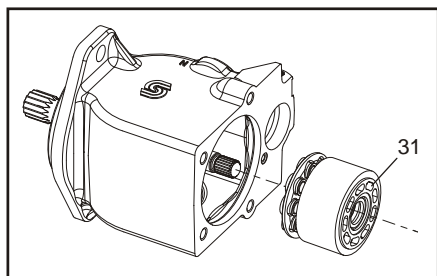
Each displacement has a unique valve plate. For identification, the last two digits of the valve plate part number are stamped on its surface.

16. Remove and discard the O-rings (27, 28).
17. Remove the rear shaft bearing (29) from the endcap with a bearing puller.

The bearing may be difficult to remove with a puller. Try this as an alternative: Pack the bearing cavity with heavy grease. After the shaft is removed, insert it into the bearing cavity and tap lightly with a soft mallet on the splined end. The grease will force the bearing out. Use caution not to drive the bearing past the rear shaft journal as the bearing may become trapped on the shaft and damaged.

## SECTION 3 - CHASSIS & TURNTABLE

18. Remove minimum angle stop (29) and servo spring (30) from the housing.



31. Cylinder Kit Assembly

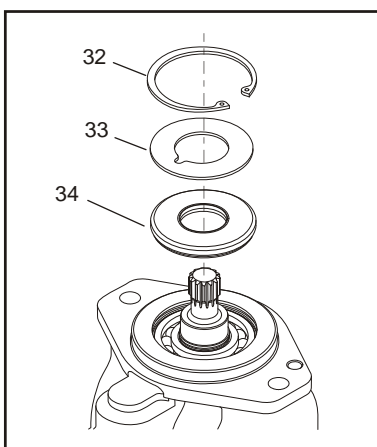
**Figure 3-13. Cylinder Kit**

19. Turn the housing on its side and remove the cylinder kit assembly (31). Set the assembly aside, being careful not to scratch the running surface.

**NOTE:** Grooves on the surface of the cylinder kit identify its displacement:

**Table 3-5. Displacement Identifiers**

# of Grooves	Frame L	Frame K
1	25	38
2	30	45
3	35	--



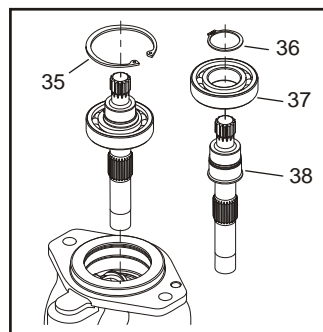
32. Snap Ring  
33. Support Washer  
34. Shaft Seal

**Figure 3-14. Shaft Seal**

20. Turn the housing over and remove the snap ring (32) retaining the shaft seal and support washer. Remove the support washer (33) and carefully pry out the

shaft seal (34). Discard the seal.

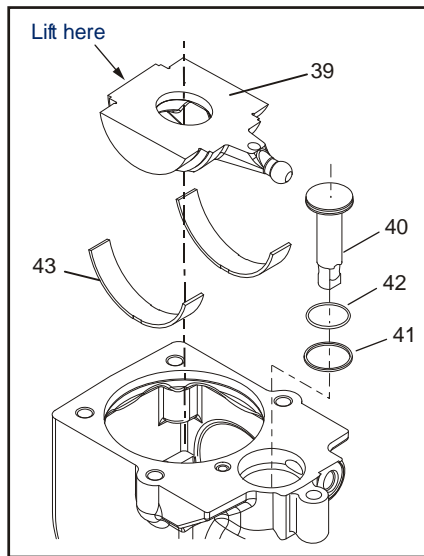
To avoid damaging the shaft during seal removal. Install a large sheet metal screw into the chuck of a slide hammer. Drive the screw into the seal surface and use the slide hammer to pull the seal.



35. Inner Snap Ring  
36. Snap Ring  
37. Bearing  
38. Shaft

**Figure 3-15. Shaft & Front Bearing**

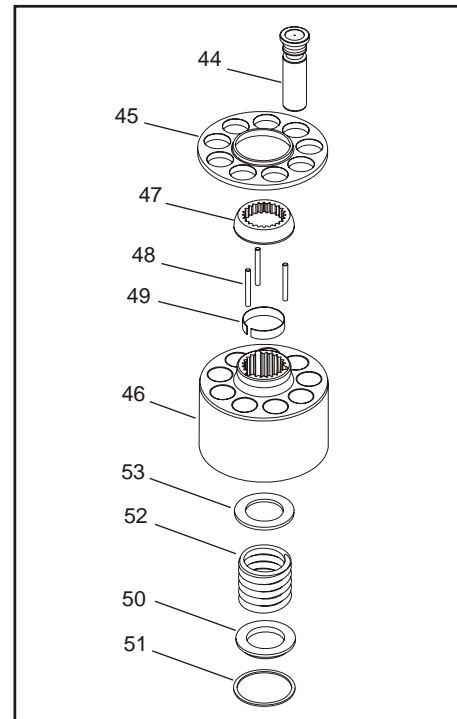
21. Remove the inner snap ring (35) and the shaft / bearing assembly.
22. Remove the snap-ring (36) retaining the shaft front bearing. Pull the bearing (37) off of the shaft (38).



- 39. Swashplate
- 40. Servo Piston
- 41. Piston Seal
- 42. O-ring
- 43. Journal Bearings

**Figure 3-16. Swash Plate & Servo Piston**

- 23. Turn housing over and remove the swashplate (39) by lifting on the end opposite the servo lever.
- 24. Remove the servo piston (40). Remove the piston seal (41) and O-ring (42) from the servo piston. Discard the seal and O-ring.
- 25. Remove the journal bearings (43) from the housing. If the bearings are to be reused, note the location and orientation of each bearing for reassembly.



- 44. Piston
- 45. Slipper Retainer
- 46. Cylinder Block
- 47. Ball Guide
- 48. Holddown Pins
- 49. Retaining Ring
- 50. Block Spring Washer
- 51. Spiral Retaining Ring
- 52. Block Spring
- 53. Inner Block Spring Washer

**Figure 3-17. Cylinder Kit Disassembly**

- 26. Remove pistons (44) and slipper retainer (45) from the cylinder block (46).

The pistons are not selectively fitted, however units with high hourly usage may develop wear patterns. Number the pistons and bores for reassembly if they are to be reused.

- 27. Remove the ball guide (47), hold-down pins (48), and retaining ring (49) from the cylinder block.

**NOTE:** Most repairs do not require block spring removal. Perform this procedure only if you suspect problems with the block spring.

**⚠ WARNING**

**RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES FORCE OF ABOUT 80 TO 90 LBF (350 TO 400 N). USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO REMOVE THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS REMOVED.**

## SECTION 3 - CHASSIS & TURNTABLE

28. Turn the block over. Using a press, apply pressure on the block spring washer (50) to compress the block spring. Compress the spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind the spiral retaining ring (51). Carefully release the pressure and remove the outer block spring washer (50), block spring (52), and inner block spring washer (53) from the cylinder block.

### Inspection

After disassembly, wash all parts (including the end-cap and housing) thoroughly with clean solvent and allow to air dry. Blow out oil passages in the housing and endcap with compressed air. Conduct inspection in a clean area and keep all parts free from contamination. Clean and dry parts again after any rework or resurfacing.

### PISTON

Inspect the pistons for damage and discoloration. Discolored pistons may indicate excessive heat; do not reuse.

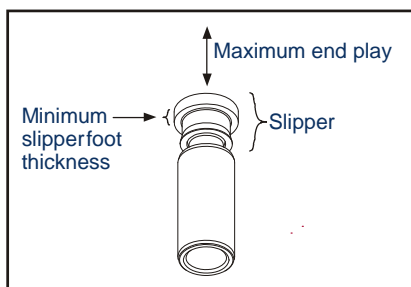
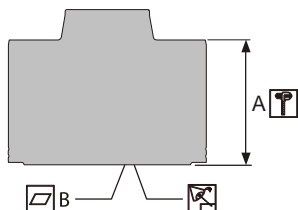


Table 3-7. Cylinder Block Measurements

Measurement	L25	L30	L35	K38	K45
Minimum Cylinder Block Height (A)	50.8 (2.00)	50.8 (2.00)	50.8 (2.00)	54.4 (2.14)	54.4 (2.14)
Cylinder Block Surface Flatness	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)



### SLIPPERS

Inspect the running surface of the slippers. Replace any piston assemblies with scored or excessively rounded slipper edges. Measure the slipper foot thickness. Replace any piston assemblies with excessively worn slippers. Check the slipper axial end-play. Replace any piston assemblies with excessive end-play.

Minimum slipper foot thickness and maximum axial end-play are given in the table below.

Table 3-6. Slipper Foot Thickness & End Play

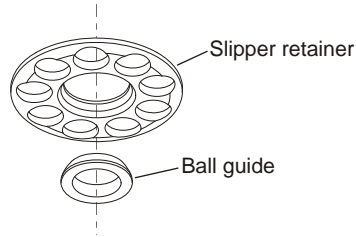
Measurement		L Frame	K Frame
Slipper Foot Thickness	mm (in.)	2.71 (0.11)	4.07 (0.16)
Piston/Slipper End Play		0.15 (0.006)	

### CYLINDER BLOCK

Measure the cylinder block height. Replace blocks worn beyond the minimum height specification. Inspect the running surface of the cylinder block. Replace or resurface worn or scratched blocks. Blocks may be resurfaced to the specifications shown in the drawing, provided resurfacing will not reduce the block height below the minimum specification. Table 3-7, Cylinder Block Measurements.

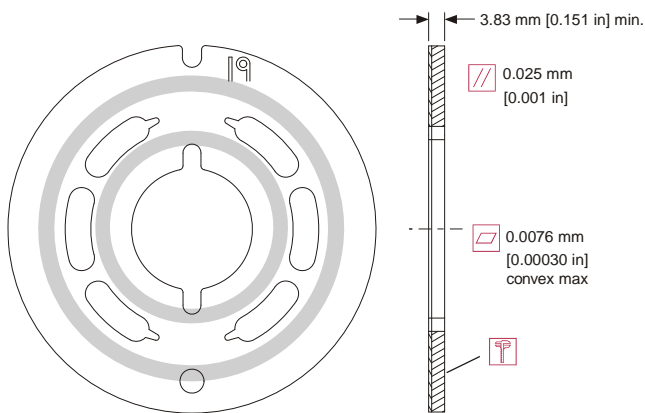
**BALL GUIDE AND SLIPPER RETAINER**

Inspect the ball guide and slipper retainer for damage, discoloration, or excessive wear. A discolored ball guide or slipper retainer indicates excessive heat. Do not reuse.



**VALVE PLATE**

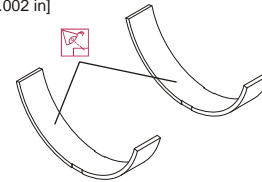
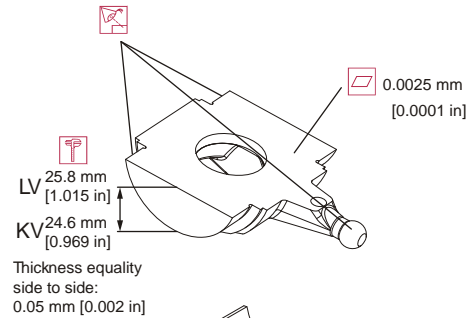
The condition of the valve plate is critical to the efficiency of the motor. Inspect the valve plate surfaces carefully for excessive wear, grooves, or scratches. Replace or resurface grooved or scratched valve plates. Measure the valve plate thickness and replace if worn beyond the minimum specification. Valve plates may be resurfaced to the specifications shown in the drawing, provided resurfacing will not reduce the thickness below the minimum specification.



**SWASHPLATE AND JOURNAL BEARINGS**

Inspect the running face, servo ball-joint, and swashplate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable providing the surface condition meets specifications shown from the journals to the running face. Measure the swashplate thickness from the journals to the running face. Replace swashplate if damaged or worn beyond minimum specification.

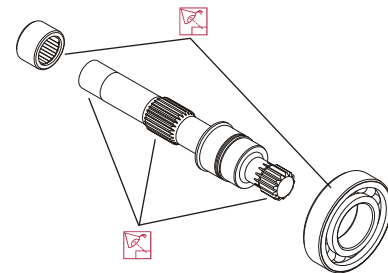
Replace swashplate if the difference in thickness from one side to the other exceeds specification.



Inspect the journal bearings for damage or excessive wear. Replace journal bearings if scratched, warped, or excessively worn. The polymer wear layer must be smooth and intact.

**SHAFT BEARINGS**

Inspect bearings for excessive wear or contamination. Rotate the bearings while feeling for uneven movement. Bearings should spin smoothly and freely. Replace bearings that appear worn or do not rotate smoothly.

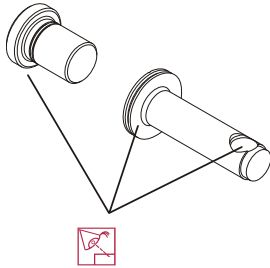


**SHAFT**

Inspect the motor shaft. Look for damage or excessive wear on the output and block splines. Inspect the bearing surfaces and sealing surface. Replace shafts with damaged or excessively worn splines, bearing surfaces, or sealing surfaces.

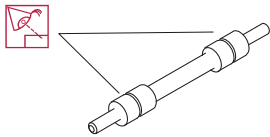
**SERVO PISTON AND MINIMUM ANGLE STOP**

Inspect the minimum angle stop, servo piston head, and servo piston ball-socket for damage or excessive wear. Replace if necessary.



**LOOP FLUSHING SPOOL**

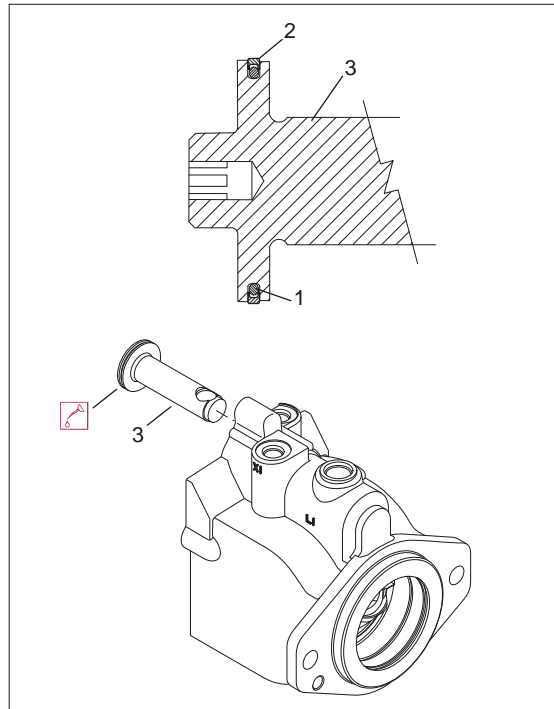
Inspect the loop flushing spool. Check for cracks or damage. Replace if necessary.



**Assembly**

1. Install new O-ring (1) and piston seal (2) to the servo piston (3). Install the piston seal over the O-ring.

Installing the piston seal stretches it, making it difficult to install the servo piston in its bore. Allow 30 minutes for the seal to relax after installation. To speed up seal relaxation, compress the seal by installing the piston head into the servo cavity in the end-cap and let it stand for at least five minutes.



1. O-ring
2. Piston Seal
3. Servo Piston

**Figure 3-18. Servo Piston**

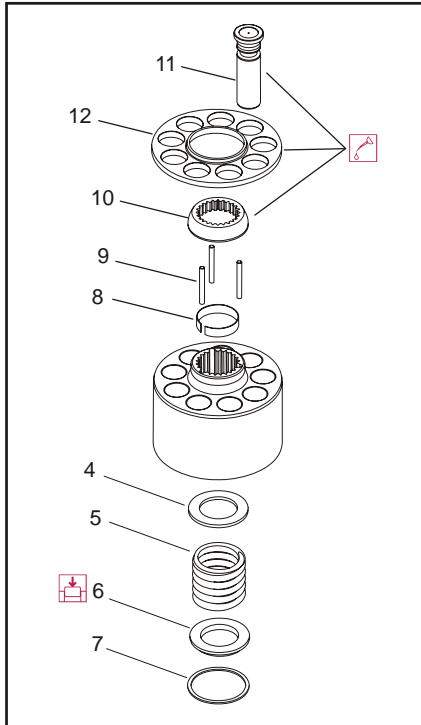
2. After piston seal has relaxed, lubricate and install servo piston into the housing bore. Align the piston with the ball socket facing the inside of the housing.

**⚠ WARNING**

**RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES ABOUT 80 TO 90 LBF (350 TO 400 N) OF FORCE. USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO INSTALL THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS INSTALLED.**



3. Install the inner block spring washer (4), block spring (5), and outer washer (6) into the cylinder block. Using a press, compress the block spring enough to expose the retaining ring groove. Wind the spiral retaining ring (7) into the groove in the cylinder block.

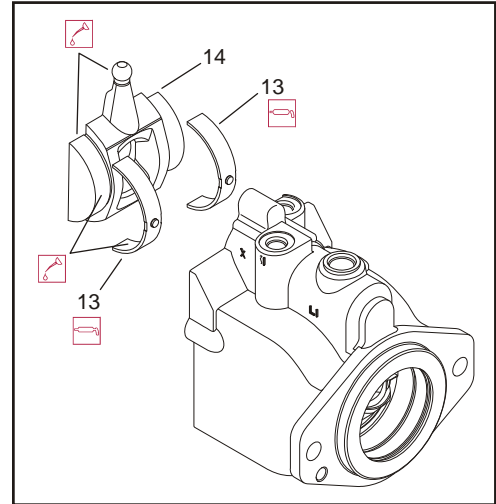


- |                          |                      |
|--------------------------|----------------------|
| 4. Block Spring Washer   | 9. Holddown Pins     |
| 5. Block Spring          | 10. Ball Guide       |
| 6. Outer Washer          | 11. Piston           |
| 7. Spiral Retaining Ring | 12. Slipper Retainer |
| 8. Retaining Ring        |                      |

**Figure 3-19. Cylinder Kit Assembly**

4. Turn the block over and install the retaining ring (8), hold-down pins (9), and ball guide (10) to the cylinder block.
5. Install the pistons (11) to the slipper retainer (12). Install the piston/retainer assembly into the cylinder block. Ensure the concave surface of the retainer seats on the ball guide. If you're reusing the pistons, install them to the original block bores. Lubricate the pistons, slippers, retainer, and ball guide before assembly. Set the cylinder kit aside on a clean surface until needed.

6. Install the journal bearings (13) into the housing seats. Use assembly grease to keep the bearings seated during assembly. Ensure the locating nubs drop into the cavities in the seats. If you're reusing the bearings, install them in the original location and orientation. Lubricate the journal bearings.

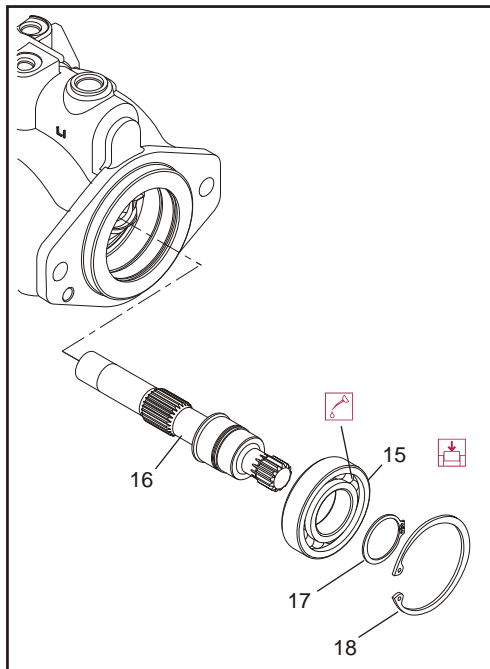


- |                      |
|----------------------|
| 13. Journal Bearings |
| 14. Swash Plate      |

**Figure 3-20. Swash Plate and Journal Bearing**

7. Install the swashplate (14) into the housing. Tilt the swashplate and guide the servo lever ball into its socket in the servo piston rod. Ensure the swashplate seats into the journal bearings and moves freely. Lubricate the running surface of the swashplate.

8. Press front shaft bearing (15) onto shaft (16). Press bearing onto shaft with lettering facing out. Lubricate bearing rollers. Install snap-ring (17) onto shaft.

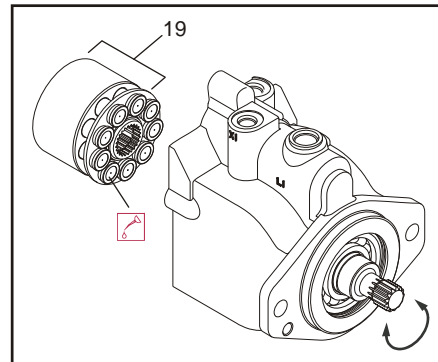


- 15. Front Shaft Bearing
- 16. Shaft
- 17. Snap Ring
- 18. Snap Ring

**Figure 3-21. Shaft and Front Bearing**

9. While holding the swashplate in place, turn the housing on its side. Install the install shaft/bearing assembly into housing from the flange end. Install the snap-ring (18).

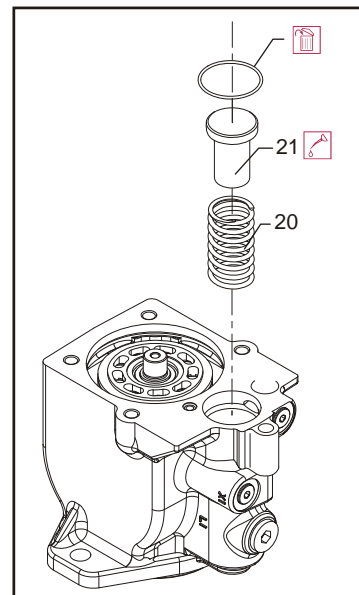
10. Verify swashplate and bearings are properly seated. Install the cylinder kit (19) onto the shaft. Install with the slippers facing the swashplate. Rock the shaft to align the block splines and slide the cylinder kit into place. Orient the motor with the shaft pointing downward and verify the cylinder kit, swashplate, journal bearings, and servo piston are all secure and properly installed.



19. Cylinder Kit

**Figure 3-22. Cylinder Kit Installation**

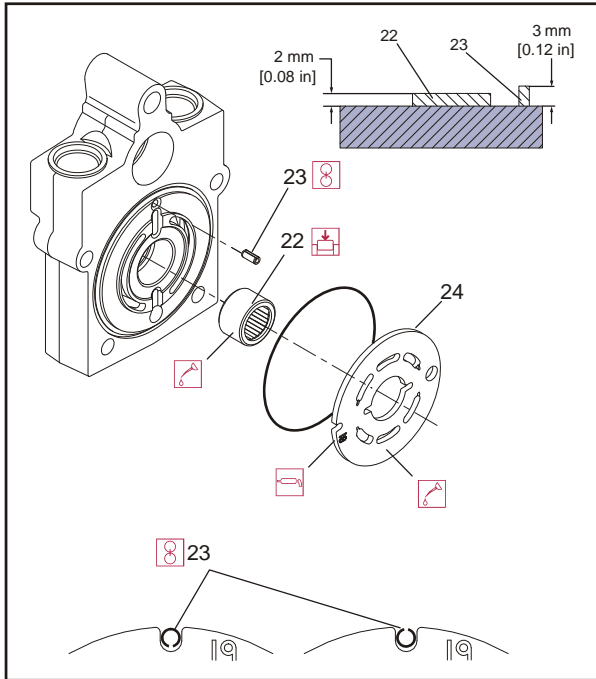
11. Lubricate and install the servo spring (20), and minimum angle stop (21) into the housing bore.



- 20. Servo Spring
- 21. Minimum Angle Stop

**Figure 3-23. Servo Spring and Minimum Angle Stop**

12. Press the rear shaft bearing (22) into the endcap. Install the bearing with letters facing out. Press until bearing surface is  $0.08 \pm 0.01$  in ( $2 \pm 0.25$  mm) above endcap surface.

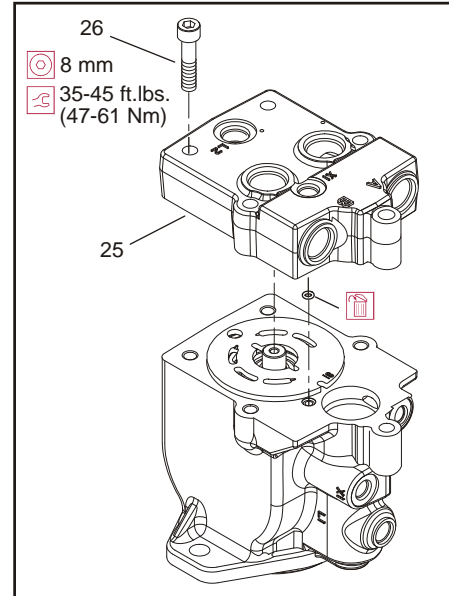


22. Rear Shaft Bearing  
23. Timing Pin  
24. Valve Plate

Figure 3-24. Valve Plate and Rear Bearing

13. Install timing pin (23) into its bore in the endcap. Install the pin with its groove facing toward or away from the shaft. Press the pin until the end protrudes  $0.12 \pm 0.01$  in ( $3 \pm 0.25$  mm) above endcap surface.
14. Install the valve plate (24) onto the endcap. Install the valve plate with the yellow surface toward the cylinder block. Align the slot in the valve plate with the timing pin. Apply a liberal coat of assembly grease to the endcap side of the valve plate to keep it in place during installation.

15. Install the endcap (25) onto the housing with the endcap screws (26). Check to ensure the endcap will properly seat onto the housing without interference. Improper assembly of the internal components may prevent the endcap from seating properly. Ensure the O-rings seat properly when installing the endcap.



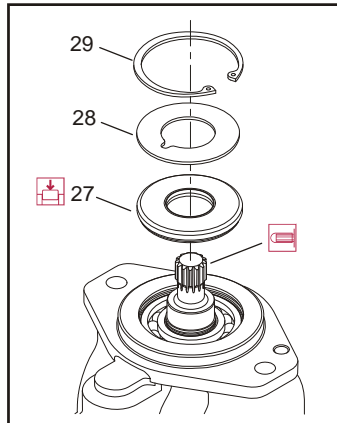
25. End Cap  
26. Screw

Figure 3-25. End Cap

16. Using an 8 mm internal hex wrench, tighten the endcap screws. Tighten the screws in opposite corners slowly and evenly to compress the servo spring and properly seat the endcap. Torque endcap screws 35-45 ft.lbs. (47-61 Nm).
17. Before installing the shaft seal, ensure the shaft turns smoothly with less than 120 in.lbs. (13.5 Nm) of force. If the shaft does not turn smoothly within the specified maximum force, disassemble and check the unit.

## SECTION 3 - CHASSIS & TURNTABLE

18. Cover shaft splines with an installation sleeve. Install a new shaft seal (27) with the cup side facing the motor. Press seal into housing until it bottoms out. Press evenly to avoid binding and damaging the seal. Install seal support washer (28) and snap ring (29).



- 27. Shaft Seal
- 28. Seal Support Washer
- 29. Snap Ring

Figure 3-26. Shaft Seal

19. Install remaining plugs and fittings to the housing. Refer to the drawing below for wrench sizes and installation torques.

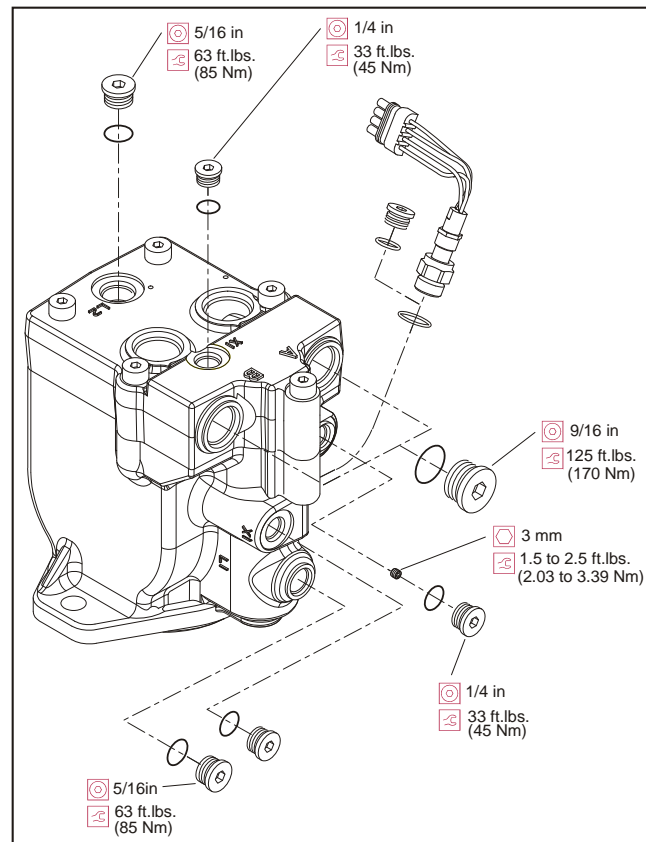
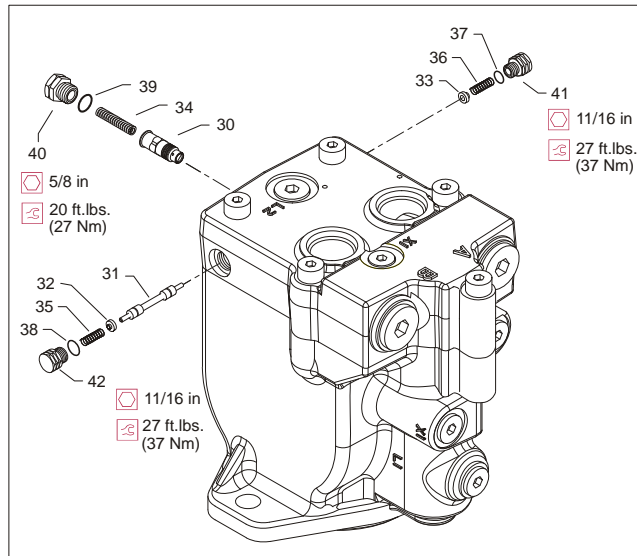


Figure 3-27. Plugs and Fittings Installation

## 20. Install orifice poppet (30).



30. Orifice Poppet	34. Spring	37. O-ring	40. Plug
31. Shift Spool	35. Spring	38. O-ring	41. Plug
32. Spring	36. Spring	39. O-ring	42. Plug
33. Spring			

Figure 3-28. Loop Flushing Spool

21. Install shift spool (31).
22. Install spring retaining washers onto springs (32 and 33).
23. Carefully install centering springs (34, 35, and 36).
24. Install new O-rings (37, 38, and 39).
25. Using a 5/8 in wrench torque plug (40) to 20 ft.lbs. (27 Nm).
26. Using a 11/16 in wrench, torque plugs (41 and 42) to 27 ft.lbs. (37 Nm).

## Initial Start-up Procedures

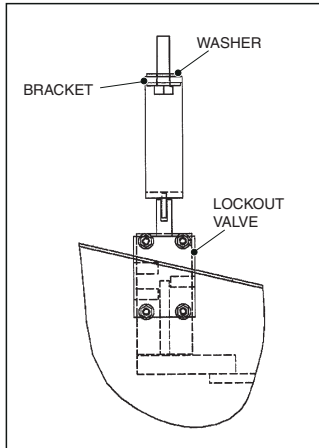
Follow this procedure when starting-up a new motor or when installing a motor that has been removed.

Prior to installing the motor, inspect for damage incurred during shipping. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

1. Fill the reservoir with recommended hydraulic fluid. Always filter fluid through a 10 micron filter when pouring into the reservoir. Never reuse hydraulic fluid.
2. Fill the inlet line leading from the pump to the reservoir. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
3. Fill the pump and motor housing with clean hydraulic fluid. Pour filtered oil directly into the upper most case drain port.
4. To ensure the pump and motor stay filled with oil, install case drain lines into the upper most case drain ports.
5. Install a 0 to 500 psi (0 to 35 bar) gauge in the charge pressure gauge port of the pump to monitor system pressure during start up.
6. While watching the pressure gauge, run the engine at the lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shut down the prime mover, determine cause, and take corrective action.
7. Operate the hydraulic system for at least fifteen minutes under light load conditions.
8. Check and adjust control settings as necessary after installation.
9. Shut down the prime mover and remove the pressure gauge. Replace plug at the charge pressure gauge port.
10. Check the fluid level in the reservoir; add clean filtered fluid if necessary. The motor is now ready for operation.

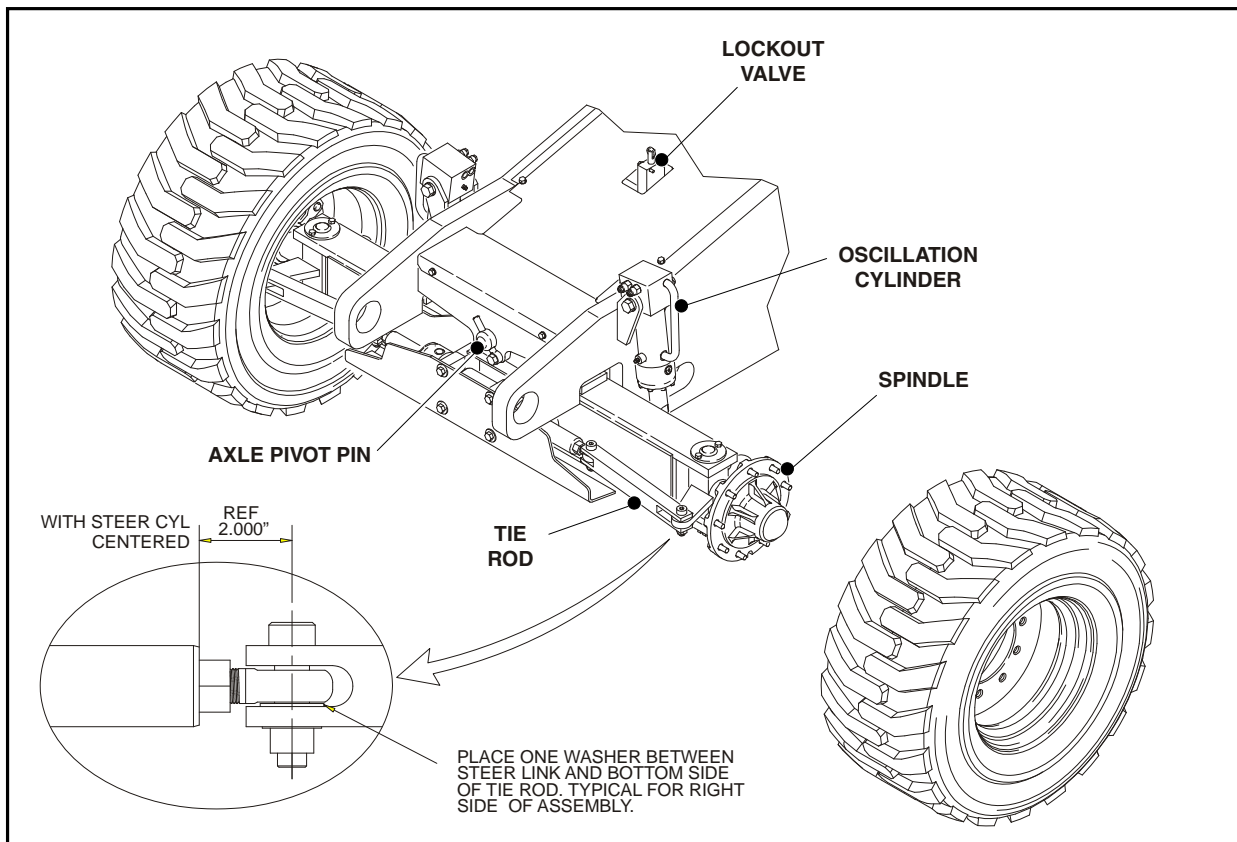
**3.8 ADJUSTMENT PROCEDURE FOR LOCKOUT VALVE**

1. With the turntable centered, adjust the bracket with the washers to push the plunger in  $5/16" \pm 1/16"$ .
2. The ideal adjustment is  $3/8"$ . Do not push the plunger in more than  $3/8"$ . The extra adjustment is needed for the turntable bearing play



**3.9 TOE-IN ADJUSTMENT**

1. Measure from the same point, on the tire, from the front side, then on the back side.
2. The tires must be within  $0 \pm 0.25"$  ( $0 \pm 6.35$  mm).

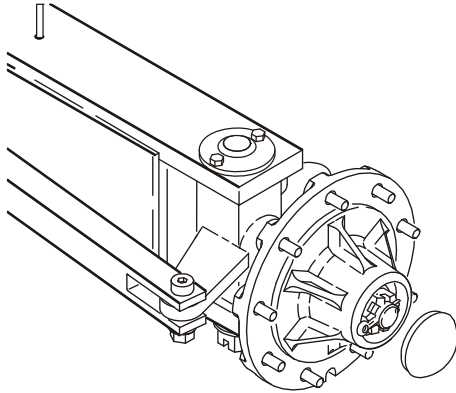


**Figure 3-29. Front Axle**

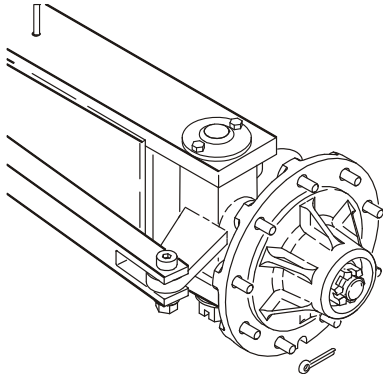
### 3.10 2WD HUB

#### Removal & Disassembly

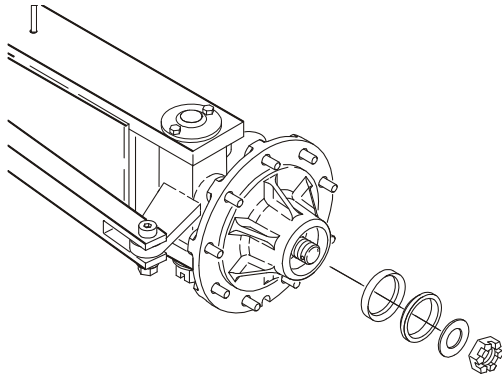
1. Remove the tire and wheel. Refer to Section 3.1, Tires & Wheels.
2. Remove the dust cap.



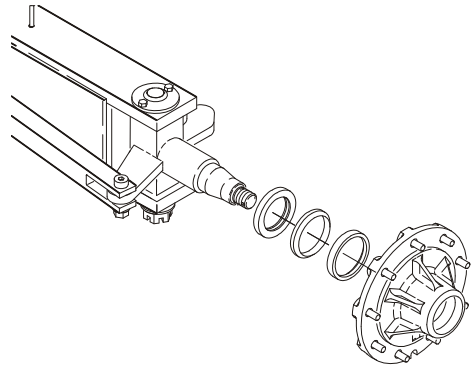
3. Remove the cotter pin securing the castle nut.



4. Remove the castle nut. Pull the hub assembly off of the spindle being careful not to let the outer bearing cone fall. The inner bearing and seal will come off with the hub.

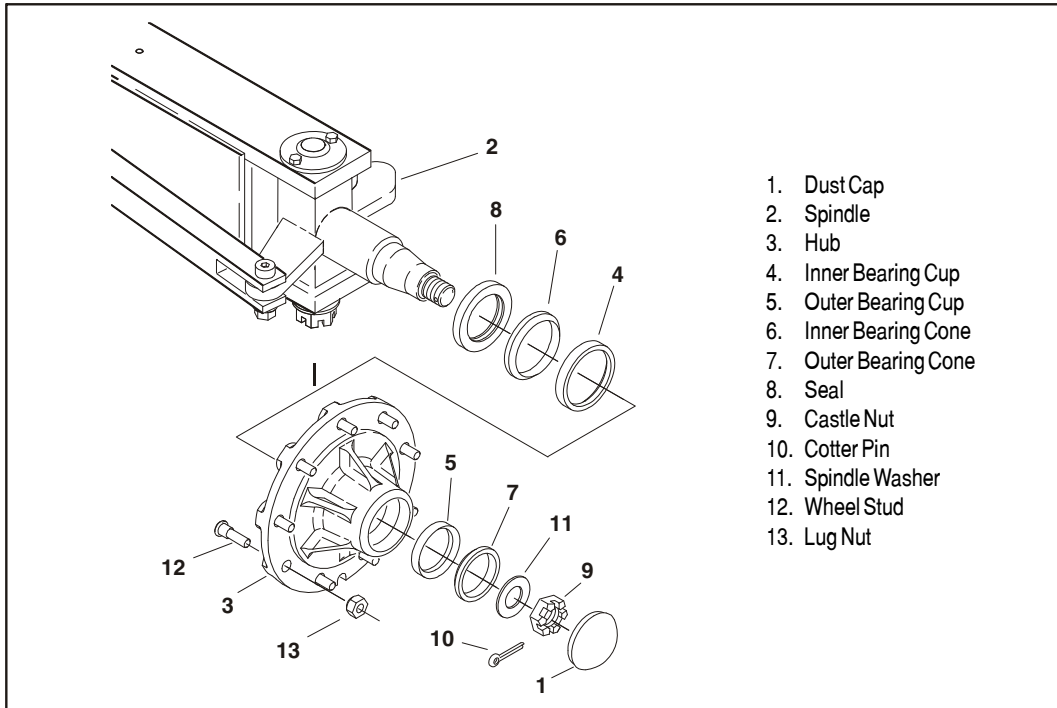


5. Use the inner cone and a mild steel bar to drive the seal out of the hub. Take care to ensure the bar doesn't damage the bearing cone or cage.



#### Cleaning & Inspection

1. Remove all the old lubricant from the hub and spindle, then clean them with kerosene or mineral oil. Inspect the spindle for scoring, bending, thread or other damage. File off nicks and burrs. A light grease coating on the cone seats will make installation easier and help prevent fretting.
2. Inspect the cups in the housing for pitting, metal flaking, scoring, rust, or other obvious damage. Remove the damaged cups with a mild steel bar. Replace the cups and mating cones. Inspect the hub bore and cup backing shoulder and remove nicks and burrs that may prevent the cup from seating properly.
3. Using a long-bristled brush and kerosene or mineral oil, wash all the old lubricant off of the bearing cones. Allow the cones to air dry. Do not spin the rollers with air as this may damage the cone. Inspect the cones for wear, metal flaking, rust, cage damage, or other visible defects. Replace all damaged cones and mating cups.



1. Dust Cap
2. Spindle
3. Hub
4. Inner Bearing Cup
5. Outer Bearing Cup
6. Inner Bearing Cone
7. Outer Bearing Cone
8. Seal
9. Castle Nut
10. Cotter Pin
11. Spindle Washer
12. Wheel Stud
13. Lug Nut

Figure 3-30. 2WD Hub

## Assembly & Installation

1. Use a cup driver or mild steel bar to press or drive the new cup into the hub until it is solidly seated against the rotor hub shoulder. Be careful not to damage the cup surfaces. Never use a cone to drive a cup.
2. Re-pack the cones immediately after inspection or when installing a new cone. A pressure grease packer is suggested.

### **⚠ WARNING**

**FAILURE TO CORRECTLY LUBRICATE THE BEARING AND MAINTAIN PROPER LUBRICATION MAY RESULT IN BEARING DAMAGE WHICH COULD CAUSE THE WHEEL TO LOCK UP OR COME OFF.**

3. Grease seals must be replaced when they leak or when bearings are being repacked or replaced. Install the inner cone in the hub, then the seal. Make sure the seal lips are pointed in the right direction. Use the proper seal installation tool.
4. Slide the hub assembly back over the spindle, taking care not to damage the seal against the spindle outer end or threads. Insert the grease-packed outer cone, spindle washer, and castle nut.
5. Tighten the adjusting nut while turning the hub. When the hub binds slightly, all parts are properly seated. Back off the nut 1/5 to 1/4 turn or sufficiently

to allow 0.001 to 0.010" end play, then lock the nut with a new cotter pin.

### **⚠ WARNING**

**FAILURE TO BACK OFF THE ADJUSTING NUT WILL CAUSE THE BEARING TO RUN HOT AND BE DAMAGED WHICH COULD CAUSE THE WHEEL TO LOCK UP OR COME OFF.**

6. Use a dial indicator to measure end play. Mount the indicator base as close to the center of the hub as possible. With the indicator tip against the end of the spindle, set the indicator at zero. Grasp the hub at 9 o'clock and at 3 o'clock. Push the hub in and out oscillating it at the same time to seat the parts. Read the bearing end play as the total indicator movement.



### 3.11 OSCILLATING AXLE BLEEDING PROCEDURE

#### NOTICE

ENSURE PLATFORM IS FULLY LOWERED AND BOOM IS CENTERED OVER REAR AXLE PRIOR TO BEGINNING BLEEDING PROCEDURE.

MAKING SURE MACHINE IS ON A LEVEL SURFACE AND REAR WHEELS ARE BLOCKED, DISENGAGE DRIVE HUBS. OPTIONAL 4WD ALL HUBS MUST BE DISENGAGED.

1. Making sure machine is on a level surface and rear wheels are blocked, disengage drive hubs. Optional 4WD all hubs must be disengaged.
2. Make up an adapter with an air regulator, remove filler cap on hydraulic tank and install regulator.
3. Attach air supply to the regulator and set regulator to 2 - 5 psi (0.14-0.34 Bar).

#### CAUTION

DO NOT EXCEED 5 PSI (0.34 BAR) INTO HYDRAULIC TANK. MORE THAN 5 PSI (0.34 BAR) WILL CAUSE DAMAGE TO THE HYDRAULIC TANK.

4. Activate machine hydraulic system from platform control station.
5. Place LOW ENGINE, HIGH DRIVE SPEED and HIGH WHEEL MOTOR SPEED control switches to their respective HIGH positions.
6. Depress footswitch and activate DRIVE CONTROLLER to "FORWARD" position.
7. Using a suitable lifting equipment lift front of machine and place a 6 in. (15.2 cm) high block under right front wheel.

8. Lower machine so both of the lockout cylinders are oscillated; one extended, the other retracted.
9. Use suitable containers to retain any residual hydraulic fluid, place containers under each lockout cylinder.
10. With DRIVE CONTROLLER activated and engine at idle, open all four bleeder screws (two on each lockout cylinder), one at a time, then close bleeder screws when all air is dissipated (bled).
11. Using a suitable lifting equipment lift front of machine and remove the 6 in. (15.2 cm) high block.
12. Transfer the 6 in. (15.2 cm) high block to the left front wheel and repeat steps 2 thru 7, substituting the word "right" for "left" in step 5.
13. Perform oscillating axle lockout test.

### 3.12 OSCILLATING AXLE LOCKOUT TEST

#### NOTICE

LOCKOUT SYSTEM TEST MUST BE PERFORMED QUARTERLY, ANY TIME A SYSTEM COMPONENT IS REPLACED, OR WHEN IMPROPER SYSTEM OPERATION IS SUSPECTED.

*NOTE: Ensure boom is fully retracted, lowered, and centered between drive wheels prior to beginning lockout cylinder test.*

1. Place a 6 in. (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control station, activate machine hydraulic system.
3. Place DRIVE control lever to FORWARD position and carefully drive machine up ascension ramp until left front wheel is on top of block.
4. Carefully activate SWING control lever and position boom over right side of machine.
5. With boom over right side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.

6. Have an assistant check to see that right front wheel remains locked in position off of ground.
7. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). After boom reaches stowed position, activate DRIVE and lockout cylinders should release and allow wheel to rest on ground.
8. Place the 6 in. (15.2 cm) high block with ascension ramp in front of right front wheel.
9. Place DRIVE control lever to FORWARD and carefully drive machine up ascension ramp until right front wheel is on top of block.
10. Carefully activate SWING control lever and position boom over left side of machine.
11. With boom over left side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.
12. Have an assistant check to see that right front wheel remains locked in position off of ground.
13. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). After boom reaches stowed position, activate DRIVE and lockout cylinders should release and allow wheel to rest on ground.

If lockout cylinders do not function properly, have qualified personnel correct the malfunction prior to any further operation.

### 3.13 SWING BEARING

#### Turntable Bearing Mounting Bolt Condition Check

**NOTE:** This check is designed to replace the existing bearing bolt torque checks on JLG Lifts in service. This check must be performed after the first 50 hours of machine operation and every 600 hours of machine operation thereafter. If during this check any bolts are found to be missing or loose, replace missing or loose bolts with new bolts and torque to the value specified in the torque chart, after lubricating the bolt threads with loctite #271. After replacing and retorquing bolt or bolts recheck all existing bolts for looseness.

Check the frame to bearing. Attach bolts as follows:

1. Elevate the fully retracted boom to full elevation and rotate platform 90°.
2. Swing turntable over the side.
3. On the frame, at the rear of the turntable, try to insert the 0.0015" feeler gauge between the bolt head and hardened washer at the indicated position. (Table 3-31., Swing Bearing Feeler Gauge Check)
4. Assure that the 0.0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
5. Swing the turntable 90 degrees, and check some selected bolts at the new position.
6. Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.
7. Lower the boom to horizontal and fully extend the boom.
8. Swing the turntable over the side.
9. On the frame, at the front of the turntable, try to insert the 0.0015" feeler gauge between the bolt head and hardened washer at the indicated position. (Figure 3-31.)
10. Assure that the 0.0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
11. Swing the turntable 90 degrees, and check some selected bolts at the new position.
12. Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.

Check the turntable to bearing. Attach bolts as follows:

1. Elevate the fully retracted boom to full elevation and rotate the platform 90°.
2. Swing the turntable over the side.
3. At turntable rear, try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
4. Assure that the 0.0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
5. Swing the turntable 90 degrees, and check some selected bolts at the new position.
6. Continue rotating the turntable at 90 degree intervals until a sampling of bolts have been checked in all quadrants.

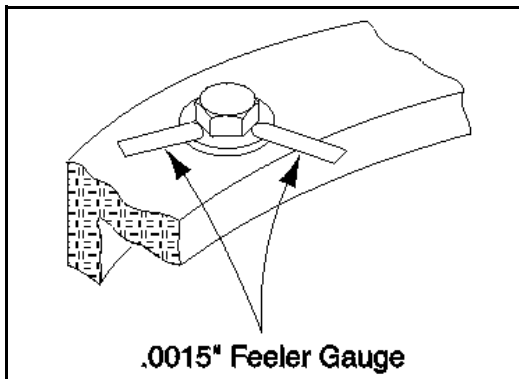


Figure 3-31. Swing Bearing Feeler Gauge Check

7. Lower the boom to horizontal and fully extend the boom.
8. At turntable front, try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
9. Assure that the 0.0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
10. Swing the turntable 90 degrees, and check some selected bolts at the new position.
11. Continue rotating the turntable at 90 degree intervals until a sampling of bolts have been checked in all quadrants.

## Wear Tolerance

1. With the boom positioned over the side of the machine, the Boom horizontal with telescope fully extended, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable front.
2. With the boom positioned over the side of the machine, the Boom fully elevated, retracted, and platform rotated 90°, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable rear.

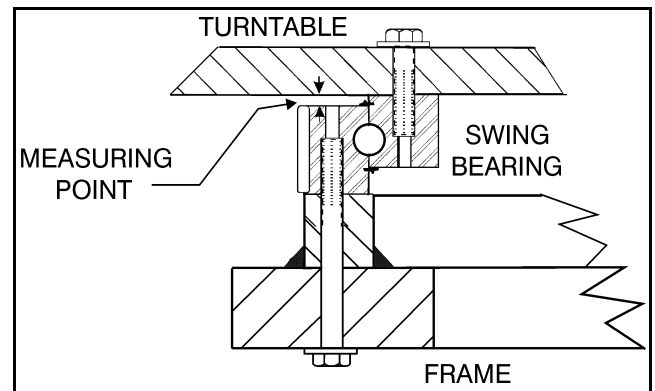


Figure 3-32. Swing Bearing Tolerance Measuring Point

3. If a difference greater than 0.057 in. (1.40 mm) is determined, the swing bearing should be replaced.
4. If a difference less than 0.057 in. (1.40 mm) is determined, and any of the following conditions exist, the bearing should be removed.
  - a. Metal particles in the grease.
  - b. Increased drive power.
  - c. Noise.
  - d. Rough rotation.
5. If bearing inspection shows no defects, reassemble bearing and return to service.

### Replacement of Swing Bearing

Removal of the swing bearing is as follows:

1. Attach an adequate support sling to the boom and draw all slack from sling. Prop or block the boom if feasible.
2. Tag and disconnect hydraulic lines running through center of turntable and frame. Use a suitable container to retain any residual hydraulic fluid. Cap lines and ports.
3. Attach suitable overhead lifting equipment to the base of turntable weldment.
4. Use a suitable tool to scribe a line on the inner race of the swing bearing and on the underside of the turntable. This will aid in aligning the bearing upon installation. Remove bolts, nuts and washers which attach the turntable to the bearing inner race. Discard nuts and bolts.
5. Use the lifting equipment to carefully lift the complete turntable assembly from the bearing. Ensure that no damage occurs to the turntable, bearing or frame mounted components.
6. Carefully place the turntable on a suitably supported trestle.
7. Use a suitable tool to scribe a line on the outer race of the swing bearing and the frame. This line will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the outer race of the bearing to the frame. Discard the bolts. Use suitable lifting equipment to remove the bearing and rotation box assembly from the frame; move to a clean, suitably supported work area.
8. Remove the two capscrews securing the bearing to the rotation box to separate the two for inspection.

Installation of the swing bearing is as follows:

1. Install bearing to turntable with two capscrews, so that fill plug of bearing is as close to gear as bolt pattern will allow. Do not tighten capscrews.
2. Line up high spot (yellow) of bearing with center tooth of bull gear. Set backlash to 0.008 - 0.010 inch (0.20 - 0.25 mm). Tighten capscrews as shown in Figure 3-33., Swing Bearing Torque Sequence
3. Grease bearing with Mobilith SHC Bearing Grease. Grease fitting is on inside wall of inner race of bearing.

**NOTE:** If Mobiletac 375NC is not available, Tribol Molub-Alloy 936 Open Gear Compound or Mobilith SHC Bearing Grease or Multi-Purpose Grease (MPG) can be substituted, however the service interval will be shorter.

4. Using suitable lifting equipment, install bearing/assembly to frame with soft spot (red) 90 degree relative to load axis. If reusing old bearing, ensure that scribed line of outer race of the bearing aligns with the scribed mark on the frame.

#### **⚠ CAUTION**

**JLG INDUSTRIES RECOMMENDS THAT ALL REMOVED GRADE 8 BEARING NUTS AND BOLTS BE DISCARDED AND REPLACED WITH NEW GRADE 8 NUTS AND BOLTS. SINCE THE SWING BEARING IS THE ONLY STRUCTURAL LINK BETWEEN THE FRAME AND TURNTABLE, IT IS IMPERATIVE THAT SUCH REPLACEMENT HARDWARE MEETS JLG SPECIFICATIONS. USE OF GENUINE JLG HARDWARE IS HIGHLY RECOMMENDED.**

5. Apply a light coating of Loctite 271 to the new bearing bolts and loosely install the bolts and washers through the frame and outer race of bearing.

#### **⚠ CAUTION**

**IF COMPRESSED AIR OR ELECTRICALLY OPERATED IMPACT WRENCH IS USED FOR TIGHTENING THE BEARING ATTACHMENT BOLTS, THE TORQUE SETTING ACCURACY OF THE TOOL SHOULD BE CHECKED PRIOR TO USE.**

6. Following the torque sequence diagram shown in Figure 3-33., Swing Bearing Torque Sequence, tighten the bolts to an initial torque of 130 ft. lbs. (175 Nm). Then following the same sequence, tighten to a final torque of 190 ft. lbs. (260 Nm).
7. Remove lifting equipment from bearing.
8. Use suitable lifting equipment to carefully position the turntable assembly above the machine frame.
9. Carefully lower the turntable onto the swing bearing. Ensure that the scribed line of the inner race of the bearing aligns with the scribed mark on the turntable. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft centerline of the turntable.
10. Apply a light coating of Loctite 271 to the new bearing bolts and install through the turntable and inner race of bearing.
11. Following the torque sequence shown in Figure 3-33., Swing Bearing Torque Sequence tighten the bolts to an initial torque of 130 ft. lbs. (175 Nm). Then following the same sequence, tighten the bolts to 190 ft. lbs. (260 Nm).
12. Remove the lifting equipment.
13. Route hydraulic lines through center of turntable and frame and connect as tagged prior to removal.

- Using all applicable safety precautions, activate the hydraulic system and functionally check swing system for proper and safe operation

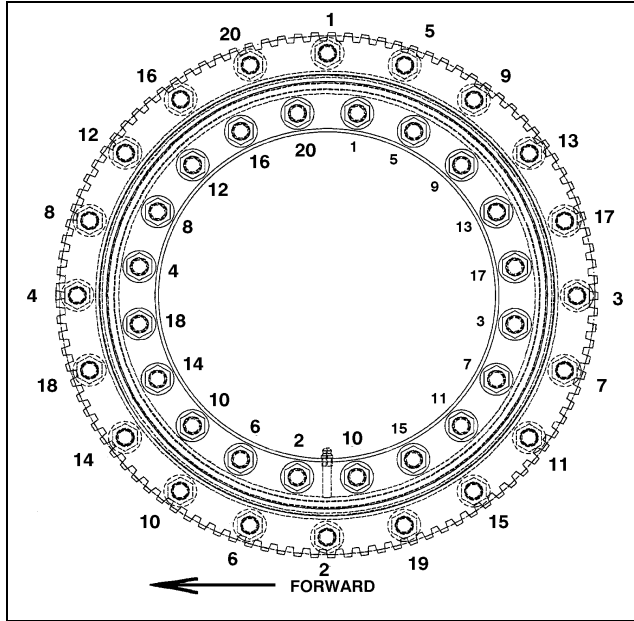


Figure 3-33. Swing Bearing Torque Sequence

### Swing Bearing Torque Value

Install with Loctite - 190 ft. lbs. (260 Nm).

### Swing Drive Installation

- Insure that the T/T mounting plate is clean and free of paint runs and drips.
- Mount swing drive motor to mounting plate.
- Position Swing drive to location of bearing gear max eccentric tooth. (high spot) High spot is marked with yellow paint in tooth.
- Slide drive motor into swing gear and shim to achieve  $+.008"/>.012$ " backlash. (+.20mm /30mm)
- Torque four 3/4-10 Soc. hd. Cap Scrs. with Loctite #242 to 285 ft.lbs. (386 Nm).
- Torque six 5/8-11Hex. hd. Cap Scrs. to 190 ft. lbs. (260 Nm).

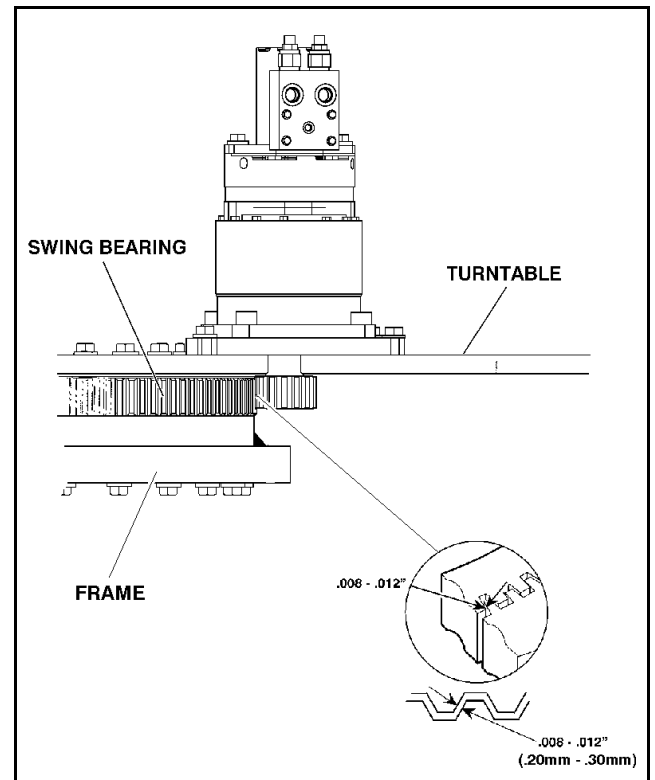
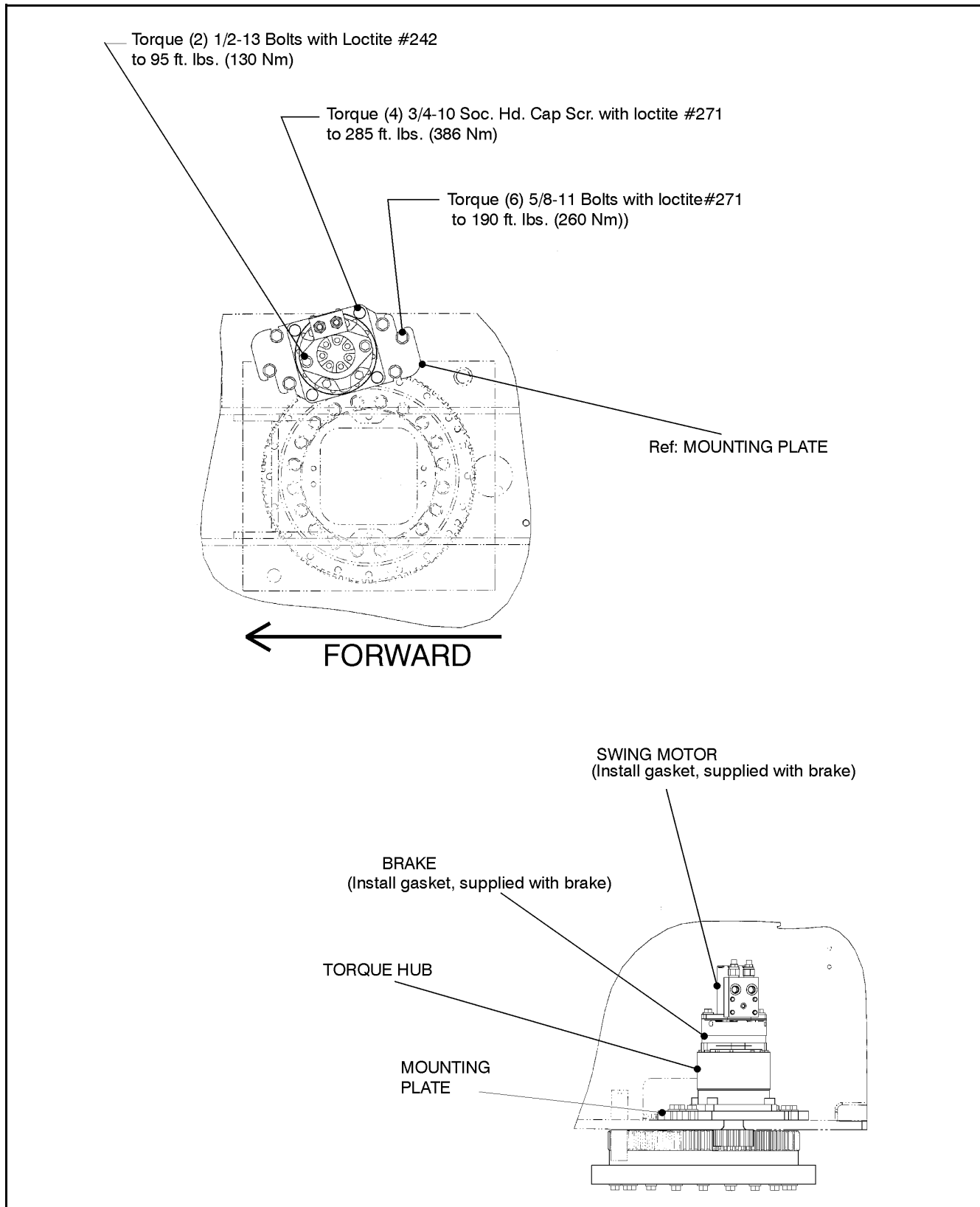


Figure 3-34. Drive Motor Adjustment

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**Figure 3-35. Swing Drive Installation**

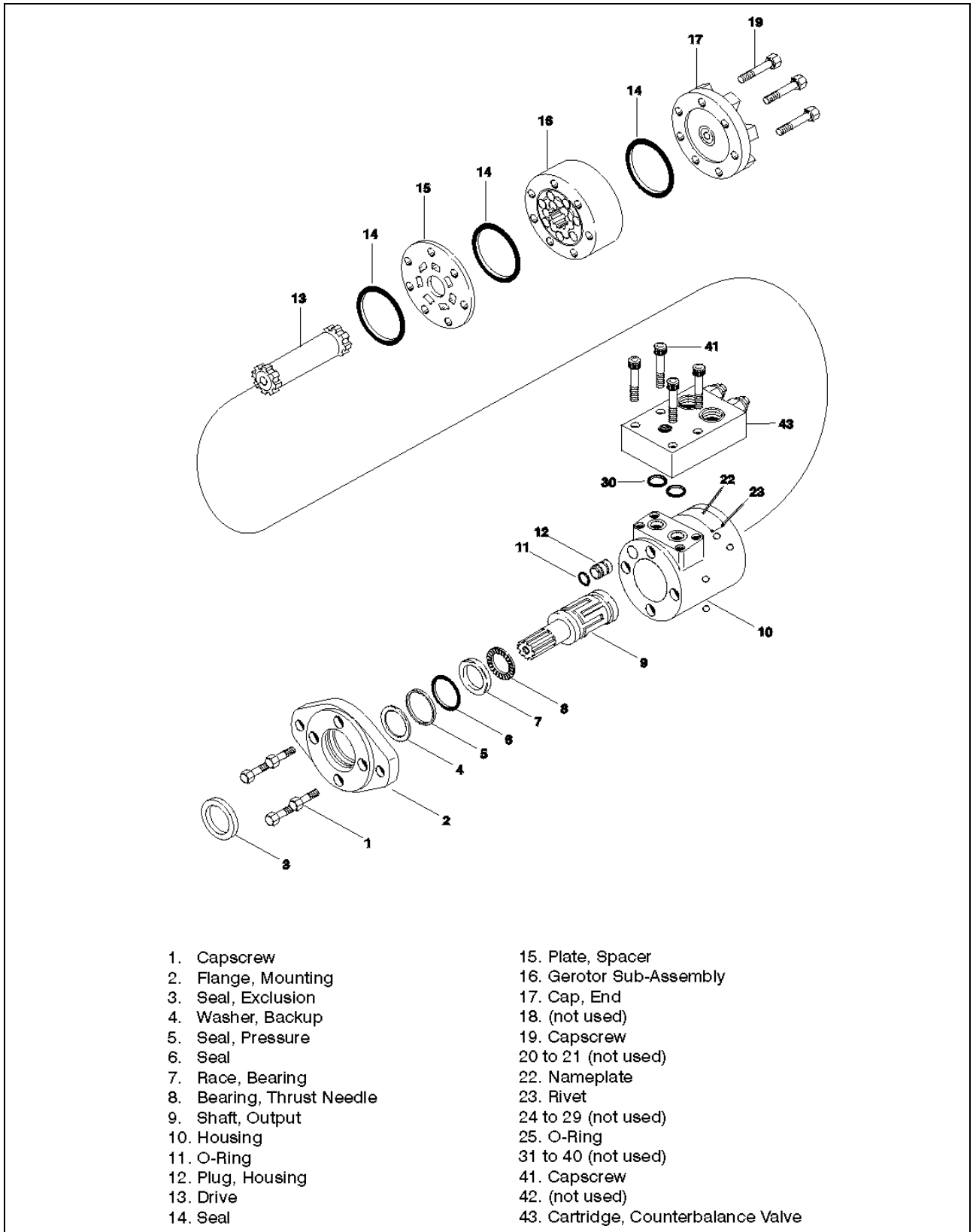


Figure 3-36. Swing Motor

### 3.14 SWING BRAKE (PRIOR TO S/N 64802)

The multi disc brake is spring loaded to apply the brake and hydraulic pressure is required to release or hold off the brake. Normal operation is to have the brake pressurized in the released position with the vehicle hydraulic system running. Any function which reduces the system pressure below the release pressure of the brake will cause the brake to be applied.

#### **⚠ CAUTION**

**FOR CORRECT OPERATION, HYDRAULIC PRESSURE TO THE BRAKE MUST FALL TO ZERO PSI. ANY RESIDUAL BACK PRESSURE APPLIED TO THE BRAKE WILL DEGRADE FUNCTION AND MAY RESULT IN A HAZARDOUS CONDITION.**

### Installation

1. Assemble brake between motor and gearbox. Place mounting gaskets on mounting faces before assembly. If needed, the brake shaft can be rotated by applying hydraulic pressure to the piston inlet port.
2. Insert four 1/2" dia. bolts (Grade 5) and lock washers through the motor flange, The gasket, and the threaded holes in the gear reducer. make sure that the bolts are not too long so they do not bottom out in the gear reducer threaded holes before clamping.
3. To prevent binding, run the bolts in alternately until snug. Torque the bolts to 75-85 ft. lbs. (102-115 Nm).
4. With brake bolted together, connect inlet hydraulic line. Brake inlet is 1/4" tubing, straight thread O-ring boss (7-16-20 unf).

### Brake Disassembly

1. Disassemble in the following order: Bolts (alternately), power plate, gasket, stationary discs, rotating discs, primary disc, torque pins, compression springs, and spring retainer.
2. Further disassemble is not recommended and should not be attempted unless necessary to replace the bearing. The seal, or the shaft. If further disassemble is needed, proceed as follows:

**NOTE:** *If the bearing and seal are removed for any reason, both must be replaced.*

- a. The shaft must be removed by pressing on the end of the shaft with a shop press.
- b. Using an appropriate tool. Pry the seal out from the inside of the brake. Take care not to damage the bore. Remove the retaining ring and tap out the bearing with a plastic mallet.

3. Remove the piston from the power plate by introducing low pressure air (15 psi) into the hydraulic inlet. Make sure the piston is directed away from the operator. Do not remove O-ring unless replacement is necessary because the will be damaged.

### Assembly Information

#### **NOTICE**

**THERE MAY BE MORE PARTS IN A SERVICE KIT THEN YOUR BRAKE REQUIRES. CHECK THE PARTS LIST CAREFULLY FOR THE EXACT QUANTITY.**

**NOTE:** *All parts must be thoroughly cleaned prior to reassembly.*

Use the reverse of the disassemble procedure with the following notes and additions:

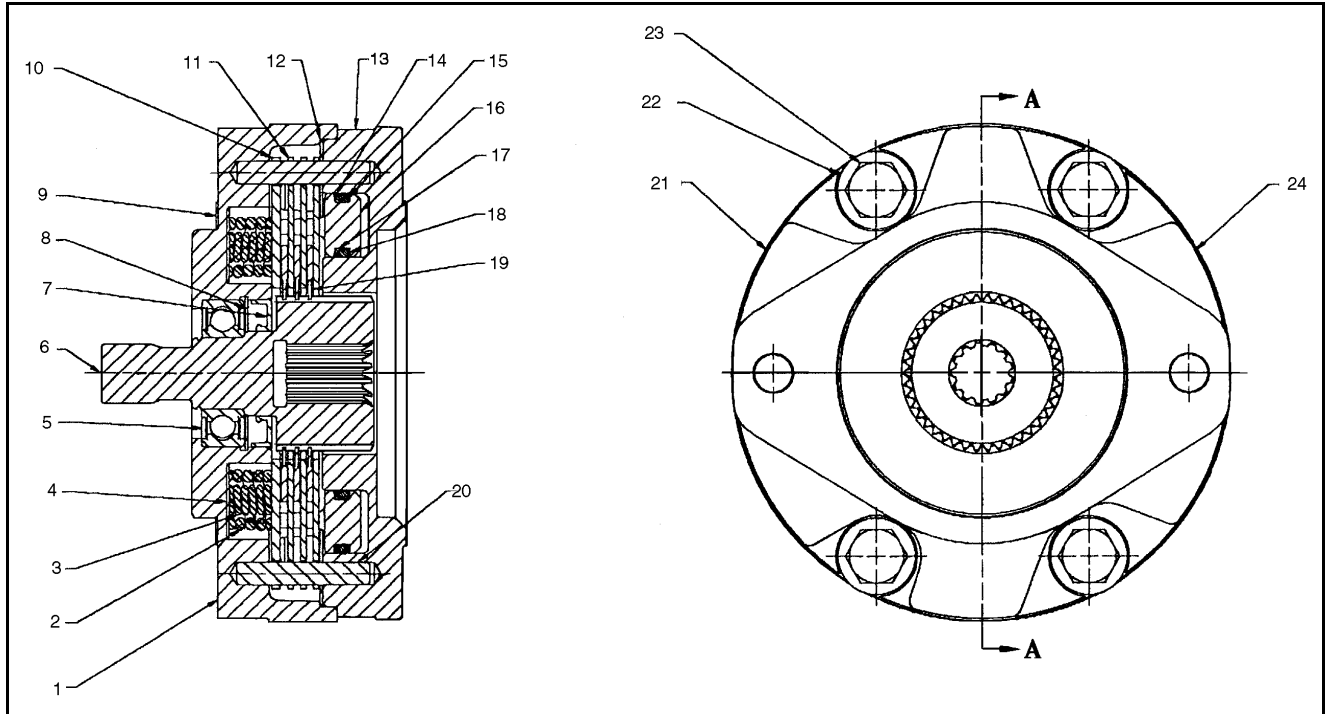
1. Worn and damaged O-rings, or worn Teflon backup rings must be replaced prior to reassembly.
2. Cylinder of the power plate, piston, and O-rings must be clean and pre-lubed prior to reassembly.
3. Piston Assembly: Assemble piston into power plate using a shop press. Being careful not to damage the O-ring or Teflon backup rings. Visually align the center of the cutouts in the piston with the torque pin holes in the power plate.

#### **⚠ CAUTION**

**THE DEPTH THAT THE PISTON IS INSTALLED INTO THE POWER PLATE IS CRITICAL. THE PISTON CUTOUTS MUST BE FLUSH TO.120 (3 MM) BELOW THE SURFACE OF THE POWER PLATE OR PISTON WILL COCK RESULTING IN A COMPLETE LOSS OF BRAKING.**

4. Bearing Assembly: Use a shop press to press the bearing into the shaft. Press only on the inner race of the bearing.
5. Lip Seal Assembly: Lip of seal must face the bearing to seal the brake.
6. Rotating, Stationary, Primary Disc Assembly: Rotating Disc must be clean. The lining material and mating surfaces of the Stationary Discs must be thoroughly clean and free from debris. Worn or scarred Rotating Discs must be replaced.
7. Install Bolts in the Power Plate. Tighten sequentially, one turn at a time, until Power Plate is properly seated. Torque to 85-90 ft. lbs.(115-122 Nm).





- |                       |                     |                             |
|-----------------------|---------------------|-----------------------------|
| 1. Housing            | 9. Gasket           | 17. Backup Ring             |
| 2. Compression Spring | 10. Primary Disc    | 18. O-ring                  |
| 3. Compression Spring | 11. Stationary Disc | 19. Rotating Disc           |
| 4. Spring Retainer    | 12. Gasket          | 20. Torque Pin              |
| 5. Bearing            | 13. Power Plate     | 21. Hex Plug                |
| 6. Shaft              | 14. Backup Ring     | 22. Plain Washer (Hardened) |
| 7. Lip Seal           | 15. O-ring          | 23. Bolt 1/2-13 Hex Hd.     |
| 8. Snap Ring          | 16. Piston          | 24. Protective Plug         |

Figure 3-37. Swing Brake Prior to S/N 64802

### 3.15 SWING BRAKE S/N 64802 TO PRESENT

#### Disassembly

1. Remove pressure plate (2) from cover (16) by removing washer head cap screws (1).

#### **⚠ CAUTION**

**PRESSURE PLATE IS UNDER SPRING TENSION OF APPROXIMATELY 907 KGF (2000 LBS.) THE TWO WASHER HEAD CAP SCREWS MUST BE LOOSENED EVENLY TO RELIEVE THIS FORCE. IF A HYDRAULIC PRESS IS AVAILABLE, 1361 KGF (3000 LBS.) MINIMUM, THE PRESSURE PLATE CAN BE HELD IN POSITION WHILE REMOVING THE WASHER HEAD CAP SCREWS.**

2. Remove case seal (3) from cover (16).
3. Remove piston (6) from pressure plate (2).
4. Remove o-ring (4), back-up ring (5), o-ring (7) and back-up ring (8) from piston (6).
5. Remove stack assembly, consisting of stator disc (10), rotor disc (11) and return plate (12) from cover (16).
6. Remove dowel pins (15), springs (13) and spring retainer (14) from cover (16).

**NOTE:** *Not all models use the same number of springs or spring pattern. Record this information for assembly purposes.*

7. Remove retaining ring (19) from cover (16).
8. Remove shaft by pressing or using a soft mallet on the male end of the shaft (9).
9. Remove retaining ring (20) from cover (16) and press out oil seal (17) and bearing (18) if required.

#### Assembly

**NOTE:** *Lubricate all rubber components from repair kit with clean type fluid used in the system*

1. Use an alkaline wash to clean parts before assembly.
2. Press oil seal (17) into cover (16) until it is flush with bearing shoulder. Note direction of seal.
3. Press bearing (18) into position until it bottoms out on borestep.
4. Install retaining ring (20) in cover (16).
5. Press shaft (9) into bearing (18) until it bottoms on the shoulder. Bearing (18) inner race must be supported during this operation.
6. Install retaining ring (19) on shaft (9).

7. Insert dowel pins (15), spring retainer (14) and springs (13) in cover (16).

**NOTE:** *Be sure to use the same number of springs and the same spring pattern as recorded during disassembly.*

8. Position plate (12) on spring (13).

**NOTE:** *Discs (10 & 11) and plate (12) must remain dry during installation. No oil residue must be allowed to contaminate disc surfaces.*

9. Install rotor disc (11) and stator disc (10).
10. Install o-ring (4), back-up ring (5), o-ring (7) and back-up ring (8) on piston (6). Note order of o-rings and back-up rings. Insert piston (6) into pressure plate (2).

**NOTE:** *Be careful not to shear o-rings or back-up rings. Be careful not to scratch or mar piston.*

11. Install new case seal (3) in cover (16).
12. Position pressure plate (2) on cover (16) aligning dowel pins (15) with holes in pressure plate.
13. Install washer head cap screws (1) and tighten evenly to draw pressure plate (2) to cover (16). Torque washer head cap screws 55 ft. lbs. (74.6 Nm).

**NOTE:** *A hydraulic press will simplify installation of pressure plate on cover. Clamp pressure plate in position while tightening the washer head cap screws.*

#### **⚠ CAUTION**

**IF HYDROSTATIC BENCH TESTING IS PERFORMED ON THE BRAKE ASSEMBLY, RELEASE PRESSURE MUST NOT EXCEED 2000 PSI (137.9 BARS) UNLESS TWO ADDITIONAL BOLTS ARE USED FOR SUPPLEMENTAL CLAMPING.**

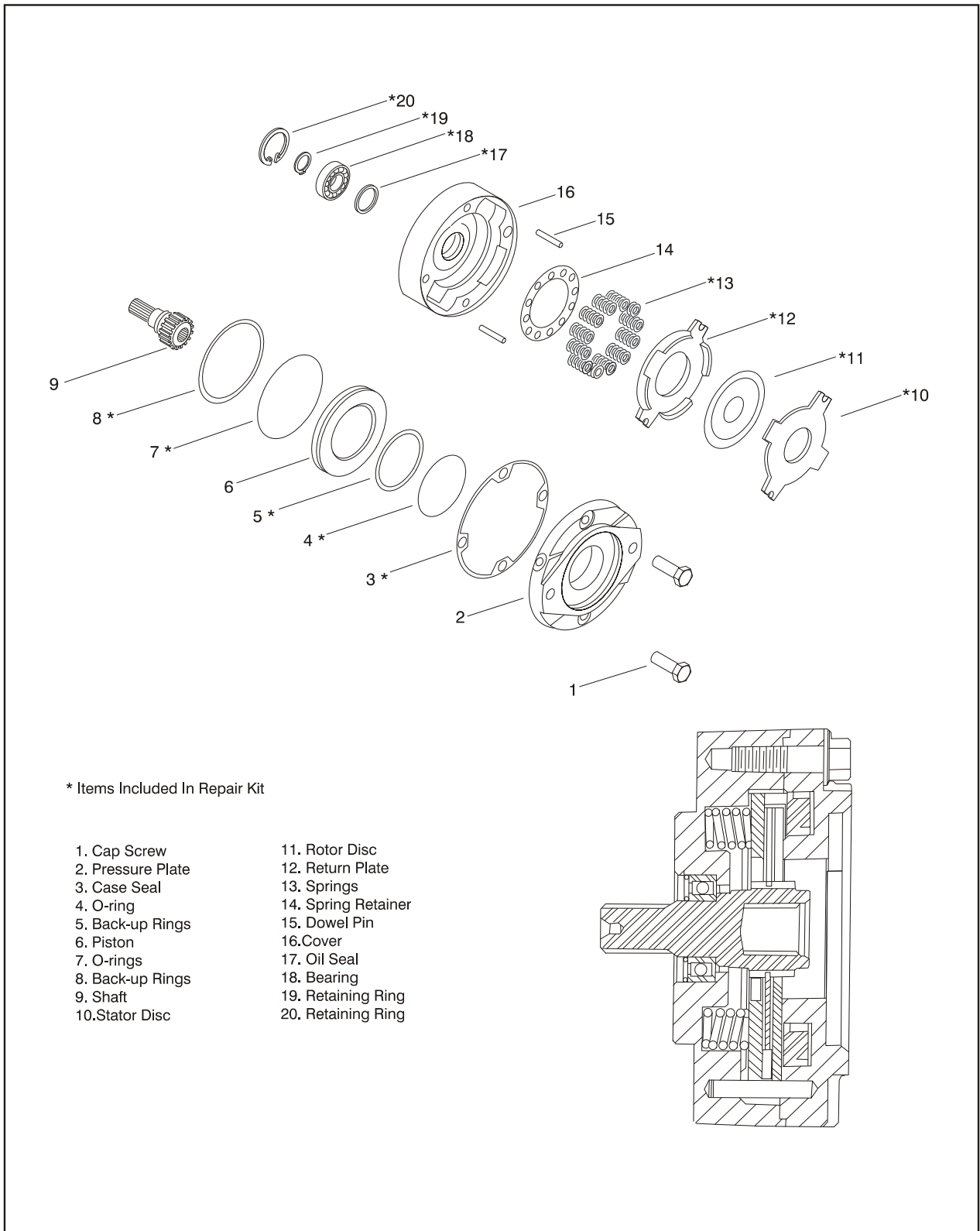


Figure 3-38. Swing Brake S/N 64802 to Present

### 3.16 SWING DRIVE TORQUE HUB

#### Disassembly Procedure

1. Loosen all 12 cover bolts (12)&(13) and drain the oil from the unit.
2. Remove the 12 cover bolts (12)&(13) and lift off the cover (6). Remove and discard the "O" ring (5) from the counterbore of the cover (6).
3. Remove the Input Gear (8) and Thrust washer (10).
4. Lift out the Carrier Assembly (3) and top Thrust Washer (11). This Thrust Washer (11) may stick to the Cover (6).
5. Remove the Input Thrust Spacer (9).
6. Lift out the Internal Gear (2) and thrust Washer (11). The Thrust Washer (11) may stick to the underside of the Carrier (3).
7. Remove the Retaining Ring (1I) from the Output Shaft (1A) and discard.

#### **WARNING**

**EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL.**

8. Remove Bearing Shim (1H) from the Output Shaft (1A).
9. The Output Shaft (1A) may now be pressed out of the Hub (1G).
10. The Bearing Cups (1C)&(1E) will remain in Hub (1G) as will Bearing Cone (1F). Bearing Cone (1D) will remain on the Output Shaft (1A). The Seal (1B) will be automatically removed during this procedure.

**NOTE:** *If bearing replacement is necessary, the bearing cups can be removed with a slide hammer puller or driven out with a punch.*

11. To remove the Cluster Gears (3F) from the Carrier (3A), drive the Anti-roll Pin (3G) into the Planet Shaft (3E). The Planet Shaft (3E) may now be tapped out of the Carrier. After Planet Shaft (3E) can be driven out.
12. The Cluster Gear (3F) can now be removed from the Carrier (3A). The Thrust Washers (3B) will be removed with the Cluster gear (3F).
13. The Needle Rollers (3C) and Spacer (3D) are now removed from the Cluster Gear (3F).

#### **WARNING**

**WHEN REBUILDING OR REPAIRING THE UNIT, THE RETAINING RING (1I), "O" RINGS (5) AND SEAL (1B) SHOULD ALWAYS BE REPLACED.**

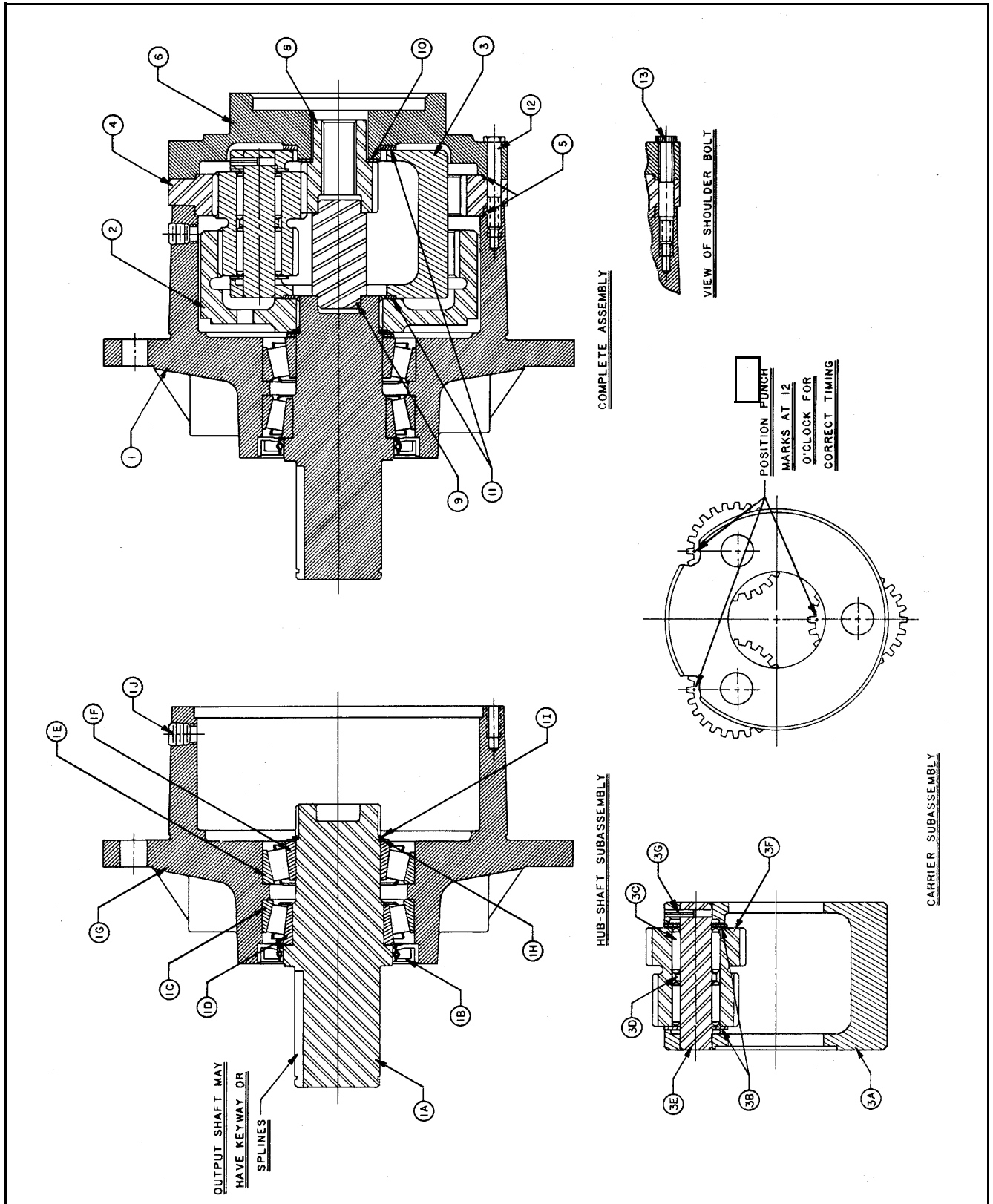
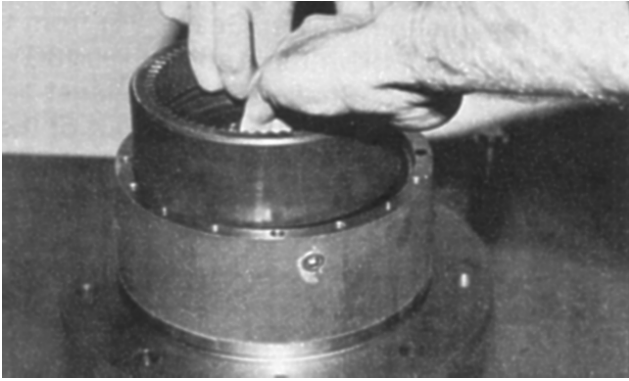
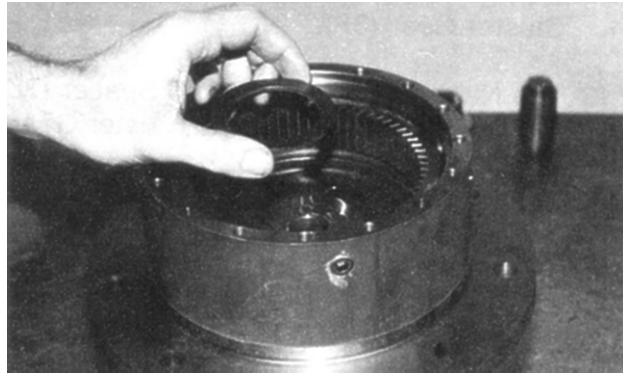


Figure 3-39. Swing Torque Hub

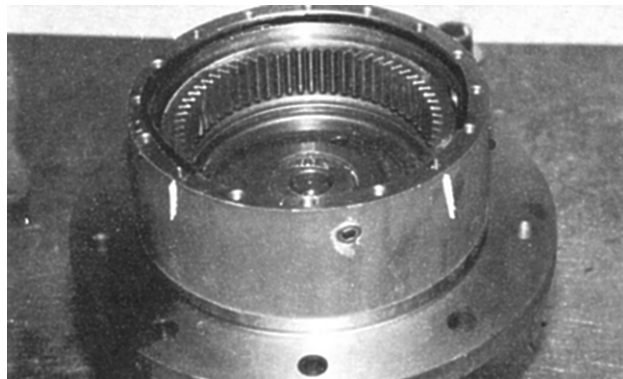
## SECTION 3 - CHASSIS & TURNTABLE



14. With the Hub Shaft Sub assembly resting on the Shaft (1A), install Internal Gear (2). The Spline of the Internal Gear (2) will mesh with the spline of the Output Shaft (1A).



15. Thrust Washer (11) is installed on the face of the Output Shaft (1A). Sufficient grease or petroleum jelly should be used to hold thrust Washer (11) in place.

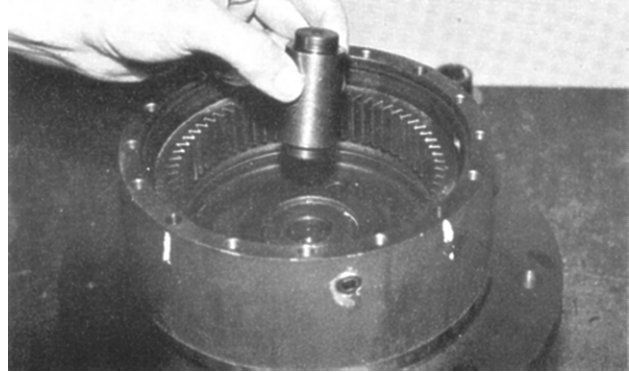


16. Place "O" Ring (5) into Hub counterbore. Use petroleum jelly to hold "O" Ring in place.

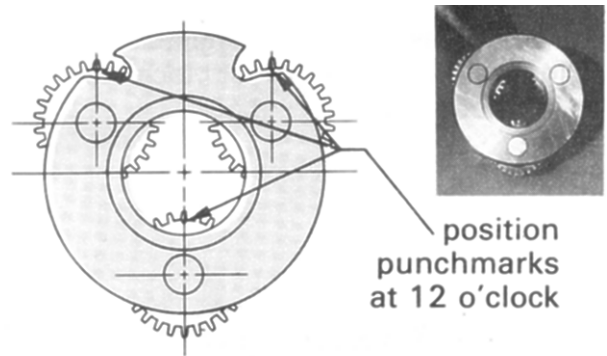
### **⚠ WARNING**

**BEWARE OF SHARP EDGES OF THE COUNTERBORE WHILE SEATING THE "O" RING.**

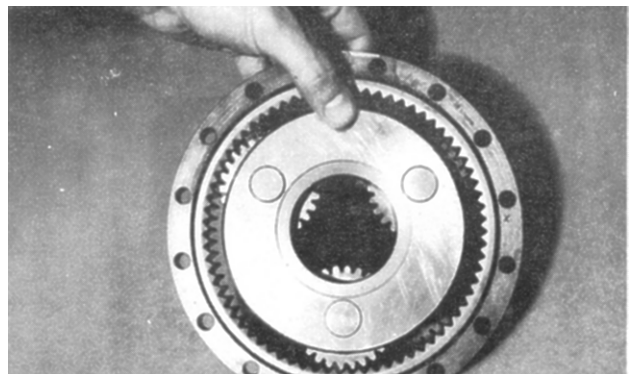
Also at this time locate and mark the 4 counter beamed holes in the face of the Hub (1G). This is for Identification later in the assembly.



17. Thrust Spacer (9) is installed into the bore of the Output Shaft (1A). This should be a slip fit and the Thrust Spacers should rotate in this location.

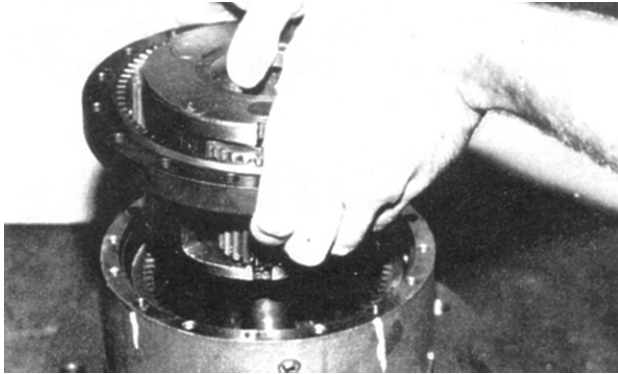


18. Place Carrier Assembly (3) on a flat surface with the large gears (3F) up and positioned as shown. Find the punch marked tooth on each large gear (3F) and locate at 12 o'clock (straight-up) from each planet pin. Marked tooth will be located just under the carrier (3A) on upper two gears (3F).



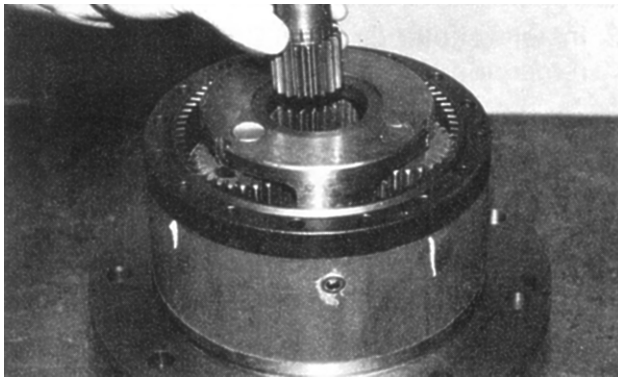
19. With shoulder side of Ring Gear (4) facing down, place Ring Gear over (into mesh with) large gears.

Be sure that punch marks remain in correct location during Ring gear installation. The side of the Ring Gear with "X" stamped on it should be up.

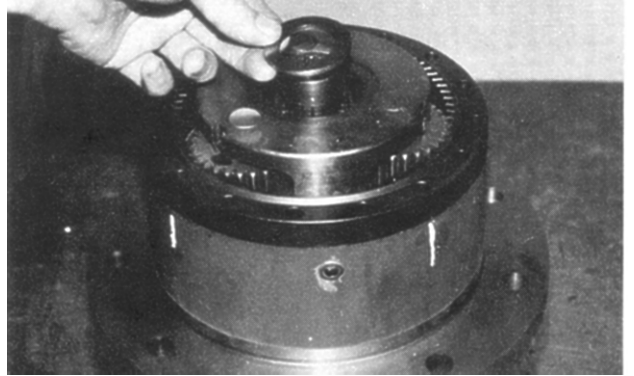


20. While holding Ring Gear (4) and Cluster Gear (3F) in mesh, place small side of Cluster Gears (3F) into mesh with the Internal Gear (13). On the Ring Gear locate the hole marked "X" over one of the marked counterbored holes (step 3) in Hub (1G).

**NOTE:** If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing.



21. Input Gear (8) is installed, meshing teeth of the large diameter Cluster Gear (3F). The counterbore on the Input Gear (3F). The counterbore on the Input Gear (8) locates on the shoulder of the Thrust Spacer (9). This is to be a slip fit and operate freely.



22. Thrust Washer (10) is installed onto the Input Gear (8) and should locate on the gear teeth shoulder.



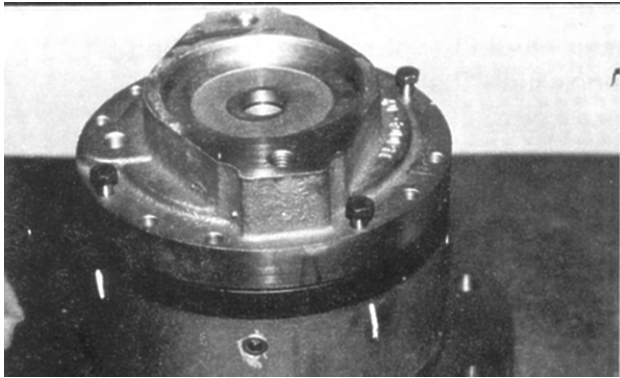
23. Thrust Washer (11) is installed into the counterbore of the Carrier (3).



24. Place "O" Ring (5) into cover (6) counterbore. Use petroleum jelly to hold "O" Ring in place.

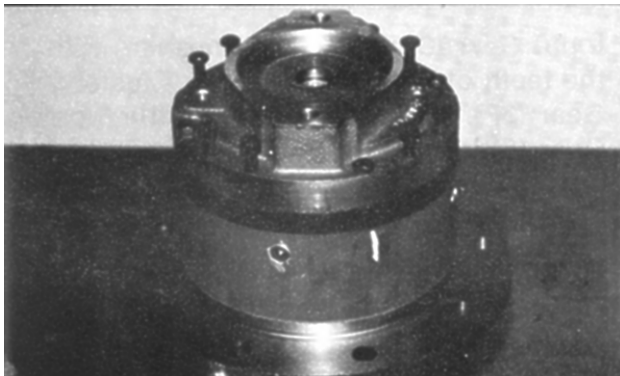
**⚠ WARNING**

**BEWARE OF SHARP EDGES OF THE COUNTERBORE WHILE SEATING THIS "O" RING.**



25. The Cover (6) is now installed on this assembly. Taking care to correctly align Pipe Plug hole (20) with those in the Hub (1J), usually 90° to one another.

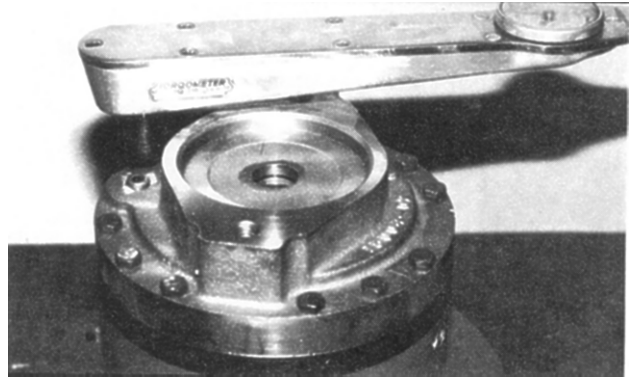
Locate the 4 counterbore holes in Hub (1G) [marked in Step 3] and install 4 Shoulder Bolts (13). A slight tap with a hammer may be necessary to align Shoulder Bolt with Hub (1G) counterbore.



26. Install regular Grade 8 Bolts (12) into remaining holes.



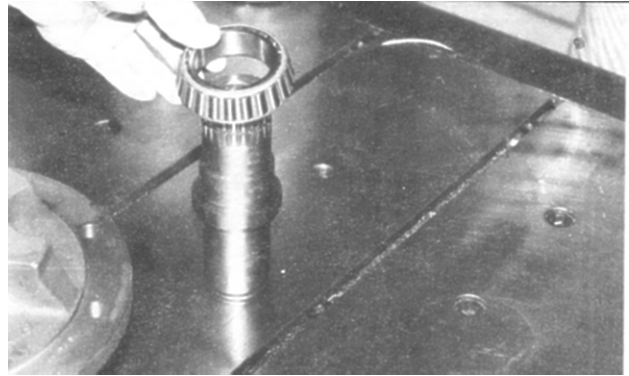
27. Pipe Plugs (20) are to be installed into Cover (6) using a lubricant seal of some sort.



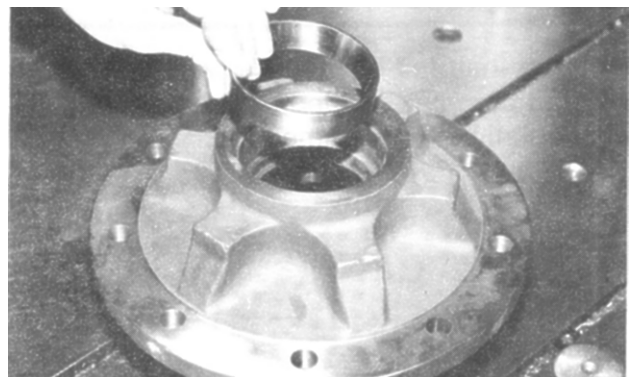
28. Torque Shoulder Bolts (13) to 23-27 ft.lbs. (31-37 Nm) and regular Grade 8 Bolts (12) to 23-23 ft.lbs. (31-37 Nm)

This completes the assembly. The unit must be filled completely with EP 90 lubricant when mounted vertically

### **Hub Shaft Sub-Assembly Procedure**

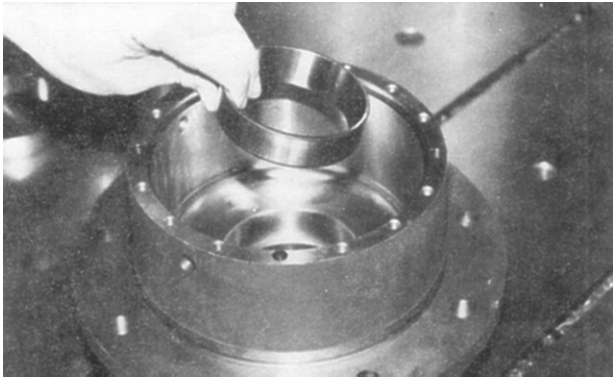


1. Press Bearing Cone (1D) onto Shaft (1A).

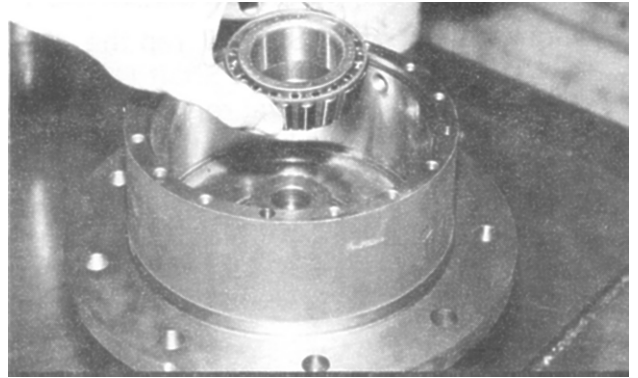


2. Press Bearing Cup (1C) into Hub (1G) taking care to insure cup start square with the bore of Hub (1G).

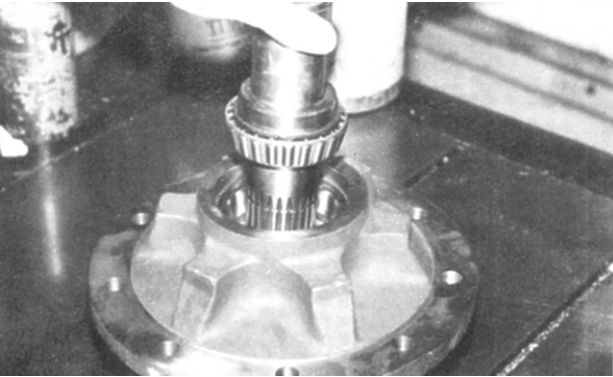




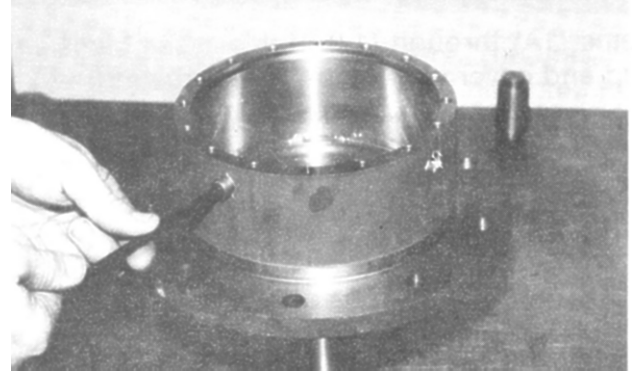
- 3.** Invert Hub (1G) and press Bearing Cup (1E) into counterbore of Hub (1G).



- 6.** The Bearing Cone (1F) is an interference fit and has to be pressed or tapped on.



- 4.** Returning the Hub (1G) to locate on the large diameter end, the Output Shaft (1A) is carefully installed into the Hub (1G).



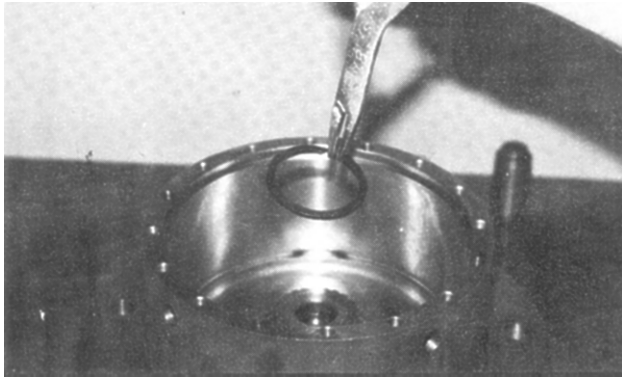
- 7.** Pipe Plugs (1J 7 1K) should be checked and/or installed at this time in the assembly.



- 5.** The Shaft Seal (1B) is installed over the Output Shaft (1A) and into the counterbore of the Hub (1G). Care should be taken to insure the seal (1B) is being correctly installed (smooth face up and located just flush with the counterbore face).



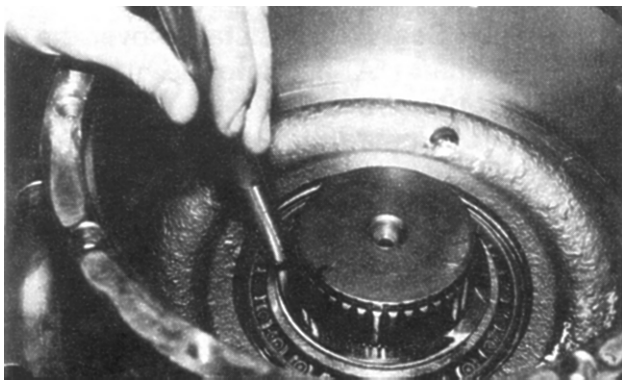
- 8.** Bearing Spacer (1H) is installed around the Output Shaft (1A) and locates on Bearing Cone (1F).



9. Retaining Ring (11) installed into the groove provided in the output Shaft (1A). This retaining Ring (11) should never be reused in a repair or rebuild.

**⚠ WARNING**

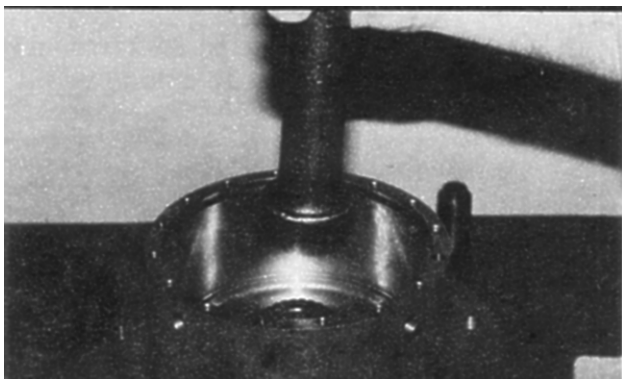
**EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**



10. A soft metal punch should be used to insure that this retaining ring (11) is completely seated in the groove of the Output Shaft (1A).

**⚠ WARNING**

**EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**



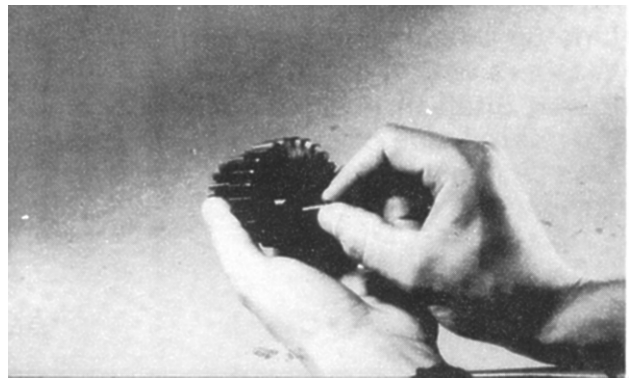
11. Upon completion of step 10, rap the internal end of the Output Shaft (1A) twice with a piece of soft metal

rod. This will release the preload which was on the bearings.

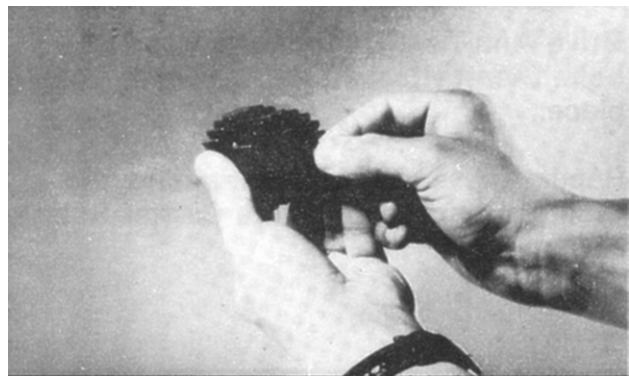
**Carrier Sub-Assembly Procedure**



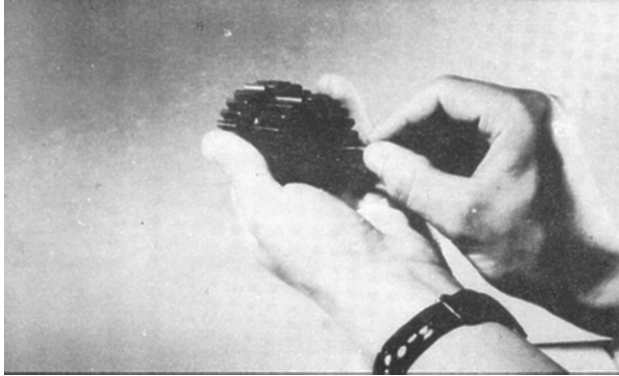
1. Apply a coat of grease or petroleum jelly to Cluster Gear bore.



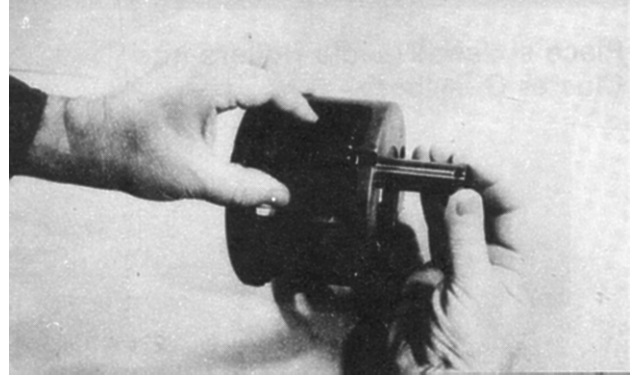
2. lace sixteen Needle Rollers into Cluster Gear bore.



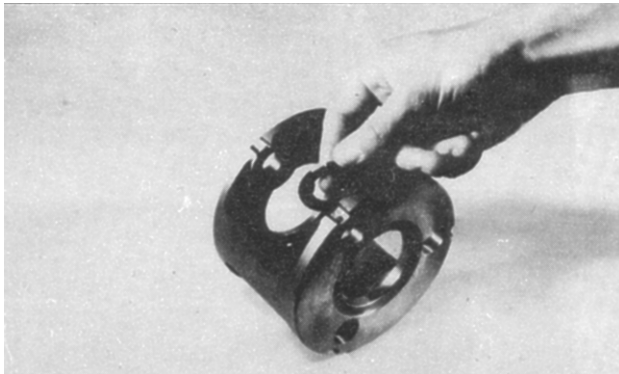
3. Place Spacer Washer into opposite side of Cluster Gear and against Needle Rollers.



4. Place second set of sixteen Needle Rollers into Cluster Gear.

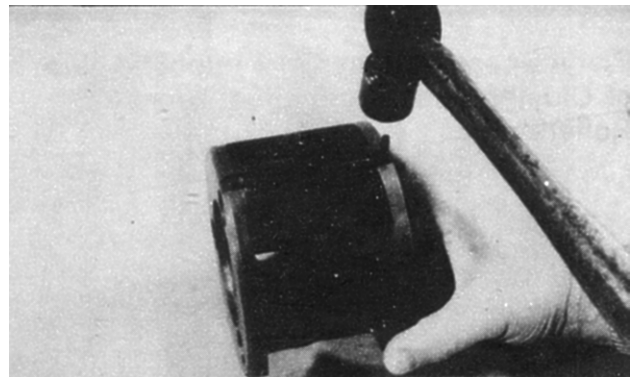


7. Line up Cluster Gear and Thrust Washers with hole in Carrier and slide Planet Shaft through. Line up chamfered side of hole in Planet Shaft with pin hole in Carrier.



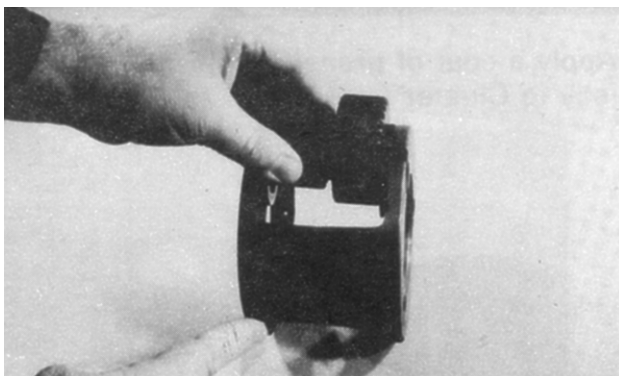
5. Apply grease or petroleum jelly to the tang side of two Thrust Washers. Place Thrust Washers against bosses in Carrier with washer tang fitting into slot in Carrier outside diameter.

**NOTE:** Some old style Carriers will not have slots and tangs should be located inside boss relief.



8. Drive Anti-Roll Pin flush into Carrier hole, thereby locking Planet Shaft into place.

Repeat these steps for remaining two Cluster Gears to complete Carrier Sub Assembly.



6. While keeping Thrust Washers in place, slide Cluster Gear into Carrier with the larger gear on the side with the small pin hole.

### 3.17 SEMI-TRACK

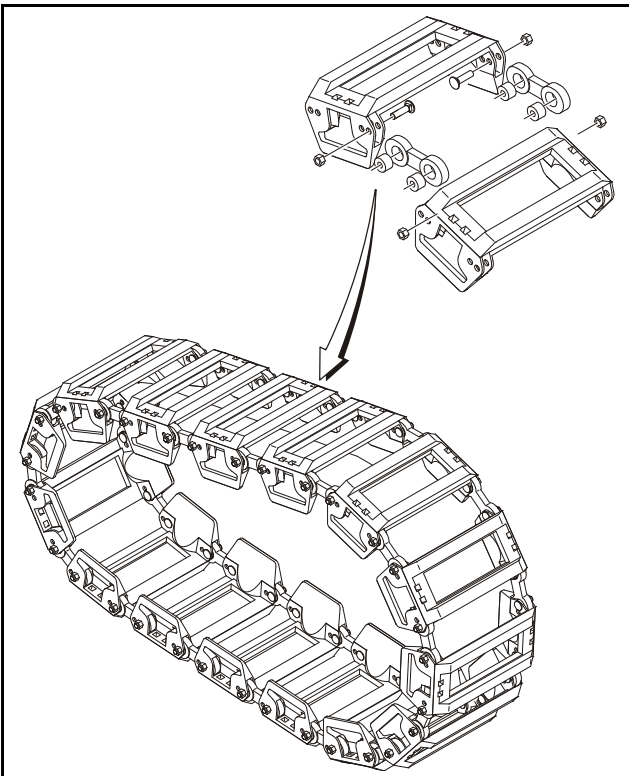
The semi-track option is available in either soft or hard track configurations. The semi-track provides increased traction in rough terrain applications.

#### Testing the Track

With both sides installed, drive the machine slowly in both directions to see that the track does not catch or hit any part of the machine. Test the machine until it can be driven at top speed and on side slopes without the tracks hitting. In the first few days after use, check the track frequently to see that all bolts are staying tight and that no damage is being caused to the tires or machine.

**Removing the Track**

If the tracks are muddy, it is a good idea to wash them off or drive the loader through water before removing. If the tracks are going to be stored in the laid out position just as they come off the machine, then move the machine to the storage area to remove the tracks. If the tracks are going to be rolled up and put on a pallet, it is best to remove them on a hard surface. Remove the bolts that hold the track together. These bolts are accessible over the front tires. After the nuts are removed, pound them flush with the pad. Drive the machine ahead until the bolts are at the bottom between tires. Remove the inside bolts by turning them out with a wrench and punch out the outside bolts. Drive the machine ahead and take off the tracks. If the track is to be rolled up, it is best to set the track on edge and roll it. Secure the end of the track and put the loose hardware in the end of the track.



**Assuming Normal Wear**

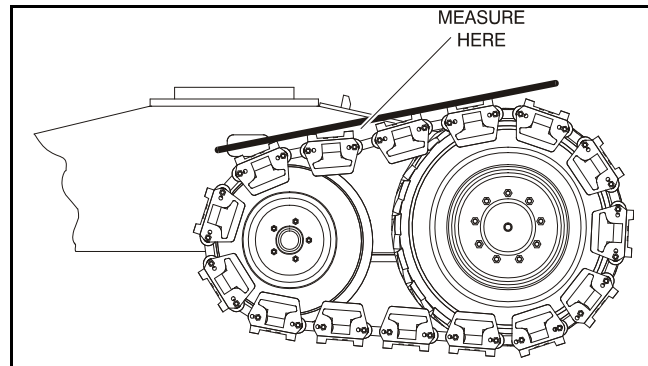
It is normal for the bushing to wear down to the bolt and for the link hole to wear oblong till it is ready to break out the end.

**Adjustment**

**⚠ CAUTION**

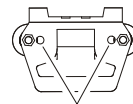
**IMPROPER SLACK ADJUSTMENT COULD CAUSE TRACK PARTS TO BREAK.**

Place a straight edge long enough to reach from the idler to the drive wheel on the tracks. Measure the maximum amount of track sag from the high point of the track segment to the bottom of the straight edge. Properly adjusted track will have approximately 1 to 2 inches (25 to 50 mm) slack.

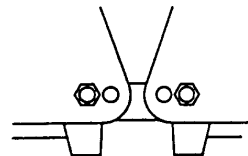


To adjust the slack measurement, move the bolts from the first hole to the second to create less slack, or from the second to the first to create more slack.

BOLTS SHOWN IN FIRST HOLE



SECOND HOLE



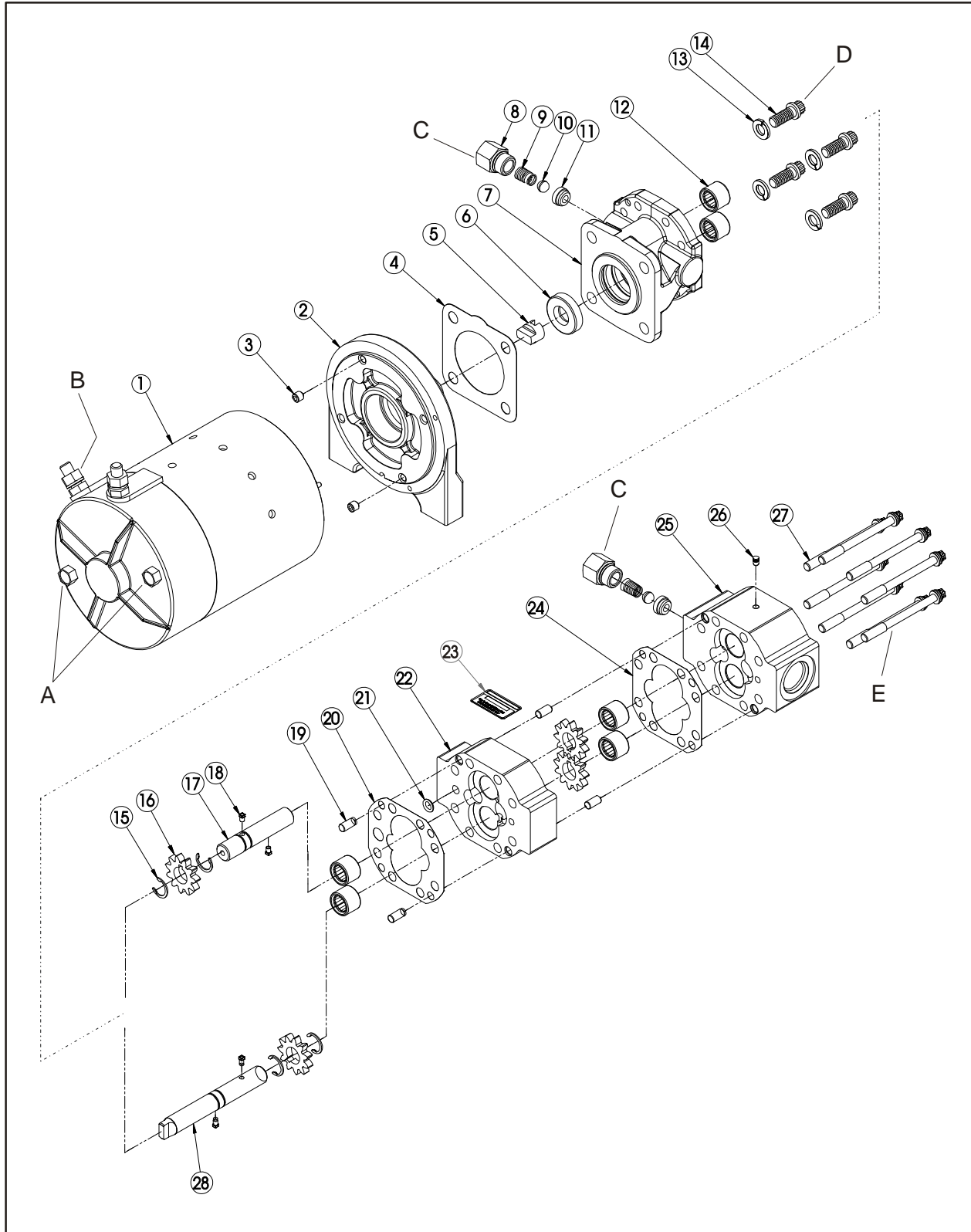
**DO NOT DOUBLE SHORTEN LINKS**

**TRACK LINK ADJUSTMENT**

**Table 3-8. Adjustment Chart**

<b>Move</b>	<b>1 Hole</b>	<b>2 Holes</b>	<b>3 Holes</b>	<b>4 Holes</b>	<b>5 Holes</b>	<b>6 Holes</b>	<b>7 Holes</b>	<b>8 Holes</b>	<b>9 Holes</b>	<b>10 Holes</b>	<b>11 Holes</b>	<b>12 Holes</b>
<b>Equals</b>	0.81 in (20.5 mm)	1.62 in (41 mm)	2.43 in (62 mm)	3.25 in (82.5 mm)	4.06 in (103 mm)	4.87 in (124 mm)	5.68 in (144 mm)	6.50 in (165 mm)	7.31 in (186 mm)	8.12 in (206 mm)	8.93 in (227 mm)	9.75 in (248 mm)

**SECTION 3 - CHASSIS & TURNTABLE**



**Figure 3-40. Auxiliary Pump - Sheet 1 of 2**

- |                    |                    |                  |
|--------------------|--------------------|------------------|
| 1. Motor           | 11. Seat           | 21. O-ring       |
| 2. Adapter         | 12. Needle Bearing | 22. Gear Housing |
| 3. Setscrew        | 13. Washer         | 23. I.D. Label   |
| 4. Mounting Gasket | 14. Screw          | 24. Gasket       |
| 5. Coupling        | 15. Retaining Ring | 25. Gear Housing |
| 6. Shaft Seal      | 16. Gear           | 26. Beta Plug    |
| 7. Stator          | 17. Idler Shaft    | 27. Screw        |
| 8. Cap Assembly    | 18. Drive Pin      | 28. Drive Shaft  |
| 9. Spring          | 19. Dowel Pin      | 29. Plastic Plug |
| 10. Ball           | 20. Gasket         | 30. Plastic Plug |

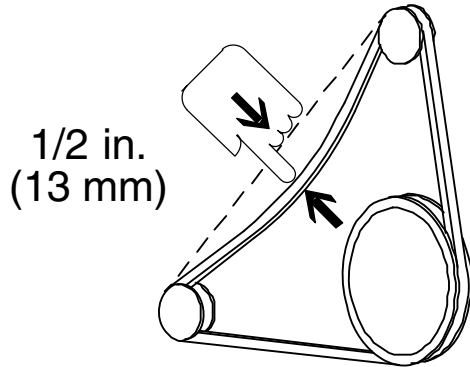
- A. Torque 96 to 120 inch-pounds (11 to 13.5 Nm)
- B. Torque to 84 inch-pounds (9.5 Nm)
- C. Torque 144 to 180 inch-pounds (16 to 20 Nm)
- D. Torque 180 to 216 inch-pounds (16 to 24 Nm)
- E. Torque 114 to 150 inch-pounds (12 to 17 Nm)

**Figure 3-41. Auxiliary Pump - Sheet 2 of 2**

### 3.18 GENERATOR

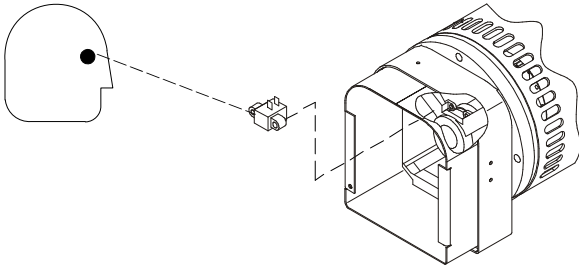
#### Every 250 hours

Every 250 hours of operation, check the drive belt for proper tension.

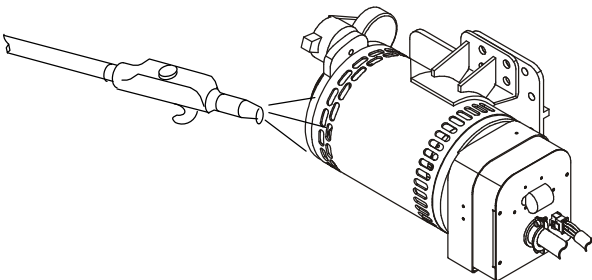


#### Every 500 hours

Every 500 hours of operation, service the generator brushes and slip rings. Hostile environments may require more frequent service.



Every 500 hours of service, blow out the inside of the generator. If operating in a hostile environment, clean monthly.

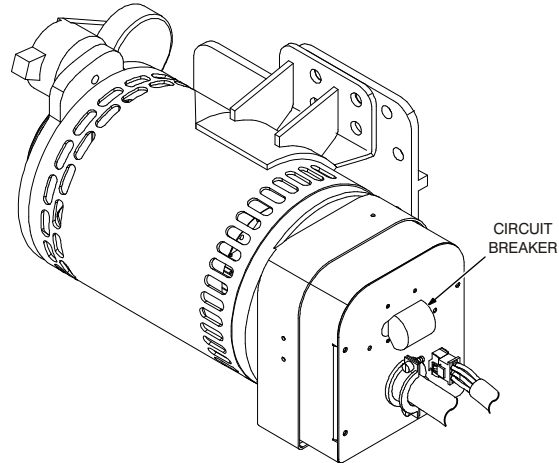


### Overload Protection

#### **⚠ CAUTION**

**STOP THE ENGINE WHENEVER CHECKING OR INSPECTING THE CIRCUIT BREAKER.**

The circuit breaker protects the generator windings from overload. If the circuit breaker opens, generator output stops. If the circuit breaker continues to open, check for faulty equipment connected to the platform receptacles.



### Inspecting Brushes, Replacing Brushes, and Cleaning Slip Rings

Refer to Figure 3-42., *Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings.*

#### INSPECTING BRUSH POSITION

Inspect brush alignment with slip rings. View alignment through the air vents in the stator barrel. The brushes must ride completely on the slip rings.

#### INSPECTING BRUSHES

Remove the end panel. Inspect the wires. Remove the brush holder assembly. Pull the brushes from the holders.

Replace the brushes if damaged, or if the brush is at or near minimum length.

#### CLEANING SLIP RINGS

Visually inspect the slip rings. Under normal use, the rings turn dark brown.

If the slip rings are corroded or their surface is uneven, remove the belt to turn the shaft by hand for cleaning.

Clean the rings with 220 grit emery paper. Remove as little material as possible. If the rings are deeply pitted and do not clean up, consult generator factory service.

Reinstall the belt, brush holder assembly, and end panel.



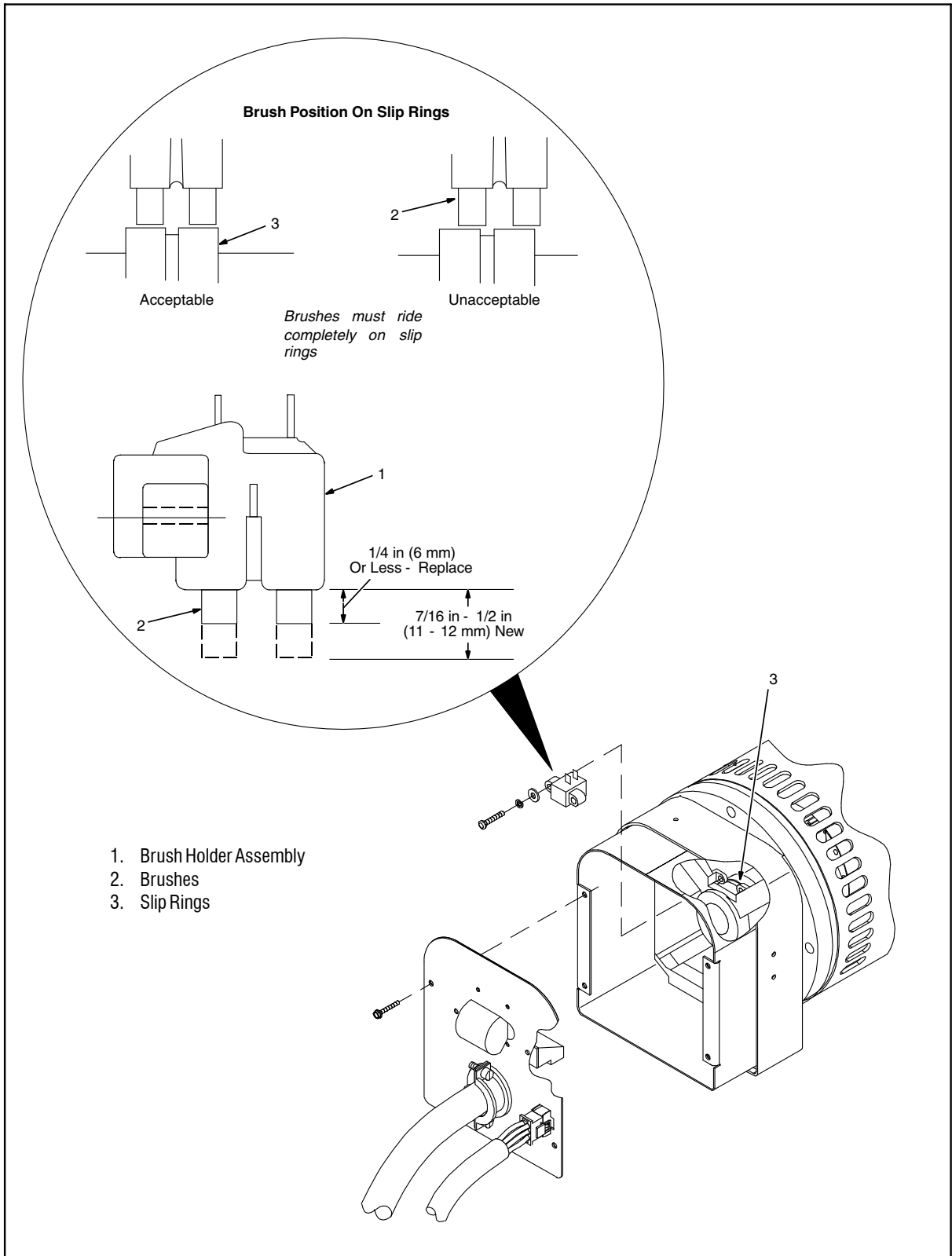


Figure 3-42. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

### 3.19 FORD EFI ENGINE

#### Performing Diagnostics

1. Verify the complaint and determine if it is a deviation from normal operation.
2. Once the complaint has been verified, preliminary checks can be done. Conduct a thorough visual inspection, be alert for unusual sounds or odors, and gather diagnostic trouble code information.
3. Perform a system check that will verify the proper operation of the system in question and check for recent information updates.
4. If a diagnostic trouble code (DTC) is stored, contact a JLG distributor to make an effective repair.
5. If no DTC is stored, select the symptom from the symptom tables and follow the diagnostic path or suggestions to complete the repair.
6. After the repair has been made and validated for proper operation, the old part should be momentarily re-installed to verify that it was indeed the source of the problem.

If no matching symptom is available, analyze the complaint and develop a plan for diagnostics utilizing the wiring diagrams, technical assistance, and repair history.

Intermittent conditions may be resolved by using a check sheet to pinpoint the circuit or electrical system component. Some diagnostic charts contain Diagnostic Aids which give additional information about a system. Be sure to use all of the information that is available to you.

#### Visual/Physical Engine Inspection Check

Perform a careful visual and physical engine inspection before performing any diagnostic procedure. Perform all necessary repairs before proceeding with additional diagnosis, this can often lead to repairing a problem without performing unnecessary steps. Use the following guidelines when performing a visual/physical inspection check:

- Inspect engine for modifications or aftermarket equipment that can contribute to the symptom; verify that all electrical and mechanical loads or accessory equipment is “OFF” or disconnected before performing diagnosis.
- Inspect engine fluids for correct levels and evidence of leaks.
- Inspect vacuum hoses for damage, leaks, cracks, kinks and improper routing, inspect intake manifold sealing surface for a possible vacuum leak.
- Inspect PCV valve for proper installation and operation.
- Inspect all wires and harnesses for proper connections and routing; bent or broken connector pins; burned, chafed, or pinched wires; and corrosion. Verify that harness grounds are clean and tight.
- Inspect engine control module (ECM), sensors, and actuators for physical damage.
- Inspect ECM grounds for cleanliness, tightness, and proper location.
- Inspect fuel system for adequate fuel level, and fuel quality (concerns such as proper octane, contamination, winter/summer blend).
- Inspect intake air system and air filter for restrictions.
- Inspect battery condition and starter current draw.

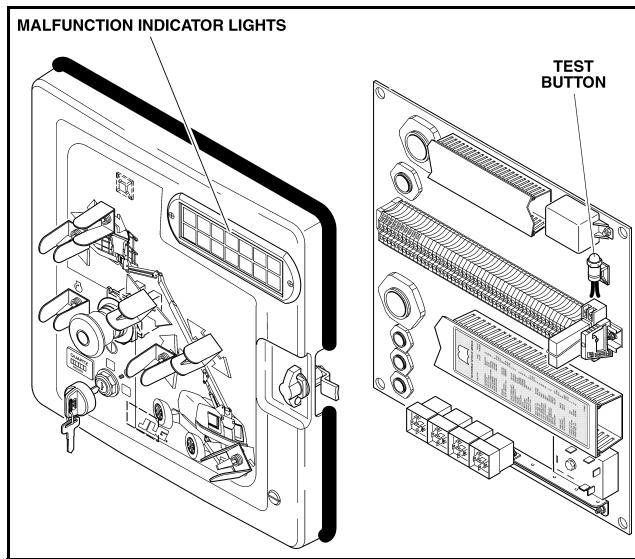
If no evidence of a problem is found after visual/physical engine check has been performed, proceed to MIL DTC retrieval procedure.

#### EFI Diagnostics (Prior to S/N 61718)

The EFI diagnostics are designed to assist in locating a faulty circuit or component. When a malfunction is detected by the Engine Control Module (ECM), a diagnostic trouble code (DTC) is set and the Malfunction Indicator Lamp (MIL) will be illuminated.

##### MIL DTC RETRIEVAL

Diagnostic trouble codes (DTCs) can be retrieved by pushing and holding the test button on the side of the ground control box. The Malfunction Indicator Light will illuminate for 2-3 seconds when the key is positioned to the on position to act as a self-test. If a DTC is present, the light will illuminate and stay on.



**Figure 3-43. Malfunction Indicator Light and Test Button**

When reading Diagnostic Trouble Codes thru the MIL, the following conditions apply:

- The flashing MIL is on for 0.4 second and off for 0.4 second.
- The MIL is off for 1.2 seconds between digits of two digit DTCs.
- The MIL is off for 2.4 seconds between DTCs.
- Each DTC repeats 3 times before the next stored DTC begins flashing.
- Up to 6 DTCs can be stored.
- Once all stored DTCs are flashed, the process repeats with the first stored DTC.
- DTCs are stored in the order in which they were set.

#### **CLEARING TROUBLE CODES**

To clear the trouble codes from the ECM, the electrical current running to the ECM must be shut off. To do this, disconnect the negative terminal from the battery for a period of approximately 15 minutes.

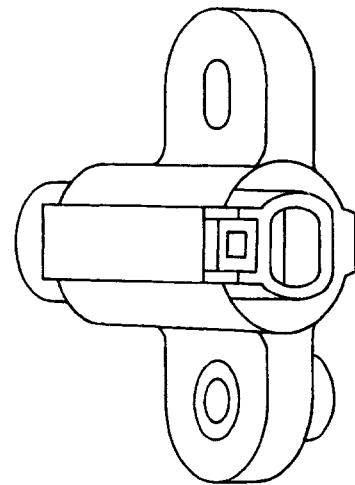
## **ECM AND SENSORS**

### **CRANKSHAFT POSITION (CKP) SENSOR**

The crankshaft position (CKP) sensor provides a signal used by the engine control module (ECM) to calculate the ignition sequence. The CKP sensor initiates the reference pulses which the ECM uses to calculate RPM and crankshaft position.

### **CAMSHAFT POSITION (CMP) SENSOR AND SIGNAL**

The camshaft position (CMP) sensor sends a CMP signal to the ECM. The ECM uses this signal as a “sync pulse” to trigger the injectors in the proper sequence. The ECM uses the CMP signal to indicate the position of the #1 piston during its power stroke. The CMP uses a Hall Effect sensor to measure piston position. This allows the ECM to calculate true sequential fuel injection (SFI) mode of operation. If the ECM detects an incorrect CMP signal while the engine is running, DTC 53 will set. If the CMP signal is lost while the engine is running, the fuel injection system will shift to a calculated sequential fuel injection mode based on the last fuel injection pulse, and the engine will continue to run. As long as the fault is present, the engine can be restarted. It will run in the previously established injection sequence.



## SECTION 3 - CHASSIS & TURNTABLE

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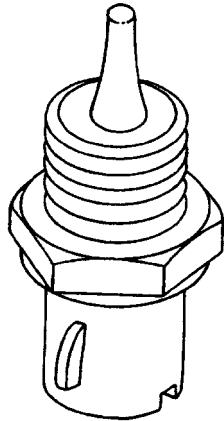
**Table 3-9. ECM Diagnostic Trouble Codes**

<b>Diagnostic Trouble Code</b>	<b>Description</b>
11	All Systems OK
12	Throttle Position (TP) Sensor Low Voltage
14	Manifold Absolute Pressure (MAP) Low Voltage
21	Overspeed
22	Throttle Position (TP) Sensor High Voltage
24	Manifold Absolute Pressure (MAP) High Voltage
31	Fuel Pump Low Voltage
32	Heated Oxygen Sensor (HO2S) Low Voltage
33	Engine Coolant Temperature (ECT) Sensor High Voltage
35	Intake Air Temperature (IAT) Sensor High Voltage
41	Fuel Pump High Voltage
42	Heated Oxygen Sensor (HO2S) High Voltage
43	Engine Coolant Temperature (ECT) Sensor Low Voltage
45	Intake Air Temperature (IAT) Sensor Low Voltage
51	Low Oil Pressure
52	Crankshaft Position (CKP) Sensor Extra/Missing Pulses
53	Camshaft Position Sensor (CMP) Sensor Illegal Pattern
54	Engine Control Module (ECM) Fault Illegal Operation
55	Engine Control Module (ECM) Fault Illegal Interruption
56	Engine Control Module (ECM) Fault COP (Computer Operating Properly) Failure
61	System Voltage Low
62	System Voltage High

### ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The engine coolant temperature (ECT) sensor is a thermistor (a resistor which changes value based on temperature) mounted in the engine coolant stream. Low coolant temperature produces a high resistance of 100,000 ohms at  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ). High temperature causes a low resistance of 70 ohms at  $130^{\circ}\text{C}$  ( $266^{\circ}\text{F}$ ). The ECM supplies a 5-volt signal to the ECT sensor through resistors in the ECM and measures the voltage. The signal voltage will be high when the engine is cold and low when the engine is hot. By measuring the voltage, the ECM calculates the engine coolant temperature. Engine coolant temperature affects most of the systems that the ECM controls.

After engine start-up, the temperature should rise steadily to about  $85^{\circ}\text{C}$  ( $185^{\circ}\text{F}$ ). It then stabilizes when the thermostat opens. If the engine has not been run for several hours (overnight), the engine coolant temperature and intake air temperature displays should be close to each other. A fault in the engine coolant sensor circuit will set DTC 33 or DTC 43.



### ELECTRICALLY ERASABLE PROGRAMMABLE READ ONLY MEMORY (EEPROM)

The electrically erasable programmable read only memory (EEPROM) is a permanent memory chip that is located within the ECM. The EEPROM contains the program and the calibration information that the ECM needs to control engine operations.

If the ECM is replaced, the new ECM will need to be programmed. An IBM-compatible computer and software containing the correct program and calibration for the application are required to program the ECM.

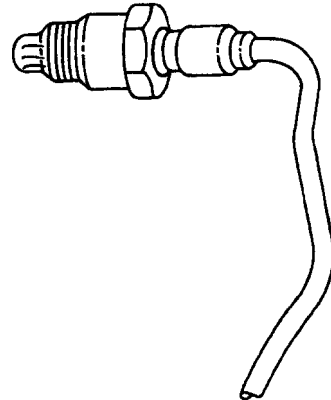
### HEATED OXYGEN SENSOR

The heated oxygen sensor is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust gas. The oxygen present in the exhaust gas reacts with the sensor to produce a voltage output. This voltage should constantly fluctuate from approximately 100 mV to 900 mV. The heated oxygen sensor voltage can be monitored on an IBM PC-compatible computer with diagnostic software. By monitoring the voltage output of the oxygen sensor, the ECM calculates the pulse width command for the injectors to produce the proper combustion chamber mixture.

Low HO<sub>2</sub>S voltage indicates a lean mixture which will result in a rich command to compensate.

High HO<sub>2</sub>S voltage indicates a rich mixture which will result in a lean command to compensate.

A constant voltage below 200 mV for 10 consecutive seconds will set OTC 32. A constant voltage above 650 mV for 10 consecutive seconds will set OTC 42.



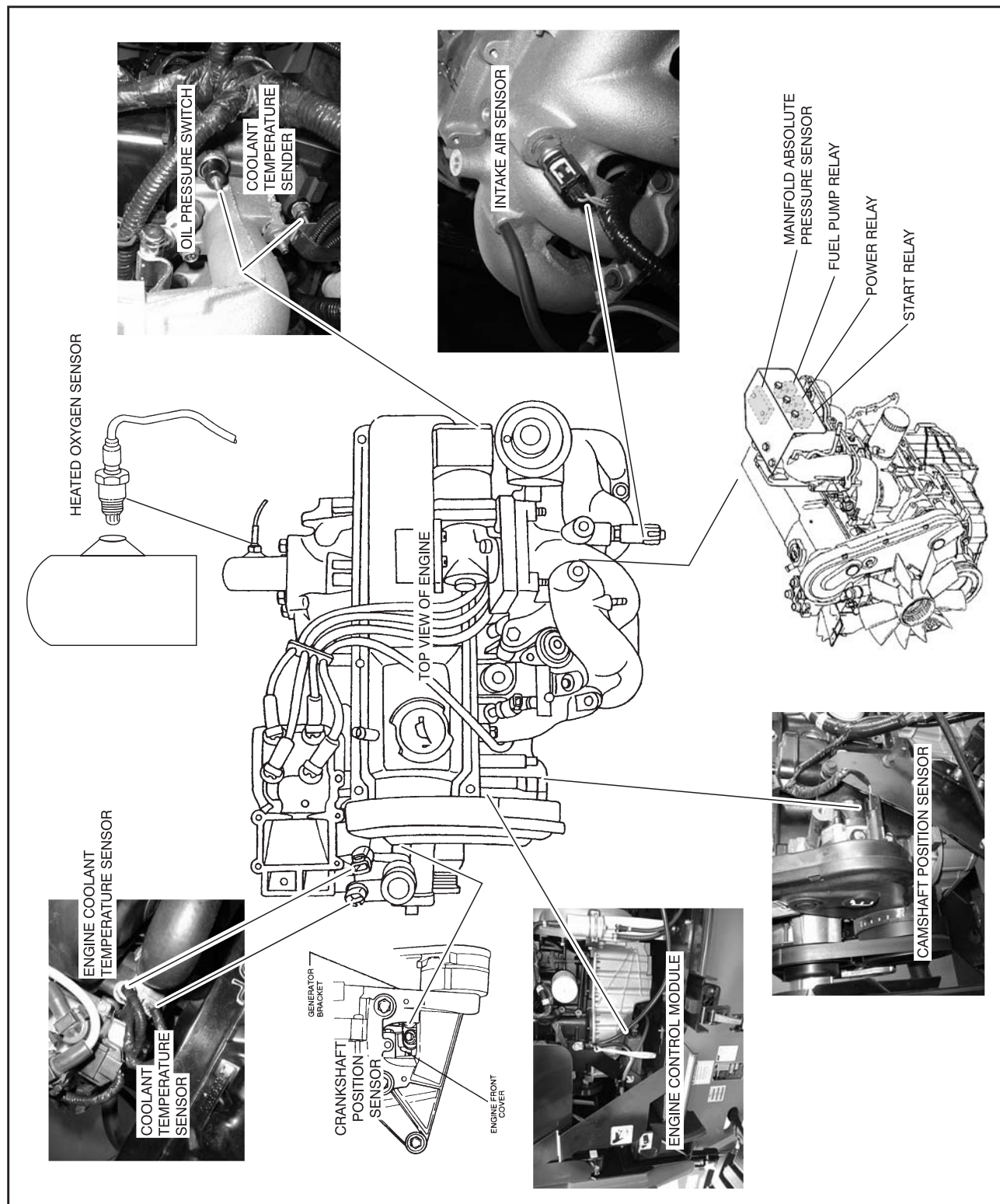
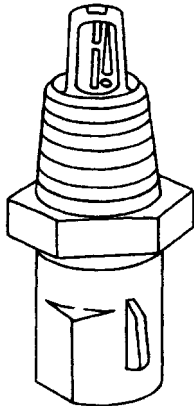


Figure 3-44. EFI Component Location

**INTAKE AIR TEMPERATURE (IAT) SENSOR**

The intake air temperature (IAT) sensor is a thermistor which changes its resistance based on the temperature of air entering the engine. Low temperature produces a high resistance of 100,000 ohms at -40°C (-40°F). High temperature causes a low resistance of 70 ohms at 130°C (266°F). The ECM supplies a 5-volt signal to the sensor through a resistor in the ECM and monitors the signal voltage. The signal voltage will be high when the incoming air is cold and low when the incoming air is hot. By measuring the voltage, the ECM calculates the incoming air temperature. The IAT sensor signal is used to adjust spark timing according to the incoming air density. An IBM PC-compatible computer with diagnostic software can be used to display the temperature of the air entering the engine. The temperature should read close to the ambient air temperature when the engine is cold, and rise as engine compartment temperature increases. If the engine has not been run for several hours (overnight), the IAT sensor temperature and engine coolant temperature should read close to each other. A failure in the IAT sensor circuit will set DTC 35 or DTC 45.

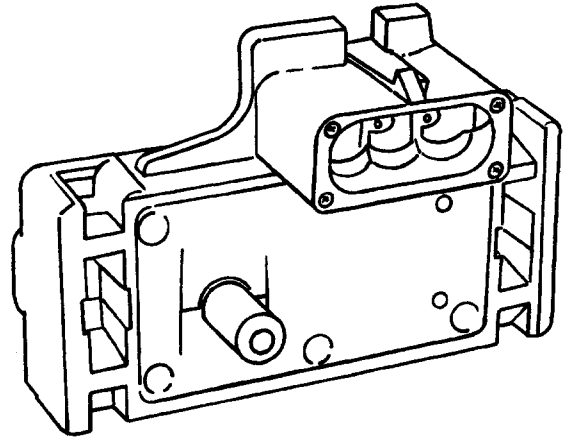
**MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR**

The manifold absolute pressure (MAP) sensor responds to changes in intake manifold pressure (vacuum). The MAP sensor signal voltage to the ECM varies from below 2 volts at idle (high vacuum) to above 4 volts with the ignition ON, engine not running or at wide-open throttle (low vacuum).

The MAP sensor is used to determine the following:

- Engine vacuum level for engine control purposes.
- Barometric pressure (BARO)

If the ECM detects a voltage that is significantly lower than the estimated MAP value for 2 or more consecutive seconds, DTC 14 will be set. A signal voltage significantly higher than the estimated MAP value for 2 or more consecutive seconds will set DTC 24.

**ENGINE CONTROL MODULE (ECM)**

The ECM controls the following:

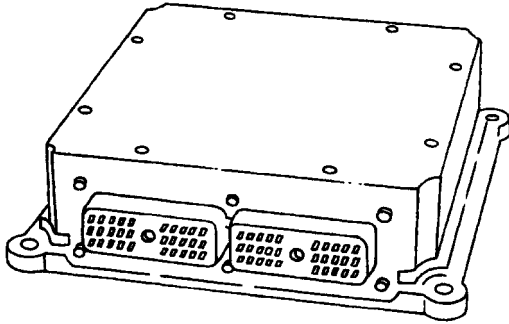
- Fuel metering system
- Ignition timing
- On-board diagnostics for engine functions

The ECM constantly observes the information from various sensors. The ECM controls the systems that affect engine performance. The ECM performs the diagnostic function of the system. It can recognize operational problems, alert the operator through the Malfunction Indicator Lamp (MIL), and store diagnostic trouble codes (DTCs). DTCs identify the problem areas to aid the technician in making repairs.

The ECM supplies either 5 or 12 volts to power various sensors or switches. The power is supplied through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, a digital voltmeter with at least 10 meg ohms input impedance is required to ensure accurate voltage readings. The ECM controls output circuits such as the fuel injectors, electronic governor, etc., by controlling the ground or the power feed circuit through transistors or other solid state devices.

## SECTION 3 - CHASSIS & TURNTABLE

The ECM is designed to maintain exhaust emission levels to government mandated standards while providing excellent operation and fuel efficiency. The ECM monitors numerous engine functions via electronic sensors such as the throttle position (TP) sensor and the heated oxygen sensor (HO2S).



### ECM INPUTS/OUTPUTS

#### Inputs—Operating Conditions

- Engine Coolant Temperature
- Crankshaft Position
- Exhaust Oxygen Content
- Manifold Absolute Pressure
- Battery Voltage
- Throttle Position
- Fuel Pump Voltage
- Intake Air Temperature
- Camshaft Position

#### Outputs - System Controlled

- Fuel Control
- Idle Air Control
- Electric Fuel Pump
- Diagnostics:
  - Malfunction Indicator Lamp
  - Data Link Connector (DLC)

### ECM SERVICE PRECAUTIONS

The ECM is designed to withstand normal current draws associated with engine operation. When servicing the ECM, observe the following guidelines:

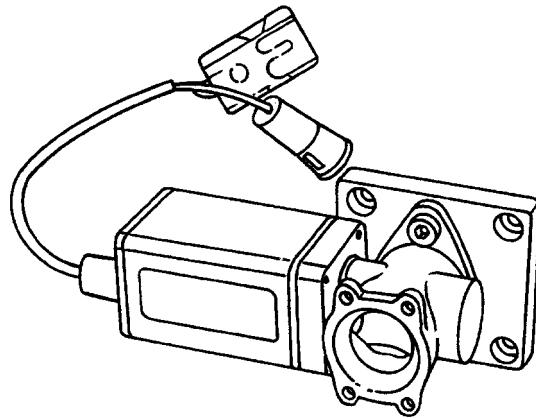
- Do not overload any circuit.
- Do not probe wires for testing. This can cause a voltage drop that would be critical to the operation of the ECM.
- When testing for opens and shorts, do not ground or apply voltage to any of the ECM's circuits unless instructed to do so.

- When measuring voltages, use only a digital voltmeter with an input impedance of at least 10 megohms.
- Do not jump start with more than 12 volts. This could cause damage to the electronic components.
- Do not employ any non-standard practices such as charging the battery with an arc welder.
- Take proper precautions to avoid static damage to the ECM. Refer to "Electrostatic Discharge Damage" for more information.

### THROTTLE POSITION (TP) SENSOR

The throttle position (TP) sensor is a potentiometer connected to the throttle shaft on the throttle body which is built into the electronic governor. The ECM monitors the voltage on the signal line and calculates throttle position. As the throttle valve angle is changed, the TP sensor signal also changes. At a closed throttle position, the output of the TP sensor is low. As the throttle valve opens, the output increases so that at wide open throttle (WOT), the output voltage should be above 4 volts.

The ECM calculates fuel delivery based on throttle valve angle (operator demand). A broken or loose TP sensor may cause intermittent bursts of fuel from an injector and unstable idle because the ECM thinks the throttle is moving. A hard failure in the TP sensor 5-Volt reference or signal circuits for greater than 2 consecutive seconds will set either a DTC 12 or DTC 22. A hard failure with the TP sensor ground circuit for more than two consecutive seconds may set DTC 22. If either DTC 12 or DTC 22 are set, the throttle will be forced to a 6% (idle) position.



### USE OF CIRCUIT TESTING TOOLS

Do not use a test light to diagnose the engine electrical systems unless specifically instructed by the diagnostic procedures. A test light can put an excessive load on an ECM circuit and result in component damage. For voltage measurements, use only a digital voltmeter with an input impedance of at least 10 megohms.



**ELECTROSTATIC DISCHARGE DAMAGE**

Electronic components used in the ECM are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to some electronic components. By comparison, It takes as much as 4000 volts for a person to feel the spark of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and induction.

An example of charging by friction is a person sliding across a seat.

Charge by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore it is important to-use care when handling and testing electronic components.

To prevent possible electrostatic discharge damage, follow these guidelines:

- Do not touch the ECM connector pins or soldered components on the ECM board.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the part from the package, ground the package to a known good ground on the equipment.
- If the part has been handled while sliding across a seat, while sitting down from a standing position, or while walking a distance, touch a known good ground before installing the part.

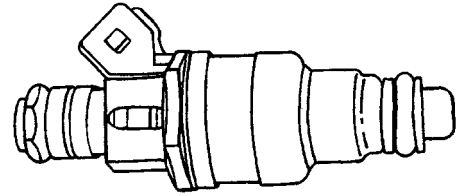
**Fuel System**

**FUEL INJECTOR**

The Electronic Fuel Injection (EFI) fuel injector is a solenoid-operated device controlled by the ECM. The ECM energizes the solenoid, which opens a valve to allow fuel delivery.

The fuel is injected under pressure in a conical spray pattern at the opening of the intake valve. Excess fuel not used by the injectors passes through the fuel pressure regulator before being returned to the fuel tank.

A fuel injector which is stuck partly open will cause a loss of fuel pressure after the engine is shut down, causing long crank times.



**FUEL METERING SYSTEM COMPONENTS**

The fuel metering system is made up of the following parts:

- The fuel injectors
- The fuel rail
- The fuel pressure regulator/filter assembly
- The electronic governor
- The ECM
- The crankshaft position (CKP) sensor
- The camshaft position (CMP) sensor
- The fuel pump
- The fuel pump relay

**BASIC SYSTEM OPERATION**

The fuel metering system starts with the fuel in the fuel tank. The fuel is drawn up to the fuel pump through a pre-filter. The electric fuel pump then delivers the fuel to the fuel rail through an inane fuel filter. The pump is designed to provide fuel at a pressure above the pressure needed by the injectors. A fuel pressure regulator in the fuel filter assembly keeps fuel available to the fuel injectors at a constant pressure. A return line delivers unused fuel back to the tank.

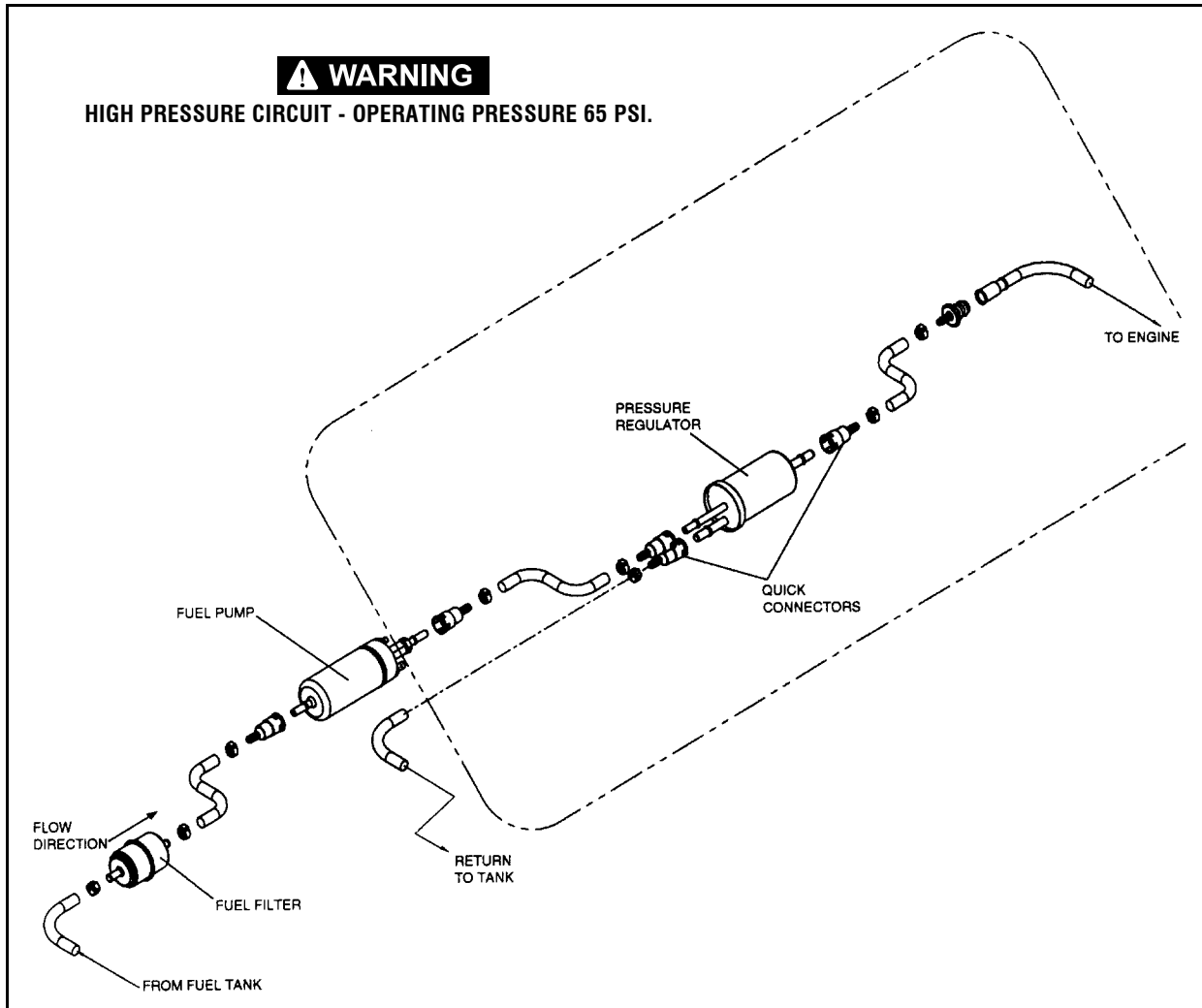


Figure 3-45. Typical Fuel System

### FUEL METERING SYSTEM PURPOSE

The basic function of the air/fuel metering system is to control the air/fuel delivery to the engine. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each intake valve.

The main control sensor is the heated oxygen sensor (H02S) located in the exhaust system. The H02S tells the ECM how much oxygen is in the exhaust gas. The ECM changes the air/fuel ratio to the engine by controlling the amount of time that the fuel injector is "ON." The best mixture to minimize exhaust emissions is 14.7 parts of air to 1 part of gasoline by weight, which provides the most efficient combustion. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "closed loop" system.

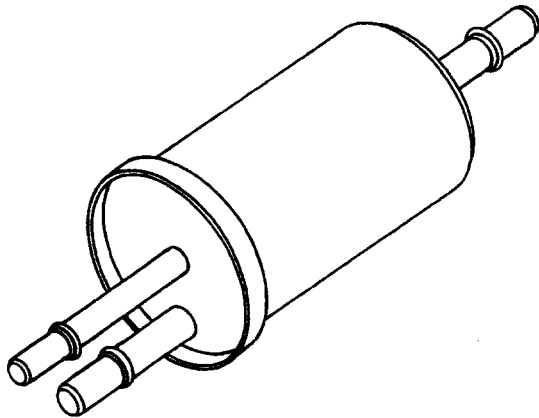
The ECM monitors signals from several sensors in order to determine the fuel needs of the engine. Fuel is delivered under one of several conditions called "modes." All modes are controlled by the ECM. Refer to "Open Loop and Closed Loop Operation" for more information.

**FUEL PRESSURE REGULATOR**

The fuel pressure regulator is a relief valve mounted in the fuel filter. It provides a constant fuel pressure of 441 kPa (64 psi).

If the pressure is too low, poor performance and a DTC 32 will set. If the pressure is too high, excessive odor and/or a DTC 42 will result.

When replacing the fuel filter, be sure to use an identical filter/regulator assembly. A standard fuel filter does not regulate pressure and could cause engine problems or component damage.



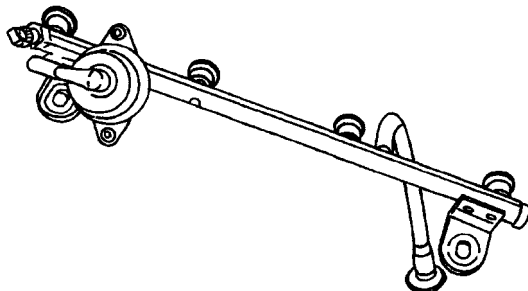
**FUEL PUMP ELECTRICAL CIRCUIT**

When the key is first turned “ON,” the ECM energizes the fuel pump relay for two seconds to build up the fuel pressure quickly. If the engine is not started within two seconds, the ECM shuts the fuel pump off and waits until the engine is cranked. When the engine is cranked and crankshaft position signal has been detected by the SECM, the ECM supplies 12 volts to the fuel pump relay to energize the electric fuel pump.

An inoperative fuel pump will cause a “no-start” condition. A fuel pump which does not provide enough pressure will result in poor performance.

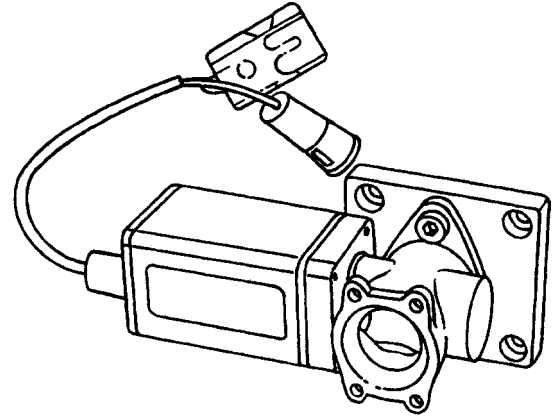
**FUEL RAIL**

The fuel rail is mounted to the top of the engine and distributes fuel to the individual injectors. Fuel is delivered to the fuel inlet tube of the fuel rail by the fuel lines.



**ELECTRONIC GOVERNOR AND THROTTLE BODY**

In the 2.5L EFI industrial engine, throttle control is achieved by using an electronic governor which is controlled by the engine control module (ECM).



The electronic governor consists of a throttle body, an electronically-actuated throttle plate, and a built-in throttle position (TP) sensor. There are two pigtails that exit the governor body. The 3-wire pigtail connects the TP sensor to the ECM. Refer to “Throttle Position (TP) Sensor” for more information.

The 2-wire pigtail carries the throttle signal from the ECM to the governor. Desired engine speeds are stored in the configuration program for each specific application, and can be changed with the ECM calibration software. When an engine speed is selected with the toggle switch, the ECM sends the appropriate signal to the governor. This is a pulse-width modulated (PWM) signal which cannot be read with conventional diagnostic tools such as a voltmeter. A 12-volt signal is pulsed on and off at a high rate of speed. The width of the “on” pulse determines the amount of throttle opening. The ECM sends a signal with the appropriate pulse width to the governor based on the operator’s choice of switch settings.

The electronic governor also acts as an idle air control (IAC) valve. Changes in engine load are detected by the ECM by comparing manifold absolute pressure (MAP) with throttle position. When the ECM detects a change in engine load, it can adjust idle speed by changing the PWM signal to the governor.

### OPEN LOOP AND CLOSED LOOP OPERATION

The ECM will operate in the following two modes:

- Open loop
- Closed loop

When the engine is first started, the system is in “open loop” operation. In open loop, the ECM ignores the signal from the heated oxygen sensor (HO2S). It uses a pre-programmed routine to calculate the air/fuel ratio based on inputs from the TP, ECT, and MAP sensors.

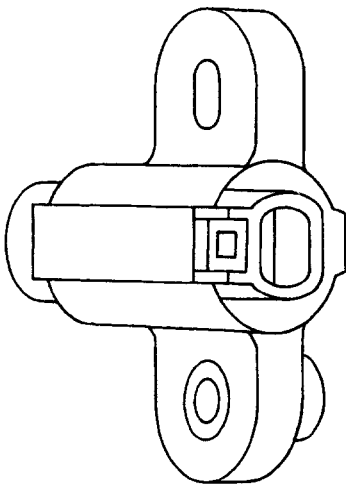
The system remains in open loop until the following conditions are met:

- The HO2S has a varying voltage output showing that it is hot enough to operate properly (this depends on temperature).
- The ECT has reached 160°F (71°C).
- Seven minutes has elapsed since starting the engine.

After these conditions are met, the engine is said to be operating in “closed loop.” In closed loop, the ECM continuously adjusts the air/fuel ratio by responding to signals from the HO2S (except at wide-open throttle). When the HO2S reports a lean condition (low sensor signal voltage), the ECM responds by increasing the “on” time of the fuel injectors, thus enriching the mixture. When the HO2S reports a rich condition (high sensor signal voltage), the ECM responds by reducing the “on” time of the fuel injectors, thus leaning out the mixture.

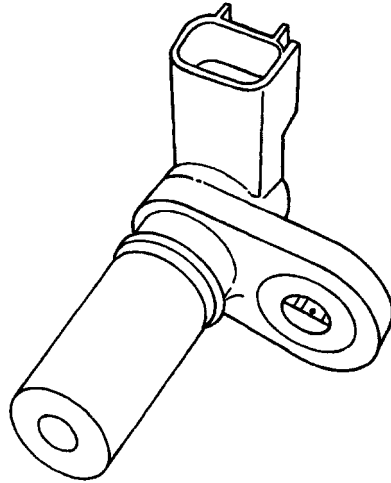
### CAMSHAFT POSITION (CMP) SENSOR

The CMP sensor uses a variable reactor sensor to detect camshaft position. The CMP signal is created as piston #1 is a predetermined number of degrees after top dead center on the power stroke.



### CRANKSHAFT POSITION (CKP) SENSOR

The crankshaft position (CKP) sensor provides a signal used by the engine control module (ECM) to calculate the ignition sequence. The sensor initiates the reference pulses which the ECM uses to calculate RPM and crankshaft position.



### ELECTRONIC IGNITION

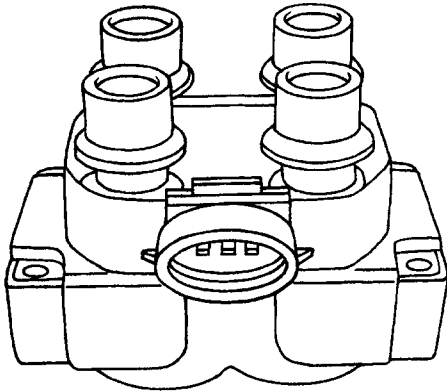
The electronic ignition system controls fuel combustion by providing a spark to ignite the compressed air/fuel mixture at the correct time. To provide optimum engine performance, fuel economy, and control of exhaust emissions, the ECM controls the spark advance of the ignition system. Electronic ignition has the following advantages over a mechanical distributor system:

- No moving parts
- Less maintenance
- Remote mounting capability
- No mechanical load on the engine
- More coil cooldown time between firing events
- Elimination of mechanical timing adjustments
- Increased available ignition coil saturation time

**IGNITION COIL**

The electronic ignition system uses a coil pack with one ignition coil for each two cylinders in the engine. Each cylinder is paired with its opposing cylinder in the firing order, so that one cylinder on compression fires simultaneously with the opposing cylinder on exhaust. The spark that occurs in the cylinder on the exhaust stroke is referred to as a "waste spark."

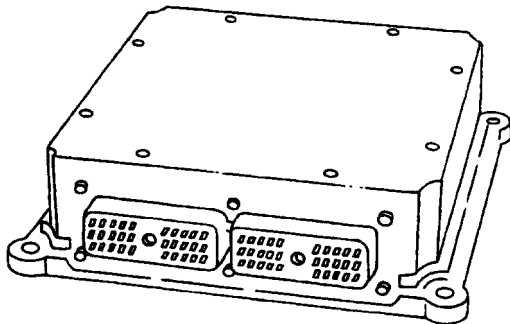
The primary coils in the coil pack are triggered by the "Ignition Coil Feed #1" and "Ignition Coil Feed #2" Signals from the ECM.



**ENGINE CONTROL MODULE (ECM)**

The ECM is responsible for maintaining proper spark and fuel injection timing for all operating conditions. To provide optimum operation and emissions, the ECM monitors the input signals from the following components in order to calculate spark timing:

- Engine coolant temperature (ECT) sensor
- Intake air temperature (IAT) sensor
- Throttle position sensor
- Crankshaft position sensor



**3.20 THROTTLE CHECKS AND ADJUSTMENTS - DEUTZ ENGINE (PRIOR TO S/N 61718)**

**General**

The throttle control system on the Deutz engine includes the positional controller and the actuator.

Four LEDs are incorporated in the controller. They are as follows:

- Red - failure: signals a problem with the system - needs service or adjustment
- Green - clutch engaged; operation normal while system is powered.
- Amber - motor extend
- Amber - motor retract

The controller is designed so that when the system voltage reaches 10.5 volts, the actuator clutch will be released and the motor drive turned off in order to prevent unpredictable operation from occurring.

When a failure condition occurs (i.e. position time-out) the controller will release the clutch and turn off the actuator motor. This will prevent unnecessary motor wear.

**Table 3-10. Position Controller Truth Table**

Control Wiring					Actuator Position
TRIM POT #	Black	Red	White	Green	
	GND	OFF	X	X	OFF POSITION (FREEWHEEL)
1	GND	+12 VDC	OFF	OFF	IDLE - 1200 rpm
2	GND	+12 VDC	+12 VDC	OFF	MID - 1800 rpm
3	GND	+12 VDC	OFF	+12 VDC	NOT USED
4	GND	+12 VDC	+12 VDC	+12 VDC	HIGH - 2900 RPM

GND = POWER SUPPLY OR BATTERY GROUND

OFF = GROUND OR OPEN CIRCUIT

X = DON'T CARE

+12 VDC = +12 VOLT POWER SUPPLY OR BATTERY SYSTEM, VIA A 5 AMP FUSE OR CIRCUIT BREAKER

TRIMMER ADJUSTMENTS

- 1 - POSITION 1 CW=RETRACT
- 2 - POSITION 2 CW=RETRACT
- 3 - POSITION 3 CW=RETRACT
- 4 - POSITION 4 CW=RETRACT

LED INDICATORS

- R - RETRACT INDICATOR (AMBER)
- E - EXTEND INDICATOR (AMBER)
- C - CLUTCH INDICATOR (GREEN)
- F - FAILURE INDICATOR (RED)

**Procedure**

**NOTE:** Never run fuel tank dry. Diesel engines cannot be restarted after running out of fuel until fuel system has been air-vented or bled of air. See Deutz Instruction Manual for procedure.

1. Power the ignition switch at the ground control panel. Set the idle rpm.
2. Supply 12 volts of power to the white wire on the controller. Set the mid engine rpm.
3. Supply 12 volts of power to the white & green wires on the controller. Set the high engine rpm.

**NOTE:** Actuator rod travel must stop slightly before lever makes contact with throttle lever stop. Failure to do so will burn out actuator.

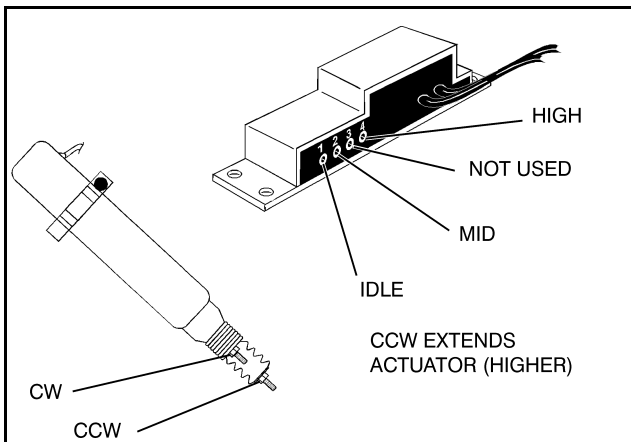
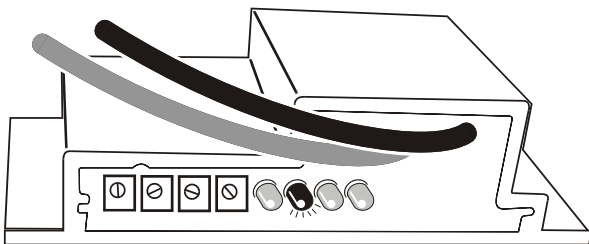


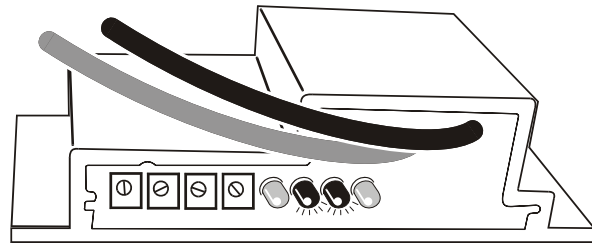
Figure 3-46. Addco Adjustments - Deutz

**Controller Status**

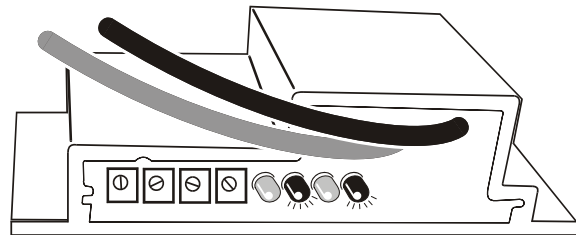
Clutch engaged no actuator movement



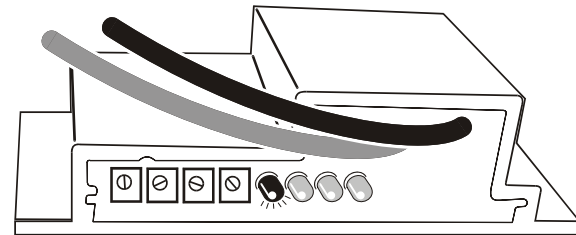
Clutch engaged actuator extending.



Clutch engaged actuator retracting

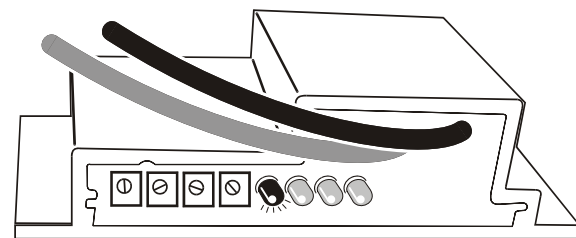


Controller fault - clutch disengaged and no actuator movement



**Failure Modes**

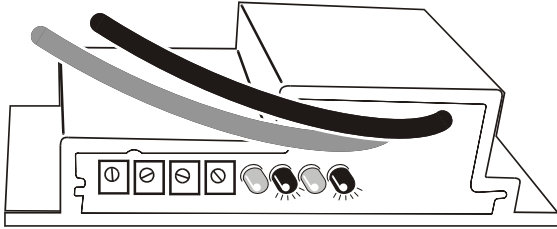
Immediate Red Light



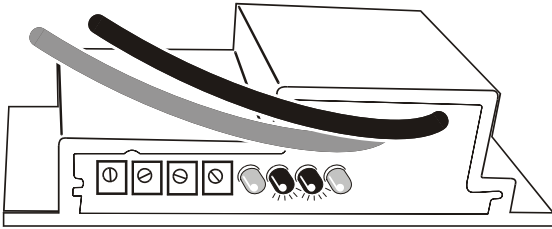
Action:

1. Recycle power to determine if the problem is intermittent.
2. The input voltage must be greater than 10.5 Vdc.
3. Check wiring for any damage and correct.
4. Disconnect engine harness and actuator connections.
5. If problem reoccurs return unit.

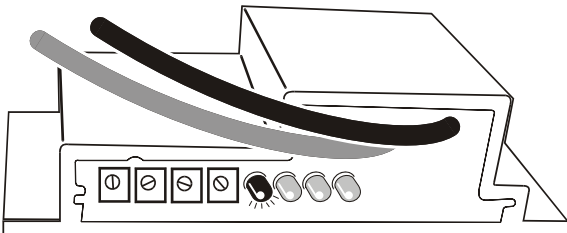
**Green and either Amber light followed by a red light.**



**or**



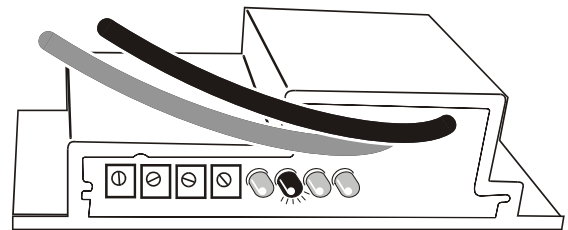
**then**



**Action:**

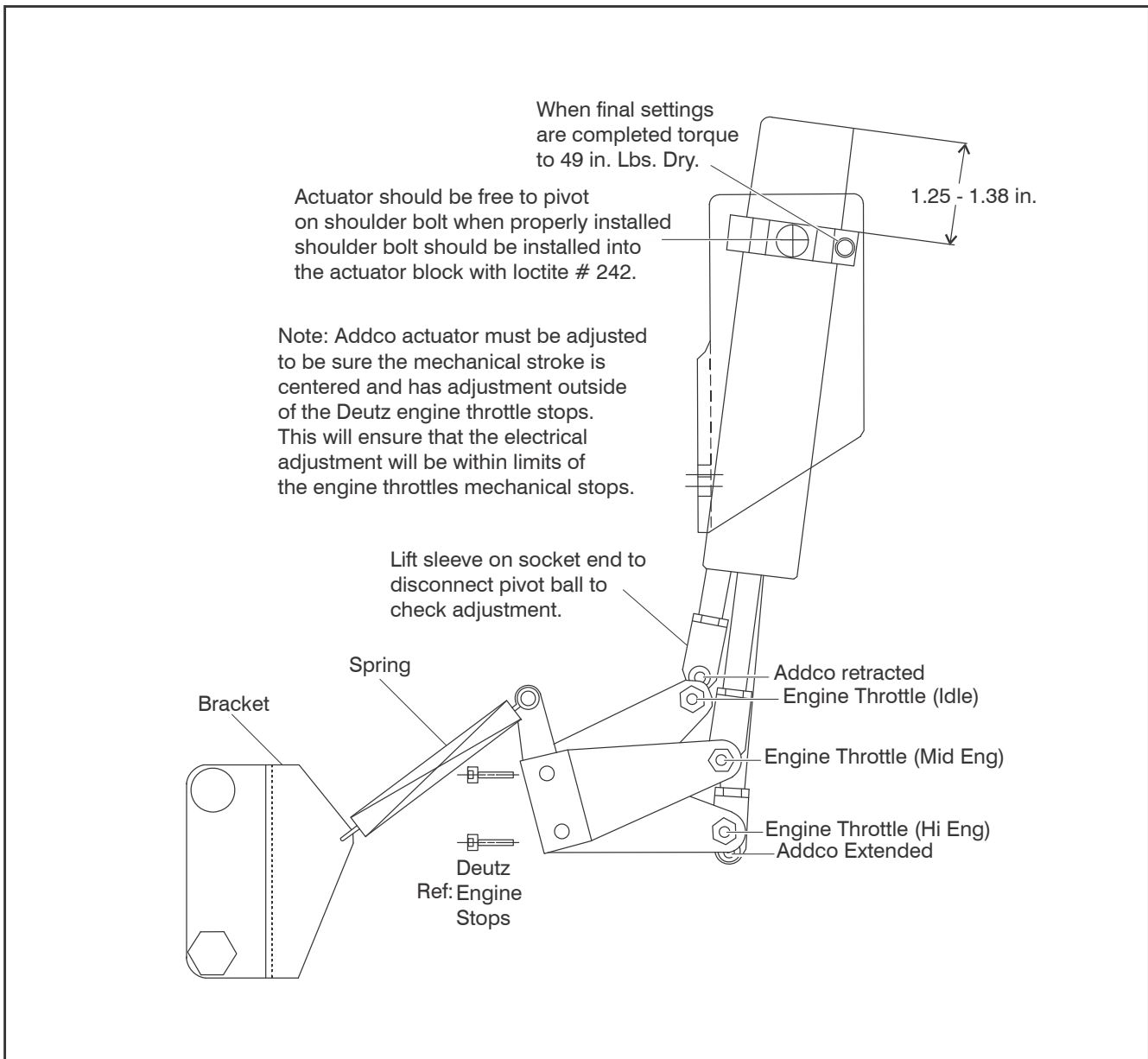
1. Inspect and clean wiring connections.
2. Examine throttle linkage for any damage or bent components and correct.
3. With linkage disconnected, check each potentiometer for operation.
4. Reconnect linkage and reset each potentiometer for correct operation.
5. If failure continues to occur, replace unit.

**Only green light on and no actuator movement**



**Action:**

1. Adjust trim potentiometers.
2. If problem continues, replace unit.



**Figure 3-47. Addco Throttle Actuator**



### 3.21 TILT ALARM SWITCH (PRIOR TO S/N 61718)

#### **⚠ CAUTION**

PERFORM TILT ALARM SWITCH LEVELING PROCEDURE A MINIMUM OF EVERY SIX MONTHS TO ENSURE PROPER OPERATION AND ADJUSTMENT OF SWITCH.

#### Manual Adjustment

1. Park the machine on a flat, level surface. Ensure machine is level and tires are filled to rated pressure.

**NOTE:** Ensure switch mounting bracket is level and securely attached.

2. Level the base of the indicator by tightening the three flange nuts through approximately one quarter of its spring travel. DO NOT ADJUST THE "X" NUT DURING THE REMAINDER OF THE PROCEDURE.
3. With the electrical connections complete, using bubble level on top of indicator, slowly tighten or loosen the three flange nuts until indicator is level.
4. Individually push down on one corner at a time; there should be enough travel to cause the switch to trip. If the switch does not trip in all three tests, the flange nuts have been tightened too far. Loosen the "X" nut and repeat steps (2). through (4).

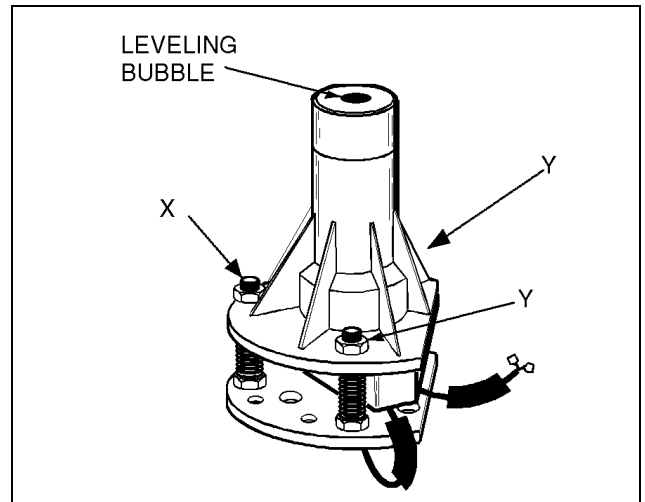
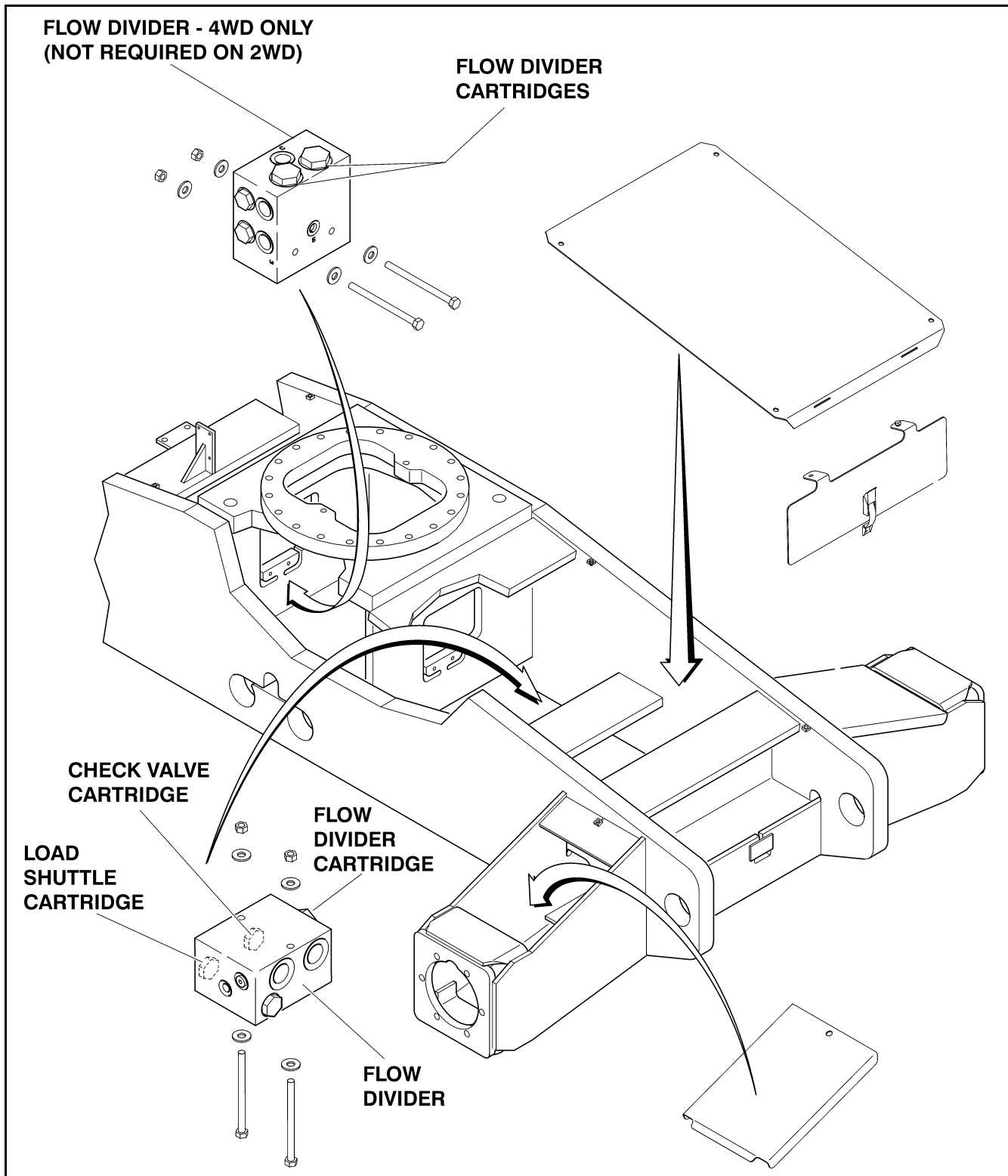


Figure 3-48. Tilt Switch Adjustment



**Figure 3-49. Valve Location - Chassis**

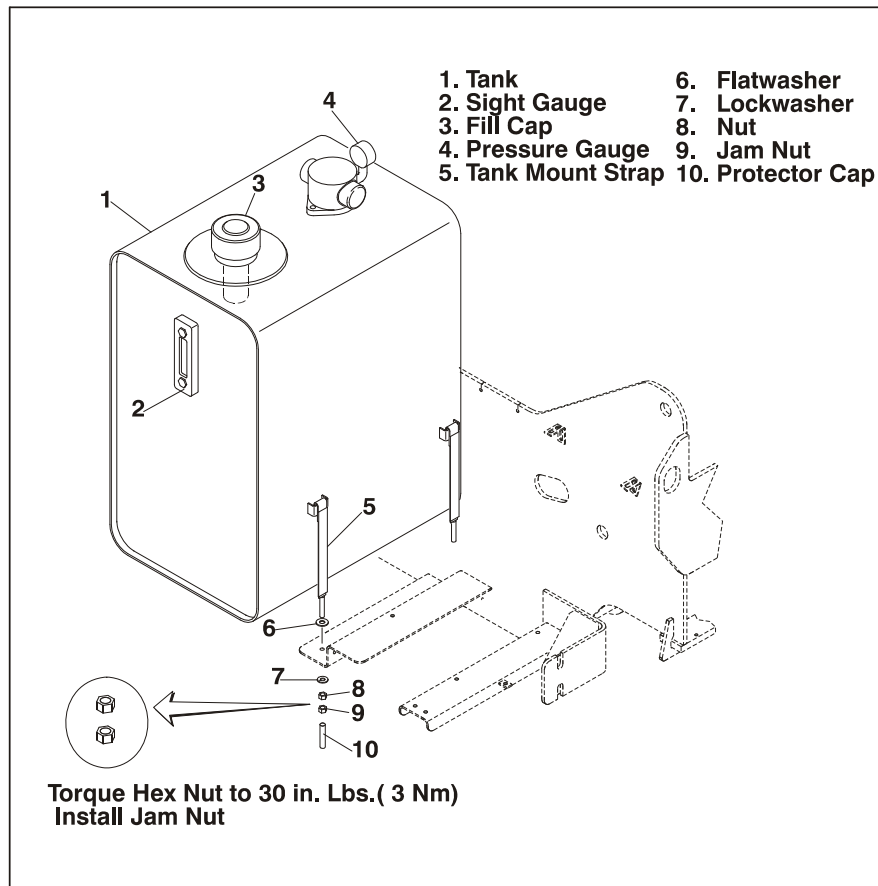


Figure 3-50. Hyd Tank Installation

### 3.22 HYDRAULIC WELDER (225-4)

1. To remove top cover.
  - a. Remove 4 screws on each side.
  - b. Pull cover upward.
2. To remove end cover.
  - a. Remove air intake(4 screws).
  - b. Remove 4 screws (5mm x 45mm).
  - c. Holding receptacle panel to welder disconnect two orange wires coming from front control.
  - d. Unplug plastic connector.

### Replacement of Weld Transformer

1. Remove top cover.
2. Disconnect three heavy wires (6ga) from weld impedance (transformer).
3. Remove seven position Selecta switch.
4. Disconnect all wires from seven step Selecta switch.

**NOTE:** Wire numbers to numbers on switch.

5. Un-bolt weld impedance (transformer) from welder.
6. Mount new transformer.
7. Reconnect the small wires to the seven step Selecta switch.

**NOTE:** Be sure wire numbers match terminal numbers.

8. Reconnect heavy wires.

**NOTE:** Be sure those connections are very tight.

9. Re-mount top cover.

### Replacement of Hydraulic Motor

1. Remove coupling cover.
2. Loosen setscrew in motor coupling.
3. Remove pressure line, return line and case drain line.

**NOTE:** Mark pressure line so you don't accidentally reverse the two lines.

4. Remove flow regulator from motor (four bolts).
5. Remove motor from motor mount (two bolts).
6. Remove coupling from motor shaft.
7. Install coupling on new motor.
8. Mount motor to motor mount.

**NOTE:** Be sure to align coupling.

9. Slide couplings together and tighten setscrews.
10. Remove back cover from motor and install flow regulator on back.
11. Re-install pressure line, return line and case drain line.

**NOTE:** Be sure to put the pressure line into the aluminum block (flow regulator).

### **NOTICE**

**IF YOU ACCIDENTALLY REVERSE THE PRESSURE LINE AND THE RETURN LINE THE FLOW REGULATOR WILL NOT LIMIT THE FLOW AND ALLOW THE WELDER TO ROTATE AT THE SPEED DETERMINED BY THE FLOW. IT WILL NOT LIMIT THE SPEED. THIS COULD CAUSE SERIOUS DAMAGE TO THE WELDER DUE TO OVER SPEED.**

### Replacement of Fine Control

1. Remove receptacle panel including fine control.
2. Disconnect two wires connecting fine control.
3. Remove knob from fine control.
4. Remove hex nut holding fine control in place.
5. Remove defective fine control and install new fine control.
6. Reconnect wires (polarity doesn't matter).
7. Re-mount receptacle panel.

## Rotor Replacement

1. Remove coupling guard held with two 10/32 screws.
2. Un-bolt motor mount from welder (four each 5/16-18 Screws)
3. Loosen setscrew and coupling and remove from welder shaft.
4. Remove two each fan grids.
5. Un-bolt welder from base.
6. Remove receptacle panel.
7. Remove rails - each held with two 5/16-18 screws.
8. Remove brush holder held with one screw.
9. Remove four plastic stop nuts holding front shield (fa housing).
10. With gear puller push out rotor from slip ring side.
11. Remove rotor assembly from stator.
12. Remove snap ring from shaft end which had coupling on it.
13. Push rotor out of front shield.
14. Examine bearing and front shield to be sure it does not need to be replaced.
15. Push new rotor into front shield.
16. Re-install small snap ring.
17. Be sure snap ring is in groove.
18. Carefully re-install rotor into stator (use rubber mallet to tap in place).
19. Re-install four elastic stop nuts.
20. Tighten elastic stop nuts in a criss/cross manner.
21. Turn rotor by hand to make sure it turns freely.
22. If rotor seems not to turn freely, tap the casting with a small metal hammer on the slip ring end casting. (this will seat the bearing)
23. Apply 12 volts to the slip ring for about 20 seconds.(this will make sure that the residual magnetism is energized)
24. Re-install brush holder.
25. Check for brush alignment to slip ring.
26. Re-install the rails.
27. Re-install the two fan grids.
28. Heat the coupling to 300 degrees.
29. Install 24mm coupling too welder shaft. The shaft extrudes at least 1/4 of a inch threw the coupling.

30. Re-install receptacle panel.
31. Re-install welder on base plate.
32. Lift motor mount onto welder.

**NOTE:** *Be sure coupling jaws are aligned.*

33. Mount with four each 5/16-18 1 inch screws ad lock washers.
34. Slide coupling together and tighten setscrews.
35. Re-install coupling cover with 2 10/32 screws.

## Replacement of Flow Regulator

1. Remove pressure line from flow regulator.
2. Remove case drain line.
3. Remove four bolts holding flow regulator to motor.

**NOTE:** *Be sure seals on motor are still in place*

4. Push four bolts threw mounting holes on flow regulator.
5. Push flow regulator onto back of motor, align four bolts, tighten four bolts.

**NOTE:** *Do not over tighten bolts, mounting flange is aluminum.*

6. Re-install case drain line.
7. Re-install pressure line.

## Replacement of Exciting Rectifier Bridge

1. Remove receptacle panel.
2. Remove wires from Excitation Bridge and transfer to replacement Bridge.

**NOTE:** *Be sure that the positive wire is on the positive terminal and the AC wires are connected to the AC terminals.*

3. Remove defective Rectifier Bridge with one screw in center.
4. Install new rectifier bridge with same screw.
5. Remount receptacle panel.

### Replacement of Weld Rectifier Bridge

1. Remove top cover and control panel.
2. Disconnect three six gauge wires from rectifier bridge.
3. Un-bolt rectifier Bridge upward from base.
4. One elastic stop nut on each end.
5. Lift defective Rectifier Bridge upward out of slots.
6. Re-install new bridge.
7. Insert two elastic stop nuts.

**NOTE:** Be sure two mounting studs are all the way on bottom of slots.

#### **NOTICE**

**AS YOU TIGHTEN, THE TWO NUT RECTIFIER BRIDGES MUST BE PERFECTLY HORIZONTAL. IF IT TILT FORWARD OR BACKWARD, IT WILL SHORT OUT AGAINST THE CASE.**

8. Reconnect the three wires.
9. Remount the panels and top covers.

### Replace Brushes on Sky Welder

1. Remove receptacle panel.
2. Cut tie raps holding brush holder wires, red & black.
3. Unplug red & black from rectifier bridges.
4. Install wires in same way with new brush holder - red to red and black to black.
5. Remove old brush holder by removing one screw holding brush holder.
6. Do not lose plastic insulator located behind the brush holder.
7. Check slip rings.
8. Clean and polish with very fine sandpaper.
9. Check resistance of rotor (armature) on slip rings.

10. Reading should be a 22 ohms  $\pm$  3 ohms.
11. Install new brush holder with brushes.

**NOTE:** Make sure brush holder is seated (dimple in casting).

12. Check brushes to be on slip rings.
13. Install tie raps to hold wires.
14. Check resistance of rotor (armature) on slip rings.
15. Reading should be a 22 ohms  $\pm$  3 ohms.

### Replacing Range Switch

1. Remove top cover held with four screws.
2. Remove nut holding range switch to front panel.
3. Install range switch in front panel.

**NOTE:** Be sure key on threaded bushing is pointing the same way.

4. Move wires from old switch to new switch.
5. Re-install top cover.

### Replacing Selector Switch

1. Remove top cover held with four screws.
2. Remove phillips screw from selector knob.
3. Remove two phillips screws from selector switch front panel.
4. Transfer all wires to new selector switch.

**NOTE:** Be careful not to mix up any of the wires. All wires have wire markers on them.

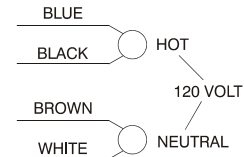
5. Mount new selector switch to front panel with two phillips screws.
6. Re-install knob, be sure knob pointer aligns with all markings on front panel.
7. Re-install top cover.

## Replacement of Couplings

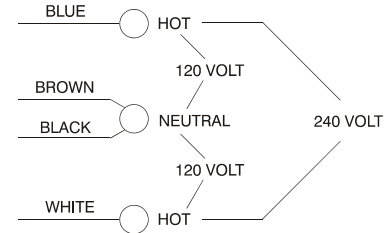
1. Remove coupling held by two 10/32 screws and nuts.
2. Un-bolt hydraulic motor from motor mount.(Two each 3/8-16 screws and nuts.)
3. Remove motor mount from welder four each 5/16-18 screws.
4. Loosen setscrews in both couplings.
5. Remove both couplings with gear puller.
6. Push new coupling onto hydraulic motor shaft (.625 bore).
7. Heat 24mm bore coupling to about 300 degrees ad slide on generator shaft.
8. Let generator coupling cool.
9. Install sox spider o welder coupling.
10. Re-install motor mount onto welder, do not over tighten, the threads are aluminum.
11. Re-align hydraulic motor coupling with welder coupling and re-install hydraulic motor on motor mount.
12. Push couplings together and tighten setscrews in both couplings.
13. Re-install coupling guard.

## Voltage Change Over - 120/240 Volt

1. The welder/generator has a connector with 4 wires, located in the lower portion of the welder.
2. The wire colors are blue, black, white, and brown.
3. For 120 volt only, connect the blue & black together. This is the hot leg. Connect brown & white together. This is neutral.



4. For 120/240 volt, use the blue wire as the hot leg. Use the white wire as the other hot leg (white to blue = 240 volt). Connect the black & brown together. This is neutral.



### 3.23 TROUBLESHOOTING OF THE SKY WELDER

#### Low Sky Welder Speed

If the welder/generator is running below 3600 RPM, the welder or generator can not function properly. Low speed is caused by only three factors.

1. Low hydraulic flow.
2. Mis-adjusted flow regulator.
3. Worn hydraulic motor.

Carefully loosen the lock nut on the adjustment screw and on top of the flow regulator located on the end of the hydraulic motor. While monitoring the speed slowly turn the adjustment screw with an allen key counterclockwise to increase speed. If you do not see an increase by turning the screw a quarter to a half a turn, return the screw to the original position and lock the lockout. This was an indication that the flow coming to the regulator is too low. Your problem could be engine speed or a worn hydraulic pump. If the welder speed increases turn the adjustment screw so the welder rotates at 3700 RPM no load, lock adjustment nut.

#### Low Welding Amps

Low welding amps can be caused by three components. Excitation Bridge located on the bottom right hand corner - defective. The second component that could cause this is an open fine control. Resistance should be 6 ohms. A thermal trip in the windings. Disconnect the two AC wires off the bottom right hand Excitation Bridge (white & orange) and take a resistance reading. With the seven-step selector switch in the lowest position and range switch in the highest position you should get about 2 ohms. Move the seven-step switch while observing the ohmmeter all the way to its highest position. The resistance should increase slightly with every step. You should end up with about 3 ohms. If you do not start off with 2 ohms and the circuit shows open move your ohmmeter lead over 1 lead to the center terminal on the range switch, the other ohm meter lead onto the terminal RL1 on the seven position switch. If you have a reading, there about 2 ohms the transformer is ok. To test for the terminal trip in a winding take a reading between the center post of the range switch and the white wire you removed from the Excitation Bridge. You should get 0 ohms. Any other readings on the trip is defective. To check the fine control put one ohmmeter lead on the seven-step switch terminal RL1, the other lead on the orange wire you removed from the Excitation Bridge. You should be able by moving the fine control up and down adjust the ohmmeter reading between 0 and 6 ohms. To check the Excitation Bridge, remove all wires from it and measure forward and backward going around clockwise. In any position and in any

combination between terminals you should get a high and low reading. If any one of the readings come out the same, the bridge is defective.

#### No Output on Weld Receptacles or AC Receptacles

This problem can be caused by many different factors. *At rare occasions a welder/generator could lose its residual magnetism, which will cause the welder to be completely dead.* To re-energize the magnetism remove the receptacle panel. Locate the two excitation bridges on the bottom left and bottom right, pull off the red and black wire coming from the brushes on the left bridge and the red wire jumped over to the right bottom bridge. With an ohm meter check resistance between red and black wire which will check the resistance off the rotor, this should be about 22 ohms, try to rotate the rotor while you take the reading to be sure the brushes are receded, if the reading is intermittent check the resistance at the right on the slip rings. If necessary, remove the brush holder (see brush holder replacement). Apply 12 volts to the terminals on the red and black wire coming from the brush holder. Apply 12 volts for about 15 seconds. Re-install wires, re-install receptacle panel and start welding.

#### No AC Output but Weld Output

If the welder section functions properly but you have no AC output remove the receptacle panel and make sure the white four terminal plugs are plugged solid. If they are connected all the way, disconnect and take resistance reading as follows.

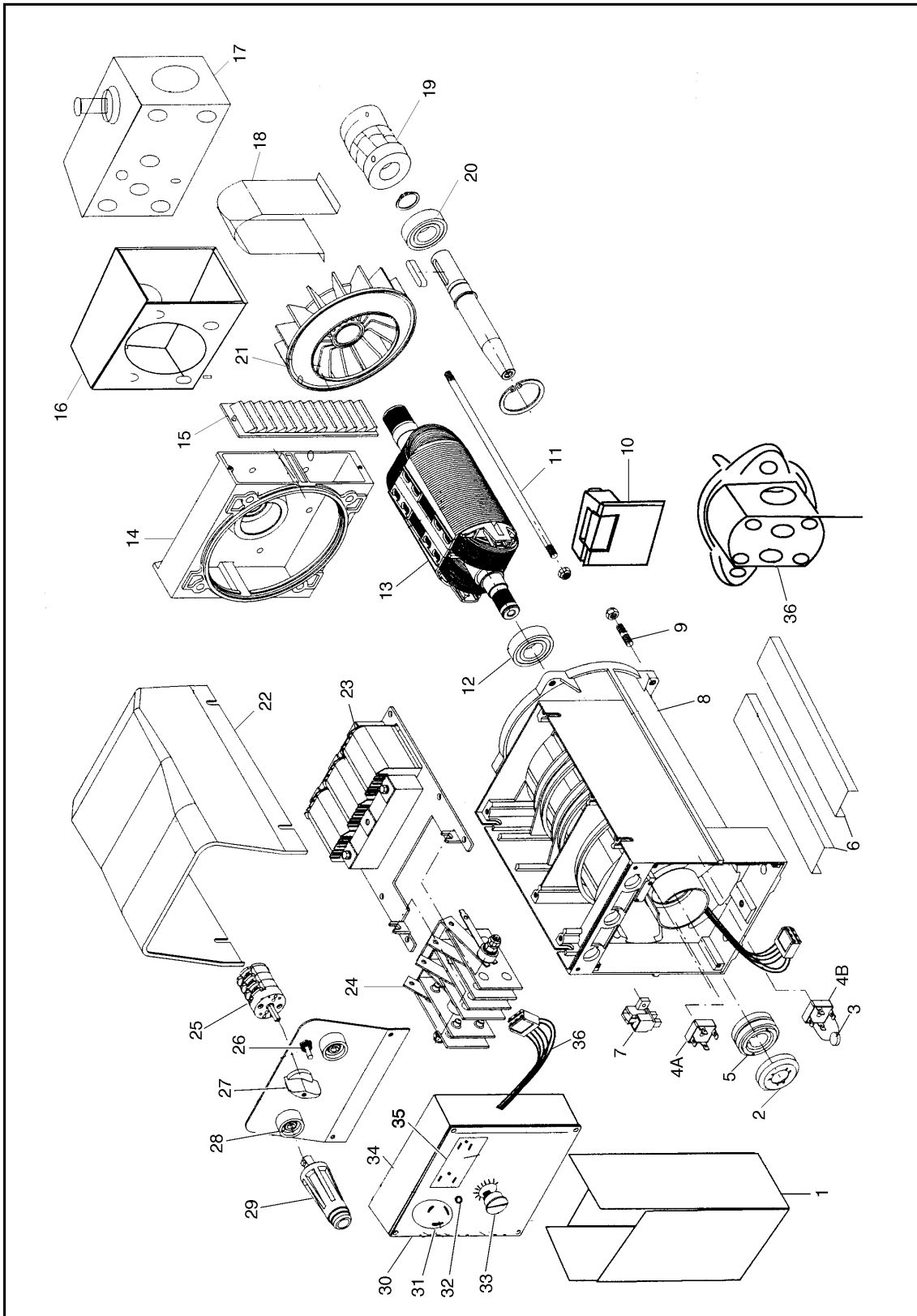
- a. Blue to Brown (1.2 ohms)
- b. Black to White (1.2 ohms)

If either one of these two readings is open the AC windings are defective. If they both check out ok, check the receptacle and the wires going to the receptacle. To be certain that it is in the receptacle panel wiring, very carefully start up the welder and check for 120 volts AC between Blue and Brown and again 120 volts AC between Black and White. If you have 120 volts AC pressing at those two readings, you must have a defective receptacle or receptacle wiring.



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**SECTION 3 - CHASSIS & TURNTABLE**



**Figure 3-51. Hydraulic Welder 225-4 (sht 1 of 2)**

- |                                     |   |
|-------------------------------------|---|
| 1. Air Intake.                      | 19. Coupling set 99.                          |
| 2. Slip ring cover.                 | 20. Bearing.                                  |
| 3. Varistor.                        | 21. Fan.                                      |
| 4A. Single-ph rectifier Bridge.     | 22. Black top hood.                           |
| 4B. Single-ph rectifier Bridge.     | 23. 225 Dc weld impedance (transformer).      |
| 5. Slip ring.                       | 24. Welding rectifier bridge.                 |
| 6. Rails (set).                     | 25. Seven position Step switch (200- 225 DC). |
| 7. Dc brush holder with brushes.    | 26. Range selector (two position) 200-225 DC. |
| 8. Housing L & stator 225 DC 60 Hz. | 27. Step switch knob.                         |
| 9. Stud M8 x 30.                    | 28. Female 400A welding terminal.             |
| 10. Weld receptacle with cover.     | 29. Male 400A welding terminal.               |
| 11. Shaft stay bolt and nut.        | 30. Receptacle panel only.                    |
| 12. Bearing.                        | 31. Twistlock receptacle.                     |
| 13. Rotor (225-250 Amp)             | 32. AC light.                                 |
| 14. Front Shield.                   | 33. Fine control.                             |
| 15. Front grid.                     | 34. Receptacle panel complete.                |
| 16. Motor mount.                    | 34. Receptacle.                               |
| 17. Flow regulator CC.              | 35. Harness.                                  |
| 18. Coupling guard.                 | 36. Hydraulic motor U 19.                     |

Figure 3-52. Hydraulic Welder 225-4 (sht 2 of 2)

### No Output on Weld Receptacle but AC Receptacle Output OK

If you have no welding power at all but the AC (120 volts) is fully operational, this could be caused by three components.

- a. The welding impedance (transformer).
- b. The stator windings.
- c. The main welding rectifier bridge.

Using the electrical diagram check for continuity of the welding impedance (transformer). By disconnecting the three heavy lead wires from the main welding bridge rectifier, you can check continuity between those three wires. In any combination, the resistance should be between one and two ohms. All three readings should be the same. If you have readings that determines that the stator winding and impedance winding are in good condition. With the three wires removed, you can now check resistance of the main Rectifier Bridge. By measuring resistance between the three terminals forward and reverse you always should get a high and low reading, for example; if you measure between one and two, if the first reading is very high the reverse reading should be very low. You can also check the bridge by taking a resistance reading on the main welding terminals. Again, you should have a high and low reading by reversing the leads.

### Welder Completely Dead - No AC or Weld Power

Make sure welder is at proper speed = 3600RPM. Unplug all external connections. A shorted weld cable or generator accessory plugged in can cause the welder not to build up. Several components can cause the welder to stop functioning completely. This is mainly in the excitation circuit. Consisting of the armature (rotor), excitations bridge (left bottom corner) and auxiliary winding. Check the resistance of the auxiliary winding by removing the two purple wires from the Excitation Bridge located at the left bottom corner. The reading should be about 1.5 ohms. Check the resistance of the armature between the two slip rings, this should be 22 ohms. Remove all wires for the left bottom Rectifier Bridge and test for continuity between terminals. Again, you should get a high and low reading. If those three main components test ok, try to flash the armature with a 24 volts circuit (previously explained).

### Intermittent Welder Operation

Welder works properly for a few minutes and then stops operating but returns to full welding power after several minutes of cooling off.

This will occur when the welder is operated past its duty cycle or in extreme high ambient temperatures or if welder cooling circuit is blocked. Be sure air intake is mount to receptacle panel. Allow fresh air to enter louvered end cover on welder. A cooling off period of 4-5 times longer if welder is turned off and sitting still. Running it at its RPM will speed up the cooling and reset the internal trip.

### **3.24 DEUTZ EMR 2 (S/N 77682 TO PRESENT)**

The EMR2 consists of the sensors, the control unit and the actuator. Engine-side controls as well as the JLG Control System are connected by means of separate cable harnesses to the EMR control unit.

The sensors attached to the engine provide the electronics in the control unit with all the relevant physical parameters. In accordance with the information of the current condition of the engine and the preconditions (throttle position etc.), the EMR2 controls an actuator that operates the control rod of the injection pump and thus doses the fuel quantity in accordance with the performance requirements.

The exact position of the regulating rod is reported back and, if necessary, is corrected, by means of the control rod travel sensor, situated together with the rotation magnets in a housing of the actuator.

The EMR2 is equipped with safety devices and measures in the hardware and software in order to ensure emergency running (Limp home) functions.

In order to switch the engine off, the EMR2 is switched in a de-energized fashion over the ignition switch. A strong spring in the actuator presses the control rod in the de-energized condition into the zero position. As a redundancy measure, an additional solenoid serves for switching off and this, independently of the actuator, also moves the control rod in the de-energized condition into the zero position.

After the programming, that is carried out over the ISO9141 interface, the EMR2 possesses a motor-specific data set and this is then fixedly assigned to the engine. Included in this are the various application cases as well as the customer's wishes regarding a particular scope of function.

Each EMR2 module is matched by serial number to the engine. Modules cannot be swapped between engines.

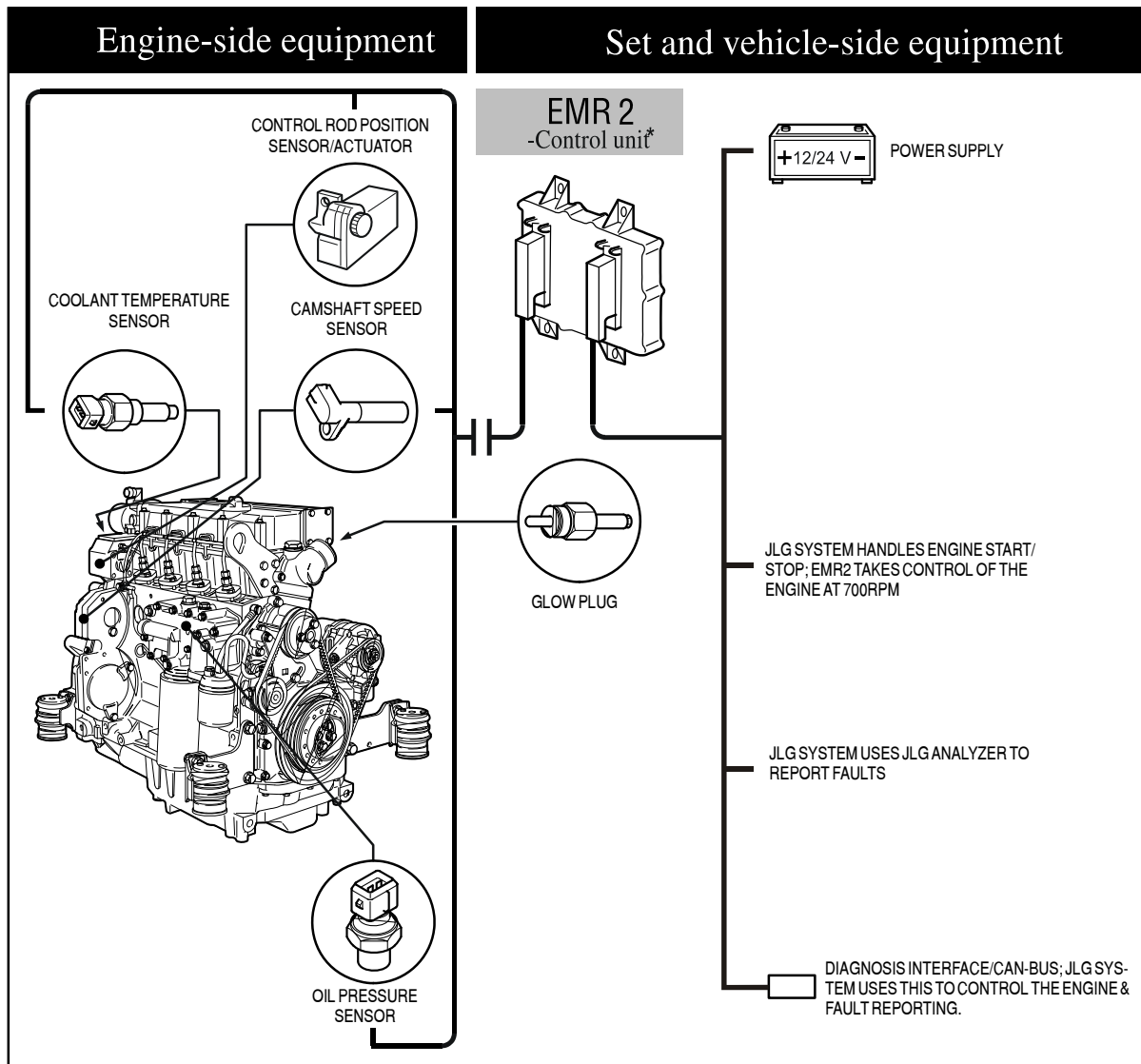


Figure 3-53. EMR 2 Engine Side Equipment

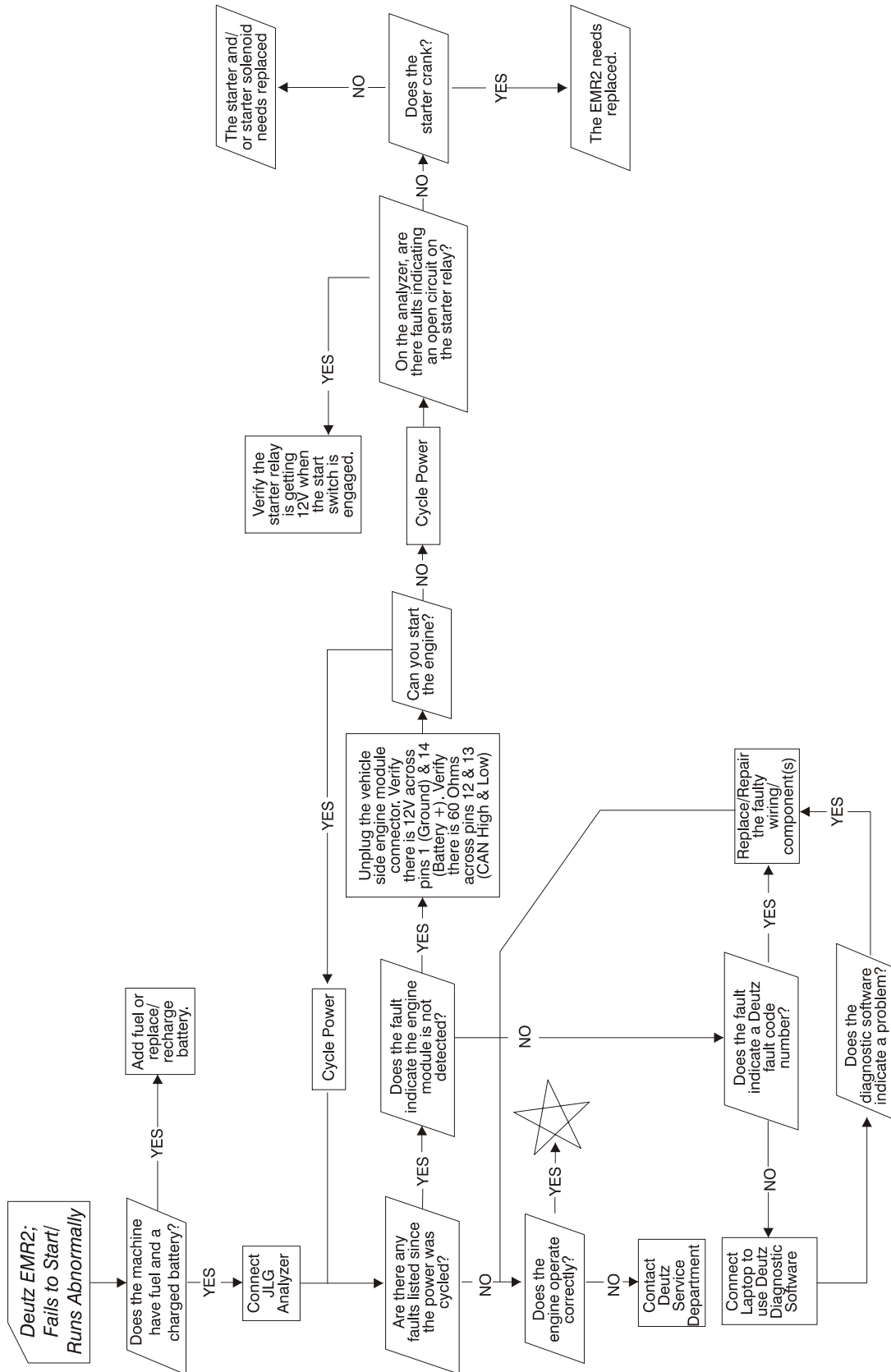


Figure 3-54. Deutz EMR 2 Troubleshooting Flow Chart

# SECTION 3 - CHASSIS & TURNTABLE

- Notes: (N ...)
- equipment designation according to H22986, part 1, e.g.
  - bus terminal resistance for CAN-buslines SAE J 1939 to be monitored externally, see page 043 307/10
  - cross-section of conducting lines: 1,5 mm<sup>2</sup>
  - control unit ECU → battery: 7 m
  - control unit ECU → battery: 10 m
  - equipment plug → control- and display elements: 5 m
  - max. permissible current: 30 mA
  - not supplied by BUZ1
  - don't connect end-signal to chassis behind fuse F75
  - place connection points near ECU

- Notes: (N ...)
- Gerätezeichnung nach H22990 Teil 1, z.B. extern beschriften, siehe Anmerkung SAE J 1939
  - Busabschlusswiderstände für CAN-Schnittstelle SAE J 1939
  - max. zulässige Stromstärke: 30 mA
  - Kein BUZ1 Lieferant
  - Nicht mit Lit. Motoren verbinden
  - Nach Sicherung
  - Keine zusätzlichen Verbraucher anschliessen
  - Anschlusspunkte nahe an Steuergerät montieren

- Notes: (N ...)
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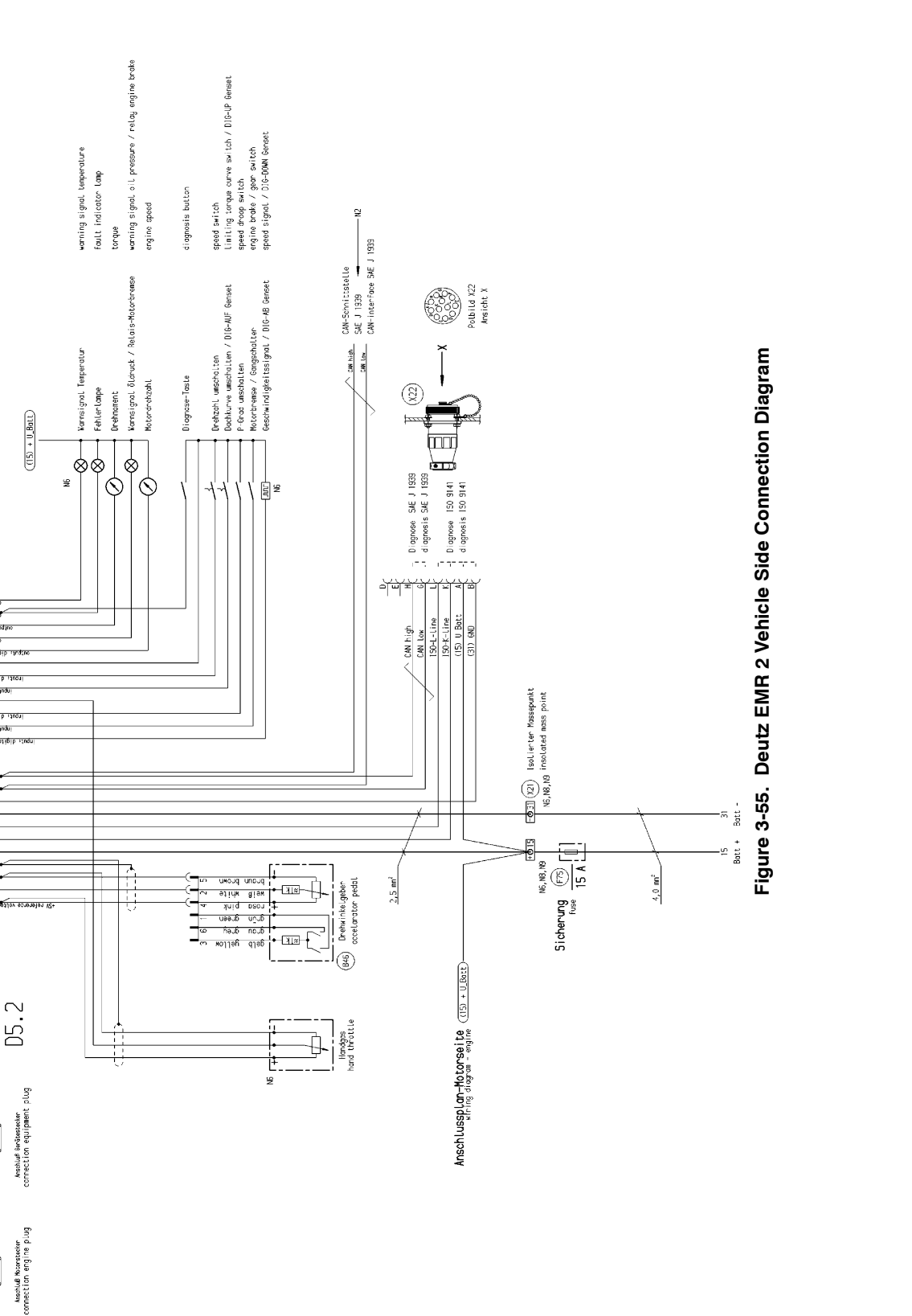
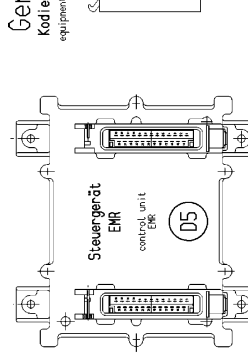


Figure 3-55. Deutz EMR 2 Vehicle Side Connection Diagram



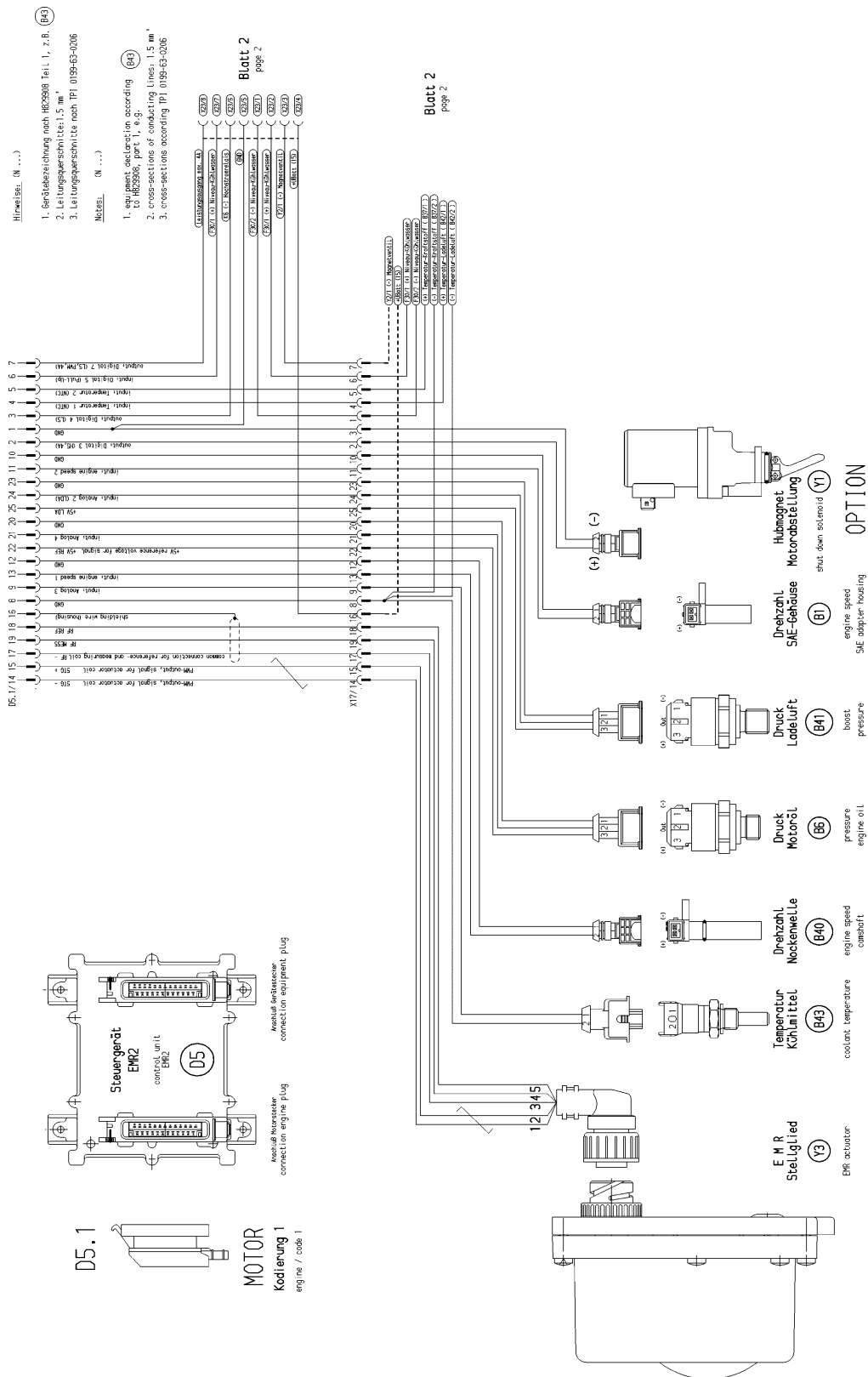
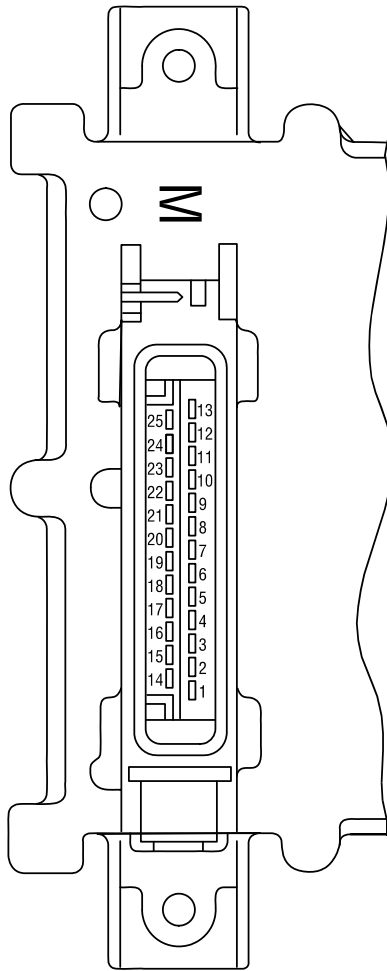


Figure 3-56. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2



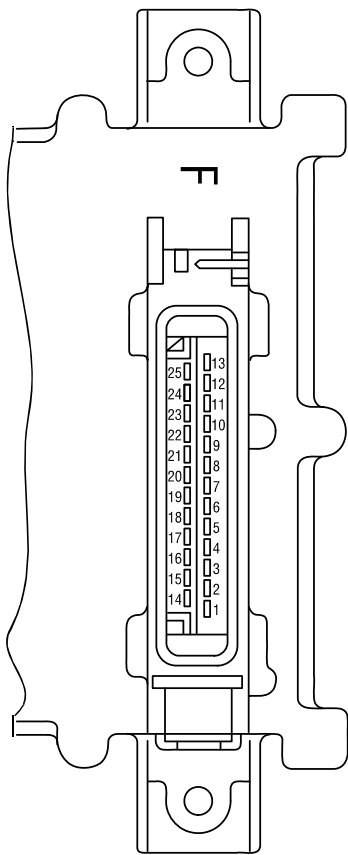


Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid <sup>1)</sup>
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature <sup>2)</sup>
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) DigIn 5	Coolant level / oil level
7	Output: PWM2/digital 6	
8	GND	Reference potential for analog signal at pin 9
9	Input: analog 7	Analog input for Coolant temperature sensor (NTC)
10	GND	Reference potential for analog signal at pin 11
11	Multi-function input: speed 2/DigIn 2	Digital input second engine speed (crankshaft) (optional) and speed signal (optional)
12	GND	Reference potential for analog signal at pin 13
13	Input: speed 1	Digital input first engine speed (camshaft)
14	STG -	PWM output, signal for actuator coil
15	STG +	PWM output, signal for actuator coil
16	Screen	Screening regulating rod travel sensor (for lines 17, 18, 19)
17	RF -	General connection for reference and measuring coil
18	RF REF	Analog input, reference signal of the reference coil
19	RF MESS	Analog input, measuring signal of the measuring coil
20	GND	Reference potential for signal at pin 21
21	Input: analog 4/digital 9	Analog input 4 (sensor signal oil pressure sensor) or digital input 9
22	+5 V REF	+5 V Reference voltage for signal at pin 21 (max. 15 mA)
23	GND	Reference potential for signal at pin 24
24	Input: analog 2/digital 7	Analog input 2 (sensor signal charge air) or digital input 7
25	+5 V LDA	+5 V Reference potential for signal at pin 24 (max. 15 mA)

1) For continuous power: < 4 A

2) Corresponds to special function"fuel temperature compensation at the EMR (0211 2571)

Figure 3-58. EMR 2 Engine Plug Pin Identification



Pin-No.	Designation	Description
1	U Batt -	Negative pole at battery (clamp 31)
2	GND	Reference potential for signal
3	Output: digital 2	PWM or digital output, various functions
4	Input / output: DigInOut	Fault lamp and diagnostic button
5	Output: PWM 1/Dig 1	PWM or digital output, various functions
6	Multi-function input: DigIn 3	Genset applications/gear shift/motor brake
7	Input: digital 10/velocity	Speed signal (tacho input)
8	NC	Not occupied
9	NC	Not occupied
10	L-line	Serial ISO 9141 interface
11	K-line	Serial ISO 9141 interface
12	CAN high	Interface for CAN-Bus
13	CAN low	Interface for CAN-Bus
14	U Batt +	Positive pole for battery (clamp 15)
15	Output: digital 5	Digital output, various functions
16	Output: digital 7/Frequency	Frequency, PWM or digital output, various functions
17	Ground	Reference potential for signal at pins 18, 19 and 21
18	Input: digital 1 / PWM 1	PWM 1 or digital input 1, various functions
19	Multi-function input: DigIn 4	Performance curve switching/genset applications
20	Multi-function input: digital 8 / analog 3	Hand hand throttle/genset applications, Digital (8) or analog input (3)
21	Input: digital 2 / PWM 2	PWM 2 or digital input 2, various functions
22	Screen	Screening (e.g. for lines hand throttle or PWG)
23	GND	Reference potential for signal at pin 24
24	Input: analog 1 / digital 6	Analog input 1 (pedal value sensor, PWG) or digital input 6
25	+5 V REF	+5 V Reference voltage for signal at pin 24

Figure 3-59. EMR 2 Vehicle Plug Pin Identification

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Zero error display	-	No faults	524287	31	No active faults present		
Revolutions / speed acquisition	01	Speed sensor 1	190	8	Sensor failure. Distance from gear too far. Additional fault impulses. Cable joint interrupted.	Governor in emergency operation (if sensor 2 available). Emergency switch-off (if sensor 2 not available or failed). Governor in emergency operation (with sensor 1). Emergency switch-off (if sensor 1 not available or failed).	Check distance. Check cable connection. Check sensor and replace if required.
	03	Speed sensor	84	8	Tacho failed. Additional fault impulses. Cable connection interrupted.	Governor in emergency operation.	Check cable connection and Tacho. Replace if required.
	04	Excess speed switch-off	190	0	Speed was/is in excess of limit.e. Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator (impulse on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.	Engine stop.	Check parameter (21). Check speed settings.
Sensors	07	Charge air pressure	102	2			
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2	Fault at corresponding sensor entry (e.g. short circuit or cable break).	With failure of the sensor, the associated monitoring function is de-activated.	Check sensor cable. Check sensor and replace if required. Check fault limits for sensor.
	10	Charge air temperature	105	2			
	11	Fuel temperature	174	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-60. EMR2 Fault Codes - Sheet 1 of 5

**SECTION 3 - CHASSIS & TURNTABLE**

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault warning	30	Oil pressure warning	100	1	Oil pressure below speed-dependent warning line characteristic	Fault message (disappears when oil pressure is again above recovery limit). After a delay time - fill limitation.	Check engine (oil level, oil pump). Check oil pressure sensor and cable. Check oil pressure warning line characteristic.
	31	Coolant temperature warning	110	0	Coolant temperature has exceeded warning level.	Fault message (disappears when coolant temperature again drops below recovery level). After a delay time - fill limitation.	Check coolant. Check coolant temperature sensor and cable.
	32	Charge air temperature warning	105	0	Charge air temperature has exceeded warning level.	Fault message (disappears when charge air temperature gain drops below recovery level). After a delay time - fill limitation.	Check charge air. Check charge air-temperature sensor and cable.
	34	Coolant level warning	111	1	Switch input "Low coolant level" is active.	Fault message.	Check coolant level. Check coolant level sensor and cable.
	35	Speed warning (with thrust mode operation).	SID 190	14	revolutions was/is above (top) revolution speed limit. "Thrust mode" function is active.		Check parameters. Check speed settings.
	36	Fuel temperature warning	174	0	Fuel-temperature has exceeded warning level.	Fault message (disappears when fuel temperature again drops below recovery level).	Check fuel. Check fuel temperature sensor and cable.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

**Figure 3-61. EMR2 Fault Codes - Sheet 2 of 5**

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault, switch-off	42	Charge air temperature switch-off	105	0	Charge air temperature has exceeded switch-off limit.	Emergency stop	Check charge air. Check charge air-temperature sensor and cable. Check switch-off limit.
	44	Coolant level switch-off	111	1	Switch input "Low coolant level" is active.	Emergency stop. Start lock.	Check coolant level. Check coolant level sensor and cable.
Actuator	50	Feedback	SID 24	12	Actuator not connected. Fault in actuator confirmation.	Emergency switch-off. Actuator cannot be operated.	Check actuator, replace if required. Check cable, check fault limits for "Confirmation".
	52	Reference feedback	SID 24	13			Check actuator, replace if required. Check cable, check fault limits for "Rifeness confirmation".
	53	Control travel difference	SID 23	7	Injection pump/actuator jammed or not connected. Difference between nominal/actual control travel is > 10 % of the overall control path.	Fault message (disappears when difference is < 10 %).	Check actuator/actuator rods / injection pump, replace if required. Check actuator cable.
	59	Auto calibration BOSCH-EDC pumps faulty operation	SID 23	13	No automatic actuator equalization possible. Incorrect input of the actuator reference values.	Engine stop / start lock. Governor cannot be taken into use. EDC actuator calibration required.	Check actuator and replaced if required. Check feedback cable. Check fault limits and reference values of the feedback. Program the fault limits for feedback, save the fault limits for feedback, save values. Switch ignition off and on again. Check again, if faulty, inform DEUTZ-Service and carry out automatic equalization again. Set fault limits again.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-62. EMR2 Fault Codes - Sheet 3 of 5

**SECTION 3 - CHASSIS & TURNTABLE**

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Hardware inputs/outputs	60	Digital output 3 (Switch-off solenoid, pin M 2)	SID 51	2	Fault (short circuit / cable break) at digital output.	Driver level is switched off.	Check cable of digital output (cable break or short circuit).
	62	Digital output 6, pin M 7	SID 60	2		Fault message.	
	63	Excess voltage switch-off solenoid	SID 51	6			
	67	Error Hand Setp1	91	11			
	68	Error CAN Setp1	898	2			
	Communication	70	CAN-Bus controller	SID 231	12	CAN-controller for CAN-bus is faulty. Fault removal despite re-initialising continuously not possible	Application-dependent.
71		CAN interface SAE J 1939	SID 231	9	Overflow in input buffer or a transmission cannot be placed on the bus.		
74		Cable break, short circuit or bus-error	SID 231	14			Check CAN connection, cable connection. Check sensor and replace if required.
Memory	76	Parameter programming (write EEPROM)	SID 253	12	Fault in parameter programming in the governor fixed value memory.	Emergency switch-off, engine cannot be started.	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service
	77	Cyclic program test	SID 240	12	Constant monitoring of program memory shows error (so-called "Flash-test").		
	78	Cyclic RAM test	SID 254	2	Constant monitoring of working memory shows error.		

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

**Figure 3-63. EMR2 Fault Codes - Sheet 4 of 5**



Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Control unit hardware	80	Power supply (Actuator)	SID 254	2	Power supply for actuator not in the permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	83	Reference voltage 1	SID 254	2	Reference voltage for actuator not in the permissible range.	Fault message (disappears when power again in the normal range). Auxiliary value 5 V	Check voltage supply. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	84	Reference voltage 2	SID 254	2			
	85	Reference voltage 4	SID 254	2			
	86	Internal temperature	171	12	Internal temperature for control unit not in permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
87	Atmospheric pressure	108	12	Atmospheric pressure not in permissible range.	Fault message (disappears when power again in normal range). Atmospheric pressure monitoring function de-activated.	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.	
Program logic	90	Parameter fault (EEPROM retrieval or checksum faulty).	SID 253	2	No data found or checksum of data is faulty (note: fault only occurs during setting of parameter / saving or reset).	Engine cannot be started.	Check data for correct settings. Save parameters. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	93	Stack overflow	SID 240	2	Internal calculation fault (so-called "Stack overflow" fault).	Emergency switch-off. Engine cannot be started.	Note parameters (3897 and 3898). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	94	Internal fault	SID 254	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-64. EMR2 Fault Codes - Sheet 5 of 5

## 3.25 GM ENGINE GENERAL MAINTENANCE

### Maintenance of the Drive Belt

The serpentine drive belt utilizes a spring loaded tensioner which keeps the belt properly adjusted. The drive belt is an integral part of the cooling and charging systems and should be inspected frequently.

When inspecting the belts check for:

- Cracks or breaks
- Chunking of the belt
- Splits
- Material hanging from the belt
- Glazing and hardening
- Damaged or improperly aligned pulleys
- Improperly performing tensioner

Check the belt tensioner by pressing down on the midway point of the longest stretch between pulleys. The belt should not depress beyond 1/2 inch (13mm). If the depression is more than allowable adjust the tension.

#### **NOTICE**

**THE ENGINE MANUFACTURER DOES NOT RECOMMEND THE USE OF "BELT DRESSING" OR "ANTI SLIPPING AGENTS" ON THE DRIVE BELT.**

### Engine Electrical System Maintenance

The engine electrical system incorporates computers and microprocessors to control the engine ignition, fuel control, and emissions. Due to the sensitivity of the computers to good electrical connections periodic inspection of the electrical wiring is necessary. When inspecting the electrical system use the following:

- Check and clean the battery terminal connections and insure the connections are tight
- Check the battery for any cracks or damage to the case
- Check the Positive and Negative battery cables for any corrosion build up, rubbing or chafing, check connection on the chassis to insure they are tight
- Check the entire engine wire harness for rubbing chafing, cuts or damaged connections, repair if necessary
- Check all wire harness connectors to insure they are fully seated and locked

- Check ignition coil and spark plug cables for hardening, cracking, chafing, separation, split boot covers and proper fit
- Replace spark plugs at the proper intervals as prescribed in the engine manufacturer's manual
- Check to make sure all electrical components are fitted securely
- Check the ground and platform control stations to insure all warning indicator lights are functioning

### Checking/Filling Engine Oil Level

#### **CAUTION**

**AN OVERFILLED CRANKCASE (OIL LEVEL OVER THE SPECIFIED FULL MARK) CAN CAUSE AN OIL LEAK, A FLUCTUATION OR DROP IN THE OIL PRESSURE, AND ROCKER ARM "CLATTER" IN THE ENGINE.**

#### **NOTICE**

**CARE MUST BE TAKEN WHEN CHECKING THE ENGINE OIL LEVEL. OIL LEVEL MUST BE MAINTAINED BETWEEN THE "ADD" MARK AND "FULL" MARK ON THE DIPSTICK.**

To ensure that you are not getting a false reading, make sure the following steps are taken to before check the oil level.

1. Stop the engine if in use.
2. Allow sufficient time (approximately 5 minutes) for the oil to drain back into the oil pan.
3. Remove the dipstick. Wipe with a clean cloth or paper towel and reinstall. Push the dipstick all the way into the dipstick tube.
4. Remove the dipstick and note the oil level.
5. Oil level must be between the "FULL" and "ADD" marks.

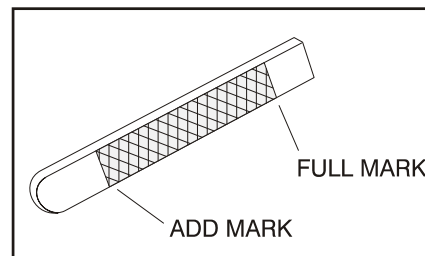


Figure 3-65. Engine Oil Dip Stick

6. If the oil level is below the "ADD" mark, proceed to Step 7 and 8 and reinstall the dipstick into the dipstick tube.
7. Remove the oil filter cap from the valve rocker arm cover.
8. Add the required amount of oil to bring the level up to but not over "FULL" mark on the dipstick.
9. Reinstall the oil fill cap to the valve rocker cover and wipe away any excess oil.

## Changing The Engine Oil

### NOTICE

WHEN CHANGING THE OIL, ALWAYS CHANGE THE OIL FILTER. CHANGE OIL WHEN THE ENGINE IS WARM FROM OPERATION AS THE OILS WILL FLOW FREELY AND CARRY AWAY MORE IMPURITIES.

To change the oil use the following steps:

1. Start the engine and run until it reaches normal operating temperature.
2. Stop the engine.
3. Remove the drain plug and allow the oil to drain.
4. Remove and discard the oil filter and its sealing ring.
5. Coat the sealing ring on the filter with clean engine oil and wipe the sealing surface on the filter mounting surface to remove any dust, dirt and debris. Tighten the filter securely (follow the filter manufacturers instructions). Do not over tighten.
6. Check the sealing ring on drain plug for any damage, replace if necessary, wipe the plug with a clean rag, and wipe the sealing surface on the pan and reinstall the pan plug. Do not over tighten.
7. Fill the crankcase with oil.
8. Start the engine and check for oil leaks.
9. Stop the engine and check the oil level to insure the oil level is at "FULL".
10. Dispose of the oil and filter in a safe manner.

## Coolant Fill Procedure - Dual Fuel Engine

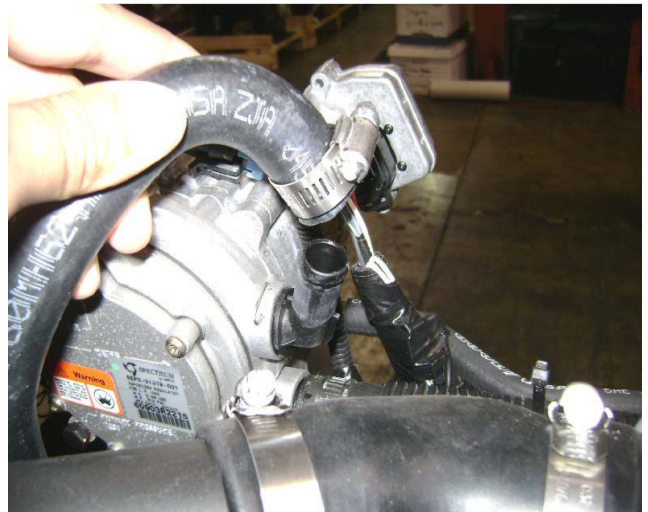
### NOTICE

DAMAGE TO THE ENGINE COULD OCCUR IF NOT PROPERLY FILLED WITH COOLANT. LPG FUELED ENGINES ARE MOST PRONE TO CREATING AN AIR LOCK DURING A COOLANT FILL OPERATION DUE TO THE ELECTRONIC PRESSURE REGULATOR (EPR) BEING THE HIGHEST POINT IN THE COOLING SYSTEM. AN EPR THAT APPEARS TO HAVE FROST FORMING ON IT IS A SIGN THAT THE ENGINE COOLING SYSTEM CONTAINS AIR. THE APPEARANCE AND TEMPERATURE OF THE EPR SHOULD BE MONITORED DURING THE COOLANT FILL OPERATION. A WARM EPR IS AN INDICATION THAT THE COOLING SYSTEM IS PROPERLY FILLED AND FUNCTIONING.

### CAUTION

MAKE SURE ENGINE IS COOL BEFORE PERFORMING ANY MAINTENANCE WORK.

1. Loosen the worm gear clamp on the coolant line running into the EPR as shown below and remove the hose from the EPR. Place a rag under the hose to prevent coolant from running onto the engine/machine.



## SECTION 3 - CHASSIS & TURNTABLE

2. Remove the radiator cap. Fill the radiator with coolant until coolant starts to appear from the previously removed hose at the EPR. Reinstall the hose back onto the EPR and continue to fill radiator with coolant.



3. With the radiator cap still removed, start the engine and run until the thermostat opens. The thermostat opens at 170° F (77° C), which can be checked using the JLG handheld analyzer.

### **NOTICE**

**WHILE ENGINE IS RUNNING, AIR AND/OR STEAM MAY BE PRESENT COMING FROM THE RADIATOR. THIS IS NORMAL.**

4. After running the engine for 5 minutes after it has reached operating temperature, shut the engine off and continue to step 5.

### **CAUTION**

**WITH THE ENGINE RUNNING OR WHEN SHUTTING OFF THE ENGINE, SOME HEATED COOLANT MAY SPILL OUT DUE TO AIR "BURPING" OUT OF THE SYSTEM WITH THE RADIATOR CAP OFF.**

5. Next, verify that the 2 coolant hoses on the EPR are warm. If they are not warm repeat step 3 and 4, otherwise continue to step 6.

### **NOTICE**

**A PROPERLY PURGED COOLING SYSTEM WILL YIELD A WARM UPPER RADIATOR HOSE AND A WARM EPR HOSE. IF THE UPPER RADIATOR HOSE AND/OR EPR HOSE ARE NOT WARM TO THE TOUCH AFTER THE ENGINE HAS RUN FOR 5-8 MINUTES AFTER REACHING OPERATING TEMPERATURE, THE SYSTEM MAY STILL CONTAIN AIR. IT MAY BE NECESSARY TO REPEAT THE ABOVE STEPS.**

6. Fill radiator with coolant as needed and install the radiator cap. Next, remove the cap off the coolant recovery bottle and fill just below the HOT FULL line and reinstall the caps.



### 3.26 GM ENGINE DUAL FUEL SYSTEM

The Dual Fuel system allows the operator to operate the vehicle on either gasoline or LPG by positioning a selector switch in the operator's platform. When the operator places the selector switch in the gasoline mode the gasoline fuel pump is energized. While in the gasoline mode the LPG fuel lock-off is isolated and will not energize. In addition the gasoline injector circuit is enabled and injector pulses are provided to each injector and the ECM calibration for gasoline is also enabled. When the operator selects the LPG mode the Low Pressure LPG lock-off is energized and fuel from the LPG tank flows to the Electronic Pressure Regulator (EPR). The EPR receives an electronic signal to position the secondary lever for the start or run positions and when the engine begins to crank the mixer air valve will rise and fuel will begin flowing to engine. During this mode the gasoline fuel pump is isolated and will not be activated. The primary components of the gasoline dual fuel system are the gasoline tank, electric fuel pump and filter, fuel supply line, injector rail and injectors and the fuel pressure regulator. The primary components of the LPG dual fuel system are the LPG fuel tank, in-fuel filter, LPG Low Pressure lock-off, Electronic Pressure Regulator (EPR) and the fuel mixer module. The LPG fuel system operates at pressures which range from 14.0 inches (355.60 mm) of water column up to 312 psi (21.5 BAR).

Components which are shared by both systems include the Electronic Throttle Control and the ECM. The ECM contains a dual calibration; one controls the gasoline fuel system during gasoline operation and one controls the LPG fuel system during LPG operation.

### Fuel Filter

Propane fuel like all other motor fuels is subject to contamination from outside sources. Refueling of the equipment's tank and removal of the tank from the equipment can inadvertently introduce dirt and other foreign matter into the fuel system. It is therefore necessary to filter the fuel prior to entering the fuel system components downstream of the tank. An inline fuel filter has been installed in the fuel system to remove the dirt and foreign matter from the fuel. The inline filter is replaceable as a unit only. Maintenance of the filter is critical to proper operation of the fuel system and should be replaced as Section 1. In severe operating condition more frequent replacement of the filter may be necessary.

### Electric Lock Off

The Electric Lock Off device is an integrated assembly. When energized the solenoid opens the valve and allows the Propane fuel to flow through the device. The valve opens during cranking and run cycles of the engine. The lock off supply voltage is controlled by the engine control module (ECM).

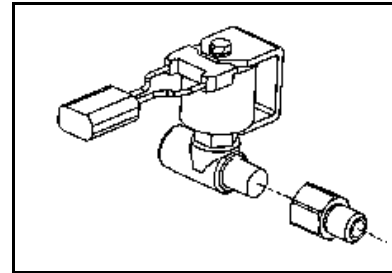
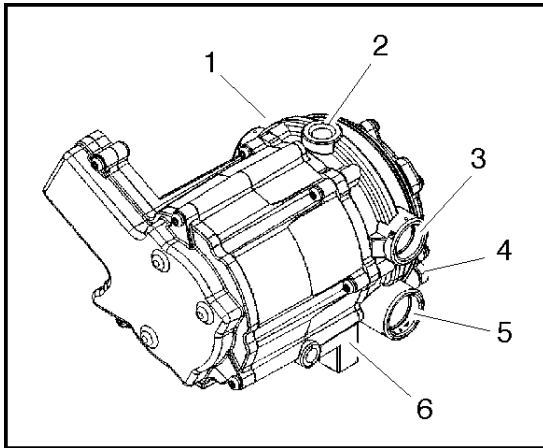


Figure 3-66. Electric Fuel Lock Off

## EPR Assembly

The EPR assembly is a combination Low Pressure Regulator and a Voice Coil Assembly. The Voice coil is an electronic actuator which is controlled by an internal microprocessor. The microprocessor provides output data to the ECM and receives input data over a CAN BUS connection. The internal microprocessor receives electrical signals from the Fuel Pressure Sensor FPS and the Fuel Temperature Pressure FTP and communicates the data to the ECM. The ECM uses the FPS and FTP data to calculate the location of the secondary lever in the LPR and sends that data back to the EPR via the CAN BUS. The internal microprocessor in the EPR will then output a signal, which causes the voice coil to move and position the secondary lever to the correct location.



- |                               |                        |
|-------------------------------|------------------------|
| 1. Pressure Regulator Section | 4. Primary Test Port   |
| 2. Fuel Inlet                 | 5. Secondary Test Port |
| 3. Coolant Passage            | 6. Voice Coil Section  |

Figure 3-67. EPR Assembly

## Low Pressure Regulator (LPR)

The LPR is a combination vaporizer, pressure regulating device. The LPR is a negative pressure, two stage regulator that is normally closed when the engine is not running. When the engine is cranking or running, a partial vacuum is created in the fuel line which connects the regulator to the mixer. This partial vacuum opens the regulator permitting fuel to flow to the mixer.

Propane fuel enters the primary port of the LPR and passes through the primary jet and into the primary/exchanger chamber. As the propane passes through the heat exchanger the fuel expands and creates pressure inside the chamber. The pressure rises as the fuel expands when the pressure rises above 1.5 psi (10.34 kpa), sufficient pressure is exerted on the primary diaphragm to cause the diaphragm plate to pivot and press against the primary valve pin thus closing off the flow of fuel. This action causes the flow of fuel into the regulator to be regulated.

When the engine is cranking, sufficient vacuum will be introduced into the secondary chamber from the mixer drawing the secondary diaphragm down onto the spring loaded lever and opening the secondary valve allowing vaporized fuel to pass to the mixer. This mechanical action in conjunction with the EPR reactions causes the downward action on the secondary lever causing it to open wider allowing more fuel to flow to the mixer.

### ⚠ WARNING

**THE VOICE COIL SECTION OF THE EPR ASSEMBLY IS AN EMISSIONS CONTROL DEVICE AND CANNOT BE REBUILT. IF THE COIL ASSEMBLY FAILS TO OPERATE PROPERLY, REPLACE IT WITH AN OEM REPLACEMENT PART ONLY.**

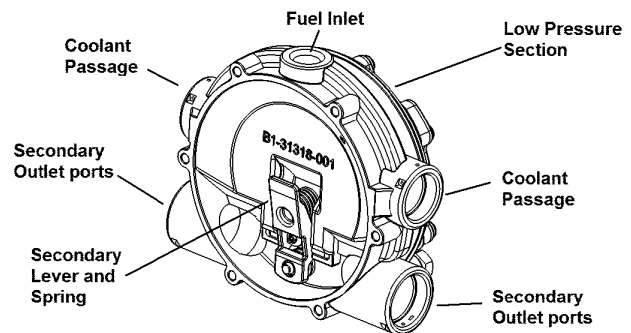


Figure 3-68. Low Pressure Regulators

## Air Fuel Mixer

The air valve mixer is an air-fuel metering device and is completely self-contained. The mixer is an air valve design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking to full load. The mixer is mounted in the air stream ahead of the throttle control device.

When the engine begins to crank, it draws in air with the air valve covering the inlet, negative pressure begins to build. This negative pressure signal is communicated to the top of the air valve chamber through 4 vacuum ports in the air valve assembly. A pressure/force imbalance begins to build across the air valve diaphragm between the air valve vacuum chamber and the atmospheric pressure below the diaphragm. The air valve vacuum spring is calibrated to generate from 4.0 inches (101.6 mm) of water column at start to as high as 14.0 inches (355.60 mm) of water column at full throttle. The vacuum being created is referred to as Air Valve Vacuum (AVV). As the air valve vacuum reaches 4.0 inches (101.6mm) of water column, the air valve begins to lift against the air valve spring. The amount of AVV generated is a direct result of the throttle position. At low engine speed the air valve vacuum is low and the air valve position is low thus creating a small venturi for the fuel to flow. As the engine speed increase the AVV increases and the air valve is lifted higher thus creating a much larger venturi. This air valve vacuum is communicated from the mixer venturi to the LPR secondary chamber via the low pressure fuel supply hose. As the AVV increases in the secondary chamber the secondary diaphragm is drawn further down forcing the secondary valve lever to open wider.

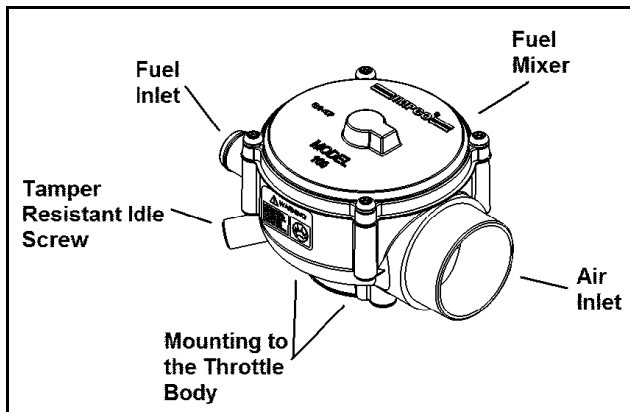


Figure 3-69. Air Fuel Mixer

## Electronic Throttle Control (ETC)

Engine speed and load control is maintained by an ETC device. Speed and load control are determined by the ECM. Defaults programmed into the ECM software and throttle position sensors allow the ECM to maintain safe operating control over the engine. The Electronic Throttle Control device or "throttle body assembly" is connected to the intake manifold of the engine. The electronic throttle control device utilizes an electric motor connected to the throttle shaft. When the engine is running electrical signals are sent from the equipment controls to the engine ECM when the operator depresses an equipment function switch. The ECM then sends an electrical signal to the motor on the electronic throttle control to increase or decrease the angle of the throttle blade thus increasing or decreasing the air/fuel flow to the engine.

The electronic throttle control device also incorporates two internal Throttle Position Sensors (TPS) which provide output signals to the ECM as to the location of the throttle shaft and blade. The TPS information is used by the ECM to correct speed and load control as well as emission control.

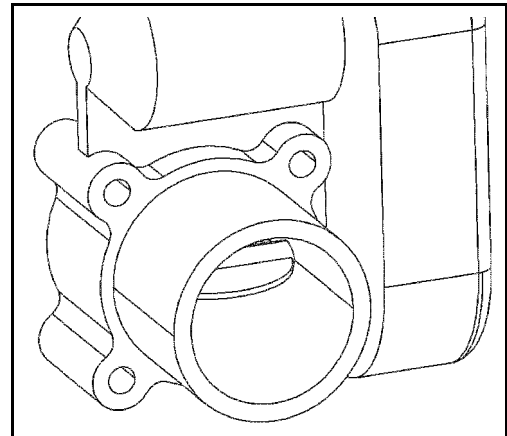


Figure 3-70. ETC throttle control device

## Engine Control Module

To obtain maximum effect from the catalyst and accurate control of the air fuel ratio the emission certified engine is equipped with an onboard computer or Engine Control Unit (ECM). The ECM is a 32 bit controller which receives input data from sensors fitted to the engine and fuel system and then outputs various signals to control engine operation.

One specific function of the controller is to maintain "closed loop fuel control". Closed loop fuel control is accomplished when the exhaust gas oxygen sensor (HEGO) mounted in the exhaust system sends a voltage signal to the controller. The controller then calculates any correction that may need to be made to the air fuel ratio. The controller then outputs signals to the EPR to correct the amount of fuel being supplied to the mixer. At the same time the ECM may correct the throttle blade position to correct speed and load of the engine.

The controller also performs diagnostic functions on the fuel system and notifies the operator of malfunctions by turning on a Malfunction Indicator Light (MIL) mounted in the Ground Control Station and the Platform Control Station. Malfunctions in the system are identified by a Diagnostic Code number. In addition to notifying the operator of the malfunction in the system the controller also stores the information about the malfunction in its memory.

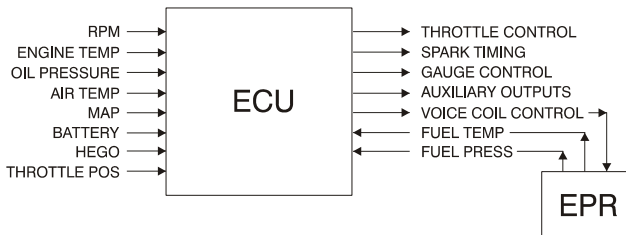


Figure 3-71. LPG Engine Control Unit (ECM)

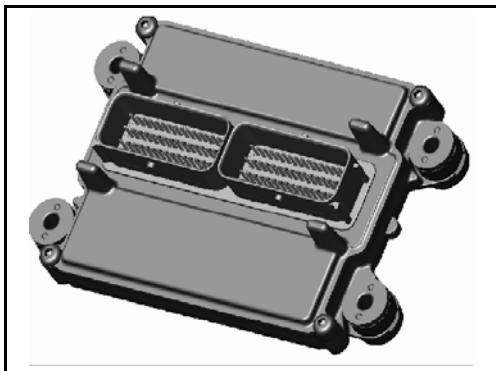


Figure 3-72. ECM Assembly

## Heated Exhaust Gas Oxygen Sensor

There are two Heated Exhaust Gas Oxygen Sensors (HEGO). The first HEGO is mounted in the exhaust system downstream of the engine. It is used to measure the amount of oxygen present in the exhaust stream and communicate that to the ECM via an electrical signal. The amount of oxygen present in the exhaust stream indicates whether the fuel/air ratio is too rich or too lean. If the HEGO sensor signal indicates that the exhaust stream is too rich the ECM will decrease or lean the fuel mixture during engine operation, if the mixture is too lean the ECM will richen the mixture. The ECM continuously monitors the HEGO sensor output. If a rich or lean condition is present for an extended period of time, and the ECM cannot correct the condition, the ECM will set a diagnostic code and turn on the MIL light in control box.

The second HEGO is mounted in the exhaust system after the muffler. It measures the amount of oxygen in the exhaust system after the catalyst treatment has been completed in the muffler. If the ECM detects that the catalytic action in the muffler is not sufficient and fuel correction cannot correct the malfunction the MIL light is illuminated in the control box and a DTC code will stored in the computer.

### ⚠ CAUTION

**THE HEATED EXHAUST GAS OXYGEN SENSOR IS AN EMISSION CONTROL DEVICE. IF THE HEGO FAILS TO OPERATE, REPLACE IT WITH AN OEM REPLACEMENT PART. THE HEGO SENSOR IS SENSITIVE TO SILICONE OR SILICONE BASED PRODUCTS AND CAN BECOME CONTAMINATED. AVOID USING SILICONE SEALERS OR HOSES TREATED WITH SILICONE LUBRICANTS IN THE AIR STREAM OR FUEL LINES.**



Figure 3-73. Heated Exhaust Gas Oxygen Sensor (HEGO)

## Gasoline Multi Point Fuel Injection System (MPFI)

The primary components of the Gasoline Multi Point Fuel Injection (MPFI) fuel system are the fuel tank, electric fuel pump, fuel pressure and temperature sensor manifold, fuel filter and fuel rail.



## Gasoline Fuel Pump

The Gasoline is stored as a liquid in the fuel tank and is drawn into the fuel system by an electric fuel pump. The fuel pump will receive a signal from the ECM to prime the fuel system for approximately 2 seconds prior to start. Priming of the fuel system provides for a quicker start, when the engine begins to crank.

## Gasoline Pressure And Temperature Sensor Manifold

This engine is equipped with a fuel injector rail that does not have a pressure regulator or a return circuit to the fuel tank. Fuel pressure for this engine is regulated by the engine's ECM. The ECM receives fuel pressure and temperature feedback from the gasoline fuel sensor manifold and uses this information to control the ground side of the fuel pump. Fuel pressure is regulated by the ECM pulse width modulating (PWM) the fuel pump. The fuel pressure and temperature sensor manifold has a return or "bleed" circuit that connects back to the fuel tank. This circuit is used to bleed off any vapor that develops in the line and return a small amount of fuel to the tank. The fuel comes from the fuel tank and passes through the fuel pump. Fuel exits the fuel pump, passes through the filter and then enters the fuel pressure and temperature manifold assembly. Fuel flows through the feed circuit and is delivered to the fuel injector rail. Fuel that enters the bleed circuits through the bypass valve in the manifold is returned to the fuel tank.

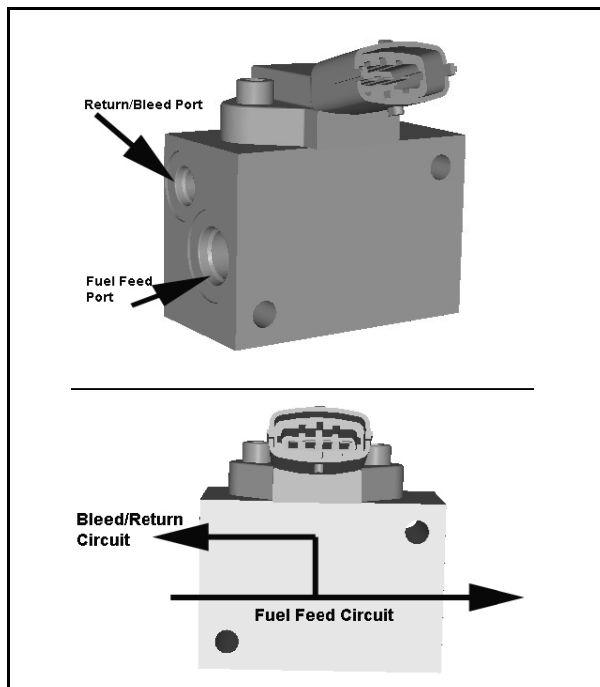


Figure 3-74. Gasoline Fuel Pressure and Temperature Manifold Assembly

## Fuel Filter

After the fuel is drawn into the fuel pump, the fuel flows through the gasoline fuel filter. The fuel filter will trap small particles as the fuel passes through the filter to remove debris and prevents the fuel pressure and temperature manifold and fuel injectors from becoming damaged. Maintenance of the fuel filter is required as indicated in Section 1.

## Fuel Injector Rail

Fuel flows from the fuel pressure and temperature manifold assembly to the fuel rails where the fuel is delivered to the fuel injectors. The fuel rail also contains a Schrader valve which is utilized to test the regulated pressure of the fuel system.

## Fuel Injector

The fuel supply is maintained on the top of the injector from the injector rail. The injector is fed a "pulse" signal through the wire harness which causes the injector to open. During regular operating conditions the ECM controls the opening and duration of opening of the injector. During lower RPM operation the injector signals or "pulses" are less frequent than when the engine is operating at higher RPMs. The engine has been calibrated to deliver the precise amount of fuel for optimum performance and emission control.

### 3.27 GM ENGINE FUEL SYSTEM REPAIR

#### Propane Fuel System Pressure Relief

**CAUTION**

THE PROPANE FUEL SYSTEM OPERATES AT PRESSURES UP TO 312 PSI (21.5 BAR). TO MINIMIZE THE RISK OF FIRE AND PERSONAL INJURY, RELIEVE THE PROPANE FUEL SYSTEM PRESSURE (WHERE APPLICABLE) BEFORE SERVICING THE PROPANE FUEL SYSTEM COMPONENTS.

To relieve propane fuel system pressure:

1. Close the manual shut-off valve on the propane fuel tank.
2. Start and run the vehicle until the engine stalls.
3. Turn the ignition switch OFF.

**NOTICE**

RESIDUAL VAPOR PRESSURE WILL BE PRESENT IN THE FUEL SYSTEM. ENSURE THE WORK AREA IS WELL VENTILATED BEFORE DISCONNECTING ANY FUEL LINE.

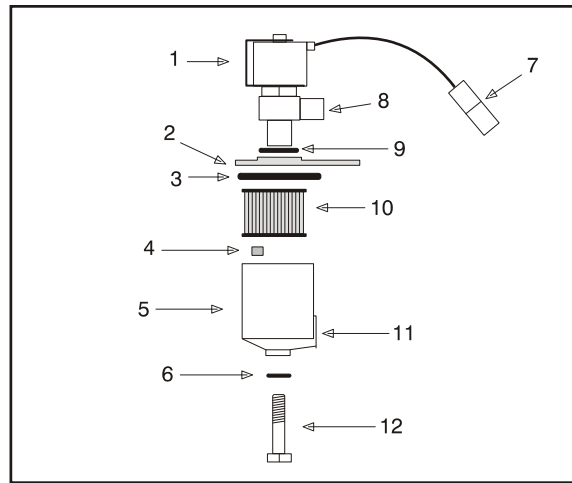
#### Propane Fuel System Leak Test

**CAUTION**

NEVER USE AN OPEN FLAME OF ANY TYPE TO CHECK FOR PROPANE FUEL SYSTEM LEAKS.

Always inspect the propane fuel system for leaks after performing service. Check for leaks at the fittings of the serviced or replaced component. Use a commercially available liquid leak detector or an electronic leak detector. When using both methods, use the electronic leak detector first to avoid contamination by the liquid leak detector.

#### Propane Fuel Filter Replacement



- |                               |                         |
|-------------------------------|-------------------------|
| 1. Electric Lock Off Solenoid | 7. Electrical Connector |
| 2. Mounting Plate             | 8. Fuel Outlet          |
| 3. Housing Seal               | 9. O-ring               |
| 4. Filter Magnet              | 10. Filter              |
| 5. Filter Housing             | 11. Fuel Inlet          |
| 6. Seal                       | 12. Retaining Bolt      |

Figure 3-75. Filter Lock Assembly

#### REMOVAL

1. Relieve the propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slowly loosen the Filter housing retaining bolt and remove it.
4. Pull the filter housing from the Electric lock off assembly.
5. Locate Filter magnet and remove it.
6. Remove the filter from the housing.
7. Remove and discard the housing seal.
8. Remove and discard the retaining bolt seal.
9. Remove and discard mounting plate to lock off O-ring seal.

#### INSTALLATION

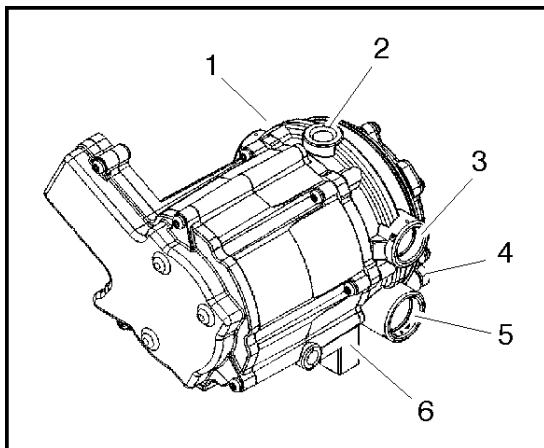
**NOTICE**

BE SURE TO REINSTALL THE FILTER MAGNET INTO THE HOUSING BEFORE INSTALLING NEW SEAL.

1. Install the mounting plate to lock off O-ring seal.
2. Install the retaining bolt seal.
3. Install the housing seal.

4. Drop the magnet into the bottom of the filter housing.
5. Install the filter into the housing.
6. Install the retaining bolt into the filter housing.
7. Install the filter up to the bottom of the electric lock off.
8. Tighten the filter retaining bolt to 106 in lbs (12 Nm).
9. Open manual shut-off valve. Start the vehicle and leak check the propane fuel system at each serviced fitting Refer to Propane Fuel System Leak Test.

### Electronic Pressure Regulator (EPR) Assembly Replacement



- |                               |                        |
|-------------------------------|------------------------|
| 1. Pressure Regulator Section | 4. Primary Test Port   |
| 2. Fuel Inlet                 | 5. Secondary Test Port |
| 3. Coolant Passage            | 6. Voice Coil Section  |

Figure 3-76. EPR Assembly

The EPR assembly is made up of two separate components. The Voice Coil Section is not serviceable and can only be replaced as an assembly. The pressure regulator section is serviceable and will be detailed in this section.

#### REMOVAL

1. Relieve the propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slowly remove the fuel inlet fitting at the Electric Lock Off.

**NOTE:** Residual vapor pressure will be present in the fuel system.

4. Disconnect the electrical connector to the Electric Lock off .

5. Remove the Electric Lock Off from the regulator.
6. Remove the lock pin from the vapor fitting on the regulator housing and remove the fitting and hose and retain the pin.
7. Remove the lock pin from the pressure sensor on the regulator housing and remove the Sensor and retain the pin.
8. Using a clamp pliers pinch off the hoses on the coolant lines to the regulator
9. Remove the lock pin from both the water fittings on the regulator housing and remove the fittings and hoses and retain the pin
10. Disconnect the EPR electrical connector
11. Remove the (3) three nuts from the EPR isolators and the EPR mounting bracket
12. Remove the EPR from the bracket
13. Remove the (3) three mounting isolators

#### INSTALLATION

#### NOTICE

**DO NOT USE TEFLON TAPE ON ANY FUEL FITTING. USE A LIQUID PIPE THREAD SEALANT WHEN INSTALLING FITTINGS.**

**CHECK ALL THE O-RINGS ON THE VAPOR AND WATER FITTINGS FOR ANY DAMAGE REPLACE IF NECESSARY.**

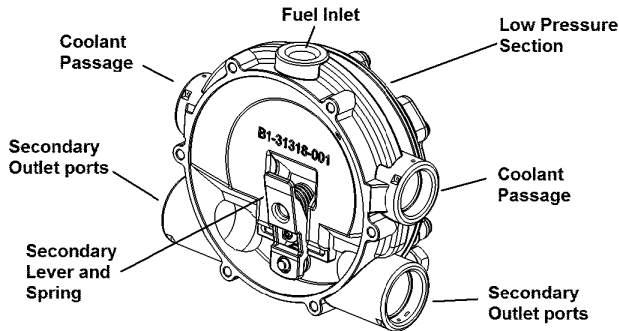
**LUBE ALL THE O-RINGS WITH AN O-RING LUBE BEFORE INSTALLING.**

1. Install the three (3) rubber isolators to the bottom of the EPR
2. Install the EPR assembly to the bracket and tighten the retaining nuts.

**NOTE:** Do not over tighten the isolators and cause a separation of the isolators.

3. Install the fuel temperature sensor into the regulator opening and lock in place with the locking pin, connect the electrical connector.
4. Insert the fuel vapor line and fitting into the regulator port and lock in place with the locking pin.
5. Install both the water hoses and fittings into the regulator and lock in place with the locking pin remove the clamp pliers from the hoses.
6. Install the electric lock off into the regulator inlet and tighten into proper location, connect the electrical connector.
7. Connect the fuel supply line and tighten until fully seated.

8. Connect the EPR electrical connector.
9. Open the manual valve.
10. Start the vehicle and leak check the propane fuel system at each serviced fitting Refer to Propane Fuel System Leak Test.



**Figure 3-77. Pressure Regulator Section**

**PRESSURE REGULATOR SECTION REMOVAL**

1. Remove the EPR refer to EPR Removal Procedure.
2. Remove the six (6) regulator to voice coil screws using the special tool and separate the regulator from the actuator.

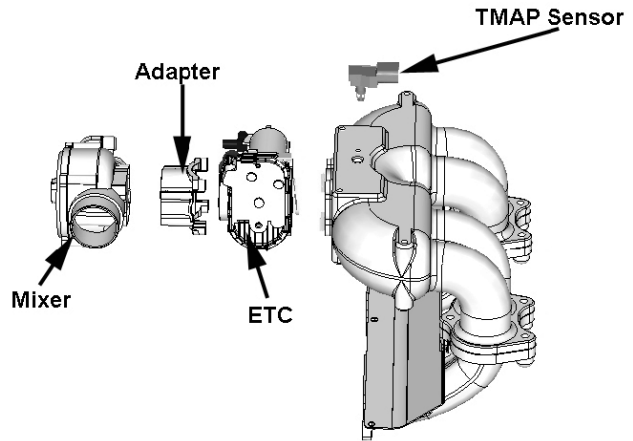
**NOTICE**

**DO NOT REMOVE THE SECONDARY DIAPHRAGM RETAINING PLATE AND DIAPHRAGM THIS WILL VOID THE WARRANTY OF THE ACTUATOR SECTION.**

**PRESSURE REGULATOR SECTION INSTALLATION**

1. Install the regulator to the actuator section using the six (6) retaining screws and tighten 70 in lbs (8 Nm).
2. Install the EPR refer to EPR Installation.

**Temperature Manifold Absolute Pressure (TMAP) Sensor**



**Figure 3-78. (TMAP) Sensor & Electronic Throttle Control (ETC)**

**REMOVAL**

1. Disconnect the TMAP electrical connector.
2. Remove the two retaining bolts.
3. Remove the TMAP.

**INSTALLATION**

**NOTE:** Apply a small amount of O-ring lubricant before installation.

1. Install in the TMAP.
2. Tighten retaining bolts to 62 lb-in (7 Nm).
3. Start the vehicle and check for proper operation.

## Electronic Throttle Control Replacement

See Figure 3-78.

### REMOVAL

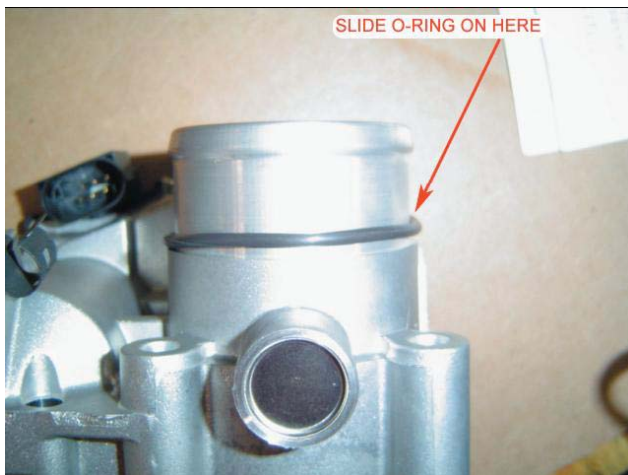
1. Disconnect the negative battery cable.
2. Remove the air intake duct.
3. Release the hose clamp on the vapor fuel line and remove the vapor hose.
4. Disconnect the TMAP electrical connector.
5. Disconnect the electronic throttle control connector.
6. Remove the manifold to throttle body adapter bolts and remove the throttle body mixer assembly.
7. Pull the throttle body assembly from the adapter.
8. Remove electronic throttle control device.
9. Remove the O-rings gasket and discard.

### INSTALLATION

#### NOTICE

LIGHTLY LUBRICATE BOTH THROTTLE CONTROL DEVICE TO ADAPTER O-RINGS.

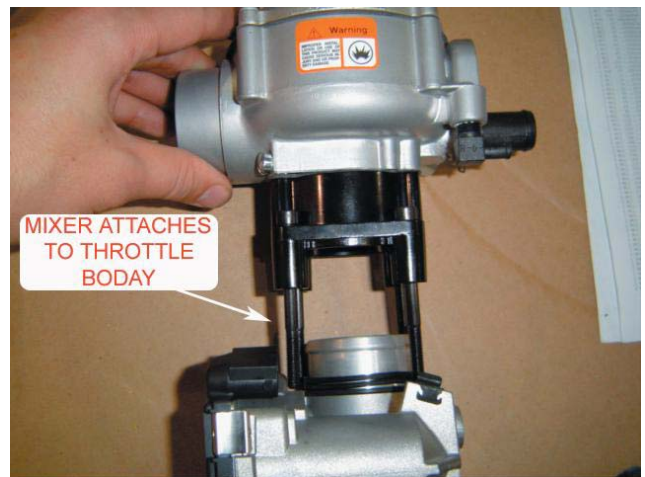
1. Install the O-ring on throttle body. Press it down to the bottom of the surface.



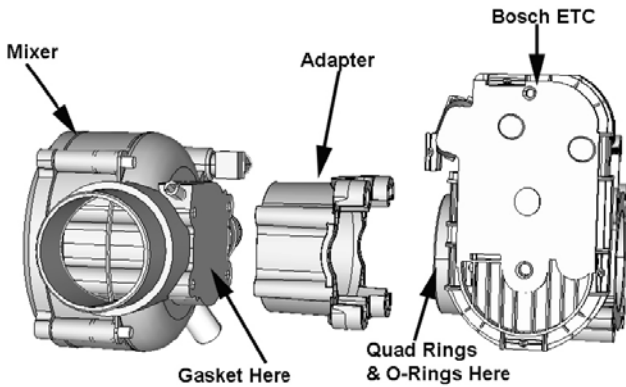
2. Install the two quad seals. Install one seal at a time to insure the seal does not roll. The seal must sit flat on the throttle body.



3. Attach mixer and throttle body together. The two parts do not bolt together; they will be secured when you mount it on the intake. Notice the orientation of the air inlet and throttle body cover.



- Place gasket on intake manifold and attach mixer/throttle assembly to manifold.



**Figure 3-79. Mixer Assembly**

## Mixer Replacement

See Figure 3-79.

### REMOVAL

- Remove the Throttle control device Refer to Electronic Throttle Body Replacement.
- Remove the four (4) bolts to the throttle control device to mixer adapter bolts.
- Remove and discard the mixer to adapter gasket.

### INSTALLATION

#### **NOTICE**

**COVER THROTTLE BODY ADAPTER OPENING TO PREVENT DEBRIS FROM ENTERING ENGINE UNTIL REASSEMBLY.**

- Install Mixer to adapter gasket onto the mixer.
- Install the mixer to the throttle control device to mixer adapter and secure with the 4 retaining screws. Tighten 80 lb-in (9 Nm)
- Install Throttle body. Refer to Electronic Throttle Control Device Replacement.
- Start the engine and leak check all fittings and connections.

## Coolant Hose Replacement

### REMOVAL

- Drain the coolant.
- Using hose clamp pliers, disconnect both hose clamps on each hose.
- Remove the hose from each of the fittings.

### INSTALLATION

**NOTE:** Use hose material and lengths specified by JLG.

- Install the hose clamps to each hose and set the clamp back on each hose to make installation easier.
- Fit the hose to the fittings.
- Secure by positioning each of the clamps.

## Vapor Hose Replacement

### REMOVAL

- Using hose clamp pliers disconnect both hose clamps.
- Remove the vapor hose from each fitting.

### INSTALLATION

#### **NOTICE**

**THE VAPOR SUPPLY HOSE IS SPECIFICALLY DESIGNED, DO NOT USE HOSE MATERIAL OR LENGTH OTHER THAN JLG SPECIFIED PARTS.**

- Install hose clamps and set back on each hose.
- Reinstall the vapor hose to each fitting.
- Reset clamps.
- Start engine and check for leaks.

## Engine Control Module Replacement

### REMOVAL

1. Disconnect Negative battery cable.
2. Remove controller from mounting bracket.
3. Push connector lock back to unlock connector.
4. Unplug controller and remove.

### INSTALLATION

#### **NOTICE**

**THE CONTROLLER IS CALIBRATED FOR EACH ENGINE VERIFY YOU HAVE THE CORRECT CONTROLLER**

1. Plug connector into controller.
2. Push lock into place.
3. Mount controller into mounting bracket.
4. Reconnect the battery cable.
5. Start engine.
6. Check for any DTC codes and clear.
7. Verify engine is in closed loop and no warning lights are illuminated.

## Heated Exhaust Gas Oxygen Sensor Replacement

### REMOVAL

1. Disconnect Negative battery cable.
2. Disconnect the O2 sensor electrical connector.
3. Using an O2 Sensor socket, remove the O2 Sensor and discard.

### INSTALLATION

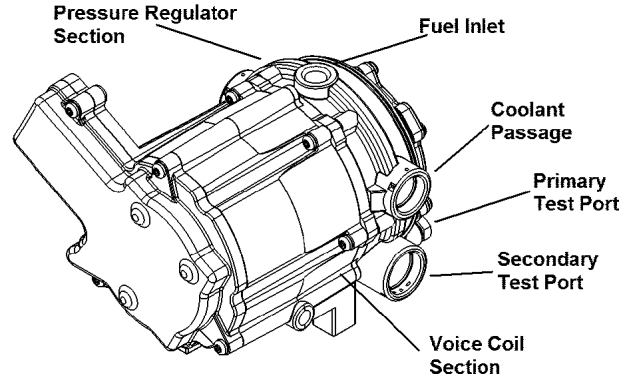
#### **NOTICE**

**BEFORE INSTALL THE O2 SENSOR LUBRICATE THREADS WITH ANTI-SEIZE COMPOUND GM P/N 5613695 OR EQUIVALENT. AVOID GETTING COMPOUND ON THE SENSOR TIP.**

1. Install O2 sensor. Tighten to 30 lb-ft (41 Nm).
2. Start engine.
3. Check for any DTC codes and clear.
4. Verify engine is in closed loop and no warning lights are illuminated.

## 3.28 GM ENGINE LPG FUEL SYSTEM DIAGNOSIS

### Fuel System Description



**Figure 3-80. EPR Assembly**

To maintain fuel and emission control on the LPG fuel system the Engine Control Units (ECM) relies on numerous engine sensor and output data from the Electronic Pressure Regulator (EPR). The ECM will then determine the target fuel calibration and command the EPR to reposition the voice coil to the proper position which, subsequently reposition the secondary lever in the pressure regulator to maintain proper control. The EPR and ECM will continue to communicate back and forth during normal operation.

In the event that the EPR fails to communicate or the Communications Area Network (CAN) cable fails to transmit data the regulator will operate in an open loop configuration. As the air valve vacuum in the mixer venturi is communicated to the secondary chamber of the regulator the secondary diaphragm will be drawn in a downwards motion. This downward motion will cause the secondary lever to open thus allowing more fuel to enter the mixer.

In the (LPR) the fuel is vaporized and the pressure reduced in two stages. The first stage reduces the pressure to approximately 1.0 to 3.0 psi (6.8 to 20.6 kPa). The second stage reduces the pressure to approximately negative 1.5" of water column.

The fuel is then drawn from the secondary chamber of the LPR by the vacuum generated by air flowing through the mixer. This vacuum signal is also used to generate lift for the mixer air valve. This vacuum signal is most commonly referred to as air valve vacuum. In the mixer, the fuel mixes with the air entering the engine. This air/ fuel mixture is then drawn into the engine for combustion.

### Diagnostic Aids

This procedure is intended to diagnose a vehicle operating on LPG. If the vehicle will not continue to run on LPG, refer to Hard Start for preliminary checks. Before proceeding with this procedure, verify that the vehicle has a sufficient quantity of fuel and that liquid fuel is being delivered to the LPR. Also, ensure that the manual shut off valve on the LPG tank is fully opened and that the excess flow valve has not been activated.

#### Tools Required:

- 7/16 Open end wrench (for test port plugs)
- DVOM (GM J 39200, Fluke 88 or equivalent).
- 12 volt test light

#### Diagnostic Scan Tool

- Diagnostic Display tool.

### Pressure Gauges

- IMPCO ITK-2 Test kit
- Water Column Gauge / Manometer (GM 7333-6 or equivalent).
- 0-10 PSI Gauge

### Test Description

The numbers below refer to step numbers on the diagnostic table.

5. This step determines if the LPR requires replacement

6. This step determines if the problems are in the mechanical side of the Pressure Regulator or the Electronic Voice Coil

10. This step determines if the Mixer requires replacement

14. This step determines if the Lock Off requires replacement

17. This step determines if the Fuel Filter requires replacement.



**Table 3-11. LPF Fuel System Diagnosis**

STEP	ACTION	VALUE(S)	YES	NO
1	Were you referred to this procedure by a DTC diagnostic chart?	--	Go to Step 3	Go to Step 2
2	Perform the On Board Diagnostic (OBD) System Check. Are any DTCs present in the ECM?	--	Go to the applicable DTC Table	Go to Step 3
3	Verify that the LPG fuel tank has a minimum of 1/4 tank of fuel, that the manual valve is open and the tank quick connect is fully engaged Does the vehicle have fuel?	--	Go to Step 4	--
4	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Start the engine and allow it to reach operating temperature. Does the engine start and run?	--	Go to Step 5	Go to Step 8
5	With the engine idling, observe the pressure reading for the LPR secondary pressure. Does the fuel pressure fluctuate rhythmically OUTSIDE the specified range?	-1.0" to -2.0" w.c	Go to Step 25	Go to Step 6
6	1. Disconnect the EPR electrical connectors. NOTE: This action will cause a DTC to be set by the ECM 2. With the engine idling observe the pressure reading on the secondary test port. Is the fuel pressure WITHIN the specified range?	-1.0" to -2.0" w.c	Go to Fuel Control System Diagnosis	Go to Step 7
7	1. Inspect the air intake stream between the mixer assembly and the throttle body for leaks. 2. Inspect the fuel hose connection between the LPR and mixer assembly for damage or leakage. 3. Inspect any vacuum hoses for leaks Was a problem found and corrected?	--	Go to Step 26	Go to Step 22
8	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR secondary pressure. Does the fuel pressure indicate a vacuum is present?	--	Go to Step 12	Go to Step 9
9	1. Remove Air induction hose to the mixer 2. Observe the air valve for movement while the engine is cranking. Note: Movement of the air valve will be minimal at cranking speeds. Does the air valve move when the engine is cranked?	--	Go to Step 11	Go to Step 10
10	1. Inspect the air intake stream to the mixer assembly and the throttle body for vacuum leaks. 2. Inspect the vacuum hoses from the mixer for proper connection and condition. Was a problem found and repaired?	--	Go to Step 26	Go to Step 24
11	Inspect the fuel hose connection between the LPR and the mixer assembly for damage or leakage. Was a problem found and repaired?	--	Go to Step 26	Go to Step 12
12	1. Connect a 0-10 psi gauge to the primary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR primary pressure. Is the fuel pressure ABOVE the specified value?	1-3 PSI	Go to Step 22	Go to Step 13

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-11. LPF Fuel System Diagnosis**

STEP	ACTION	VALUE(S)	YES	NO
13	1. Turn OFF the ignition. 2. Disconnect the LPL connector. 3. Install a test light between the pins of the LPL connector. 4. Crank the engine. The test light should illuminate. Does the test light illuminate?	--	Go to Step 14	Go to Step 16
14	Using a DVOM, check the resistance of the low pressure lock-off (LPL). Is the resistance within the specified range?	12W - 16W	Go to Step 15	Go to Step 23
15	1. Turn the ignition OFF. 2. Close the manual shut-off valve on the LPG tank. CAUTION: When disconnecting LPG fuel lines, liquid LPG may be present. Perform this step in a well ventilated area. 3. Loosen the fuel inlet hose fitting at the inlet of the LPL. Was fuel present when the fitting was loosened?	--	Go to Step 23	Go to Step 17
16	1. Turn OFF the ignition. 2. Connect the test light to chassis ground and probe pin A of the LPL connector. 3. Crank the engine. The test light should illuminate. Does the test light illuminate?	--	Go to Step 20	Go to Step 21
17	1. Remove the LPG fuel filter / LPL. 2. Remove the filter from the LPL. 3. Empty the contents of the inlet side of the LPG fuel filter onto a clean surface. 4. Inspect the contents of the LPG fuel filter for an excessive amount of foreign material or water. If necessary, locate and repair the source of contamination. 5. Verify the LPG fuel filter is not restricted or plugged. Was a problem found?	--	Go to Step 19	Go to Step 18
18	The fuel supply system or hoses are plugged or restricted, locate and repair the problem. Is the action complete?	--	Go to Step 26	--
19	Replace the fuel filter. Refer to Fuel Filter Replacement. Is the action complete?	--	Go to Step 26	--
20	Repair the open in the lock-off ground circuit. Is the action complete?	--	Go to Step 26	--
21	Repair the open in the lock-off power circuit. Is the action complete?	--	Go to Step 26	--
22	Replace the low pressure regulator (LPR). Refer to Low Pressure Regulator Replacement. Is the action complete?	--	Go to Step 26	--
23	Replace the lock-off. Refer to Lock-off Replacement. Is the action complete?	--	Go to Step 26	--
24	Replace the mixer assembly. Refer to Fuel Mixer Replacement. Is the action complete?	--	Go to Step 26	--

**Table 3-11. LPF Fuel System Diagnosis**

<b>STEP</b>	<b>ACTION</b>	<b>VALUE(S)</b>	<b>YES</b>	<b>NO</b>
25	<p>The fuel supply system is operating normally, if a failure of the control solenoids is suspected. Refer to Fuel Control System Diagnosis.</p> <p>1. Install the test plug in the LPR secondary chamber.                      2. If you were sent to this routine by another diagnostic chart, return to the previous diagnostic procedure.                      Is the action complete?</p>	--	System OK	--
26	<p>1. Disconnect all test equipment                      2. Install the primary and secondary test port plugs.                      3. Start the engine.                      4. Using SNOOP or equivalent, leak check the test port plugs.                      Is the action complete?</p>	--	System OK	--

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-12. Symptom Diagnosis**

Checks	Action
Important Preliminary Checks	
Before Using This Section	<p>Before using this section, you should have performed On Board Diagnostic Check and determined that:</p> <ol style="list-style-type: none"> <li>1. The Control Module and MIL (Malfunction Indicator Lamp) are operating correctly.</li> <li>2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL.</li> </ol> <p>Several of the following symptom procedures call for a careful visual and physical check. The visual and physical checks are very important. The checks can lead to correcting a problem without further checks that may save valuable time.</p>
LPG Fuel System Check	<ol style="list-style-type: none"> <li>1. Verify the customer complaint.</li> <li>2. Locate the correct symptom table.</li> <li>3. Check the items indicated under that symptom.</li> <li>4. Operate the vehicle under the conditions the symptom occurs. Verify HEGO switching between lean and rich.</li> </ol> <p><b>IMPORTANT! Normal HEGO switching indicates the LPG fuel system is in closed loop and operating correctly at that time.</b></p>
Visual and Physical Checks	<ul style="list-style-type: none"> <li><input type="checkbox"/> Check all ECM system fuses and circuit breakers.</li> <li><input type="checkbox"/> Check the ECM ground for being clean, tight and in its proper location.</li> <li><input type="checkbox"/> Check the vacuum hoses for splits, kinks and proper connections.</li> <li><input type="checkbox"/> Check thoroughly for any type of leak or restriction.</li> <li><input type="checkbox"/> Check for air leaks at all the mounting areas of the intake manifold sealing surfaces.</li> <li><input type="checkbox"/> Check for proper installation of the mixer module assembly.</li> <li><input type="checkbox"/> Check for air leaks at the mixer assembly.</li> <li><input type="checkbox"/> Check the ignition wires for the following conditions: <ul style="list-style-type: none"> <li>- Cracking</li> <li>- Hardness</li> <li>- Proper routing</li> <li>- Carbon tracking</li> </ul> </li> <li><input type="checkbox"/> Check the wiring for the following items: <ul style="list-style-type: none"> <li>- Proper connections, pinches or cuts.</li> </ul> </li> <li><input type="checkbox"/> The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first.</li> </ul>
Intermittent	
DEFINITION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	<ul style="list-style-type: none"> <li><input type="checkbox"/> Refer to Important Preliminary Checks.</li> <li><input type="checkbox"/> Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.</li> </ul>
Faulty Electrical Connections or Wiring	<ul style="list-style-type: none"> <li><input type="checkbox"/> Faulty electrical connections or wiring can cause most intermittent problems.</li> <li><input type="checkbox"/> Check the suspected circuit for the following conditions: <ul style="list-style-type: none"> <li>- Faulty fuse or circuit breaker</li> <li>- Connectors poorly mated</li> <li>- Terminals not fully seated in the connector (backed out)</li> <li>- Terminals not properly formed or damaged</li> <li>- Terminal to wires poorly connected</li> <li>- Terminal tension insufficient.</li> </ul> </li> <li><input type="checkbox"/> Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension.</li> <li><input type="checkbox"/> Checking for poor terminal to wire connections requires removing the terminal from the connector body.</li> </ul>
Operational Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates the problem may be in that circuit.

Table 3-12. Symptom Diagnosis

Checks	Action
Intermittent Malfunction Indicator Lamp (MIL)	The following components can cause intermittent MIL and no DTC(s): <ul style="list-style-type: none"> <li><input type="checkbox"/> A defective relay, Control Module driven solenoid, or a switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating.</li> <li><input type="checkbox"/> The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc.</li> <li><input type="checkbox"/> The ignition secondary voltage shorted to a ground.</li> <li><input type="checkbox"/> The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground.</li> <li><input type="checkbox"/> The Control Module grounds.</li> </ul>
Loss of DTC Memory	To check for the loss of the DTC Memory: <ol style="list-style-type: none"> <li>1. Disconnect the TMAP sensor.</li> <li>2. Idle the engine until the Malfunction Indicator Lamp illuminates.</li> </ol> <p>The ECM should store a TMAP DTC. The TMAP DTC should remain in the memory when the ignition is turned OFF. If the TMAP DTC does not store and remain, the ECM is faulty</p>
Additional Checks	
No Start	
DEFINITION: The engine cranks OK <input type="checkbox"/> but does not start.	
Preliminary Checks	Refer to Important Preliminary Checks.
Control Module Checks	If a scan tool is available: <ul style="list-style-type: none"> <li><input type="checkbox"/> Check for proper communication with both the ECM</li> <li><input type="checkbox"/> Check the fuse in the ECM battery power circuit. Refer to Engine Controls Schematics.</li> <li><input type="checkbox"/> Check battery power, ignition power and ground circuits to the ECM. Refer to Engine Control Schematics. Verify voltage and/or continuity for each circuit.</li> </ul>
Sensor Checks	<ul style="list-style-type: none"> <li><input type="checkbox"/> Check the TMAP sensor.</li> <li><input type="checkbox"/> Check the Magnetic pickup sensor (RPM).</li> </ul>
Fuel System Checks	<p><b>Important:</b> A closed LPG manual fuel shut off valve will create a no start condition.</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Check for air intake system leakage between the mixer and the throttle body.</li> <li><input type="checkbox"/> Verify proper operation of the low pressure lock-off solenoids.</li> <li><input type="checkbox"/> Check the fuel system pressures. Refer to the LPG Fuel System Diagnosis.</li> <li><input type="checkbox"/> Check for proper mixer air valve operation.</li> </ul>
Ignition System Checks	<p>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions.</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Check for the proper ignition voltage output with J 26792 or the equivalent.</li> <li><input type="checkbox"/> Verify that the spark plugs are correct for use with LPG (R42LTS)</li> <li><input type="checkbox"/> Check the spark plugs for the following conditions:                             <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> </ul> </li> <li><input type="checkbox"/> Check for bare or shorted ignition wires.</li> <li><input type="checkbox"/> Check for loose ignition coil connections at the coil.</li> </ul>
Engine Mechanical Checks	<p><b>Important:</b> The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system.</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Check for the following:                             <ul style="list-style-type: none"> <li>- Vacuum leaks</li> <li>- Improper valve timing</li> <li>- Low compression</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Broken or weak valve springs</li> <li>- Worn camshaft lobes.</li> </ul> </li> </ul>

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-12. Symptom Diagnosis**

Checks	Action
Exhaust System Checks	<input type="checkbox"/> Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> <li>- Inspect the exhaust system for damaged or collapsed pipes</li> <li>- Inspect the muffler for signs of heat distress or for possible internal failure.</li> </ul> <input type="checkbox"/> Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis
<b>Hard Start</b>	
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	<input type="checkbox"/> Refer to Important Preliminary Checks. <input type="checkbox"/> Make sure the vehicle's operator is using the correct starting procedure.
Sensor Checks	<input type="checkbox"/> Check the Engine Coolant Temperature sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. IF the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Refer to DTC 111 <input type="checkbox"/> Check the Crankshaft Position (CKP) sensor. <input type="checkbox"/> Check the Throttle position (TPS) sensor.
Fuel System Checks	Important: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition. <input type="checkbox"/> Verify the excess flow valve in the LPG manual shut-off valve is not tripped. <input type="checkbox"/> Check mixer module assembly for proper installation and leakage. <input type="checkbox"/> Verify proper operation of the low pressure lock-off solenoids. <input type="checkbox"/> Verify proper operation of the EPR <input type="checkbox"/> Check for air intake system leakage between the mixer and the throttle body. <input type="checkbox"/> Check the fuel system pressures. Refer to the Fuel System Diagnosis.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. <input type="checkbox"/> Check for the proper ignition voltage output with J 26792 or the equivalent. <input type="checkbox"/> Verify that the spark plugs are correct for use with LPG (R42LTS) <input type="checkbox"/> Check the spark plugs for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> </ul> <input type="checkbox"/> Check for bare or shorted ignition wires. <input type="checkbox"/> Check for moisture in the distributor cap if applicable. <input type="checkbox"/> Check for loose ignition coil connections. <b>Important:</b> 1. If the engine starts but then immediately stalls, Check the Crankshaft Position (CKP). 2. Check for improper gap, debris or faulty connections.
Engine Mechanical Checks	Important: The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. <input type="checkbox"/> Check for the following: <ul style="list-style-type: none"> <li>- Vacuum leaks               <ul style="list-style-type: none"> <li>- Improper valve timing</li> <li>- Low compression</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Broken or weak valve springs</li> <li>- Worn camshaft lobes.</li> </ul> </li> </ul> <input type="checkbox"/> Check the intake and exhaust manifolds for casting flash.

Table 3-12. Symptom Diagnosis

Checks	Action
Exhaust System Checks	<input type="checkbox"/> Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> <li>- Inspect the exhaust system for damaged or collapsed pipes</li> <li>- Inspect the muffler for signs of heat distress or for possible internal failure.</li> </ul> <input type="checkbox"/> Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis or Exhaust System in the GM Base Engine Service Manual
Additional Checks	<input type="checkbox"/>
Cuts Out, Misses	
<b>DEFINITION:</b> A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	<input type="checkbox"/> Refer to Important Preliminary Checks.
Ignition System Checks	<input type="checkbox"/> Start the engine. <input type="checkbox"/> Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. <input type="checkbox"/> Check for proper ignition output voltage with spark tester J 26792. <input type="checkbox"/> Check for a cylinder misfire. <input type="checkbox"/> Verify that the spark plugs are correct for use with LPG (R42LTS) <input type="checkbox"/> Remove the spark plugs in these cylinders and check for the following conditions: <ul style="list-style-type: none"> <li><input type="checkbox"/> Insulation cracks</li> <li><input type="checkbox"/> Wear</li> <li><input type="checkbox"/> Improper gap</li> <li><input type="checkbox"/> Burned electrodes</li> <li><input type="checkbox"/> Heavy deposits</li> </ul> <input type="checkbox"/> Visually/Physically inspect the secondary ignition for the following: <ul style="list-style-type: none"> <li><input type="checkbox"/> Ignition wires for arcing, cross-firing and proper routing</li> <li><input type="checkbox"/> Ignition coils for cracks or carbon tracking</li> </ul>
Engine Mechanical Checks	<input type="checkbox"/> Perform a cylinder compression check. <input type="checkbox"/> Check the engine for the following: <ul style="list-style-type: none"> <li>- Improper valve timing</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Worn camshaft lobes.</li> <li>- Broken or weak valve springs.</li> </ul> <input type="checkbox"/> Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	<input type="checkbox"/> Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. <input type="checkbox"/> Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). <ul style="list-style-type: none"> <li><input type="checkbox"/> EMI on the reference circuit can cause a missing condition.</li> <li><input type="checkbox"/> Monitoring the engine RPM with a scan tool can detect an EMI.</li> <li><input type="checkbox"/> A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present.</li> <li><input type="checkbox"/> If the problem exists, check the routing of the secondary wires and the ground circuit.</li> </ul>

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-12. Symptom Diagnosis**

Checks	Action
Hesitation, Sag, Stumble	
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	Refer to Important Preliminary Checks.
Fuel System Checks	<ul style="list-style-type: none"> <li><input type="checkbox"/> Check the fuel pressure. Refer to LPG Fuel System Diagnosis.</li> <li><input type="checkbox"/> Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system.</li> <li><input type="checkbox"/> Check the Manifold Absolute Pressure (MAP) sensor response and accuracy.</li> <li><input type="checkbox"/> Check LPL electrical connection</li> <li><input type="checkbox"/> Check the mixer air valve for sticking or binding.</li> <li><input type="checkbox"/> Check the mixer module assembly for proper installation and leakage.</li> <li><input type="checkbox"/> Check the EPR electrical connections.</li> </ul>
Ignition System Checks	<p>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only ignition system failure and test the system accordingly.</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Check for the proper ignition voltage output with J 26792 or the equivalent.</li> <li><input type="checkbox"/> Verify that the spark plugs are correct for use with LPG (R42LTS)</li> <li><input type="checkbox"/> Check for faulty spark plug wires</li> <li><input type="checkbox"/> Check for fouled spark plugs.</li> </ul>
Additional Check	<ul style="list-style-type: none"> <li><input type="checkbox"/> Check for manifold vacuum or air induction system leaks</li> <li><input type="checkbox"/> Check the generator output voltage.</li> </ul>
Backfire	
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	<input type="checkbox"/> Refer to Important Preliminary Checks.
Ignition System Checks	<p><b>Important! LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. The ignition system must be maintained in peak condition to prevent backfire.</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Check for the proper ignition coil output voltage using the spark tester J26792 or the equivalent.</li> <li><input type="checkbox"/> Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.</li> <li><input type="checkbox"/> Check the connection at each ignition coil.</li> <li><input type="checkbox"/> Check for deteriorated spark plug wire insulation.</li> <li><input type="checkbox"/> Check the spark plugs. The correct spark plugs for LPG are (R42LTS)</li> <li><input type="checkbox"/> Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> </ul> </li> </ul>
Engine Mechanical Check	<p>Important! The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than a gasoline fuel supply system.</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Check the engine for the following: <ul style="list-style-type: none"> <li>- Improper valve timing</li> <li>- Engine compression</li> <li>- Manifold vacuum leaks</li> <li>- Intake manifold gaskets</li> <li>- Sticking or leaking valves</li> <li>- Exhaust system leakage</li> </ul> </li> <li><input type="checkbox"/> Check the intake and exhaust system for casting flash or other restrictions.</li> </ul>
Fuel System Checks	<input type="checkbox"/> Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.



Table 3-12. Symptom Diagnosis

Checks	Action
<b>Lack of Power, Sluggishness, or Sponginess</b>	
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	<input type="checkbox"/> Refer to Important Preliminary Checks. <input type="checkbox"/> Refer to the LPG Fuel system OBD System Check <input type="checkbox"/> Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. Do not compare the power output of the vehicle operating on LPG to a vehicle operating on gasoline as the fuels do have different drive feel characteristics <input type="checkbox"/> Remove the air filter and check for dirt or restriction. <input type="checkbox"/> Check the vehicle transmission Refer to the OEM transmission diagnostics.
Fuel System Checks	<input type="checkbox"/> Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to LPG Fuel System Diagnosis. <input type="checkbox"/> Check for the proper ignition output voltage with the spark tester J 26792 or the equivalent. <input type="checkbox"/> Check for proper installation of the mixer module assembly. <input type="checkbox"/> Check all air inlet ducts for condition and proper installation. <input type="checkbox"/> Check for fuel leaks between the LPR and the mixer. <input type="checkbox"/> Verify that the LPG tank manual shut-off valve is fully open. <input type="checkbox"/> Verify that liquid fuel (not vapor) is being delivered to the LPR.
Sensor Checks	<input type="checkbox"/> Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. Check for proper operation of the MAP sensor. <input type="checkbox"/> Check for proper operation of the TPS sensor.
Exhaust System Checks	<input type="checkbox"/> Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> <li>- Inspect the exhaust system for damaged or collapsed pipes</li> <li>- Inspect the muffler for signs of heat distress or for possible internal failure.</li> <li>- Check for possible plugged catalytic converter.</li> </ul>
Engine Mechanical Check	Check the engine for the following: <ul style="list-style-type: none"> <li><input type="checkbox"/> Engine compression</li> <li><input type="checkbox"/> Valve timing</li> <li><input type="checkbox"/> Improper or worn camshaft. Refer to Engine Mechanical in the Service Manual.</li> </ul>
Additional Check	<input type="checkbox"/> Check the ECM grounds for being clean, tight, and in their proper locations. <input type="checkbox"/> Check the generator output voltage. <input type="checkbox"/> If all procedures have been completed and no malfunction has been found, review and inspect the following items: <input type="checkbox"/> Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. <input type="checkbox"/> Check the scan tool data.
<b>Poor Fuel Economy</b>	
DEFINITION: Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by an by refueling records.	
Preliminary Checks	<input type="checkbox"/> Refer to Important Preliminary Checks. <input type="checkbox"/> Check the air cleaner element (filter) for dirt or being plugged. <input type="checkbox"/> Visually (Physically) check the vacuum hoses for splits, kinks, and proper connections. <input type="checkbox"/> Check the operators driving habits for the following items: <ul style="list-style-type: none"> <li>- Is there excessive idling or stop and go driving?</li> <li>- Are the tires at the correct air pressure?</li> <li>- Are excessively heavy loads being carried?</li> <li>- Is their often rapid acceleration?</li> </ul> <input type="checkbox"/> Suggest to the owner to fill the fuel tank and to recheck the fuel economy. <input type="checkbox"/> Suggest that a different operator use the equipment and record the results.
Fuel System Checks	<input type="checkbox"/> Check the LPR fuel pressure. Refer to LPG Fuel System Diagnosis. <input type="checkbox"/> Check the fuel system for leakage.
Sensor Checks	<input type="checkbox"/> Check the Temperature Manifold Absolute Pressure (TMAP) sensor.

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-12. Symptom Diagnosis**

Checks	Action
Ignition System Checks	<input type="checkbox"/> Verify that the spark plugs are correct for use with LPG (R42LTS) <input type="checkbox"/> Check the spark plugs. Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> </ul> <input type="checkbox"/> Check the ignition wires for the following items: <ul style="list-style-type: none"> <li>- Cracking</li> <li>- Hardness</li> <li>- Proper connections</li> </ul>
Cooling System Checks	<input type="checkbox"/> Check the engine thermostat for always being open or for the wrong heat range
Additional Check	<input type="checkbox"/> Check the transmission shift pattern. Refer to the OEM Transmission Controls section the Service Manual. <input type="checkbox"/> Check for dragging brakes.
Rough, Unstable, or Incorrect Idle, Stalling	
<b>DEFINITION:</b> The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Check	Refer to Important Preliminary Checks.
Sensor Checks	<input type="checkbox"/> Check for silicon contamination from fuel or improperly used sealant. The sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel delivered to the engine causing a severe driveability problem. <input type="checkbox"/> Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance: <input type="checkbox"/> Check the Temperature Manifold Absolute Pressure (TMAP) sensor response and accuracy.
Fuel System Checks	<input type="checkbox"/> Check for rich or lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. <input type="checkbox"/> Check for a sticking mixer air valve. <input type="checkbox"/> Verify proper operation of the EPR. <input type="checkbox"/> Perform a cylinder compression test. Refer to Engine Mechanical in the Service Manual. <input type="checkbox"/> Check the LPR fuel pressure. Refer to the LPG Fuel System Diagnosis. <input type="checkbox"/> Check mixer module assembly for proper installation and connection.
Ignition System Checks	<input type="checkbox"/> Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. <input type="checkbox"/> Verify that the spark plugs are correct for use with LPG (R42LTS) <input type="checkbox"/> Check the spark plugs. Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Blistered insulators</li> <li>- Heavy deposits</li> </ul> <input type="checkbox"/> Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	<b>Important:</b> The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. <input type="checkbox"/> Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. <input type="checkbox"/> Check the ECM grounds for being clean, tight, and in their proper locations. <input type="checkbox"/> Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality.

**Table 3-12. Symptom Diagnosis**

Checks	Action
Engine Mechanical Check	<input type="checkbox"/> Check the engine for the following: <ul style="list-style-type: none"> <li>- Broken motor mounts</li> <li>- Improper valve timing</li> <li>- Low compression</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Broken or weak valve springs</li> <li>- Worn camshaft lobes</li> </ul>
Surges/Chuggles	
DEFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down with no change in the accelerator pedal.	
Preliminary Checks	Refer to Important Preliminary Checks.
Sensor Checks	<input type="checkbox"/> Check Heated Exhaust Gas Oxygen Sensor (HEGO) performance.
Fuel System Checks	<input type="checkbox"/> Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. <input type="checkbox"/> Check the fuel pressure while the condition exists. Refer to LPG Fuel System Diagnosis. <input type="checkbox"/> Verify proper fuel control solenoid operation. <input type="checkbox"/> Verify that the LPG manual shut-off valve is fully open. <input type="checkbox"/> Check the in-line fuel filter for restrictions.
Ignition System Checks	<input type="checkbox"/> Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. <input type="checkbox"/> Verify that the spark plugs are correct for use with LPG (R42LTS) <input type="checkbox"/> Check the spark plugs. Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> <li>- Check the Crankshaft Position (CKP) sensor.</li> </ul>
Additional Check	<input type="checkbox"/> Check the ECM grounds for being clean, tight, and in their proper locations. <input type="checkbox"/> Check the generator output voltage. <input type="checkbox"/> Check the vacuum hoses for kinks or leaks. <input type="checkbox"/> Check Transmission

## SECTION 3 - CHASSIS & TURNTABLE

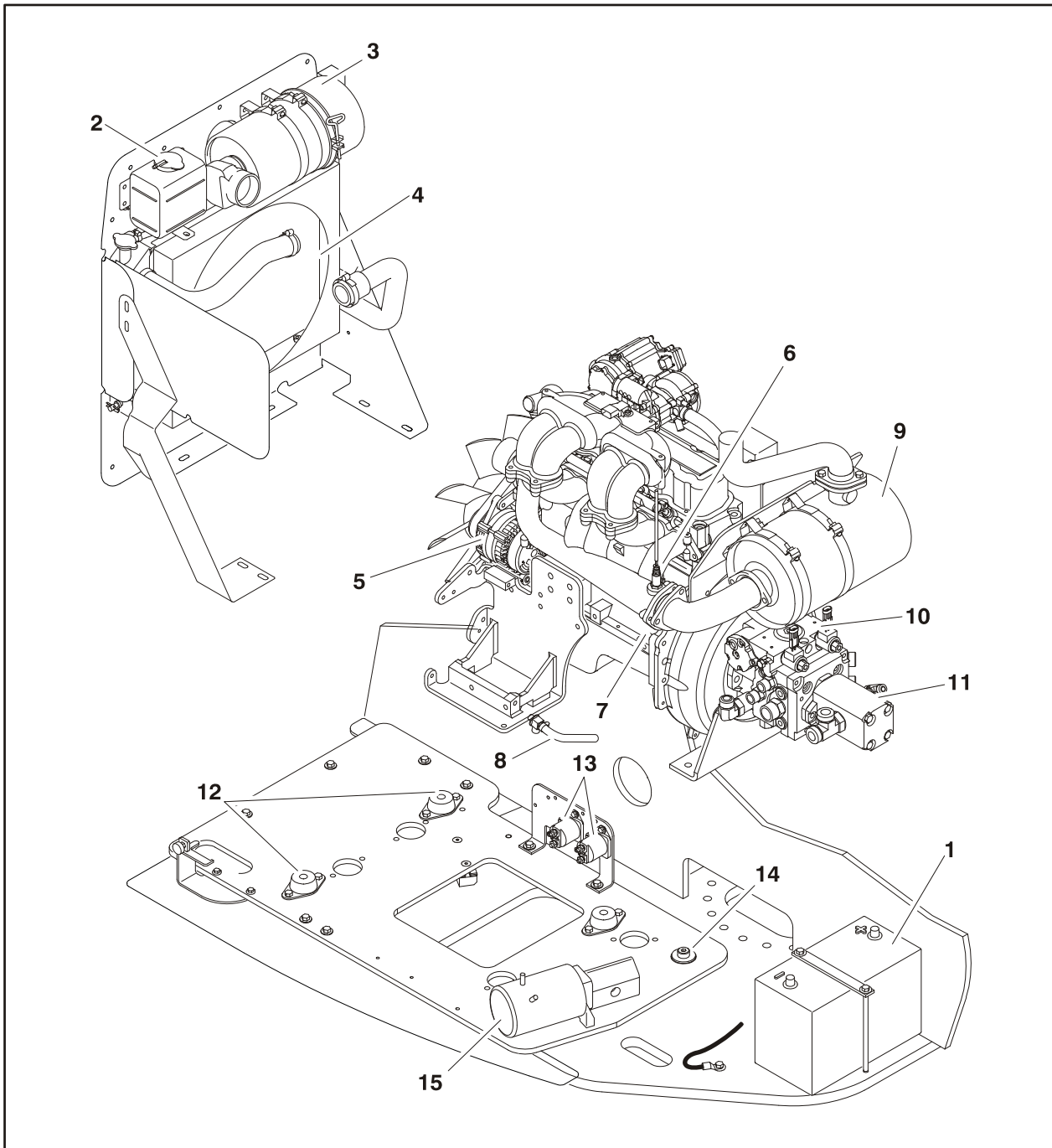
**Table 3-13. DTC to SPN/FMI Cross Reference Chart**

DTC	Description	SPN Code	FMI Code
16	Crank Never Synced at Start	636	8
91	Fuel Pump Low Voltage	94	4
92	Fuel Pump High Voltage	94	3
107	MAP Low Voltage	106	4
108	MAP High Pressure	106	16
111	IAT Higher Than Expected 1	105	15
112	IAT Low Voltage	105	4
113	IAT High Voltage	105	3
116	ECT Higher Than Expected 1	110	15
117	ECT Low Voltage	110	4
118	ECT High Voltage	110	3
121	TPS 1 Lower Than TPS 2	51	1
122	TPS 1 Signal Voltage Low	51	4
123	TPS 1 Signal Voltage High	51	3
127	IAT Higher Than Expected 2	105	0
129	BP Low Pressure	108	1
134	EGO 1 Open/Inactive	724	10
154	EGO 2 Open/Inactive	520208	10
171	Adaptive Learn High Gasoline	520200	0
172	Adaptive Learn Low Gasoline	520200	1
182	Fuel Temp Gasoline Low Voltage	174	4
183	Fuel Temp Gasoline High Voltage	174	3
187	Fuel Temp LPG Low Voltage	520240	4
188	Fuel Temp LPG High Voltage	520240	3
217	ECT Higher Than Expected 2	110	0
219	Max Govern Speed Override	515	15
221	TPS 2 Signal Voltage Low	51	0
222	TPS 2 Signal Low Voltage	520251	4
223	TPS 2 Signal High Voltage	520251	3
261	Injector Driver 1 Open	651	5
262	Injector Driver 1 Shorted	651	6
264	Injector Driver 2 Open	652	5
265	Injector Driver 2 Shorted	652	6
267	Injector Driver 3 Open	653	5
268	Injector Driver 3 Shorted	653	6
270	Injector Driver 4 Open	654	5
271	Injector Driver 4 Shorted	654	6
336	Crank Sync Noise	636	2
337	Crank Loss	636	4
341	Cam Sync Noise	723	2
342	Cam Sensor Loss	723	4
420	Gasoline Cat Monitor	520211	10
524	Oil Pressure Low	100	1

Table 3-13. DTC to SPN/FMI Cross Reference Chart

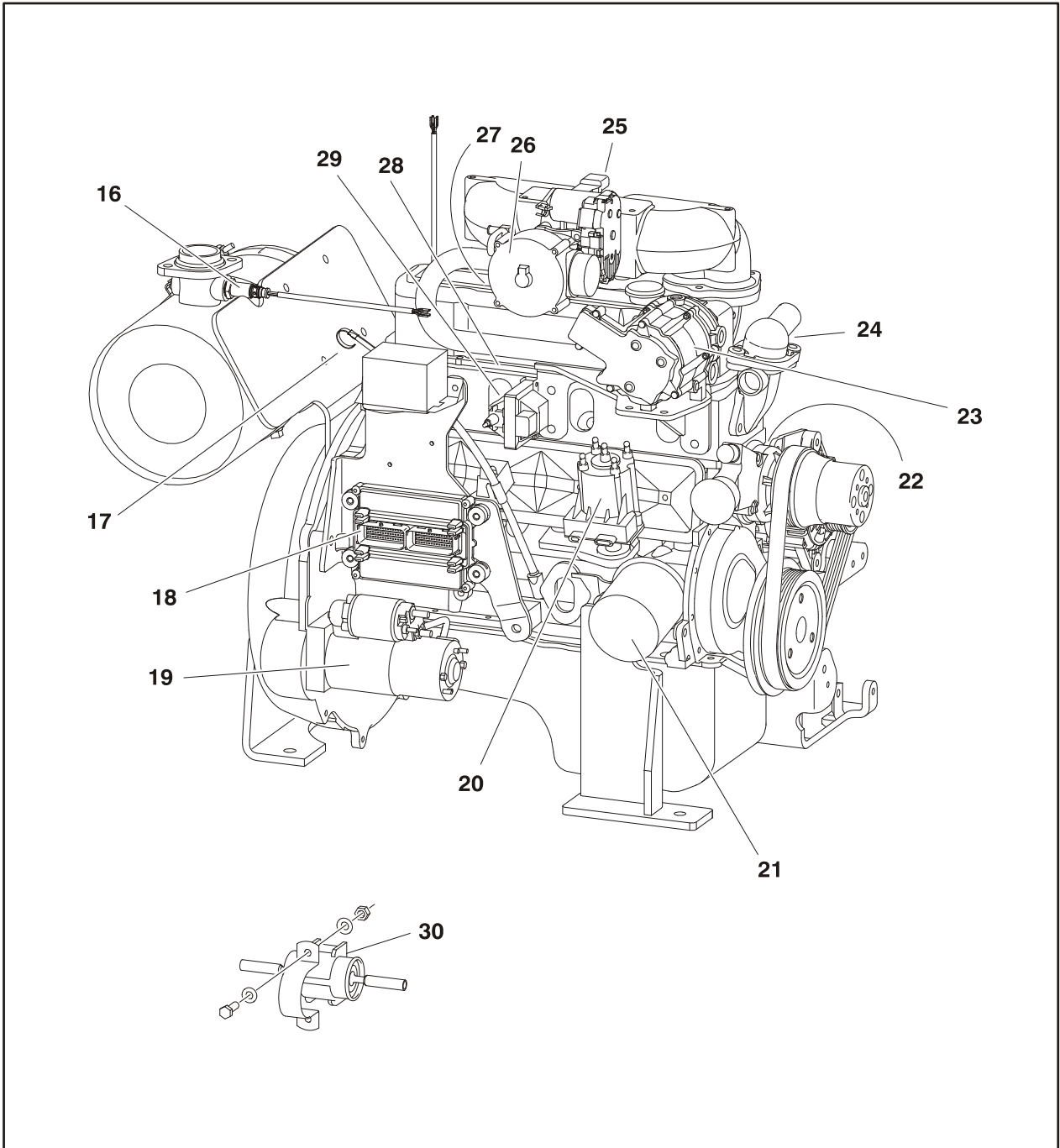
DTC	Description	SPN Code	FMI Code
562	System Voltage Low	168	17
563	System Voltage High	168	15
601	Flash Checksum Invalid	628	13
604	RAM Failure	630	12
606	COP Failure	629	31
642	External 5V Reference Low	1079	4
643	External 5V Reference High	1079	3
685	Power Relay Open	1485	5
686	Power Relay Shorted	1485	4
687	Power Relay Short to Power	1485	3
1111	Fuel Rev Limit	515	16
1112	Spark Rev Limit	515	0
1151	Closed Loop Multiplier High LPG	520206	0
1152	Closed Loop Multiplier Low LPG	520206	1
1155	Closed Loop Multiplier High Gasoline	520204	0
1156	Closed Loop Multiplier Low Gasoline	520204	1
1161	Adaptive Learn High LPG	520202	0
1162	Adaptive Learn Low LPG	520202	1
1165	LPG Cat Monitor	520213	10
1171	LPG Pressure Higher Than Expected	520260	0
1172	LPG Pressure Lower Than Expected	520260	1
1173	EPR Comm Lost	520260	31
1174	EPR Voltage Supply High	520260	3
1175	EPR Voltage Supply Low	520260	4
1176	EPR Internal Actuator Fault	520260	12
1177	EPR Internal Circuitry Fault	520260	12
1178	EPR Internal Comm Fault	520260	12
1612	RTI 1 loss	629	31
1613	RTI 2 Loss	629	31
1614	RTI 3 Loss	629	31
1615	A/D Loss	629	31
1616	Invalid Interrupt	629	31
1625	Shutdown Request	1384	31
1626	CAN Tx Failure	639	12
1627	CAN Rx Failure	639	12
1628	CAN Address Conflict Failure	639	13
1629	Loss of TSC 1	639	31
2111	Unable to Reach Lower TPS	51	7
2112	Unable to Reach Higher TPS	51	
2135	TPS 1/2 Simultaneous Voltages	51	31
2229	BP Pressure High	108	0

**SECTION 3 - CHASSIS & TURNTABLE**



- |                     |                               |                            |
|---------------------|-------------------------------|----------------------------|
| 1. Battery          | 6. O2 Sensor                  | 11. Gear Pump              |
| 2. Coolant Overflow | 7. Crankshaft Position Sensor | 12. Motor Mount            |
| 3. Air Cleaner      | 8. Oil Drain Valve            | 13. Start/Aux Power Relays |
| 4. Radiator         | 9. Muffler                    | 14. Engine Tray Pivot      |
| 5. Alternator       | 10. Piston Pump               | 15. Auxiliary Pump         |

**Figure 3-81. GM 3.0L Engine - Sheet 1 of 2**



- |                    |                        |                         |
|--------------------|------------------------|-------------------------|
| 16. O2 Sensor      | 21. Oil Filter         | 26. Mixer               |
| 17. Dipstick       | 22. Water Pump         | 27. PCV Valve           |
| 18. Control Module | 23. Coolant Sensor     | 28. Oil Pressure Switch |
| 19. Starter        | 24. Pressure Regulator | 29. Coil                |
| 20. Distributor    | 25. MAP Sensor         | 30. Fuel Filter         |

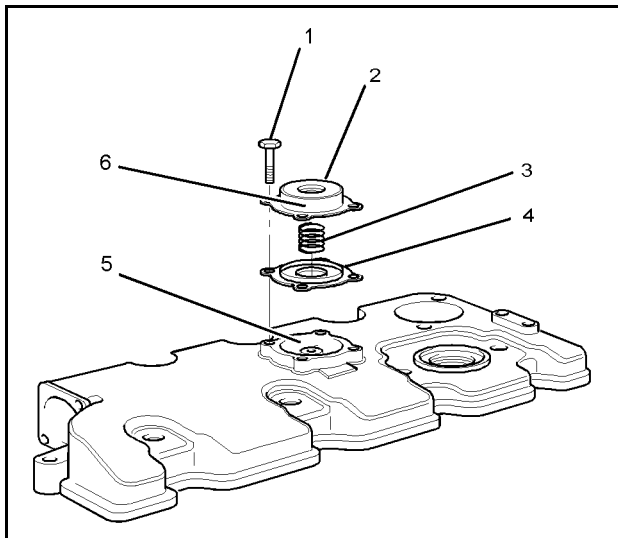
Figure 3-82. GM 3.0L Engine - Sheet 2 of 2

### 3.29 PERKINS ENGINE GENERAL MAINTENANCE

#### Replacing the Engine Crankcase Breather

**NOTICE**

KEEP ALL PARTS CLEAN FROM CONTAMINANTS. CONTAMINANTS MAY CAUSE RAPID WEAR AND SHORTENED COMPONENT LIFE.



1. Screws for the breather cover
2. Breather cover
3. Spring
4. Diaphragm and plate
5. Cavity
6. Vent hole

Figure 3-83. Crankcase Breather - Perkins

1. Loosen the screws (1) and remove the breather cover (2) from the valve mechanism cover.
2. Remove the spring (3). Remove the diaphragm and plate (4).
3. Clean the vent hole (6) and the cavity (5) in the valve mechanism cover.

**NOTICE**

MAKE SURE THAT THE COMPONENTS OF THE BREATHER ASSEMBLY ARE INSTALLED CORRECTLY. ENGINE DAMAGE MAY OCCUR IF THE BREATHER ASSEMBLY IS NOT WORKING CORRECTLY.

4. Install a new diaphragm and plate (4) for the breather assembly into the cavity (5) of the valve mechanism cover.

5. Install a new spring (3).
6. Install the breather cover (2) and the four screws (1). Tighten the screws.

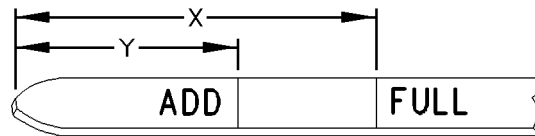
#### Engine Oil Level - Check

**WARNING**

HOT OIL AND HOT COMPONENTS CAN CAUSE PERSONAL INJURY. DO NOT ALLOW HOT OIL OR HOT COMPONENTS TO CONTACT THE SKIN.

**NOTE:** Perform this maintenance with the engine stopped.

1. Maintain the oil level between "ADD" mark (Y) and "FULL" mark (X) on oil level gauge (1). Do not fill the crankcase above "FULL" mark (X).



**NOTE:** Operating your engine when the oil level is above the "FULL" mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

2. Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

#### Engine Oil and Filter - Change

**WARNING**

HOT OIL AND HOT COMPONENTS CAN CAUSE PERSONAL INJURY. DO NOT ALLOW HOT OIL OR HOT COMPONENTS TO CONTACT THE SKIN.

**NOTICE**

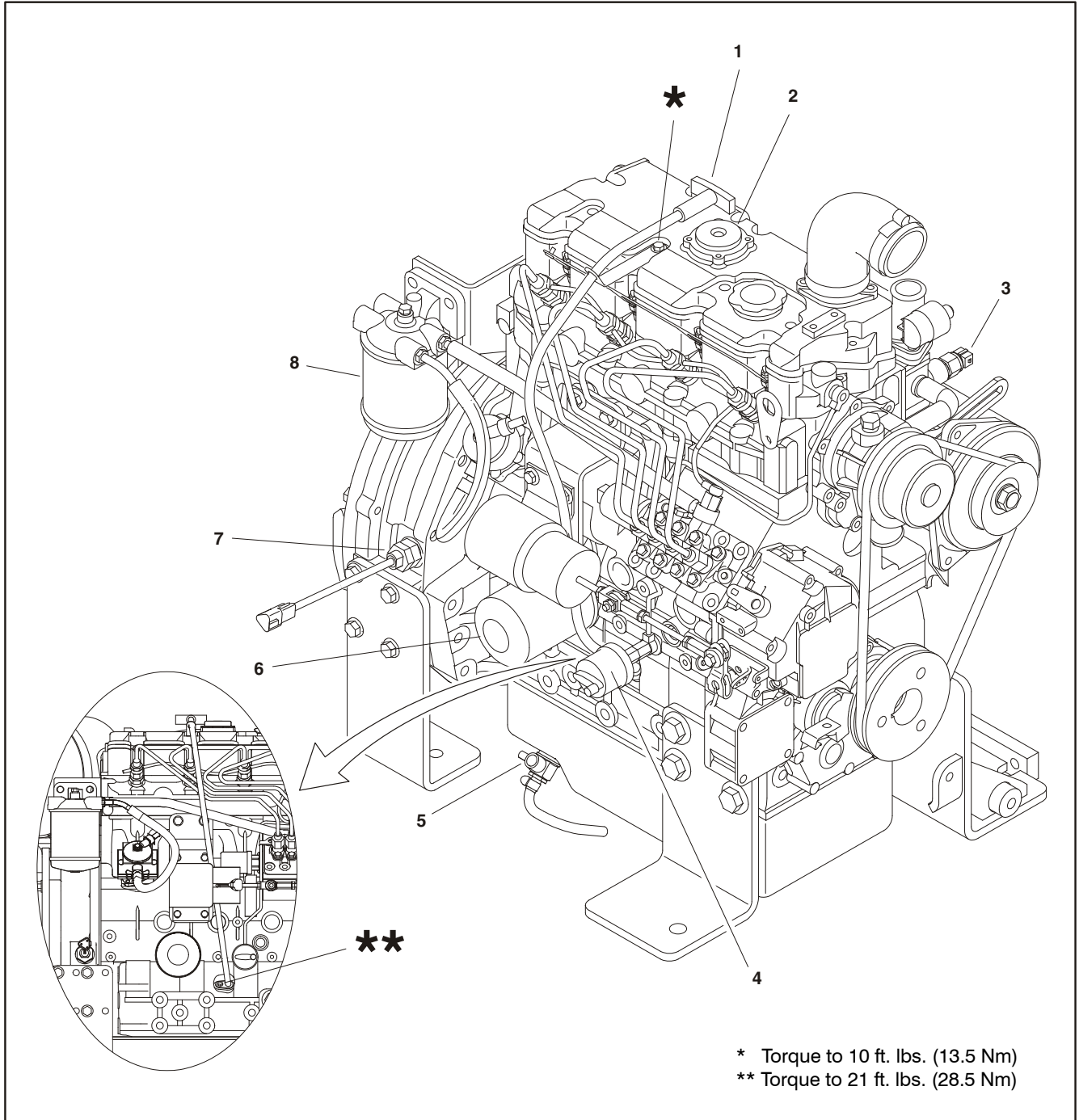
CARE MUST BE TAKEN TO ENSURE THAT FLUIDS ARE CONTAINED DURING PERFORMANCE OF INSPECTION, MAINTENANCE, TESTING, ADJUSTING AND REPAIR OF THE PRODUCT. BE PREPARED TO COLLECT THE FLUID WITH SUITABLE CONTAINERS BEFORE OPENING ANY COMPARTMENT OR DISASSEMBLING ANY COMPONENT CONTAINING FLUIDS.

DISPOSE OF ALL FLUIDS ACCORDING TO LOCAL REGULATIONS AND MANDATES.

**NOTE:** Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.





\* Torque to 10 ft. lbs. (13.5 Nm)  
 \*\* Torque to 21 ft. lbs. (28.5 Nm)

- |                        |                    |
|------------------------|--------------------|
| 1. Dipstick            | 5. Oil Drain Valve |
| 2. Crankcase Breather  | 6. Oil Filter      |
| 3. Coolant Sensor      | 7. Speed Sensor    |
| 4. Oil Pressure Sensor | 8. Fuel Filter     |

**Figure 3-84. Perkins Engine**

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained correctly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

### DRAINING THE ENGINE OIL

After the engine has been run at the normal operating temperature, stop the engine. Turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.

### FILLING THE ENGINE CRANKCASE

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual for more information on lubricant specifications. Fill the crankcase with the correct amount of oil. Refer to the Operation and Maintenance Manual for more information on refill capacities.

#### **NOTICE**

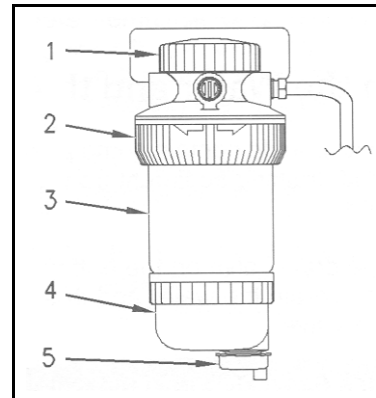
**UNDERFILLING OR OVERFILLING THE CRANKCASE WITH OIL CAN CAUSE ENGINE DAMAGE.**

#### **NOTICE**

**TO PREVENT CRANKSHAFT BEARING DAMAGE, CRANK THE ENGINE WITH THE FUEL OFF. THIS WILL FILL THE OIL FILTERS BEFORE STARTING THE ENGINE. DO NOT CRANK THE ENGINE FOR MORE THAN 30 SECONDS.**

2. Start the engine and run the engine at "LOW IDLE" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.
3. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.
4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the "MIN" and "MAX" marks on the oil level gauge.

## Fuel Filter/Water Separator



1. Cap
2. Locking Ring
3. Element
4. Water Separator Bowl
5. Drain

**Figure 3-85. Fuel Filter/Water Separator**

#### **WARNING**

**FUEL LEAKED OR SPILLED ONTO HOT SURFACES OR ELECTRICAL COMPONENTS CAN CAUSE A FIRE. TO HELP PREVENT POSSIBLE INJURY, TURN THE START SWITCH OFF WHEN CHANGING FUEL FILTERS OR WATER SEPARATOR ELEMENTS. CLEAN UP FUEL SPILLS IMMEDIATELY.**

#### **NOTICE**

**THE WATER SEPARATOR IS NOT A FILTER. THE WATER SEPARATOR SEPARATES WATER FROM THE FUEL. THE ENGINE SHOULD NEVER BE ALLOWED TO RUN WITH THE WATER SEPARATOR MORE THAN HALF FULL. ENGINE DAMAGE MAY RESULT.**

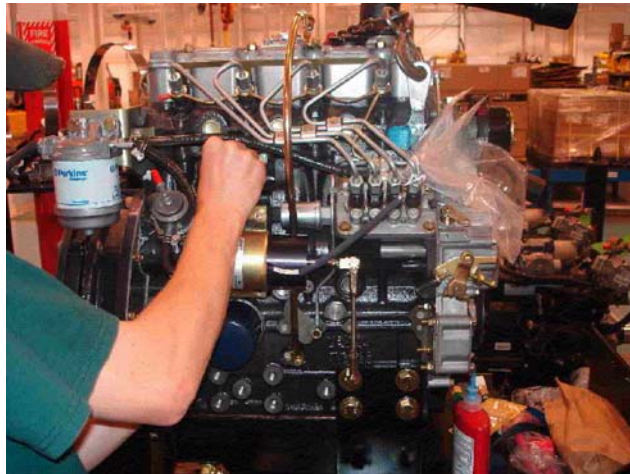
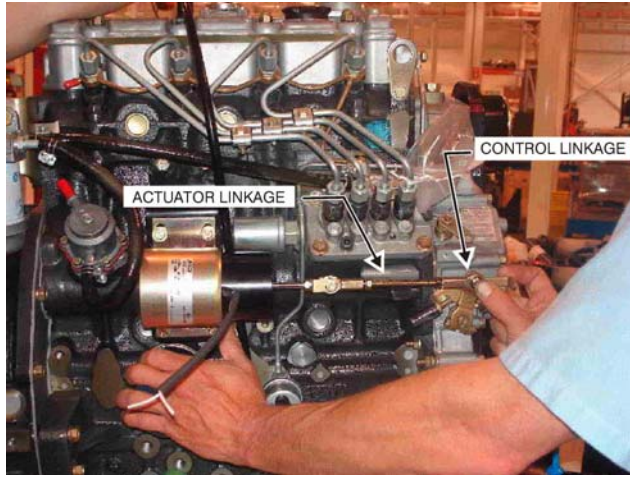
1. Open the drain at the bottom of the separator. Catch the draining water in a suitable container. Properly dispose of the drained water.
2. Close the drain.

#### **NOTICE**

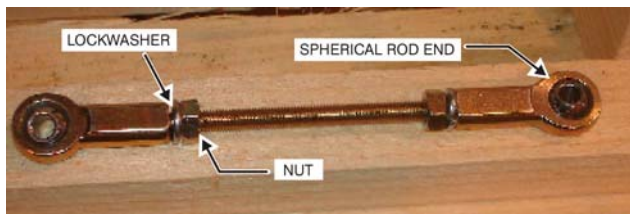
**THE WATER SEPARATOR IS UNDER SUCTION DURING NORMAL ENGINE OPERATION. ENSURE THE DRAIN VALVE IS SECURELY TIGHTENED TO HELP PREVENT AIR FROM ENTERING THE FUEL SYSTEM.**

## Setting the Actuator

1. Remove the bolt from the control linkage

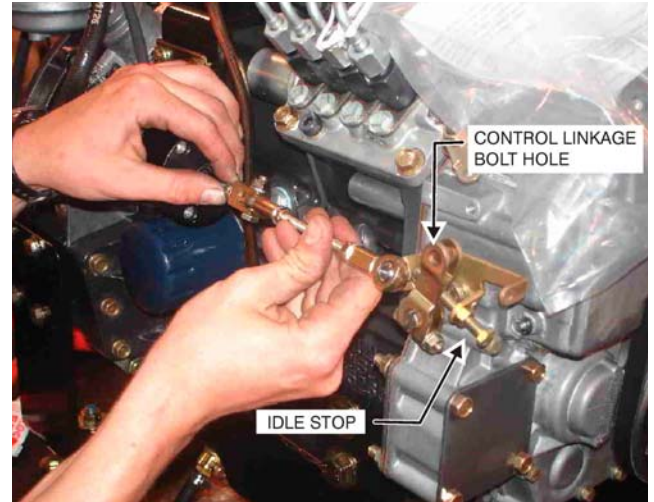


2. With the control linkage pushed against the idle stop, begin to make adjustments to the actuator linkage in order to align the bearing of the spherical rod end with the control linkage bolt hole. When making linkage adjustments, thread the spherical rod end and threaded rod evenly (for every turn of spherical rod end, turn the threaded rod.)

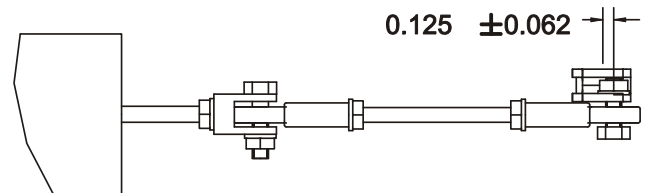


### NOTICE

DURING THIS PROCEDURE IT'S VERY IMPORTANT TO KEEP THE CONTROL LINKAGE PUSHED AGAINST THE STOP.



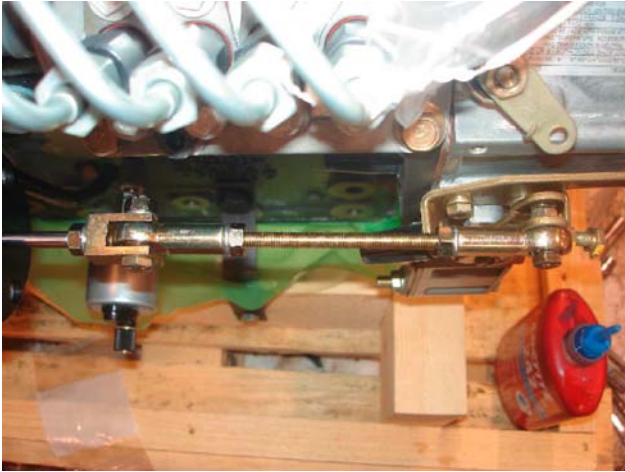
3. Once the adjustments have been made to align the spherical rod end bearing with the control linkage bolt hole, lengthen the actuator linkage by continuing to turn the spherical rod end and threaded rod 2-2 1/2 turns (1-1 1/4 turns of spherical rod end and 1-1 1/4 turns of threaded rod.) This will provide 1/8" (3 mm) preload.



Use a measuring device to ensure the preload is approximately 1/8" (3 mm), then secure the actuator linkage to the control linkage with original bolt and nut. Make sure the spherical ball is seated in the control linkage bolt hole.

Tighten the 2 nuts on the threaded rod of the actua-

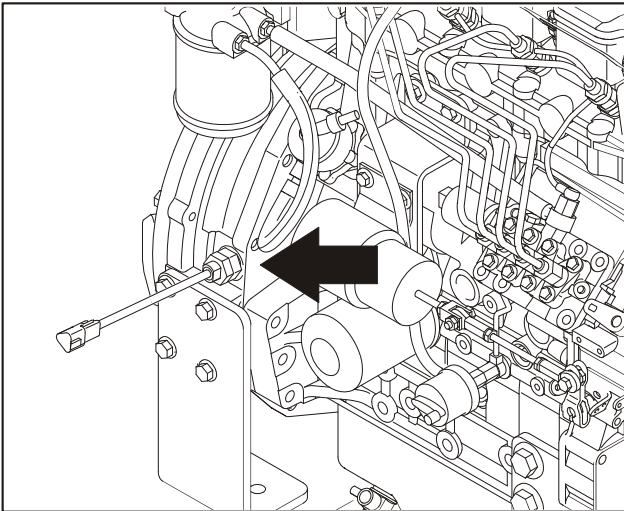
tor linkage and using two wrenches to prevent binding of clevis heads.



### Speed Sensor Installation

**NOTE:** A new speed sensor comes with two hex nuts.

1. Remove one hex nut from the speed sensor and discard it.
2. Install the speed sensor into the housing until it contacts the flywheel.



3. Back off the sensor 1/4 to 3/4 turn and ensure the sensor flats are vertical and tighten the nut.

### 3.30 ENGINE RADIATOR FILL PROCEDURE - PERKINS & CATERPILLAR

#### NOTICE

DUE TO THE CONFIGURATION OF THE COOLING SYSTEM, SOME ENGINES REQUIRE A SPECIAL RADIATOR FILL PROCEDURE. FAILURE TO FOLLOW THIS PROCEDURE CAN RESULT IN DAMAGE TO THE ENGINE.

#### WARNING

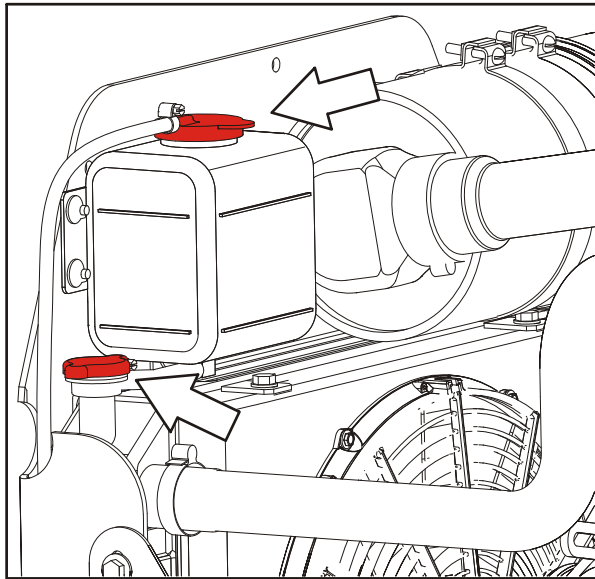
THE FOLLOWING FILL PROCEDURE SHOULD ONLY BE PERFORMED WHEN THE ENGINE IS COLD.

#### WARNING

ENGINE COOLANT IS UNDER PRESSURE. DO NOT REMOVE THE RADIATOR CAP WHILE THE ENGINE IS WARM.

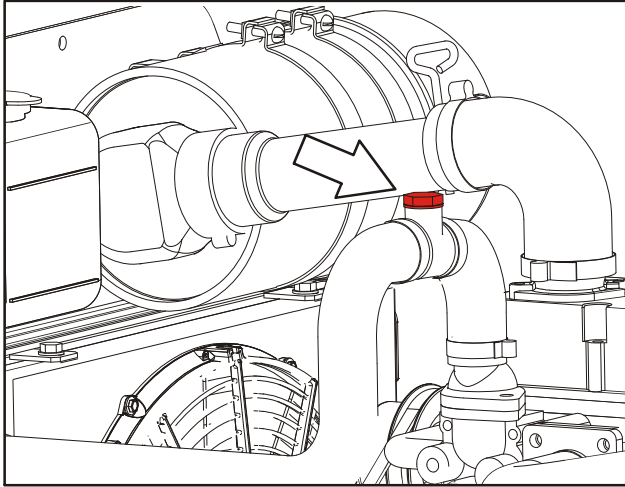
**NOTE:** If the radiator cap is removed at any time after the following steps are performed, coolant will flow out regardless of whether the engine is cold or hot.

1. Remove the radiator cap and the reservoir cap.

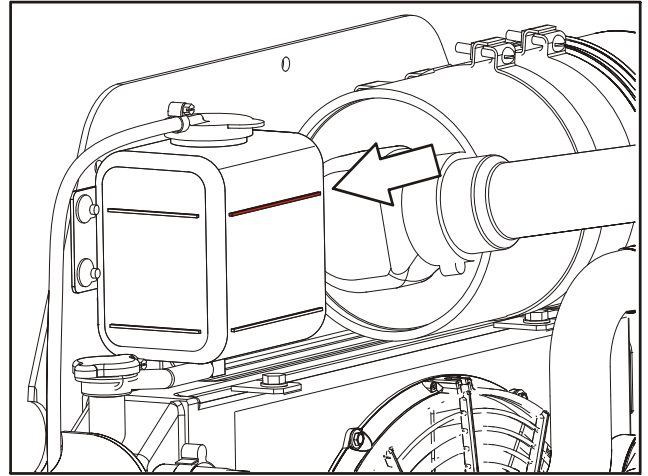


2. Fill the radiator to the top. Allow enough time for the coolant to properly settle into the radiator and add coolant as necessary to top off the radiator.
3. Install the radiator cap back on the radiator.

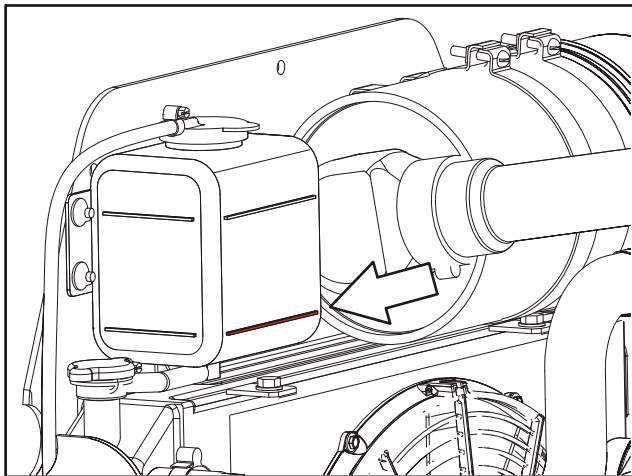
4. Remove the plug from the adapter and add coolant at this location until the radiator hose is full of coolant.



8. Make sure the coolant reaches the hot level line on the coolant recovery reservoir. Add coolant as needed.



5. Using sealant JLG P/N 0100020 (Loctite #567), install the plug back into the adapter.
6. Remove the fill cap and fill the coolant recovery reservoir to the cold level line. Put the fill cap back on the reservoir when done.



7. Start the engine and run it long enough to bring the coolant up to operating temperature. Turn off the engine.

**⚠ WARNING**

**ENGINE COOLANT IS UNDER PRESURE. DO NOT REMOVE THE RADIATOR CAP WHILE THE ENGINE IS WARM.**

**NOTICE**

**IF THE RADIATOR CAP IS REMOVED AND COOLANT IS LOST, REPEAT THIS PROCEDURE TO ENSURE THE COOLING SYSTEM IS FILLED TO THE PROPER LEVEL.**

### 3.31 DGC DIAGNOSTIC SUPPORT AND TROUBLE CODE DEFINITIONS

This section defines the diagnostics and recommended troubleshooting procedures associated with an EControls

Diesel Governor Control (DGC) engine control module (ECM) for use on industrial engines.

#### Section Layout

This section is organized in the following manner:

**DTC XXXX- Diagnostic Condition**

Block Diagram of Circuit

- *External Hardware Input/Output*- This identifies the hardware that either sends an input to the ECM or is driven by and ECM output.
- *Check Condition*- This defines what condition to troubleshoot the fault condition.
- *Fault Condition(s)*- This identifies the condition(s) that set the fault.
- *Corrective Action(s)*- This identifies the *RECOMMENDED* corrective action(s) that the ECM is generally programmed to perform. In some instances, the calibration engineer(s) may choose to perform a different action.
- Emissions or Non-emissions related fault

Text to identify the circuit of interest and its use for control.

Text to describe the conditions that cause the fault to set.

**DTC XXXX- Diagnostic Condition**

**Note: Helpful tips used to aid troubleshooting**

```

graph TD
    A[ ] --> B{ }
    B -- Yes --> C[ ]
    B -- No --> D[ ]
            
```

} Troubleshooting flow chart

**Diagnostic Aids**

- Tip #1
- Tip #2 ...

**List of Abbreviations in this Section**

AL	Adaptive Learn	LED	Light Emitting Diode
BP	Barometric Pressure	LPG	Liquefied Propane Gas
CAN	Controller Area Network	MAP	Manifold Absolute Pressure
CCP	CAN Calibration Protocol	MGCP	Marine Global Control Platform
CHT	Cylinder Head Temperature	μP	Microprocessor
CL	Closed Loop	Mfg	Manufacture
CNG	Compressed Natural Gas	MIL	Malfunction Indicator Lamp
DBW	Drive-By-Wire	NG	Natural Gas
DGC	Diesel Governor Control	OBD	On-Board Diagnostics
DM	Diagnostic Message	OEM	Original Equipment Manufacture
DMM	Digital Multi-Meter (high impedance)	PC	Personal Computer
DST	Diagnostic Scan Tool	PCU	Powertrain Control Unit
DTC	Diagnostic Trouble Code	PFI	Port Fuel Injection
DVOM	Digital Voltage and Ohm Meter (high impedance)	PGN	Parameter Group Number
ECI	EControls Inc.	PWM	Pulse Width Modulated
ECIPP	EControls Inc. Proprietary Protocol	RAM	Random Access Memory
ECM	Engine Control Module	RPM	Revolutions Per Minute
ECT	Engine Coolant Temperature	Rx	Receive
ECU	Engine Control Unit	SAE	Society of Automotive Engineering
EDIS	EControls Display and Interface Software	SA	Source Address
EGO	Exhaust Gas Oxygen Sensor, typically heated	SPFI	Sequential Port Fuel Injection
EMWT	Exhaust Manifold Water Temperature	SPN	Suspect Parameter Number
EPR	Electronic Pressure Regulator	Tach	Tachometer
ERWT	Exhaust Manifold Riser Temperature	TBI	Throttle Body Injection
ETB	Electronic Throttle Body	TDC	Top Dead Center
ETC	Electronic Throttle Control	TIP	Throttle Inlet Pressure
FDR	Flight Data Recorder	TPS	Throttle Position Sensor
FMI	Failure Mode Indicator	TSC	Torque/Speed Control
FO	Firing Order	Tx	Transmit
FP	Fuel Pressure	UEGO	Universal Exhaust Gas Oxygen Sensor (also called wide-range EGO)
FPP	Foot Pedal Position	VDC	Voltage, Direct Current
FRP	Fuel Rail Pressure	VR	Variable Reluctance
FRT	Fuel Rail Temperature	Vsw	Switched, Ignition Voltage

## SECTION 3 - CHASSIS & TURNTABLE

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FSS	Fault Snapshot	WGP	Waste-Gate Pressure
FT	Fuel Temperature		
GCP	Global Control Platform		
HDGCP	Heavy-Duty Global Control Platform (On-Road Heavy-Duty)		
HEGO	Heated Exhaust Gas Oxygen Sensor (same as HO2S)		
HO2S	Heated Oxygen Sensor (same as HEGO)		
IAC	Idle Air Control		
IAT	Intake Air Temperature		
ICAV	Instant Crank Angle Velocity		
IVS	Idle Validation Switch		
LDGCP	Light-Duty Global Control Platform (Industrial, Smart/ Logic Coil)		

---

### Fault Code Broadcast

All diagnostic trouble codes are broadcast through EDIS for display on a PC. EDIS can acquire the data from the ECU via CAN using the EControls Inc. Proprietary Protocol (ECIPP). Faults may also be acquired over the CAN network through CAN J1939-based scan tools or multi-function display units.

### Diagnostic Trouble Codes

The numeric diagnostic trouble codes assigned to the faults in this manual are cross-referenced to SAE's "Recommended Practice for Diagnostic Trouble Code Definitions" (SAE J2012). While these codes are recommended, customers may define their own codes by assigning a new number to the flash code in the diagnostic calibration. This will assign both the DTC as displayed in EDIS as well as the flash code output on the MIL output pin. EDIS may be used to connect to the DGC ECM via CAN.

### CAN

The DGC supports SAE J1939 CAN based diagnostic support. This includes:

- DM1: Active Diagnostic Trouble Codes
- DM2: Previously Active Diagnostic Trouble Codes
- DM3: Diagnostic Data Clear/Reset of Previously Active DTCs
- DM4: Freeze Frame Parameters
- DM5: Diagnostic Readiness (bytes 1, 2, and 3 are supported)
- DM11: Diagnostic Data Clear/Reset For Active DTCs

- DM12: Emissions-Related Active Diagnostic Trouble Codes
- DM19: Calibration Information

All diagnostic trouble codes broadcast over CAN will be SAE J1939 DM1 and DM2 formatted messages. DGC ECMs are compliant with J1939 OBD-M, supporting the Diagnostic Messages above as well as user indicators and CAN data defined in the OBD-M protocol. Faults available for broadcast and their respective SPN/FMI numbers are dependent on the application and engine calibration. There are 4 CAN SPN/FMI lists available in the DGC software set, contact EControls Inc. for a list of CAN SPN/FMIs.

The data capture at the occurrence of a fault, known in the ECM as fault snapshot (FSS), is available upon DM4 request. The following bytes are supported for DM4 if configured in the ECM software:

- Byte 1: Freeze Frame Length
- Byte 2-6: SPN, FMI, SPN Conversion Method, and Occurrence
- Byte 7: Manifold Absolute Pressure
- Byte 8-9: Engine Speed
- Byte 10: Engine Load (MAP based estimate)
- Byte 11: Engine Coolant Temperature
- Byte 14: # of starts since fault was last active
- Byte 15: Index into FSS\_storage table for Fault Snapshot retrieval

Resetting active and previously active DTCs is handled through DM11 and DM3, respectively DM1 and DM2 lamp indicators are assigned to each fault based on the fault's diagnostic action as defined in the calibration. The lamps



are assigned based on the configuration outlined in Table 3-14.

**Table 3-14. J1939 Diagnostic Lamp Configuration**

ECI DIAGNOSTIC ACTION	J1939 LAMP
MIL	MIL
Soft Warning	Amber
Hard Warning, Low Rev Limit, Shutdown	Red Stop
Power Derate 1 & 2	Protect
Forced Idle	None (use in combination with other action)

### MIL Output

The MIL output is used to convey fault information to the equipment operator. The MIL is always on (grounded) when the system is in a key-on (Vsw), engine-off state. This provides assurance that the output is functional. If a DTC is logged as previously-active (historic), the MIL will send a single flash for the “Blink on-time” every “Blink off-time.”

### Diagnostic Calibration Configuration and Corrective Actions

Each fault within the DGC is capable of being uniquely configured in the engine.s diagnostic calibration to cause one or more corrective actions while a given fault is active. Table 2 identifies the configuration options and corrective actions available for configuration of each fault. The desired action is set by the OEM calibration engineers.

**Table 3-15. Diagnostic Corrective Actions**

CORRECTIVE ACTION	DESCRIPTION
Enable	Enables the fault for fault detection
Shutdown	Cause an engine shutdown when fault becomes active
Never Forget	Retain fault as historic/previously active until cleared by a technician and does not allow historic fault to be “auto-cleared”
Turn on MIL	Turn on MIL output when fault becomes active
CL Disable	Disable closed-loop while the fault is active
CL Disable Key- Cyc	Disable closed-loop while the fault is active and for the remainder of the key cycle
AL Disable	Disable adaptive learn while the fault is active
AL Disable Key-Cyc	Disable adaptive learn while the fault is active and for the remainder of the key cycle
Power Derate 1	Limit TPS to the Power Derate 1 percent set in the diagnostic calibration while the fault is active. The Power Derate 1 TPS percent should be set higher than Power Derate 2 as Power Derate 2 adds a higher level of protection.
Power Derate 2	Limit TPS to the Power Derate 2 percent set in the diagnostic calibration while the fault is active. If the calibration is set to “Latched for Key-Cycle” Power Derate 2 remains active until engine speed and FPP conditions are satisfied. The Power Derate 2 TPS percent should be set lower than Power Derate 1 as Power Derate 2 adds a higher level of protection.
Low Rev Limit	Limit RPM to the Low Rev Limit speed set in the diagnostic calibration while the fault is active. If the calibration is set to “Latched for Key-Cycle” Low Rev Limit remains active until engine speed and FPP conditions are satisfied.
Forced Idle	Limit RPM to the Forced Idle speed set in the diagnostic calibration while the fault is active and for the remainder of the key cycle
Soft Warning	Turn on the soft warning output when the fault becomes active
Hard Warning	Turn on the hard warning output when the fault becomes active
Stopped Check	Run fault detection/checking while the engine is in a key-on, engine-off condition. NOTE: It is recommended that this feature only be used for general sensor faults (high/low voltage) and some output drivers

### Fault/Diagnostic Trouble Code Interaction

All fault and diagnostic information is managed through the Faults page. Interaction includes viewing fault messages, downloading fault data (fault snapshot and flight data recorder), erasing faults from memory, and defining variables for fault data logging.

Faults are separated into two categories, Active and Historic. Active faults are active in real-time and historic faults have been generated at some instance in time that may or

may not be active in real-time. Once a fault has become active, it is immediately logged as historic and a snapshot and flight data log is saved. Figure 3-86. shows an example of the fault page when an active fault has been generated. Notice that the fault is present in both the active and historic lists and the malfunction indicator lamp (MIL) has been illuminated. Figure 3-87. shows an example of the fault page with a historic fault stored in memory.

The screenshot displays the EDIS ECI Serial Communications interface with the following sections:

- Faults:** MIL indicator is lit (red).
- Engine Parameters:** Engine Speed (725 rpm), Manifold Pressure (6.27 psia), Barometric Pressure (14.50 psia), Coolant Temperature (95.7 °F), Cylinder Head Temp (95.6 °F), Manifold Temperature (93.8 °F), Intake Air Temperature (97.6 °F), Spark Advance (6.0 °BTDC), Pulse width (4.8 ms), Gaseous pressure target (0.00 "H2O), Gaseous pressure actual (0.00 "H2O), Engine Load (20.9 %), Current governor target (709 rpm), Vbat (14.5 volts), Vsw (14.4 volts), Hour meter (0.000 hours), Cumulative starts (0 starts).
- Close-Loop Control:** EGO1 (0.031 volts), Closed-loop 1 (0.0 %), Adaptive 1 (0.0 %), EGO2 (0.034 volts), Closed-loop 2 (0.0 %), Adaptive 2 (0.0 %), EGO3 (0.000 volts), Post-cat CL offset (0.000 phi), Alternate-Fuel trim duty-cycle (0.0 %).
- System States:** Run Mode (Running), Fuel Type (Gasoline), Fuel Control Mode (Open Loop), Governor switch state (Gov3), Active governor type (Min), Active governor mode (Droop), Brake input level (Ground), Oil pressure state (DK), Oil pressure config (Open = DK), IVS state (Oil Idle).
- Monitored Drivers:** Injector Driver (firing order) 1-6, Injector-on low-side voltage, Injector-off low-side voltage, Coil Driver (firing order) 1-10, Spark Coil dwell ms.
- Diagnostic Modes:** Spark kill (Normal), Injector kill (Normal), DBW test (Off), External power (Automatic).
- DBW Variables:** TPS command (6.2 %), TPS position (7.0 %), TPS1 percent (6.3 %), TPS2 percent (5.5 %), TPS1 voltage (0.854 volts), TPS2 voltage (4.117 volts), FPP command (0.0 %), FPP position (0.0 %), FPP1 voltage (0.005 volts), FPP2 voltage (5.000 volts), IVS voltage (5.000 volts).
- Input Voltages:** Gov1 voltage (0.4 volts), Gov2 voltage (0.4 volts), Oil pressure voltage (5.0 volts), MAP voltage (1.7 volts), ECT/CHT voltage (2.3 volts), IAT voltage (2.2 volts).
- Historic Faults:** DTC 512: FPP1 voltage low.
- Active Faults:** DTC 512: FPP1 voltage low.
- Variable Definition Tables:**
  - Snapshot Base Definitions: run\_time\_sec (CL\_BM1), rpm (CL\_BM2), MAP (A\_BM1), ECT (A\_BM2).
  - Snapshot Custom Definitions: (EMPTY).
  - Flight Data Base Definitions: MAP (CL\_BM1), FPP\_pct (CL\_BM2), rpm (rpm).
  - Flight Data Custom Definitions: (EMPTY).

Callout boxes provide the following information:

- Base Fault snapshot variable definitions (CAN NOT be altered)** - Points to the Snapshot Base Definitions table.
- Custom Fault Snapshot variable definitions (User Defined)** - Points to the Snapshot Custom Definitions table.
- Base Flight Data Recorder variable definitions (CAN NOT be altered)** - Points to the Flight Data Base Definitions table.
- Custom Flight Data Recorder variable definitions (User Defined)** - Points to the Flight Data Custom Definitions table.

Figure 3-86. Faults Page with Active Fault Message

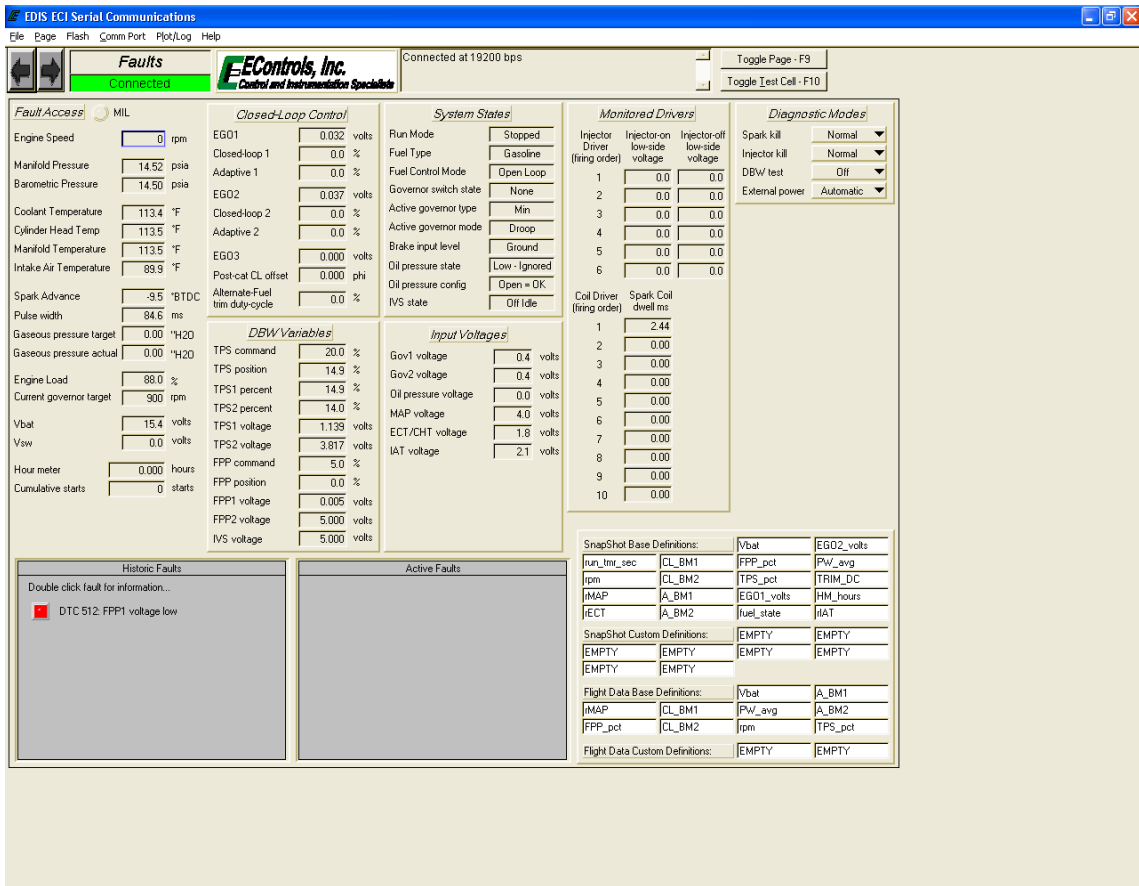


Figure 3-87. Faults Page with Historic Fault Message

Once an active fault has occurred two sets of data are recorded, fault snapshot and flight data recorder. The fault snapshot (FSS) is a sample of data taken at the instance the fault triggered. Variables included in the FSS are defined in the Snapshot Base and Snapshot Custom Definition fields found on the Faults Page. A FSS is saved with each of the first eight (8) faults for the first time the fault becomes active. Conversely, the flight data recorder (FDR) is a ten-second stream of data that includes eight-seconds prior and two-seconds after triggering the fault. An FDR is saved for each of the first two (2) faults for the first time the fault becomes active. Variables included in the FDR are defined in the Flight Data Base and Flight Data Custom Definition fields found on the Faults Page.

The memory location of the FDR is RAM, therefore this data is only available if the ECM has not lost battery power. In addition, if there is a "Dirty Flash Page" in the ECM, the FDR data will not be available. The memory location of the FSS data is EEPROM and is retained when the ECM loses battery power.

Both sets of data are accessed from the Historic Fault Information interface and can be saved to the PC upon retrieval. Base variables for FSS and FDR are generally defined by the OEM to include variables most often referenced during fault diagnosis. The base definitions are not fault dependent. Additional variables may be selected for capture during a fault occurrence through a single, left-click of the custom table and selecting the desired variables from a list. An example of custom fault variable definitions is shown in Figure 3-88.

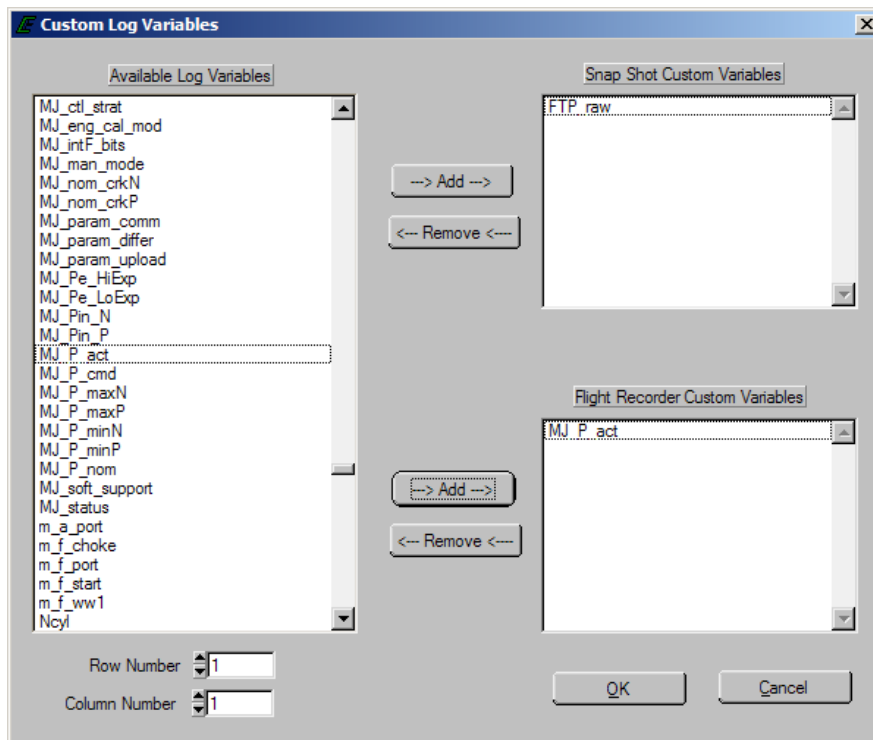


Figure 3-88. Custom Fault Variable Interface

Accessing fault information is accomplished through a double left-click of the fault LED in the historic fault list. This produces the Historic Fault Information interface shown in Figure 3-89. From this interface the user can interpret a diagnostic trouble code (DTC) message, identify whether or not the fault occurred during the current key cycle, identify if the fault caused the engine to shut-down, determine how many key cycles have occurred since the fault was last active, clear selected or all historic faults, and view snapshot and flight data. Table 3-16 outlines the options displayed in the Historic Fault Information screen. Historic faults are not overwritten if the same fault becomes active, storing data from the original active fault.

Figure 3-90. is an example of a fault snapshot after View Fault Snapshot is selected. Data is presented in two columns, base and custom variables. Once retrieved, the FSS data may be saved to the PC in text format with an .fss extension. A FSS saved to a PC may be reviewed in any ASCII based software program.

Figure 3-91. shows the Flight Data Recorder interface after View Flight Data Recorder is selected. The FDR captures a ten second (eight seconds prior and two seconds after generating the fault) strip of data for base and custom variables. FDR data is presented in an interface similar to the Plot interface for a quick graphical presentation. From this interface, the FDR data may be saved to the PC in text, tab-delimited format with an .fdr file extension. Once saved to PC, FDR data may be reviewed using any graphical post-processing software capable of handling tab-delimited formatting.

Fault information may be manually erased using the “Clear” button functions. Once a “Clear” function has been selected, the dialog prompt shown in Figure 3-92. will be displayed. Choosing YES deletes all fault information from the ECM.

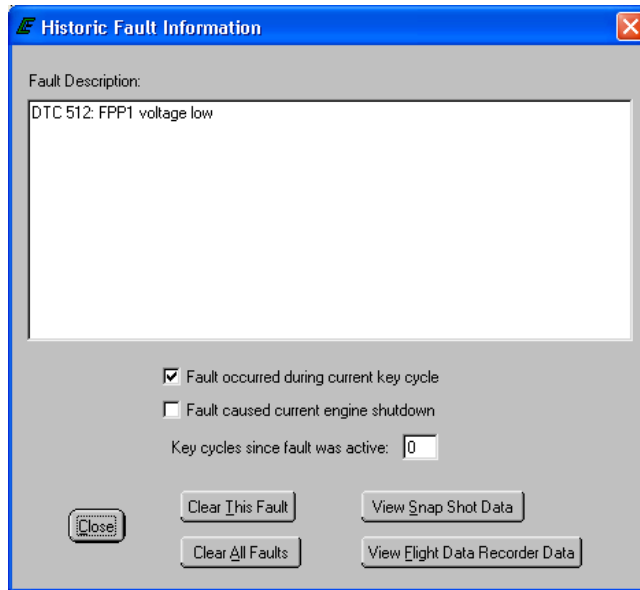


Figure 3-89. Historic Fault Information Interface

Table 3-16. Historic Fault Information Interface Functions

Fault Description Message Box	Customized text that references the DTC flash code and describes the fault.
Fault During Key Cycle Checkbox	Informs that the fault occurred during the current key-on event.
Fault Caused Engine Shutdown Checkbox	Informs that the fault caused the engine to shutdown.
Key Cycles Since Fault Active Indicator	Displays the amount of key-on events since the fault was last active.
Clear This Fault Button*	Erases the selected historic fault from the ECM.
Clear All Faults Button*	Erases all historic faults from the ECM.
View Snap Shot Data Button	Retrieves a data “snap shot” from the ECM for variables defined in the base and custom snapshot variable definition lists. An example of a fault snap shot is shown in Figure 5.
View Flight Data Recorder Data Button	Retrieves a 10-second data strip chart (8 seconds prior, 2seconds after fault trigger) from the ECM for variables defined in the base and custom flight data recorder definition lists. An example of a fault snap shot is shown in Figure 6.
Close Button	Exits the Historic Fault Information interface. DOES NOT cancel or clear any faults.
* Snapshot and flight data recorder data for historic faults is erased after the prompt shown in Figure 3-92. is satisfied	

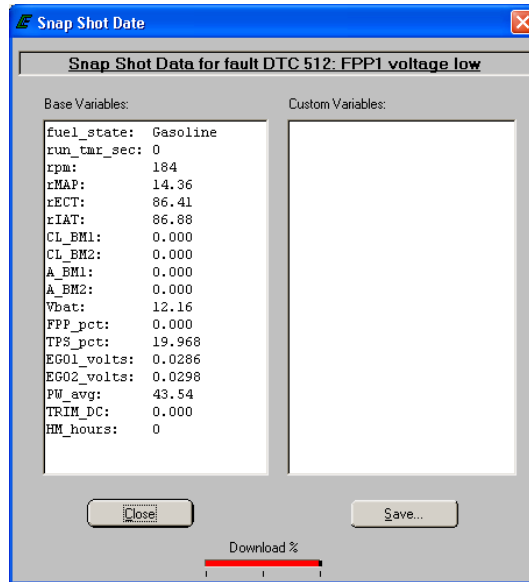


Figure 3-90. Snapshot Data Interface

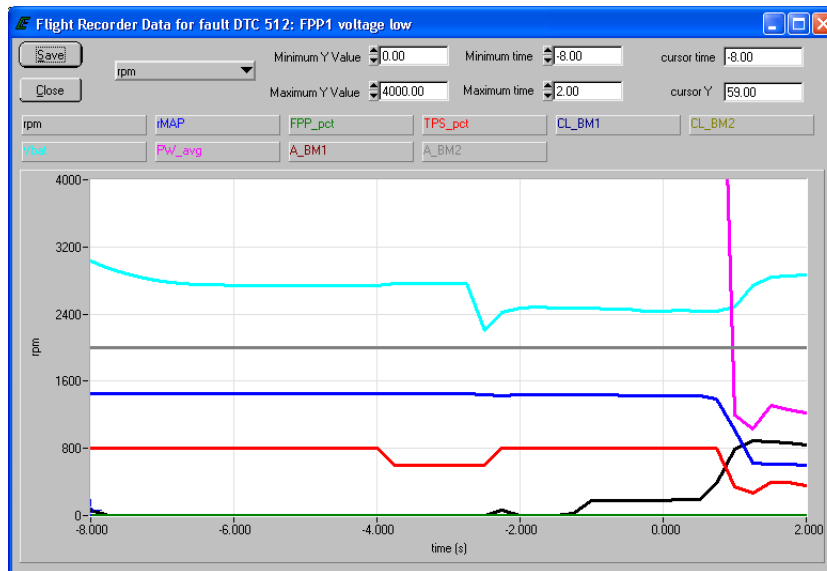


Figure 3-91. Flight Data Recorder Interface

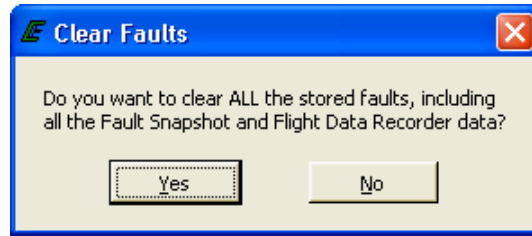


Figure 3-92. Clear Faults Prompt

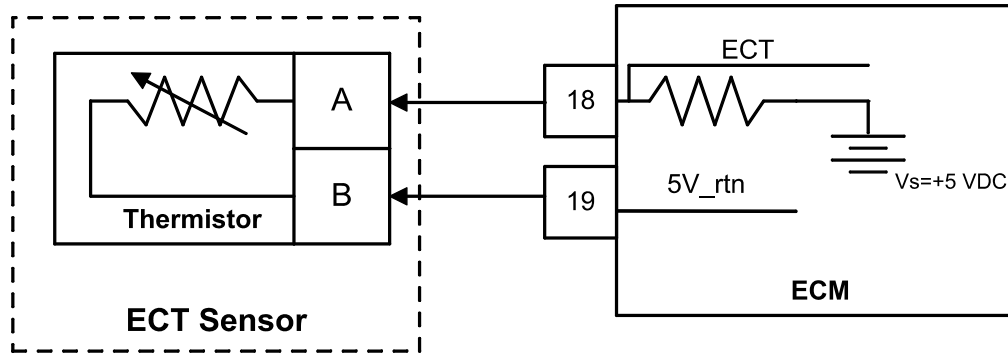
## DBW Diagnostic Test

The DGC engine control module incorporates a diagnostic test that may be used to verify proper drive-by-wire throttle actuator operation. This diagnostic test is software selectable through the EDIS using the ECIPP protocol. This test permits full-authority operation of an electronic throttle via the throttle command input while the engine is in the "Stopped" state only. The ECM reverts to normal operation if "Off" state is selected, ignition voltage is lost, or engine speed is sensed.

To enable the test, go to the DBW page of the EDIS. Set "DBW test mode" to "Enabled". Double-click on the "TPS Command" setting and enter the desired DBW throttle actuator position. Under normal operation, the throttle actuator should move to the position entered. To disable the test, set "DBW test mode" to "Off."

### 3.32 DIAGNOSTIC TROUBLE CODE FAULT DESCRIPTIONS

#### DTC 116- ECT Higher Than Expected Stage 1



- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-Engine Coolant Temperature reading or estimate greater than the stage 1 limit when operating at a speed greater than defined in the diagnostic calibration
- Corrective Action(s): Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during active fault. Recommend a power derate 1/2 and/or a low rev limit to protect engine from possible damage.
- Non-emissions related fault

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection. The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.

This fault will help protect the engine in the event of over temperature. When the coolant exceeds x deg. F and engine RPM exceeds y RPM for the latch time this fault will set.

#### Diagnostic Aids

If the "ECT High Voltage" fault is also present, follow the troubleshooting procedures for that fault as it may have caused "ECT Higher Than Expected 1."

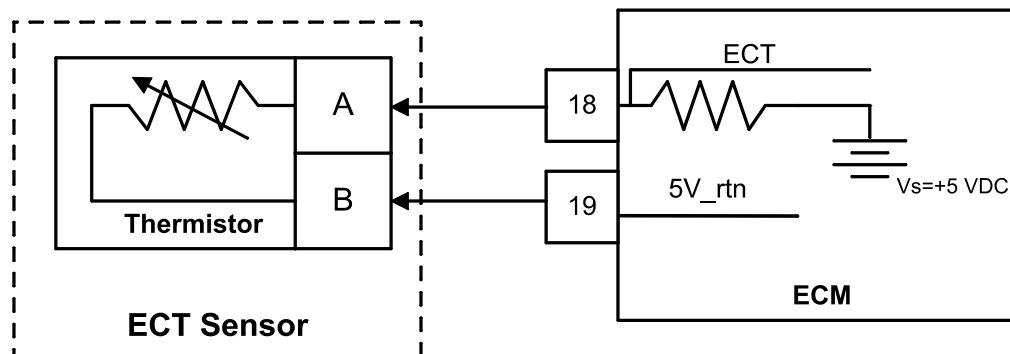
If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:

- Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking
- Ensure that there is no trapped air in the cooling path
- Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
- Check that the fan is operating properly
- Check that the thermostat is not stuck closed

If the cooling system utilizes a water-to-water heat exchanger:

- Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking
- Ensure that there is no trapped air in the cooling path
- Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
- Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected
- Check that the thermostat is not stuck closed
- Check that the raw water pump/impeller is tact and that it is not restricted

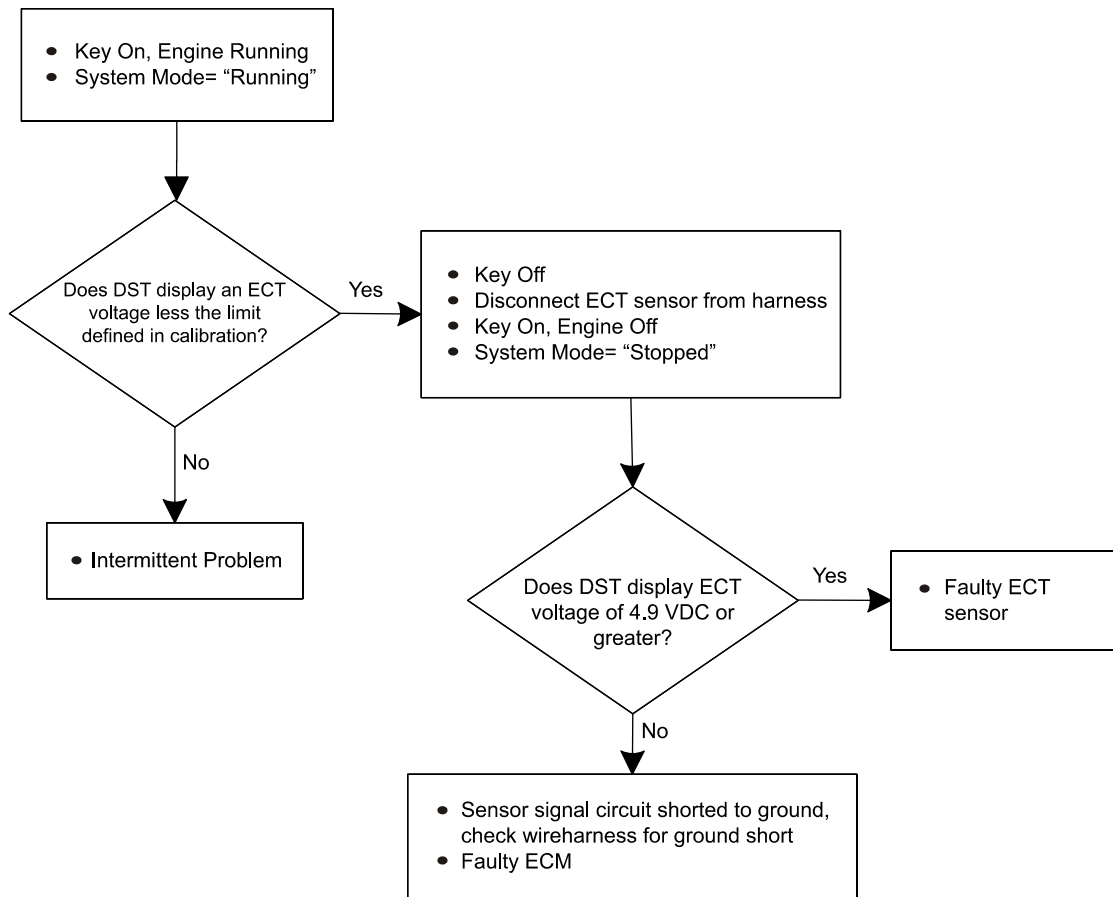


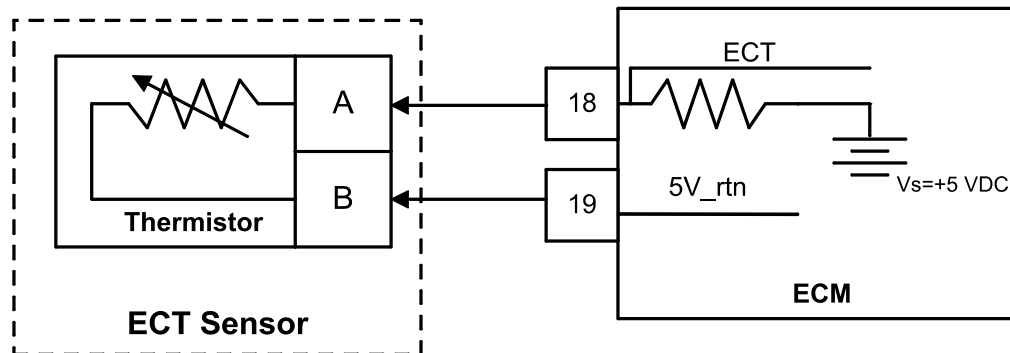
**DTC 117- ECT/CHT Low Voltage**

- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-CHT/ECT sensor voltage less than the limit defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during active fault, or any combination thereof as defined in calibration. Recommend a power derate 1/2 to reduce the possibility of engine damage due to the inability to sense temperature.
- Non-emissions related fault

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use an ECT sensor that is located in the coolant near the thermostat. Some engines use a CHT (Cylinder Head Temperature) sensor that is located in the coolant in the cylinder head. If the engine is equipped with an ECT sensor then the CHT value is estimated. If equipped with a CHT sensor then the ECT value is estimated. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm.

This fault will set if the signal voltage is less than the limit defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 0.10 VDC. The ECM will use a default value for the CHT/ECT sensor in the event of this fault.



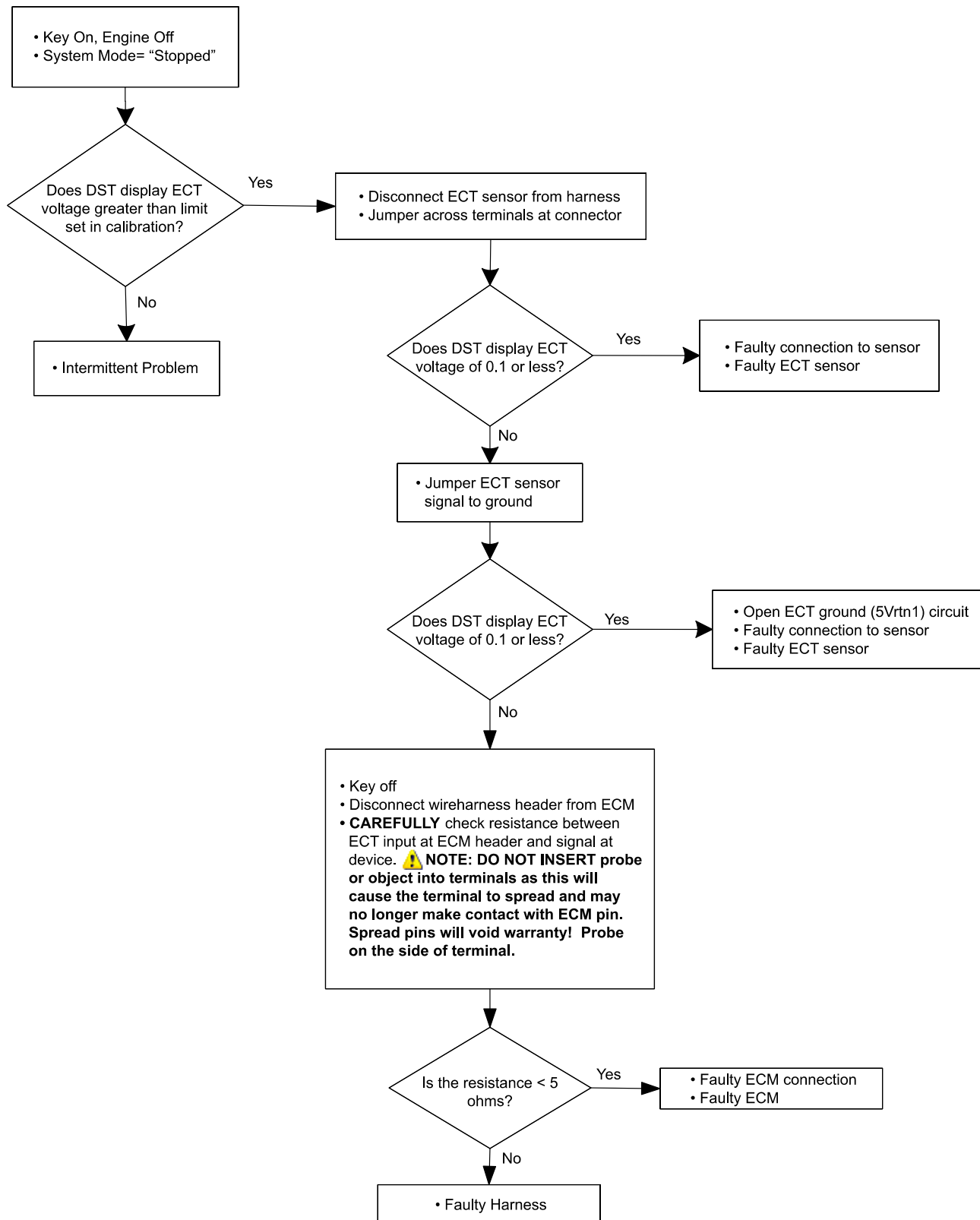
**DTC 118- ECT/CHT High Voltage**

- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-CHT/ECT sensor voltage higher than the limit defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during active fault, or any combination thereof as defined in calibration. Recommend a power derate 1/2 to reduce the possibility of engine damage due to the inability to sense temperature.
- Non-emissions related fault

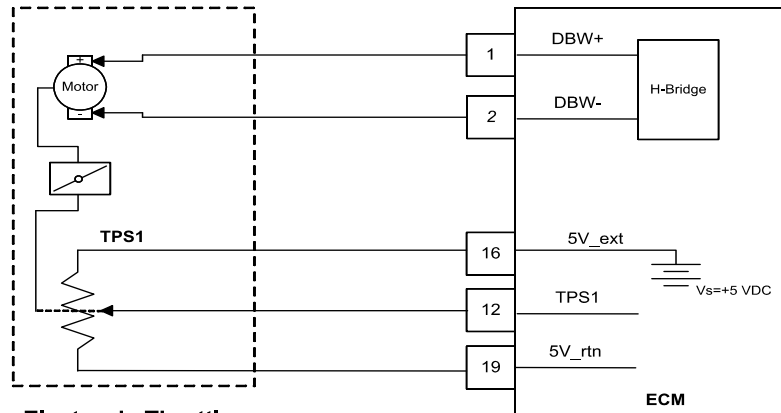
The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use an ECT sensor that is located in the coolant near the thermostat. Some engines use a CHT (Cylinder Head Temperature) sensor that is located in the coolant in the cylinder head. If the engine is equipped with an ECT sensor then the CHT value is estimated. If equipped with a CHT sensor then the ECT value is estimated. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm.

This fault will set if the signal voltage is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the CHT/ECT sensor being disconnected from the engine harness, an open-circuit or short-to-power of the CHT/ECT circuit in the wire harness, or a failure of the sensor. The ECM will use a default value for the CHT/ECT sensor in the event of this fault.

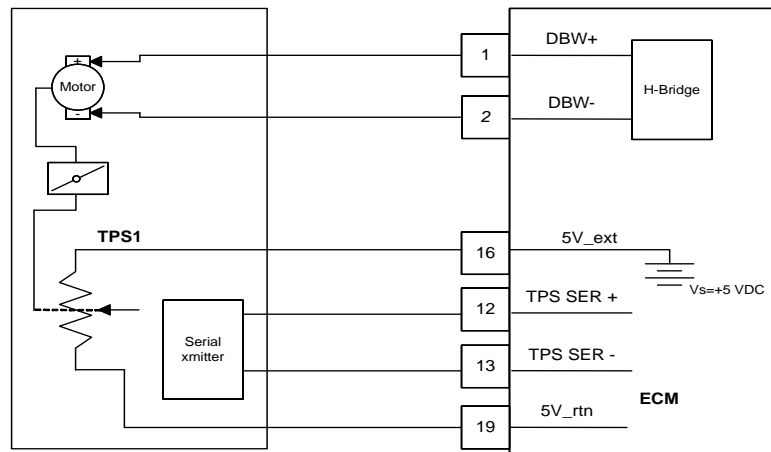
## SECTION 3 - CHASSIS & TURNTABLE



**DTC 122- TPS1 Signal Voltage Low**



**Electronic Throttle Actuator w/Analog Position Feedback**



**Electronic Throttle Actuator w/Serial Position Feedback**

## SECTION 3 - CHASSIS & TURNTABLE

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- Throttle Position Sensor 1
- Check Condition-Key On, Engine Off
- Fault Condition-TPS1 sensor voltage lower than the limit defined in the diagnostic calibration
- Corrective Action(s): Sound audible warning or illuminate secondary warning lamp, shutdown engine
- Non-emissions related fault

In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, references to the throttle and throttle position sensor refer to these fuel injection pump control actuators and their position feedback sensors. When the fuel injection pump is electronically controlled it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either;

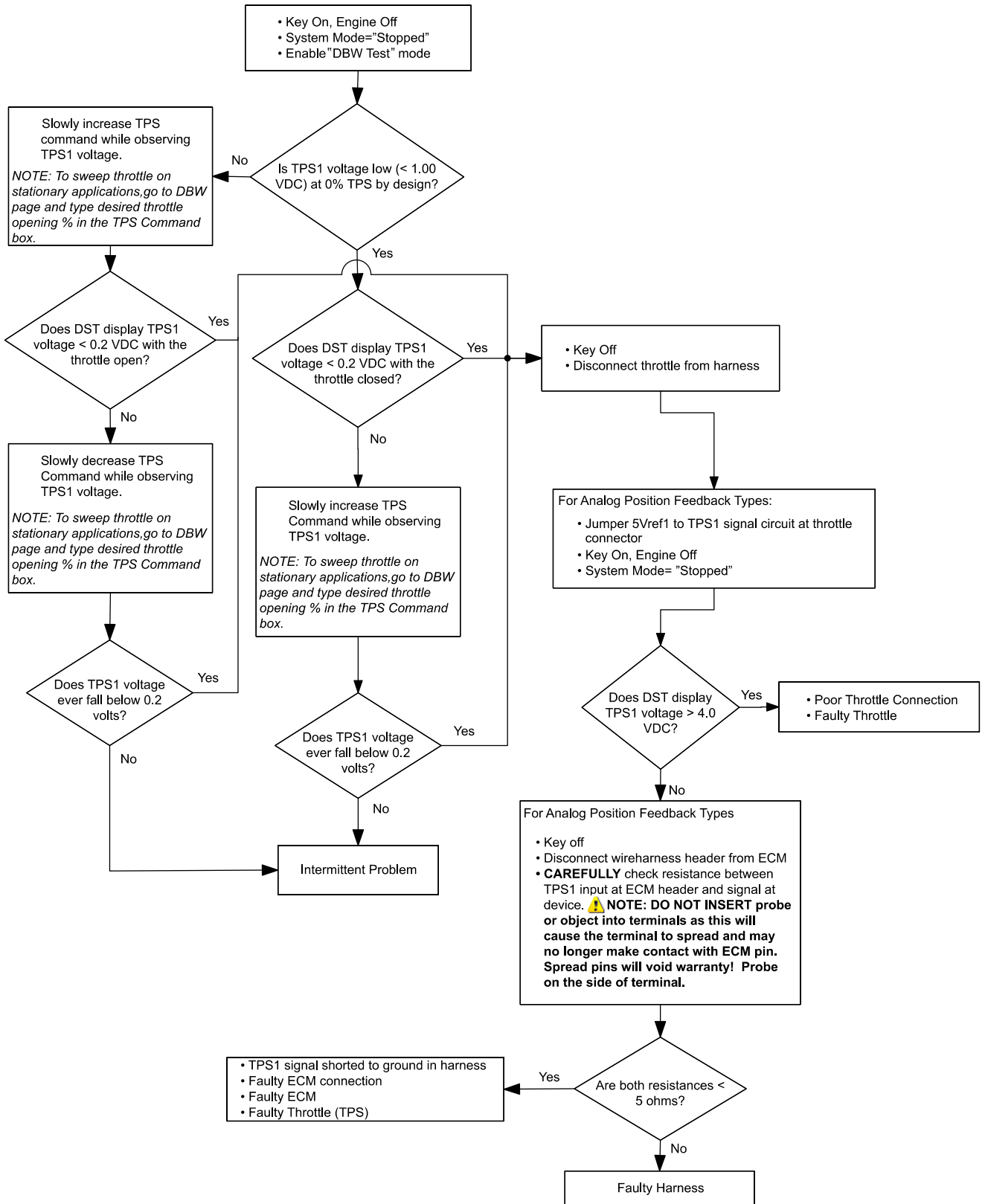
- 1) a variable resistor and voltage divider circuit or
- 2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

There are two types of throttle actuators;

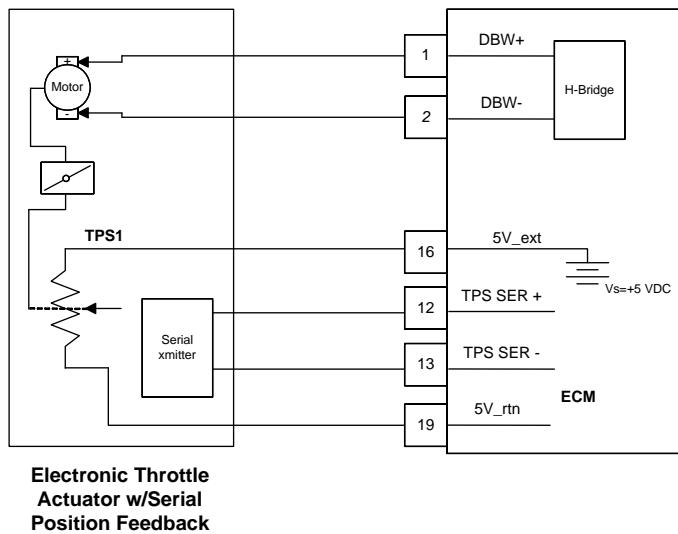
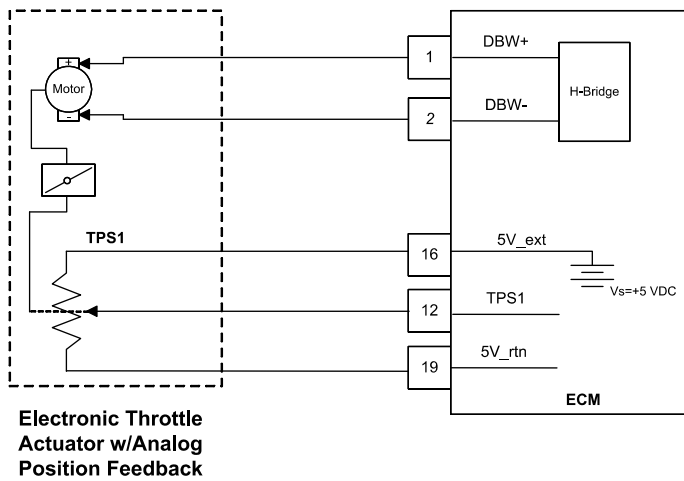
- 1) actuator with analog position feedback and
- 2) actuator with digital position feedback

The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position. The second type, with digital position feedback, provides a serial data signal to the ECM with the throttle actuator position voltage level encoded in the data stream.

This fault will set if TPS1 voltage is lower than the low voltage limit as defined in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the TPS sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the TPS circuit in the wire harness, or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.



## DTC 123- TPS1 Signal Voltage High



- Throttle Position Sensor 1
- Check Condition-Key On, Engine Off
- Fault Condition-TPS1 sensor voltage higher than the limit defined in the diagnostic calibration
- Corrective Action(s): Sound audible warning or illuminate secondary warning lamp, shutdown engine
- Non-emissions related fault

In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, references to the throttle and throttle position sensor refer to these fuel injection pump control actuators

and their position feedback sensors. When the fuel injection pump is electronically controlled it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either;

- 1) a variable resistor and voltage divider circuit or
- 2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

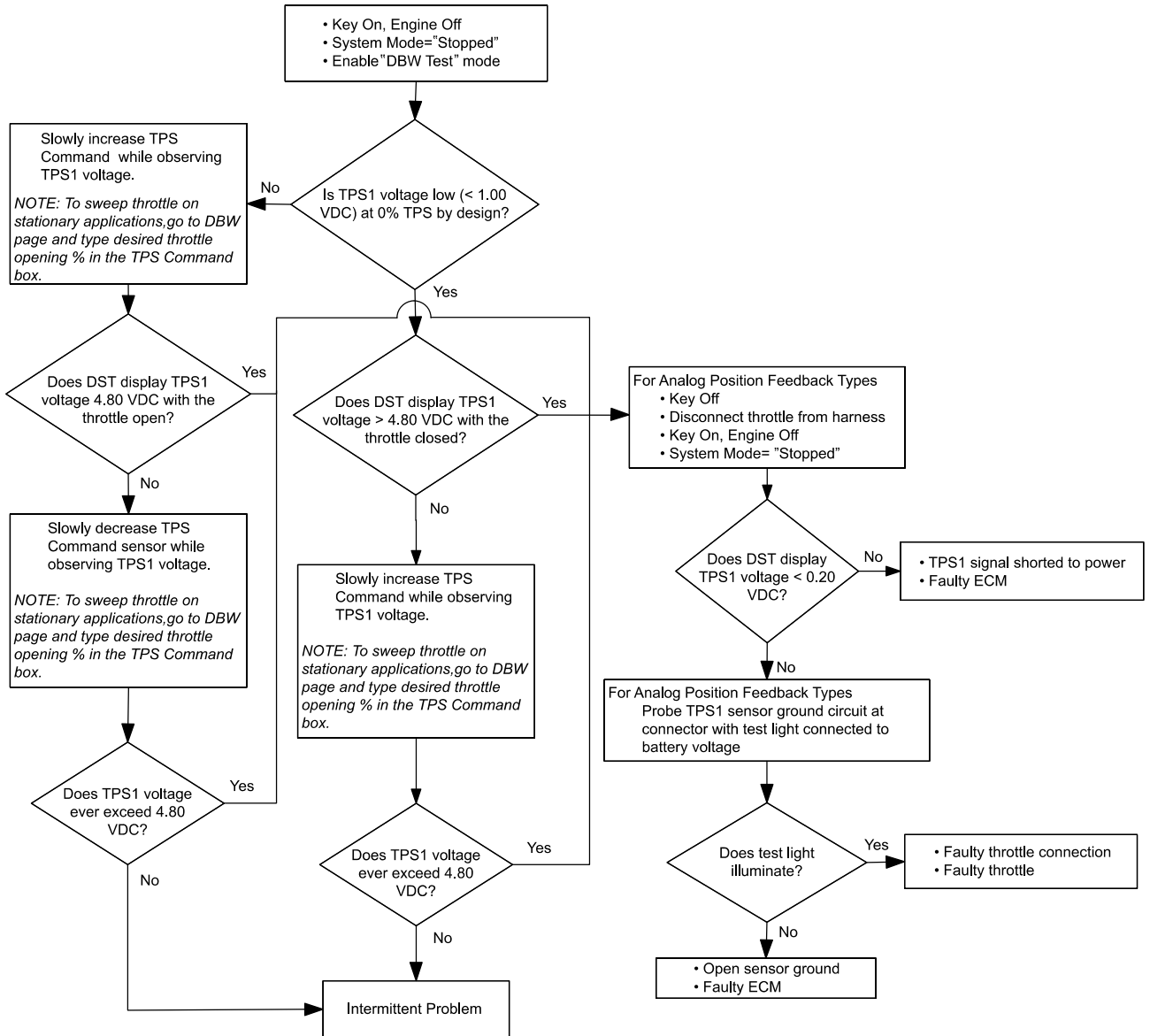
There are two types of throttle actuators, 1) actuator with analog position feedback and 2) actuator with digital position feedback. The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position.



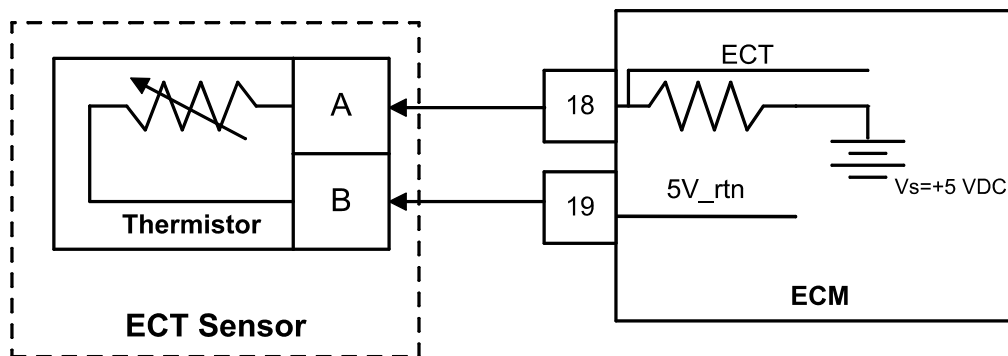
The second type, with digital position feedback, provides a serial data signal to the ECM with the throttle actuator position voltage level encoded in the data stream.

This fault will set if TPS1 voltage is higher than the limit set in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is gener-

ally set to 4.90 VDC. In many cases, this condition is caused by a short-to-power of the TPS circuit in the wire harness or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.



## DTC 217- ECT Higher Than Expected 2



- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-Engine Coolant Temperature reading or estimate greater than the stage 2 limit when operating at a speed greater than defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during active fault. Recommend a power derate 2 and/or a forced idle or engine shutdown to protect engine from possible damage.
- Non-emissions related fault

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.

This fault will help protect the engine in the event of over temperature. When the coolant exceeds x deg. F and engine RPM exceeds y RPM for the latch time this fault will set.

### Diagnostic Aids

If the "ECT High Voltage" fault is also present, follow the troubleshooting procedures for that fault as it may have caused "ECT Higher Than Expected 2."

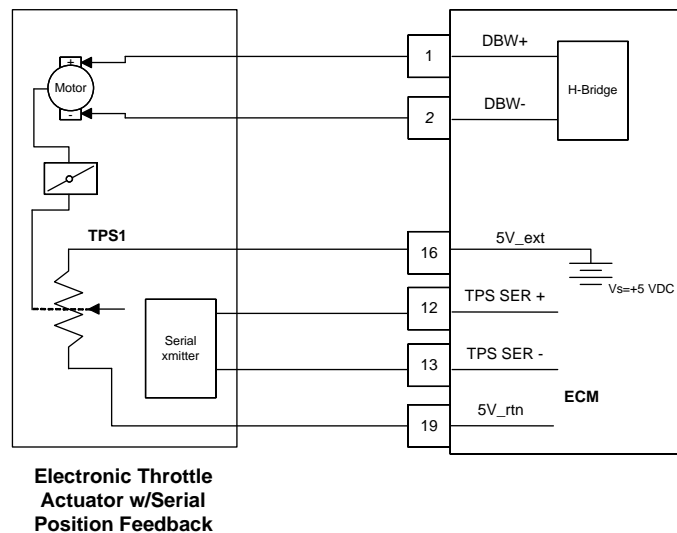
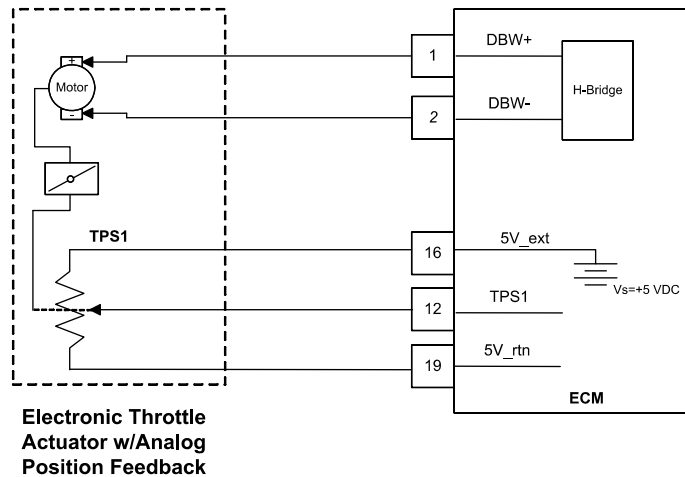
If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:

- Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking
- Ensure that there is no trapped air in the cooling path
- Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
- Check that the fan is operating properly
- Check that the thermostat is not stuck closed

If the cooling system utilizes a water-to-water heat exchanger:

- Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking
- Ensure that there is no trapped air in the cooling path
- Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
- Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected
- Check that the thermostat is not stuck closed
- Check that the raw water pump/impeller is tact and that it is not restricted

## DTC 219- RPM Higher Than Max Allowed Governed Speed



- Max Govern Speed Override- Crankshaft Position Sensor
- Check Condition-Engine Running
- Fault Condition-Engine speed greater than the max governor override speed as defined in the diagnostic calibration
- Corrective Action(s): Sound audible warning or illuminate secondary warning lamp, reduce throttle to limit speed. Recommend closed loop and adaptive learn fueling correction remains active during fault.
- Non-emissions related fault

This fault will set anytime the engine RPM exceeds the limit set in the diagnostic calibration for the latch time or more. This speed overrides any higher max governor

speeds programmed by the user. This fault is designed to help prevent engine or equipment damage.

The throttle will be lowered in order to govern the engine to the speed set in the diagnostic calibration.

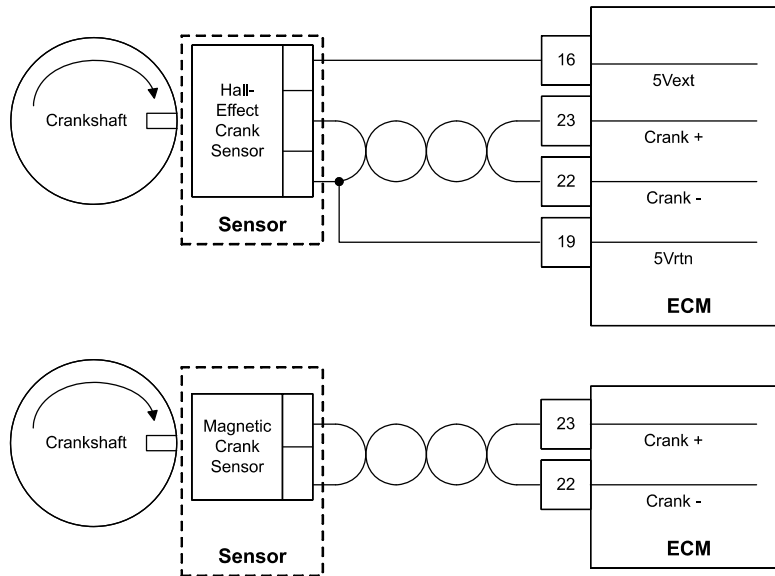
DTC 219- RPM Higher Than Max Allowed Governed Speed (continued)

### Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- Ensure that no programmed governor speeds exceed the limit set in the diagnostic calibration for Max Gov Override Speed
- Check mechanical operation of the throttle actuator

## DTC 336- Crank Signal Input Noise

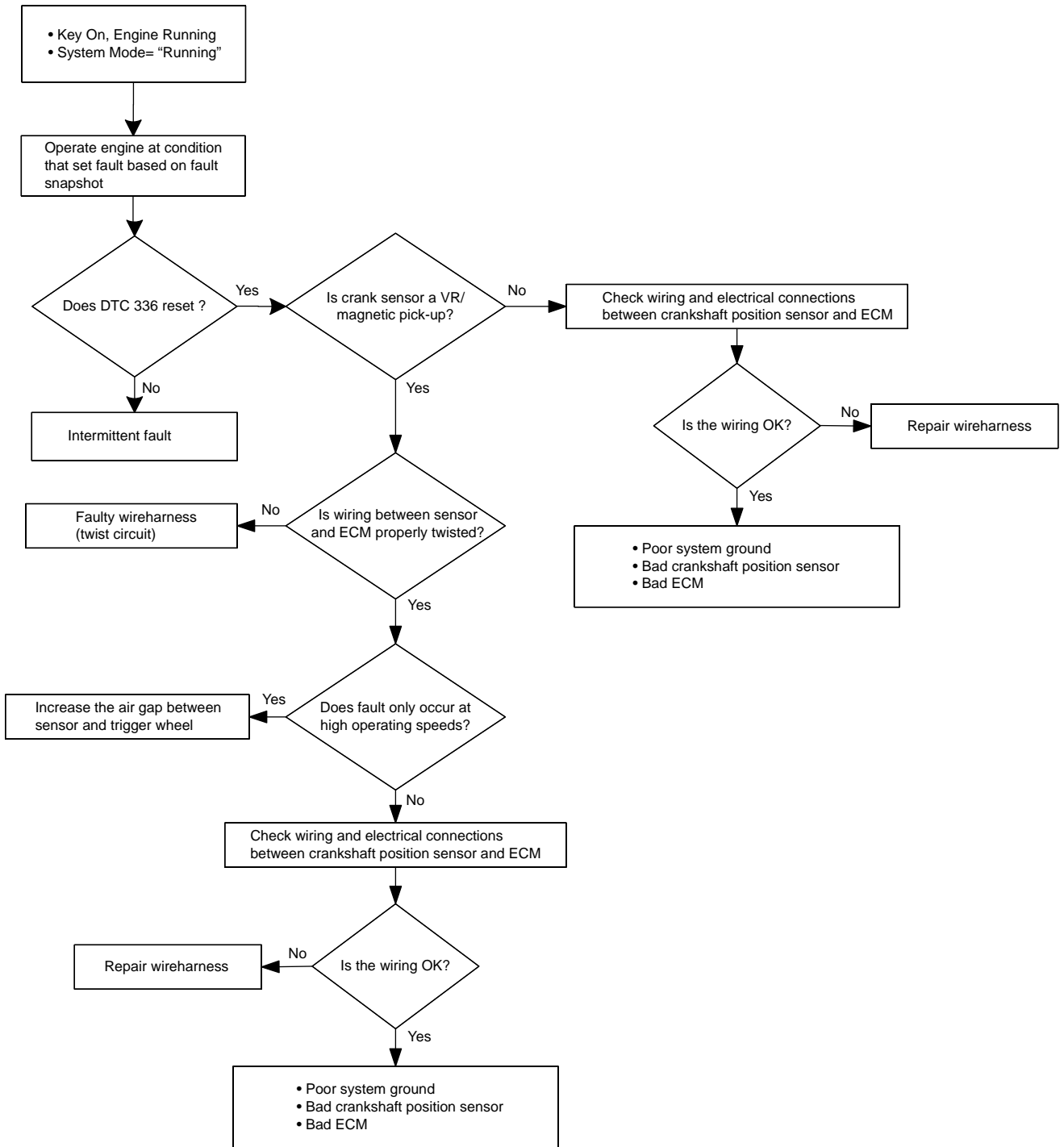


- Crankshaft Position sensor
- Check Condition- Key On, Engine On
- Fault Condition- Electrical noise or irregular crank pattern detected causing x number of crank resynchronization events as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp and disable adaptive fueling correction for remainder of key-cycle.
- Emissions related fault

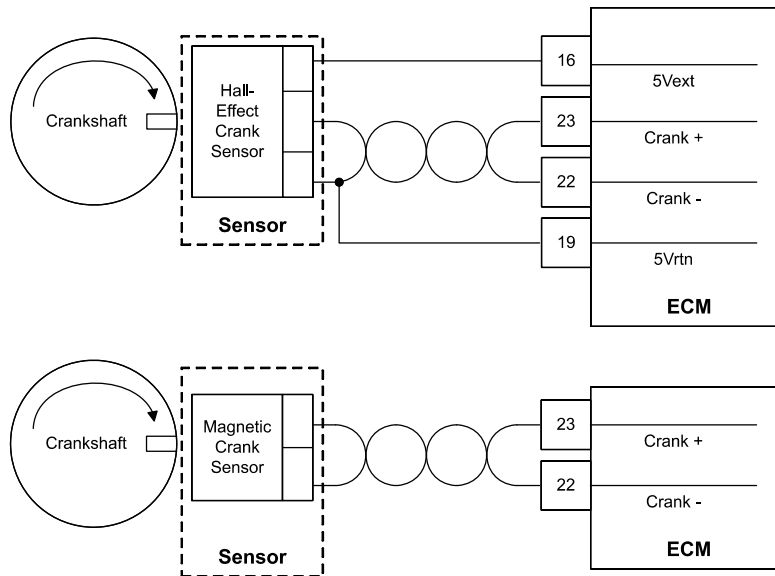
The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or halleffect) installed in the engine block adjacent to a "coded" trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control.

The ECM must see a valid crankshaft position signal while running. If no signal is present, the signal amplitude is too high (due to improper air gap with respect to trigger wheel), or an irregular crank pattern is detected causing the ECM to resynchronize x times for y ms or longer as defined in the diagnostic calibration, this fault will set. Irregular crank patterns can be detected by the ECM due to electrical noise, poor machining of trigger wheel, or trigger wheel runout and/or gear lash.

Ensure crank circuit used with VR/magnetic pick-up sensors are properly twisted.



## DTC 337- Loss of Crank Input Signal



- Crankshaft Position sensor
- Check Condition- Key On, Engine On
- Fault Condition- Loss of crankshaft position signal while valid camshaft position signals continue for x number of cam pulses as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp
- Emissions related fault

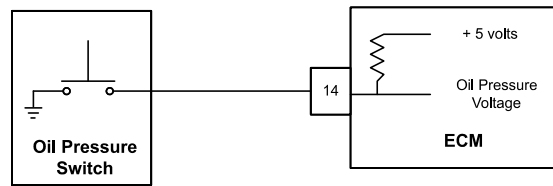
The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or halleffect) installed in the engine block adjacent to a trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control.

The ECM must see a valid crankshaft position signal while running. If no signal is present while x cam pulses continue the fault will set. The engine typically stalls or dies as a result of this fault condition due to the lack of crankshaft speed input resulting in the inability to control ignition timing.

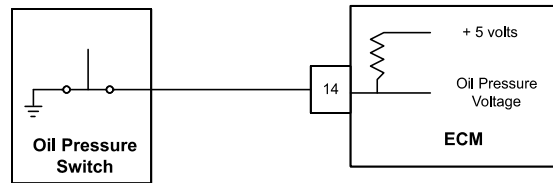
### Diagnostic Aids

- Check that crankshaft position sensor is securely connected to harness
- Check that crankshaft position sensor is securely installed into engine block
- Check crankshaft position sensor circuit wiring for open circuit

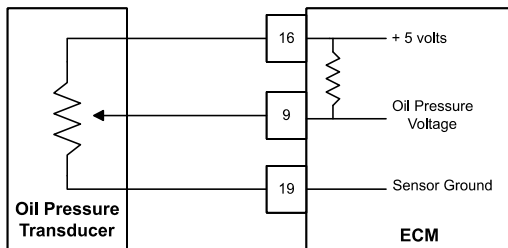
## DTC 521- Oil Pressure Sender/Switch High Pressure



Normally-Open  
Switch-Type



Normally-Closed  
Switch-Type



Sensor-Type

- Engine Oil Pressure
- Check Condition- Key on, Engine on (or Engine off)
- Fault Condition- For sender types, oil pressure higher than  $\underline{x}$  psia while engine speed is greater than  $\underline{y}$  RPM. For switch types, oil pressure is indicating high when the engine has been stopped for more than  $\underline{n}$  seconds.
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, possibly configure for power derate 1 or low rev limit
- Non-emissions related fault

The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

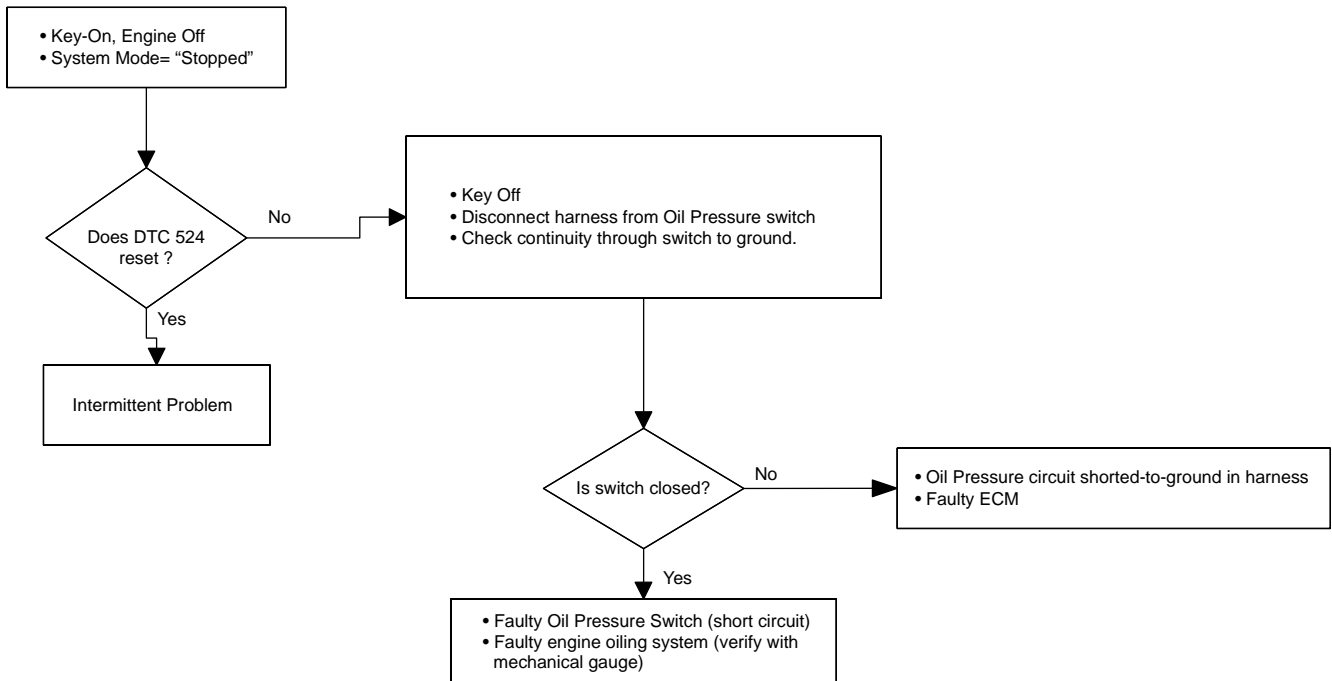
Additionally for normally-open type oil pressure switches, a high pressure indication while the engine is off is a

symptom of a failed oil pressure switch. The ECM can monitor oil pressure indication when the engine is stopped for this failure mode.

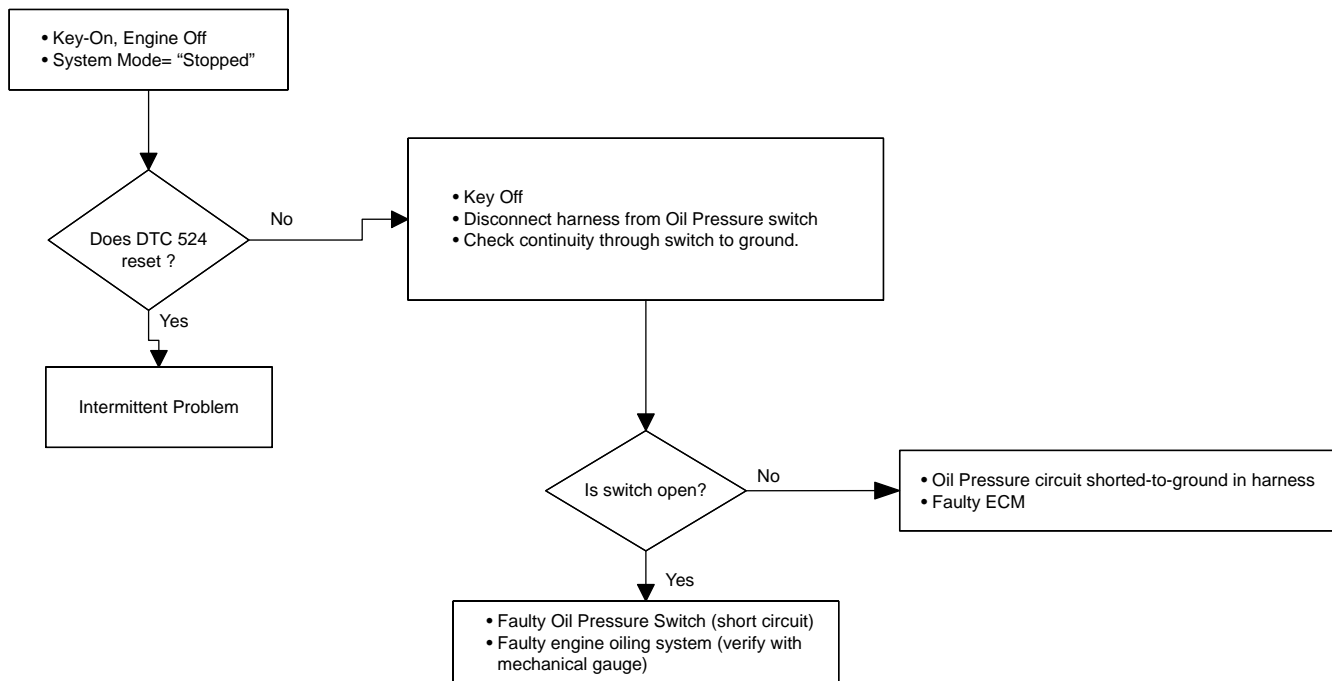
For sender types, this fault sets if the engine oil pressure is higher than  $x$  psia and engine speed greater than  $y$  RPM as defined in the diagnostic calibration. For switch types, this fault sets if the engine oil pressure is indicating high when the engine is stopped for more than  $n$  seconds. Recommend a power derate and/or low rev limit to help prevent possible engine damage and reduce oil pressure.

## SECTION 3 - CHASSIS & TURNTABLE

### Normally Open Switch

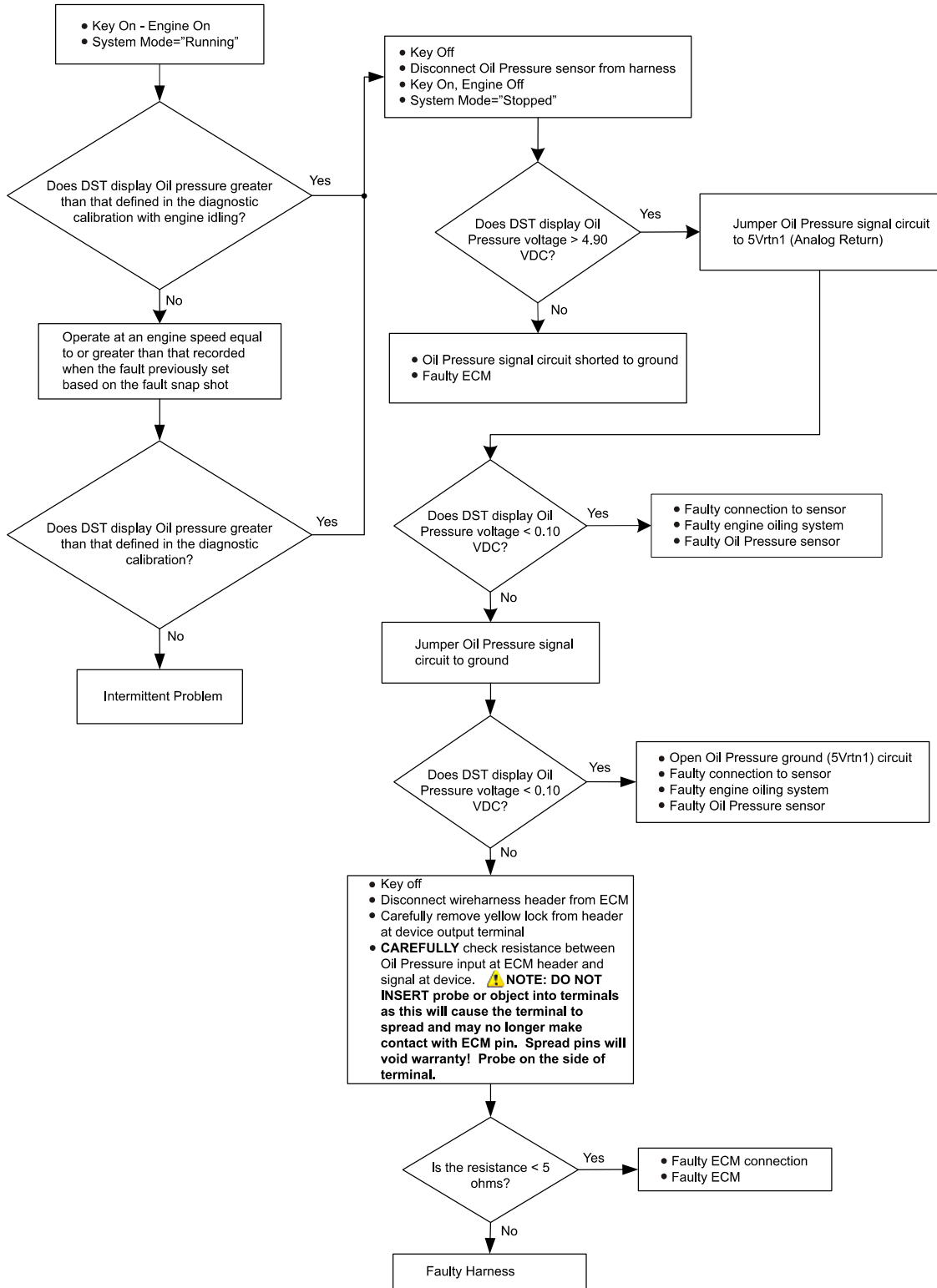


### Normally Closed Switch

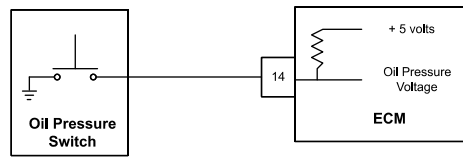




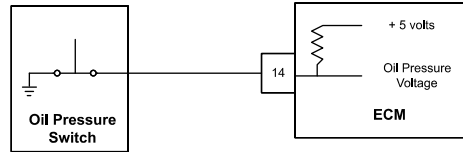
Sensor/Transducer Type



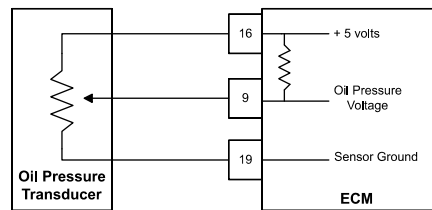
**DTC 524- Oil Pressure Low**



Normally-Open  
Switch-Type



Normally-Closed  
Switch-Type



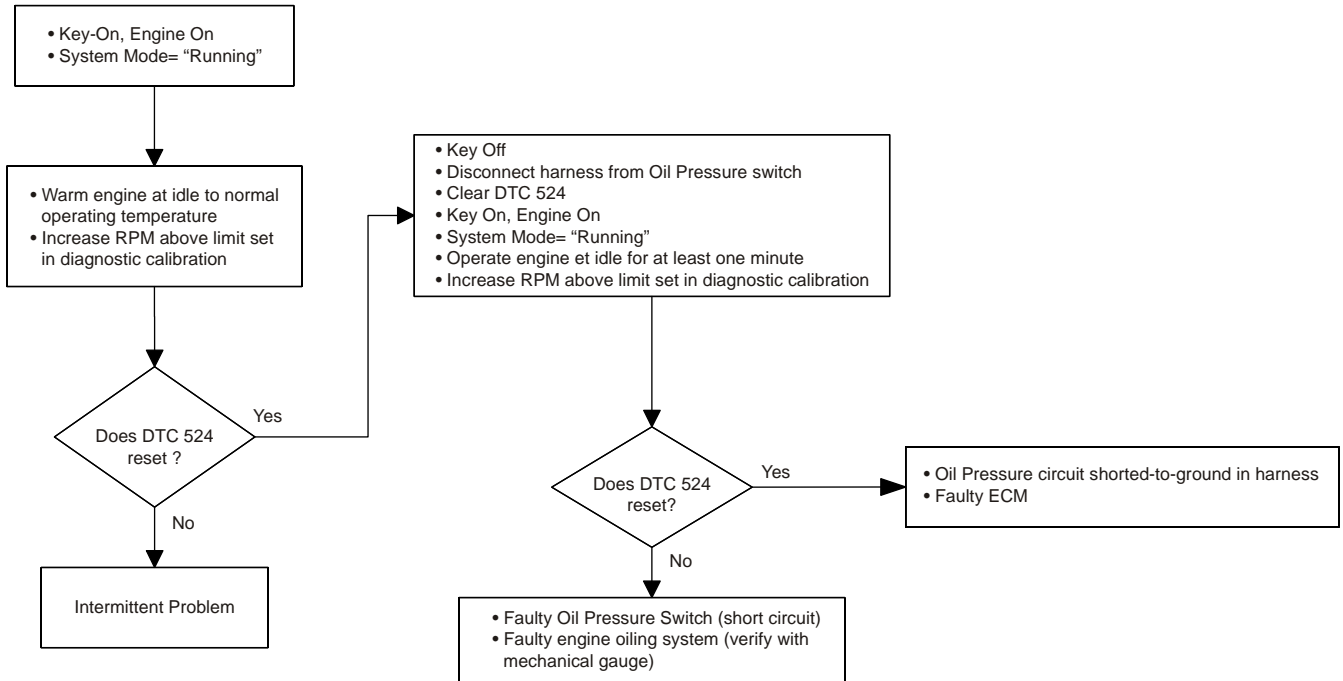
Sensor-Type

- Engine Oil Pressure
- Check Condition- Key on, Engine on
- Fault Condition- Engine oil pressure lower than expected while engine has been running for a minimum amount of time while engine speed is above some limit as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, generally configured to derate the engine and trigger an engine shutdown
- Non-emissions related fault

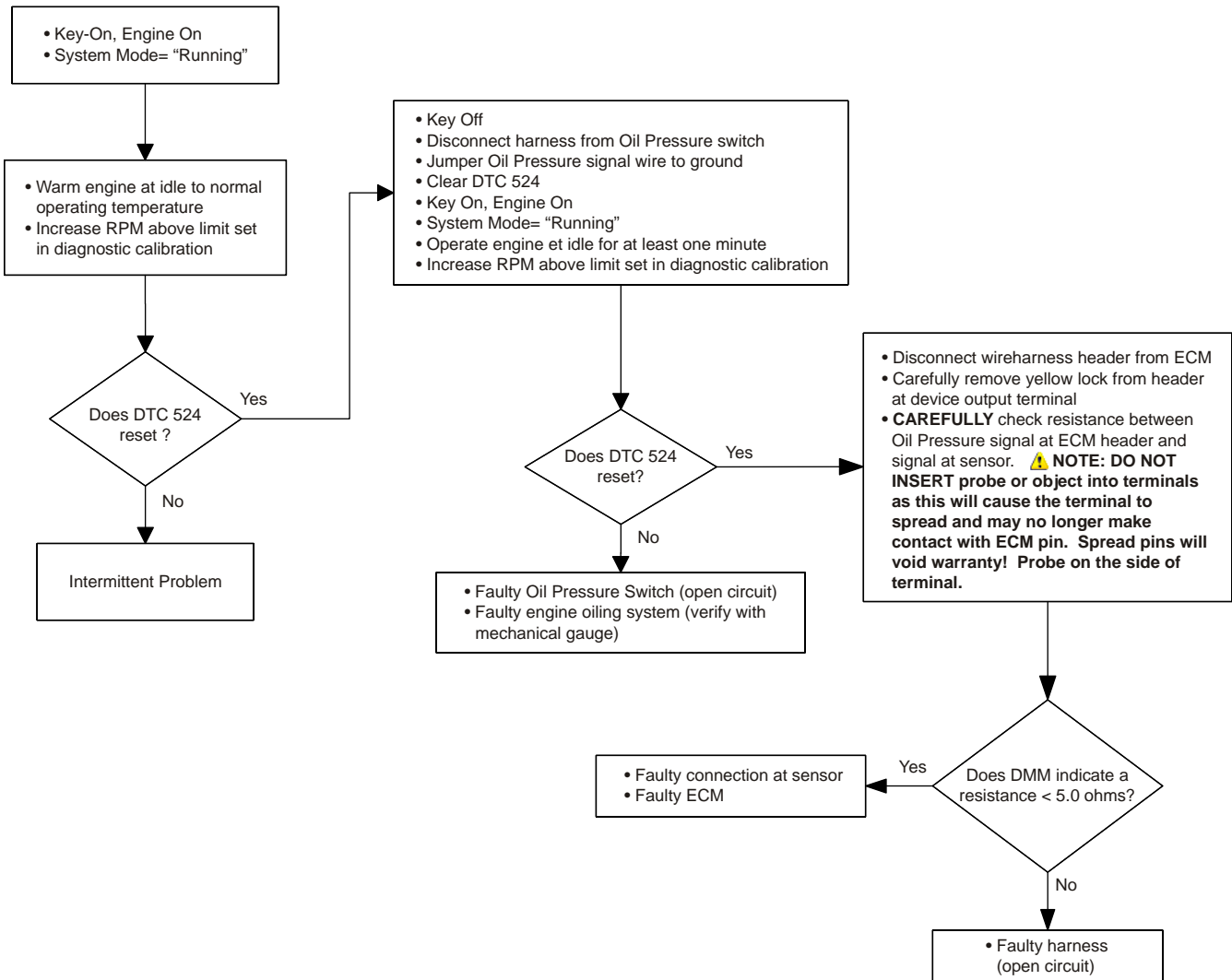
The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

For systems that use a transducer, this fault sets if the engine oil pressure is less than  $\underline{x}$  psia and engine speed is greater than  $\underline{y}$  RPM after the engine has been running for  $\underline{z}$  seconds as defined in the diagnostic calibration. For systems that use a switch this fault can be configured two different ways. It may use a normally closed switch or a normally open switch. If the switch is normally open, the fault will set if the circuit becomes grounded. If the switch is normally closed, the fault will set if the circuit becomes open. Go to the Faults page in EDIS to determine how the input is configured. ("Open=OK" is normally open and "Ground=OK" is normally closed). The engine will should be configured to derate or force idle and/or shut down in the event of this fault to help prevent possible damage.

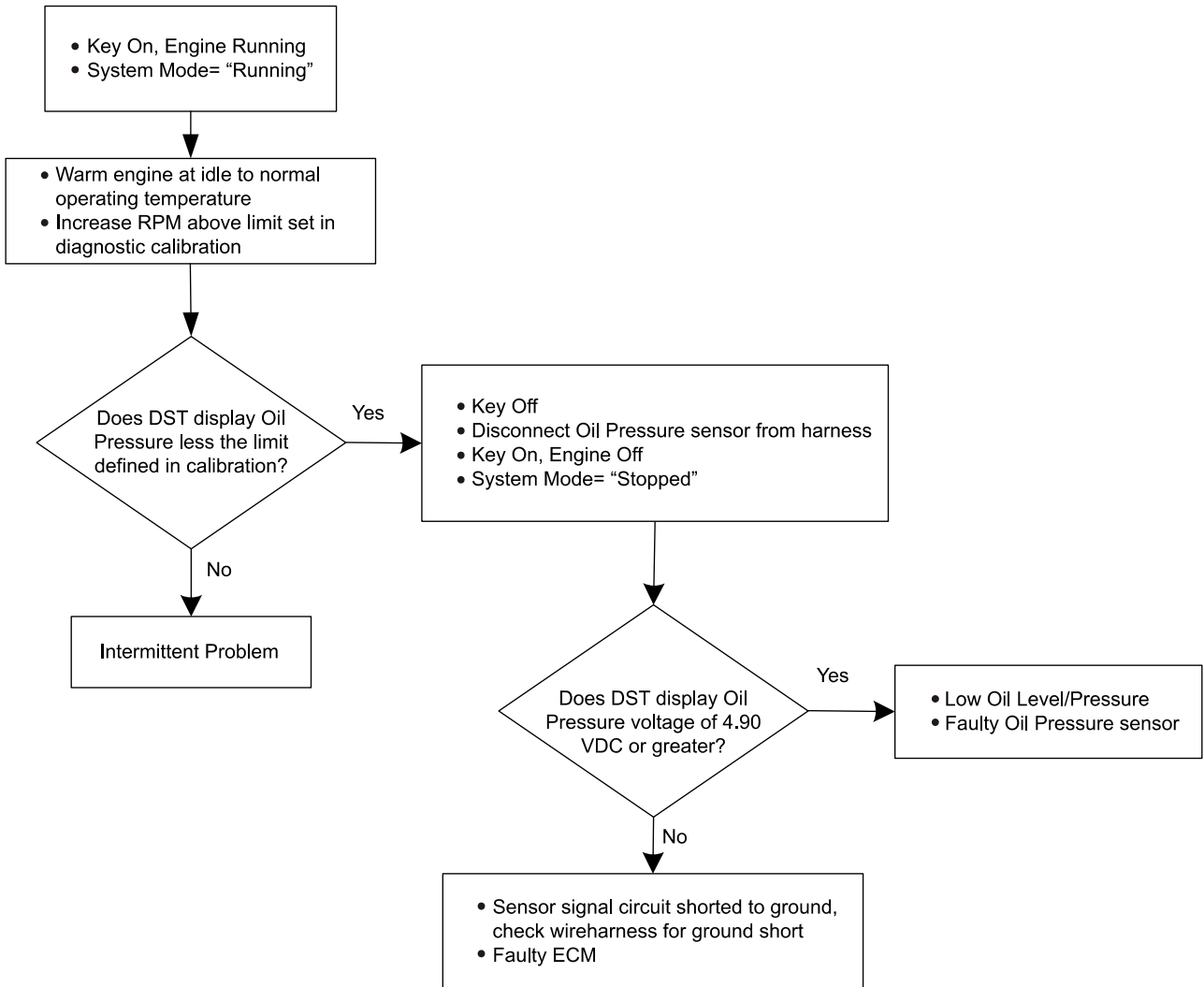
**Normally Open Switch**



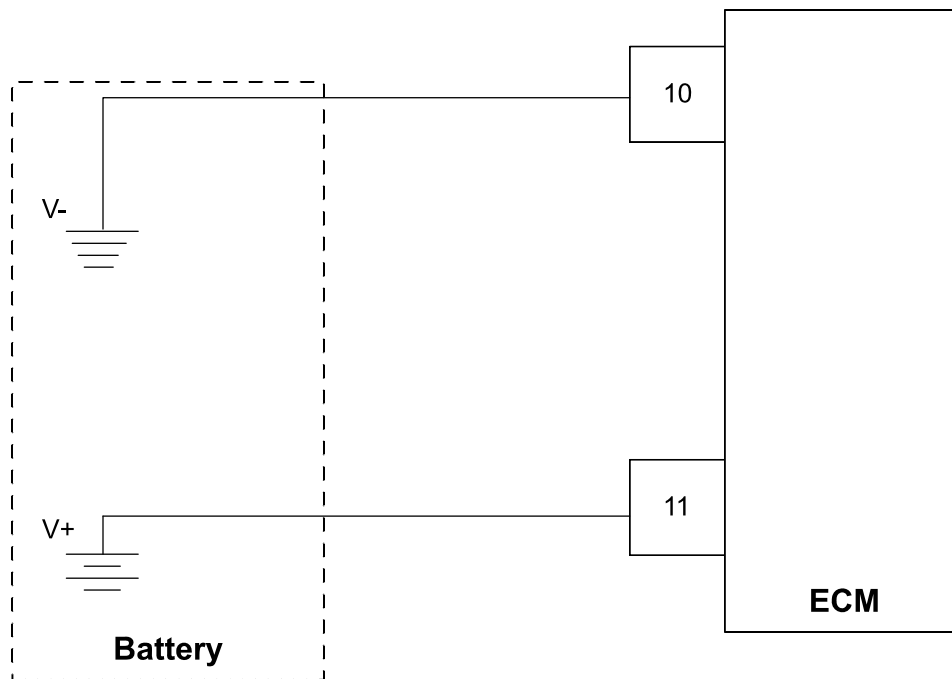
Normally Closed Switch



**Sensor/Transducer Type**



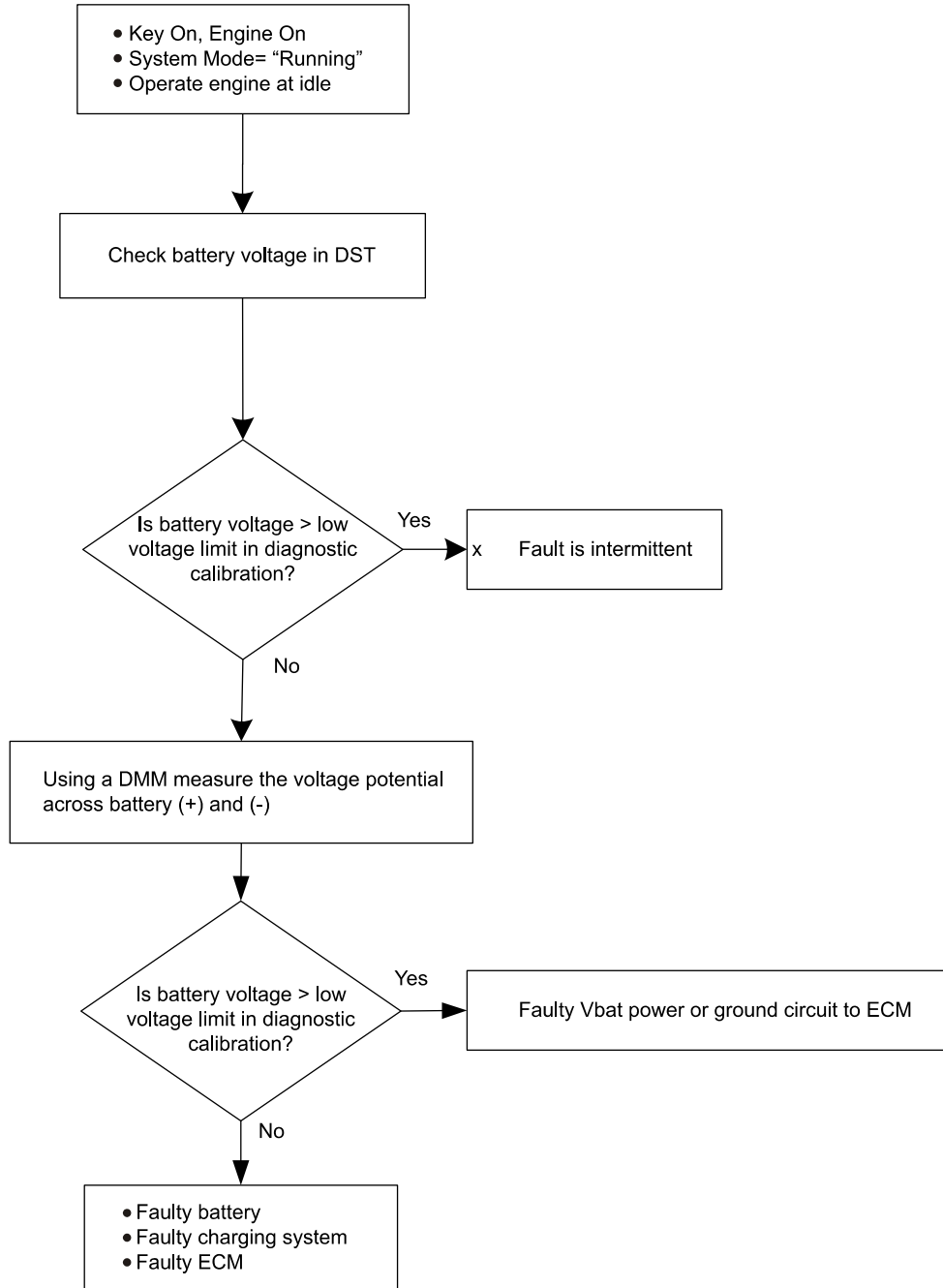
### DTC 562- Battery Voltage (VBat) Low



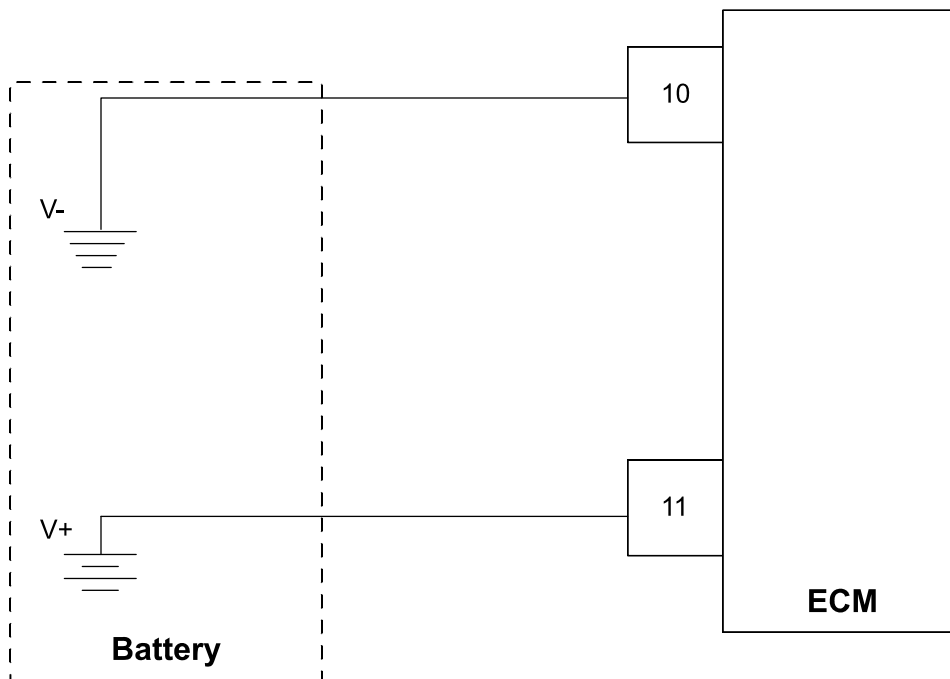
- System voltage to ECM
- Check Condition- Key on, Engine on
- Fault Condition- Battery voltage to ECM less than x volts while the engine is operating at y RPM or greater as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle
- Non-emissions related fault

The battery voltage powers the ECM and must be within limits to correctly operate throttle actuator, power supplies, and other powered devices that the ECM controls.

This fault will set if the ECM detects system voltage less than  $\underline{x}$  volts while the engine is operating at  $\underline{y}$  RPM as defined in the diagnostic calibration as the alternator should be charging the system.



### DTC 563- Battery Voltage (VBat) High

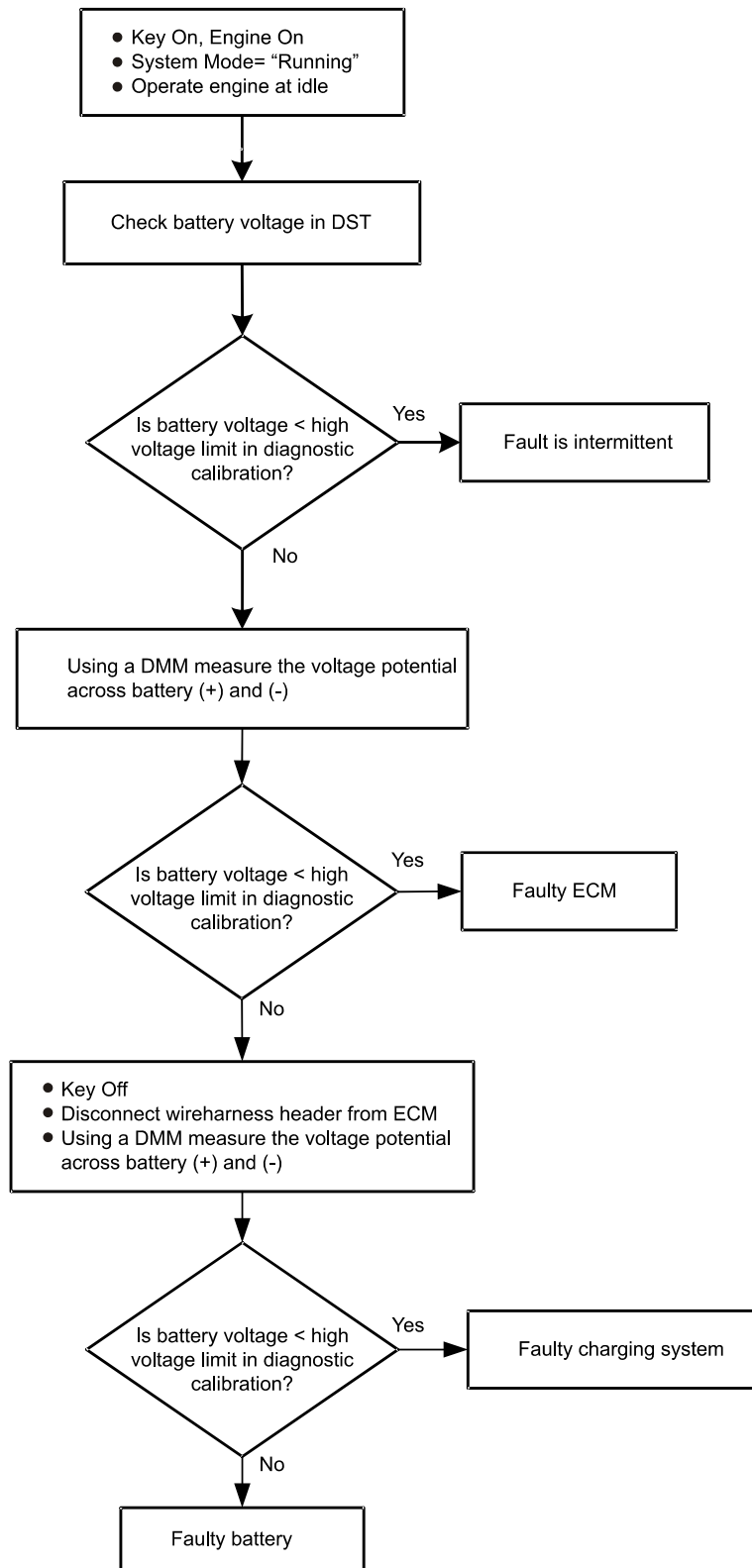


- System voltage to ECM
- Check Condition- Key on, Engine Cranking or Running
- Fault Condition- Battery voltage to ECM greater than  $\underline{x}$  volts while the engine is running as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle
- Non-emissions related fault

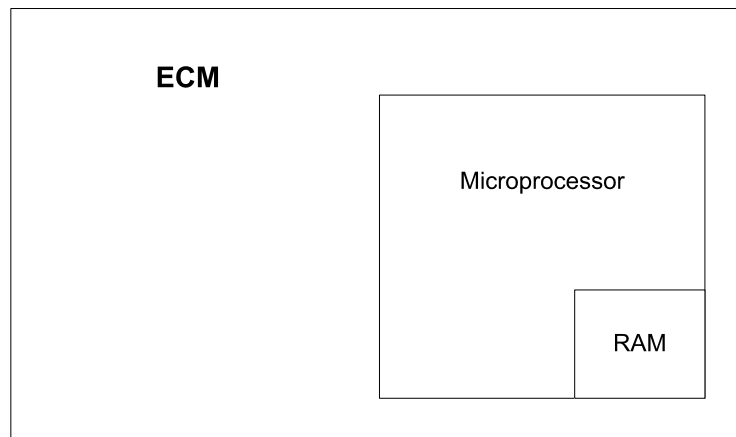
The battery voltage powers the ECM and must be within limits to correctly operate throttle actuator, power supplies, and other powered devices that the ECM controls.

This fault will set if the ECM detects system voltage greater than  $\underline{x}$  volts while the engine is running or cranking as defined in the diagnostic calibration.





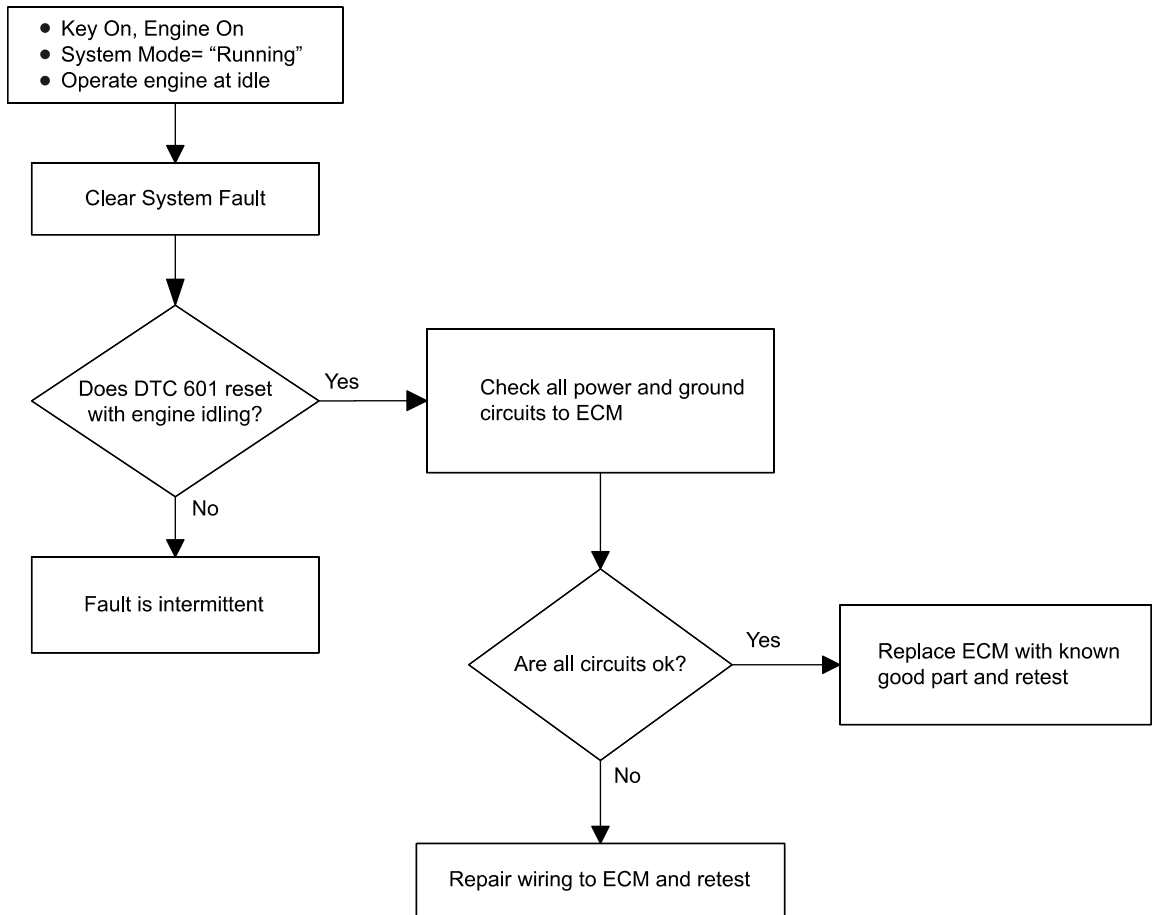
## DTC 601- Microprocessor Failure - FLASH



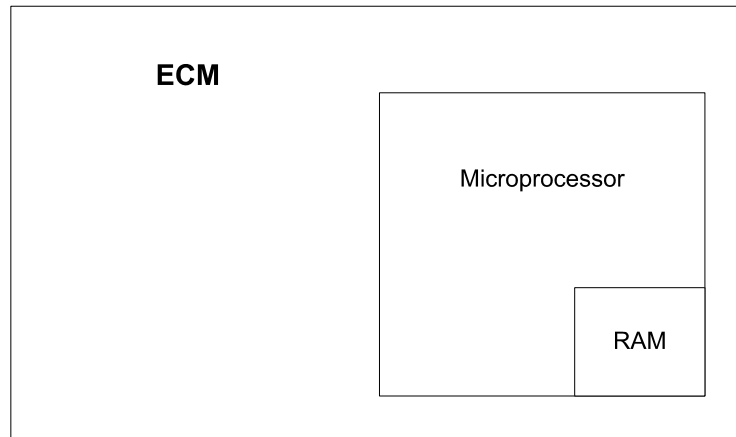
- Engine Control Module- Flash Memory
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle, recommend power derate 2 and low rev limit to reduce possible engine damage and/or overspeed condition
- Non-emissions related fault

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition. A fault of flash memory can occur for any calibration variable set and thus could cause undesirable operation.



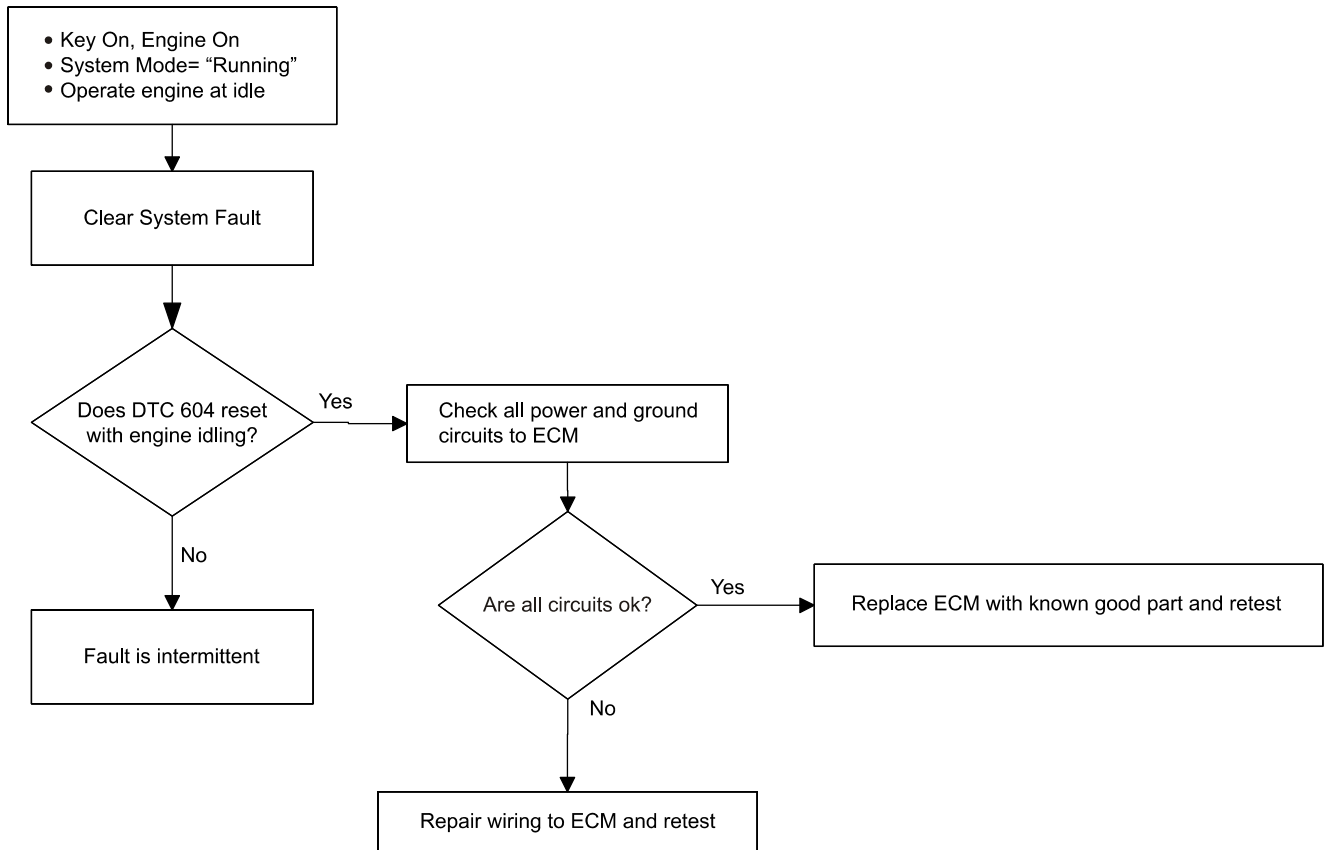
## DTC 604- Microprocessor Failure - RAM



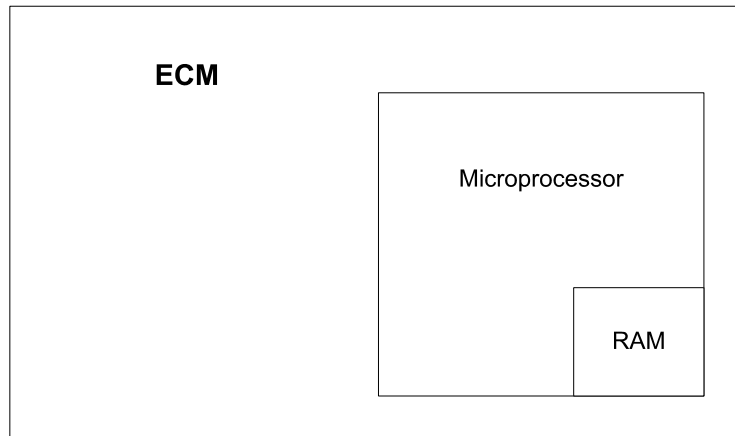
- Engine Control Module- Random Access Memory
- Check Condition- Key on
- Fault Condition- Internal ECM microprocessor memory access failure
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle, recommend power derate 2 and low rev limit to reduce possible engine damage and/or overspeed condition
- Non-emissions related fault

Random Access Memory is located within the microprocessor and can be read from or written to at any time. Data stored in RAM include DTCs (when fault configuration is set to "Battery Power Retained"), adaptive fuel learn tables, octane adaptation table, misfire adaptation tables, and closed loop fuel multipliers. The ECM has checks that must be satisfied each time an instruction is executed.

This fault will set if the ECM detects a problem accessing or writing information to RAM and should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition. If this fault sets, the ECM will reset itself and log the code. This fault should be erased by a technician after diagnostics are performed. The fault should be configured to never forget and will not self-erase.



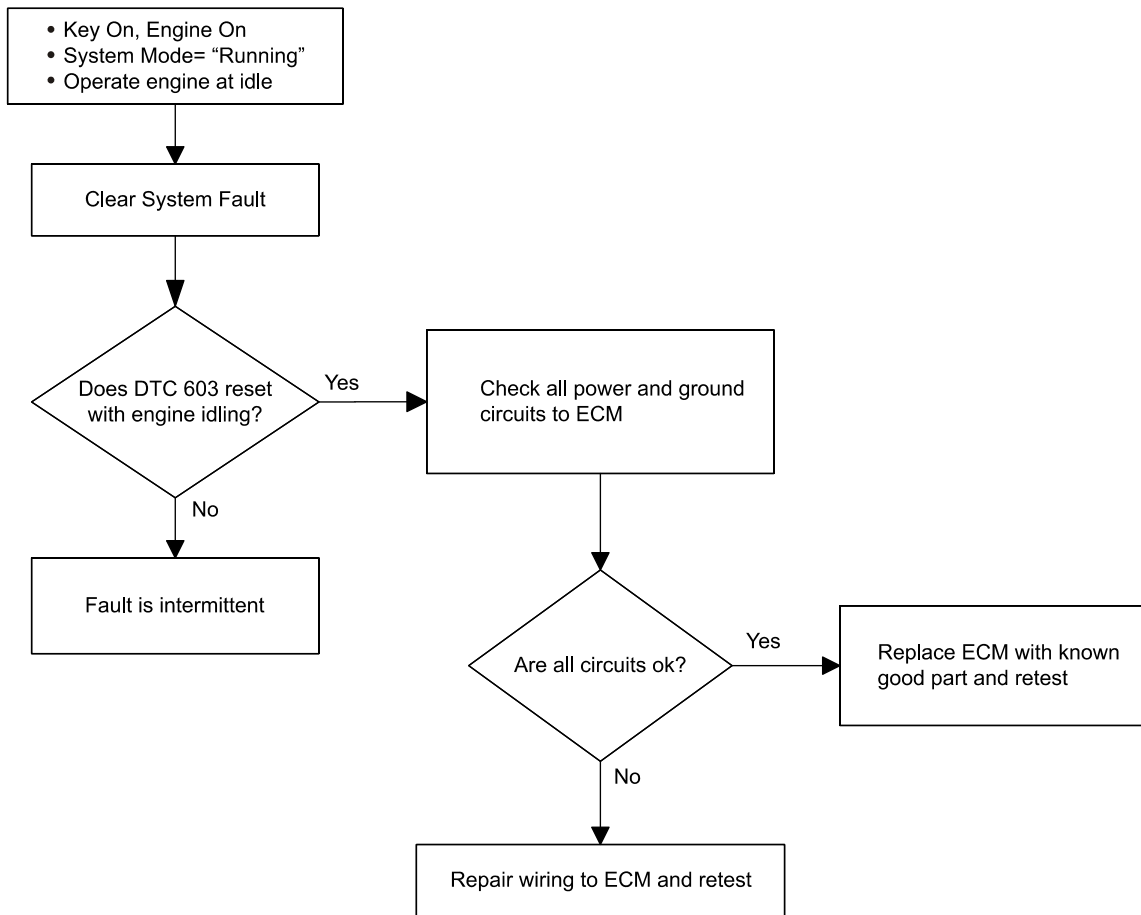
**DTC 606- Microprocessor Failure - COP**



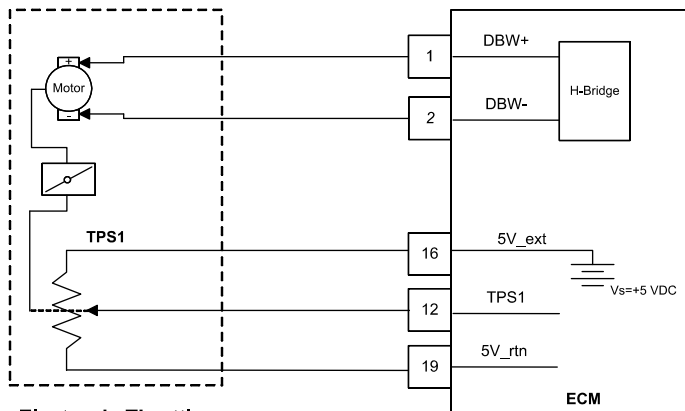
- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- Corrective Action(s) - Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle, recommend power derate 2 and low rev limit to reduce possible engine damage and/or overspeed condition
- Non-emissions related fault

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

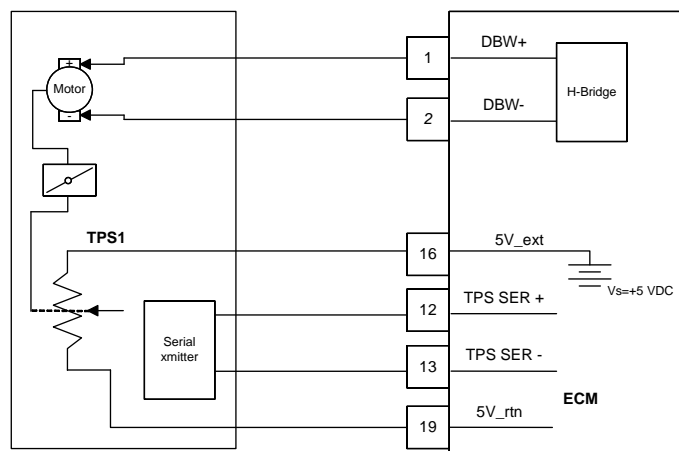
If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition.



**DTC 642- 5 Volt External Low Voltage**



**Electronic Throttle Actuator w/Analog Position Feedback**



**Electronic Throttle Actuator w/Serial Position Feedback**



- Engine Control Module
- Check Condition- Key on
- Fault Condition- ECM 5-volt output is below the acceptable limit
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

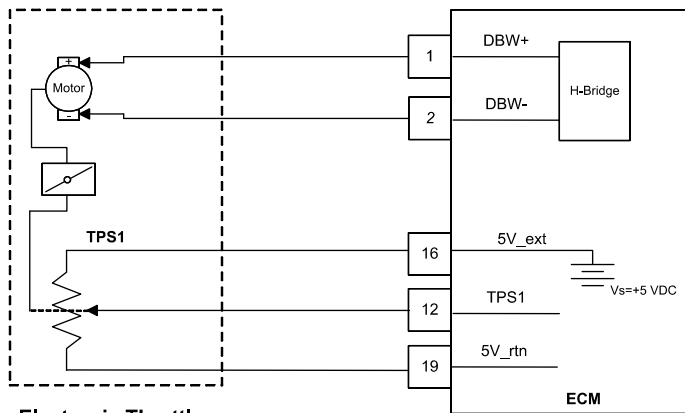
The ECM supplies 5-volt power to sensors, switches, and actuators external to the ECM. By supplying the power to these devices, the ECM can accurately measure their output relative to its own ground reference. The ECM can also control when the devices are active and put the devices in a low or no power state based on the current operating condition of the engine or vehicle.

If this fault sets, something other than the ECM is drawing the 5-volt power output of the ECM below an acceptable threshold. This may be due to a short in the wire harness, malfunctioning device, or failure of the ECM power output circuitry.

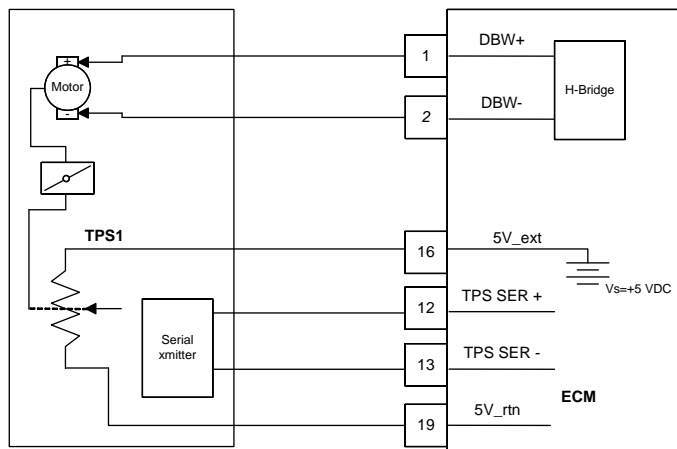
### **Diagnostic Aids**

- Measure the 5-volt output of the ECM while cycling the key on and the engine stopped. Verify that the output is lower than the fault thresholds configured in the diagnostic calibration.
- Inspect the 5-Volt output circuit in the wire harness and look for shorts to ground or other harness circuits.
- Disconnect each device powered by the 5-volt output of the ECM one-at-a-time. Powered devices may include the throttle actuator, smart sensors, smart actuators, etc. After disconnecting device, observe the system fault and determine if the fault has cleared. If the fault clears, troubleshoot the disconnected device for failures.
- With all 5-volt powered devices disconnected, look for a change in the fault state and measure the 5-volt output of the ECM and verify it is within acceptable limits.

**DTC 643- 5 Volt External High Voltage**



**Electronic Throttle Actuator w/Analog Position Feedback**



**Electronic Throttle Actuator w/Serial Position Feedback**

- Engine Control Module
- Check Condition- Key on
- Fault Condition- ECM 5-volt output is above the acceptable limit
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

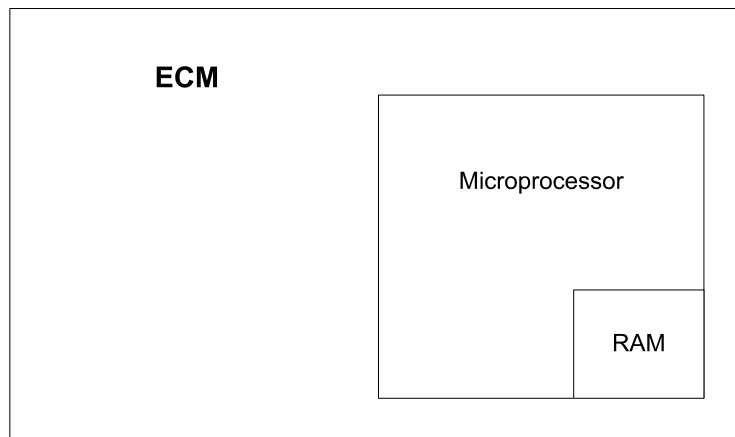
The ECM supplies 5-volt power to sensors, switches, and actuators external to the ECM. By supplying the power to these devices, the ECM can accurately measure their output relative to its own ground reference. The ECM can also control when the devices are active and put the devices in a low or no power state based on the current operating condition of the engine or vehicle.

If this fault sets, something other than the ECM is drawing the 5-volt power output of the ECM above an acceptable threshold. This may be due to a short in the wire harness, malfunctioning device, or failure of the ECM power output circuitry.

### **Diagnostic Aids**

- Measure the 5-volt output of the ECM while cycling the key on and the engine stopped. Verify that the output is lower than the fault thresholds configured in the diagnostic calibration.
- Inspect the 5-Volt output circuit in the wire harness and look for shorts to ground or other harness circuits.
- Disconnect each device powered by the 5-volt output of the ECM one-at-a-time. Powered devices may include the throttle actuator, smart sensors, smart actuators, etc. After disconnecting device, observe the system fault and determine if the fault has cleared. If the fault clears, troubleshoot the disconnected device for failures.
- With all 5-volt powered devices disconnected, look for a change in the fault state and measure the 5-volt output of the ECM and verify it is within acceptable limits.

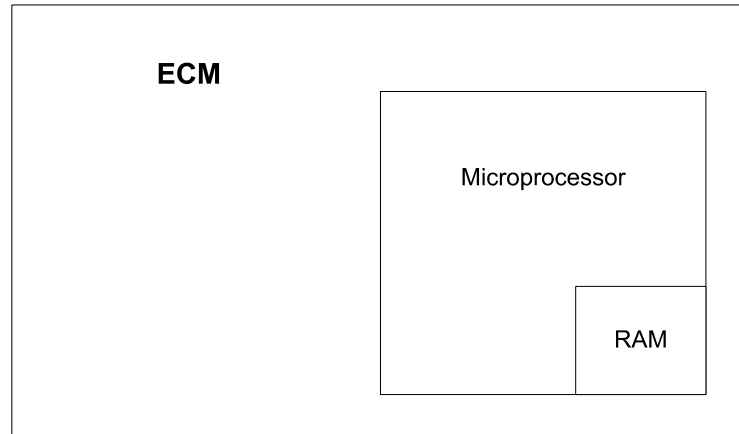
**DTC 1612- Microprocessor Failure - RTI 1**



- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

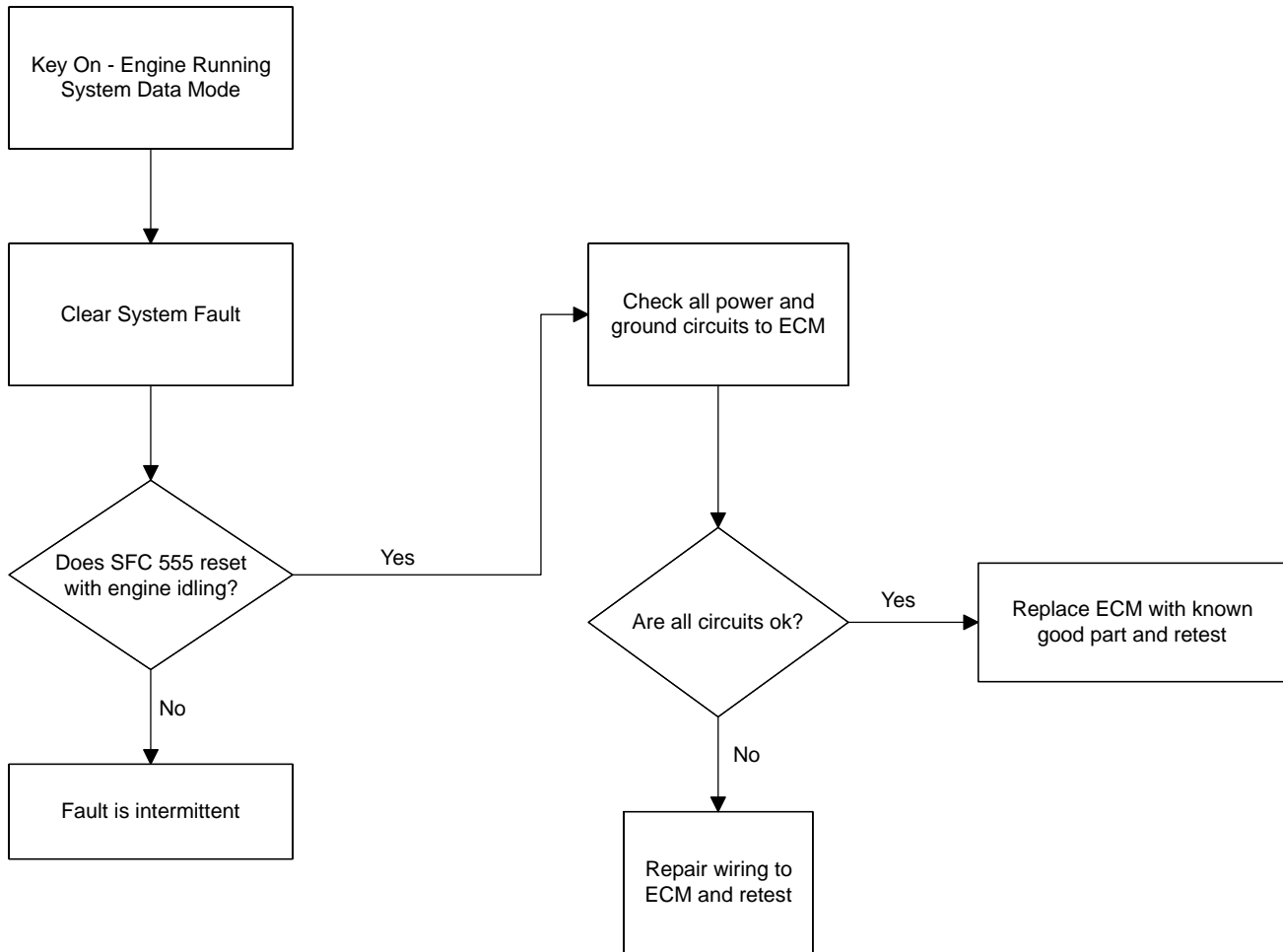
**DTC 1613- Microprocessor Failure - RTI 2**

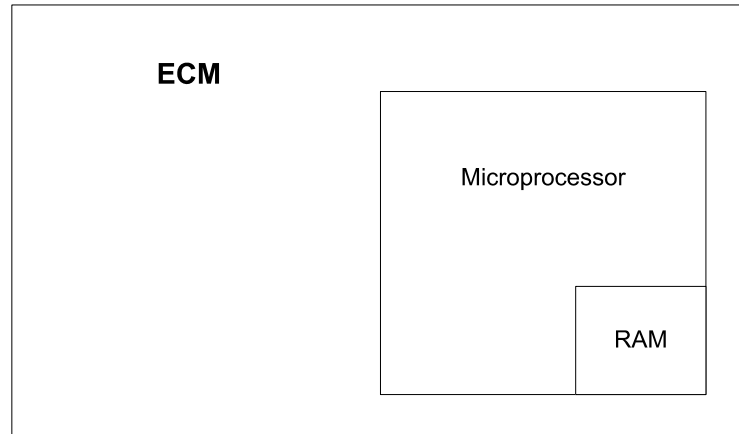
- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

## SFC 555- RTI 2 Loss



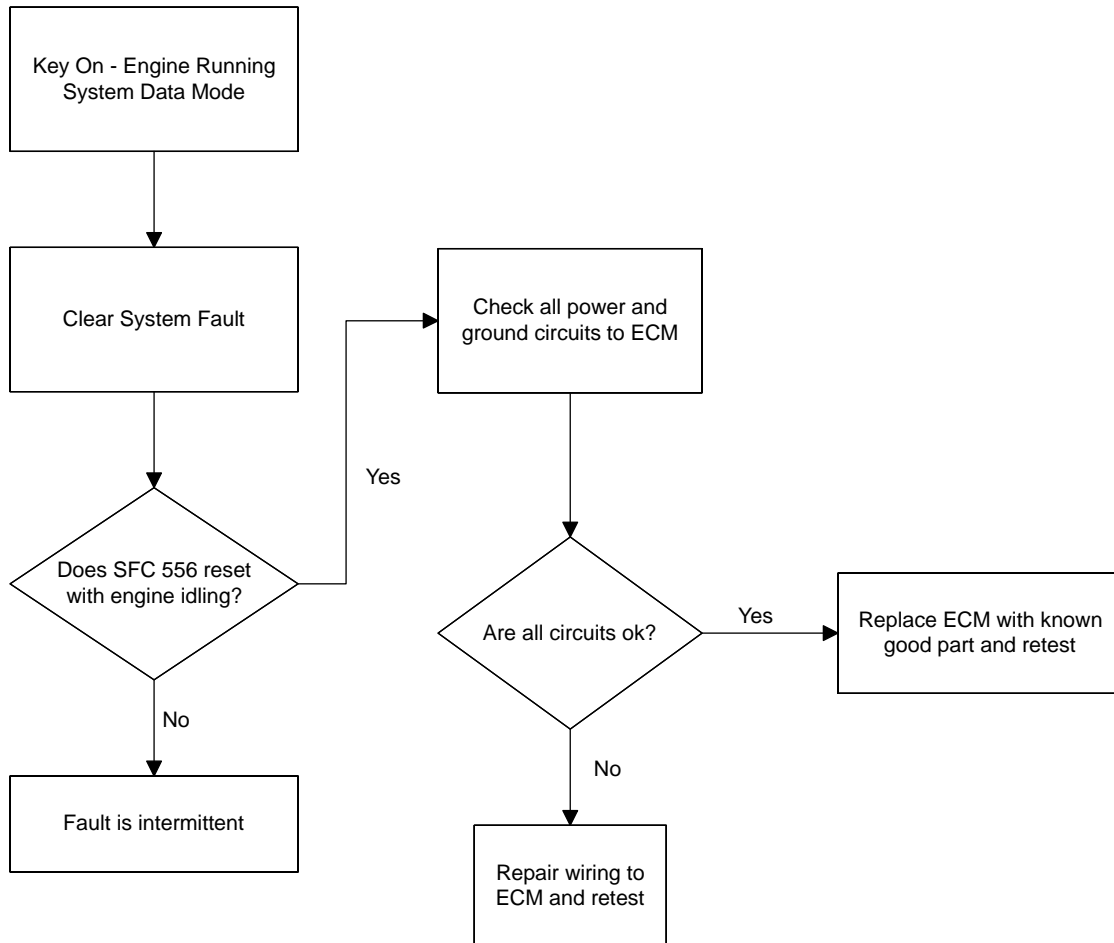
**DTC 1614- Microprocessor Failure - RTI 3**

- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

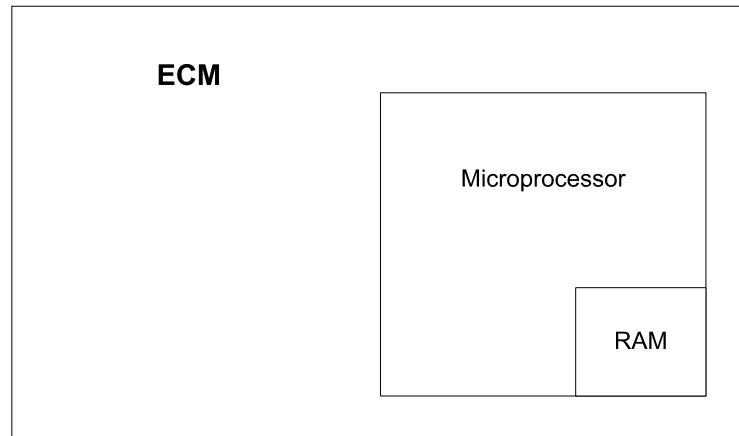
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

## SFC 556- RTI 3 Loss





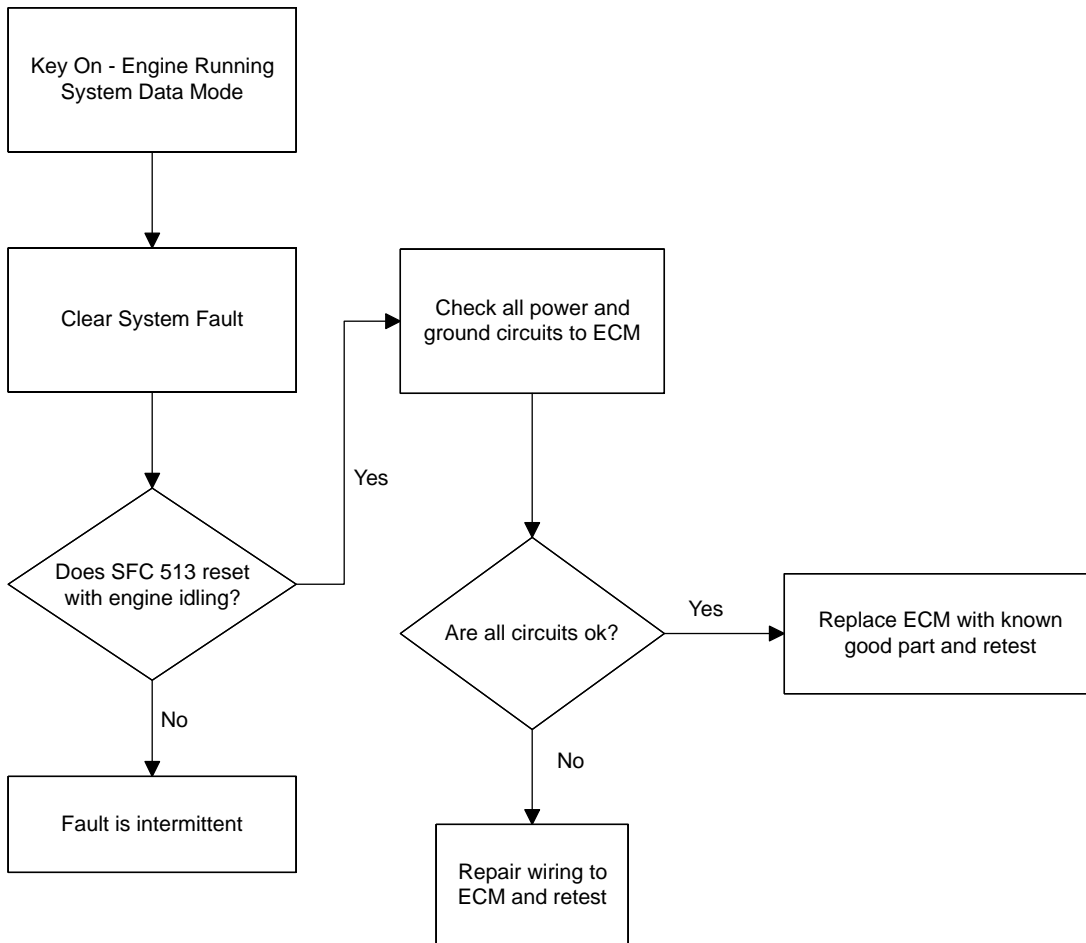
**DTC 1615- Microprocessor Failure - A/D**

- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

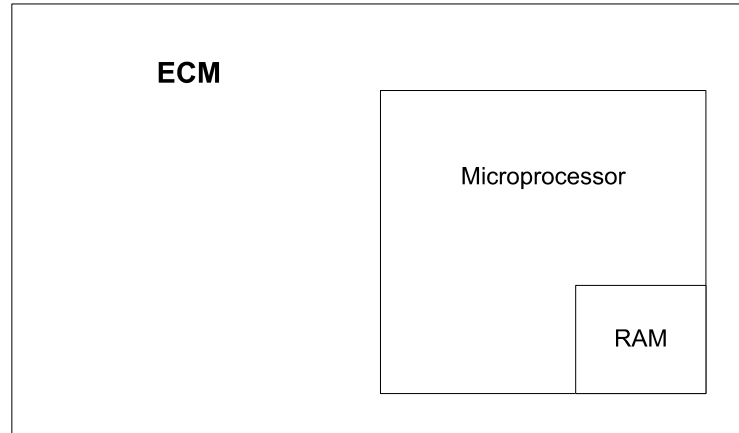
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

## SFC 513- A/D Loss



## DTC 1616- Microprocessor Failure - interrupt

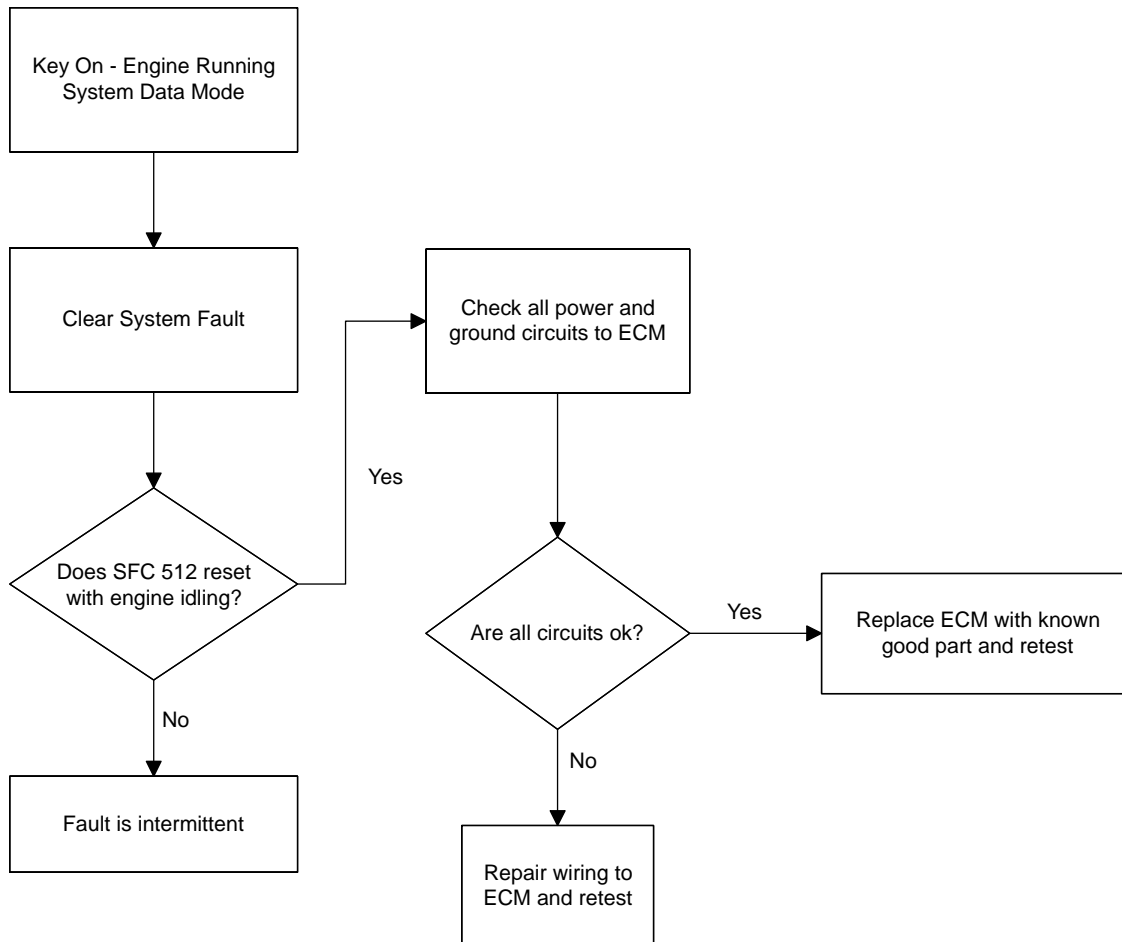


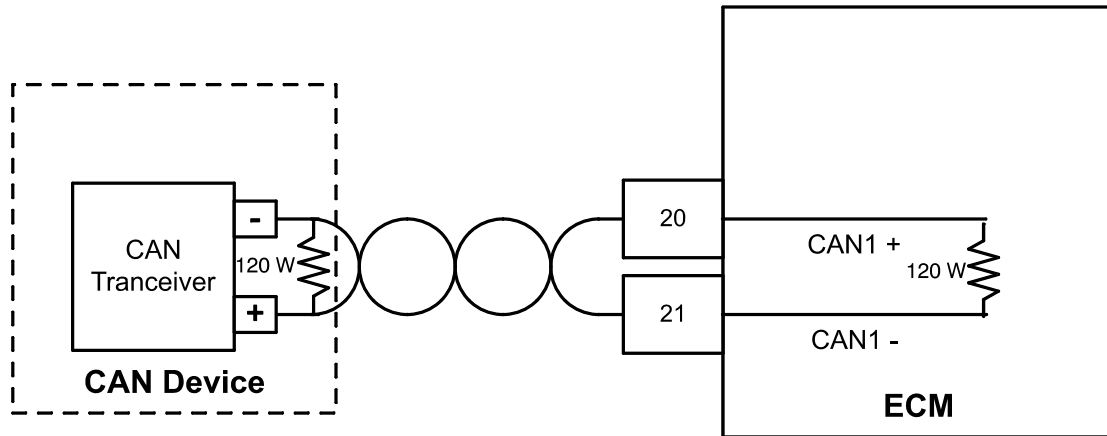
- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

## SFC 512- Invalid Interrupt



**DTC 1625- CAN J1939 Shutdown Request**

- Controller Area Network
- Check Condition- Key On, Engine Off and/or Running
- Fault Condition- ECM has received shutdown message from another CAN device and is shutdown on request.
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

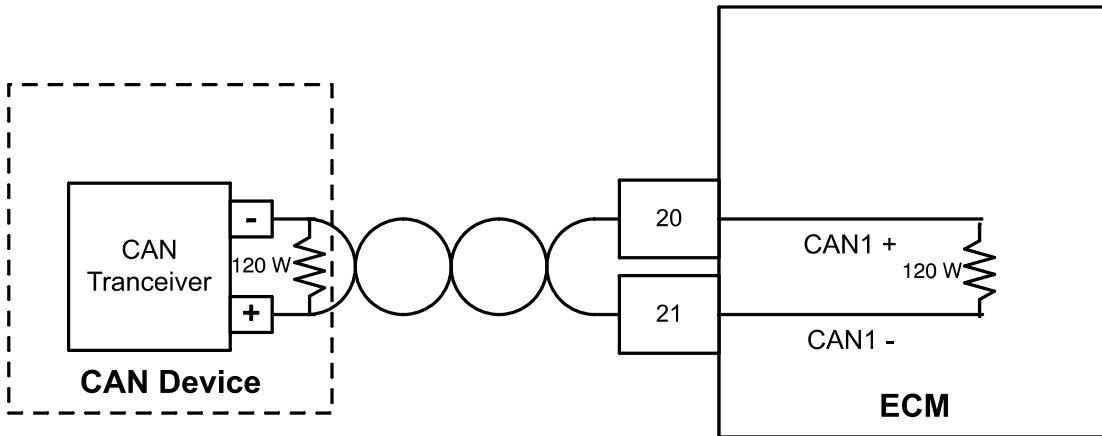
In some situations, external controllers may send a request to the ECM to shutdown engine operation and stop the engine. This request may be sent in response to a safety related condition in the vehicle.

This fault will set if the ECM receives the J1939 shutdown request via the CAN interface. This is the expected behavior.

**Diagnostic Aids**

- The ECM has shutdown the engine upon command by a external controller. This is the requested and expected behavior.

**DTC 1626- CAN J1939 Transmit (Tx) Fault**



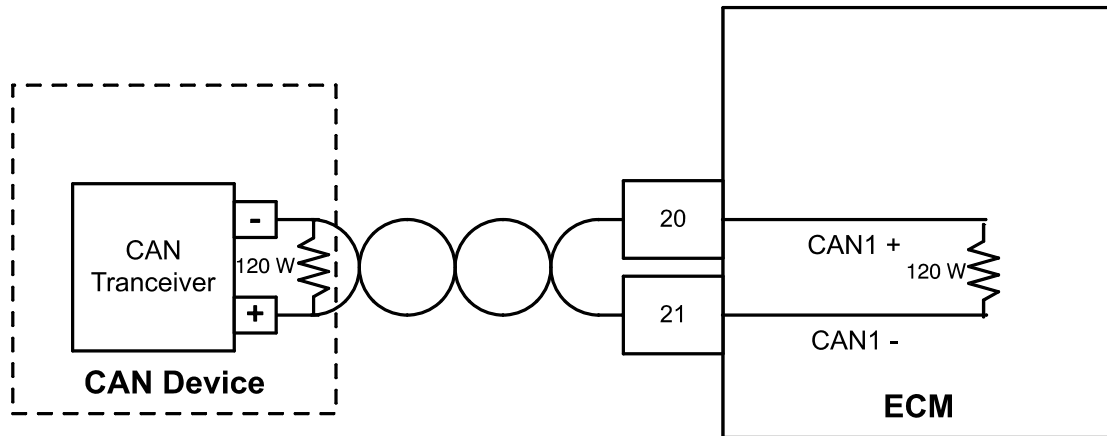
- Controller Area Network
- Check Condition- Key On, Engine Off and/or Running
- Fault Condition- ECM CAN transceiver transmit error counts greater than the limit defined in the diagnostic calibration (must be < 125 failures)
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators, smart sensors, dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.

This fault will set if CAN communication is enabled and the ECM transceiver broadcasts a number of packets (as defined in the diagnostic calibration, must be set to less than 125 failures) to the network that are not received.

**Diagnostic Aids**

- Verify that all CAN devices are powered and are properly grounded
- Verify that the CAN network is properly terminated
- Check CAN wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- Check CAN (+) and (-) wires for short circuits

**DTC 1627- CAN J1939 Receive (Rx) Fault**

- Controller Area Network
- Check Condition- Key On, Engine Off and/or Running
- Fault Condition- ECM CAN transceiver receive error counts greater than the limit defined in the diagnostic calibration (must be < 125 failures)
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

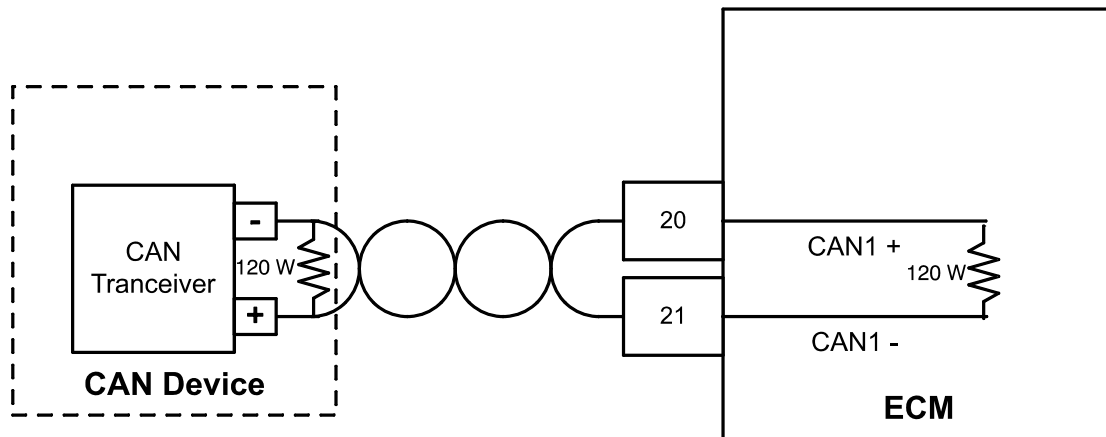
The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators, smart sensors, dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.

This fault will set if CAN communication is enabled and the ECM transceiver is expecting to see network traffic and either does not see traffic (as defined in the diagnostic calibration, must be set to less than 125 failures).

**Diagnostic Aids**

- Verify that all CAN devices are powered and are properly grounded
- Verify that the CAN network is properly terminated
- Check CAN wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- Check CAN (+) and (-) wires for short circuits

## DTC 1628- CAN Address Conflict Failure

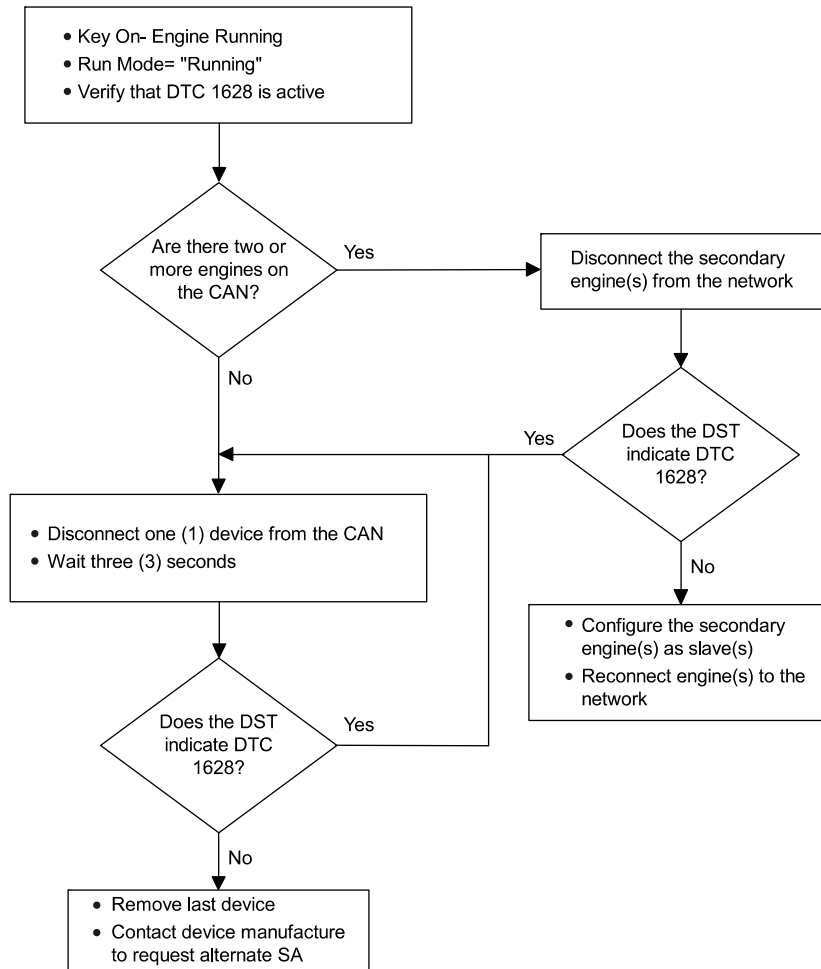


- CAN device(s)
- Check Condition- Key On, Engine on
- Fault Condition- two or more devices on the network that contain the same SA
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

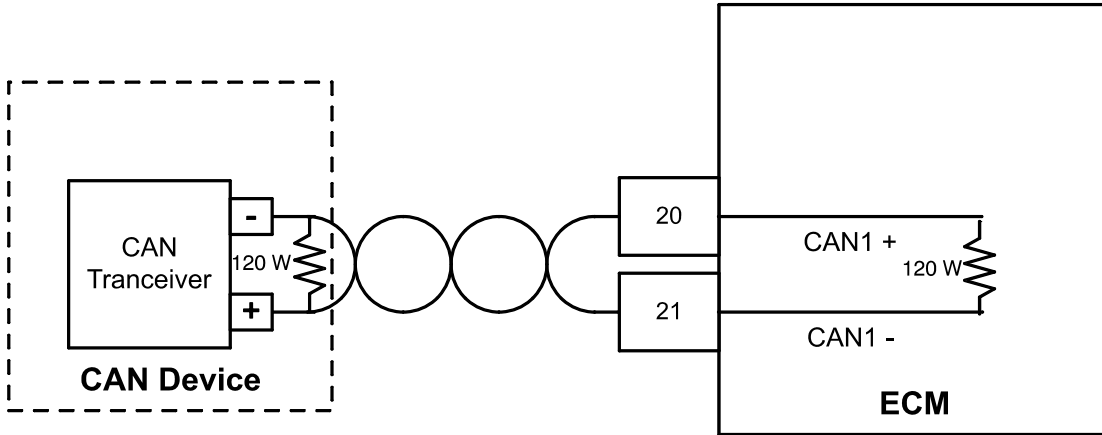
The Controller Area Network serves as a communication portal between intelligent devices. These devices may be but are not limited to other engine ECMs (slave), diagnostic tools, "smart" gauges, "smart" sensors, powertrain control units, vehicle controllers, actuators, etc. The network permits several devices to communicate with each other receiving and broadcasting commands as programmed. This type of network allows devices to be added to an entire system through only two conductors and permits all other devices to broadcast and receive commands to and from the device when properly commanded.

This fault indicates that there are two (2) or more devices on the network that use the same source address.





**DTC 1629- J1939 TSC1 Message Receipt Loss**



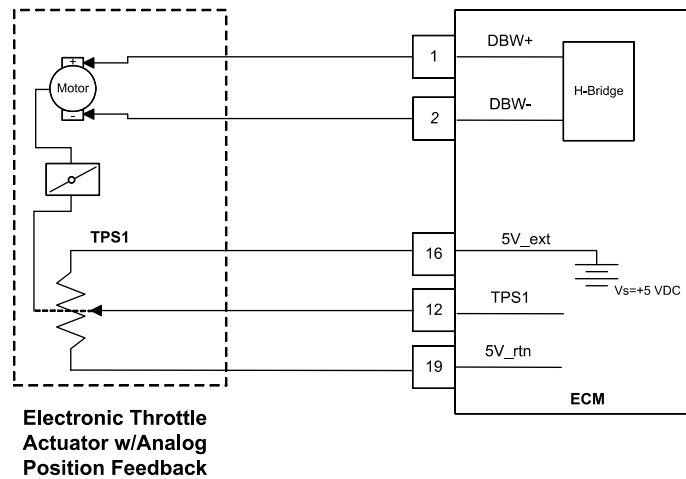
- Controller Area Network
- Check Condition- Key On, Engine Running
- Fault Condition- ECM is expecting to receive J1939 TSC1 messages and has not received a message for more than  $\underline{n}$  seconds (as defined in the diagnostic calibration).
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp. Govern engine speed at a forced idle.
- Non-emissions related fault

J1939 TSC1 may be used to send a commanded (or desired) engine speed to the ECM. If configured, the ECM will govern the engine speed to this commanded speed if possible. When operating in this mode, the ECM expects to receive TSC1 messages on a regular interval. When this message is not received, the ECM must operate the engine at a default idle speed until commanded to do otherwise.

This fault will set if CAN communication is enabled, the engine is running, and no TSC1 messages are received over the CAN bus for more than  $\underline{n}$  seconds (as determined by the diagnostic calibration).

**Diagnostic Aids**

- Verify that that the CAN device generating the TSC1 message is powered and properly grounded
- Verify that the CAN network is properly terminated
- Check CAN wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- Check CAN (+) and (-) wires for short circuits

**DTC 1652- TPS1 Loss of Communications**

- Throttle Actuator (with serial/digital position feedback)
- Check Condition- Key On, Engine Running and/or Stopped
- Fault Condition- ECM is expecting to receive throttle position information from the throttle actuator and is not.
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp. Shut-down engine.
- Non-emissions related fault

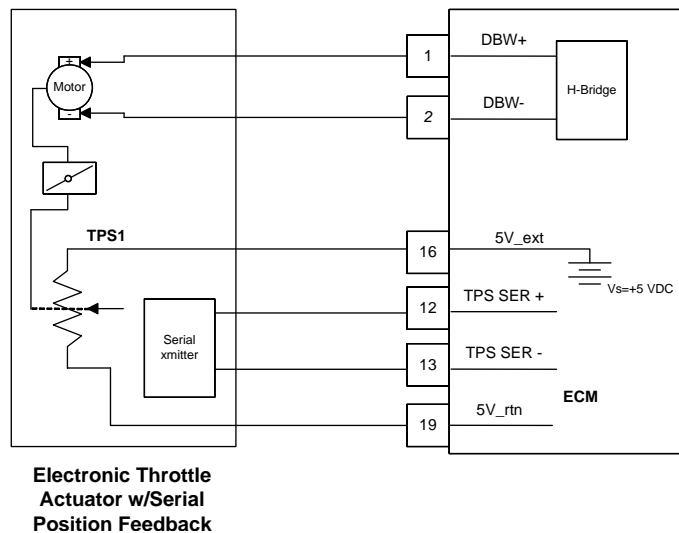
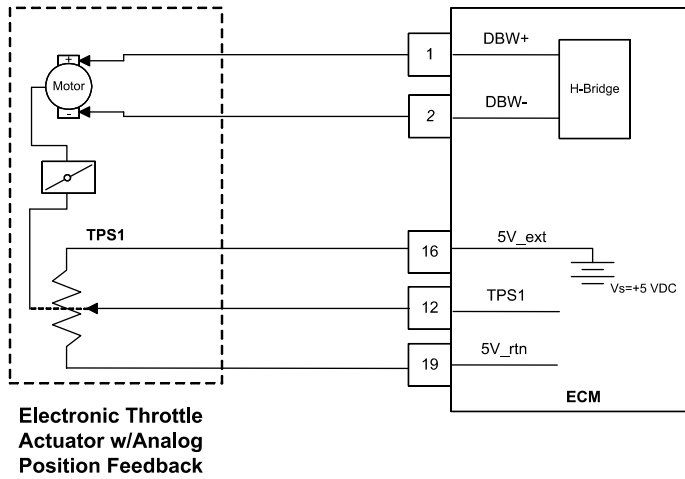
In the case of a throttle actuator with serial/digital position feedback, the ECM receives a constant data stream from the throttle actuator. If the communication is absent or interrupted, the ECM can no longer control the position of the throttle.

This fault will set if the key is on, the throttle actuator is receiving power, and the ECM is not receiving digital information from the actuator.

**Diagnostic Aids**

- Verify that the throttle actuator 5V supply voltage is present at the actuator.
- Check for a all four TPS feedback wires for short circuits.
- Check TPS SER+ and TPS SER- wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary.

### DTC 2111- Unable to Reach Lower TPS



- Throttle Position Sensor
- Check Condition-Cranking or Running
- Fault Condition-Throttle command is 20% less than throttle position for 200ms or longer
- MIL-On during active fault
- Engine Shut Down

In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, references to the throttle and throttle position sensor refer to these fuel injection pump control actuators and their position feedback sensors. When the fuel injection pump is electronically controlled it can be used to

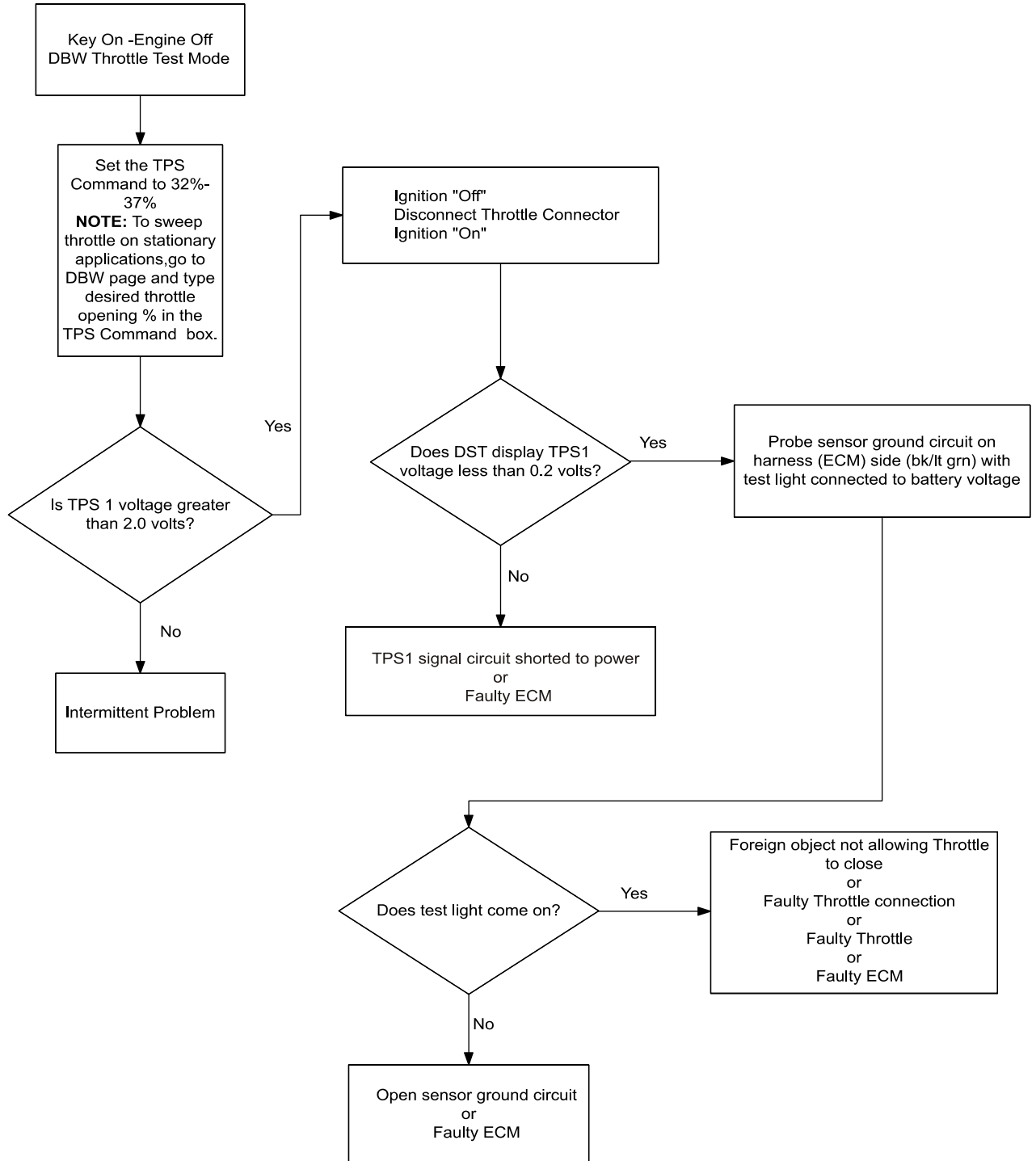
control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

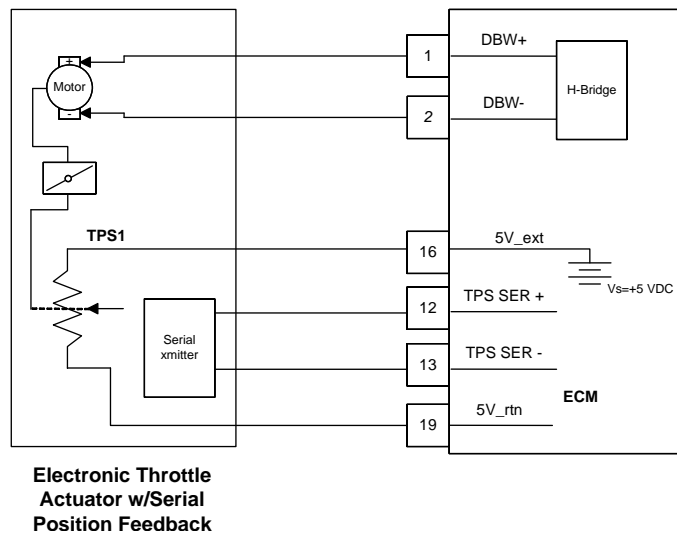
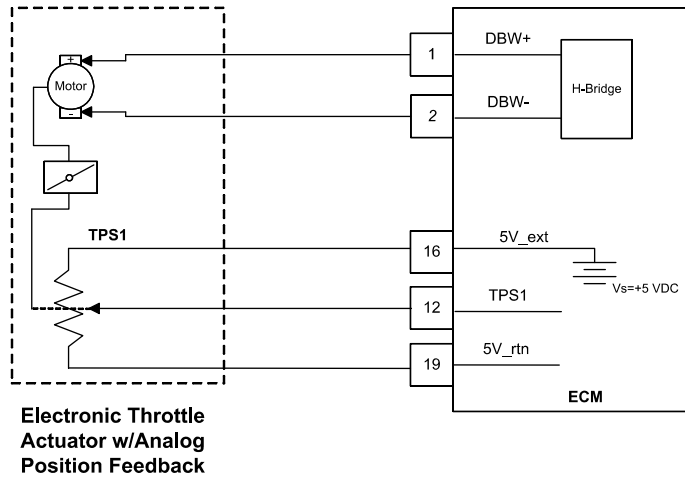
There are two types of throttle actuators, 1) actuator with analog position feedback and 2) actuator with digital position feedback. The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position. The second type, with digital position feedback, provides a serial data signal to the ECM with the throttle actuator position voltage level encoded in the data stream.

This fault will set if the throttle command is 20% less than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.

## SFC 638-Throttle Unable To Close



## DTC 2112- Unable to Reach Higher TPS



- Throttle Position Sensor
- Check Condition-Cranking or Running
- Fault Condition-Throttle command is 20% more than actual throttle position
- MIL-On during active fault
- Engine Shut Down

In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, references to the throttle and throttle position sensor refer to these fuel injection pump control actuators and their position feedback sensors. When the fuel injection pump is electronically controlled it can be used to

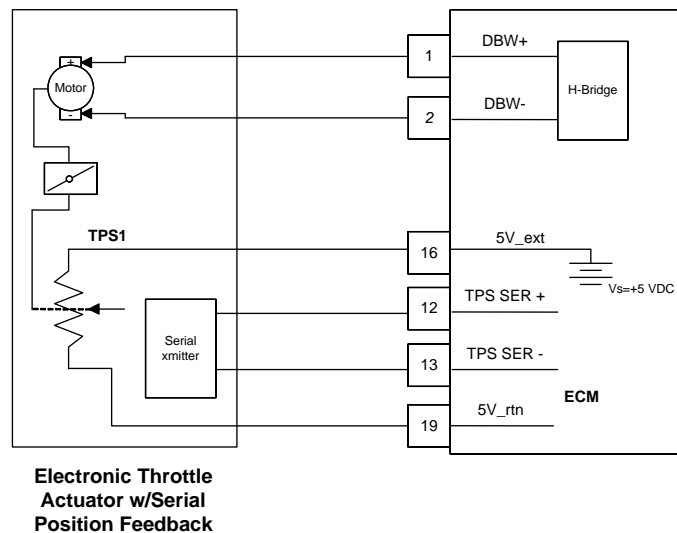
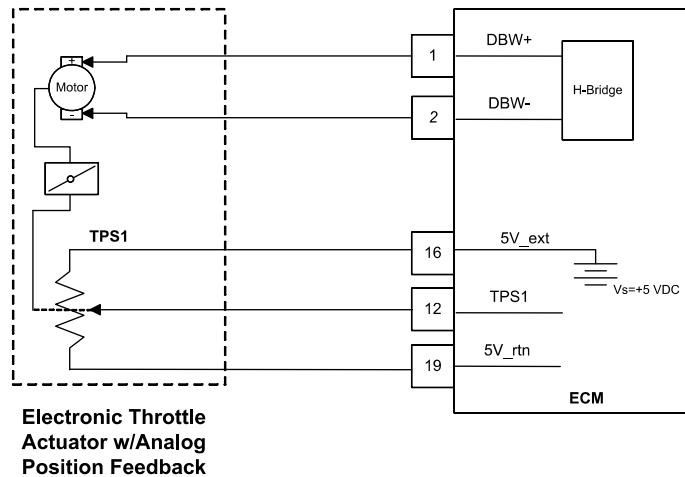
control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

There are two types of throttle actuators, 1) actuator with analog position feedback and 2) actuator with digital position feedback. The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position. The second type, with digital position feedback, provides a serial data signal to the ECM with the throttle actuator position voltage level encoded in the data stream.

This fault will set if the throttle command is 20% or more than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.

## DTC 9999- Throttle Actuator Failsafe Spring Failure



- Throttle Actuator
- Check Condition- Key Off, Engine Stopped
- Fault Condition- When the key is off (or the actuator is unpowered), the ECM is expecting the failsafe spring in the actuator to return the throttle position to near 0%. If the throttle does not reach this position when the actuator is powered, a fault is generated.
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp. Govern the engine speed to a forced idle speed.
- Non-emissions related fault

The throttle actuator has a return spring that causes the throttle to move to a near 0% position when powered off. This causes the engine to shutdown following a key off. If

the ECM detects the throttle position to be above  $\underline{x}$  volts when the key is off (as determined by the diagnostic calibration), it will power up the actuator and attempt to drive it to a zero position. This should ensure that the engine is stopped.

This fault will set if the throttle does not return to a near 0% position with the key is off.

### Diagnostic Aids

- Disconnect the throttle actuator from the wire harness. Remove the throttle actuator from the engine and manually move it. Verify that the internal spring forces the throttle back to near 0% position.
- Inspect the throttle arm or fuel rack on the fuel pump. Verify that it is not stuck.

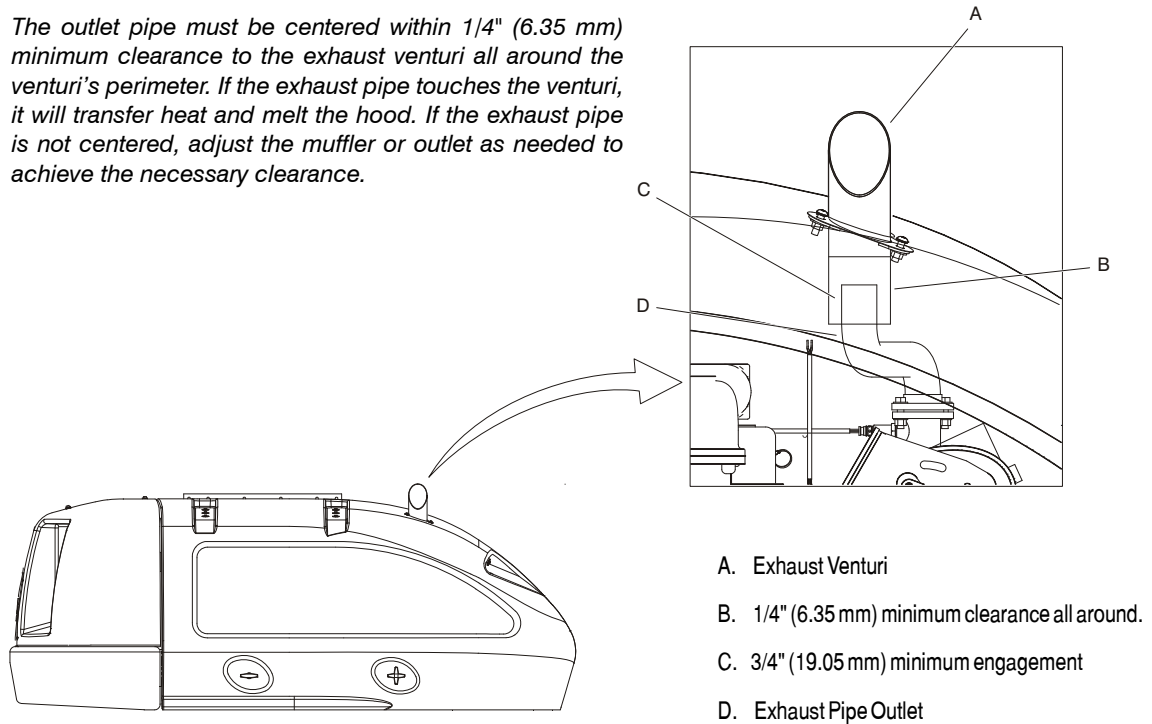
## SECTION 3 - CHASSIS & TURNTABLE

### DTC to SPN/FMI Table

FAULT INDEX	DESCRIPTION	DTC SET	
		SPN	FMI
2	DTC 118: ECT voltage high	110	3
3	DTC 117: ECT voltage low	110	4
4	DTC 116: ECT higher than expected stage 1	110	15
9	DTC 563: Vbat voltage high	168	15
10	DTC 562: Vbat voltage low	168	17
11	DTC 643: Sensor supply voltage 1 high	1079	3
12	DTC 642: Sensor supply voltage 1 low	1079	4
13	DTC 123: TPS1 voltage high	51	3
14	DTC 122: TPS1 voltage low	51	4
29	DTC 524: Oil pressure low	100	1
86	DTC 217: ECT higher than expected stage 2	110	0
89	DTC 2112: Unable to reach higher TPS	51	7
90	DTC 2111: Unable to reach lower TPS	51	7
96	DTC 336: CRANK input signal noise	636	2
98	DTC 606: Microprocessor failure - COP	629	31
99	DTC 1612: Microprocessor failure - RTI 1	629	31
100	DTC 1613: Microprocessor failure - RTI 2	629	31
101	DTC 1614: Microprocessor failure - RTI 3	629	31
102	DTC 1615: Microprocessor failure - A/D	629	31
103	DTC 1616: Microprocessor failure - Interrupt	629	31
104	DTC 601: Microprocessor failure - FLASH	628	13
105	DTC 604: Microprocessor failure - RAM	630	12
106	DTC 219: RPM higher than max allowed govern speed	515	15
144	DTC 337: Crank signal loss	636	4
145	DTC 1625: J1939 shutdown request	1384	31
146	DTC 1626: CAN-J1939 Tx fault	639	12
147	DTC 1627: CAN-J1939 Rx fault	639	12
175	DTC 1628: J1939 CAN address / engine-number conflict	639	13
188	DTC 521: Oil pressure high	100	0
189	DTC 1652: TPS1 loss of communications	51	9
190	DTC 1629: CAN-J1939 TSC1 Parameter Rx Fault	695	9
191	DTC 1113: Unable to achieve lower RPM	515	31
192	DTC 9999: TPS1 failsafe spring failure	51	7



**NOTE:** The outlet pipe must be centered within 1/4" (6.35 mm) minimum clearance to the exhaust venturi all around the venturi's perimeter. If the exhaust pipe touches the venturi, it will transfer heat and melt the hood. If the exhaust pipe is not centered, adjust the muffler or outlet as needed to achieve the necessary clearance.



**Figure 3-93. Exhaust Venturi Adjustment**



## SECTION 4. BOOM &amp; PLATFORM

## 4.1 BOOM

## Removal

1. Remove the platform and platform support as follows:
  - a. Disconnect electrical cable from the platform control console.
  - b. Using an overhead crane or suitable lifting device, use nylon support straps to support the platform/support.

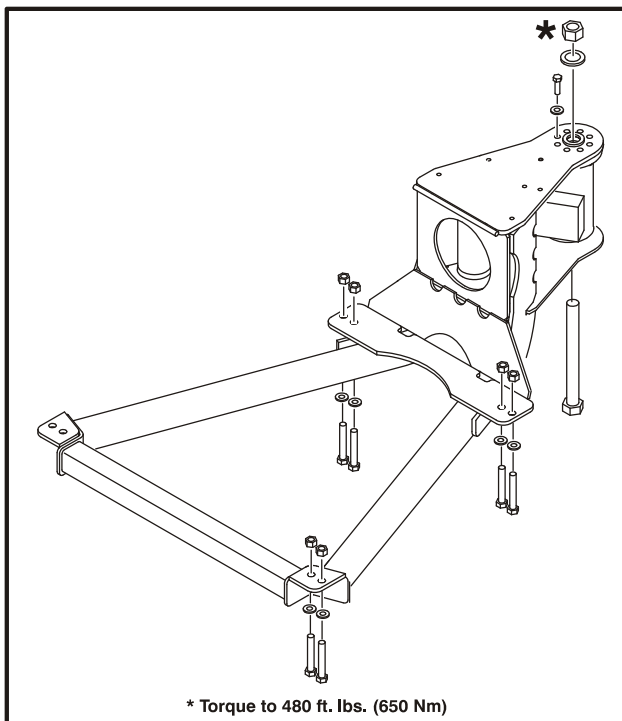


Figure 4-1. Support - Side Entry Platform

**NOTE:** The platform/support assembly will weigh approximately 220 to 370 lbs. (100 to 170 kg) depending upon platform configuration. These values DO NOT reflect any optional equipment attached to the platform.

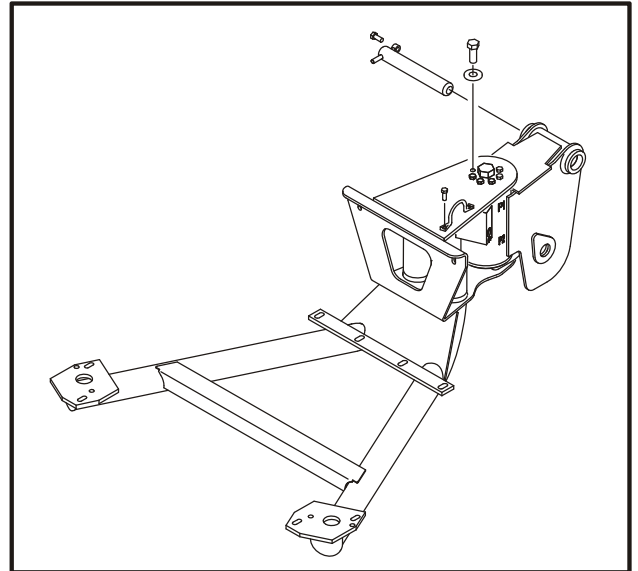
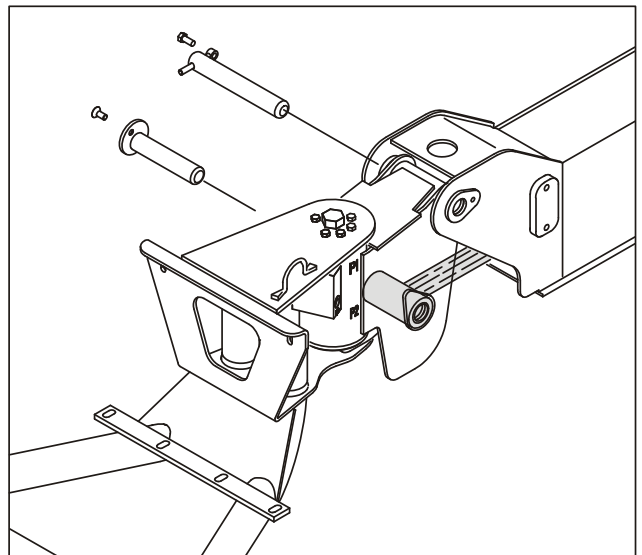


Figure 4-2. Support - Rear Entry Platform

**NOTE:** When removing the retaining pin from the rod end of the level cylinder, make sure the cylinder is properly supported.

- c. Remove bolts and keeper pins that secure the retaining pins attaching the platform support to the boom. Using a suitable brass drift and hammer, remove the retaining pins from the platform support and boom nose.



2. Remove the boom from the turntable as follows:

- a. Disconnect wiring harness from ground control harness connector.

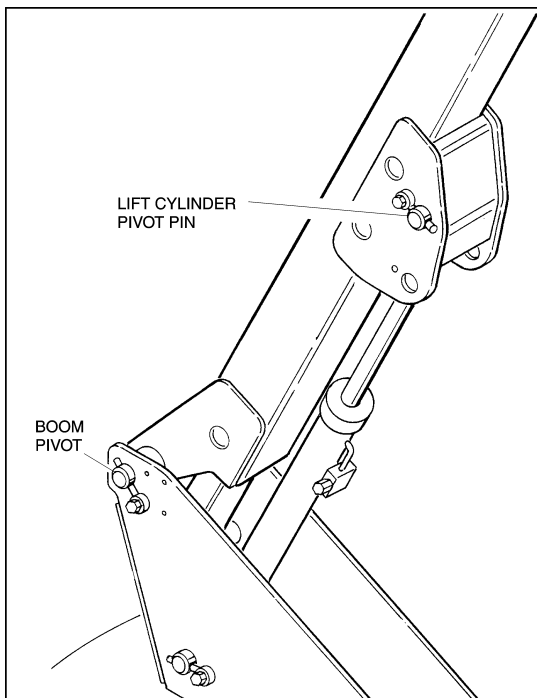
**⚠ CAUTION**

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

- b. Tag and disconnect hydraulic lines from boom to control valve. Use a suitable container to catch escaping hydraulic fluid. Cap all hydraulic lines and ports.
- c. Using a suitable lifting device, adequately support boom weight along entire length.

**NOTE:** The 400S boom weighs approximately 985 lbs. (447 kg). The 460SJ boom weighs approximately 1250 lbs. (567 kg).

- d. Remove the bolts and keeper pins securing the lift cylinder pivot pin. Using a suitable brass drift and hammer, remove the pivot pin from the lower boom.

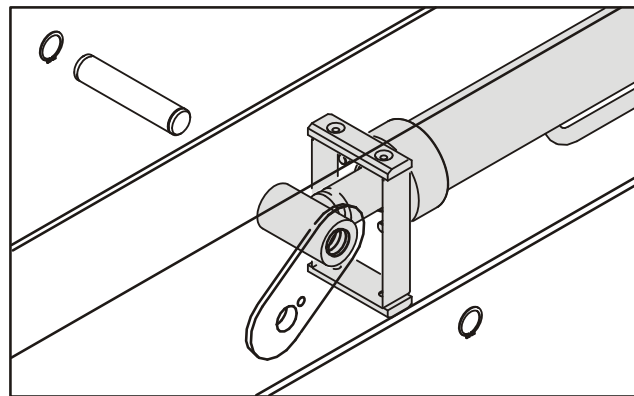


**Figure 4-3. Location of Components - Boom Removal**

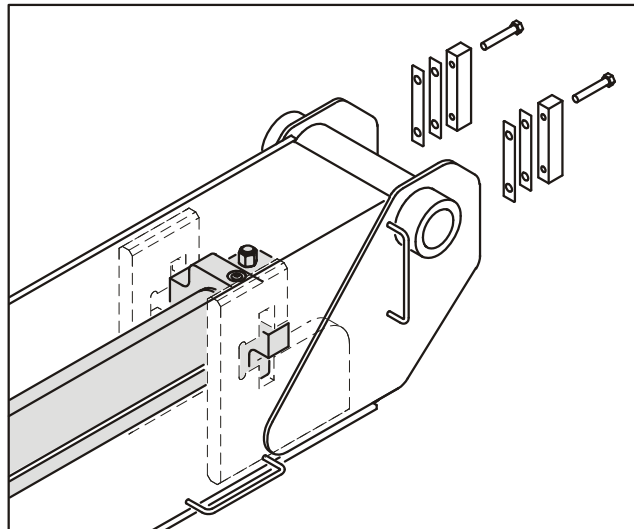
- e. Remove hardware securing the boom pivot pin. Using a suitable brass drift and hammer, remove pin from the turntable.
- f. Carefully lift boom assembly clear of turntable and lower to ground or suitable supported work surface.

**Disassembly**

1. Using a portable power source, attach hose to telescope cylinder port block. Using all applicable safety precautions, activate hydraulic system and extend cylinder to gain access to cylinder rod retaining pin. Shut down hydraulic system.
2. Carefully disconnect hydraulic hose from retract port of cylinder. There will be initial weeping of hydraulic fluid which can be caught in a suitable container. After initial discharge, there should be no further leakage from the retract port.
3. Remove hardware securing telescope cylinder to the fly boom section, then remove pin from fly.



4. Remove hardware securing telescope cylinder to the base boom section.

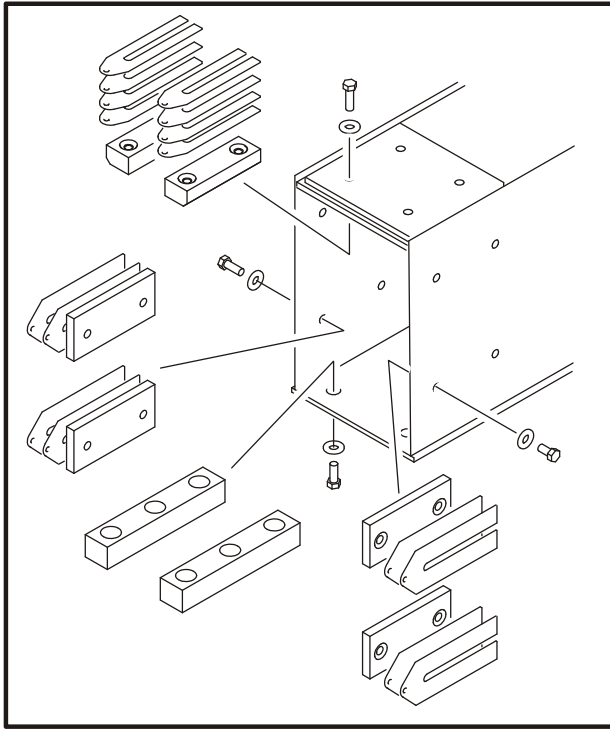


5. Using a suitable lifting device, remove telescope cylinder from boom sections.

**NOTE:** The telescope cylinder weighs approximately 324 lbs. (147 kg).

6. Tag all hoses and wires from front of fly boom and bottom of base boom for reassembly.

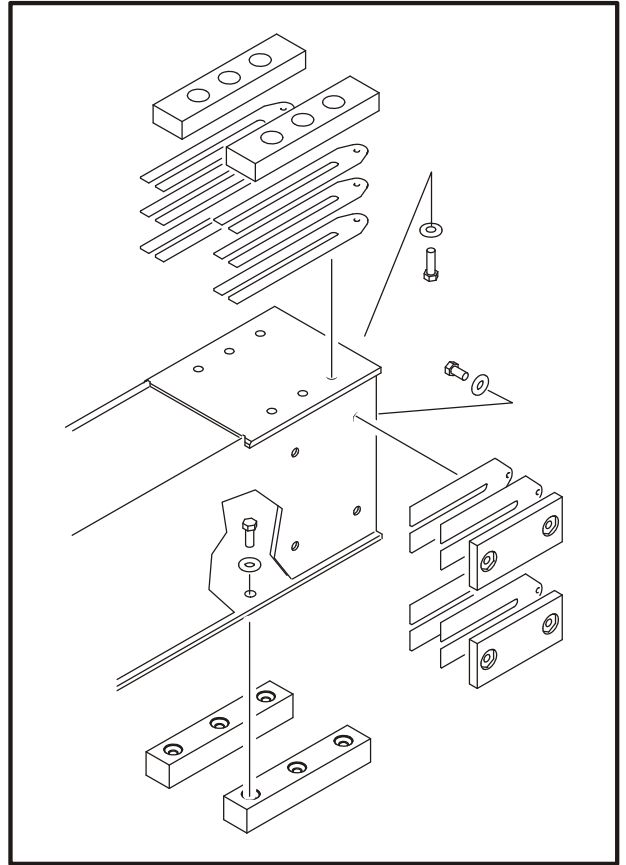
7. Remove hardware securing the front wear pads on base boom section, remove wear pads.



8. Remove hardware securing the powertrack to the front end of the fly boom section.
9. Using a suitable lifting device, remove fly boom from boom section.

**NOTE:** The fly boom section weighs approximately 430 lbs. (195 kg).

10. If necessary, remove the wear pads from the rear of the fly boom section.



11. Remove hydraulic lines and electrical cables from powertrack.
12. Remove hardware securing powertrack to the base boom section. Remove powertrack.

### Inspection

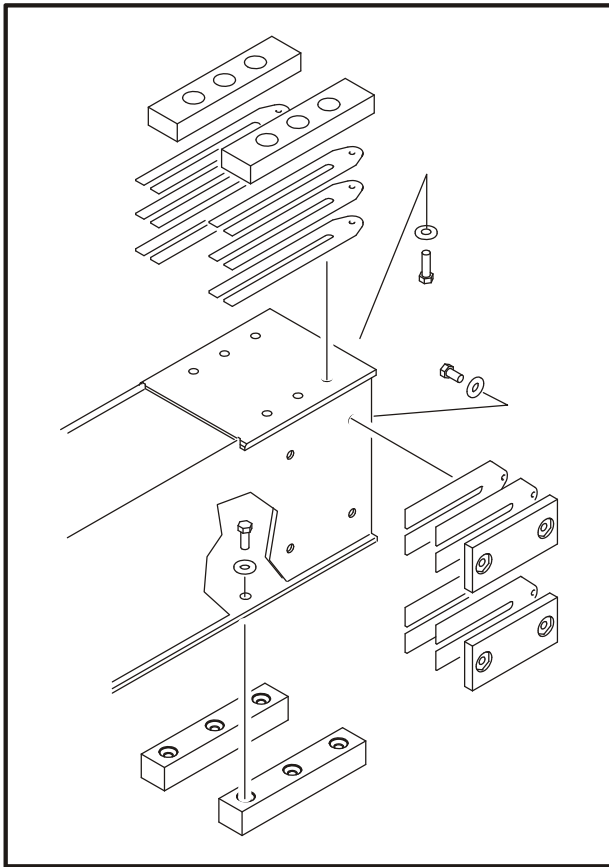
1. Inspect all boom pivot pins for wear, scoring or other damage, and for tapering or ovality. Replace pins as necessary.
2. Inspect lift cylinder pins for wear, scoring or other damage, and for tapering or ovality. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
3. Inspect telescope cylinder rod attach pin for wear, scoring or other damage. Replace pin as necessary.
4. Inspect inner diameter of boom pivot bushings for scoring, distortion, wear or other damage. Replace bushings as necessary.
5. Inspect wear pads for wear.

## SECTION 4 - BOOM & PLATFORM

6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

### Assembly

1. Install power track to the attach point on the base boom section. Secure power track with the attaching hardware.
2. Install hydraulic lines and electrical cables into the power track as tagged during disassembly.
3. Install wear pads to the rear of the fly section.



4. Using suitable lifting equipment, slide fly section into the base section until the telescope cylinder attach point aligns with holes in side of base section.

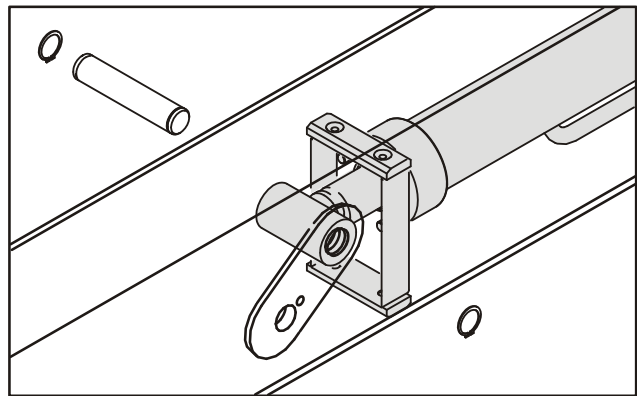
**NOTE:** The fly boom section weighs approximately 430 lbs. (195 kg).

5. Measure the distance between the telescope cylinder port block attach point on base boom section and the attach point on fly boom section.

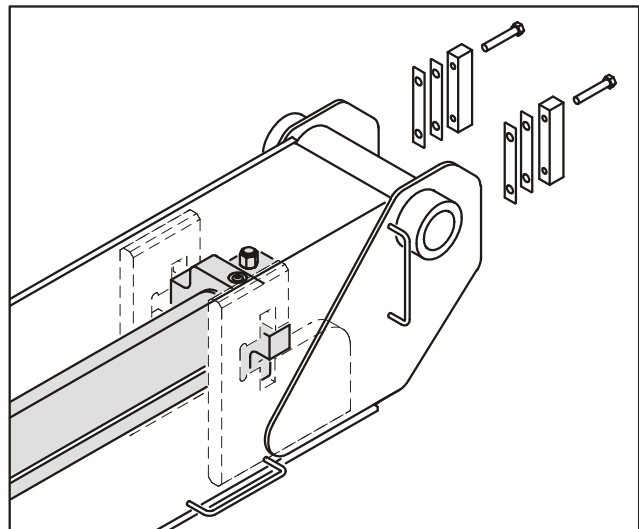
6. Connect a suitable auxiliary hydraulic power source to the telescope cylinder port block.
7. Extend the telescope cylinder the distance of the two attach points.
8. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.

**NOTE:** The telescope cylinder weighs approximately 324 lbs. (147 kg).

9. Slowly slide the telescope cylinder into boom assembly, align rod end with attach point in fly section. Insert pin and secure with retaining ring.

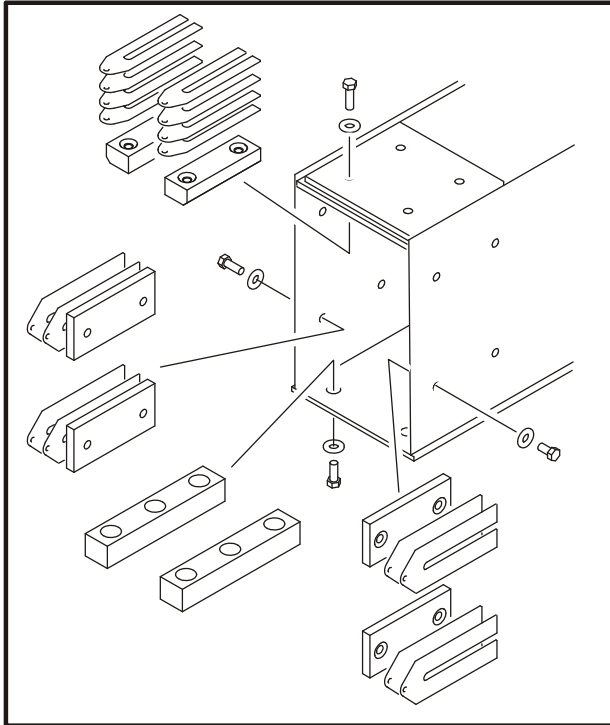


10. Align bolt holes at aft end of base boom section with telescope cylinder port block. Secure telescope cylinder with hardware.



11. Install wear pads at end of base boom section. Using shims, adjust the adjustable wear pads to zero clearance. Adjust pads alternately side to side,

so that fly boom section is centered in base boom section.

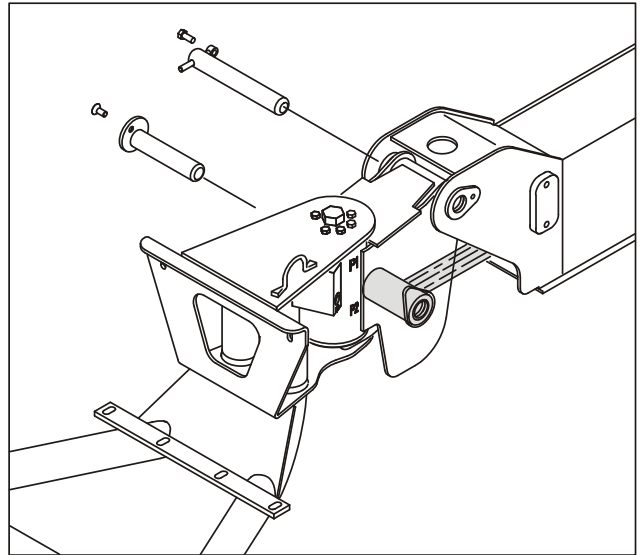


12. Retract boom section fully. Using shims, adjust wear pads at aft end of boom section to zero clearance. Adjust pads alternately side to side, so that fly boom section is centered in base boom section.
13. Disconnect auxiliary power source from telescope cylinder.

**Installation**

1. Using suitable lifting equipment, position boom assembly on turntable so that boom pivot holes in both boom and turntable are aligned.
2. Install boom pivot pin, ensuring that location of the hole in pivot pin aligns with attach point on upright.
3. Using all applicable safety precautions, operate lifting equipment in order to position boom lift cylinder so that holes in cylinder rod end are aligned with the one in the turntable. Insert cylinder pins.
4. If necessary, gently tap pins into position with a soft headed mallet, ensuring that attach holes in pins are aligned with attach holes in boom structure. Secure with hardware.
5. Connect all hosing and wiring.

6. Install the platform to the boom assembly.



7. Connect all hosing and wiring at platform control station.
8. Using all safety precautions, operate machine systems and extend and retract boom for four or five cycles.
9. Shut down machine systems and check for leakage. Cylinder Checking Procedure

## 4.2 ARTICULATING JIB

### Removal

1. Place the Articulating Jib in a horizontal position and support the complete assembly with adequate blocking.

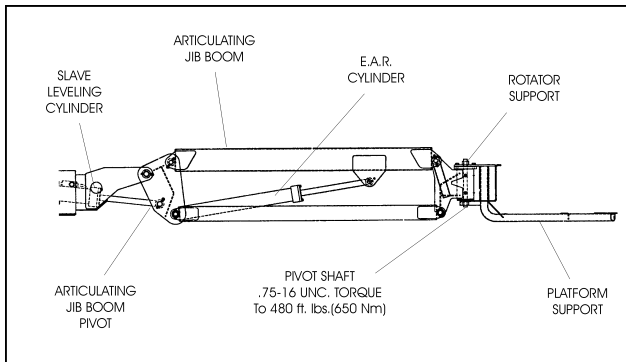
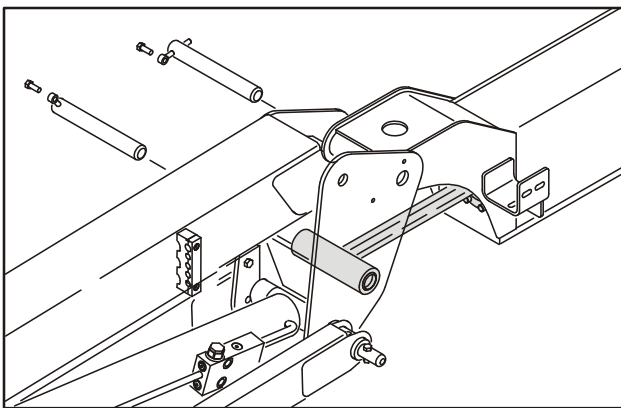


Figure 4-4. Articulating Jib

2. Remove the Platform as outlined under Section 4.1, Boom, Removal.
3. Tag and disconnect the hydraulic lines running to the Jib. Use a suitable container to collect any residual fluid. Cap the hydraulic lines and ports.
4. Remove the hardware securing the Jib pivot pin at the boom. Using a suitable brass drift and hammer, remove the pin from the fly boom. Use a suitable lifting device and remove the Jib.



## 4.3 LIMIT SWITCH ADJUSTMENTS

See Figure 4-5., Figure 4-6., Figure 4-7., and Figure 4-8.

### Boom Horizontal Limit Switch

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

**NOTE:** Angle indicator should be placed on the top flat surface of the boom, near the pivot point.

### Dual Capacity Angle Limit Switch

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

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

4. Raise, extend, retract, and lower boom. Check for smooth operation.

### Boom Length Limit Switch

1. Place machine on a level surface.
2. Raise boom to approximate horizontal.
3. Extend the retracted fly boom. See Figure 4-5., Figure 4-6., or Figure 4-7. as applicable for the proper dimension for switch activation.



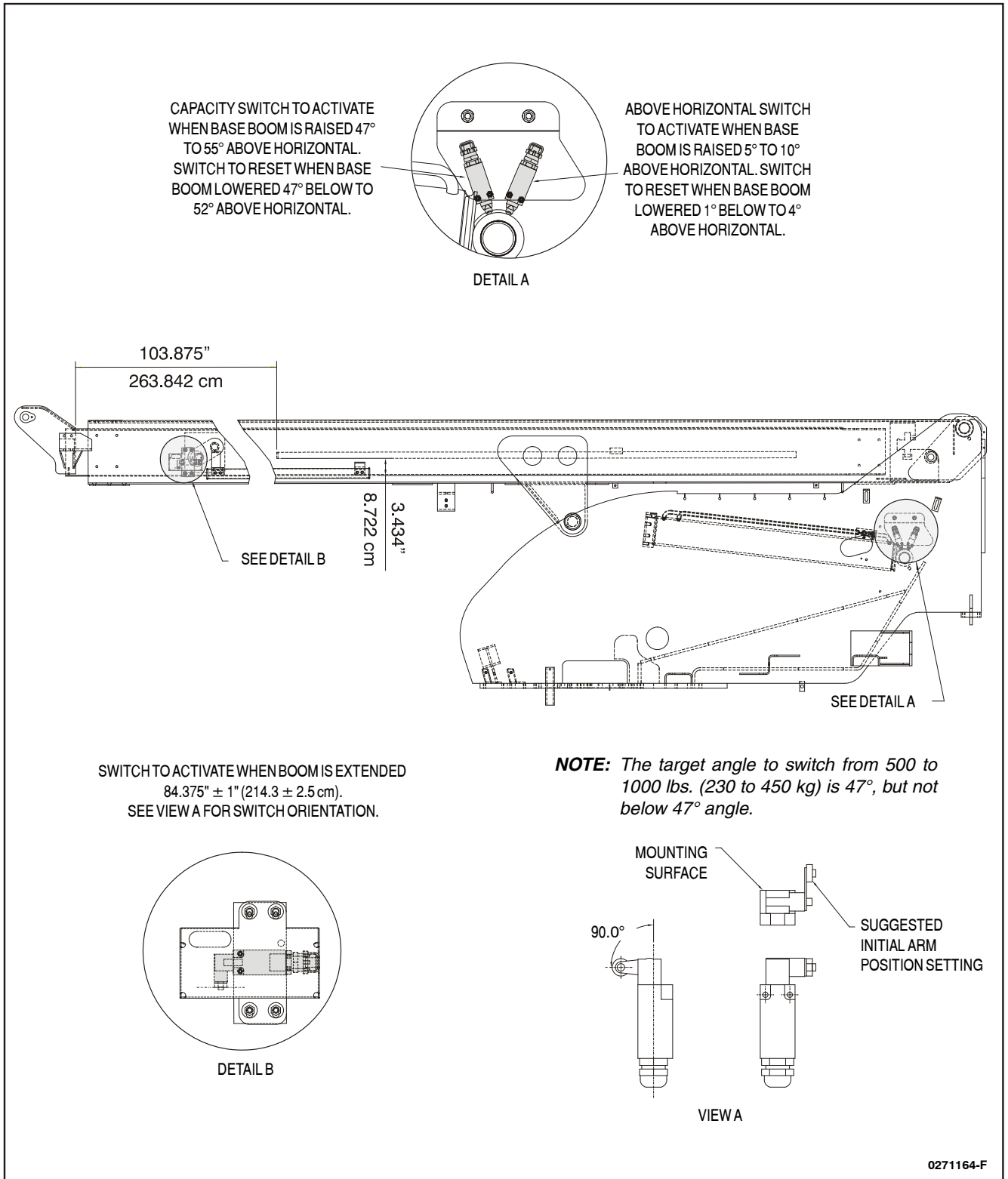
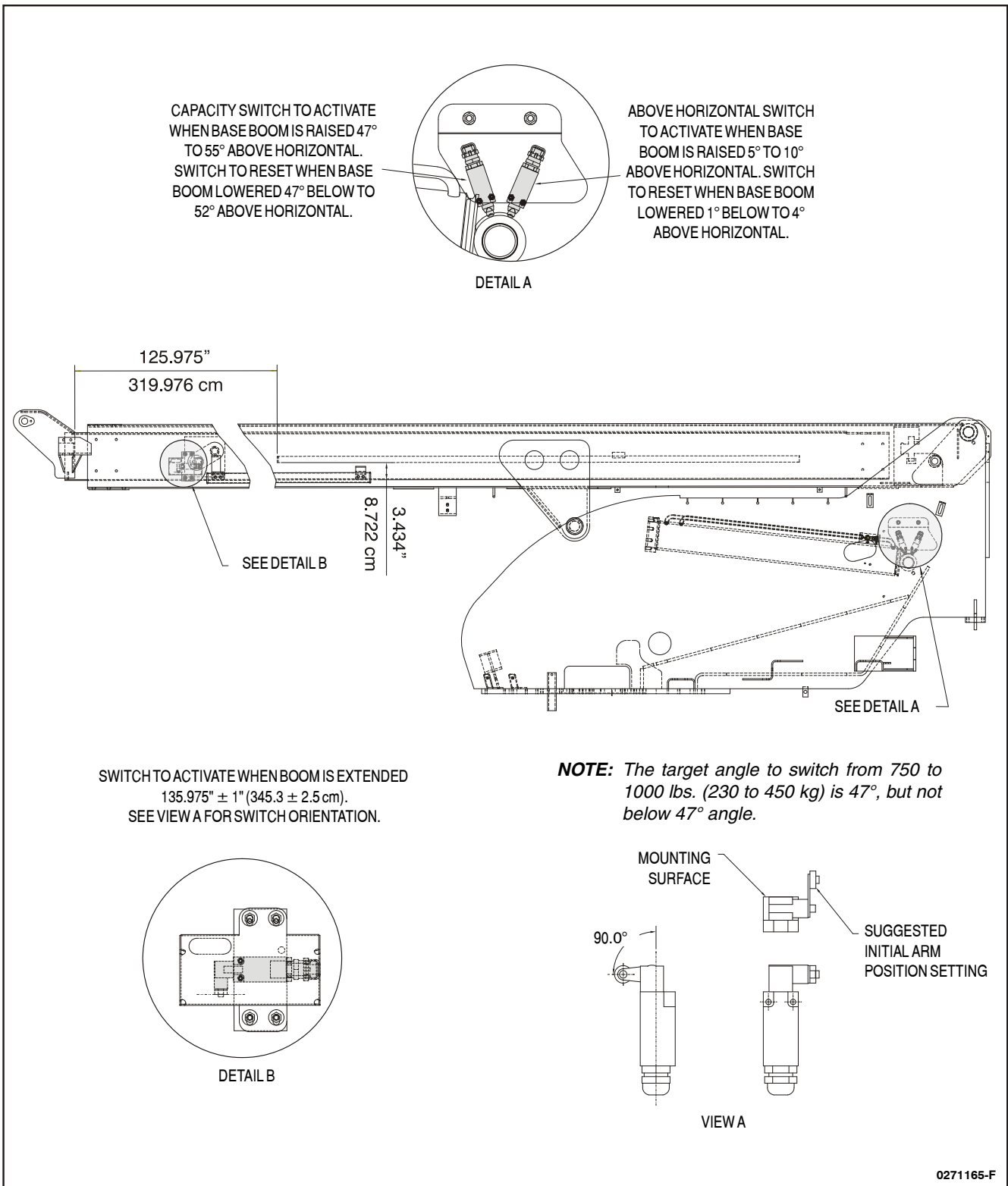


Figure 4-5. Limit Switches - 500 / 1000 LB (230 / 450 kg) Capacity

**SECTION 4 - BOOM & PLATFORM**



**Figure 4-6. Limit Switches - 750 LB (340 kg) Capacity**

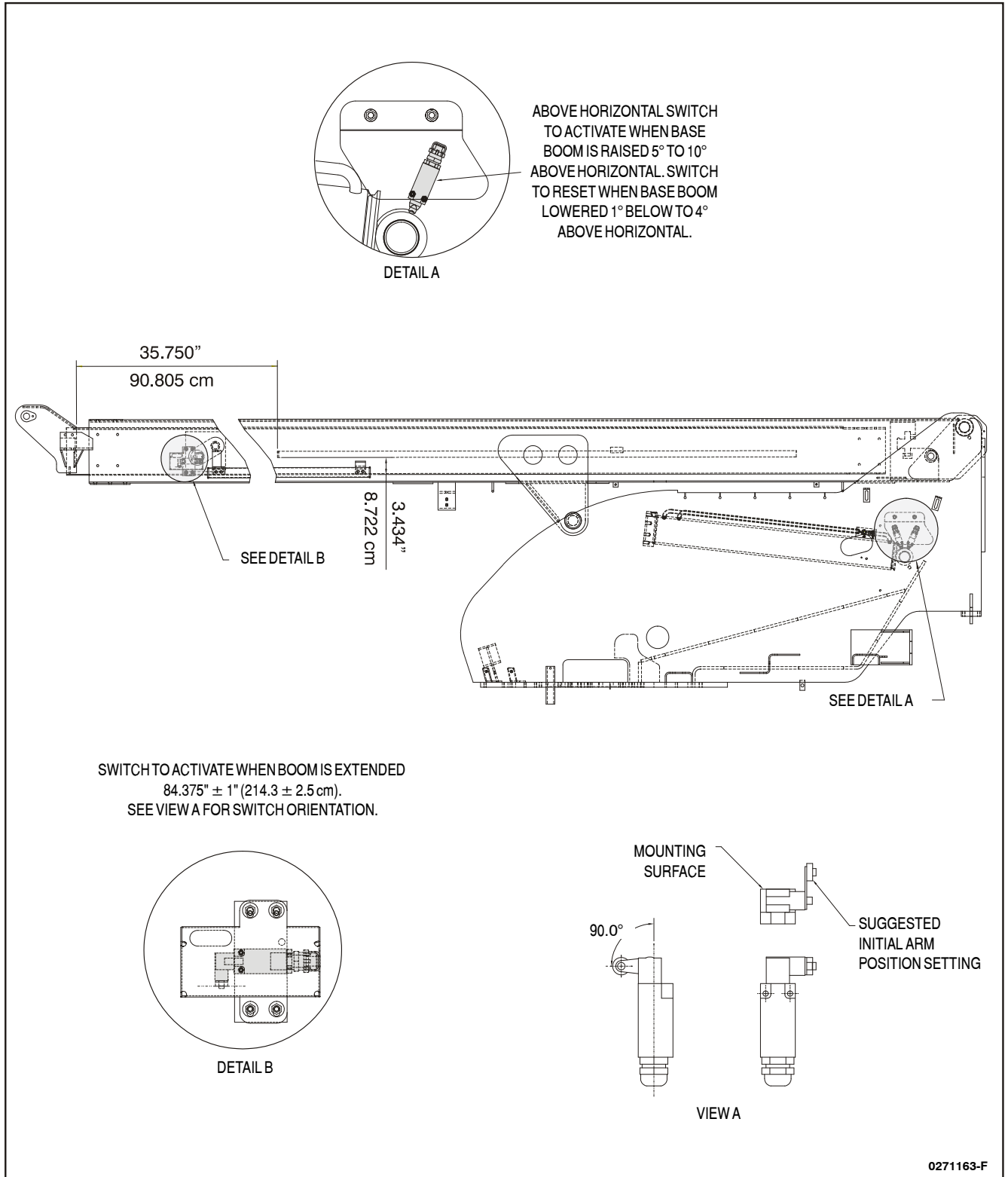


Figure 4-7. Limit Switches - CE Machines

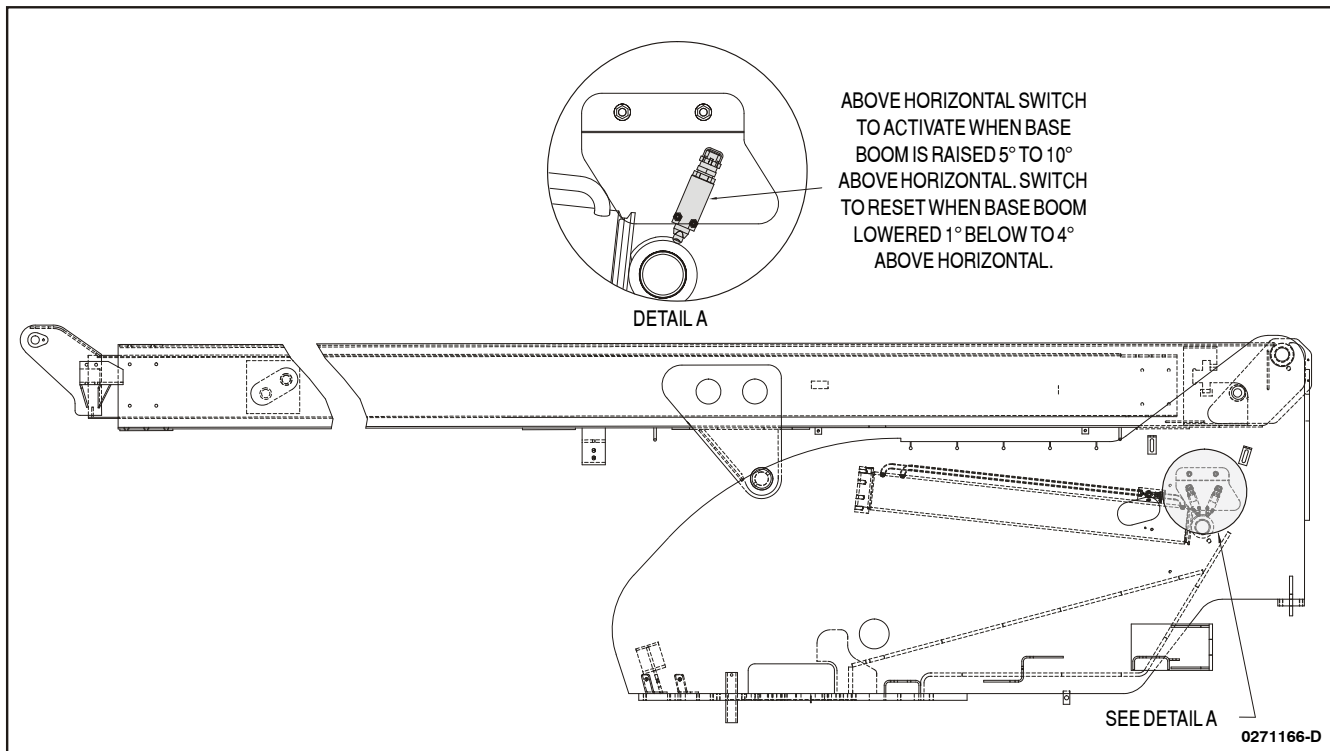


Figure 4-8. Limit Switches - 460SJ

## 4.4 DRIVE CARD SETUP PROCEDURES

### Machine Orientation When Doing Speed Tests

**Lift:** Boom Retracted. Telescope Retracted. Lift Up, Record Time, Lift Down, Record Time.

**Swing:** Boom at Full Elevation. Telescope Retracted. Swing the Turntable 360°, Record Time. Swing the Opposite Direction 360°, Record Time.

**Telescope:** Boom at Full Elevation; Telescope Retracted; Telescope Out, Record Time. Telescope In, Record Time.

**Drive:** Test to be done on a smooth level surface. Drive Select Switch should be set at High Speed, High Engine. Start approximately 25 ft. (7.62 m) from starting point so that the unit is at maximum speed when starting the test. Results should be recorded for a 200 ft. (60.96 m) course. Drive Forward, record time. Drive Reverse, Record Time.

**Drive (Above Horizontal):** Test should be done on a smooth level surface. Drive Select Switch should be set to Low Speed, Low Engine. The Platform Speed Knob should be selected out of the creep speed. This verifies that the switches are working when the boom is above

horizontal. Results should be recorded for a 50 ft. course. Drive Forward, Record Time. Drive Reverse, Record Time.

**Platform Rotate:** Platform level and completely rotated one direction. Rotate the opposite direction, Record Time. Rotate the other direction, Record Time.

**Articulating Jib:** Platform level and centered with the boom. Start with the Jib down. Jib Up, Record Time. Jib Down, Record Time.

**Lower Lift:** Upper Boom horizontal. Telescoped In. Lower Lift Up, Record Time. Lower Lift Down, Record Time.

### Test Notes

1. Stop watch should be started with the function, not with the controller or switch.
2. All speed tests are run from the platform. These speeds do not reflect the ground control operation.
3. The platform speed knob control must be at full speed (turned clockwise completely).
4. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).

**NOTE:** The following procedures are to be used as a beginning basis for controller adjustment. After completing the procedure, final adjustments are to be made based on the machines function speed.

**Table 4-1. Function Speeds**

Function	Function Speed
	In Seconds
<b>Lift</b>	
Up	26-32
Down	19-25
<b>Swing Speed</b>	
Full 360°	70-90
<b>Telescope</b>	
Extend	18-23
Retract	23-29
<b>Platform Rotation</b>	
Left	9-15
Right	9-15
<b>Jib Boom (460SJ)</b>	
Up	17-23
Down	13-20
<b>Drive Speed (2WD)</b>	
	27-32 @ 200ft.
<b>Drive Speed (4WD)</b>	
	46-115 @ 50ft.

**Lift, Swing, and Drive Cards**

- Center the input potentiometers. Power up the card, but do not start the engine. Place the common lead of a voltmeter on pin #6 and place the other lead on pin #8. Rotate the potentiometer, leaving the joystick in the center position, until the voltmeter reads 2.5 volts. Secure the set screw on the potentiometer. When the potentiometer is centered and the joystick is in the center position, LED #3 should not be illuminated.
- Install test harness JLG P/N 4922012.
- Set the minimum and maximum currents. The input potentiometer must be centered before continuing with this procedure. Power up the card, but do not start the engine. Place the current meter in series with the “A” output. Turn P3 counter clockwise until the adjustment potentiometer starts to click. This will set to maximum current to its lowest value. Move the joystick until LED #3 illuminates and hold the stick in this position. Adjust P4 until the meter equals the setting given in table #1. Rotating the adjustment potentiometer clockwise will increase the current. This will set the minimum current setting for the “A”

output. To set the maximum current for the “A” output, hold the joystick in its maximum position. Turn P3 clockwise until the meter reading equals the setting in table #1. Follow the same procedure for the “B” output. Use P8 for the minimum current adjustment and P7 for the maximum current adjustment.

- Set the ramp up and the ramp down times. Step 2 must be performed before continuing with procedure. Power up the card, but do not start the engine. Place the current meter in series with the “A” output. Move the joystick from the center position to the extreme position. Watch the meter for the time it takes the output to go to from 0 current to maximum current. This is the ramp up time. Adjust P1 until this time matches the time given in table 2. Rotating the adjustment potentiometer clockwise will increase the ramp time. To set the ramp down time, hold the joystick in the extreme position. Release the joystick and watch the meter for the time it takes the output to go from the maximum current setting to 0 current. Adjust P2 until this time matches the time in table 2. Rotating the adjustment potentiometer clockwise will increase the ramp time. Follow the same procedure for the “B” output. Use P5 for the ramp up adjustment and P6 for the ramp down adjustment.

**Flow Control Card**

- Set the input potentiometer. Power up the card, but do not start the engine. Place the common lead of a voltmeter on pin #15 and place the other lead on pin #8. Rotate the potentiometer and verify the input to the card is 3.8 volts when the input potentiometer is in its minimum position. Rotate the input potentiometer to its maximum position and verify the input to the card is 0 volts.
- Set the minimum and maximum current settings. The input potentiometer must function properly before continuing with this procedure. Turn P3 counter clockwise until the adjustment pot starts clicking. Place a current meter in series with the “A” output. Rotate the input potentiometer to its minimum setting and operate the telescope function. Adjust P4 until the meter reading matches the setting in table 1. This sets the minimum current setting for the card. Rotate the input potentiometer to its extreme position and operate the telescope function. Turn P3 clockwise until the meter reading matches the setting in Table 1. This sets the maximum current for the card.
- Set the ramp up and the ramp down times. Step 2 must be completed before continuing with this procedure. Power up the card, but do not start the engine. Place the current meter in series with the “A” output. Turn the input potentiometer to its extreme position and operate the telescope function. Watch

## SECTION 4 - BOOM & PLATFORM

the meter for the time it takes the output to go from 0 current to maximum current. This is ramp up time. Adjust P1 until this time matches the time in table 2. Rotating the adjustment potentiometer clockwise will increase ramp time. To set the ramp down time, hold the telescope function switch and watch the time it takes the output to go from the maximum current down to 0 current. This is the ramp down time. Adjust P2 until this time matches the setting in table 2. Rotating the adjustment potentiometer clockwise will increase the ramp time.

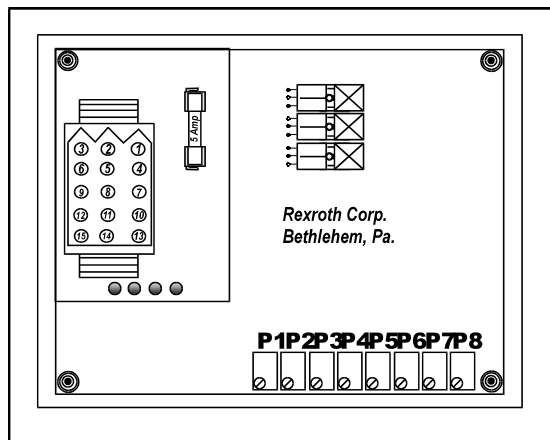


Figure 4-9. Control Card

Table 4-2. Flow Control Card Settings

S Models		
Function	Minimum Current	Maximum Current
Lift Up	400 mA	1320 mA
Lift Down	500 mA	1500 mA
Swing Right	400 mA	935 mA
Swing Left	400 mA	935 mA
Flow Control	700 mA	1600 mA
Drive Forward (Deutz)	820 mA	1120 mA
Drive Reverse (Deutz)	820 mA	1120 mA
Drive Forward (Ford)	820 mA	1200 mA
Drive Reverse (Ford)	820 mA	1200 mA

Table 4-3. Flow Control Card Ramp Time

Function	Ramp Time
Lift Up	Ramp Up Time = 2:00 sec. Ramp Down Time = 2:00 sec.
Lift Down	Ramp Up Time = 3:00 sec. Ramp Down Time = 2:00 sec.
Swing Right	Ramp Up Time = 3:50 sec. Ramp Down Time = 2:00 sec.
Swing Left	Ramp Up Time = 3:50 sec. Ramp Down Time = 2:00 sec.
Drive Forward	Ramp Up Time = none Ramp Down Time = none
Drive Reverse	Ramp Up Time = none Ramp Down Time = none
Flow Control (Tele, Rotate, Jib)	Ramp Up Time = 3:00 sec. Ramp Down Time = 0:00 sec.

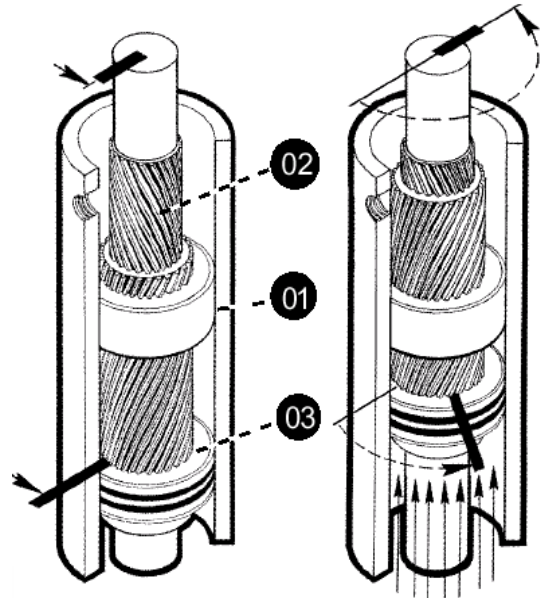
**NOTE:** No ramp needed for drive forward and reverse. The drive pump is a slow reacting pump with internally built in ramp up and down times.

## 4.5 HELAC ROTARY ACTUATOR

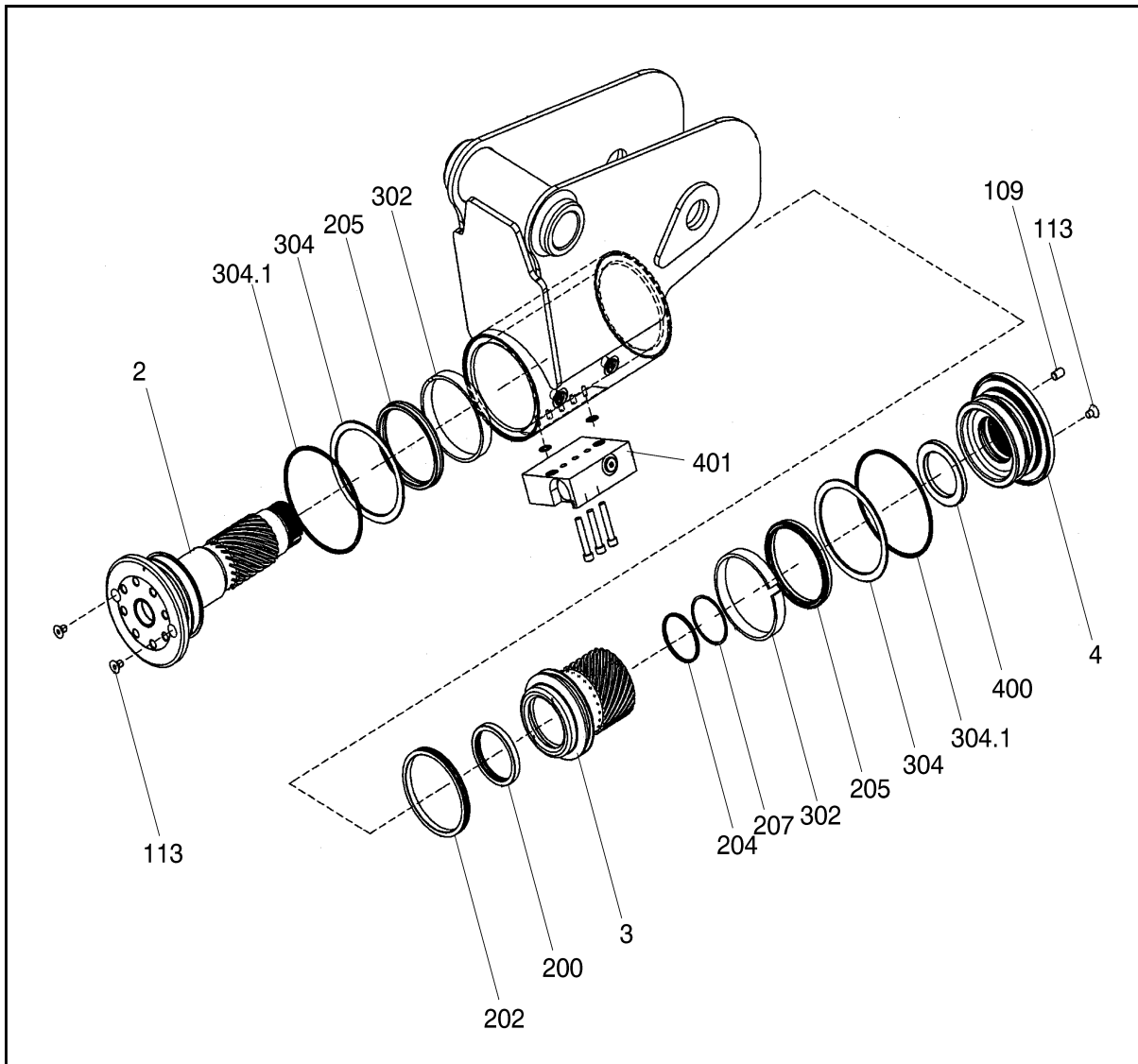
### Theory Of Operation

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

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



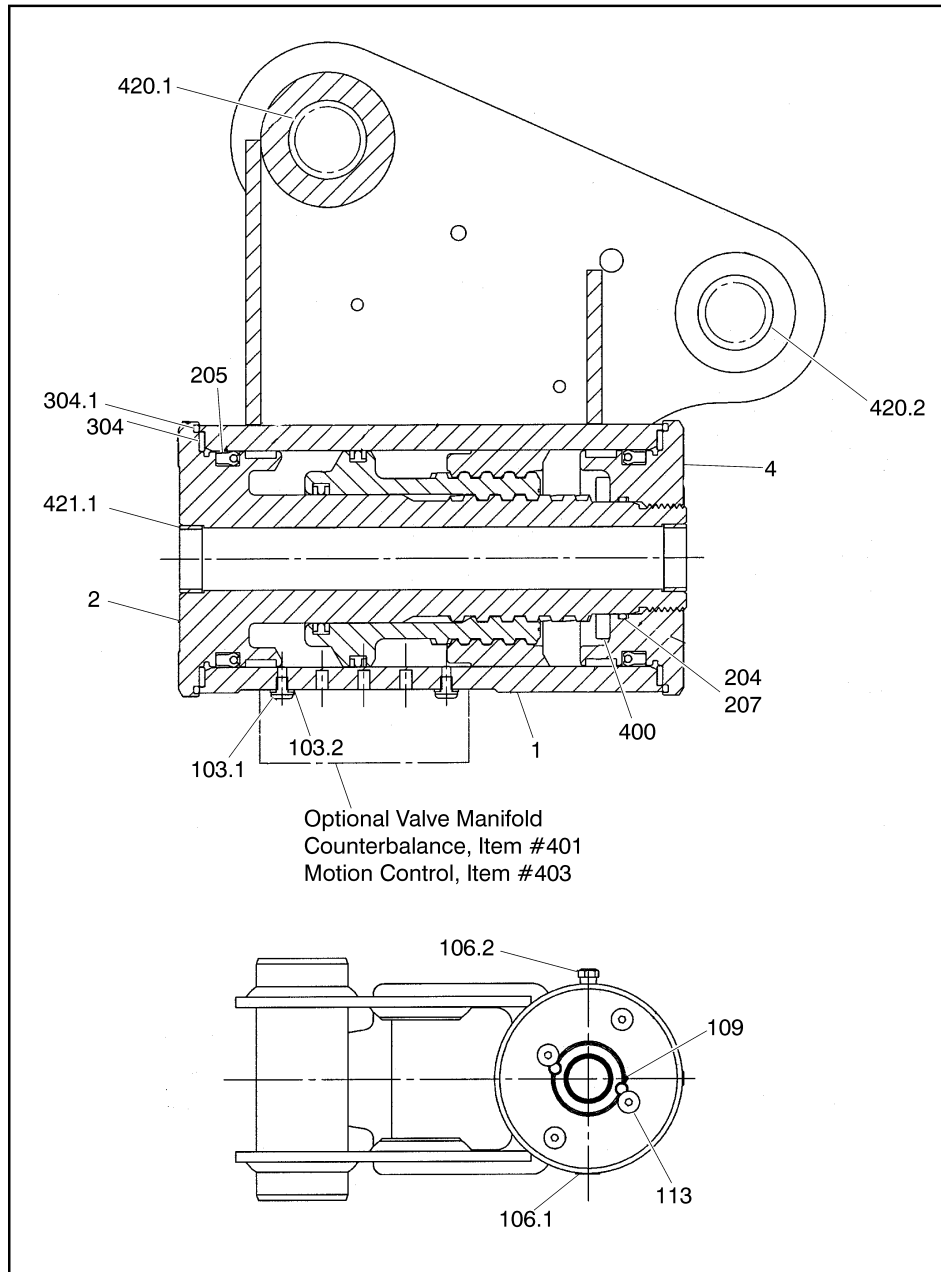
**NOTE:** Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary. As fluid pressure is applied, the piston is displaced axially while the helical gearing causes the piston and shaft to rotate simultaneously. The double helix design compounds rotation: shaft rotation is about twice that of the piston.



- |                  |                 |                           |
|------------------|-----------------|---------------------------|
| 1. Housing       | 200. T-Seal     | 304. Thrust Washer        |
| 2. Shaft         | 202. T-Seal     | 304.1. Wiper Seal         |
| 3. Piston Sleeve | 204. O-Ring     | 400. Stop Tube (Optional) |
| 4. End Cap       | 205. Cup Seal   | 401. Counterbalance Valve |
| 109. Lock Pin    | 207. Back-Up    |                           |
| 113. Cap Screw   | 302. Wear Guide |                           |

Figure 4-10. Rotary Actuator (Exploded View)





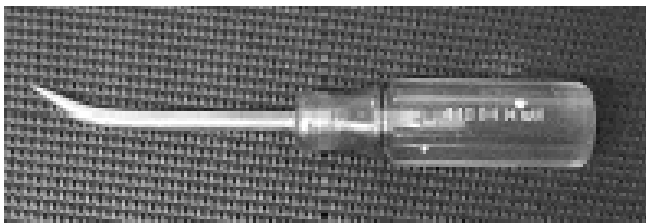
- |                  |                 |                           |
|------------------|-----------------|---------------------------|
| 1. Housing       | 200. T-Seal     | 304. Thrust Washer        |
| 2. Shaft         | 202. T-Seal     | 304.1. Wiper Seal         |
| 3. Piston Sleeve | 204. O-Ring     | 400. Stop Tube (Optional) |
| 4. End Cap       | 205. Cup Seal   | 401. Counterbalance Valve |
| 109. Lock Pin    | 207. Back-Up    |                           |
| 113. Cap Screw   | 302. Wear Guide |                           |

Figure 4-11. Cutaway View

### Tools Required for Assembly/Disassembly

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

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



The seal tool is merely a customized standard flat head screwdriver. To make this tool you will need to heat the flat end with a torch. Secure the heated end of the screwdriver in a vice and physically bend the heated end to a slight radius. Once the radius is achieved round off all sharp edges of the heated end by using a grinder. There may be some slight modifications for your own personal preference.

### Disassembly



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



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



3. Remove the lock pins using an "Easy Out" (a size #2 is shown). If the pin will not come out with the "Easy Out", use 5/16" drill bit to a depth of 1/2" (12.7mm) to drill out the entire pin.



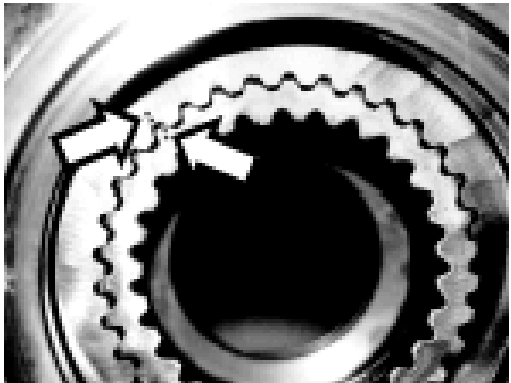
4. Install the end cap (4) removal tools provided with the Helac seal kit.



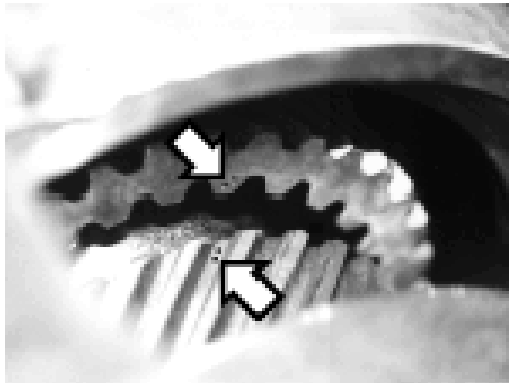
7. Remove the stop tube if included. The stop tube is an available option to limit the rotation of the actuator.



5. Using a metal bar, or something similar, un-screw the end cap (4) by turning it counter clock-wise.



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



8. Every actuator has timing marks for proper engagement.

## SECTION 4 - BOOM & PLATFORM



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



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



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



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



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



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



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



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



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



- 19.** Remove the piston O.D. seal (202).



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



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

**Inspection**



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



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



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

**Assembly**



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



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



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



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



Beginning with the inner seal (200) insert one end of b/u ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly. Repeat this step for the outer seal (202).



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



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



6. Install the inner T-seal (200) into the piston (3) using a circular motion. Install the outer T-seal (202) by stretching it around the groove in a circular motion. Each T-seal has 2 back-up rings (see drawing for orientation).

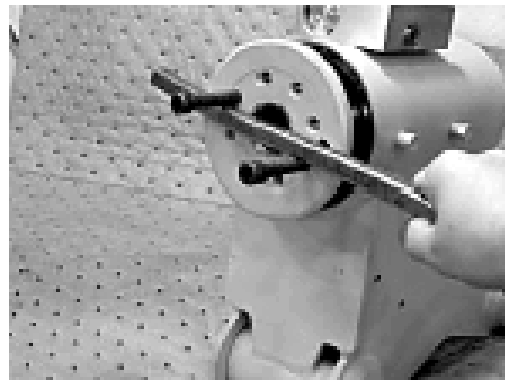


8. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.

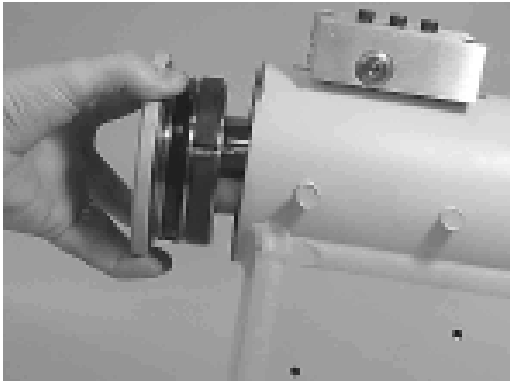
## SECTION 4 - BOOM & PLATFORM



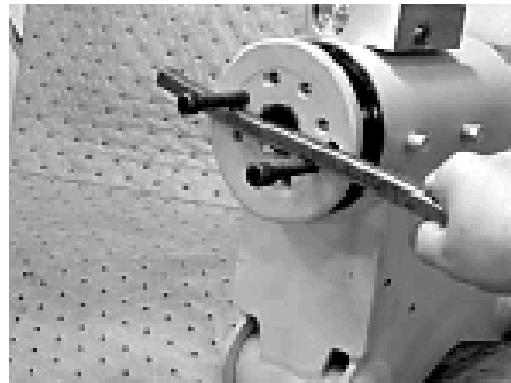
9. Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.



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



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



13. Install the stop tube onto the shaft end. Stop tube is an available option to limit the rotation of an actuator.



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



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





- 15.** Install the O-ring (204) and back-up ring (207) into the inner seal groove on the end cap (4).



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



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



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



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

### **Installing Counterbalance Valve**

*Refer to Figure 4-12., Rotator Counterbalance Valve.*

- 1.** Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old Loctite.
- 2.** Make sure the new valve has the O-rings in the counterbores of the valve to seal it to the actuator housing.
- 3.** The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. Loctite #242 should be applied to the shank of the three bolts at the time of installation.
- 4.** Torque the 1/4-inch bolts 110 to 120 inch pounds (12.4 to 13.5 Nm). Do not torque over 125 inch pounds (14.1 Nm). Torque the 5/16-inch bolts 140 inch pounds (15.8 Nm). Do not torque over 145 inch pounds (16.3 Nm).

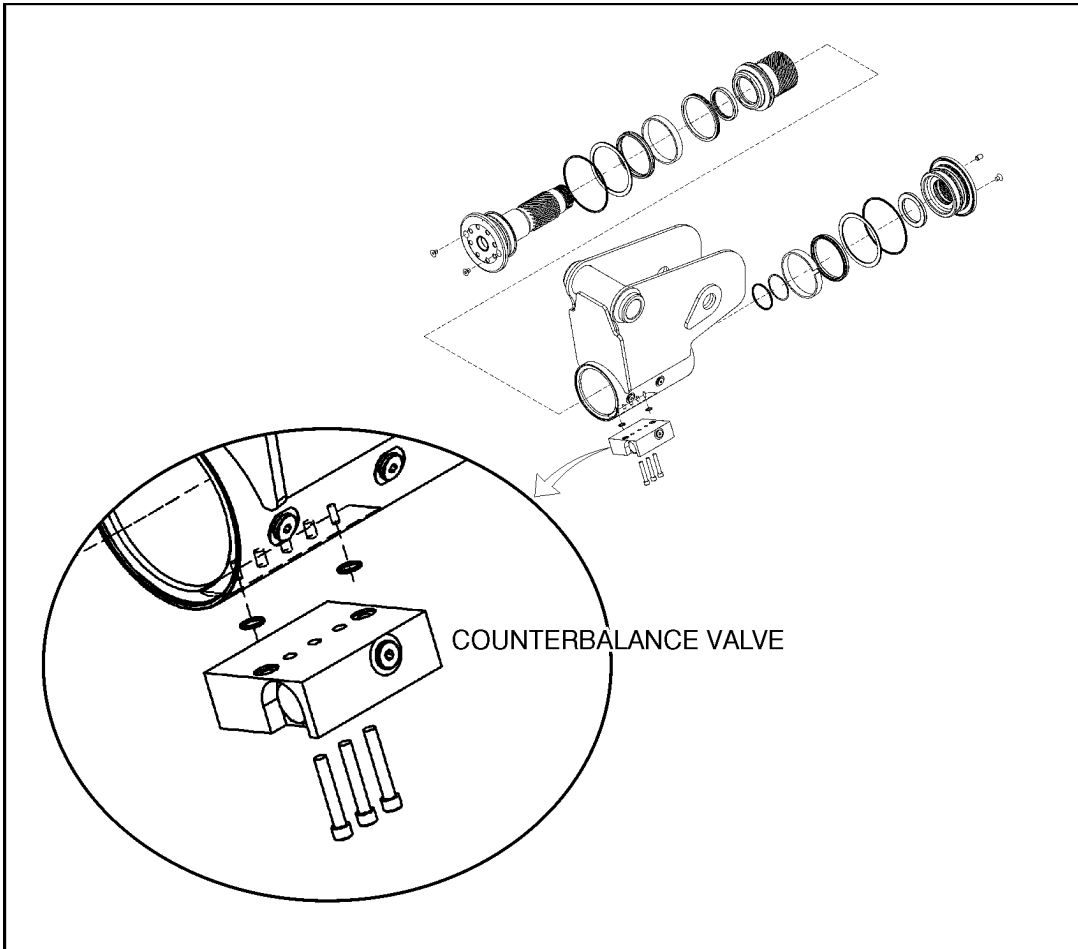


Figure 4-12. Rotator Counterbalance Valve

## SECTION 5. HYDRAULICS

### 5.1 CYLINDERS - THEORY OF OPERATION

#### Systems Incorporating Double Acting Cylinders

Cylinders are of the double acting type. Systems incorporating double acting cylinders are as follows: Slave Level, Master Level, Lift, Telescope, Axle Lockout and Steer. A double acting cylinder is one that requires oil flow to operate the cylinder rod in both directions. Directing oil (by actuating the corresponding control valve to the piston side of the cylinder) forces the piston to travel toward the rod end of the barrel, extending the cylinder rod (piston attached to rod). When the oil flow is stopped, movement of rod will stop. By directing oil to the rod side of the cylinder, the piston will be forced in the opposite direction and the cylinder rod will retract.

#### Systems Incorporating Holding Valves

Holding valves are used in the - Lift, Telescope, Lockout, and Slave Level circuits to prevent retraction of the cylinder rod should a hydraulic line rupture or a leak develop between the cylinder and its related control valve.

### 5.2 CYLINDER REPAIR

#### Cylinders Without Counterbalance Valves

*Master Cylinder and Steer Cylinder*

1. Using all applicable safety precautions, activate engine and fully extend cylinder to be checked. Shut down engine.
2. Carefully disconnect hydraulic hoses from retract port of cylinder. There will be some initial weeping of hydraulic fluid which can be caught in a suitable container. After the initial discharge, there should be no further drainage from the retract port.
3. Activate engine and extend cylinder.
4. If cylinder retract port leakage is less than 6-8 drops per minute, carefully reconnect hose to port and retract cylinder. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repair must be made.
5. With cylinder fully retracted, shut down engine and carefully disconnect hydraulic hose from cylinder extend port.
6. Activate engine and retract cylinder. Check extend port for leakage.

7. If extend port leakage is less than 6-8 drops per minute, carefully reconnect hose to extend port, than activate cylinder through one complete cycle and check for leaks. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repairs must be made.

#### Cylinders With Dual Counterbalance Valves

*Slave Level, Lift, and Telescope*

#### **NOTICE**

**OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.**

1. Using all applicable safety precautions, activate hydraulic system.

#### **⚠ WARNING**

**IF WORKING ON THE PLATFORM LEVEL CYLINDER, STROKE PLATFORM LEVEL CYLINDER FORWARD UNTIL PLATFORM SITS AT A 45 DEGREES ANGLE.**

2. Shut down hydraulic system and allow machine to sit for 10-15 minutes. Move control lever for applicable cylinder in each direction. This is done to relieve pressure in the hydraulic lines. Carefully remove hydraulic hoses from appropriate cylinder port block.
3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should be no further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, the counterbalance valve is defective and must be replaced.
4. To check piston seals, carefully remove the counterbalance valve from the retract port. After initial discharge, there should be no further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, the piston seals are defective and must be replaced.
5. If no repairs are necessary or when repairs have been made, replace counterbalance valve and carefully connect hydraulic hoses to cylinder port block.
6. If used, remove lifting device from upright or remove prop from below main boom, activate hydraulic system and run cylinder through one complete cycle to check for leaks.

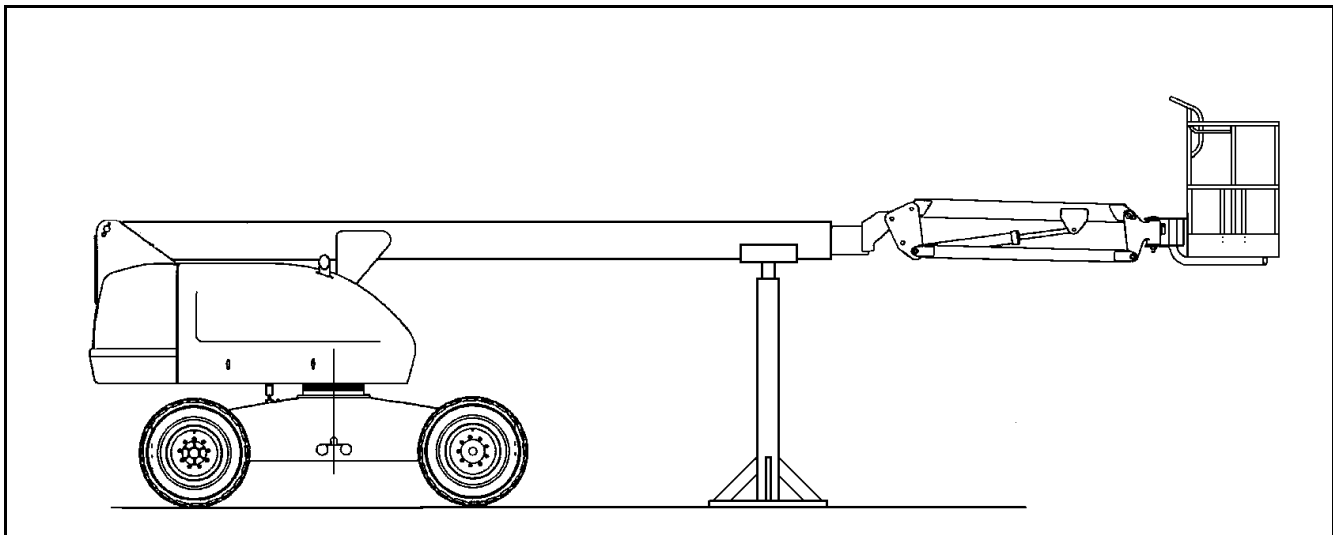


Figure 5-1. Boom Prop Configuration

**NOTE:** The following are general procedures that apply to all of the cylinders on this machine. Procedures that apply to a specific cylinder will be so noted.

## Disassembly

### NOTICE

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

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

### WARNING

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

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

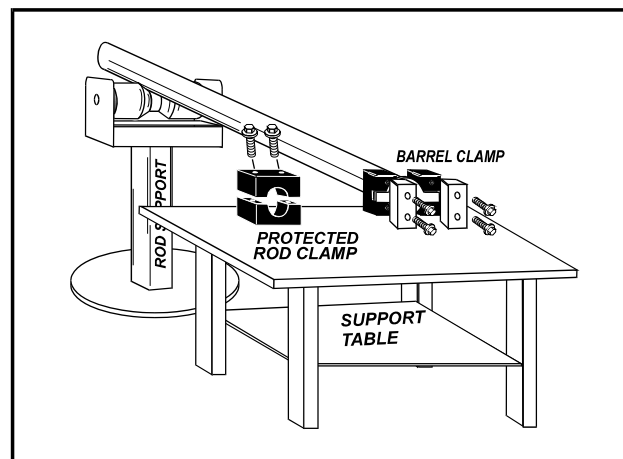


Figure 5-2. Cylinder Barrel Support

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

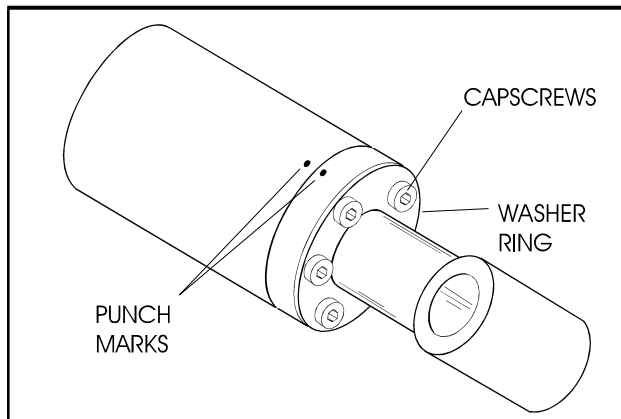


Figure 5-3. Capscrew Removal

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

**NOTICE**

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

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

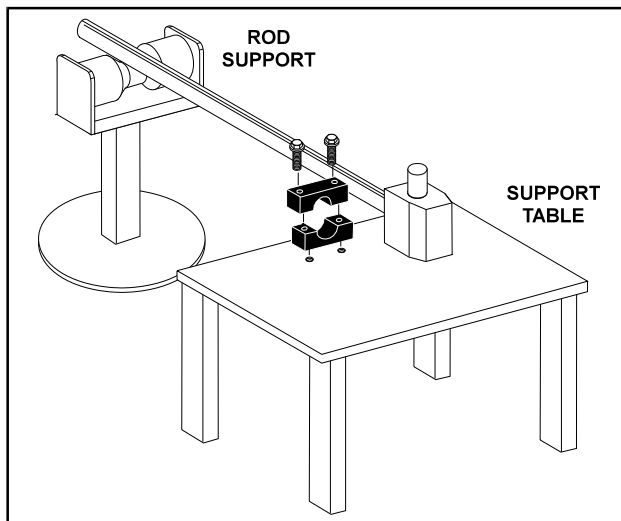


Figure 5-4. Cylinder Rod Support

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Loosen and remove the cap screw(s), if applicable, which attach the tapered bushing to the piston.

10. Insert the cap screw(s) in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the cap screw(s) until the bushing is loose on the piston.
11. Remove the bushing from the piston.

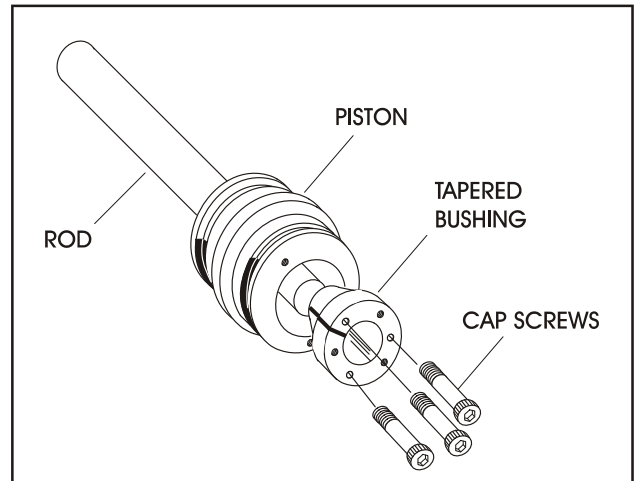


Figure 5-5. Tapered Bushing Removal

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

**Cleaning and Inspection**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect 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.

## SECTION 5 - HYDRAULICS

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 the steel bushing with WD 40 prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

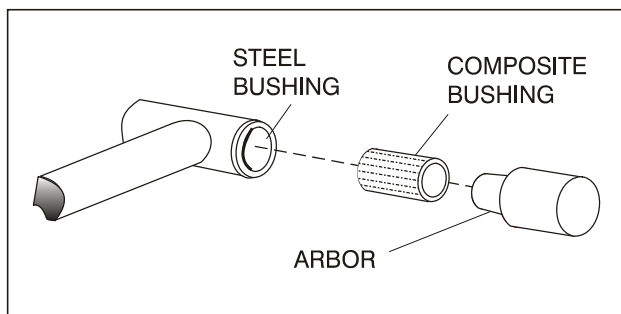


Figure 5-6. Composite Bearing Installation

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.

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

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

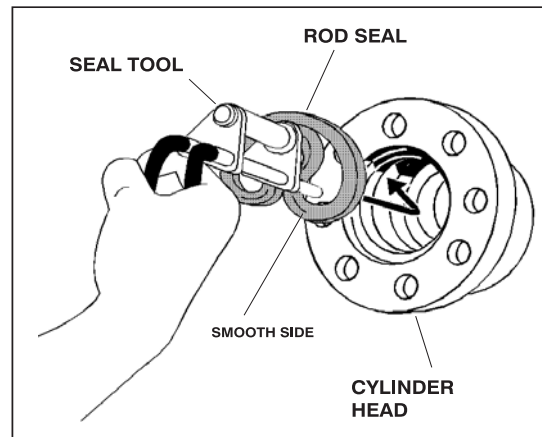
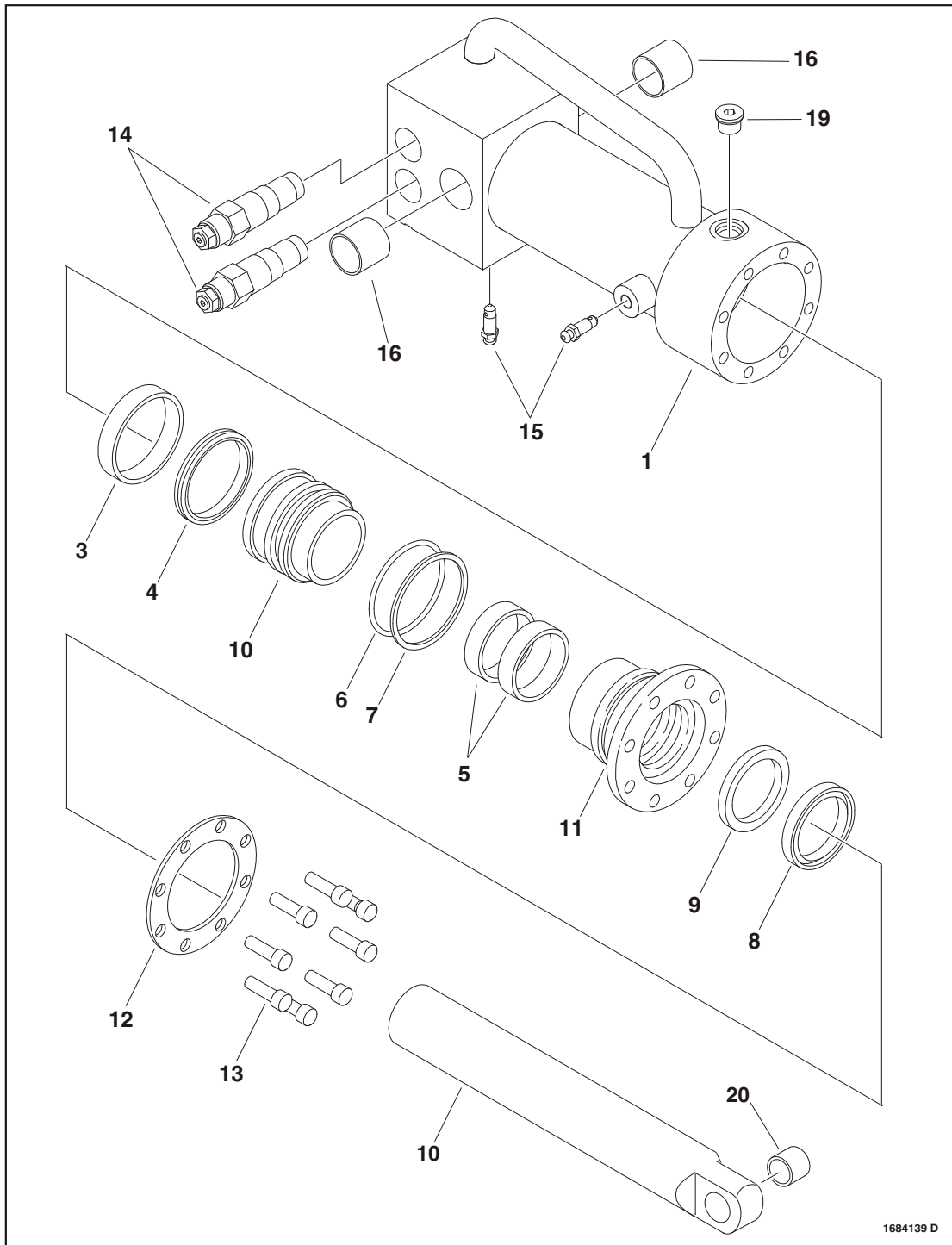


Figure 5-7. Rod Seal Installation

### 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.**

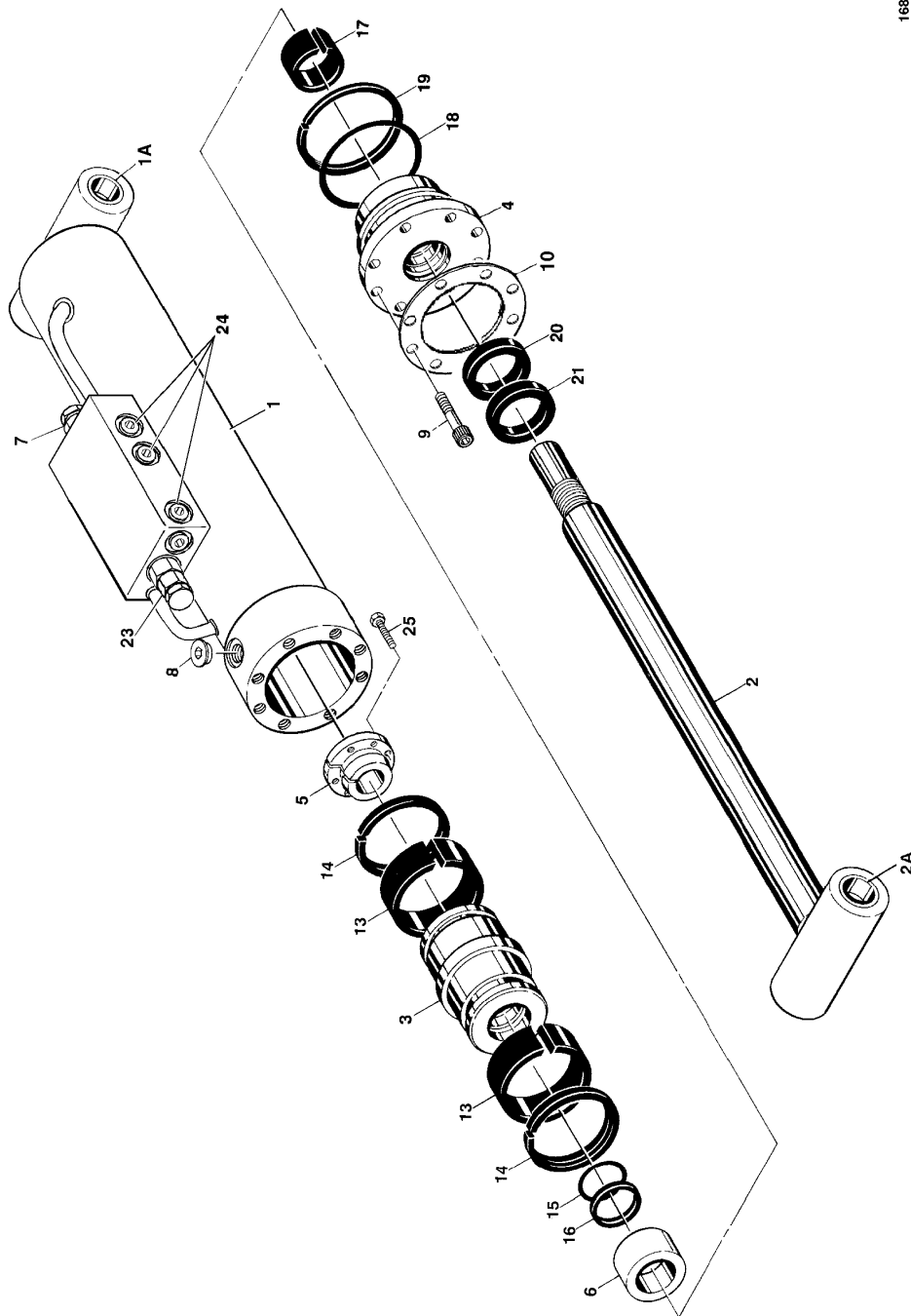
2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.



- |              |                |                 |                     |                    |
|--------------|----------------|-----------------|---------------------|--------------------|
| 1. Barrel    | 5. Wear Ring   | 9. Seal         | 13. Bolt            | 17. Loctite #242   |
| 2. Not Used  | 6. O-ring      | 10. Rod         | 14. Valve Cartridge | 18. Locking Primer |
| 3. Wear Ring | 7. Backup Ring | 11. Cap         | 15. Bleeder Valve   | 19. O-ring Plug    |
| 4. T-Seal    | 8. Wiper       | 12. Washer Ring | 16. Bushing         | 20. Bushing        |

Figure 5-8. Axle Lockout Cylinder

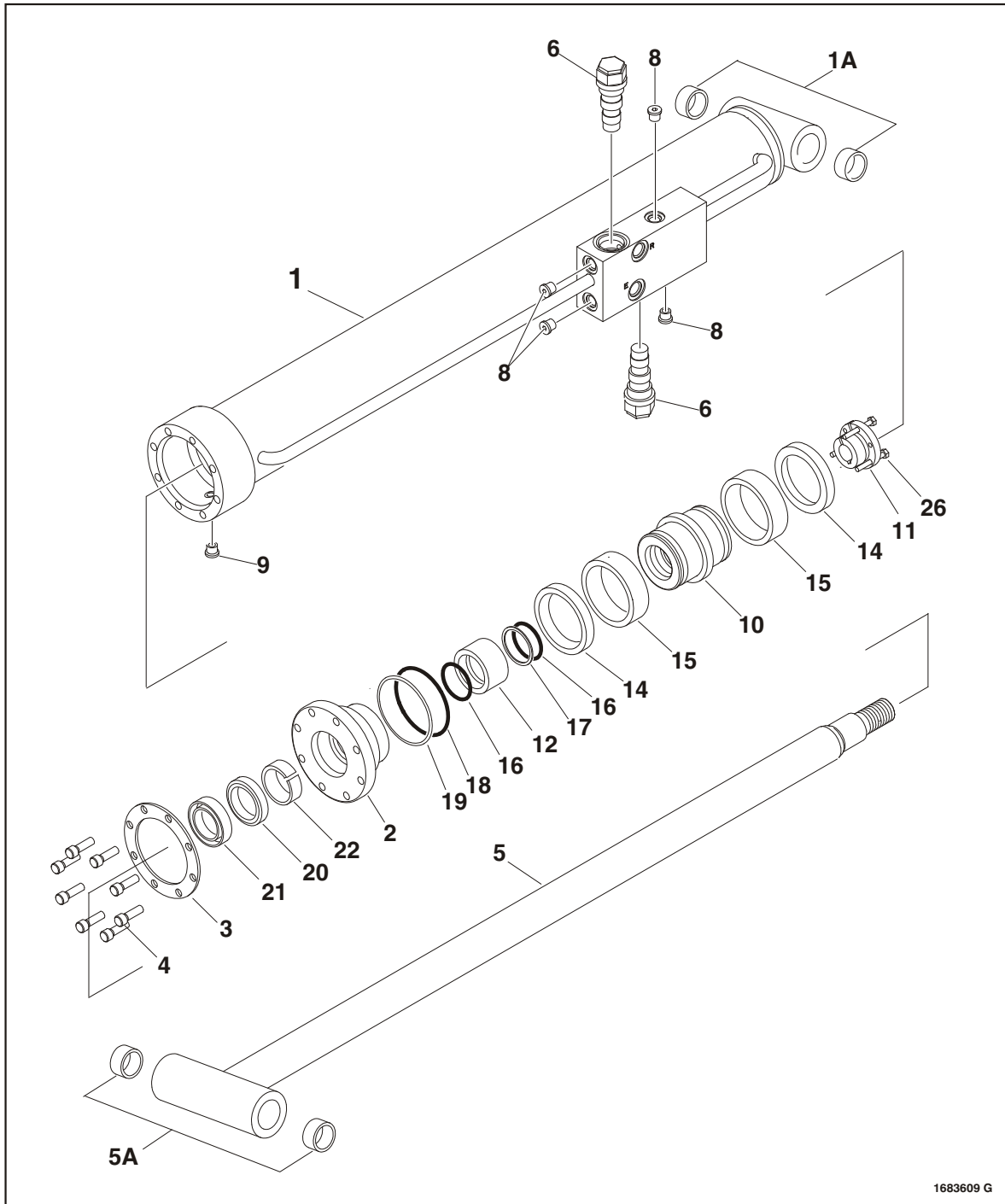
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1684013 A



- |             |                    |                    |                 |                     |
|-------------|--------------------|--------------------|-----------------|---------------------|
| 1. Barrel   | 5. Tapered Bushing | 11. Loctite #242   | 17. Wear Ring   | 23. Valve Cartridge |
| 1A. Bushing | 6. Spacer          | 12. Locking Primer | 18. O-ring      | 24. O-ring Plug     |
| 2. Rod      | 7. Valve Cartridge | 13. Seal           | 19. Backup Ring | 25. Screw           |
| 2A. Bushing | 8. O-ring Plug     | 14. Lock Ring      | 20. Rod Seal    | 26. Loctite RC609   |
| 3. Piston   | 9. Capscrew        | 15. O-ring         | 21. Wiper       |                     |
| 4. Head     | 10. Washer Ring    | 16. Backup Ring    | 22. Not Used    |                     |

Figure 5-9. Platform Level Cylinder



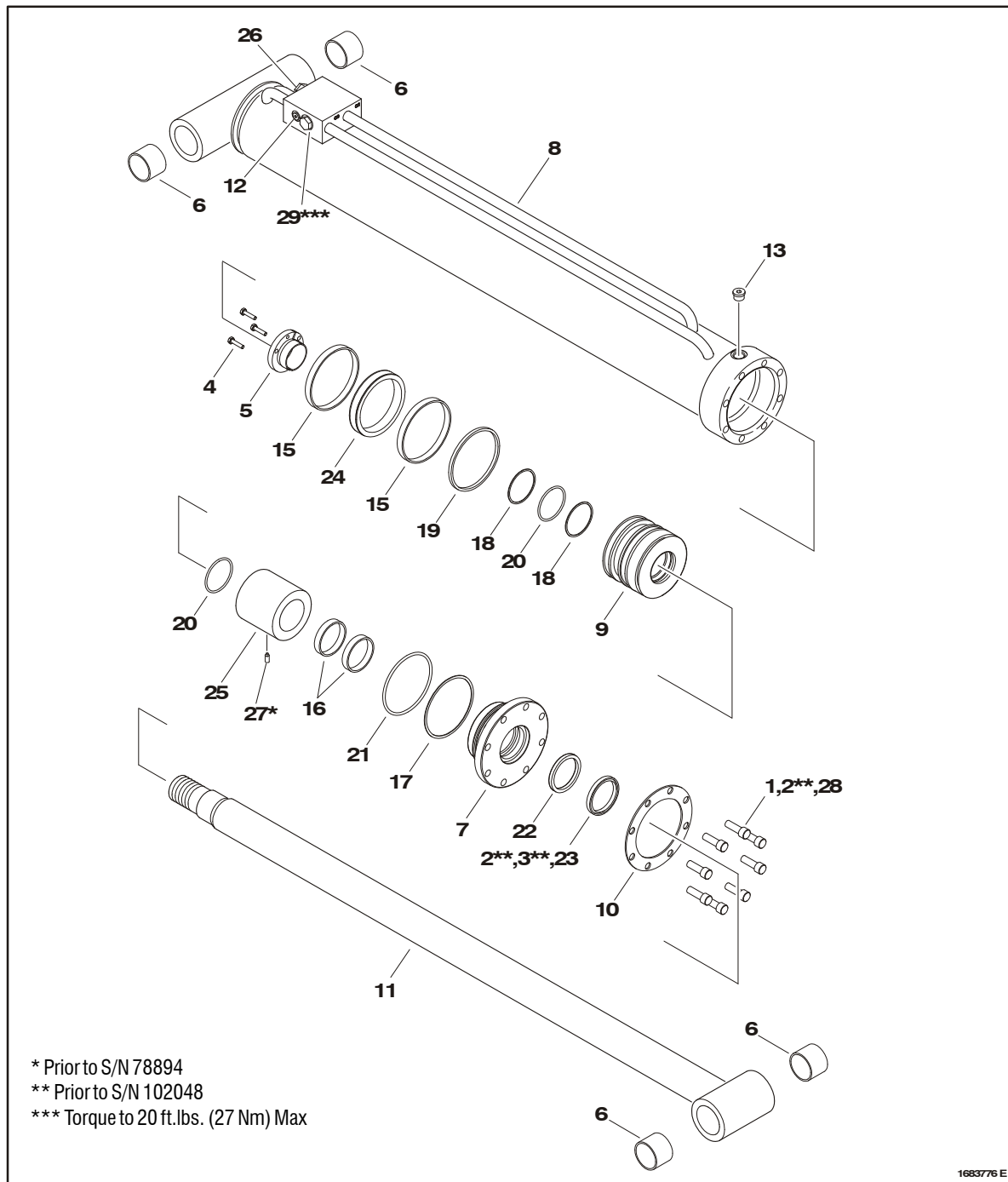


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- |                |                    |                     |                 |                  |                    |
|----------------|--------------------|---------------------|-----------------|------------------|--------------------|
| 1. Barrel      | 5. Rod             | 9. O-ring Plug      | 14. Lock Ring   | 19. Backup Ring  | 24. Locking Primer |
| 1A. Bushing    | 5A. Bushing        | 10. Piston          | 15. Piston Seal | 20. Seal         | 25. Not Used       |
| 2. Head        | 6. Valve Cartridge | 11. Tapered Bushing | 16. O-ring      | 21. Wiper        | 26. Capscrew       |
| 3. Ring Washer | 7. Not Used        | 12. Tube Spacer     | 17. Backup Ring | 22. Wear Ring    |                    |
| 4. Bolt        | 8. O-ring Plug     | 13. Not Used        | 18. O-ring      | 23. Loctite #242 |                    |

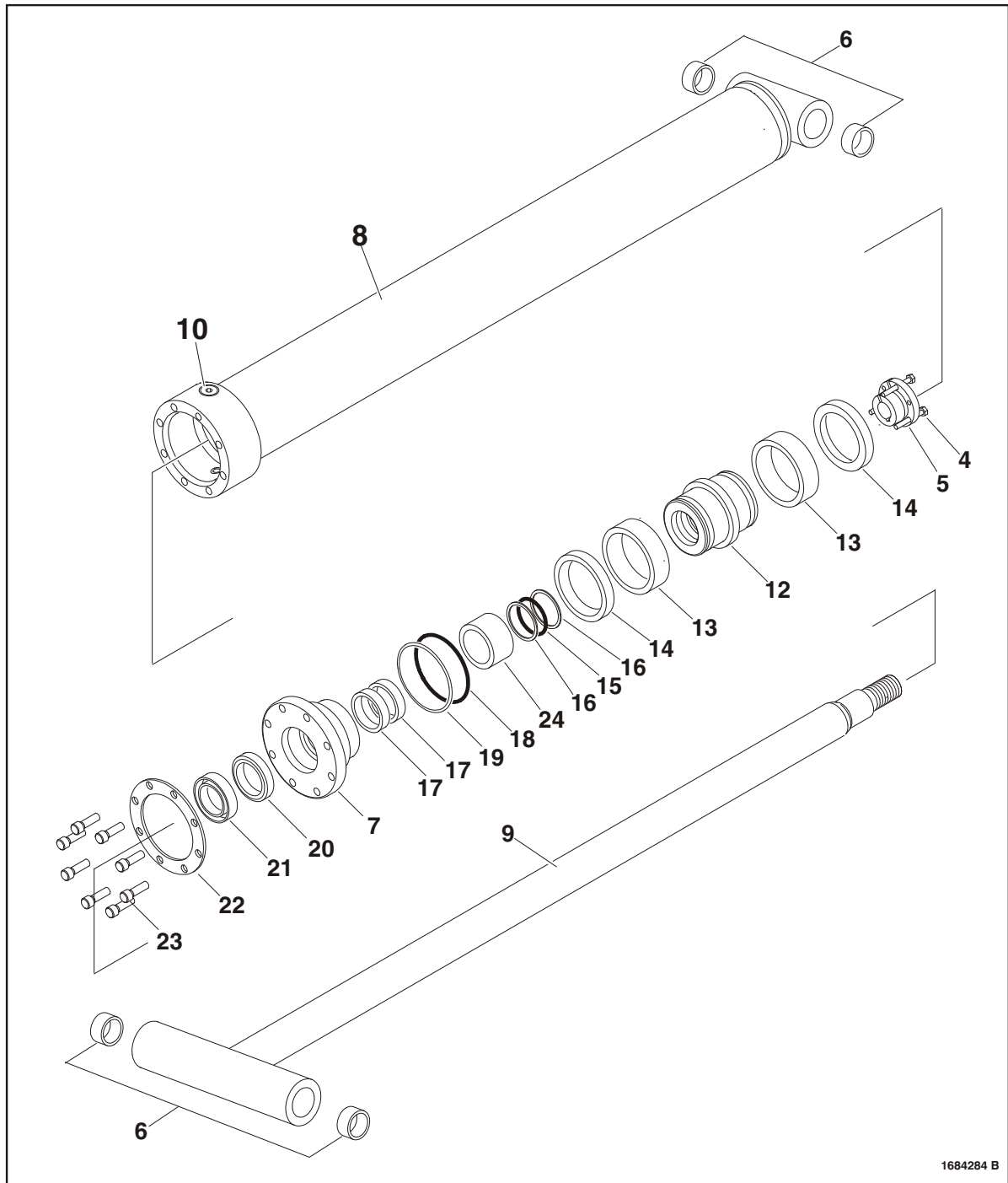
Figure 5-10. Jib Lift Cylinder (460SJ)

## SECTION 5 - HYDRAULICS



- |                      |                  |                 |               |                          |
|----------------------|------------------|-----------------|---------------|--------------------------|
| 1. Loctite #242      | 7. Head          | 13. Plug        | 19. Seal      | 25. Tube Spacer          |
| 2. Locking Primer    | 8. Barrel        | 14. Not Used    | 20. O-ring    | 26. Counterbalance Valve |
| 3. Loctite           | 9. Piston        | 15. Wear Ring   | 21. O-ring    | 27. Setscrew             |
| 4. Bolt              | 10. Wear Ring    | 16. Wear Ring   | 22. Poly Seal | 28. Capscrew             |
| 5. Tapered Bushing   | 11. Cylinder Rod | 17. Backup Ring | 23. Wiper     | 29. Cartridge Valve      |
| 6. Composite Bushing | 12. Plug         | 18. Backup Ring | 24. T-Seal    |                          |

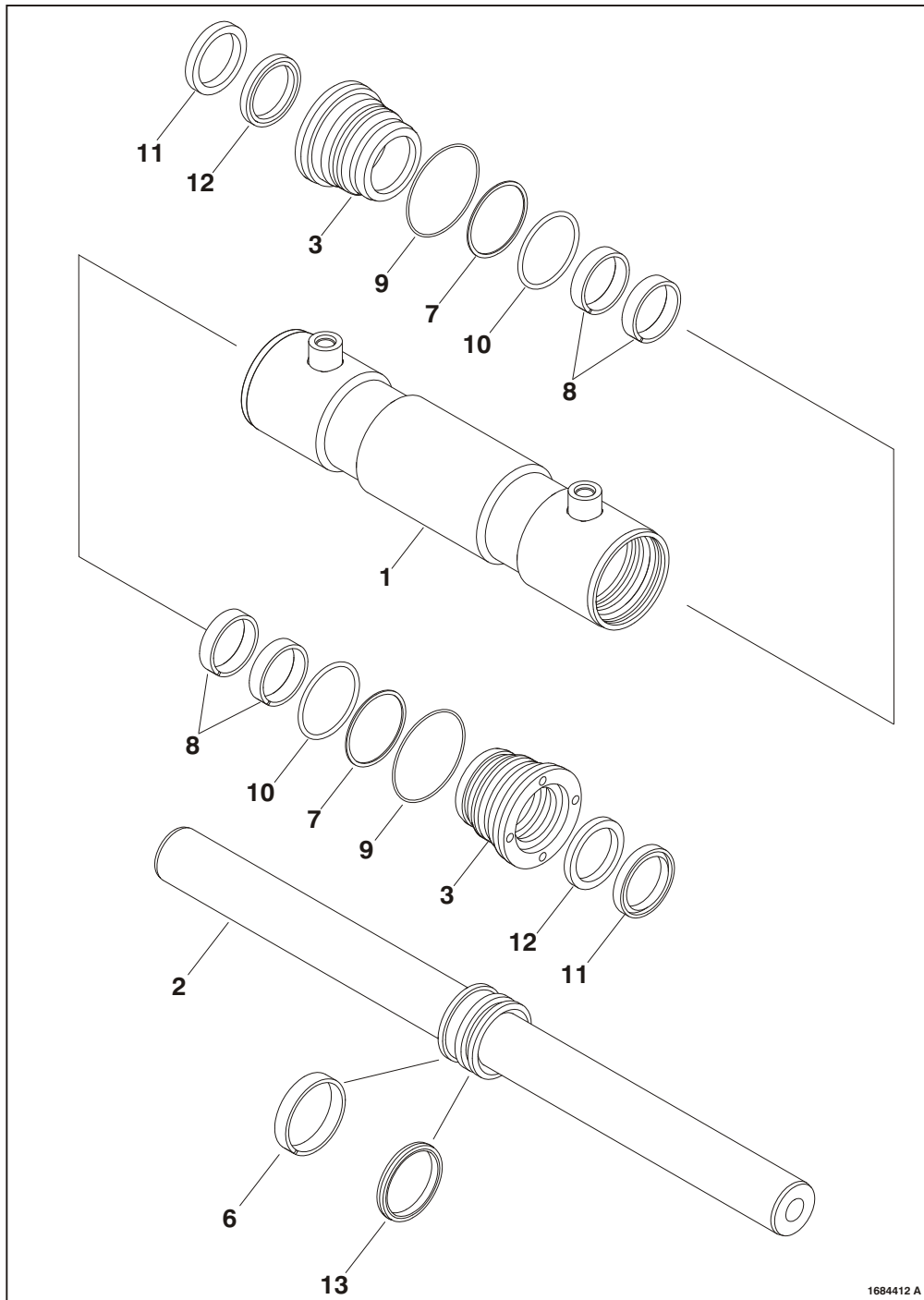
**Figure 5-11. Lift Cylinder**



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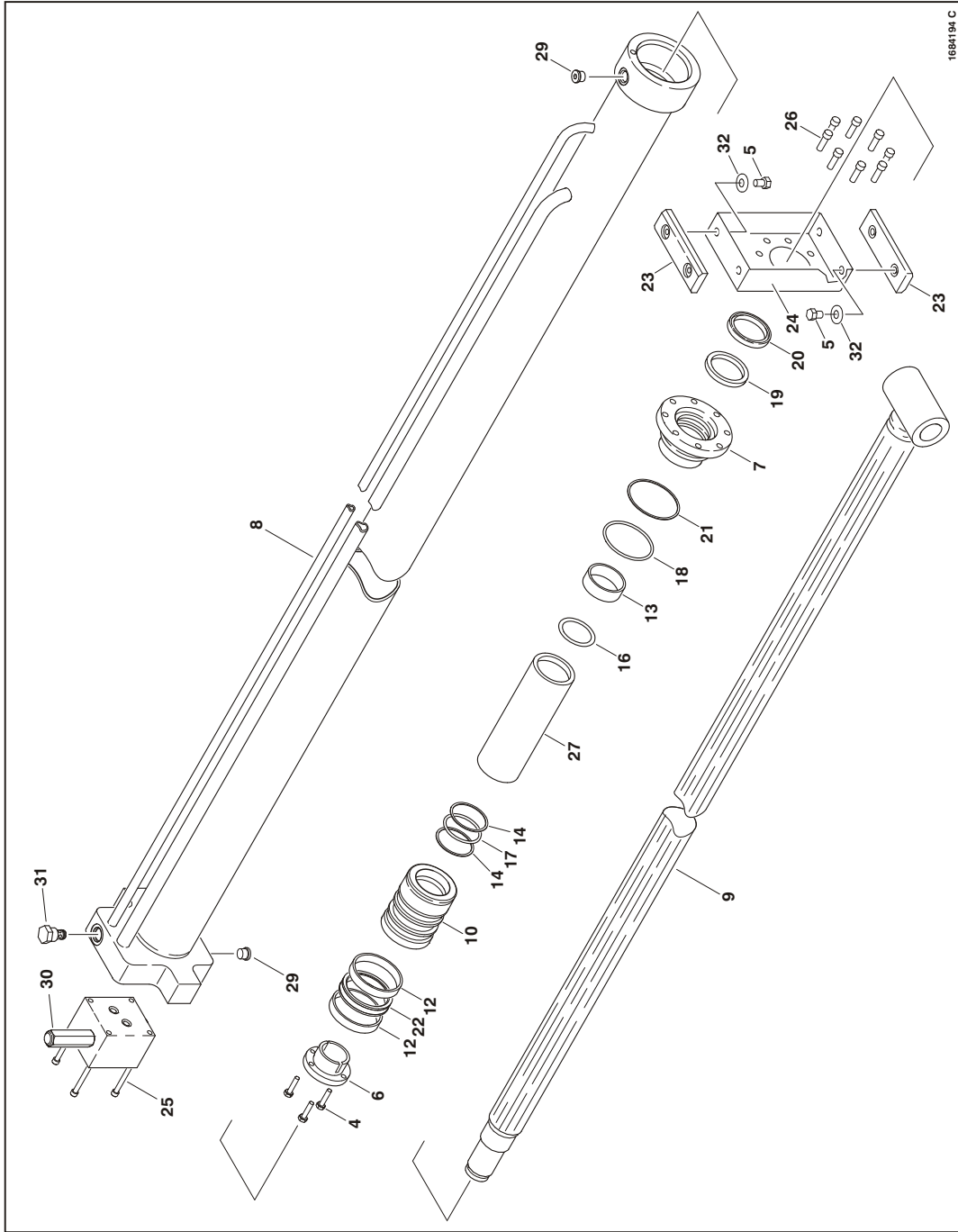
- |                    |                 |                    |                 |                 |
|--------------------|-----------------|--------------------|-----------------|-----------------|
| 1. Loctite #242    | 6. Bushing      | 11. Not Used       | 16. Backup Ring | 21. Wiper       |
| 2. Locking Primer  | 7. Head         | 12. Piston         | 17. Wear Ring   | 22. Washer Ring |
| 3. Not Used        | 8. Barrel       | 13. Hydrolock Ring | 18. O-ring      | 23. Capscrew    |
| 4. Bolt            | 9. Rod          | 14. Guidelock Ring | 19. Backup Ring | 24. Tube Spacer |
| 5. Tapered Bushing | 10. O-ring Plug | 15. O-ring         | 20. Poly Seal   |                 |

Figure 5-12. Master Cylinder



- |                  |                |            |
|------------------|----------------|------------|
| 1. Barrel        | 6. Wear Ring   | 11. Wiper  |
| 2. Rod           | 7. Backup Ring | 12. Seal   |
| 3. Cylinder Head | 8. Wear Ring   | 13. T-Seal |
| 4. Anti-Seize    | 9. O-ring      |            |
| 5. Not Used      | 10. O-ring     |            |

**Figure 5-13. Steer Cylinder**



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- |                    |               |                 |                 |                    |                 |
|--------------------|---------------|-----------------|-----------------|--------------------|-----------------|
| 1. Loctite #242    | 7. Head       | 13. Wear Ring   | 18. O-ring      | 23. Wear Pad       | 28. Not Used    |
| 2. Locking Primer  | 8. Barrel     | 14. Backup Ring | 19. Rod Seal    | 24. Mounting Plate | 29. O-ring Plug |
| 3. Loctite         | 9. Rod        | 15. Not Used    | 20. Wiper       | 25. Capscrew       | 30. Valve       |
| 4. Bolt            | 10. Piston    | 16. O-ring      | 21. Backup Ring | 26. Capscrew       | 31. O-ring Plug |
| 5. Bolt            | 11. Not Used  | 17. O-ring      | 22. Seal        | 27. Tube Spacer    | 32. Flatwasher  |
| 6. Tapered Bushing | 12. Wear Ring |                 |                 |                    |                 |

Figure 5-14. Telescope Cylinder

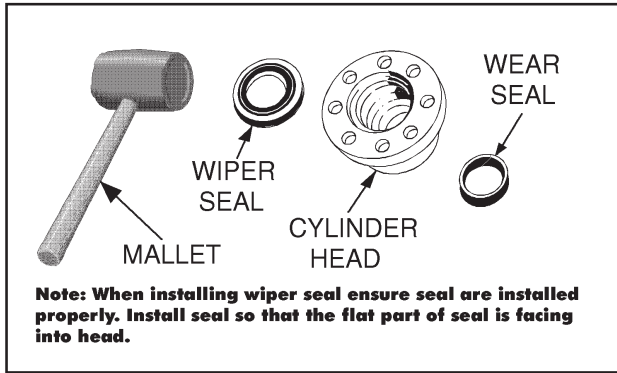


Figure 5-15. Wiper Seal Installation

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

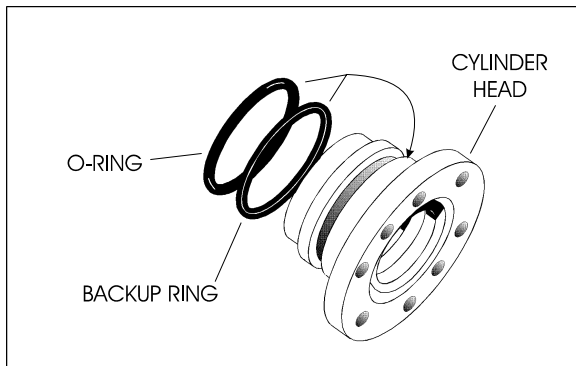


Figure 5-16. Installation of Head Seal Kit

- 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.
- Carefully slide the piston spacer on the rod.
- If applicable, correctly place new o-ring in the inner piston diameter groove. (The backup ring side facing the O-ring is grooved.)
- 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 5-17.) The split of seals and backup rings are to be positioned so as not to be in alignment with each other.

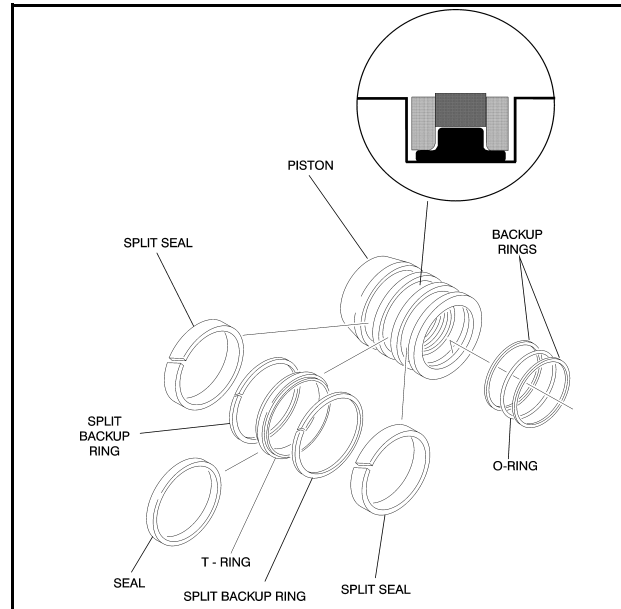


Figure 5-17. Piston Seal Kit Installation.

- Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
- Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
- Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

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

**NOTE:** When rebuilding the steer, axle oscillation, level cylinder, lift cylinder, or e.a.r. cylinders, tighten securely. (See Table 5-1, Cylinder Head and Tapered Bushing Torque Specifications).

- Assemble the tapered bushing loosely into the piston and insert JLG cap screws (not vendor cap screws) through the drilled holes in the bushing and into the tapped holes in the piston.

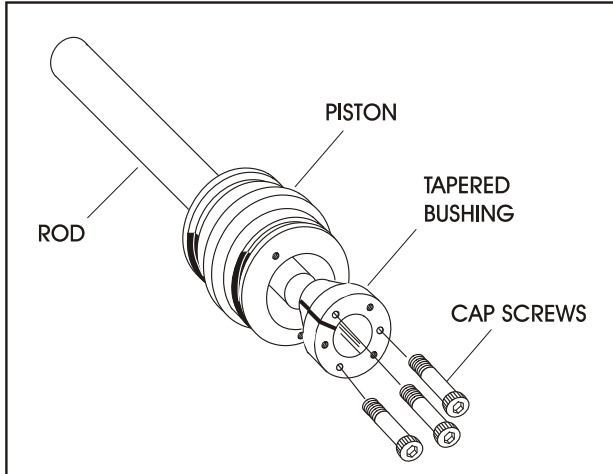


Figure 5-18. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to the specified torque value. (See Table 5-1, Cylinder Head and Tapered Bushing Torque Specifications.)
13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

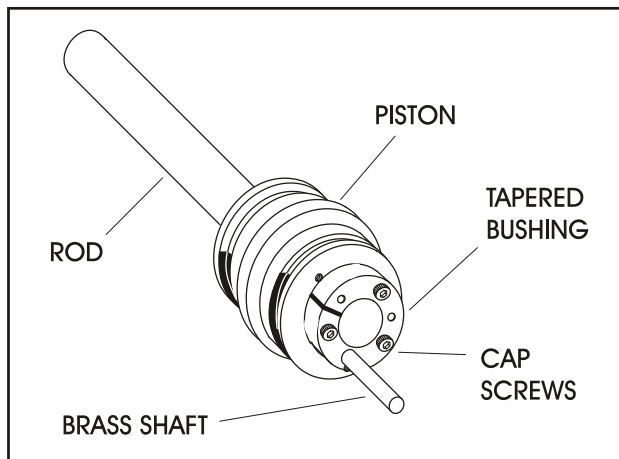


Figure 5-19. Seating the Tapered Bearing

14. Retorque the capscrews evenly and progressively in rotation to the specified torque value. (See Table 5-1, Cylinder Head and Tapered Bushing Torque Specifications.)

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 5-17., Piston Seal Kit Installation.)

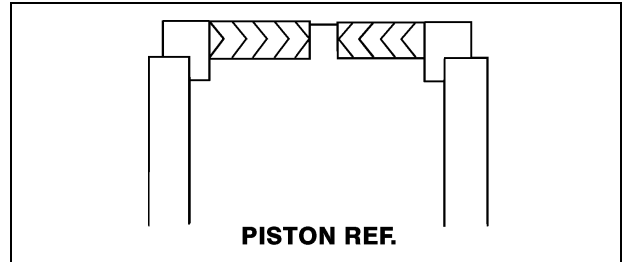


Figure 5-20. Poly-Pak Piston Seal Installation

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

**NOTICE**

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

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
19. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
20. Secure the cylinder head gland using the washer ring and socket head bolts. See Figure 5-1, Cylinder Head and Tapered Bushing Torque Specifications

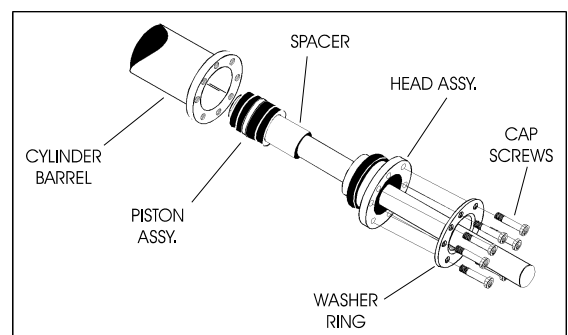


Figure 5-21. Rod Assembly Installation

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.

## SECTION 5 - HYDRAULICS

**NOTE:** If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. (See Table 5-2, Holding Valve Torque Specification.)

**Table 5-1. Cylinder Head and Tapered Bushing Torque Specifications**

Description	Head Torque Value (Wet)	Tapered Bushing Torque Value (Wet)
Lift Cylinder	120 ft. lbs. (162 Nm)	9 ft. lbs. (12 Nm)
Lift Cylinder (SJ)	30 ft. lbs. (41 Nm)	5 ft. lbs. (7 Nm)
Tele Cylinder	30 ft. lbs. (41 Nm)	9 ft. lbs. (12 Nm)
Level Cylinder	50 ft. lbs. (68 Nm)	9 ft. lbs. (12 Nm)
Master Cylinder	50 ft. lbs. (68 Nm)	9 ft. lbs. (12 Nm)
Level Cylinder (SJ)	50 ft. lbs. (68 Nm)	9 ft. lbs. (12 Nm)
Axle Oscillation Cylinder	30 ft. lbs. (41 Nm)	N/A
Steer Cylinder	30 ft. lbs. (41 Nm)	N/A

**Table 5-2. Holding Valve Torque Specification.**

Description	Torque Value
SUN - 7/8 HEX M20 x 1.5 THDS.	30-35 ft.lbs. (41-48 Nm)
SUN - 1 1/8 HEX 1-14 UNS THDS.	45-50 ft.lbs. (61-68 Nm)
SUN - 1 1/4 HEX M36 x 2 THDS.	150-160 ft.lbs. (204-217 Nm)
RACINE - 1 1/8 HEX 1 1/16-12 THDS.	50-55 ft.lbs. (68-75 Nm)
RACINE - 1 3/8 HEX 1 3/16-12 THDS.	75-80 ft.lbs. (102-109 Nm)
RACINE - 1 7/8 HEX 1 5/8-12 THDS.	100-110 ft.lbs. (136-149 Nm)

### **⚠ CAUTION**

**IF THE CYLINDER IS TO BE TESTED PRIOR TO INSTALLATION ON THE MACHINE, EXTREME CARE SHOULD BE USED TO INSURE THAT THE OUTER END OF THE ROD IS SUPPORTED. USE EITHER A TRAVELING OVERHEAD HOIST, FORK-LIFT, OR OTHER MEANS TO SUPPORT THE OVERHANGING WEIGHT OF THE EXTENDING ROD.**

## 5.3 VALVES - THEORY OF OPERATION

### Solenoid Control Valve

Control valves used are four-way three-position solenoid valves of the sliding spool design. When a circuit is activated and the control valve solenoid energizes, the spool is shifted and the corresponding work port opens to permit oil flow to the component in the selected circuit with the opposite work port opening to reservoir. Once the circuit is deactivated (control returned to neutral) the valve spool returns to neutral (center) and oil flow is then directed through the valve body and returns to reservoir. A typical control valve consist of the valve body, sliding spool, and two solenoid assemblies. The spool is machine fitted in the bore of the valve body. Lands on the spool divide the bore into various chambers, which, when the spool is shifted, align with corresponding ports in the valve body open to common flow. At the same time other ports would be blocked to flow. The spool is spring loaded to center position, therefore when the control is released, the spool automatically returns to neutral, prohibiting any flow through the circuit.



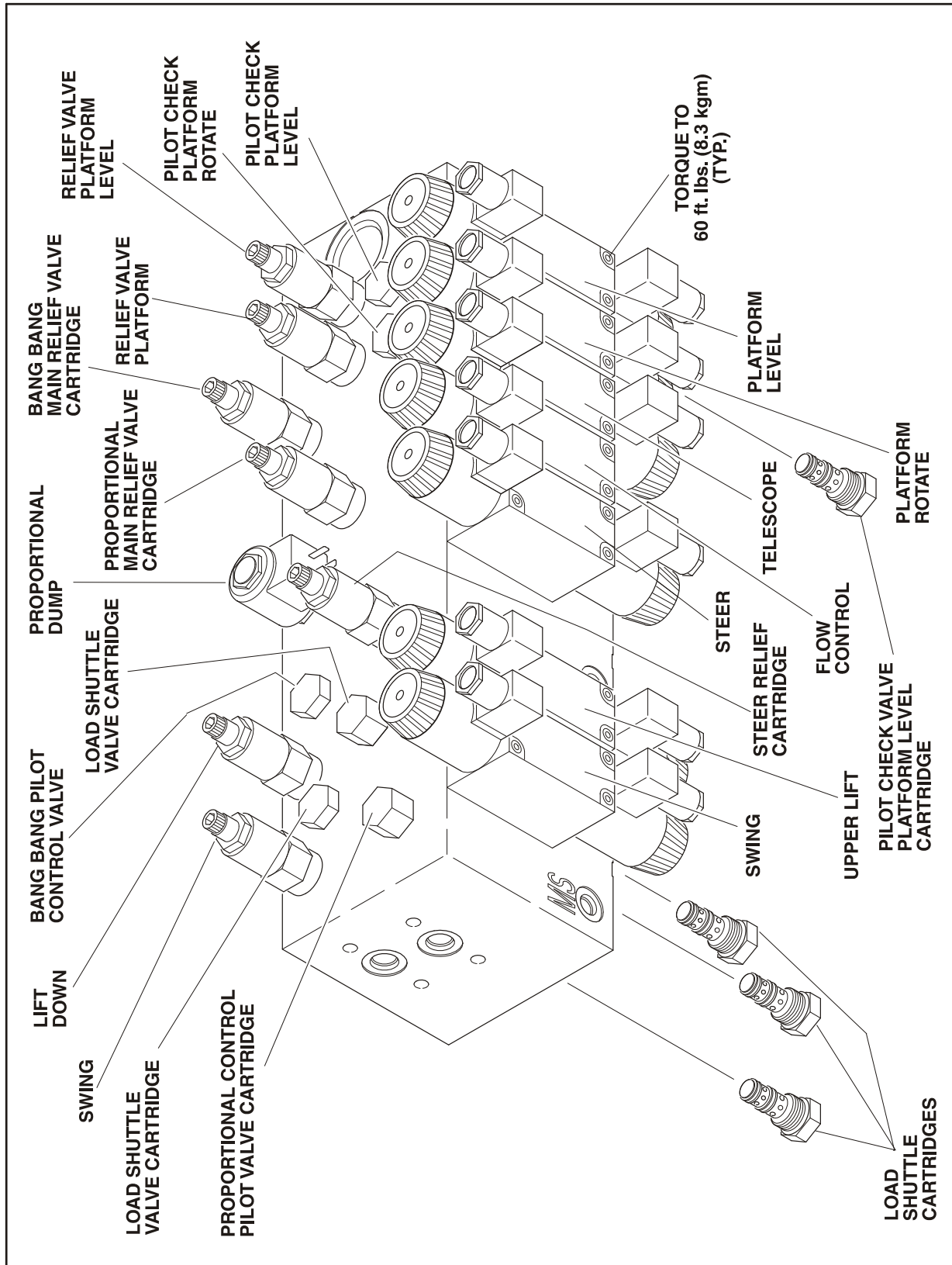
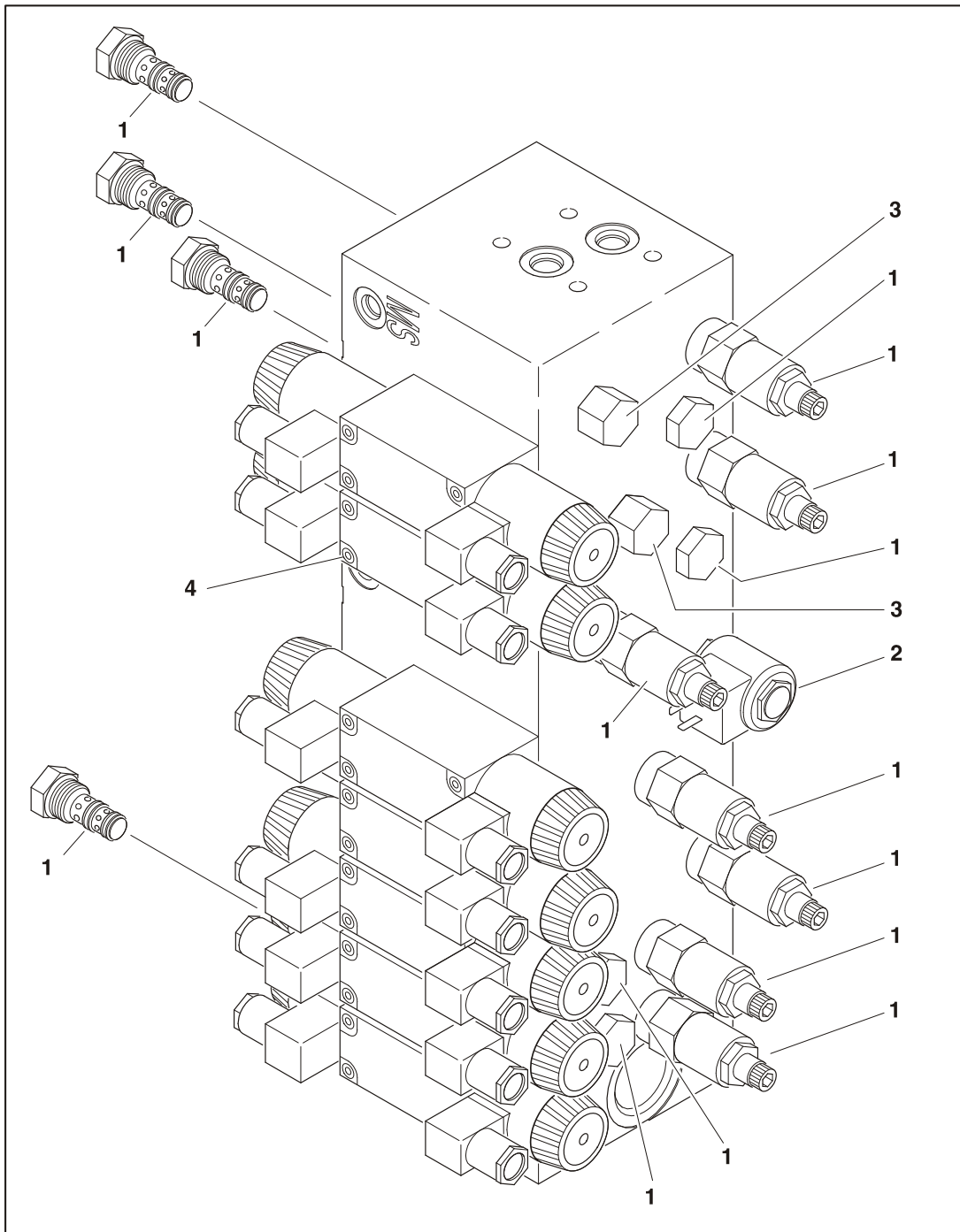


Figure 5-22. Main Valve



	Ft-Lbs.	Nm
1	18-20	24.5-27.2
2	4-5	6.5-9.5
3	25-27	34-36.7
4	5	9.5

Figure 5-23. Main Valve Cartridge Torque Values

## Relief Valves

Relief valves are installed at various points within the hydraulic system to protect associated systems and components against excessive pressure. Excessive pressure can be developed when a cylinder reaches its limit of travel and the flow of pressurized fluid continues from the system control. The relief valve provides an alternate path for the continuing flow from the pump, thus preventing rupture of the cylinder, hydraulic line or fitting. Complete failure of the system pump is also avoided by relieving circuit pressure. The relief valve is installed in the circuit between the pump outlet (pressure line) and the cylinder of the circuit, generally as an integral part of the system valve bank. Relief pressures are set slightly higher than the load requirement, with the valve diverting excess pump delivery back to the reservoir when operating pressure of the component is reached.

1. Remove the boom from the turntable as follows:
  - a. Disconnect wiring harness from ground control harness connector.

### CAUTION

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

- b. Tag and disconnect hydraulic lines from boom to control valve. Use a suitable container to retain any residual hydraulic fluid. Cap all hydraulic lines and ports.
- c. Using a suitable lifting equipment, adequately support boom weight along entire length.
- d. Remove the bolts and keeper pins securing the lift cylinder pivot pin. Using a suitable brass drift and hammer, remove the pivot pin from the lower boom.
- e. Remove hardware securing the level link pivot pin. Using a suitable brass drift and hammer, remove the pin from the level link and turntable.
- f. Remove hardware securing the boom pivot pin. Using a suitable brass drift and hammer, remove pin from the turntable.

Using all applicable safety precautions, carefully lift boom assembly clear of turntable and lower to ground or suitable supported work surface.

## 5.4 PRESSURE SETTING PROCEDURES

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until hydraulic system has warmed to normal operating temperatures prior to checking pressures. We also recommend using a calibrated gauge. Pressure read-

ings are acceptable if within +/- 5% of specified pressures.

**NOTE:** Engine RPM's must be correct. Mid engine 1800, and High engine 2800 for Deutz engines; 2900 for Ford engines. The adjustable resistor at the ground control for lift and swing should be set to maximum speed for these functions while setting pressures. After this procedure is done, it can be reset.

### 1. Bang-Bang Main Relief Valve;

This valve will be reset at the end of this procedure. In order to be able to set other pressures, we need to set this valve to 3000 psi. Install a high pressure gauge at the port marked "M1" located behind the tank port. Activate telescope in. Adjust the valve to 3000 psi, located on top of main valve, 3<sup>rd</sup> relief valve to the left of the tank port. Turn clockwise to increase and counterclockwise to decrease.

### 2. Steer;

Install a high pressure gauge at the port marked "M5". Activate steer and adjust the relief valve to 2500 psi. The relief valve is located on the top of the main valve, the 5<sup>th</sup> relief valve down from the tank port. Turn clockwise to increase and counterclockwise to decrease.

### 3. Platform Level Up;

Install a high pressure gauge at the port marked "M3, located on the front face of the block at the top right corner. There is pressure trapped at this test port. To release this pressure, activate level down to the end of stroke. (the pressure in the up side goes to 0) This will allow you to snap a gauge on this port. Activate level up to the end of stroke, you should read 2800 psi. The level up relief valve is located on the top of the main valve and is the 1<sup>st</sup> relief valve to the left of the tank port. Turn clockwise to increase, and counterclockwise to decrease.

### 4. Platform Level Down;

Install a high pressure gauge at the port marked "M4, located at the front face, bottom right corner. To get a gauge on this point, activate level up to the end of stroke, (the pressure in the down side goes to 0) allowing you to snap on a gauge. Activate level down to the end of stroke, you should read 1800 psi. The level down relief valve is located on the top of the main valve and is the 2<sup>nd</sup> relief valve to the left of the tank port. Turn clockwise to increase, and counterclockwise to decrease.

### 5. Articulating Jib Up;

Install a high pressure gauge on "M" port of jib block, located on the left side of the main valve. Activate jib up, reading should be 2500 psi. The up relief valve is the front

cartridge on the jib block. Turn clockwise to increase, counterclockwise to decrease.

**6. Articulating Jib Down;**

Install a high pressure gauge on the “M” port of the jib block, located on the left side of the main valve. Activate jib down, reading should be 1200 psi. The down relief valve is the back cartridge on the jib block. Turn clockwise to increase, counterclockwise to decrease.

**7. The Bang-Bang Main Relief Valve;**

This valve will need to be reset from 3000 psi to 2500 psi. Install a high pressure gauge at the port marked “M1” located behind the tank port. Activate telescope in. Adjust the valve to 2500 psi. This valve is located on the top of the main valve, the 3<sup>rd</sup>. relief valve to the left of the tank port. Turn clockwise to increase, counterclockwise to decrease.

**8. The Proportional Main Relief Valve;**

Install a high pressure gauge at the port marked “M2” located on top of the main valve in front of the tank port. This relief valve is located on top of the main valve and is the 4<sup>th</sup>. relief valve to the left of the tank port. Adjust valve to 2750 psi. This is done by raising the boom to the end of stroke, or removing the hoses from ports #9 and #10 of the main valve and plugging the hoses and capping the ports. Activate lift up to read 2750 psi. Turn clockwise to increase and counterclockwise to decrease. Leave the hoses plugged and ports capped for lift down.

**9. Lift Down;**

Install a high pressure gauge at the port marked “M2”, located on top of the main valve in front of the tank port. The relief valve is located on top of the main valve and is the 6<sup>th</sup>. relief valve to the left of the tank port. This relief valve should be adjusted to 1600 psi. Activate lift down. Turn clockwise to increase, counterclockwise to decrease. Connect the hoses to the lift section.

**10. Swing;**

Left and right swing are done with (1) adjustment. Install a high pressure gauge at the port marked “MS”, located on the front face of the main valve at far left corner. The relief valve is located on top of the main valve and is the #7 relief valve to the left of the tank port. adjust relief valve to 1600 psi. This can done by using the turntable lock, or removing the wires from the swing valve, or by removing the hoses from ports #11 and #12 of the main valve, plugging the hoses and capping the ports. Activate swing in either direction. Turn clockwise to increase, counterclockwise to decrease.

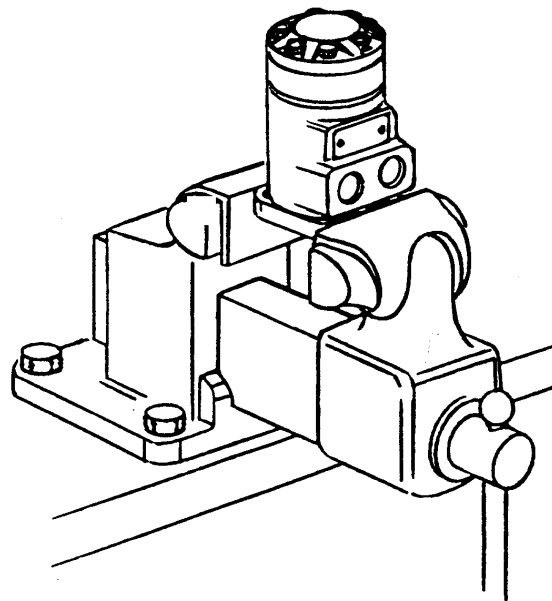
**5.5 HYDRAULIC MOTOR REPAIR (H SERIES CHAR-LYNN)**

Cleanliness is extremely important when repairing these motors. Work in a clean area. Before disconnecting lines, clean port area of motor. Remove key when used. Check shaft and key slot. Remove burrs, nicks, and sharp edges. Before disassembly, drain oil from motor. Then plug ports and thoroughly clean exterior of motor.

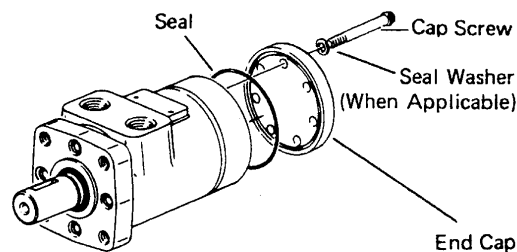
Although not all drawings show the motor in a vise, we recommend that you keep the motor in a vise during disassembly. Follow the clamping procedure explained throughout the manual.

**Disassembly**

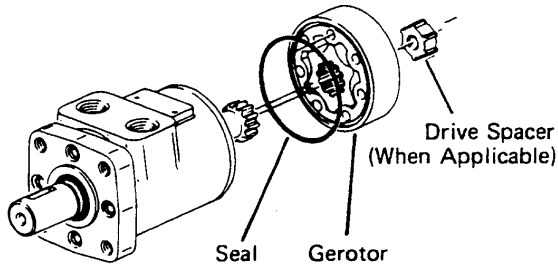
1. Place motor in a vise and clamp across edge of flange with output shaft down. When clamping, use protection devise on vise such as special soft jaws, pieces of rubber or board.



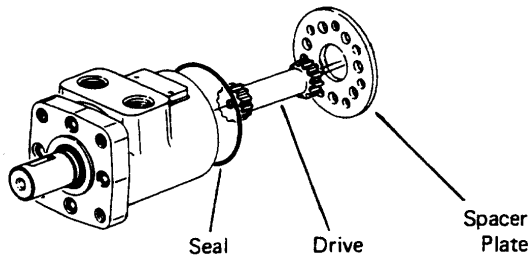
2. Remove cap screws and seal washers (when applicable).



3. Remove end cap.
4. Remove seal from end cap.
5. Remove gerotor.
6. Remove seal from gerotor.

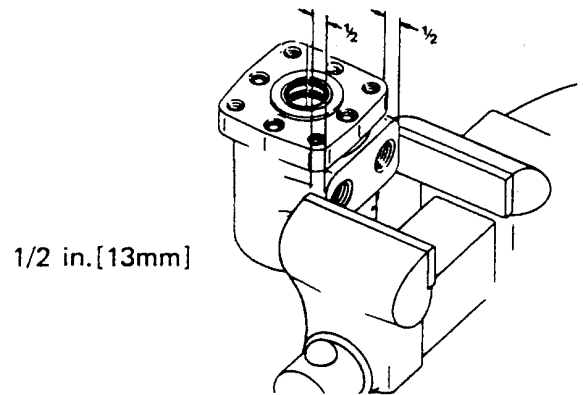


7. Remove driver spacer if applicable.



8. Remove drive.
9. Remove spacer plate.
10. Remove seal from housing.
11. Remove output shaft from housing.
12. Remove needle thrust bearing from shaft or housing.
13. Reposition motor in vise. Clamp across ports as shown. Do not clamp on side of housing. Excessive

clamping pressure on side of housing causes distortion.

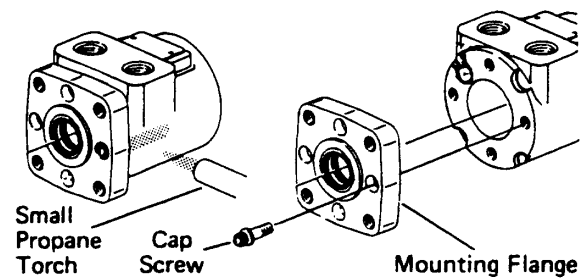


14. Remove cap screws from mounting flange. These screws are assembled with Loctite to hold them in place. The screws will require 300- 400 in-lbs (11 Nm) of torque to break loose and 100 in-lbs to remove. Do not use impact wrench on Loctite screws. This could result in rounded heads or broken sockets.

**NOTE:** If torque higher than given above is required to break screws loose, apply heat according to following instructions:

When heated, Loctite partially melts. This reduces torque required to remove screw. Use small propane torch to heat small area of housing where screws enter. Be careful not to overheat housing and damage motor. Gradually apply torque to screw with socket wrench as heat is applied for 8 to 10 seconds. Continue turning screw until it is completely removed.

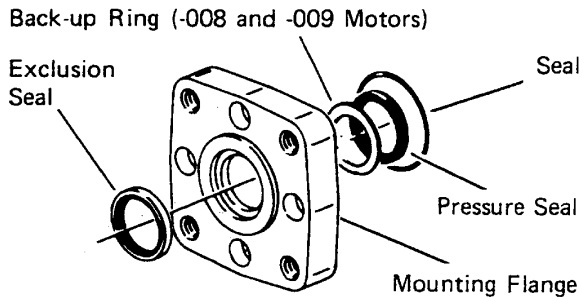
15. Carefully remove flange from housing.



**NOTICE**

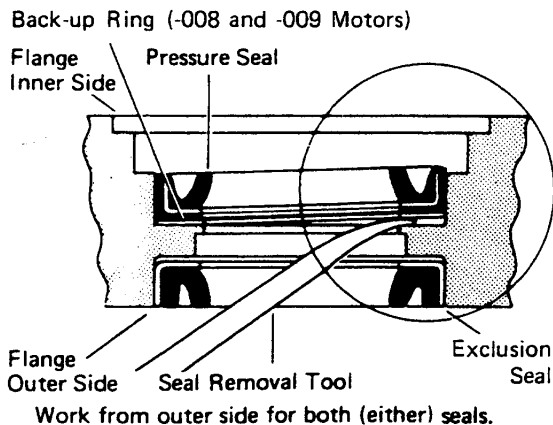
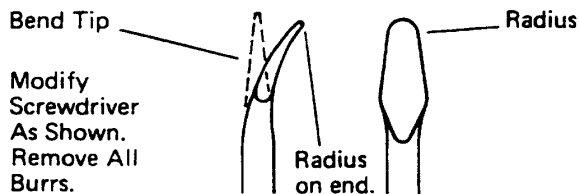
SOME MOTORS MAY HAVE A QUAD SEAL AND BACK - UP RING IN PLACE OF THE PRESSURE SEAL. THE QUAD SEAL AND BACK - UP RING ARE NO LONGER AVAILABLE AND ARE REPLACED BY THE PRESSURE SEAL. THEY ARE INTERCHANGEABLE, BUT SOME PRECAUTIONS MUST BE TAKEN TO INSURE PROPER INSTALLATION. FOLLOW THE REASSEMBLY INSTRUCTIONS.

16. Exclusion seal, back -up ring, pressure seal and seal will come off with flange. Use seal removal tool, to remove exclusion and pressure seals.

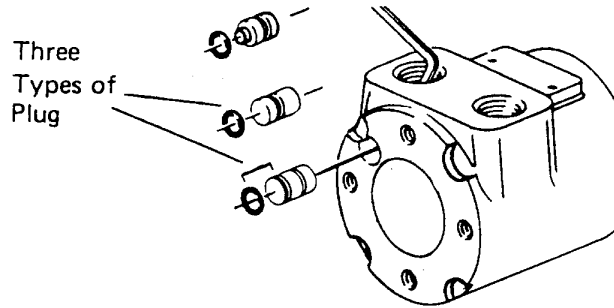


**NOTICE**

BE CAREFUL NOT TO SCRATCH SEAL CAVITY O.D. THIS COULD CREATE A LEAK PATH.



17. A metal plug, with seal, plugs a machining hole in the housing. It is not necessary to remove plug and replace seal unless leakage occurs around plug. To remove plug, insert 3/16 in. (5mm) hex key through port opening and push it out. The 009 plug is not interchangeable with 007 and 008 plugs.



**Reassembly Shaft End**

Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage or damage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe parts with cloth or paper towel because lint or other matter could get into hydraulic system and cause damage.

Check around key slot and chamfered area of shaft for burrs, nicks or sharp edges that could damage seals during reassembly. Remove nicks or burrs with a hard smooth stone (such as an Arkansas stone). Do not file or grind motor parts.

**NOTE:** Lubricate all seals with petroleum jelly. Use new seals when reassembly motor. Refer to parts list 6-121 for proper seal kit numbers.

**NOTICE**

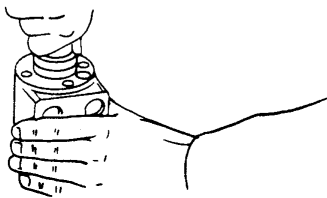
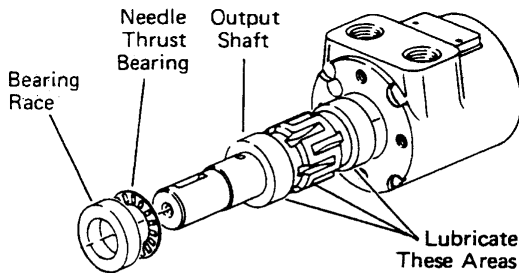
**DO NOT STRETCH SEALS BEFORE INSTALLING THEM.**

Cleanliness is extremely important in the successful application of Loctite. Before Loctite can be applied, the parts should be cleaned as follows:

**NOTE:** Fully cured Loctite resists most solvents, oils, gasoline and kerosene and is not affected by cleaning operations. It is not necessary to remove cured Loctite that is securely bonded in tapped holes; however, any loose particles of cured Loctite should be removed.

- a. Wash the housing in solvent to remove oils, grease and debris. Pay particular attention to four tapped holes on flange end.
- b. Blow dry with compressed air. Clean and dry tapped holes.

- c. Wire brush screw threads to remove cured Loctite and other debris. Discard any screws that have damaged threads or rounded heads.
  - d. Wash screws with non - petroleum base solvent. Blow dry with compressed air.
1. If you remove plug and seal, lubricate new seal and install on plug. Some plugs have two o-ring grooves but require only one o-ring. Install o-ring groove closest to end of plug. Push plug into housing so plug and housing are flush. Be careful not to damage seal.



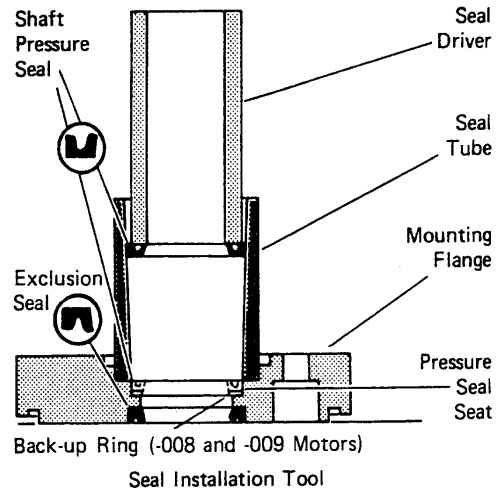
2. Lubricate output shaft with hydraulic oil, then install shaft in housing.

**NOTICE**

DO NOT PERMIT OIL TO GET INTO THE FOUR TAPPED HOLES.

3. Install needle thrust bearing, then bearing race on shaft. Pull shaft part way out of the housing. Push all three parts in housing together. The bearing race must rotate freely when in position.

4. Install exclusion seal in flange. Carefully press exclusion seal into place.



5. Visually check seal seat in mounting flange for scratches or other marks that might damage the pressure seal. Check for cracks in flange that could cause leakage.
6. Lubricate I.D. of seal tube and O.D. of shaft pressure seal with light film of clean petroleum jelly. Align small I.d. end of seal tube with seal seat in mounting flange. Install back - up ring and pressure seal in tube with lips of seal face up. See Figure 2-46. Insert seal driver in tube and firmly push seal seat with a rotating action.

**NOTICE**

AFTER INSTALLING SEAL IN FLANGE, EXAMINE SEAL CONDITION. IF DAMAGED OR IMPROPERLY INSTALLED, YOU MUST REPLACE IT BEFORE CONTINUING WITH REASSEMBLY.

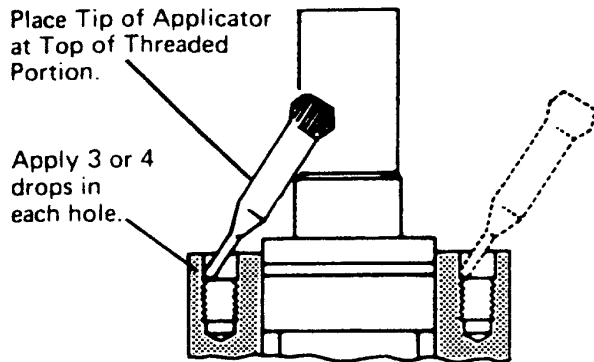
7. Install 1 5/16 in. (49 mm) I.D. seal in flange.
8. It is recommended to apply a light coat of Loctite Primer NF in tapped holes of housing. Allow primer to air dry for at least 1 minute. Do not force dry with air jet; the primer will blow away.

Use of primer is optional. With primer, Loctite curing time is approximately 15 minutes. Without primer, curing time is approximately 6 hours.

## SECTION 5 - HYDRAULICS

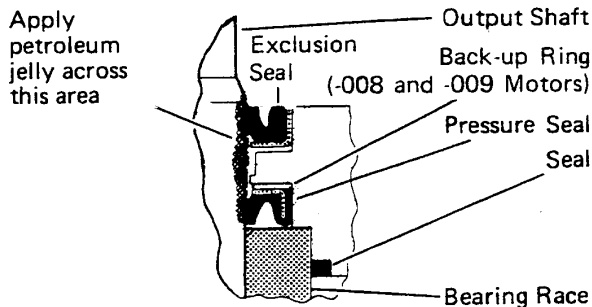
- Apply 3 or 4 drops of Loctite sealant at top of thread for each of four holes in housing. Do not allow parts with Loctite applied to come in contact with any metal parts other than those for assembly. Wipe off excess Loctite from housing face, using a non-petroleum base solvent.

Do not apply Loctite to threads more than 15 minutes before installing screws. If housing for more than 15 minutes, repeat application. No additional cleaning or removal of previously applied Loctite is necessary.



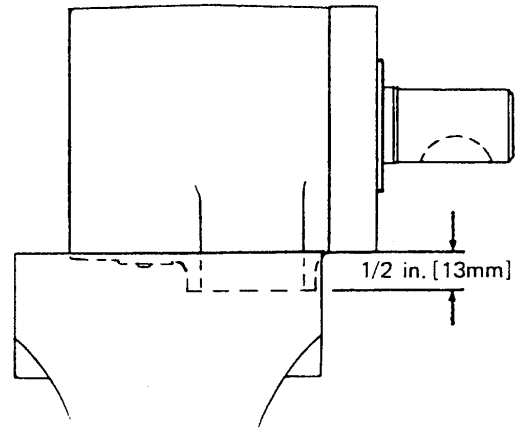
- Before installing flange and seal assembly over shaft, place protective sleeve or bullet over shaft. Then lubricate space between exclusion seal and pressure seal, as well as lips of both seals.

Install flange. Rotate flange slowly while pushing down over shaft. Be careful not to invert or damage seals.



- After removing bullet, clamp motor in vise as shown in Figure 2-49. Make sure shaft cannot fall out. Install **dry** screws and alternately torque them immediately to 250 in-lbs (28 Nm). If you use primer, allow to cure for **10 to 15 minutes**. Without primer, allow 6 hours curing time before subjecting motor to high torque reversals. On all other applications, you can run motor immediately.

If you use new screws, make sure they are the correct length: 7/8 in. (22mm) under head length. See parts list for correct part number.



### Gerotor End

- Reposition motor with gerotor end up, then clamp across ports. Do not clamp on side of housing.

#### **NOTICE**

**TO AID INSTALLATION OF SEALS, APPLY LIGHT COAT OF CLEAN PETROLEUM JELLY TP SEALS. DO NOT STRETCH SEALS BEFORE INSTALLING THEM IN GROOVE.**

- Pour approximately 35 cc of clean hydraulic oil in output shaft cavity.
- Install 2 7/8 in. (73 mm) I.D. seal in housing seal groove. Avoid twisting seal.



### Timing Procedure

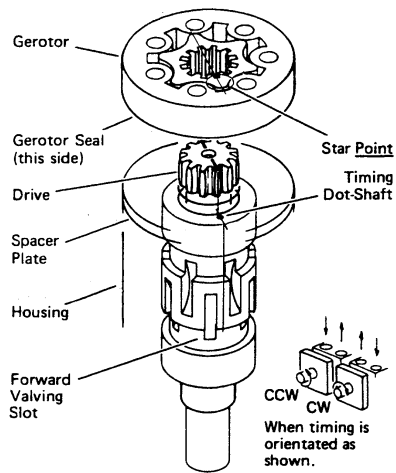
- a. Install drive. Use felt tip marker to mark one tooth. Align this tooth with timing dot on shaft.

**NOTE:** If drive is not symmetrical, install larger splined end into shaft.

- b. Install spacer plate.
- c. Install 2 7/8 in. (73 mm) I.D. seal in gerotor seal groove. Carefully place gerotor on spacer plate, seal side toward spacer plate.

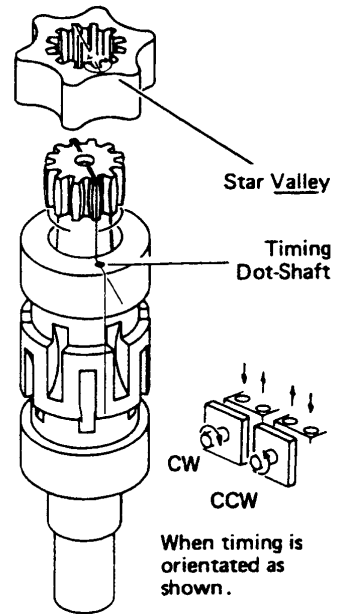
### Standard Rotation

Align any star point with tooth marked on drive.



### Reverse Rotation

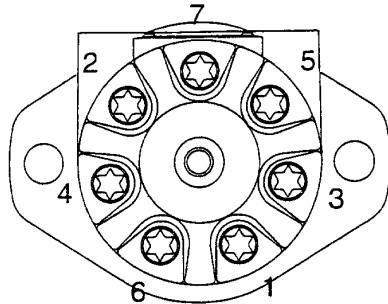
Align any star valley with marked tooth.



15. Rotate gerotor to line up with bolt holes. Be careful not to disengage star from drive or disturb gerotor seal.

## SECTION 5 - HYDRAULICS

16. Install drive spacer if applicable.
17. Install 2 7/8 in. (73 mm) seal in end cap. Carefully place end cap on gerotor.
18. Install cap screws and seal washers (if applicable) in end cap. Pretighten screws to 40 in-lbs (4 Nm). Make sure seals are properly seated. Then torque screws 235 - 250 in - lbs (27 - 28 Nm) in sequence.



Bolt Torquing Sequence

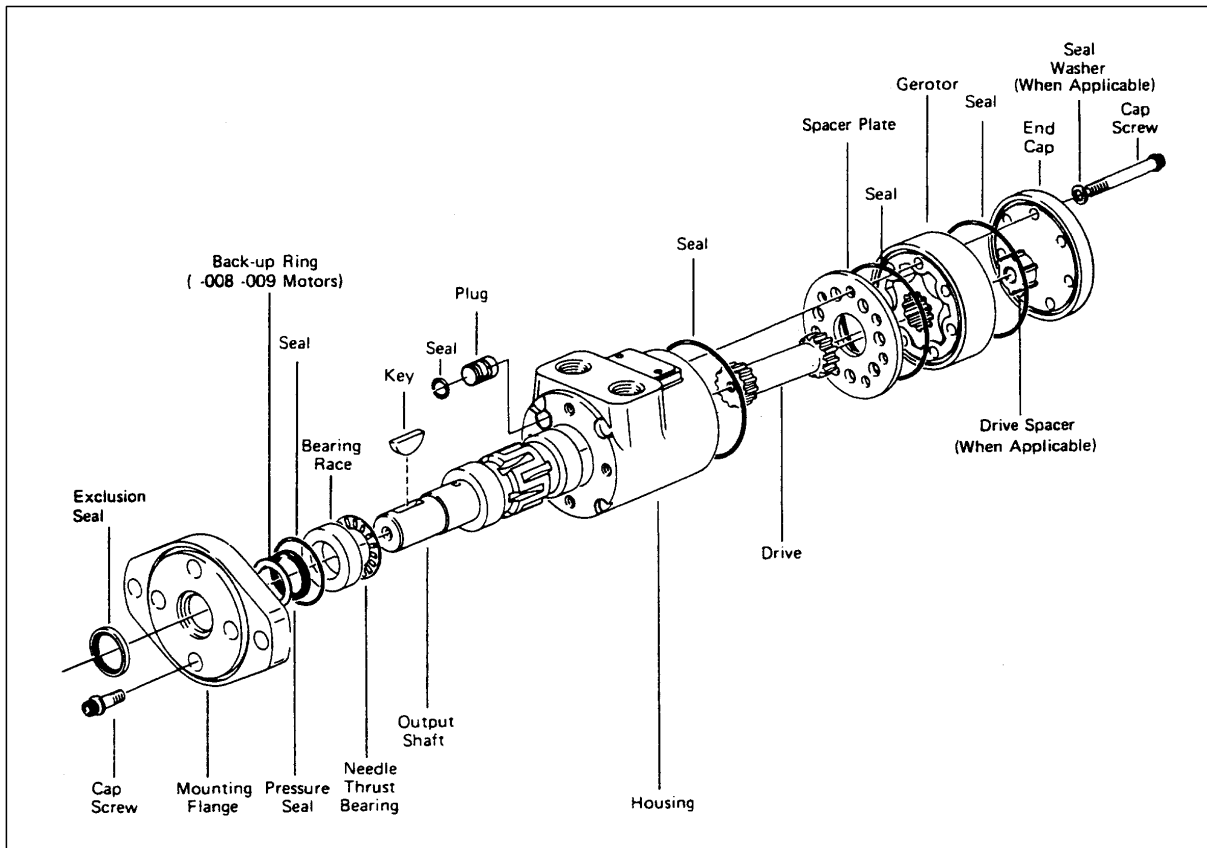


Figure 5-24. Char-Lynn H Series Hydraulic Motor

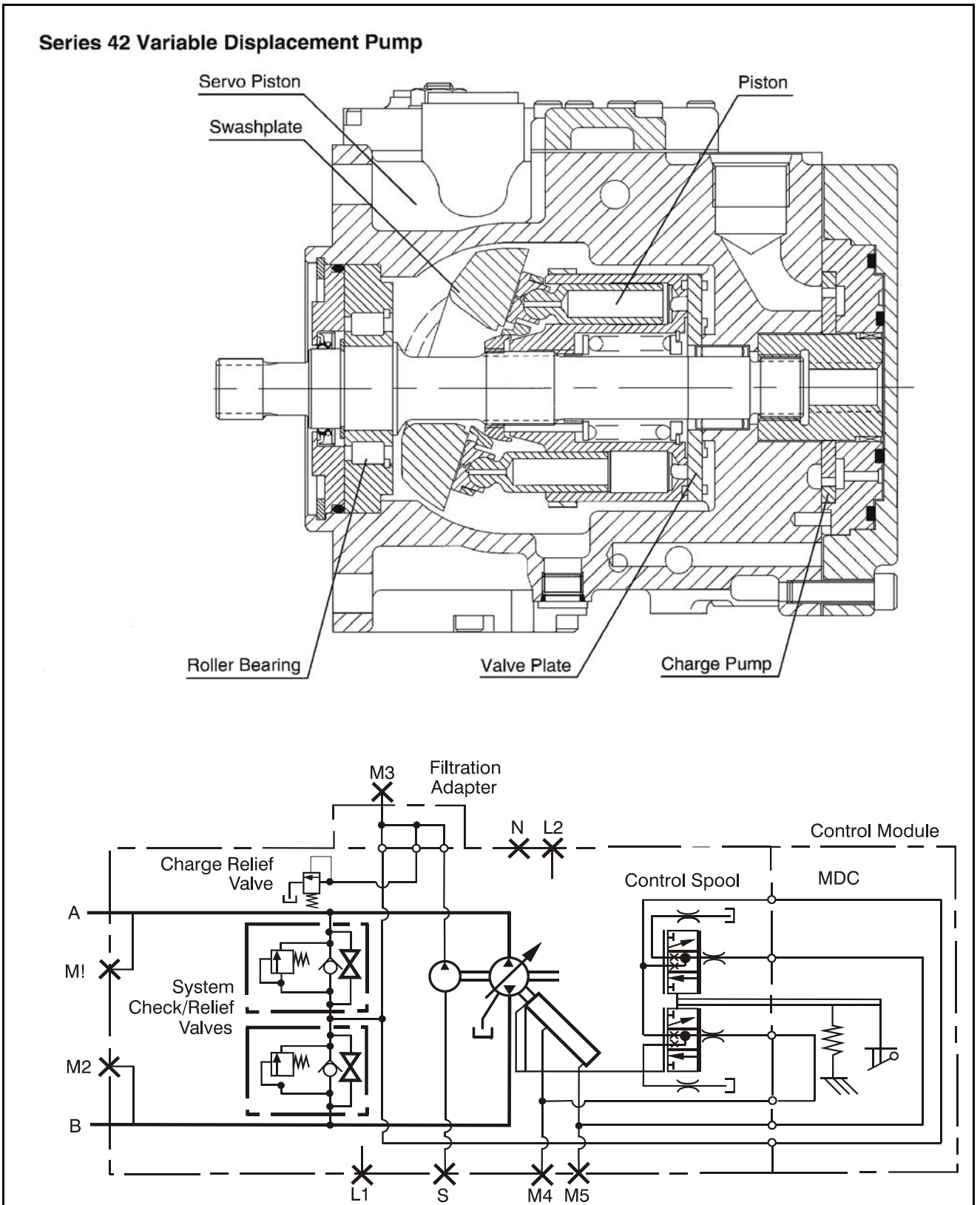


Figure 5-25. Variable Displacement Hydraulic Pump.

## 5.6 HYDRAULIC PUMP “NEUTRAL” OR NULL ADJUSTMENT

The pump neutral or null adjustment sets the position of the servo piston and pump swash plate relative to the controlling mechanism.

### **⚠ WARNING**

**THE FOLLOWING PROCEDURE REQUIRES THE MACHINE TO BE DISABLED (WHEELS RAISED OFF OF THE GROUND, WORK FUNCTION DISCONNECTED, ETC.) WHILE PERFORMING THE PROCEDURE IN ORDER TO PREVENT INJURY TO THE TECHNICIAN AND OTHER PERSONNEL.**

1. Disconnect machine function.(raise wheels off ground, or chock wheels and disconnect hubs)
2. Connect a hose between gauge ports M4 and M5 to equalize the pressure on both ends of the servo piston.
3. Install pressure gauges in gauge ports M1 and M2 to measure system pressure.
4. Start the engine and operate at Mid speed.
5. Loosen the pump “neutral” or null adjustment seal lock nut. Turn the pump “neutral” adjustment screw until the system pressure gauge readings are equal.
6. Turn the adjustment screw clockwise until one of the gauges registers an increase in system pressure. Note the position of the adjustment screw. Turn the screw counterclockwise until the other gauge registers an increase in system pressure. Note the position of the adjustment screw.
7. Turn the adjustment screw clockwise to a position half-way between the position noted above. The system pressure gauges should indicate equal pressures.
8. While holding the adjustment screw in position, Torque the seal lock-nut 15-19 ft. lb.(20 Nm-25 Nm).L
9. Stop the prime mover and remove the hose between gauge ports M4 and M5. Remove the pressure gauges installed in gauge ports M1 and M2. Reinstall the plugs in the gauge ports.
10. Reconnect work function.

## 5.7 NON-FEEDBACK, PROPORTIONAL ELECTRICAL CONTROL - NFPE

The Non-Feedback Proportional Electric (NFPE) control is a hydraulic control in which an electric input signal activates one of two solenoids which port charge pressure to either side of the pump servo control cylinder.

Series 42 pumps equipped with an (NFPE) control have a special servo cylinder capable of providing proportional control with an electric input.

The pump displacement is proportional to the solenoid signal current, but is also dependent upon the pump input speed and system pressure. This characteristic provides a power limiting function by reducing the pump swash plate angle as system pressure increases. A typical response characteristic is shown in the accompanying graph.

### Features and Benefits of the NFPE Control

1. Electric Control.
2. Eliminates mechanical linkage for flexibility of control design.
3. Power limiting characteristic reduces machine power requirements.
4. Smooth operation.

### Input Signal requirements

The (NFPE) control requires a pulse-width-modulated (PWM) input current to optimize performance. The recommended PWM frequency is 200Hz. The minimum PWM frequency is 80Hz. Coil resistance is 5.6 Ohms at 22°C (72°F).

**Table 5-3. Pump Flow Direction with NFPE Control**

	Input Shaft Rotation			
	CW		CCW	
Higher Pressure into Control Port	A	B	A	B
Port “A” Flow	In	Out	Out	In
Port “B” Flow	Out	In	In	Out
High Servo Gauge Port	M4	M5	M4	M5

## 5.8 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

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

### **⚠ WARNING**

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

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

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

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

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

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

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

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

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

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

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

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

### **⚠ WARNING**

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

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

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

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

### **⚠ WARNING**

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

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

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

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

The machine is now ready for operation.

## SECTION 6. JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

### 6.1 INTRODUCTION

#### NOTICE

WHEN INSTALLING A NEW GROUND MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

#### NOTICE

IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based motor control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

The upper lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer, JLG part no. 1600244 & Cable, JLG part no. 1600633) which will display two lines of information at a time, by scrolling through the program.

**NOTE:** Each module has a label with the JLG part number and a serial number which contains a date code.

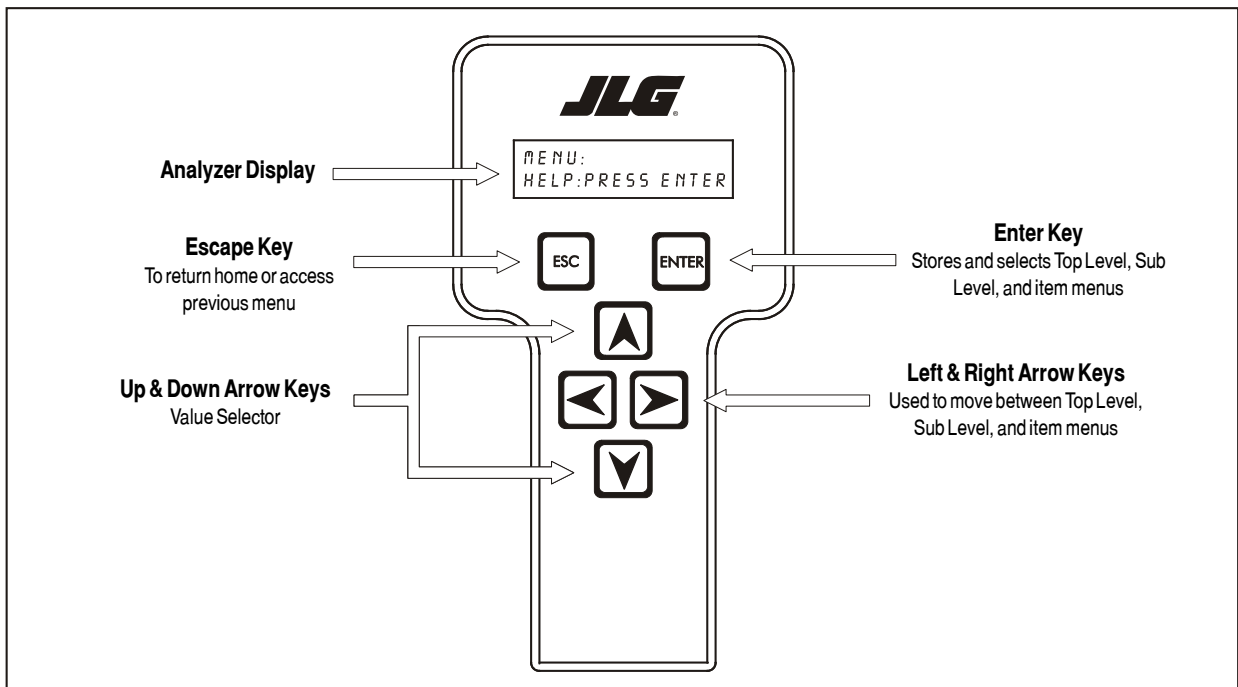
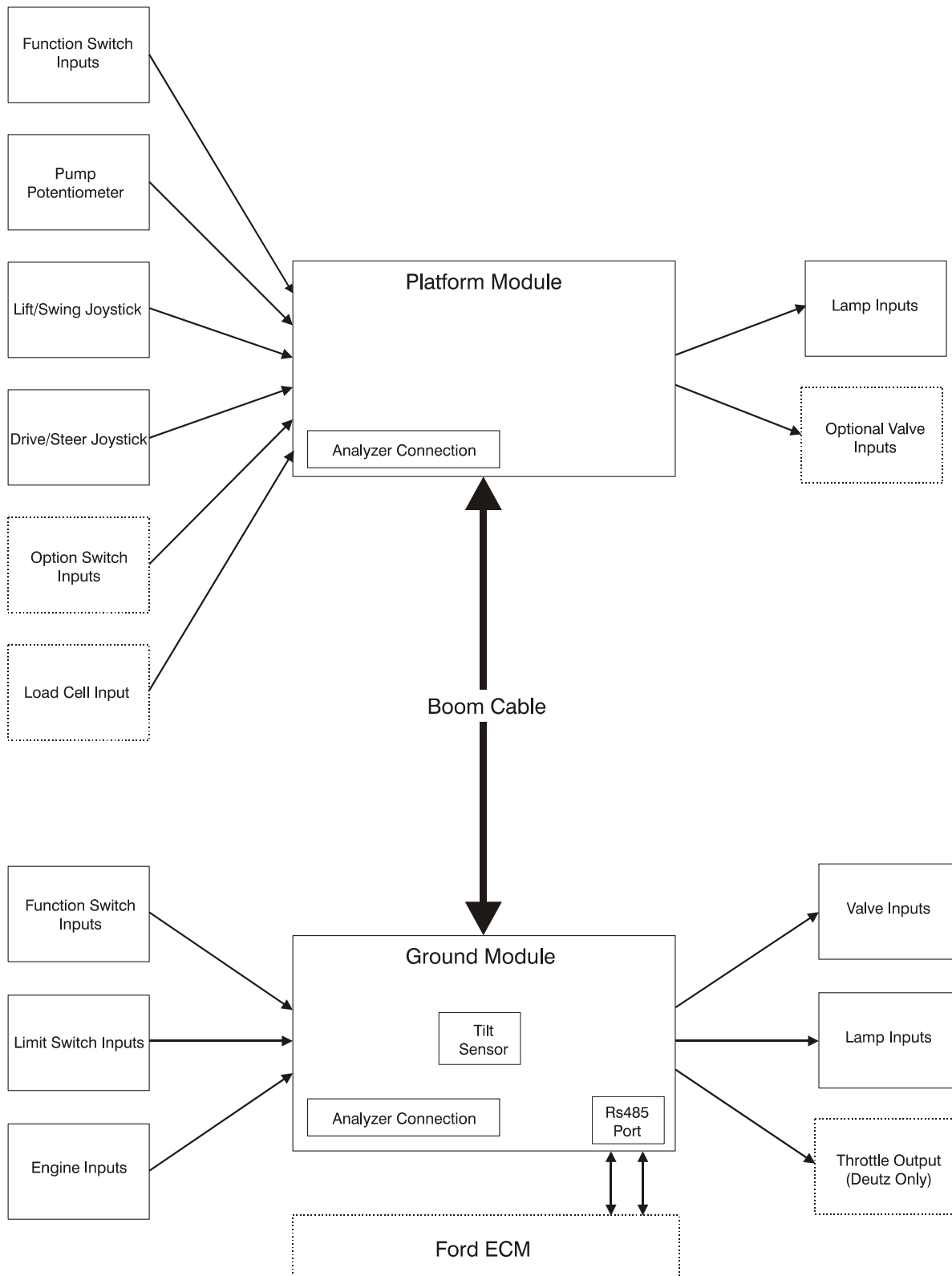


Figure 6-1. Hand Held Analyzer

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**



**Figure 6-2. ADE Block Diagram**



## 6.2 TO CONNECT THE JLG CONTROL SYSTEM ANALYZER

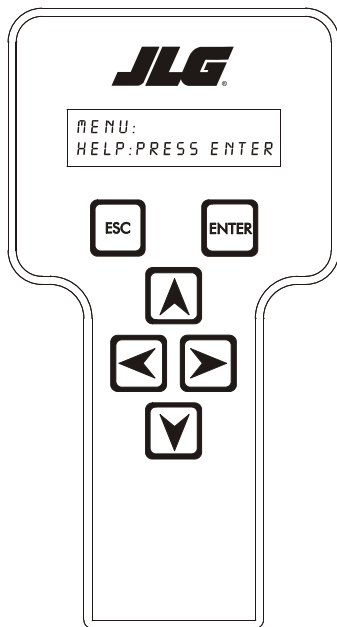
1. Connect the four pin end of the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

**NOTE:** The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.

2. Power up the Control System by turning the lower key to the platform or ground position and pulling both emergency stop buttons on.

## 6.3 USING THE ANALYZER

With the machine power on and the analyzer connected properly, the analyzer will display the following:



**HELP:  
PRESS ENTER**

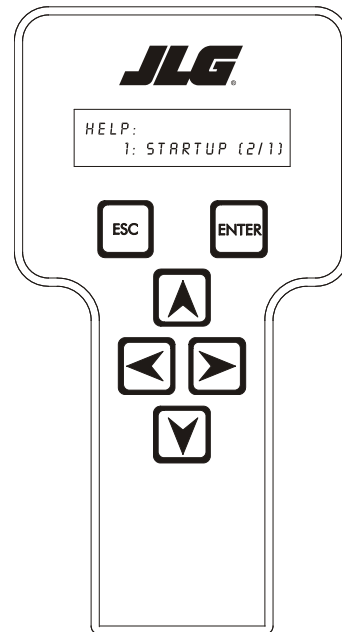
At this point, using the **RIGHT** and **LEFT** arrow keys, you can move between the top level menu items. To select a displayed menu item, press **ENTER**. To cancel a selected menu item, press **ESC**.; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

**HELP  
DIAGNOSTICS  
SYSTEM TEST  
ACCESS LEVEL  
PERSONALITIES  
MACHINE SETUP  
CALIBRATIONS (view only)**

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 there was no fault detected, the display will read: **HELP: EVERYTHING OK**. If powered up at the ground station, the display will read: **GROUND OK**.

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



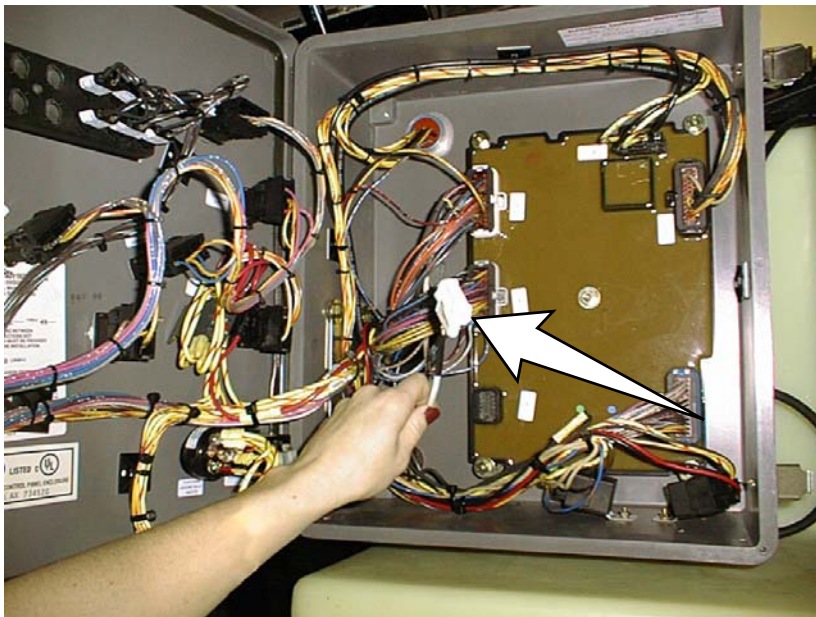
**LOGGED HELP  
1: POWER CYCLE (0/0)**

At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESC**. two times. **POWER CYCLE (0/0)** indicates a power up.

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**



**PLATFORM CONNECTION**



**GROUND CONTROL CONNECTION**

**Figure 6-3. Analyzer Connecting Points**

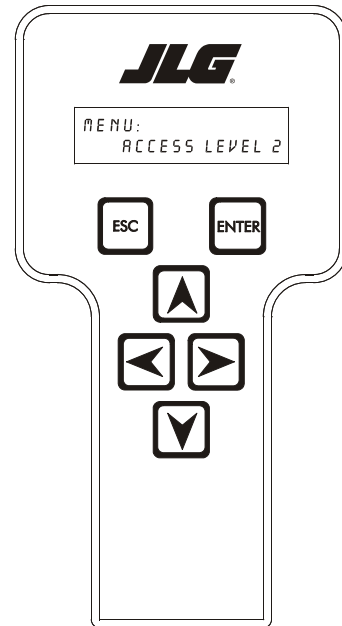
When a top level menu is selected, a new set of menu items may be offered: for example:

**DRIVE**  
**BOOM**  
**SYSTEM**  
**DATALOG**  
**VERSIONS**

Pressing **ENTER** with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected menu item by pressing the **ESC**. key.

#### 6.4 CHANGING THE ACCESS LEVEL OF THE HAND HELD ANALYZER

When the analyzer is first connected, you will be in access level 2 which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change the access level, the correct password must be entered. To enter the password, scroll to the **ACCESS LEVEL** menu. For example:



**MENU:**  
**ACCESS LEVEL 2**

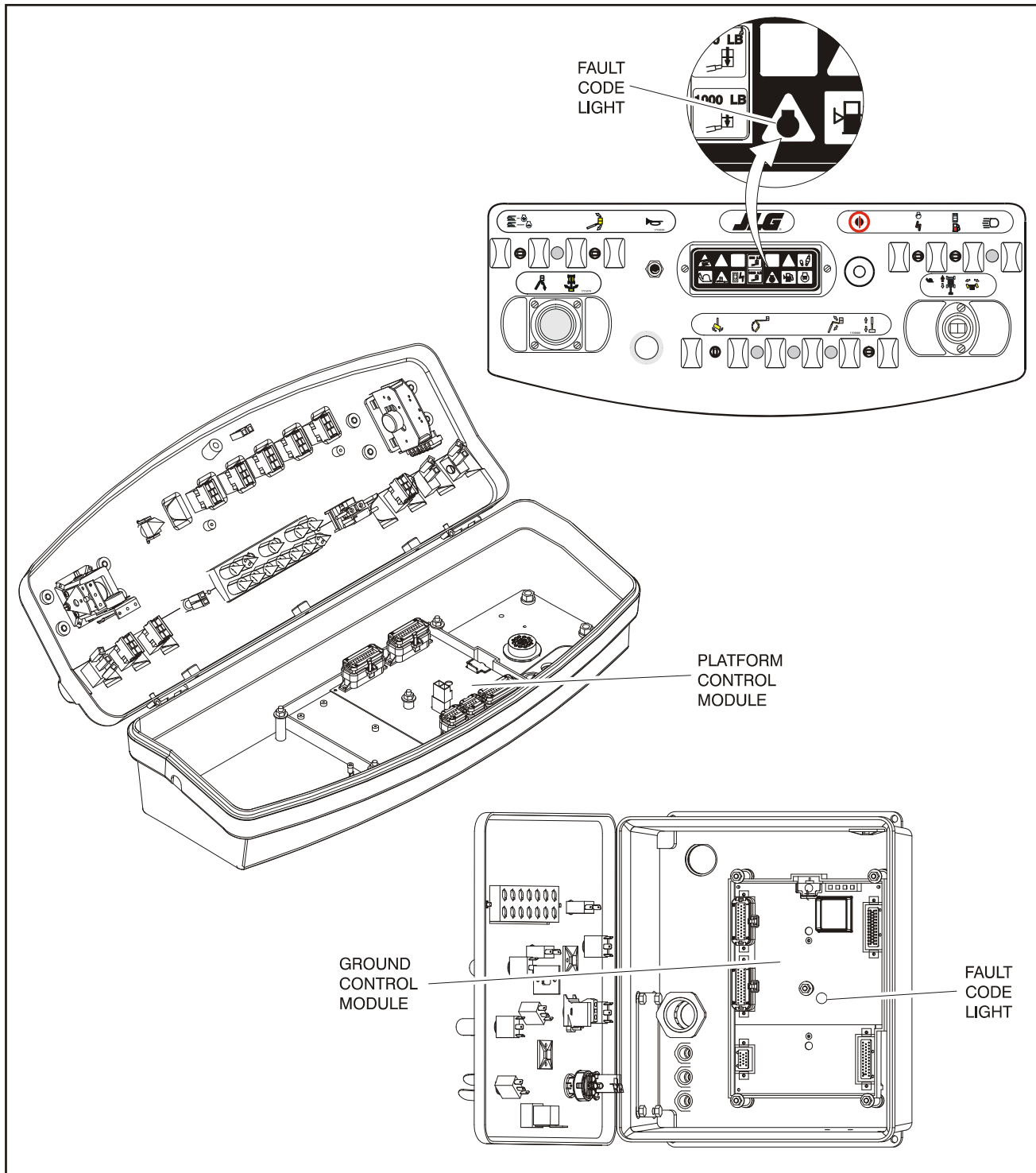
Press **ENTER** to select the **ACCESS LEVEL** menu.

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.

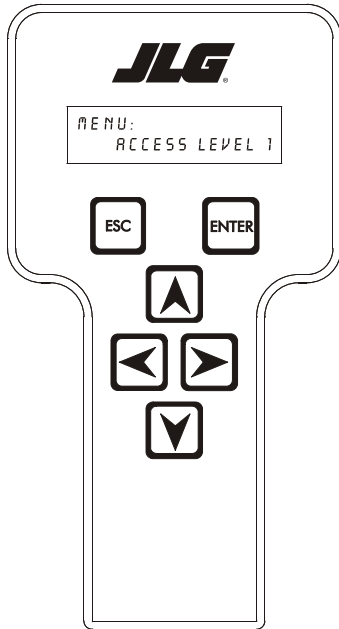
Use the **UP** or **DOWN** arrow key to enter the second digit of the password which is 33271.

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**



**Figure 6-4. Control Module Location**

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:

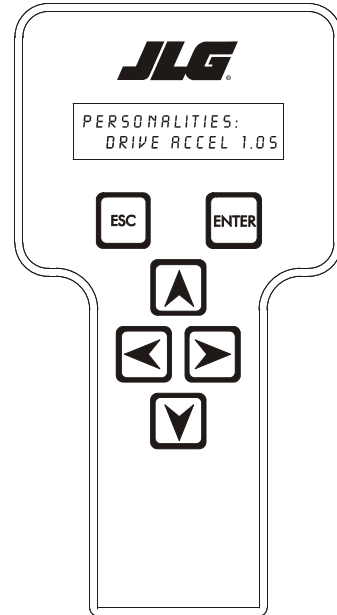


**MENU:  
ACCESS LEVEL 1**

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

## 6.5 ADJUSTING PARAMETERS USING THE HAND HELD ANALYZER

Once you have gained access to level 1, and a personality item is selected, press the **UP** or **DOWN** arrow keys to adjust its value, for example:

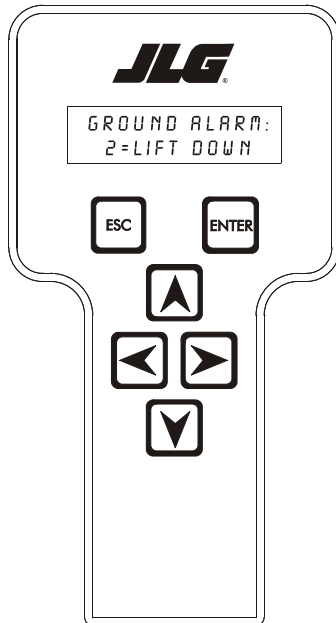


**PERSONALITIES:  
DRIVE ACCEL 1.0s**

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.

## 6.6 MACHINE SETUP

When a machine digit item is selected, press the UP or DOWN arrow keys to adjust its value, for example:



**GROUND ALARM:  
2 = LIFT DOWN**

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when lifting down. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

**NOTE:** Refer to Table 6-1, Personality Ranges/Defaults, and in this Service Manual for the recommended factory settings.

**NOTE:** Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

**ELEVATION CUTBACK**

**⚠ WARNING**

**CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.**

### NOTICE

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 (30.5CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

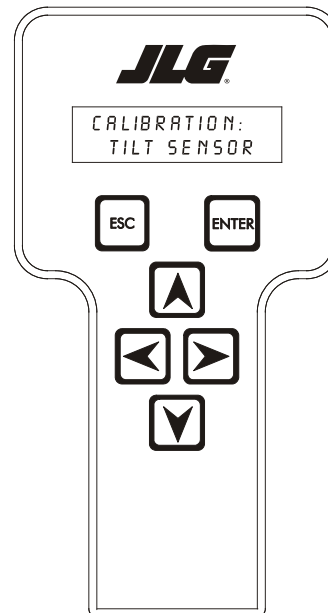
## 6.7 LEVEL VEHICLE DESCRIPTION

### NOTICE

A NEW TILT MODULE WILL ACT AS IF IT IS TILTED ALL OF THE TIME UNTIL THE FOLLOWING PROCEDURE IS PERFORMED.

### ⚠ WARNING

DO NOT CALIBRATE THE LEVEL SENSOR EXCEPT ON A LEVEL SURFACE.



Place machine in stowed position with the boom between the rear wheels.

To level machine chose:

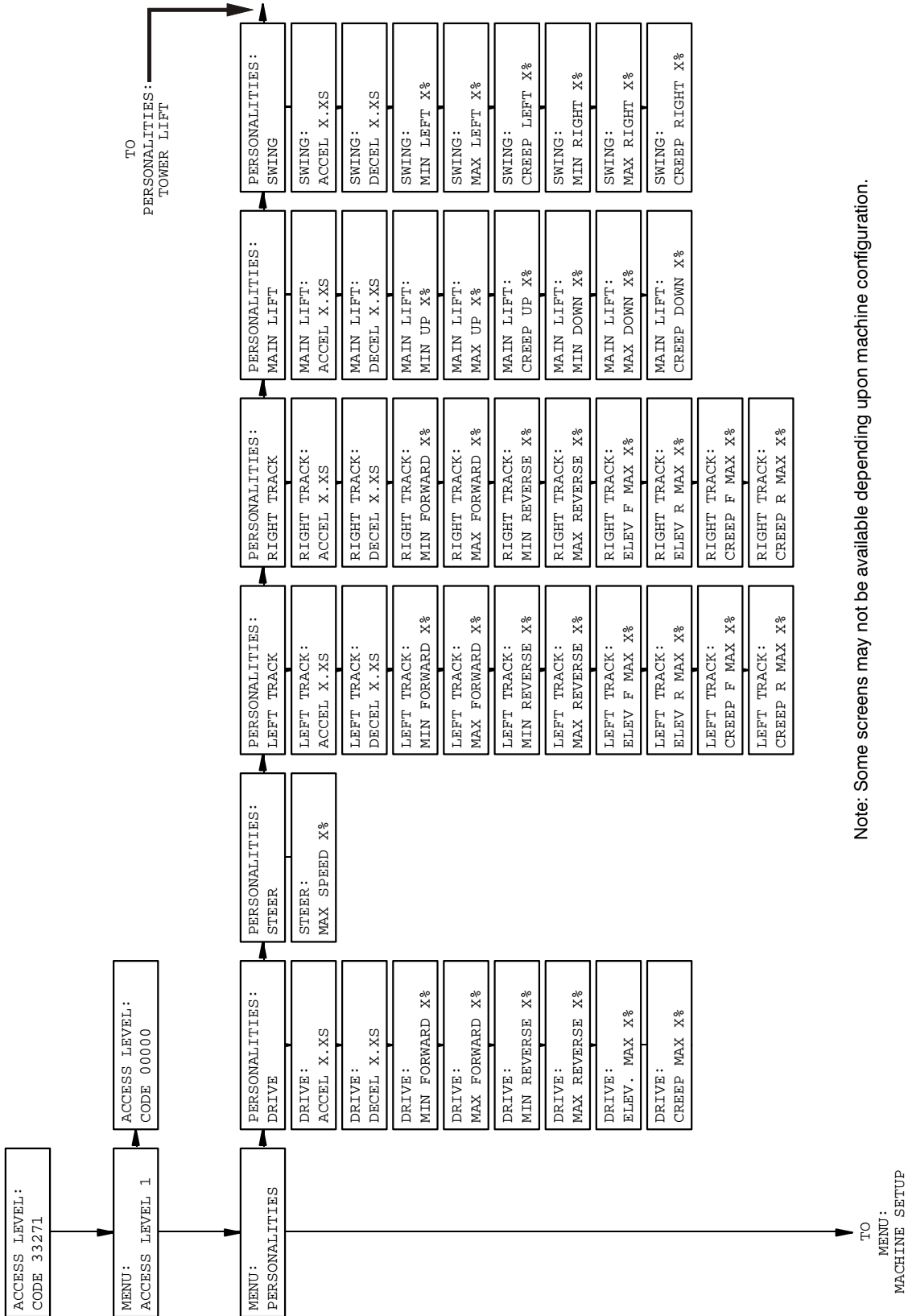
CALIBRATION:  
TILT SENSOR

Press ENTER.

When prompted, swing machine 180°

Press ENTER.

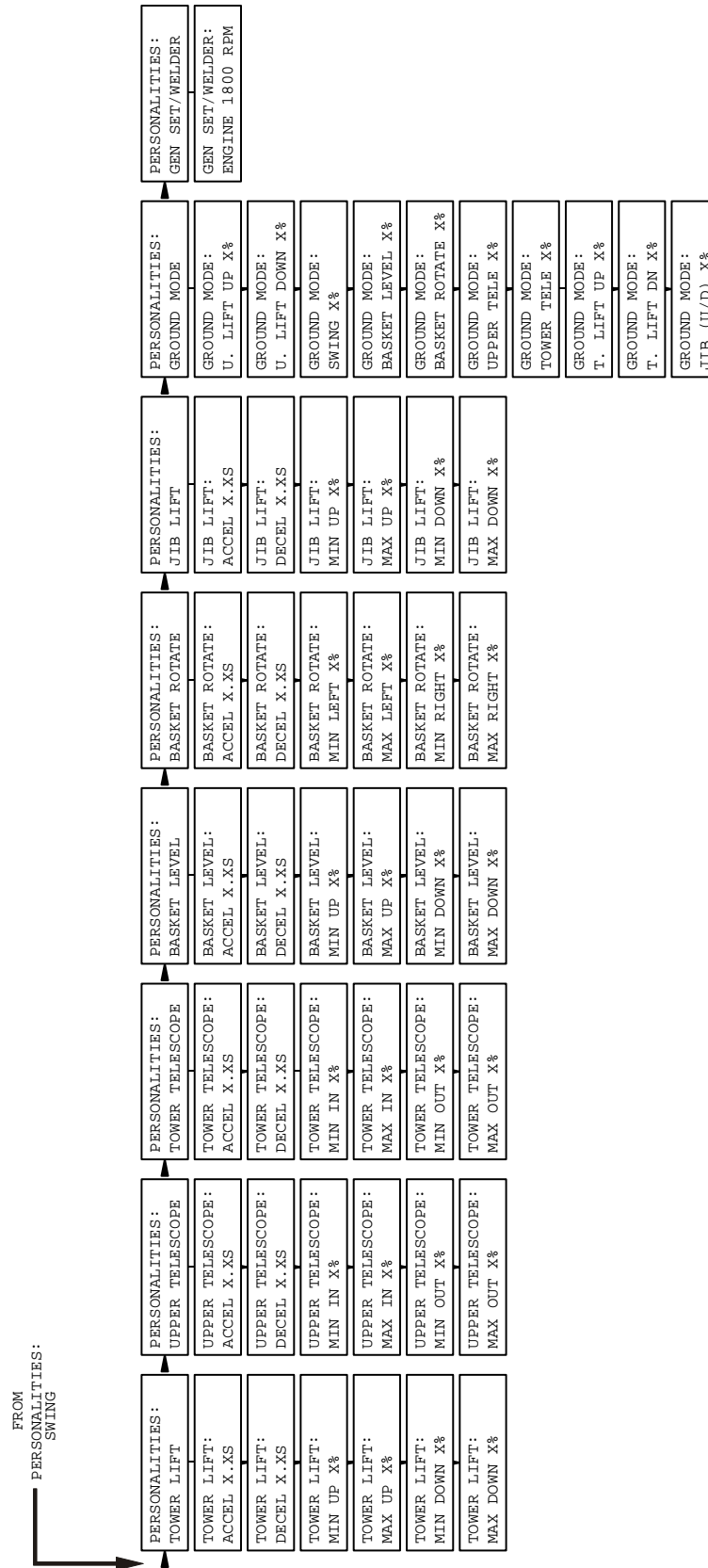
SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)



Note: Some screens may not be available depending upon machine configuration.

Figure 6-5. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 1 of 4

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**



**Figure 6-6. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 2 of 4**



SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

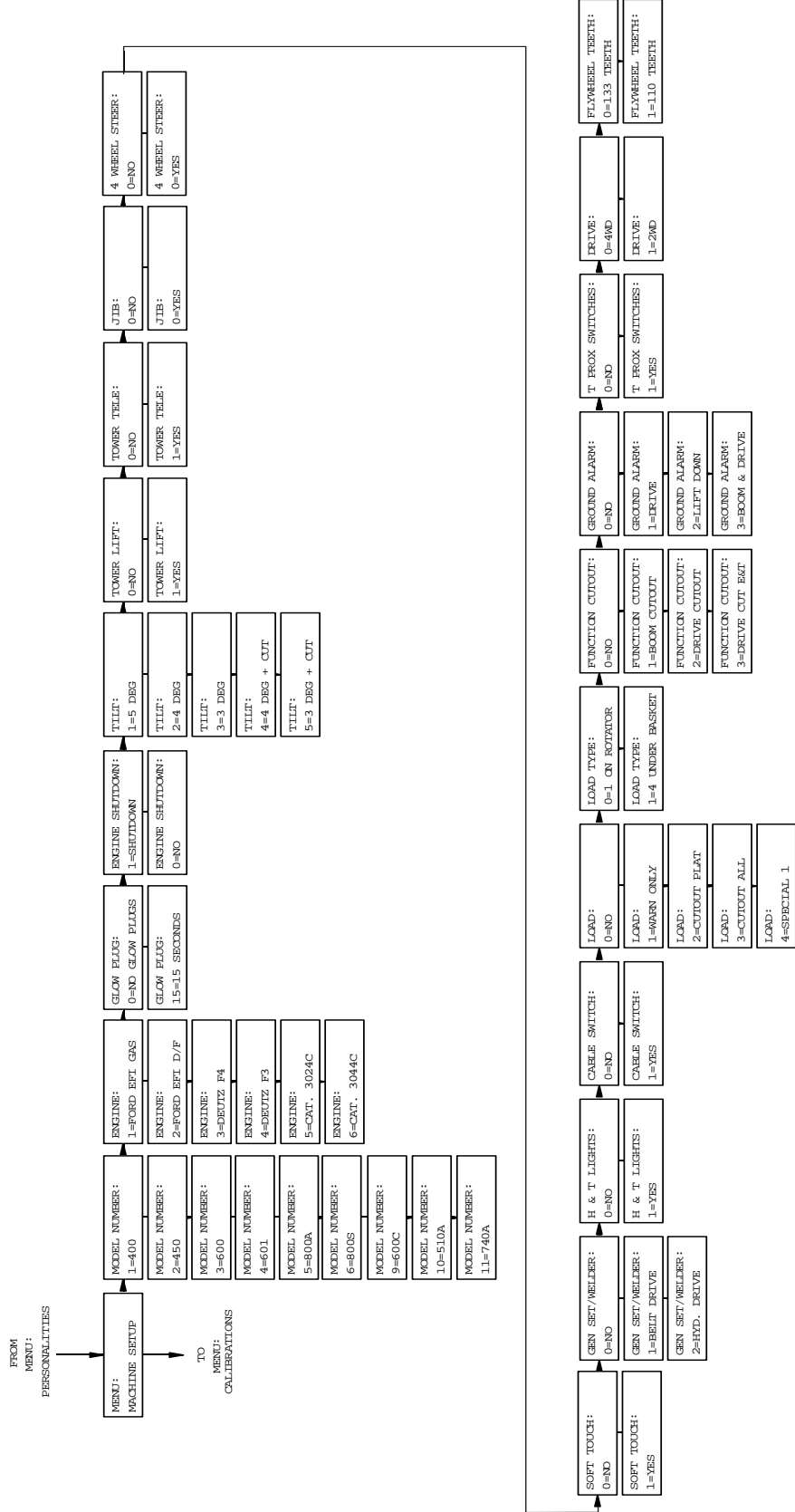
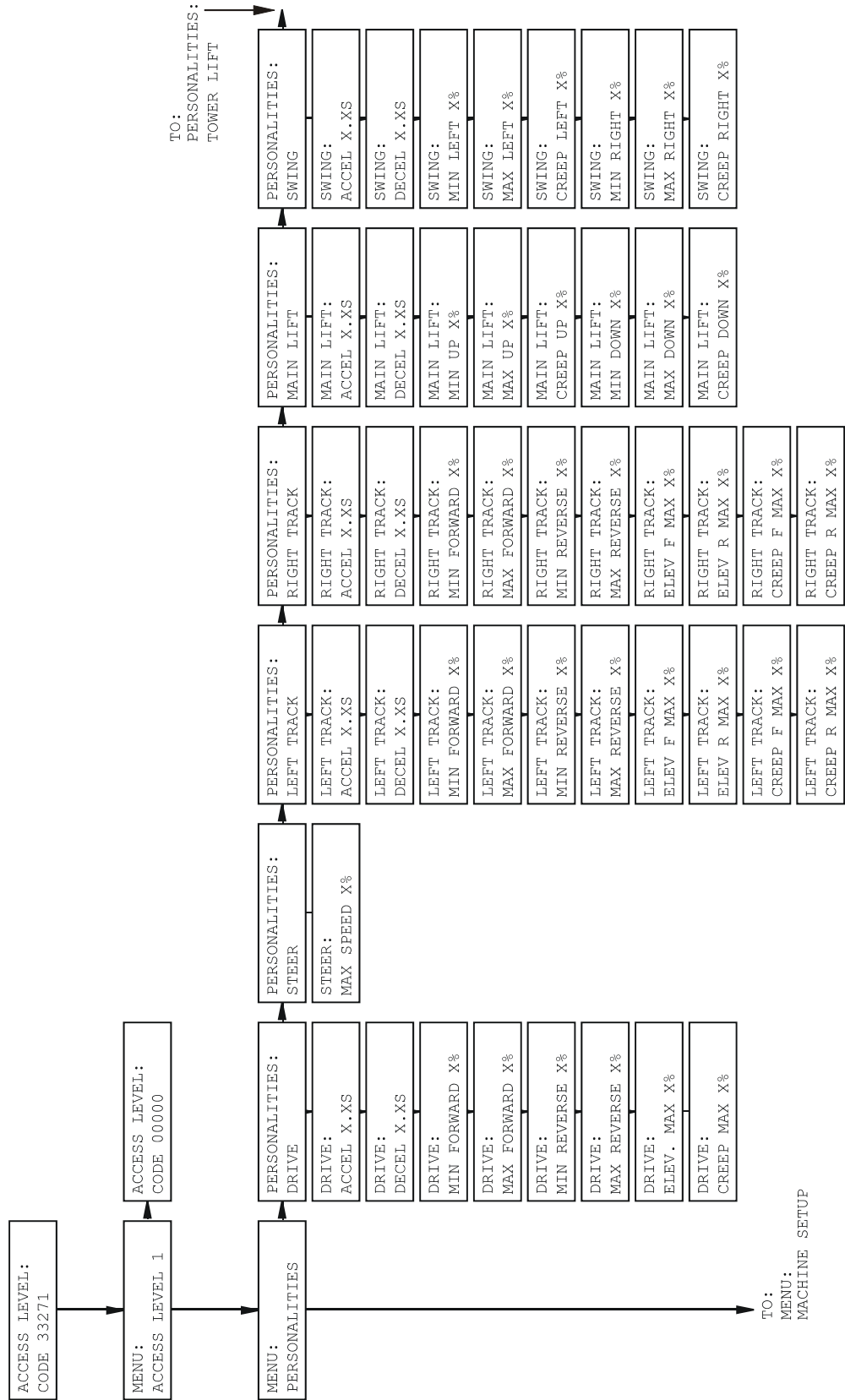


Figure 6-7. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 3 of 4



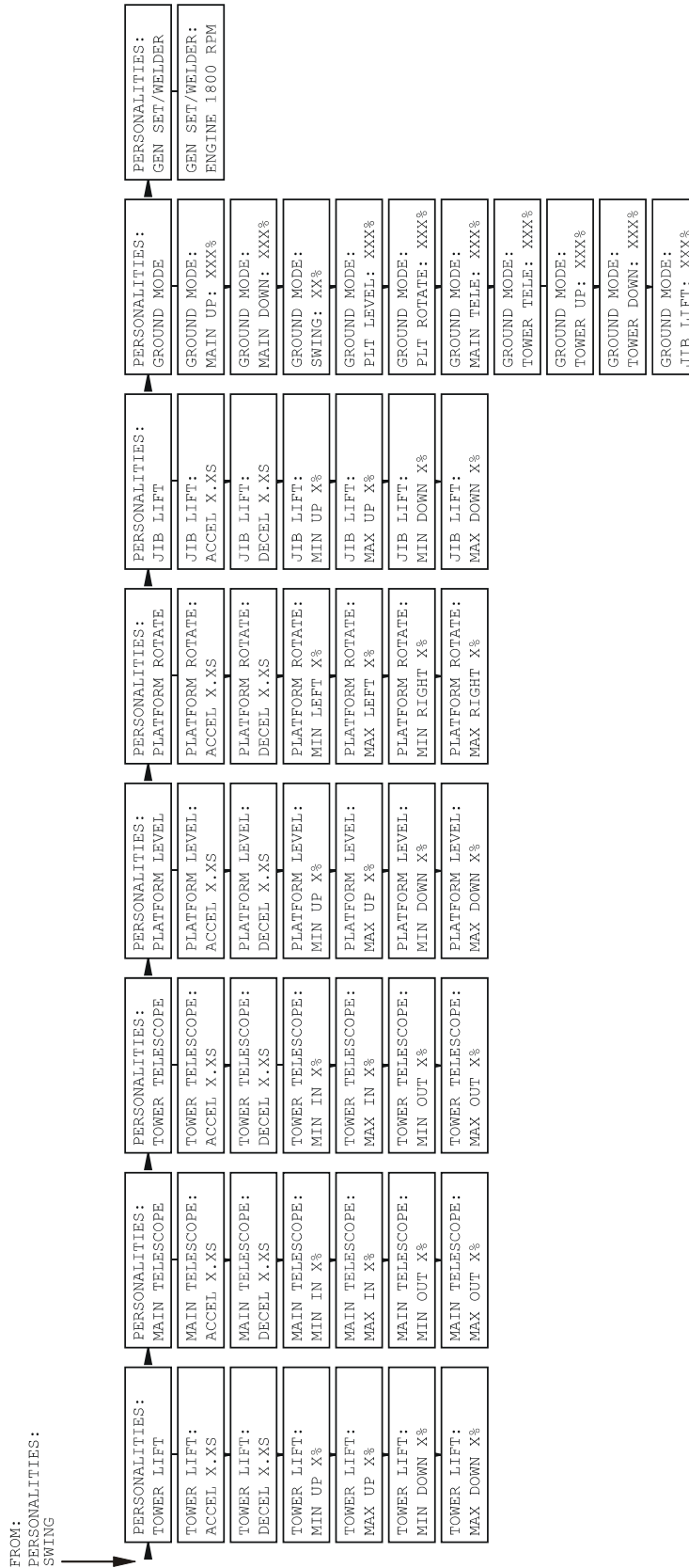
SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)



NOTE: Some screens may not be available depending upon machine configuration.

Figure 6-9. Analyzer Flow Chart, Version 5.X Software - Sheet 1 of 4

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**



**Figure 6-10. Analyzer Flow Chart, Version 5.X Software - Sheet 2 of 4**

SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

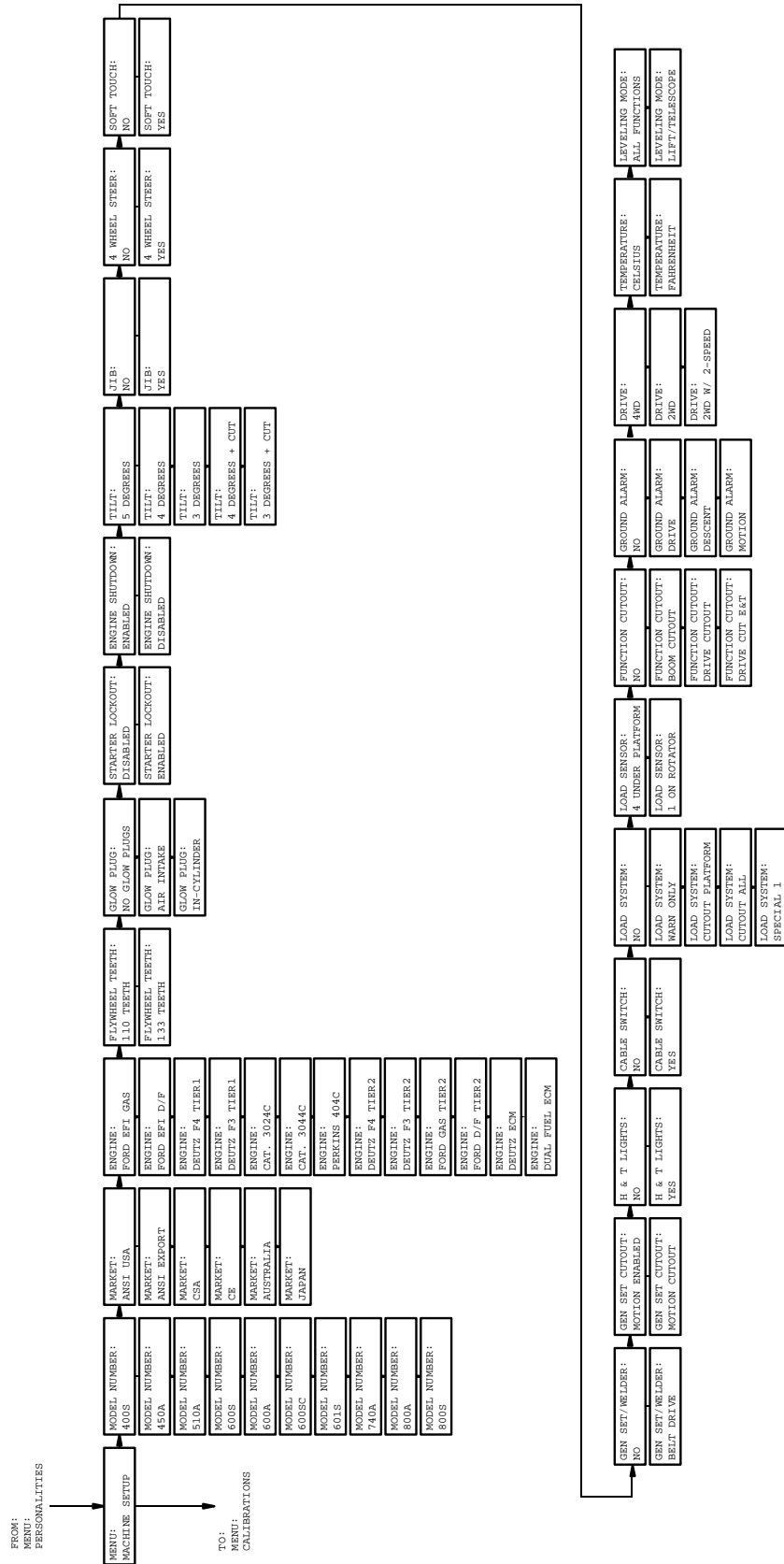


Figure 6-11. Analyzer Flow Chart, Version 5.X Software - Sheet 3 of 4

# SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

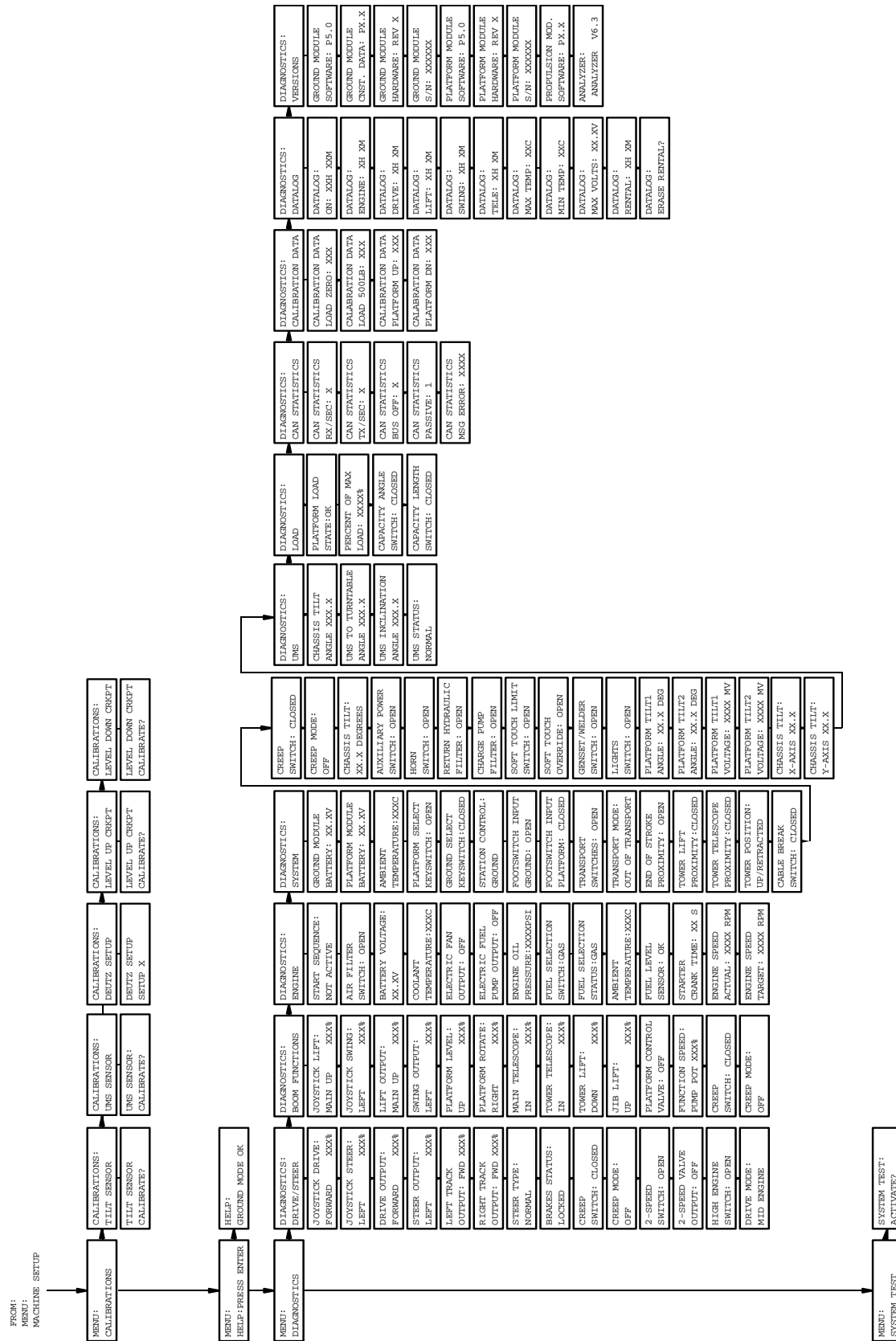


Figure 6-12. Analyzer Flow Chart, Version 5.X Software - Sheet 4 of 4

**6.8 MACHINE PERSONALITY SETTINGS**

*NOTE: Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.*

**Table 6-1. Personality Ranges/Defaults**

<b>FUNCTION</b>	<b>PERSONALITY</b>	<b>RANGE</b>	<b>DEFAULTS</b>
DRIVE	ACCEleration	0.1s to 5.0s	2.0
	DECEleration	0.1s to 3.0s	0.5
	Forward MINimum speed	0 to 35%	29
	Forward MAXimum speed	0 to 100%	49
	Reverse MINimum speed	0 to 35%	29
	Reverse MAXimum speed	0 to 100%	48
	ELEVATED MAXimum speed	0 to 50%	35
	CREEP MAXimum speed	0 to 50%	40
	Engine RPM	800 to 2900	1800
LIFT	ACCEleration	0.1 to 5.0	2.3
	DECEleration	0.1 to 3.0	1.1
	MINimum UP speed	0 to 60%	41
	MAXimum UP speed	0 to 100	80
	CREEP Maximum UP speed	0 to 65	49
	MINimum DOWN speed	0 to 60	43
	MAXimum DOWN speed	0 to 100	80
	CREEP maximum DOWN speed	0 to 75	49
	Engine RPM	800 to 2900	1800
SWING	ACCEleration	0.1 to 5.0s	4.8
	DECEleration	0.1 to 3.0s	2.0
	MINimum LEFT speed	0 to 50%	40
	MAXimum LEFT speed	0 to 100%	65
	CREEP maximum LEFT speed	0 to 65%	49
	MINimum RIGHT speed	0 to 50%	37
	MAXimum RIGHT speed	0 to 100%	63
	CREEP maximum RIGHT speed	0 to 65%	46
	Engine RPM	800 to 2900	1400

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-1. Personality Ranges/Defaults**

<b>FUNCTION</b>	<b>PERSONALITY</b>	<b>RANGE</b>	<b>DEFAULTS</b>
TELEscope	ACCEleration	0.1 to 5.0	2.8
	DECEleration	0.1 to 3.0	0.8
	MINimum IN speed	0 to 65	60
	MAXimum IN speed	0 to 100	100
	MINimum OUT speed	0 to 65	55
	MAXimum OUT speed	0 to 100	80
	Engine RPM	800 to 2900	1800
BASKET LEVEL	ACCEleration	0.1 to 5.0	2.5
	DECEleration	0.1 to 3.0	0.5
	MINimum UP speed	0 to 65	48
	MAXimum UP speed	0 to 100	56
	MINimum DOWN speed	0 to 65	47
	MAXimum DOWN speed	0 to 100	59
	Engine RPM	800 to 2900	1500
BASKET ROTATE	ACCEleration	0.1 to 5.0	1.5
	DECEleration	0.1 to 3.0	0.5
	MINimum LEFT speed	0 to 65	47
	MAXimum LEFT speed	0 to 100	65
	MINimum RIGHT speed	0 to 65	46
	MAXimum RIGHT speed	0 to 100	65
	Engine RPM	800 to 2900	1500
JIB	Lift ACCEleration	0.1 to 5.0	4.2
	Lift DECEleration	0.1 to 3.0	1.0
	MINimum UP speed	0 to 65	65
	MAXimum UP speed	0 to 100	100
	MINimum DOWN speed	0 to 65	47
	MAXimum DOWN speed	0 to 100	100
	Engine RPM	800 to 2900	1800
STEER	MAXimum speed	0 to 100	71
	Engine RPM	800 to 2900	1800



**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-1. Personality Ranges/Defaults**

<b>FUNCTION</b>	<b>PERSONALITY</b>	<b>RANGE</b>	<b>DEFAULTS</b>
GROUND MODE	LIFT UP speed	0 to 100	60
	LIFT DOWN speed	0 to 100	60
	SWING speed	0 to 100	60
	TELEscope speed	0 to 100	70
	BASKET ROTATE speed	0 to 100	55
	BASKET LEVEL speed	0 to 100	54
	JIB LIFT speed	0 to 100	55

4150365-3

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-2. Help Fault Codes, Displayed Faults, and Descriptions - Prior to S/N 66995**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
None	No flash code is indicated for the following help messages. They are intended to hint at a possible problem if the vehicle is not behaving as expected.		1
	EVERYTHING OK	The "normal" help message in platform mode	
	GROUND MODE OK	The "normal" help message in ground mode	
	DRIVING AT CREEP - TILTED	Drive speed is limited to creep because the vehicle is tilted.	
	FSW OPEN	A drive or boom function has been selected but footswitch is open.	
	RUNNING AT CREEP - CREEP SWITCH OPEN	All function speeds are limited to creep because the creep switch is open.	
	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	All function speeds are limited to creep because the vehicle is tilted and above elevation.	
	RUNNING AT CUTBACK - ABOVE ELEVATION	Drive speed is limited to "ELEVATED MAX" because the vehicle is above elevation.	
	TESTS ACTIVE – RECYCLE EMS TO END	The system tests have been activated; normal vehicle operation is not allowed.	
1/1	Flash code 1/1 indicates a "sleep" mode. NOT REQUIRED		
2/1	Flash code 2/1 indicates problems with footswitch.		2
	FSW FAULTY	The two foot switch signals do not agree. EMS recycle required.	
	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously	
2/2	Flash code 2/2 indicates problems with drive & steer selection.		3
	DRIVE JOYSTICK FAULTY	The drive joystick center tap is out of valid range, or the wiper is wire-off.	
	DRIVE LOCKED – JOYSTICK MOVED BEFORE EMS/FSW	Drive was selected before and during footswitch closure.	
	FSW INTERLOCK TRIPPED	Footswitch was closed for seven seconds with no function selected.	
	STEER LOCKED – SELECTED BEFORE EMS/FSW	Steer was selected before and during footswitch closure.	
	STEER SWITCHES FAULTY	Both steer switches are active together.	
	WAITING FOR FSW TO BE OPEN	Footswitch was closed when platform mode was selected.	
	JOYSTICK FAULTS – CHECK PLATFORM BOX WIRING	More than one of the drive, lift, and swing joystick center tap or wiper voltages is out of range. This is probably due to a short-circuit across a joystick pot.	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-2. Help Fault Codes, Displayed Faults, and Descriptions - Prior to S/N 66995**

2/3	Flash code 2/3 indicates problems with boom function selection.		3
	LIFT/SWING JOYSTICK FAULTY	The lift or swing joystick center tap is out of valid range, or the wiper is wire-off.	
	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE EMS/FSW	Platform upper lift or swing was selected before and during foot-switch closure.	
	PUMP POT FAULTY	The pump pot is open-circuit; all platform boom functions except upper lift & swing will run at creep.	
	PUMP SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	A boom function (lower lift, telescope, basket level, basket rotate, jib) has both directions selected together.	
	PUMP SWITCHES LOCKED - SELECTED BEFORE EMS/FSW	A platform boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before key switch or footswitch closure.	
	PUMP SWITCHED LOCKED - SELECTED BEFORE EMS	A ground boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before key switch.	
	SWING/LIFT JOYSTICK FAULTY	The swing joystick center tap is out of valid range, or the wiper is wire-off.	
2/4	Flash code 2/4 indicates that steering digital inputs are faulty. NOT REQUIRED		
2/5	Flash code 2/5 indicates that a function is prevented due to a cutout.		4
	BOOM PREVENTED - DRIVE SELECTED	A boom function is selected while a drive function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED - ABOVE ELEVATION	Drive is selected while above elevation and drive cutout is configured to prevent drive.	
	DRIVE PREVENTED - BOOM MOVEMENT SELECTED	Drive is selected while a boom function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	Drive is selected while tilted and above elevation and tilt is configured to cutout drive.	
	BOOM PREVENTED - FUNCTION CUTOUT ACTIVE	A boom function is selected while function cutout is active and configured to cutout boom functions.	
	BOOM & DRIVE PREVENTED - FUNCTION CUTOUT ACTIVE	Drive or a boom function is selected while function cutout is active and configured to cutout all functions.	
2/7	Flash code 2/7 indicates that the accelerator input is faulty. NOT REQUIRED		
2/8	Flash code 2/8 indicates that the hydraulic filter is being bypassed.		5
	RETURN FILTER BYPASSED	Hydraulic return filter clogged	
	CHARGE PUMP FILTER BYPASSED	Charge pump filter clogged	
3/1	Flash code 3/1 indicates that a contactor did not close when energized. NOT REQUIRED		

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-2. Help Fault Codes, Displayed Faults, and Descriptions - Prior to S/N 66995**

3/2	Flash code 3/2 indicates that a contactor did not open when energized. NOT REQUIRED		
3/3	Flash code 3/3 indicates that a driver is short-circuit.		6
	ADD DRIVER FAULTS		
3/5	Flash code 3/5 indicates a brake pressure problem. NOT REQUIRED		7
4/2	Flash code 4/2 indicates that the engine is over temperature. NOT REQUIRED		8
4/3	Flash code 4/3 indicates problems with the engine		9
	ENGINE TEMP GREATER THAN 130°C (266° F)		
	AIR FILTER BYPASSED	Air filter clogged	
	NO ALTERNATOR OUTPUT	The measured battery voltage is less than 12.5 VDC	
	OIL PRESSURE LESS THAN 0.5 BAR (8PSI)		
4/4	Flash code 4/4 indicates problems with the battery supply.		7
	BATTERY LOW	Battery voltage is below 11V. This is a warning - the controller does not shut down.	
	BATTERY TOO HIGH - SYSTEM SHUT DOWN	Battery voltage is above 18V. EMS recycle required.	
	BATTERY TOO LOW - SYSTEM SHUT DOWN	Battery voltage is below 6V. EMS recycle required.	
5/5	Flash code 5/5 indicates problems with vehicle engine RPM or the encoder.		8
	SPEED SENSOR READING INVALID SPEED	Speed sensor is indicating an impossible number of pulses. This is probably due to a faulty speed sensor.	
	SPEED INPUT LOST	This indicates that the control system has determined that the diesel engine speed input to the system has been lost. This is probably due to wiring problems at the ground module or a faulty speed sensor.	
	ENGINE SPEED DOES NOT MATCH COMMAND	This indicates that the control system has determine that the diesel engine governor has stuck. This is probably due to electrical or mechanical problems with the governor.	
6/6	Flash code 6/6 indicates problems with the CAN bus.		10
	CAN BUS FAILURE:	The ground module or platform module is not receiving. This is probably due to wiring problems between the platform and ground modules.	
7/7	Flash code 7/7 indicates problems with a motor. NOT REQUIRED		

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

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**Table 6-2. Help Fault Codes, Displayed Faults, and Descriptions - Prior to S/N 66995**

9/9	Flash code 9/9 indicates problems with the controller.		11
	PLATFORM MODULE FAILURE: hwfs CODE 1	Platform module V(Low) FET has failed	
	GROUND MODULE FAILURE: hwfs CODE 1	Ground module V(Low) FET has failed	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
None		No flash code is indicated for the following help messages. They are intended to hint at a possible problem if the vehicle is not behaving as expected.	1
	EVERYTHING OK	The "normal" help message in platform mode	
	GROUND MODE OK	The "normal" help message in ground mode	
	FSW OPEN	A drive or boom function has been selected but footswitch is open.	
	RUNNING AT CREEP – CREEP SWITCH OPEN	All function speeds are limited to creep because the creep switch is open.	
	RUNNING AT CREEP – TILTED AND ABOVE ELEVATION	All boom function speeds are limited to creep because the vehicle is tilted and above elevation.	
	RUNNING AT CUTBACK – OUT OF TRANSPORT POSITION	Drive speed is limited to "ELEVATED MAX" because the vehicle is out of transport position.	
	CHASSIS TILT SENSOR OUT OF RANGE	The chassis tilt sensor has indicated a tilt angle greater than 19 degrees for more than 4 seconds. Not reported during 2 second power-up.	
	LOAD SENSOR READING UNDER WEIGHT	The load sensor is reading 20% or more under the calibrated zero point. This fault may occur if the basket is resting on the ground. Not reported during 2 second power-up.	
	ENVELOPE ENCROACHED – HYDRAULICS SUSPENDED	Only occurs on machines with envelope control. The system has detected an envelope violation	
	OVER MOMENT – HYDRAULICS SUSPENDED	Only occurs on machines with moment control. The system has detected an over moment violation.	
UNDER MOMENT – HYDRAULICS SUSPENDED	Only occurs on machines with moment control. The system has detected an under moment violation.		
1/1		<b>Flash code 1/1 indicates a "sleep" mode. NOT REQUIRED</b>	
2/1		<b>Flash code 2/1 indicates problems with footswitch.</b>	2
	FSW FAULTY	The two footswitch inputs have read the same state for more than one second. An EMS cycle is required.	
	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

<b>Fault Flash Code</b>	<b>Communicated (Displayed on Analyzer) Fault</b>	<b>Description</b>	<b>Priority</b>
<b>2/2</b>		<b>Flash code 2/2 indicates problems with drive &amp; steer selection. Except where noted, these faults are not reported during 2 second power-up sequence.</b>	<b>3</b>
	DRIVE LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Drive was selected before and during footswitch closure. Can be reported during power-up sequence.	
	FSW INTERLOCK TRIPPED	Footswitch was closed for seven seconds with no function selected. Can be reported during power-up sequence.	
	STEER LOCKED – SELECTED BEFORE FOOTSWITCH	Steer was selected before and during footswitch closure.	
	STEER SWITCHES FAULTY	Both steer switches are active at the same time.	
	D/S JOY. OUT OF RANGE LOW	Resistive joysticks: These faults do not occur.	
	D/S JOY. OUT OF RANGE LOW	Resistive joysticks: These faults do not occur.	
	D/S JOY. OUT OF RANGE HIGH	Resistive joysticks: These faults do not occur if the Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred.	
	D/S JOY. CENTER TAP BAD	Resistive joysticks: These faults occur when the center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	
	WAITING FOR FSW TO BE OPEN	Footswitch was closed when platform mode was selected. Can be reported during power-up sequence.	
FOOTSWITCH SELECTED BEFORE START	The user attempted to start the machine with the footswitch engaged.		
<b>2/3</b>		<b>Flash code 2/3 indicates problems with boom function selection.</b>	<b>3</b>
	LIFT/SWING LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Platform upper lift or swing was selected before and during footswitch closure.	
	PUMP SWITCHES FAULTY – CHECK DIAGNOSTICS/BOOM	A boom function (lower lift, telescope, basket level, basket rotate, jib) has both directions selected together.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE FOOTSWITCH	A platform boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before key switch or footswitch closure.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE AUX POWER	A ground boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before aux power.	
	l/s joy. out of range low	Resistive joysticks: These faults do not occur.	
	l/s joy. out of range high	Resistive joysticks: These faults do not occur if the Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred.	
	l/s joy. center tap bad	Resistive joysticks: These faults occur when the center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE START SWITCH	This fault occurs when a hydraulic function switch is closed before the start switch is closed.	
	FOOTSWITCH SELECTED BEFORE START	The user attempted to start the machine with the footswitch engaged.	
<b>2/4</b>		<b>Flash code 2/4 indicates that steering digital inputs are faulty. NOT REQUIRED</b>	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
2/5		<b>Flash code 2/5 indicates that a function is prevented due to a cutout.</b>	<b>4</b>
	BOOM PREVENTED – DRIVE SELECTED	A boom function is selected while a drive function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED – ABOVE ELEVATION	Drive is selected while above elevation and drive cutout is configured to prevent drive.	
	DRIVE PREVENTED – BOOM SELECTED	Drive is selected while a boom function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED – TILTED & ABOVE ELEVATION	Drive is selected while tilted and above elevation and tilt is configured to cutout drive.	
	JIB SWING PREVENTED – IN 1000# MODE	The user is trying to jib swing in 1000# mode, which is not allowed.	
	CAN DONGLE ATTACHED – HYDRAULICS NOT RESTRICTED	The system allows the user to operate all hydraulics with very limited restrictions.	
	MODEL CHANGED – HYDRAULICS SUSPENDED – CYCLE EMS	User changed the model number using the analyzer. User must cycle power before the hydraulics system will be active again.	<b>11</b>
	BACKUP BLAM COMMUNICATIONS ACTIVE	The serial backup communications link to the BLAM module is active	
	DISCONNECT ANALYZER AND CYCLE EMS TO PERFORM BOOM RETRIEVAL	The ground module has detected that it needs to use the RS232 backup communications link to the BLAM module but an analyzer is connected. Remove the analyzer and cycle power	
	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	Reported if the major version of the platform module does not match the major version of the ground module	
	FUNCTIONS LOCKED OUT - CHASSIS MODULE SOFTWARE VERSION IMPROPER	Reported if the major version of the chassis module does not match the major version of the ground module	
FUNCTIONS LOCKED OUT - BLAM MODULE SOFTWARE VERSION IMPROPER	Reported if the major version of the BLAM module does not match the major version of the ground module		
2/7		<b>Flash code 2/7 indicates that the accelerator input is faulty. NOT REQUIRED</b>	
2/8		<b>Flash code 2/8 indicates a problem with a hydraulic filter. Not reported during 2 second power-up.</b>	<b>5</b>
	RETURN FILTER BYPASSED	Hydraulic return filter clogged	
	charge pump filter bypassed	Charge pump filter clogged	
3/1		<b>Flash code 3/1 indicates that a contactor did not close when energized. NOT REQUIRED</b>	
3/2		<b>Flash code 3/2 indicates that a contactor did not open when energized. NOT REQUIRED</b>	



**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
3/3		<b>Flash code 3/3 indicates a driver problem. All driver faults are detected in a similar manner. Open circuit faults are detected when the analog feedback reads too high and the output is commanded off. Short to ground is detected when the analog feedback reads low and the output is commanded on. Short to battery is detected when the analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up. An EMS cycle is required.</b>	6
	RIGHT FORWARD DRIVE PUMP SHORT TO GROUND	Only occurs on machines with a chassis module.	
	RIGHT FORWARD DRIVE PUMP SHORT TO BATTERY	Only occurs on machines with a chassis module.	
	RIGHT FORWARD DRIVE PUMP OPEN CIRCUIT	Only occurs on machines with a chassis module.	
	RIGHT REVERSE DRIVE PUMP SHORT TO GROUND	Only occurs on machines with a chassis module.	
	RIGHT REVERSE DRIVE PUMP SHORT TO BATTERY	Only occurs on machines with a chassis module.	
	RIGHT REVERSE DRIVE PUMP OPEN CIRCUIT	Only occurs on machines with a chassis module.	
	LEFT FORWARD DRIVE PUMP SHORT TO GROUND	Only occurs on machines with a chassis module.	
	LEFT FORWARD DRIVE PUMP SHORT TO BATTERY	Only occurs on machines with a chassis module.	
	LEFT FORWARD DRIVE PUMP OPEN CIRCUIT	Only occurs on machines with a chassis module.	
	LEFT REVERSE DRIVE PUMP SHORT TO GROUND	Only occurs on machines with a chassis module.	
	LEFT REVERSE DRIVE PUMP SHORT TO BATTERY	Only occurs on machines with a chassis module.	
	LEFT REVERSE DRIVE PUMP OPEN CIRCUIT	Only occurs on machines with a chassis module.	
	ALTERNATOR/ECM POWER SHORT TO GROUND		
	HOUR METER SHORT TO GROUND		
	HOUR METER SHORT TO BATTERY		
	HORN SHORT TO GROUND		
	HORN OPEN CIRCUIT		
	HORN SHORT TO BATTERY		
	AUX POWER SHORT TO GROUND		
	AUX POWER OPEN CIRCUIT		
	AUX POWER SHORT TO BATTERY		
	GLOW PLUG SHORT TO GROUND	Only occurs on machines with glow plugs configured.	
	GLOW PLUG OPEN CIRCUIT	Only occurs on machines with glow plugs configured.	
	GLOW PLUG SHORT TO BATTERY	Only occurs on machines with glow plugs configured.	
	LP LOCK SHORT TO GROUND	Only occurs on machines with dual-fuel engines.	
	LP LOCK OPEN CIRCUIT	Only occurs on machines with dual-fuel engines.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	LP LOCK SHORT TO BATTERY	Only occurs on machines with dual-fuel engines.	
	LP START ASSIST SHORT TO GROUND	Only occurs on machines with dual-fuel engines.	
	LP START ASSIST OPEN CIRCUIT	Only occurs on machines with dual-fuel engines.	
	LP START ASSIST SHORT TO BATTERY	Only occurs on machines with dual-fuel engines.	
	MAIN DUMP SHORT TO GROUND		
	MAIN DUMP OPEN CIRCUIT		
	MAIN DUMP SHORT TO BATTERY		
	PARKING BRAKE SHORT TO GROUND		
	PARKING BRAKE OPEN CIRCUIT		
	PARKING BRAKE SHORT TO BATTERY		
	START SOLENOID SHORT TO GROUND	Only occurs on machines with diesel engines.	
	START SOLENOID OPEN CIRCUIT	Only occurs on machines with diesel engines.	
	START SOLENOID SHORT TO BATTERY	Only occurs on machines with diesel engines.	
	MAIN LIFT APU SHORT TO GROUND	Only occurs on the 1250AJP machine	
	MAIN LIFT APU OPEN CIRCUIT	Only occurs on the 1250AJP machine	
	MAIN LIFT APU SHORT TO BATTERY	Only occurs on the 1250AJP machine	
	MAIN LIFT PILOT PRESSURE FAILURE	Only occurs on the 1250AJP machine	
	NO MAIN LIFT PILOT PRESSURE	Only occurs on the 1250AJP machine	
	MAIN LIFT PILOT PRESSURE SWITCH FAILURE	Only occurs on the 1250AJP machine	
	STEER DUMP SHORT TO GROUND		
	STEER DUMP OPEN CIRCUIT		
	STEER DUMP SHORT TO BATTERY		
	TWO SPEED SHORT TO GROUND		
	TWO SPEED OPEN CIRCUIT		
	TWO SPEED SHORT TO BATTERY		
	GROUND ALARM SHORT TO GROUND	Only occurs on machines with ground alarm configured.	
	GROUND ALARM OPEN CIRCUIT	Only occurs on machines with ground alarm configured.	
	GROUND ALARM SHORT TO BATTERY	Only occurs on machines with ground alarm configured.	
	GEN SET/WELDER SHORT TO GROUND	Only occurs on machines with a generator configured.	
	GEN SET/WELDER OPEN CIRCUIT	Only occurs on machines with a generator configured.	
	GEN SET/WELDER SHORT TO BATTERY	Only occurs on machines with a generator configured.	
	HEAD TAIL LIGHT SHORT TO GROUND	Only occurs on machines with the headlights option configured.	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

<b>Fault Flash Code</b>	<b>Communicated (Displayed on Analyzer) Fault</b>	<b>Description</b>	<b>Priority</b>
	HEAD TAIL LIGHT OPEN CIRCUIT	Only occurs on machines with the headlights option configured.	
	HEAD TAIL LIGHT SHORT TO BATTERY	Only occurs on machines with the headlights option configured.	
	BASKET UP OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.	
	BASKET UP OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.	
	BASKET UP OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.	
	BASKET UP SHORT TO GROUND		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	BASKET DOWN OPEN CIRCUIT		
	BASKET DOWN SHORT TO BATTERY		
	BASKET DOWN OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.	
	BASKET DOWN OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.	
	BASKET DOWN OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.	
	TOWER LIFT APU VALVE STUCK OPEN	Only occurs on 1250AJP	
	TOWER LIFT ENABLE STUCK OPEN	Only occurs on 1250AJP	
	TOWER LIFT ENABLE SHORT TO GROUND	Only occurs on 1250AJP	
	TOWER LIFT ENABLE OPEN CIRCUIT	Only occurs on 1250AJP	
	TOWER LIFT ENABLE SHORT TO BATTERY	Only occurs on 1250AJP	
	TOWER TELESCOPE APU SHORT TO GROUND	Only occurs on 1250AJP	
	TOWER TELESCOPE APU OPEN CIRCUIT	Only occurs on 1250AJP	
	TOWER TELESCOPE APU SHORT TO BATTERY	Only occurs on 1250AJP	
	BASKET LEFT OPEN CIRCUIT		
	BASKET LEFT SHORT TO BATTERY		
	BASKET LEFT SHORT TO GROUND		
	BASKET RIGHT SHORT TO GROUND		
	BASKET RIGHT OPEN CIRCUIT		
	BASKET RIGHT SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB DOWN SHORT TO GROUND		

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	JIB DOWN OPEN CIRCUIT		
	JIB DOWN SHORT TO BATTERY		
	JIB LEFT SHORT TO GROUND		
	JIB LEFT OPEN CIRCUIT		
	JIB LEFT SHORT TO BATTERY		
	JIB RIGHT SHORT TO GROUND		
	JIB RIGHT OPEN CIRCUIT		
	JIB RIGHT SHORT TO BATTERY		
	TOWER UP SHORT TO GROUND		
	TOWER UP OPEN CIRCUIT		
	TOWER UP SHORT TO BATTERY		
	TOWER DOWN SHORT TO GROUND		
	TOWER DOWN OPEN CIRCUIT		
	TOWER DOWN SHORT TO BATTERY		
	TOWER IN SHORT TO GROUND		
	TOWER IN OPEN CIRCUIT		
	TOWER IN SHORT TO BATTERY		
	TOWER OUT SHORT TO GROUND		
	TOWER OUT OPEN CIRCUIT		
	TOWER OUT SHORT TO BATTERY		
	MAIN IN SHORT TO GROUND		
	MAIN IN OPEN CIRCUIT		
	MAIN IN SHORT TO BATTERY		
	MAIN OUT SHORT TO GROUND		
	MAIN OUT OPEN CIRCUIT		
	MAIN OUT SHORT TO BATTERY		
	LIFT UP DUMP SHORT TO GROUND		
	LIFT UP DUMP OPEN CIRCUIT		
	LIFT UP DUMP SHORT TO BATTERY		
	LIFT DOWN HOLDING SHORT TO GROUND		
	LIFT DOWN HOLDING OPEN CIRCUIT		
	LIFT DOWN HOLDING SHORT TO BATTERY		
	LIFT PILOT VALVE SHORT TO GROUND	Only occurs on machines with gravity lift down.	
	LIFT PILOT VALVE SHORT TO BATTERY	Only occurs on machines with gravity lift down.	
	LIFT PILOT VALVE OPEN CIRCUIT	Only occurs on machines with gravity lift down.	
	LIFT DOWN AUX VALVE SHORT TO GROUND	Only occurs on machines with gravity lift down.	
	LIFT DOWN AUX VALVE SHORT TO BATTERY	Only occurs on machines with gravity lift down.	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

<b>Fault Flash Code</b>	<b>Communicated (Displayed on Analyzer) Fault</b>	<b>Description</b>	<b>Priority</b>
	LIFT DOWN AUX VALVE OPEN CIRCUIT	Only occurs on machines with gravity lift down.	
	TOWER LIFT APU SHORT TO GROUND	Only occurs on 1250AJP	
	TOWER LIFT APU OPEN CIRCUIT	Only occurs on 1250AJP	
	TOWER LIFT APU SHORT TO BATTERY	Only occurs on 1250AJP	
	MAIN LIFT ENABLE SHORT TO GROUND	Only occurs on 1250AJP	
	MAIN LIFT ENABLE OPEN CIRCUIT	Only occurs on 1250AJP	
	MAIN LIFT ENABLE SHORT TO BATTERY	Only occurs on 1250AJP	
	TOWER TELE APU VALVE STUCK OPEN	Only occurs on 1250AJP	
	TOWER TELE ENABLE STUCK OPEN	Only occurs on 1250AJP	
	TOWER TELE APU SHORT TO GROUND	Only occurs on 1250AJP	
	TOWER TELE APU OPEN CIRCUIT	Only occurs on 1250AJP	
	TOWER TELE APU SHORT TO BATTERY	Only occurs on 1250AJP	
	PVG VALVE SHORT TO GROUND	Only occurs on 1250AJP	
	PVG VALVE OPEN CIRCUIT	Only occurs on 1250AJP	
	PVG VALVE SHORT TO BATTERY	Only occurs on 1250AJP	
	FOX SPARE OUTPUT SHORT TO GROUND	Only occurs on Fox machines.	
	FOX SPARE OUTPUT SHORT TO BATTERY	Only occurs on Fox machines.	
	FOX SPARE OUTPUT OPEN CIRCUIT	Only occurs on Fox machines.	
	HOUR METER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.	
	RESTRICTED TO TRANSPORT – AXLE LOCKOUT VALVE STB OR OC	Only occurs on machines with electrically released oscillating axles configured. A short to battery or open circuit has been detected on the axle lockout valve and the machine is restricted to transport position.	
	RESTRICTED TO TRANSPORT – PARKING BRAKE STB	Only occurs on machines with electrically released oscillating axles configured. A short to battery has been detected on the parking brake valve and the machine is restricted to transport position.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
3/4		Flash code 3/4 indicates a driver problem on a platform valve block valve driver. All driver faults are detected in a similar manner. Open circuit faults are detected when the analog feedback reads too high and the output is commanded off. Short to ground is detected when the analog feedback reads low and the output is commanded on. Short to battery is detected when the analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up. An EMS cycle is required.	6
	BASKET UP SHORT TO BATTERY		
	BASKET UP SHORT TO GROUND		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling	
	BASKET DOWN SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	bASKET DOWN OPEN CIRCUIT		
	BASKET DOWN SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling.	
	BASKET LEFT SHORT TO BATTERY		
	BASKER LEFT SHORT TO GROUND		
	BASKET LEFT OPEN CIRCUIT		
	BASKET RIGHT SHORT TO BATTERY		
	BASKET RIGHT SHORT TO GROUND		
	BASKET RIGHT OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB DOWN SHORT TO BATTERY		
	JIB DOWN SHORT TO GROUND		
	JIB DOWN OPEN CIRCUIT		
	JIB LEFT SHORT TO BATTERY		
	JIB LEFT SHORT TO GROUND		
	JIB LEFT OPEN CIRCUIT		
	JIB RIGHT SHORT TO BATTERY		
	JIB RIGHT SHORT TO GROUND		
	JIB RIGHT OPEN CIRCUIT		
PLATFORM CONTROL VALVE SHORT TO BATTERY	Only occurs on machines with electronic basket leveling		
PLATFORM CONTROL VALVE SHORT TO GROUND	Only occurs on machines with electronic basket leveling		
PLATFORM CONTROL VALVE OPEN CIRCUIT	Only occurs on machines with electronic basket leveling		
3/5		Flash code 3/5 indicates a brake pressure problem. <b>NOT REQUIRED</b>	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

<b>Fault Flash Code</b>	<b>Communicated (Displayed on Analyzer) Fault</b>	<b>Description</b>	<b>Priority</b>
4/2		<b>Flash code 4/2 indicates that the engine is over temperature. NOT REQUIRED</b>	
4/3		<b>Flash code 4/3 indicates problems with the engine. Except where noted, these faults are not reported during 2 second power-up sequence.</b>	<b>9</b>
	HIGH ENGINE TEMP	Occurs when the engine temperature is above 117 degrees Celsius for the Ford engines, and above 130 degrees Celsius for the Deutz engines.	
	AIR FILTER BYPASSED	Air filter clogged	
	NO ALTERNATOR OUTPUT	The engine has been running for 15 seconds or more and the battery voltage is still below 11.5 volts.	
	LOW OIL PRESSURE	If a Deutz engine is configured, the oil pressure is below 8 PSI and the engine has been running for at least 10 seconds. If a Ford engine is configured, the Ford ECM has reported a low oil pressure fault.	
	OIL PRESSURE SHORT TO BATTERY	If a Deutz engine is configured, this indicates that the oil pressure sensor is reading above 6.6 volts.	
	OIL PRESSURE SHORT TO GROUND	If a Deutz engine is configured, this indicates that the oil pressure sensor is reading below 0.1 volts for more than 5 seconds. This fault is not detected during crank.	
	COOLANT TEMPERATURE SHORT TO GROUND	If a Deutz engine is configured, this indicates that the coolant temperature is reading below 0.1 volts.	
	FORD FAULT CODE ##	All Ford fault codes except 63 are simply passed through from the FORD ECM. They only occur if a Ford engine is selected in the machine configuration digits. Can be reported during power-up sequence.	
	ENGINE FAULT CODE : ###(SPN) :###(FMI)	All J1939 CANBUS ECMs will report fault messaging in this format. The SPN number represents what is broken and FMI number represents how the component is broken.	
	FORD FAULT CODE UNKNOWN	An unrecognized Ford ECM fault code has been received. Can be reported during power-up sequence.	
	485 COMMUNICATIONS LOST	This fault only occurs with a Ford engine. It occurs when no responses are received from the ECM for 2.5 seconds. Can be reported during power-up sequence.	
	FUEL SENSOR SHORT TO BATTERY	Indicates that the fuel sensor is reading above 4.3 volts.	
	FUEL SENSOR SHORT TO GROUND	Indicates that the fuel sensor is reading below 0.2 volts.	
WRONG ENGINE SELECTED – ECM PRESENT	Indicates an Engine Control Module (ECM) has been detected on the CANBUS. This fault will only be applicable when non-CANBUS engine setups are configured.		
ECM CAN COMMUNICATION LOST	The engine is configured to have a CANBUS controlled engine and the JLG system does not detect the presence of an ECM. This fault can be the result of the power lost to the ECM or a break in the CANBUS communications connection from the ECM to the JLG system.		
4/4		<b>Flash code 4/4 indicates problems with the battery supply. Not reported during 2 second power-up.</b>	<b>7</b>
	BATTERY LOW	Battery voltage is below 11V for more than 5 seconds. This fault is not detected during crank. This is a warning – the controller does not shut down.	
	BATTERY TOO HIGH – SYSTEM SHUT DOWN	Battery voltage is above 16V. EMS recycle required.	
	BATTERY TOO LOW – SYSTEM SHUT DOWN	Battery voltage is below 9V.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
4/5		<b>Flash code 4/5 indicates problems with the S-D CAN based PVG valves currently used on the 1250AJP only.</b>	7
	MAIN LIFT PVG COMMUNICATIONS	CAN communications lost with the Main Lift PVG valve.	
	tower lift pvg communications	CAN communications lost with the Tower Lift PVG valve.	
	TOWER TELESCOPE PVG COMMUNICATIONS	CAN communications lost with the Tower Telescope PVG valve.	
	MAIN LIFT PVG internal fault	Main boom lift pvg valve has an internal fault.	
	tower lift pvg internal fault	Tower boom lift pvg valve has an internal fault.	
	TOWER TELESCOPE PVG internal fault	Tower boom telescope pvg valve has an internal fault.	
	MAIN LIFT PVG VALVE HIGH VOLTAGE	Main boom lift pvg valve has detected high excitation voltage.	
	TOWER LIFT PVG VALVE HIGH VOLTAGE	Tower boom lift pvg valve has detected high excitation voltage.	
	TOWER TELESCOPE PVG VALVE HIGH VOLTAGE	Tower boom telescope pvg valve has detected high excitation voltage.	
	MAIN LIFT PVG VALVE LOW VOLTAGE	Main boom lift pvg valve has detected low excitation voltage.	
	TOWER LIFT PVG VALVE LOW VOLTAGE	Tower boom lift pvg valve has detected low excitation voltage.	
	TOWER TELESCOPE PVG VALVE LOW VOLTAGE	Tower boom telescope pvg valve has detected low excitation voltage.	
	MAIN LIFT PVG VALVE STUCK NEUTRAL	Main boom lift pvg valve detected its' spool is stuck in the neutral position.	
	TOWER LIFT PVG VALVE STUCK NEUTRAL	Tower boom lift pvg valve detected its' spool is stuck in the neutral position.	
	TOWER TELESCOPE PVG VALVE STUCK NEUTRAL	Tower boom telescope pvg valve detected its' spool is stuck in the neutral position.	
	MAIN LIFT PVG VALVE STUCK EXTENDED	Main boom lift pvg valve detected its' spool is stuck in the extended position.	
	TOWER LIFT PVG VALVE STUCK EXTENDED	Tower boom lift pvg valve detected its' spool is stuck in the extended position.	
	TOWER TELESCOPE PVG VALVE STUCK EXTENDED	Tower boom telescope pvg valve detected its' spool is stuck in the extended position.	
	MAIN LIFT PVG VALVE STUCK RETRACTED	Main boom lift pvg valve detected its' spool is stuck in the retracted position.	
TOWER LIFT PVG VALVE STUCK RETRACTED	Tower boom lift pvg valve detected its' spool is stuck in the retracted position.		
TOWER TELESCOPE PVG VALVE STUCK RETRACTED	Tower boom telescope pvg valve detected its' spool is stuck in the retracted position.		
MAIN LIFT PVG VALVE OBSTRUCTED	Main boom lift pvg valve detected its' spool could not achieve command.		
TOWER LIFT PVG VALVE OBSTRUCTED	Tower boom lift pvg valve detected its' spool could not achieve command.		
TOWER TELESCOPE PVG VALVE OBSTRUCTED	Tower boom telescope pvg valve detected its' spool could not achieve command.		



## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	MAIN LIFT PVG VALVE COMMAND IMPROPER	Main boom lift pvg valve received an invalid command from the control system.	
	TOWER LIFT PVG VALVE COMMAND IMPROPER	Tower boom lift pvg valve received an invalid command from the control system.	
	TOWER TELESCOPE PVG VALVE COMMAND IMPROPER	Tower boom telescope pvg valve received an invalid command from the control system.	
	MAIN LIFT PVG VALVE TIMEOUT	Main boom lift pvg valve has not received a position command in 250mS.	
	TOWER TELESCOPE PVG VALVE TIMEOUT	Tower boom lift pvg valve has not received a position command in 250mS.	
	TOWER TELESCOPE PVG VALVE TIMEOUT	Tower boom telescope pvg has not received a position command in 250mS.	
	MAIN LIFT PVG VALVE SETUP FAULT	Main boom lift pvg valve setup data is incorrect. Requires a valve calibration.	
	TOWER LIFT PVG VALVE SETUP FAULT	Tower boom lift pvg valve setup data is incorrect. Requires a valve calibration.	
	TOWER TELESCOPE PVG VALVE SETUP FAULT	Tower boom telescope pvg valve setup data is incorrect. Requires a valve calibration.	
	MAIN LIFT PVG VALVE SENT UNRECOGNIZED FAULT	Main boom lift pvg valve sent an unrecognized fault.	
	TOWER LIFT PVG VALVE SENT UNRECOGNIZED FAULT	Tower boom lift pvg valve sent an unrecognized fault.	
	TOWER TELESCOPE PVG VALVE SENT UNRECOGNIZED FAULT	Tower boom telescope pvg valve sent an unrecognized fault.	
	MAIN LIFT PVG VALVE PARAMETERS INCORRECT	The main lift pvg valves spool data is incorrect. Requires a valve calibration.	
	TOWER LIFT PVG VALVE PARAMETERS INCORRECT	The tower lift pvg valves spool data is incorrect. Requires a valve calibration.	
	TOWER TELESCOPE PVG VALVE PARAMETERS INCORRECT	The tower telescope pvg valves spool data is incorrect. Requires a valve calibration.	
	MAIN LIFT PVG VALVE LOCATION IMPROPER	Main lift pvg valve was hosed wrong or the wiring was incorrect during calibration.	
	TOWER LIFT PVG VALVE LOCATION IMPROPER	Tower lift pvg valve was hosed wrong or the wiring was incorrect during calibration.	
	TOWER TELESCOPE PVG VALVE LOCATION IMPROPER	Tower telescope pvg valve was hosed wrong or the wiring was incorrect during calibration.	
	MAIN LIFT PVG VALVE WIRING INCORRECT	The power wire for the main lift pvg valve is not wired to that valve.	
	TOWER LIFT PVG VALVE WIRING INCORRECT	The power wire for the tower lift pvg valve is not wired to that valve.	
	TOWER TELESCOPE PVG VALVE WIRING INCORRECT	The power wire for the tower telescope pvg valve is not wired to that valve.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
5/5		<b>Flash code 5/5 indicates problems with vehicle engine RPM or the encoder. Not reported during 2 second power-up.</b>	8
	SPEED SENSOR READING INVALID SPEED	This fault is detected with diesel engines only. The RPM pickup is indicating a speed that greater than 4000 RPM or approximately 8875 Hz.	
	SPEED INPUT LOST	This fault is detected with diesel engines only. It occurs if there is no RPM detected and the oil pressure input is reading above 8 PSI for more than three seconds. This is probably due to wiring problems at the ground module or a faulty speed sensor.	
6/6		<b>Flash code 6/6 indicates problems with the CAN bus.</b>	10
	PLATFORM CAN COMMUNICATIONS LOST	The ground module or platform module is not receiving CAN messages. This is probably due to wiring problems between the platform and ground modules.	
	BLAM CAN COMMUNICATIONS LOST	Only occurs on machines with a BLAM. The ground module or BLAM module is not receiving CAN messages. This is probably due to wiring problems between the BLAM and ground modules.	
	CHASSIS CAN COMMUNICATIONS LOST	Only occurs on machines with a chassis module. The ground module or chassis module is not receiving CAN messages. This is probably due to wiring problems between the chassis and ground modules.	
	CYLINDER LOAD PIN CAN COMMUNICATIONS LOST	Only occurs on machines with a cylinder load pin. The ground module or cylinder load pin is not receiving CAN messages. This is probably due to wiring problems between the cylinder load pin and ground module.	
	EXCESSIVE CAN BUS COMMUNICATION ERRORS	More than 500 Bus Off or more than 500 Bus Passive conditions has been detected by the Ground Module in the current power cycle.	
	MAIN ANGL1 CAN COMMUNICATIONS LOST	The control system lost CAN communications with main boom angle sensor #1 (1250AJP only)	
	MAIN ANGL2 CAN COMMUNICATIONS LOST	The control system lost CAN communications with main boom angle sensor #2 (1250AJP only)	
7/7		<b>Flash code 7/7 indicates problems with a motor. NOT REQUIRED</b>	
8/1		<b>Flash code 8/1 indicates problems with the Chassis tilt detection system.</b>	10
	CHASSIS TILT SENSOR NOT CALIBRATED	The leveling (zeroing) calibration has not been performed for the chassis tilt sensor.	
8/2		<b>Flash code 8/2 indicates problems with the platform load sensing system.</b>	10
	LOAD SENSOR NOT CALIBRATED	The calibration procedure has not been performed for the load sensor.	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

<b>Fault Flash Code</b>	<b>Communicated (Displayed on Analyzer) Fault</b>	<b>Description</b>	<b>Priority</b>
<b>8/3</b>		<b>Flash code 8/3 indicates problems with the Basket Leveling system.</b>	<b>10</b>
	BASKET LEVELING CRACKPOINT UP NOT CALIBRATED	Only occurs on machines with electronic leveling systems. Indicates that the basket up valve crackpoint has not been calibrated	
	BASKET LEVELING CRACKPOINT DOWN NOT CALIBRATED	Only occurs on machines with electronic leveling systems. Indicates that the basket down valve crackpoint has not been calibrated	
	BASKET LEVELING SENSOR 1 NOT ZERO CALIBRATED	Only occurs on machines with electronic leveling systems. Indicates that the primary basket leveling tilt sensor has not been calibrated.	
	BASKET LEVELING SENSOR 1 ZERO OUT OF RANGE	Only occurs on machines with electronic leveling systems. Indicates that the primary basket leveling tilt sensor zero is outside of the allowable range	
	BASKET LEVELING SENSOR 1 SHORT TO BATTERY	Only occurs on machines with electronic leveling systems. Indicates that the primary basket leveling tilt sensor is shorted to battery. An EMS cycle is required.	
	BASKET LEVELING SENSOR 1 SHORT TO GROUND OR OPEN CIRCUIT	Only occurs on machines with electronic leveling systems. Indicates that the primary basket leveling tilt sensor is either shorted to ground or is not connected. An EMS cycle is required.	
	BASKET LEVELING SENSOR 2 NOT ZERO CALIBRATED	Only occurs on machines with electronic leveling systems. Indicates that the secondary basket leveling tilt sensor is not zero calibrated.	
	BASKET LEVELING SENSOR 2 ZERO OUT OF RANGE	Only occurs on machines with electronic leveling systems. Indicates that the secondary basket leveling system tilt sensor zero is outside the allowable range.	
	BASKET LEVELING SENSOR 2 SHORT TO BATTERY	Only occurs on machines with electronic leveling systems. Indicates that the secondary basket leveling tilt sensor is shorted to battery. An EMS cycle is required.	
	BASKET LEVELING SENSOR 2 SHORT TO GROUND OR OPEN CIRCUIT	Only occurs on machines with electronic leveling systems. Indicates that the secondary basket leveling tilt sensor is either shorted to ground or not connected. An EMS cycle is required.	
	BASKET LEVELING TILT REFERENCE 1 OUT OF RANGE	Only occurs on machines with electronic leveling systems. Indicates that the reference voltage for the primary basket leveling tilt sensor is outside the expected range (4.9 to 5.1 volts). An EMS cycle is required.	
	BASKET LEVELING TILT REFERENCE 2 OUT OF RANGE	Only occurs on machines with electronic leveling systems. Indicates that the reference voltage for the secondary basket leveling tilt sensor is outside the expected range. (4.9 to 5.1 volts). An EMS cycle is required.	
	BASKET LEVELING TILT SENSOR DIFFERENCE TOO GREAT	Only occurs on machines with electronic leveling systems. Indicates that the basket leveling tilt readings both appear to be good but their measurements do not agree within a specified adjustable tolerance. An EMS cycle is required.	
	BASKET LEVELING SYSTEM TIME-OUT	Only occurs on machines with electronic leveling systems. Indicates that the basket was not able to maintain the desired level within an adjustable range for and adjustable time	
	BASKET LEVELING OVERRIDE ON	User has forced basket leveling on through Access Level 0.	
	BASKET LEVELING OVERRIDE OFF	User has forced basket leveling off through Access Level 0.	
	BASKET LEVELING TILT SENSOR 1 COMMUNICATIONS LOST	Communications have been lost with a serial leveling sensor. Only on 1200S and 1350S models. An EMS cycle is required.	
BASKET LEVELING TILT SENSOR 2 COMMUNICATIONS LOST	Communications have been lost with a serial leveling sensor. Only on 1200S and 1350S models. An EMS cycle is required.		

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
8/4		<b>Flash code 8/4 indicates problems with the envelope system. Only occur on machines with envelope control.</b>	<b>10</b>
	BOOM ANGLE SENSOR DISAGREEMENT	The boom angle sensors are reporting angles that differ too greatly. An EMS cycle is required.	
	BOOM LENGTH SWITCH FAILED	The boom length switch inputs are reporting the same state. An EMS cycle is required.	
	BOOM LENGTH SWITCH/SENSOR DISAGREEMENT	The boom length switch and sensor differ in their reports of extended or retracted. An EMS cycle is required.	
	BOOM LENGTH SENSOR NOT DETECTING LENGTH CHANGE	The boom length sensor has not detected a change in length while the user is commanding telescope. An EMS cycle is required.	
	BOOM LENGTH SENSOR OUT OF RANGE HIGH	Indicates that the voltage for the boom length sensor is above the expected range.	
	BOOM LENGTH SENSOR OUT OF RANGE LOW	Indicates that the voltage for the boom length sensor is below the expected range.	
	BOOM LENGTH SENSOR VALUE OUT OF RANGE HIGH	Indicates the length reported for the boom length sensor is above the expected range. An EMS cycle is required.	
	BOOM LENGTH SENSOR VALUE OUT OF RANGE LOW	Indicates the length reported for the boom length sensor is below the expected range. An EMS cycle is required.	
	BOOM ANGLE SENSOR #1 COMMUNICATIONS FAULT	Boom angle sensor #1 lost communications with the BLAM. An EMS cycle is required.	
	BOOM ANGLE SENSOR #2 COMMUNICATIONS FAULT	Boom angle sensor #2 lost communications with the BLAM. An EMS cycle is required.	
	ANGLE SENSOR #1 INVALID ANGLE	An EMS cycle is required.	
	ANGLE SENSOR #2 INVALID ANGLE	An EMS cycle is required.	
	WRONG TELE RESPONSE	The boom telescope is contrary to the user command	
	WRONG LIFT RESPONSE	The boom lift is contrary to the user command	
	TOWER ANGLE SENSOR DISAGREEMENT	The tower angle sensors are reporting angles that differ too greatly. An EMS cycle is required.	
	TOWER LENGTH SENSOR DISAGREEMENT	The tower length sensors are reporting angles that differ too greatly. An EMS cycle is required.	
	MAIN ANGLE SENSOR DISAGREEMENT	The main boom angle sensors are reporting angles that differ too greatly. An EMS cycle is required.	
	BOOM LENGTH SENSOR #1 OUT OF RANGE HIGH	Reported from the BLAM, indicates tower length sensor one value is out of range high.	
	BOOM LENGTH SENSOR #1 OUT OF RANGE LOW	Reported from the BLAM, indicates tower length sensor one value is out of range low.	
	BOOM LENGTH SENSOR #2 OUT OF RANGE HIGH	Reported from the BLAM, indicates tower length sensor two value is out of range high.	
	BOOM LENGTH SENSOR #2 OUT OF RANGE LOW	Reported from the BLAM, indicates tower length sensor two value is out of range low.	
	TWR LENGTH SENSOR NOT DETECTING LENGTH CHANGE	Tower tele is being commanded and the length sensors are not changing value.	
TWR LENGTH MOVEMENT WITHOUT CMD	Tower length is changing without a tower tele command		
TWR LENGTH SENSOR ONE VALUE OUT OF RANGE HIGH	This fault is reported by the Ground module when the length sensor value is outside the constant data limit		

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

<b>Fault Flash Code</b>	<b>Communicated (Displayed on Analyzer) Fault</b>	<b>Description</b>	<b>Priority</b>
	TWR LENGTH SENSOR ONE VALUE OUT OF RANGE LOW	This fault is reported by the Ground module when the length sensor value is outside the constant data limit	
	TWR LENGTH SENSOR TWO VALUE OUT OF RANGE HIGH	This fault is reported by the Ground module when the length sensor value is outside the constant data limit	
	TWR LENGTH SENSOR TWO VALUE OUT OF RANGE LOW	This fault is reported by the Ground module when the length sensor value is outside the constant data limit	
	TWR ANGL1 INVALID ANGLE	Tower boom angle sensor #1 out of range	
	TWR ANGL2 INVALID ANGLE	Tower boom angle sensor #2 out of range	
	INVALID ANGLE SENSOR #1 MODEL	Wrong tower angle sensor Mfgr. Installed on a 1250AJP (Must be a Rieker, not Spectron)	
	INVALID ANGLE SENSOR #2 MODEL	Wrong tower angle sensor Mfgr. Installed on a 1250AJP (Must be a Rieker, not Spectron)	
	MAIN ANGL1 INVALID ANGLE	Main boom angle sensor #1 out of range	
	MAIN ANGL2 INVALID ANGLE	Main boom angle sensor #2 out of range	
	MAIN ANGLE SENSOR NOT DETECTING ANGLE CHANGE	The main boom is being commanded to move and the main angle sensors are not detecting any movement	
	MAIN ANGLE MOVEMENT WITHOUT CMD	The main boom angle is changing without a main lift command	
	WRONG TWR TELE RESPONSE	The tower telescope is moving in the opposite direction the user is commanding.	
	WRONG TWRLIFT RESPONSE	The tower lift is moving in the opposite direction the user is commanding	
	TWR CYL ANGLE SENSOR OUT OF RANGE LOW	The tower cylinder angle sensor is below 4721 A/D counts	
	TWR CYL ANGLE SENSOR OUT OF RANGE HIGH	The tower cylinder angle sensor is above 29535 A/D counts.	
	TWR CYL ANGLE NOT DETECTING ANGLE CHANGE	The cylinder angle is not changing during a tower lift up/down user command.	
	TWR CYL ANGLE MOVEMENT WITHOUT CMD	The cylinder angle is changing without a tower lift command	
	MAIN TRN ANGLE SW FAILED	The system detected a disagreement of the N.O. vs N.C. contacts on the main boom angle switch.	
	TWR TRN SW DISAGREEMENT	The system detected a disagreement between the tower boom length switch and the tower length sensors.	
	TRN DUAL CAP SWITCHES BAD	The system detected both the Dual capacity and the transport switches are bad.	
	TRN DUAL CAP BAD TRANSITION	The system detected that the Dual capacity or the transport switches changed state out of order.	
	MAIN TRN LEN SW DISAGREEMENT	The system detected a disagreement between the main boom transport length switches.	
	DCAP LEN SW DISAGREEMENT	The system detected a disagreement between the main boom dual capacity length switches.	
	MAIN BOOM TRN ANGLE SW/SENSOR DISAGREEMENT	The system detected a disagreement between the main boom transport angle switch and the main boom angle sensors.	
	CYL ANGLE SENSOR/SW DISAGREEMENT	The system detected a disagreement of the tower angle input from the BLAM and the tower cylinder angle sensor.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
8/5		<b>Flash code 8/5 indicates problems with the moment or load pin system. Only occur on machines with moment or load pin control. An EMS cycle is required.</b>	<b>10</b>
	MOMENT PIN HORIZONTAL FORCE OUT OF RANGE	The horizontal force is out of the allowed range.	
	MOMENT PIN VERTICAL FORCE OUT OF RANGE	The vertical force is out of the allowed range.	
	LOAD PIN HORIZONTAL FORCE OUT OF RANGE	The horizontal force is out of the allowed range.	
	LOAD PIN VERTICAL FORCE OUT OF RANGE	The vertical force is out of the allowed range.	
	MOMENT PIN SENSOR FAULT	The moment pin has reported a fault flag.	
	LOAD PIN SENSOR FAULT	The load pin has reported a fault flag.	
	NEW MOMENT PIN DETECTED FAULT	A moment pin was detected on the system different from the one used to calibrate the machine.	
	NEW LOAD PIN DETECTED FAULT	A load pin was detected on the system different from the one used to calibrate the machine.	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
8/6		<b>Flash code 8/6 indicates problems with the steering system. Except as noted, an EMS cycle is required.</b>	<b>10</b>
	RESTRICTED TO TRANSPORT – OSC AXLE PRESS SW DISAGREEMENT	Only occurs on machines with electrically released oscillating axles configured. The oscillating axle pressure switch indicates pressure while the machine is not driving or does not indicate pressure while the machine is driving and the machine is restricted to transport position.	
	AXLE EXT STB OR OC	A short to battery or open circuit was detected on the axles extension valve.	
	AXLE EXT STG	A short to ground was detected on the axles extension valve.	
	AXLE RET STB OR OC	A short to battery or open circuit was detected on the axles retract valve.	
	AXLE RET STG	A short to ground was detected on the axles retract valve.	
	RT FNT STEER RT STB OR OC	A short to battery or open circuit has been detected on the right front steer right valve.	
	RT FNT STEER RT STG	A short to ground has been detected on the right front steer right valve.	
	RT FNT STEER LT STB OR OC	A short to battery or open circuit has been detected on the right front steer left valve.	
	RT FNT STEER LT STG	A short to ground has been detected on the right front steer left valve.	
	LT FNT STEER RT STB OR OC	A short to battery or open circuit has been detected on the left front steer right valve.	
	LT FNT STEER RT STG	A short to ground has been detected on the left front steer right valve.	
	LT FNT STEER LT STB OR OC	A short to battery or open circuit has been detected on the left front steer left valve.	
	LT FNT STEER LT STG	A short to ground has been detected on the left front steer left valve.	
	RT REAR STEER RT STB OR OC	A short to battery or open circuit has been detected on the right rear steer right valve.	
	RT REAR STEER RT STG	A short to ground has been detected on the right rear steer right valve.	
	RT REAR STEER LT STB OR OC	A short to battery or open circuit has been detected on the right rear steer left valve.	
	RT REAR STEER LT STG	A short to ground has been detected on the right rear steer left valve.	
	LT REAR STEER RT STB OR OC	A short to battery or open circuit has been detected on the left rear steer right valve.	
	LT REAR STEER RT STG	A short to ground has been detected on the left rear steer right valve.	
	LT REAR STEER LT STB OR OC	A short to battery or open circuit has been detected on the left rear steer left valve.	
	LT REAR STEER LT STG	A short to ground has been detected on the left rear steer left valve.	
	FRONT LEFT WHEEL FAULT – CHECK MOUNTING	This indicates that the steering angle sensor has become decoupled.	
	FRONT RIGHT WHEEL FAULT – CHECK MOUNTING	This indicates that the steering angle sensor has become decoupled.	
	REAR LEFT WHEEL FAULT – CHECK MOUNTING	This indicates that the steering angle sensor has become decoupled.	
	REAR RIGHT WHEEL FAULT – CHECK MOUNTING	This indicates that the steering angle sensor has become decoupled.	
	FRONT LEFT WHEEL BLOCKED	The wheel is not responding to steer commands. Fault clears when condition clears.	
	FRONT RIGHT WHEEL BLOCKED	The wheel is not responding to steer commands. Fault clears when condition clears.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	REAR LEFT WHEEL BLOCKED	The wheel is not responding to steer commands. Fault clears when condition clears.	
	REAR RIGHT WHEEL BLOCKED	The wheel is not responding to steer commands. Fault clears when condition clears.	
	FRONT LEFT WHEEL SENSOR OUT OF RANGE LOW	A short to ground or open circuit has been detected on the steering angle sensor.	
	FRONT LEFT WHEEL SENSOR OUT OF RANGE HIGH	A short to battery has been detected on the steering angle sensor.	
	FRONT RIGHT WHEEL SENSOR OUT OF RANGE LOW	A short to ground or open circuit has been detected on the steering angle sensor.	
	FRONT RIGHT WHEEL SENSOR OUT OF RANGE HIGH	A short to battery has been detected on the steering angle sensor.	
	REAR LEFT WHEEL SENSOR OUT OF RANGE LOW	A short to ground or open circuit has been detected on the steering angle sensor.	
	REAR LEFT WHEEL SENSOR OUT OF RANGE HIGH	A short to battery has been detected on the steering angle sensor.	
	REAR RIGHT WHEEL SENSOR OUT OF RANGE LOW	A short to ground or open circuit has been detected on the steering angle sensor.	
	REAR RIGHT WHEEL SENSOR OUT OF RANGE HIGH	A short to battery has been detected on the steering angle sensor.	
<b>8/7</b>		<b>Flash code 8/7 indicates new main angle sensors</b>	<b>10</b>
	NEW MAIN ANGL1 SENSOR DETECTED	The system detected a different main angle #1 sensor than it was calibrated with. (1250AJP only.)	
	NEW MAIN ANGL2 SENSOR DETECTED	The system detected a different main angle #2 sensor than it was calibrated with. (1250AJP only.)	



**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

<b>Fault Flash Code</b>	<b>Communicated (Displayed on Analyzer) Fault</b>	<b>Description</b>	<b>Priority</b>
9/9		<b>Flash code 9/9 indicates problems with the controller or the user disabling safety systems from Access Level 0.</b>	<b>11</b>
	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	Platform module code is too old to support the EIM or BPE load sensor and the machine is configured to use one of these two sensors. The PM code must be updated to a newer version.	
	GROUND MODULE CONSTANT DATA UPDATE REQUIRED	The ground module has old constant data that is not compatible with the current ground module software. The GM constant data must be updated to a newer version. An EMS cycle is required.	
	HIGH RESOLUTION A2D FAILURE – INTERRUPT LOST	The ADS1213 chip in the platform module has stopped asserting its interrupt (DRDY) line for some reason. An EMS cycle is required.	
	HIGH RESOLUTION A2D FAILURE-REINIT LIMIT	The ADS1213 has needed to be reset 3 or more times. An EMS cycle is required.	
	PLATFORM MODULE FAILURE: hwfs CODE 1	Platform module V(Low) FET has failed. An EMS cycle is required.	
	GROUND MODULE FAILURE: hwfs CODE 1	Ground module V(Low) FET has failed. An EMS cycle is required.	
	GROUND SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc goes out of range. Not reported during 2 second power-up. An EMS cycle is required.	
	GROUND MODULE FAILURE: HIGH SIDE DRIVER CUTOFF FAULTY	This fault occurs when there is a fault with the hardware based high side driver cutoff circuit. An EMS cycle is required.	
	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc goes out of range. Not reported during 2 second power-up. An EMS cycle is required.	
	EEPROM FAILURE – CHECK ALL SETTINGS	A critical failure occurred with the EEPROM. Personalities, machine configuration digits, etc may be reset to default values and should be checked. An EMS cycle is required.	
	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	Indicates that the chassis tilt sensor calibration information has been lost. Machine will indicate that it is tilted at all times. This calibration data is programmed into the unit at the factory.	
	CHASSIS TILT SENSOR GAIN OUT OF RANGE	Indicates that the chassis tilt sensor calibration has become corrupted. This calibration data is programmed into the unit at the factory.	
	ENVELOPE CONTROL DISABLED	Only occurs on machines with envelope control. The user has forced envelope control off with the analyzer from Access Level 0.	
	MOMENT CONTROL DISABLED	Only occurs on machines with envelope control. The user has forced moment control off with the analyzer from Access Level 0.	
	STEER SENSORS NOT CALIBRATED	Only occurs on machines with a chassis module. The steer sensors require a calibration that has not yet been performed.	
	BOOM SENSORS NOT CALIBRATED	Only occurs on machines with a BLAM module. The boom sensors require a calibration that has not yet been performed.	
	LIFT CRACKPOINTS NOT CALIBRATED	Only occurs on 1200S and 1350S machines. The lift valves require a calibration that has not yet been performed.	
	TELESCOPE CRACKPOINTS NOT CALIBRATED	Only occurs on 1200S and 1350S machines. The telescope valves require a calibration that has not yet been performed.	
	DRIVE CRACKPOINTS NOT CALIBRATED	Only occurs on 1200S and 1350S machines. The drive valves require a calibration that has not yet been performed.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66995 to Present**

<b>Fault Flash Code</b>	<b>Communicated (Displayed on Analyzer) Fault</b>	<b>Description</b>	<b>Priority</b>
	BLAM SENSOR SUPPLY OUT OF RANGE HIGH	Indicates that the supply voltage for the boom angle sensors is above the expected range. An EMS cycle is required.	
	BLAM SENSOR SUPPLY OUT OF RANGE LOW	Indicates that the supply voltage for the boom angle sensors is below the expected range. An EMS cycle is required.	
	LENGTH SENSOR REF VOLTAGE HIGH	Indicates that the supply voltage for the boom length sensors is above the expected range. An EMS cycle is required.	
	LENGTH SENSOR REF VOLTAGE LOW	Indicates that the supply voltage for the boom length sensors is below the expected range. An EMS cycle is required.	
	BLAM HIGH RES A/D FAILURE	The high resolution Analog to digital converter in the BLAM module has failed. An EMS cycle is required.	
	CHASSIS SENSOR SUPPLY OUT OF RANGE LOW	Indicates that the supply voltage for chassis sensors is below the expected range. An EMS cycle is required.	
	CHASSIS SENSOR SUPPLY OUT OF RANGE HIGH	Indicates that the supply voltage for chassis sensors is above the expected range. An EMS cycle is required.	
	BLAM BACKUP COMMUNICATIONS LINK FAULTY	Reported if the backup communications link to the BLAM failed the test at startup.	
	BLAM BACKUP COMMUNICATIONS LOST - HYDRAULICS SUSPENDED	The backup communications link to the BLAM module was activated but could not establish/maintain communications with the BLAM.	

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**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-4. Machine Configuration Programming Information Prior to Software Version P5.3**

Configuration Digit	Number	Description	Default Number
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
ENGINE: 3* * Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	11
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	8	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	9	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	10	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	11	DEUTZ ECM: Engine Control Module - ECM	
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0	133 TEETH: 133 flywheel teeth.	1
	1	110 TEETH: 110 flywheel teeth.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-4. Machine Configuration Programming Information Prior to Software Version P5.3**

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	1
	1	W/O STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.	
	2	W/ STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	
ENGINE SHUTDOWN: 6	0	DISABLED: No engine shutdown.	1
	1	ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 psi.	
TILT: 7* * Certain market selections will limit tilt options.	1	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.	1
	2	4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep.	
	3	3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep.	
	4	4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	5	3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.  <i>Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.</i>	
JIB: 8* * Only visible under certain model selections	0	NO: No jib installed.	0
	1	YES: Jib installed which has up and down movements only.	
4 WHEEL STEER: 9* * Only visible under certain model selections.	0	NO: No four-wheel steer installed.	0
	1	YES: Four-wheel steer installed.	
SOFT TOUCH: 10* * Only visible under certain model selections.	0	NO: No soft touch system installed.	0
	1	YES: Soft touch system installed.	
GEN SET/WELDER: 11	0	NO: No generator installed.	0
	1	BELT DRIVE: Belt driven setup.	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-4. Machine Configuration Programming Information Prior to Software Version P5.3**

Configuration Digit	Number	Description	Default Number
GENSET CUTOFF: 12* * Only visible if Gen Set / Welder Menu selection is not 0.	0	MOTION ENABLED: Motion enabled when generator is ON.	0
	1	MOTION CUTOFF: Motion cutoff in platform mode only.	
H & T LIGHTS: 13	0	NO: No head and tail lights installed.	0
	1	YES: Head and tail lights installed.	
CABLE SWITCH: 14* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0	NO: No broken cable switch installed.	0
	1	YES: Broken cable switch installed.	
LOAD SYSTEM: 15* * Only visible under certain model selections. * Certain market selections will limit load system options or alter default setting.	0	NO: No load sensor installed.	0
	1	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	2	CUTOFF PLATFORM: All functions cutoff, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	CUTOFF ALL: All functions cutoff, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
	4	SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	
LOAD SENSOR: 16* * Only visible if Load Sensor Menu selection is not 0. * Market selections will limit certain load sensor options.	0	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	
FUNCTION CUTOFF: 17* * Only visible under certain market selections. * Certain market selections will limit function cutoff options or alter default setting.	0	NO: No drive cutoff.	0
	1	BOOM CUTOFF: Boom function cutoff while driving above elevation.	
	2	DRIVE CUTOFF: Drive cutoff above elevation.	
	3	DRIVE CUT E&T: Drive cutoff above elevation and tilted.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-4. Machine Configuration Programming Information Prior to Software Version P5.3**

Configuration Digit	Number	Description	Default Number
GROUND ALARM: 18* * Certain market selections will alter default setting.	0	NO: No ground alarm installed.	0
	1	DRIVE: Travel alarm sounds when the drive function is active (Option).	
	2	DESCENT: Descent alarm sounds when lift down is active (Option).	
	3	MOTION: Motion alarm sounds when any function is active (Option).	
DRIVE: 19* * Only visible under certain model selections.	0	4WD: Four wheel drive.	0
	1	2WD: Two wheel drive.	
	2	2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	
TEMPERATURE: 20	0	CELSIUS: Celsius unit selection.	1
	1	FAHRENHEIT: Fahrenheit unit selection.	
LEVELING MODE: 21* * Only visible on 800S models.	0	ALL FUNCTIONS: Platform level with all functions.	0
	1	LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	

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**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1**

Configuration Label/ Digit	Number	Description	Default Number
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1**

Configuration Label/ Digit	Number	Description	Default Number
ENGINE: 3* * Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	7
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0	133 TEETH: 133 flywheel teeth.	1
	1	110 TEETH: 110 flywheel teeth.	
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	IN-CYLINDER: Glow plugs installed in each cylinder.	
STARTER LOCKOUT: 6	0	DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.	0
	1	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	



**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1**

Configuration Label/ Digit	Number	Description	Default Number
ENGINE SHUTDOWN: 7	0	DISABLED: No engine shutdown.	1
	1	ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.	
TILT: 8* * Certain market selections will limit tilt options and alter default setting.  <i>Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.</i>	1	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.	1
	2	4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep.	
	3	3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep.	
	4	4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	5	3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
JIB: 9* * Only visible under certain model selections.	0	NO: No jib installed.	0
	1	YES: Jib installed which has up and down movements only.	
4 WHEEL STEER: 10* * Only visible under certain model selections.	0	NO: No four-wheel steer installed.	0
	1	YES: Four-wheel steer installed.	
SOFT TOUCH: 11* * Only visible under certain model selections.	0	NO: No soft touch system installed.	0
	1	YES: Soft touch system installed.	
GEN SET/WELDER: 12	0	NO: No generator installed.	0
	1	BELT DRIVE: Belt driven setup.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1**

Configuration Label/ Digit	Number	Description	Default Number
GEN SET CUTOUT: 13* * Only visible if Gen Set / Welder Menu selection is not 0.	0	MOTION ENABLED: Motion enabled when generator is ON.	0
	1	MOTION CUTOUT: Motion cutout in platform mode only.	
H & T LIGHTS: 14	0	NO: No head and tail lights installed.	0
	1	YES: Head and tail lights installed.	
CABLE SWITCH: 15* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0	NO: No broken cable switch installed.	0
	1	YES: Broken cable switch installed.	
LOAD SYSTEM: 16* * Only visible under certain market selections. * Certain market selections will limit load system options or alter default set- ting.	0	NO: No load sensor installed.	0
	1	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	2	CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
	4	SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	
LOAD SENSOR: 17* * Only visible if Load Sen- sor Menu selection is not 0 and under certain market selections. * Certain market selections will limit load sensor options.	0	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1**

Configuration Label/ Digit	Number	Description	Default Number
<b>FUNCTION CUTOUT: 18*</b> * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0	NO: No drive cutout.	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive & steer cutout above elevation.	
	3	DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	
<b>GROUND ALARM: 19*</b> * Certain market selections will alter default setting.	0	NO: No ground alarm installed.	3
	1	DRIVE: Travel alarm sounds when the drive function is active (Option).	
	2	DESCENT: Descent alarm sounds when lift down is active (Option).	
	3	MOTION: Motion alarm sounds when any function is active (Option).	
<b>DRIVE: 20*</b> * Only visible under certain model selections.	0	4WD: Four wheel drive.	0
	1	2WD: Two wheel drive.	
	2	2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	
<b>TEMPERATURE: 21*</b> * Certain market selections will alter default setting.	0	CELSIUS: Celsius unit selection.	1
	1	FAHRENHEIT: Fahrenheit unit selection.	
<b>LEVELING MODE: 22*</b> * Only visible on 800S models.	0	ALL FUNCTIONS: Platform level with all functions.	0
	1	LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	

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**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present**

Configuration Label/ Digit	Number	Description	Default Number
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present**

Configuration Label/ Digit	Number	Description	Default Number
ENGINE: 3* * Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	14
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	14	PERKINS ECM	
	15	CAT ECM	
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0	133 TEETH: 133 flywheel teeth.	1
	1	110 TEETH: 110 flywheel teeth.	
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	IN-CYLINDER: Glow plugs installed in each cylinder.	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present**

Configuration Label/ Digit	Number	Description	Default Number
STARTER LOCKOUT: 6	0	DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.	0
	1	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	
ENGINE SHUTDOWN: 7	0	DISABLED: No engine shutdown.	1
	1	ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.	
TILT: 8* * Certain market selections will limit tilt options and alter default setting.  <i>Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.</i>	1	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.	1
	2	4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep.	
	3	3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep.	
	4	4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	5	3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
JIB: 9* * Only visible under certain model selections.	0	NO: No jib installed.	0
	1	YES: Jib installed which has up and down movements only.	
4 WHEEL STEER: 10* * Only visible under certain model selections.	0	NO: No four-wheel steer installed.	0
	1	YES: Four-wheel steer installed.	
SOFT TOUCH: 11* * Only visible under certain model selections.	0	NO: No soft touch system installed.	0
	1	YES: Soft touch system installed.	

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present**

Configuration Label/ Digit	Number	Description	Default Number
GEN SET/WELDER: 12	0	NO: No generator installed.	0
	1	BELT DRIVE: Belt driven setup.	
GEN SET CUTOUT: 13* * Only visible if Gen Set / Welder Menu selection is not 0.	0	MOTION ENABLED: Motion enabled when generator is ON.	0
	1	MOTION CUTOUT: Motion cutout in platform mode only.	
H & T LIGHTS: 14	0	NO: No head and tail lights installed.	0
	1	YES: Head and tail lights installed.	
CABLE SWITCH: 15* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0	NO: No broken cable switch installed.	0
	1	YES: Broken cable switch installed.	
LOAD SYSTEM: 16* * Only visible under certain market selections. * Certain market selections will limit load system options or alter default set- ting.	0	NO: No load sensor installed.	0
	1	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	2	CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
	4	SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present**

Configuration Label/ Digit	Number	Description	Default Number
LOAD SENSOR: 17* * Only visible if Load Sensor Menu selection is not 0 and under certain market selections. * Certain market selections will limit load sensor options.	0	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	
FUNCTION CUTOUT: 18* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0	NO: No drive cutout.	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive & steer cutout above elevation.	
	3	DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	
GROUND ALARM: 19* * Certain market selections will alter default setting.	0	NO: No ground alarm installed.	3
	1	DRIVE: Travel alarm sounds when the drive function is active (Option).	
	2	DESCENT: Descent alarm sounds when lift down is active (Option).	
	3	MOTION: Motion alarm sounds when any function is active (Option).	
DRIVE: 20* * Only visible under certain model selections.	0	4WD: Four wheel drive.	0
	1	2WD: Two wheel drive.	
	2	2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	
TEMPERATURE: 21* * Certain market selections will alter default setting.	0	CELSIUS: Celsius unit selection.	1
	1	FAHRENHEIT: Fahrenheit unit selection.	



**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present**

Configuration Label/ Digit	Number	Description	Default Number
LEVELING MODE: 22* * Only visible on 800S models.	0	ALL FUNCTIONS: Platform level with all functions.	0
	1	LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	
DRIVE CONTROL: 23	0	NORMAL: Drive coils are energized from the Ground Module.	2
	1	PROPULSION: Drive coils are energized from the Propulsion Module.	
	2	ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.	
CLEARSKY: 24	0	NO: Clearsky (telematics) option is disabled.	0
	1	YES: Clearsky (telematics) option is enabled.	
CRIBBING OPTION: 25	0	NO: Cribbing Option is disabled.	0
	1	YES: Cribbing Option is enabled.	

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## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**NOTE:** Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed. Shaded cells indicate a hidden menu or selection.

400S																											
	MODEL NUMBER	MARKET	ENGINE	FLYWHEEL TEETH		GLOW PLUGS			STARTER LOCKOUT		ENGINE SHUTDOWN		TILT					JIB		4 WHEEL STEER		SOFT TOUCH		GEN SET / WELDER		GEN SET CUTOFF	
				0	1	0	1	2	0	1	0	1	1	2	3	4	5	0	0	0	1	0	1	0	1		
ANSI USA	<b>2</b>	<b>0</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>1</b>	2	3	4	5	0	0	0	1	0	1	0	1		
ANSI EXPORT	<b>2</b>	<b>1</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>1</b>	2	3	4	5	0	0	0	1	0	1	0	1		
CSA	<b>2</b>	<b>2</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>1</b>	2	3	4	5	0	0	0	1	0	1	0	1		
CE	<b>2</b>	<b>3</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	X	<b>2</b>	3	4	5	0	0	0	1	0	1	0	1		
AUSTRALIA	<b>2</b>	<b>4</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	X	<b>2</b>	3	4	5	0	0	0	1	0	1	0	1		
JAPAN	<b>2</b>	<b>5</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>1</b>	2	3	4	5	0	0	0	1	0	1	0	1		

400S																										
	HEAD & TAIL LIGHTS		CABLE BREAK SWITCH		LOAD SYSTEM				LOAD SENSOR		FUNCTION CUTOFF			GROUND ALARM			DRIVE TYPE		TEMPERATURE		LEVELING MODE					
	0	1	0	1	0	X	X	X	X	0	1	0	X	X	X	0	1	2	3	0	1	2	0	1		
ANSI USA	0	1	0	<b>1</b>	0	X	X	X	X	0	<b>1</b>	0	X	X	X	0	1	2	3	0	1	2	0	<b>1</b>	0	1
ANSI EXPORT	0	1	0	<b>1</b>	0	<b>1</b>	2	3	4	0	<b>1</b>	0	1	2	3	0	1	2	3	0	1	2	0	<b>1</b>	0	1
CSA	0	1	0	<b>1</b>	0	X	X	X	X	0	<b>1</b>	0	1	2	3	0	1	2	<b>3</b>	0	1	2	0	1	0	1
CE	0	1	0	<b>1</b>	0	X	2	<b>3</b>	X	0	<b>1</b>	0	<b>1</b>	X	X	0	1	2	<b>3</b>	0	1	2	0	1	0	1
AUSTRALIA	0	1	0	<b>1</b>	0	<b>1</b>	2	3	4	0	<b>1</b>	0	1	2	3	0	1	2	3	0	1	2	0	1	0	1
JAPAN	0	1	0	<b>1</b>	0	<b>1</b>	2	3	4	0	<b>1</b>	0	1	2	3	0	1	2	<b>3</b>	0	1	2	0	1	0	1

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**NOTE:** Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed. Shaded cells indicate a hidden menu or selection.

460SJ																											
	MODEL NUMBER	MARKET	ENGINE	FLYWHEEL TEETH		GLOW PLUGS			STARTER LOCKOUT		ENGINE SHUTDOWN		TILT					JIB		4 WHEEL STEER		SOFT TOUCH		GEN SET / WELDER		GEN SET CUTOFF	
ANSI USA	<b>1</b>	<b>0</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>1</b>	2	3	4	5	<b>1</b>	<b>0</b>	<b>0</b>	1	0	1	0	1	0	1
ANSI EXPORT	<b>1</b>	<b>1</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>1</b>	2	3	4	5	<b>1</b>	<b>0</b>	<b>0</b>	1	0	1	0	1	0	1
CSA	<b>1</b>	<b>2</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>1</b>	2	3	4	5	<b>1</b>	<b>0</b>	<b>0</b>	1	0	1	0	1	0	1
CE	<b>1</b>	<b>3</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>X</b>	<b>2</b>	3	4	5	<b>1</b>	<b>0</b>	<b>0</b>	1	0	1	0	1	0	1
AUSTRALIA	<b>1</b>	<b>4</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>X</b>	<b>2</b>	3	4	5	<b>1</b>	<b>0</b>	<b>0</b>	1	0	1	0	1	0	1
JAPAN	<b>1</b>	<b>5</b>	<b>7</b>	0	<b>1</b>	0	1	<b>2</b>	0	1	0	<b>1</b>	<b>1</b>	2	3	4	5	<b>1</b>	<b>0</b>	<b>0</b>	1	0	1	0	1	0	1

460SJ																														
	HEAD & TAIL LIGHTS		CABLE BREAK SWITCH		LOAD SYSTEM				LOAD SENSOR		FUNCTION CUTOFF				GROUND ALARM				DRIVE TYPE		TEMPERATURE		LEVELING MODE							
ANSI USA	0	1	0	<b>1</b>	0	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	0	<b>1</b>	0	<b>X</b>	<b>X</b>	<b>X</b>	0	1	2	3	0	1	2	3	0	1	2	0	<b>1</b>	0	1
ANSI EXPORT	0	1	0	<b>1</b>	0	<b>1</b>	2	3	4	0	<b>1</b>	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	0	<b>1</b>	0	1
CSA	0	1	0	<b>1</b>	0	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	0	<b>1</b>	0	1	2	3	0	1	2	<b>3</b>	0	1	2	<b>3</b>	0	1	2	0	1	0	1
CE	0	1	0	<b>1</b>	0	<b>X</b>	2	<b>3</b>	<b>X</b>	0	<b>1</b>	0	<b>1</b>	<b>X</b>	<b>X</b>	0	1	2	<b>3</b>	0	1	2	<b>3</b>	0	1	2	0	1	0	1
AUSTRALIA	0	1	0	<b>1</b>	0	<b>1</b>	2	3	4	0	<b>1</b>	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	0	1	0	1
JAPAN	0	1	0	<b>1</b>	0	<b>1</b>	2	3	4	0	<b>1</b>	0	1	2	3	0	1	2	<b>3</b>	0	1	2	<b>3</b>	0	1	2	0	1	0	1

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

### 6.9 SYSTEM TEST

The Control System Incorporates a built-in system test to check the system components and functions. To use this function, use the following procedures.

#### Test from the Platform

1. Position the Platform/Ground select switch to the Platform position.



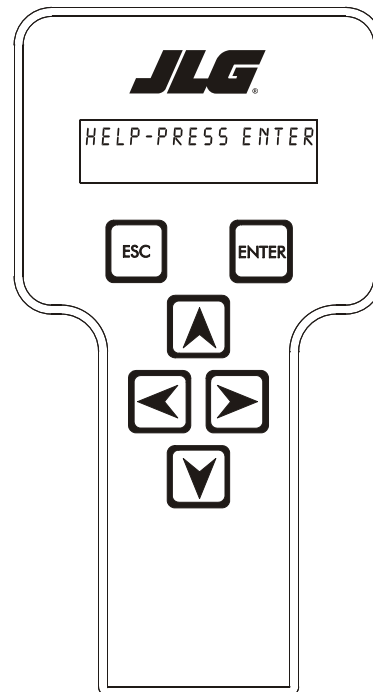
2. Plug the analyzer into the connector at the base of the platform control box.



3. Pull out the Emergency Stop switch and Start the engine.



4. The analyzer screen should read:



5. Use the arrow button to reach SYSTEM TEST. Hit Enter. The analyzer will prompt you asking if you want to activate the system test; hit Enter again to activate.
6. Follow the flow path in Figure 6-13., System Test Flow Chart - Platform Tests and go through the component tests. Hit the ESC key during any part of the test to return to the main menu without completing all tests or wait until all tests are complete. During the TEST ALL INPUTS sequence, the analyzer allows control switches to be operated and shows if they are closed (CL) or open (OP).

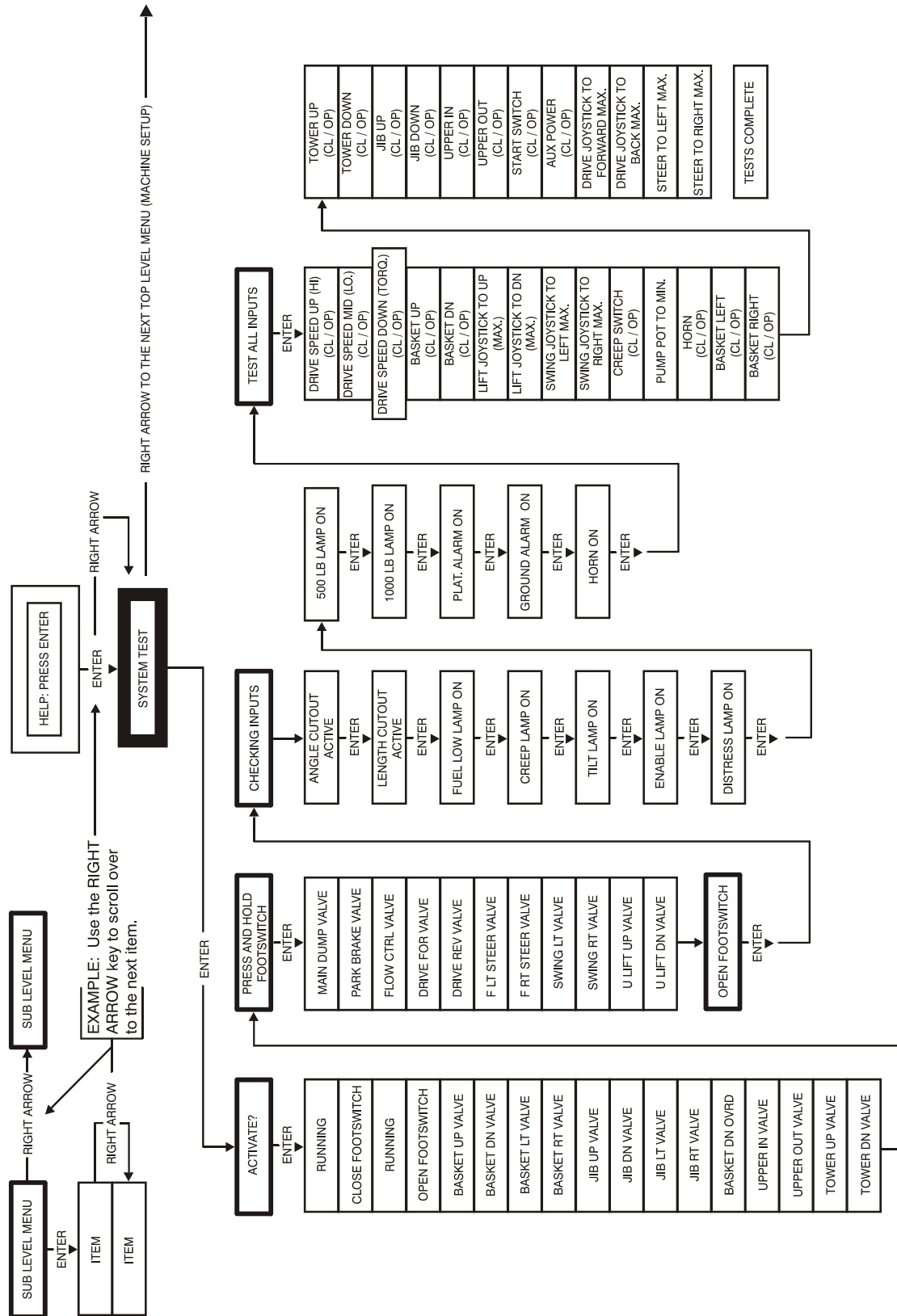


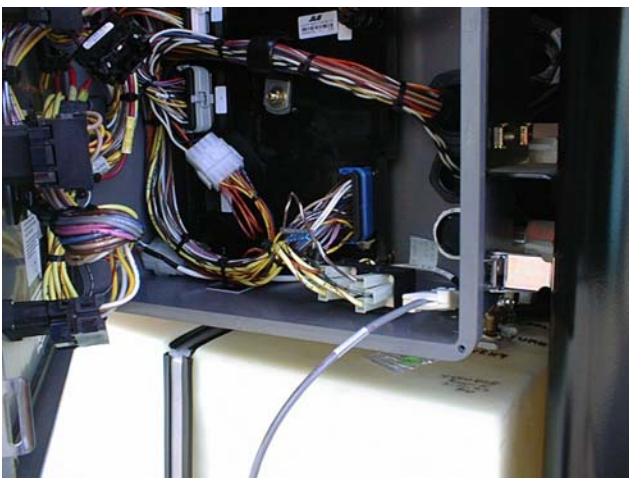
Figure 6-13. System Test Flow Chart - Platform Tests

## Test from the Ground Station

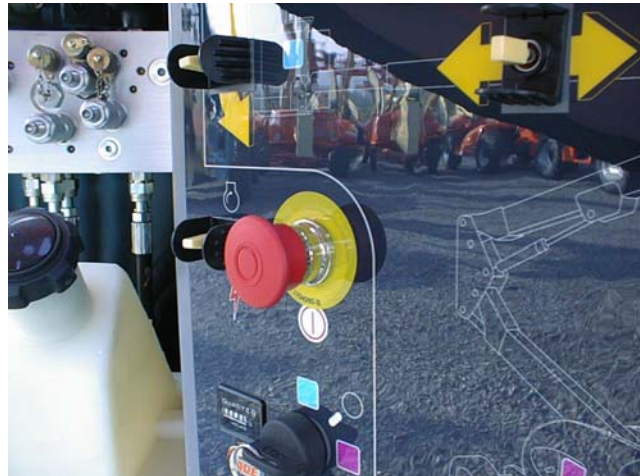
1. Position the Platform/Ground select switch to the Ground position.



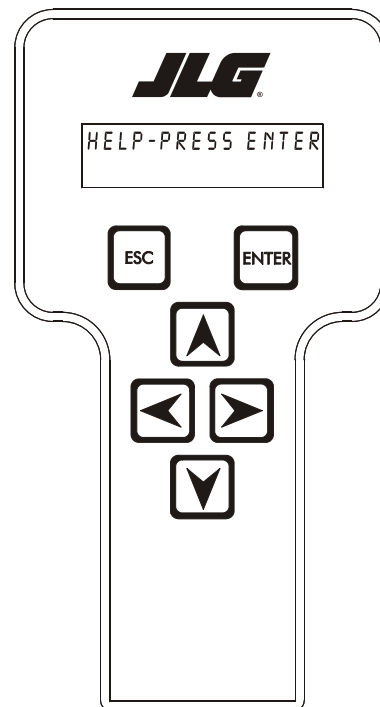
2. Plug the analyzer into the connector inside the Ground control box.



3. Pull out the Emergency Stop switch, and Start the engine.



4. The analyzer screen should read:



5. Use the arrow button to reach SYSTEM TEST. Hit Enter. The analyzer will prompt you asking if you want to activate the system test; hit Enter again to activate.
6. Follow the flow path in Figure 6-14., System Test Flow Chart - Ground Station Tests and go through the component tests. Hit the ESC key during any part of the test to return to the main menu without completing all tests or wait until all tests are complete. During the TEST ALL INPUTS sequence, the analyzer allows control switches to be operated and shows if they are closed (CL) or open (OP).

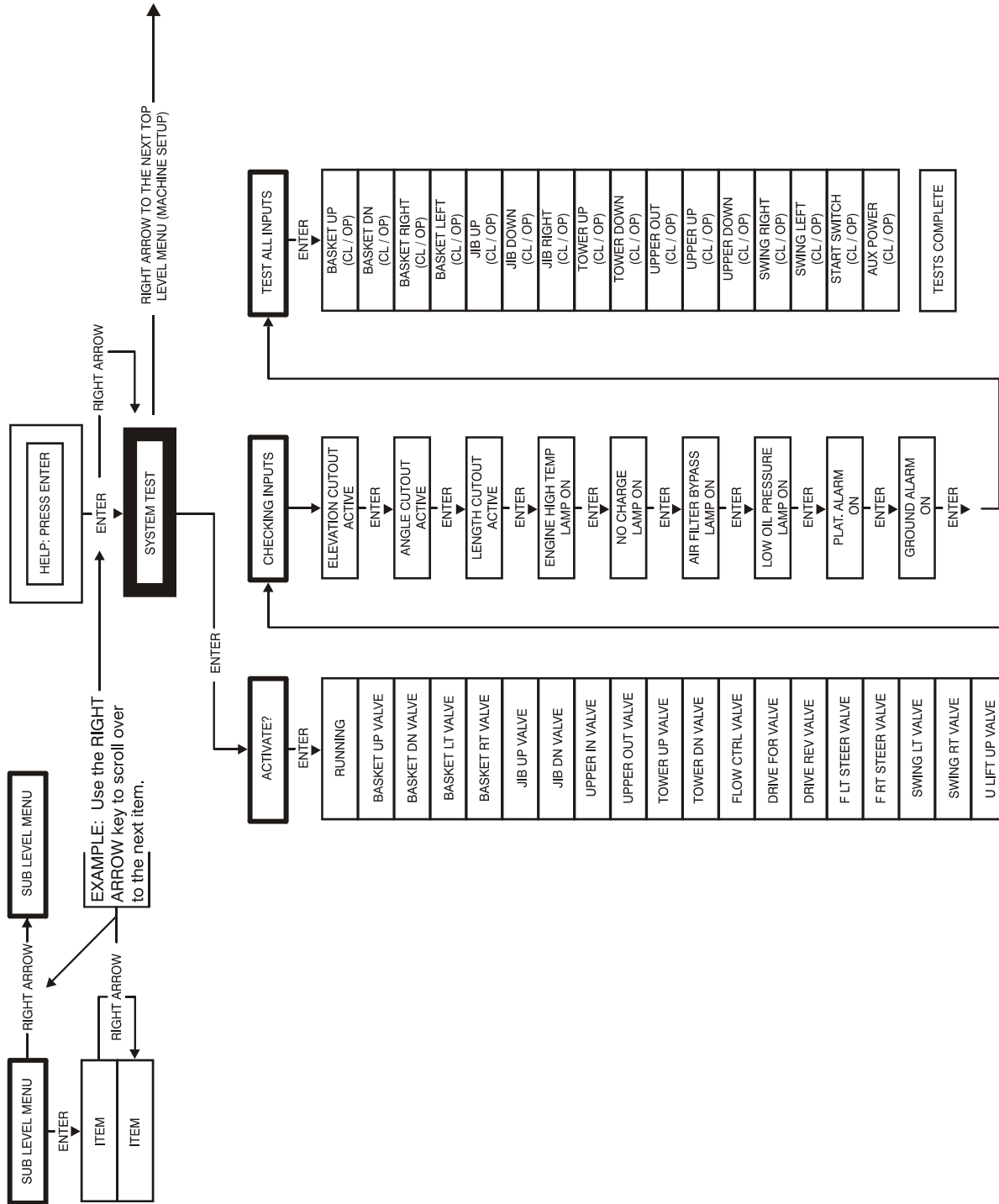


Figure 6-14. System Test Flow Chart - Ground Station Tests

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-7. System Test Messages**

Message Displayed on Analyzer	Message Displayed on Analyzer	Description
RUNNING		Initial display when system test is run; certain "critical" checks are made. Problems that can be reported include below messages.
	ONLY 1 ANALYZER!	Do not connect two Analyzers while running the system test.
	BATTERY TOO LOW	The system test cannot run with battery voltage below minimum (9 V).
	BATTERY TOO HIGH	The system test cannot run with battery voltage above maximum. (16 V).
	CHECK CAN WIRING	The system test cannot run in platform mode unless data is being received from the platform and ground modules. The system test cannot run in ground mode unless data is being received from the platform module.
	CHECK SPEED	There is an open- or short- circuit in the speed encoder wiring. Check speed encoder.
	BAD GROUND MODULE	An internal problem was detected in the ground module.
	HIGH TILT ANGLE	The vehicle is very tilted (19.3°), or the tilt sensor has been damaged. Check tilt sensor.
	HOT ENGINE	The engine temperature exceeds 100°C. This is only a warning.
	BAD I/O PORTS	The controller detected a problem with its internal circuits at switch on. If other problems are also detected, the controller may need replacing.
	SUSPECT EEPROM	The controller detected a problem with its EEPROM stored personality settings at switch on. Check and, if necessary correct, all personality settings.
	OPEN FSW	In platform mode, the footswitch must be open at the start of the test.
	CLOSE FSW	In platform mode, the footswitch must be closed when this message is displayed; the footswitch <b>MUST BE KEPT CLOSED</b> during the valve & contactor tests.
BAD FSW	The two footswitch signals are not changing together, probably because one is open-circuit. One footswitch signal ("FSW1") is routed to the power module, the other ("FSW2") is routed to the platform module. Check footswitch and wiring.	



## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-7. System Test Messages**

Message Displayed on Analyzer	Message Displayed on Analyzer	Description
TESTING VALVES		<p>Indicates that the valve test is beginning. Each valve is alternately energized and de-energized; checks are made for open- and short- circuit valve coils.</p> <p>NOTE: In platform mode, the footswitch must be closed.</p> <p>NOTE: Tower lift valves are not tested if TOWER LIFT=NO. Tower telescope valves are not tested if TOWER TELE=NO. Jib valves are not tested if JIB = NO. Extendable axle valves are not tested if EXT AXLES=NO. Four wheel steer valves are not tested if 4WS=NO.</p> <p>NOTE: Left/right jib valves are not tested unless JIB = SIDESWING.</p> <p>Problems that can be reported include below messages.</p>
	CANT TEST VALVES	There is a wiring problem, which prevents the valve test from functioning correctly. Check valve wiring. Check ground alarm & hour meter wiring.
	XXXXXXX S/C	The named valve is drawing too much current so is presumed to be short-circuited. Check valve wiring.
	XXXXXXX O/C	The named valve is drawing too little current so is presumed to be open-circuit. Check valve wiring.
CHECKING INPUTS		<p>Indicates that the inputs test is beginning. Every input is checked to ensure that it is in its "normal" position; function switches should be open, cutout switches should be closed, joysticks should be in neutral.</p> <p>In platform mode any non-neutral platform switch or joystick is reported; any active cutouts are reported.</p> <p>In ground mode any non-neutral ground switches is reported; any active cutouts are reported.</p> <p>NOTE: Switches, which are not in use (due to the settings of machine digits), are not checked.</p> <p>NOTE: The pump pot is checked only for a wire-off condition; it can be at any demand from creep to maximum.</p> <p>Problems that can be reported include below messages.</p>
	CHECK XXXXXXXX	The named switch is not in its "normal" position. Check switch & wiring.
	CHECK XXXXXXXX JOY	The named joystick appears to be faulty. Check joystick.
TESTING LAMPS		<p>Indicates that the lamps test is beginning. Each lamp is energized in turn; a prompt asks for confirmation that the lamp is lit.</p> <p>ENTER must be pressed or clicked to continue the test.</p> <p>NOTE: Lamps, which are not in use (due to the settings of machine digits), are not checked.</p> <p>NOTE: Platform Lamps are only tested in platform mode.</p> <p>NOTE: The GM overload lamp and 500# capacity lamp are not tested.</p> <p>NOTE: Head and tail lamps are tested in both platform and ground mode if enabled by a machine digit.</p>
TESTING ALARMS		<p>Indicates that the alarms test is beginning. Each alarm is energized in turn; a prompt asks for confirmation that the alarm is sounding.</p> <p>ENTER must be pressed or clicked to continue the test.</p> <p>NOTE: The platform alarm and the horn are only tested in platform mode.</p> <p>NOTE: The ground alarm is not tested if GROUND ALARM = NO.</p>

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-7. System Test Messages**

Message Displayed on Analyzer	Message Displayed on Analyzer	Description
TEST ALL INPUTS?		Prompts whether to check every operator input. If ESC is pressed or clicked, the system test ends. If ENTER is pressed or clicked, each operator input is prompted for in turn. In platform mode every platform switch and joystick is tested. In ground mode every ground switch is tested. NOTE: Tower lift switches are not tested if TOWER LIFT=NO. Tower telescope switches are not tested if TOWER TELE=NO. Jib switches are not tested if JIB = NO. Extendable axle switches are not tested if EXT AXLES=NO. Four wheel steer switches are not tested if 4WS=NO. NOTE: Left/right jib switches are not tested unless JIB = SIDESWING. Prompts displayed during the operator input test below messages.
	CLOSE XXXXXXXX	The named switch should be closed.
	OPEN XXXXXXXX	The named switch should be opened.
	XXXXXXXX XXXXXXXX TO MAX	The named joystick should be pushed to its full extent in the named direction.
	XXXXXXXX XXXXXXXX TO MIN	The named joystick should be returned to neutral from the named direction.
	PUMP POT TO MAX	The pump pot should be turned to maximum.
	PUMP POT TO MIN	The pump pot should be turned to minimum.
MULTIPLE CLOSURE	More than one operator input is closed; if only one has been operated, there could be a short between two inputs.	
TESTS COMPLETE		Indicates that the system test is complete. Any problems reported should have been noted and should now be rectified. Press ESC/CANCEL to return to the RUN SYSTEM TEST Analyzer menu.

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-8. Machine Configuration Parameters**

Configuration Digit	Parameter (Displayed on Analyzer 1 <sup>st</sup> Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description	Range	Definition	Data Increment	Default Value
1	Model Number:	1=400 2=450 3=600 4=601 5=800	Displays/adjusts machine model	1 2 3 4 5	400 450 600 601 800	1	1
2	Engine:	1=FORD EFI GAS 2=FORD EFI D/F 3=DEUTZ F4 4=DEUTZ F3	Displays/adjusts engine manufacturer/type	1 2 3	Ford LRG425EFI Gas Ford LRG425EFI Gas with dual fuel Deutz F4M1011F Diesel Deutz F3M1011F Diesel	1	1
3	Glow Plug:	0=NO 1="NUMBER OF MINUTES"	Display/adjusts glow plug presence and on-time	0 1-10	No glow plugs installed Setting this number tells the controller how many minutes after the EMS is pulled to output to the glow plugs before permitting the engine to be started.	1	0
4	ENG SHUTDOWN:	0=NO 1=SHUTDOWN	Displays/adjusts presence of the engine shutdown feature.	0 1	No engine shutdown Shutdown engine when coolant temperature is greater than 130° C (266° F) or the oil pressure is less than 0.5 bar (8 psi).	1	0
5	JOYSTICK TYPE:	1=RESISTIVE 2=INDUCTIVE	Displays/adjusts joystick type	1 2	Resistive Inductive	1	0

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-8. Machine Configuration Parameters**

6	Tilt:	1=5Deg 2=4Deg 3=3Deg	Displays/adjusts tilt sensor function	1	5 degree – reduces the maximum speed of all boom functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted ANSI (US); ANSI (EXPORT); CSA; JAPAN-All Models	1	1
				2	4 degree - reduces the maximum speed of all boom functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted. CE; AUSTRALIA - Model 400S Only		
				3	3 degree – reduces the maximum speed of all boom functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted. CE; AUSTRALIA - Models 450, 600, 601, and 800.		
7	Tower Lift:	0=NO 1=YES	Displays/adjusts tower lift presence	0	No Tower Lift installed	1	0
				1	Yes		
8	Tower Tele:	0=NO 1=YES	Displays/adjusts tower telescope presence	0	No Tower Telescope installed	1	0
				1	Yes		
9	Jib:	0=NO 1=YES 2=SIDESWING	Displays/adjusts jib presence	0	No Jib installed	1	0
				1	Jib installed which has up and down movements only		
				2	Jib installed which has up and down movements and side to side movements		
10	4ws	0=NO 1=YES	Displays/adjusts 4 wheel steer presence	0	No 4 wheel steer installed	1	0
				1	Yes		
11	soft touch	0=NO 1=YES	Displays presence of soft touch system	0	No Soft Touch System installed	1	0
				1	Yes		
12	generator	0=NO 1=YES	Displays presence of generator	0	No Generator installed	1	0
				1	Yes		

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-8. Machine Configuration Parameters**

13	Head & Tail LIGHTS	0=NO 1=YES	Displays presence of head and tail lights	0 No Head and Tail Lights installed 1 Yes	1	0
14	BROKEN Cable switch	0=NO 1=YES	Displays presence of broken cable switch	0 No Broken Cable Switch installed 1 Yes	1	0
15	load SENSOR	0=NO 1=WARN ONLY 2=WARN & CUTOUT	Displays presence/function of load sensor	0 No Load Sensor installed 1 Functions in Creep, Overload Lamp Lit, Platform Alarm Beeps Continuously 2 All functions cutout, flash overload light (500mS on, 500mS off), Platform Alarm beeps (5 sec. on, 55 sec. off, 5 sec. on)	1	0
16	angle SENSOR	0=NO 1=DIGITAL 2=ANALOG	Displays presence/function of angle sensor	0 No Angle Sensor installed 1 Limit switches are installed 2 An analog sensor is installed	1	0
17	length SENSOR	0=NO 1=DIGITAL 2=ANALOG	Displays presence/function of length sensor	0 No Length Sensor Installed 1 Limit switch installed 2 An analog sensor is installed	1	0
18	FUNCTION CUTOUT	0=NO 1=BOOM CUTOUT 2=DRIVE CUTOUT 3=DRIVE CUTE & T	Displays presence/function of drive cutout.	0 No Drive Cutout 1 Boom Function Cutout While Driving Above Elevation. (CE) 2 Drive Cutout Above Elevation 3 Drive Cutout Above Elevation And Tilted	1	0
19	ground alarm	0=NO 1=DRIVE 2=LIFT DOWN 3=BOOM & DRIVE	Displays/adjusts ground alarm presence/function	0 No Ground Alarm installed 1 Travel alarm – sounds when the drive function is active. (Option) 2 Descent alarm – sounds when either lift down is active. (Option) 3 Motion alarm – sounds when any function is active. (Option)	1	0

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

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**Table 6-8. Machine Configuration Parameters**

20	PLATFORM ALARM	0=NO 1=FAULT CODE	Displays/adjusts platform alarm presence/functions	0	Sounds Continuously When Above Elevation And Tilted Only.	1	0
				1	Sounds Continuously When Above Elevation And Tilted, And In Conjunction With Fault Code Flashes. (Option)		
21	Tower Prox Switches	0=NO 1=YES	Displays presence/function of Tower Proximity switches for the models specified.	0	No Tower Prox Switches Installed	1	0
				1	Tower Prox Switches Installed		

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-9. Analyzer Fault Code Listing**

<b>DTC</b>	<b>Analyzer Text</b>
001	EVERYTHING OK
002	GROUND MODE OK
0010	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION
0011	FSW OPEN
0012	RUNNING AT CREEP - CREEP SWITCH OPEN
0013	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION
0014	CHASSIS TILT SENSOR OUT OF RANGE
0015	LOAD SENSOR READING UNDER WEIGHT
0035	APU ACTIVE
211	POWER CYCLE
212	KEYSWITCH FAULTY
213	FSW FAULTY
227	STEER SWITCHES FAULTY
2211	FSW INTERLOCK TRIPPED
2212	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH
2213	STEER LOCKED - SELECTED BEFORE FOOTSWITCH
2214	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE
2216	D/S JOY. OUT OF RANGE HIGH
2217	D/S JOY. CENTER TAP BAD
2218	L/S JOY. OUT OF RANGE LOW
2219	L/S JOY. OUT OF RANGE HIGH
2220	L/S JOY. CENTER TAP BAD
2221	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH
2222	WAITING FOR FSW TO BE OPEN
2223	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE
2224	FOOTSWITCH SELECTED BEFORE START
234	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM
235	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER
236	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH
237	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH
259	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS
2513	GENERATOR MOTION CUTOUT ACTIVE
2514	BOOM PREVENTED - DRIVE SELECTED
2516	DRIVE PREVENTED - ABOVE ELEVATION
2517	DRIVE PREVENTED - TILTED & ABOVE ELEVATION
2518	DRIVE PREVENTED - BOOM SELECTED
2519	DRIVE PREVENTED - TILTED & EXTENDED OR HIGH ANGLE
2520	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER
2530	UMS SENSOR FORWARD LIMIT REACHED
2531	UMS SENSOR OUT OF USABLE RANGE
2532	UMS SENSOR BACKWARD LIMIT REACHED

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)****Table 6-9. Analyzer Fault Code Listing**

<b>DTC</b>	<b>Analyzer Text</b>
331	BRAKE - SHORT TO BATTERY
332	BRAKE - OPEN CIRCUIT
3311	GROUND ALARM - SHORT TO BATTERY
3316	RIGHT FORWARD DRIVE PUMP - SHORT TO GROUND
3319	RIGHT FORWARD DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3320	RIGHT REVERSE DRIVE PUMP - SHORT TO GROUND
3323	RIGHT REVERSE DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3324	LEFT FORWARD DRIVE PUMP - SHORT TO GROUND
3327	LEFT FORWARD DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3328	LEFT REVERSE DRIVE PUMP - SHORT TO GROUND
3331	LEFT REVERSE DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3332	FORWARD DRIVE PUMP - SHORT TO GROUND
3333	FORWARD DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3334	REVERSE DRIVE PUMP - SHORT TO GROUND
3335	REVERSE DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3336	ALTERNATOR POWER - SHORT TO GROUND
3340	AUX POWER - SHORT TO GROUND
3341	AUX POWER - OPEN CIRCUIT
3342	AUX POWER - SHORT TO BATTERY
3346	ELECTRIC FAN - SHORT TO GROUND
3347	ELECTRIC FAN - OPEN CIRCUIT
3348	ELECTRIC FAN - SHORT TO BATTERY
3349	ELECTRIC PUMP - SHORT TO GROUND
3350	ELECTRIC PUMP - OPEN CIRCUIT
3351	ELECTRIC PUMP - SHORT TO BATTERY
3352	LP LOCK - SHORT TO GROUND
3353	LP LOCK - OPEN CIRCUIT
3354	LP LOCK - SHORT TO BATTERY
3355	LP START ASSIST - SHORT TO GROUND
3356	LP START ASSIST - OPEN CIRCUIT
3357	LP START ASSIST - SHORT TO BATTERY
3358	MAIN DUMP VALVE - SHORT TO GROUND
3359	MAIN DUMP VALVE - OPEN CIRCUIT
3360	MAIN DUMP VALVE - SHORT TO BATTERY
3361	BRAKE - SHORT TO GROUND
3362	START SOLENOID - SHORT TO GROUND
3363	START SOLENOID - OPEN CIRCUIT
3364	START SOLENOID - SHORT TO BATTERY
3365	STEER DUMP VALVE - SHORT TO GROUND
3366	STEER DUMP VALVE - OPEN CIRCUIT
3367	STEER DUMP VALVE - SHORT TO BATTERY
3368	TWO SPEED VALVE - SHORT TO GROUND
3369	TWO SPEED VALVE - OPEN CIRCUIT



**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-9. Analyzer Fault Code Listing**

<b>DTC</b>	<b>Analyzer Text</b>
3370	TWO SPEED VALVE - SHORT TO BATTERY
3371	GROUND ALARM - SHORT TO GROUND
3372	GROUND ALARM - OPEN CIRCUIT
3373	GEN SET/WELDER - SHORT TO GROUND
3374	GEN SET/WELDER - OPEN CIRCUIT
3375	GEN SET/WELDER - SHORT TO BATTERY
3376	HEAD TAIL LIGHT - SHORT TO GROUND
3377	HEAD TAIL LIGHT - OPEN CIRCUIT
3378	HEAD TAIL LIGHT - SHORT TO BATTERY
3379	HOURLY METER - SHORT TO GROUND
3382	PLATFORM LEVEL UP VALVE - SHORT TO GROUND
3383	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT
3384	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY
3385	PLATFORM LEVEL UP OVERRIDE VALVE - SHORT TO GROUND
3386	PLATFORM LEVEL UP OVERRIDE VALVE - OPEN CIRCUIT
3387	PLATFORM LEVEL UP OVERRIDE VALVE - SHORT TO BATTERY
3388	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND
3389	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT
3390	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY
3391	PLATFORM LEVEL DOWN OVERRIDE VALVE - SHORT TO GROUND
3392	PLATFORM LEVEL DOWN OVERRIDE VALVE - OPEN CIRCUIT
3393	PLATFORM LEVEL DOWN OVERRIDE VALVE - SHORT TO BATTERY
3394	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND
3395	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT
3396	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY
3397	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND
3398	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT
3399	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY
33100	JIB LIFT UP VALVE - SHORT TO GROUND
33101	JIB LIFT UP VALVE - OPEN CIRCUIT
33102	JIB LIFT UP VALVE - SHORT TO BATTERY
33103	JIB LIFT DOWN VALVE - SHORT TO GROUND
33104	JIB LIFT DOWN VALVE - OPEN CIRCUIT
33105	JIB LIFT DOWN VALVE - SHORT TO BATTERY
33106	TOWER LIFT UP VALVE - SHORT TO GROUND
33107	TOWER LIFT UP VALVE - OPEN CIRCUIT
33108	TOWER LIFT UP VALVE - SHORT TO BATTERY
33109	TOWER LIFT DOWN VALVE - SHORT TO GROUND
33110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT
33111	TOWER LIFT DOWN VALVE - SHORT TO BATTERY
33112	TOWER TELESCOPE IN VALVE - SHORT TO GROUND
33113	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT
33114	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)****Table 6-9. Analyzer Fault Code Listing**

<b>DTC</b>	<b>Analyzer Text</b>
33115	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND
33116	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT
33117	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY
33118	SWING RIGHT VALVE - SHORT TO GROUND
33119	SWING RIGHT VALVE - OPEN CIRCUIT
33120	TELESCOPE IN VALVE - SHORT TO BATTERY
33121	SWING RIGHT VALVE - SHORT TO BATTERY
33122	SWING LEFT VALVE - SHORT TO GROUND
33123	TELESCOPE OUT VALVE - SHORT TO BATTERY
33124	LIFT UP DUMP VALVE - SHORT TO GROUND
33125	LIFT UP DUMP VALVE - OPEN CIRCUIT
33126	LIFT UP DUMP VALVE - SHORT TO BATTERY
33127	LIFT DOWN HOLDING VALVE - SHORT TO GROUND
33128	LIFT DOWN HOLDING VALVE - OPEN CIRCUIT
33129	LIFT DOWN HOLDING VALVE - SHORT TO BATTERY
33130	THROTTLE ACTUATOR - SHORT TO GROUND
33131	THROTTLE ACTUATOR - OPEN CIRCUIT
33132	THROTTLE ACTUATOR - SHORT TO BATTERY
33133	PLATFORM CONTROL VALVE - SHORT TO GROUND
33134	PLATFORM CONTROL VALVE - OPEN CIRCUIT
33135	PLATFORM CONTROL VALVE - SHORT TO BATTERY
33170	LIFT DOWN VALVE - OPEN CIRCUIT
33171	LIFT DOWN VALVE - SHORT TO BATTERY
33172	LIFT DOWN VALVE - SHORT TO GROUND
33175	JIB ROTATE LEFT VALVE - OPEN CIRCUIT
33176	JIB ROTATE LEFT VALVE - SHORT TO BATTERY
33177	JIB ROTATE LEFT VALVE - SHORT TO GROUND
33178	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT
33179	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY
33180	JIB ROTATE RIGHT VALVE - SHORT TO GROUND
33186	TELESCOPE OUT VALVE - OPEN CIRCUIT
33188	TELESCOPE OUT VALVE - SHORT TO GROUND
33189	TELESCOPE IN VALVE - OPEN CIRCUIT
33190	TELESCOPE IN VALVE - SHORT TO GROUND
33207	HORN - OPEN CIRCUIT
33208	HORN - SHORT TO BATTERY
33209	HORN - SHORT TO GROUND
33279	GLOWPLUG - OPEN CIRCUIT
33280	GLOWPLUG - SHORT TO BATTERY
33281	GLOWPLUG - SHORT TO GROUND
33295	SWING LEFT VALVE - OPEN CIRCUIT
33306	SWING LEFT VALVE - SHORT TO BATTERY
33314	FLOW CONTROL VALVE - OPEN CIRCUIT

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-9. Analyzer Fault Code Listing**

<b>DTC</b>	<b>Analyzer Text</b>
33315	FLOW CONTROL VALVE - SHORT TO BATTERY
33316	FLOW CONTROL VALVE - SHORT TO GROUND
33317	DRIVE FORWARD VALVE - OPEN CIRCUIT
33318	DRIVE FORWARD VALVE - SHORT TO BATTERY
33319	DRIVE FORWARD VALVE - SHORT TO GROUND
33320	DRIVE REVERSE VALVE - OPEN CIRCUIT
33321	DRIVE REVERSE VALVE - SHORT TO BATTERY
33322	DRIVE REVERSE VALVE - SHORT TO GROUND
33323	LIFT UP VALVE - OPEN CIRCUIT
33324	LIFT UP VALVE - SHORT TO BATTERY
33325	LIFT UP VALVE - SHORT TO GROUND
33331	DRIVE - CURRENT FEEDBACK READING TOO LOW
33332	LEFT TRACK - CURRENT FEEDBACK READING TOO LOW
33333	RIGHT TRACK - CURRENT FEEDBACK READING TOO LOW
33408	LEFT TRACK - CURRENT FEEDBACK READING LOST
33409	RIGHT TRACK - CURRENT FEEDBACK READING LOST
33410	DRIVE - CURRENT FEEDBACK READING LOST
341	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT
342	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY
343	PLATFORM LEVEL UP VALVE - SHORT TO GROUND
344	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT
345	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT
346	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY
347	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND
348	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT
349	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT
3410	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY
3411	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND
3412	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT
3413	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY
3414	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND
3415	JIB LIFT UP VALVE - OPEN CIRCUIT
3416	JIB LIFT UP VALVE - SHORT TO BATTERY
3417	JIB LIFT UP VALVE - SHORT TO GROUND
3418	JIB LIFT DOWN VALVE - OPEN CIRCUIT
3419	JIB LIFT DOWN VALVE - SHORT TO BATTERY
3420	JIB LIFT DOWN VALVE - SHORT TO GROUND
3421	JIB ROTATE LEFT VALVE - OPEN CIRCUIT
3422	JIB ROTATE LEFT VALVE - SHORT TO BATTERY
3423	JIB ROTATE LEFT VALVE - SHORT TO GROUND
3424	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT
3425	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY
3426	JIB ROTATE RIGHT VALVE - SHORT TO GROUND

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

Table 6-9. Analyzer Fault Code Listing

DTC	Analyzer Text
431	FUEL SENSOR - SHORT TO BATTERY
432	FUEL SENSOR - SHORT TO GROUND
433	OIL PRESSURE - SHORT TO BATTERY
434	OIL PRESSURE - SHORT TO GROUND
435	COOLANT TEMPERATURE - SHORT TO GROUND
436	FORD FAULT CODE ##
437	ENGINE TROUBLE CODE
438	HIGH ENGINE TEMP
439	AIR FILTER BYPASSED
4310	NO ALTERNATOR OUTPUT
4311	LOW OIL PRESSURE
4312	485 COMMUNICATIONS LOST
4313	THROTTLE ACTUATOR FAILURE
4314	WRONG ENGINE SELECTED - ECM DETECTED
4322	LOSS OF ENGINE SPEED SENSOR
4323	SPEED SENSOR READING INVALID SPEED
441	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN
442	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN
445	BATTERY VOLTAGE LOW
662	CANBUS FAILURE - PLATFORM MODULE
664	CANBUS FAILURE - ACCESSORY MODULE
665	CANBUS FAILURE - PROPULSION MODULE
666	CANBUS FAILURE - ENGINE CONTROLLER
6620	CANBUS FAILURE - UMS SENSOR
671	ACCESSORY FAULT
813	CHASSIS TILT SENSOR NOT CALIBRATED
815	CHASSIS TILT SENSOR DISAGREEMENT
816	UMS SENSOR NOT CALIBRATED
817	UMS SENSOR FAULT
825	LSS HAS NOT BEEN CALIBRATED
826	RUNNING AT CREEP - PLATFORM OVERLOADED
827	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED
828	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED
831	PLATFORM LEVELING OVERRIDE ON
832	PLATFORM LEVELING OVERRIDE OFF
833	PLATFORM LEVEL UP CRACKPOINT - NOT CALIBRATED
834	PLATFORM LEVEL DOWN CRACKPOINT - NOT CALIBRATED
835	PLATFORM LEVEL SENSOR #1 - NOT ZERO CALIBRATED
836	PLATFORM LEVEL SENSOR #1 - ZERO OUT OF RANGE
837	PLATFORM LEVEL SENSOR #1 - SHORT TO BATTERY
838	PLATFORM LEVEL SENSOR #1 - SHORT TO GROUND OR OPEN CIRCUIT
839	PLATFORM LEVEL SENSOR #2 - NOT ZERO CALIBRATED
8310	PLATFORM LEVEL SENSOR #2 - ZERO OUT OF RANGE

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-9. Analyzer Fault Code Listing**

<b>DTC</b>	<b>Analyzer Text</b>
8311	PLATFORM LEVEL SENSOR #2 - SHORT TO BATTERY
8312	PLATFORM LEVEL SENSOR #2 - SHORT TO GROUND OR OPEN CIRCUIT
8313	PLATFORM LEVEL SENSOR #1 - REFERENCE VOLTAGE OUT OF RANGE
8314	PLATFORM LEVEL SENSOR #2 - REFERENCE VOLTAGE OUT OF RANGE
8315	PLATFORM LEVELING SENSOR - DISAGREEMENT
8316	PLATFORM LEVEL SENSOR #1 - COMMUNICATIONS LOST
8317	PLATFORM LEVEL SENSOR #2 - COMMUNICATIONS LOST
8318	PLATFORM LEVELING SYSTEM TIMEOUT
8639	FRONT LEFT STEER VALVE - OPEN CIRCUIT
8640	FRONT LEFT STEER VALVE - SHORT TO BATTERY
8641	FRONT LEFT STEER VALVE - SHORT TO GROUND
8642	FRONT RIGHT STEER VALVE - OPEN CIRCUIT
8643	FRONT RIGHT STEER VALVE - SHORT TO BATTERY
8644	FRONT RIGHT STEER VALVE - SHORT TO GROUND
8645	REAR LEFT STEER VALVE - OPEN CIRCUIT
8646	REAR LEFT STEER VALVE - SHORT TO BATTERY
8647	REAR LEFT STEER VALVE - SHORT TO GROUND
8648	REAR RIGHT STEER VALVE - OPEN CIRCUIT
8649	REAR RIGHT STEER VALVE - SHORT TO BATTERY
8650	REAR RIGHT STEER VALVE - SHORT TO GROUND
8652	RIGHT TRACK FORWARD VALVE - OPEN CIRCUIT
8653	RIGHT TRACK FORWARD VALVE - SHORT TO BATTERY
8654	RIGHT TRACK FORWARD VALVE - SHORT TO GROUND
8655	RIGHT TRACK REVERSE VALVE - OPEN CIRCUIT
8656	RIGHT TRACK REVERSE VALVE - SHORT TO BATTERY
8657	RIGHT TRACK REVERSE VALVE - SHORT TO GROUND
8658	LEFT TRACK FORWARD VALVE - OPEN CIRCUIT
8659	LEFT TRACK FORWARD VALVE - SHORT TO BATTERY
8660	LEFT TRACK FORWARD VALVE - SHORT TO GROUND
8661	LEFT TRACK REVERSE VALVE - OPEN CIRCUIT
8662	LEFT TRACK REVERSE VALVE - SHORT TO BATTERY
8663	LEFT TRACK REVERSE VALVE - SHORT TO GROUND
871	RETURN FILTER BYPASSED
872	CHARGE PUMP FILTER BYPASSED
998	EEPROM FAILURE - CHECK ALL SETTINGS
9910	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER
9913	FUNCTIONS LOCKED OUT - PROPULSION MODULE SOFTWARE VERSION IMPROPER
9914	PLATFORM MODULE SOFTWARE UPDATE REQUIRED
9915	CHASSIS TILT SENSOR NOT GAIN CALIBRATED
9916	CHASSIS TILT SENSOR GAIN OUT OF RANGE
9917	HIGH RESOLUTION A2D FAILURE - INTERRUPT LOST
9918	HIGH RESOLUTION A2D FAILURE - REINIT LIMIT
9919	GROUND SENSOR REF VOLTAGE OUT OF RANGE

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

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**Table 6-9. Analyzer Fault Code Listing**

<b>DTC</b>	<b>Analyzer Text</b>
9920	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE
9921	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOFF FAULTY
9922	PLATFORM MODULE FAILURE - HWFS CODE 1
9923	GROUND MODULE FAILURE - HWFS CODE 1
9924	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED
9944	CURRENT FEEDBACK GAINS OUT OF RANGE
9945	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT

**6.10 ANALYZER DIAGNOSTICS MENU  
STRUCTURE**

the next outer level. The LEFT/RIGHT arrow keys move between items in the same level. The UP/DOWN arrow keys alter a value if allowed

In the following structure descriptions, an intended item is selected by pressing ENTER; pressing ESC steps back to

**Table 6-10. ADJUSTMENTS - Personality Descriptions**

<b>DRIVE</b>	
ACCEL ...	Displays/adjusts drive acceleration
DECEL ...	Displays/adjusts drive deceleration
MIN FORWARD ...	Displays/adjusts minimum forward drive speed
MAX FORWARD ...	Displays/adjusts maximum forward drive speed
MIN REVERSE ...	Displays/adjusts minimum reverse drive speed
MAX REVERSE ...	Displays/adjusts maximum reverse drive speed
ELEVATED MAX ...	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed
CREEP MAX ...	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active
STEER MAX ...	Displays/adjusts the maximum steer speed
<b>LIFT</b>	
ACCEL ...	Displays/adjusts upper lift acceleration
DECEL ...	Displays/adjusts upper lift deceleration
MIN UP ...	Displays/adjusts minimum upper lift up speed
MAX UP ...	Displays/adjusts maximum upper lift up speed
CREEP UP ...	Displays/adjusts maximum upper lift up speed NOTE: used when creep switch on pump pot is active
MIN DOWN ...	Displays/adjusts minimum upper lift down speed
MAX DOWN ...	Displays/adjusts maximum upper lift down speed
CREEP DOWN ...	Displays/adjusts maximum upper lift down speed NOTE: used when creep switch on pump pot is active

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-10. ADJUSTMENTS - Personality Descriptions**

SWING	
ACCEL ...	Displays/adjusts swing acceleration
DECEL ...	Displays/adjusts swing deceleration
MIN LEFT ...	Displays/adjusts minimum swing left speed
MAX LEFT ...	Displays/adjusts maximum swing left speed
CREEP LEFT ...	Displays/adjusts maximum swing left speed NOTE: used when creep switch on pump pot is active
MIN RIGHT ...	Displays/adjusts minimum swing right speed
MAX RIGHT ...	Displays/adjusts maximum swing right speed
CREEP RIGHT ...	Displays/adjusts maximum swing right speed NOTE: used when creep switch on pump pot is active
UPPER TELESCOPE	
ACCEL ...	Displays/adjusts telescope acceleration
DECEL ...	Displays/adjusts telescope deceleration
MIN IN ...	Displays/adjusts minimum telescope in speed
MAX IN ...	Displays/adjusts maximum telescope in speed
MIN OUT ...	Displays/adjusts minimum telescope out speed
MAX OUT ...	Displays/adjusts maximum telescope out speed
BASKET LEVEL	
ACCEL ...	Displays/adjusts basket level acceleration
DECEL ...	Displays/adjusts basket level deceleration
MIN UP ...	Displays/adjusts minimum basket level up speed
MAX UP ...	Displays/adjusts maximum basket level up speed
MIN DOWN ...	Displays/adjusts minimum basket level down speed
MAX DOWN ...	Displays/adjusts maximum basket level down speed
BASKET ROTATE	
ACCEL ...	Displays/adjusts basket rotate acceleration
DECEL ...	Displays/adjusts basket rotate deceleration
MIN LEFT ...	Displays/adjusts minimum basket rotate left speed
MAX LEFT ...	Displays/adjusts maximum basket rotate left speed
MIN RIGHT ...	Displays/adjusts minimum basket rotate right speed
MAX RIGHT ...	Displays/adjusts maximum basket rotate right speed



**Table 6-10. ADJUSTMENTS - Personality Descriptions**

JIB LIFT	Not displayed if JIB = NO
ACCEL ...	Displays/adjusts jib acceleration
DECEL ...	Displays/adjusts jib deceleration
MIN UP ...	Displays/adjusts minimum jib up speed
MAX UP ...	Displays/adjusts maximum jib up speed
MIN DOWN ...	Displays/adjusts minimum jib down speed
MAX DOWN ...	Displays/adjusts maximum jib down speed
MIN LEFT ...	Displays/adjusts minimum jib left speed
MAX LEFT ...	Displays/adjusts maximum jib left speed
MIN RIGHT ...	Displays/adjusts minimum jib right speed
MAX RIGHT ...	Displays/adjusts maximum jib right speed
<b>STEER</b>	
MAX SPEED ...	Displays/adjusts maximum steer speed, which applies when vehicle speed is at minimum
<b>GROUND MODE</b>	
LIFT UP ...	Displays/adjusts fixed lift up speed
LIFT DOWN ...	Displays/adjusts fixed lift down speed
SWING ...	Displays/adjusts fixed swing speed
TELE ...	Displays/adjusts fixed telescope speed
BASKETLEVEL ...	Displays/adjusts fixed basket level speed
BASKETROTATE ...	Displays/adjusts fixed basket rotate speed
JIB (U/D) ...	Displays/adjusts jib lift speed Not displayed if JIB = NO
JIB (L/R)...	Displays/adjusts jib swing speed Not displayed if JIB = NO

## SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)

**Table 6-11. Diagnostic Menu Descriptions**

<b>DRIVE</b>	
DRIVE FOR ...	Displays drive joystick direction & demand
STEER ...	Displays steer switch direction & demand NOTE: steer demand is inversely proportional to vehicle speed
BRAKES ...	Displays brake control system status
CREEP ...	Displays pump pot creep switch status
TWO SPEED...	Displays two speed switch status
2 SPEED MODE	Displays status of two speed valve
HIGH ENGINE	Displays high engine switch status
<b>BOOM</b>	
U LIFT UP ...	Displays lift joystick direction & demand
SWING LEFT ...	Displays swing joystick direction & demand
LEVEL UP ...	Displays basket level switch direction & demand NOTE: demand is controlled by the pump pot
ROT. LEFT ...	Displays basket rotate switch direction & demand NOTE: demand is controlled by the pump pot
U TELE IN ...	Displays telescope switch direction & demand NOTE: demand is controlled by the pump pot
JIB UP ...	Displays jib lift switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
JIB LEFT ...	Displays jib swing switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
PUMP POT ...	Displays pump pot demand
<b>ENGINE</b>	
START ...	Displays start switch status
AIR FILTER ...	Displays air filter status
BATTERY ...	Displays measured battery voltage
COOLANT ...	Displays coolant temperature
OIL PRS ...	Displays oil pressure status
FUEL SELECT ...	Displays selected fuel (Dual Fuel only)
FUEL LEVEL ...	Displays fuel level status
RPM	Displays Engine RPM
GM BATTERY	Displays battery voltage at ground module

**SECTION 6 - JLG CONTROL SYSTEM (S/N 61718 TO PRESENT)**

**Table 6-11. Diagnostic Menu Descriptions**

PM BATTERY ...	Displays battery voltage at platform module
TEMP..	Displays ground module temperature
ELEV. CUTOUT ...	Displays elevation cutout switch status
FUNC. CUTOUT ...	Displays function cutout switch status
CREEP...	Displays creep switch status
TILT ...	Displays measured vehicle tilt
AUX POWER ...	Displays status of auxiliary power switch
HORN ...	Displays status of horn switch
R FILTER ...	Displays status of return filter switch
C FILTER ...	Displays status of charge pump filter
LOAD LENGTH ...	Displays length switch status
ANGLE ...	Displays angle switch status
LOAD ...	Displays load sensor value NOTE: Not displayed if load = 0.
<b>DATALOG</b>	
ON ...	Displays total controller on (EMS) time
ENGINE ...	Displays engine run time
DRIVE ...	Displays total controller drive operation time
LIFT ...	Displays total controller lift operation time
SWING ...	Displays total controller swing operation time
TELE ...	Displays total controller tele operation time
MAX.TEMP ...	Displays maximum measured heat sink temp.
MIN.TEMP ...	Displays minimum measured heat sink temp.
MAX.VOLTS ...	Displays maximum measured battery voltage
RENTAL ...	Displays total controller operation time NOTE: can be reset
ERASE RENTAL	Not available at password level 2
YES:ENTER, NO:ESC	ENTER resets rental datalog time to zero
<b>VERSIONS</b>	
GROUND ...	Displays ground module software version
PLATFORM ...	Displays platform module software version
ANALYSER ...	Displays Analyzer software version



## SECTION 7. BASIC ELECTRICAL INFORMATION & SCHEMATICS

### 7.1 GENERAL

This section contains basic electrical information and schematics to be used for locating and correcting most of the operating problems which may develop. 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.

### 7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

#### Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

#### Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

#### Min/Max

Use of the "Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read the Voltage applied to a solenoid when it is only operational while a switch, far from the solenoid and meter, is held down.

#### Polarity

Getting a negative Voltage or current reading when expecting a positive reading frequently means the leads

are reversed. Check what reading is expected, the location of the signal and that the leads are connected to the device under test correctly. Also check that the lead on the "COM" port goes to the Ground or negative side of the signal and the lead on the other port goes to the positive side of the signal.

#### Scale

M = Mega = 1,000,000 \* (Displayed Number)

k = kilo = 1,000 \* (Displayed Number)

m = milli = (Displayed Number) / 1,000

$\mu$  = micro = (Displayed Number) / 1,000,000

Example: 1.2 k $\Omega$  = 1200  $\Omega$

Example: 50 mA = 0.05 A

#### Voltage Measurement

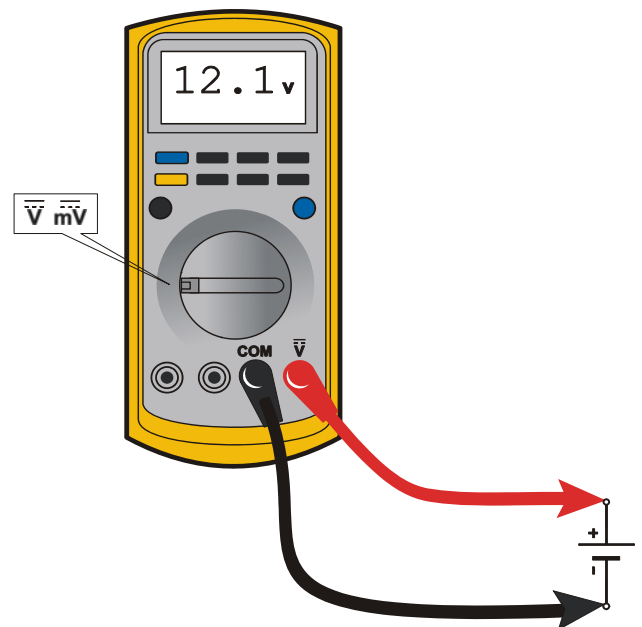
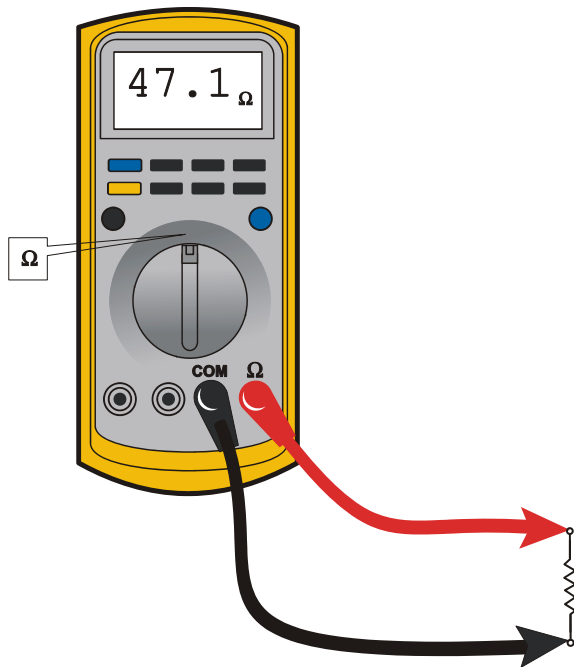


Figure 7-1. Voltage Measurement (DC)

- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)
- Use firm contact with meter leads

## Resistance Measurement

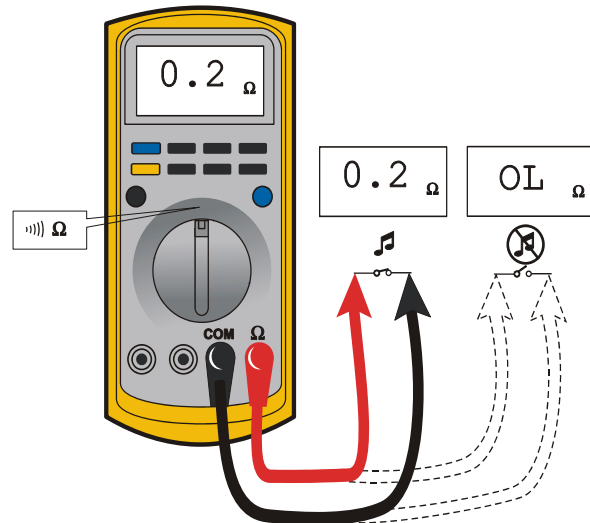


**Figure 7-2. Resistance Measurement**

- First test meter and leads by touching leads together. Resistance should read a short circuit (very low resistance)
- Circuit power must be turned OFF before testing resistance
- Disconnect component from circuit before testing
- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)

- Use firm contact with meter leads

## Continuity Measurement



**Figure 7-3. Continuity Measurement**

- Some meters require a separate button press to enable audible continuity testing
- Circuit power must be turned OFF before testing continuity
- Disconnect component from circuit before testing
- Use firm contact with meter leads
- First test meter and leads by touching leads together. Meter should produce an audible alarm, indicating continuity

## Current Measurement

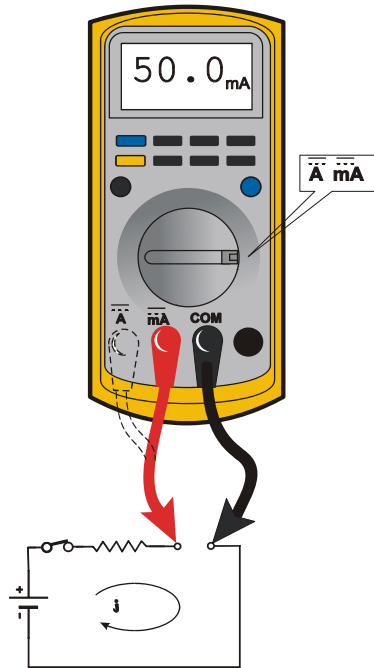


Figure 7-4. Current Measurement (DC)

- Set up the meter for the expected current range
- Be sure to connect the meter leads to the correct jacks for the current range you have selected
- If meter is not auto ranging, set it to the correct range (See multi meter's operation manual)
- Use firm contact with meter leads

## 7.3 CHECKING 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.

### 7.4 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

**NOTE:** This section is not applicable for battery terminals.

#### NOTICE

**JLG P/N 0100048 DIELECTRIC GREASE (NOVAGARD G661) IS THE ONLY MATERIAL APPROVED FOR USE AS A DIELECTRIC GREASE.**

**NOTE:** Do NOT apply dielectric grease to the following connections:

- Main Boom Rotary sensor connections (on Celesco Sensor),
- LSS Modules connections,
- Deutz EMR 2 ECM connection.

Silicone Dielectric Compound must be used on all electrical connections except for those mentioned above for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors. This procedure applies to all plug connections not enclosed in a box. Silicone grease should not be applied to connectors with external seals.

1. To prevent oxidation, silicone grease must be packed completely around male and female pins on the inside of the connector prior to assembly. This is most easily achieved by using a syringe.

**NOTE:** Over a period of time, oxidation increases electrical resistance at the connection, eventually causing circuit failure.

2. To prevent shorting, silicone grease must be packed around each wire where they enter the outside of the connector housing. Also, silicone grease must be applied at the joint where the male and female connectors come together. Any other joints (around strain reliefs, etc.) where water could enter the connector should also be sealed.

**NOTE:** This condition is especially common when machines are pressure washed since the washing solution is much more conductive than water.



- Anderson connectors for the battery boxes and battery chargers should have silicone grease applied to the contacts only.

**NOTE:** *Curing-type sealants might also be used to prevent shorting and would be less messy, but would make future pin removal more difficult.*

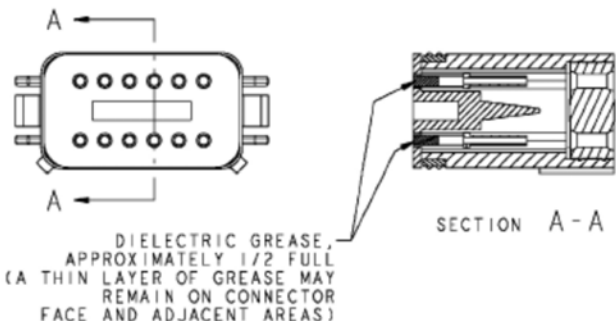
When applied to electrical connections, dielectric grease helps to prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from the application of dielectric grease.

Dielectric grease shall be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

### Installation of Dielectric Grease

Before following these instructions, refer to excluded connector types (See Exclusions below).

- Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
- Apply dielectric grease to the female contact (fill it approximately 1/2 full; see example below)
- Leave a thin layer of dielectric grease on the face of the connector
- Assemble the connector system immediately to prevent moisture ingress or dust contamination
- Pierce one of the unused wire seals prior to assembly if the connector system tends to trap air (i.e. AMP Seal) and then install a seal plug.



### Deutsch HD, DT, DTM, DRC Series

The Deutsch connector system is commonly used for harsh environment interconnect. Follow the installation instructions.



### AMP Seal

The AMP Seal connector system is used on the Control ADE Platform and Ground Modules.

Apply dielectric grease to the female contact. If trapped air prevents the connector from latching, pierce one of the unused wire seals. After assembly, install a seal plug (JLG #4460905) in that location to prevent moisture ingress.

Note that seal plugs may be installed by the wire harness manufacturer if an unused wire seal becomes compromised (wire inserted in the wrong cavity during assembly and then corrected).



Figure 7-5. Application to Female Contacts

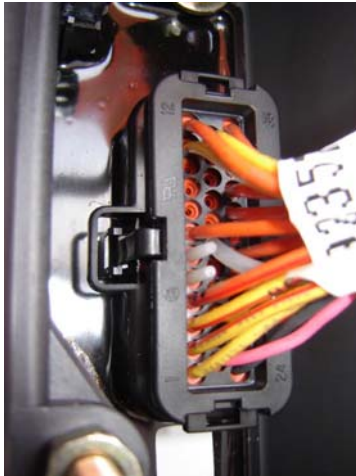
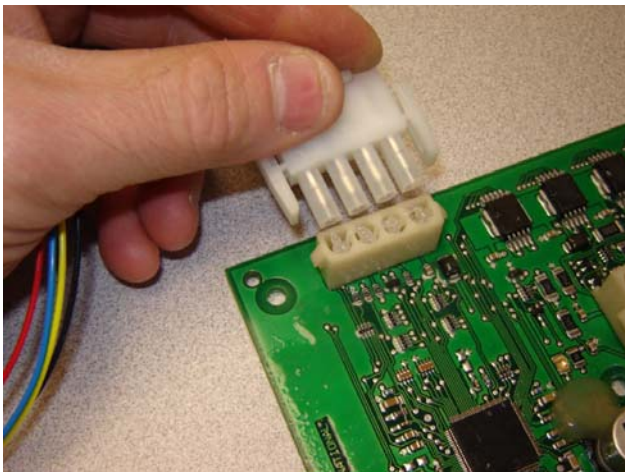


Figure 7-6. Use of Seal Plugs

## AMP Mate-N-Lok

Follow the installation instructions.



## DIN Connectors

This connector is typically used on hydraulic valves. Follow the installation instructions.



## Exclusions

A limited number of connectors do not benefit from dielectric grease, or may be permanently damaged by application. Dielectric grease may not be required in properly sealed enclosures.

### BRAD HARRISON / PHOENIX CONTACT M12

The connector uses gold contact material to resist corrosion and an o-ring seal for moisture integrity. If dielectric grease is mistakenly applied to this connector system, the low-force contacts cannot displace the grease to achieve electrical contact. Once contaminated, there is no practical way to remove the dielectric grease (replacement of female contacts required). The JLG Load Sensing System and 1250AJP Rotary Angle Sensors are examples of components with the M12 connector system.



**AMP JUNIOR TIMER**

This type of connector uses back-seals for moisture integrity. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease. The EMR2 engine control module from Deutz employs this connector system (for example).



**MIL-C-5015 SPEC CONNECTORS**

Crown Connector Inc's recommendation is to not use dielectric grease for this series connector. For similar model series connectors, the manufacturer should be contacted for confirmation before applying dielectric grease. A typical application for this connector is on David Clark Intercom connections in Aerial Work Platforms.



**SEALED ENCLOSURES**

Application of dielectric grease is not required in properly sealed enclosures. To meet criteria, the enclosure must be rated to at least IP66 (dust tight; protected from powerful jets of water). The enclosure must be fitted with a high quality, continuous gasket and all wiring must pass through cable entrances.



## 7.5 AMP CONNECTOR

### Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on the inside of the connector after the mating of the housing to the header. This is easily achieved by using a syringe to fill the header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling the housing to the header, it is possible that the housing will become air locked, thus preventing the housing latch from engaging.
2. Pierce one of the unused wire seals to allow the trapped air inside the housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

### Assembly

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

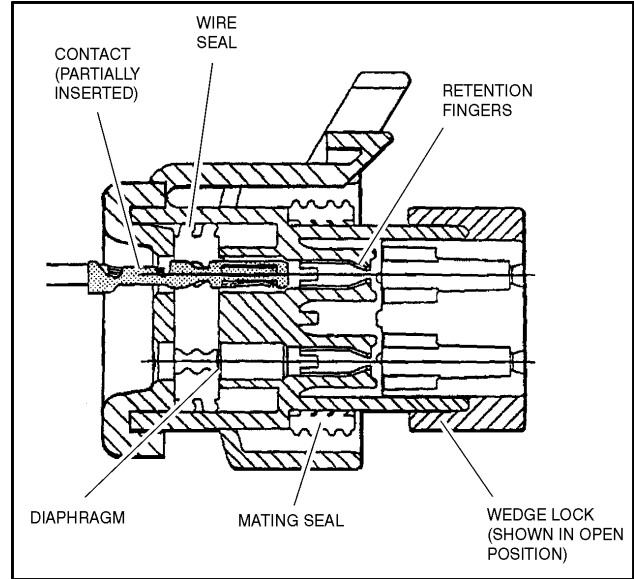


Figure 7-7. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-9.).
2. Pull back on the contact wire with a force of 1 or 2 lbs. to be sure the retention fingers are holding the contact (See Figure 7-9.).

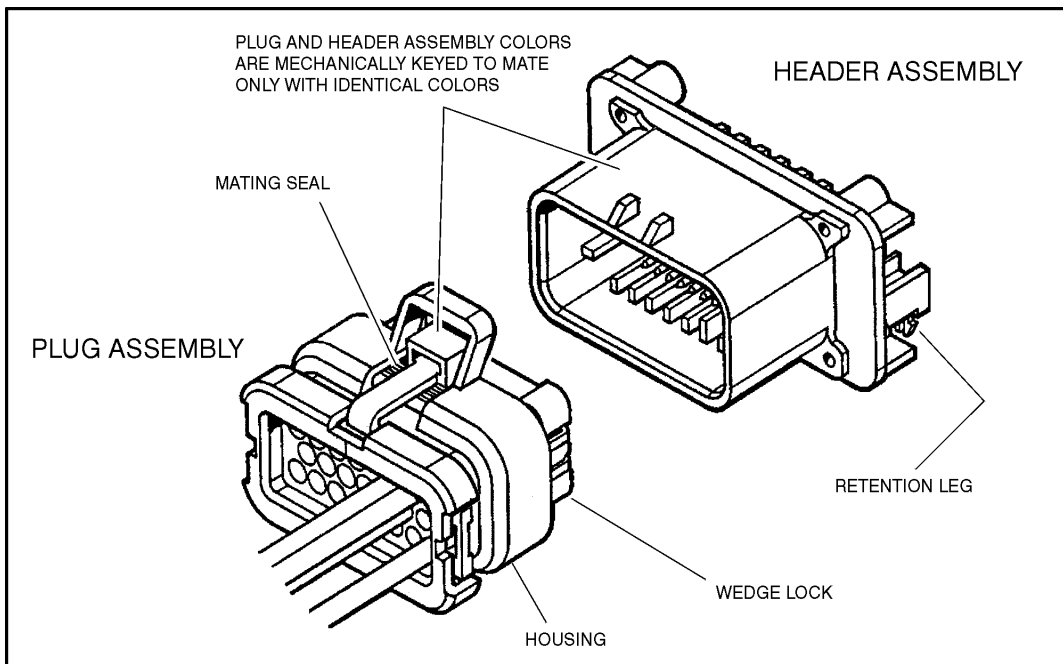


Figure 7-8. AMP Connector

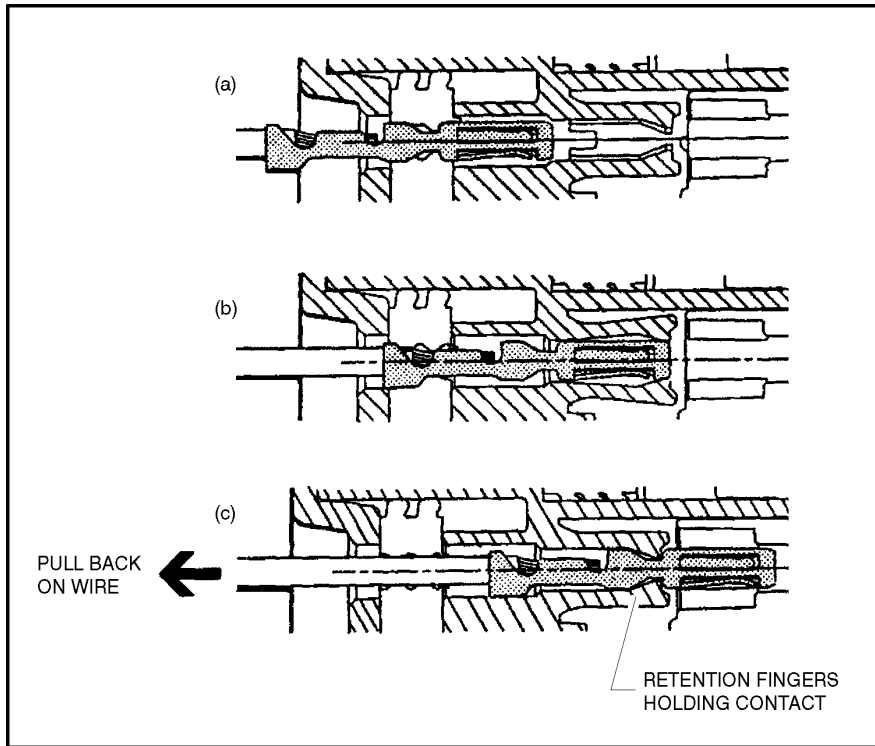


Figure 7-9. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (See Figure 7-10.).

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-11.).

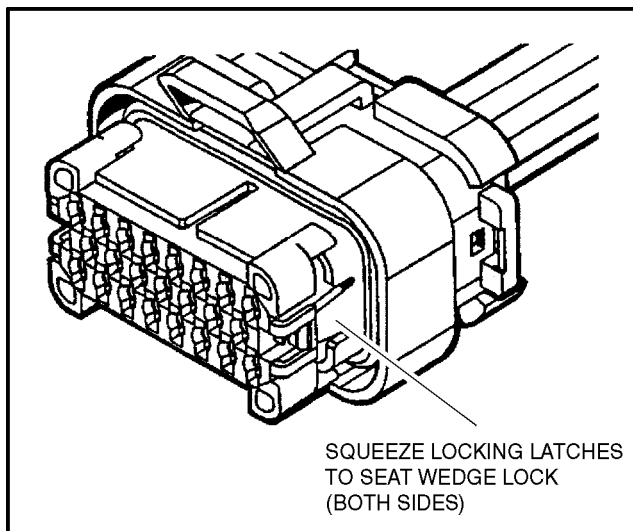


Figure 7-10. Connector Assembly Figure 3

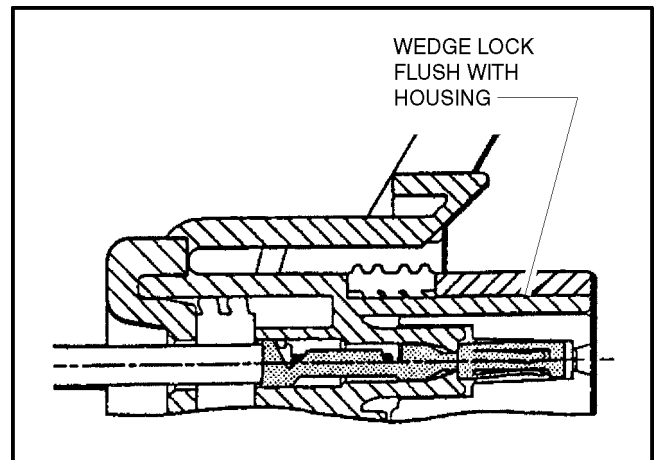


Figure 7-11. Connector Assembly Figure 4

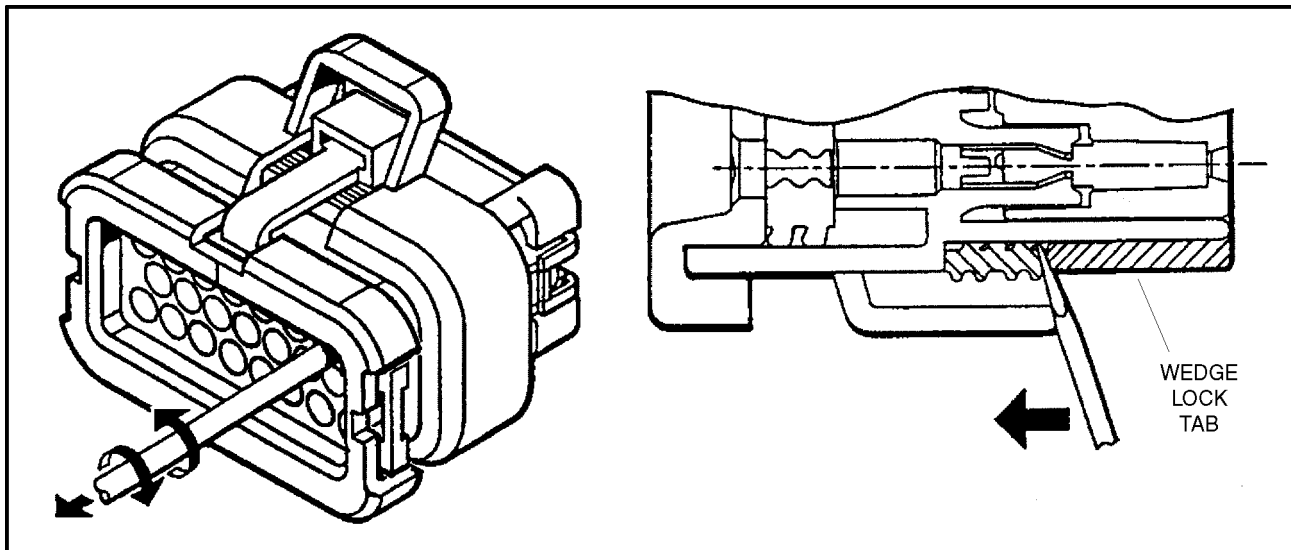


Figure 7-12. Connector Disassembly

### 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.

**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.

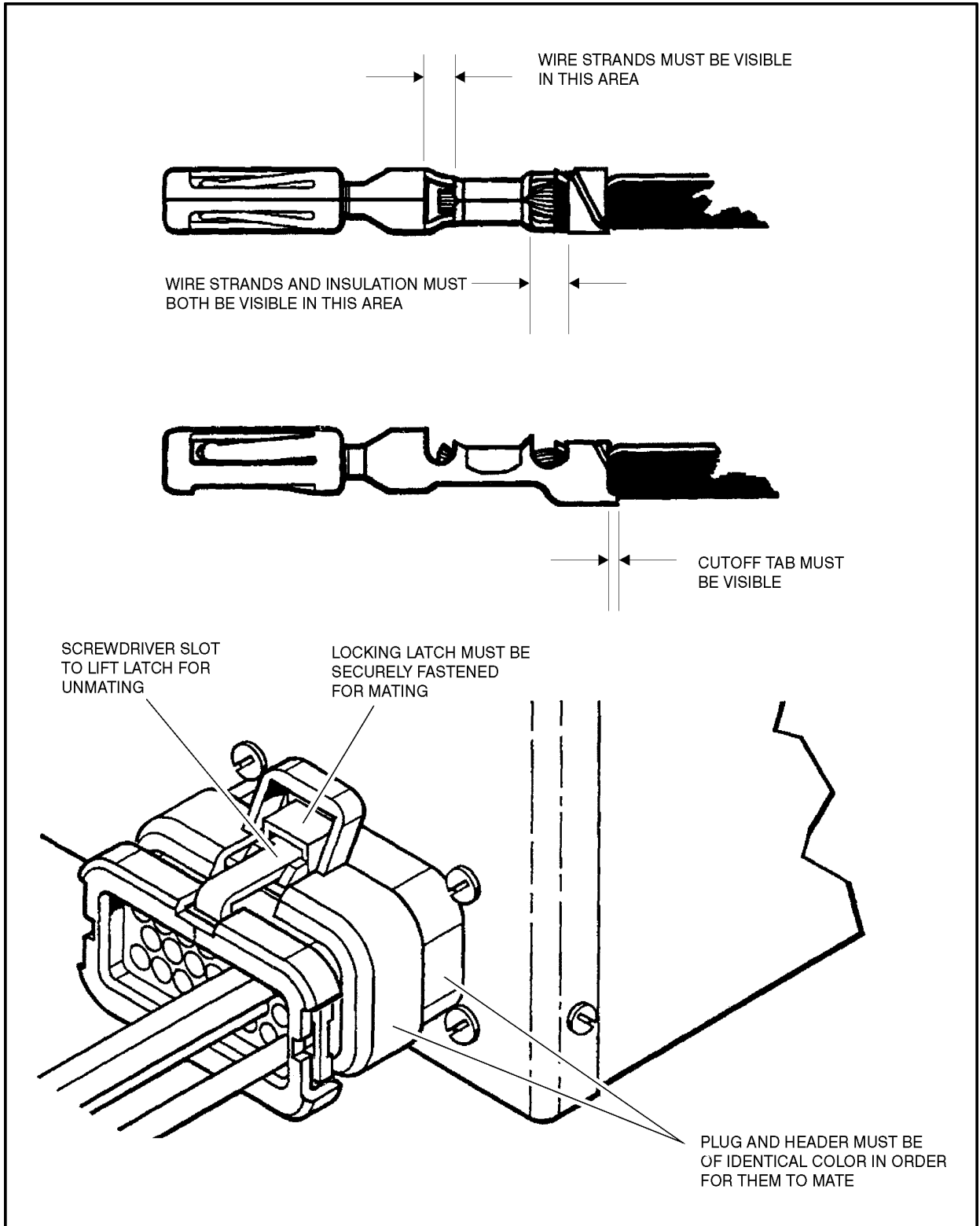


Figure 7-13. Connector Installation

## 7.6 DEUTSCH CONNECTORS

### DT/DTP Series Assembly

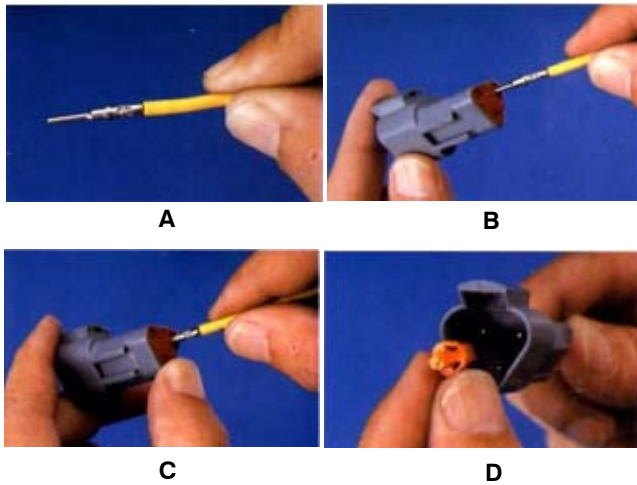


Figure 7-14. DT/DTP Contact Installation

1. Grasp crimped contact about 25mm behind the contact barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that it is properly locked in place.
4. Once all contacts are in place, insert wedgelock with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. They may go in either way.

*NOTE: The receptacle is shown - use the same procedure for plug.*

### DT/DTP Series Disassembly

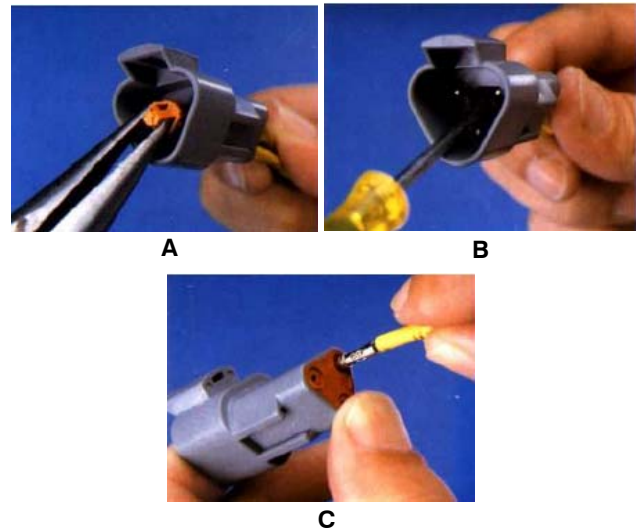
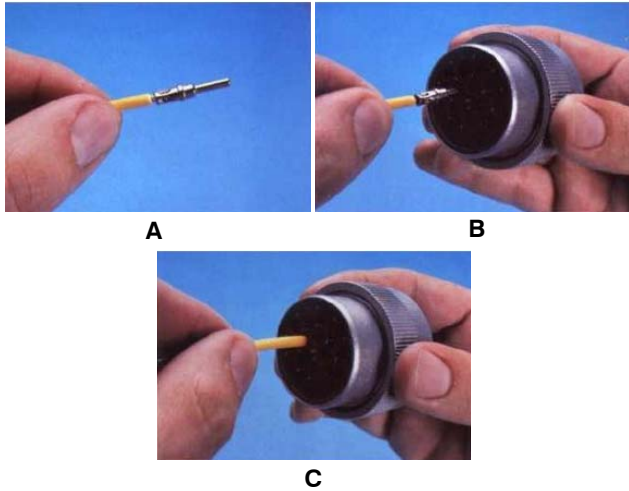


Figure 7-15. DT/DTP Contact Removal

1. Remove wedgelock using needlenose 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.

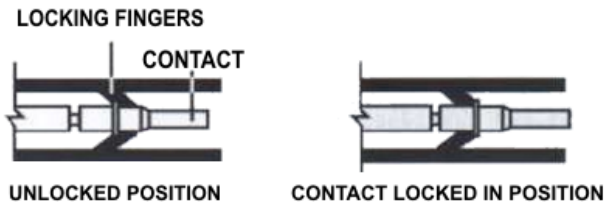


**HD30/HDP20 Series Assembly**



**Figure 7-16. HD/HDP Contact Installation**

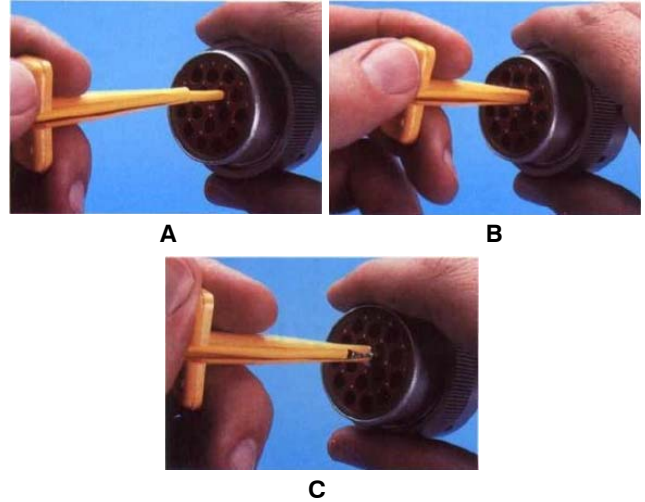
1. Grasp contact about 25mm behind the contact crimp barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm that it is properly locked in place.



**Figure 7-17. HD/HDP Locking Contacts Into Position**

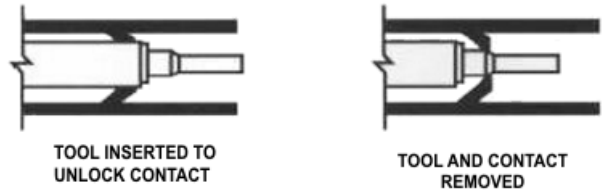
**NOTE:** For unused wire cavities, insert sealing plugs for full environmental sealing

**HD30/HDP20 Series Disassembly**



**Figure 7-18. HD/HDP Contact Removal**

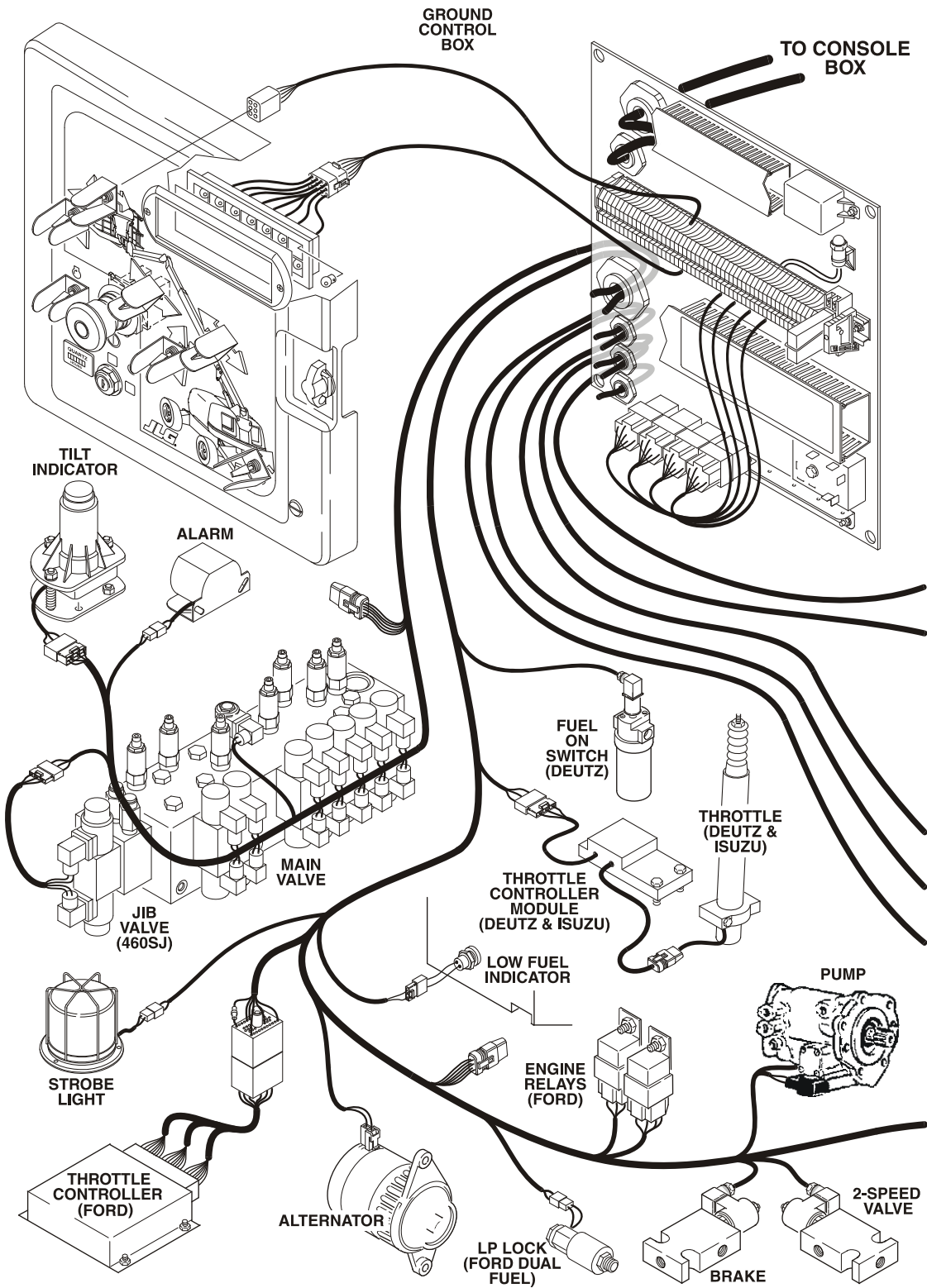
1. With rear insert toward you, snap appropriate size extractor tool over the wire of contact to be removed.
2. Slide tool along into the insert cavity until it engages contact and resistance is felt.
3. Pull contact-wire assembly out of connector.



**Figure 7-19. HD/HDP Unlocking Contacts**

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

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



**Figure 7-20. Electrical Components Installation w/o JLG Control System - Sheet 1 of 2**

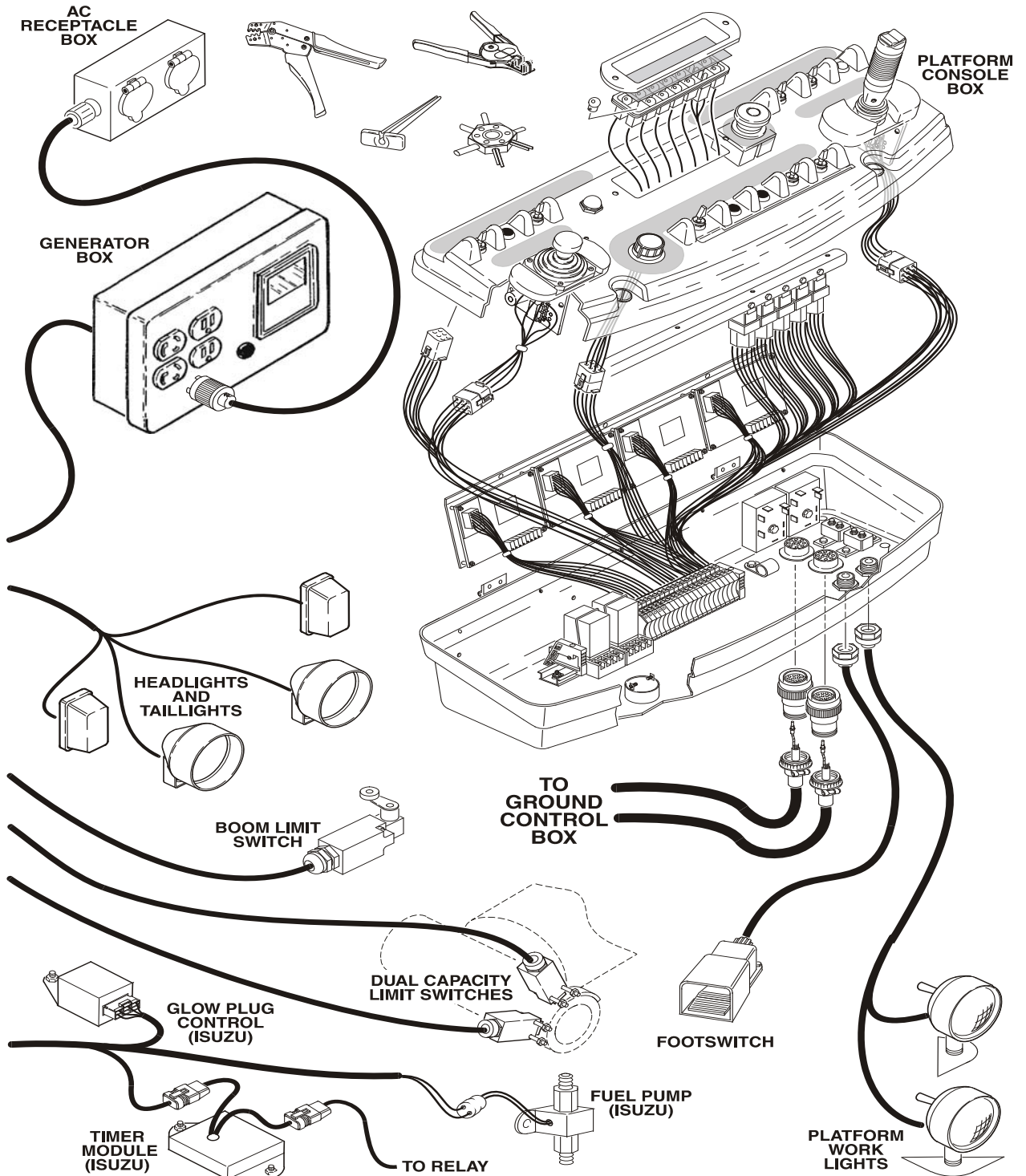
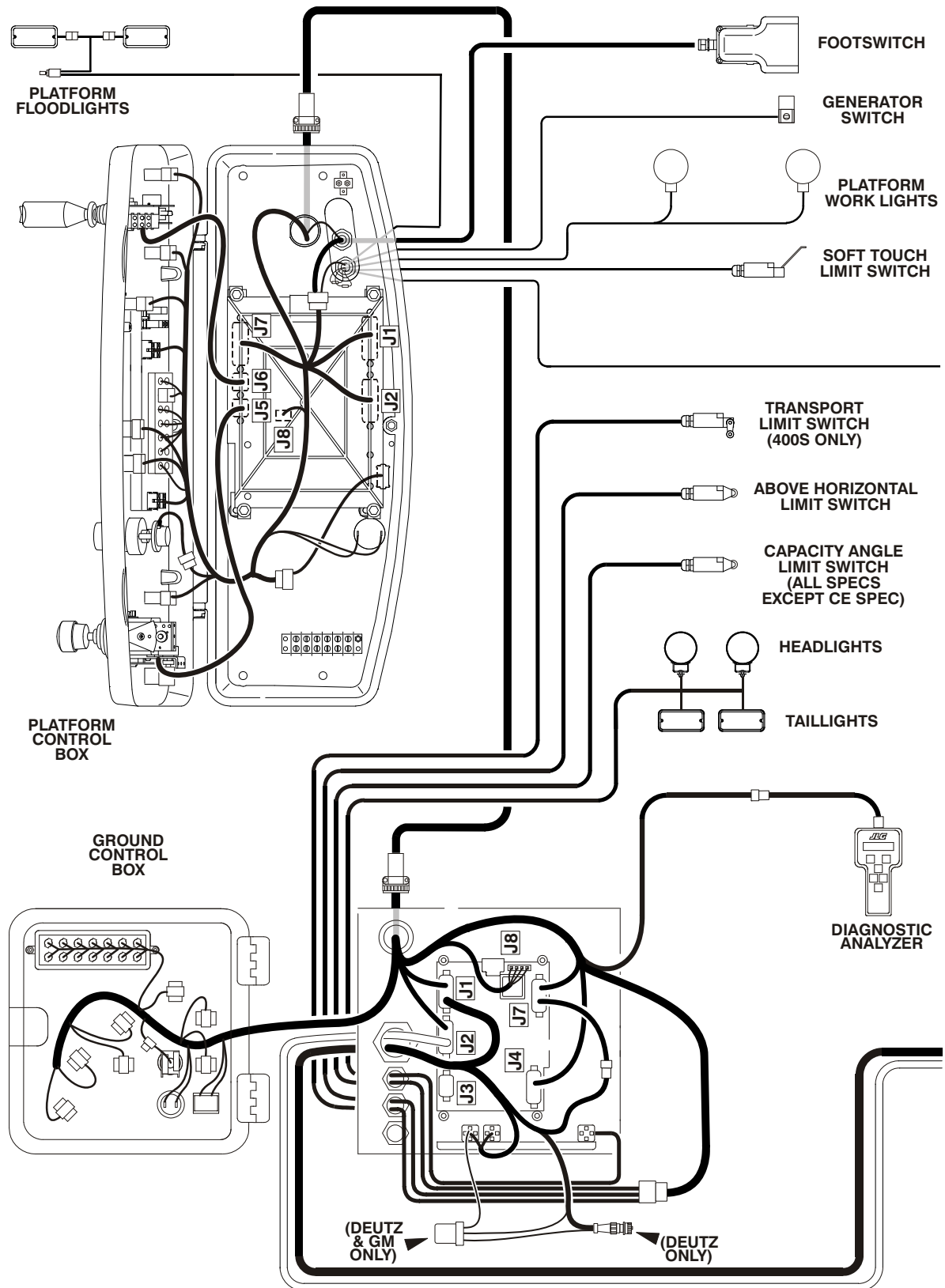


Figure 7-21. Electrical Components Installation w/o JLG Control System - Sheet 2 of 2

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



**Figure 7-22. Electrical Components Installation with JLG Control System - Sheet 1 of 2**

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

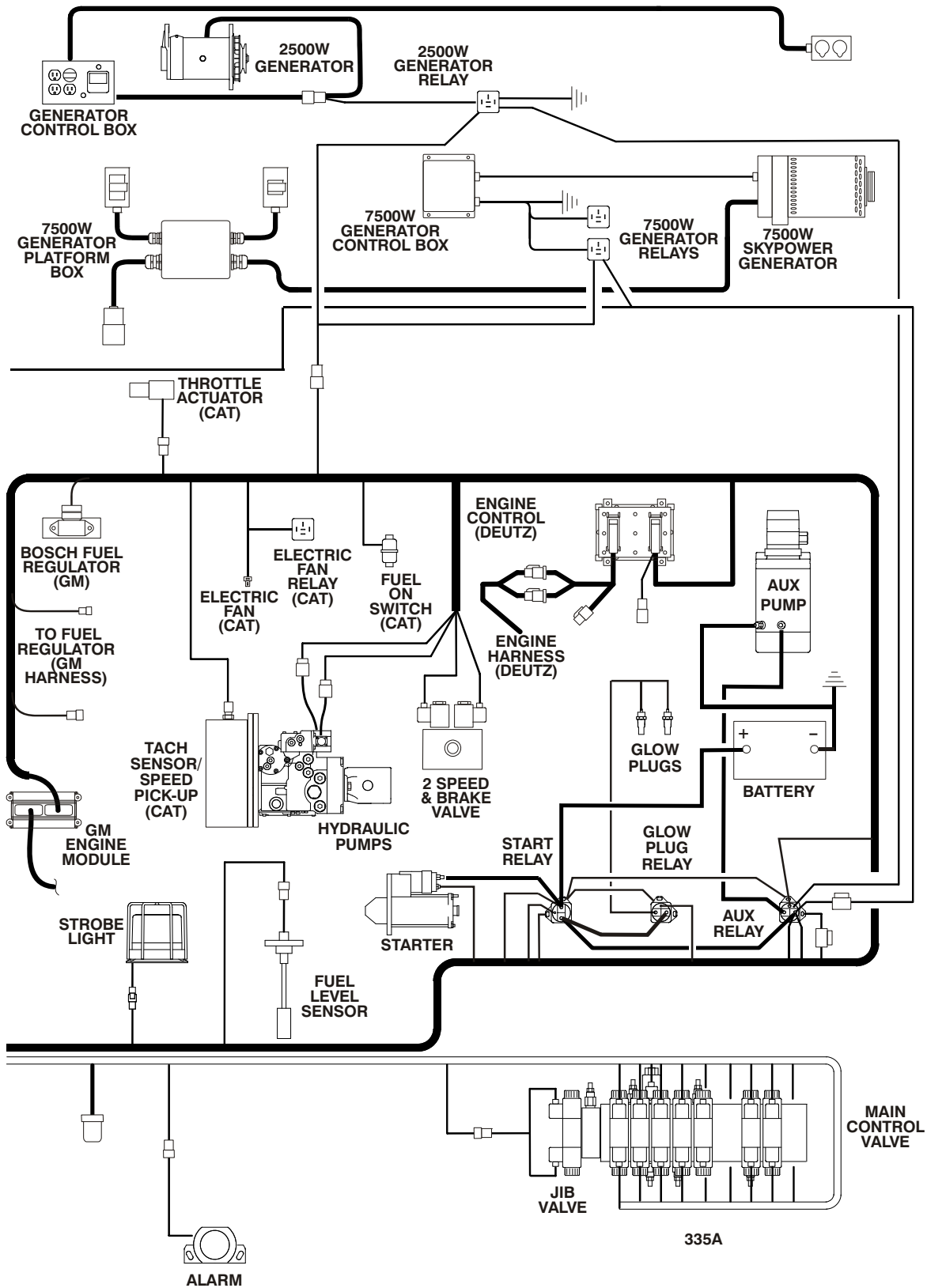
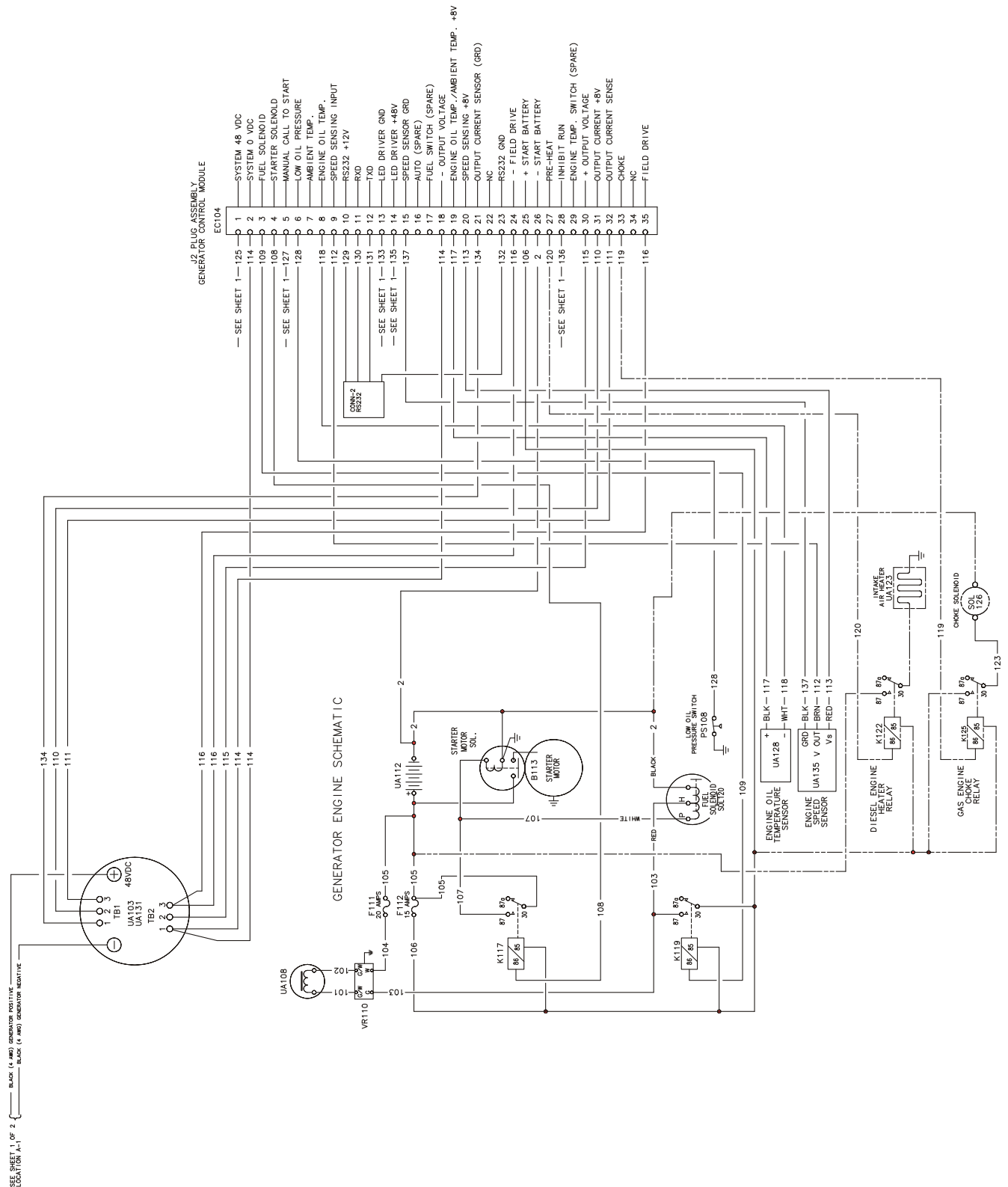


Figure 7-23. Electrical Components Installation with JLG Control System - Sheet 2 of 2

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# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



**Figure 7-24. On Board Generator Electrical Schematic. (if equipped)**

# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

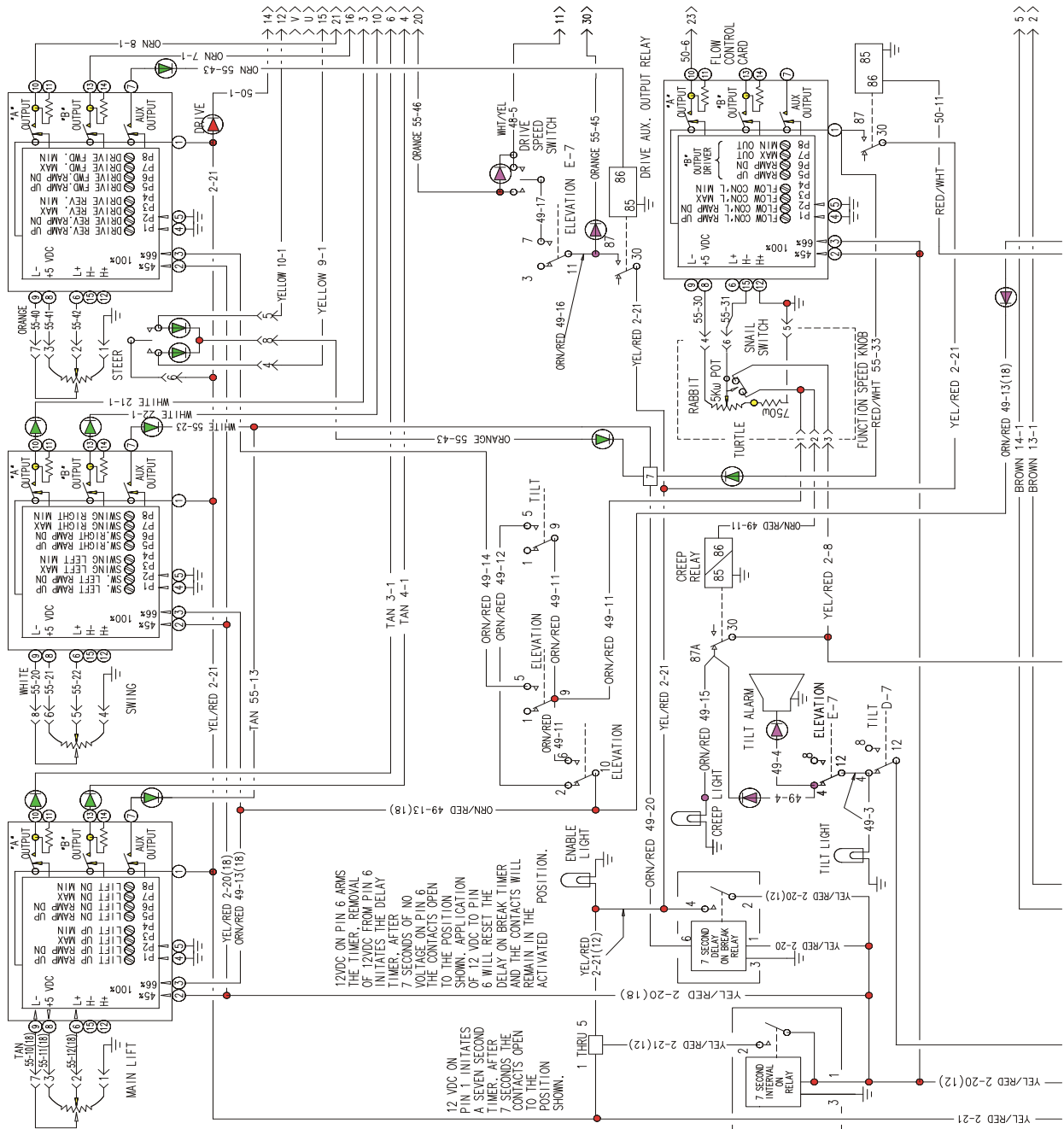


Figure 7-25. Electrical Schematic - Ford Engine w/o JLG Control System - Sheet 1 of 4





# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

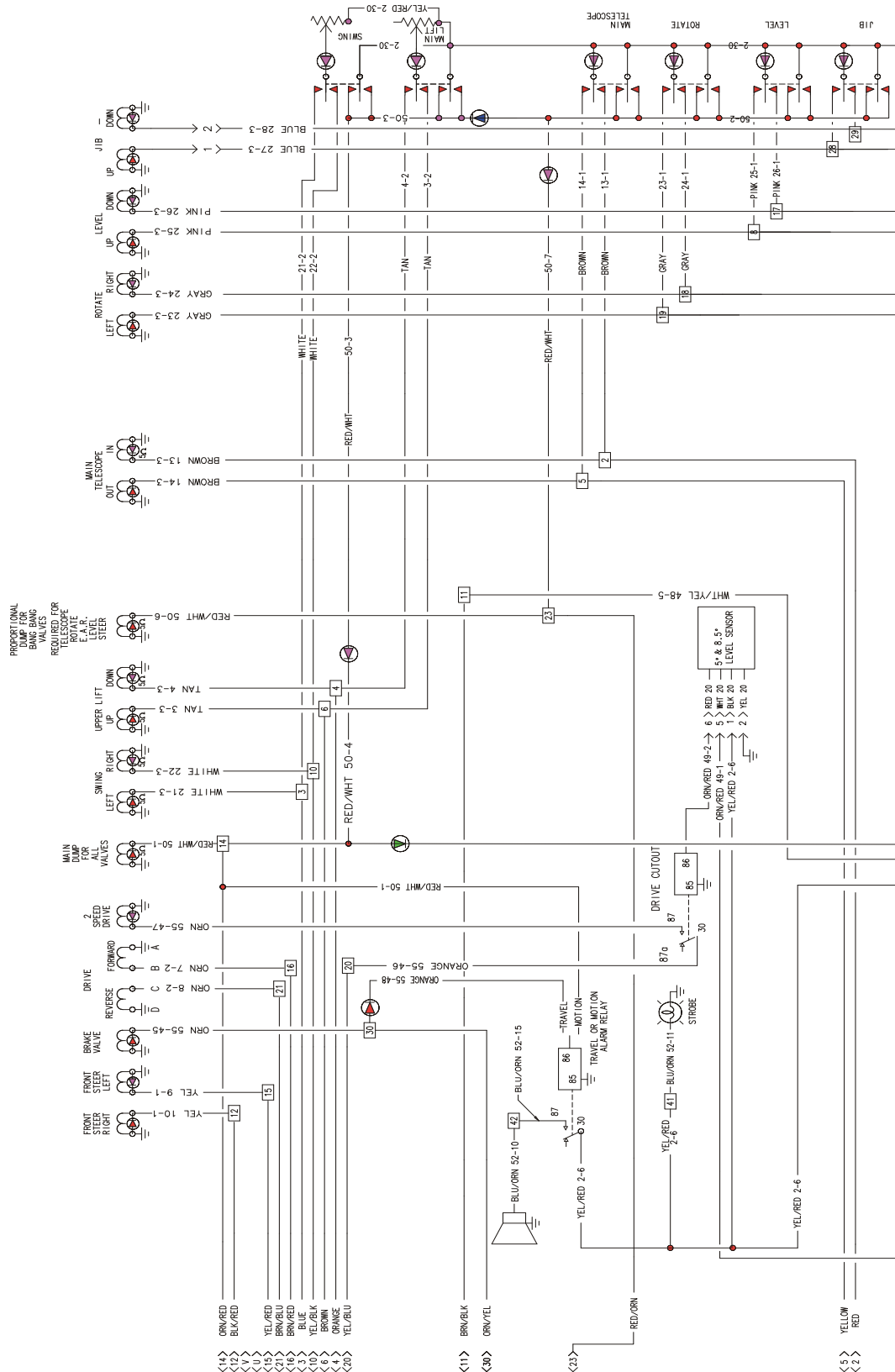
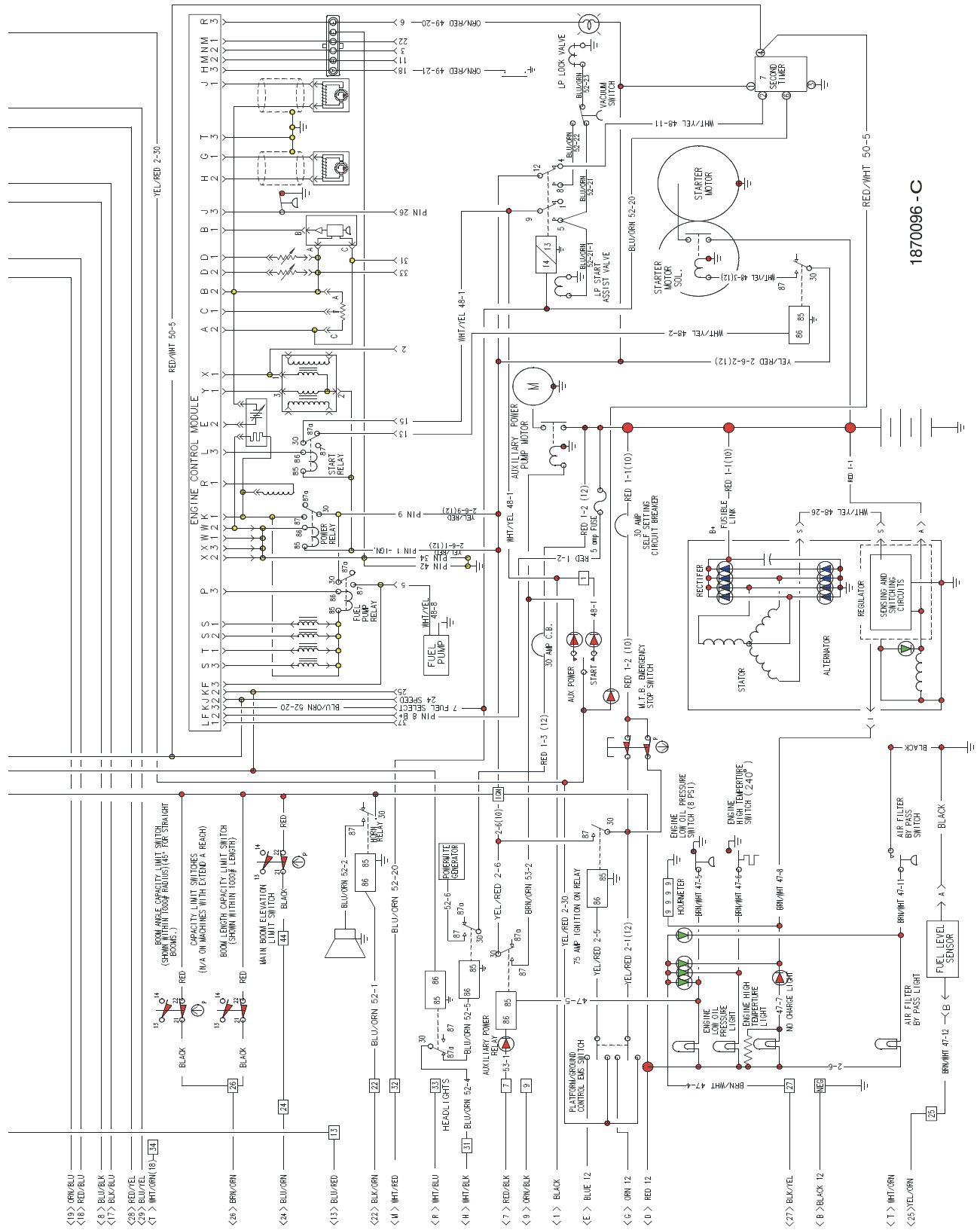


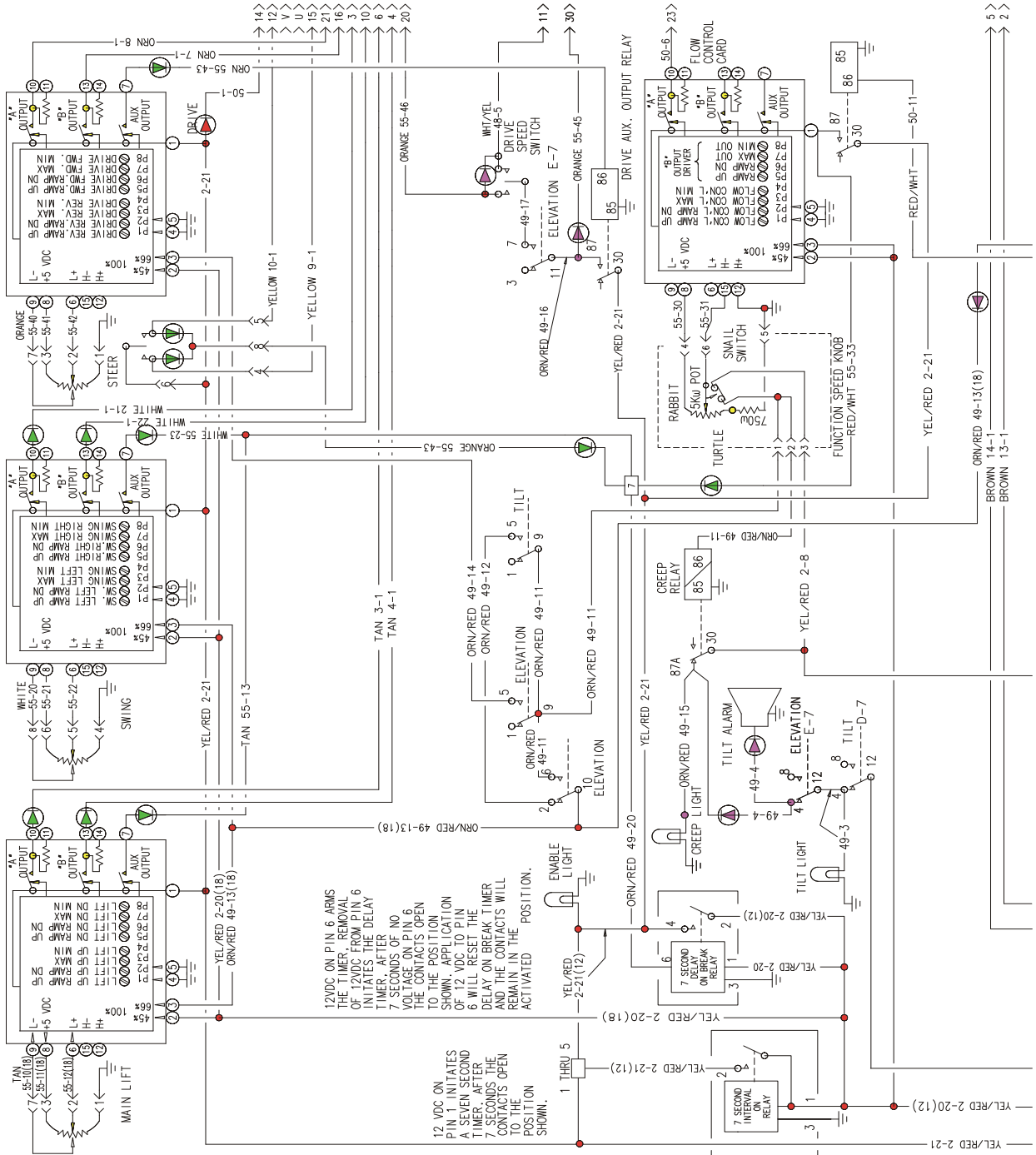
Figure 7-27. Electrical Schematic - Ford Engine w/o JLG Control System - Sheet 3 of 4



1870096 -C

Figure 7-28. Electrical Schematic - Ford Engine w/o JLG Control System - Sheet 4 of 4

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



**Figure 7-29. Electrical Schematic - Deutz Engine w/o JLG Control System - Sheet 1 of 4**

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

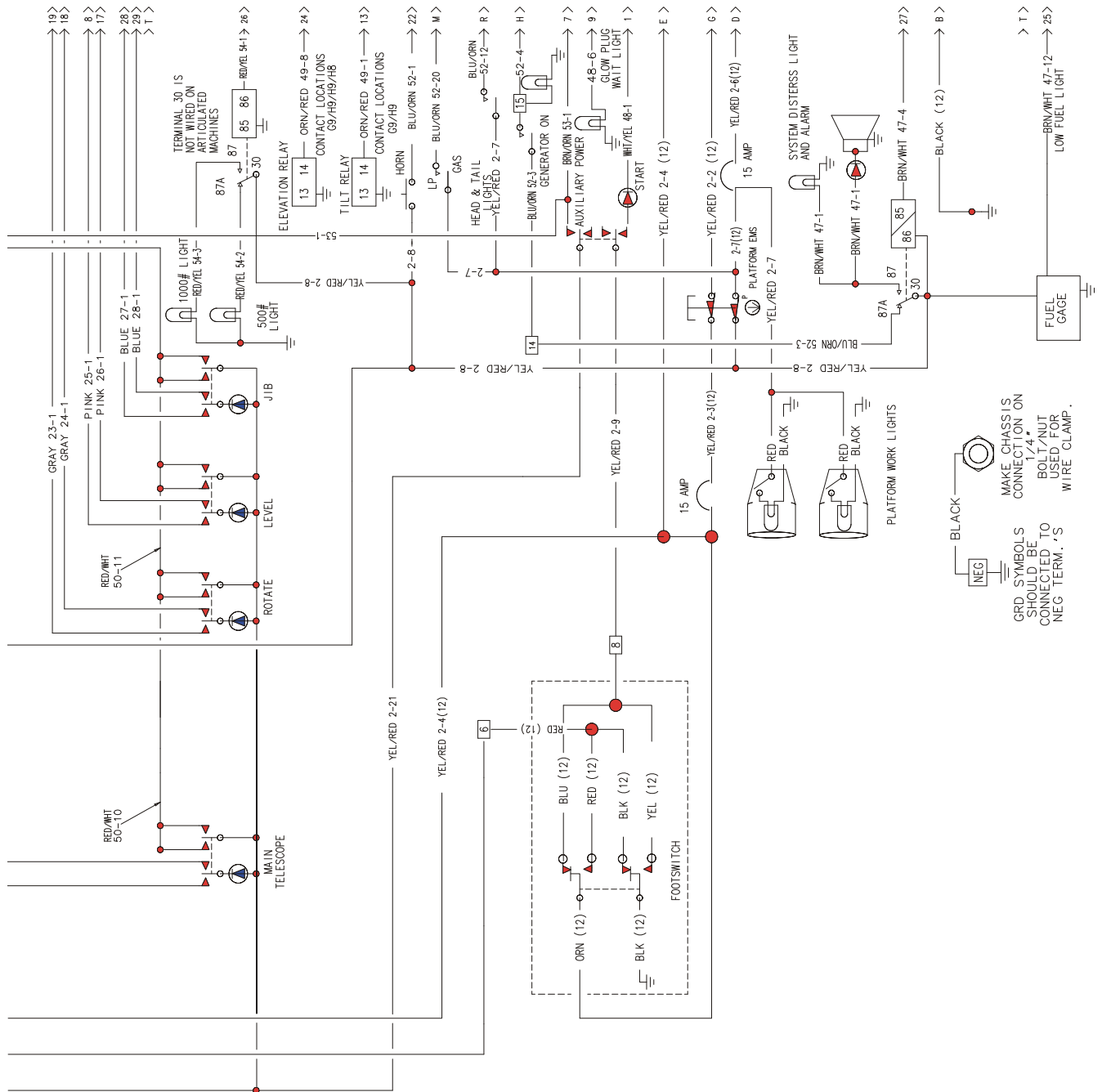
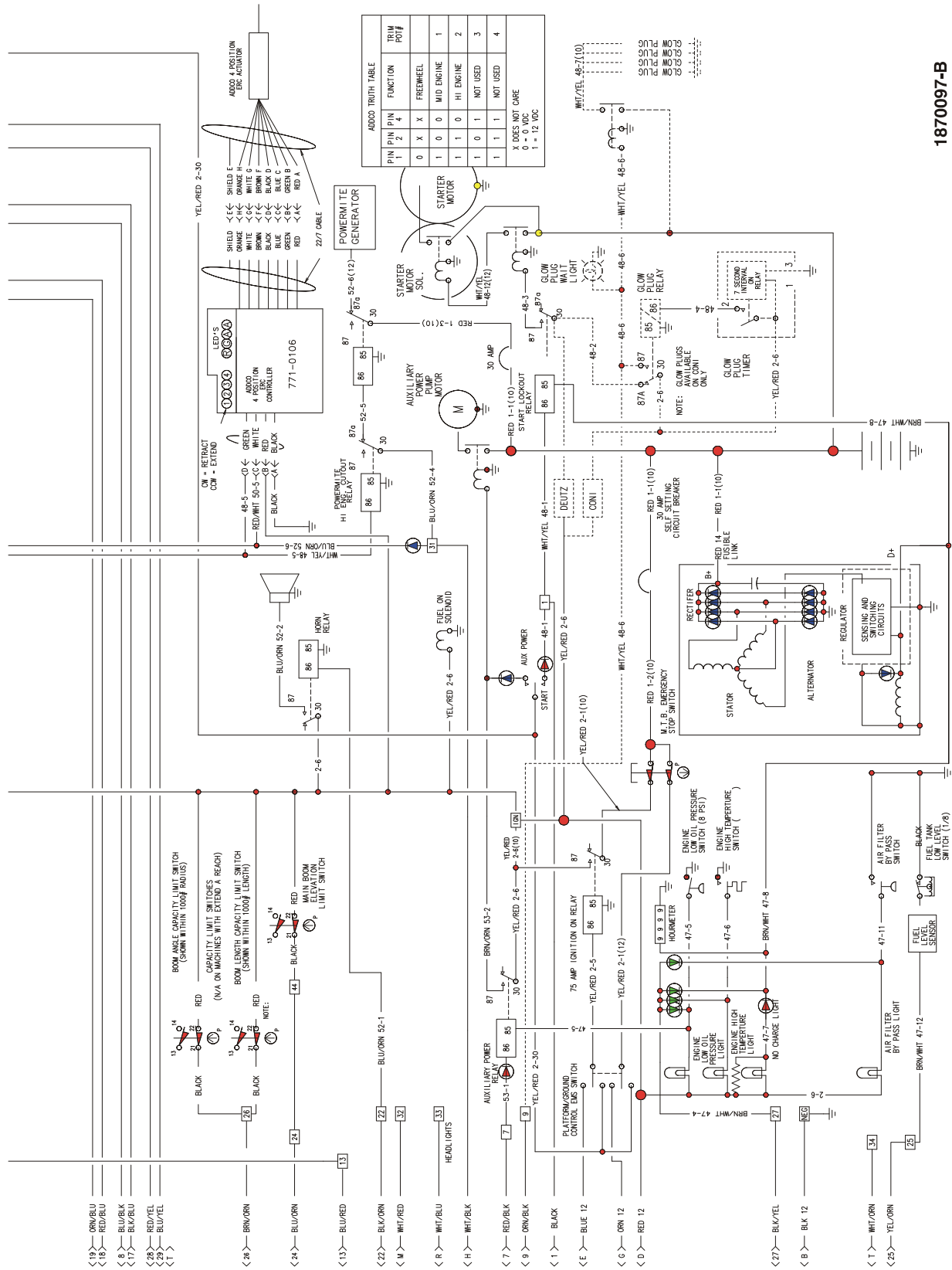


Figure 7-30. Electrical Schematic - Deutz Engine w/o JLG Control System - Sheet 2 of 4

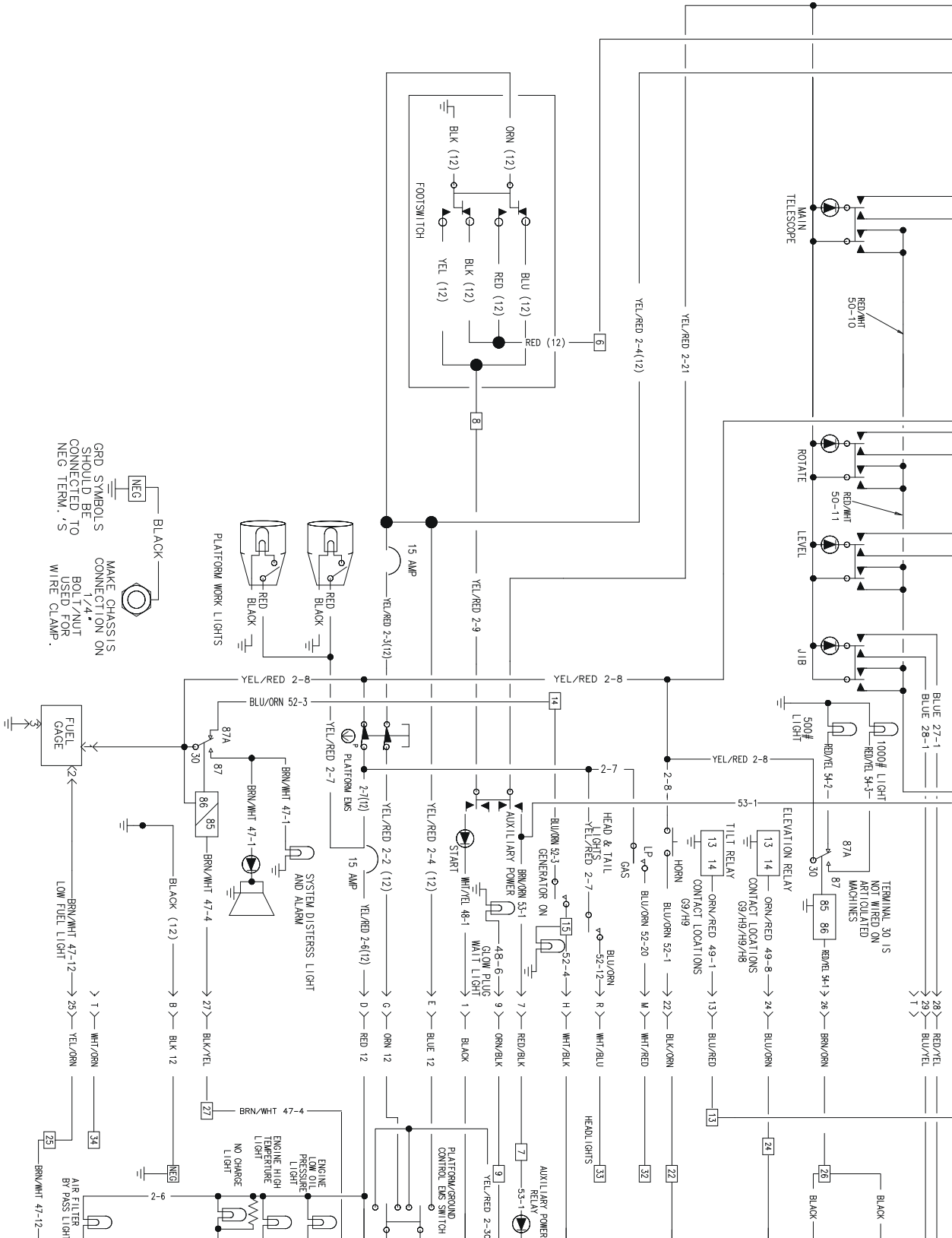




1870097-B

Figure 7-32. Electrical Schematic - Deutz Engine w/o JLG Control System - Sheet 4 of 4

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



**Figure 7-33. Electrical Schematic - Isuzu Engine w/o JLG Control System - Sheet 1 of 4**





# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

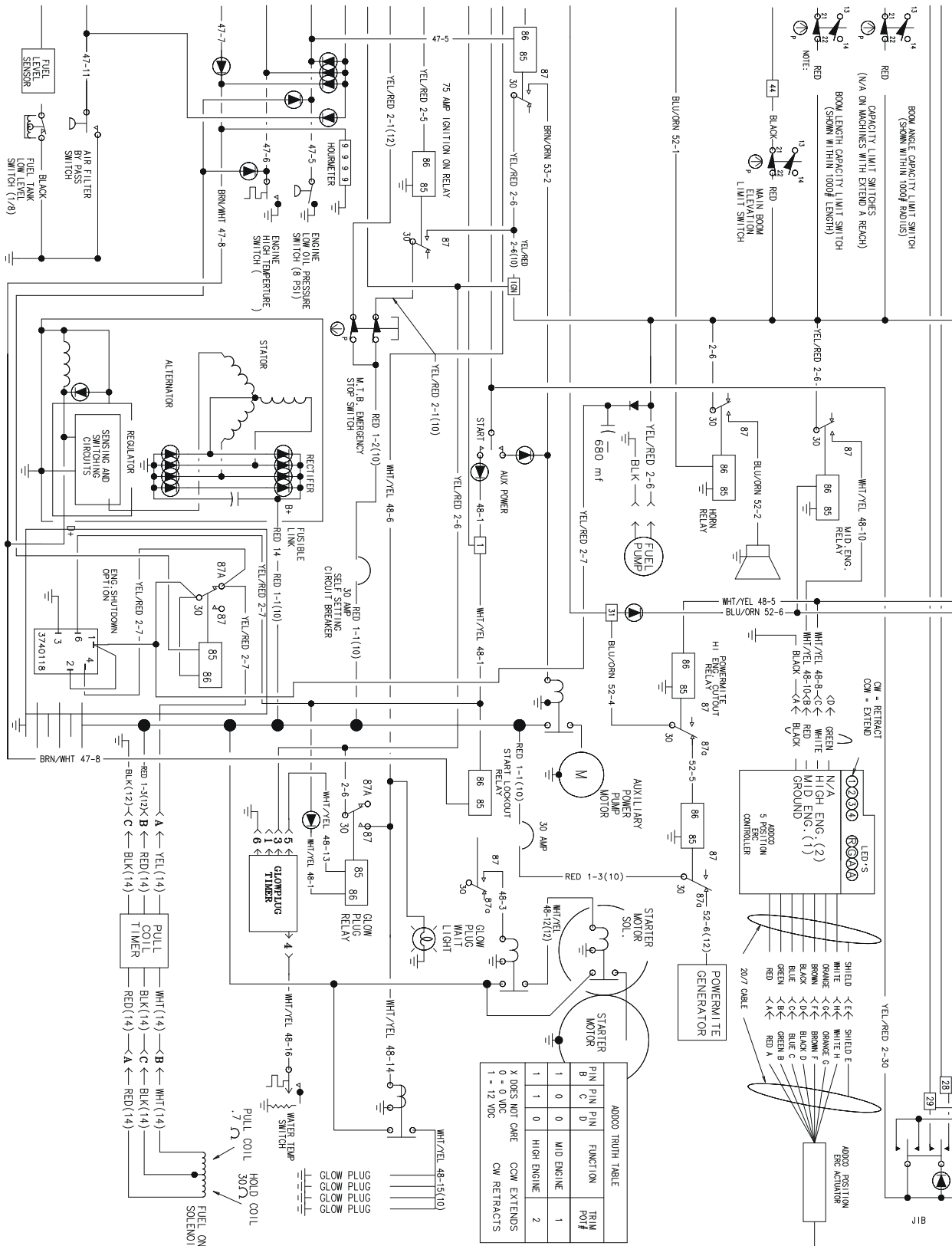


Figure 7-35. Electrical Schematic - Isuzu Engine w/o JLG Control System - Sheet 3 of 4

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

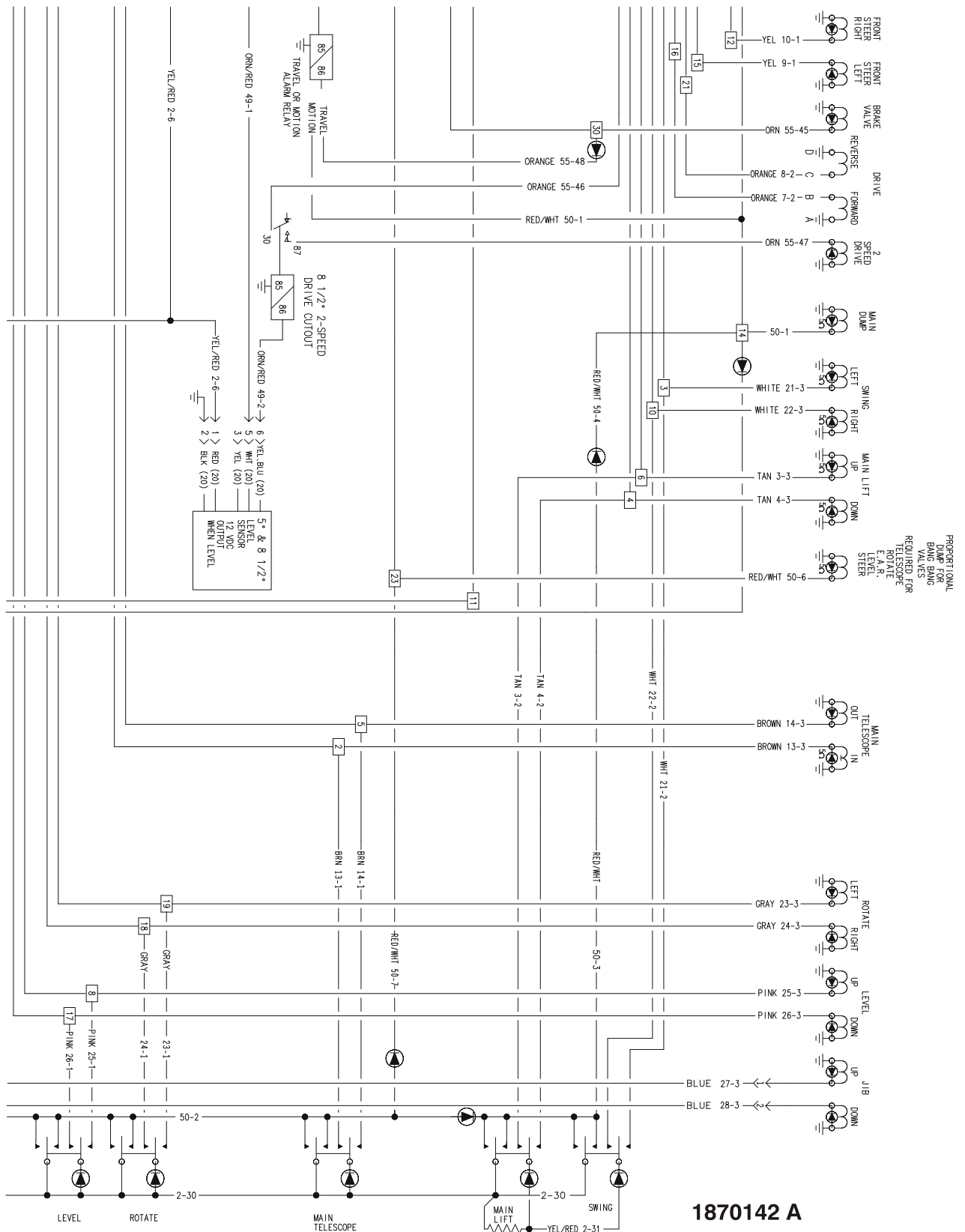
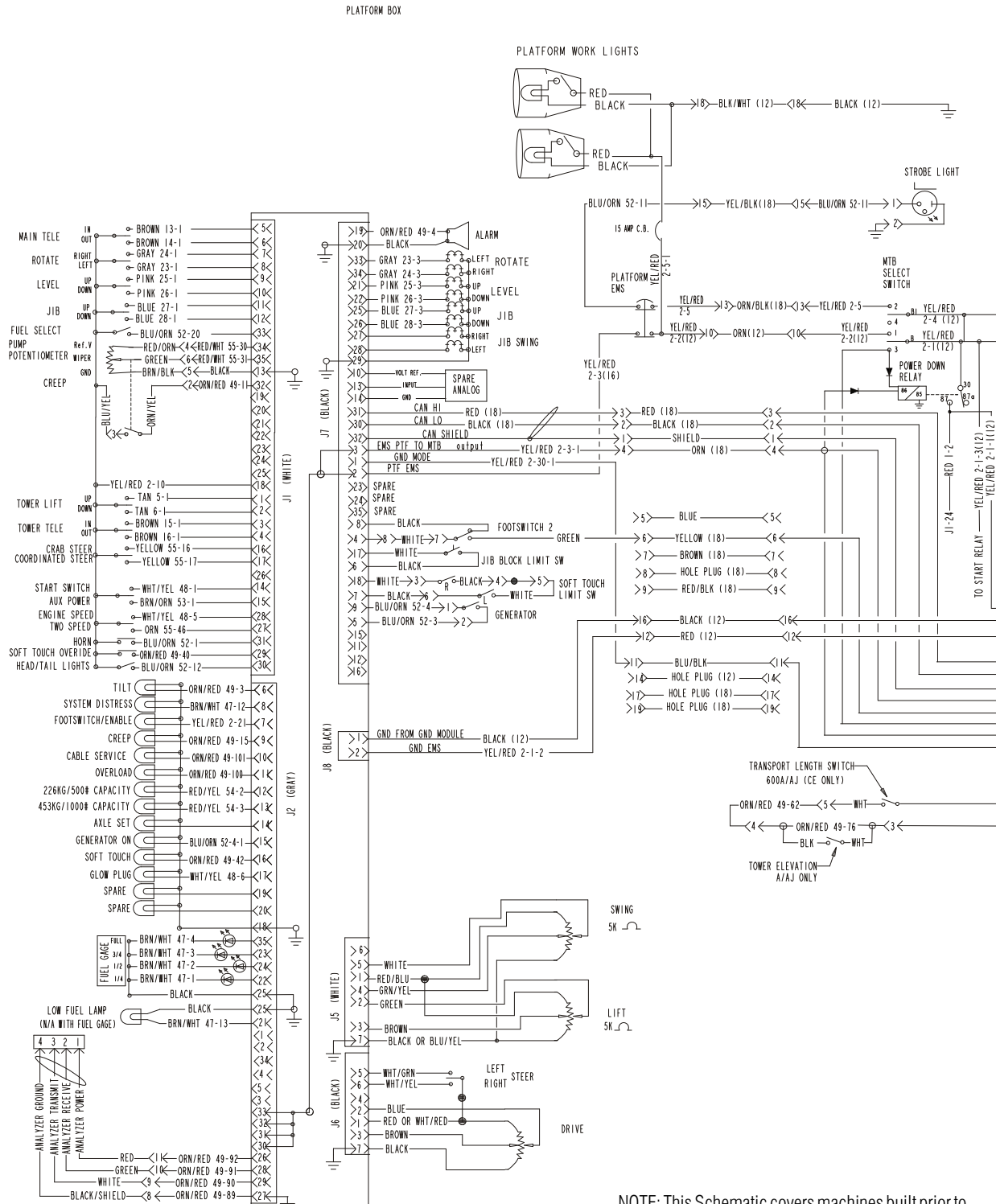


Figure 7-36. Electrical Schematic - Isuzu Engine w/o JLG Control System - Sheet 4 of 4

# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



NOTE: This Schematic covers machines built prior to S/N 99084.

Figure 7-37. Electrical Schematic - Caterpillar Engine - Sheet 1 of 6

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

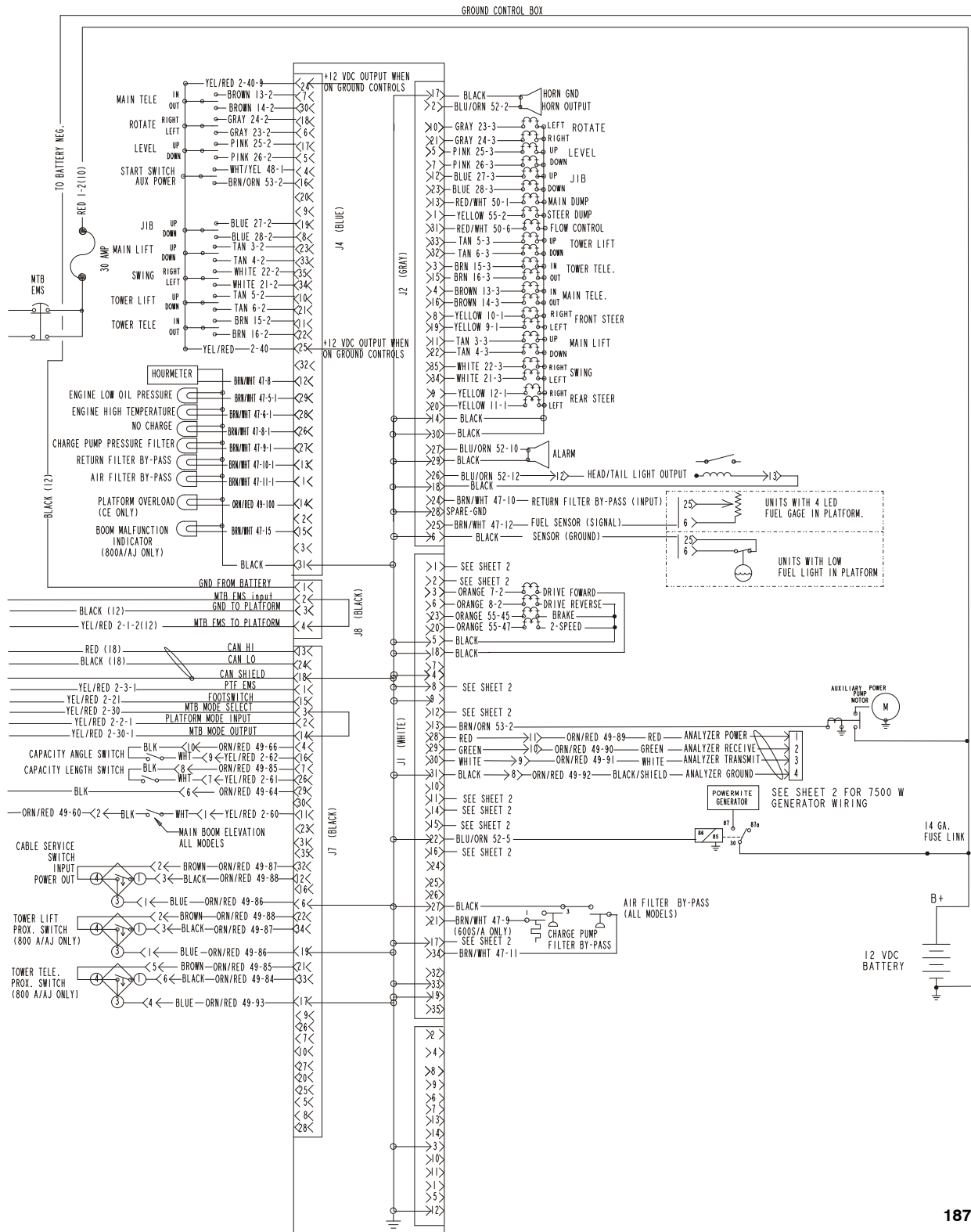
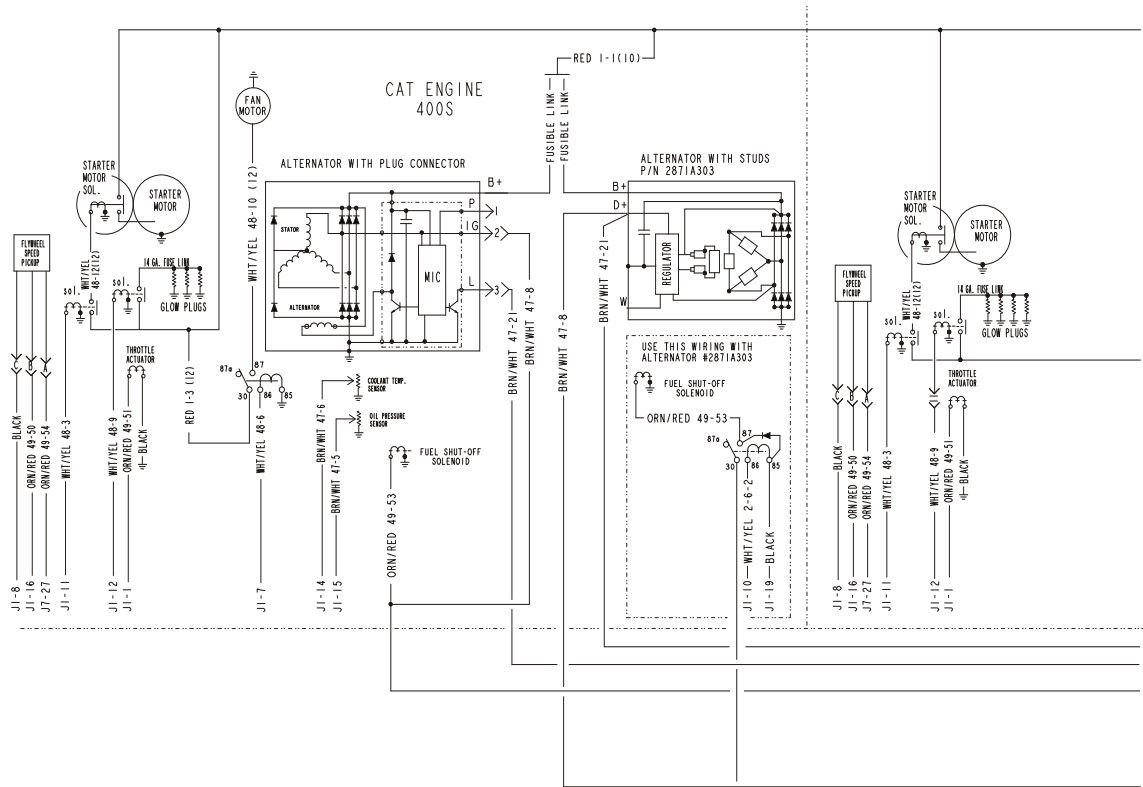


Figure 7-38. Electrical Schematic - Caterpillar Engine - Sheet 2 of 6

# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



NOTE: This Schematic covers machines built prior to S/N 99084.

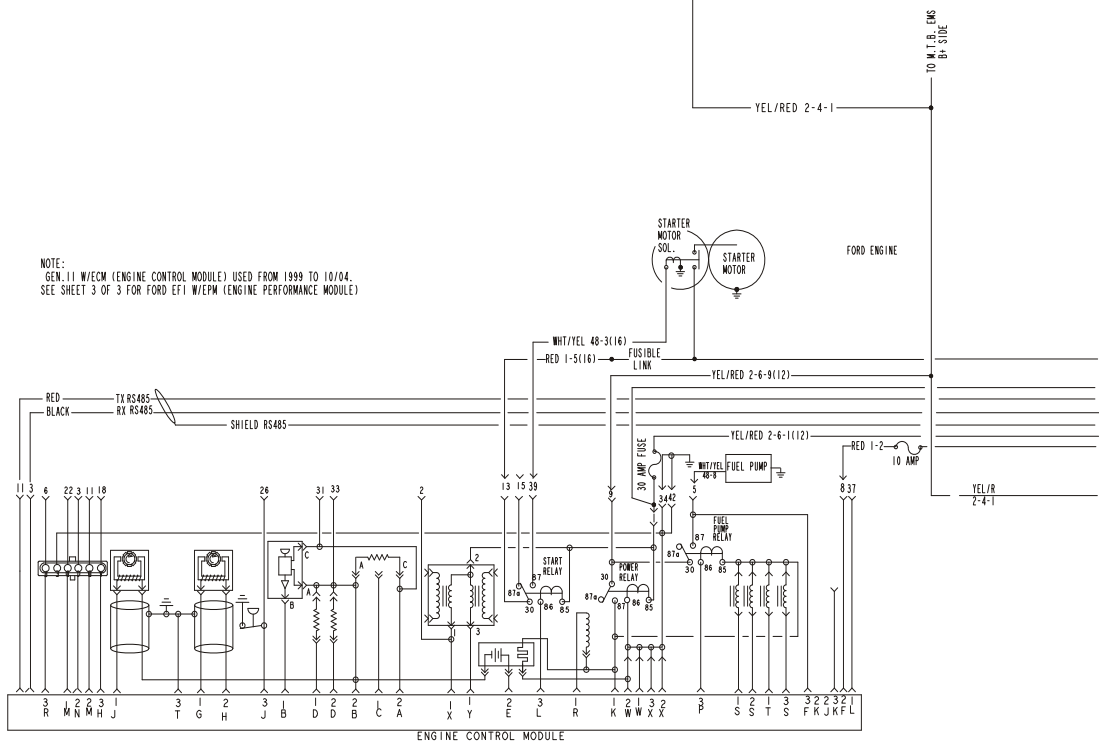


Figure 7-39. Electrical Schematic - Caterpillar Engine - Sheet 3 of 6

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

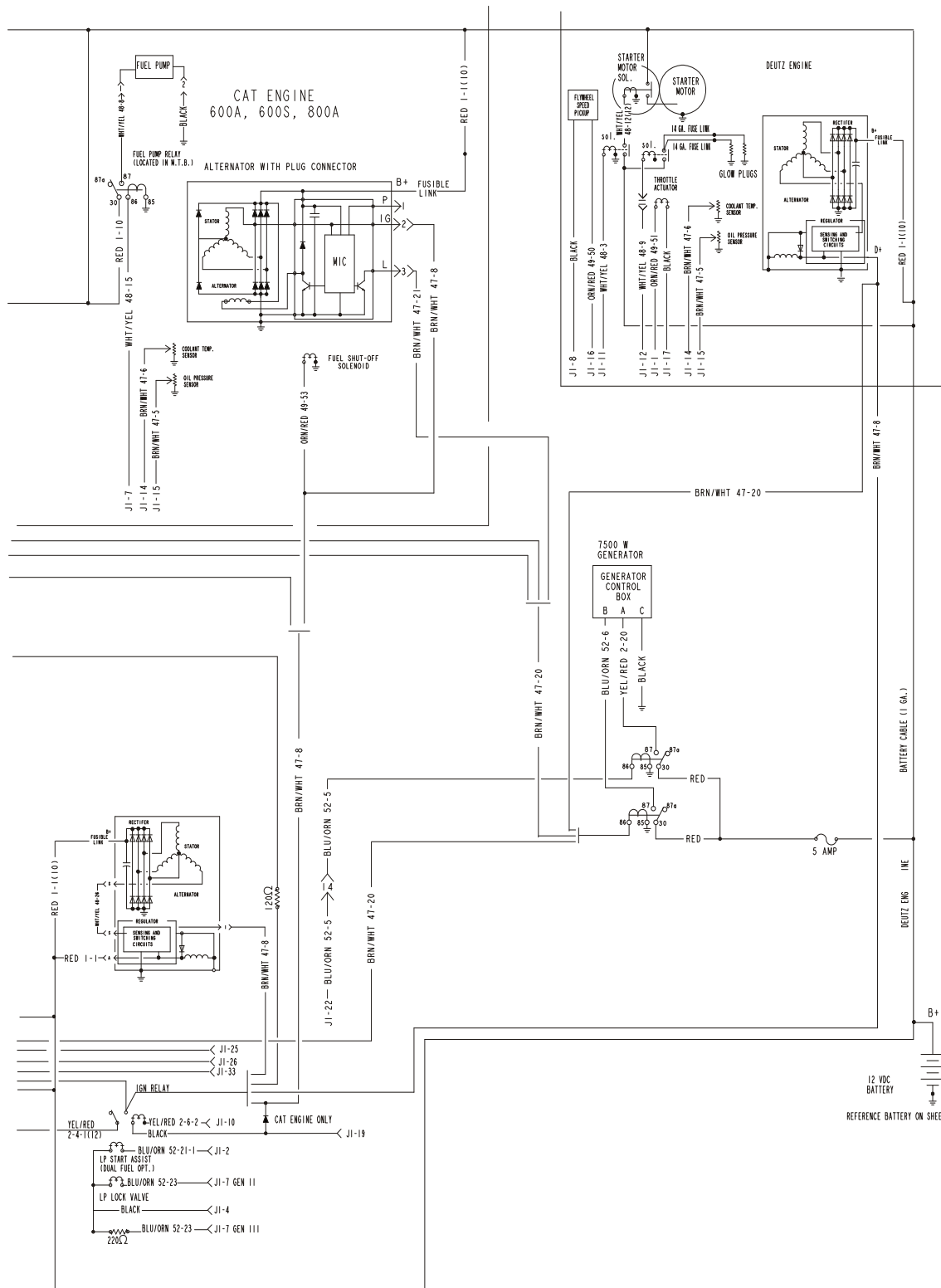


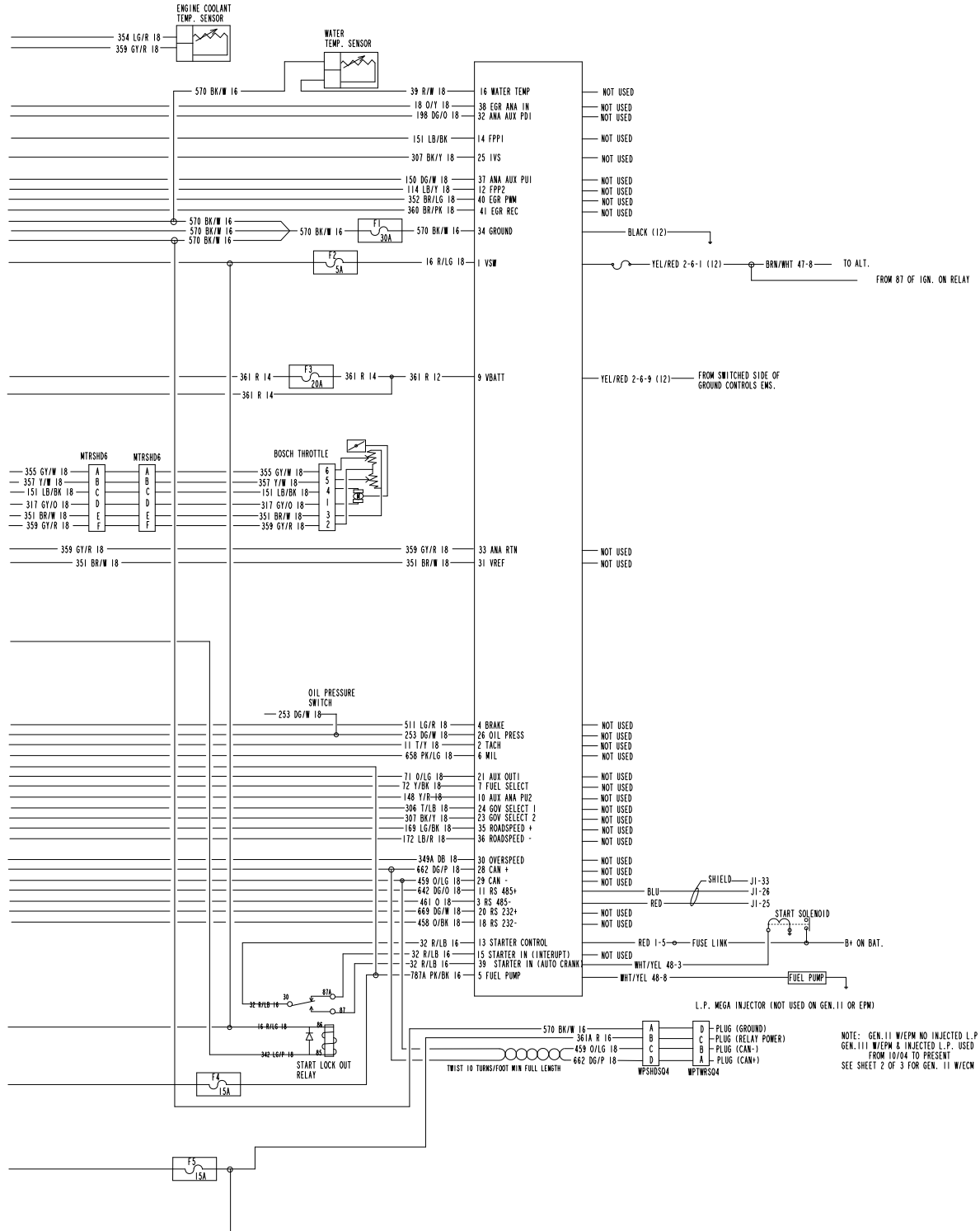
Figure 7-40. Electrical Schematic - Caterpillar Engine - Sheet 4 of 6

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# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



**Figure 7-42. Electrical Schematic - Caterpillar Engine - Sheet 6 of 6**

# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

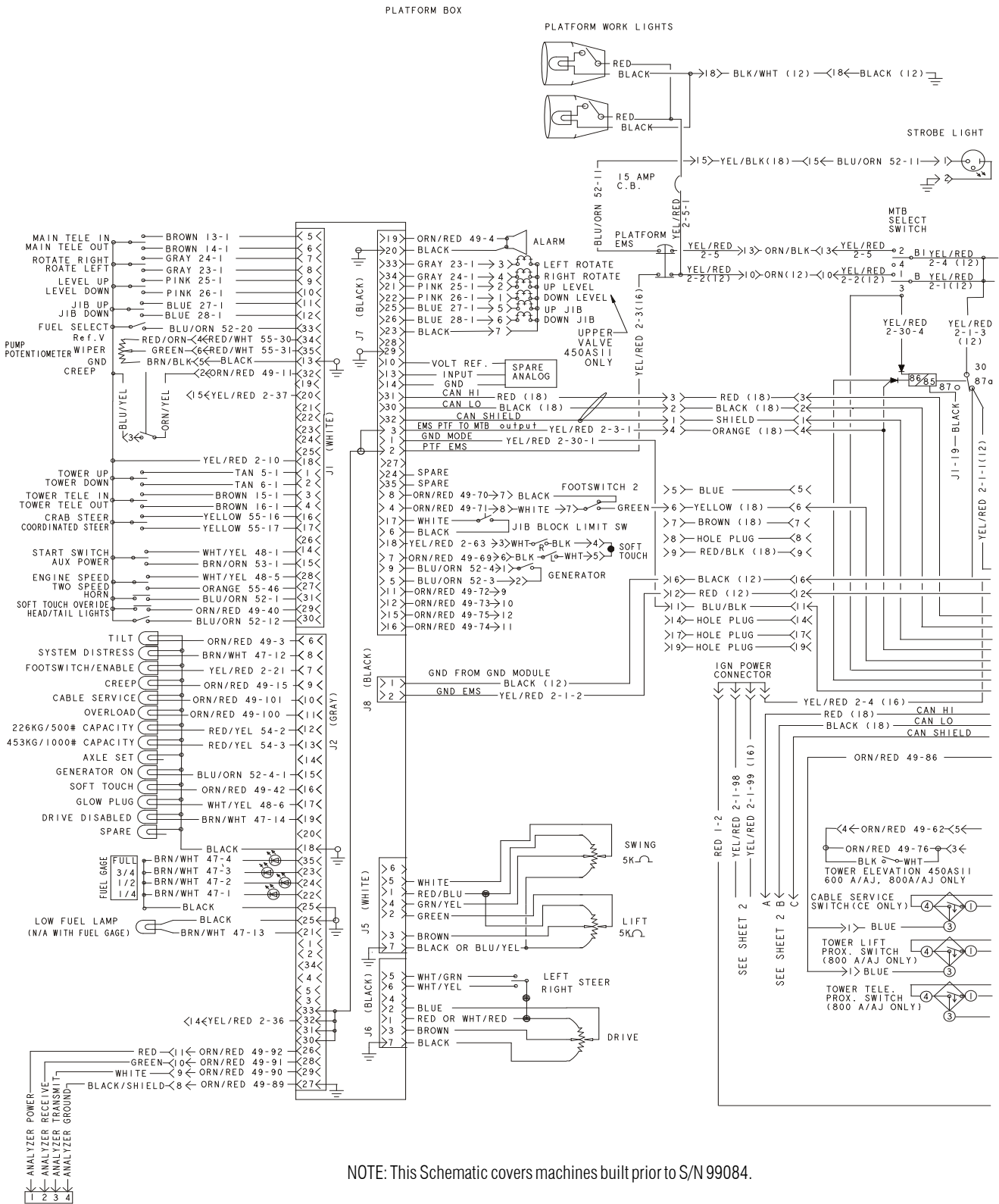
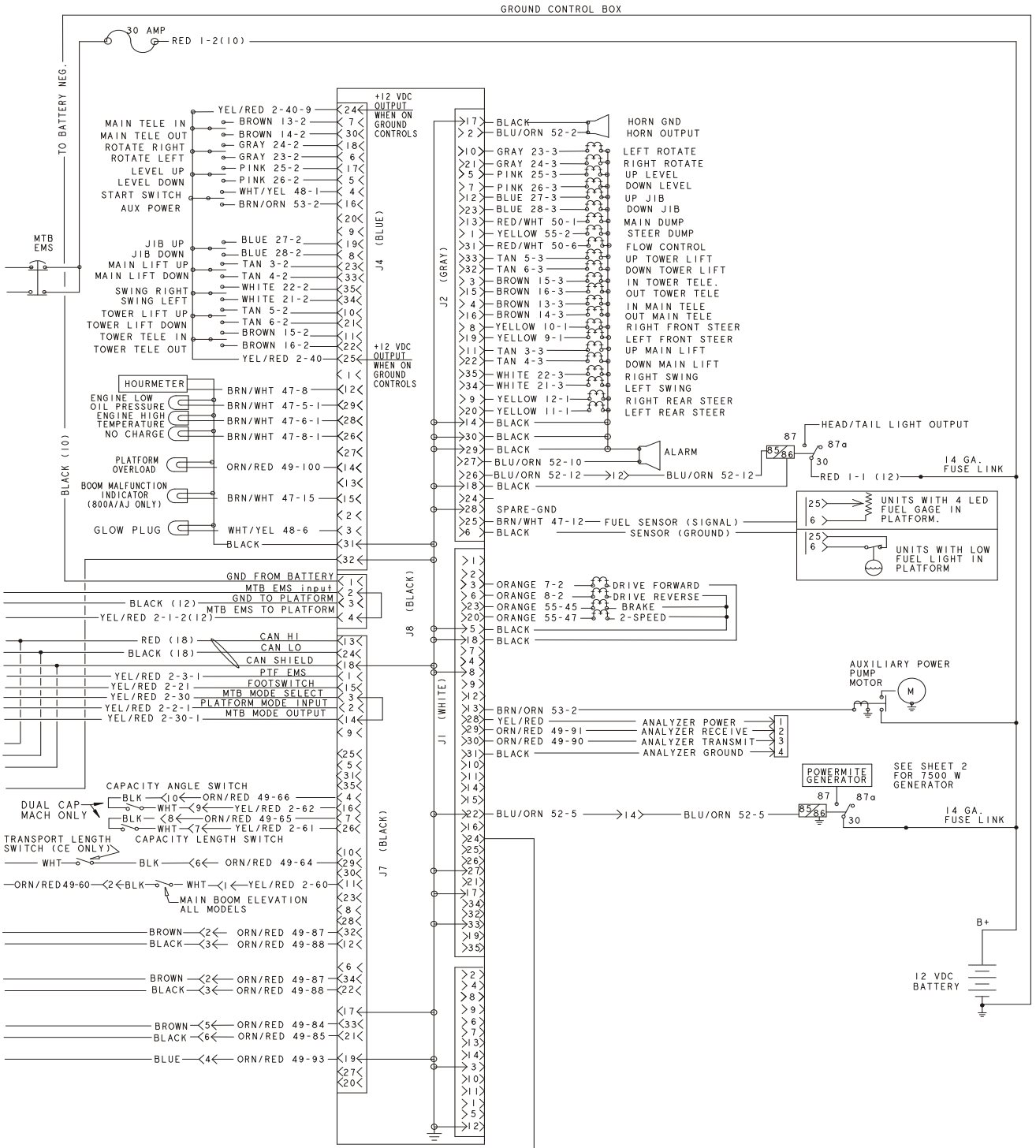


Figure 7-43. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 1 of 6

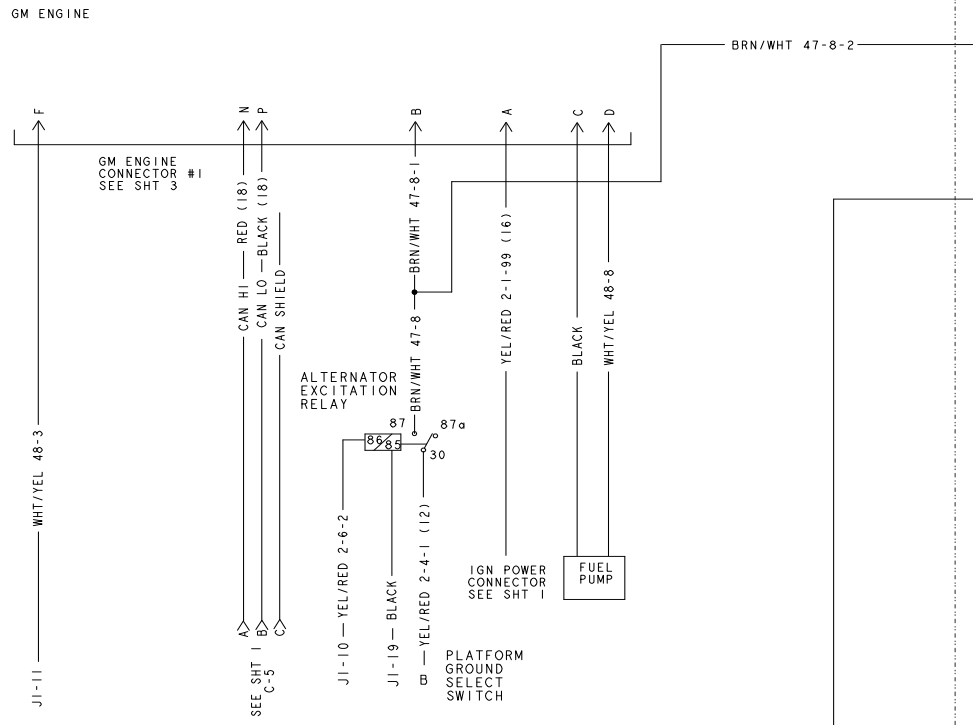
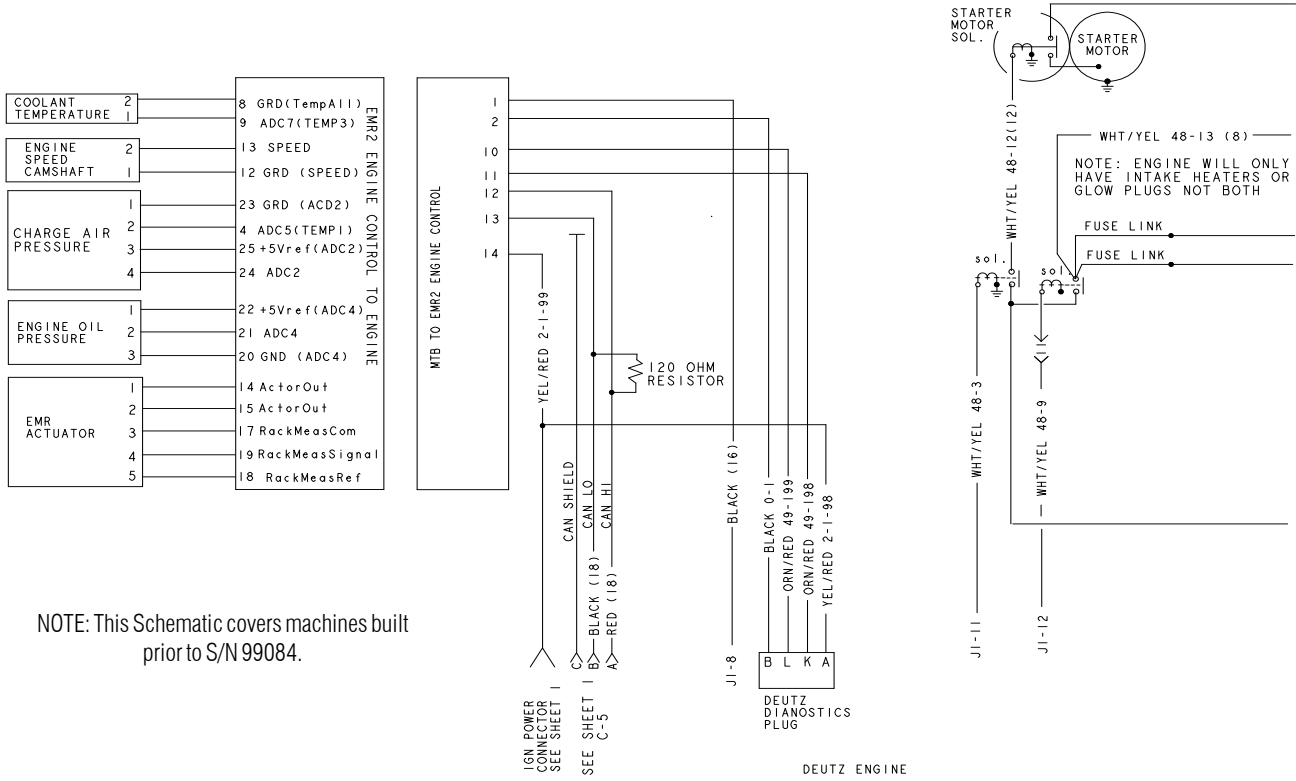
# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



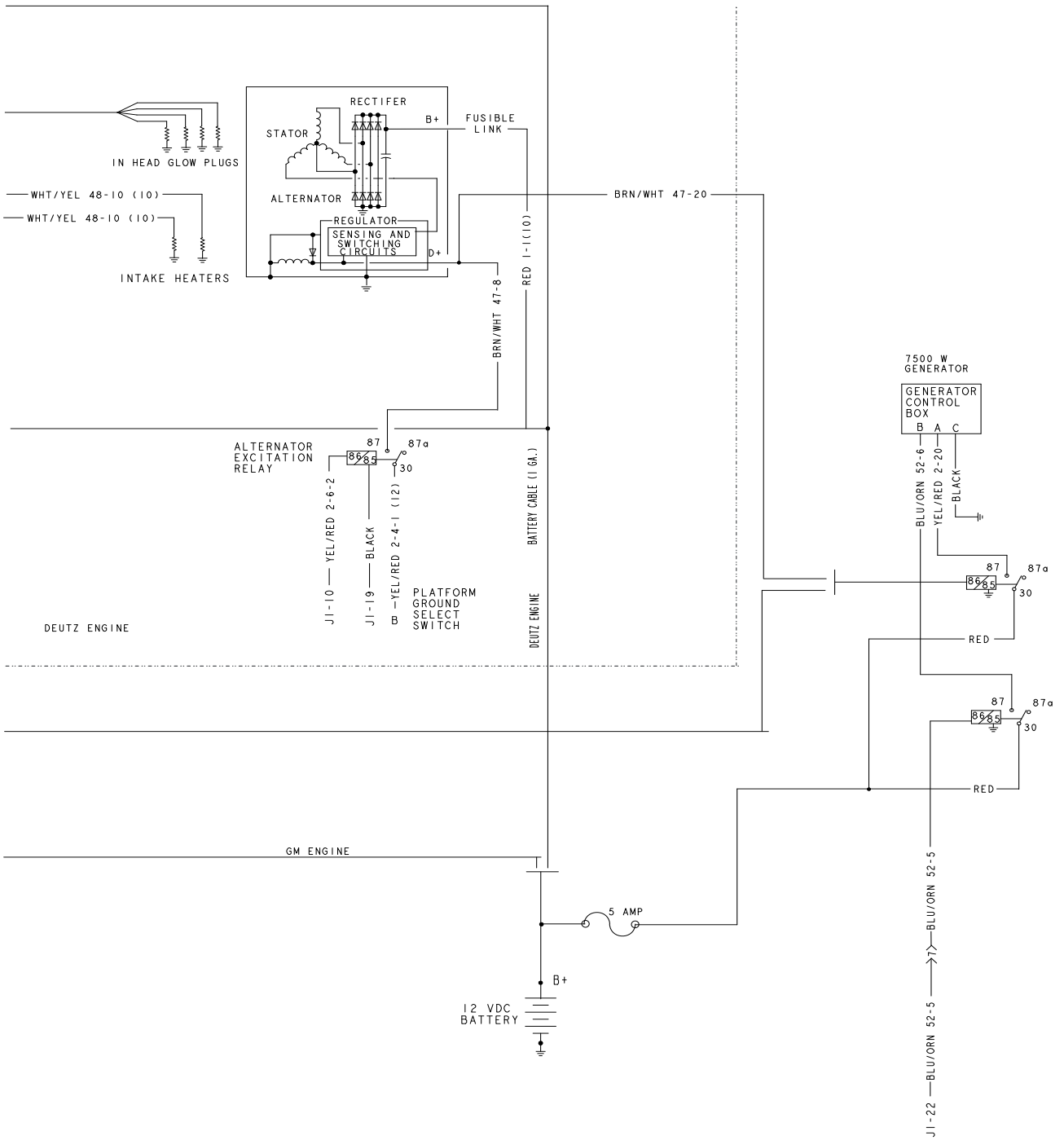
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Figure 7-44. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 2 of 6

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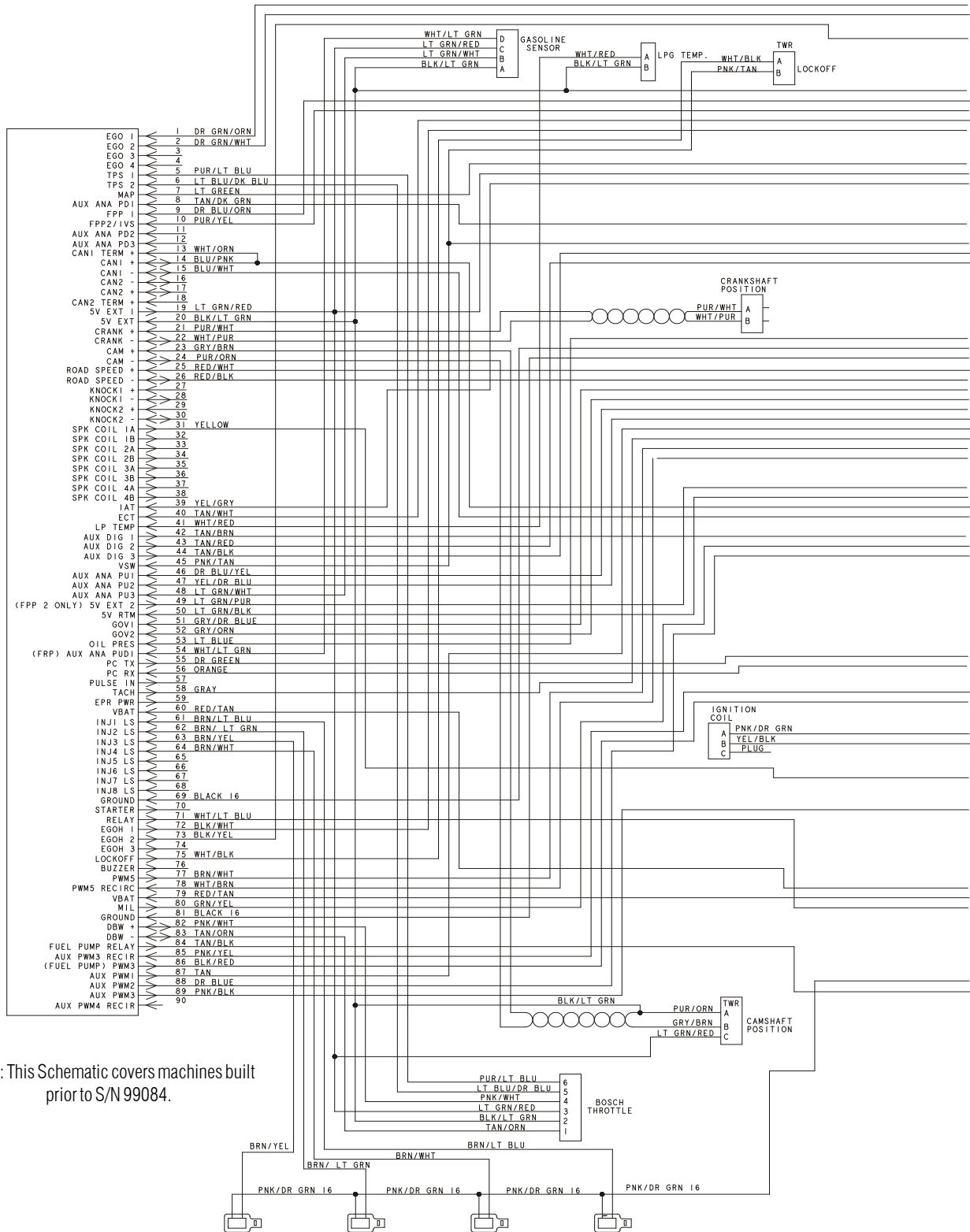
SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



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Figure 7-46. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 4 of 6

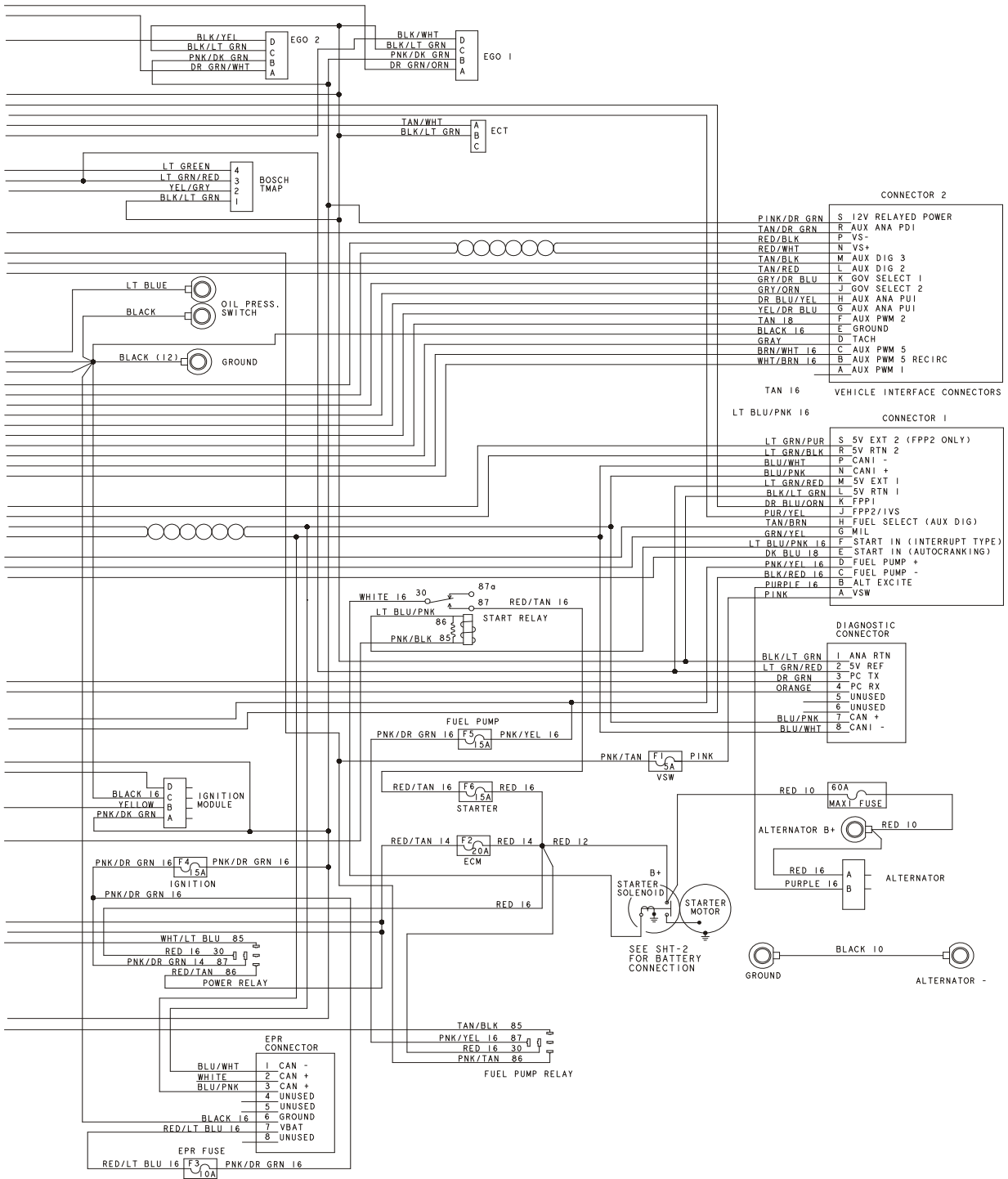
# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



NOTE: This Schematic covers machines built prior to S/N 99084.

Figure 7-47. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 5 of 6

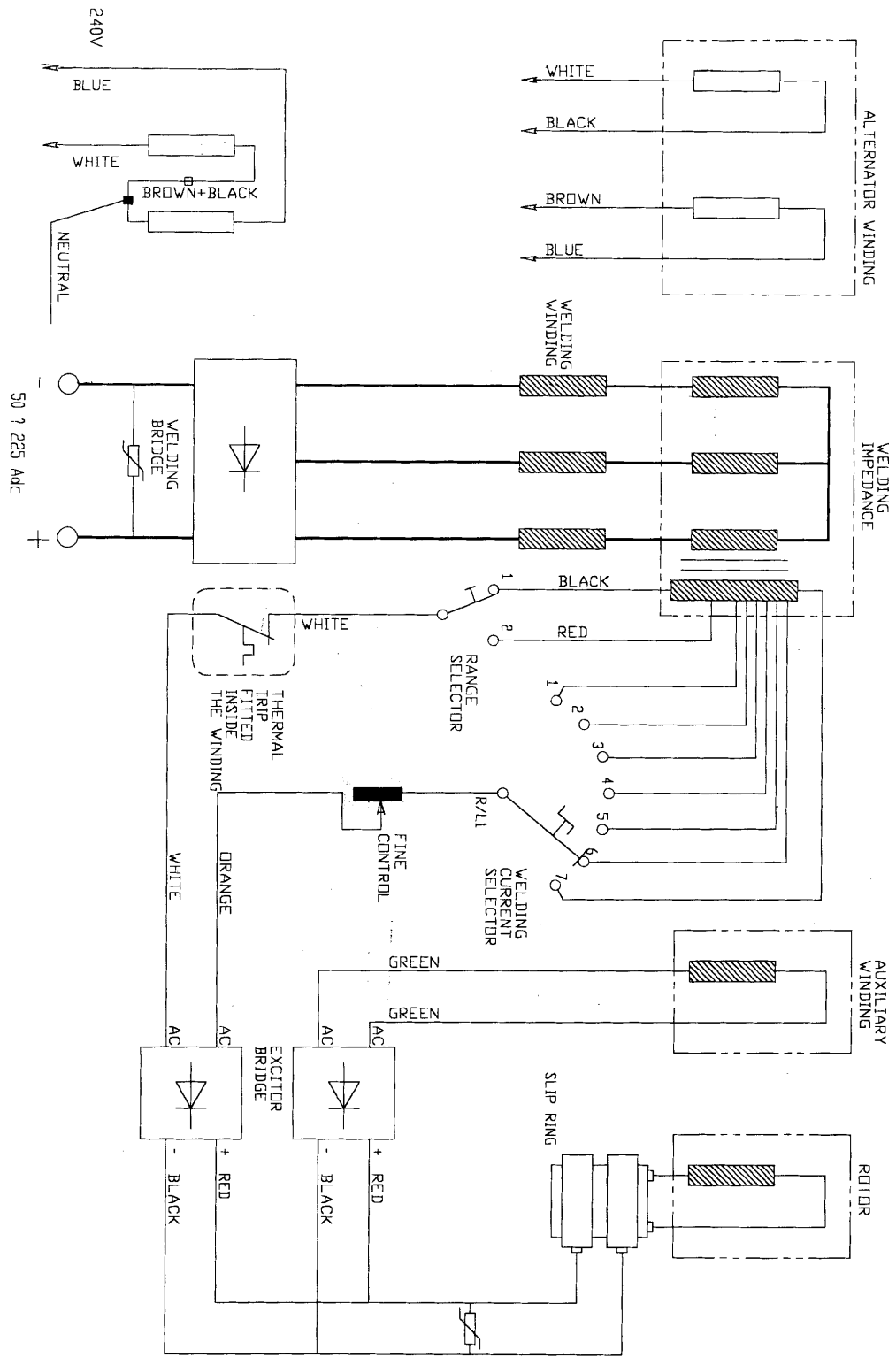
# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



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Figure 7-48. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 6 of 6

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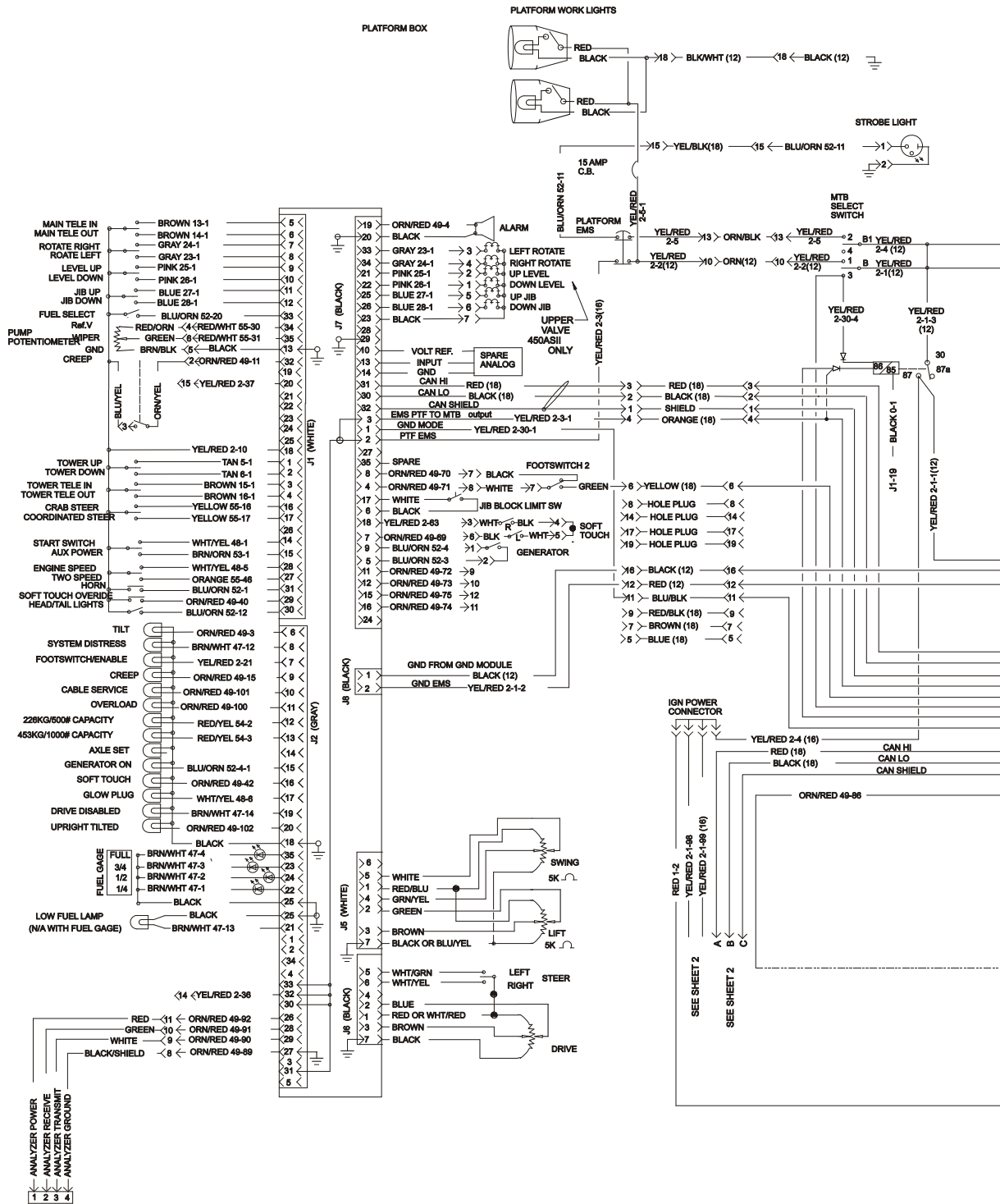


**Figure 7-49. Electrical Schematic - Hydraulic Welder**



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# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

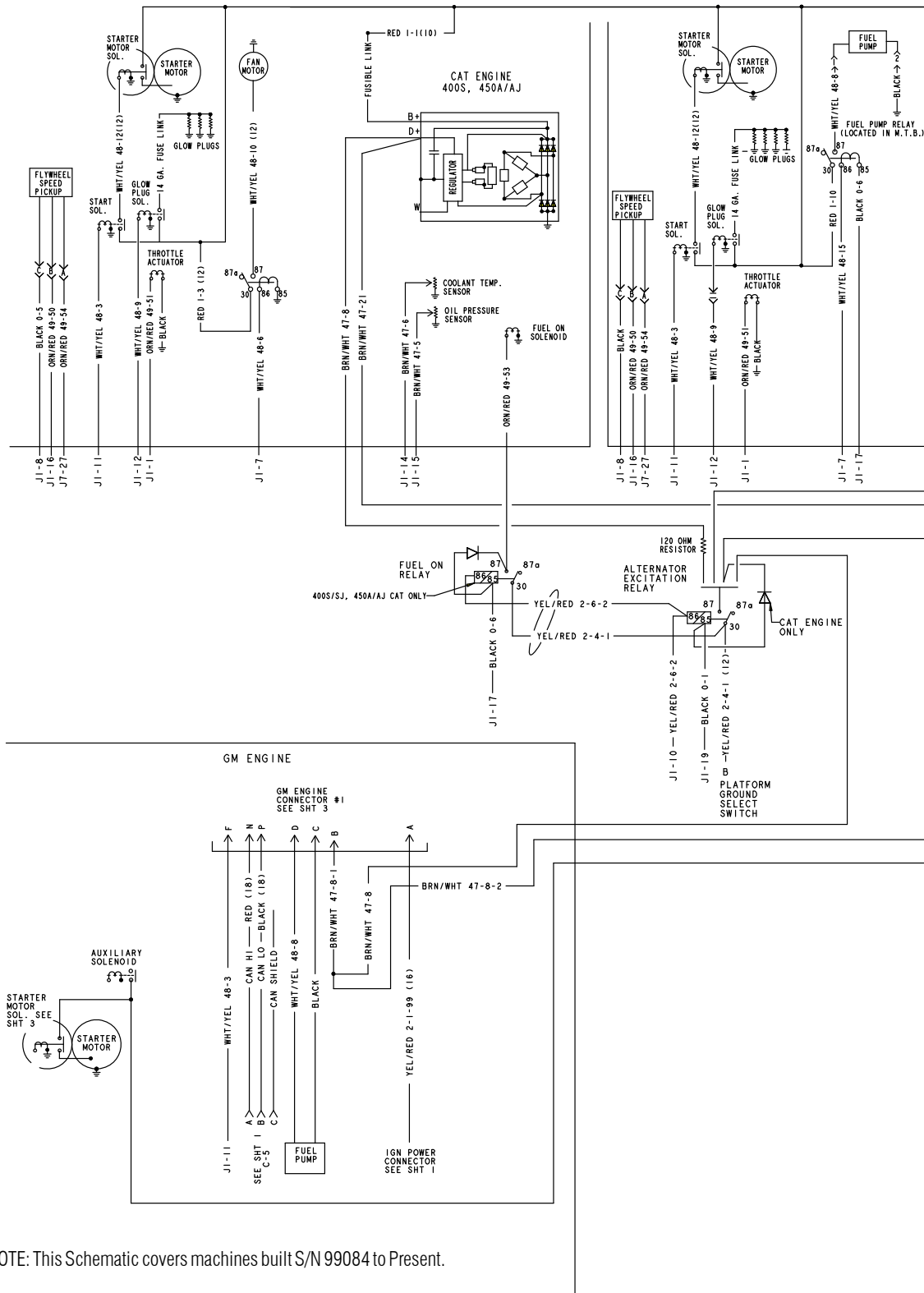


NOTE: This Schematic covers machines built S/N 99084 to Present.

Figure 7-50. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 1 of 6



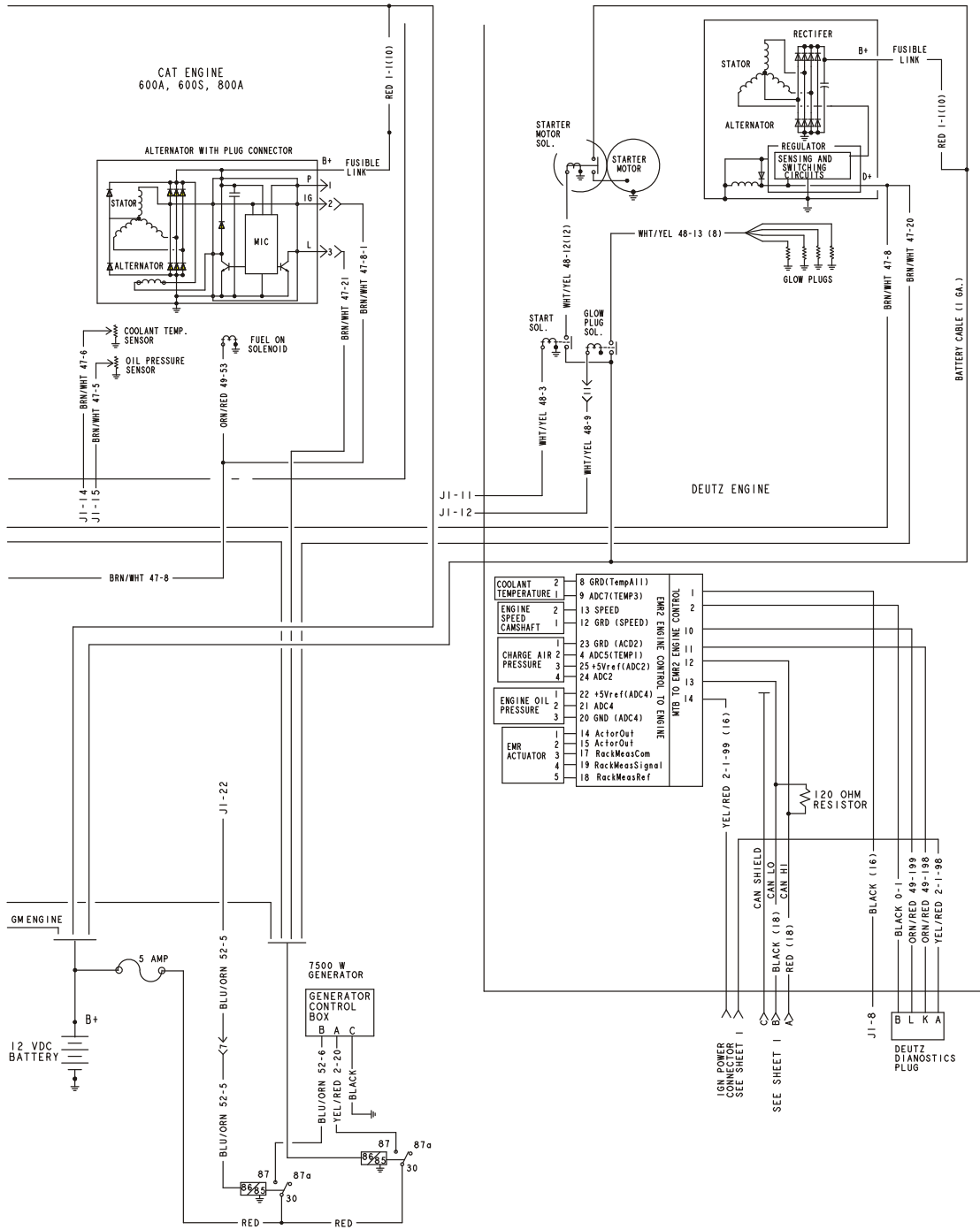
# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



NOTE: This Schematic covers machines built S/N 99084 to Present.

Figure 7-52. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 3 of 6

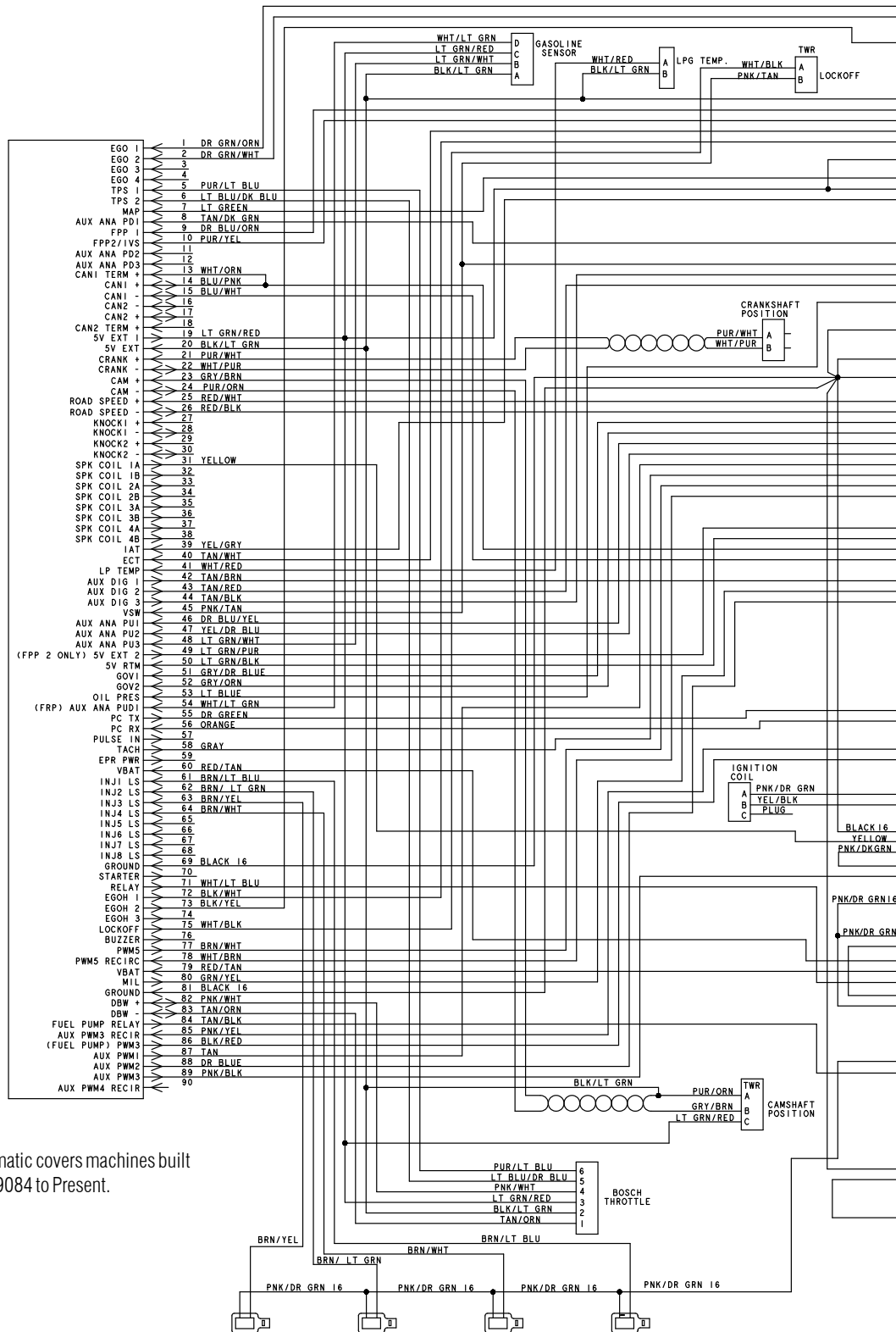
SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



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Figure 7-53. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 4 of 6

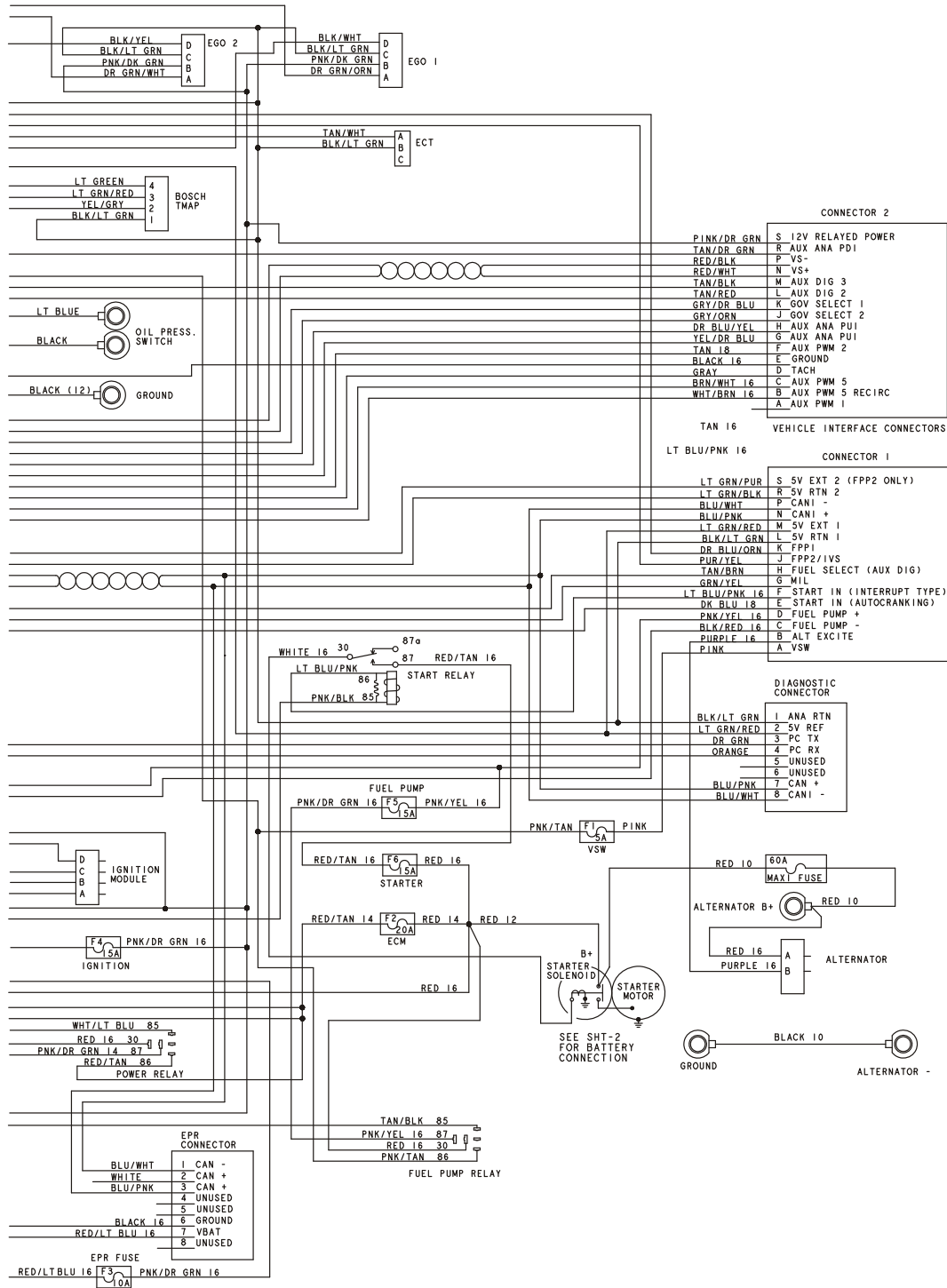
# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



NOTE: This Schematic covers machines built S/N 99084 to Present.

Figure 7-54. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 5 of 6

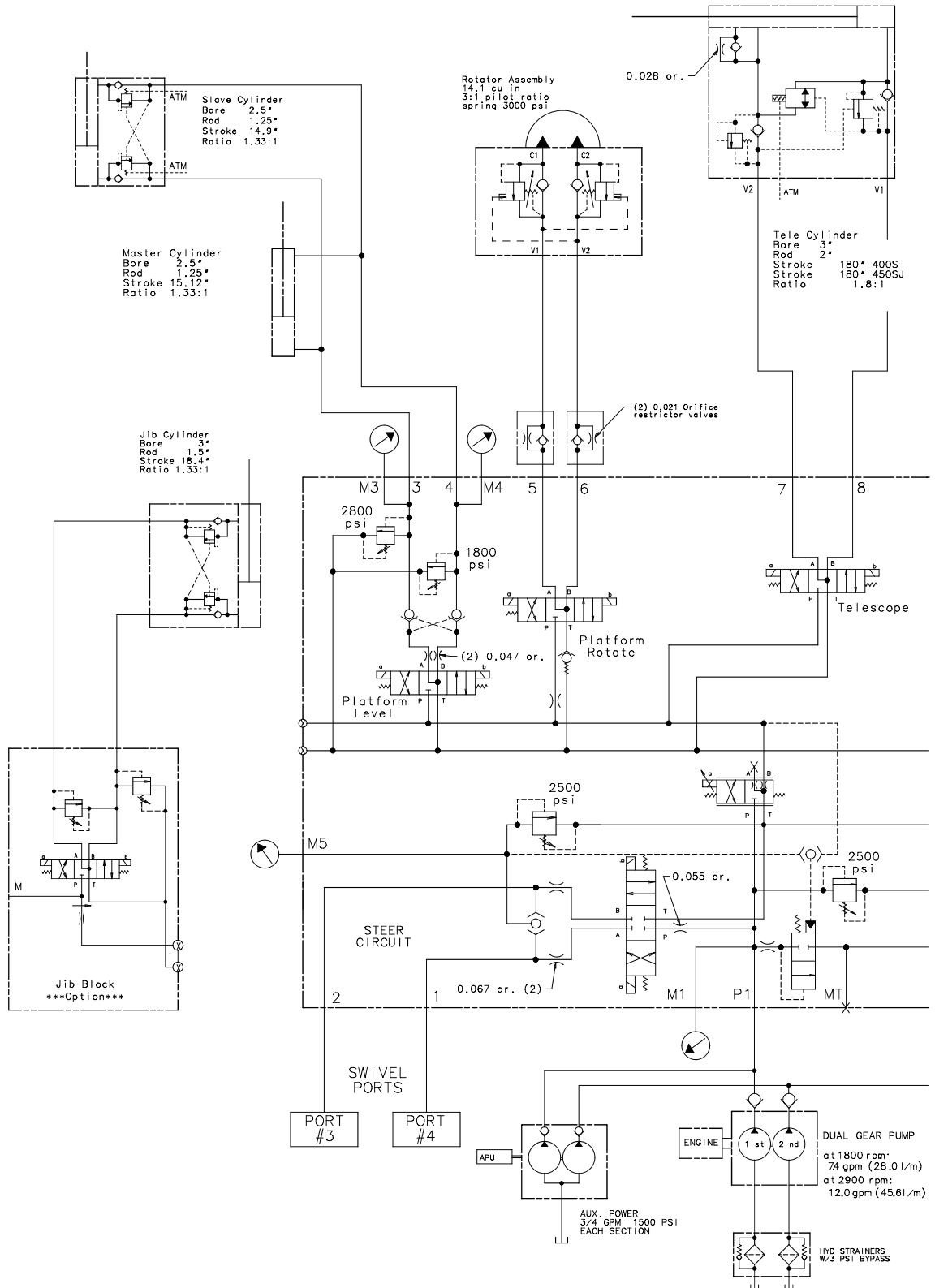
SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



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Figure 7-55. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 6 of 6

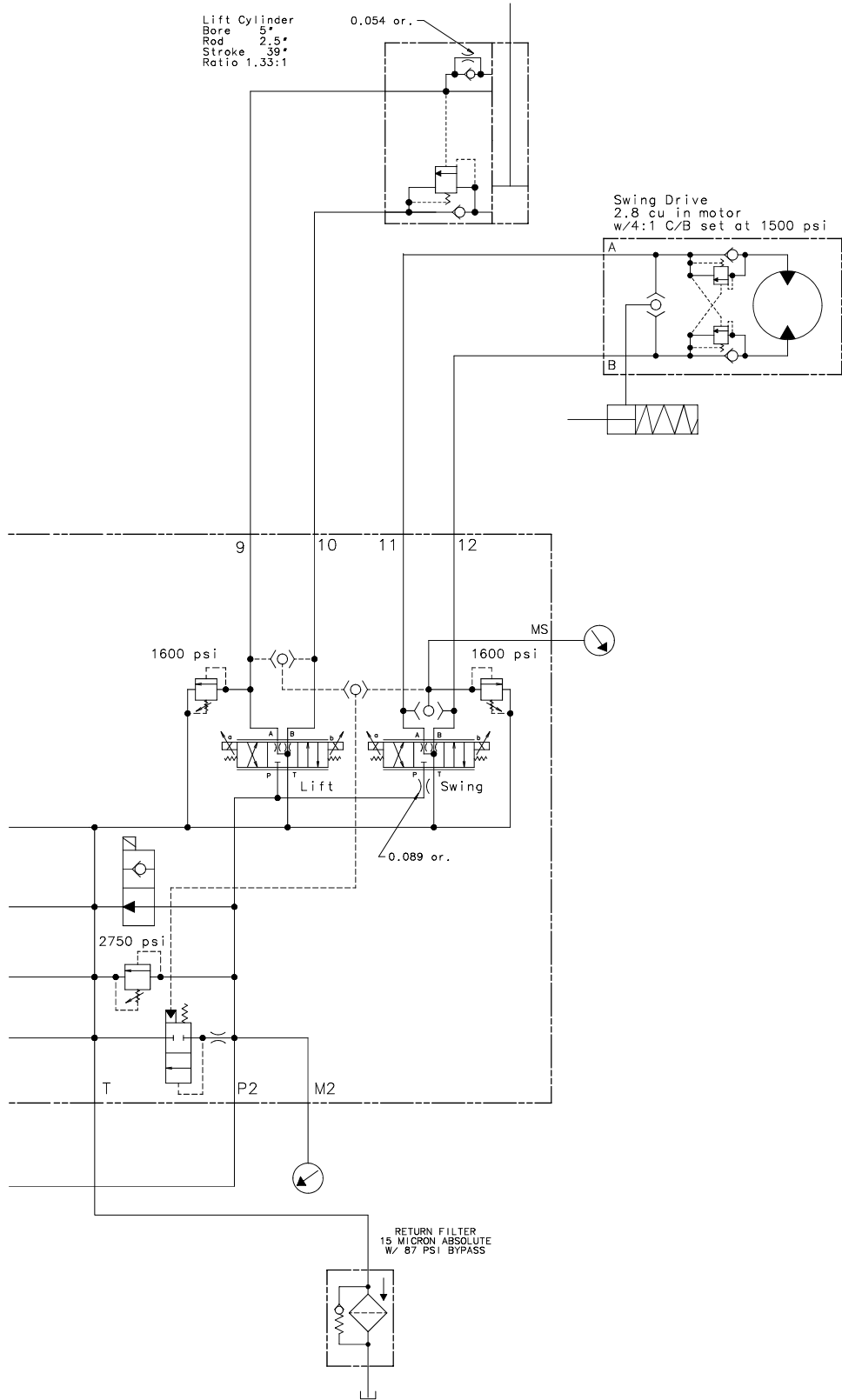
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**Figure 7-56. Hydraulic Schematic - (Sheet 1 of 6)**



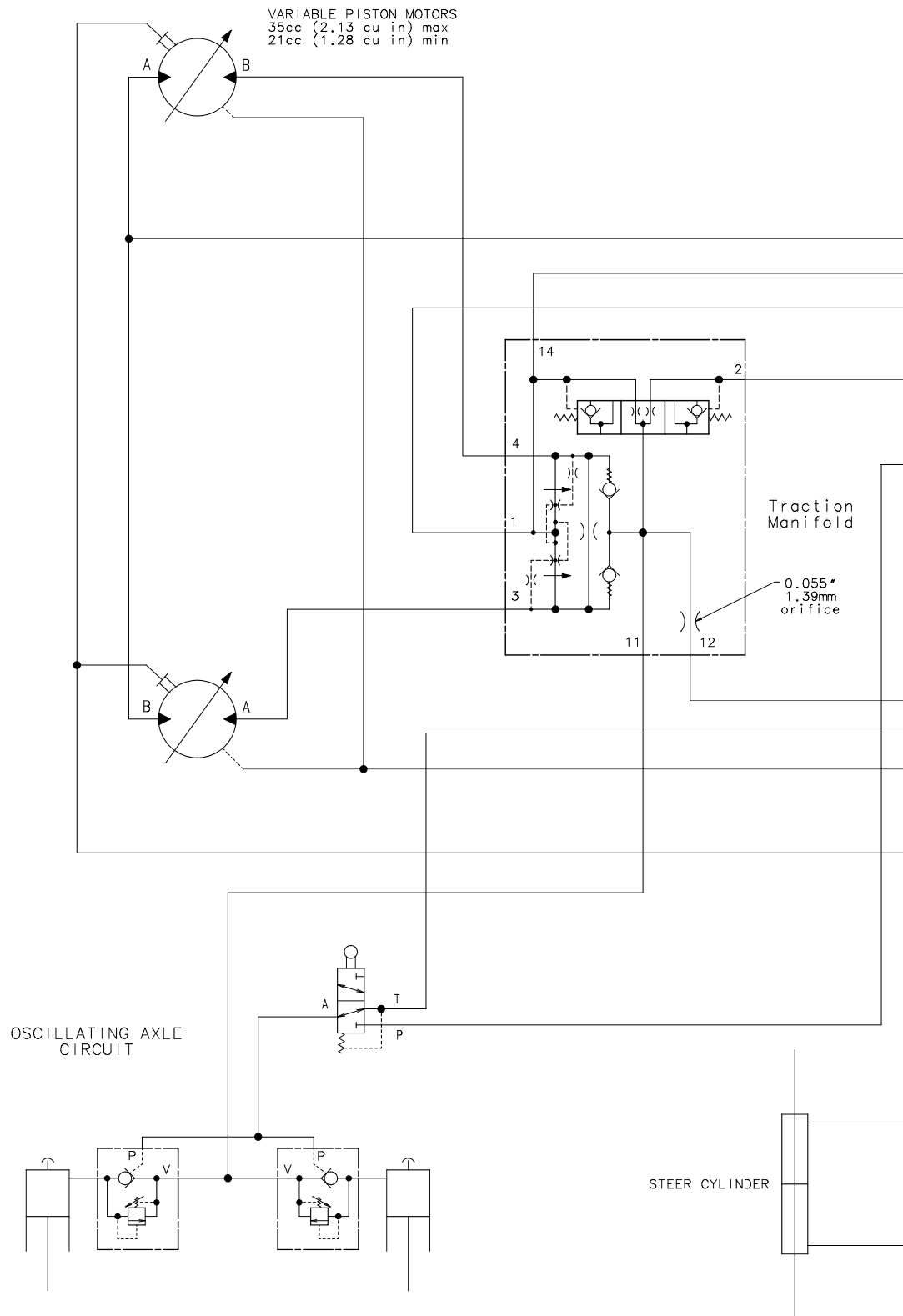
**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**



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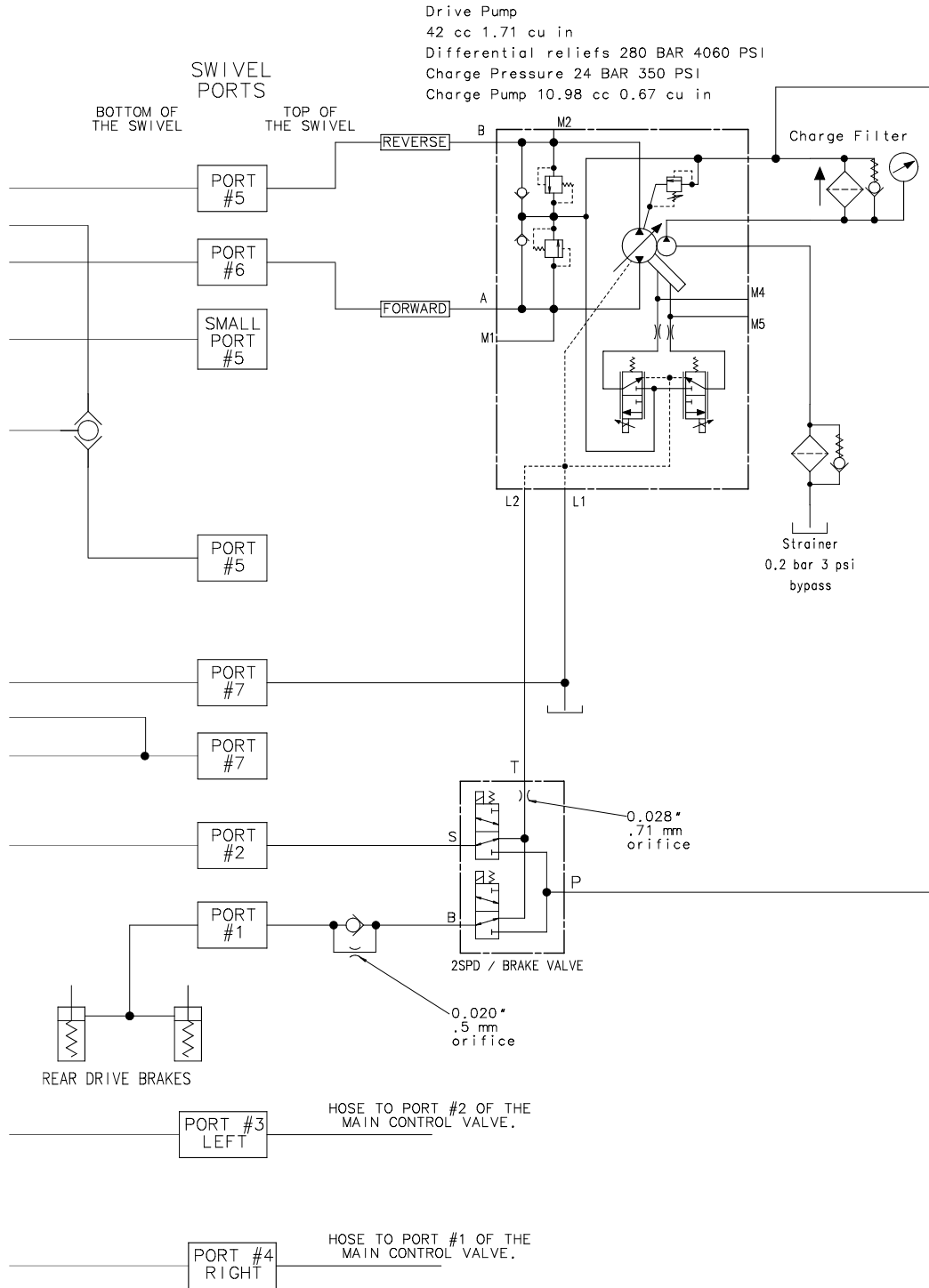
**Figure 7-57. Hydraulic Schematic - (Sheet 2 of 6)**

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**Figure 7-58. Hydraulic Schematic - (Sheet 3 of 6)**

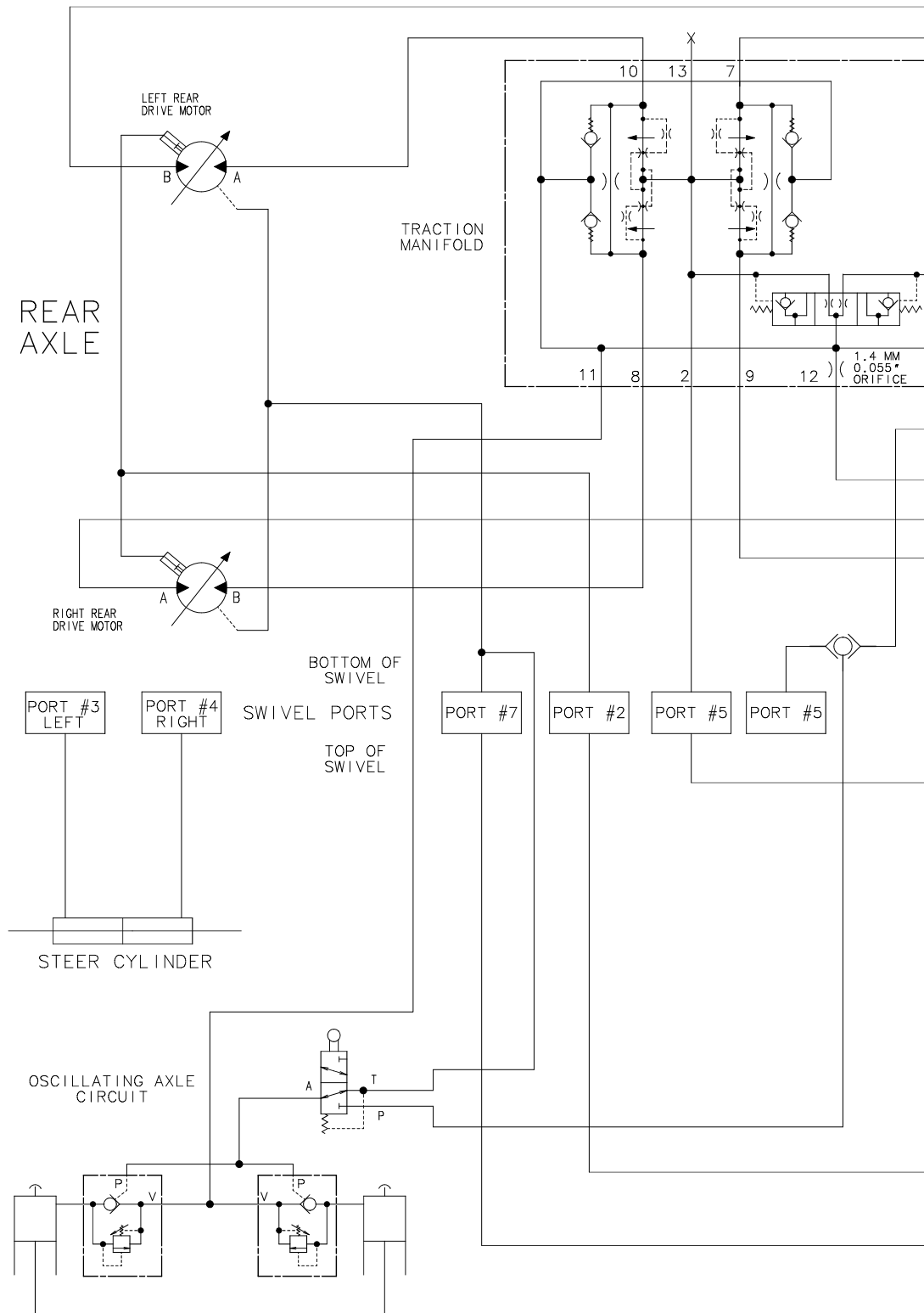
**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-59. Hydraulic Schematic - (Sheet 4 of 6)**

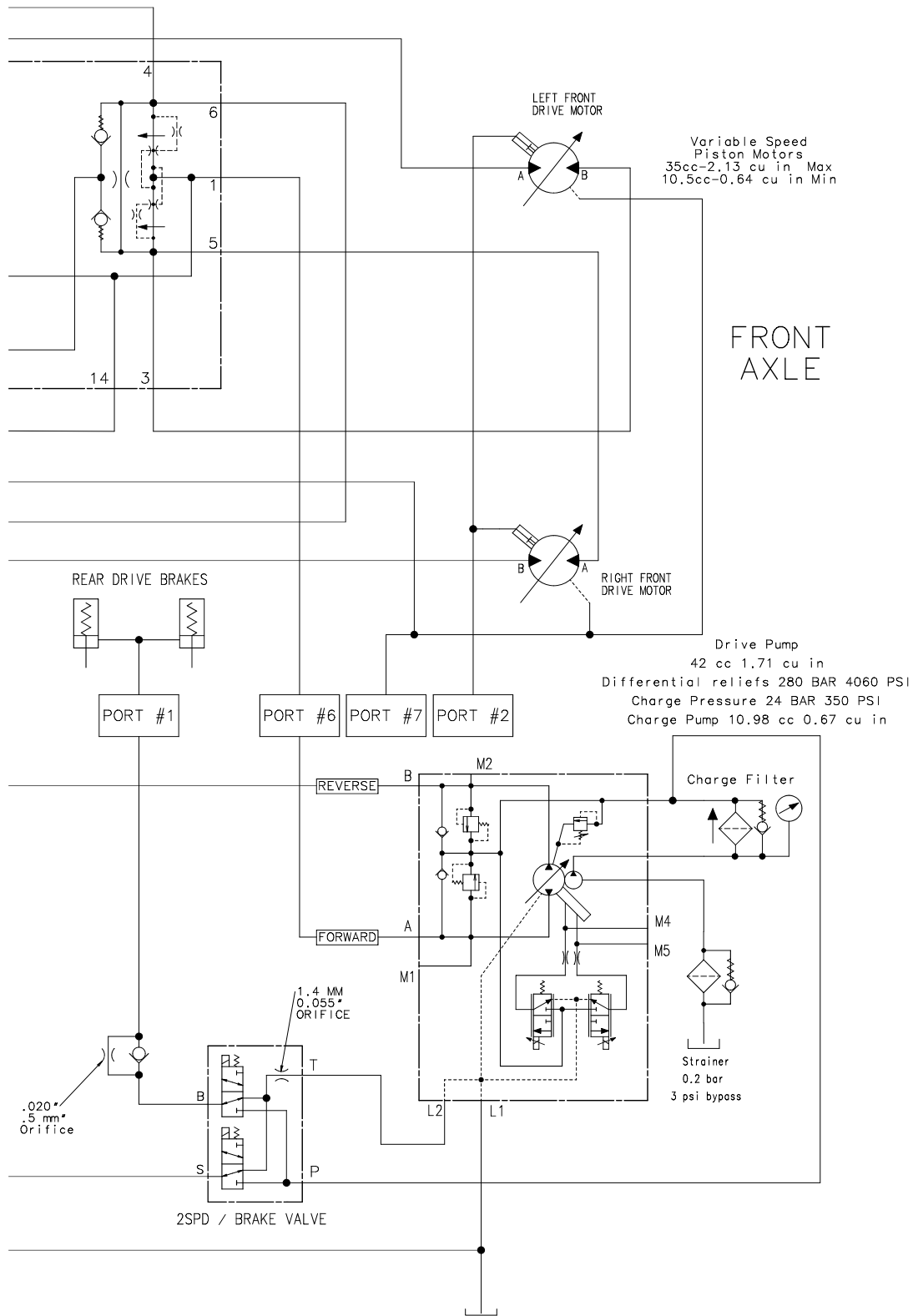
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**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-60. Hydraulic Schematic - (Sheet 5 of 6)**

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



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Figure 7-61. Hydraulic Schematic - (Sheet 6 of 6)



## **PROPOSITION 65 WARNING**

- **Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.**
- **Batteries also contain other chemicals known to the State of California to cause cancer.**
- **Wash hands after handling.**



**WARNING:**



**The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.**

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