An Oshkosh Corporation Company

Service and Maintenance Manual

Models
1200SJP
1350SJP

P/N - 3121142

July 22, 2014

ANSI

CE

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 IS THE 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.

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 DISCONNECTEDDURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

REVISON LOG

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SECTION 1. SPECIFICATIONS

1.1 CAPACITIES

Table 1-1. Capacities

Hydraulic Tank	55 gallons (208 liters)
Fuel Tank	31 gallons (117 liters)
Hydraulic System	66 gallons (250 liters)

1.2 TIRES

Table 1-2. Tire Specifications

Size	445/50D710
Load Range	J
Ply Rating	18
Load Rating	26,500 lbs. @ 100 psi (12020 kg @ 6.9 Bar)
Foam Fill	Poly urethane HD (55 Durometer) Foam
Max Tire Load 1200SJP 1350SJP	 25,000 lbs. (11,340 kg) 26,250 lbs. (11,907 kg)

1.3 ENGINE DATA

Deutz Prior to S/N 0300127698

Table 1-3. Deutz BF4M2011 Specifications

Type	Liquid Cooled
Number of Cylinders	4
Bore	3.7 in. (94 mm)
Stroke	4.4 in. (112 mm)
Total Displacement	190 cu. in. (3108 cm^3)
Compression Ratio	17.5
Firing Order	1-3-4-2
Output	87hp (65 kW)
Oil Capacity Cooling System w/Filter Total Capacity	 5 Quarts (4.5 L) 11 Quarts (10.5 L) 16 Quarts (15 L)
Average Fuel Consumption	1.1 gph (4.1 lph)
Idle Engine RPM	1200
Mid Engine RPM	1800
High Engine RPM	2475

Deutz S/N 0300127698 to Present

Table 1-4. Deutz TD2011L4 Specifications

Type	Liquid Cooled
Number of Cylinders	4
Bore	3.7 in. (94 mm)
Stroke	4.4 in. (112 mm)
Total Displacement	190 cu. in. (3108 cm^3)
Compression Ratio	17.5
Firing Order	1-3-4-2
Output	75hp (56 kW)
Oil Capacity Cooling System w/Filter Total Capacity	 5 Quarts (4.5 L) 11 Quarts (10.5 L) 16 Quarts (15 L)
Average Fuel Consumption	1.1 gph (4.1 lph)
Idle Engine RPM	1200
Mid Engine RPM	1800
High Engine RPM	2475

Caterpillar

Table 1-5. Caterpillar 3.4T

Type	Liquid Cooled, Antifreeze
Number of Cylinders	4
Bore	3.7 in. (94 mm)
Stroke	4.7 in. (120 mm)
Total Displacement	201 cu. in. (3294 cm^3)
Compression Ratio	19.5:1
Firing Order	1-3-4-2
Output	73.7hp (55 kW)
Oil Capacity	10.5 Quarts (10 L)
Average Fuel Consumption	1.36 gph (5.14 lph)
Idle Engine RPM	1200
Mid Engine RPM	1800
High Engine RPM	2475

1.4 SPECIFICATIONS AND PERFORMANCE DATA

Reach Specifications

Table 1-6. Reach Specifications

Maximum Work Load (Capacity) Unrestricted Restricted	 500 lb (230 kg) 1000 lb. (450 kg)
Max.Vertical Platform Height (Unrestricted) 1200SJP 1350SJP	 120 ft. (36.6 m) 135 ft. (41.2 m)
Max.Vertical Platform Height (Restricted) 1200SJP 1350SJP	 115 ft. (35.1 m) 125 ft. (38.1 m)
Max.Horizontal Platform Reach (Unrestricted) 1200SJP 1350SJP	 75 ft. (22.9 m) 80 ft. (24.4 m)
Max.Horizontal Platform Reach (Restricted) 1200SJP 1350SJP	 65 ft. (19.8 m) 70 ft. (21.3 m)
JibPLUS Length Horizontal Motion Vertical Motion	 8ft. (2.44m) 180° working, 244° stowed 130° (+75/-55)

Dimensional Data

Table 1-7. Dimensional Data

Overall Width Axles Retracted Axles Extended	 8ft. 2in. (2.49 m) 12ft. 6in. (3.8 m)
Stowed Height	10ft. (3.04 m)
Stowed Length (Transport Mode) 1200SJP 1350SJP	 34ft. 11in. (10.64 m) 38ft. 11in. (11.86 m)
Stowed Length (Working Mode) 1200SJP 1350SJP	 44ft. 11in. (13.69 m) 48ft. 11in. (14.91 m)
Wheelbase	12ft. 6in. (3.81 m)
Tailswing	5ft. 6 in. (1.6 m)
Ground Clearance (Axle)	12 in. (30.4 cm)
Ground Clearance (Chassis)	25.5 in. (64.7 cm)

Chassis

Table 1-8. Chassis Specifications

Maximum Travel Grade With boom in stowed position (Gradeability)	45%
Maximum Travel Grade With boom in stowed position (Side Slope)	5°
Turning Radius (Axles Retracted) Outside Inside	 22 ft. 6 in. (6.8 m) 14 ft. 5 in. (4.4 m)
Turning Radius (Axles Extended) Inside Outside	 8 ft. (2.4 m) 19 ft. 4 in. (5.9 m)
Max Tire Load 1200SJP 1350SJP	 25,000 lbs. (11,340 kg) 26,250 lbs. (11,907 kg)
Max Ground Bearing Pressure 1200SJP 1350SJP	 100 psi (7.03 kg/cm^2) 105 psi (7.38 kg/cm^2)
Maximum Drive Speed	3.25 mph (5.2 kph)
Max. Hydraulic System Pressure	4600 psi (317 Bar)
Maximum Wind Speed	28 mph (12.5 m/s)
Maximum Manual Force	400 N
Electrical System Voltage	12 Volts
Gross Machine Weight (Platform Empty) 1200SJP 1350SJP	 41,100 lb. (18,643 kg) 44,750 lb. (20,298 kg)

1.5 TORQUE REQUIREMENTS

Table 1-9. Torque Requirements

Description	Torque Value (Dry)	Interval Hours
Wheel Bolts	180 ft. lbs. (252 Nm)	150
Swing Bearing Bolts	190 ft. lbs. (258 Nm)	50/600*
Tele Cylinder Regen Valve Mounting Bolts	13 ft. lbs. (18 Nm)	As required
Starter Solenoid Contacts Coil	 95 in. lbs. (9.5 Nm) 40 in. lbs. (4 Nm)	As required
*Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter. (See Swing Bearing in Section 3.)		
NOTE: *When maintenance becomes necessary or a fastener has loosened, refer to the Torque Chart to determine proper torque value.*		

Table 1-10. Engine Torque Requirements

Description	Torque Value Ft. Lb.s	Torque Value Nm
Cylinder Head Cover	6	8.5
Cylinder Head Cover	6	8.5
Rocker Arm Adjustment Screw	15	21
Intake Manifold	6	8.5
Air Intake Pipe	15	21
Exhaust Manifold	16	22
Oil Drain Plug	39	55
Oil Pan (sheet metal)	15	21
Oil Pan (cast)	22	31
Injection Line Attachment	21	30
Injection Valve Attachment	15	21
Lube Oil Filter Cartridge	19	27

1.6 HYDRAULIC OIL

Table 1-11. Hydraulic Oil Specifications

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 Industries 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 DTE13.*

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 1-12. 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 1-13. Mobil DTE 13M Specs

ISO Viscosity Grade	#32
Specific Gravity	0.877
Pour Point, Max	-40°F (-40°C)
Flash Point, Min.	330°F (166°C)
Viscosity	
at 40° C	33cSt
at 100° C	6.6 cSt
at 100° F	169 SUS
at 210° F	48 SUS
cp at -20° F	6,200
Viscosity Index	140

Table 1-14. UCon Hydrolube HP-5046

Type	Synthetic Biodegradable
Specific Gravity	1.082
Pour Point, Max	-58°F (-50°C)
pH	9.1
Viscosity	
at 0° C (32° F)	340 cSt (1600SUS)
at 40° C (104° F)	46 cSt (215SUS)
at 65° C (150° F)	22 cSt (106SUS)
Viscosity Index	170

Table 1-15. 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 1-16. Exxon Univis 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

NOTE: *Mobil/Exxon recommends that this oil be checked on a yearly basis for viscosity.*

1.7 MAJOR COMPONENT WEIGHTS

Table 1-17. Component Weights

Component	Pounds	Kilograms
Tire & Wheel	867	393
Drive Hub & Motor	275.5	123
Swing Drive	290	132
Engine Assembly	1275	579
1350 Boom (Complete)	11850	5375
1200 Boom (Complete)	11100	5035
Lift Cylinder	787	357
1350 Tele Cylinder	1322	600
1200 Tele Cylinder	1170	531
Jib Cylinder	69	31
Axle Oscillation Cylinder	74	34
Axle Extend Cylinder	92	42
Level Cylinder	89	40
Platform 36 x 96	245	111
Platform 36 x 72	195	89
1350 Counterweight	8500	3856
1200 Counterweight	5494	2492
T/T Assy. (less Cwt)	9450	4286

1.8 PRESSURE SETTINGS

Table 1-18. Pressure Settings

Circuit	PSI	Bar
Function Pump, High	3400	234.4
Function Pump, Low	300	20.6
Drive, Pre-Set	5000	344.7
Lift Up	2750	189.6
Lift Down	1500	103.4
Swing	1500	103.4
Tele Out	3000	206.8
Telescope In	3200	220.6
Steer Right	2000	137.9
Steer Left	2500	172.3
Platform Level Up	2500	172.3
Platform Level Down	1500	103.4
Jib Up	2750	189.6
Jib Down	2750	189.6
Extendable Axles	2500	172.3

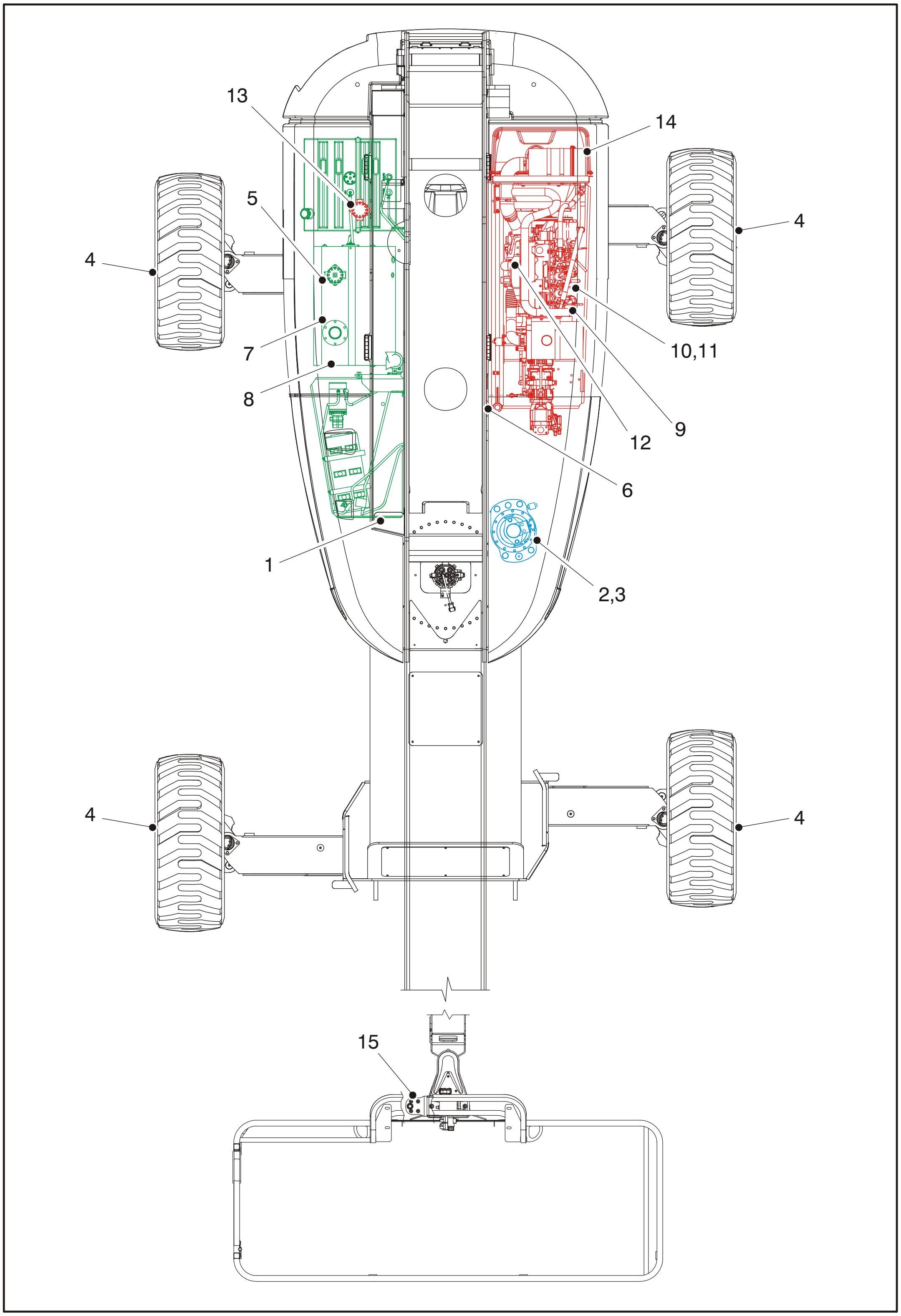


Figure 1-1. Lubrication and Operator Maintenance Diagram

1.9 LUBRICATION AND OPERATOR MAINTENANCE

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

Table 1-19. 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.

NOTICE

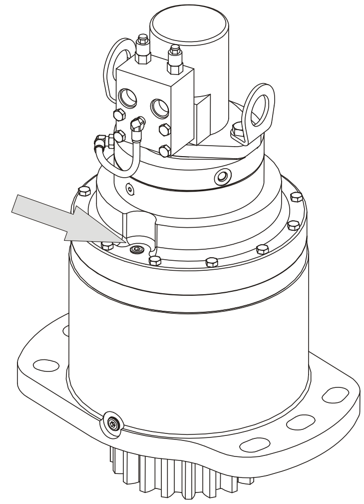
LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

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

1. Swing Bearing - Remote Lube

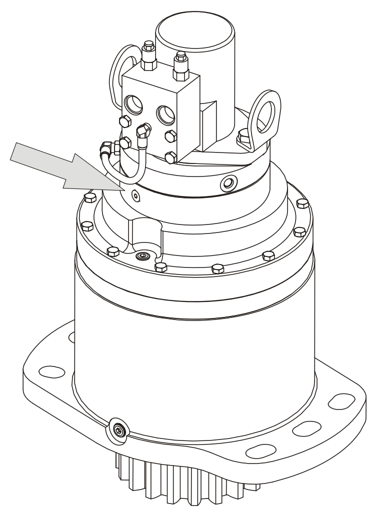
Lube Point(s) - 2 Grease Fitting
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hours of operation

2. Swing Gearbox



Lube Point(s) - Fill Plug
Capacity - 79 ounces (2.3 L)
Lube - GL-5
Interval - Check level every 150 hrs/Change every 1200 hours of operation. Fill to cover ring gear.

3. Swing Brake



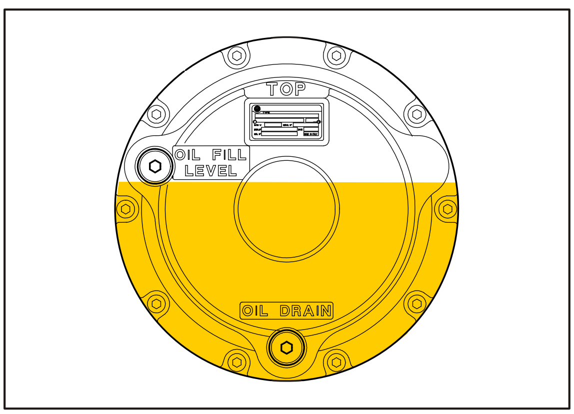
Lube Point(s) - Fill Plug
Capacity - 2.7 ounces (80 ml)
Lube - DTE24
Interval - Check level every 150 hrs/Change every 1200 hours of operation.

NOTE: *After S/N 0300134389 machines may be built with either Bonfiglioli or Reggiana Riduttori wheel drive hubs.*

4. A. Wheel Drive Hub - Rexroth (Prior to S/N 100128)

Lube Point(s) - Level/Fill Plug
Capacity - 0.5 liters (1/2 full)
Lube - EPGL
Interval - Change after first 150 hours then every 1200 hours of operation
Comments - Place Fill port at 12 o'clock position and Check port at 3 o'clock position. Pour lubricant into fill port until it just starts to flow out of check port.

B: Wheel Drive Hub - Bonfiglioli (S/N 100131 to Present)

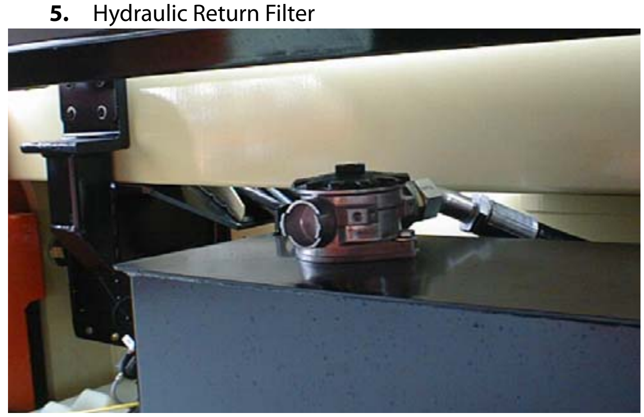


Lube Point(s) - Level/Fill Plug
Capacity - 2.1 quarts (2 liters) ± 10%
Lube - EPGL
Interval - Change after first 150 hours then every 1200 hours of operation
Comments - Place Fill port at 12 o'clock position and Check port at 8 o'clock position. Pour lubricant into fill port until it just starts to flow out of check port.

C: Wheel Drive Hub - Reggiana Riduttori (S/N 134389 to Present)

Lube Point(s) - Level/Fill Plug
Capacity - 0.5 quarts (0.5 liters) ± 10%
Lube - EPGL
Interval - Change after first 150 hours then every 1200 hours of operation
Comments - Place Fill port at 12 o'clock position and Check port at 3 o'clock position. Pour lubricant into fill port until it just starts to flow out of check port.

5. Hydraulic Return Filter

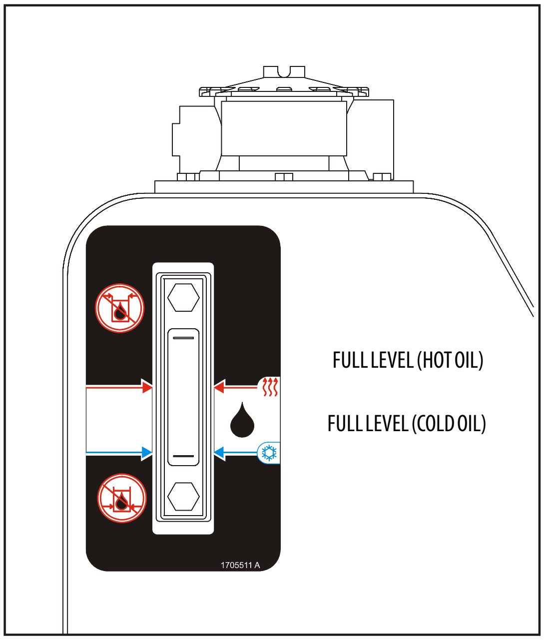


Lube Point(s) - Replaceable Element
Interval - Change after first 50 hours and every 300 hours thereafter or as indicated by condition indicator

6. Hydraulic Charge Filter

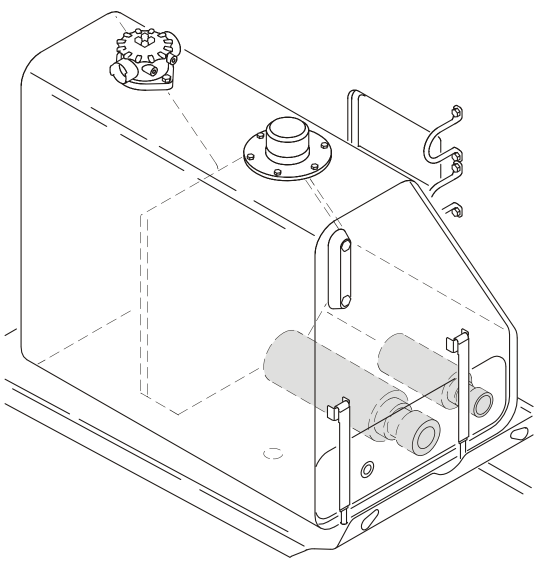
Lube Point(s) - Replaceable Element
Interval - Change after first 50 hours and every 300 hours thereafter or as indicated by condition indicator.

7. Hydraulic Oil



Lube Point(s) - Fill Cap
Capacity - 55 gallons (208 liters) Tank
Lube - HO
Interval - Check level daily. Change every 2 years or 1200 hours of operation.

8. Suction Strainers (In Tank)



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

9. Oil Change w/Filter - Deutz

Lube Point(s) - Fill Cap/Spin-on Element
Capacity -
5 Quarts (4.5 L) Cooling System
11 Quarts (10.5 L) w/Filter
16 Quarts (15 L) Total Capacity
Lube - EO
Interval - Check level daily; change every 500 hours or six months, whichever comes first. Adjust final oil level by mark on dipstick. Refer to Figure 1-2., Deutz Engine Dipstick.

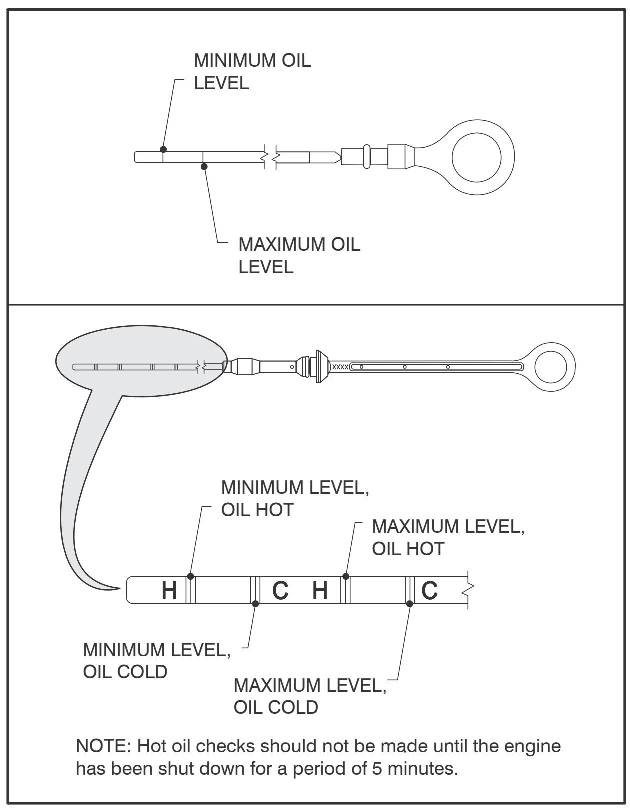
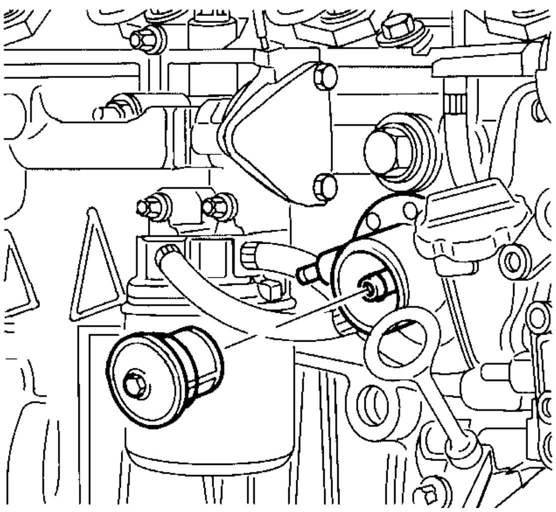


Figure 1-2. Deutz Engine Dipstick

10. Fuel Filter - Deutz

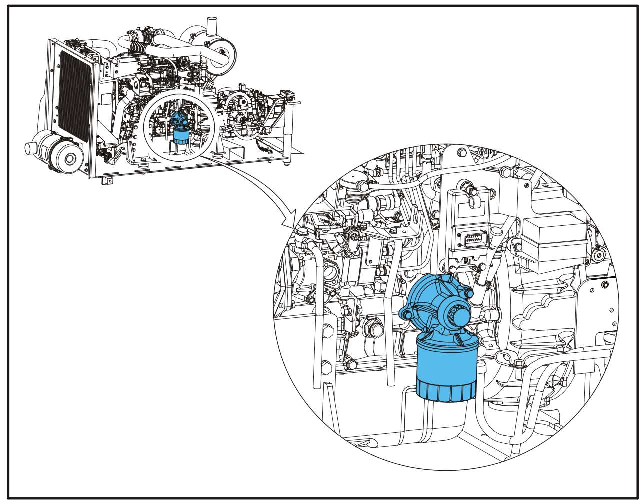
Lube Point(s) - Replaceable Element
Interval - Every year or 600 hours of operation

11. Fuel Strainer



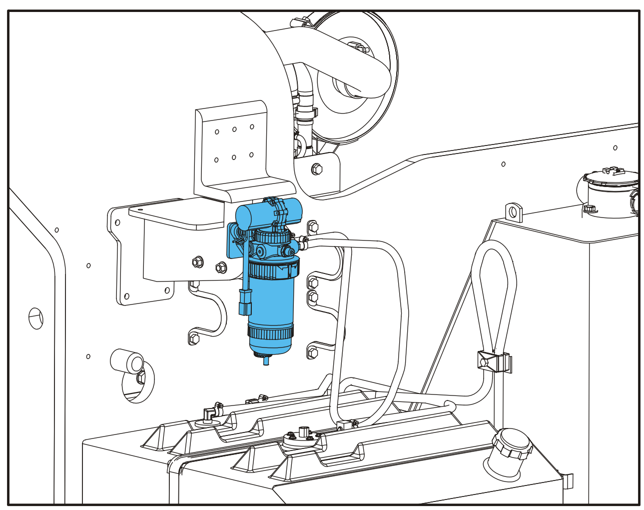
Lube Point(s) - Replaceable Element
Interval - Every year or 600 hours of operation

12. Oil Change w/Filter - CAT



Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 10.5 Quarts (10 L)
Lube - EO
Interval - Check level daily; change every 150 hours or three months, whichever comes first. Adjust final oil level by mark on dipstick.

13. Fuel Filter - CAT



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

14. Air Filter

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

15. Platform Filter

Lube Point(s) - Replaceable Element
Interval - Change after first 50 hours and then every year or 600 hours of operation thereafter

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)		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	
		Values for Zinc Yellow Chromate Fasteners (Ref 4150707)																	
				SAE GRADE 5 BOLTS & GRADE 2 NUTS									SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*						
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
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					1320	43	5				
10	24	0.1900	0.01750	1120	43	4.8	32	3.5					1580	60	7				
	32	0.1900	0.02000	1285	49	5.5	36	4					1800	68	8				
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12			2860	143	16	129	15		
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15			3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	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	4720	25	35	20	25	20	25
	24	0.3125	0.0580	3700	19	26	14	19	21	29	17	23	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48	28	38	7000	45	60	40	55	35	50
	24	0.3750	0.0878	5600	35	47	25	34	40	54	32	43	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75	45	61	9550	70	95	65	90	50	70
	20	0.4375	0.1187	7550	55	75	40	54	60	82	50	68	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116	68	92	12750	105	145	95	130	80	110
	20	0.5000	0.1599	10700	90	122	65	88	100	136	80	108	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163	98	133	16400	155	210	140	190	115	155
	18	0.5625	0.2030	12950	120	163	90	122	135	184	109	148	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224	135	183	20350	210	285	190	260	160	220
	18	0.6250	0.2560	16300	170	230	130	176	190	258	153	207	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	21300	260	353	200		285	388	240	325	30100	375	510	340	460	280	380
	16	0.7500	0.3730	23800	300	407	220	298	330	449	268	363	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646	386	523	41600	605	825	545	740	455	620
	14	0.8750	0.5090	32400	470	637	350	475	520	707	425	576	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	38600	640	868	480	651	675	918	579	785	51500	860	1170	770	1045	645	875
	12	1.0000	0.6630	42200	700	949	530	719	735	1000	633	858	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142	714	968	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	47500	880	1193	660	895	925	1258	802	1087	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175	1598	1009	1368	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	59600	1240	1681	920	1247	1300	1768	1118	1516	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074	1322	1792	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750	2380	1506	2042	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754	1755	2379	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300	3128	1974	2676	142200	3555	4835	3200	4350	2665	3625

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

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REFERENCE JLG 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 1-3. Torque Chart - Sheet 1 of 5 - (SAE Fasteners)

				Values for Magni Coating Fasteners (Ref 4150701)														
				SAE GRADE 5 BOLTS & GRADE 2 NUTS							SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*							
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15		Clamp Load	Torque (Dry or Loctite® 263) K= 0.17		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	7	0.8											
	48	0.1120	0.00661	420	8	0.9											
6	32	0.1380	0.00909	580	14	1.5											
	40	0.1380	0.01015	610	14	1.6											
8	32	0.1640	0.01400	900	25	2.8											
	36	0.1640	0.01474	940	26	2.9					1320	37	4				
10	24	0.1900	0.01750	1120	36	4.1					1580	51	6				
	32	0.1900	0.02000	1285	42	4.7					1800	58	7				
1/4	20	0.2500	0.0318	2020	86	9.7	80	9			2860	122	14	114	13		
	28	0.2500	0.0364	2320	99	11.1	95	11			3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	15	20	14	19	15	20	4720	20	25	20	25	20	25
	24	0.3125	0.0580	3700	15	20	15	21	15	20	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	4940	25	35	25	34	25	34	7000	35	50	35	50	35	50
	24	0.3750	0.0878	5600	30	40	28	38	25	34	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48	9550	60	80	55	75	50	70
	20	0.4375	0.1187	7550	45	60	44	60	40	54	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75	12750	90	120	85	115	80	110
	20	0.5000	0.1599	10700	75	100	71	97	65	88	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109	16400	130	175	125	170	115	155
	18	0.5625	0.2030	12950	105	145	97	132	90	122	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156	20350	180	245	170	230	160	220
	18	0.6250	0.2560	16300	145	195	136	185	125	170	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272	30100	320	435	300	410	280	380
	16	0.7500	0.3730	23800	255	345	238	324	225	306	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435	41600	515	700	485	660	455	620
	14	0.8750	0.5090	32400	400	545	378	514	355	483	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	38600	545	740	515	700	480	653	51500	730	995	685	930	645	875
	12	1.0000	0.6630	42200	600	815	563	765	530	721	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	47500	755	1025	713	969	670	911	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237	142200	3020	4105	2845	3870	2665	3625

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

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Figure 1-4. Torque Chart - Sheet 2 of 5 - (SAE Fasteners)

				SOCKET HEAD CAP SCREWS														
				Magni Coating (Ref 4150701)*							Zinc Yellow Chromate Fasteners (Ref 4150707)*							
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		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	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-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														
10	24	0.1900	0.01750														
	32	0.1900	0.02000														
1/4	20	0.2500	0.0318	2860	122	14	114	13			2860	143	16	129	15		
	28	0.2500	0.0364	3280	139	16	131	15			3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	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	4720	25	35	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50	7000	45	60	40	55	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70	9550	70	95	65	90	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110	12750	105	145	95	130	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155	16400	155	210	140	190	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220	20350	210	285	190	260	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	30100	320	435	300		280	380	30100	375	510	340	460	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620	41600	605	825	545	740	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875	51500	860	1170	775	1055	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625	142200	3555	4835	3200	4350	2665	3625

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.

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Figure 1-5. Torque Chart - Sheet 3 of 5 - (SAE Fasteners)

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)	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
			Values for Zinc Yellow Chromate Fasteners (Ref 4150707)								
			CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS					CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M3 - M5*			
		Sq mm	KN	[N.m]	[N.m]	[N.m]	[N.m]	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.3	1.0	1.2	1.4	3.13			
3.5	0.6	6.78	2.95	2.1	1.6	1.9	2.3	4.22			
4	0.7	8.78	3.82	3.1	2.3	2.8	3.4	5.47			
5	0.8	14.20	6.18	6.2	4.6	5.6	6.8	8.85			
6	1	20.10	8.74	11	7.9	9.4	12	12.5			
7	1	28.90	12.6	18	13	16	19	18.0	25	23	19
8	1.25	36.60	15.9	26	19	23	28	22.8	37	33	27
10	1.5	58.00	25.2	50	38	45	55	36.1	70	65	55
12	1.75	84.30	36.7	88	66	79	97	52.5	125	115	95
14	2	115	50.0	140	105	126	154	71.6	200	180	150
16	2	157	68.3	219	164	197	241	97.8	315	280	235
18	2.5	192	83.5	301	226	271	331	119.5	430	385	325
20	2.5	245	106.5	426	320	383	469	152.5	610	550	460
22	2.5	303	132.0	581	436	523	639	189.0	830	750	625
24	3	353	153.5	737	553	663	811	222.0	1065	960	800
27	3	459	199.5	1080	810	970	1130	286.0	1545	1390	1160
30	3.5	561	244.0	1460	1100	1320	1530	349.5	2095	1885	1575
33	3.5	694	302.0	1990	1490	1790	2090	432.5	2855	2570	2140
36	4	817	355.5	2560	1920	2300	2690	509.0	3665	3300	2750
42	4.5	1120	487.0	4090	3070	3680	4290	698.0	5865	5275	4395

NO. 5000059 REV. K

: 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 REQ

Figure 1-6. Torque Chart - Sheet 4 of 5 - (METRIC Fasteners)

Values for Magni Coated Fasteners (Ref 4150701)										
			CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS				CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE*			
Size	PITCH	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263™) K=0.17	Torque (Loctite® 262™ OR Vibra-TITE™ 131) K=0.16	Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.15	Clamp Load	Torque (Dry or Loctite® 263™) K = 0.17	Torque (Lub OR Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K= 0.16	Torque (Loctite® 262™ OR Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.1	1.1	1.0	3.13			
3.5	0.6	6.78	2.95	1.8	1.7	1.5	4.22			
4	0.7	8.78	3.82	2.6	2.4	2.3	5.47			
5	0.8	14.20	6.18	5.3	4.9	4.6	8.85			
6	1	20.10	8.74	9	8.4	7.9	12.5	13	12	11
7	1	28.90	12.6	15	14	13	18.0	21	20	19
8	1.25	36.60	15.9	22	20	19	22.8	31	29	27
10	1.5	58.00	25.2	43	40	38	36.1	61	58	55
12	1.75	84.30	36.7	75	70	66	52.5	105	100	95
14	2	115	50.0	119	110	105	71.6	170	160	150
16	2	157	68.3	186	175	165	97.8	265	250	235
18	2.5	192	83.5	256	240	225	119.5	365	345	325
20	2.5	245	106.5	362	340	320	152.5	520	490	460
22	2.5	303	132.0	494	465	435	189.0	705	665	625
24	3	353	153.5	627	590	555	222.0	905	850	800
27	3	459	199.5	916	860	810	286.0	1315	1235	1160
30	3.5	561	244.0	1245	1170	1100	349.5	1780	1680	1575
33	3.5	694	302.0	1694	1595	1495	432.5	2425	2285	2140
36	4	817	355.5	2176	2050	1920	509.0	3115	2930	2750
42	4.5	1120	487.0	3477	3275	3070	698.0	4985	4690	4395

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.

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

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 on an annual basis, no later than thirteen (13) months from the date of the prior Annual Machine Inspection. JLG Industries recommends this task be performed by a Factory-Trained Service Technician. JLG Industries, Inc. recognizes a Factory-Trained 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 (recommended)	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 eyebolt 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, 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. Filter elements must be changed after the first 50 hours of operation and every 300 hours (unless specified otherwise) 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.

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, main 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
8	203.2	0.0038	0.10
9	228.6	0.0030	0.08

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, pealing, 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 unless otherwise instructed (i.e. sheave pins).
   - **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.
- Disconnect the moment pin connection (where fitted)
- 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.

NOTICE

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

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Boom Assembly	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	
Platform Assembly	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		15		
Lanyard Anchorage Point	2			1,2,10	1,2,10	
Turntable Assembly	9					
Swing Bearing or Worm Gear				1,2,14	1,2,3,13,14	
Oil Coupling		9				
Swing Drive System				11	11	
Turntable Lock				1,2,5	1,2,5	
Hood, Hood Props, Hood Latches				5	1,2,5	
Chassis Assembly	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						
Drive Hubs				11	11	
Functions/Controls	9					
Platform Controls	5	5		6	6	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (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	5	
Capacity Indicator					5	
Drive Brakes				5		
Swing Brakes				5		
Boom Synchronization/Sequencing Systems					5	
Manual Descent or Auxiliary Power				5	5	
Power System	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	
Hydraulic/Electric System	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	
General						
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	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (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:

[1] Prior to use each day; or at each Operator change

[2] Prior to each sale, lease, or delivery

[3] In service for 3 months or 150 Hours; or Out of service for 3 months or more; or Purchased used

[4] 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

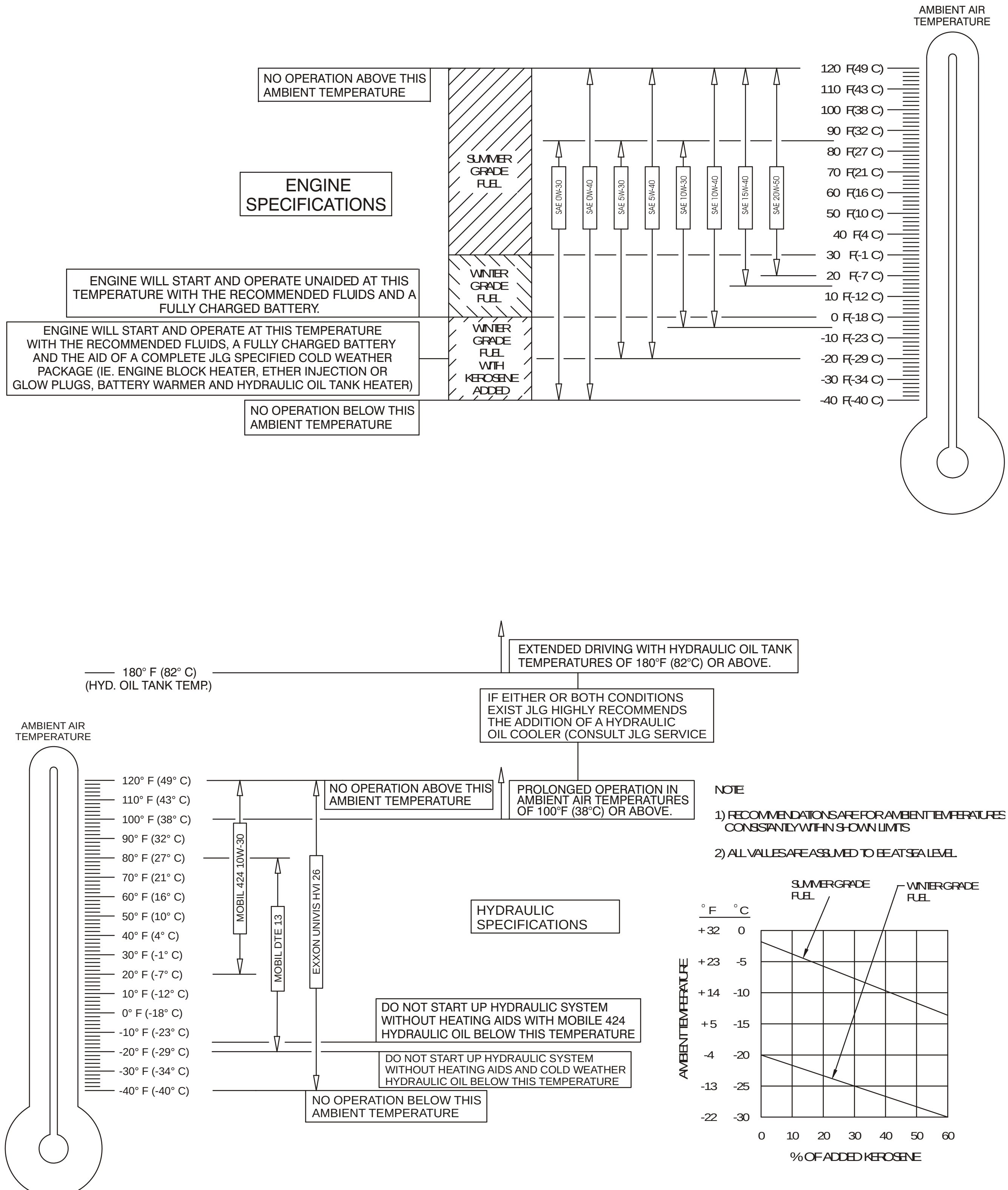

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Figure 2-1. Engine Operating Temperature Specifications - Deutz

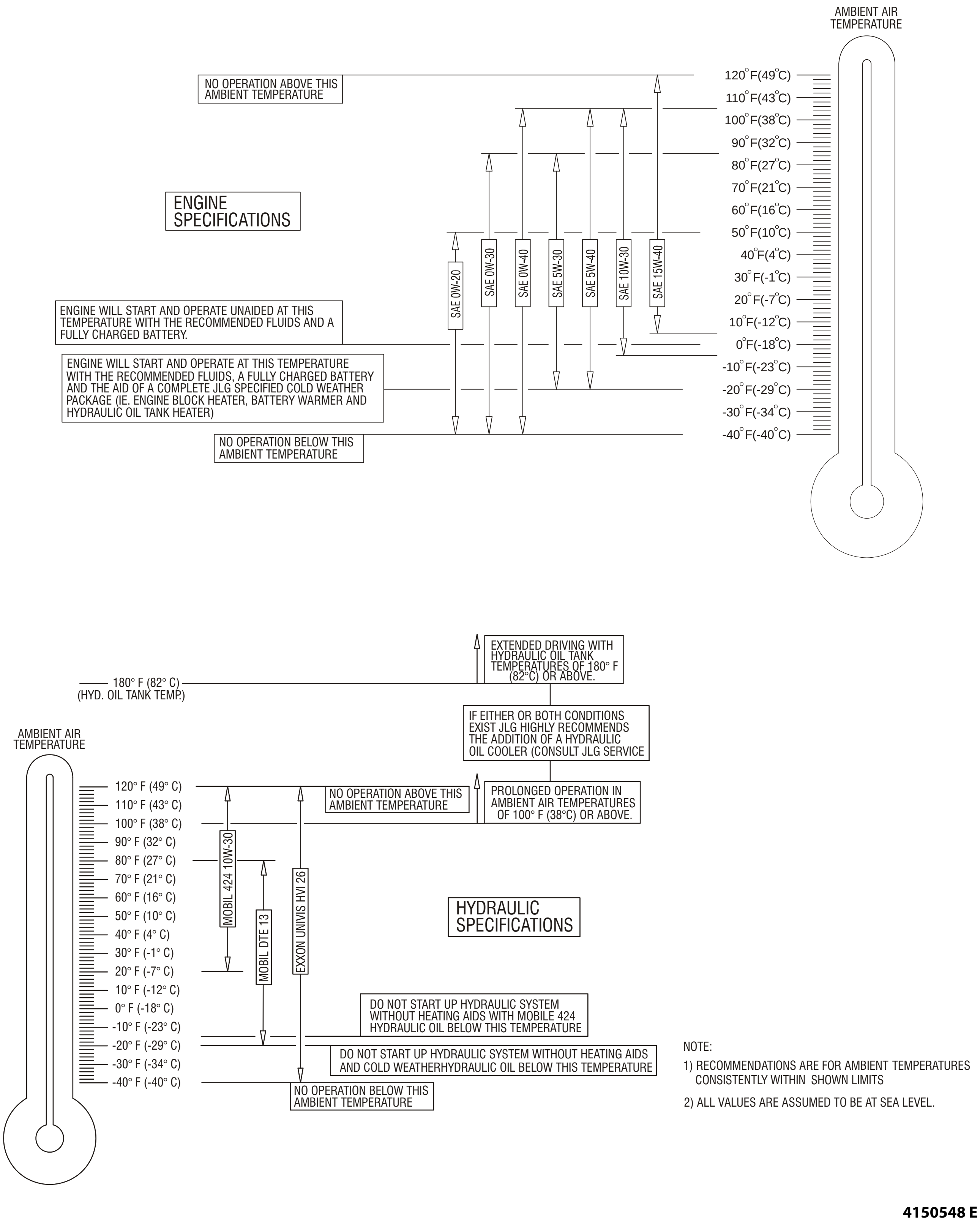


Figure 2-2. Engine Operating Temperature Specifications - Caterpillar

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 hasn't propagated beyond the allowable criteria.

Wheel and Tire 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.

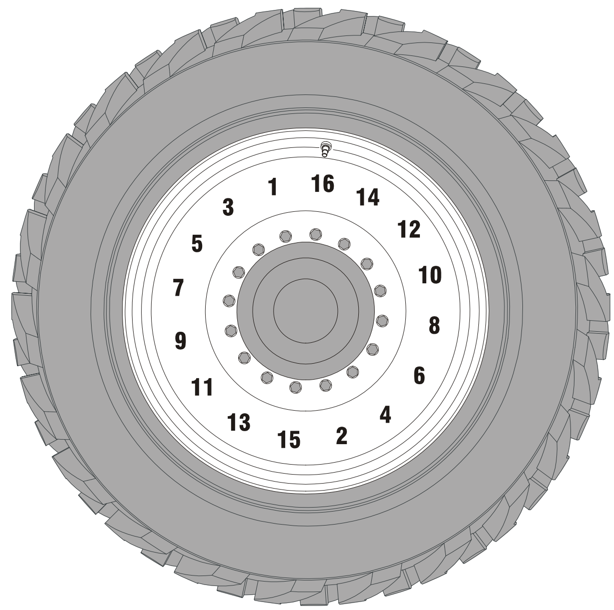
WARNING

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:



3. 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
45 ft. lbs. (60 Nm)	100 ft. lbs. (140 Nm)	180 ft. lbs. (252 Nm)

4. Wheel nuts should be torqued before first road use and after each wheel removal. Check and torque every 3 months or 150 hours of operation.

3.2 EXTENDING AXLES

The Axle Extension System allows each of the four axles to be extended and retracted together while maintaining full steering control as the machine is driven. The system allows the axles to extend or retract only while the boom is in the transport position and in order to minimize wheel scrubbing during axle movement, a minimum drive speed must be attained before axle extension/retraction will be permitted. The system uses four limit switches (one at each axle) to sense when the axles are fully extended. If any of the switches are not made, the control system considers the axles retracted. To extend/retract the axles, the user engages the axle extend/retract switch on the platform console and the drive control at the same time. The axle set indicator will be off when the axles are not fully extended and the axle extend/retract switch is not engaged. It will flash while the axles are extending or retracting and will be on constantly when the axles are fully extended. With the axles not fully extended, the boom is restricted to operation within the transport position. If a signal from any axle extend sensing switch is lost when the boom beyond the transport position, the axle set indicator will flash and drive/steer functions will be disabled until the boom is brought back into the transport position. The steering angle will be automatically limited to +/- 25 degrees anytime the axles are not fully extended. If the wheel angle is more than +/- 25 degrees when the axle retract command is engaged, the control system will automatically reduce the wheel angle to 25 degrees during axle retraction.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

3.3 AXLE LIMIT SWITCH ADJUSTMENT PROCEDURE

1. Fully extend the axles.
2. Initially position the limit switch arm straight.
3. Select the mounting plate bolt pattern to position the switch roller within 0.125 inches (3.1 mm) from the edge of the axle cutout. It may be necessary to reposition the switch arm ±10° to accomplish this.
4. Ensure the arm will clear the axle (without bottoming out to 70° stroke of the switch) in the retracted position.
5. Check for proper operation. Axle set light is to deactivate when the axle is retracted 0.625 inches (16 mm) maximum from fully extended.

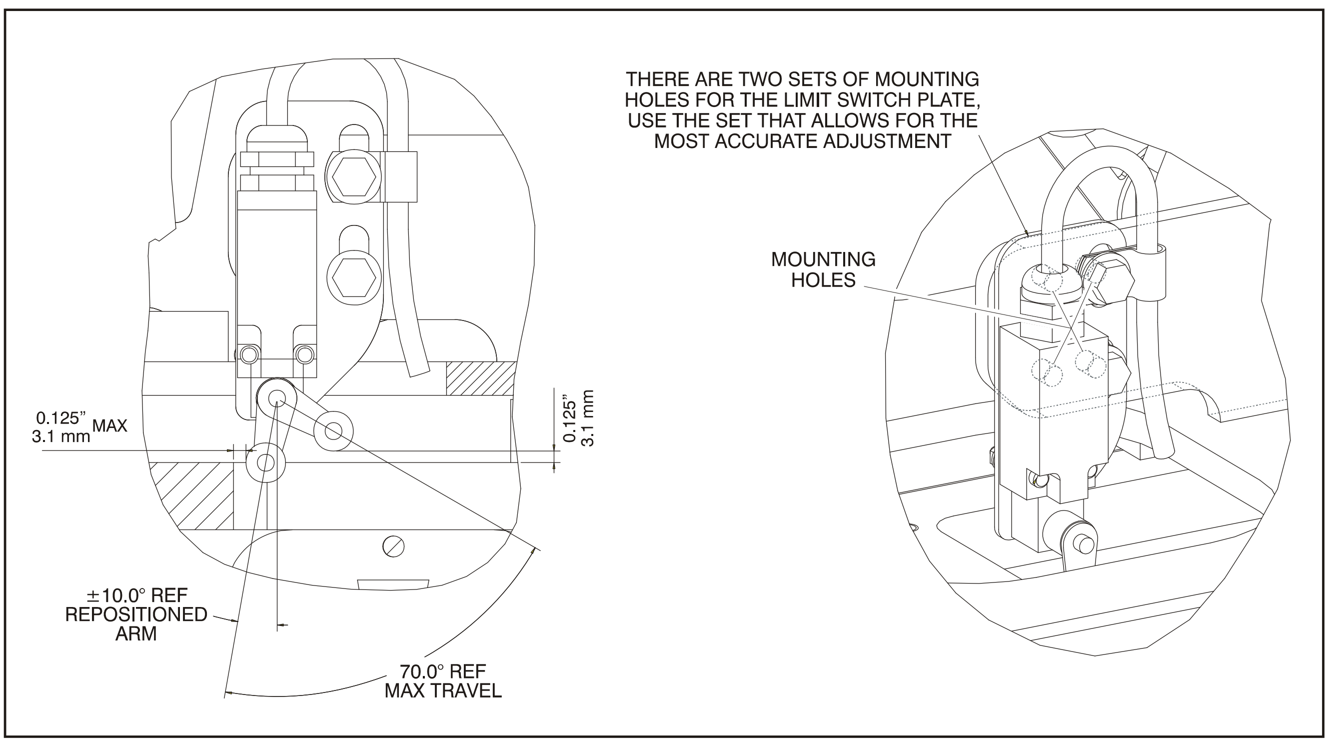


Figure 3-1. Axle Limit Switch Adjustment

3.4 DRIVE SYSTEM

The drive system utilizes 2 traction pumps so each side is powered individually. This produces maximum tractive effort to wheels by minimizing flow divider losses. The maximum drive speed is modulated with the steered angle of the wheels to eliminate the whiplash effect of driving at full speed and maximum steering lock.

3.5 STEERING CONTROL SYSTEM

Each wheel is individually steered by means of a closed circuit control system utilizing a steer sensor on each wheel, 4 steer cylinders, and proportional valves.

The control system senses the wheel position in relation to the steering command (direction and steering mode) and automatically synchronizes the movement of all 4 wheels to the desired position.

There are three different modes of steering selectable by the position of the steer select switch on the platform control panel: conventional two wheel steering, crab and coordinated. These are shown below.

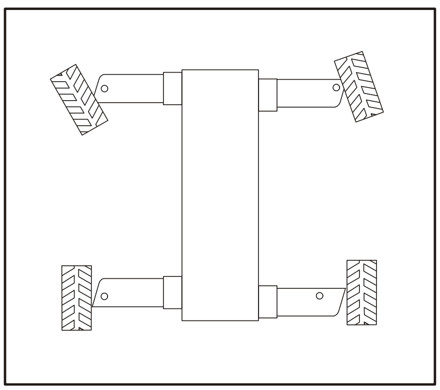


Figure 3-2. Conventional Two Wheel Steer Mode

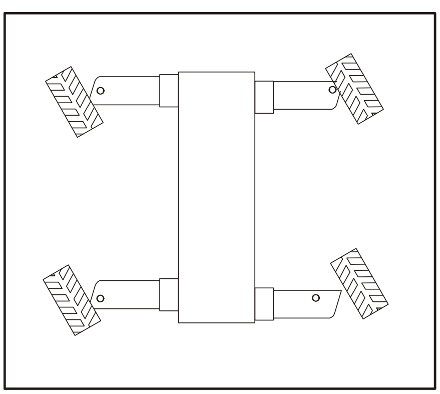


Figure 3-3. Crab Steer Mode

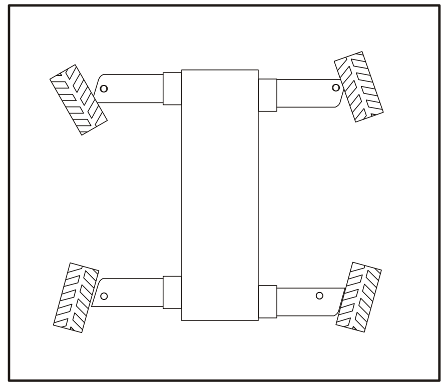


Figure 3-4. Coordinated Steer Mode

Each wheel has its own steer cylinder, wheel angle sensor, and proportional valve, allowing the control system to position each wheel to the ideal angle for all steering modes and all steering commands. Changes in steering modes while the footswitch is depressed causes the wheels to automatically adjust to the appropriate angle for the selected steering mode based on the position of the inside front wheel. If the steer select switch is changed without the footswitch depressed or the EMS is off, the wheels will not move until the footswitch is depressed and a steering or drive command has been initiated. The steering angles are limited to +/- 25 degrees anytime the axles are not fully extended. If a wheel cannot achieve its commanded angle within a specified time, it is considered jammed. When a wheel is considered jammed during steering, a fault is reported and the remaining wheels will continue to their commanded position. The fault is cleared when the footswitch is cycled. If a wheel is jammed making it significantly out of position, with regard to the other wheels, the drive motors are restricted to their maximum displacement (slow speed). Wheel angle sensor failures will result in an approximated steering control logic that will allow the operator to move the machine until it can be repaired. The wheel at the failed sensor will be driven based on the information available from the other sensors. This wheel will not track perfectly and will become farther out of position over time. When the wheel becomes prohibitively out of position, the wheels can be re synchronized by fully steering against the mechanical stops.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

3.6 DRIVE/STEERING SPEED CONTROL

The Drive/Steering Speed Control system uses the steering sensors from the steering control system to increase operator control and comfort by reducing the effect of turning the chassis on the resulting lateral platform speed. The system proportionally varies the drive speed based on the predicted turning radius of the chassis for both coordinated and conventional two wheel steer modes. The tighter the turn the slower the allowable drive speed. As crab steer does not steer on a radius, full drive speed is maintained regardless of steer angle.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

3.7 TRACTION CONTROL SYSTEM

The traction control system uses the steering sensors from the steering control system to optimize the performance of the drive system. This is especially important due to the disparity of wheel speeds generated between the inside and outside wheels of the extended axle chassis with large steering angle capability. The steering sensors are used to predict the rolling path and therefore the required wheel speed of each wheel as the steering angles change and steering modes change. The control system can then command the ideal flow from each of the two drive pumps, one for the right side of the machine and one for he left side. Two flow dividers, one for the right side front to back and one for the left side front to back absorb the variation in wheel speed front to back.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

3.8 DRIVE ORIENTATION SYSTEM

The Drive Orientation System (DOS) is intended to indicate to the operator conditions that could make the direction of movement of the chassis different than the direction of movement of the drive/steer control handle. The system indicates to the operator the need to match the black and white directional arrows on the platform control panel to the arrows on the chassis. The system uses a proximity switch mounted on the hydraulic swivel, an indicator light and an override switch on the platform display panel. The proximity switch trips when the turntable is swung +/- 45 degrees off center of the normal driving position. This occurs roughly when the boom is swung past a rear tire. When the turntable is in the normal drive position with the boom between the rear tires, no indications or interlocks are made. When the machine is actively driving when the turntable is swung past the switch point, the system is ignored until drive/steer is released. When drive is initiated with the boom swung past the switch point, the DOS indicator will flash and the drive/steer functions will be disabled. The operator must engage the DOS override switch to enable Drive/steer (high drive will remain disabled). When the DOS is enabled, the DOS indicator will be illuminated continuously and a 3-second enable timer will be started and will continue for 3 seconds after the end the last drive/steer command. If the timer expires, the DOS override switch must be re-engaged to enable drive/steer.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

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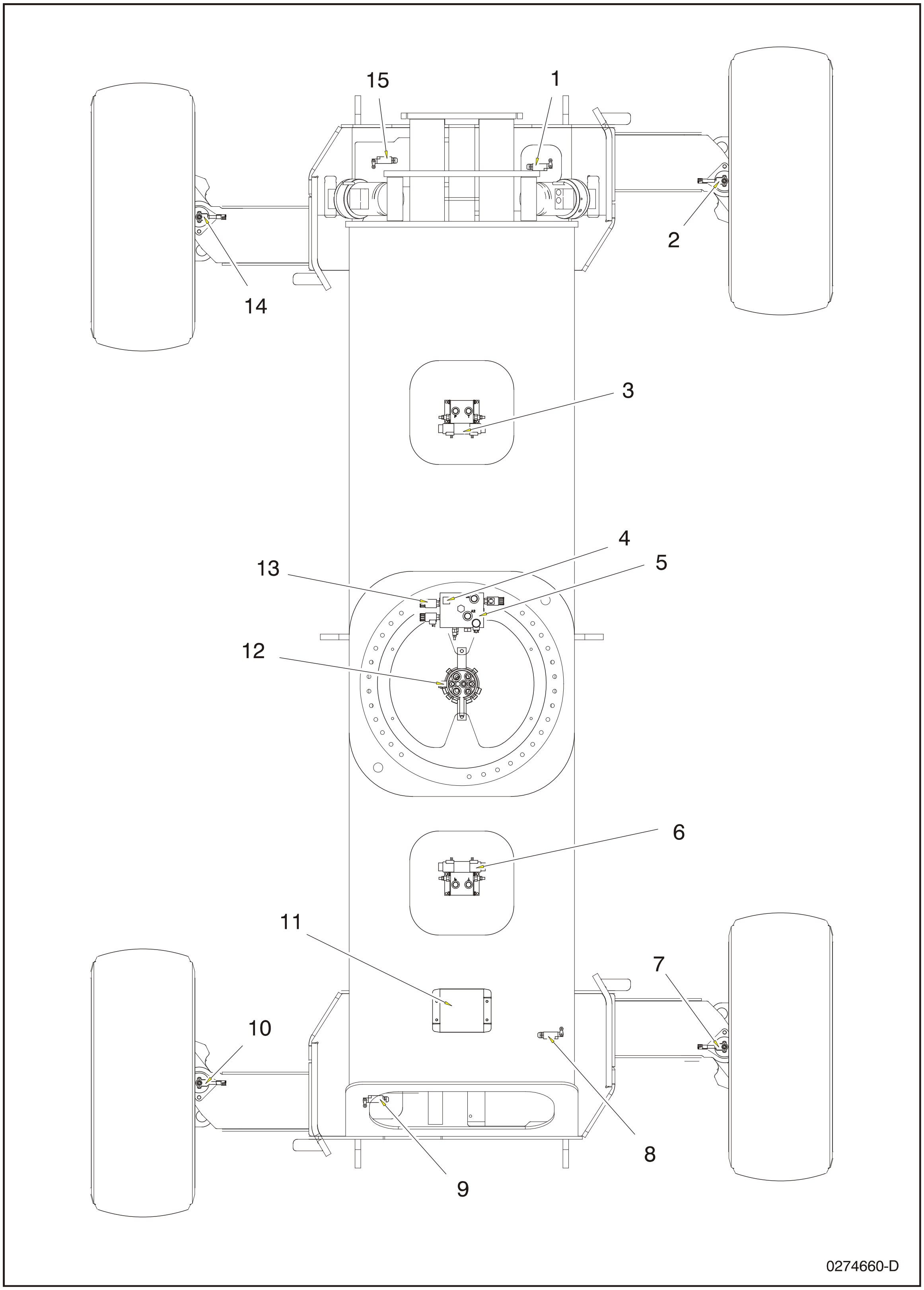


Figure 3-5. Chassis Component Location - Sheet 1 of 2

1. Axle Limit Switch (Right Front)
2. Steer Angle Sensor (Right Front)
3. Steer Valve (Front)
4. Axle Lockout Valve
5. Traction Valve
6. Steer Valve (Rear)
7. Steer Angle Sensor (Right Rear)
8. Axle Limit Switch (Right Rear)
9. Axle Limit Switch (Left Rear)
10. Steer Angle Sensor (Left Rear)
11. Chassis Module
12. Swivel/Collector Ring
13. Axle Lockout Pressure Switch
14. Steer Angle Sensor (Left Front)
15. Axle Limit Switch (Left Front)

Figure 3-6. Chassis Component Location - Sheet 2 of 2

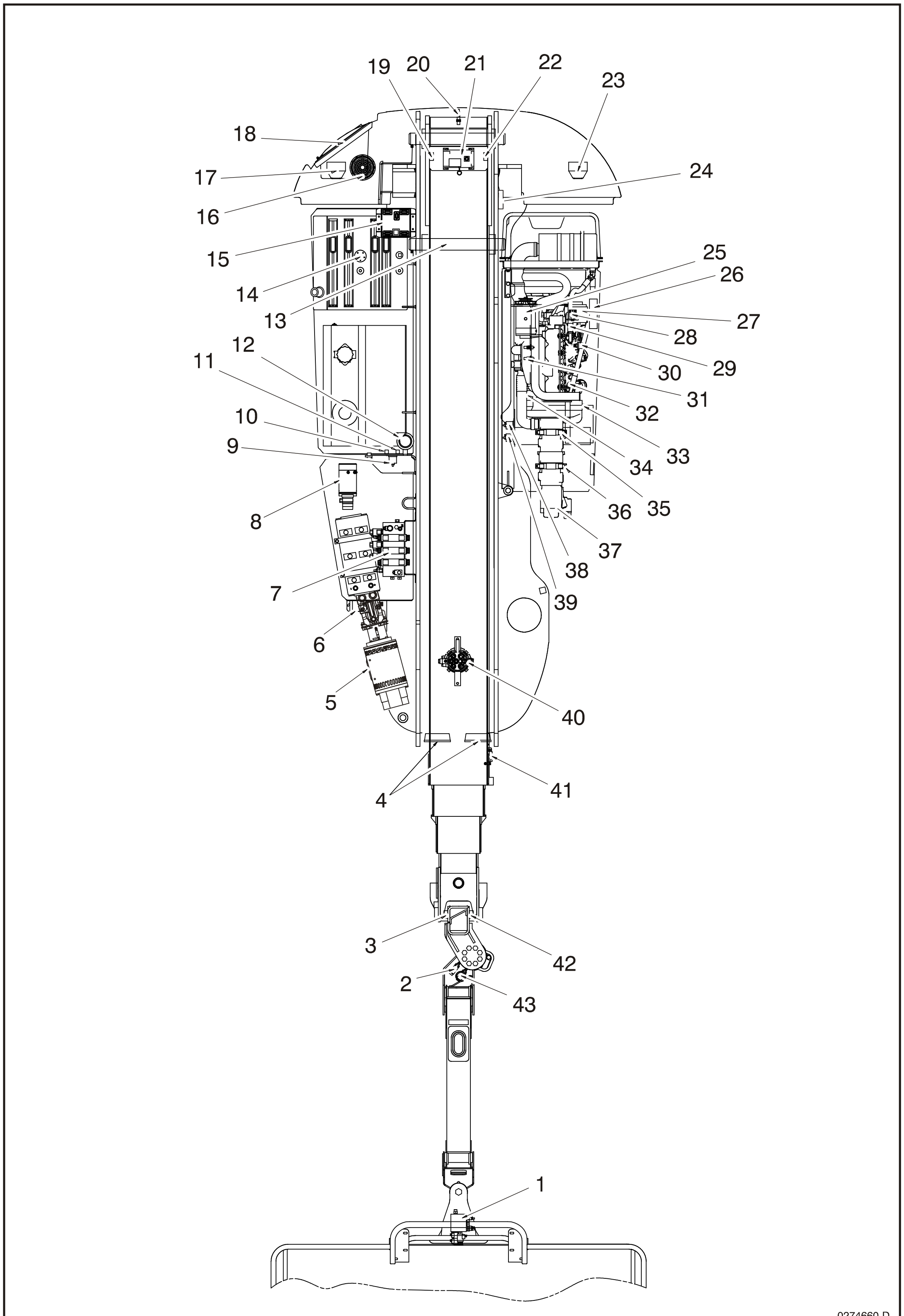


Figure 3-7. Turntable and Boom Component Location - Sheet 1 of 2

1. Platform Control Valve
2. Jib Stow Switch
3. Platform Level Sensor (Secondary - Left)
4. Tail Lights
5. Skypower Generator
6. Alarm
7. Main Control Valve
8. Auxiliary Power Pump
9. Auxiliary Power Relay
10. Chassis Power Distribution Relay
11. Headlight/Tail Light Relay
12. Horn
13. Lift Cylinder Pivot Pin
14. Fuel Level Sensor
15. B.L.A.M. Module
16. Strobe Light
17. Headlight
18. Ground Control Box
19. Boom Angle Sensor (Left)
20. Broken Cable Proximity Switch
21. Boom Length Sensor
22. Boom Angle Sensor (Right)
23. Headlight
24. Deutz EMR2 Module
25. 110V / 220V Generator
26. Generator Control Box
27. Alternator
28. Throttle Actuator
29. Oil Temperature Switch
30. Oil Pressure Switch
31. Intake Heaters
32. In Head Glow Plug
33. Engine Speed Sensor
34. Starter
35. Drive Pump (Right Side)
36. Drive Pump (Left Side)
37. Function Pump
38. Starter Relay
39. Glow Plug Relay
40. Swivel/Collector Ring
41. Transport Limit Switch
42. Platform Level Sensor (Primary - Right)
43. Dual Capacity Jib Position Switch

Figure 3-8. Turntable and Boom Component Location - Sheet 2 of 2

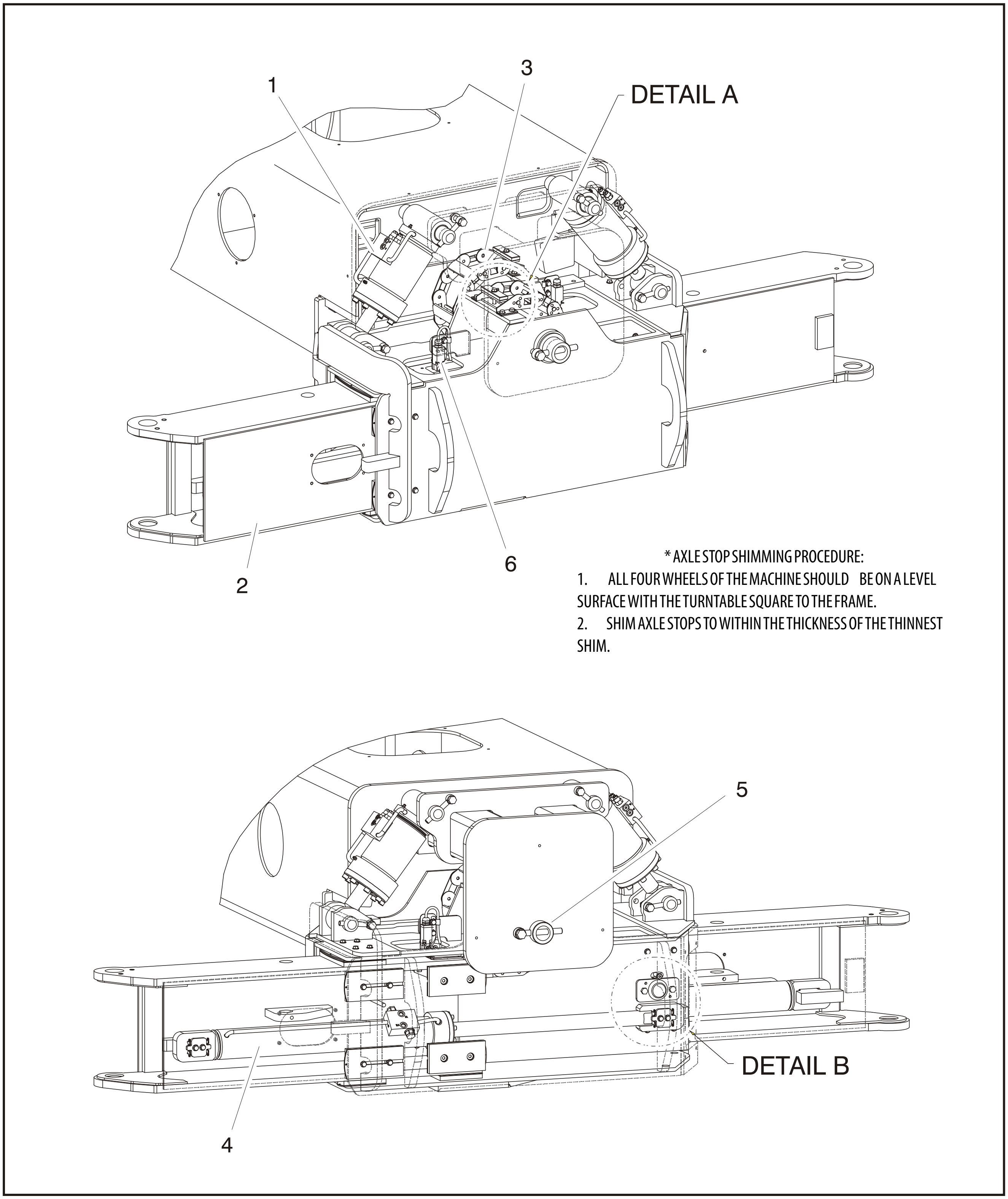
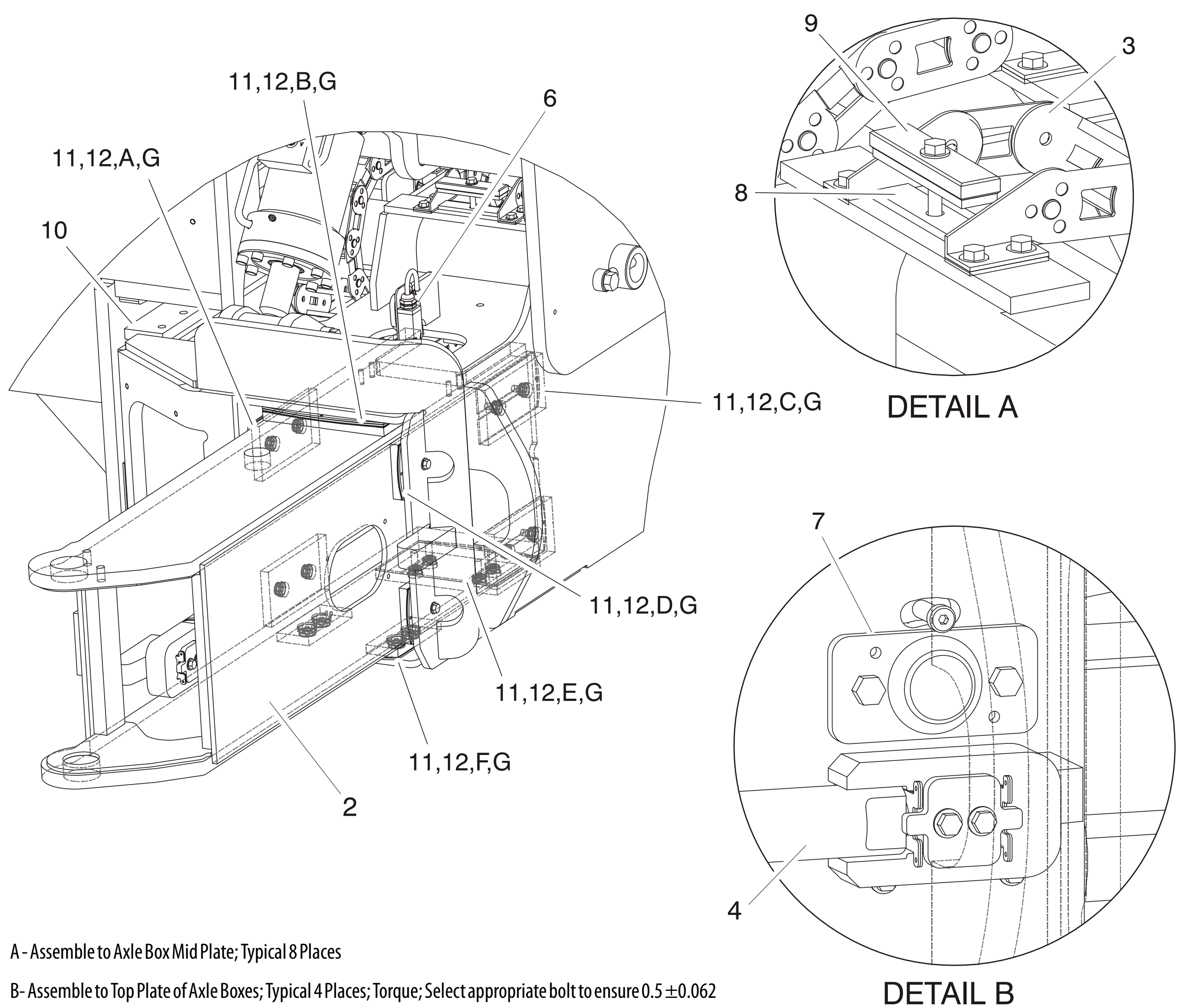


Figure 3-9. Oscillating Axle - Sheet 1 of 2



A - Assemble to Axle Box Mid Plate; Typical 8 Places

B- Assemble to Top Plate of Axle Boxes; Typical 4 Places; Torque; Select appropriate bolt to ensure 0.5 ±0.062 inches (12.7 ± 1.587 mm) thread engagement.

C - Assemble to Side Plates of Axle Weldments; Typical 16 Places.

D - Assemble to Front and Rear Plates of Axle Boxes; Typical 8 Places.

E - Assemble to Top Plate of Axle Weldment; Typical 4 Places; Torque; Select appropriate bolt to ensure 0.5 ±0.062 inches (12.7 ± 1.587 mm) thread engagement.

F - Assemble to Bottom Plate of Axle Box Weldment; Typical 8 Places.

G - See Axle Stop Shimming Procedure on Sheet 1

1. Axle Oscillation Cylinder
2. Axle
3. Axle Powertrack
4. Extension Cylinder
5. Axle Pivot Pin
6. Axle Limit Switch
7. Axle Stop Pin
8. Rubber Pad
9. Hose Clamp
10. Stop Block
11. Wear Pad
12. Shim

Figure 3-10. Oscillating Axle - Sheet 2 of 2

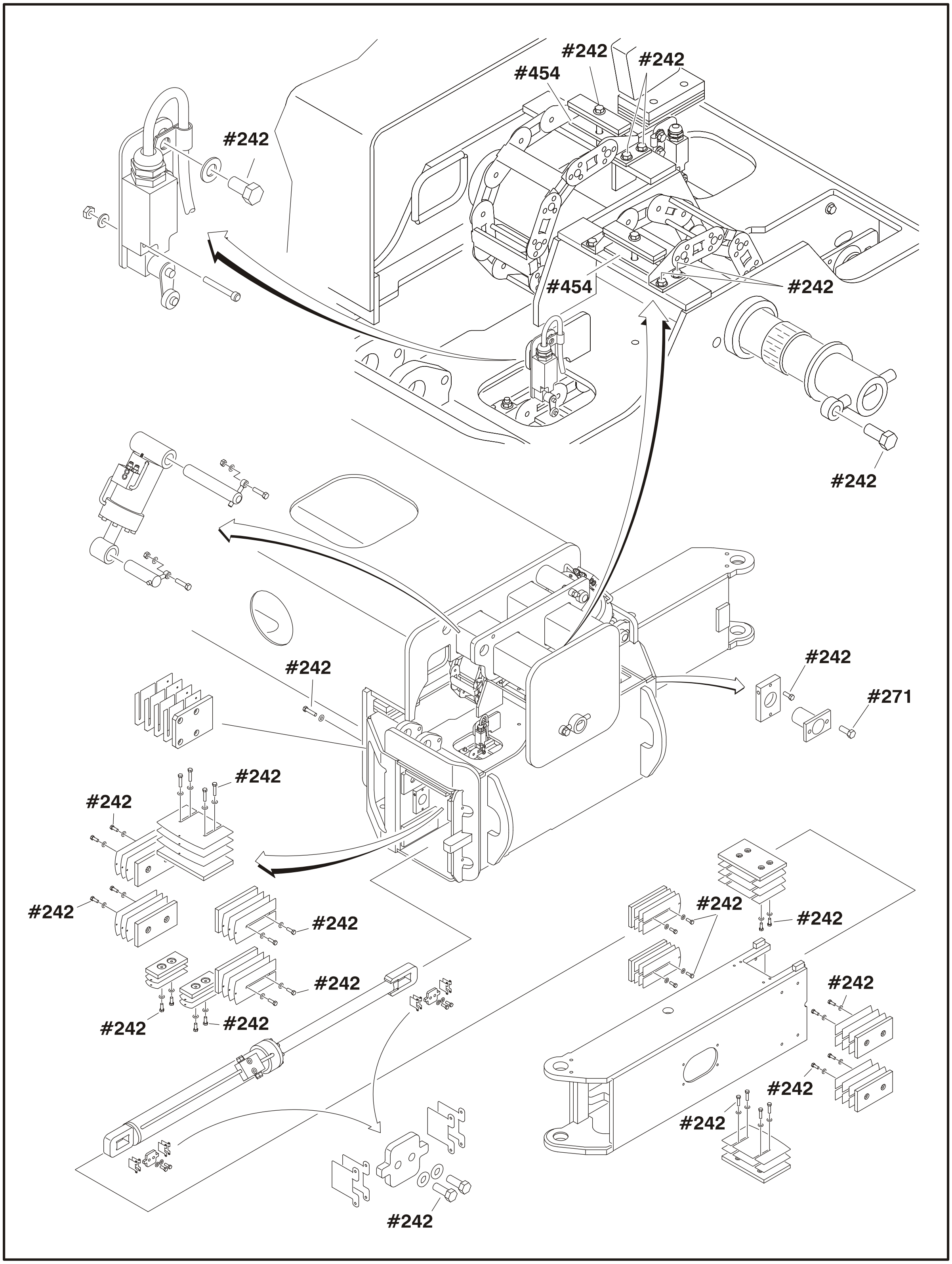
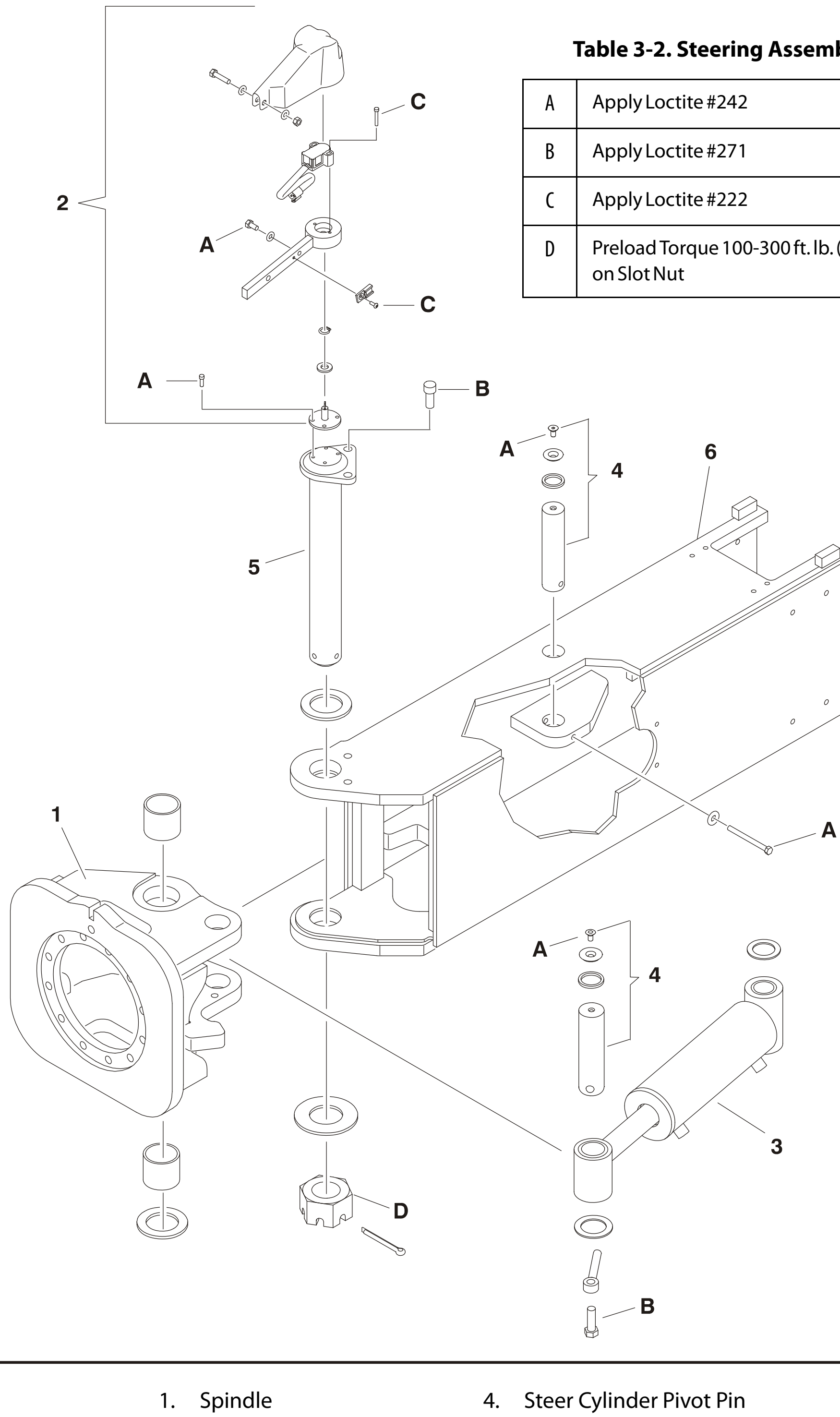


Figure 3-11. Axle Loctite Application

Table 3-2. Steering Assembly Notes

A	Apply Loctite #242
B	Apply Loctite #271
C	Apply Loctite #222
D	Preload Torque 100-300 ft. lb. (140-420 Nm) on Slot Nut



1. Spindle
2. Angle Sensor Assembly
3. Steer Cylinder
4. Steer Cylinder Pivot Pin
5. King Pin
6. Axle

Figure 3-12. Steering Installation

3.9 OSCILLATING AXLE SYSTEM

The oscillating front axle is attached to the frame by a pivot pin, which allows all four wheels to remain on the ground when traveling on rough terrain. The oscillating axle also incorporates two lockout cylinders connected between the frame and the axle. The lockout cylinders permit axle oscillation when the boom is in the transport position and drive is commanded. The lockout cylinders will lock and hold the axle when drive is not commanded or when the boom is outside the transport position. The cylinders unlock when pilot pressure is applied to the holding valves mounted on the cylinders and lock when pilot pressure is removed. Pilot pressure is available from brake pressure and is controlled by a solenoid operated NC lockout valve mounted in the frame. To ensure the lockout valve is functioning correctly, a NO pressure switch is mounted between the lockout valve and the holding valves. The system is “healthy” when pressure trips the pressure switch when the lockout valve is commanded to be open and conversely is healthy when the lack of pressure resets the pressure switch when the lockout valve is commanded to be closed. Failures in the oscillating axle system will cause the control system to disallow lift up and telescope out when the boom is within the transport position and will disallow drive/steer, lift up and telescope out when the boom is beyond the transport position.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

3.10 OSCILLATING AXLE BLEEDING PROCEDURE AND LOCKOUT TEST

Lockout Cylinder Bleeding

To start the test, the axle must be fully oscillated in one direction. Start with oscillating the axle so that the left lock-out cyl. is fully retracted (left front tire up), and the right lock-out cyl. Is fully extended (right front tire down).

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, BRAKE WIRE IS DISCONNECTED.

1. Making sure machine is on a level surface and rear wheels are blocked, machine is in transport mode.
2. Disengage the drive hubs.
3. Use suitable container to catch any residual hydraulic fluid, place container under the lockout cylinder.
4. With the left lock-out cyl. retracted, open the bleeder on top of the cylinder, then have an operator from the platform (on high engine) feather drive. Activate drive fully.
5. Close the bleeder when there is a steady stream of oil and not air.
6. With the axle in the same position, go to the right lock-out cyl. and open the bleeder at the rod end. Activate drive in the same manner and close when all air has been purged.
7. Close the bleeder when there is a steady stream of oil and not air.
8. Oscillate the axle the other direction, left lock-out cyl. extended (tire down), right lock-out cyl. retracted (tire up). Use the same procedure for the bleeder in the rod end of the left lock-out cyl., Then the piston end of the right lock-out cyl. then close.
9. Repeat this process one more time to ensure that all air has been purged from the system.
10. Perform oscillating axle lockout test.
11. If necessary, repeat steps 1 thru 9.

NOTE: *Bleeding of the oscillating axles is an infrequent operation performed after hydraulic line failure and or lock-out cylinder repair.*

Oscillating Axle Lockout Test

The front axles will oscillate when the boom is in the transport position (i.e. when the boom is less than 15° above horizontal and not extended beyond 12" [30.4 cm] on the1350SJP or 24" [60.9 cm] on the 1200SJP) and drive is selected.

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. The axles must also be fully extended.*

1. Place a 6 inch (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 FUNCTION SPEED CONTROL and DRIVE SPEED/ TORQUE SELECT control switches to their respective LOW positions.
4. Place DRIVE control lever to FORWARD position and carefully drive machine up ascension ramp until left front wheel is on top of block.
5. Telescope the boom out of the transport position.
6. Drive machine off of block and ramp back onto the level surface.
7. Have an assistant check to see that left front wheel remains locked in position off of ground.
8. Retract the boom back in to the transport position. Activate drive and the lockout cylinders should release.
9. Place the 6 inch (15.2 cm) high block with ascension ramp in front of right front wheel.
10. Place DRIVE control lever to FORWARD and carefully drive machine up ascension ramp until right front wheel is on top of block.
11. Telescope the boom out of the transport position.
12. Drive machine off of block and ramp back onto the level surface.
13. Have an assistant check to see that right front wheel remains locked in position off of ground.
14. Retract the boom back in to the transport position. Activate drive and the lockout cylinders should release.
15. If lockout cylinders do not function properly, have qualified personnel correct the malfunction prior to any further operation.

3.11 DRIVE HUB (PRIOR TO S/N 100131)

The final drive consists of two planetary stages with an integrated disconnect mechanism. Each stage incorporates a set of matched planetary gears, which provide an equal load distribution. All torque transmitting components are made of forged quenched and tempered high-alloy steels. External gears are carburized. Precision 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 oil.
2. Remove all bolts holding the motor and Remove motor from drive.
3. Compress the spring (55) using a simple fixture or other suitable device.
4. Remove snap ring (66) and release pressure on the spring (55) until loose.
5. Remove the spring (55).
6. Turn unit so that cover (8) is in the up position.
7. Remove the screw plugs (21) and seal rings (22).
8. Remove “o” ring (33).
9. Remove the first stage planetary assembly (7).
10. Remove hex bolts (23).
11. Remove ring gear (30) and “o” ring (19).
12. Remove snap rings (15).
13. 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.*

14. 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 the gears or bearings need replacing, they must be replaced as complete sets.
15. The first stage planetary gears (2) ***must*** *be changed in sets of three pieces.*
16. The first stage planetary gears (2) ***must*** be changed as a complete set of three and JLG recommends changing the sun gear shaft (43) along with this set of planets.
17. The second stage planetary bearings (11) ***must*** be replaced in sets of four pieces.
18. The second stage planetary gears (1) ***must*** be changed as a complete set of four and JLG recommends changing the sun gear (3) along with this set of planets.

Disassembly of Cover

Loosen and remove hex head bolts (53) to remove cover (51).

Disassembly of the First Stage Planetary Assembly (7)

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

Disassembly of 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 install snap ring (16).
3. Put sun gear shaft (43) into sun gear (3).
4. Pre-heat stay rings (17) and install onto planet pins (5).
5. 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. Install “o” ring (54) into groove of cover (8).
2. Install the cover (51) into cover (8) and fix cover (51) with hex bolts (53). Tighten bolts with torque wrench to 6.3 ft. lbs. (8.5 Nm).

Final Assembly

1. Install planet gears (1) onto planet pins which are part of spindle (60).
2. Install snap rings (15) on planet pins of spindle (60) in order to fix the planet gears (1).
3. Insert the first stage planetary assembly (7) into drive.
4. Install “o” ring (33) in groove of ring gear (30).
5. Install seal rings (22) and screw plugs (21).
6. Before installation of motor, CHECK THAT THERE IS 1-2 mm OF CLEARANCE BETWEEN THE MOTOR SPLINE SHAFT SHOULDER AND THE COUPLER (62).
7. Install the motor and reconnect hydraulic lines.
8. Roll motor so that one fill plug is at 12 o’clock position, and the other is at 3 o’clock. Fill to bottom of 3 o’ clock plug with gear oil. reinstall plugs.

Initial Start-up And After Repairs

Before operating the machine, make sure that the drive is filled with clean oil, approximately 0.2 US gallons(0.8 L). An accurate oil level is determined by the oil level plug, which should be removed before oil fill.

With the gear case filled to their proper levels, start the machine and allow sufficient time for run-in at moderate pressure and speed before running at full speed. After 4 hours of operation, recheck oil level.Maintenance

Daily: - Check for oil leakage

Weekly: - Check oil level

Monthly: - Check mounting bolt torque

Oil Change Interval-Gear Drive

1. Perform the first oil change after approximately 150 hours.
2. Subsequent changes, every 1500 hours or annually, whichever occurs first.

NOTE: *Flush the drive before filling with new oil.*

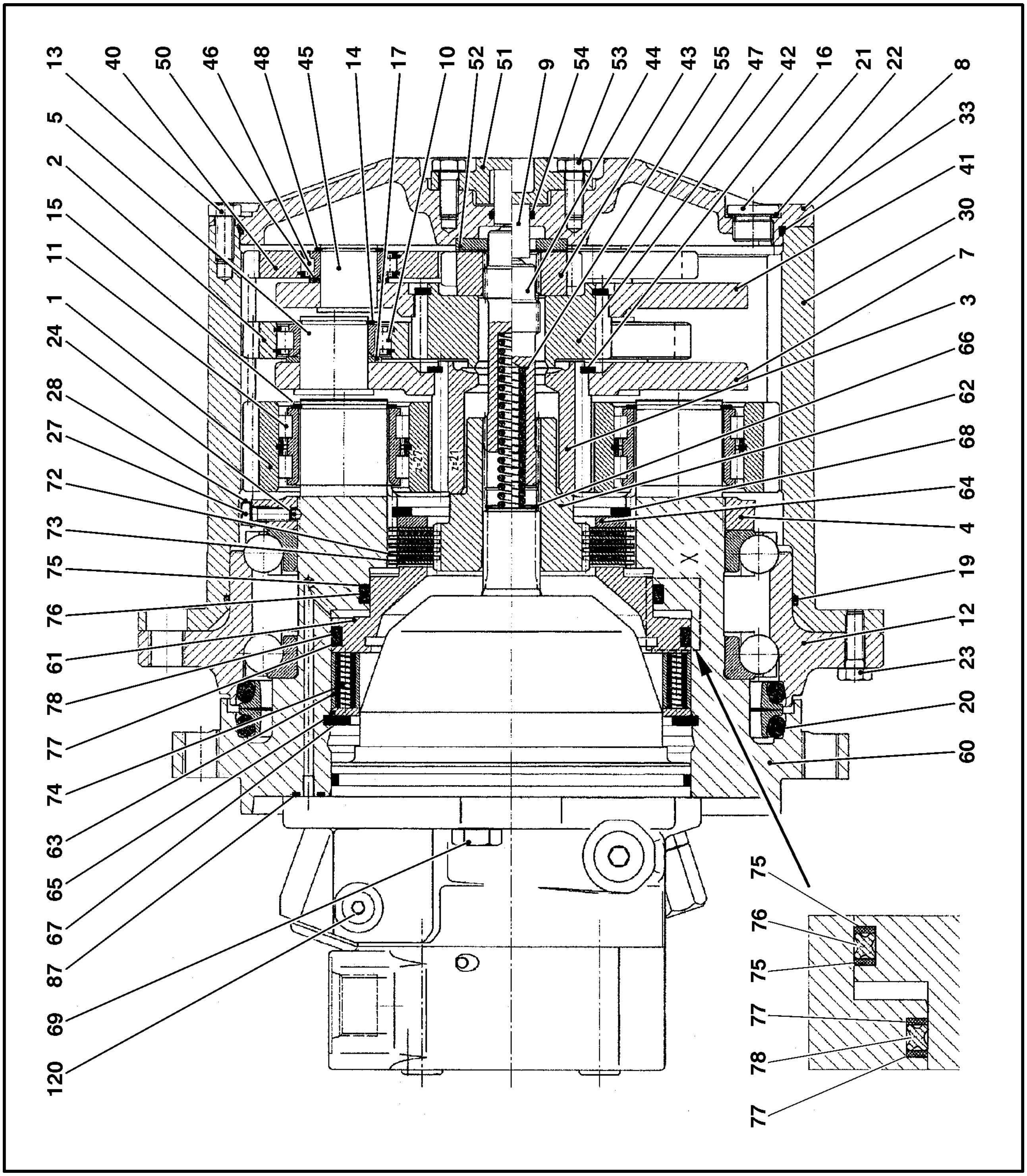


Figure 3-13. Drive Hub - Sheet 1 of 2)

1. Planet Gear
2. Planet Gear
3. Sun Gear
4. Shaft Nut
5. Planet Pin
6. Not Used
7. Planet Carrier
8. Cover
9. Thrust Button
10. Roller Bearing
11. Roller Bearing
12. Ball Bearing
13. Hex Bolt
14. Snap Ring
15. Snap Ring
16. Snap Ring
17. Stay Rings
18. Not Used
19. O-ring
20. Shaft Seal
21. Plug
22. Seal Ring
23. Bolt
24. Detent Ball
25. Not Used
26. Not Used
27. Bolt
28. Washer
29. Not Used
30. Ring Gear
31. Not Used
32. Not Used
33. O-ring
34. thru 40. Not Used
41. Planet Carrier
42. Sun Gear
43. Sun Gear
44. Not Used
45. Planet Pin
46. Roller Bearing
47. Retaining Ring
48. Retaining Ring
49. Not Used
50. Not Used
51. Cover
52. Thrust Washer
53. Bolt
54. O-ring
55. Spring
56. thru 59. Not Used
60. Spindle
61. Piston
62. Coupler
63. Ring Locator
64. Backup Plate
65. Backup Plate
66. Retaining Ring
67. Retaining Ring
68. Retaining Ring
69. Bolt
70. Not Used
71. Not Used
72. Brake Disc
73. Brake Disc
74. Spring
75. Backup Ring
76. Seal
77. Backup Ring
78. Seal
79. Not Used
80. Not Used
81. O-ring

Figure 3-14. Drive Hub - Sheet 2 of 2

3.12 DRIVE HUB - BONFIGLIOLI (S/N 100128 TO PRESENT)

NOTE: *After S/N 0300134389 machines may be built with either Bonfiglioli or Reggiana Riduttori wheel drive hubs. See Section 3.13, Drive Hub - Reggiana Riduttori (S/N 134389 to Present). Do not use different hubs on the same machine.*

Product Identification

The identification data of the hub is shown on a name plates on the hub. Figure 3-15., Drive Hub Identification Plate shows how the information is displayed.

The informations stamped on the name plates must always be readable. Use the identification data (at least serial number) for spare part enquiries, information and service, etc.

Hydraulic Motor Installation

The mating areas and the pilot diameter of the gearbox where the motor is to be mounted must be clean and without burrs.

Before assembling the hydraulic motor, verify by a depth slide gauge the correct assembly of the unit checking the axial distance as shown in the scheme below as shown in the scheme below.

1. Fit the O-ring seal, supplied with the gearbox, in its seat in the hydraulic motor, and assemble it to the gearbox being careful not to damage the seal already fitted.
2. Torque the bolts to 63.5 ft.lbs. (86 Nm) torque.

Installation of the Wheel Drive on the Machine

1. Clean the mating surfaces from oils or paint and fit the wheel drive on the machine frame.
2. Attach the gearbox to the machine frame with the mounting bolts and torque to 178 ft.lbs. (241 Nm).

Start Up and Running In

If new hubs are being installed, it is advised to follow the measures given below:

1. Bleed air from every part of the hydraulic and add oil in the tank if necessary.

NOTICE

THE PRESENCE OF RESIDUAL AIR IN THE HYDRAULIC CIRCUIT WILL BE RECOGNIZED BY THE PRESENCE OF FOAM IN THE TANK AND WILL LEAD TO A JERKING OF THE MOTOR AS WELL AS EXCESSIVE NOISE COMING FROM THE MOTOR AND THE VALVES.

2. Start the gearmotor at a low speed and gradually increase it after having verified that it is functioning correctly without any noises or vibrations.

NOTICE

DO NOT REACH MAXIMUM PRESSURE UNLESS THE ENTIRE SYSTEM HAS BEEN FILTERED TO ELIMINATE ANY PARTICLES OF DIRT THAT MAY BE PRESENT.

NOTE: *During the running-in stage follow the steps given below.*

3. Check the correct revolution and direction of rotation.
4. Make sure that the functioning is regular and without any excessive noises and vibrations.

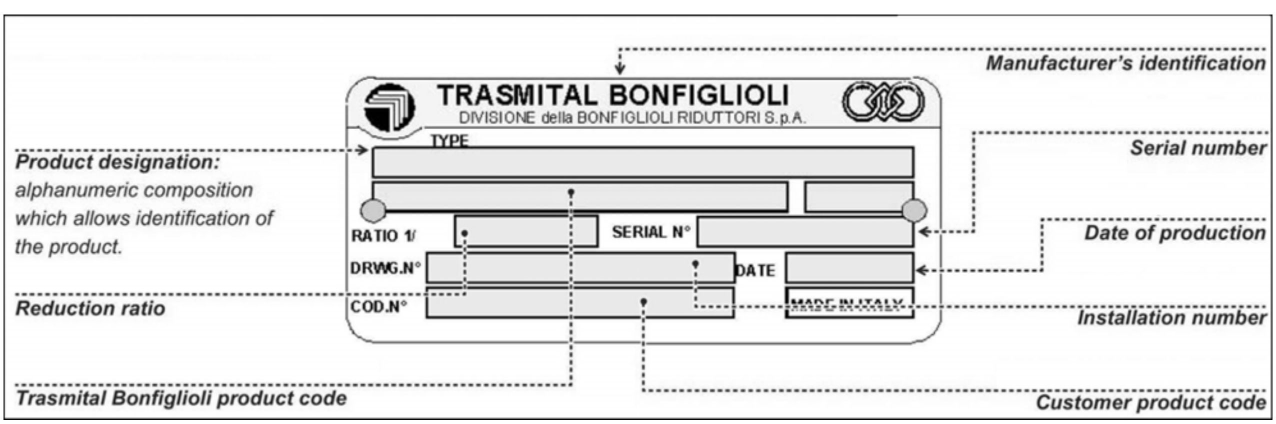


Figure 3-15. Drive Hub Identification Plate

5. Make sure that the oil temperature does not exceed values listed previously.

After having finished running-in the gearbox, follow the steps given below.

6. Check that there are no oil leaks. If leaks are present, fix them before proceeding.
7. Check the level of oil in the gearmotor.
8. It possible that the presence of air in the system during the first start up could cause the application of the brake to be slowed down. It is advised to repeat the application and release functions of the brake to purge air from the brake.
9. Check that there are no other problems in general.

General Information

The gearbox is designed and built for wheel drive.

The unit includes planetary gearbox, 3 stages, rotating housing type.

The illustrations show the parts and the main functions of the gearbox.

A strict and consistent compliance with the specifications of this technical manual ensure the minimum operating costs and a longer unit life.

Photographic documentation and drawings are supplied for educational purposes, so as to safely and properly carry out maintenance operations.

Minor deviations from pictures of this manual may appear on the actual gearbox. However, these discrepancies are not relevant to the main parameters, or maintenance functions.

Connecting the Brake

The gearbox is fitted with a negative multi disk safety brake with hydraulic control release (parking brake). For information regarding the characteristics of the brake refer to the installation drawing.

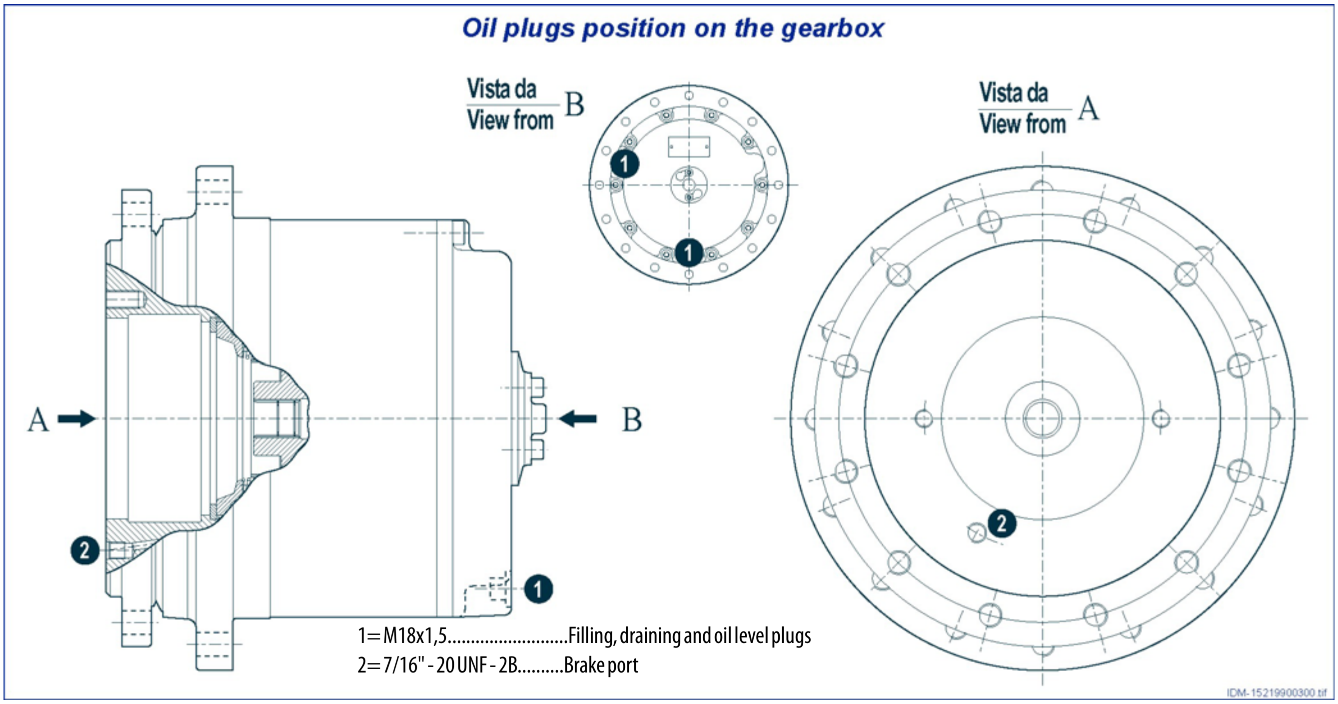
Table 3-2. Brake Technical Data

Brake Release Pressure	(16 bar)
Maximum Operating Pressure Brake	(50 bar)
Braking Torque	(265 ± 10% Nm)

Filling-up the Gearbox with Lubricating Oil

The motor and the gearbox have separate lubrication. The gearbox is lubricated by oil splashing. The recommended type of oil is SAE 80W/90 or SAE 85W/140 with EP features complying with MIL-L-2105 C & API GL5. Refer to Table 3-3, Suggested Lubricants According SAE 80W/90 and SAE 85W/140 API GL5 Grade.

NOTE: *During operation the oil temperature must not exceed 85-90° C intermittent.*



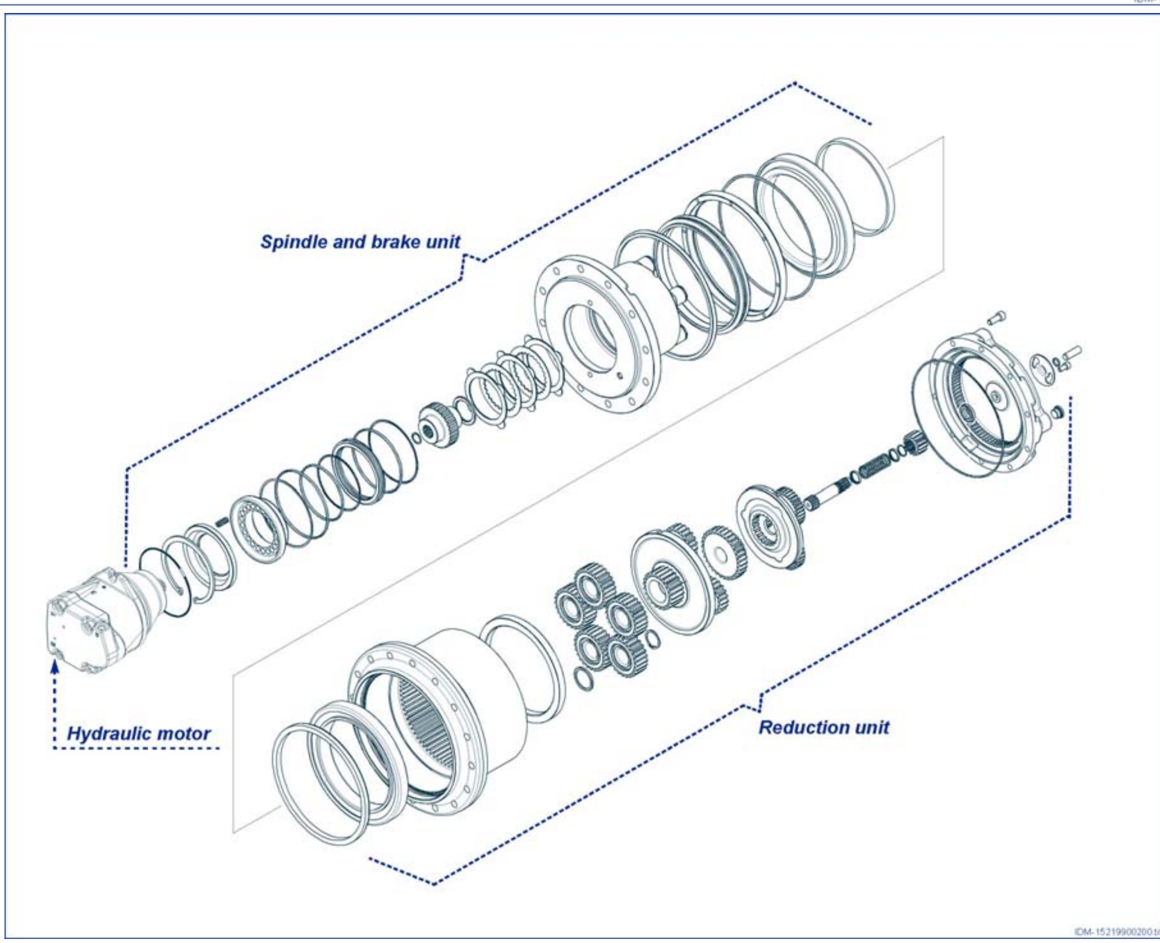


Figure 3-16. Hub Assembly

Table 3-3. Suggested Lubricants According SAE 80W/90 and SAE 85W/140 API GL5 Grade

Ambient temperature Oil viscosity		-20°C / +30°C SAE 80W/90	+10°C / +45°C SAE 85W/140
Manufacturer		Oil Brand	
	SHELL	SPIRAX HD	SPIRAX HD
	AGIP	ROTRA MP	ROTRA MP
	ARAL	GETRIEBEOL HYP	GETRIEBEOL HYP
	BP-MACH	HYPOGEAR EP	HYPOGEAR EP
	CASTROL	HYPOY	HYPOY
	CHEVRON	UNIVERSAL GEAR LUBRICANT	UNIVERSAL GEAR LUBRICANT
	ELF	TRANSELF B	TRANSELF B
	ESSO	GEAR OIL GX PONTONIC MP	GEAR OIL GX PONTONIC MP
	I.P.	PONTIAX HD	PONTIAX HD
	MOBIL	MOBILUBE HD	MOBILUBE HD
	TOTAL	TRASMISSION TM	TRASMISSION TM

NOTE: *Do not mix together oils of different brands or characteristics.*

NOTE: *The gearbox is supplied without oil; before putting the gearbox into operation, it is necessary to fill it with oil.*

This procedure is undertaken following the indications given below.

1. Check that the gearbox axis is horizontal. Rotate the gearbox housing until the drain plug (A) is on the bottom on the vertical axis of the end cover.
2. Unscrew the fill and level oil plug (B).
3. Fill from the hole until the lubricant flows out.
4. Tighten the fill and level oil plug (B) and let the gearbox run. After a few minutes, stop and check the oil level.
5. If necessary, refill with lubricant oil. Approximate oil capacity = 2 liters ±10%

Gearbox Disengagement

The gearbox is supplied with mechanical disengagement.

⚠ WARNING

THE DISENGAGEMENT OPTION MUST BE CONNECTED OR DISCONNECTED ONLY WHEN THE GEARBOX IS STOPPED ON FLAT GROUND.

NOTICE

THE MAX WHEEL SPEED WITH DISENGAGED GEARBOX MUST NOT EXCEED 25 REV/MIN.

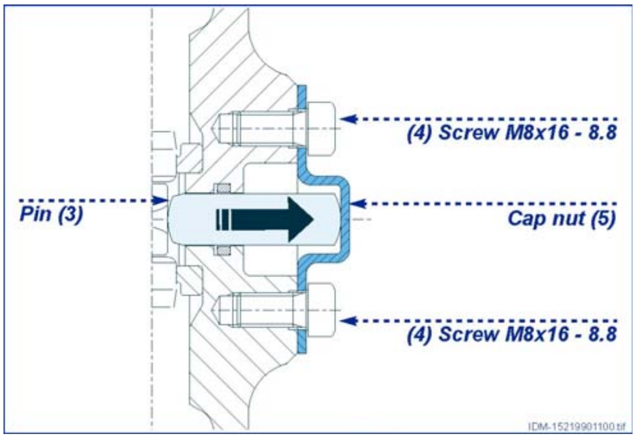


Figure 3-17. Gearbox engaged

1. Unscrew the 2 socket head screws M8x16 (4), grade 8.8, of the end cover (7) with a male hex head wrench.

2. Rotate the cap nut (5).

3. Take out the cap nut (5).

4. Turn the cap nut (5) upside down. As result the pin (3) will be pushed inside in order to permit disengagement of the gearbox.

5. Rotate the cap nut (5).

6. Tighten the 2 socket head screws M8x16 (4) with a male hex head torque wrench at 18.4 ft.lbs. (25 Nm) torque.

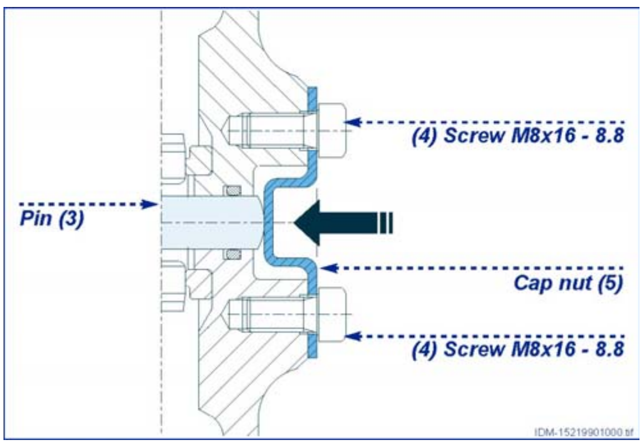


Figure 3-18. Gearbox Disengaged

7. Repeat the above steps to engage the gearbox again.

   Operation:

   a. Engaged gearbox

      At this condition the motion is transmitted from the hydraulic motor to the gearbox.

   b. Disengaged gearbox

NOTICE

AT THIS CONDITION THE HYDRAULIC MOTOR AND THE BRAKE ARE DISCONNECTED TO THE GEARBOX: THE WHEEL IS IDLE.

Maintenance Information

PERIODIC MAINTENANCE

The gearbox only requires the scheduled maintenance procedures set out by the manufacturer (see Table 3-4).

Good maintenance will ensure an ongoing functioning in time as well as maximum reliability.

Should irregularities in function arise, it will be necessary to consult the troubleshooting checklist to find the most adequate solution.

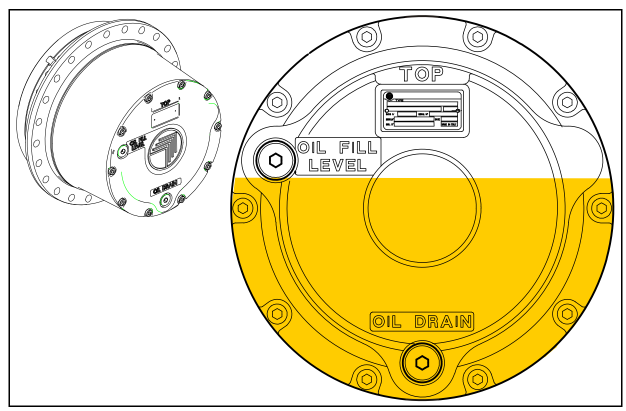
If unsuccessful, it may be necessary to partially or completely disassemble the gearbox.

Table 3-4. Drive Hub Maintenance Schedule

Inspection	Frequency	Action
Tightening bolts	After the first 50 operating hours of the gearbox	Bolt tightening torque check
Oil level	Every 150 operating hours of the gearbox	Refill oil if necessary
1st oil change	At 150 operating hours of the gearbox	Oil replacement
Next oil change	Every 1200 operating hours	Oil replacement

Changing the Lubricating oil

1. Check that the gearbox axis is horizontal. Rotate the gearbox housing until the drain plug is on the bottom of the vertical axis of the end cover.



2. Unscrew the both plugs (Fill and Drain) and let the oil flow in a large enough container; in order to facilitate draining the oil must still be warm.
3. Wait a few minutes until all the oil is drained and then proceed to screw on the plugs.
4. Proceed with the oil fill-up. Refer to Filling-up the Gearbox with Lubricating Oil.

NOTE: *Never mix mineral oils with synthetic oils and vice versa.*

NOTICE

DO NOT DISPOSE OF THE OIL IN THE NATURAL ENVIRONMENT. BE CAREFUL TO ELIMINATE IT IN COMPLIANCE WITH THE RELATIVE RULES AND REGULATIONS THAT GOVERN LOCALLY.

Troubleshooting

The following table is provided to help locate problems in the gearbox.

Table 3-5. Troubleshooting

Symptom	Causes	Remedies
External oil leakage:		
From the lifetime seal	a)Lifetime seal damaged	a)Replace lifetime seal
From the end cover	a)O-ring seal damaged	a)Replace O-ring seals
From the plugs	a)Plug seal damaged	a)Replace plug seal
	b)Plugs or screws loose	b)Tighten the plugs/screws
Too much noise:		
Hydraulic noise (during the slowing down of the motor speed)	a)Hydraulic circuit malfunctioning	a)Verify hydraulic circuit
Inside the gearmotor (reductions)	a)Internal damage	a)Check the gearbox
Other:		
Overheating	a)Insufficient oil level	a)Check the oil level and refill if necessary
	b)Hydraulic oil too warm	b)Check the hydraulic circuit
	c)Brake not fully released	c)Check brake release pressure
Parking brake malfunctioning		
Insufficient braking torque	a)Brake discs worn	a)Replace brake disc pack
	b)Damaged parts	b)Check brake components
Wheel Locked	a)Parking brake locked	a)Check the complete brake release
	b)Mechanical components damaged	b)Replace damaged parts

Disassembly Information

It is also important that this procedure is undertaken in a workshop that is equipped with the proper tools. As well as normal workshop tools it will be necessary to use special tools that can be made (see special tools attachment) or may be requested from the manufacturer.

Special Tools:

Puller...Code/: 6689960240

Tool for lifetime seal assembly........Code/: 6689960300

Puller for brake disassembly..........Code/: 6689960310

Torque multiplier............................Code/: ATZ.09.016.0

To be able to produce these special tools refer to Figure 3-20. thru Figure 3-23.

It is important to strictly adhere to all the procedures for disassembling and reassembling the gearbox. Proceed with these instructions using all the necessary safety measures, for example:

1. Plug all the Hydraulic ports on the gearbox to avoid the introduction of any foreign particles in the circuit and the gearbox.
2. Making sure that the coupling surfaces are not damaged.
3. Handle with care so as to be sure that there are no risks for personnel safety and to guarantee the reliability of the gearbox.
4. Making available a work area that is in line with work and health safety in the workplace guidelines.

Disassembly Procedure

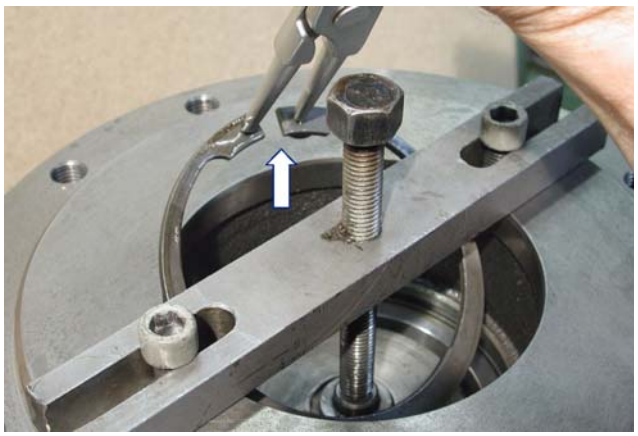
NOTE: *Below are all the steps to follow during Disassembly and Assembly. Numbers in brackets in the text correspond to the references in the exploded view.*

Initial inspection can be made without disassembling the hub from the machine. Before wheel drive disassembling, make sure that the oil is drained from the hub.

Unscrew and remove the nos. 2 screws M12, grade 8,8, and remove the hydraulic motor and its O-ring seal (48).

1. Install the special tool (6689960310) on the flanged hub (31) and turn the screw until it compresses the springs (45).

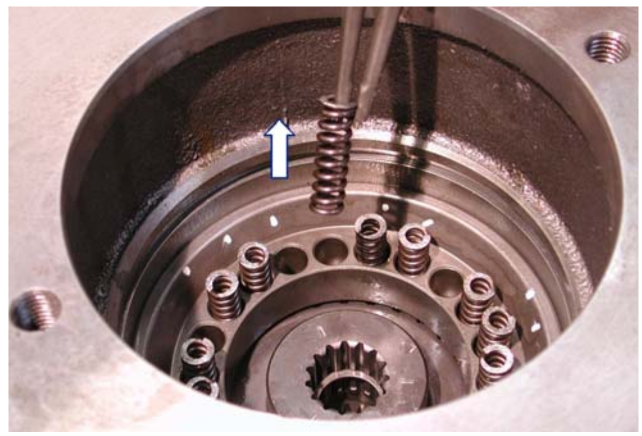
2. Remove the circlip (47) and remove the special tool.



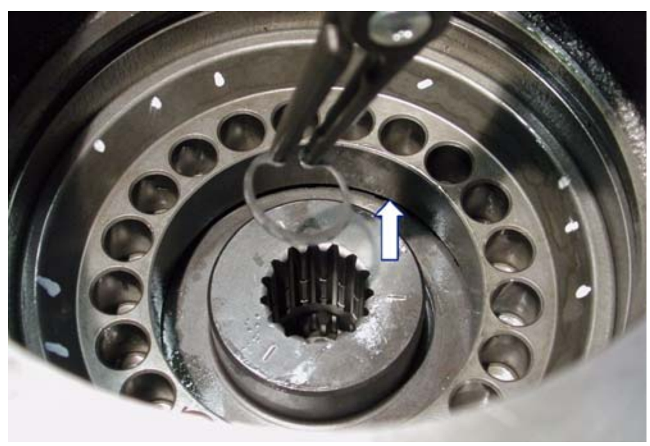
3. Remove the spring retainer disc (46).

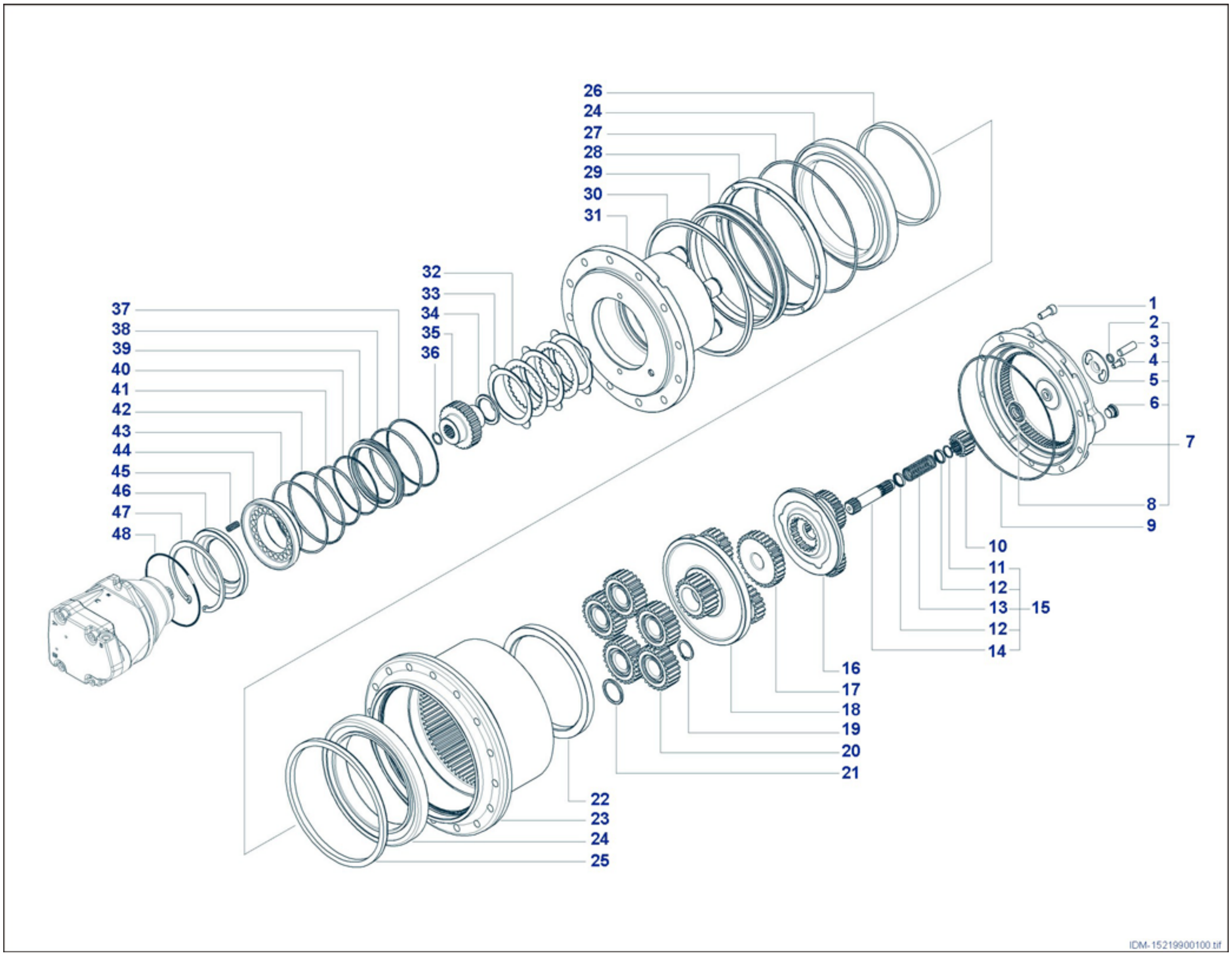
4. Mark the position of the springs (45) as a reference for the reassembly.

5. Remove the springs (45) from their seats in the brake piston (44).



6. By using pliers remove the circlip (36) from its seat in the brake shaft (35).





1. Screw
2. O-ring
3. Pin
4. Screw
5. Cap Nut
6. Oil Plug
7. End Cover
8. Pad
9. O-ring
10. 1st Stage Sun Gear
11. Elastic Ring
12. Washers
13. Spring
14. Splined Shaft
15. Disengagement Shaft
16. 1st Reduction Assembly
17. 2nd Stage Sun Gear
18. 2nd Reduction Assembly
19. Circlip
20. 3rd Reduction Assembly
21. Spacer
22. Ring Nut
23. Gearbox Housing
24. Bearing
25. Spacer
26. Spacer
27. O-ring
28. Spacer
29. Half Seal
30. Seal Ring
31. Flanged Hub
32. Disc (Internal Teeth
33. Disc (External Teeth)
34. Spacer
35. Brake Shaft
36. Circlip
37. Backup Ring
38. O-ring
39. Spacer
40. Backup Ring
41. O-ring
42. O-ring
43. Backup Ring
44. Brake Piston
45. Springs
46. Retainer Disc
47. Circlip

Figure 3-19. Drive Hub S/N 100128 to Present

7. By using a puller remove, at the same time, the brake piston (44), the spacer (39) and the brake shaft (35).

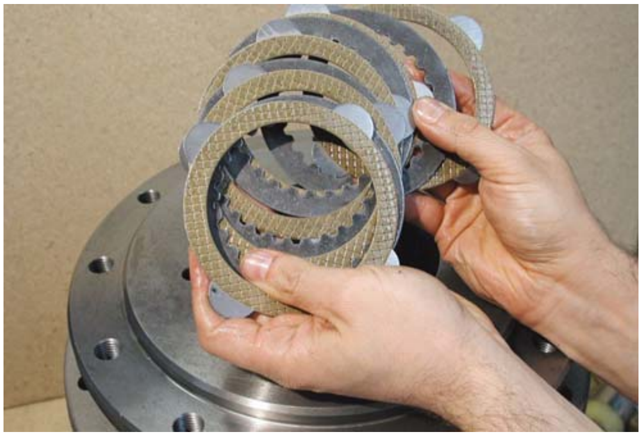
8. Remove the spacer (39) from the brake piston (44).

9. Remove the internal O-Ring seal (41) and the backup ring (40) from their seat in the spacer (39).

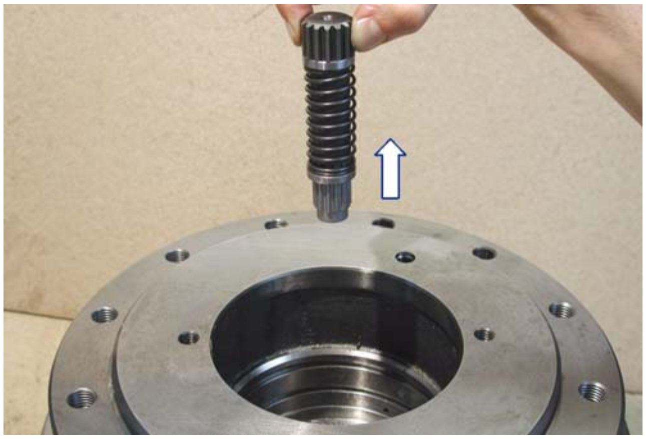
10. Remove the external O-Ring seal (38) and the backup ring (37) from their seat in the spacer (39).

11. Remove the O-ring seal (42) and the backup ring (43) from their seats in the flanged hub (31).

12. Remove brake discs pack (32-33).

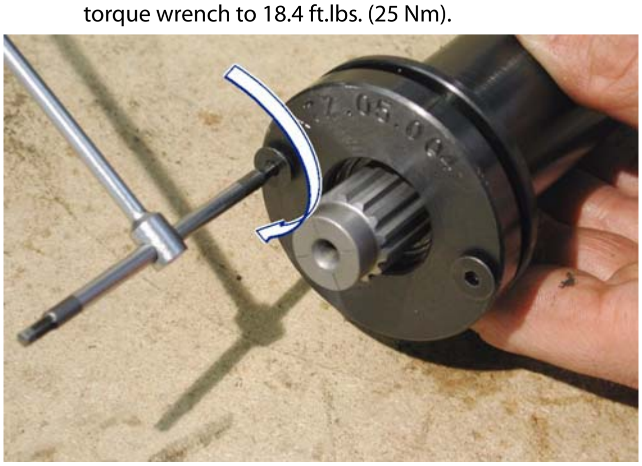


13. Remove the disengagement shaft kit (15).

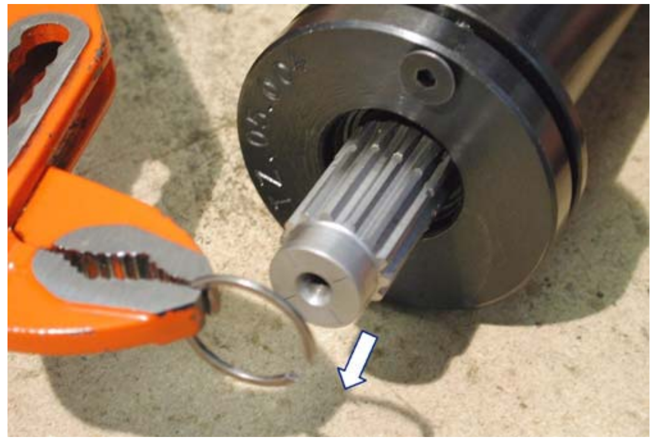


14. Place the disengagement shaft kit (15) inside the special tool (6689960240).

15. Tighten the 2 screws M5x16, grade 8.8, of the cover by a torque wrench to 18.4 ft.lbs. (25 Nm).



16. By using pliers remove the elastic ring (11) from the splined shaft (14).

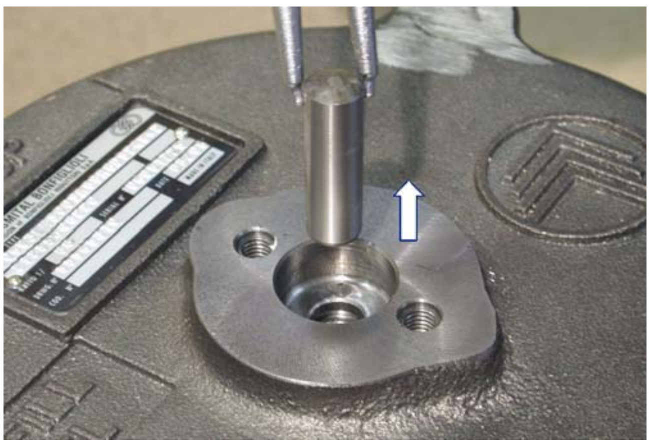


17. Remove the special tool and remove the spring (13) and the washers (12).

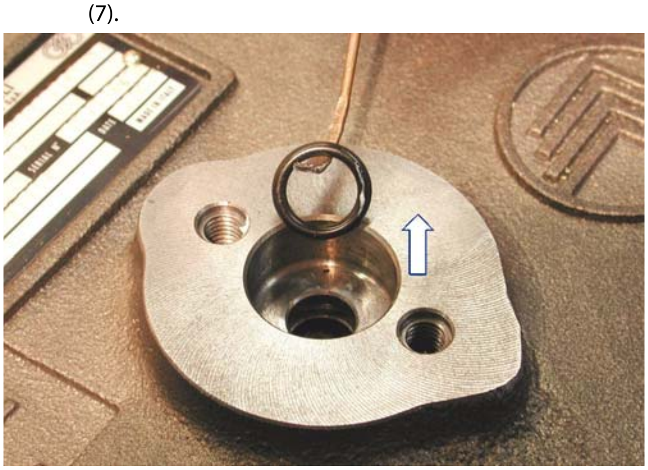
18. Turn the gearbox upside down and unscrew the 2 screws M8x16 (4), grade 8.8, of the end cover (7).

19. Remove the cap nut (5).

20. Remove the pin (3).



21. Remove the O-ring seal (2) from its seat in the end cover (7).



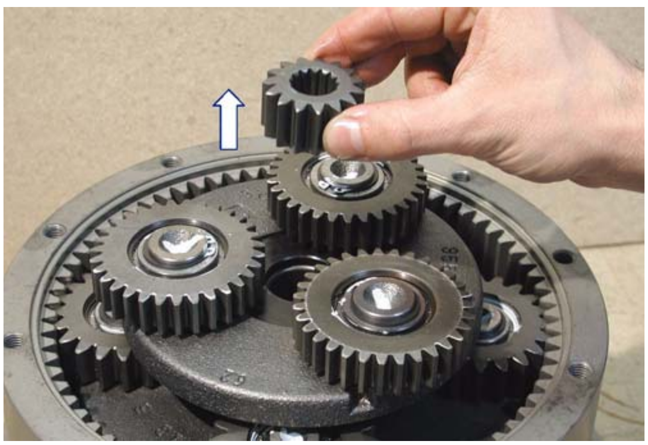
22. Unscrew the draining-filling-level oil plugs (6) by a male hex head wrench.

23. Unscrew the 10 screws M10X25 (1), grade 12,9, from the end cover (7).

24. Remove the end cover (7).

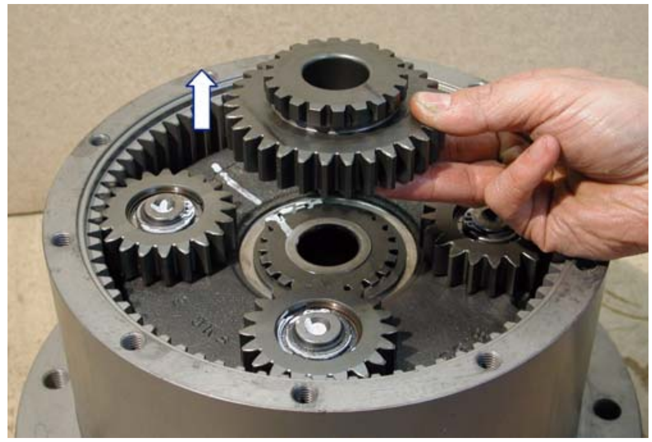
25. Remove the O-ring seal (9) from its seat in the end cover (7).

26. Remove the 1st stage sun gear (10).

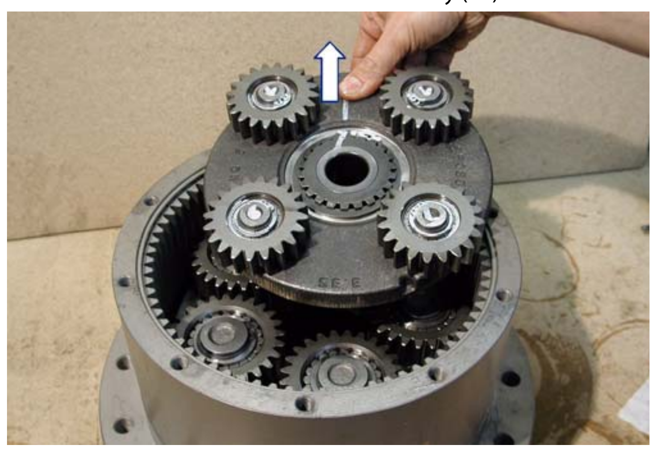


27. Remove the 1st reduction assembly (16).

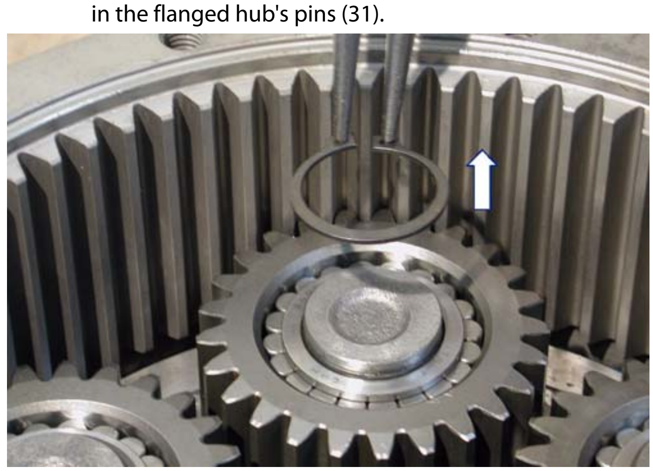
28. Remove the 2nd stage sun gear (17).



29. Remove the 2nd reduction assembly (18).

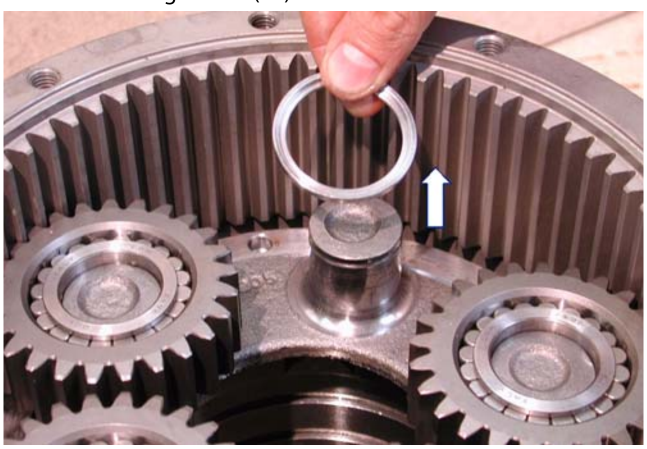


30. By using pliers remove the circlips (19) from their seats in the flanged hub's pins (31).



31. By using a puller remove the planet assemblies of the 3rd reduction (20).

32. Remove the spacer (21) from their seats in the pins of the flanged hub (31).



NOTE: *In order to proceed with the gearbox disassembly, it is now necessary to remove it from the machine and bring it to a properly equipped workshop.*

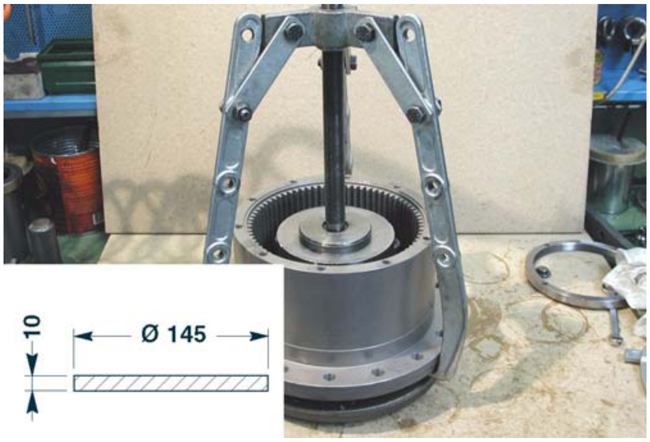
33. By using a drill remove the caulkings on the ring nut (22).

34. By using a tackle place the torque multiplier (ATZ.09.016.0) on the ring nut (22).

35. By using the torque multiplier (ATZ.09.016.0) loosen the ring nut (22).

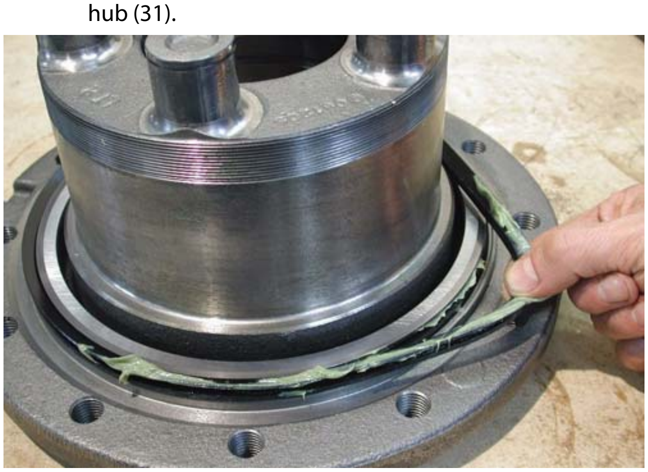
36. Take out the ring nut (22).

37. By using a puller and a metal stopper, remove the flanged hub (31) from the gearbox housing (23).



38. By using a tackle remove the gearbox housing (23) from the flanged hub (31).

39. Remove the seal ring (30) from its seat in the flanged hub (31).



NOTE: *In case of oil leaks, it may be necessary to check and eventually replace the lifetime seal (29), which means both the metal rings parts and the O-ring seals.*

40. By using a screwdriver, remove the 1st half-seal (29) from the flanged hub (31).

41. By using a screwdriver, remove the 2nd half-seal (29) from the gearbox housing (23).

NOTE: *The gearbox disassembly ends with the above operation. All items are now available for the necessary inspections.*

Inspection of Parts

The pieces that are subject to general wear and tear are the following:

- Gears.

- Bearings.

- All the seals

Replace the used or irregular parts using the following steps:

1. Remove dirt, and in particular properly clean the seals, bearings and locking rings seating.
2. Lubricate the parts before connecting them.
3. In the case of damaged gears, for example a planetary, do not proceed to replace the individual gear but the entire reduction assembly.

4. When reassembling a part always replace all the seals involved. Add some grease on the seats and on the new seals to make reassembly easier.

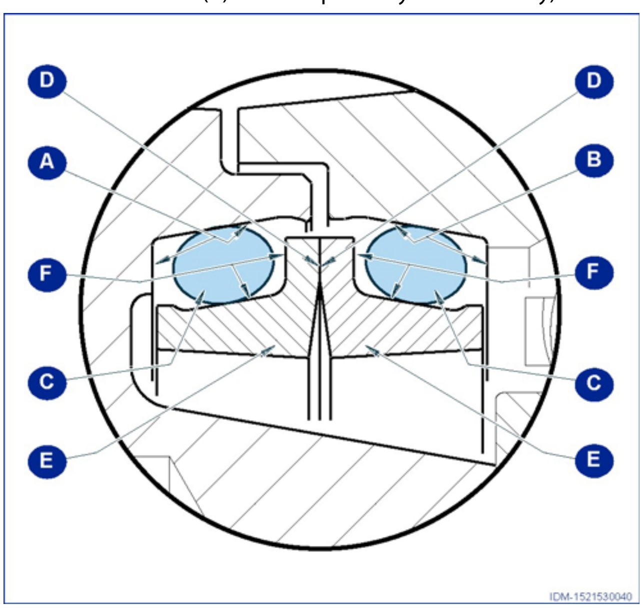
5. Replace all the damaged parts with original spare parts.

Assembly

Apply grease TECNOLUBE SEAL GS730 on the gearbox housing (23).

1. Follow the steps below to prepare the lifetime seal for assembly:

   a. Carefully clean the seats (A and B) using, if necessary, metallic brushes or solvent (surfaces in contact with or (C) must be perfectly clean and dry).



   b. Make sure that sealing surfaces (D) of metal rings (E) are free from scratches, dinges or foreign substances; metallic ring surfaces must be perfectly clean and dry. We suggest to dip the metallic rings in volatile solvent or industrial degreasing alcohol.

   c. Carefully clean the lapped surface (D) of metal rings (E) and remove dust or fingerprints. Then lubricate them with a thin oil film, taking care not to oil the other components.

2. Assemble the half seal (29) on the tool (6689960300).

3. Assemble the 1st half seal (29) on the gearbox housing (23).

4. Using the same tool (6689960300), assemble the 2nd half seal (29) on the flanged hub (31).

5. Carefully clean the metallic faces of the lifetime seal (29) and lube the surfaces with oil.

6. Insert the seal ring (30) in its seat in the flanged hub (31).

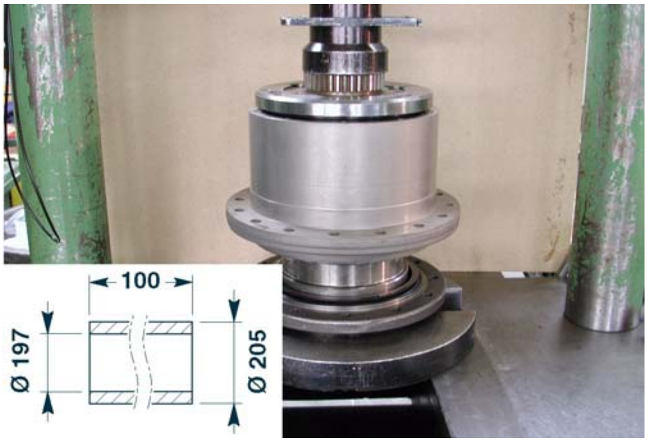
7. Apply grease TECNOLUBE SEAL GS730 on the seal ring (30).

NOTICE

AVOID GETTING GREASE IN CONTACT WITH THE LIFETIME SEAL (29)

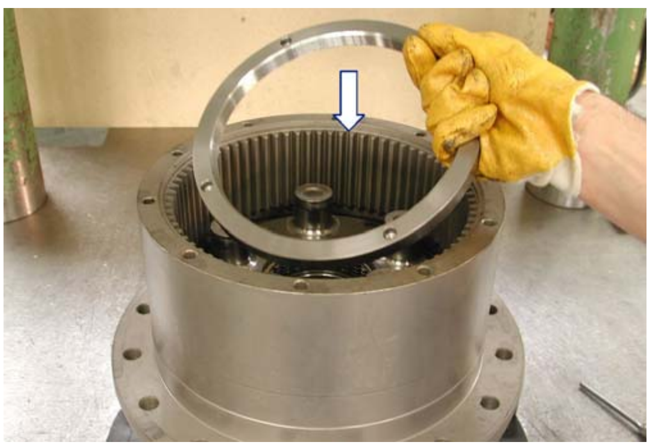
8. By using a hoist, place the gearbox housing (23) on the flanged hub (31).

9. By using a press and a metallic stopper, push the gearbox housing (23) against the shoulder on the flanged hub (31) until assembling of the unit is complete.



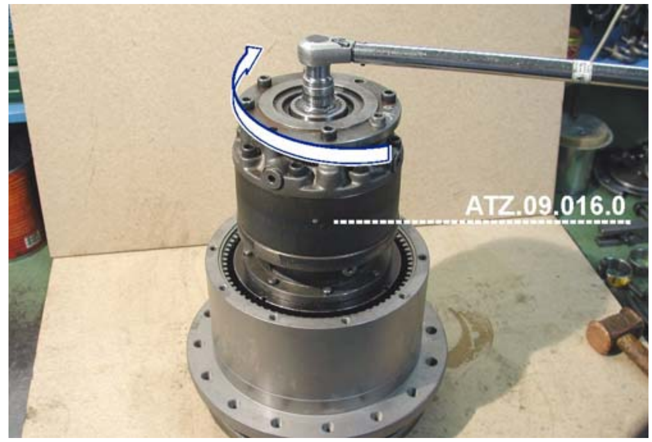
NOTICE

SCREW THE NUT (22) ON PARTIALLY IN ORDER TO PREVENT THE FLANGED HUB (31) FROM COMING OUT OF THE GEARBOX HOUSING (23) DURING THE FOLLOWING STEPS.



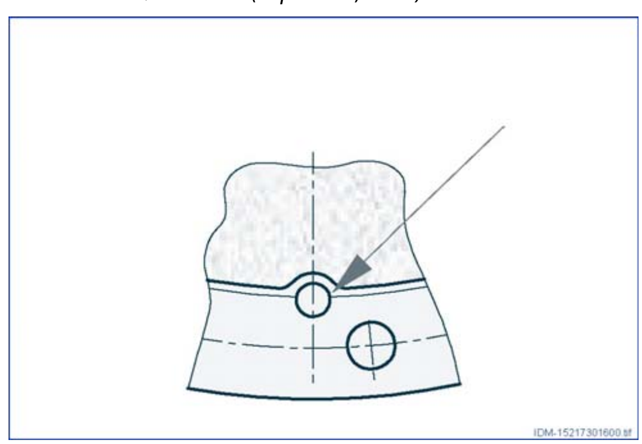
10. By using a hoist place the torque multiplier (ATZ.09.016.0) on the ring nut (22).

11. By using the mutiplier (ATZ.09.016.0), tighten the ring nut (22), using a torque wrench with an input multiplier torque of 71 ± 3 ft.lbs.(96,5 ± 4, 5 Nm) corresponding to an output multiplier torque of 3688 ± 184 ft.lbs. (5000 ± 250 Nm).

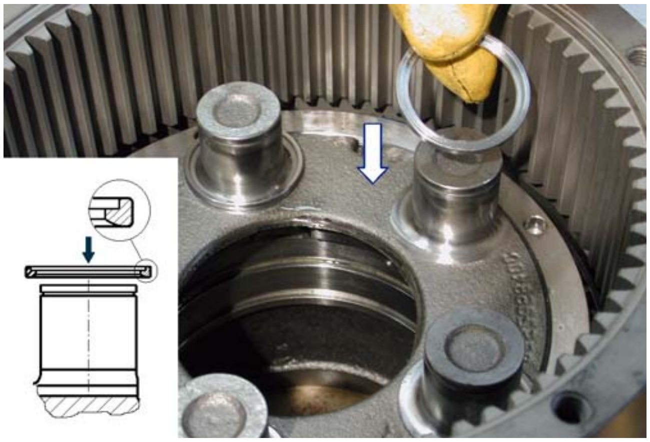


12. Stake the ring nut (22) near 2 seats at 180° of the flanged hub (31) on the right side.

NOTE: *Stake Ø 4+5 mm (depth 1+1,5 mm).*

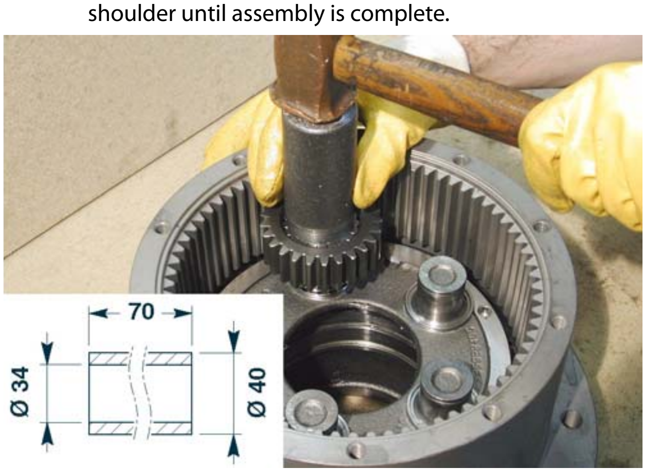


13. Assemble correctly the spacers (21) on the pins of the flanged hub (31).

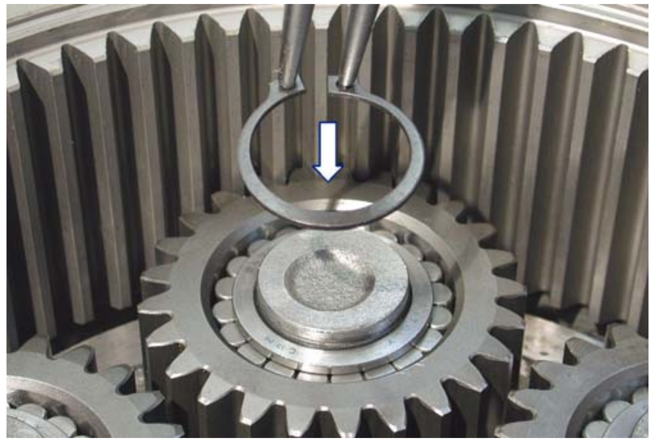


14. Place the 5 planet assemblies of the 3rd reduction (20) in the flanged hub's pin (31).

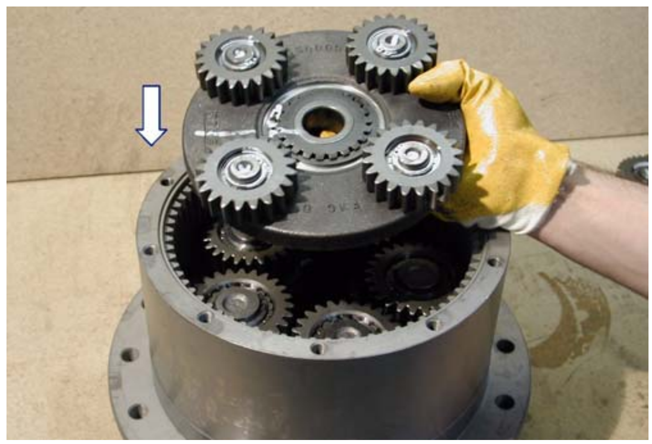
15. By using a rubber hammer and a metal stopper push the planet assemblies of the 3rd reduction (20) against the shoulder until assembly is complete.



16. By using pliers, assemble the circlips (19) in the flanged hub pin seats (31).



17. Assemble the 2nd reduction assembly (18).



18. Insert the 2nd stage sun gear (17).

19. Assemble the 1st reduction assembly (16).

20. Insert the 1st stage sun gear (10).

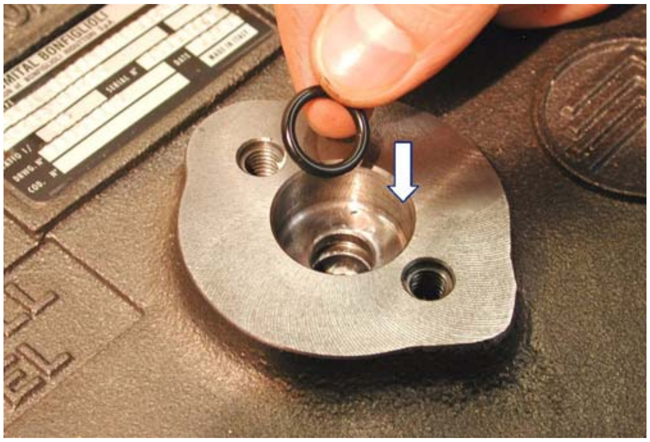
21. Assemble the O-ring seal (9) into its seat in the end cover (7).

22. Place the end cover (7) on the gearbox housing (23).

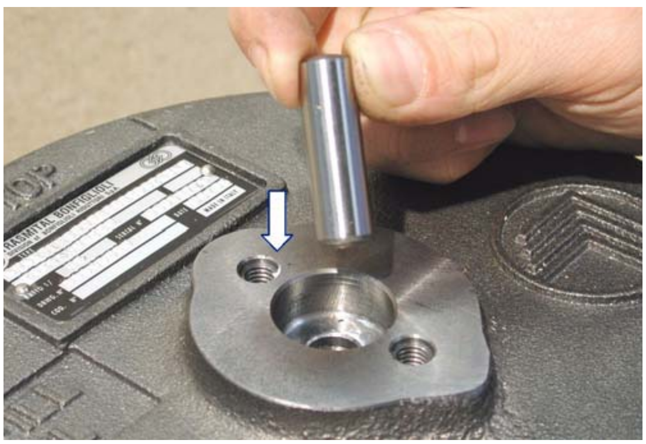
23. Tighten the 10 socket head screws M10x25 (1),grade 12,9, by a torque wrench at 62.7 ft.lbs. torque (85 Nm).

24. Insert the plugs (6) into the oil draining-filling holes of the end cover (7). Torque the plugs to 52 ± 7 ft.lbs. (70±10 Nm).

25. Assemble the O-ring seal (2) into its seat in the end cover (7).



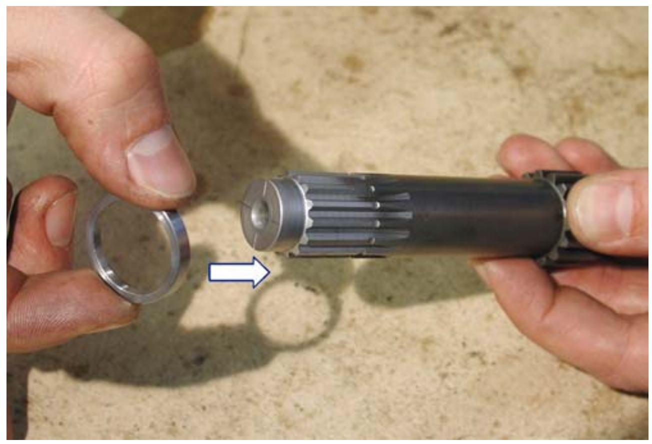
26. Protect the seat and the pin (3) with grease type MOLYKOTE G6000. Wait 15 minutes for it to completely dry. Insert the pin (3) in its seat in the end cover (7).



27. Assemble the cap nut (5).

28. Torque the 2 screws M8x16 (4) grade 8.8, to 18.4 ft.lbs. (25 Nm).

29. Insert the 1st washer (12) in the splined shaft (14).



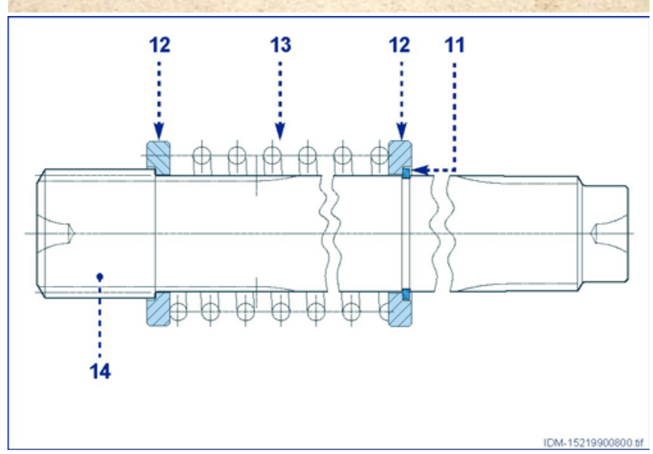
30. Insert the spring (13) in the splined shaft (14).

31. Insert the splined shaft (14) in the equipment (6689960240).

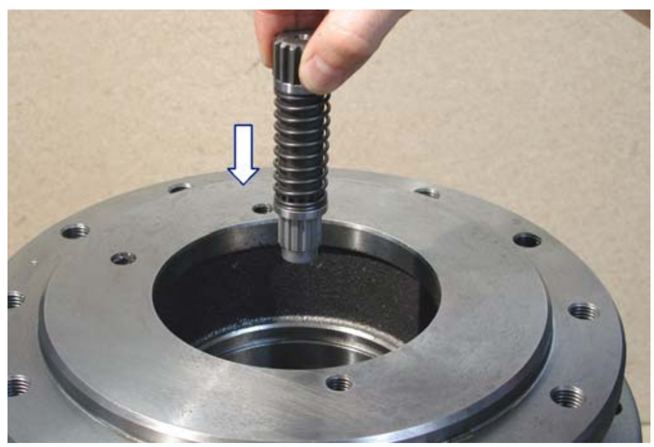
32. Insert the 2nd washer (12) correctly in the splined shaft (14).

33. Torque the 2 screws M5x16, grade 8.8, of the cover to 18.4 ft.lbs. (25 Nm).

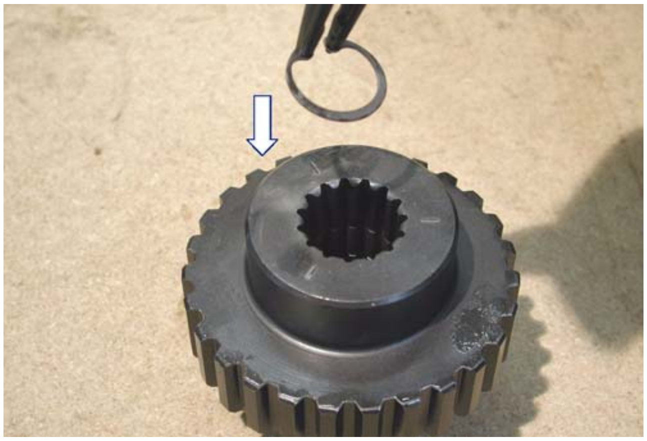
34. By using pliers, assemble the elastic ring (11) into its seat in the splined shaft (14).



35. Insert the disengagement shaft kit (15) in the flanged hub (31).

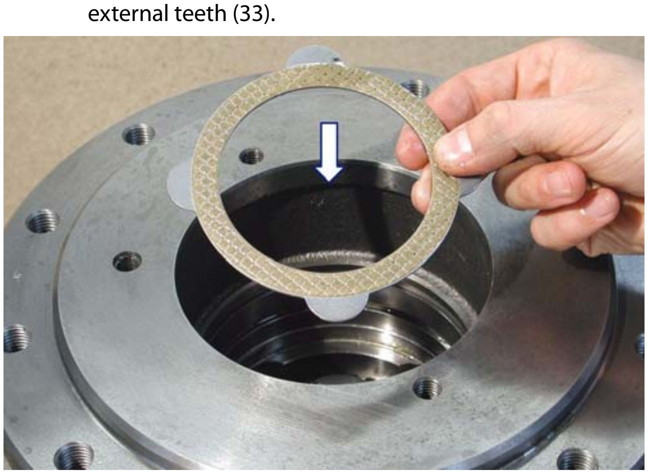


36. By using pliers assemble the circlip (36) into its seat in the brake shaft (35).



37. Turn the gearbox upside down and assemble the brake shaft (35) inside the flanged hub (31).

38. Assemble the brake discs package according to the following order: first, insert one sintered bronze disc with external teeth (33).

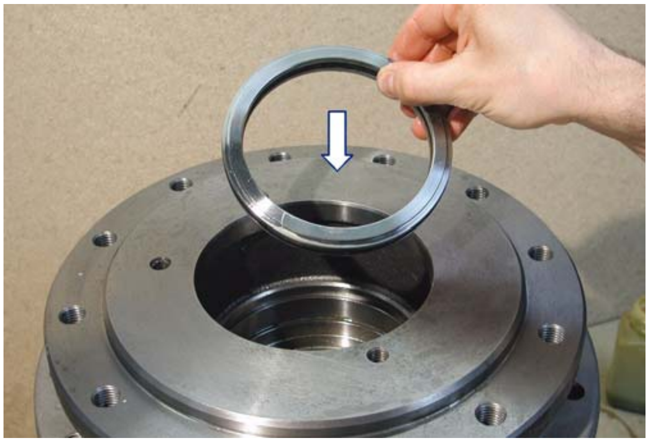


39. Then insert an internally toothed steel disc (32). Repeat the operation until all 5 sintered bronze discs and 4 steel discs have been assembled.

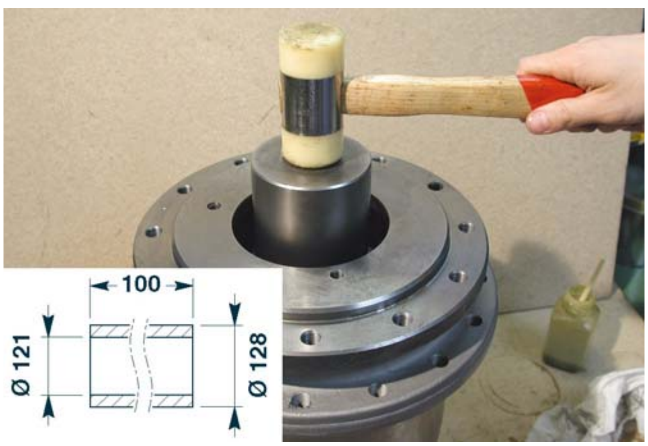
40. Fit the internal O-ring seal (41) and the backup ring (40) into their seats in the spacer (39).

41. Fit the external O-ring seal (38) and the backup ring (37) into their seats in the spacer (39).

42. Insert the spacer (39) inside the flanged hub (31), paying attention not to damage the seals already fitted.

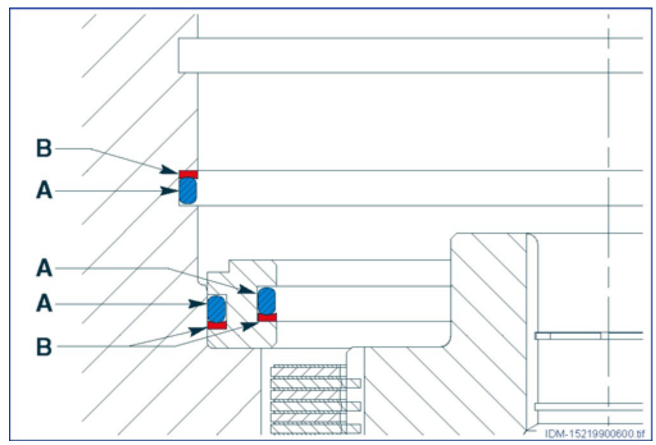


43. By using a rubber hammer and a metal stopper push the spacer (39) against the flanged hub (31), paying attention not to damage the seals already fitted.



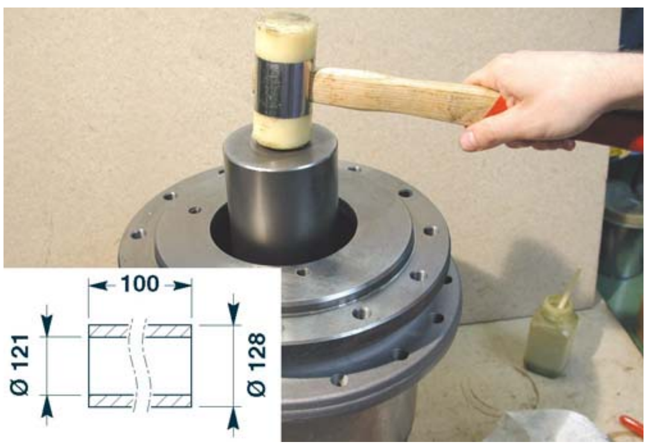
44. Lube the seal seats into the flanged hub (31) and assemble the O-ring seal (42) and the backup ring (43).

NOTE: *The O-ring seals (A) and backup rings (B) must be fitted in the seats according the mutual position as shown in the scheme.*



45. Insert the brake piston (44) inside the flanged hub (31), paying attention not to damage the seals already fitted.

46. By using a rubber hammer and a metal stopper push the brake piston (44) against the flanged hub (31), paying attention not to damage the seals already fitted.

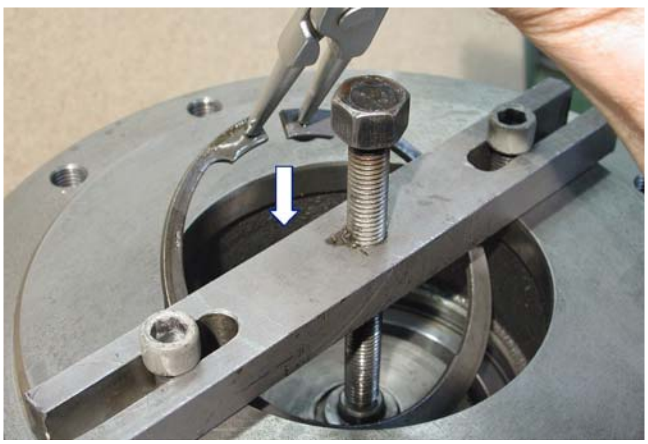


47. Insert the springs (45) into the holes in the brake piston (44) marked previously.

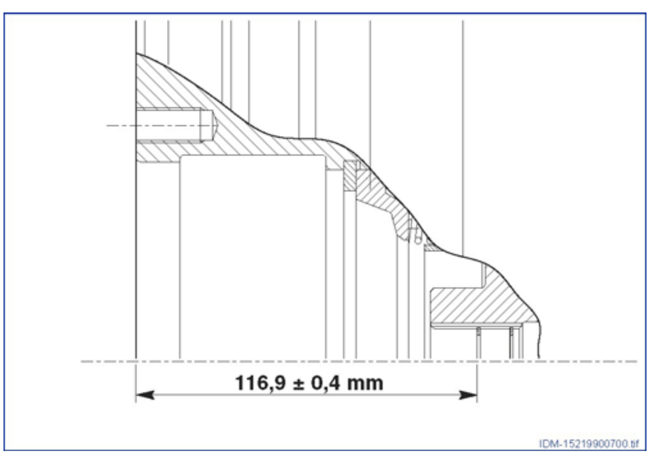
48. Insert the spring retainer disc (46).

49. Install the special tool (6689960310) on the flanged hub (31) and turn the screw until it compresses the springs (45).

50. Assemble the circlip (47) in its seat and remove the special tool.



NOTE: *Before assembling the hydraulic motor, verify by a depth slide gauge the correct assembly of the unit checking the axial distance as shown below.*



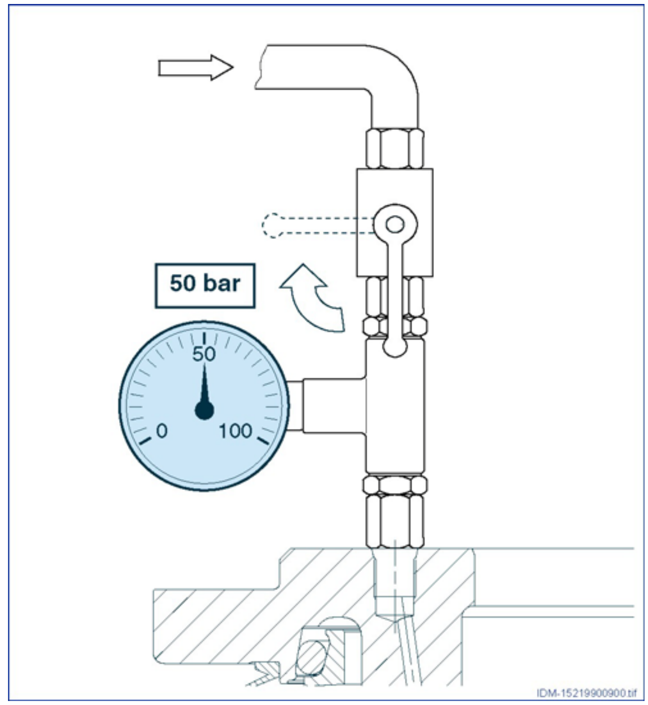
Final Test and Reinstallation

Check the product by remounting it to the machine.

Check the function of the drive hub following all the checks shown in Startup and Running In.

If work on the brake was undertaken, it is important to check that there are no oil leaks. Follow the procedure below:

1. Connect the pressure pilot line with the manometer (with a base scale of 100 bars) to the brake release port.



2. Open the flow valve and release the brake with the pilot pressure of 50 bar.
3. Close the flow valve and keep the brake released 3 minutes or longer.
4. Using the manometer, check that the pressure remains constant.

NOTE: *If the pressure drops it may mean that the brake seals are not tight and consequently they must be replaced or it may mean that the reassembling was not completed properly.*

5. After having reassembled the gearbox, install the hydraulic motor.
6. Fill the gearmotor with the lubricant oil.

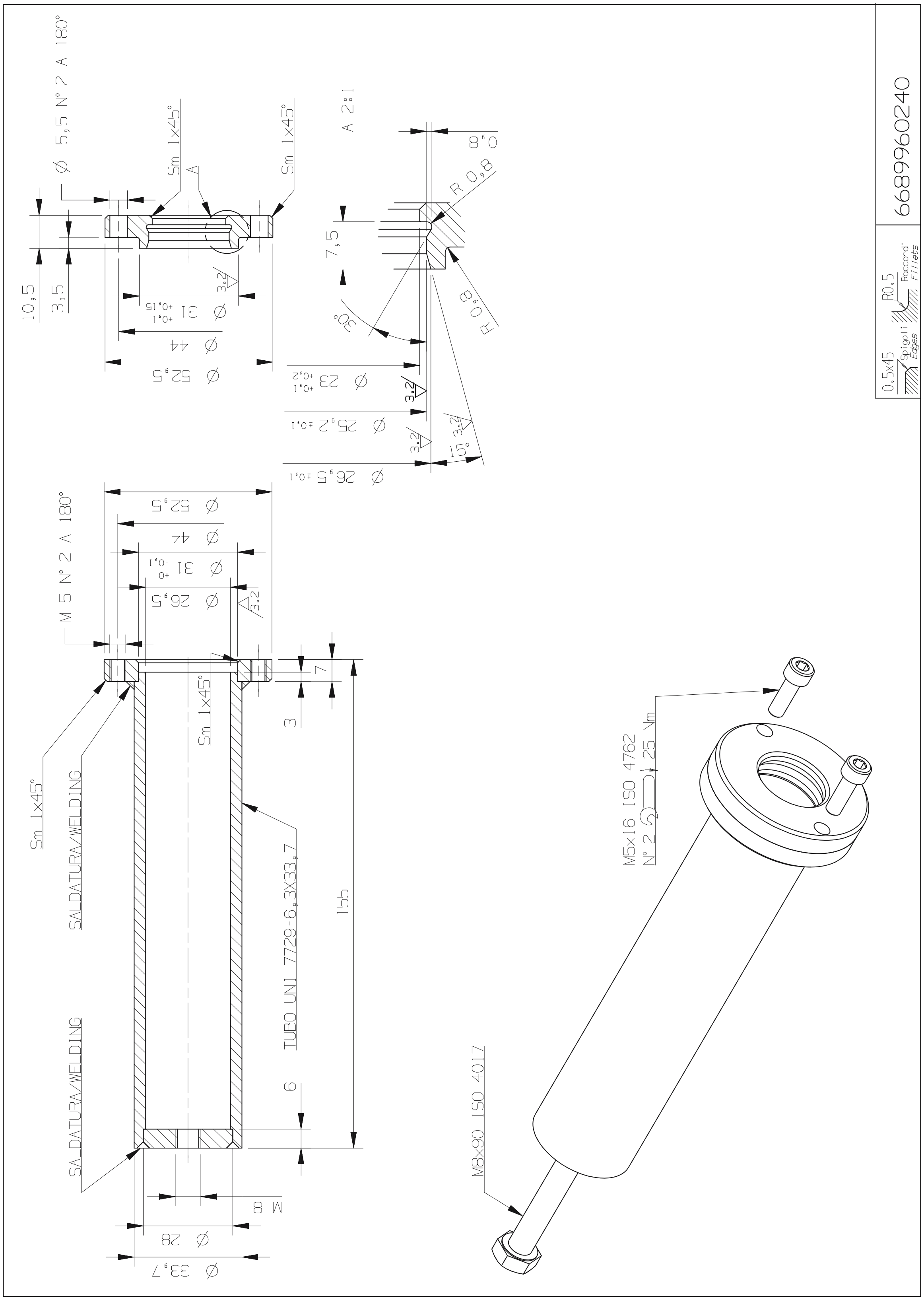


Figure 3-20. Drive Hub Special Tools - Sheet 1 of 4

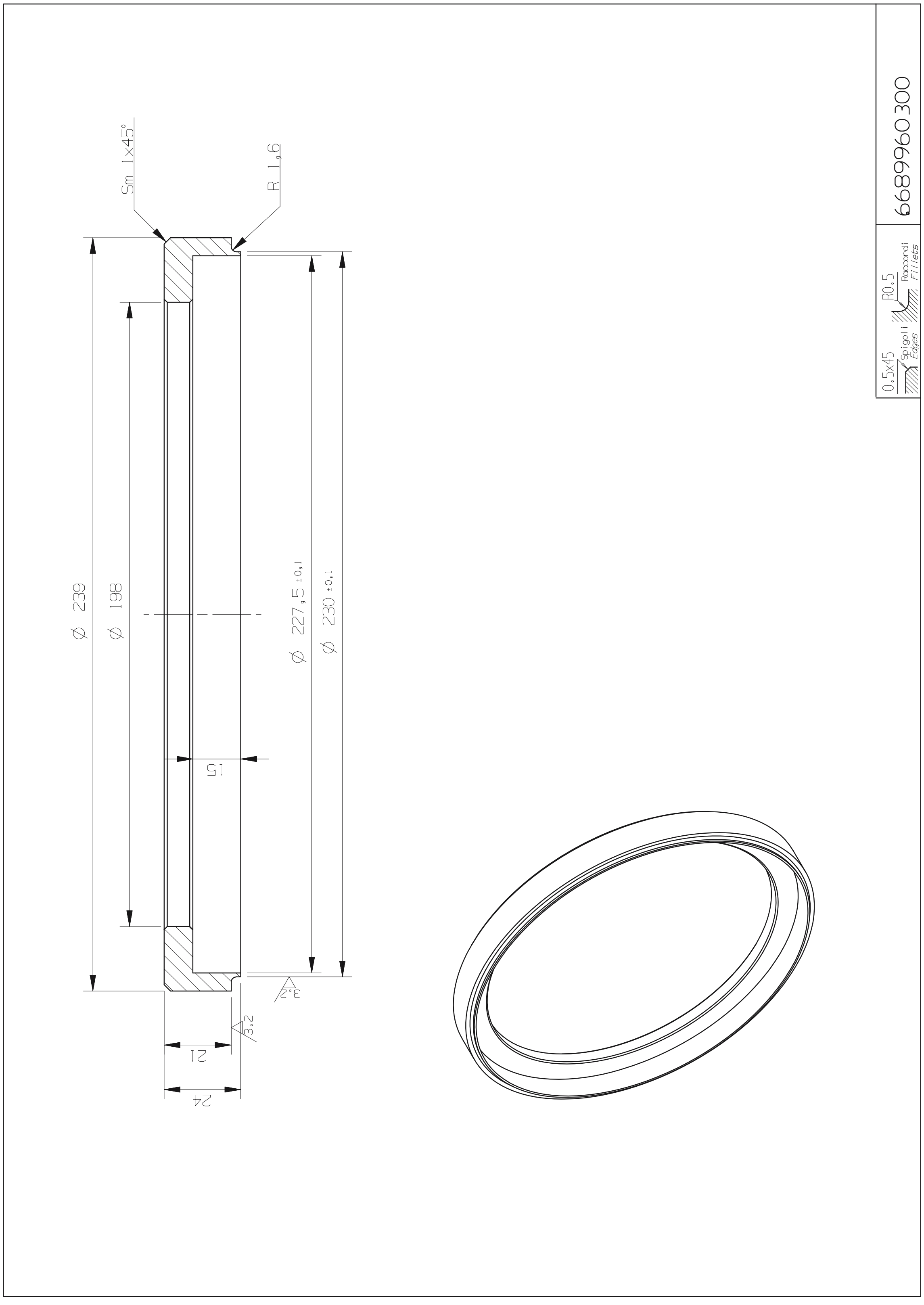


Figure 3-21. Drive Hub Special Tools - Sheet 2 of 4

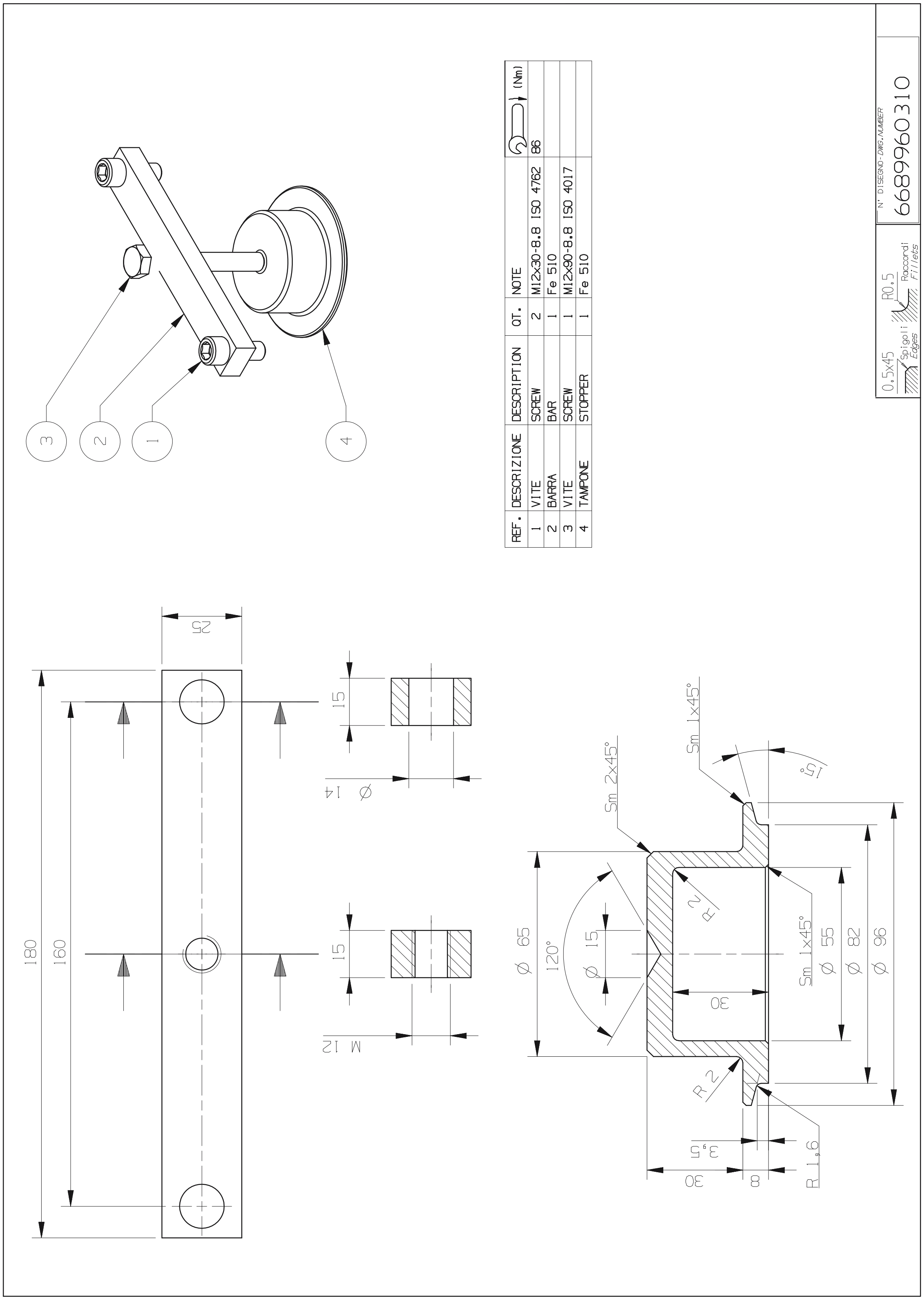


Figure 3-22. Drive Hub Special Tools - Sheet 3 of 4

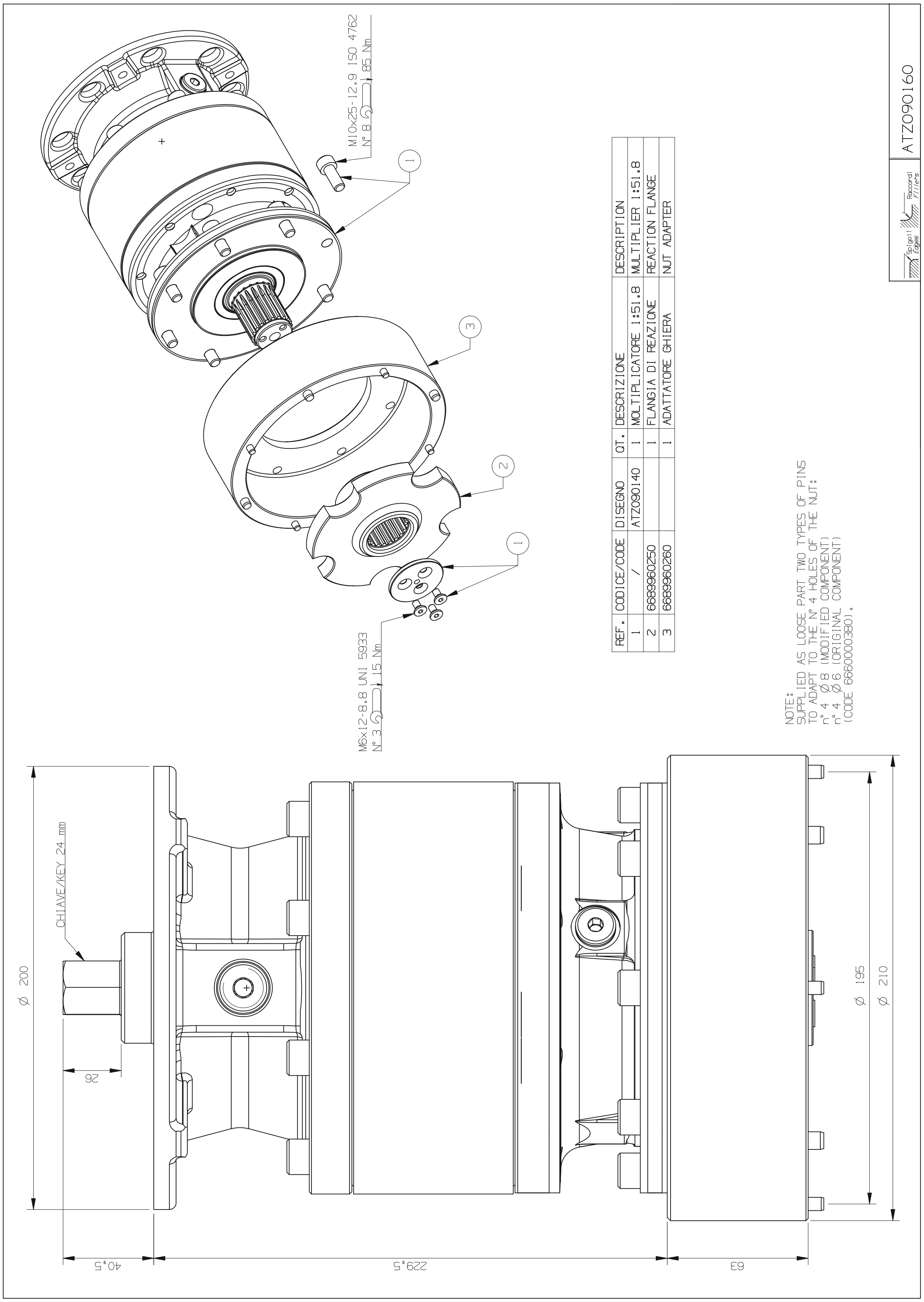


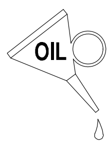
Figure 3-23. Drive Hub Special Tools - Sheet 4 of 4

3.13 DRIVE HUB - REGGIANA RIDUTTORI (S/N 134389 TO PRESENT)

NOTE: *After S/N 0300134389 machines may be built with either Bonfiglioli or Reggiana Riduttori wheel drive hubs. See Section 3.12, Drive Hub - Bonfiglioli (S/N 100128 to Present). Do not use different hubs on the same machine.*

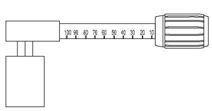
Symbol Nomenclature

= ADHESIVE

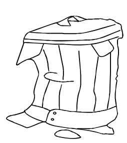


= LUBRICANT

= GREASE



= TORQUE WRENCH



= DISPOSAL

Tools

Tools required for assembling and disassembling the wheel gear RRTD1701TB

1. Hammer;
2. Clamps for inner retention rings;
3. Clamps for outer retention rings;
4. Electric or pneumatic screwdriver;
5. Special spacer mounting;
6. Torque wrench;
7. Hydraulic press;
8. Wrench for M6, M8, M10 socket head screws and 1/4"G plug.
9. Socket wrench for M6 hexagonal screw.

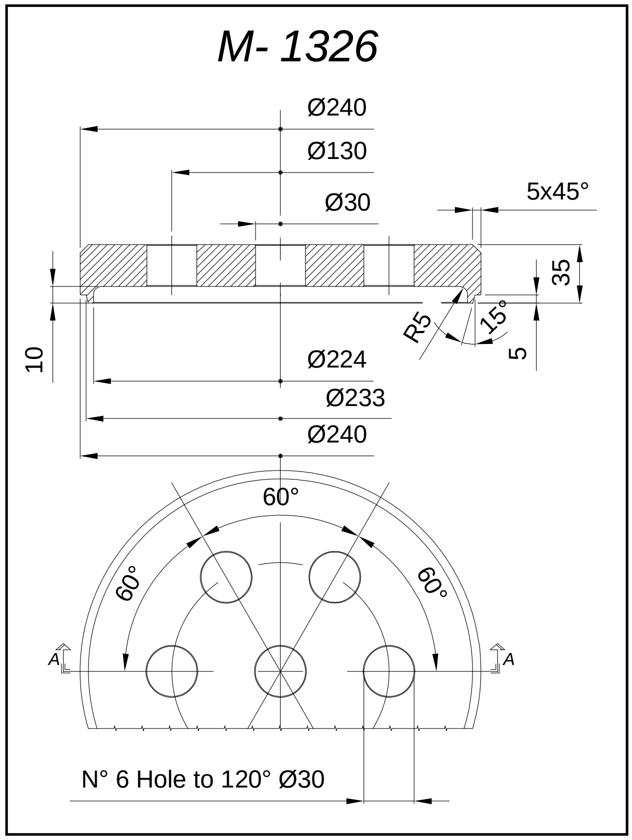


Figure 3-24. Bearing Track Spacer Mounting C016117

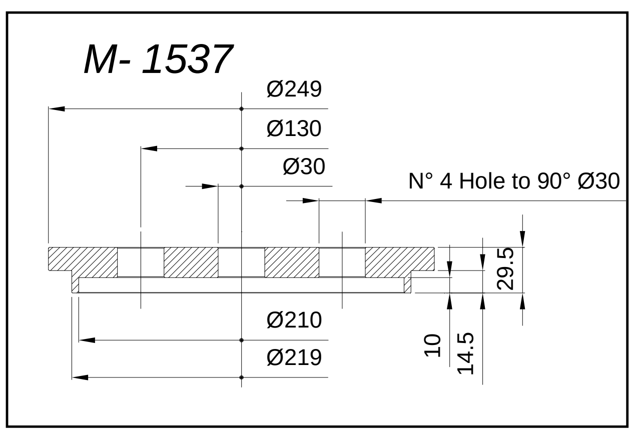


Figure 3-25. Oil Seal Spacer Mounting C125049

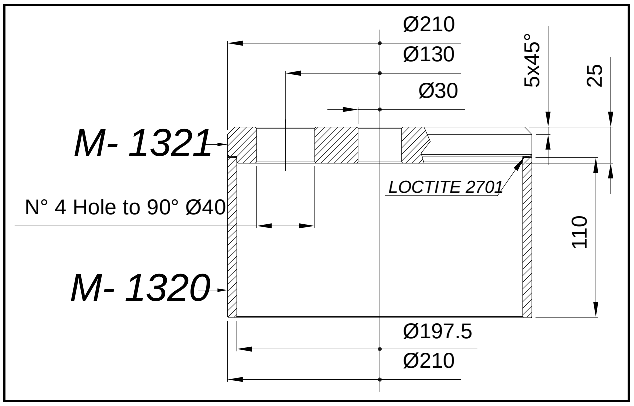


Figure 3-26. Bearing Spacer Mountng CO16117

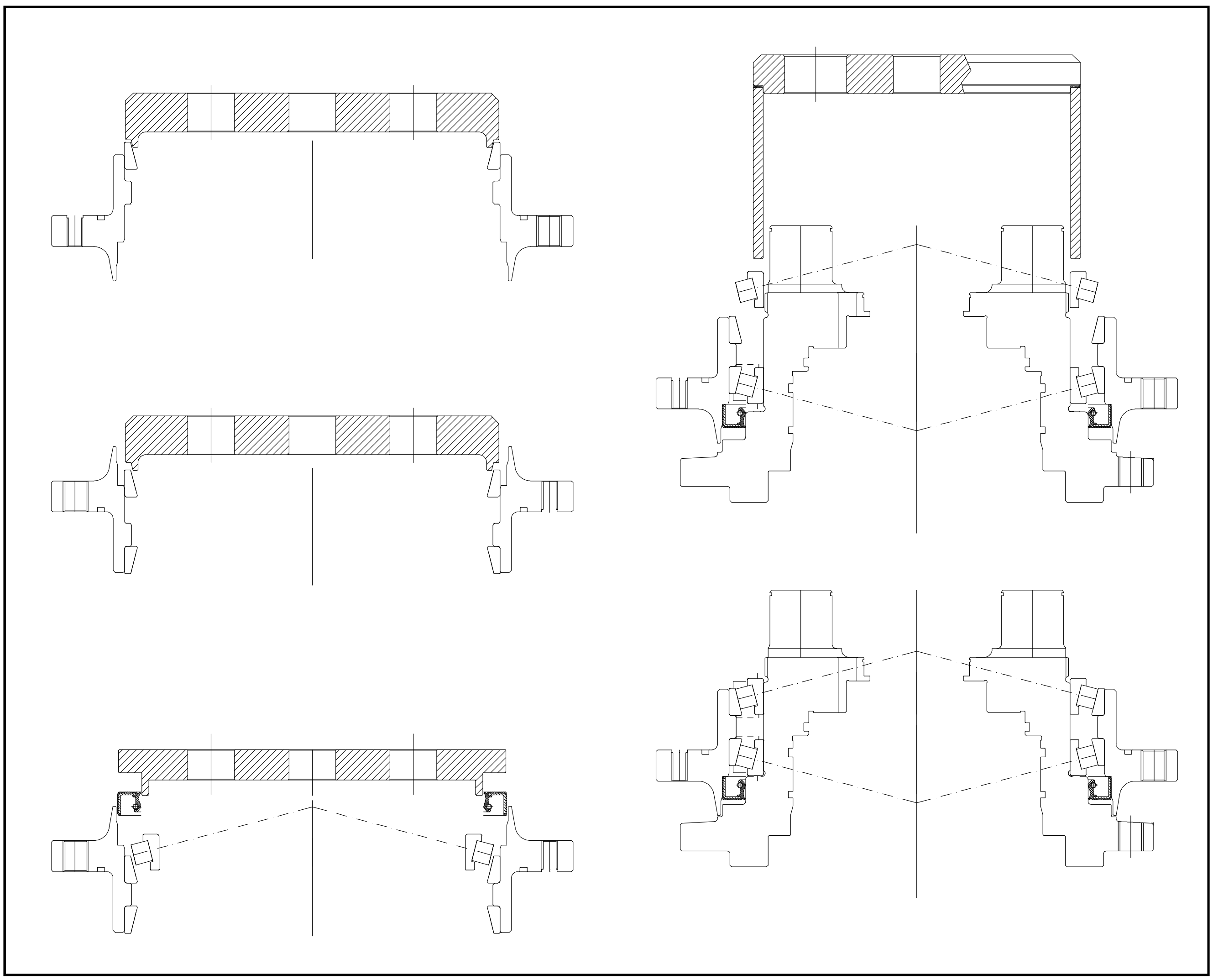


Figure 3-27. Assembly Diagram 1

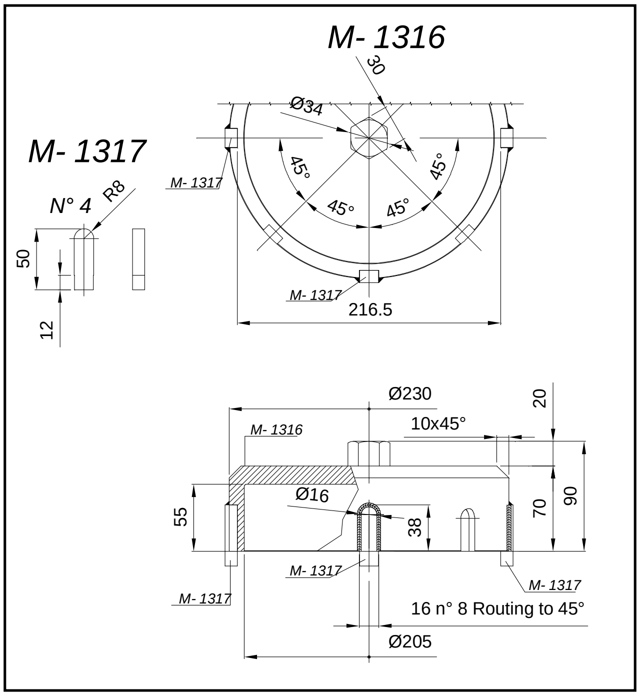


Figure 3-28. Wrench For Ring Nut

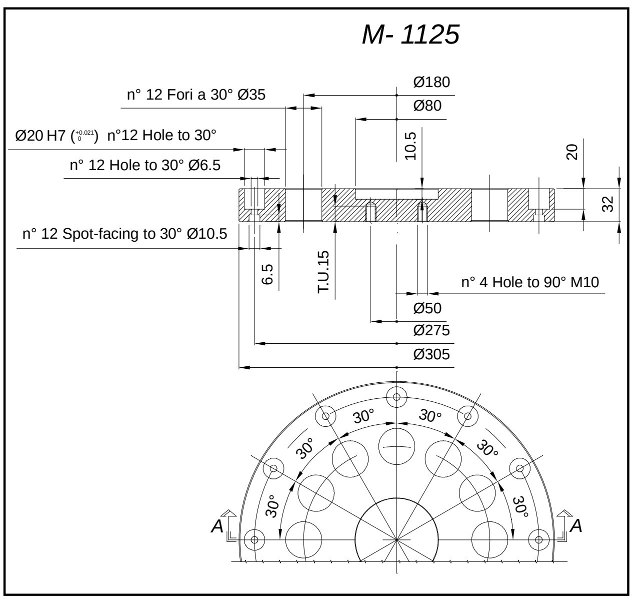


Figure 3-29. Anti-rotation Flange

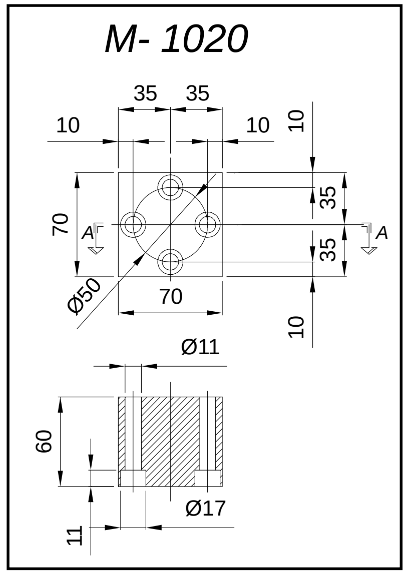


Figure 3-30. Anti-rotation Block

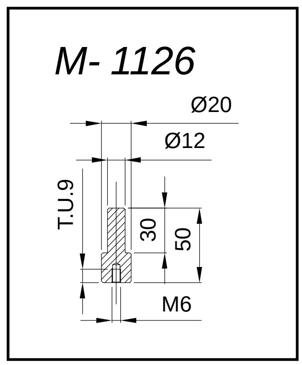


Figure 3-31. Anti-rotation Pin

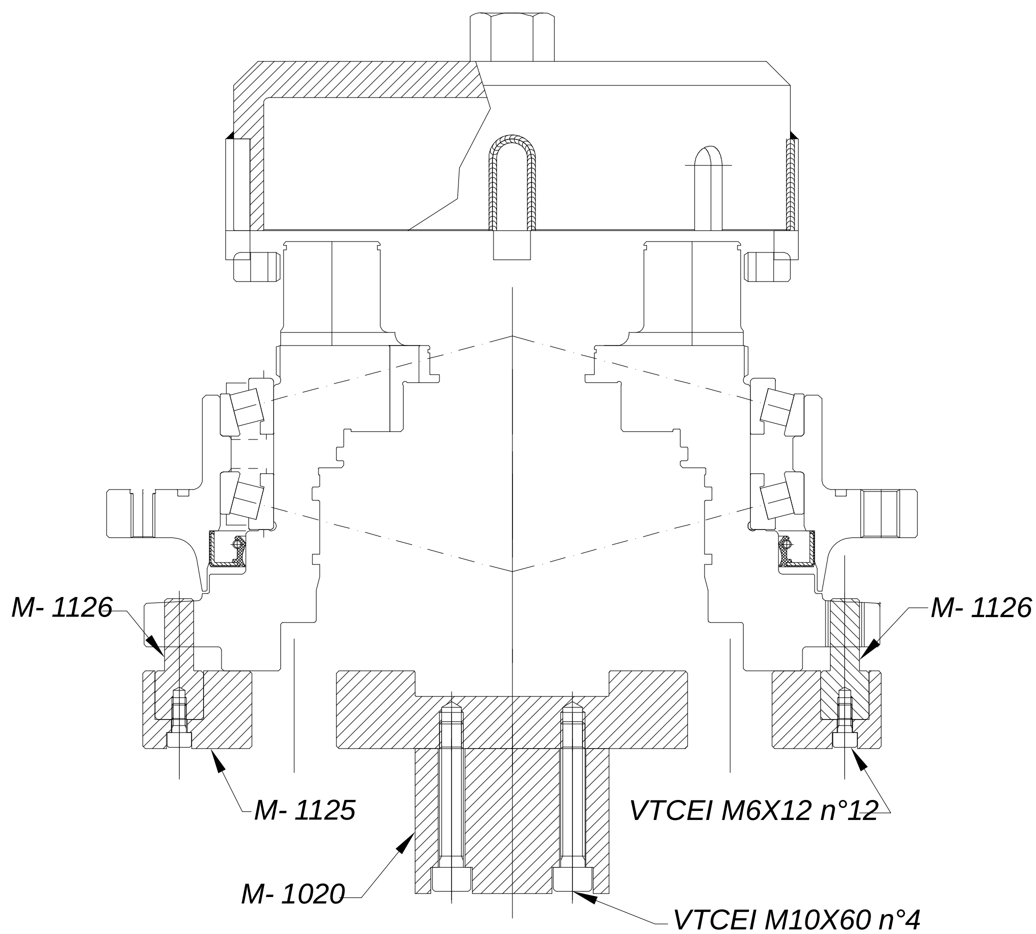


Figure 3-32. Assembly Diagram 2

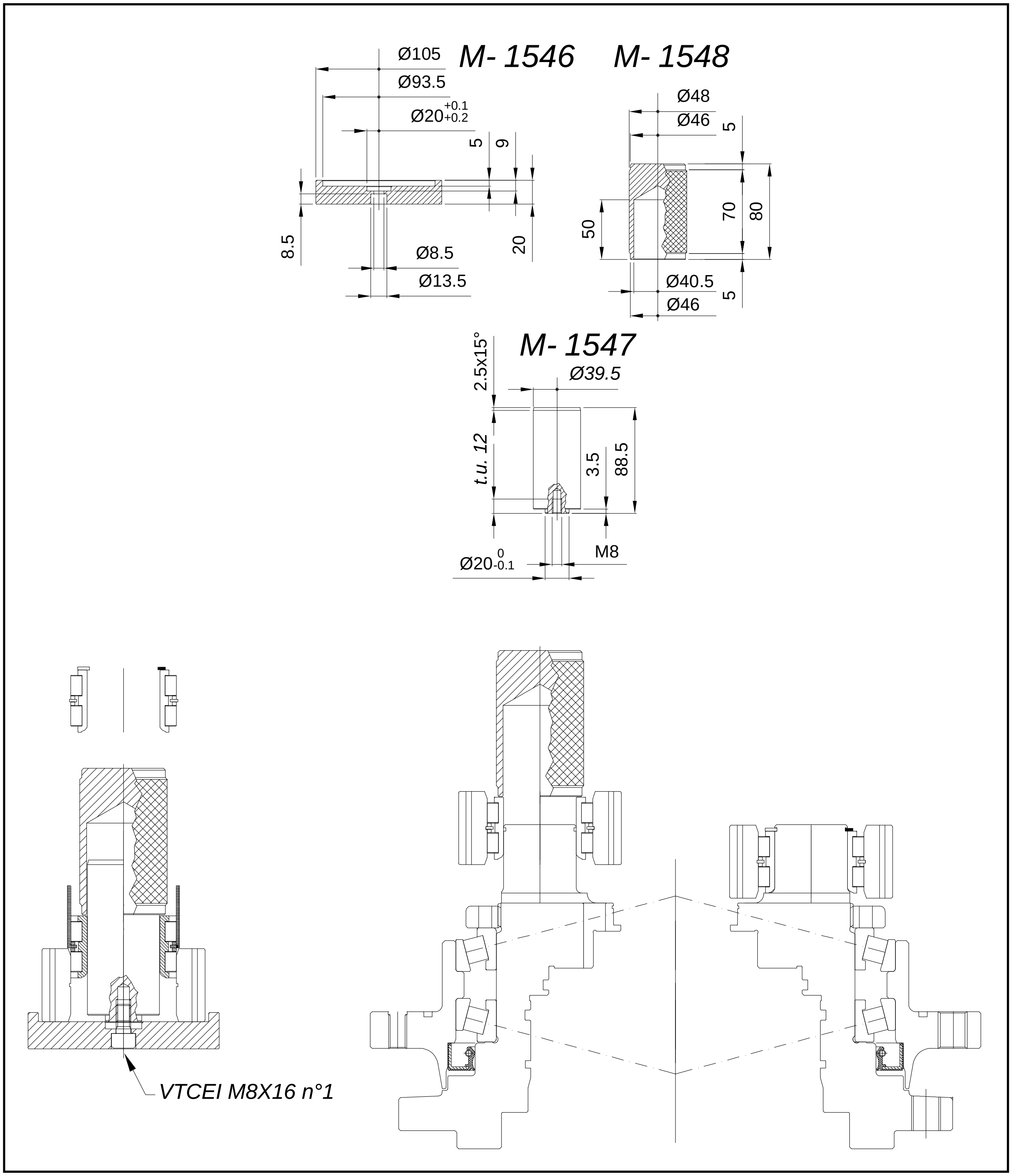
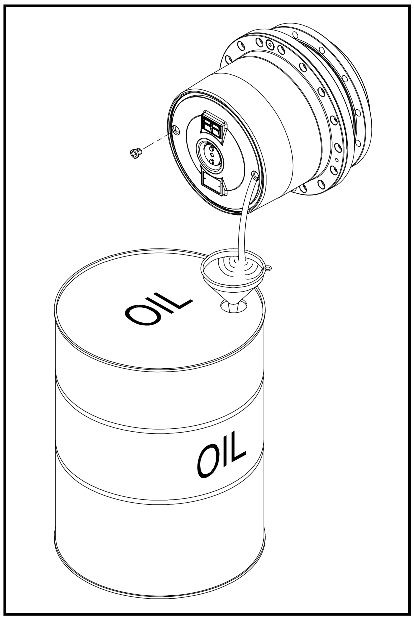


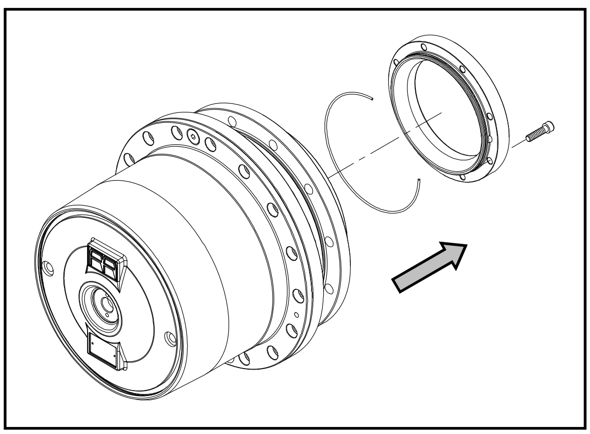
Figure 3-33. Tools For Assembling Bearing 3rd Stage Planetary Gear Assembly Diagram

Disassembly

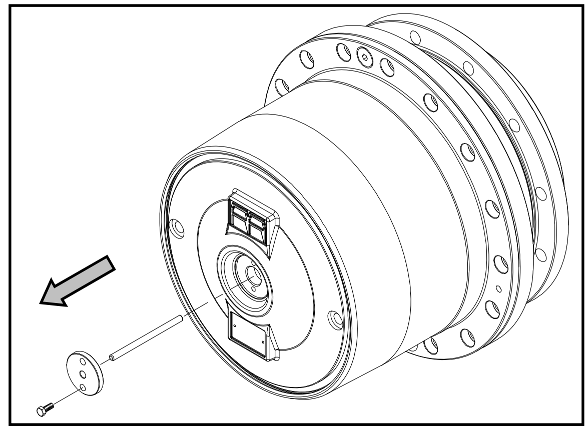
1. Remove the plugs and pour the lubricant in a container.



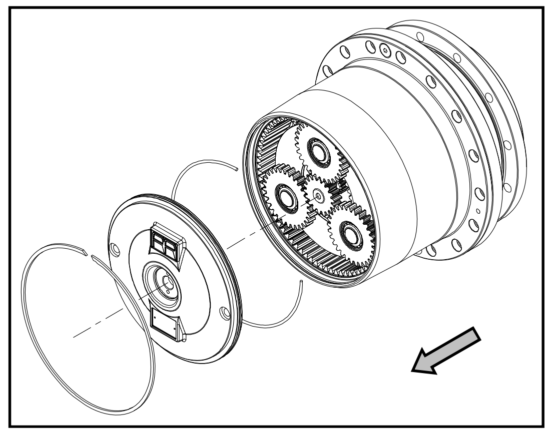
2. Release the screws to disassemble the motor flange taking care not to damage the O-Ring.



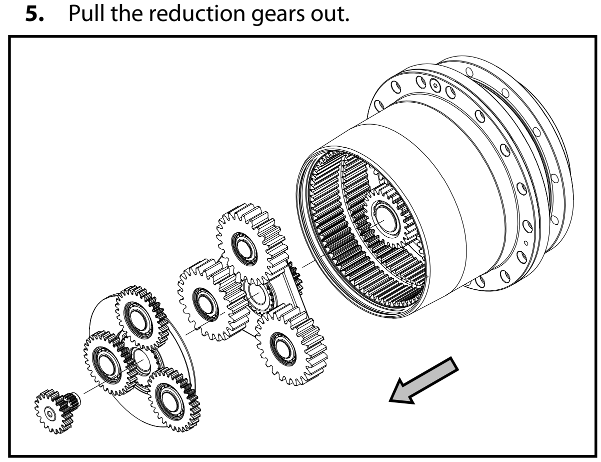
3. Release the screws from the release cover and pull the pin out.



4. Remove the BR250 ring and pull the cover out avoiding to damage the O-Ring.



5. Pull the reduction gears out.



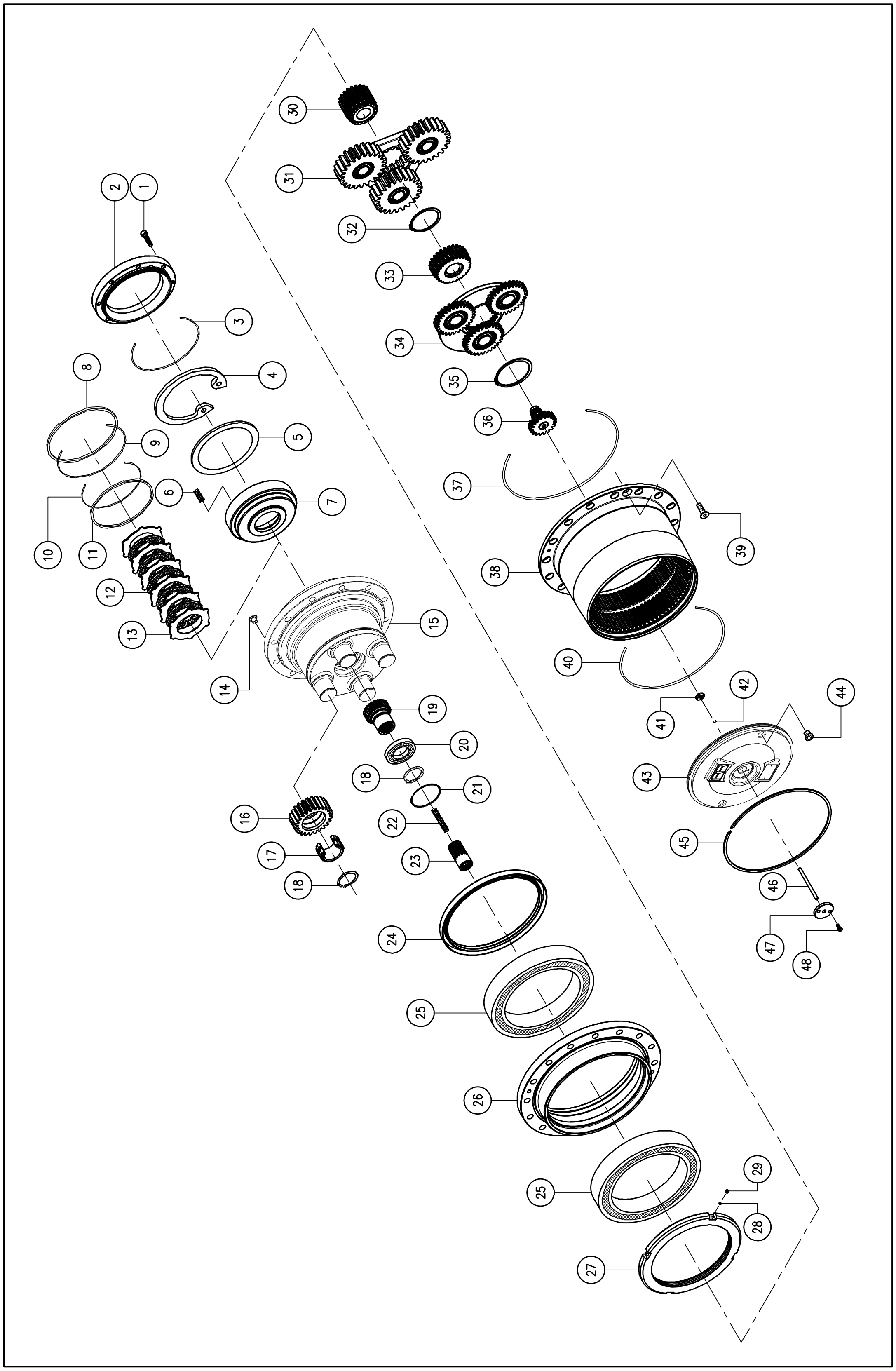
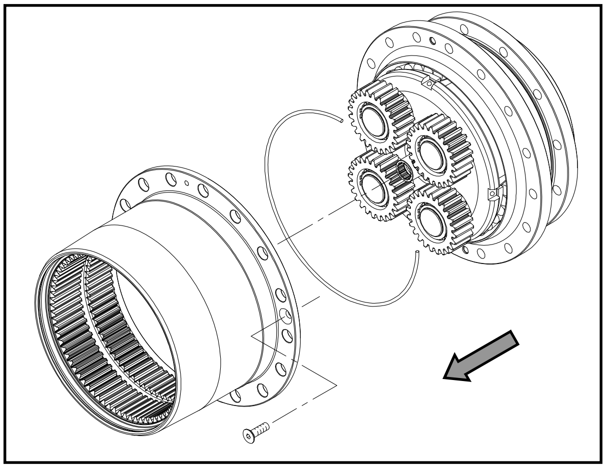


Figure 3-34. Reggiana Riduttori Hub - Sheet 1 of 2

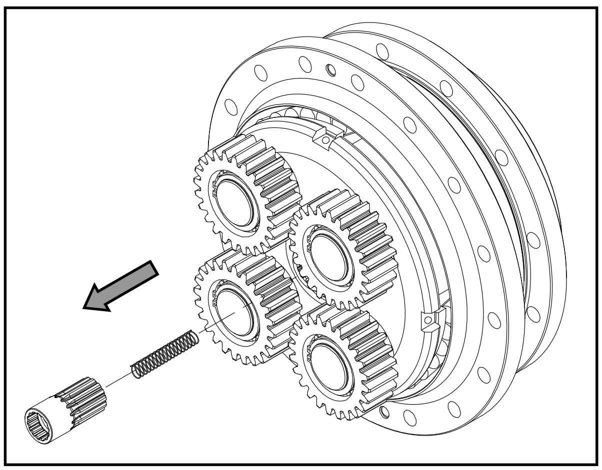
1. Screw
2. Motor Support
3. O-ring
4. Inner Retention Ring
5. Brake Spring Spacer
6. Brake Spring
7. Brake Piston
8. Parbak
9. O-ring
10. O-ring
11. Parbak
12. Sintered Brake Disc
13. Iron Brake Disc
14. Plastic Plug
15. Spindle
16. Planet Wheel
17. Bearing
18. Outer Retention Ring
19. Input Shaft
20. Input Shaft Bearing
21. Ring
22. Disengagement Spring
23. Disengagement Shaft
24. Spindle Oil Seal
25. Tapered Roller Bearing
26. Bearing Support
27. Ring Nut
28. Sphere
29. Screw
30. Pinion
31. Reduction Gears
32. Outer Retention Ring
33. Pinion
34. Reduction Gears
35. Outer Retention Ring
36. Pinion
37. O-ring
38. Crown Gear
39. Crown Gear Screw
40. O-ring
41. Support Tablet
42. O-ring
43. Cover
44. Steel Plug
45. Cover Retaining Ring
46. Disengagement Stud
47. Disengagement Cap
48. Disengagement Screw

Figure 3-35. Reggiana Riduttori Hub - Sheet 2 of 2

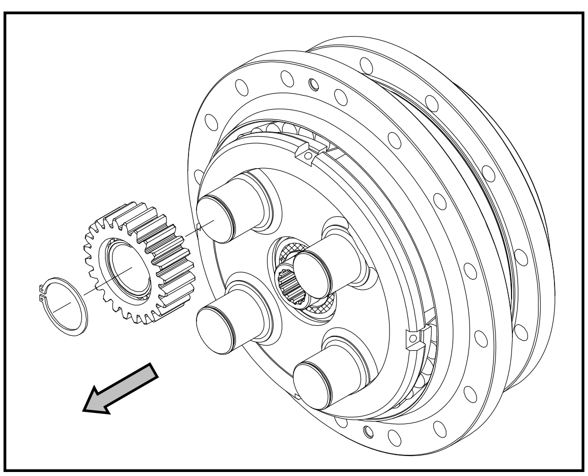
6. Loosen the M10x25 flathead socket screws and remove the planetary ring without damaging the O-Ring.



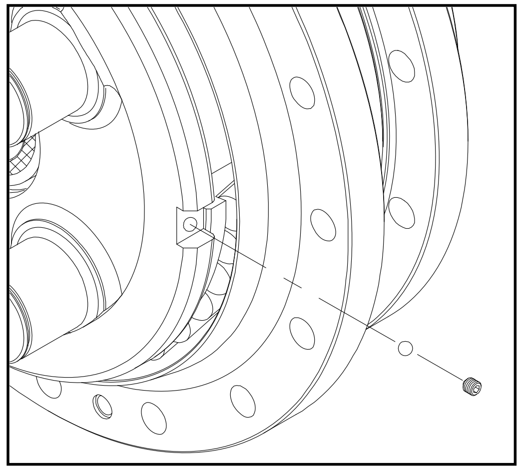
7. Remove the release joint together with the spring.



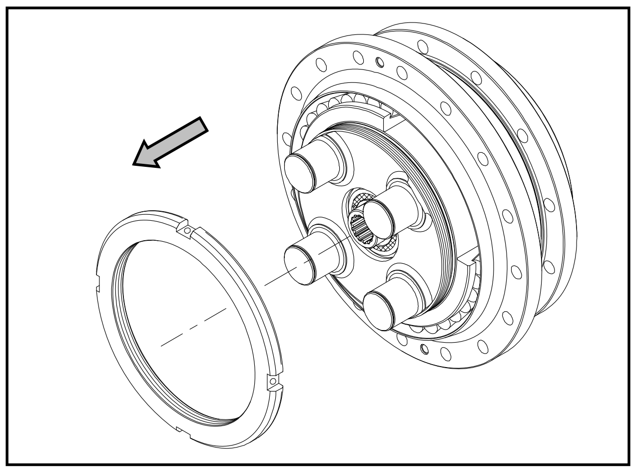
8. Disassemble the Ø40 outer snap rings and using an extractor remove the planetary gears from the spindle pins.



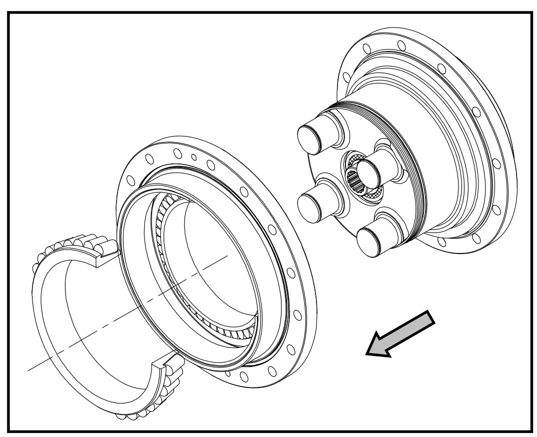
9. Loosen the M6x6 socket headless screws and also remove the 3/16" balls.



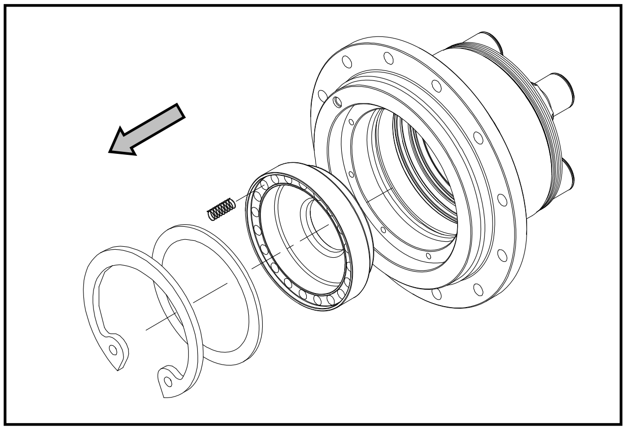
10. Loosen the ring nut using the special wrench.



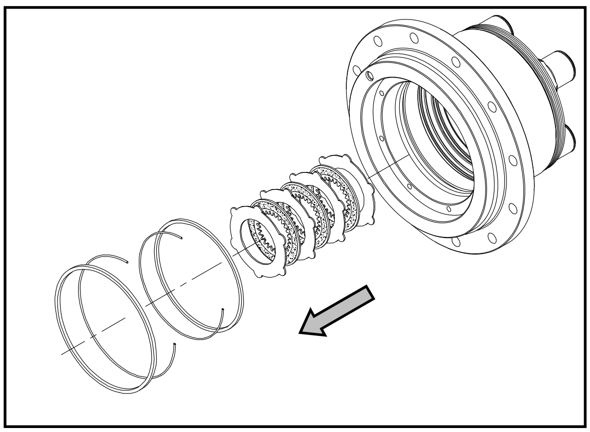
11. Remove the hub support together with the roller bearing inner track.



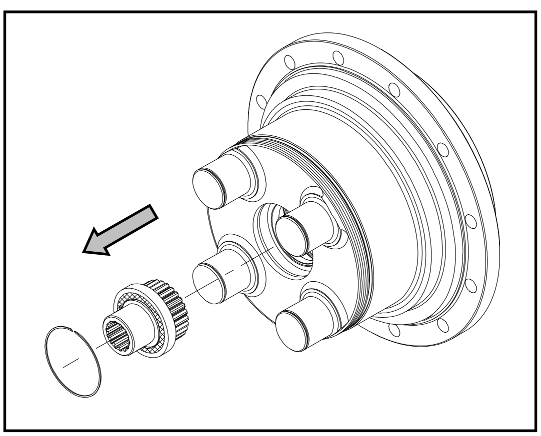
12. Disassemble the Ø160 inner snap ring and pull the spring holder spacer out. Remove the springs and using a compressed air jet in the brake control hole pull the piston out of the spindle.



13. Remove the brake discs and seals.

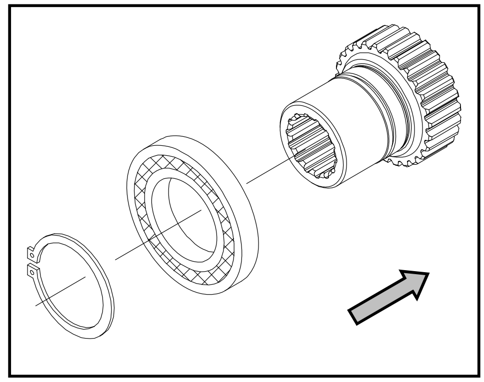


14. Fit the ball bearing into the input shaft and lock it with a Ø40 outer snap ring. Then mount the motor shaft in the spindle and lock with a BR68 ring. Lubricate the bearing.

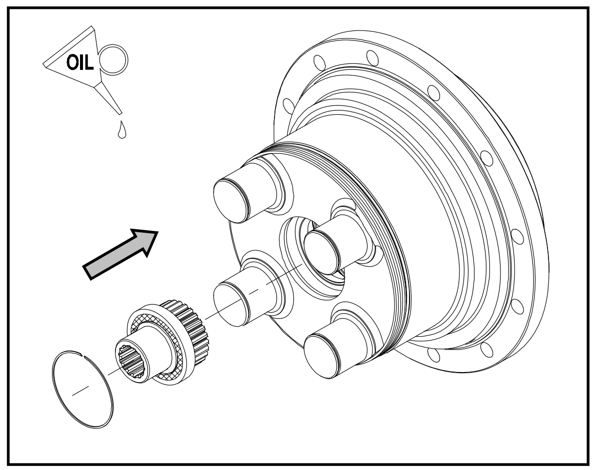


Assembly

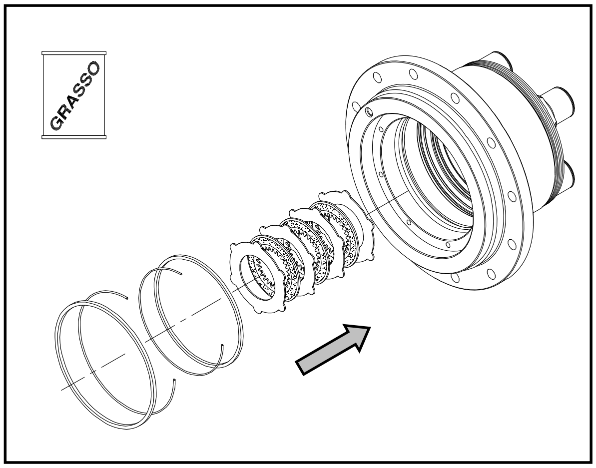
1. Make sure all the component parts of the wheel gear are devoid of burrs, machining residues and that they are correctly washed.
2. Fit the ball bearing in the input shaft and lock with a Ø40 outer snap ring.



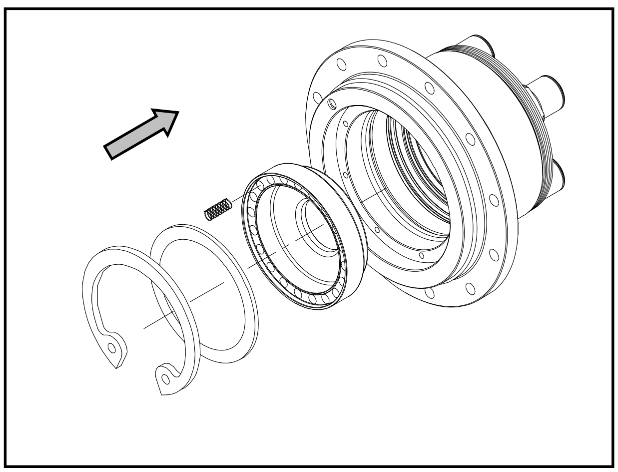
3. Mount the motor shaft in the spindle and lock with BR68 ring. Lubricate the bearing.



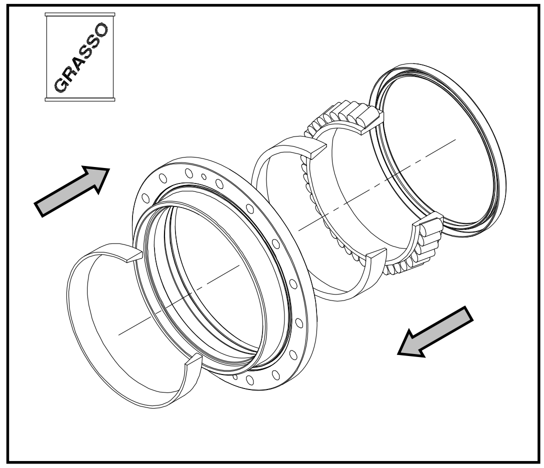
4. Fit the brake sealing rings O-Ring and PARBAK (lubricated with grease) in the respective spindle seats. Place the brake discs making sure to centre them on the spindle and on the input shaft.



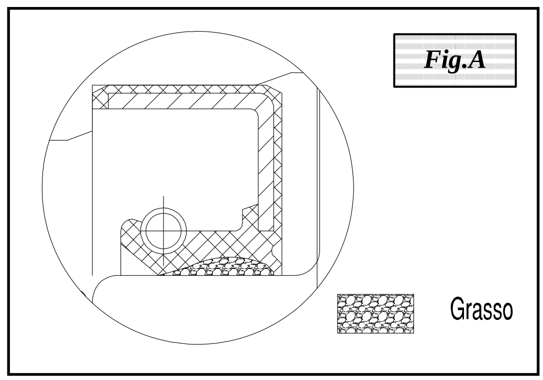
5. Insert the brake piston and place the springs into the piston holes. Close the brake fitting the spring holder plate, then lock with the Ø160 inner snap ring. Check the brake leakage, if any, as well as the static torque and minimum opening pressure.



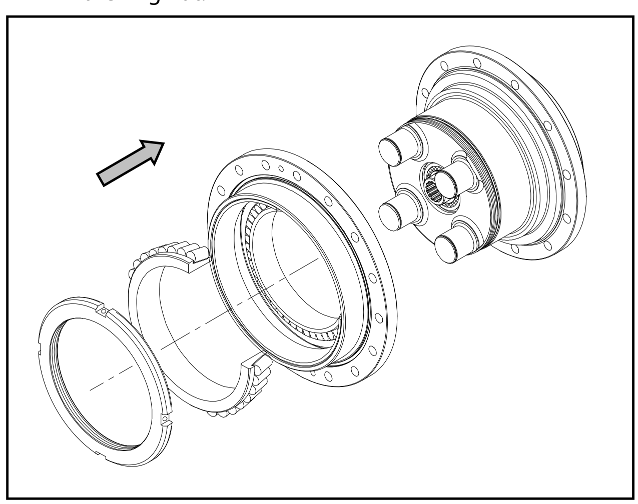
6. Prepare the hub support, mounting on it the two roller bearing outer tracks. Place the first roller bearing inner track.



7. Fit the oil seal lubricated with grease onto the support with the special spacer mounting (see figure A).

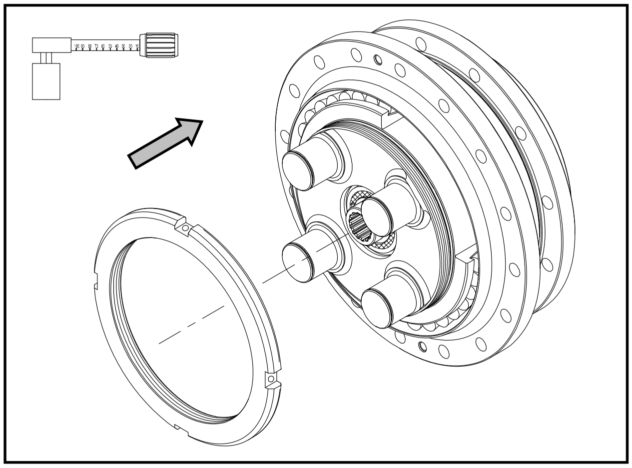


8. Place the hub support already assembled on the spindle making sure that the first roller bearing inner track goes correctly against it; then fit the second roller bearing inner track by means of the spacer mounting. Tighten the ring nut.

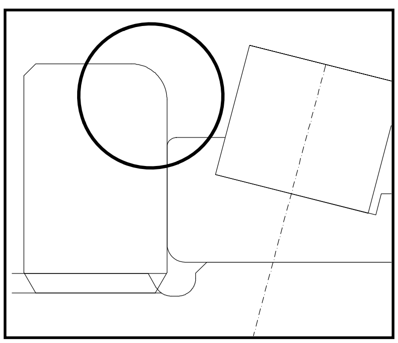


9. Now check the unit roll torque and proceed in the following order:

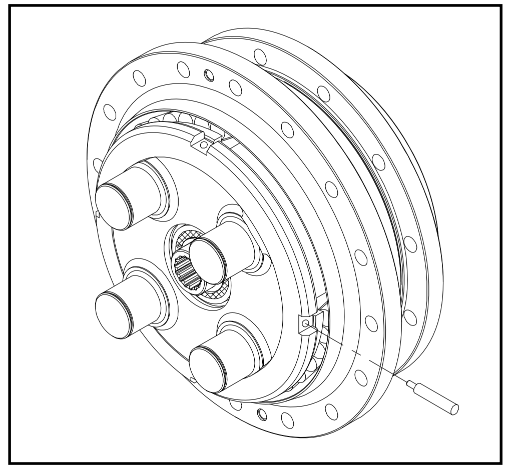
10. 7.) By keeping the spindle locked, apply a setting preload by tightening the ring nut at 40daNm, turn completely the hub support twice using the special wrench to recover any bearing cage misalignments. Release and tighten the ring nut at the final torque of 30daNm (alternate tightening and some setting turns). Check the roll torque with seal which must be within 1÷1,5 daNm.



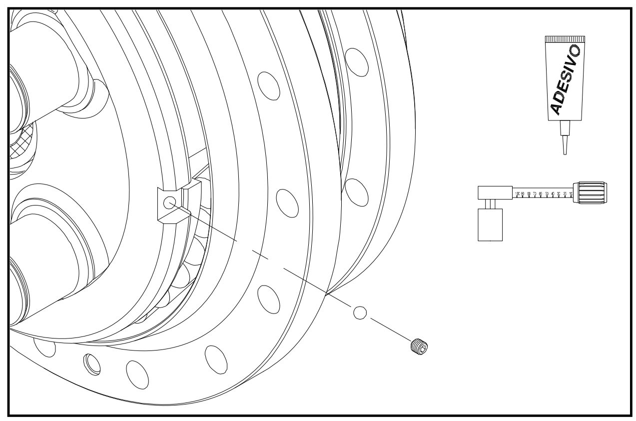
NOTE: *Place the ring nut with its convex part facing the roller bearing as shown below.*



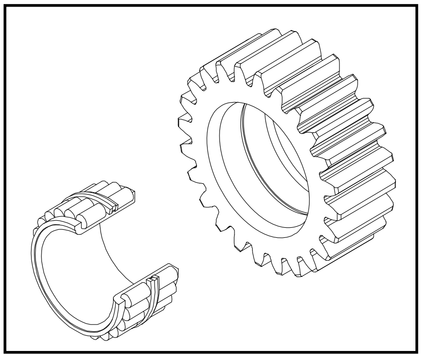
11. Using the special tool and hammer make four dents on the spindle thread by the M6 holes of the ring nut.

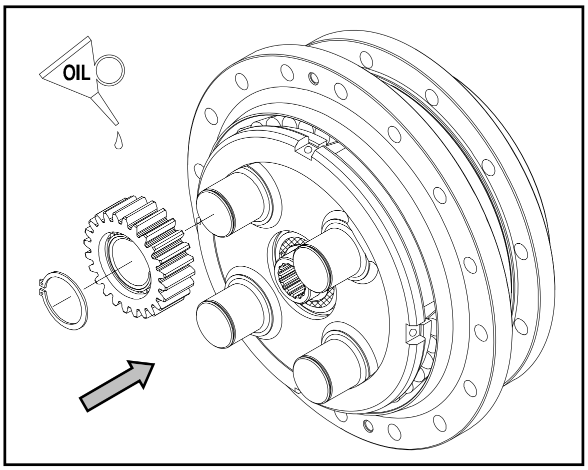


12. Fit the 4 3/16" balls and tighten with LOCTITE 243 the 4 M6x6 socket headless screws at the torque of 1daNm.

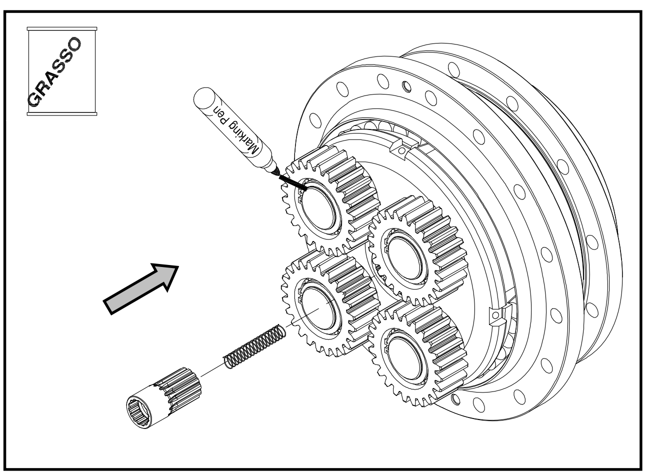


13. Fit the bearings onto the 3rd stage planetary gears and using a spacer mounting mount everything on the spindle pins. Lock with a ÿ40 outer snap ring. Lubricate the bearings.

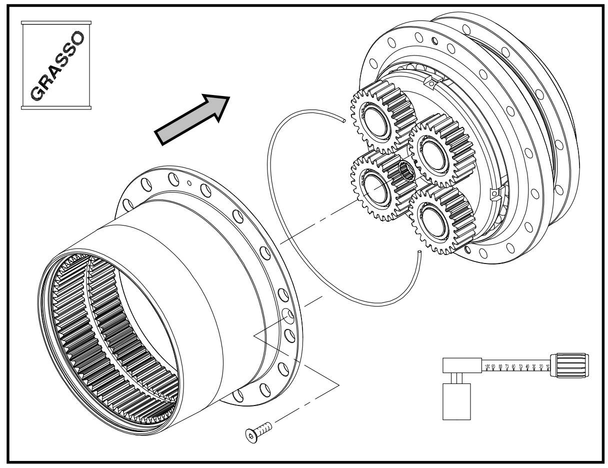




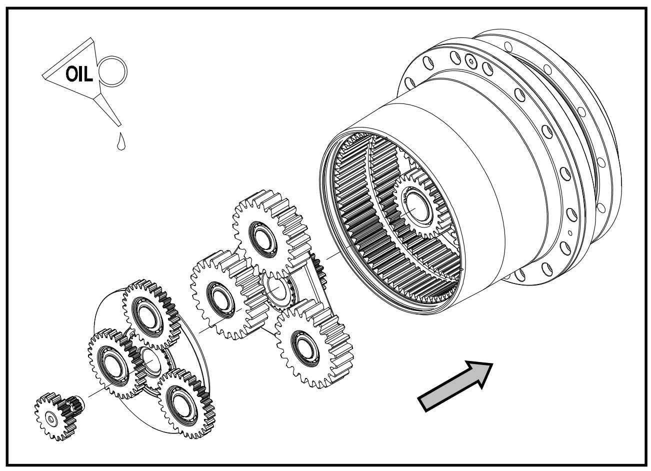
14. Using a marking pen, make a mark between the snap ring and the bearing. Fit the greased spring and the release joint. Use grease to fit the O-Ring 2-275 in the hub support seat.



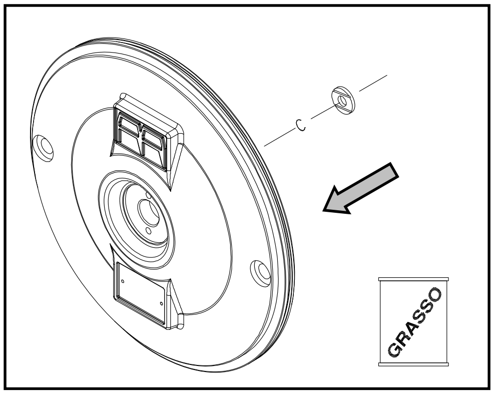
15. Place the hub onto the support making the two holes coincide for tightening the M10x25 flathead socket screws at the torque of 5daNm.



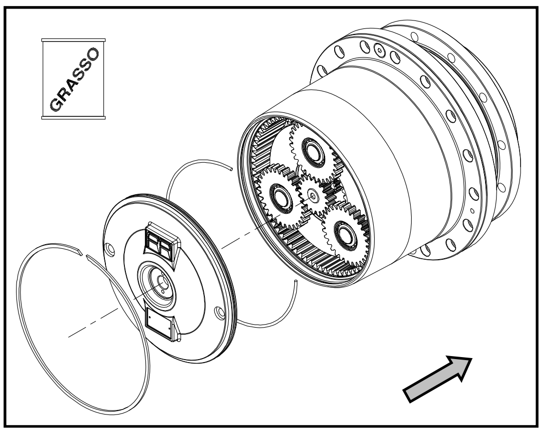
16. Fit the reduction gears and the pinion in the unit.



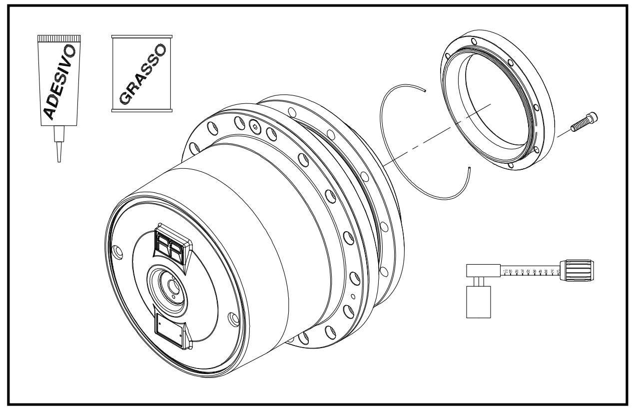
17. Prepare the closing cover fitting the O-ring 5-582 suitably greased and lock it with the shimming ring. Lubricate the bearings.



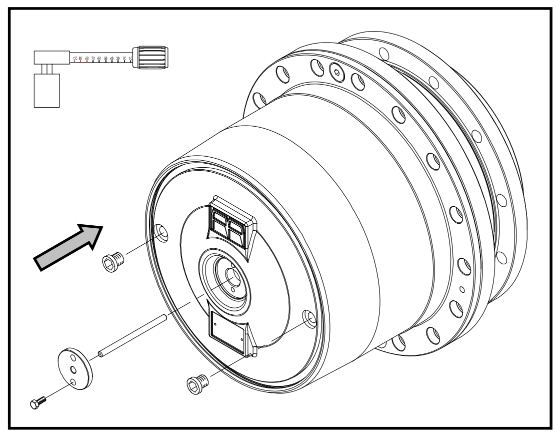
18. Fit the O-Ring 2-177 suitably greased, mount the cover locking it with the BR250 ring.

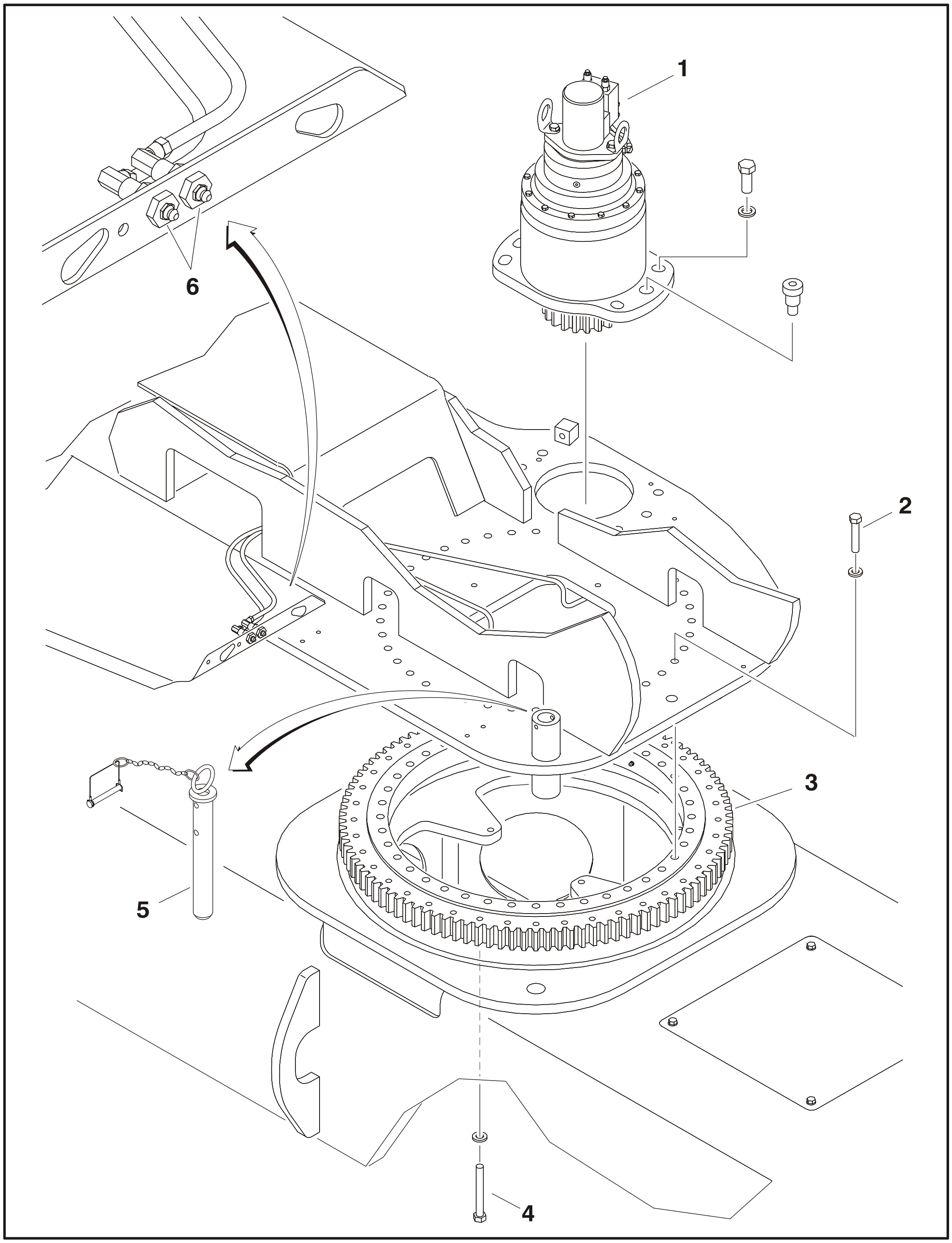


19. Fit the O-Ring 2-163 suitably greased, onto the motor coupling flange S-D LC/KC. Mount the flange on the spindle with 6 M8x25 socket cap screws at the torque of 2.4daNm with LOCTITE 243 Insert the pin and carry out the rotation test according to PGQ-22 standard.



20. Mount the release cover fastening it with 2 M6x20 hexagonal screws at the torque of 1daNm. Mount the 1/4"GAS plugs on the cover at the torque of 1daNm.





1. Swing Drive
2. Inner Race Bearing Bolt
3. Swing Bearing
4. Outer Race Bearing Bolt
5. Turntable Lock Pin
6. Remote Bearing Lubrication Fittings

Figure 3-36. Swing System

3.14 SWING DRIVE

Roll and Leak Testing

Torque-Hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears, bearings and seals are working properly. The following information briefly outlines what to look for when performing these tests.

NOTE: *The brake must be released before performing the roll test. This can be accomplished by either pressure testing using the Brake Leak Test procedure below or by tightening the 12 bolts into the piston through the end plate (See Brake Disassembly Procedure)*

NOTE: *Bolts must be removed while performing brake release test*

Roll Test

The purpose of the 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 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 should be examined 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.

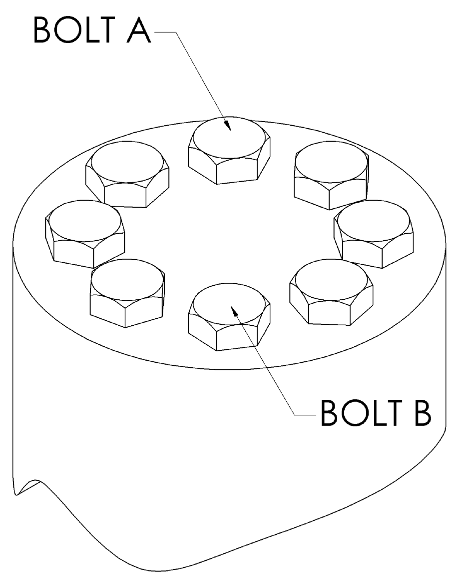
LEAK TEST (MAIN UNIT)

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 after the unit has been pressurized and allowed to equalize. Leaks will most likely occur at the pipe plugs, the main seal or wherever o-rings or gaskets are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where the o-rings or gaskets meet on the exterior of the unit, then checking for air bubbles. If a leak is detected in a seal, o-ring or gasket, the part must be replaced, and the unit rechecked. Leak test at 10 psi (0.7 bar) for 20 minutes.

Tightening and Torquing Bolts

If an air impact wrench is used to tighten bolts, extreme care should be taken to ensure that the bolts are not tightened beyond their specified torque.

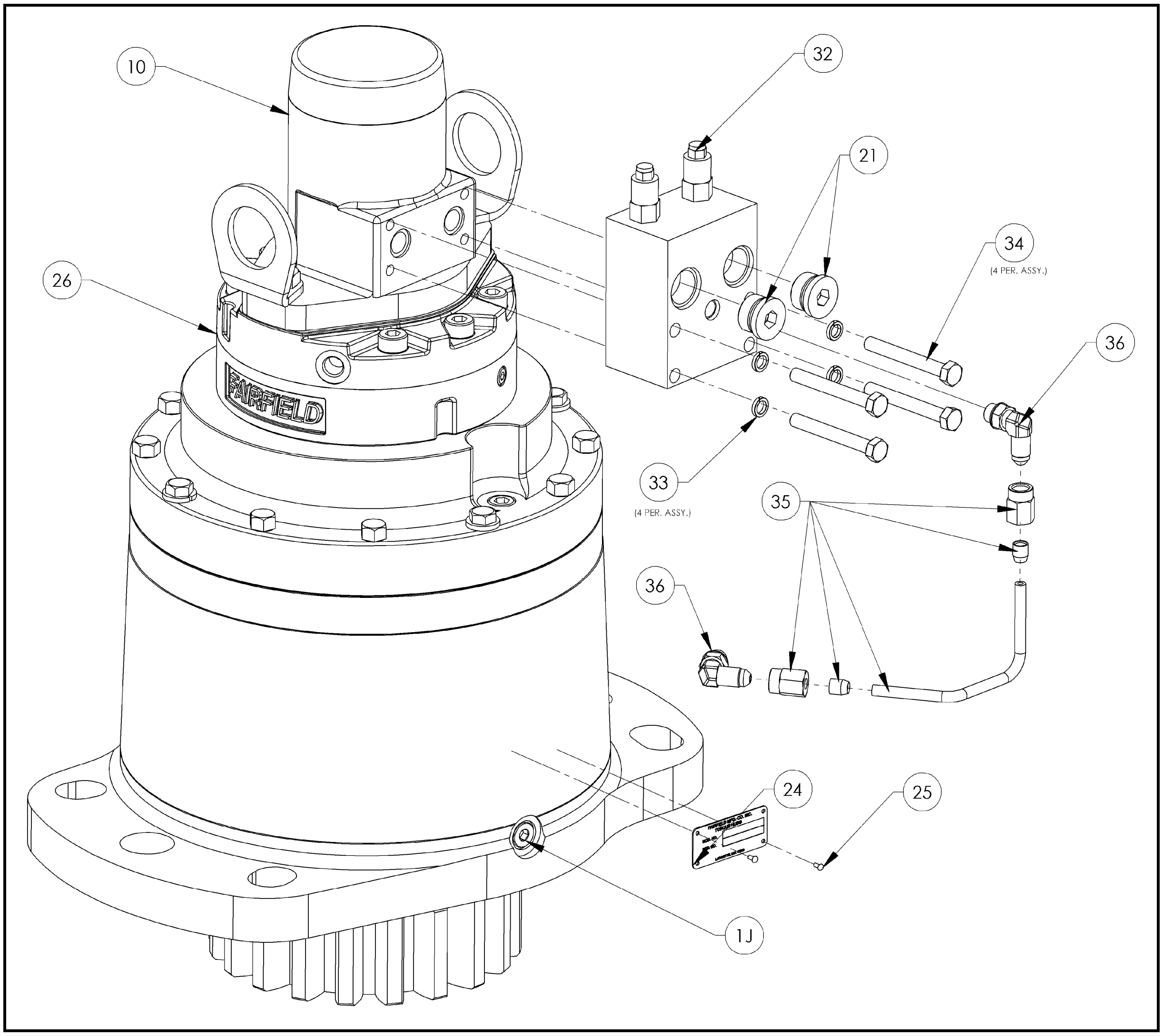
The following steps describe how to tighten and torque bolts or socket head cap screws in a bolt circle.



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. Crisscross around the bolt circle and tighten remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt "A".
5. Using the same sequence, crisscross around the bolt circle and apply an equal torque to the remaining bolts.

Motor Control Valve Disassembly

1. Place unit on bench with the motor end up.
2. Remove O-ring Plug (1J) and drain the oil from the gearbox.
3. Remove Hydraulic Tubing Assembly (35) by loosening fittings on both ends of tube with a wrench.
4. Using a wrench, loosen jam nuts on Elbow Fittings (36) and remove fittings from Brake (26) and Motor Control Valve (32).
5. Remove O-ring Plugs (21) from Motor Control Valve (32).
6. Remove Motor Control Valve (32) from Motor (10) by removing the four Bolts (34) and washers (33).

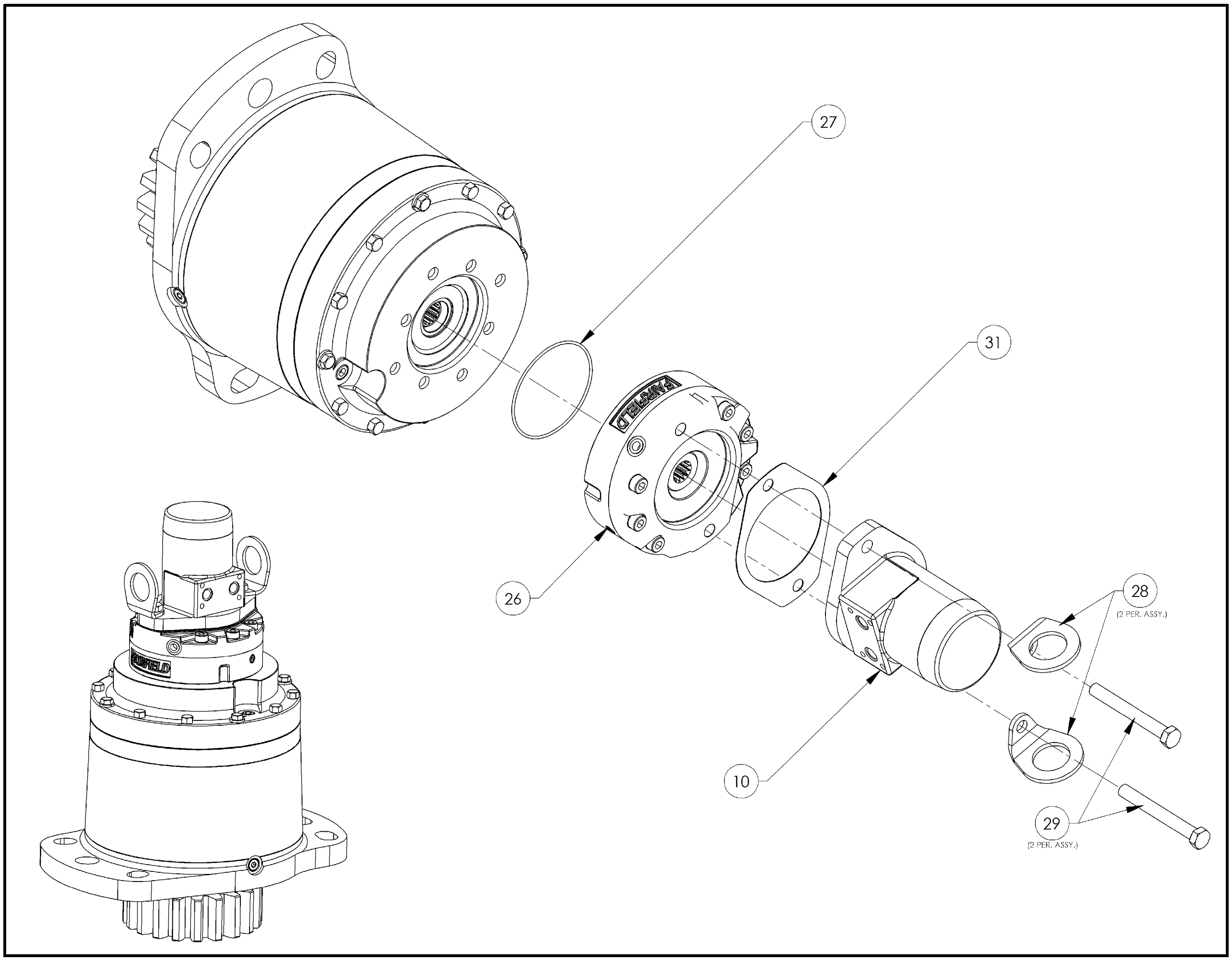


1J. O-Ring Plug
10. Hydraulic Motor
21. Plug
24. ID Plate
25. Drive Screw
26. Hydraulic Brake
32. Motor Control Valve
33. Lockwasher
34. Hex Bolt
35. Hydraulic Tubing
36. Elbow

Figure 3-37. Swing Drive - Motor Control Valve Disassembly

Motor and Brake Disassembly

1. With unit resting on bench with Motor (10) end up, loosen Hex Bolts (29) and remove Lift Lugs (28) from the Motor (10).
2. Pull Motor (10) straight up and remove Motor (10) from Brake (26).
3. Remove Gasket (31) from between Brake (26) and Motor (10).
4. Remove Brake (26) from Main Torque-Hub Assembly and dump oil out of Brake (26).
5. Remove O-ring (27) from between Motor (10) and Brake (26).

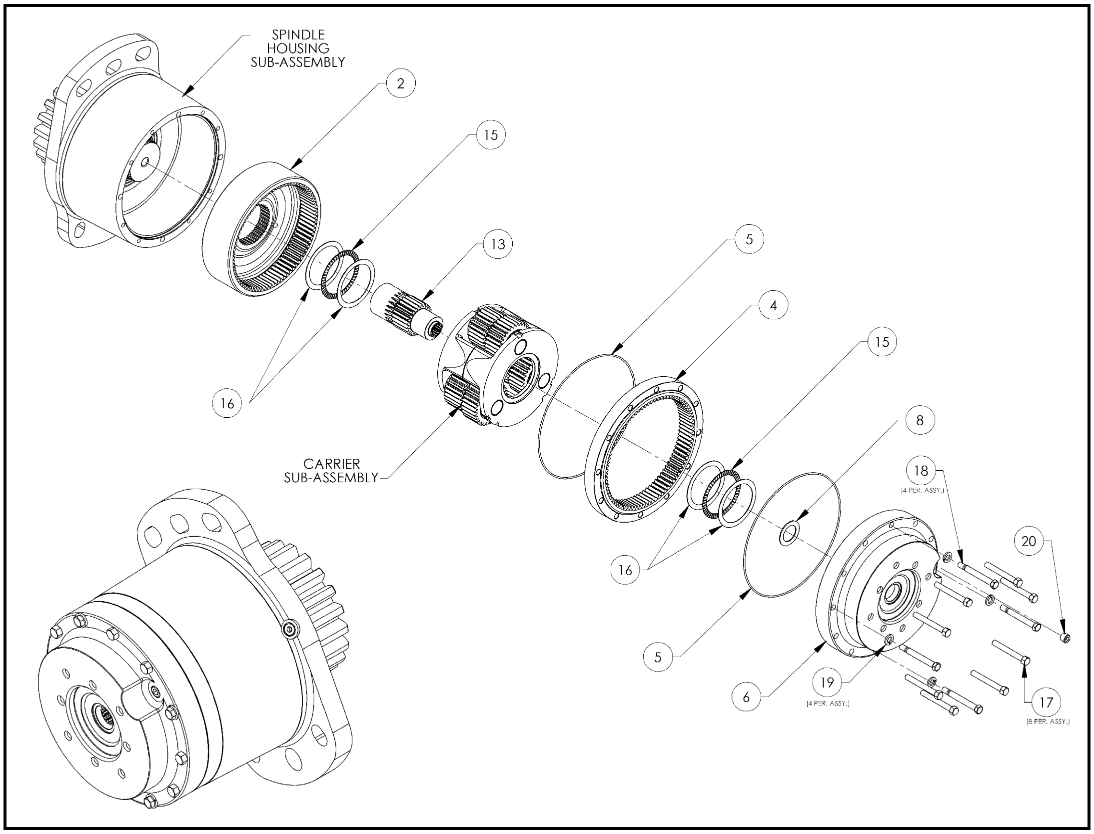


10. Hydraulic Motor	28. Lift Lug
26. Hydraulic Brake	29. Bolt
27. O-Ring	31. Gasket

Figure 3-38. Swing Drive - Motor and Brake Disassembly

Main Disassembly

1. With the unit resting on the Output Shaft (Pinion) (1A), remove the eight Bolts (17), four Shoulder Bolts (18) and four Lock Washers (19) from the Input Cover (6).
2. Thread either 1/2-13 UNC eye bolts or motor mounting Bolts (29) into threaded holes in Input Cover (6) and pull Input Cover (6) off on the main assembly.
3. Remove O-ring (5) from between Input Cover (6) and Ring Gear (4).
4. Remove Thrust Washer (8) from end of Sun Gear (13).
5. Remove Sun Gear (13).
6. Remove Thrust Washers (16) and Thrust Bearing (15) from between Input Cover (6) and Carrier (3A) Subassembly.
7. Remove Ring Gear (4) from Housing (1G).
8. Remove O-ring (5) from between Ring Gear (4) and Housing (1G).
9. Remove Carrier (3A) Subassembly.
10. Remove Thrust Washers (16) and Thrust Bearing (15) from between Carrier (3A) Subassembly and Internal Gear (2).
11. Remove Internal Gear (2).



2. Internal Gear
4. Ring Gear
5. O-Ring
6. Input Cover
8. Hex Bolt
13. Sun Gear
15. Thrust Bearing
16. Thrust Washer
17. Hex Bolt
18. Shoulder Bolt
19. Lockwasher
20. Pipe Plug

Figure 3-39. Swing Drive - Main Disassembly

Hub-Shaft Disassembly

1. Using retaining ring pliers, remove Retaining Ring (1I) from groove in Output Shaft (1A) and discard.

⚠ WARNING

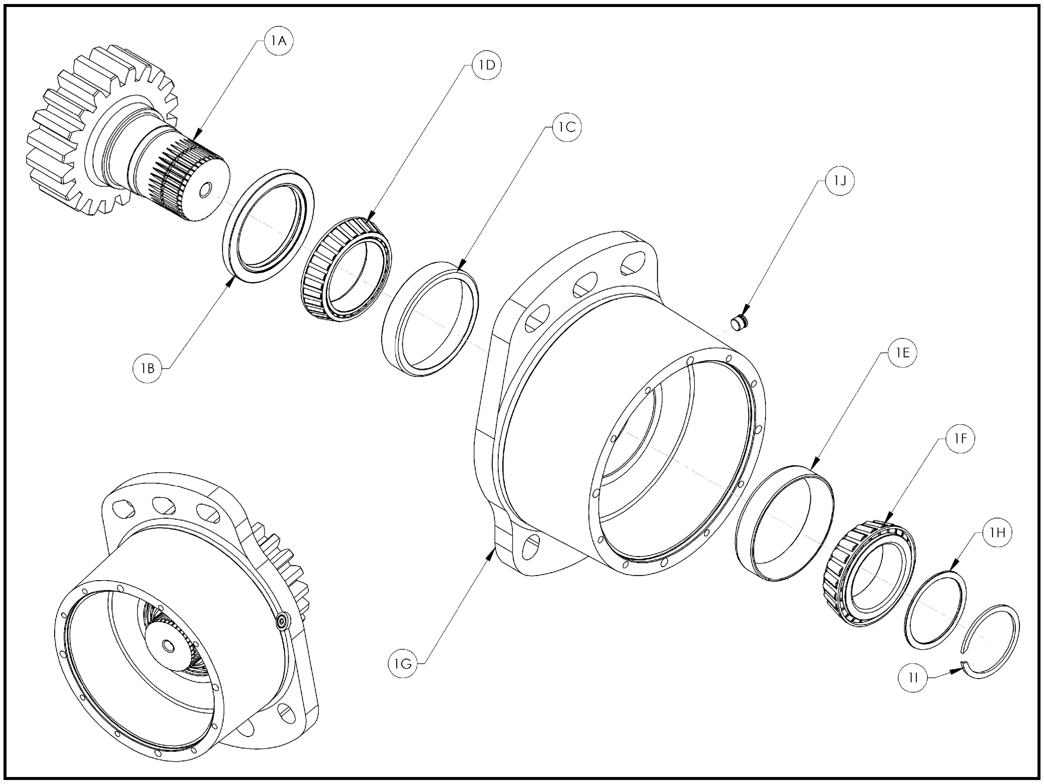
EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

2. Remove Thrust Washer (1H).
3. While supporting the Housing (1G) on the Output Shaft (1A) end, press the Output Shaft (1A) out of the Housing (1G).

NOTE: *The Lip Seal (1B) may or may not be pressed out of the Housing (1G) by the Bearing Cone (1D) during this step.*

4. Remove the Bearing Cone (1F) from the Housing (1G).
5. Invert the Housing (1G) and remove the Lip Seal (1B) if not already removed when Output Shaft (1A) was pressed out of Housing (1G).
6. Remove the Bearing Cone (1D).
7. Bearing Cups (1C & 1E) will remain in Housing (1G).

NOTE: *If bearing replacement is necessary, the Bearing Cups (1C & 1E) can be removed with a slide hammer puller or driven out with a punch.*



1A. Output Shaft
1B. Lip Seal
1C. Tapered Bearing Cup
1D. Tapered Bearing Cone
1E. Tapered Bearing Cup
1F. Tapered Bearing Cone
1G. Housing
1H. Thrust Washer
1I. Retaining Ring
1J. O-Ring Plug

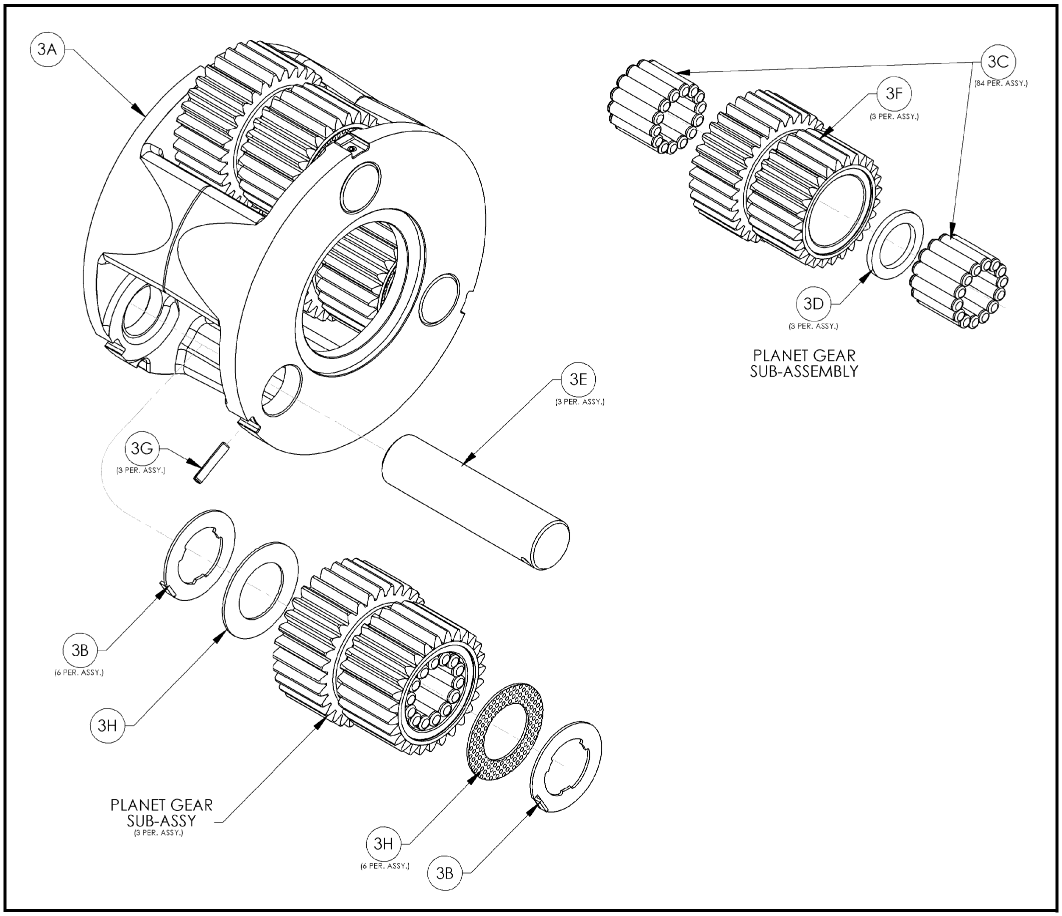
Figure 3-40. Swing Drive - Hub Shaft Disassembly

Carrier Disassembly

1. Using a 3/16" (5 mm) punch drive the Roll Pin (3G) which holds the Planet Shaft (3E) in the Carrier (3A) down into the Planet Shaft (3E) until it bottoms.

NOTE: *Make sure that the Roll Pin has bottomed. Otherwise, damage to the carrier could occur when the Planet Shaft is removed.*

2. Remove the Planet Shaft (3E) from the Carrier (3A). Use a small punch to remove the Roll Pin (3G) from the Planet Shaft (3E).
3. Slide the Planet Gear (3F), two Ball-Indented Thrust Washers (3H) and the two Thrust Washers (3B) out of the Carrier (3A).
4. Remove both rows of Needle Bearings (3C) and the Spacer (3D) from the bore of the Planet Gear (3F).
5. Repeat Steps 1 thru 4 for the remaining two Cluster Gears(3F).



3A. Carrier
3B. Tanged Thrust Washer
3C. Needle Bearing
3D. Thrust Washer
3E. Planet Shaft
3F. Cluster Gear
3G. Roll Pin
3H. Ball Indented Washer

Figure 3-41. Swing Drive - Carrier Disassembly

Hub-Shaft Sub-Assembly

1. Press Bearing Cone (1D) onto Shaft (1A).
2. Press Bearing Cup (1C) into Housing (1G), take care to insure cup starts square with bore of Hub (1G).
3. Place Bearing Cone (1D) in Bearing Cup (1C) in Housing 1G).
4. Press or tap Seal (1B) into the counterbore of Housing (1G) to the point where it becomes flush with the Housing (1G) face. Care should be taken to insure Seal (1B) is being correctly installed (smooth face up).
5. Invert Hub (1G) and press Bearing Cup (1E) into counterbore of Housing (1G).
6. Carefully lower Housing (1G) onto the Output Shaft (1A).
7. Start the Bearing Cone (1F) onto the Output Shaft (1A).
8. Press or tap the Bearing Cone (1F) onto the Output Shaft (1A) until it is seated in the Bearing Cup (1E).
9. Install Bearing Spacer (1H) onto Output Shaft (1A) and against Bearing Cone (1F).
10. Install Retaining Ring (1I) into the groove in the Output Shaft (1A). This Retaining Ring (1I) should never be reused in a repair or rebuild.

⚠ WARNING

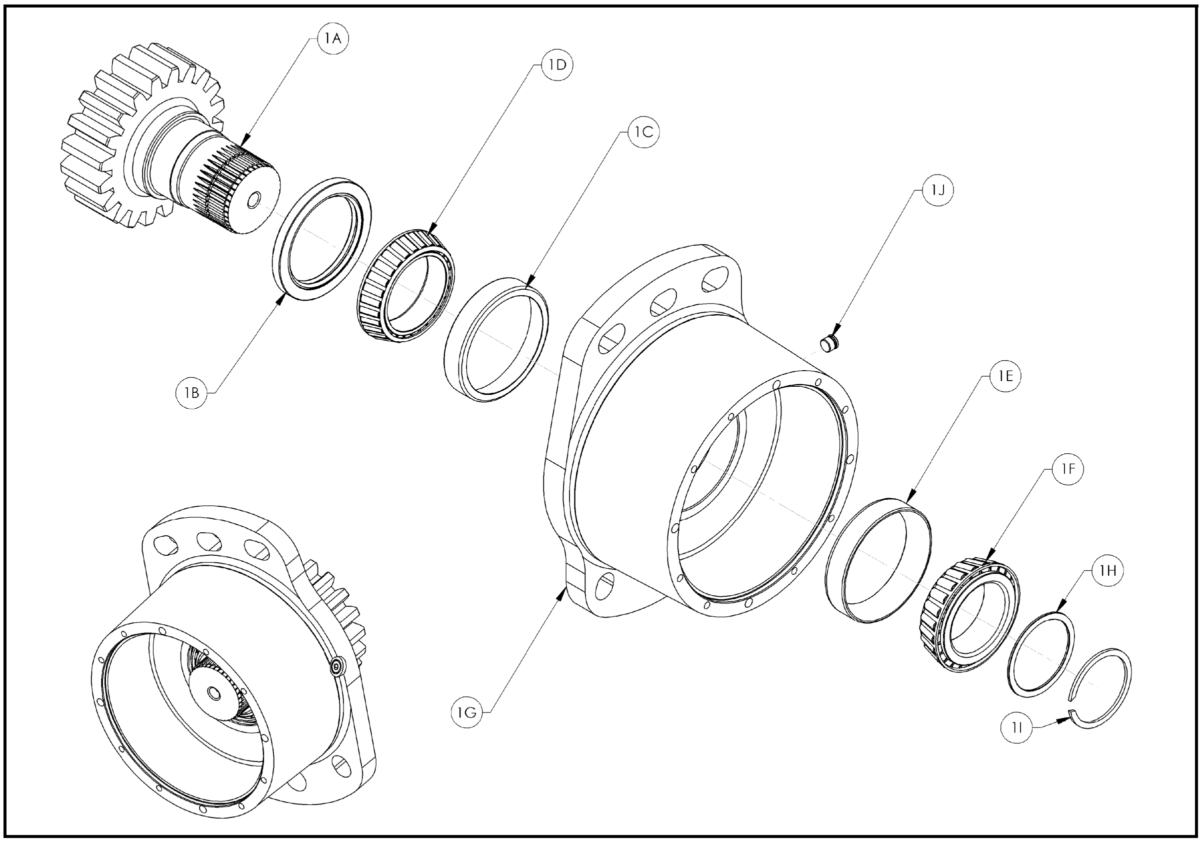
EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

11. Tap the Retaining Ring (1I) with a soft metal punch to ensure that the Retaining Ring (1I) is completely seated in the groove of the Output Shaft (1A).

⚠ WARNING

EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

12. Install O-ring Plug (1J) and torque 23 to 24 ft-lbs.(32 - 33.5 Nm).

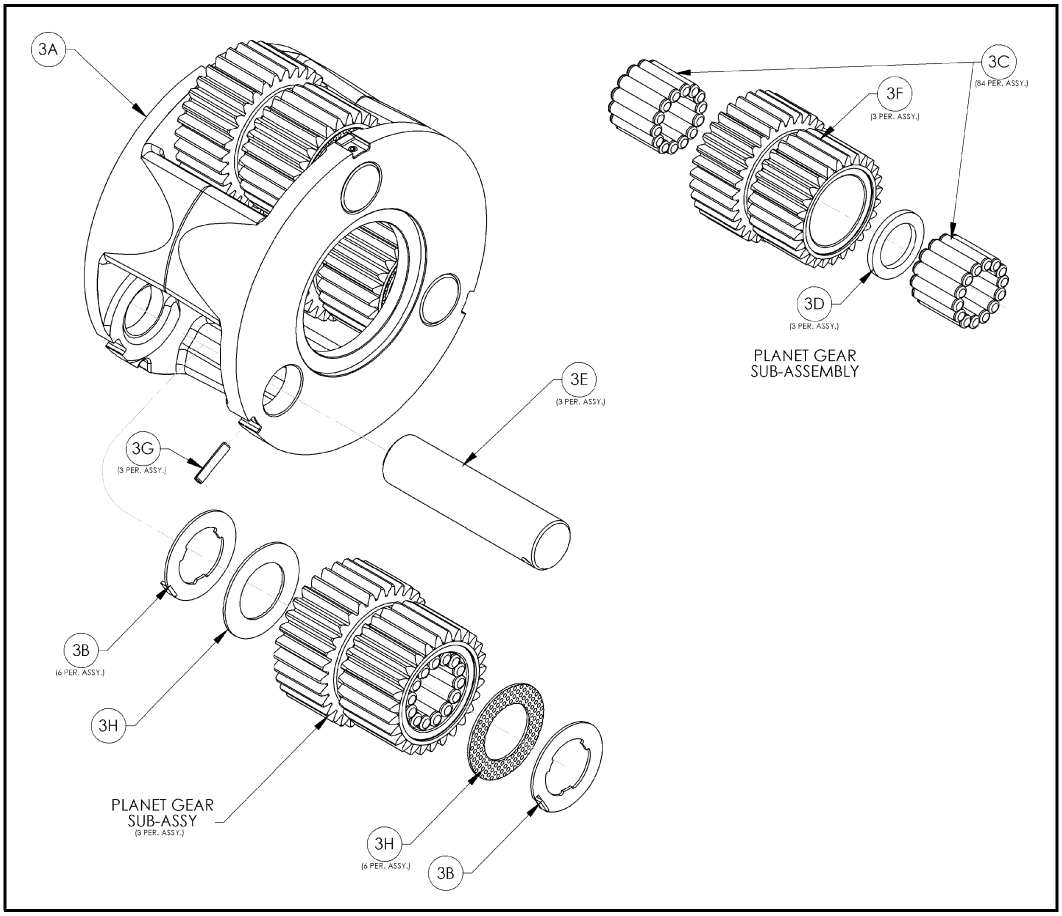


1A. Output Shaft
1B. Lip Seal
1C. Tapered Bearing Cup
1D. Tapered Bearing Cone
1E. Tapered Bearing Cup
1F. Tapered Bearing Cone
1G. Housing
1H. Thrust Washer
1I. Retaining Ring
1J. O-Ring Plug

Figure 3-42. Swing Drive - Hub Shaft Sub-Assembly

Carrier Sub-Assembly

1. Apply a liberal coat of grease to the bore of Cluster Gear (3F). This will enable the Needle Rollers (3C) to be held in place during assembly.
2. Install the first row of 14 Needle Rollers (3C) into the bore of Cluster Gear (3F).
3. Insert Spacer (3D) into bore of Cluster Gear (3F) on top of the Needle Rollers (3C).
4. Place second row of Needle Rollers (3C) into bore of Cluster Gear (3F) against Spacer (3D) and remove Planet Shaft (3E).
5. Place Carrier (3A) into tool fixture so that one of the roll pin holes is straight up.
6. Start Planet Shaft (3E) through the hole in Carrier (3A). Using ample grease to hold it in position, slide one Thrust Washer (3B) over the Planet Shaft (3E) with the tang resting in the cast slot of the Carrier (3A). Place Ball-Indented Thrust Washer (3H) on the Planet Shaft (3E) with the indents against the first washer.
7. With large end of Cluster Gear (3F) facing the roll pin hole in the carrier, place the cluster gear into position in Carrier (3A) and push Planet Shaft (3E) through the Cluster Gear (3F) without going all the way through.
8. Slide the second Thrust Washer (3E) between the Cluster Gear (3F) and the Carrier (3A) with the tang of the washer located in the cast slot of the Carrier (3A). Slide ball-indented Thrust Washer (3H) onto the end of the Planet Shaft with the indents against the second thrust Washer. Finish sliding the Planet Shaft (3E) through the Thrust Washers (3H) & (3B) and into the Carrier (3A).
9. Position the non-chamfered side on the Planet Shaft (3E) roll pin hole so that it is in line with the hole in the Carrier (3A) using a 1/8" (3 mm) diameter punch.
10. After using a 3/16" (5 mm) punch to align the two roll pin holes. Drive the Roll Pin (3G) through Carrier (3A) and into the Planet Shaft (3E) until the Roll Pin (3G) is flush with the bottom of the cast tang slot in the Carrier (3A). Use a 1/4" (6 mm) pin punch to make sure the Roll Pin (3G) is flush in the slot.
11. Repeat Steps 1 thru 10 for the remaining two Cluster Gears(3F).



3A. Carrier	3E. Planet Shaft
3B. Tanged Thrust Washer	3F. Cluster Gear
3C. Needle Bearing	3G. Roll Pin
3D. Thrust Washer	3H. Ball Indented Washer

Figure 3-43. Swing Drive - Carrier Sub-Assembly

Main Assembly

1. With the Hub Shaft Sub-Assembly resting on the Shaft (1A) install Internal Gear (2). The spline of the Internal Gear (2) bore will mesh with the spline of the Output Shaft (1A).
2. Inspect the location of the Internal Gear (2) on the Output Shaft (1A). The portion of the Output Shaft (1A), which does not have full spline, should protrude through the Internal Gear (2) bore.
3. Install two Thrust Washers (15) and one Thrust Bearing (16) on the portion of Output Shaft (1A) which protrudes through Internal Gear (2).
4. Center the Input Gear (13) on the end of the Output Shaft (1A) opposite the gear with the large diameter down.
5. Place O-ring (5) into Hub counter-bore. Use grease to hold O-ring in place.

⚠ WARNING

BEWARE OF SHARP EDGES OF THE COUNTER BORE WHILE SEATING THIS O-RING.

6. Also at this time locate and mark the four counter reamed holes in the face of the Hub (1G). This is for identification later in the assembly.
7. Place Carrier (3A) Subassembly on bench with the large end of Cluster Gears (3F) up with one at the 12 o clock position. Find the punch marked tooth on each gear at the large end and locate at 12 o'clock (straight up) from each planet pin. Marked tooth will be located just under the Carrier on upper two gears. Check the timing through the slots in the carrier.
8. With large shoulder side of Ring Gear (4) facing down, place Ring Gear (4) over (into mesh with) large end of gears. Be sure that punch marks remain in correct location during Ring Gear (4) installation. The side of the Ring Gear (4) with an "X" or punch mark stamped on it should be up.
9. While holding Ring Gear (4) and Cluster Gears (3F) in mesh, place small end of Cluster Gears (3F) into mesh with the Internal Gear (2) and Input Gear (13). On the Ring Gear (4) locate the hole marked "X", or punch marked, over one of the marked counter-bored holes (Step 5) in Hub (1G). Check timing through the slots in the carrier. Rotate carrier in assembly to check for freedom of rotation.

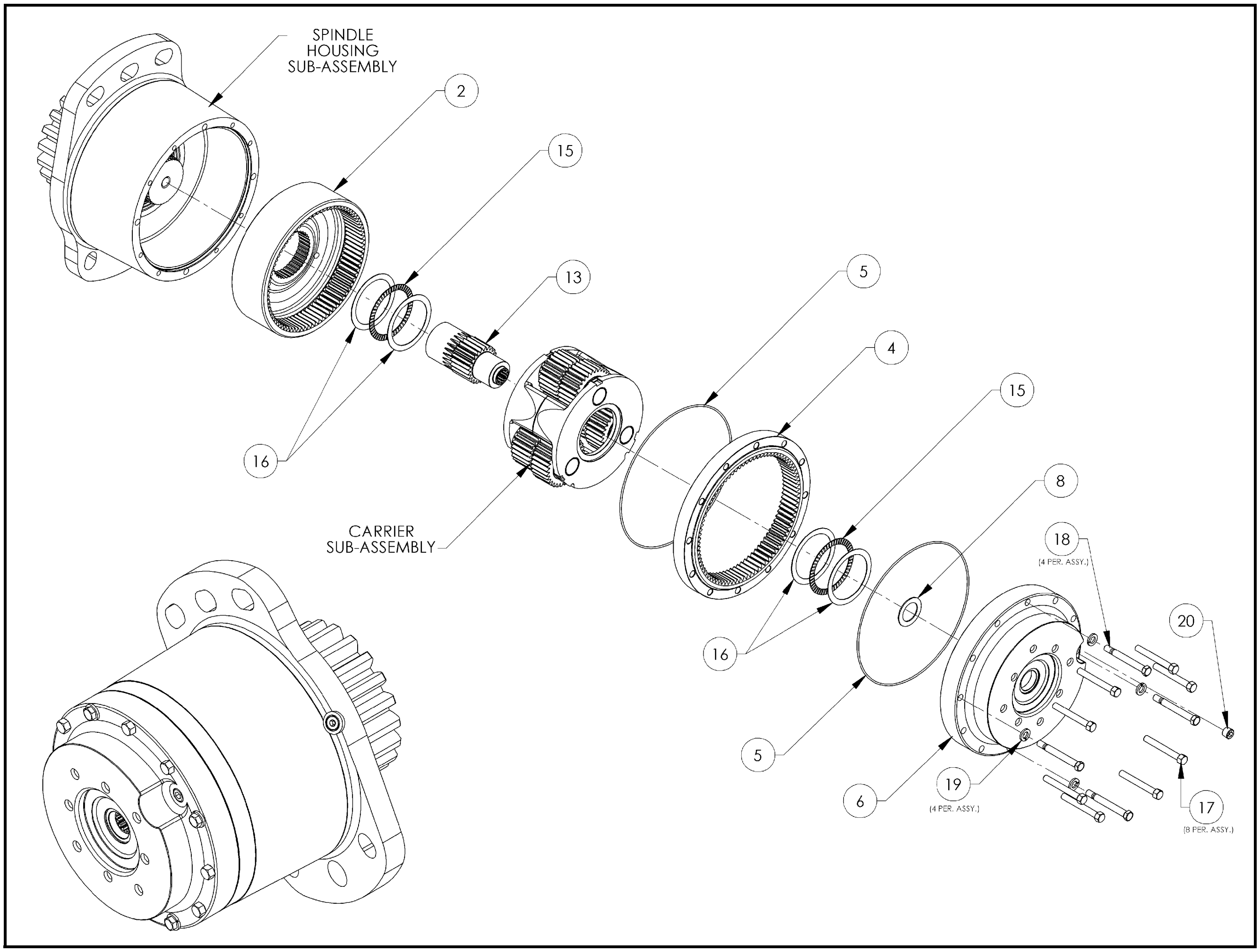
NOTE: ***NOTE:*** *If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing*

10. Install Thrust Washer (15)/Thrust Bearing (16) set into the counter-bore in the face of the carrier. Use grease to hold in place.
11. Place O-ring (5) into Cover (6) counter-bore. Use grease to hold O-Ring in place.

⚠ WARNING

CAUTION: BEWARE OF SHARP EDGES OF THE COUNTER-BORE WHILE SEATING THIS O-RING.

12. Using sufficient grease to hold in place, install Thrust Washer (8) into the counter-bore of the interface of the Cover (6).
13. The Cover (6) is now installed, taking care to correctly align Pipe Plug hole (20) with those in the Hub (1J). Check timing sheet.
14. Locate the 4 counter-bored holes in Hub (1G) [marked in Step 5] and install 4 Shoulder Bolts (18) with Lockwashers (19). Start the shoulder bolts by hand.
15. Install Grade 8 Bolts (17) with Lockwashers (19) into remaining holes.
16. Torque Shoulder Bolts (18) 43 to 47 ft.-lbs. (60 to 65 Nm) and Grade 8 Bolts (17) to 43 to 47 ft.-lbs. (60 to 65 Nm). Roll and leak test the assembly.
17. With gearbox standing on the pinion end fill gearbox with GEAROIL 80W90, to bottom of plug hole in cover at Pipe Plug (20).
18. Install Pipe Plug (20) into Cover (6) using thread sealant.

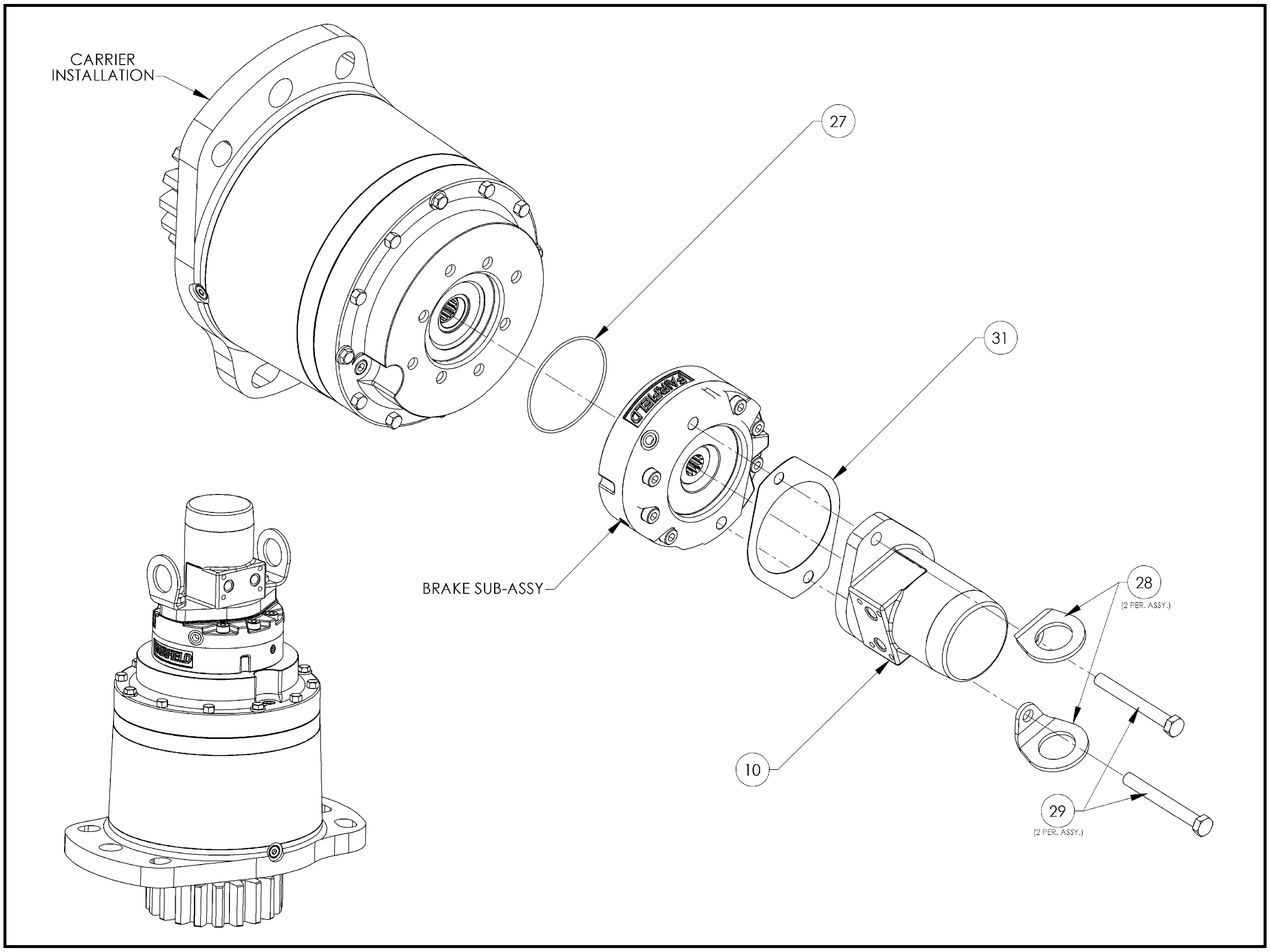


2. Internal Gear	15. Thrust Bearing
4. Ring Gear	16. Thrust Washer
5. O-Ring	17. Hex Bolt
6. Input Cover	18. Shoulder Bolt
8. Hex Bolt	19. Lockwasher
13. Sun Gear	20. Pipe Plug

Figure 3-44. Swing Drive - Main Assembly

Motor and Brake Assembly

1. Place O-ring (27) onto end of Brake (26) and locate brake into pilot of cover.
2. Place Gasket (31) onto the brake face and line up the holes.
3. Place Motor (10) into Brake pilot against the Gasket (31).
4. Assemble Lift Lugs (28) onto Hex Bolts (29). Assemble Hex Bolts (29) with Lift Lugs through the Motor (10) and Brake (26) against the motor flange. Torque to 35 ft-lbs.
5. Fill Brake (26) with 2.7 oz. (80cc) of BRAKOILVG32 (DTE24).



10. Hydraulic Motor
26. Hydraulic Brake
27. O-Ring
28. Lift Lug
29. Bolt
31. Gasket

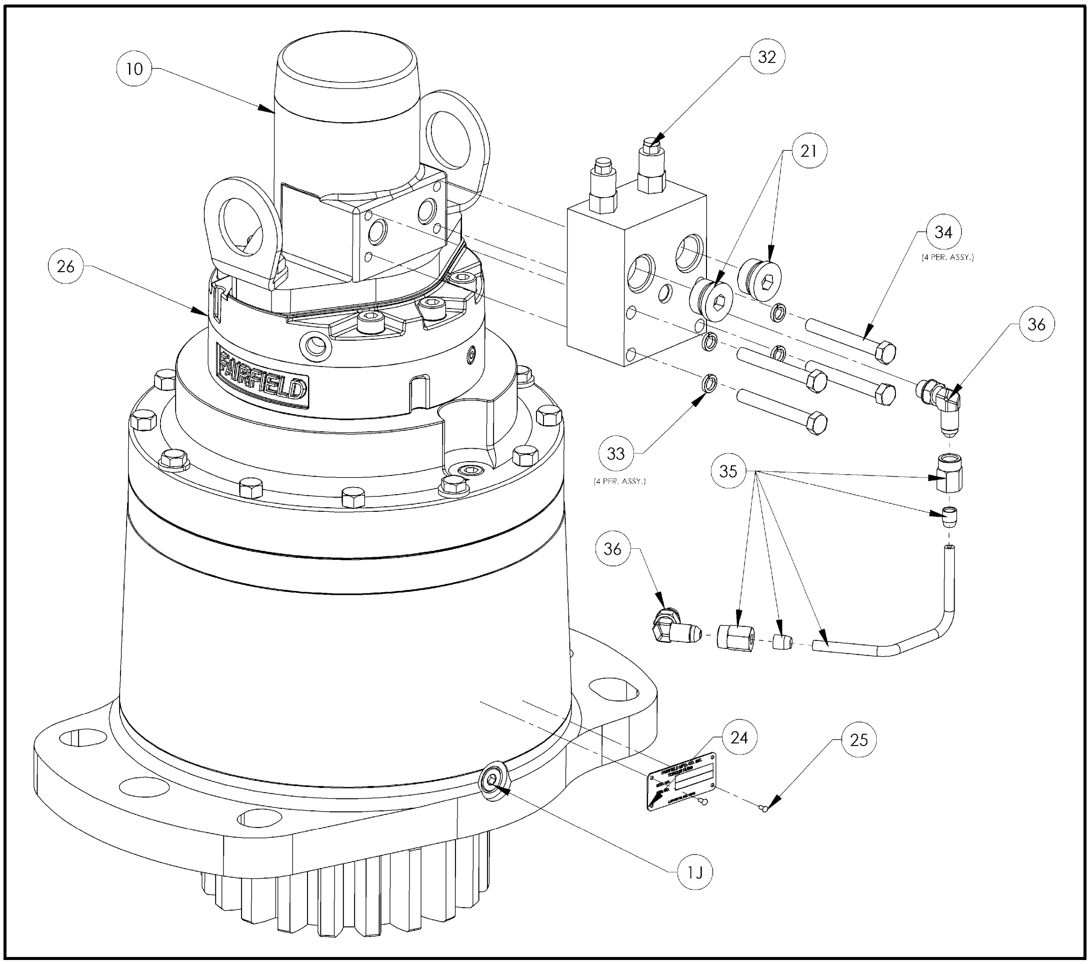
Figure 3-45. Swing Drive - Motor and Brake Assembly

Motor Control Valve Assembly

1. Lay assembly down with motor ports facing up. Remove the two plastic plugs in the motor ports, being careful not to loose the O-ring in each port. Assemble the Motor control Valve (32) onto the Motor (10) with Bolt (34) and Lock Washers (33). Torque Bolts (33) 23 to 27 ft-lbs. (32 to 38 Nm).

NOTE: *Be sure to align the holes in the control valve with the motor ports.*

2. Install Elbow Fittings (36) into Brake (26) and torque 13 to 15 ft-lbs. (18 to 21 Nm).
3. Install Elbow Fittings (36) into Motor Control Valve (32) and torque to 13 to 15 ft-lbs. (18 to 21 Nm).
4. Assemble Tube (35) into Elbow Fittings (36) and torque 13 to 15 ft-lbs. (18 to 21 Nm).
5. Install O-ring Plugs (21) into Motor Control Valve (32) and torque 30 to 31 ft-lbs. (42 to 43 Nm).
6. Pressure test brake, tube and control valve connections by applying 3000 psi (207 bar) pressure to the brake bleed port and holding for 1 minute. Check for leaks at the control-valve-motor interface and the tube connections. Release pressure.
7. Place I.D. Plate (24) onto Housing (1G) with two Drive Screws (25). I.D. Plate (24) is to be inline with O-ring Plug (1J) as shown on assembly print.



1J. O-Ring Plug
10. Hydraulic Motor
21. Plug
24. ID Plate
25. Drive Screw
26. Hydraulic Brake
32. Motor Control Valve
33. Lockwasher
34. Hex Bolt
35. Hydraulic Tubing
36. Elbow

Figure 3-46. Swing Drive - Motor Control Valve Assembly

3.15 SWING 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.

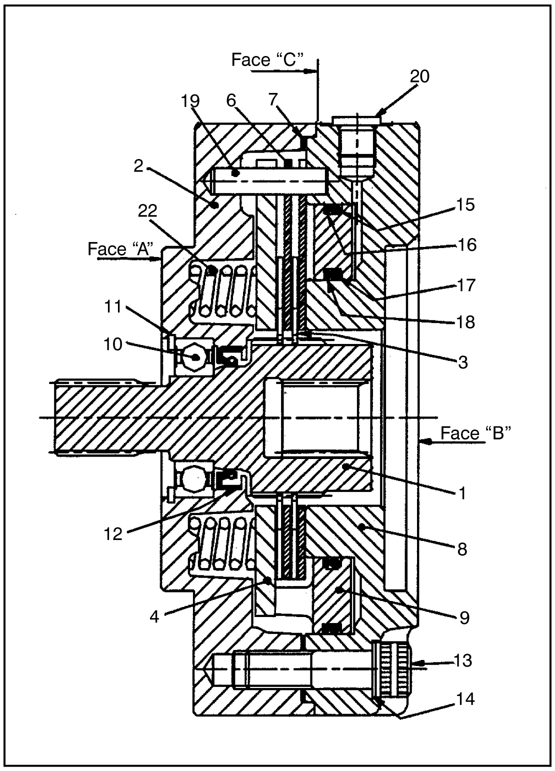
HYDRAULIC/MECHANICAL

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 3-47. Swing 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) subassembly 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 (8). Take note of quantity and orientation of springs.
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 (8).
   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 (8) in orientation required. Refer to (See Figure 3-48.) and (See Figure 3-49.).

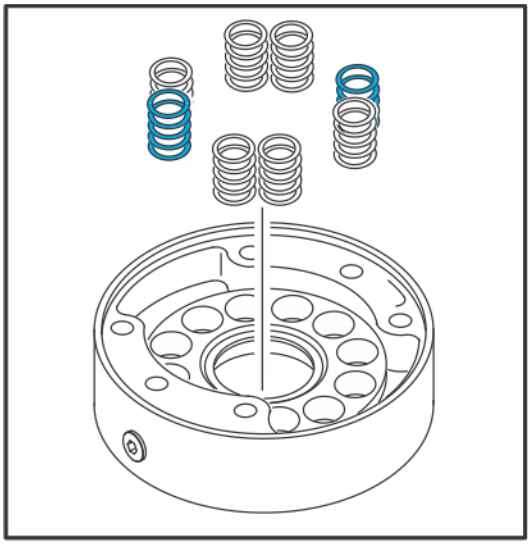


Figure 3-48. Swing Brake 8 Spring Orientation

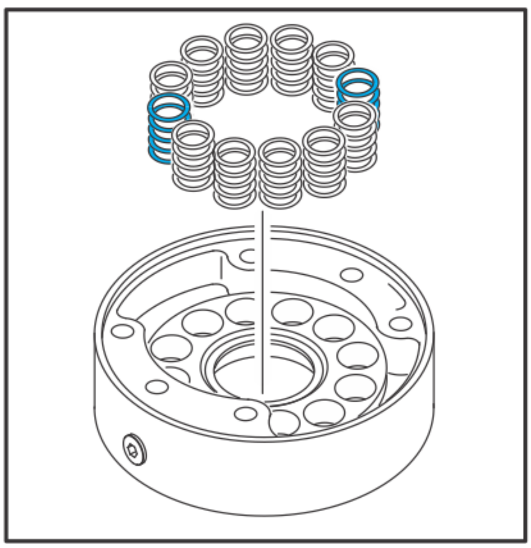


Figure 3-49. Swing Brake 12 Spring Orientation

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 ti the pressurized side of piston (9).

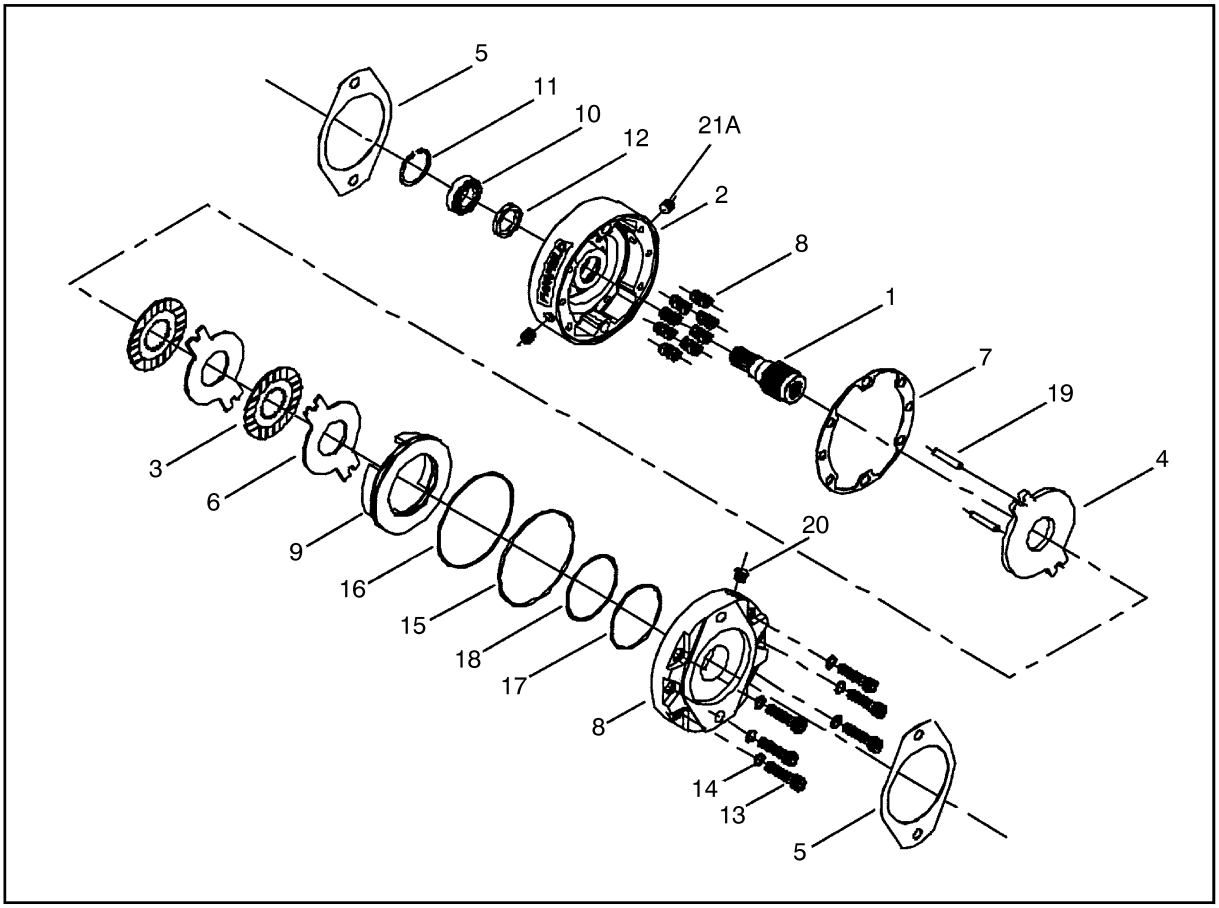
5. Correctly orientate piston (9) aligning spaces with the two dowel pin holes and, assemble into cylinder housing (2) taking care not to damage seals and carefully lay aside.

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

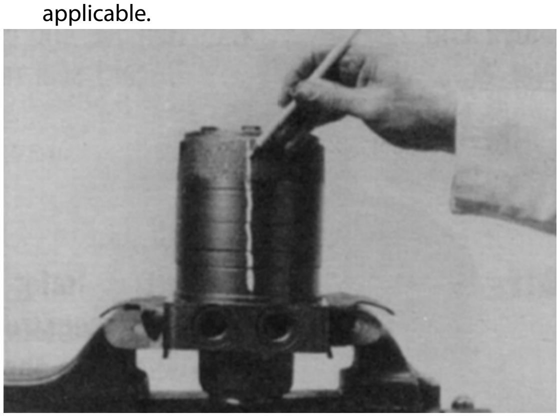
21A. Socket Pressure Plug

Figure 3-50. Swing Brake Assembly

3.16 SWING MOTOR

Disassembly and inspection

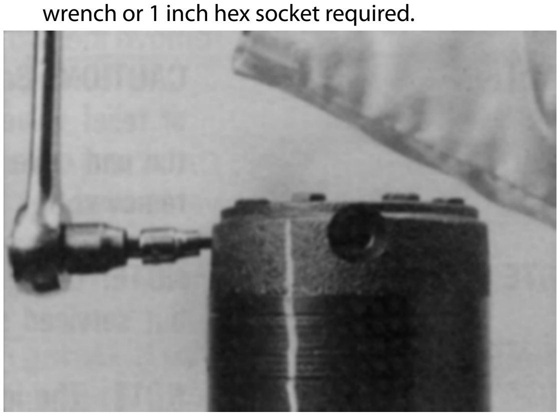
1. Place the Torqlink™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

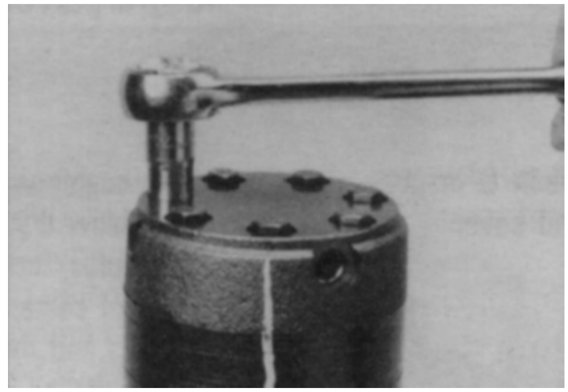


WARNING

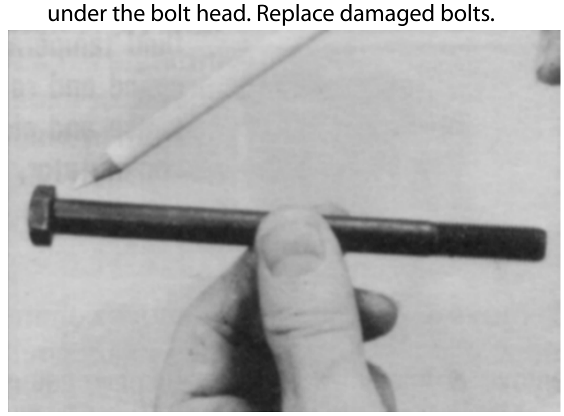
IFTHETORQLINK™ IS NOT FIRMLY HELD IN THE VISE, IT COULD BE DISLODGED DURINGTHE SERVICE PROCEDURES, CAUSING INJURY.

2. Scribe an alignment mark down and across the Torqlink™ components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 inch Allen wrench or 1 inch hex socket required.

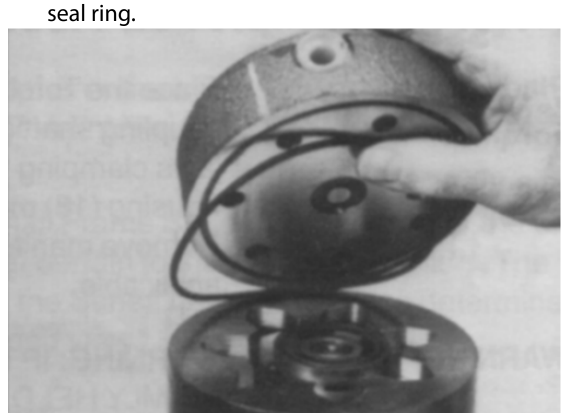




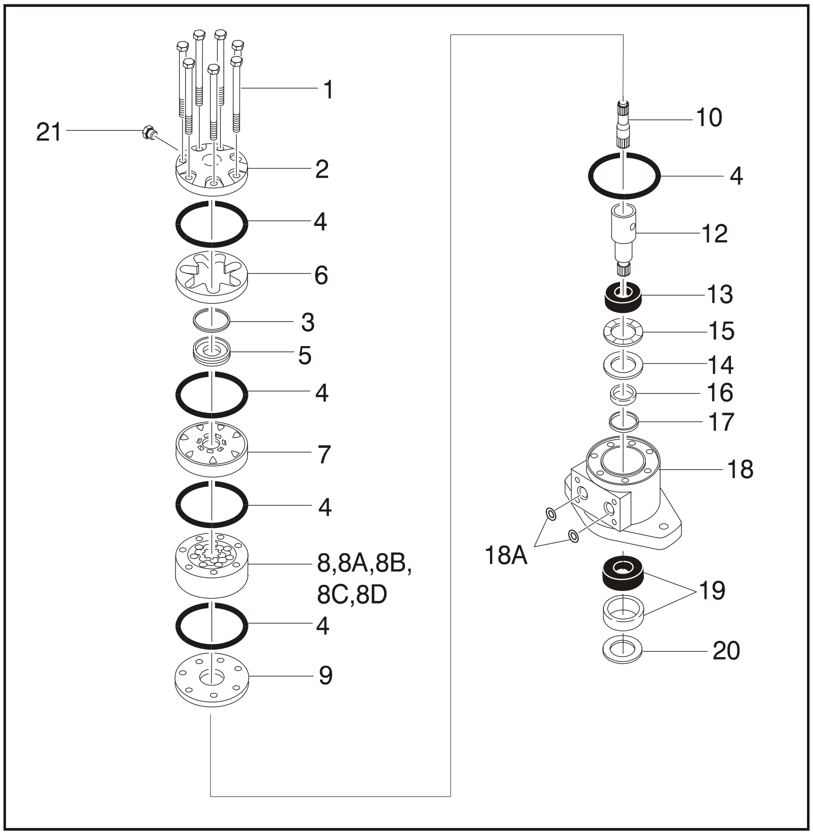
3. Remove the five, six, or seven special ring head bolts (1) using an appropriate 1/2 or 9/16 inch size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.



4. Remove end cover assembly (2) and seal ring (4). Discard seal ring.



NOTE: *Refer to the appropriate "alternate cover construction" on the exploded view to determine the end cover construction being serviced.*



1. Special Bolts
2. End Cover
3. Seal Ring-Commutator
4. Seal Ring
5. Commutator Ring
6. Commutator Ring
7. Manifold
8. Rotor Set

8A. Rotor
8B. Stator or Stator Vane
8C. Vane
8D. Stator Half

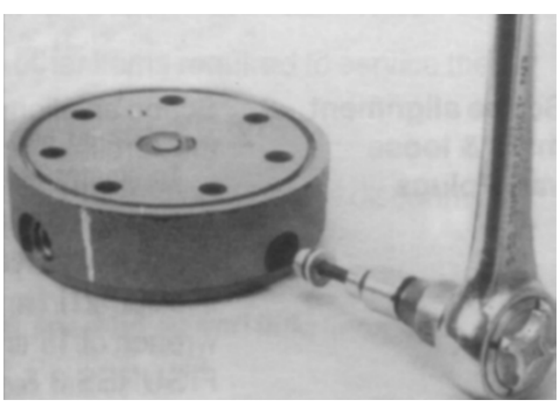
9. Wear Plate
10. Drive Link
11. Not Used
12. Coupling Shaft
13. Bearing/Bushing, Inner
14. Thrust Washer
15. Thrust Bearing
16. Seal
17. Back-up Washer
18. Housing

18A. O-Ring

19. Bearing/Bushing, Outer
20. Dirt & Water Seal
21. Plug

Figure 3-51. Swing Drive Motor

5. If the end cover (2) is equipped with shuttle valve components, remove the two previously loosened plugs (21).

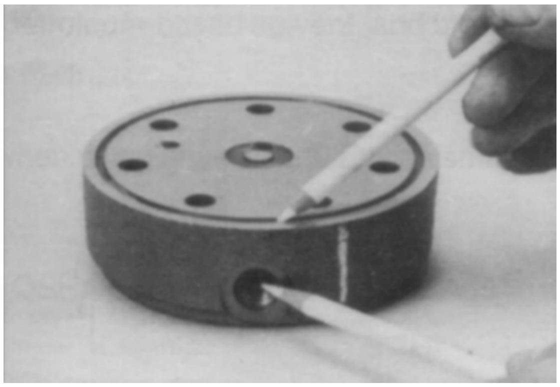


NOTICE

BE READY TO CATCH THE SHUTTLE VALVE OR RELIEF VALVE COMPONENTS THAT WILL FALL OUT OF THE END COVER VALVE CAVITY WHEN THE PLUGS ARE REMOVED.

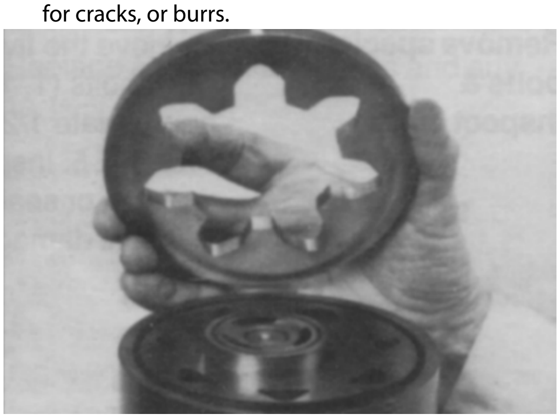
NOTE: *The insert and if included the orifice plug in the end cover (2) must not be removed as they are serviced as an integral part of the end cover.*

6. Thoroughly wash end cover (2) in proper solvent and blow dry. Be sure the end cover valve apertures, including the internal orifice plug, are free of contamination. Inspect end cover for cracks and the bolt head recesses for good bolt head sealing surfaces. Replace end cover as necessary.

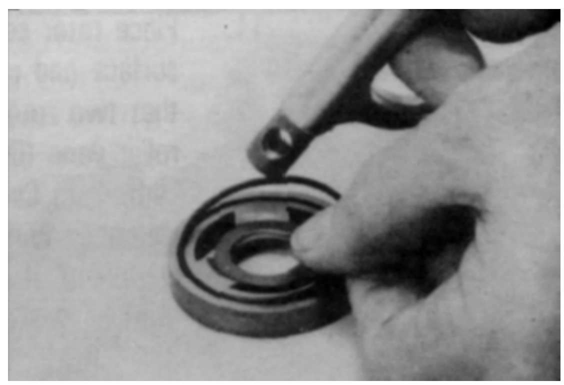


NOTE: *A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.*

7. Remove commutator ring (6). Inspect commutator ring for cracks, or burrs.



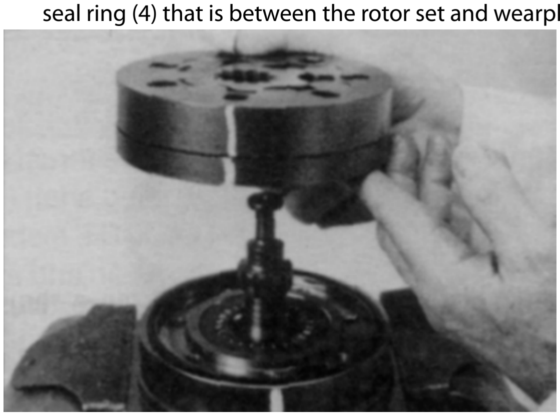
8. Remove commutator (5) and seal ring (3) Remove seal ring from commutator, using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace commutator and commutator ring as a matched set.



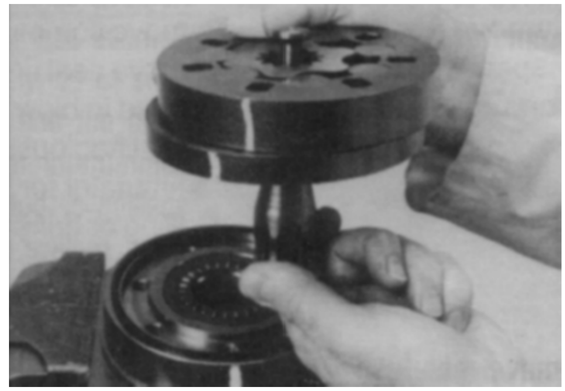
9. Remove manifold (7) and inspect for cracks surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. A polished pattern on the ground surface from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.

NOTE: *The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides oft hem an if old to ensure that same surface is reassembled against the rotor set.*

10. Remove rotor set (8) and warplane (9), together to retain the rotor set in its assembled form, maintaining the same rotor vane (8C) to stator (8B) contact surfaces. The drive link (10) may come away from the coupling shaft (12) with the rotor set, and wearplate.You may have to shift the rotor set on the warplane to work the drive link out of the rotor (8A) and warplane. Inspect the rotor set in its assembled form for nicks, scoring, or spalling on any surface and for broken or worn splines. If the rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set. Inspect the warplane for cracks, brinelling, or scoring. Discard seal ring (4) that is between the rotor set and wearplate.



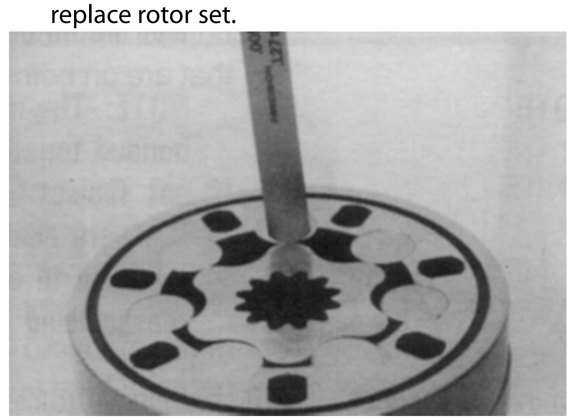
NOTE: *The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqlink™ will ensure correct reassembly of rotor into stator and rotor set intoTorqlink™.Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of rotor set andTorqlink™.*



NOTE: *Series TG Torqlinks™ may have a rotor set with two stator halves (8B) with a seal ring (4) between them and two sets of seven vanes (8C). Discard seal ring only if stator halves become disassembled during the service procedures.*

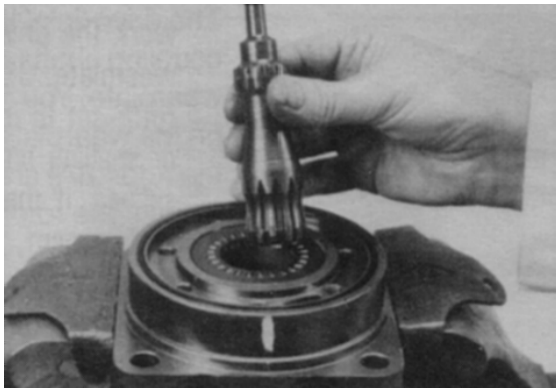
NOTE: *A polished pattern on the wear plate from rotor rotation is normal.*

11. Place rotor set (8) and wear plate (9) on a flat surface and center rotor (8A) in stator (8B) such that two rotor lobes (180 degrees apart) and a roller vane (8C) centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gage at this common centerline. If there is more than 0.005 inches (0.13 mm) of clearance, replace rotor set.



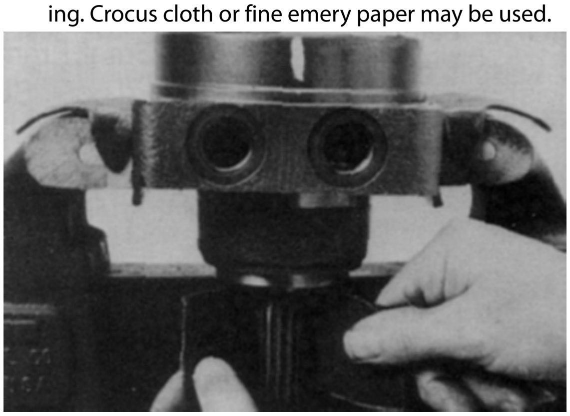
NOTE: *If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.*

12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Remove and discard seal ring (4) from housing (18).

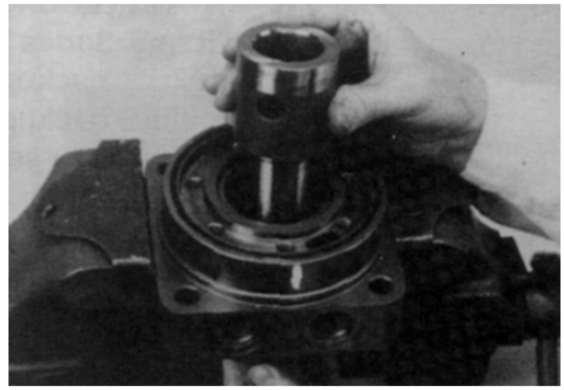


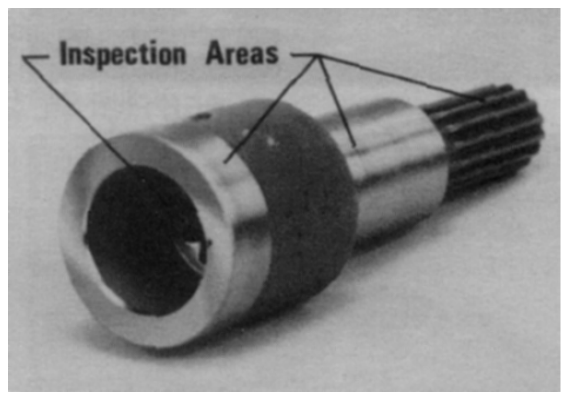
13. Remove thrust bearing (11) from top of coupling shaft (12). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.

14. Check exposed portion of coupling shaft (12) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal and bearing. Crocus cloth or fine emery paper may be used.



15. Remove coupling shaft (12), by pushing on the output end of shaft. Inspect coupling shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration. Inspect for damaged or worn internal and external splines or keyway. Replace coupling shaft if any of these conditions exist.



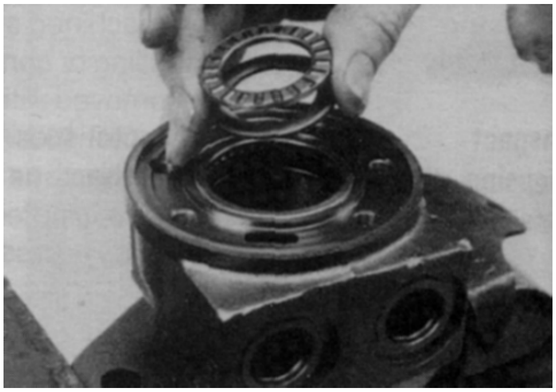


NOTE: *Minor shaft wear in seal area is permissible. If wear exceeds 0.020 inches (0.51 mm) diametrically, replace coupling shaft.*

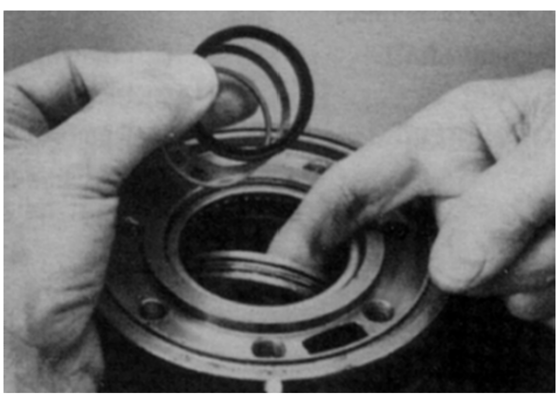
NOTE: *A slight "polish" is permissible in the shaft bearing areas. Anything more would require coupling shaft replacement.*

16. 16. Remove and discard seal ring (4) from housing (18).

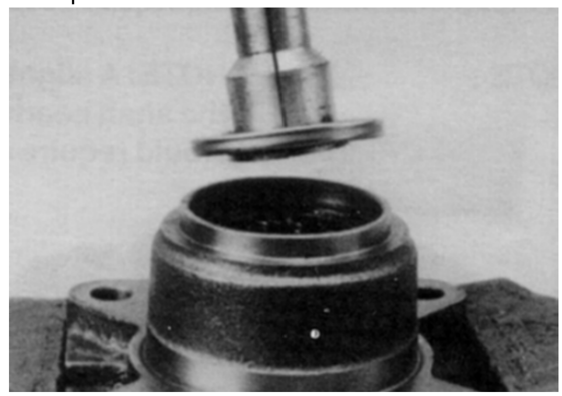
17. Remove thrust bearing (15) and thrust washer (14) Inspect for wear, brinelling, corrosion and a full complement of retained rollers.



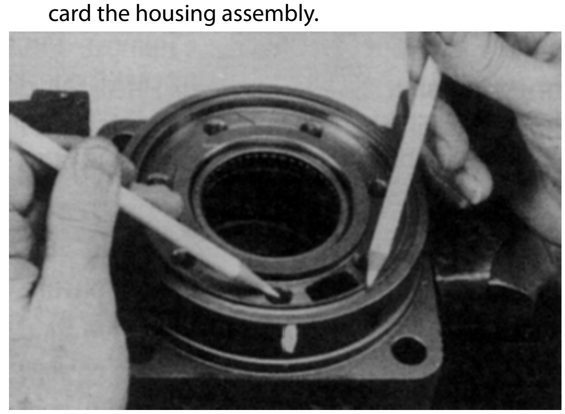
18. Remove seal (16) and back up washer (17) from Small Frame, housing (18). Discard both.



19. Remove housing (18) from vise, invert it and remove and discard seal (20). A blind hole bearing or seal puller is required.

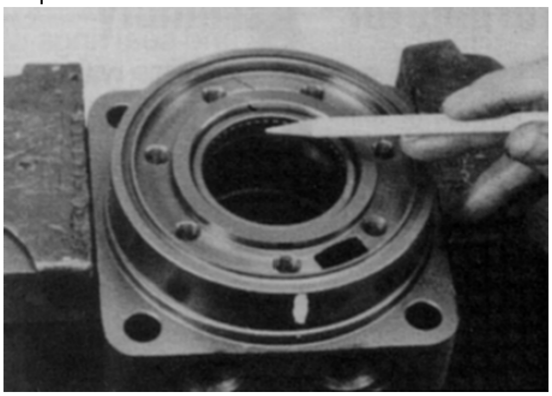


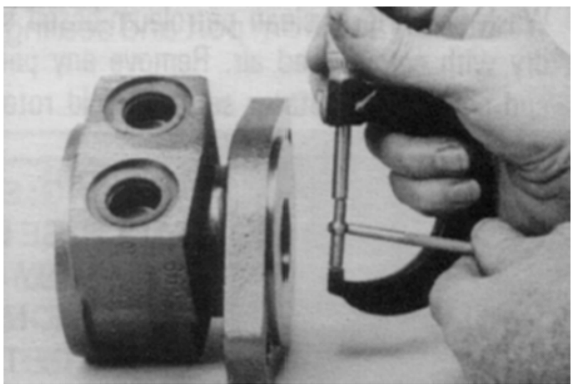
20. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly.



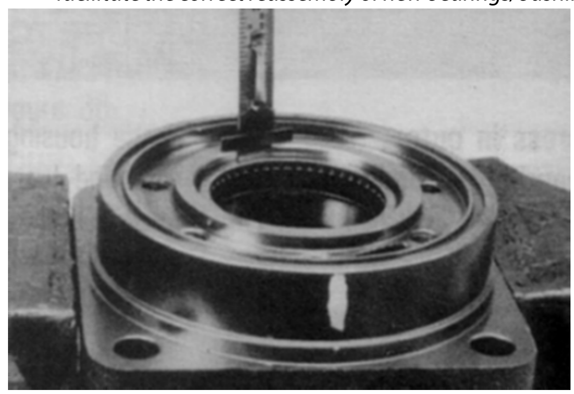
21. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and thrust washers must be free of brinelling and corrosion. The bushing (19) or (13) to coupling shaft diameter clearance must not exceed 0.010 inch (0.025 mm). A bearing, bushing, or thrust washer that does not pass inspection must be replaced. If the housing has passed

this inspection the disassembly of the Torqlink™ is completed.

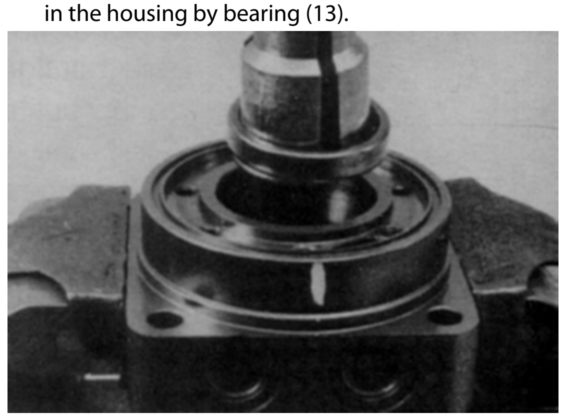


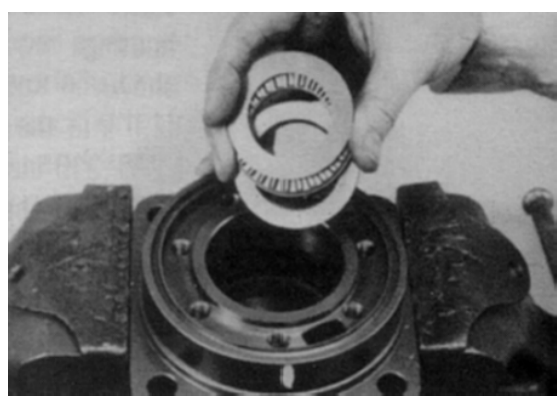


NOTE: *The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counter bore should be measured and noted before removing the bearings/ bushings. This will facilitate the correct reassembly of new bearings/bushings.*



22. If the bearings, bushing or thrust washers must be replaced use a suitable size bearing puller to remove bearing/bushings (19) and (13) from housing (18) without damaging the housing. Remove thrust washers (14) and thrust bearing (15) if they were previously retained in the housing by bearing (13).





Assembly

Replace all seals and seal rings with new ones each time you reassemble the Torqlink™ unit. Lubricate all seals and seal rings with SAE 10W40 oil or clean grease before assembly.

NOTE: *Individual seals and seal rings as well as a complete seal kit are available. The parts should be available through most OEM parts distributors or Parker approved Torqlink™ distributors. (Contact your local dealer for availability).*

NOTE: *Unless otherwise indicated, do not oil or grease parts before assembly.*

Wash all parts in clean petroleum-based solvents before assembly. Blow them dry with compressed air. Remove any paint chips from mating surfaces of the end cover, commutator set, manifold rotor set, wear plate and housing and from port and sealing areas.

DANGER

SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

WARNING

WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

1. If the housing (18) bearing components were removed for replacement, thoroughly coat and pack a **new** outer bearing/bushing (19) with clean corrosion resistant grease recommended in the material section. Press the new bearing/bushing into the counterbore at the mounting flange end of the housing, using the appropriate sized bearing mandrel, which will control the bearing/ bushing depth.

   Torqlink™ housings require the use of bearing mandrel to press bearing/ bushing (19) into the housing to a required depth of 0.151/0.161 inches (3.84/4.09 mm) from the end of the bearing counterbore.

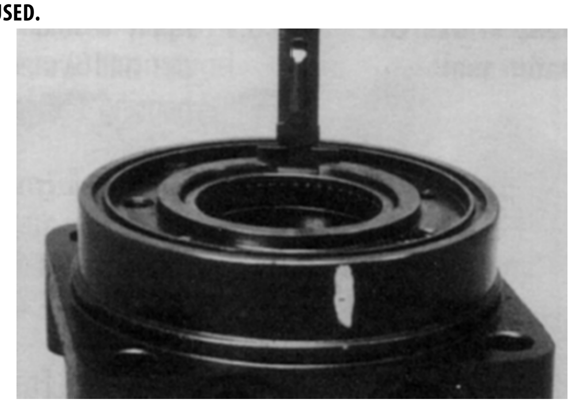
NOTE: *Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.*

NOTICE

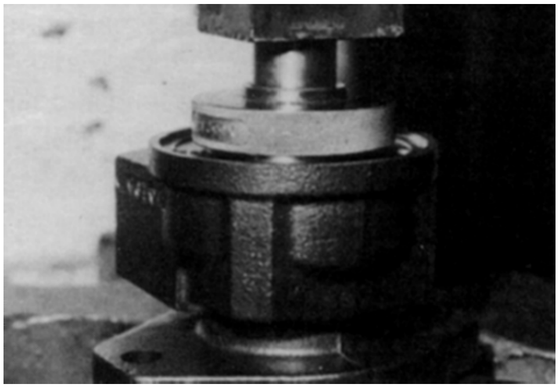
IF THE BEARING MANDREL SPECIFIED IN THE "TOOLS AND MATERIALS REQUIRED FOR SERVICING" SECTION IS NOT AVAILABLE AND ALTERNATE METHODS ARE USED TO PRESS IN BEARING/BUSHING (13) AND (19) THE BEARING/BUSHING DEPTHS SPECIFIED MUST BE ACHIEVED TO INSURE ADEQUATE BEARING SUPPORT AND CORRECT RELATIONSHIP TO ADJACENT COMPONENTS WHEN ASSEMBLED.

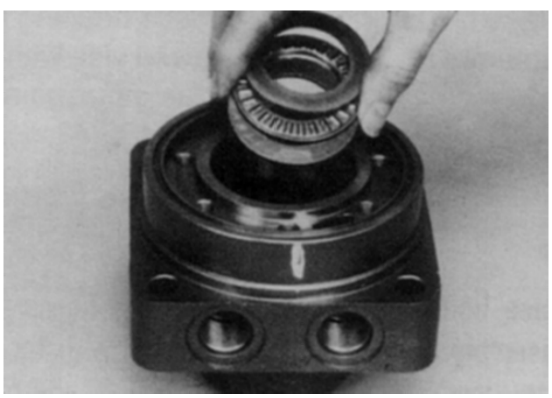
NOTICE

BECAUSE THE BEARING/BUSHINGS (13) AND (19) HAVE A PRESS FIT INTO THE HOUSING THEY MUST BE DISCARDED WHEN REMOVED. THEY MUST NOT BE REUSED.



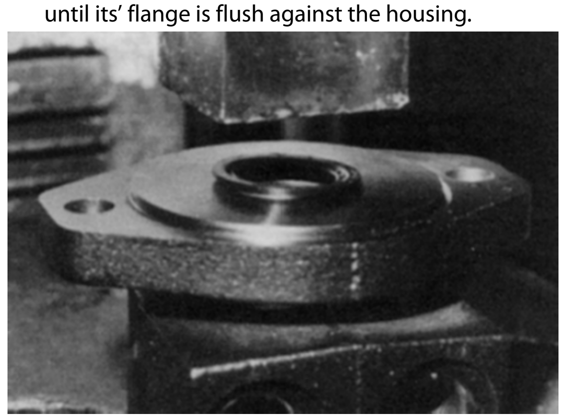
2. The Torqlink™ inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to 0.03 inch (.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/ bushing (19).

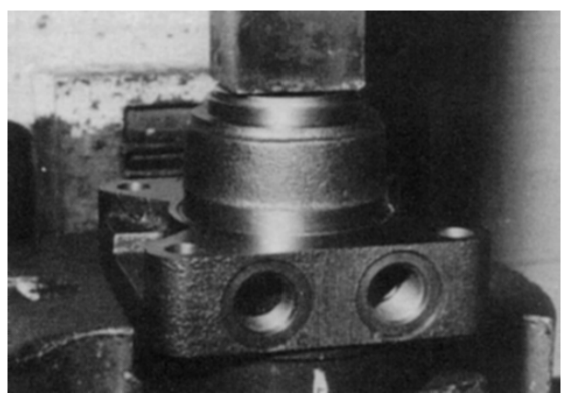




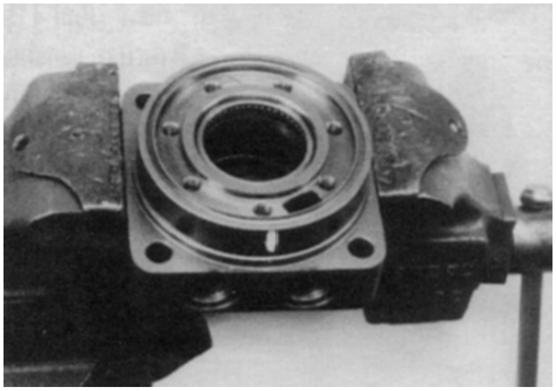
3. Press a **new** dirt and water seal (20) into the housing (18) outer bearing counterbore.

   The Torqlink™ dirt and water seal (20) must be pressed in until its' flange is flush against the housing.





4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange.

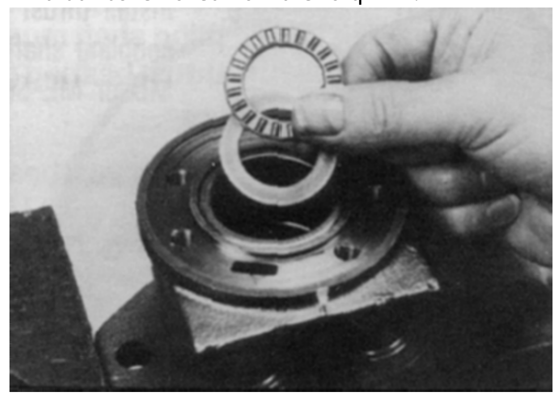


5. On the Torqlinks™ assemble a **new** backup washer (17) and **new** seal (16) with the seal lip facing toward the inside of Torqlink™, into their respective counterbores in housing (18) if they were not assembled in procedure 2.

NOTICE

ORIGINAL DESIGN LARGE FRAME, TF & TG TORQLINKS™ THAT DO NOT HAVE BACKUP WASHER (25) WHEN DISASSEMBLED MUST BE ASSEMBLED WITH A NEW BACKUP WASHER (17), NEW BACKUP WASHER (25), AND NEW SEAL (16).

6. Assemble thrust washer (14) then thrust bearing (15) that was removed from the Torqlink™.



NOTE: *Torqlinks™ require one thrust washer (14) with thrust bearing (15).The coupling shaft will be seated directly against the thrust*

7. Apply masking tape around splines or keyway on shaft (12) to prevent damage to seal.

8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in the housings.

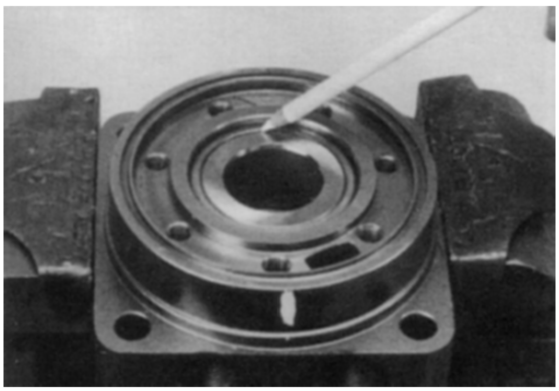
NOTICE

THE OUTER BEARING (19) IS NOT LUBRICATED BY THE SYSTEM'S HYDRAULIC FLUID. BE SURE IT IS THOROUGHLY PACKED WITH THE RECOMMENDED GREASE, PARKER GEAR GREASE SPECIFICATION #045236, E/M LUBRICANT #K-70M.

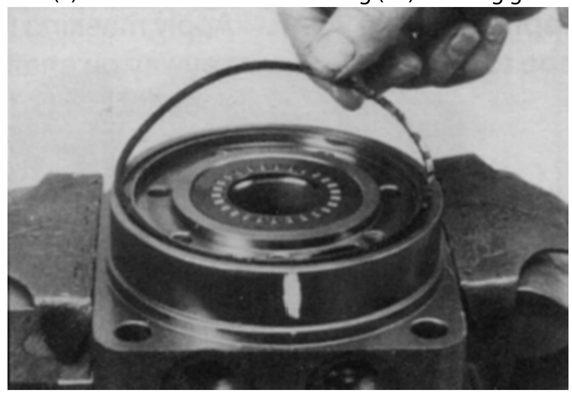
NOTE: *Mobil Mobilith SHC ® 460*

NOTE: *A 102Tube (P/N 406010) is included in each seal kit.*

NOTE: *The coupling shaft (12) will be flush or just below the housing wear plate surface on Torqlinks™ when properly seated. The coupling shaft must rotate smoothly on the thrust bearing package.*

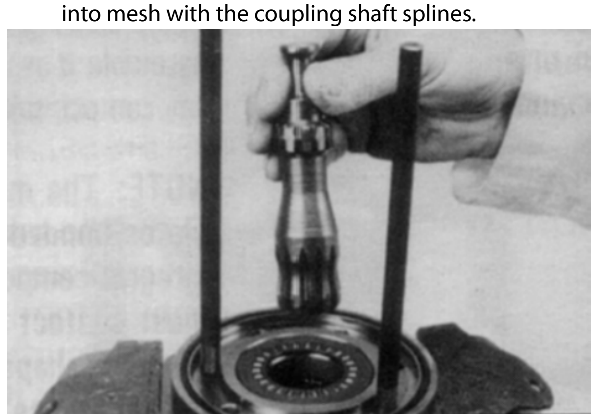


9. Apply a small amount of clean grease to a **new** seal ring (4) and insert it into the housing (18) seal ring groove.



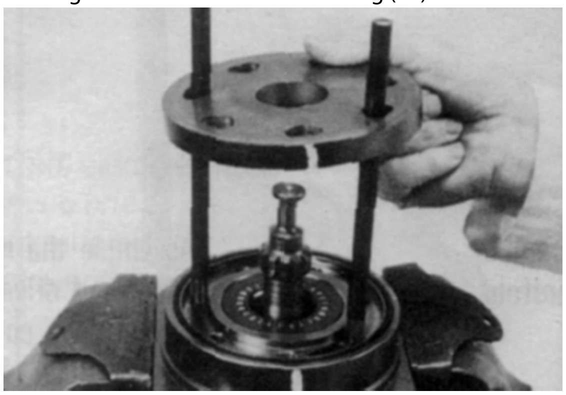
NOTE: *One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures.The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A bolts as required that are over 0.5 inch (12.7 mm) longer than the bolts (1) used in the Torqlink™.*

10. Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines.

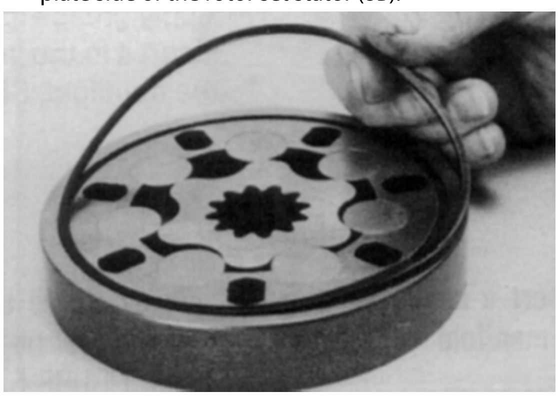


NOTE: *Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.*

11. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18).



12. Apply a small amount of clean grease to a new seal ring (4) and assemble it into the seal ring groove on the wear plate side of the rotor set stator (8B).



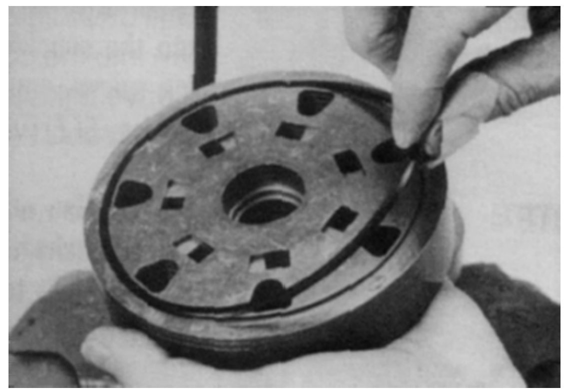
13. Install the assembled rotor set (8) onto wear plate (9) with rotor (8A) counterbore and seal ring side down and the splines into mesh with the drive link splines.

NOTE: *It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.*

NOTE: *If necessary, go to the appropriate, "Rotor Set Component Assembly Procedure."*

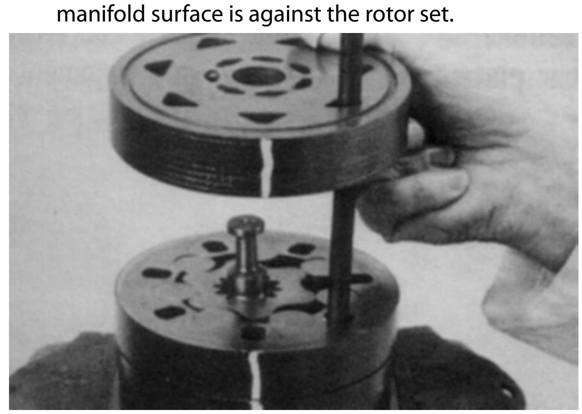
NOTE: *The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the rotor splines if apparent, to determine which side was down.The rotor set seal ring groove faces toward the wear plate (9).*

14. Apply clean grease to a **new** seal ring (4) and assemble it in the seal ring groove in the rotor set contact side of manifold (7).

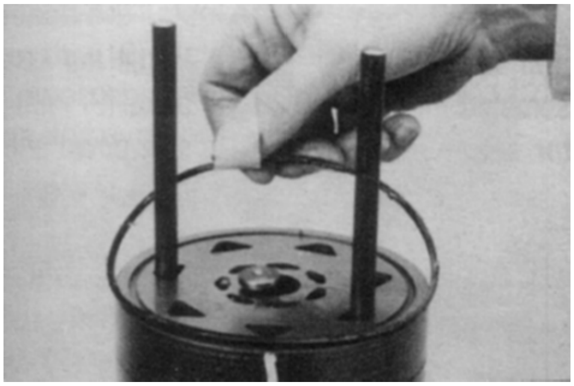


NOTE: *The manifold (7) is made up of several plates bonded together permanently to form an integral component.The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter.The polished impression left on the manifold by the rotor set is another indication of which surface must contact the rotor set.*

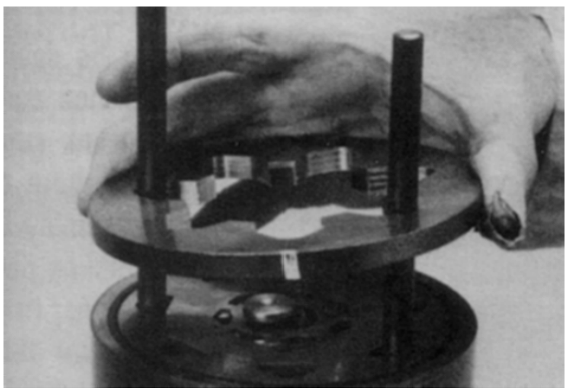
15. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



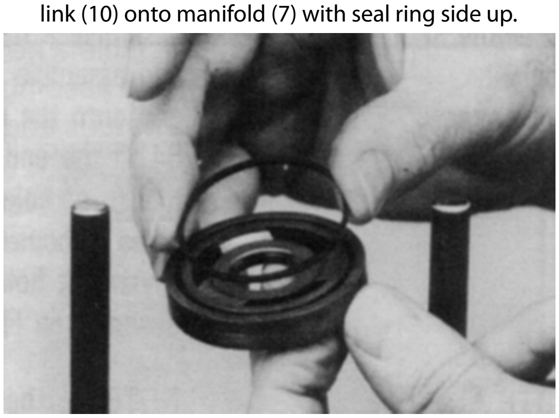
16. Apply grease to a **new** seal ring (4) and insert it in the seal ring groove exposed on the manifold.

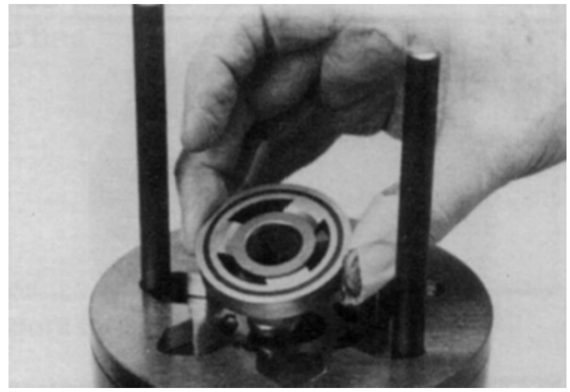


17. Assemble the commutator ring (6) over alignment studs onto the manifold.



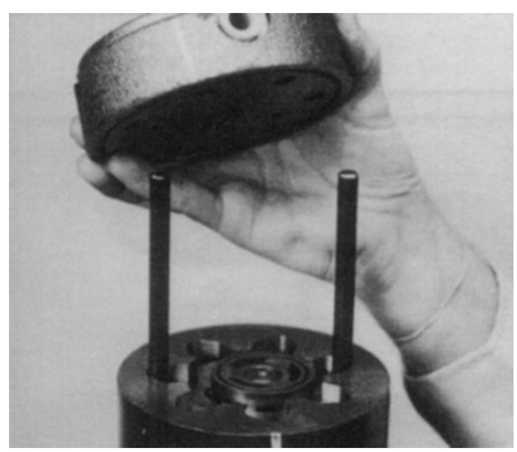
18. Assemble a **new** seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up.

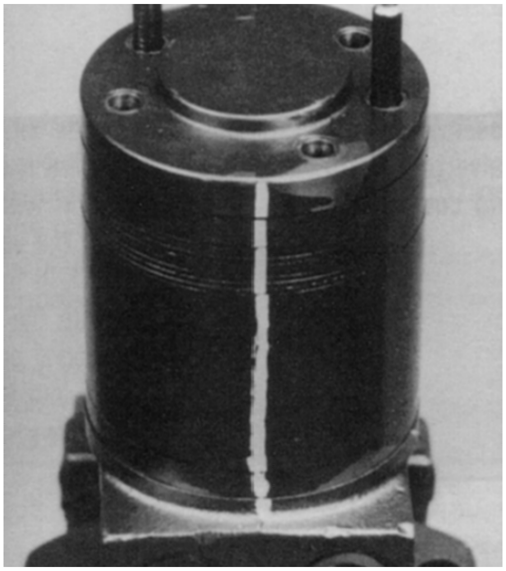




19. If shuttle valve components items #21, were removed from the end cover (2) turn a plug (21), loosely into one end of the valve cavity in the end cover. A 3/16 inch Allen wrench is required.

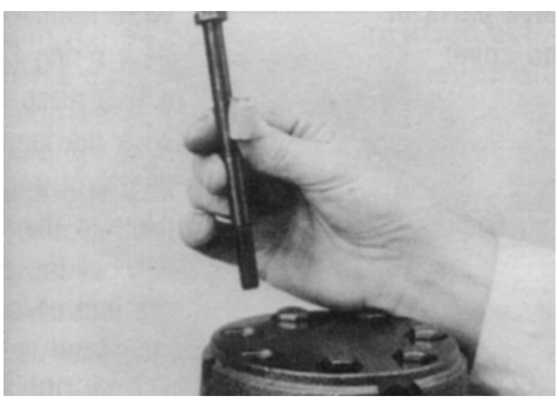
20. Assemble a **new** seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18).The correct 5 bolt end cover bolt hole relationship to housing port bosses.

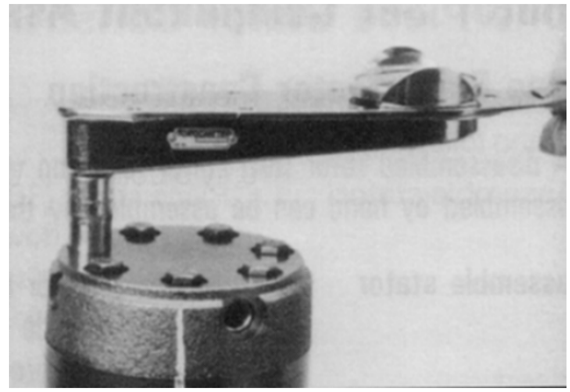


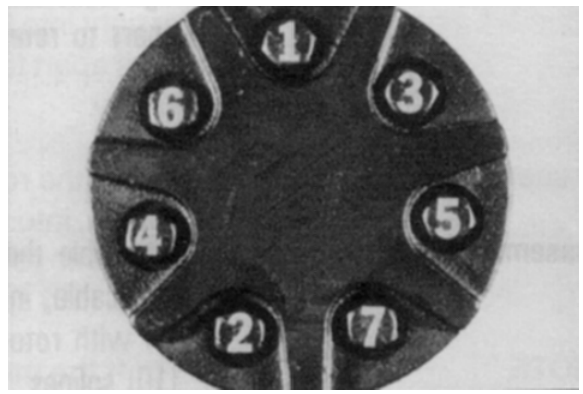


NOTE: If the end cover has a valve (24) or has five bolt holes, use the line you previously scribed on the cover to radially align the end cover into its original position.

21. Assemble the 5 or 7 special bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 22-26 ft. lbs. 45-55 ft. lbs.(61-75 N m) for the seven 3/8-24 threaded bolts.



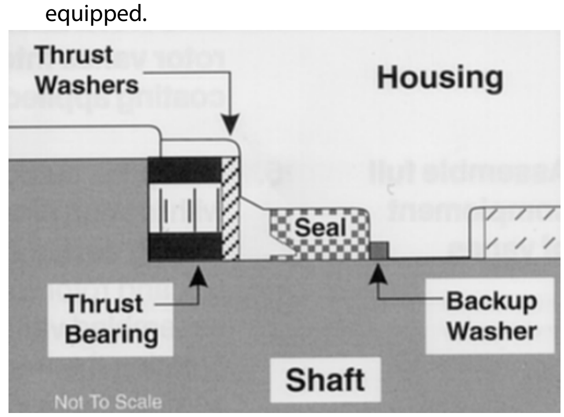




NOTE: The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard and cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.

22. Torque the two shuttle valve plug assemblies (21) in end cover assembly to 9-12 ft. lbs. (12-16 Nm) if cover is so equipped.

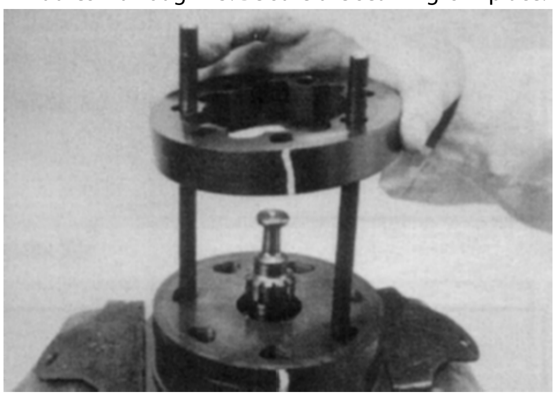
    Torque the two relief valve plug assemblies (21) in end cover assembly to 45-55 ft. lbs.(61-75 Nm) if cover is so equipped.



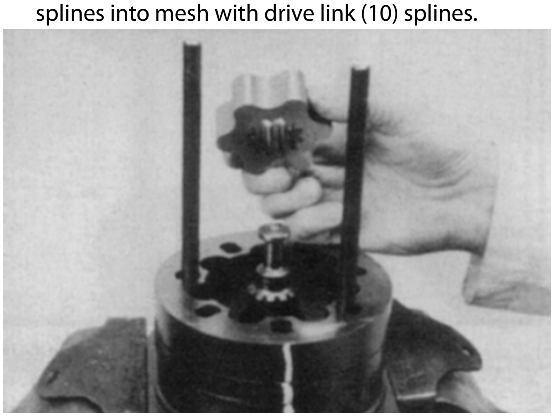
One Piece Stator Construction

A disassembled rotor (8A) stator (8B) and vanes (8C) that cannot be readily assembled by hand can be assembled by the following procedures.

1. Place stator (8B) onto wear plate (9) with seal ring (4) side down, after following Torqlink™ assembly procedures 1 through 13. Be sure the seal ring is in place.

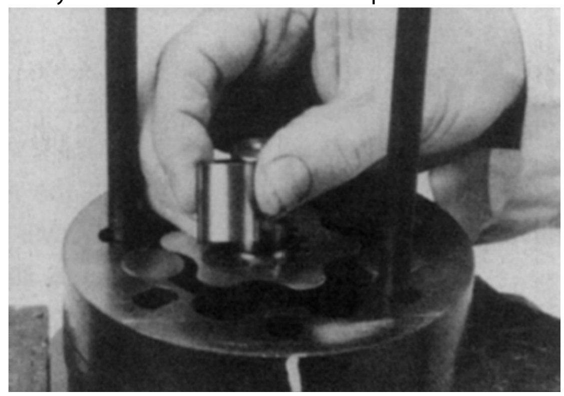


2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.
3. Assemble the rotor (8A), counterbore down if applicable, into stator (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.



NOTE: *If the manifold side of the rotor was etched during Torqlink disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wear plate.*

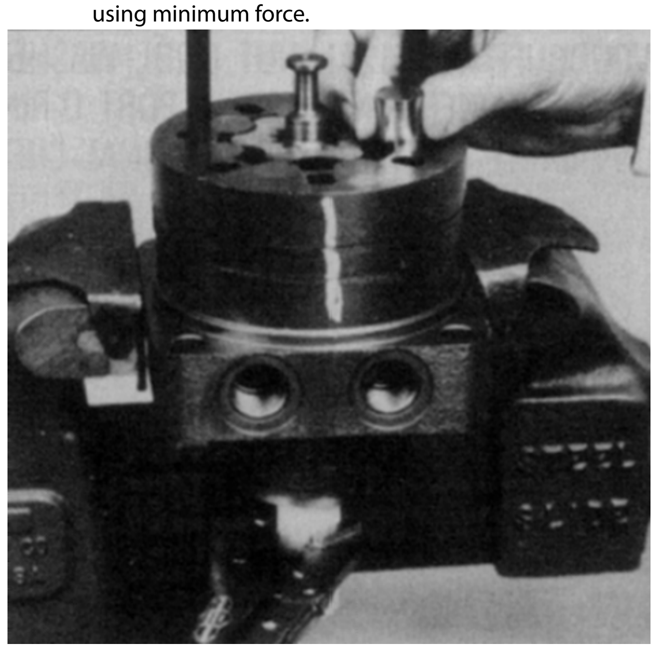
4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.



NOTICE

EXCESSIVE FORCE USED TO PUSH THE ROTOR VANES INTO PLACE COULD SHEAR OFF THE COATING APPLIED TO THE STATOR VANE POCKETS.

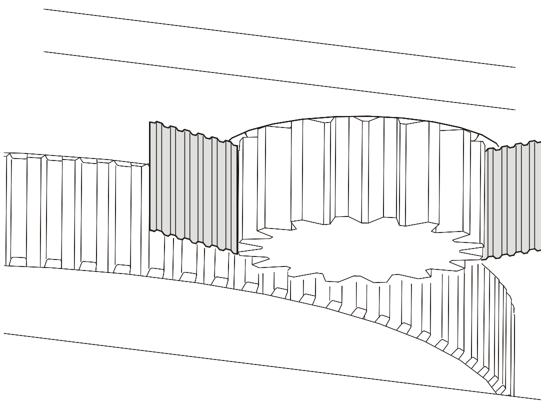
5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.



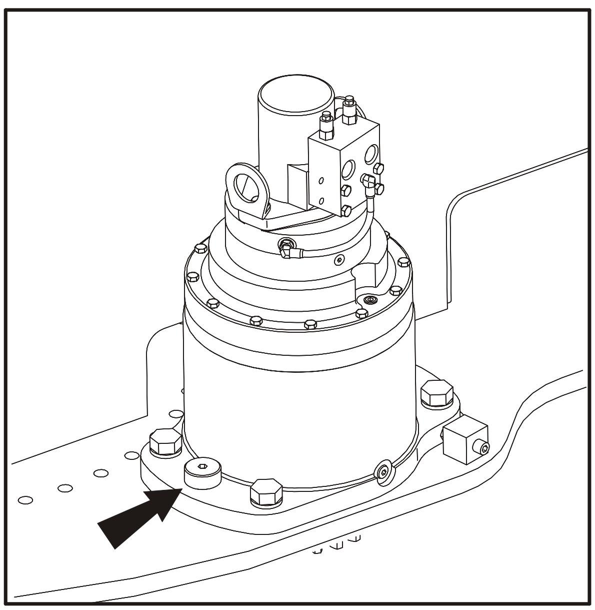
6. Remove the two assembled bolts (1) if used to retain stator and wear plate.

3.17 PROCEDURE FOR SETTING GEAR BACKLASH

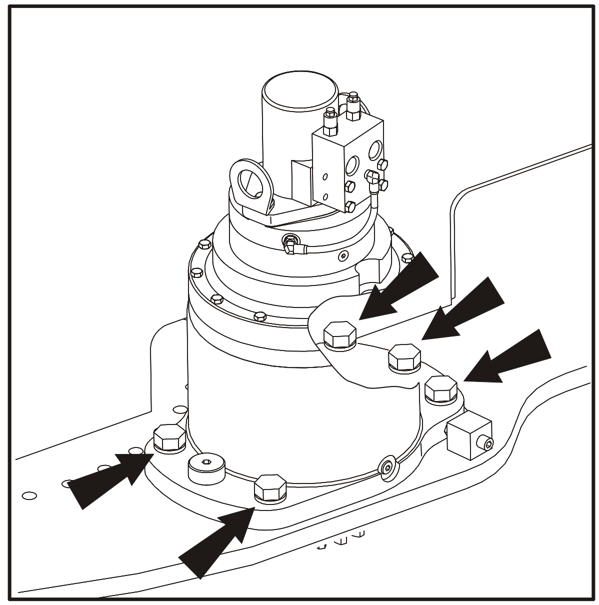
1. Set backlash to 0.010 to 0.015" using the following procedure.
2. Place shim (JLG p/n 4071041) between pinion and bearing on the bearing high spot. The bearing high spot should be stamped with an "X" on the surface below the teeth and marked with yellow paint in the tooth space.



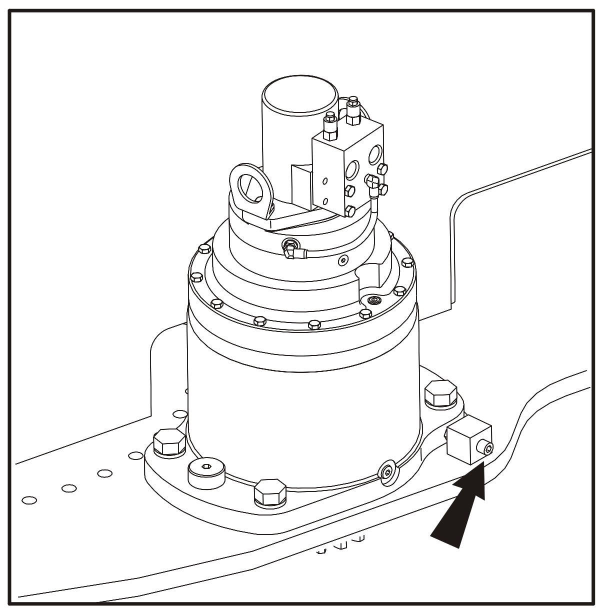
3. Torque the shoulder screw (shown below) to 660 foot-pounds (896 Nm) with Loctite #271.



4. Remove the turntable lock pin.
5. Pre-torque the capscrews (shown below) to 90 foot-pounds (122 Nm) with Loctite #271.

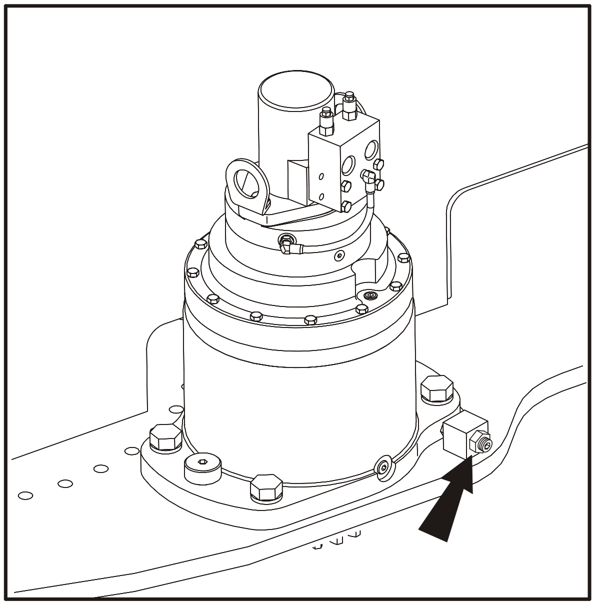


6. Tighten the setscrew (shown below) until the pinion is completely snug against the shim and bearing and then back off the setscrew.



7. Torque the setscrew to 50 foot-pounds (68 Nm).

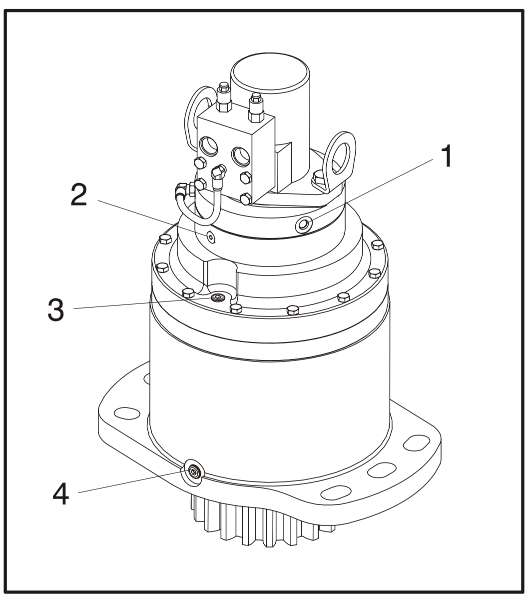
8. Tighten the jam nut (shown below) with Loctite #271.



9. Torque the capscrews shown in step 5 to 660 foot-pounds (896 Nm).

10. Remove shim and discard.

3.18 SWING DRIVE LUBRICATION



1 Brake Bleed Port
2 Brake Fill Port
3 Gearbox Fill Port
4 Gearbox Drain Port

Figure 3-52. Swing Drive Ports

The Swing Gearbox is to be filled with 79 ounces (2.3 L) of API Service Classification GL-5 Extreme Pressure Gear Lube. Fill to cover the ring gear.

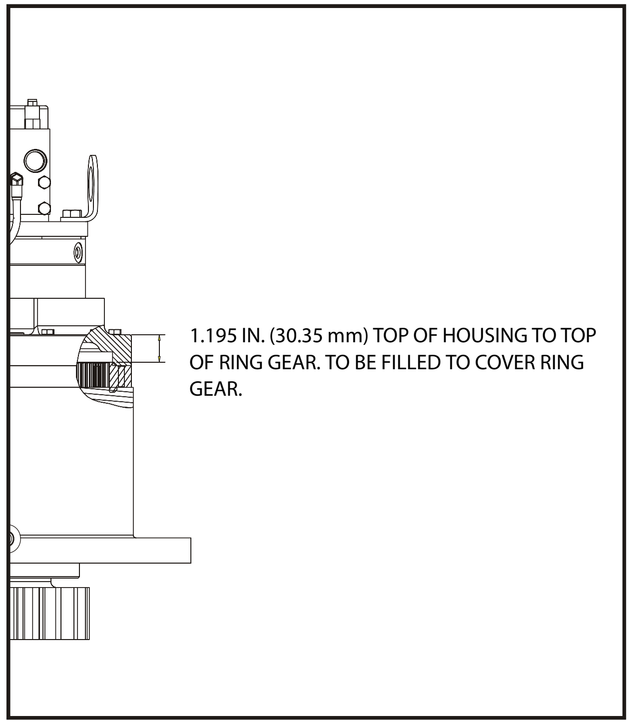


Figure 3-53. Swing Drive Lubrication

The Swing Brake is to be filled half full, 2.7 ounces (80 ml), with DTE24 oil.

3.19 SWING BEARING

Turntable Bearing Mounting Bolt Condition Check

NOTICE

THE SWING BEARING IS ONE OF THE MOST CRITICAL POINTS ON AN AERIAL LIFT. IT IS HERE THAT THE STRESSES OF LIFTING ARE CONCENTRATED, AT THE CENTER OF ROTATION. BECAUSE OF THIS, PROPER MAINTENANCE OF THE SWING BEARING BOLTS IS A MUST FOR SAFE OPERATION.

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 applying loctite #271 to the bolt threads. After replacing and retorquing bolt or bolts recheck all existing bolts for looseness.*

1. Check the frame to bearing attach bolts as follows:
   a. Fully elevate the main boom. (See Figure 3-54.)
   b. At the position indicated on Figure 3-54., try to insert a 0.0015 feeler gauge between the bolt and hardened washer at the arrow indicated position.
   c. Ensure that the 0.0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
   d. Swing the turntable 90 degrees, and check some selected bolts at the new position.
   e. Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.
2. Check the turntable to bearing Attach bolts as follows:
   a. Elevate the fully retracted main boom to full elevation.
   b. At the position indicated on Figure 3-56. try to insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
   c. Lower the boom to horizontal and fully extend the boom.
   d. At the position indicated on Figure 3-55., try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.

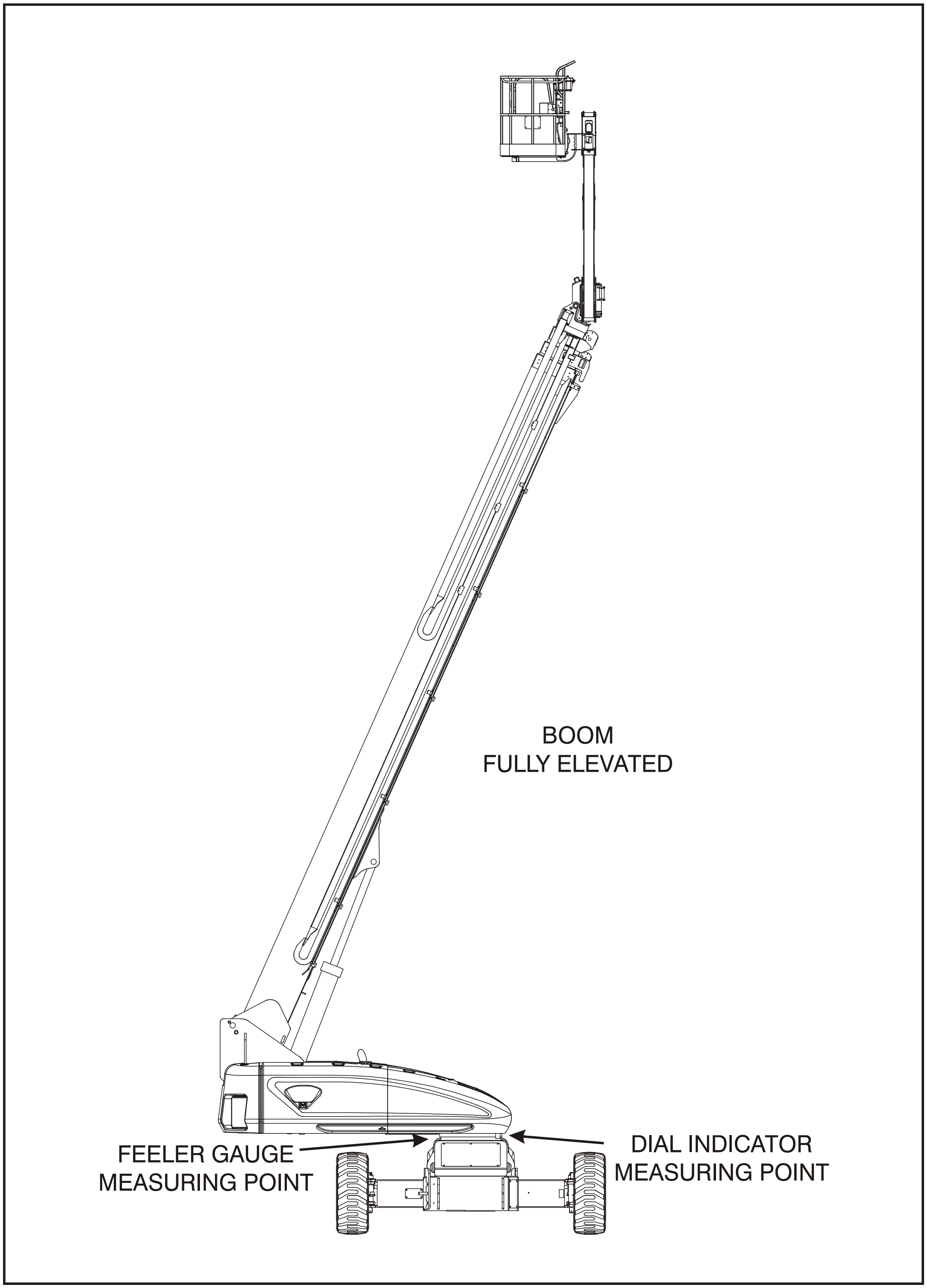


Figure 3-54. Swing Bearing Tolerance Boom Placement - Sheet 1 of 2

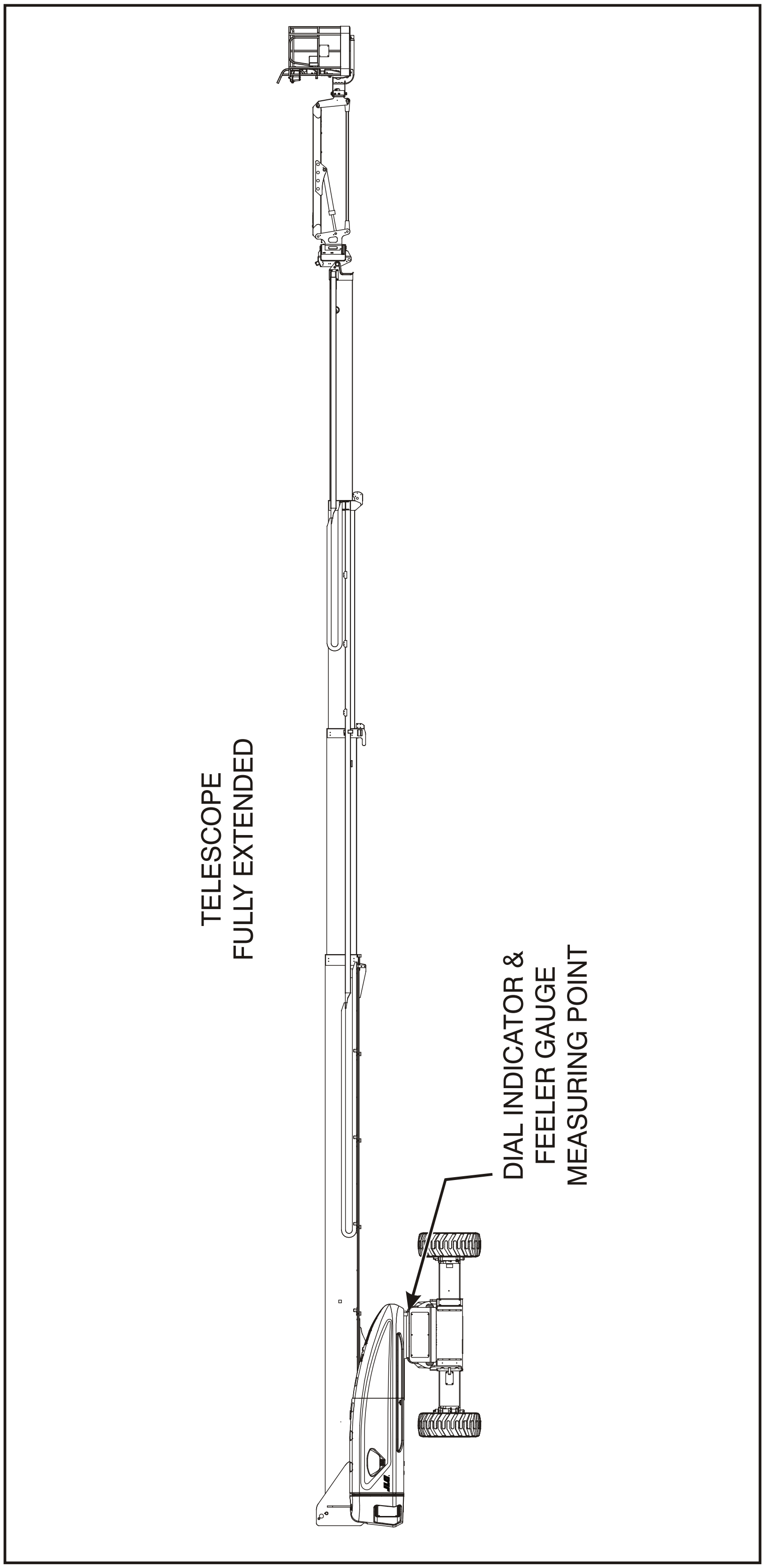


Figure 3-55. Swing Bearing Tolerance Boom Placement - Sheet 2 of 2

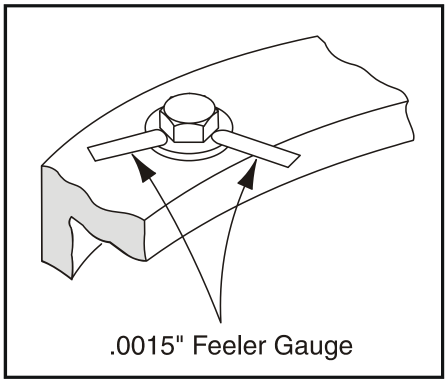


Figure 3-56. Swing Bolt Feeler Gauge Check

Wear Tolerance

1. From the underside of the machine, at rear center, with the main boom fully elevated and fully retracted, as shown in Figure 3-54., Swing Bearing Tolerance Boom Placement - Sheet 1 of 2, set up a magnetic base dial indicator as shown below and set the indicator to 0 (zero).

2. Next, position the main boom fully extended and horizontal as shown in Figure 3-55., Swing Bearing Tolerance Boom Placement - Sheet 2 of 2. Read the measurement recorded on the dial indicator gauge.
3. If the measurement is greater than 0.094 in. (2.387 mm), the swing bearing should be replaced.
4. If the measurement is less than 0.094 in. (2.387 mm), and any of the following conditions exist, the bearing should be removed, disassembled, and inspected for the following:
    a. Metal particles in the grease.
    b. Increased drive power required.
    c. Noise.
    d. Rough rotation.
5. If bearing inspection shows no defects, reassemble and return to service.

Swing Bearing Removal

1. From Ground Control station, operate the boom adequately to provide access to frame opening to rotary coupling.

DANGER

NEVER WORK BENEATH THE BOOM WITHOUT FIRST ENGAGING BOOM SAFETY PROP OR PROVIDING ADEQUATE OVERHEAD SLING SUPPORT AND/OR BLOCKING.

2. Attach an adequate support sling to the boom and draw all slack from sling. Prop or block the boom if feasible.

NOTICE

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

3. Tag and disconnect the hydraulic lines from the fittings on the top of the rotary coupling. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

NOTICE

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

4. From inside turntable, remove mounting hardware which attach rotary coupling retaining yoke brackets to turntable.

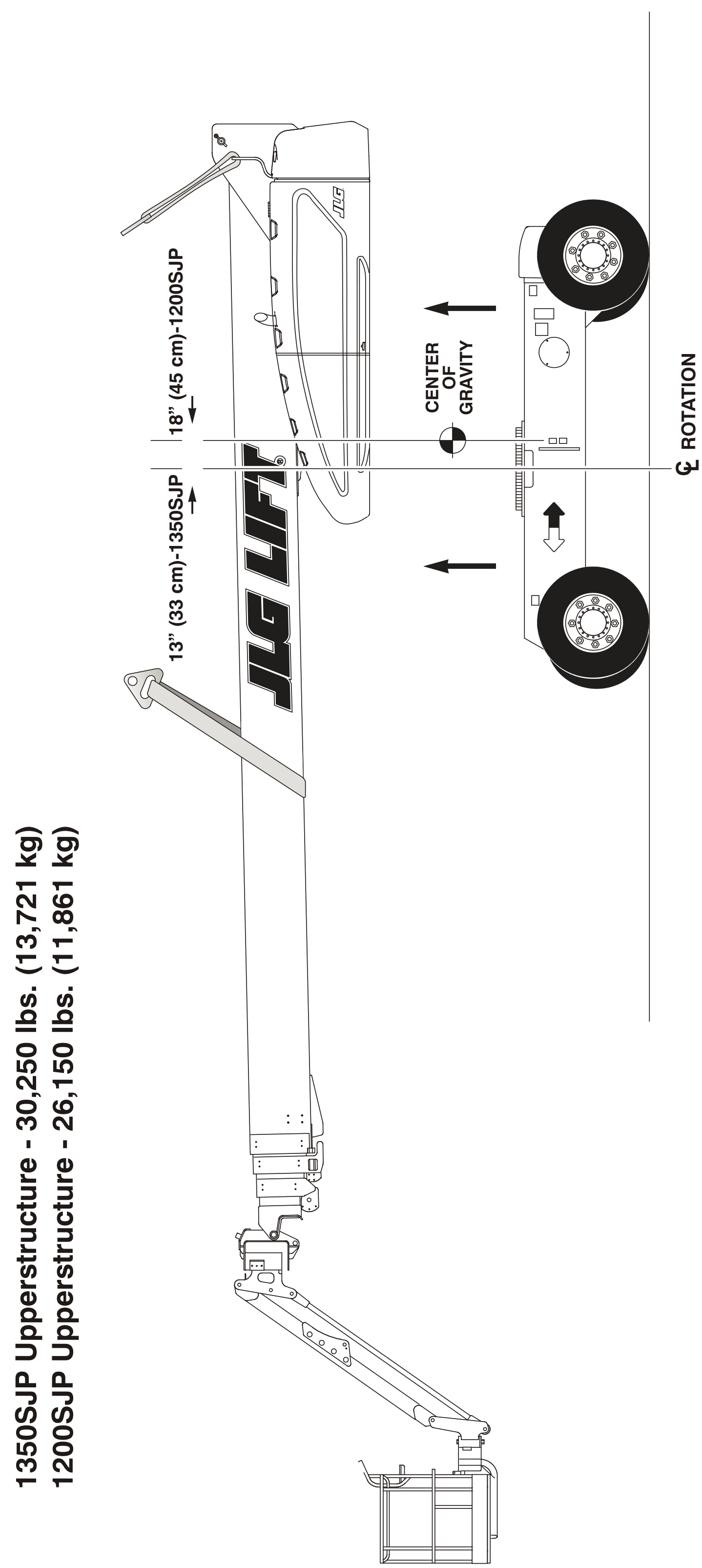
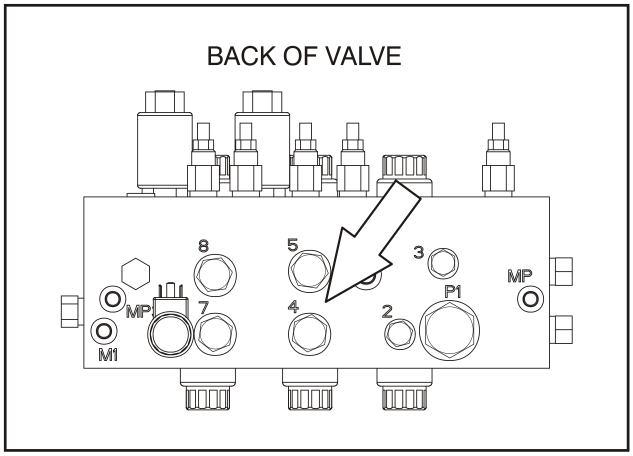


Figure 3-57. Swing Bearing Removal

5. At the rear of the main valve, remove the lift hose from port #4. Immediately cap the line and port.



6. Attach suitable overhead lifting equipment to the machine. Refer to Figure 3-57., Swing Bearing Removal.
7. 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 the bolts and washers which attach the turntable to the bearing inner race. Discard the bolts.
8. 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.
9. Carefully place the turntable on a suitably supported trestle.

NOTE: *The swing bearing weighs approximately 300 lbs. (136 kg).*

10. 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 from the frame, then move the bearing to a clean, suitably supported work area.

Swing Bearing Installation

NOTE: *The swing bearing weighs approximately 300 lbs. (136 kg).*

1. Using suitable lifting equipment, carefully lower the swing bearing into position on the frame. Ensure the scribed line of the outer race of the bearing aligns with the scribed line on the frame. If a new swing bearing is used, ensure that the spot with minimum gear backlash (marked with yellow paint) is towards the centerline of the swing drive (as close as the bolt pattern will allow).

NOTICE

JLG INDUSTRIES RECOMMENDS THAT ALL REMOVED BEARING BOLTS BE DISCARDED AND REPLACED WITH NEW 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.

2. 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.

NOTICE

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.

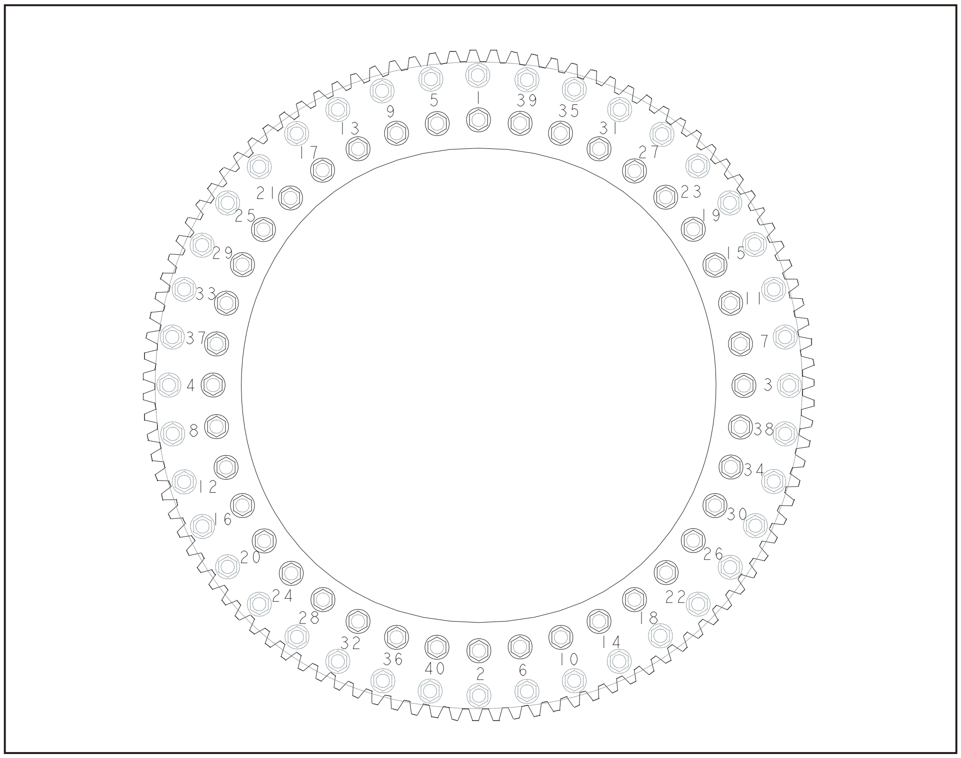
3. Refer to the Torque Sequence diagram as shown in Figure 3-58., Swing Bearing Torque Sequence. Spray a light coat of Safety Solvent 13 on the new bearing bolts. Then apply a light coating of Loctite #271 to the new bearing bolts, and install the bolts and washers through the frame and outer race of the bearing. Tighten the bolts to an initial torque of 190 ft. lbs. (258 Nm) w/Loctite.
4. Remove the lifting equipment from the bearing.
5. Using suitable lifting equipment, carefully position the turntable assembly above the machine frame.
6. Carefully lower the turntable onto the swing bearing, ensuring that the scribed line of the inner race of the bearing aligns with scribed line 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 center line of the turntable.
7. Spray a light coat of Safety Solvent 13 on the new bearing bolts. Then apply a light coating of Loctite #271 to the new bearing bolts, and install the bolts and washers through the turntable and inner race of the bearing.
8. Following the Torque Sequence diagram shown in Figure 3-58., Swing Bearing Torque Sequence, tighten the bolts to a torque of 190 ft. lbs. (258 Nm) w/Loctite.
9. Connect the hydraulic lines to the rotary coupling as tagged prior to removal.
10. Install the rotary coupling retaining yoke brackets, apply a light coating of Loctite #242 to the attaching bolts and secure the yoke to the turntable with the mounting hardware.
11. Connect the hydraulic line disconnected during removal back to port #4 on the back of the main hydraulic valve.
12. Remove the lifting equipment.
13. At ground control station, use boom lift control to lower boom to stowed position.
14. Using all applicable safety precautions, activate the hydraulic system and check the swing system for proper and safe operation.

Swing Bearing Torque Values

1. Outer Race - 190 ft. lbs. (258 Nm) w/Loctite.
2. Inner Race - 190 ft. lbs. (258 Nm) w/Loctite.
3. See Swing Bearing Torquing Sequence.

⚠ WARNING

CHECK THE INNER AND OUTER SWING BEARING BOLTS FOR MISSING OR LOOSENESS AFTER FIRST 50 HOURS OF OPERATION, AND EVERY 600 HOURS THEREAFTER.



NOTE: *Swing Bearing Torque Sequence is typical for both inner and outer races.*

Figure 3-58. Swing Bearing Torque Sequence

3.20 SWING SPEED PROPORTIONING

Swing Speed Proportioning uses the boom length and angle sensors to improve the comfort, speed and control of the turntable swing function. Turntable swing speed is increased as the distance of the platform to the center of rotation is decreased. This results in approximately constant platform speeds regardless of boom position. Swing speed proportioning is disabled with any envelope sensors failure. Disabling of swing speed proportioning will default to the slowest swing speed setting.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

3.21 CHASSIS TILT INDICATOR SYSTEM

The Chassis Tilt Indicator System measures the turntable angle with respect to level ground. The tilt sensor (which is an integral part of the ground module) has two settings; 5.0 and 8.0 degrees. The smaller angle is used for the purpose of warning the operator by means of the chassis tilt light in the platform display panel. Additionally when used in conjunction with the Beyond Transport - Drive Speed Cutback System, the tilt sensor will cause an alarm to sound, and automatically put all functions in the creep speed mode. With the exception of the speed cutback, this is a warning system only. The machine will continue to function. The operator is responsible to prevent the machine from attaining an unstable position. The 8.0 degree angle is used exclusively for the purpose of automatically shifting the drive motors to the maximum displacement position (slow speed). The control system responds to indicated angle readings 0.5 degrees smaller than the required angles to account for calibration and sensor variation.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

3.22 ROTARY COUPLING

Use the following procedure to for installing the seal kit.

1. Remove snap ring (7) from end.
2. Remove thrust ring (3) from same end.
3. Remove center body (1) from housing (3).
4. Cut off old seals (2,3,5).
5. Assemble lip seals (2) in direction shown in Figure 3-59., Rotary Coupling Seal Installation.
6. Reassemble O-ring (4).
7. Heat cap seals (5) in hydraulic oil for 5 minutes at 300° F (149° C).
8. Assemble cap seals over O-rings
9. Reinsert center body into housing (lube with hydraulic oil).
10. Replace thrust ring and snap ring.

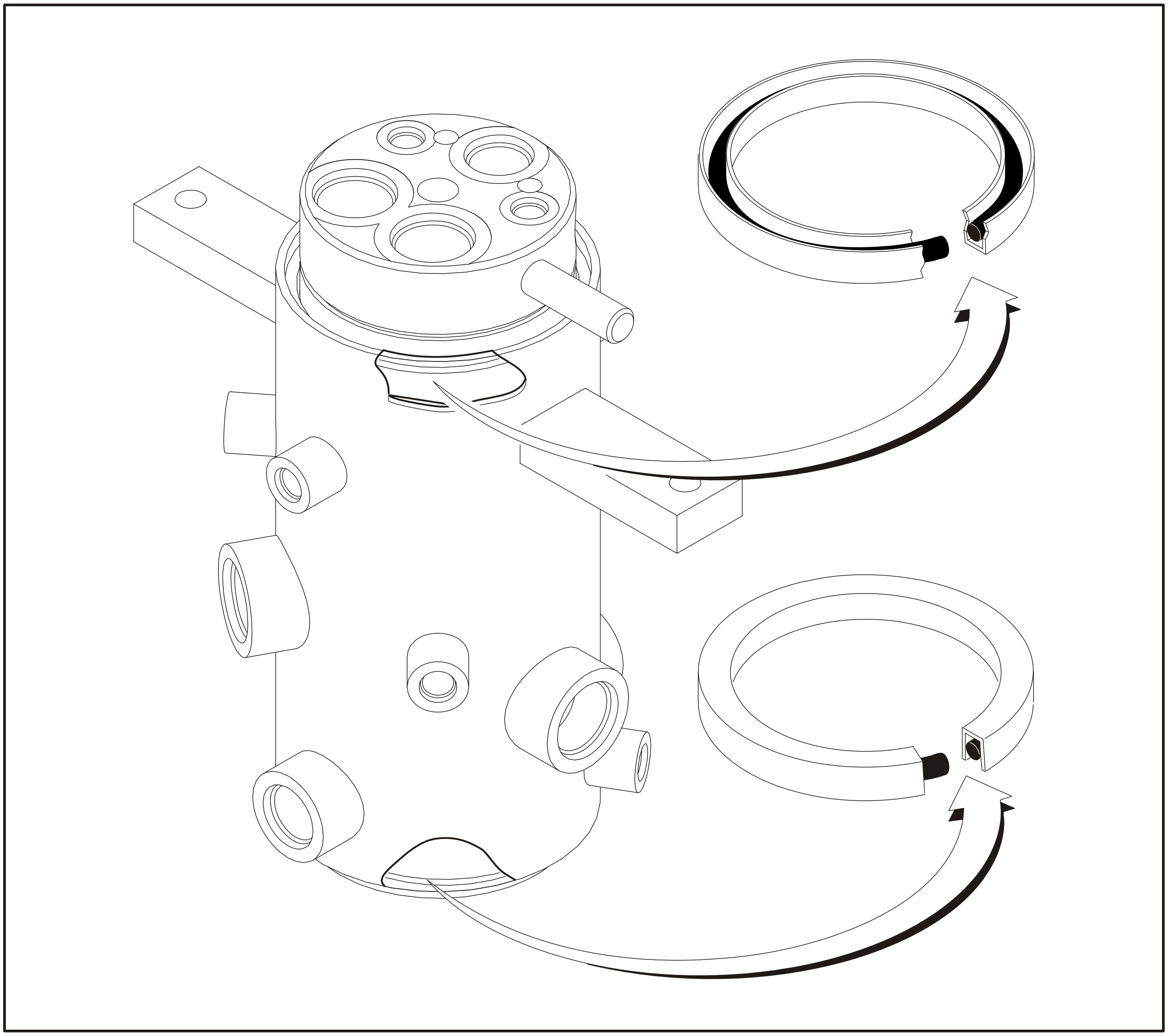
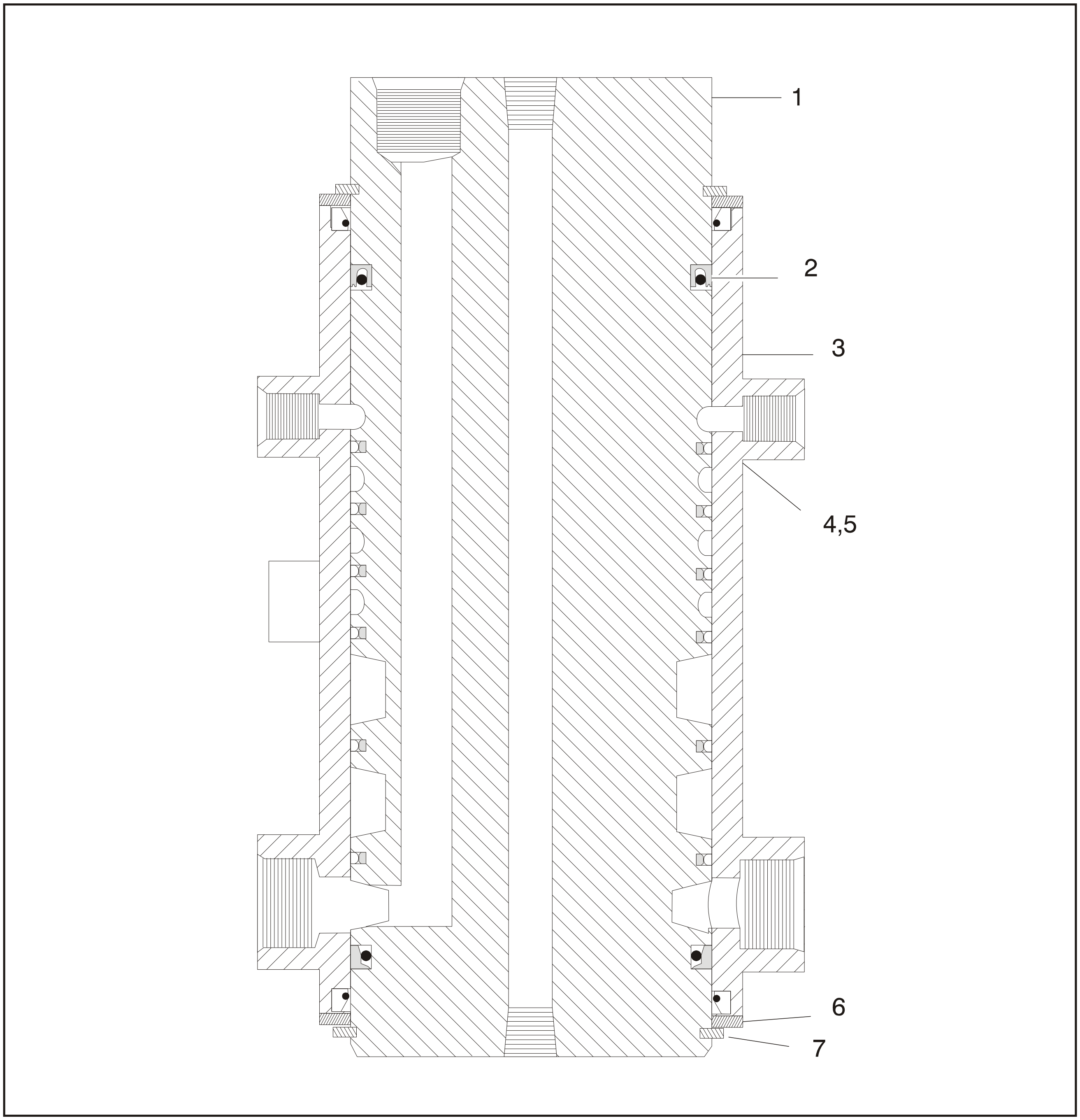
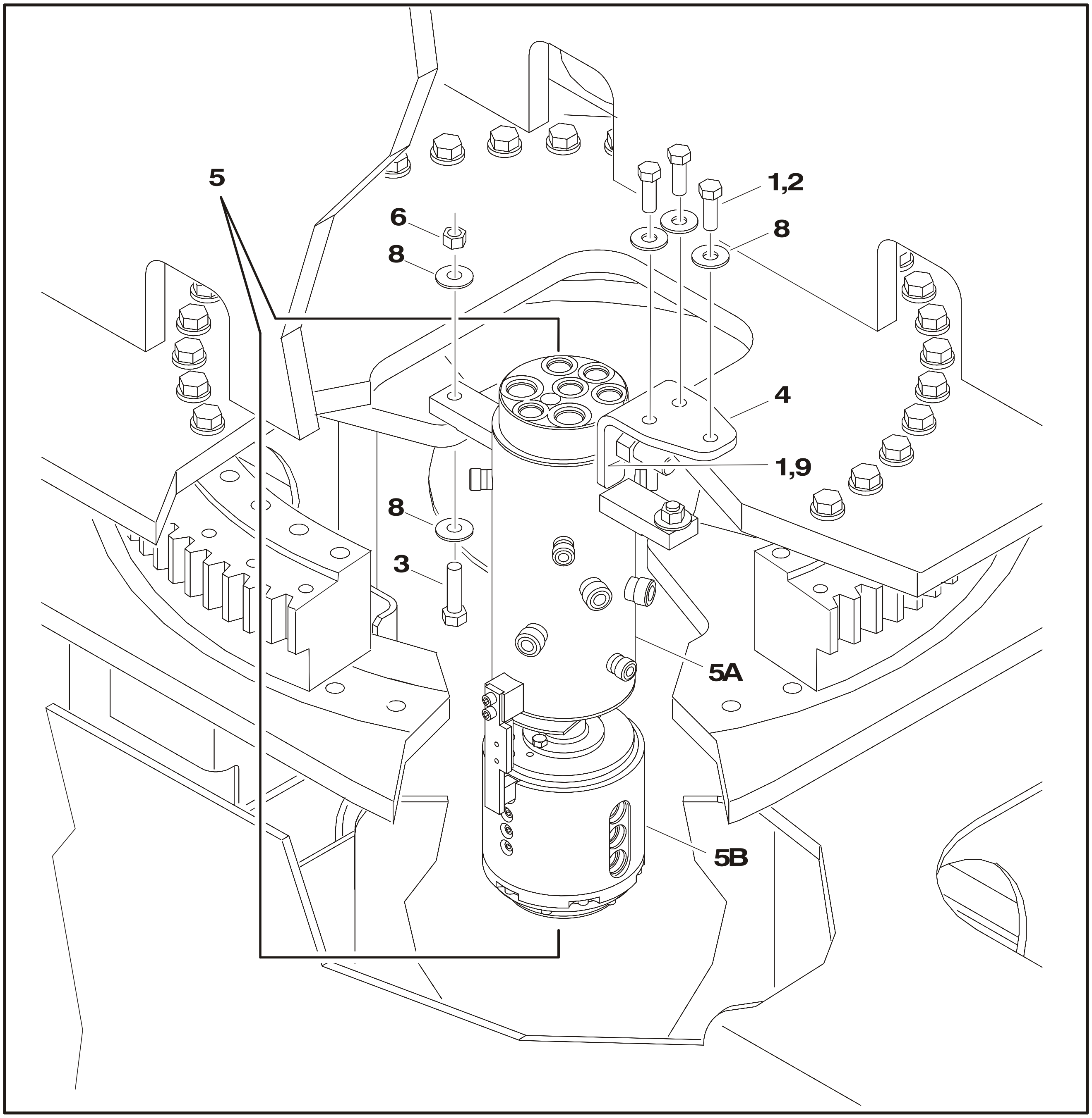


Figure 3-59. Rotary Coupling Seal Installation



1. Center Body
2. Seal
3. Housing
4. O-ring
5. Seal
6. Thrust Ring
7. Snap Ring

Figure 3-60. Rotary Coupling Cutaway



1. Loctite #242
2. Bolt
3. Bolt
4. Swivel Bracket
5. Rotary Coupling & Collector Ring Assembly
5A. Rotary Coupling
5B. Rotary Circuit Contactor
6. Locknut
7. Not Used
8. Flatwasher
9. Nut

Figure 3-61. Rotary Coupling Installation

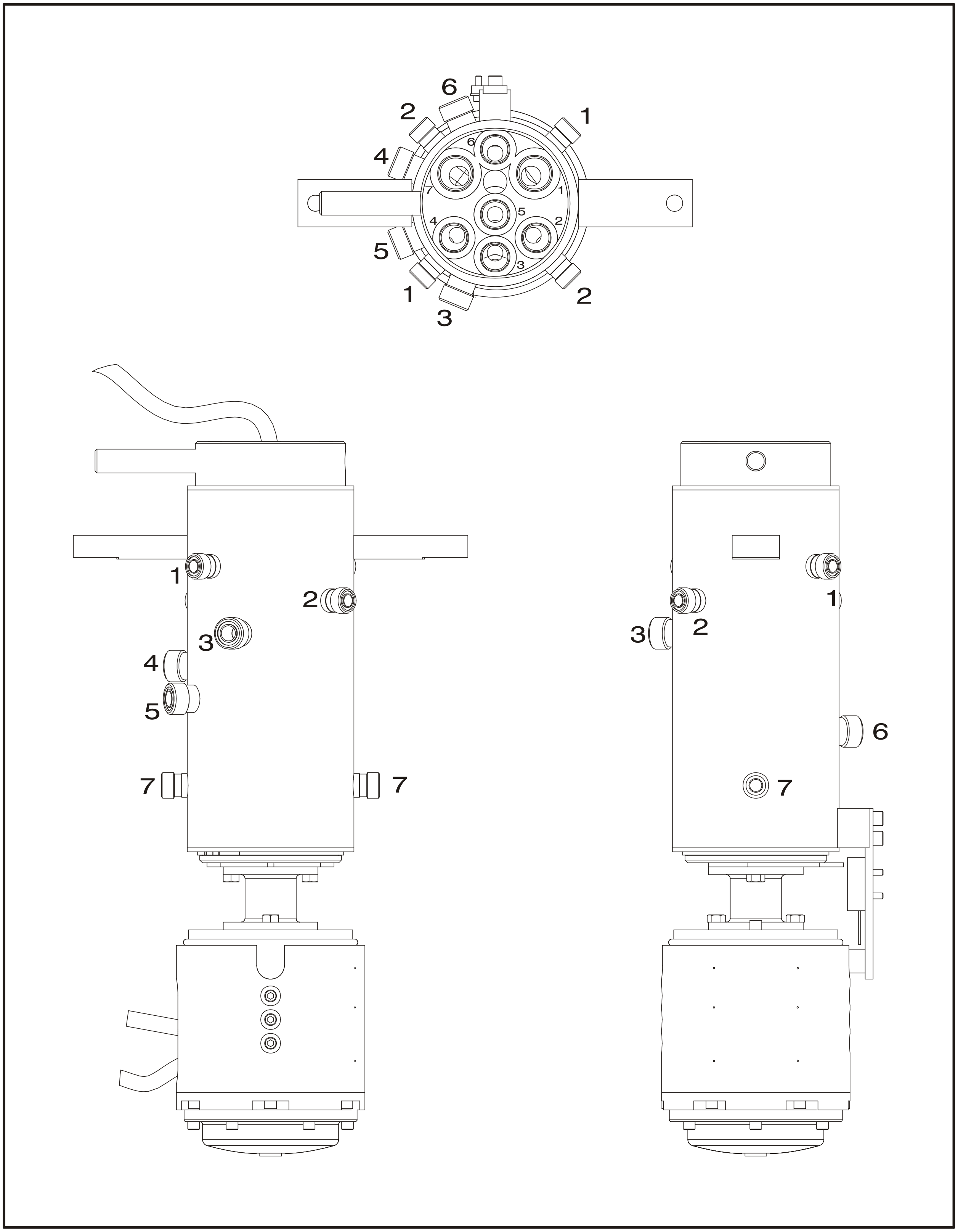


Figure 3-62. Rotary Coupling Port Location

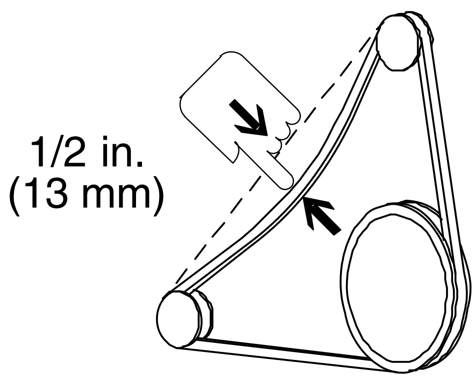
Table 3-6. Coupling Port Information Table

Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	2	-12	Steer/Axle Extend (Tank)	250 (17)	375 (26)
2	2	-10	Steer/Axle Extend (Pressure)	3000 (207)	4500 (310)
3	1	-10	Drive A	3000 (207)	4500 (310)
4	1	-10	Drive B	3000 (207)	4500 (310)
5	1	-10	Drive A	3000 (207)	4500 (310)
6	1	-10	Drive B	3000 (207)	4500 (310)
7	2	-12	Case Drain	250 (17)	375 (26)

3.23 GENERATOR

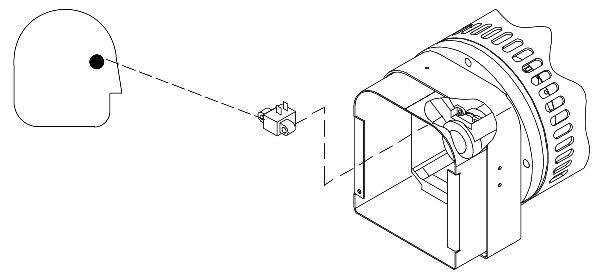
Every 250 hours

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

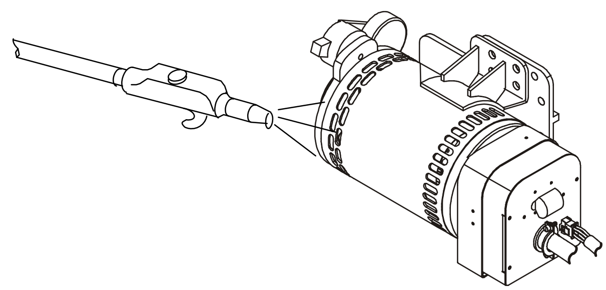


Every 500 hours

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.

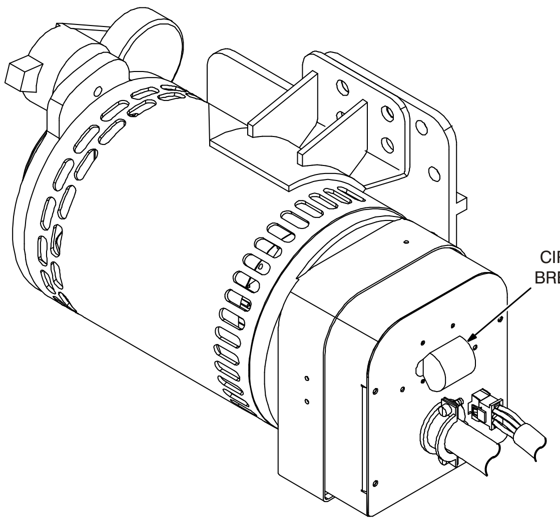


Overload Protection

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 3-63., 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.

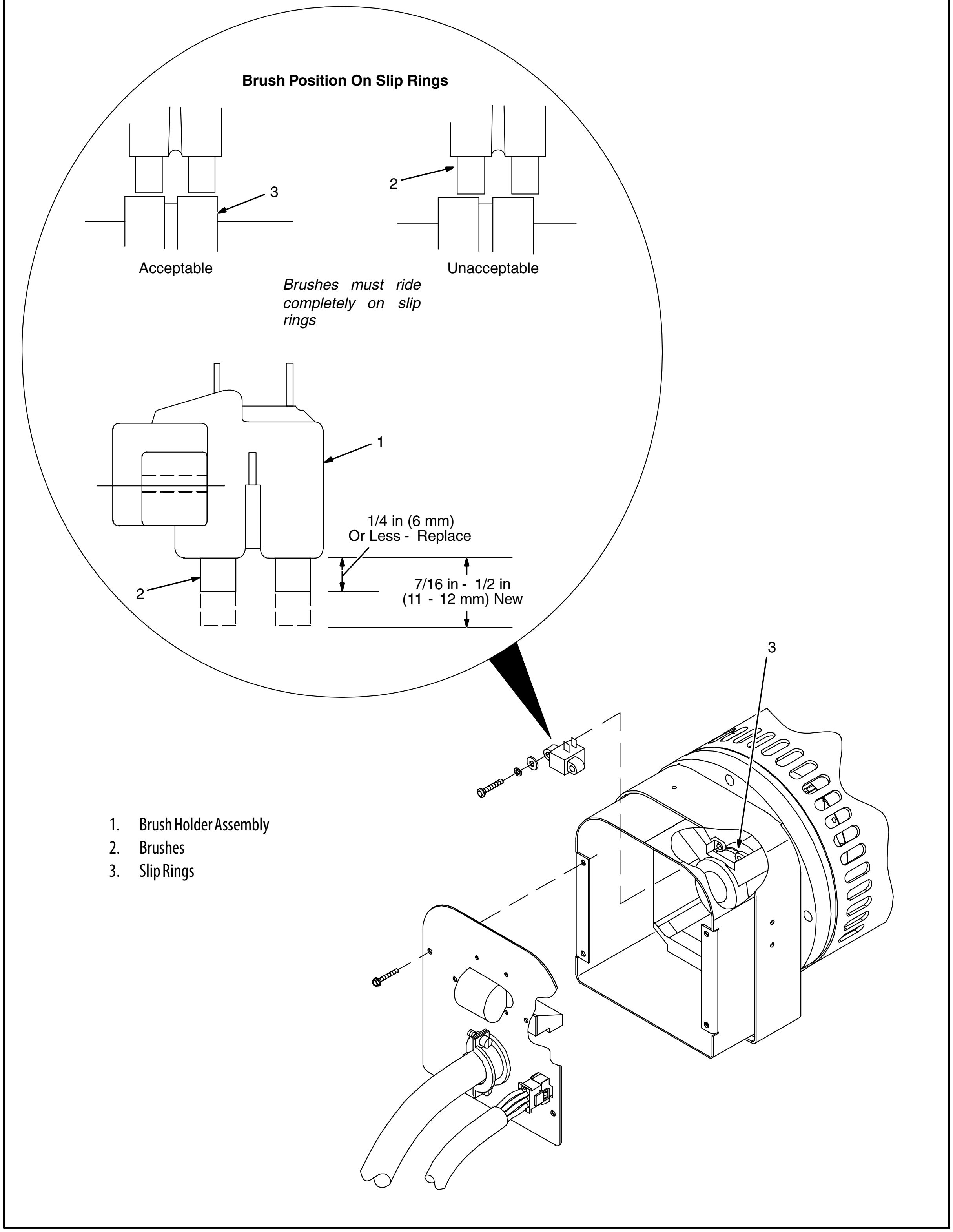
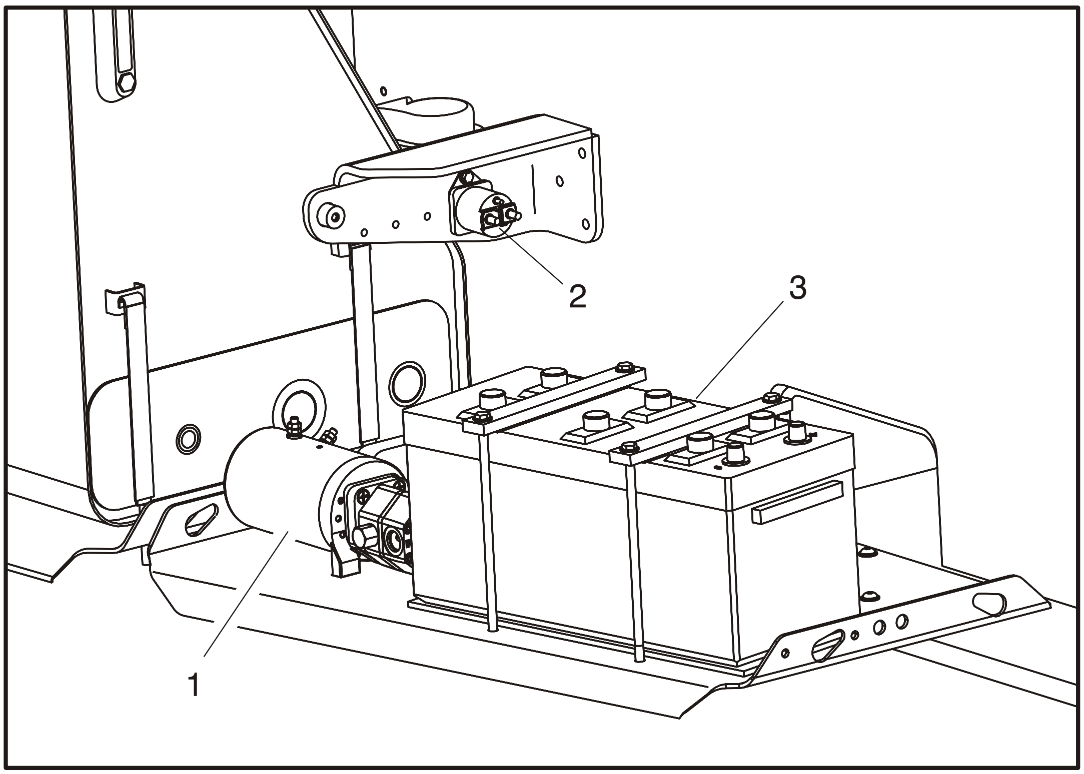


Figure 3-63. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

3.24 AUXILIARY POWER SYSTEM

The auxiliary power system is intended as a secondary means of moving the boom in the event of primary power loss. This system uses an electric motor/pump unit powered by a 12V battery capable of operating all functions except drive, controlled arc, controlled boom angle, and envelope tracking. During lift up or down functions, no other functions are permitted and during lift up functions, automatic platform leveling is not active. To reduce the demand on the battery and therefore extend the run time of the system, the auxiliary power functionality differs from the primary power functionality. The auxiliary power lift down function supplies pilot pressure to the lift cylinder allowing gravity to lower the boom. The system redirects discharge oil from the lift cylinder to retract the telescope cylinder. When the boom is retracted to the transport length, the telescope in valve is dropped out and lift down is operated alone allowing the platform to reach the ground. This not only greatly reduces the power required for these functions but also lowers the boom within the envelope regardless of starting position. Envelope control and moment control remain active during the auxiliary power function.



1. Auxiliary Pump
2. Power Relay
3. Battery

Figure 3-64. Auxiliary Pump Installation

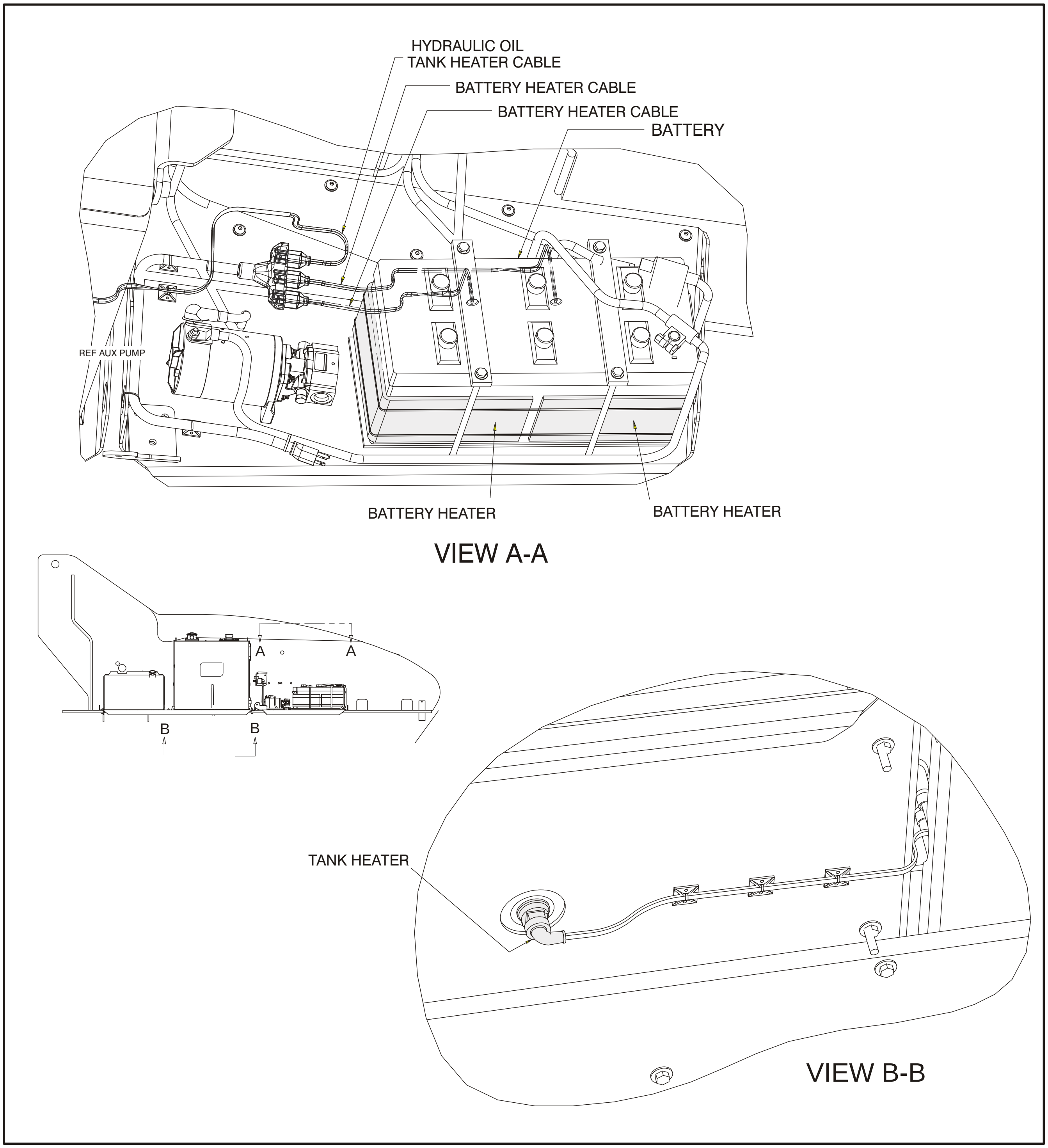


Figure 3-65. Cold Weather Package

3.25 COLD WEATHER PACKAGE

As an option, a cold weather package is available to allow the machine to be operated in lower temperatures. The package consists of battery heaters, a hydraulic tank heater, Exxon Univis hydraulic oil, and diesel fuel conditioner. See Figure 3-65., Cold Weather Package.

3.26 ENGINE

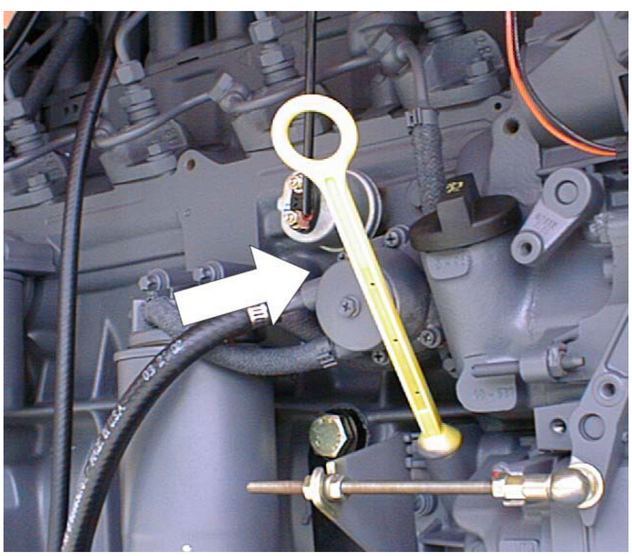
NOTE: *Refer to the engine manufacturer's manual for detailed operating and maintenance instructions.*

Glow Plugs

If the glow plug option is enabled in the JLG Control System, the glow plug and indicator lamp will be energized when the Power/Emergency Stop switch is pulled on if the ambient air temperature is less than 50° F (10° C) and the engine coolant temperature is less than 140° F (60° C). This determination will occur one second after the Power/Emergency Stop switch has been pulled on. The lamp and glow plugs will remain energized for the period of time specified by the setting in the JLG Control System. Engine start shall be disabled during this period. On Deutz engines, the glow plugs will continue (post glow) after the engine has started for three times the machine digit setting.

Checking Oil Level

1. Switch the engine off before checking oil level.
2. Make sure the machine and engine are level.
3. Remove the oil dipstick.
4. Wipe the dipstick with non-fibrous, clean cloth.
5. Insert the dipstick to the stop and remove again.



Check the oil level, and if necessary, top the oil level up to the MAX mark with an approved grade and type of oil as outlined in the engine manufacturer's operator's manual. Refer to Figure 3-66., Deutz Engine Dipstick.

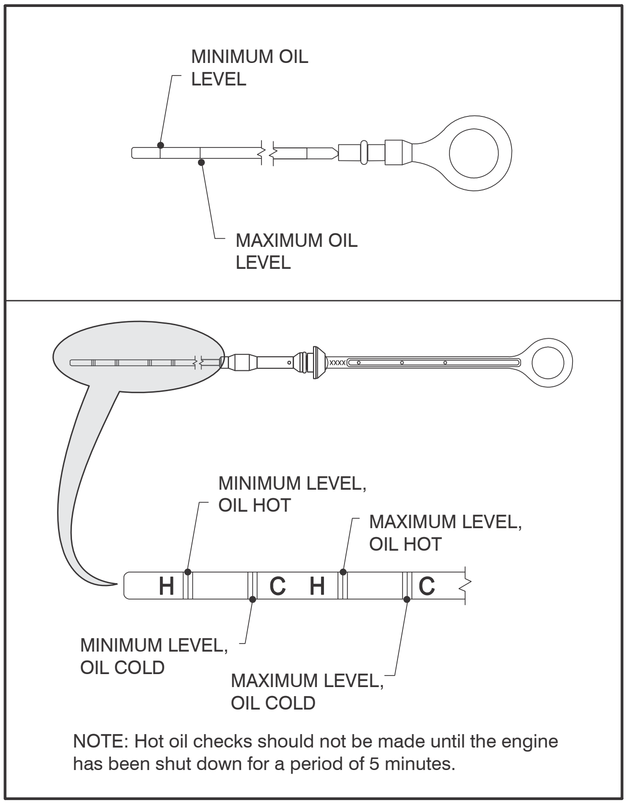


Figure 3-66. Deutz Engine Dipstick

6. Replace the dipstick making sure that it is fully seated in the dipstick tube to seal off the crankcase.

Changing Engine Oil

1. Allow the engine to warm up. The engine oil should reach approximately 176° F (80° C).
2. Make sure the machine and engine are level.
3. Switch off the engine.
4. Place an oil tray under the engine.

5. Open the oil drain valve.

⚠ WARNING

WHEN DRAINING HOT ENGINE OIL THERE IS A RISK OF SCALDING.

NOTICE

DO NOT LET USED OIL RUN INTO THE SOIL; COLLECT THE USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF THE USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.

6. Drain the oil.
7. Close the oil drain valve.
8. Pour in new engine oil. Refer to Section 1 for capacity and refer to Figure 3-67., Engine Oil Viscosity for the proper grade.

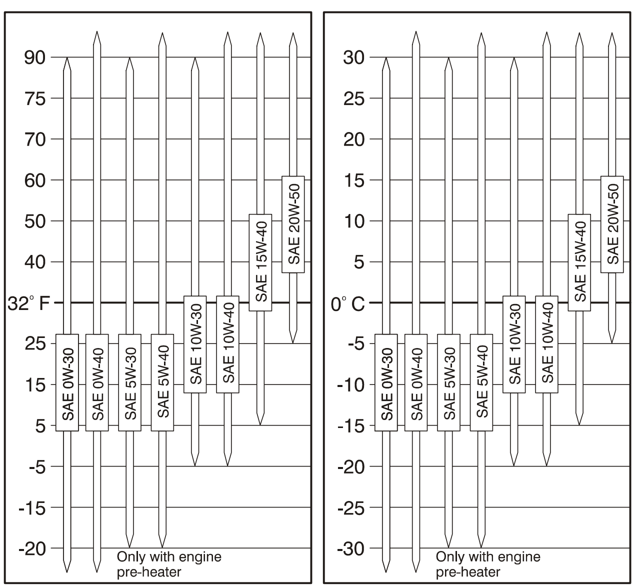
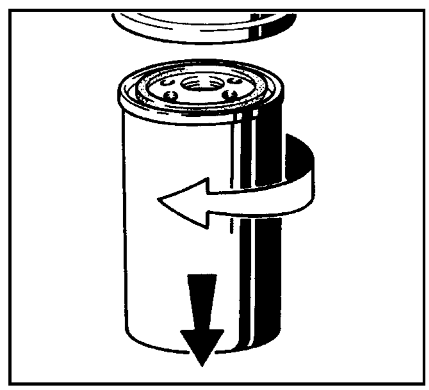


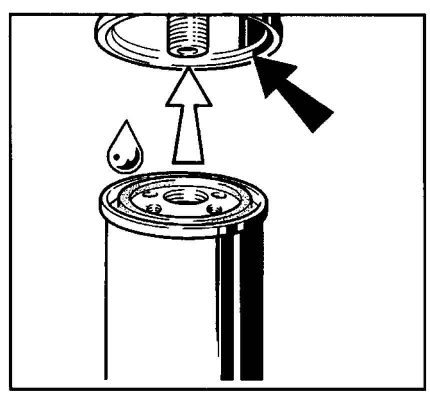
Figure 3-67. Engine Oil Viscosity

Changing the Oil Filter

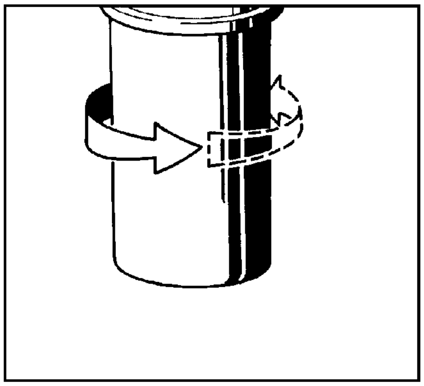
1. Wipe the area around the filter to clean any dirt from the area.
2. Using a suitable oil filter removal tool, loosen the lube oil filter cartridge and spin off.



3. Catch any escaping oil.
4. Clean any dirt from the filter carrier sealing surface.
5. Lightly oil the rubber gasket on the new oil filter.



6. Manually screw in the new filter until the gasket is flush.



7. Tighten the filter another half-turn.
8. Check the oil level.
9. Check the oil pressure.
10. Check the oil filter cartridge and make sure there are no leaks.

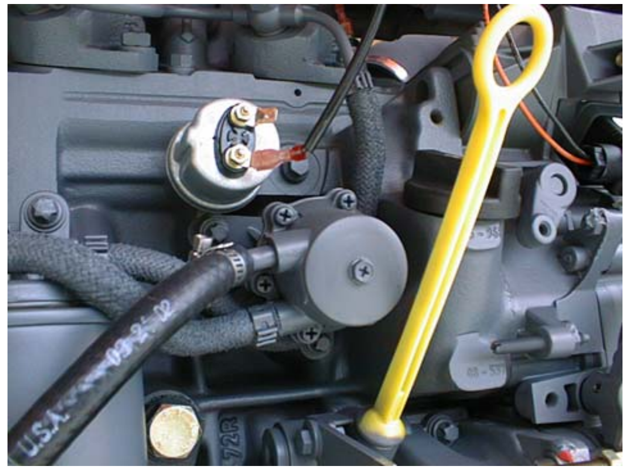
Replacing the Fuel Filter

⚠ WARNING

WHEN WORKING ON THE FUEL SYSTEM, MAKE SURE THERE ARE NO OPEN FLAMES OR SPARKS IN THE AREA. DO NOT SMOKE WHEN WORKING ON THE FUEL SYSTEM.

1. Wipe the area around the filter to clean any dirt from the area.
2. Undo the fuel filter cartridge and spin off.
3. Catch any escaping fuel.
4. Clean any dirt from the filter carrier sealing surface.
5. Apply a light film of oil or diesel fuel to the rubber gasket of the new filter cartridge.
6. Manually screw in the new filter until the gasket is flush.
7. Tighten the fuel filter cartridge with a final half-turn.
8. Open the fuel shut-off valve.
9. Check for leaks.

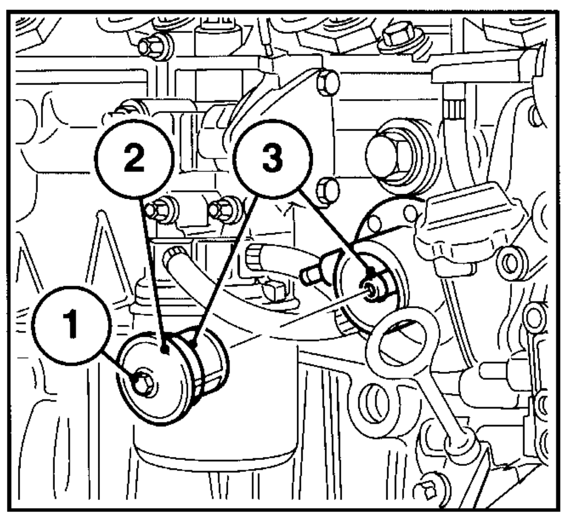
Cleaning the Fuel Strainer



⚠ WARNING

WHEN WORKING ON THE FUEL SYSTEM, MAKE SURE THERE ARE NO OPEN FLAMES OR SPARKS IN THE AREA. DO NOT SMOKE WHEN WORKING ON THE FUEL SYSTEM.

1. Unscrew the hexagonal nut (1).



2. Remove the fuel strainer cover (2).
3. Clean the fuel strainer with diesel fuel, replace if necessary.
4. Place the seal (3) in position.
5. Install the fuel strainer cover (2) in position and tighten the hexagonal screw (1).
6. Check for leaks.

3.27 DEUTZ EMR 2 (S/N 87579 TO PRESENT)

NOTE: *S/N 87532 also incorporates EMR2. S/N 87765 incorporates old Engine controls.*

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 is 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.

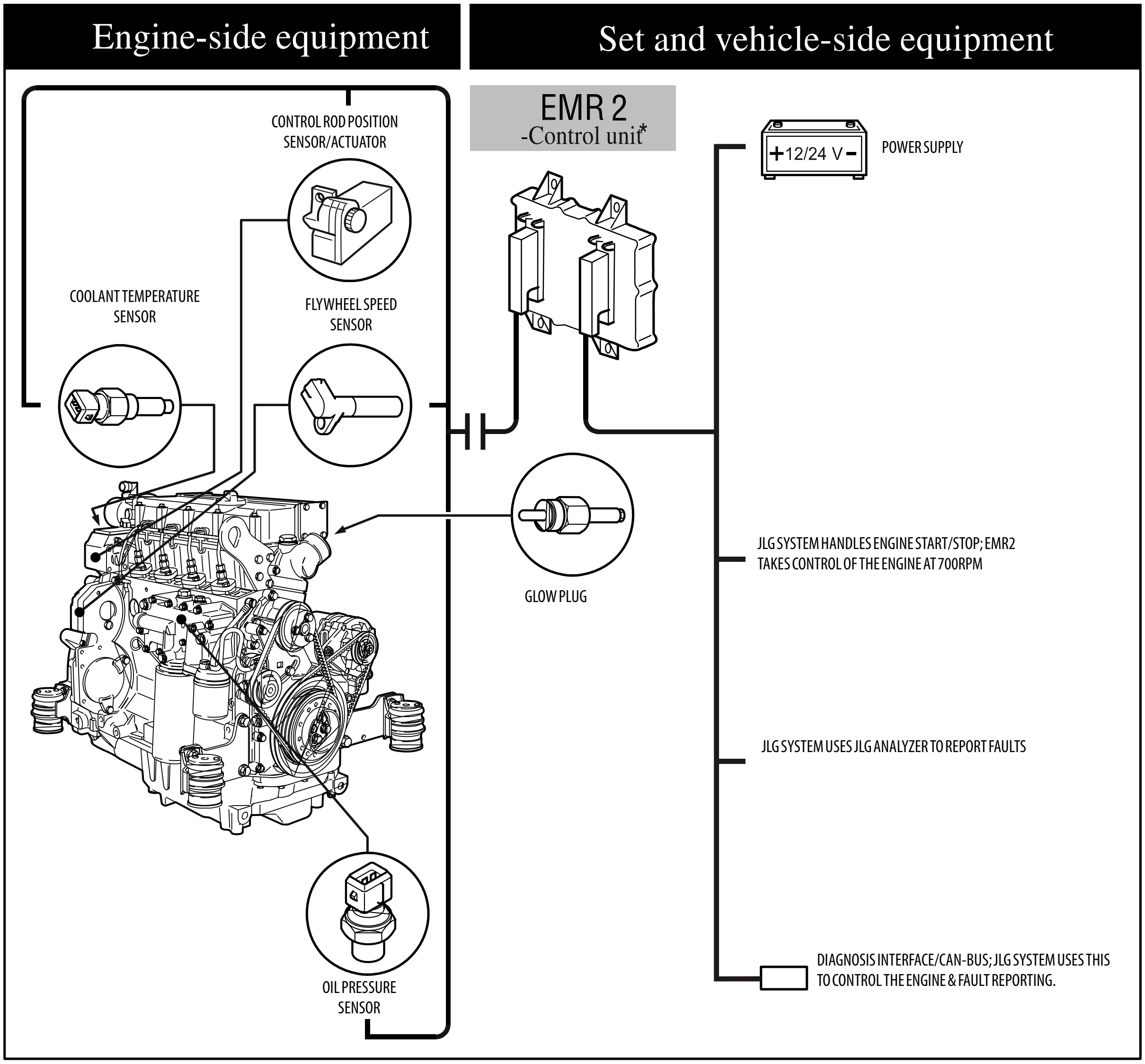


Figure 3-68. EMR 2 Engine Side Equipment

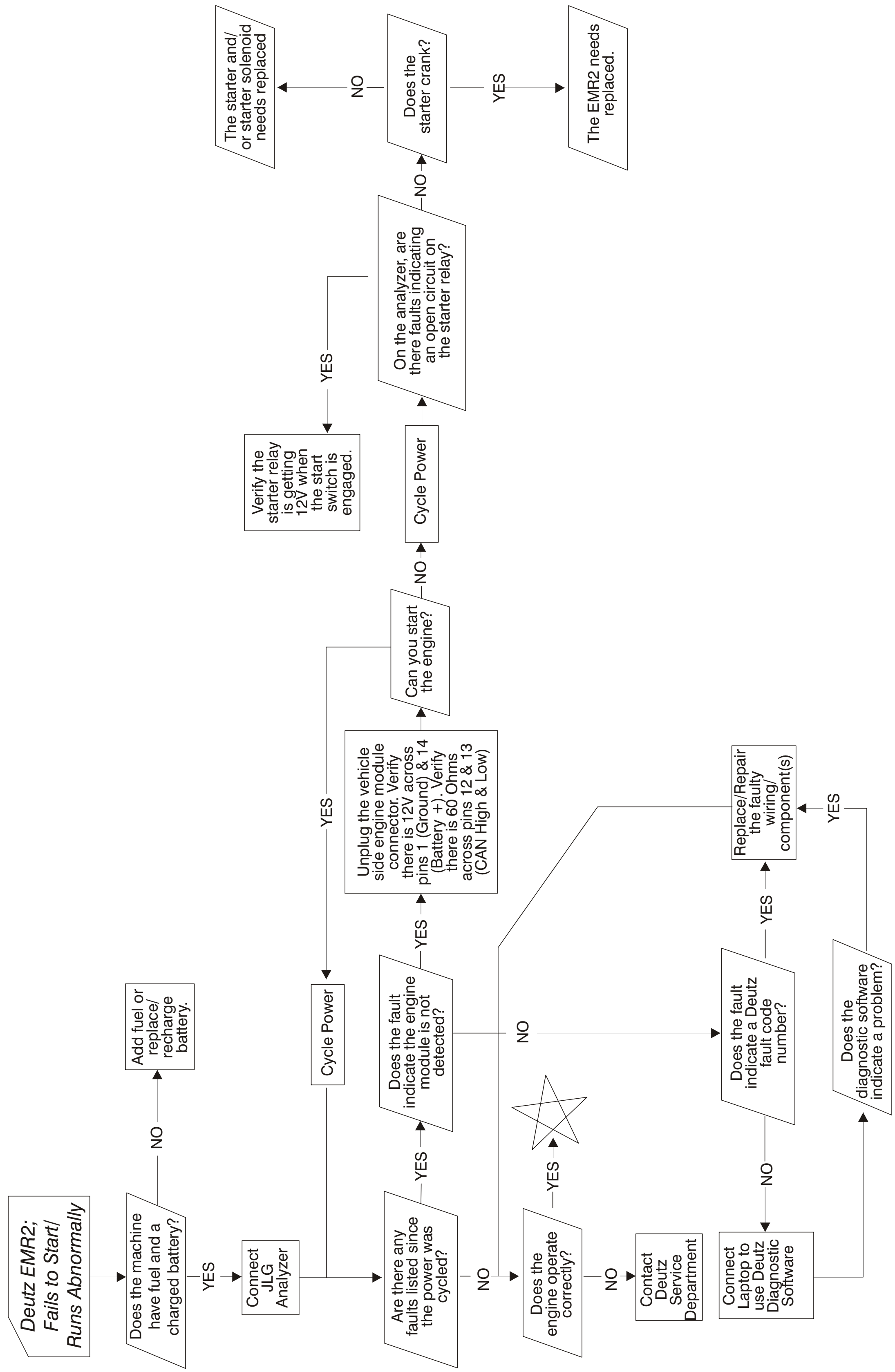


Figure 3-69. Deutz EMR 2 Troubleshooting Flow Chart

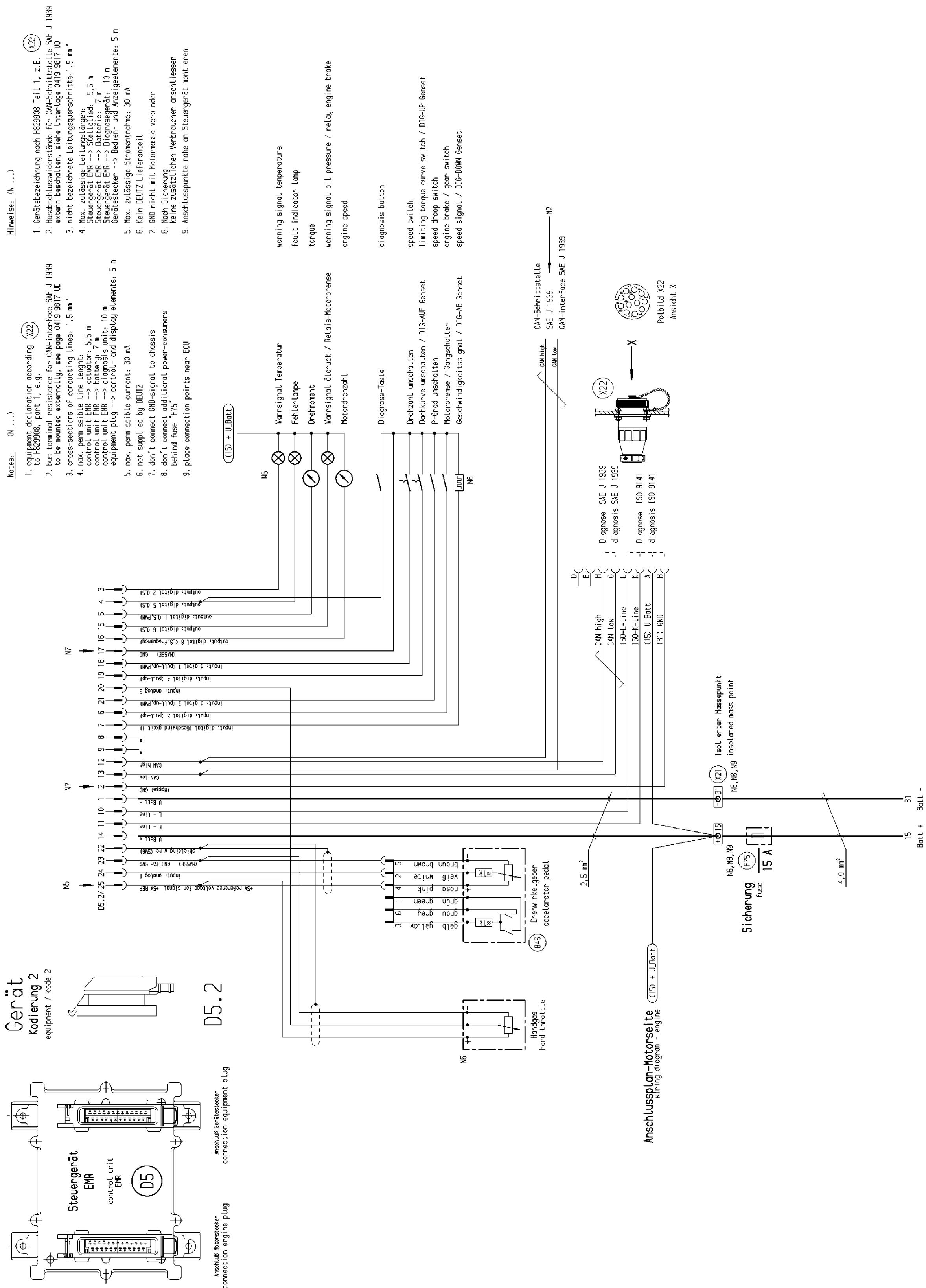


Figure 3-70. Deutz EMR 2 Vehicle Side Connection Diagram

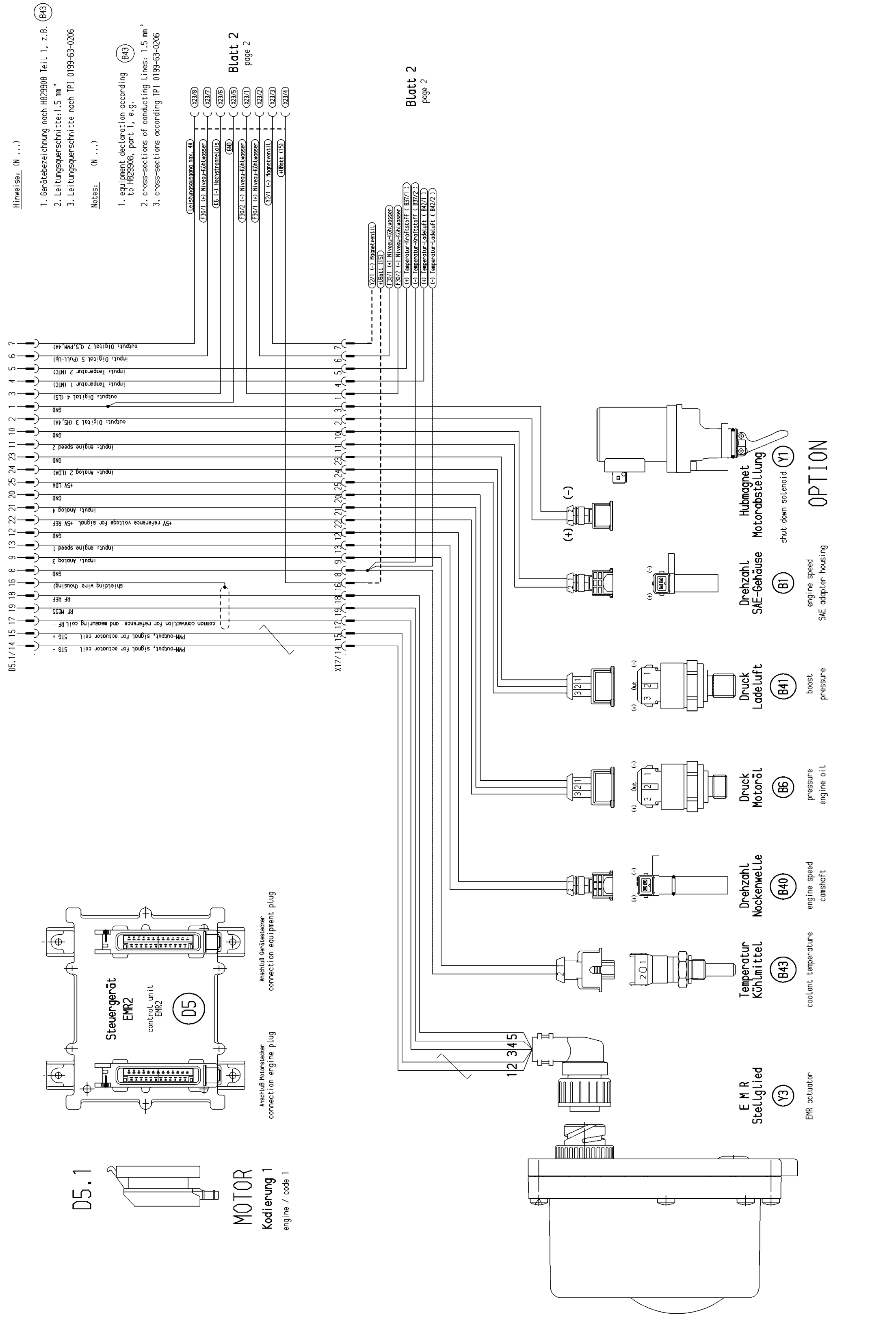


Figure 3-71. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

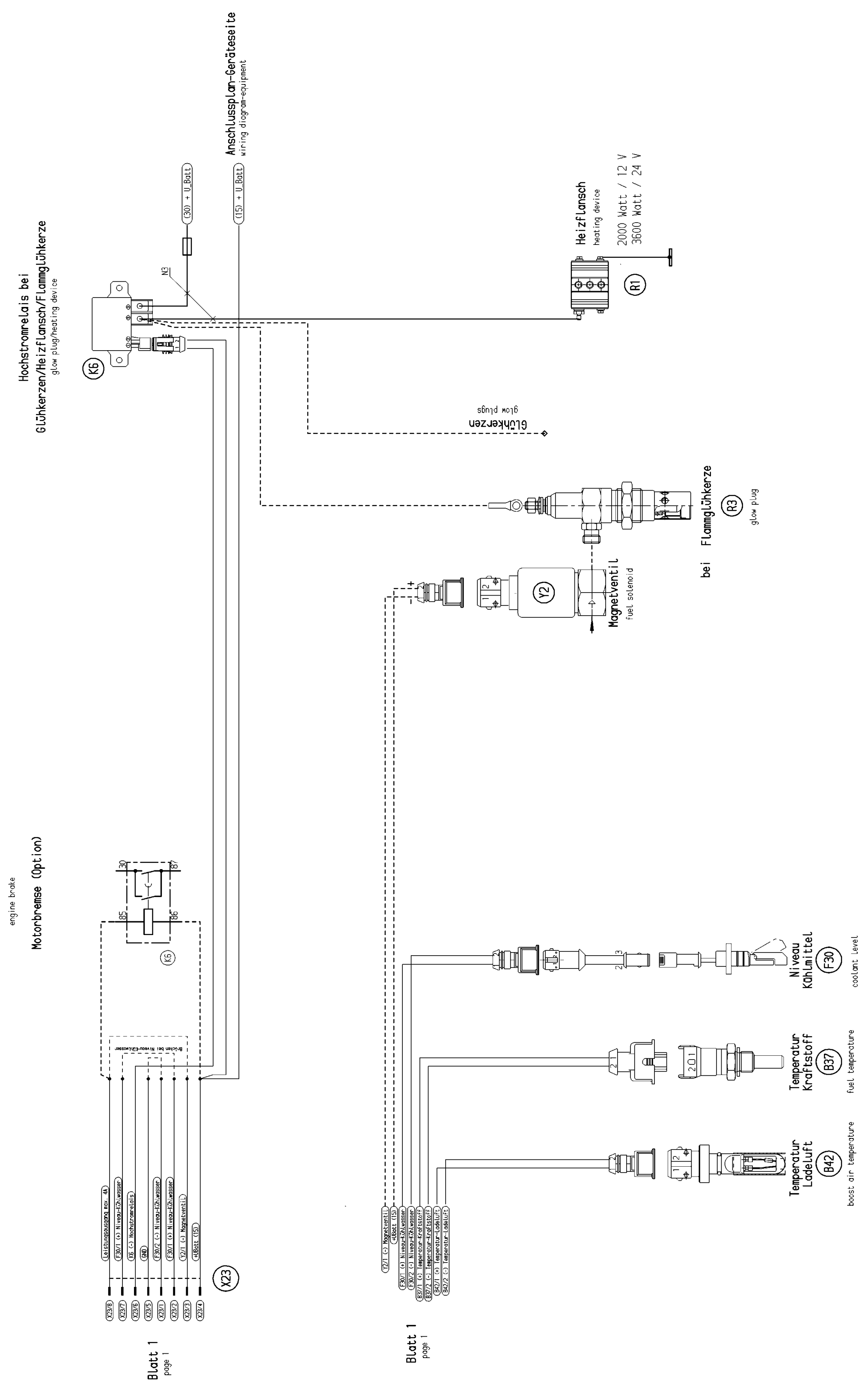
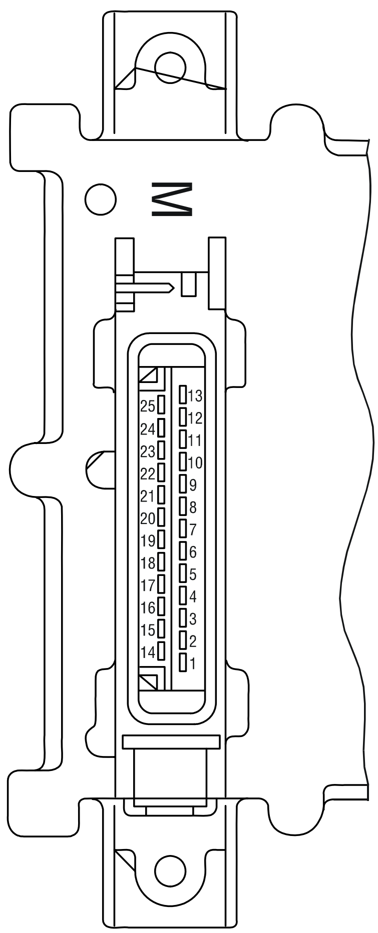


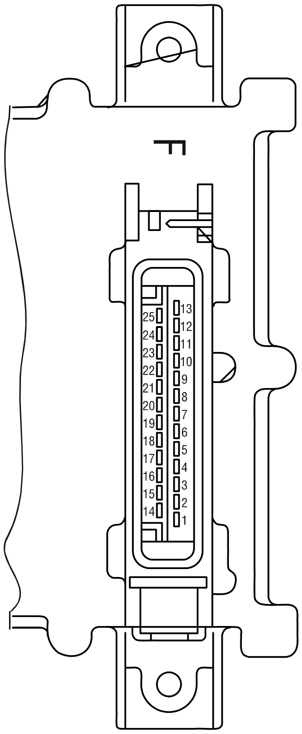
Figure 3-72. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2



Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid[1)]
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature [2)]
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 3-73. 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 3-74. 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.	Engine stop.	Check parameter (21). Check speed settings.
					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.		
Sensors	07	Charge air pressure	102	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.
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2			
	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 3-75. EMR2 Fault Codes - Sheet 1 of 5

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.
					Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator. Check speed sensor (impulses on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.		
	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 3-76. 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 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 3-77. EMR2 Fault Codes - Sheet 3 of 5

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			
Communi-cation	70	CAN-Bus controller	SID 231	12	CAN-controller for CAN-bus is faulty. Fault removal despite re-initialising continuously not possible	Application-dependent.	Check CAN connection, terminating resistor (see Chapter 12.4), Check control unit.
	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 values of parameters (3895 and 3896). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.

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 3-78. 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.	
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 3-79. EMR2 Fault Codes - Sheet 5 of 5

3.28 BIO FUEL IN DEUTZ ENGINES

General

Use of bio fuels is permitted for the compact engines made by DEUTZ.

Distillate fuels with residue oil percentages or mixed fuels may not be used in DEUTZ compact engines.

The DEUTZ vehicle engines are designed for diesel fuels in accordance with EN 590 with a cetane number of at least 51. DEUTZ engines for mobile machinery are designed for a cetane number of at least 45. When using fuels of a low cetane number, disturbing white smoke and ignition misfires are to be expected under some circumstances.

A cetane number of at least 40 is permissible for the US market, therefore special engine models have been developed to avoid starting difficulties, extreme white smoke or increased hydrocarbon emissions (EPA specification - US EPA REGULATIONS FOR LARGE NONROAD COMPRESSION-IGNITION ENGINES).

If the white smoke behavior is unacceptable when using a very low cetane number, the use of ignition improvers is to be recommended as a later remedial measure.

The certification measurements for compliance with the legal emission limits are carried out with the test fuels prescribed by law. These correspond to the diesel fuels in accordance with EN 590 and ASTM D 975. No emission values are guaranteed with the other fuels described. It is the obligation of the owner to check the permission for use of the fuels in accordance with regional regulations.

Bio Fuel

PERMITTED BIO-DIESEL FUELS

Originally only rape seed oil methylester (RME) was sold as a bio-diesel fuel in Europe but fatty acid methylester (FAME) based on other oils have come onto the market increasingly in recent years. However, with the latter there is a risk that the limit values of EN 14214 are not kept in the field. Anyone who uses bio-diesel fuel in DEUTZ engines must therefore choose his supplier very carefully and have him guarantee compliance with the EN 14214 limit values. Since experience has shown that rape seed oil methylester (RME) exceeds the limit values less often that other esters, it is expressly recommended to use only rape seed oil methyester. DEUTZ customers in Germany can additionally ensure the quality by buying bio-diesel fuel with an AGQM certificate (Arbeitsgemeinschaft Qualitäts-Management Biodiesel e.V.).

The use of US bio-diesel based on soy oil methylester is only permissible in mixtures with diesel fuel with a bio-diesel part of a max. 20 weight-%. The US bio-diesel used for the mixture must comply with the ASTM D6751-07a (B100) standard.

APPROVED ENGINES

The 912, 913, 914, 1011, 2011, 1012, 2012, 1013, 2013, 413 and 513 series are approved for bio-diesel from year of manufacture 1993 under compliance with the basic conditions specified below.

BASIC CONDITIONS TO BE OBSERVED

- A power loss of 5-9 % in relation to diesel fuel in accordance with EN 590 is possible due to the lower heating value. Blocking of the fuel injector is not allowed.
- The lubricating oil quality must correspond to TR 0199-99-3002. The lubricating oil change interval must be halved in relation to operation with diesel fuel in accordance with EN 590.
- Standstills of longer than 4 to 6 weeks must be avoided with bio-diesel. Otherwise the engine must be started and stopped with diesel fuel.
- Bio-diesels can be mixed with normal diesel fuel but the basic conditions described in this subsection apply for mixtures. Mixtures with up to 5 % (m/m) bio-diesel (B5) which have recently been on sale at European fuel stations are excepted. These fuels must be treated like normal diesel fuels because EN 590 expressly permits adding up to 5 % (m/m) bio-diesel in accordance with EN 14214.
- Approx. 30-50 hours after changing over from diesel fuel to bio-diesel, the fuel filter should be changed as a preventive measure to avoid a drop in performance due to clogged fuel filters. Deposited fuel ageing products are dissolved by bio-diesel and transported into the fuel filter. They should not be changed immediately but after approx. 30 to 50 hours because the dissolving of dirt takes a certain amount of time.

PLANT OIL

NOTICE

PURE PLANT OILS (E.G. RAPE SEED OIL, SOY OIL, PALM OIL) ARE NOT CLASSIFIED AS BIO-DIESEL AND EXHIBIT PROBLEMATICAL PROPERTIES FOR DIESEL ENGINE OPERATION (STRONG TENDENCY TO COKE, RISK OF PISTON SEIZURE, EXTREMELY HIGH VISCOSITY, POOR EVAPORATION BEHAVIOR.

The conversion of DEUTZ engines to rape seed oil fuel operation with conversion kits and modified tanks systems of various manufacturers is not allowed and leads to loss of warranty rights.

Biological Contamination In Fuels

SYMPTOMS

The following symptoms may indicate that a fuel tank is contaminated by micro-organisms:

- Internal tank corrosion,
- Filter blockage and the associated loss of power due to gel-like deposits on the fuel filter (especially after long standstills)

CAUSE

Micro-organisms (bacteria, yeasts, funguses) can form bio-sludge under unfavorable conditions (favoured particularly by heat and water).

Penetration by water is usually caused by condensation of the water in the air. Water does not dissolve in fuel so that the penetrating water collects at the bottom of the tank. The bacteria and funguses grow in the watery phase, at the phase boundary to the fuel phase, from which they draw their nutrition. There is an increased risk especially with bio-diesel (FAME).

PREVENTIVE MEASURES

- Keep the storage tank clean, regular cleaning of the tank by specialist companies
- Installation of fuel pre-filters with water traps, especially in countries with frequently fluctuating fuel qualities and high percentage of water.

If the fuel system and storage tank have already been attacked by micro-organisms. The biocide must be dosed according to the manufacturer's specifications.

- Avoid direct exposure of the storage tank to sunlight
- Use smaller storage tanks with corresponding low dwell times of the stored fuel

FUEL ADDITIVES

The use of fuel additives is not permitted. The flow improvers mentioned above are an exception. Use of unsuitable additives will result in loss of warranty.

3.29 CAT DGC DIAGNOSTIC SUPPORT AND TROUBLE CODE DEFINITIONS

This section defines the diagnostics and recommended troubleshooting procedures associated with the engine control module (ECM) on the CAT 3.4 engine.

This section is organized in the following manner:

1st page of Diagnostic Information for a Given Fault (See Figure 3-80.) then:

2nd Page of Diagnostic Information for a Given Fault (See Figure 3-81.)

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 *RECOMMENED* 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.

Figure 3-80. 1st page of Diagnostic Information for a Given Fault

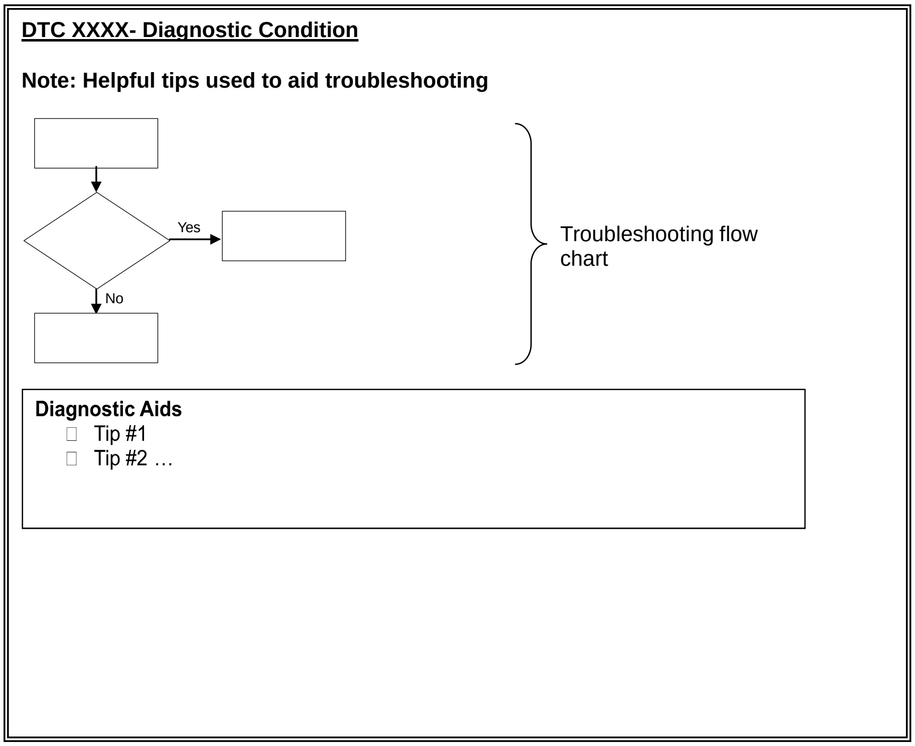


Figure 3-81. 2nd Page of Diagnostic Information for a Given Fault

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
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)		

Diagnostic Trouble Codes

The numeric diagnostic trouble codes assigned to the faults in this section are cross-referenced to SAE's "Recommended Practice for Diagnostic Trouble Code Definitions" (SAE J2012). While these codes are recommended, the manufacturer 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 Snap Shot 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 3-7.

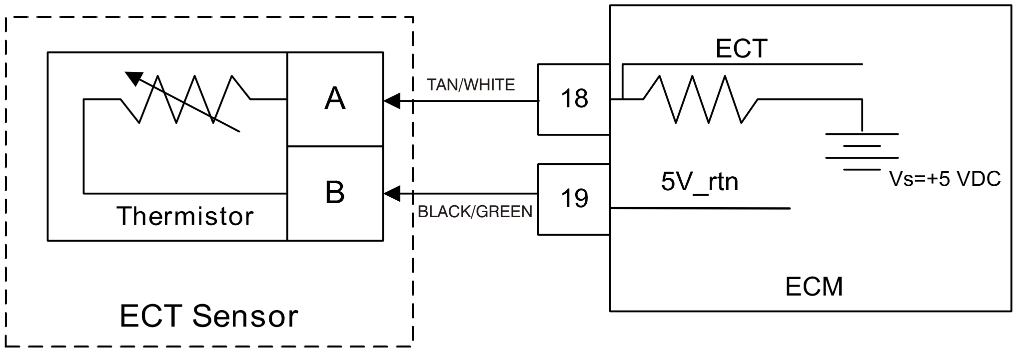
Table 3-7. J1939 Diagnostic Lamp Configuration

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.”

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."

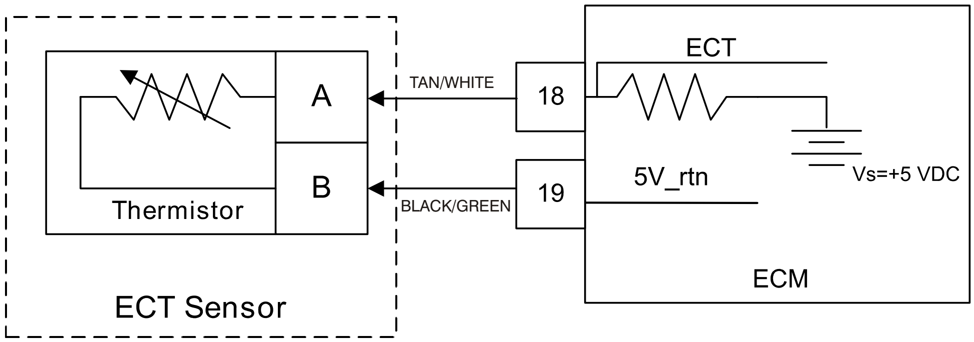
If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:

- 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

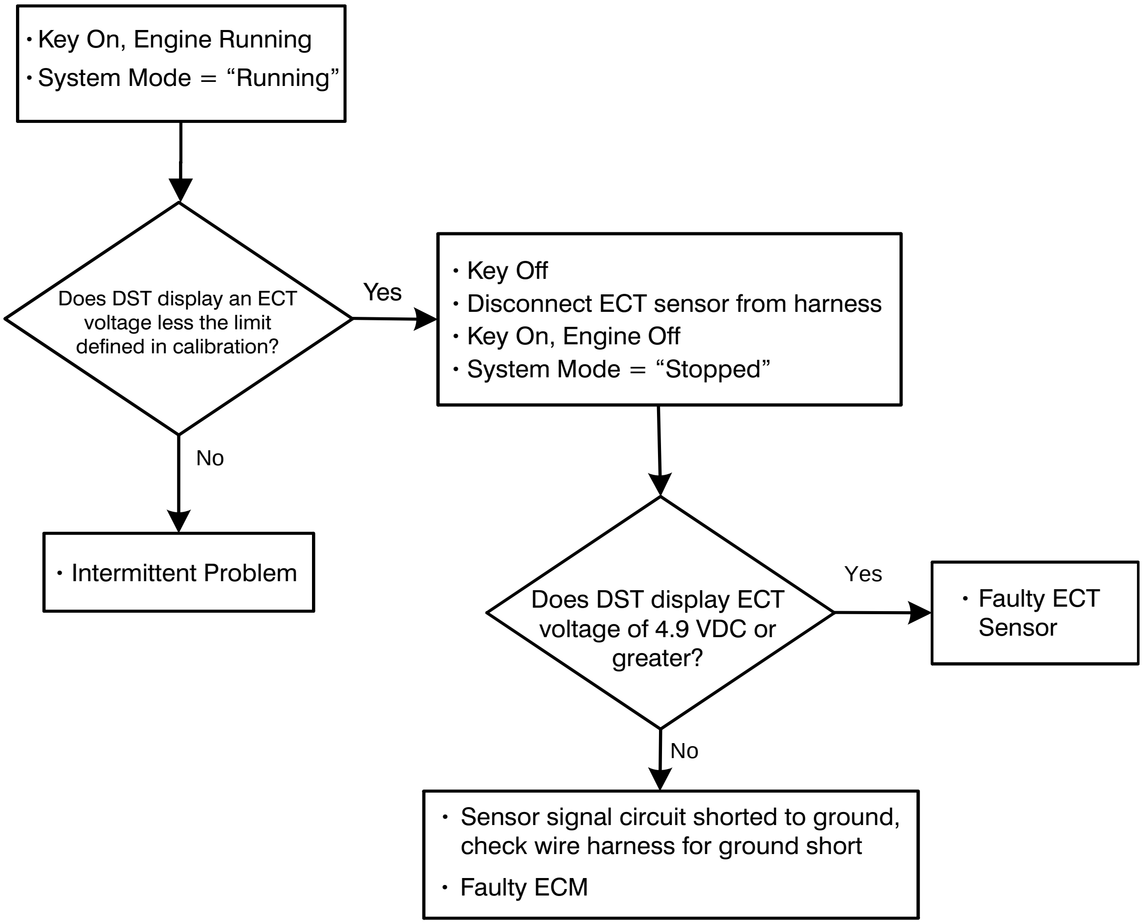
DTC 117- ECT/CHT Low Voltage



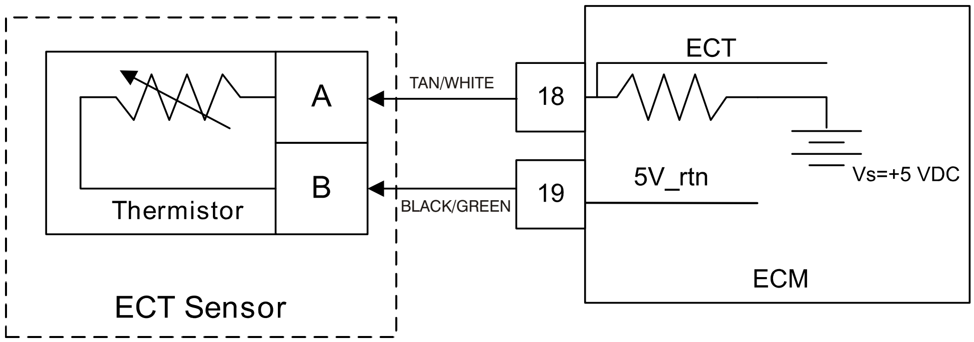
- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-CHT/ECT sensor voltage less than the limit defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during 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.


• Key On, Engine Running
• System Mode = "Running"
Does DST display an ECT voltage less the limit defined in calibration?
Yes
No
• Key Off
• Disconnect ECT sensor from harness
• Key On, Engine Off
• System Mode = "Stopped"
• Intermittent Problem
Does DST display ECT voltage of 4.9 VDC or greater?
Yes
No
• Faulty ECT Sensor
• Sensor signal circuit shorted to ground, check wire harness for ground short
• Faulty ECM

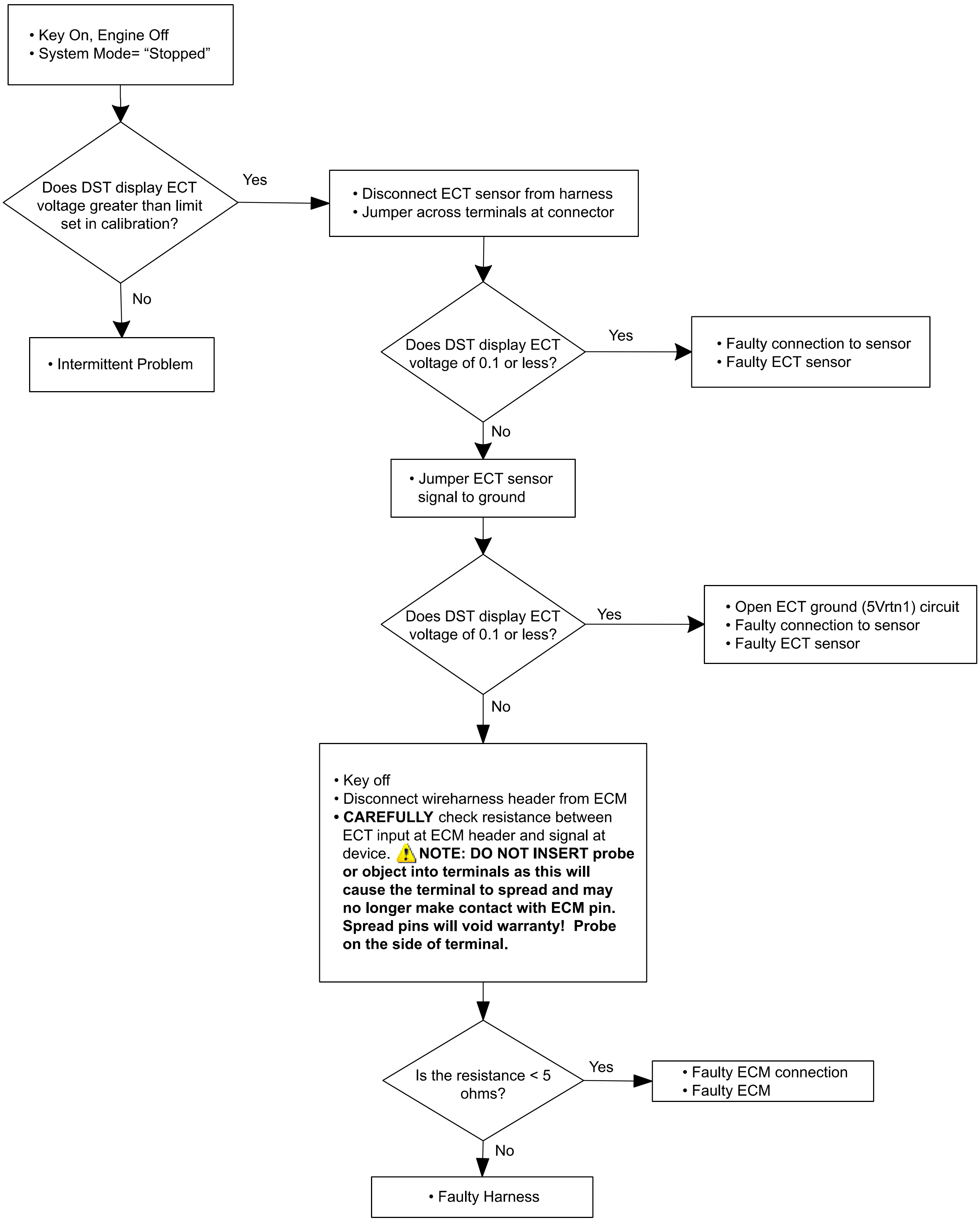
DTC 118- ECT/CHT High Voltage



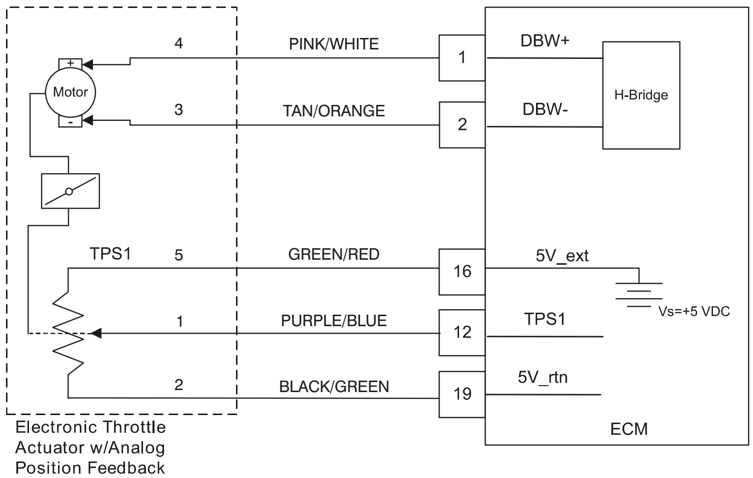
- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-CHT/ECT sensor voltage higher than the limit defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during 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.


• Key On, Engine Off
• System Mode= "Stopped"
Does DST display ECT voltage greater than limit set in calibration?
Yes
• Disconnect ECT sensor from harness
• Jumper across terminals at connector
No
• Intermittent Problem
Does DST display ECT voltage of 0.1 or less?
Yes
• Faulty connection to sensor
• Faulty ECT sensor
No
• Jumper ECT sensor signal to ground
Does DST display ECT voltage of 0.1 or less?
Yes
• Open ECT ground (5Vrtn1) circuit
• Faulty connection to sensor
• Faulty ECT sensor
No
• Key off
• Disconnect wireharness header from ECM
• CAREFULLY check resistance between ECT input at ECM header and signal at device. NOTE: DO NOT INSERT probe or object into terminals as this will cause the terminal to spread and may no longer make contact with ECM pin. Spread pins will void warranty! Probe on the side of terminal.
Is the resistance < 5 ohms?
Yes
• Faulty ECM connection
• Faulty ECM
No
• Faulty Harness

DTC 122- TPS1 Signal Voltage Low



- 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.

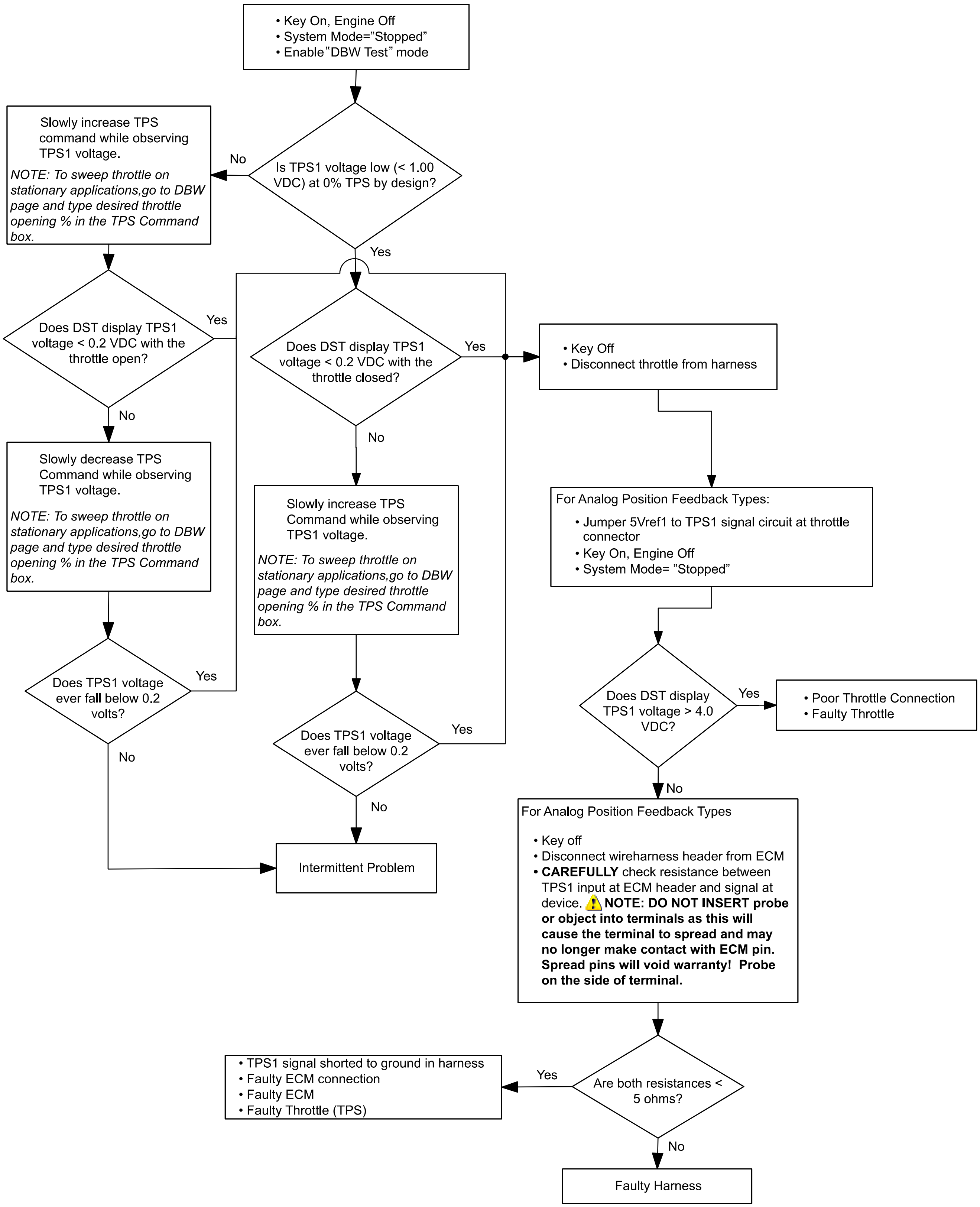
There are two types of throttle actuators;

1) actuator with analog position feedback and

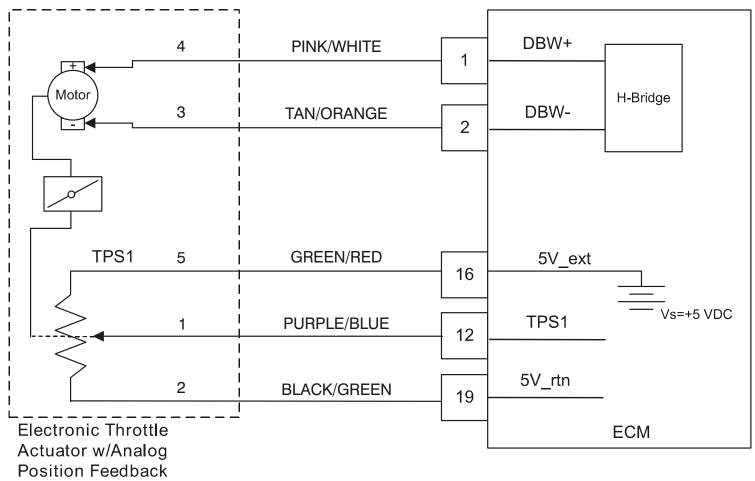
2) actuator with digital position feedback

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.


• Key On, Engine Off
• System Mode="Stopped"
• Enable "DBW Test" mode
Is TPS1 voltage low (< 1.00 VDC) at 0% TPS by design?
No
Yes
Slowly increase TPS command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does DST display TPS1 voltage < 0.2 VDC with the throttle open?
Yes
No
Slowly decrease TPS Command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does TPS1 voltage ever fall below 0.2 volts?
Yes
No
Does DST display TPS1 voltage < 0.2 VDC with the throttle closed?
Yes
No
Slowly increase TPS Command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does TPS1 voltage ever fall below 0.2 volts?
Yes
No
Intermittent Problem
• Key Off
• Disconnect throttle from harness
For Analog Position Feedback Types:
• Jumper 5Vref1 to TPS1 signal circuit at throttle connector
• Key On, Engine Off
• System Mode= "Stopped"
Does DST display TPS1 voltage > 4.0 VDC?
Yes
• Poor Throttle Connection
• Faulty Throttle
No
For Analog Position Feedback Types
• Key off
• Disconnect wireharness header from ECM
• CAREFULLY check resistance between TPS1 input at ECM header and signal at device. NOTE: DO NOT INSERT probe or object into terminals as this will cause the terminal to spread and may no longer make contact with ECM pin. Spread pins will void warranty! Probe on the side of terminal.
Are both resistances < 5 ohms?
Yes
• TPS1 signal shorted to ground in harness
• Faulty ECM connection
• Faulty ECM
• Faulty Throttle (TPS)
No
Faulty Harness

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.

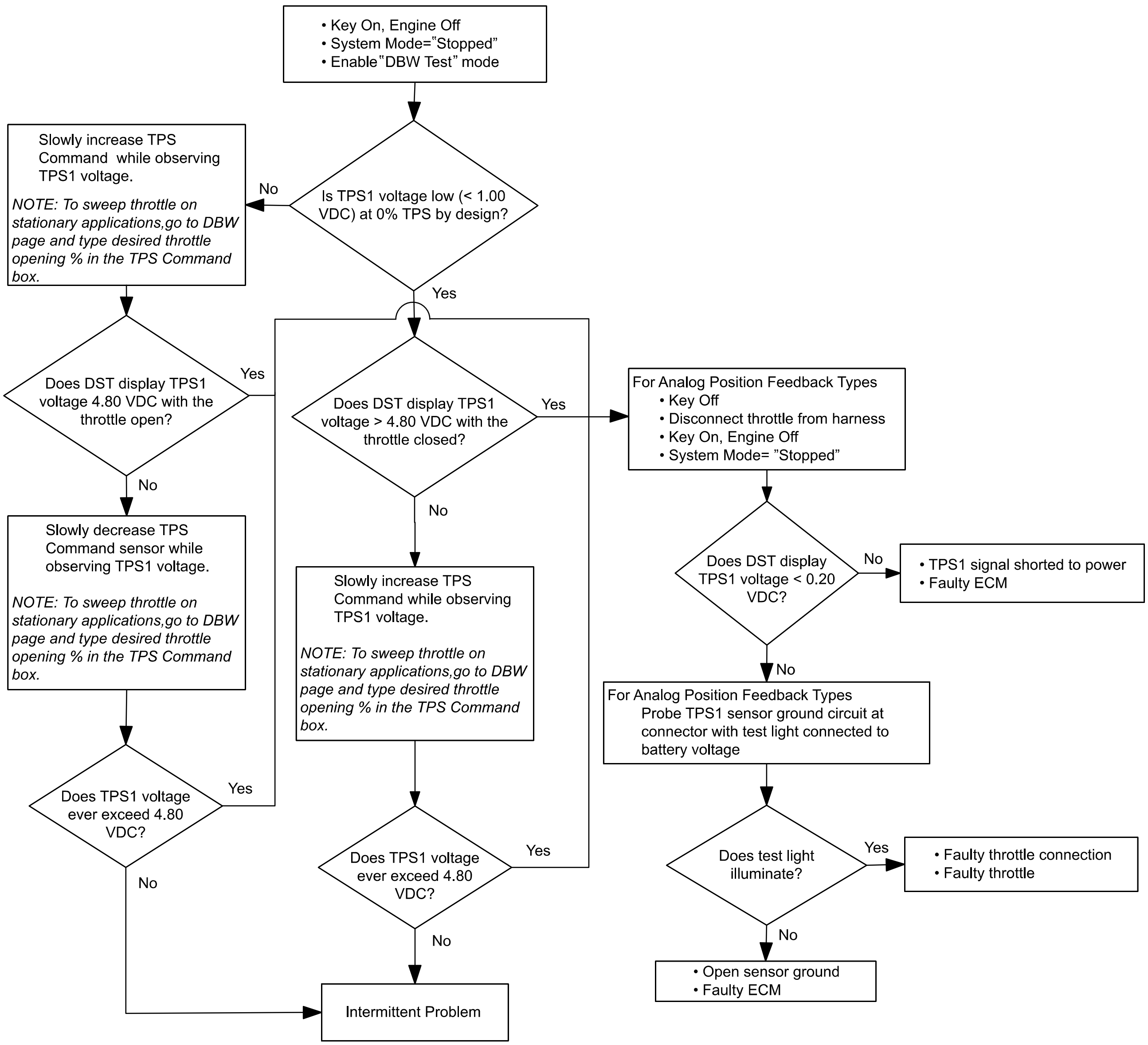
The Throttle Position Sensor uses either;

1) a variable resistor and voltage divider circuit or

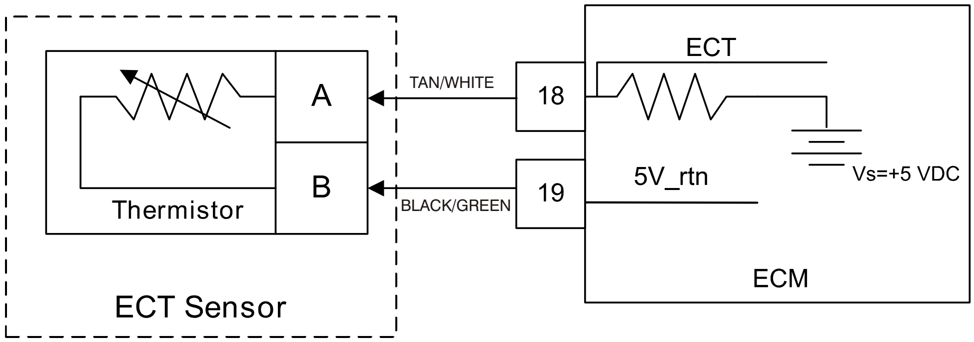
2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

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 generally 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.


• Key On, Engine Off
• System Mode="Stopped"
• Enable "DBW Test" mode
Is TPS1 voltage low (< 1.00 VDC) at 0% TPS by design?
No
Yes
Slowly increase TPS Command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does DST display TPS1 voltage 4.80 VDC with the throttle open?
Yes
No
Slowly decrease TPS Command sensor while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does TPS1 voltage ever exceed 4.80 VDC?
Yes
No
Does DST display TPS1 voltage > 4.80 VDC with the throttle closed?
Yes
No
Slowly increase TPS Command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does TPS1 voltage ever exceed 4.80 VDC?
Yes
No
Intermittent Problem
For Analog Position Feedback Types
• Key Off
• Disconnect throttle from harness
• Key On, Engine Off
• System Mode= "Stopped"
Does DST display TPS1 voltage < 0.20 VDC?
No
• TPS1 signal shorted to power
• Faulty ECM
No
For Analog Position Feedback Types
Probe TPS1 sensor ground circuit at connector with test light connected to battery voltage
Does test light illuminate?
Yes
• Faulty throttle connection
• Faulty throttle
No
• Open sensor ground
• Faulty ECM

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."

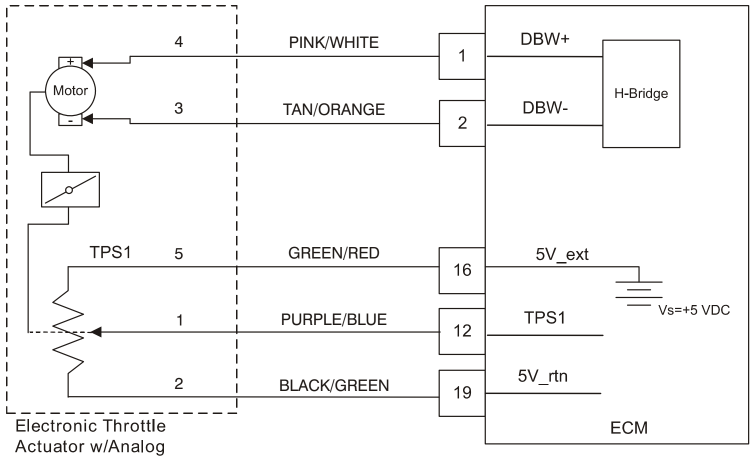
If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:

- 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.

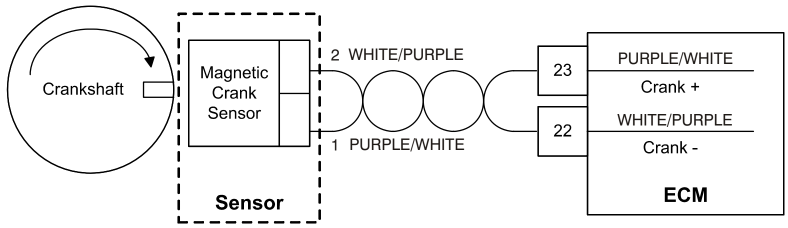
DTC 219- RPM Higher Than Max Allowed Governed Speed (continued)

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

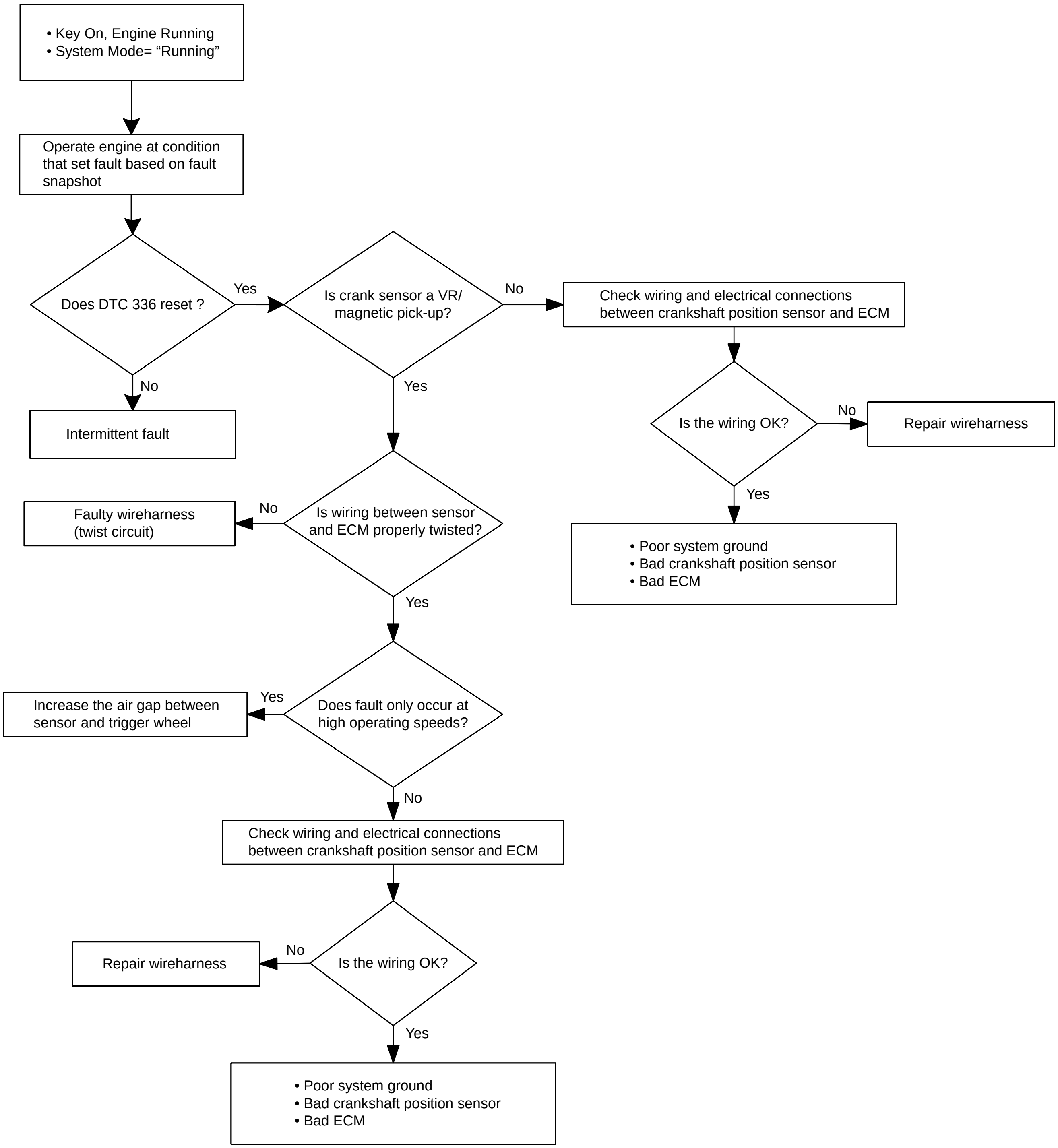


- Crankshaft Position sensor
- Check Condition- Key On, Engine On
- Fault Condition- Electrical noise or irregular crank pattern detected causing x number of crank resynchronization events as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp and disable adaptive fueling correction for remainder of key-cycle.
- Emissions related fault

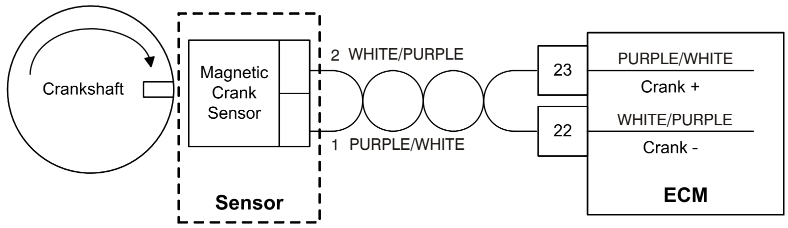
The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or halleffect) installed in the engine block adjacent to a "coded" trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #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.


• Key On, Engine Running
• System Mode= "Running"
Operate engine at condition that set fault based on fault snapshot
Does DTC 336 reset ?
Yes
No
Intermittent fault
Is crank sensor a VR/ magnetic pick-up?
No
Yes
Check wiring and electrical connections between crankshaft position sensor and ECM
Is the wiring OK?
No
Repair wireharness
Yes
• Poor system ground
• Bad crankshaft position sensor
• Bad ECM
Is wiring between sensor and ECM properly twisted?
No
Faulty wireharness (twist circuit)
Yes
Does fault only occur at high operating speeds?
Yes
Increase the air gap between sensor and trigger wheel
No
Check wiring and electrical connections between crankshaft position sensor and ECM
Is the wiring OK?
No
Repair wireharness
Yes
• Poor system ground
• Bad crankshaft position sensor
• Bad ECM

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 ¡§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.

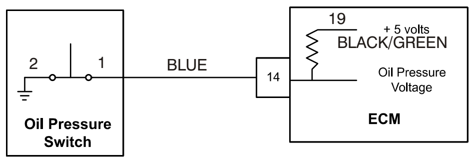
The ECM must see a valid crankshaft position signal while running. If no signal is present while x cam pulses continue the fault will set. The engine typically stalls or dies as a result of this fault condition due to the lack of crankshaft speed input resulting in the inability to control ignition timing.

DTC 337- Loss of Crank Input Signal (continued)

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-Closed Switch-Type

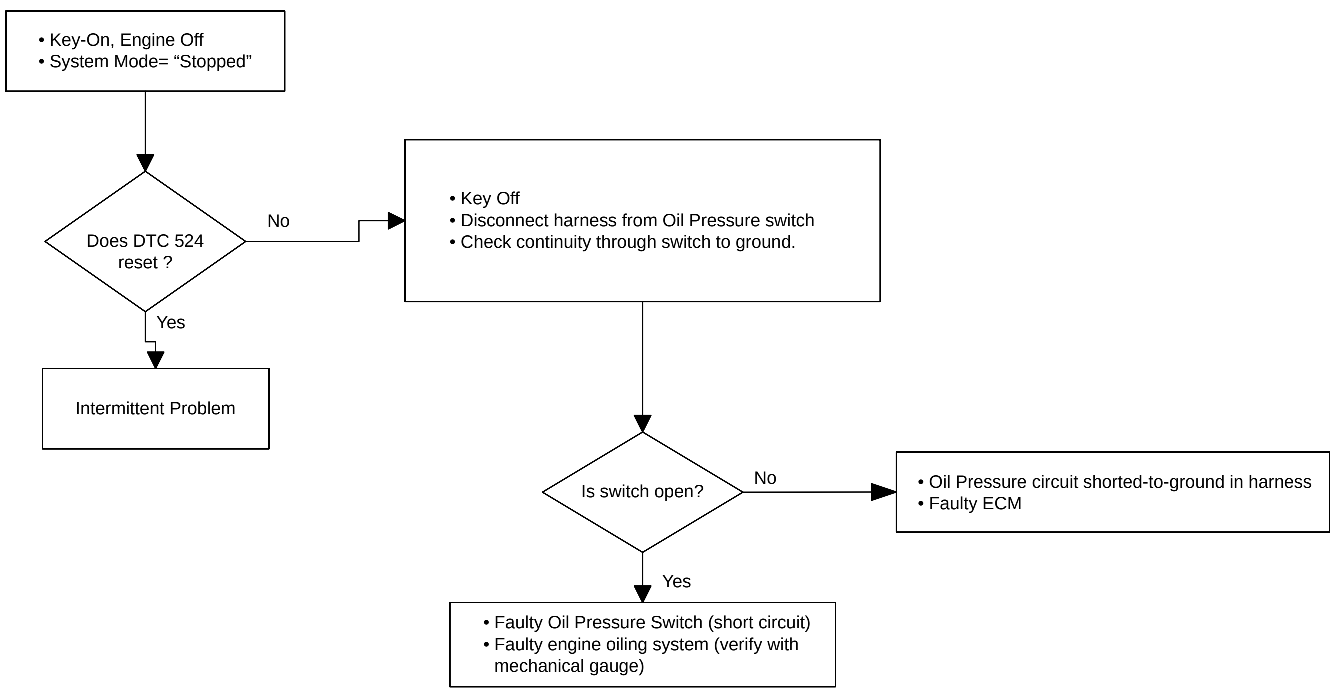
- Engine Oil Pressure
- Check Condition- Key on, Engine on (or Engine off)
- Fault Condition- For sender types, oil pressure higher than x psia while engine speed is greater that y RPM. For switch types, oil pressure is indicating high when the engine has been stopped for more than n seconds.
- Corrective 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.

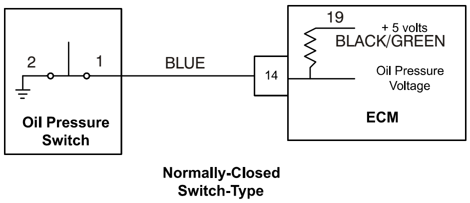
Additionally for normally-open type oil pressure switches, a high pressure indication while the engine is off is a symptom of a failed oil pressure switch. The ECM can monitor oil pressure indication when the engine is stopped for this failure mode.

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.

Normally Closed Switch



DTC 524- Oil Pressure Low

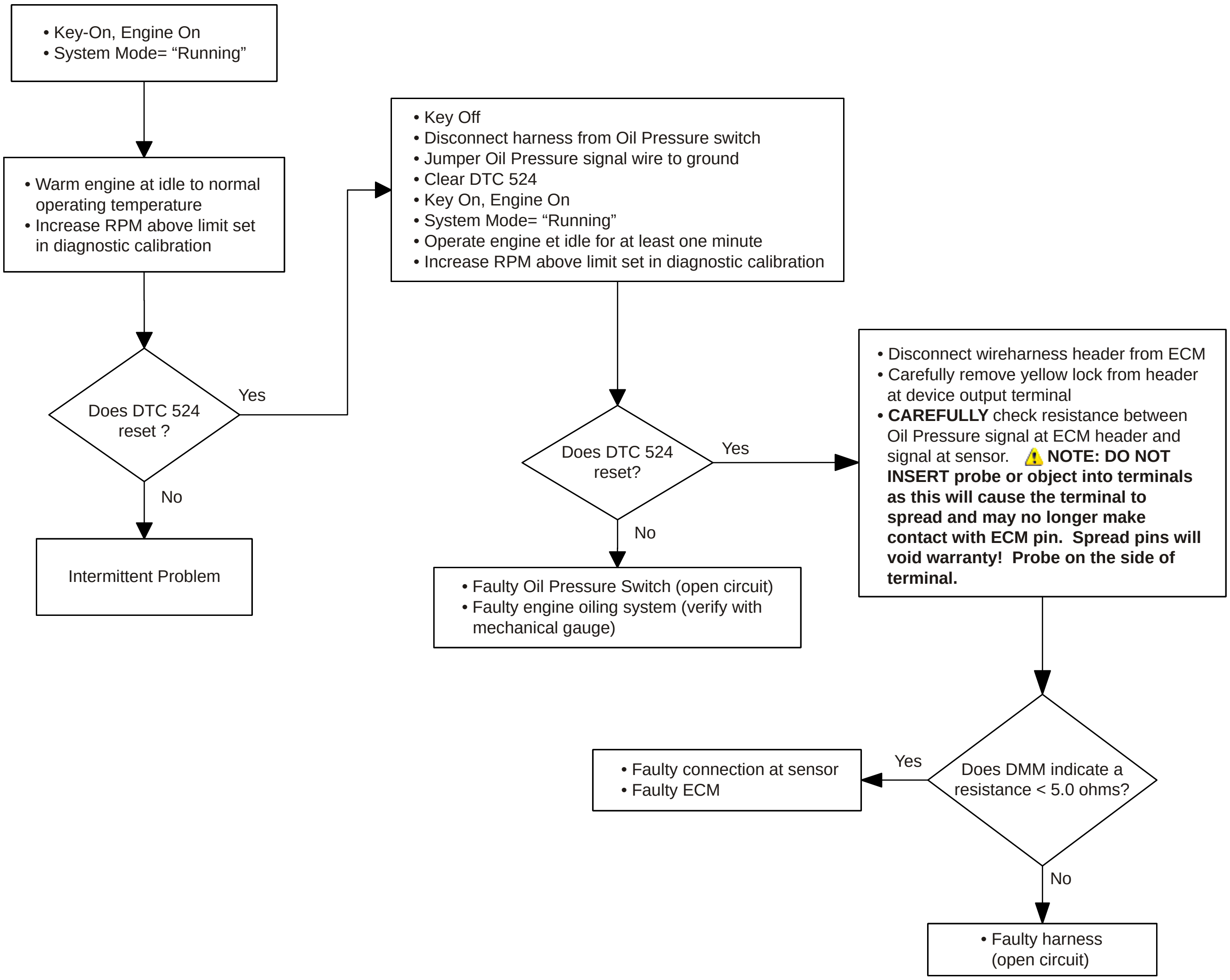


- Engine Oil Pressure
- Check Condition- Key on, Engine on
- Fault Condition- Engine oil pressure lower than expected while engine has been running for a minimum amount of time while engine speed is above some limit as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, generally configured to derate the engine and trigger an engine shutdown
- Non-emissions related fault

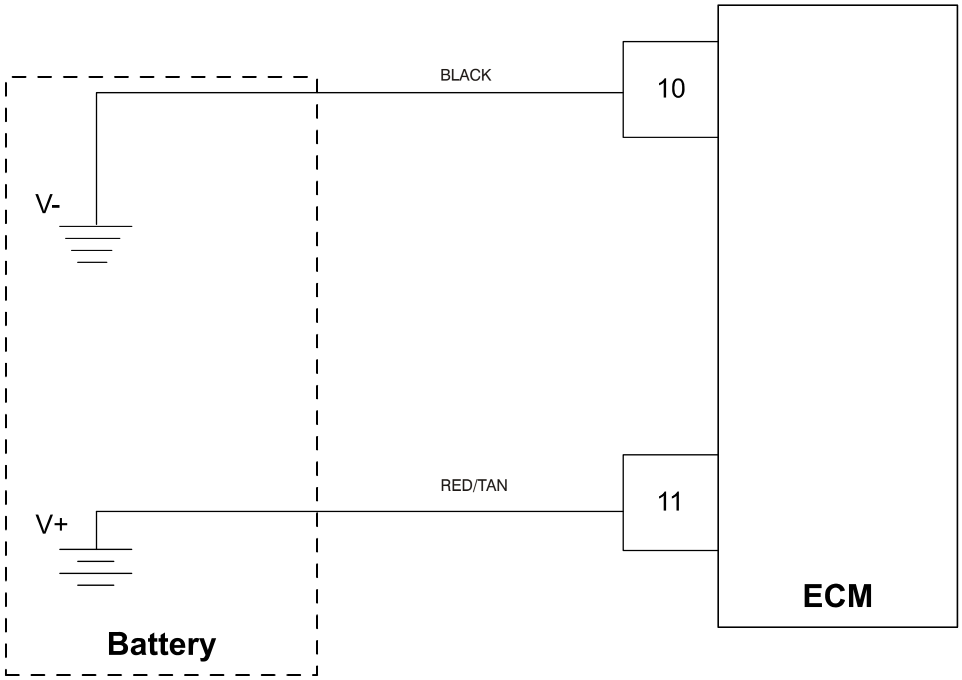
The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because 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 x psia and engine speed is greater than y RPM after the engine has been running for 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 Closed Switch



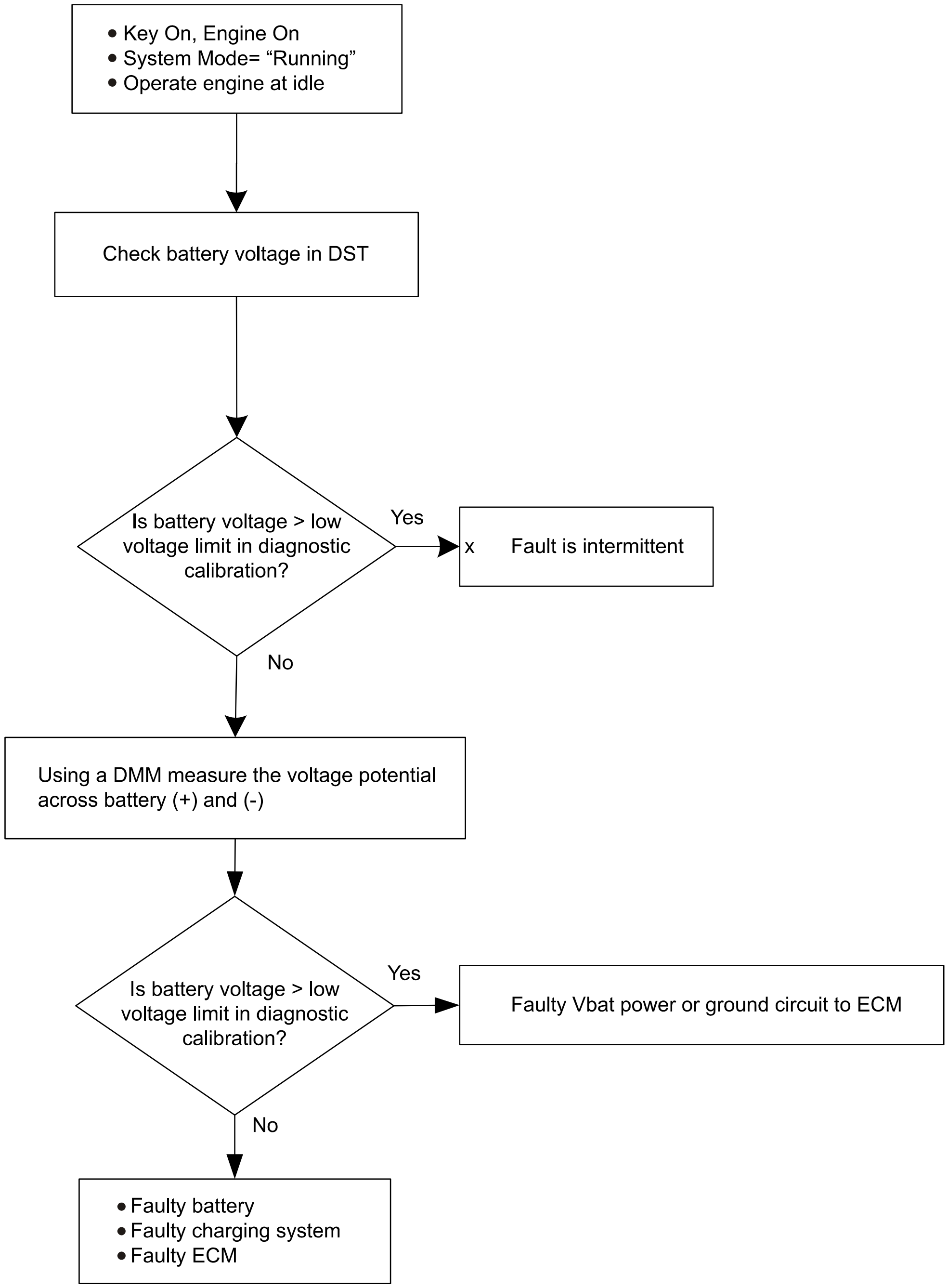
DTC 562- Battery Voltage (VBat) Low



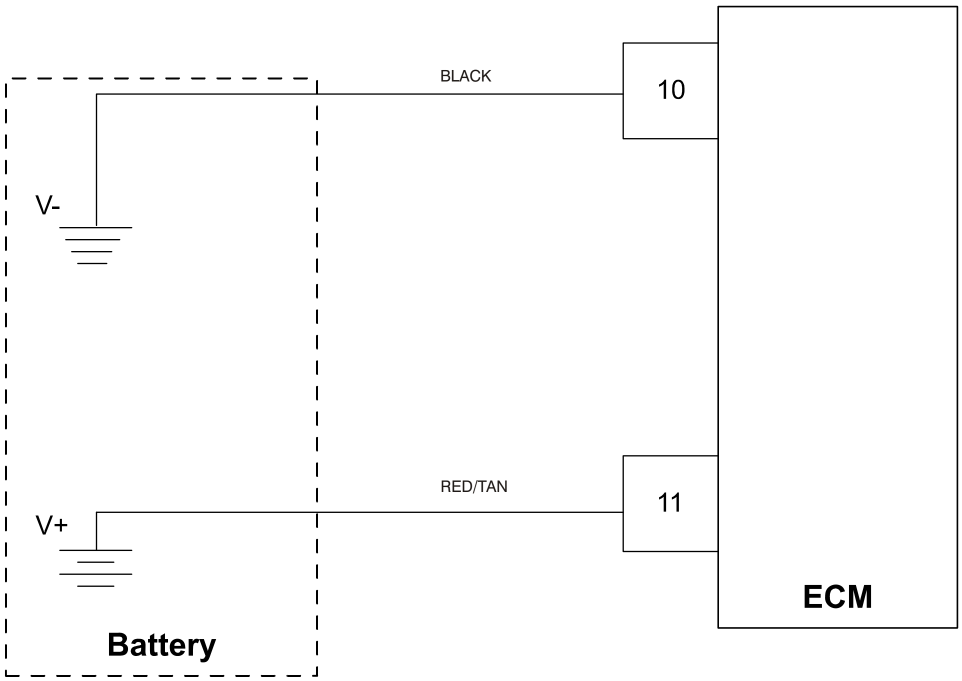
- System voltage to ECM
- Check Condition- Key on, Engine on
- Fault Condition- Battery voltage to ECM less than x volts while the engine is operating at y RPM or greater as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary 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 x volts while the engine is operating at y RPM as defined in the diagnostic calibration as the alternator should be charging the system.


• Key On, Engine On
• System Mode= "Running"
• Operate engine at idle
Check battery voltage in DST
Is battery voltage > low voltage limit in diagnostic calibration?
Yes
x
Fault is intermittent
No
Using a DMM measure the voltage potential across battery (+) and (-)
Is battery voltage > low voltage limit in diagnostic calibration?
Yes
Faulty Vbat power or ground circuit to ECM
No
• Faulty battery
• Faulty charging system
• Faulty ECM

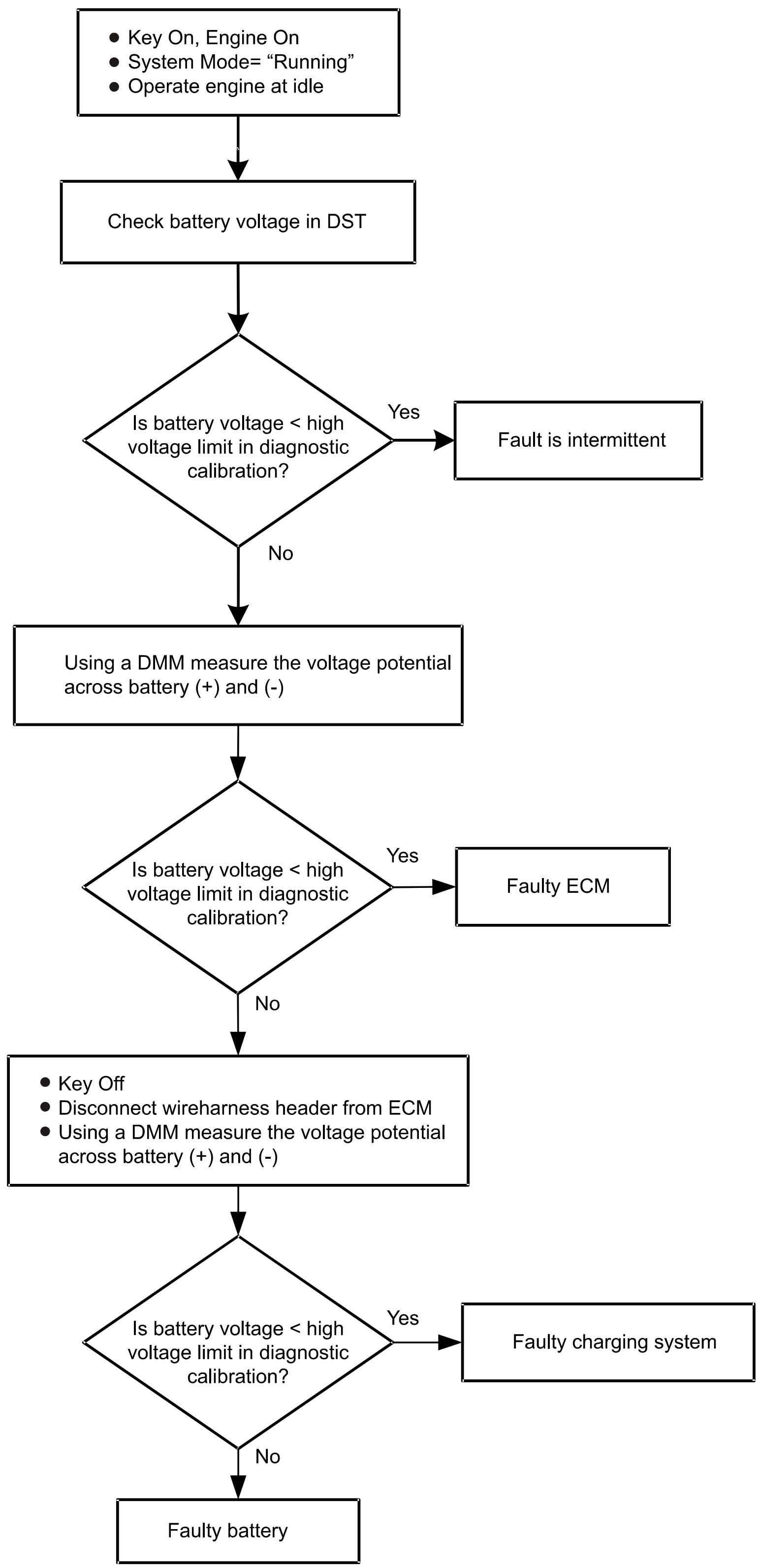
DTC 563- Battery Voltage (VBat) High



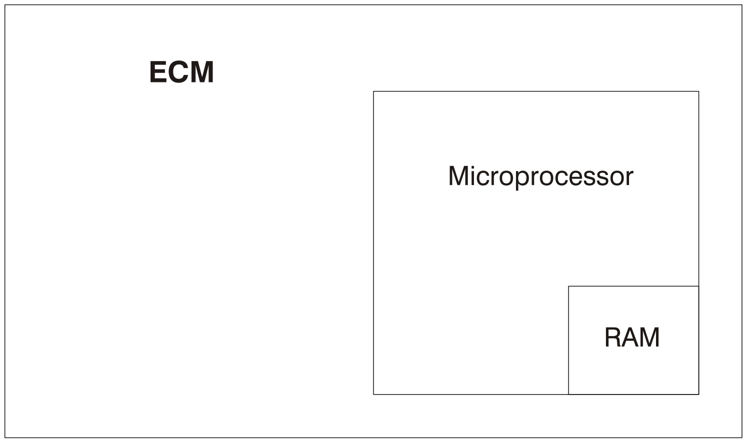
- System voltage to ECM
- Check Condition- Key on, Engine Cranking or Running
- Fault Condition- Battery voltage to ECM greater than x volts while the engine is running as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary 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 acutator, power supplies, and other powered devices that the ECM controls.

This fault will set if the ECM detects system voltage greater than x volts while the engine is running or cranking as defined in the diagnostic calibration.


Key On, Engine On
System Mode= “Running”
Operate engine at idle
Check battery voltage in DST
Is battery voltage < high voltage limit in diagnostic calibration?
Yes
Fault is intermittent
No
Using a DMM measure the voltage potential across battery (+) and (-)
Is battery voltage < high voltage limit in diagnostic calibration?
Yes
Faulty ECM
No
Key Off
Disconnect wireharness header from ECM
Using a DMM measure the voltage potential across battery (+) and (-)
Is battery voltage < high voltage limit in diagnostic calibration?
Yes
Faulty charging system
No
Faulty battery

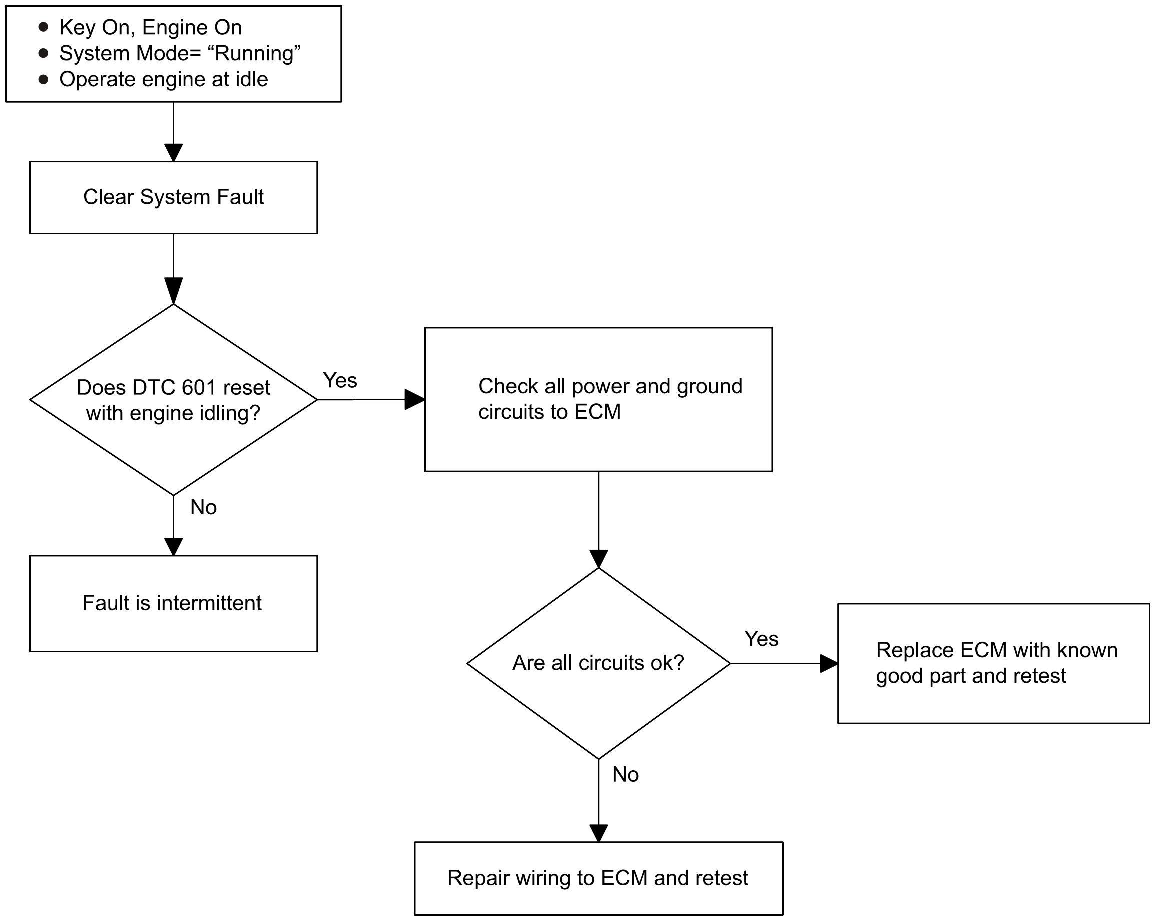
DTC 601- Microprocessor Failure - FLASH



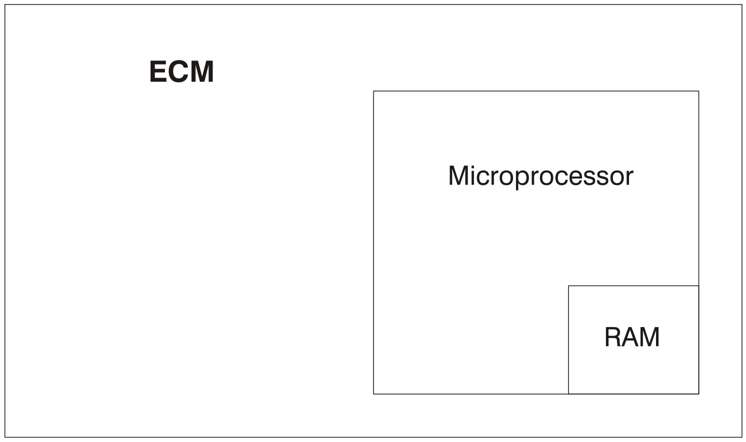
- Engine Control Module- Flash Memory
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle, recommend power derate 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.


• Key On, Engine On
• System Mode= "Running"
• Operate engine at idle
Clear System Fault
Does DTC 601 reset with engine idling?
Yes
Check all power and ground circuits to ECM
No
Fault is intermittent
Are all circuits ok?
Yes
Replace ECM with known good part and retest
No
Repair wiring to ECM and retest

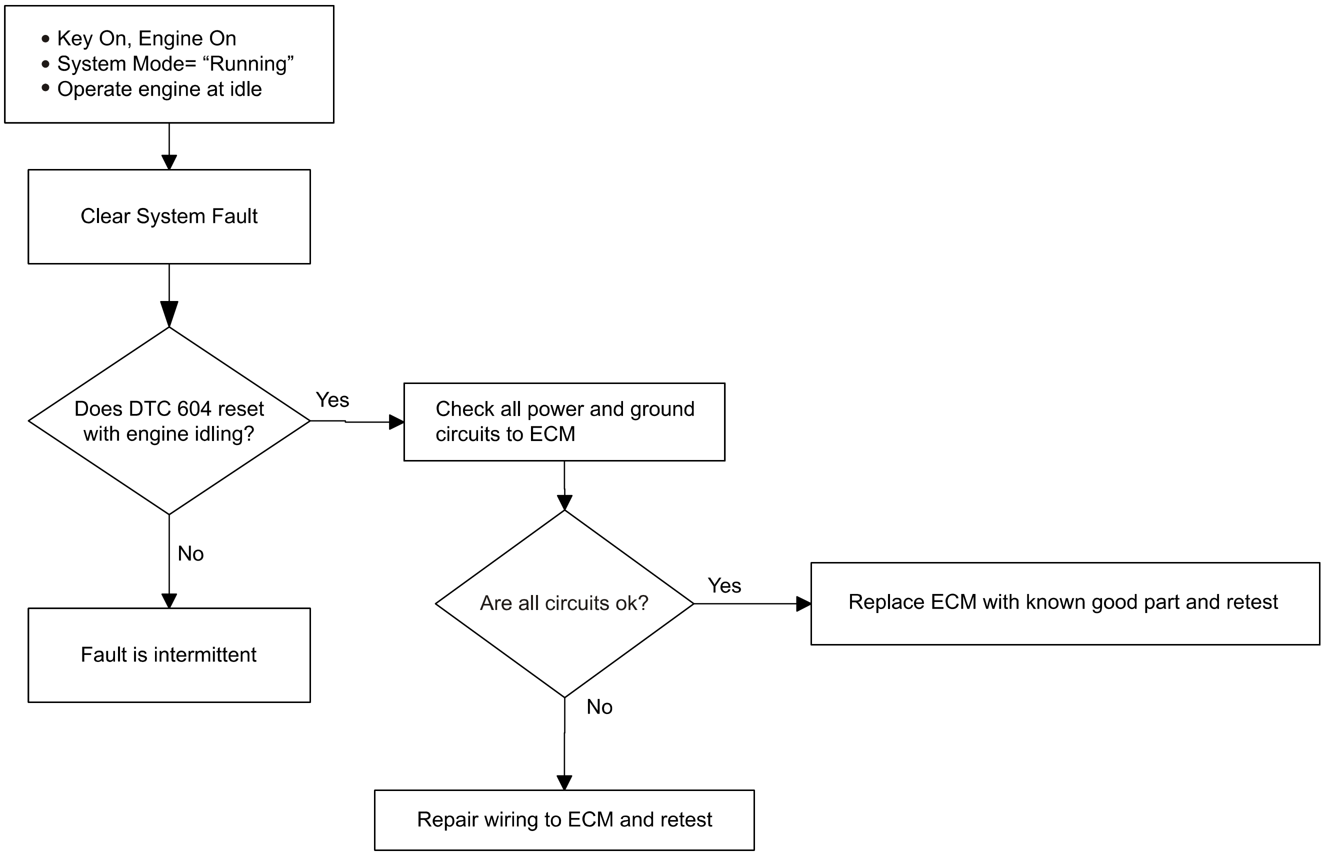
DTC 604- Microprocessor Failure - RAM



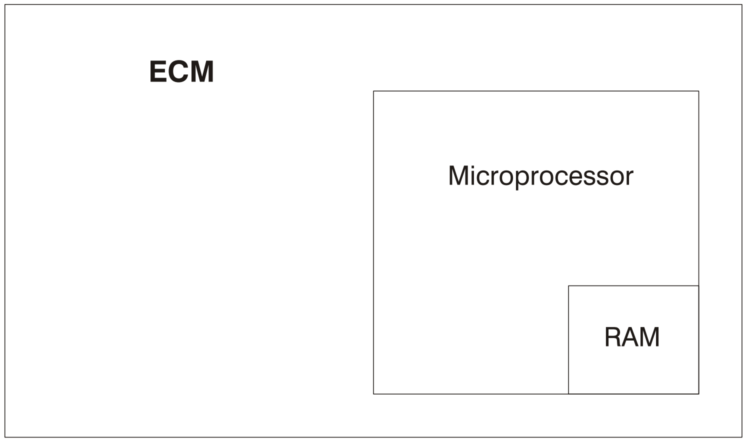
- Engine Control Module- Random Access Memory
- Check Condition- Key on
- Fault Condition- Internal ECM microprocessor memory access failure
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key 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 adaption 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.


• Key On, Engine On
• System Mode= “Running”
• Operate engine at idle
Clear System Fault
Does DTC 604 reset with engine idling?
Yes
Check all power and ground circuits to ECM
No
Fault is intermittent
Are all circuits ok?
Yes
Replace ECM with known good part and retest
No
Repair wiring to ECM and retest

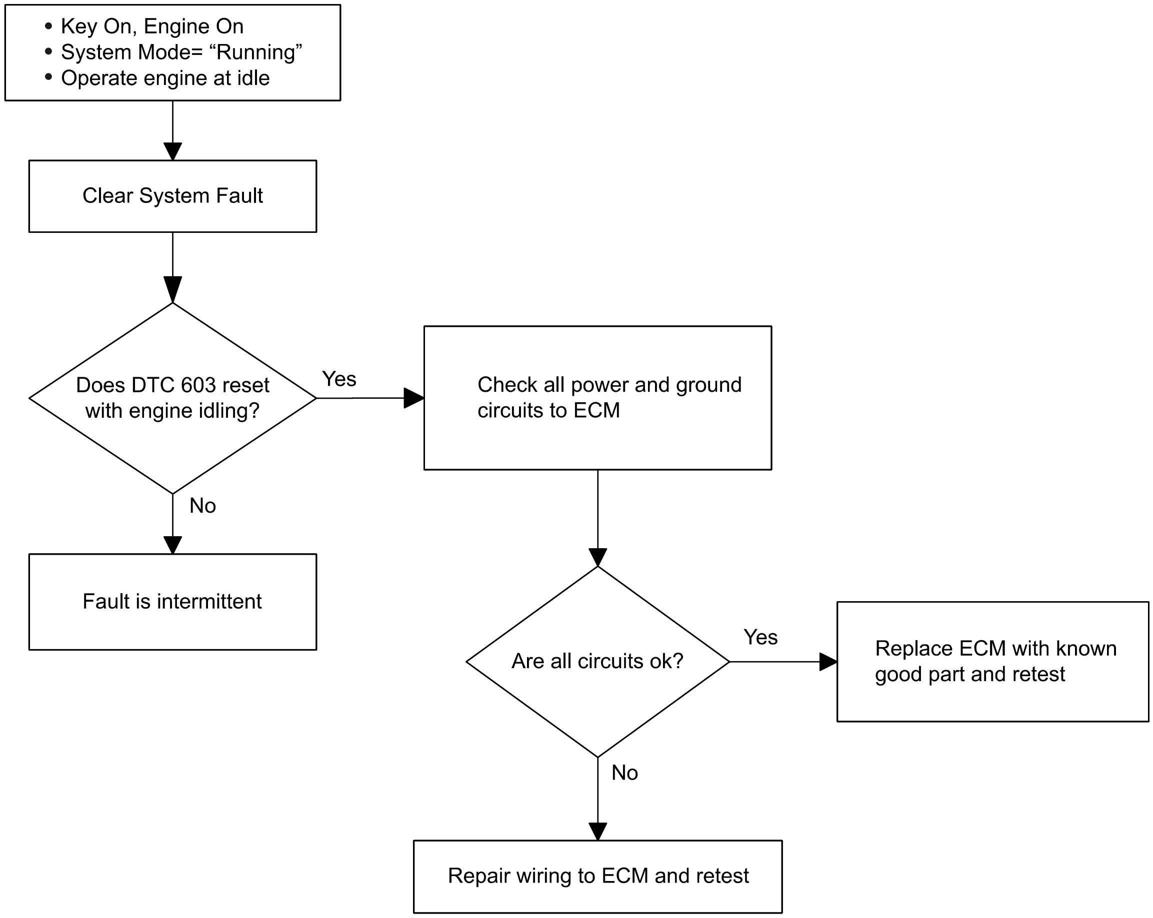
DTC 606- Microprocessor Failure - COP



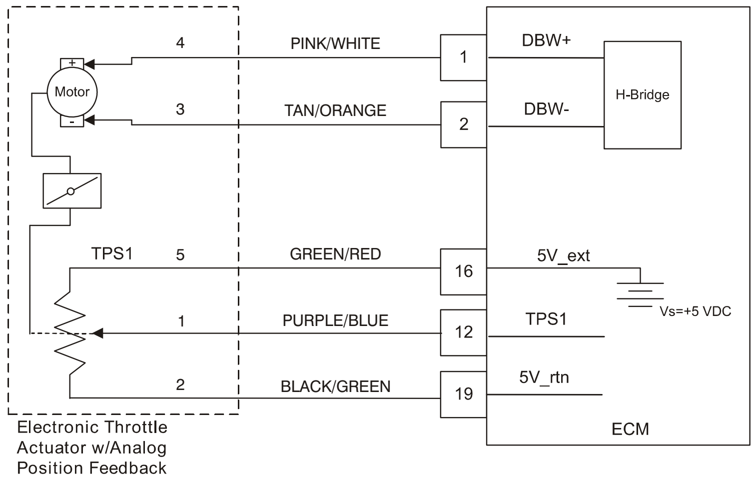
- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- Corrective Action(s) - Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle, recommend power derate 2 and low 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.


• Key On, Engine On
• System Mode= “Running”
• Operate engine at idle
Clear System Fault
Does DTC 603 reset with engine idling?
Yes
No
Check all power and ground circuits to ECM
Fault is intermittent
Are all circuits ok?
Yes
No
Replace ECM with known good part and retest
Repair wiring to ECM and retest

DTC 642- 5 Volt External Low Voltage



- 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

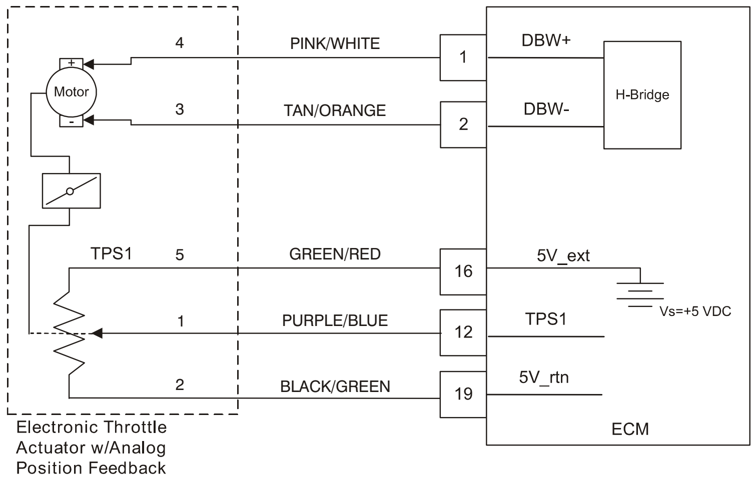
The ECM supplies 5-volt power to sensors, switches, and actuators external to the ECM. By supplying the power to these devices, the ECM can accurately measure their output relative to its own ground reference. The ECM can also control when the devices are active and put the devices in a low or no power 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



- 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

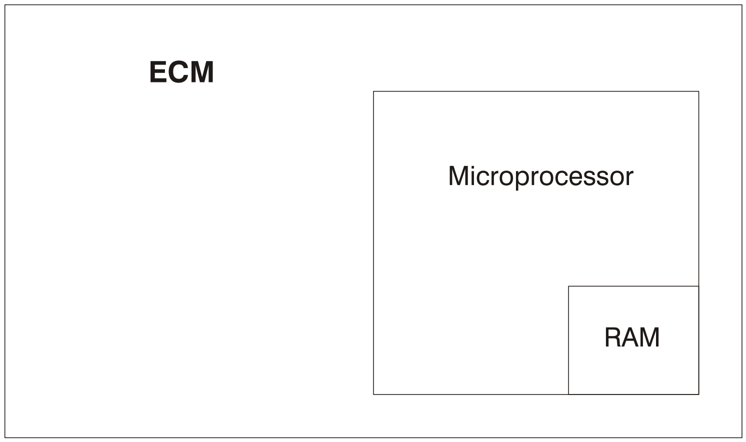
The ECM supplies 5-volt power to sensors, switches, and actuators external to the ECM. By supplying the power to these devices, the ECM can accurately measure their output relative to its own ground reference. The ECM can also control when the devices are active and put the devices in a low or no power 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

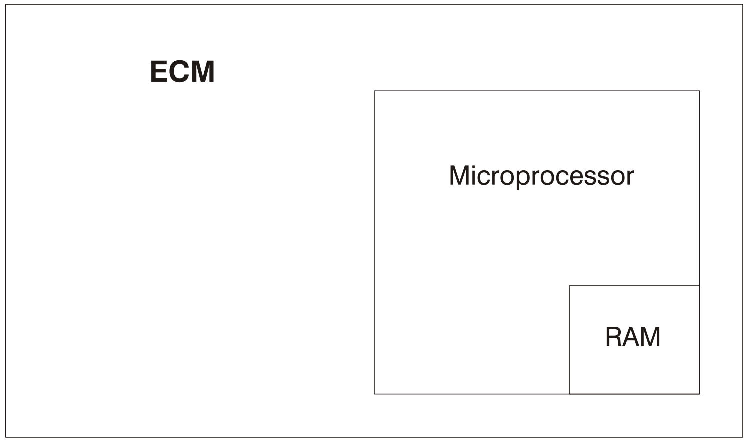


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

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

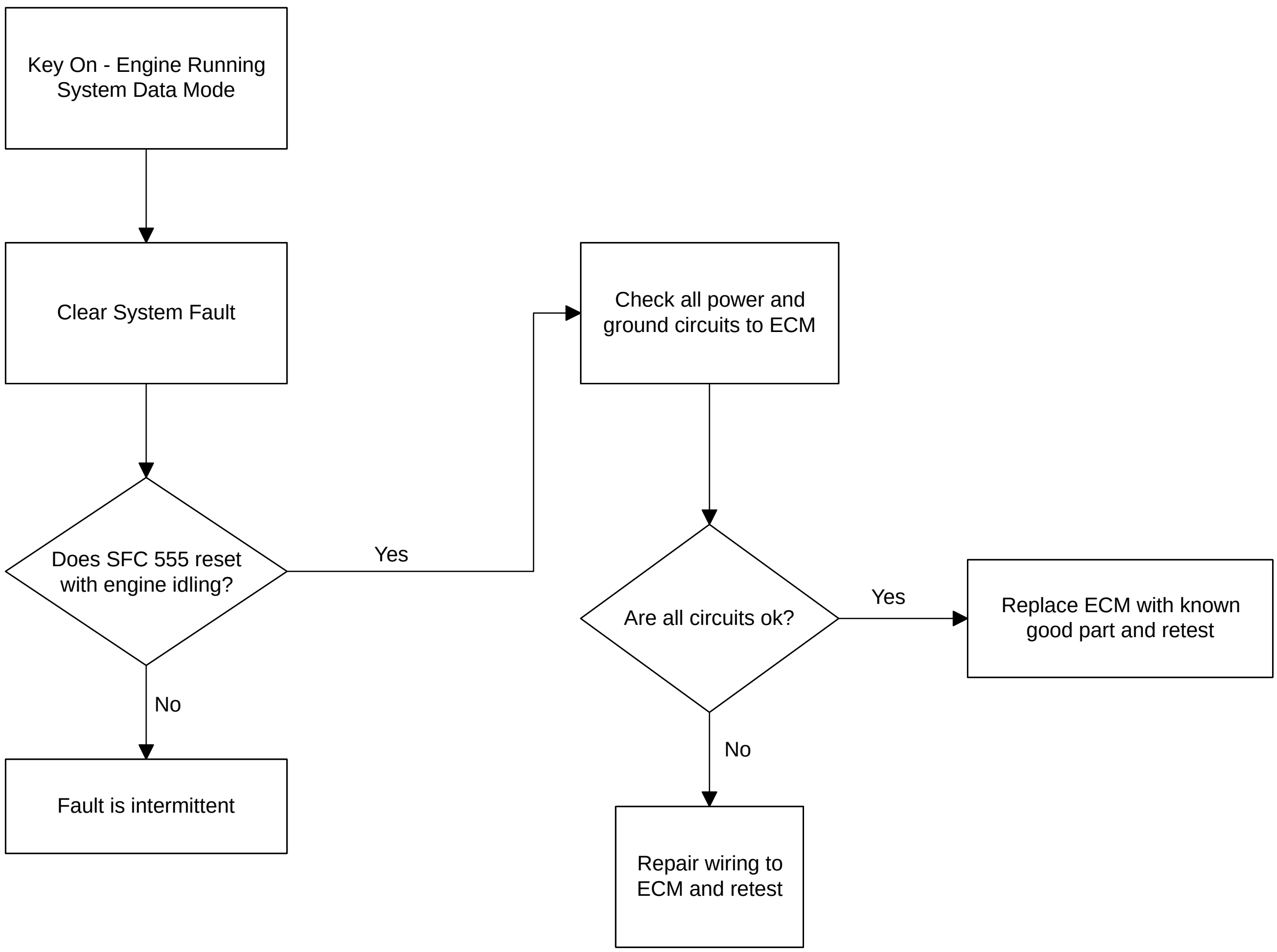


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

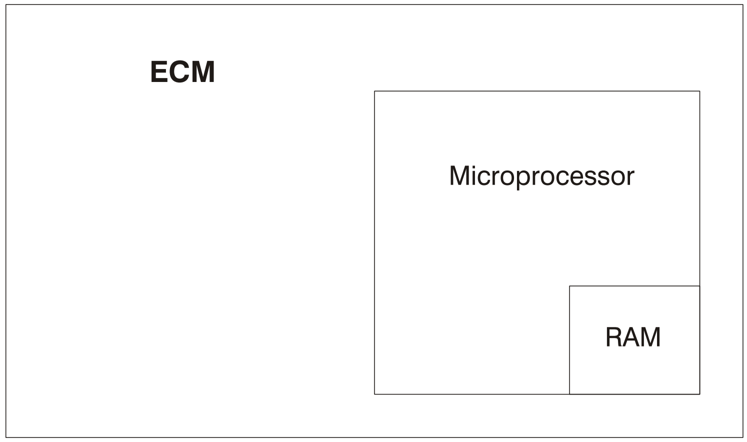
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased 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

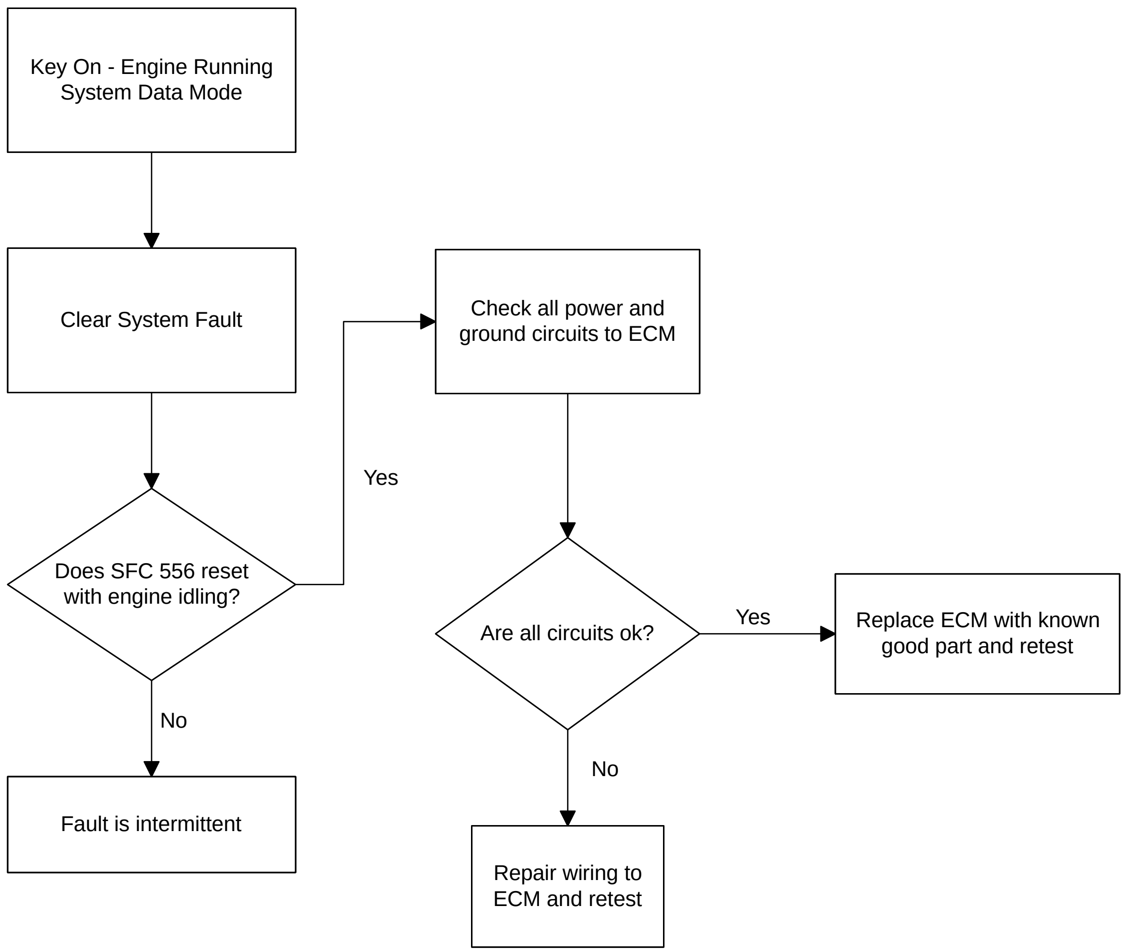


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

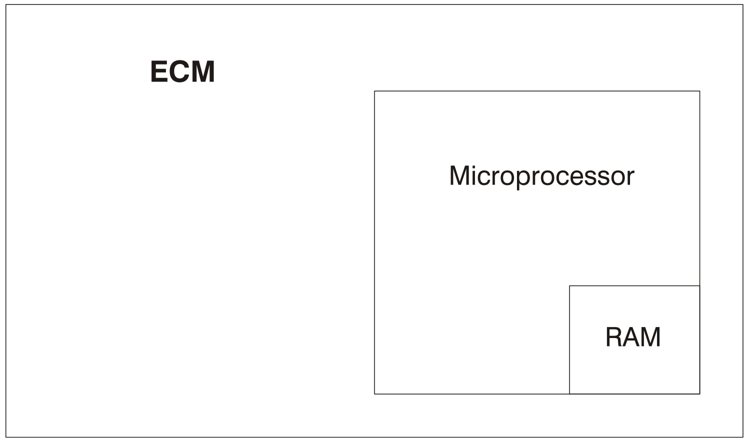
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased 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

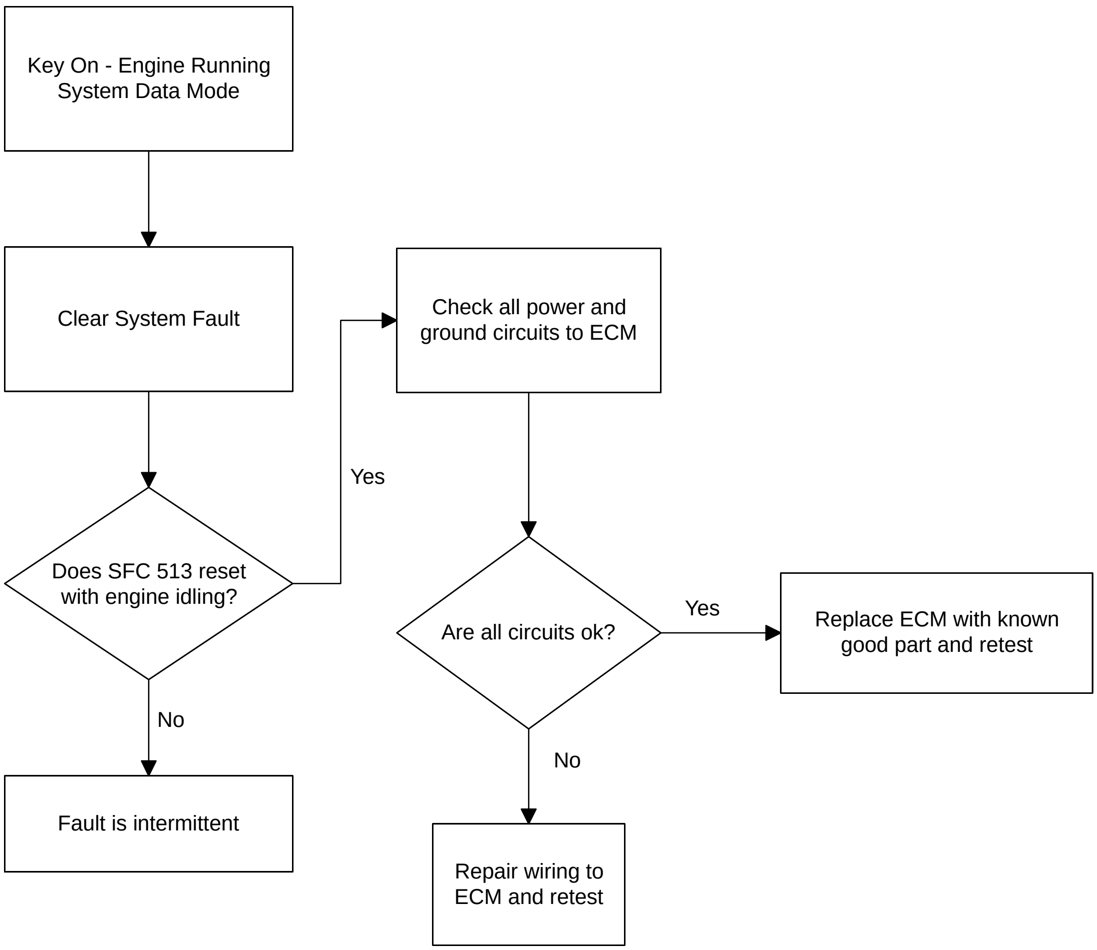


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

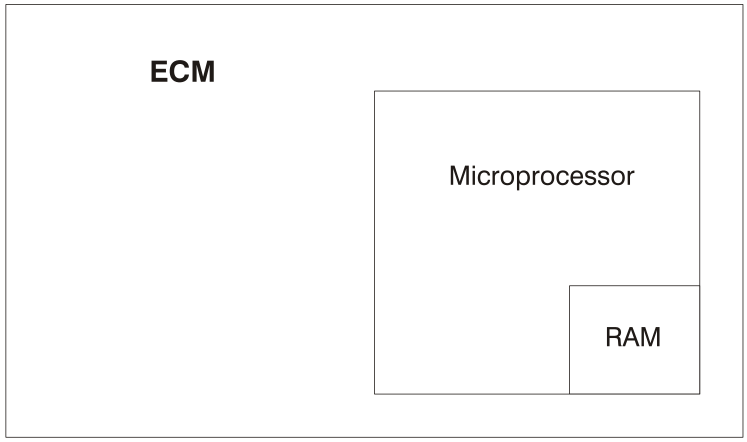
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased 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

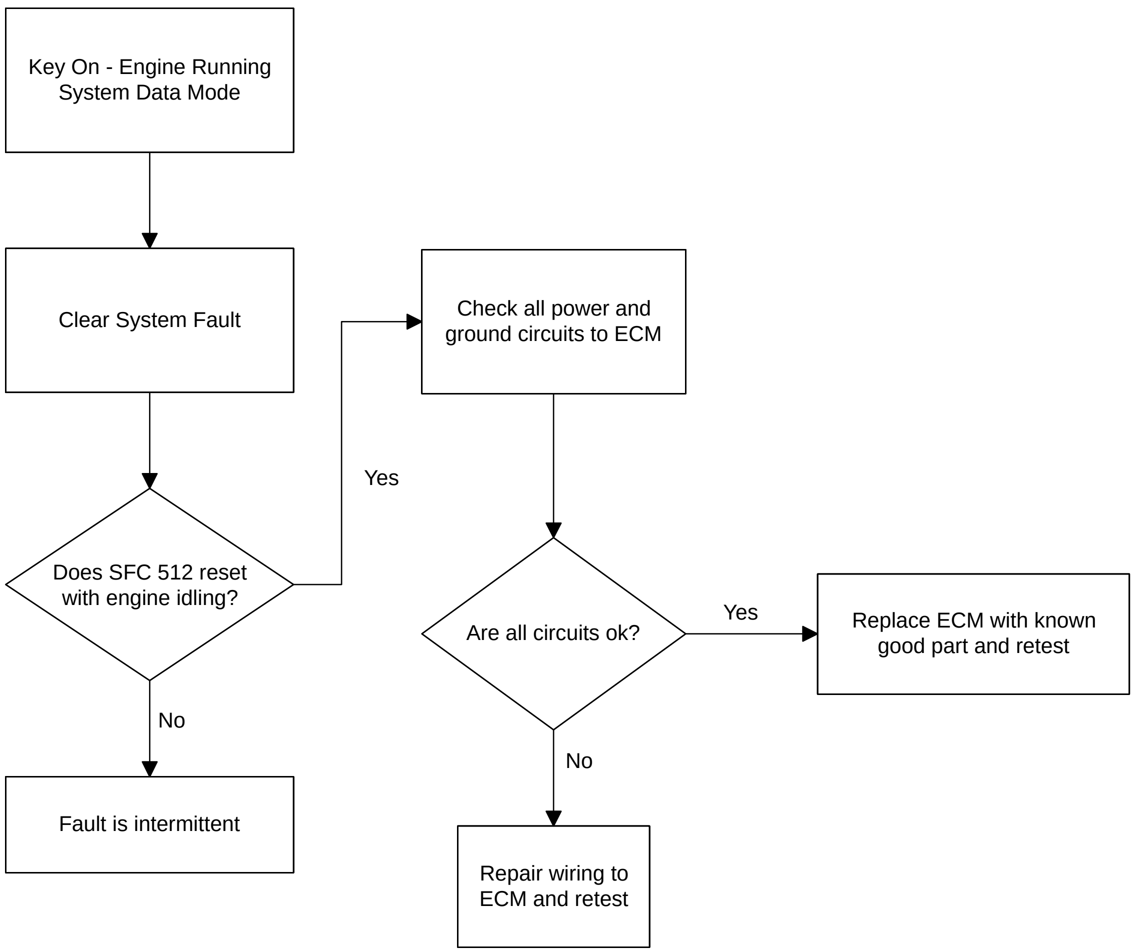


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

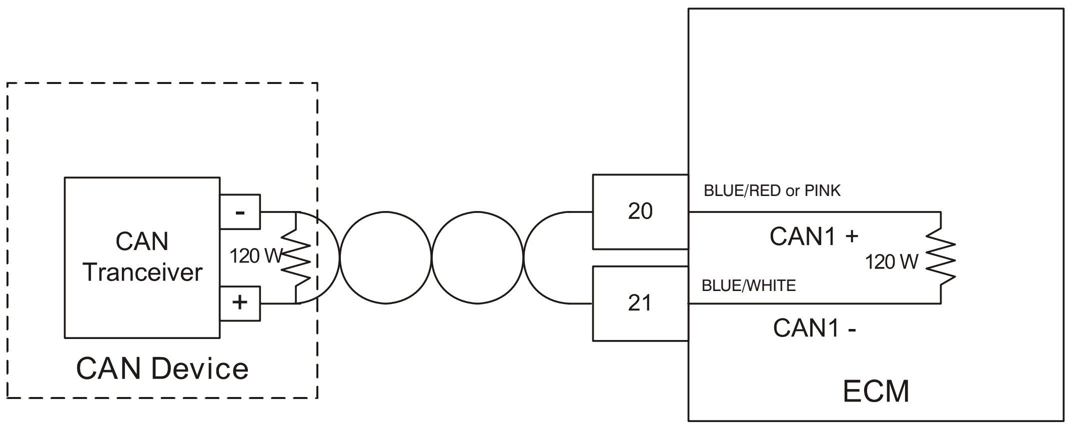
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased 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

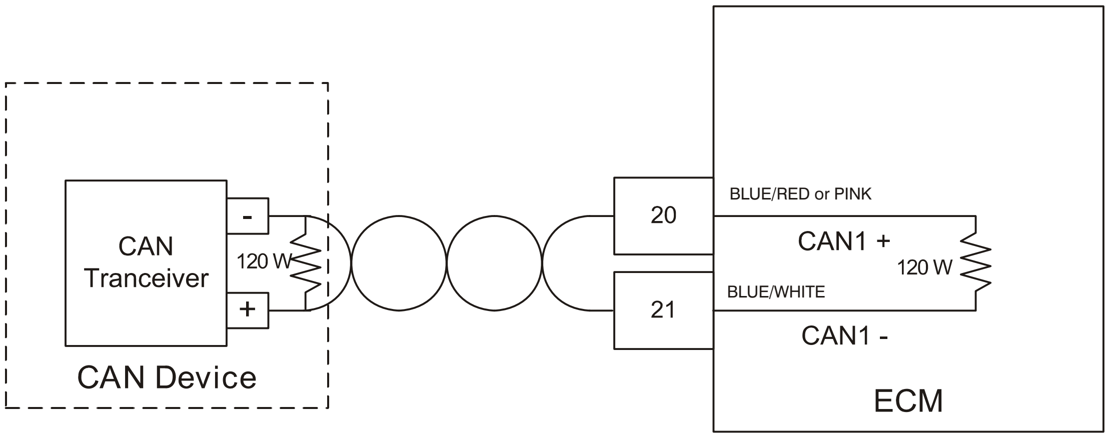
In some situations, external controllers may send a request to the ECM to shutdown engine operation and stop the engine. This request may be sent in response to a safety related condition in the vehicle.

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

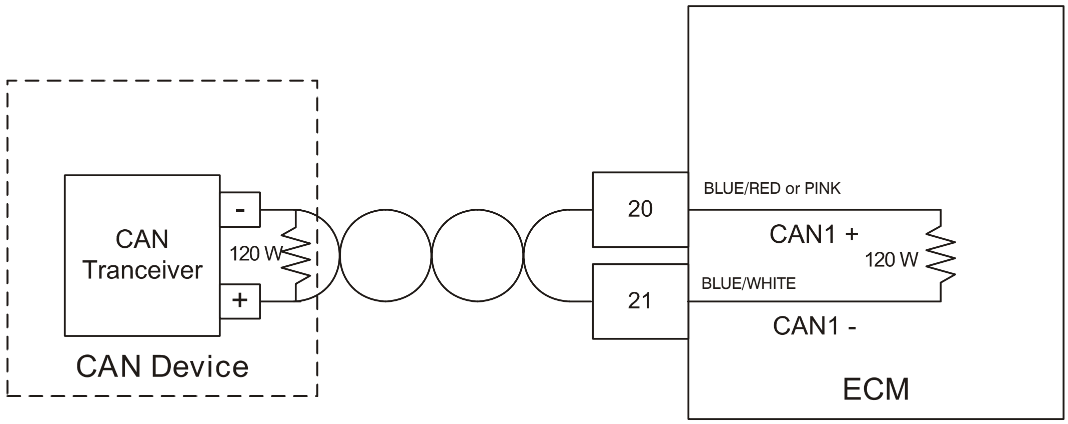
The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators, smart sensors, dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller 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

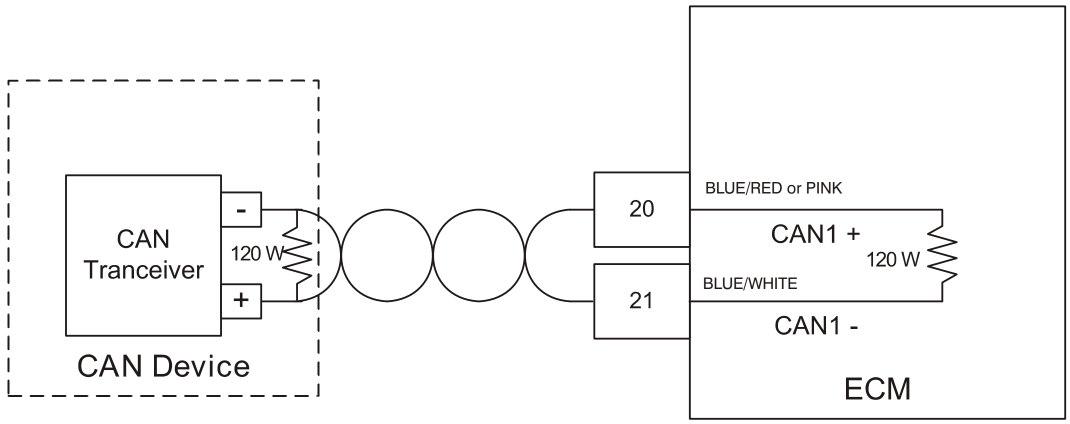
The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators, smart sensors, dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller 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

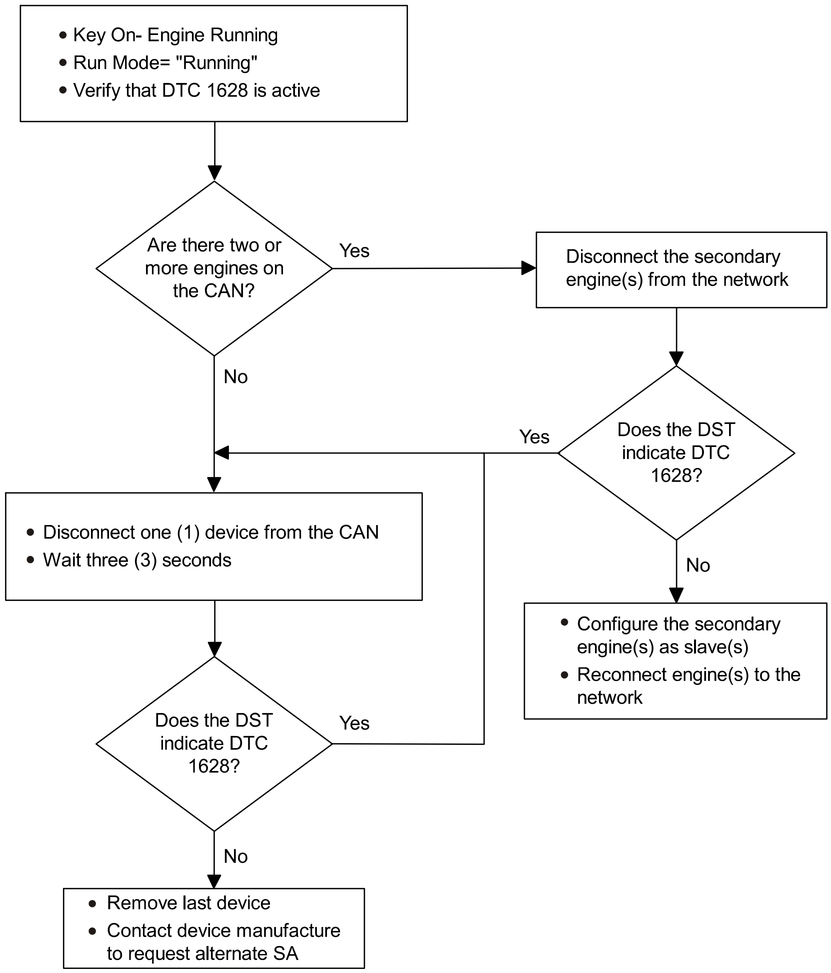
DTC 1628- CAN Address Conflict Failure



- 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

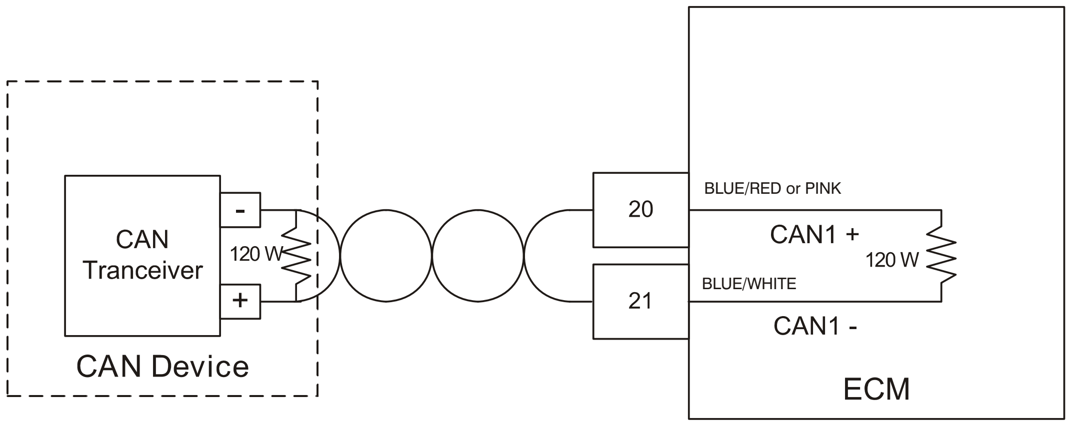
The Controller Area Network serves as a communication portal between intelligent devices. These devices may be but are not limited to other engine ECMs (slave), diagnostic tools, "smart" gauges, "smart" sensors, powertrain control units, vehicle controllers, actuators, etc. The network permits several 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.



• Key On- Engine Running
• Run Mode= "Running"
• Verify that DTC 1628 is active
Are there two or more engines on the CAN?
Yes
Disconnect the secondary engine(s) from the network
No
Yes
Does the DST indicate DTC 1628?
• Disconnect one (1) device from the CAN
• Wait three (3) seconds
No
• Configure the secondary engine(s) as slave(s)
• Reconnect engine(s) to the network
Does the DST indicate DTC 1628?
Yes
No
• Remove last device
• Contact device manufacture to request alternate SA

DTC 1629- J1939 TSC1 Message Reciept 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 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

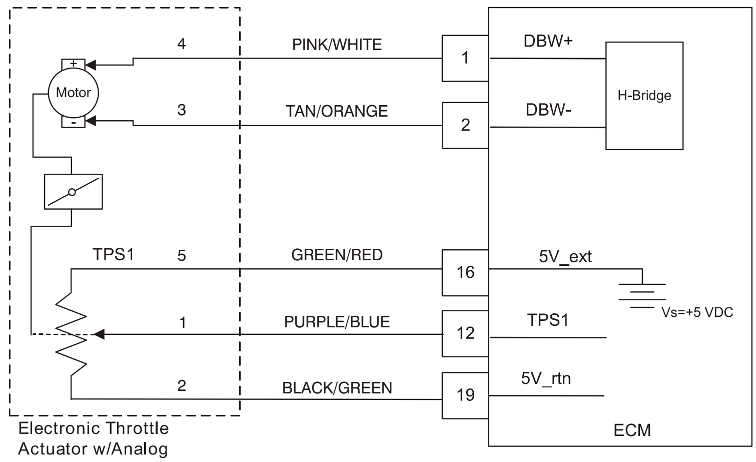
J1939 TSC1 may be used to send a commanded (or desired) engine speed to the ECM. If configured, the ECM will govern the engine speed to this commanded speed if possible. When operating in this mode, the ECM expects to receive TSC1 messages on a regular interval. When this message is not received, the 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 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. Shutdown engine.
- Non-emissions related fault

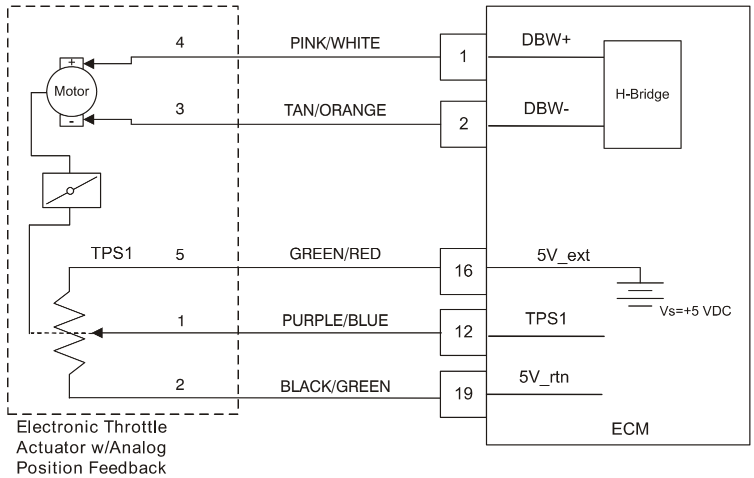
In the case of a throttle actuator with serial/digital position feedback, the ECM receives a constant data stream from the throttle actuator. If the communication is absent or interrupted, the ECM can no longer control the position of the throttle.

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

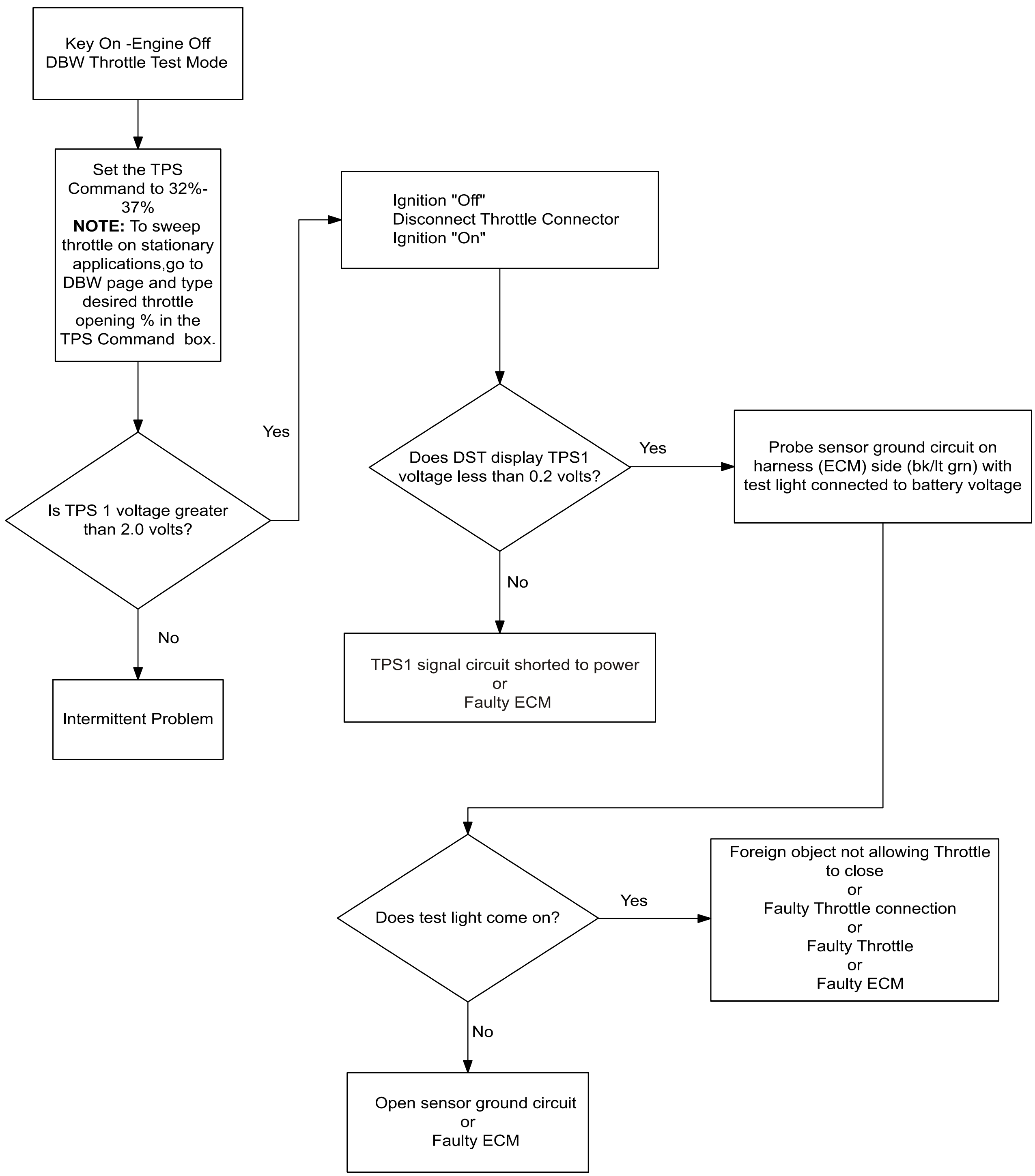
In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, 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.

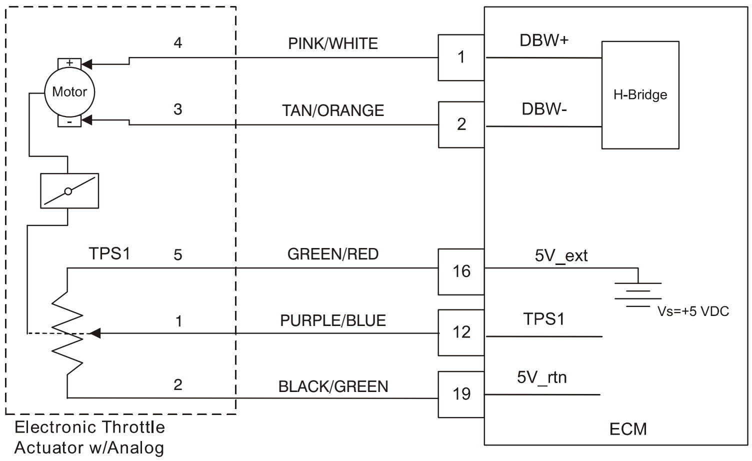
There are two types of throttle actuators, 1) actuator with analog position feedback and 2) actuator with digital position feedback. The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position. The second 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

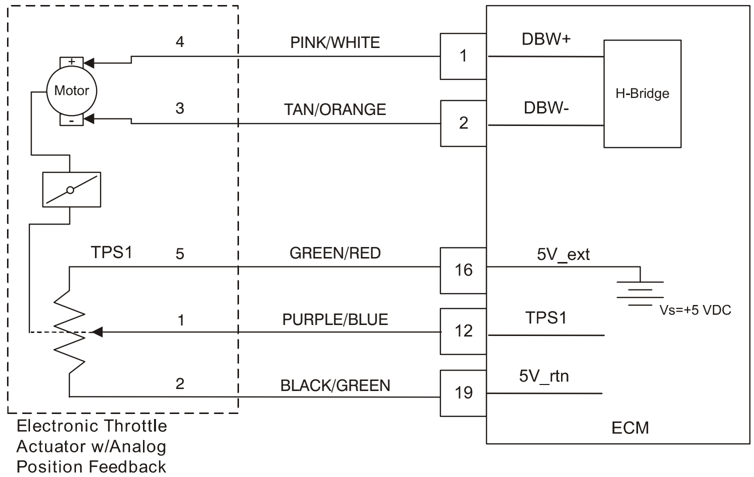
In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, 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 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.

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

SECTION 4. BOOM & PLATFORM

4.1 BOOM SYSTEMS

Broken Cable Indicator System

The boom on this model is a 4 section proportionally driven telescopic boom. The inner mid boom is driven directly by the telescope cylinder. The outer mid and fly booms are each driven by separate wire rope systems. Each rope system contains redundant ropes that are capable of allowing the operator to unknowingly continue use of the machine with a single rope failure. These kinds of failures with the extend ropes are self revealing to the operator so proper action can be taken. Failures within the fly extend ropes are self revealing as they are exposed on the exterior of the boom where a broken rope would be obvious. Failures within the outer mid ropes require the addition of the Broken Cable Indicator System in order to be self-revealing to the operator. This system uses a proximity sensor to detect excessive movement of the sensed rope as would be expected with a rope failure. A broken rope detection results in illuminating the Cable Break indicator on the platform control panel. No restrictions are made to the functionality of the control system. It is the responsibility of the operator to take the appropriate action.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Platform Control Enable System

The platform controls make use of a time dependent enable circuit to limit the time availability of "live" or enabled controls. When the footswitch is depressed, the controls are enabled and the operator has 7 seconds to operate any control. The controls will remain enabled as long as the operator continues to use any function and will remain enabled 7 seconds after the last function has been used. While the controls are "live", the enabled light will be illuminated in the platform display panel. When the time limit has been reached, the enabled light will turn off and the controls will be "dead" or disabled. To continue use of the machine the controls must be re-enabled to start the timer system over again. This is done by releasing all functions, then releasing and re-depressing the footswitch.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Transport Position Sensing System

The transport position sensing system uses the boom angle sensors and the boom length sensor mounted in the pivot end of the base boom in addition to the boom length switch mounted on the platform end of the base boom to sense when the boom is in the position associated with high speed travel. Above transport angle is recognized when one angle sensor reads more than 15° with respect to gravity and resets to within transport position when both angle sensors read less than 10° with respect to gravity. Transport length is recognized when both the length switch and length sensor read less than 1 ft extension for the 1350SJP (2 ft extension for the 1200SJP). During failures of either the length switch or length sensor, the transport length will be determined by the remaining sensor or switch. The position of the articulated jib is not considered.

This system is used to control the following systems:

- Beyond Transport - Drive Speed Cutback System
- Drive/Steer – Boom Function Interlock System – CE Only
- Jib Stow System
- Axle Extension System
- Oscillating Axle System

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Beyond Transport - Drive Speed Cutback System

When boom is positioned beyond the Transport Position, the drive motors are automatically restricted to their maximum displacement position (slow speed).

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Drive/Steer – Boom Function Interlock System (CE ONLY)

The Drive/Steer – Boom Function Interlock System uses the Transport Position Sensing System to sense when the boom is out of the transport position. All controls are simultaneously functional when the booms are within the transport position as on the standard machine. When the boom is beyond the transport position, the control functions are interlocked to prevent simultaneous operation of any boom function with drive/steer. The first function set to be operated in this mode, becomes the master function set. In other words, while operating drive/steer functions the boom functions are inoperable. Likewise, while operating boom functions drive/steer functions are inoperable.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Jib Stow System

This machine is equipped with a full function side swing rotator that is mechanically limited to 90 degree rotation to the left and electrically limited to 90 degrees to the right through the use of a positive action limit switch mounted on the rotator assembly. The machines stowed length can be reduced to facilitate transportation on standard trailers by swinging the jib further to the right using the hydraulic power of the side swing rotator. The control system will prevent swinging the jib past the 90 degree position unless the axles are retracted, the boom is in the transport position, and the jib stow override button on the platform control panel is held in combination with the jib swing function switch. When the jib is stowed, automatic platform leveling is disabled, the boom is restricted to the transport position, and axle extension is disabled. This system is functional only in the 500 lb. (230 kg) mode of the Dual Capacity System.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Envelope Tracking System

The Envelope Tracking System uses the envelope control sensors to enhance the control of the boom within the working envelope. Due to the shape of the working envelope, the maximum boom angle varies with telescope length. To maintain unrestricted operation of the boom, the lift down function is automatically introduced while telescoping in only when the boom is on the rearward edge of the envelope. This only occurs when telescoping in along the rearward edge and is not used elsewhere within the envelope or when telescoping out. Envelope tracking is disabled with any envelope or moment violations or failures. The envelope tracking functionality and be turned off using the manual position of the boom control select switch. Refer to Boom Control Select.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Moment Control System

The Moment Control System is the secondary means of controlling the stability of the machine. This system uses a load moment pin to attach the lift cylinder of the boom to the turntable. This pin is instrumented with gauges allowing the forces in the pin to be monitored. These forces are used to compare the actual boom moment (force at a distance) to a predetermined allowable boom moment. In controlling the boom moment, the position and load of the boom is controlled. The moment control system will detect moments larger than expected as well as those smaller than expected. This effectively controls the forward and rearward positions of the boom. The moment control system varies the maximum allowable moment based on ground slope. On level ground and with rated load in the platform, the allowable moments establish a working envelope slightly larger than the Envelope Control System's envelope to minimize interaction of the systems. With increasing ground slopes and rated load in the platform, the allowable moments may establish a working envelope smaller than the Envelope Control System's envelope and may result in moment violations at the extreme platform positions. Violations of the moment control systems allowable moment will result in reduced function speeds, BCS warning light illumination, restriction of functions, and sounding of the platform alarm and the flashing of the BCS light with attempts to operate restricted functions. The restricted functions due to moment system violations related to forward reach are disallowing jib functions, lift down, telescope out, swing, drive, and steer. The restricted functions due to moment system violations related to backward reach are disallowing jib functions, lift up, telescope in, swing, drive, and steer. Recognized failures within this system will result in control by the Envelope Control System, reduced function speeds, BCS warning light illumination. The boom will be restricted from leaving the transport position until the failure is resolved.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

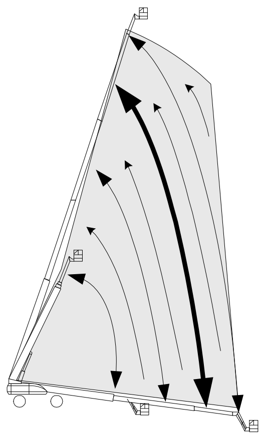
Boom Control System (BCS) Functional Check (Push to Test) System

The machine is equipped with a system for the operator to daily verify the proper functioning of the Boom Control System (Envelope Control System and the Moment Control System). The operator is instructed to position the boom in the position described by the instruction decal and to then verify the control system cut out the telescope movement at the correct length. When the operator pushes the push button mounted on the ground control panel, the control system compares the current moment reading in the moment system and compares it to the moment expected for this position. If the current moment is within allowable tolerance for the test position, the green BCS indicator will illuminate indicating the system is working properly. If the current moment is not within the allowable tolerance for the test position, the red BCS indicator will illuminate indicating the machine requires service by JLG authorized service personnel before the system is used. Failure of this test will not restrict the functionality of the machine and will not cause a system fault. It is the operators responsibility to take proper action. The machine can be in either capacity mode of the dual capacity system for this system check.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Controlled Arc System

The Controlled Arc System uses the envelope control sensors to enhance the control of the boom within the working envelope. The purpose of the controlled arc system is to minimize the interaction of lift functions with envelope edges and to increase user efficiency. This minimizes the effect of a long boom working in a comparatively narrow envelope. Because the boom is permitted to extend to longer lengths at high angles than at it is low angles, lift commands would normally cause the boom to violate the permitted envelope while lifting down or conversely require the operator to frequently command telescope out while lifting to high heights. The controlled arc system optimizes the envelope shape by automatically introducing telescope in or out during "lift only" commands. Telescope flow is regulated during lift commands to maintain a constant percentage of available boom length (0% is always fully retracted, 100% is variable as the permitted length changes when the boom is raised). The target percentage will be maintained throughout the lift command whether it is maintaining 0%, 100%, or any percentage in between. The target percentage is established at the start of lift command or end of manual telescope commands when using multiple functions with lift. The telescope command can be used independently or in combination with other functions. Manual introduction of telescope will override the controlled arc system and result in conventional control. Controlled arc will be disabled with any sensor failure, any moment violation, any envelope violation, or with auxiliary power functions. The controlled arc functionality and be turned off using the manual position of the boom control select switch. Refer to Boom Control Select.



Controlled Arc Boom Movement

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Controlled Boom Angle System

The Controlled Boom Angle System uses the envelope control sensors to enhance the control of the boom by minimizing the interaction of swing and drive functions with the envelope edges. This interaction is due to two factors. First, the envelope is controlled relative to gravity regardless of ground slope and second, the turntable/boom mounting is effected by swing and drive functions when the ground slope varies. This can cause the boom position to vary within the envelope or even violate the envelope edges when swinging or driving without intentionally moving the boom. The controlled boom angle system minimizes this effect by automatically introducing lift up or down during swing and drive commands to maintain a constant boom angle relative to gravity for all boom angles greater than 9 degrees. Controlled boom angle is disabled with any envelope or moment violations or failures. The controlled boom angle functionality and be turned off using the manual position of the boom control select switch. Refer to Boom Control Select.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Envelope Tracking

The Envelope Tracking System uses the envelope control sensors to enhance the control of the boom within the working envelope. Due to the shape of the working envelope, the maximum boom angle varies with telescope length. To maintain unrestricted operation of the boom, the lift down function is automatically introduced while telescoping in only when the boom is on the rearward edge of the envelope. This only occurs when telescoping in along the rearward edge and is not used elsewhere within the envelope or when telescoping out. Envelope tracking is disabled with any envelope or moment violations or failures. The envelope tracking functionality and be turned off using the manual position of the boom control select switch. Refer to Boom Control Select.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Slow Down System

When the boom approaches the edges of the working envelope, all functions (except jib and platform functions, telescope in or out on the rearward edge and telescope in on the forward edge) are automatically slowed down by the control system to reduce the machine dynamics and improve operator control. The slow down starts within 4 feet of all edges and is at the fully reduced speeds 2 feet from all edges. The control system indicates to the operator this automatic introduction of slow down by flashing the creep light on the platform display panel. This feature applies to both platform and ground controls, however, no indication is made on the ground control panel.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Dual Capacity System

The Dual Capacity System on this machine is a multiple envelope control system as opposed to an indication system. The control system changes the working envelope and moment limits to match the capacity select mode to either the 500 lb. (230 kg) mode or the 1000 lb. (450 kg) mode. It then displays the capacity mode on the platform and ground display panel and controls the positions of the boom within the allowable envelope for that mode. This mode is selectable by the operator with the dual capacity select switch on the platform control panel. The 500 lb. (230 kg) mode has the largest envelope and allows the use of the side swing jib. The 1000 lb. (450 kg) mode has a smaller envelope and requires the jib to be fixed in the centered position. To select the 1000 lb. (450 kg) mode the boom must already be in the smaller 1000 lb. (450 kg) envelope and the jib must be centered (+/-10 degrees) verified to the control system by the jib centered limit switch mounted on the side swing rotator. When the operator selects the 1000 lb. (450 kg) mode and these conditions are met, the capacity light changes from 500 lb. (230 kg) to 1000#, jib swing is disallowed, and the envelope and permitted moment values are changed accordingly. When the operator selects the 1000 lb. (450 kg) mode and these conditions are not met, both capacity lights will flash, the platform alarm will sound, and all functions except jib swing will be disabled until the capacity select switch is put back into the 500 lb. (230 kg) position. Operation of jib swing in this condition can be used to find the center position of the jib as the jib swing function will stop when the center position is reached.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Electronic Platform Leveling

The electronic platform leveling system uses two tilt sensors (mounted on either side of the pivot weldment), a control valve (mounted to the platform support), a level cylinder, and the platform control module (mounted in the platform control box) to automatically measure and control the incline of the platform with respect to gravity. While in the automatic position of the boom control select (item 33) platform leveling is active while operating drive, telescope, lift or swing and is not active while operating any other function (e.g. rotate, jib, or steer). While in the manual position of the boom control select, platform leveling is active while operating lift only. The system controls the platform angle relative to gravity using a set point established during power-up (cycling of the EMS) or at the conclusion of a manual platform level override by the operator using the platform level override switch from either the platform or the ground control. In other words the operator can chose a platform incline other than level with gravity and the system will maintain that incline automatically.

If a fault occurs in the platform leveling system the following will occur:

- Automatic platform leveling will stop (except when there is a fault in only one sensor)
- The platform level fault indicator will flash
- The platform alarm will sound
- All functions will default to creep speed if in platform mode and the boom is out of the transport position. Refer to Transport Position Sensing System.

To reset the fault the emergency stop switch should be recycled.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Boom Control Select

The boom control select switch is mounted on the platform control panel and allows the operator the ability to select between two different modes of boom control functionality: automatic and manual. While in either mode, the Envelope Control System and Moment Control System remains active.

When the boom control is selected to the automatic boom control position, lift and telescope movements are coordinated by the control system as described in the Controlled Arc, Controlled Boom Angle, and Envelope Tracking descriptions. These systems will remain active to automatically assist the operator in keeping the boom within the envelope boundaries.

When operating in the automatic mode, the following functionality characteristics should be noted.

- While operating Lift Up, the boom may also telescope out (Controlled Arc)
- While operating Lift Down, the boom may also telescope in (Controlled Arc)
- While operating Swing or Drive, the boom may lift up or lift down (Controlled Boom Angle)
- While operating Telescope In, the boom may lift down when at high boom angles and the creep light is flashing (Envelope Tracking)

In addition, when the boom control is selected to the automatic position, the automatic platform leveling feature is active during lift, telescope, swing, and drive movements as described in the Electronic Platform Leveling System description.

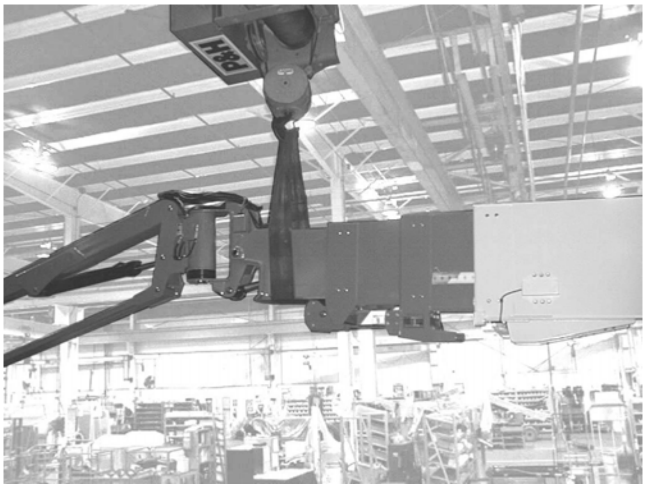
When the boom control is selected to the manual position, lift and telescope movements are controlled separately by the operator effectively turning off the controlled arc, controlled boom angle, and envelope tracking systems. Without these systems being active, the control system will stop the movements of the boom when the envelope boundaries are reached and the functions that could violate the envelope will be restricted. The platform alarm will sound and the BCS light will flash with attempts to operate a restricted function. In addition, when the boom control is selected to the manual position, the automatic platform leveling feature is active only during lift movements.

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

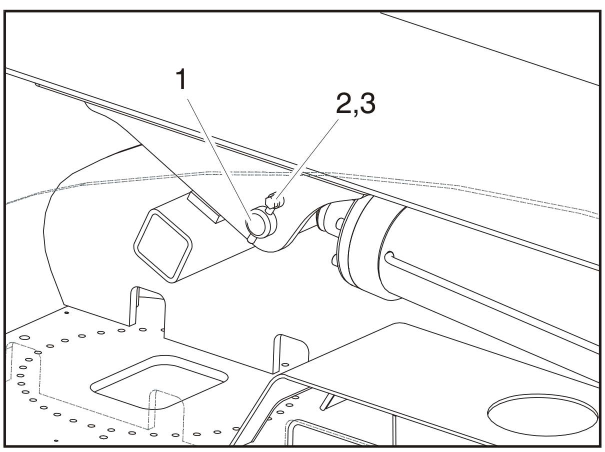
4.2 BOOM REMOVAL, DISASSEMBLY/ASSEMBLY, & CABLE REPLACEMENT

Removal

1. Place machine on firm, level ground.
2. Slightly elevate the boom and support the fly boom with a crane or an adequate lifting device capable of handling 6 - 7 tons.

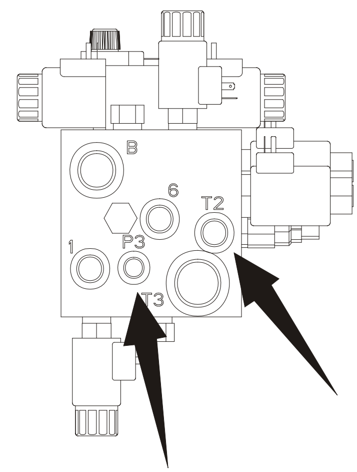


3. Place blocking under lift cylinder to hold it in place.
4. Remove lift cylinder pin securing the lift cylinder rod to the boom.

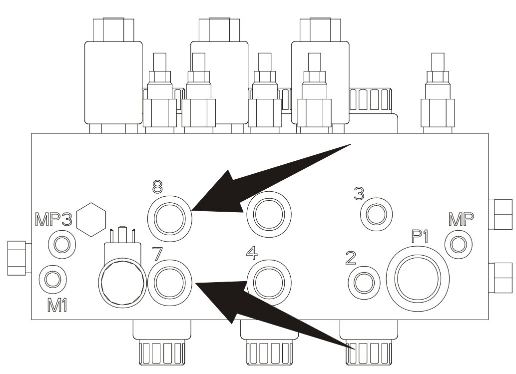


1. Pivot Pin
2. Bolt
3. Keeper Pin

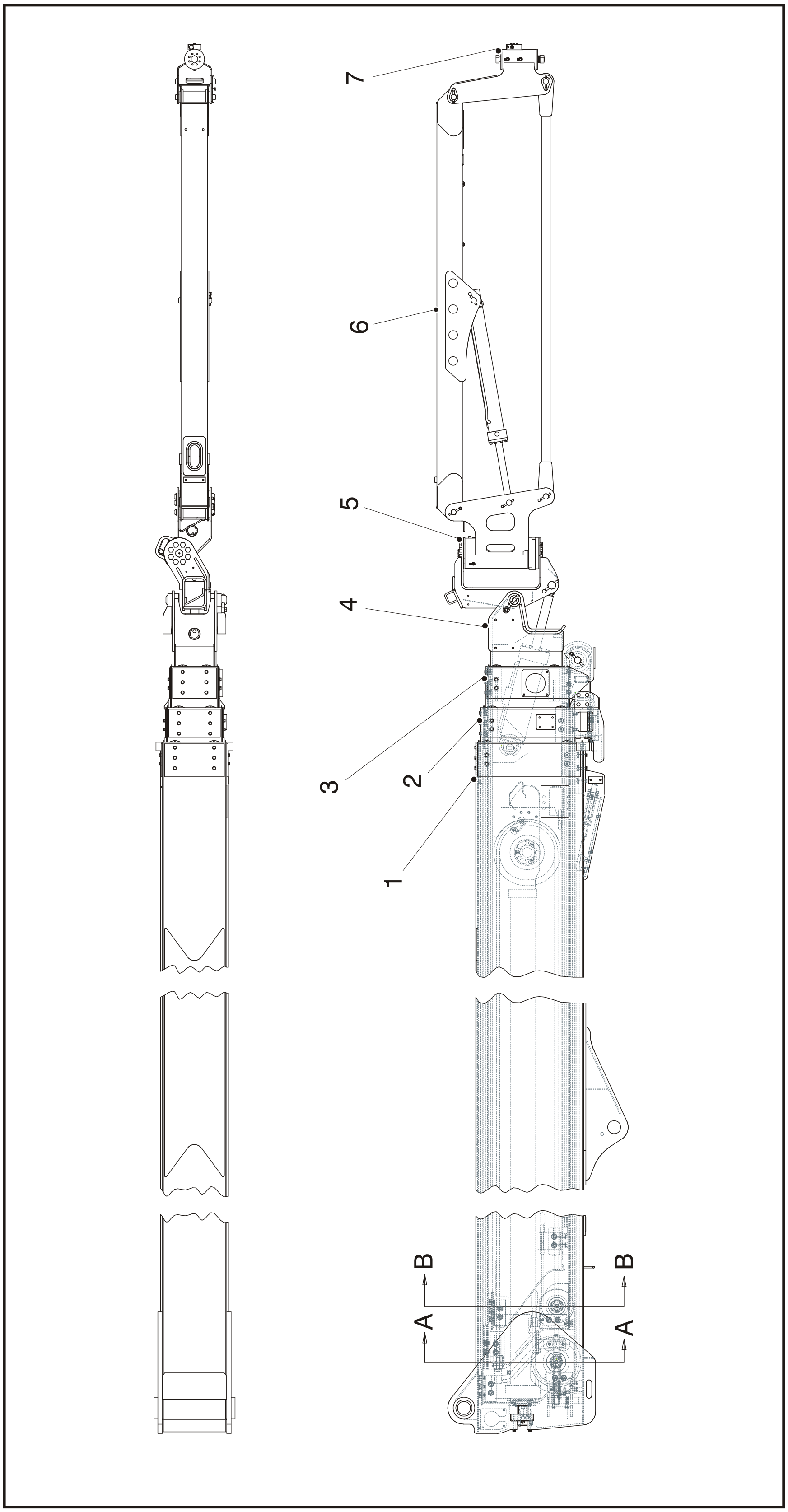
5. Remove the boom end cover.
6. Tag and disconnect the telescope, tank, and pressure hoses as indicated below from the main valve and cap ends.



LEFT END VIEW

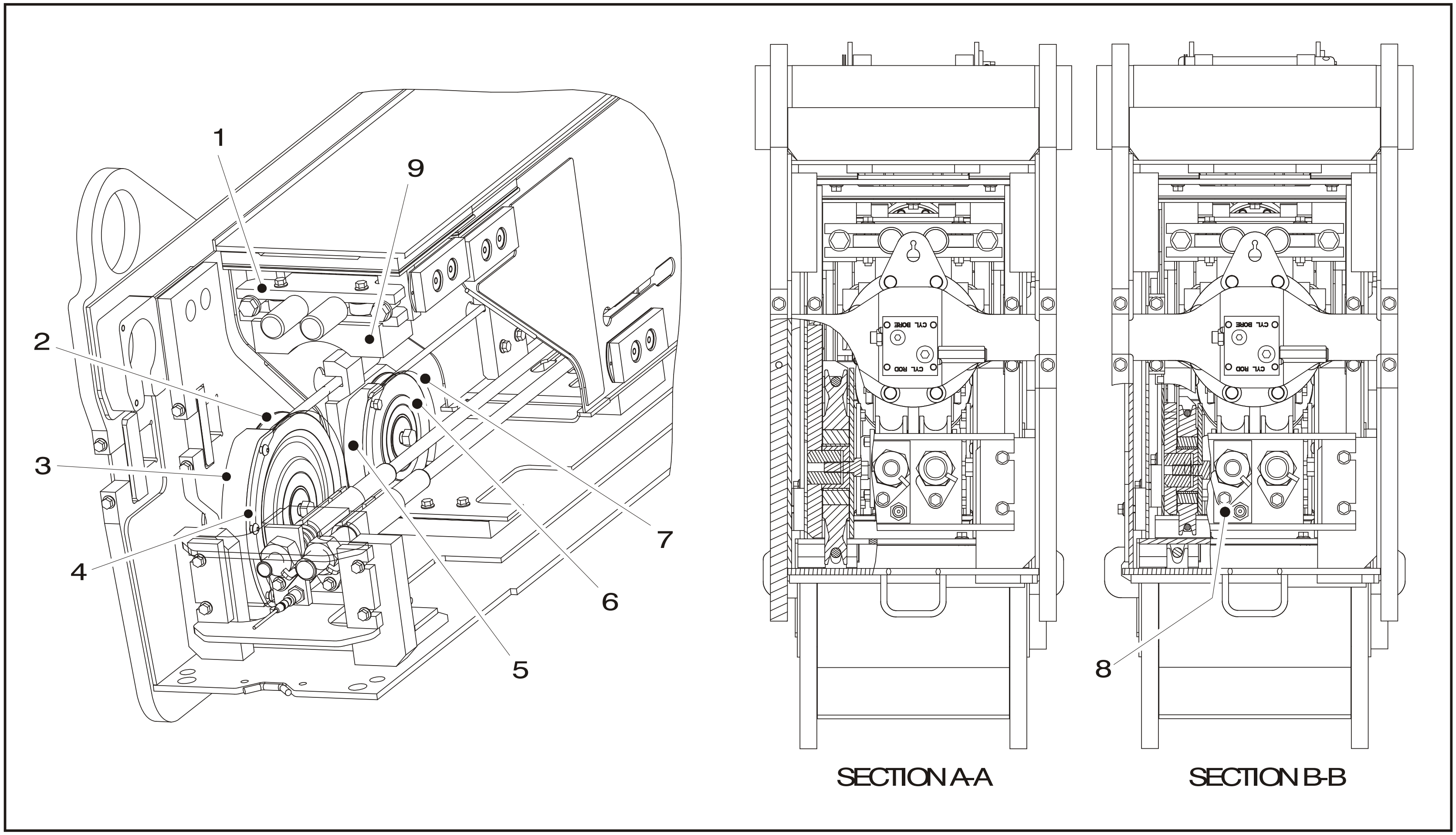


BOTTOM VIEW



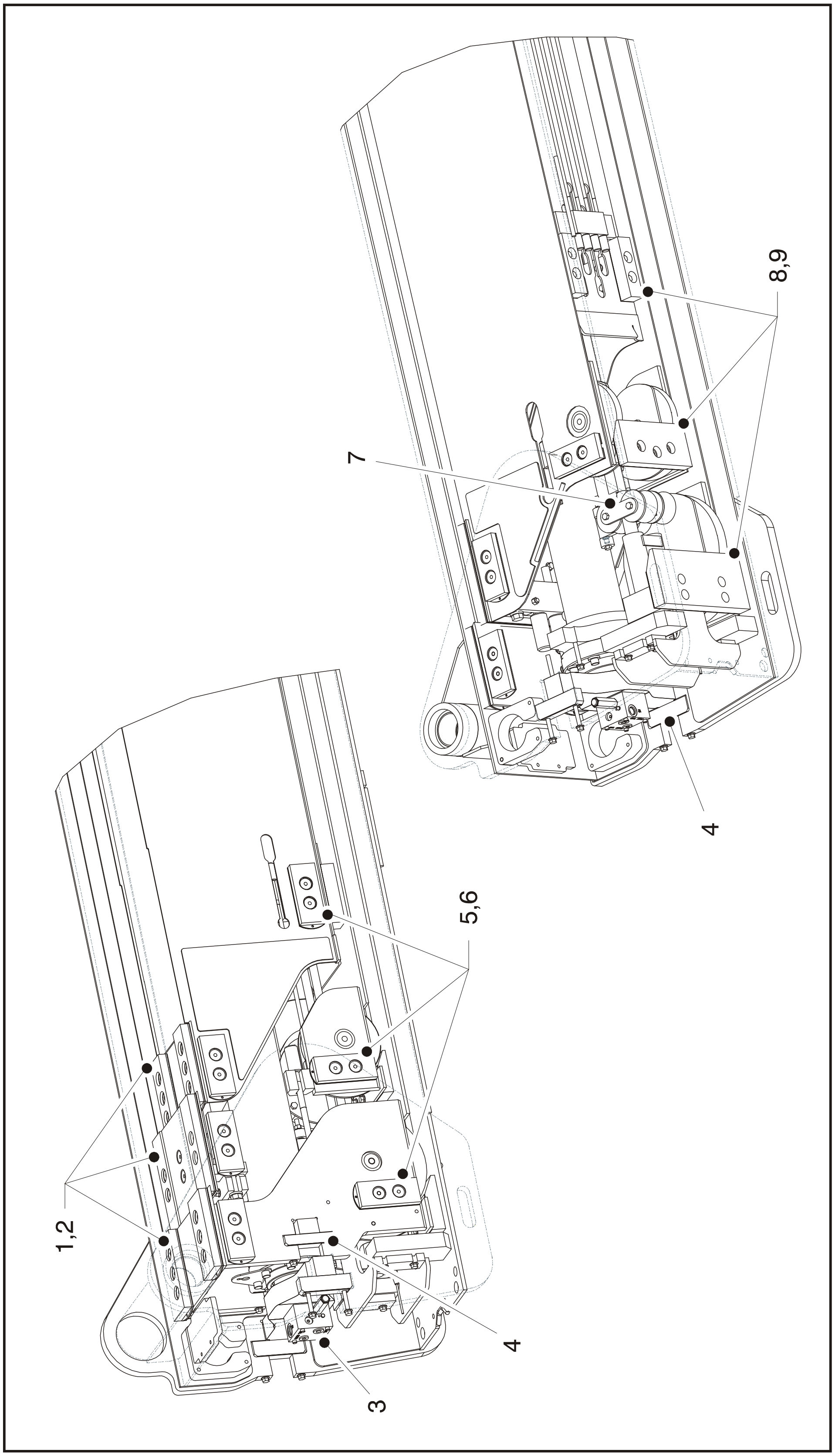
1. Boom Base
2. Boom Inner Mid
3. Boom Outer Mid
4. Boom Fly
5. Jib Rotator
6. Jib Assembly
7. Platform Rotator

Figure 4-1. Boom Assembly - Sheet 1 of 7



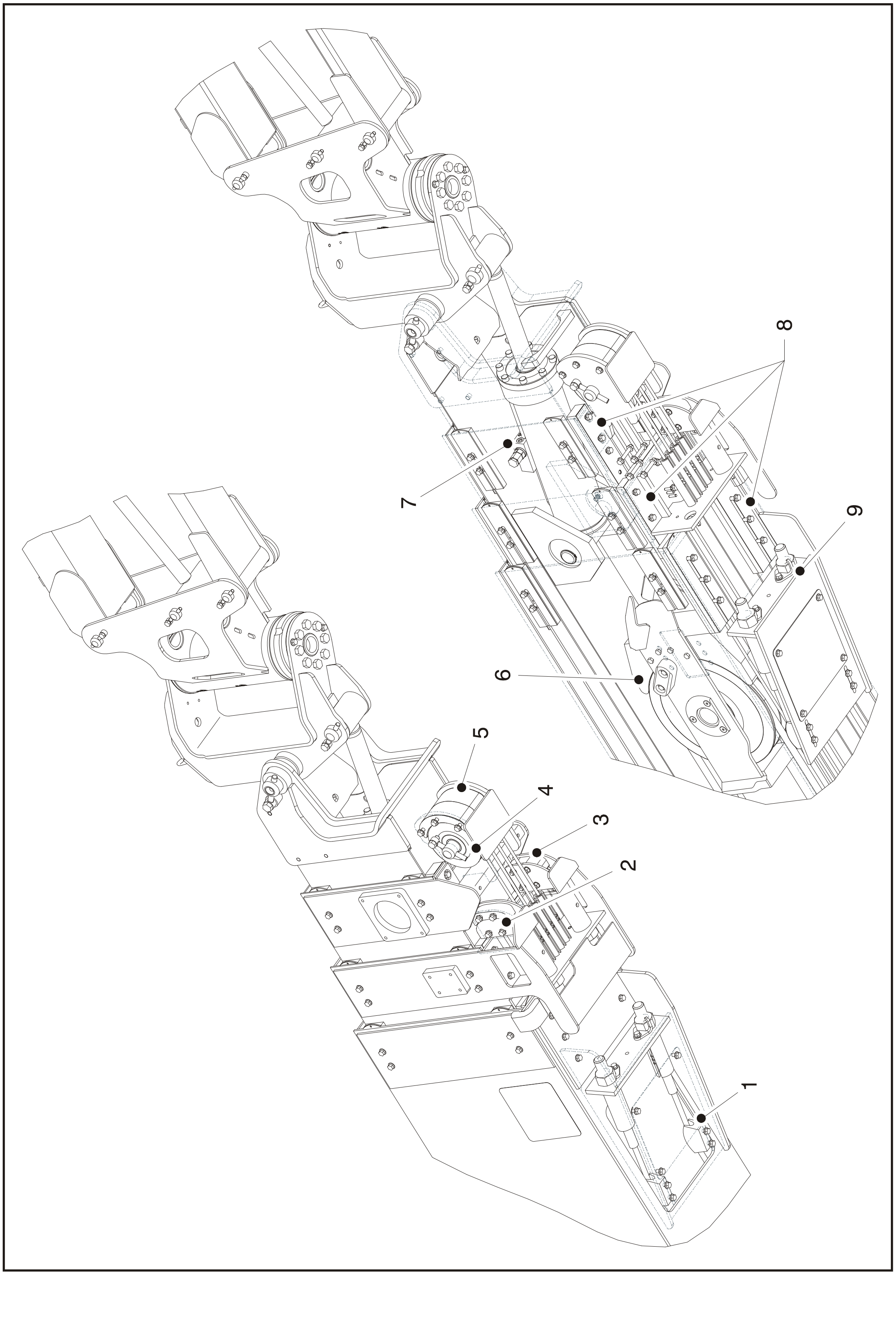
1. Outer Mid Extend Block
2. Outer Mid Retract Sheave
3. Rope Retainer Block
4. Retract Rope Retainer Plate
5. Rope Retainer Block
6. Fly Retract Sheave
7. Retract Rope Retainer Plate
8. Lock Plate
9. Tele Cylinder Wear Pad

Figure 4-2. Boom Assembly - Sheet 2 of 7



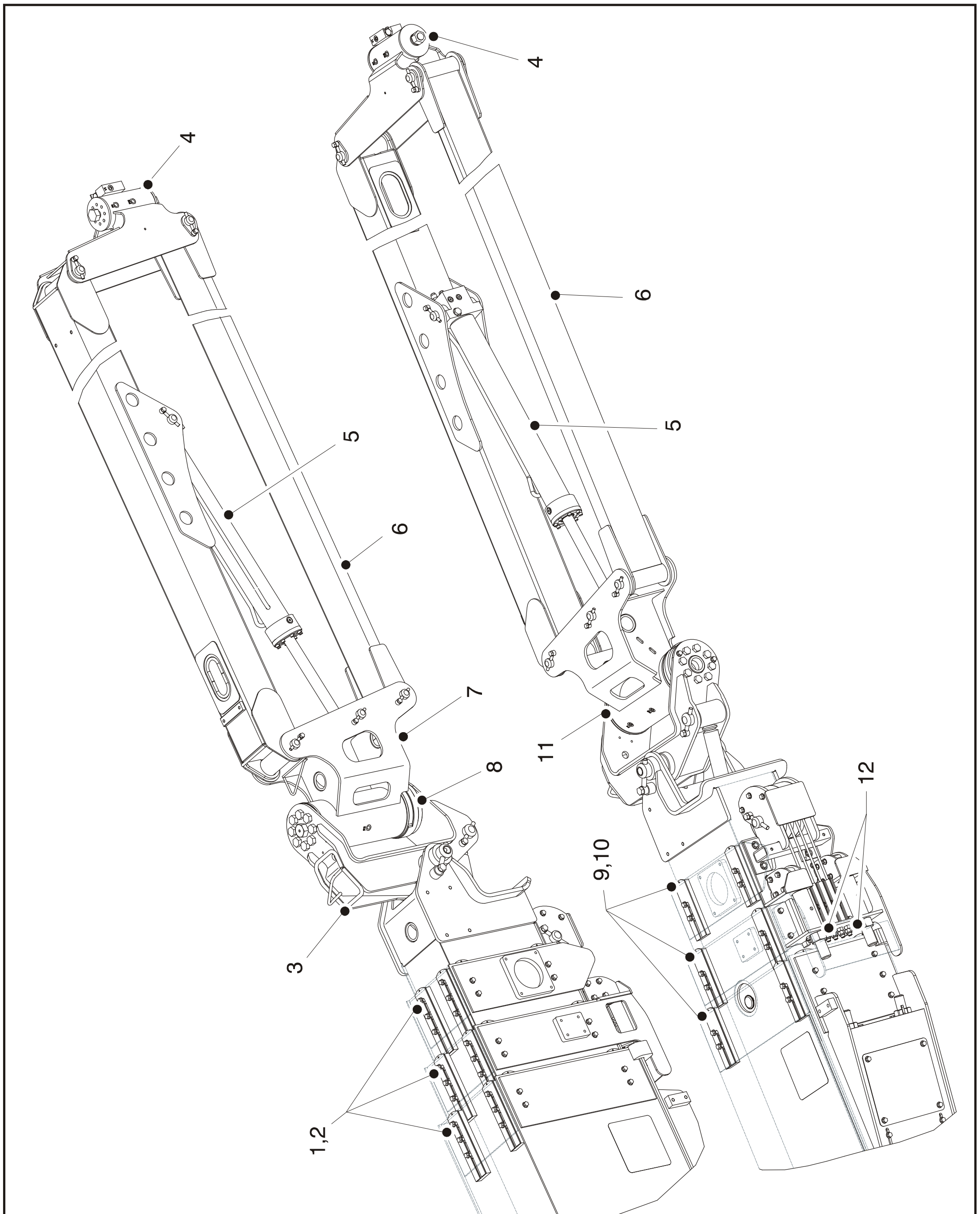
1. Upper Rear Wear Pad
2. Shim
3. Telescope Cylinder
4. Trunnion Keeper Block
5. Lower Rear Wear Pad
6. Shim
7. Tele Cylinder Pulley Assembly
8. Bottom Rear Wear Pad
9. Shim

Figure 4-3. Boom Assembly - Sheet 3 of 7



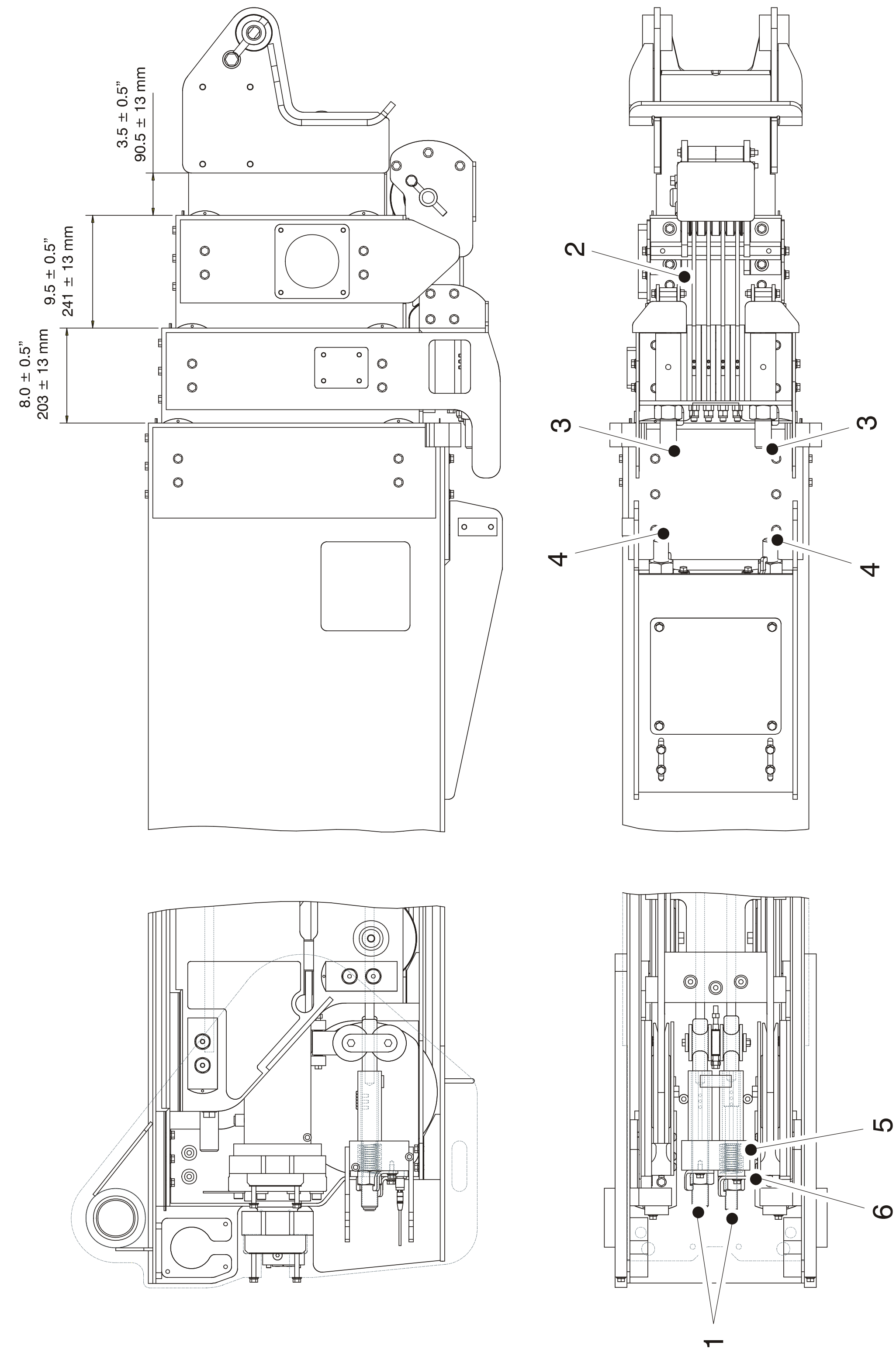
1. Sheave Deflector
2. Sheave Deflector
3. Rope Retainer Block
4. Fly Extension Sheave
5. Rope Retainer Block
6. Rope Retainer Block
7. Level Cylinder
8. Front Lower Wear Pad
9. Lock Plate

Figure 4-4. Boom Assembly - Sheet 4 of 7



1. Front Upper Wear Pad
2. Shim
3. Pivot Assembly
4. Platform Rotator
5. Jib Cylinder
6. Lower Jib Link
7. Jib Rotator
8. Jib Rotator Cam
9. Front Side Wear Pad
10. Shim
11. Shim
12. Lock Plate

Figure 4-5. Boom Assembly - Sheet 5 of 7



1. Outer Mid Extend Rope
2. Fly Extend Rope
3. Fly Retract Rope
4. Outer Mid Retract Rope
5. Proximity Switch Spring
6. Switch Adjustment Block

Figure 4-6. Boom Assembly - Sheet 6 of 7

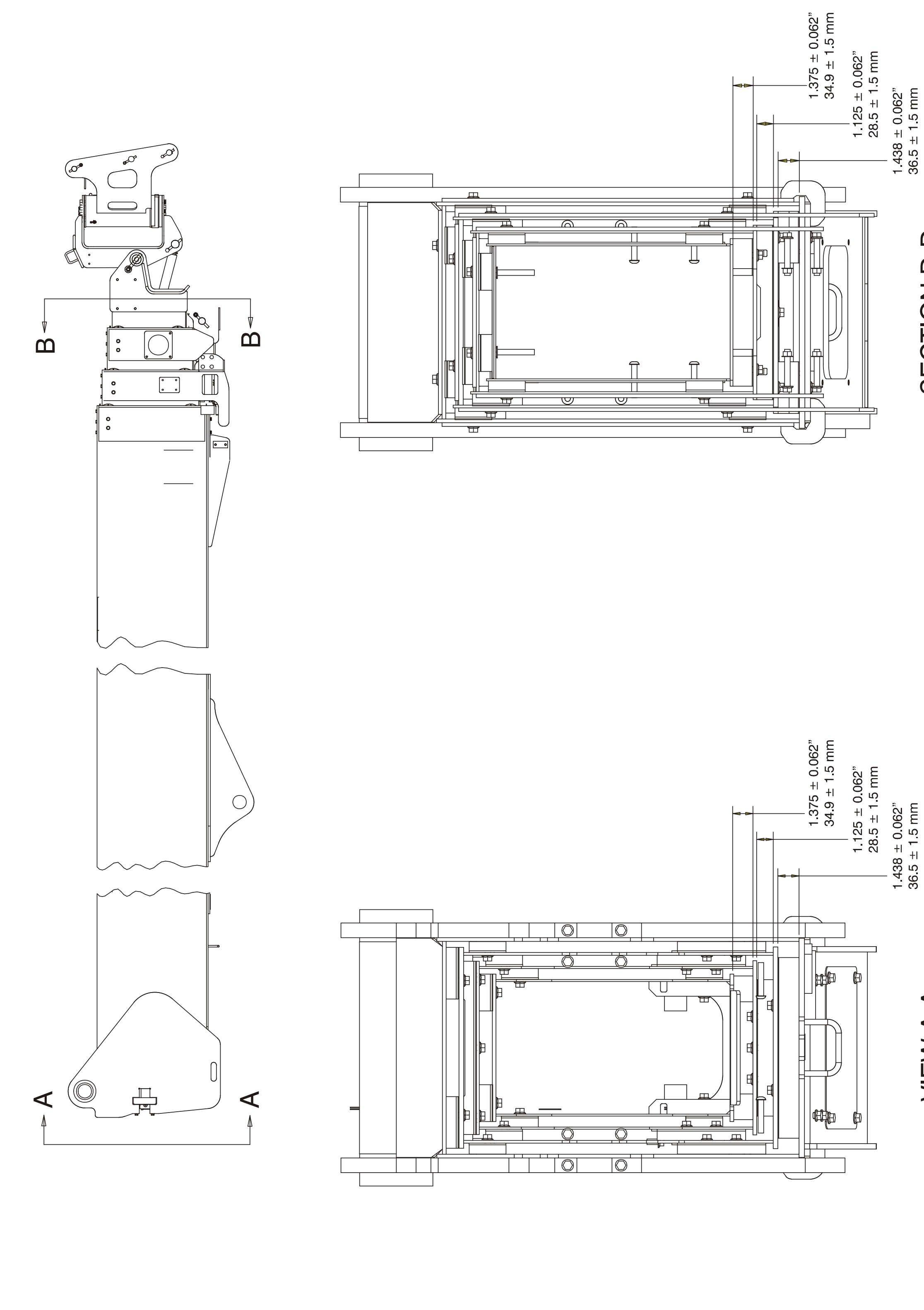


Figure 4-7. Boom Assembly - Sheet 7 of 7

7. Tag and disconnect the three electrical wires that run to the power track and the wire that goes to the proximity switch.

8. Unbolt the power track.

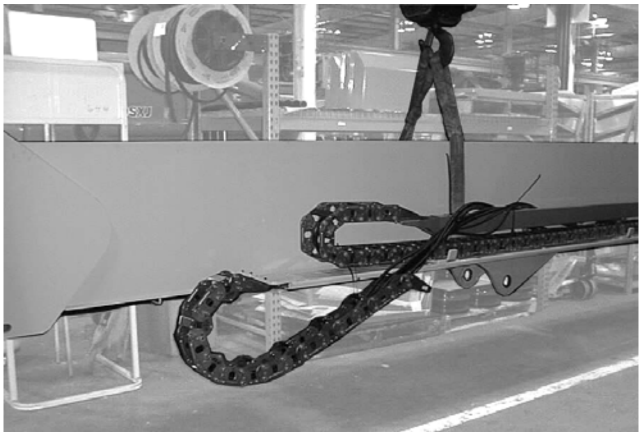
9. Remove the bolt securing the keeper pin and remove the keeper pin from boom pivot pin.

10. Using the lifting device, support the rear of the boom to remove the load from the pivot pin.

11. Remove the boom pivot pin.

12. Move all of the hydraulic hoses and electrical wires so they are free from chassis.

13. Using the lifting device, remove boom from chassis.



14. Place boom on saw horses or other adequate supports.

Disassembly

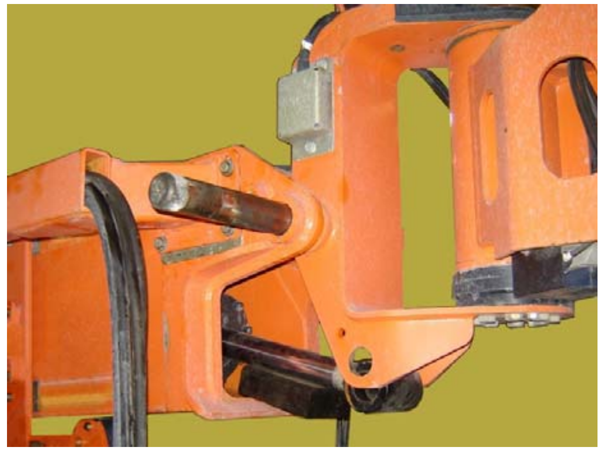
It is not necessary to completely remove the entire boom assembly from the machine to replace the cables. In the following procedure, the base boom section will remain on the machine.

WARNING

NEVER HANDLE WIRE ROPE WITH BARE HANDS.

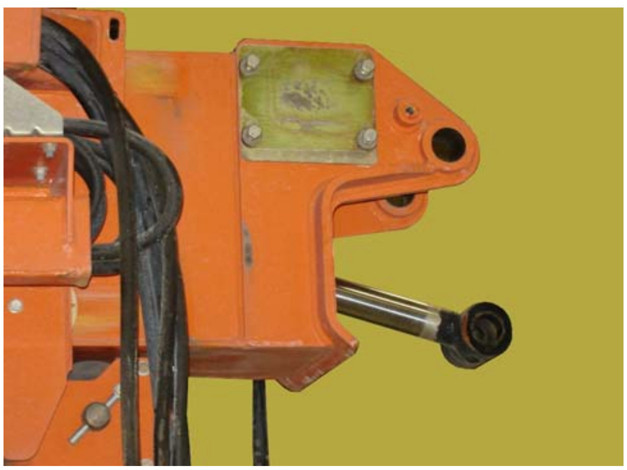
1. Position the boom so that it is horizontal. If the boom is below horizontal, ensure that the boom is not on the boom rest.
2. Use an adequate lifting device to support the weight of the jib and platform assembly.
3. Tag and disconnect the hoses and electrical harnesses that run to the platform. Cap or plug all openings.
4. Pull the hoses and harnesses through the jib and lay them off to the side of the boom.
5. Remove the bolt and keeper pin securing the platform level pivot pin and remove the pin.

6. Remove the bolt and keeper pin securing the jib pivot pin and remove the pin.

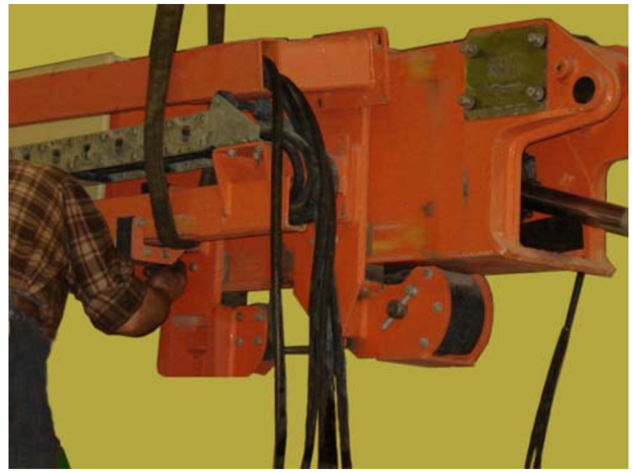


7. Remove the jib and platform assembly from the boom.

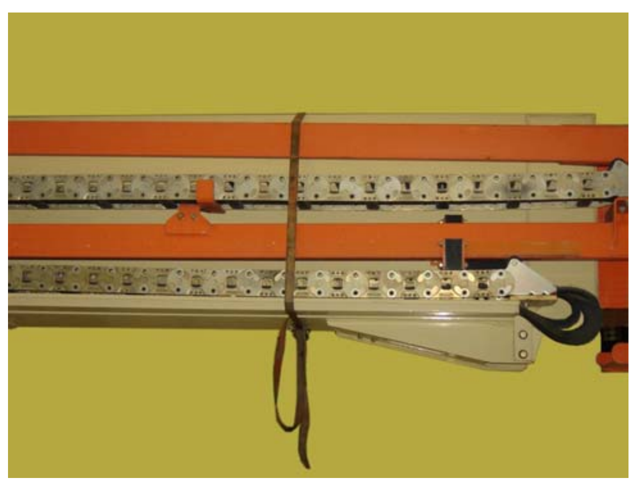
8. Attach a lifting device to the powertrack for support and unbolt the upper powertrack tube from the fly boom. Pull the disconnected tube back to allow room to disconnect the lower tube.



9. Unbolt the lower powertrack tube from the outer mid boom section and the mounting bracket from the inner mid boom section..



10. Attach a strap or other similar device around the powertrack and boom to keep the powertrack secure throughout the cable replacement procedure.



11. Remove the bolts securing the side wear pads to the front of the base boom and remove the pads and shims.

12. Remove the boom length plate.

13. Remove the cover over the boom length limit switch at the front of the boom base section. Remove the switch.

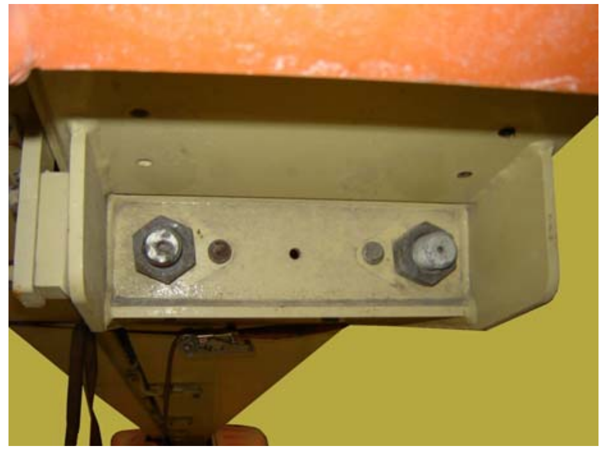
14. Remove the rear boom cover.

15. Tag and disconnect the wiring harness running to the boom length sensor. Remove all the bolts and washers securing the sensor, including those that secure the measuring cable to the telescope cylinder, and remove the length sensor.

16. Tag and disconnect the hydraulic hoses from the telescope cylinder. Cap or plug all openings.

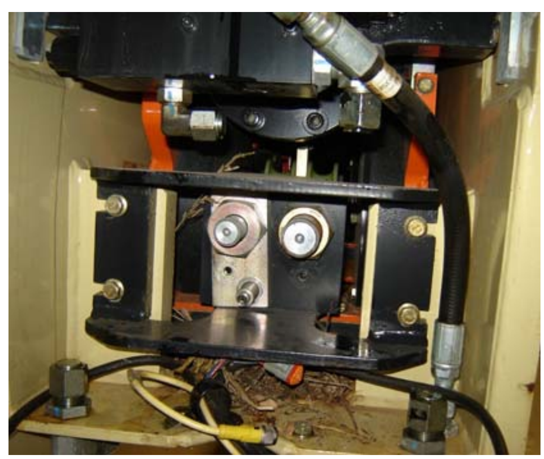
17. Remove the front side, top, and lower wear pads from the boom base section.

18. Remove the keepers for the outer mid retract cable adjustment nuts at the front of the boom base section.



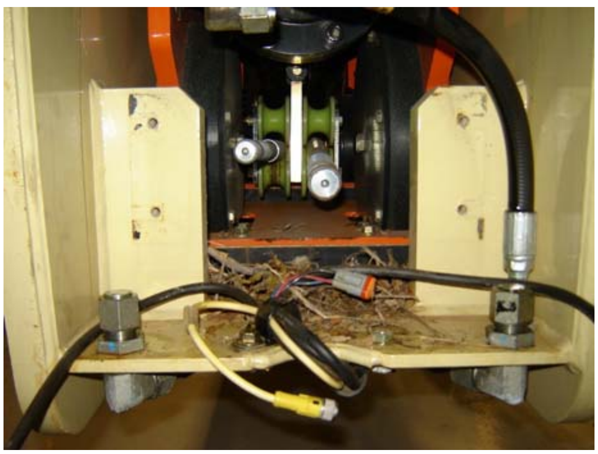
19. Loosen and remove the outer mid retract cable adjustment nuts.

20. Remove the adjustment bolt keepers for the outer mid extend cable adjustment nuts at the rear of the boom.

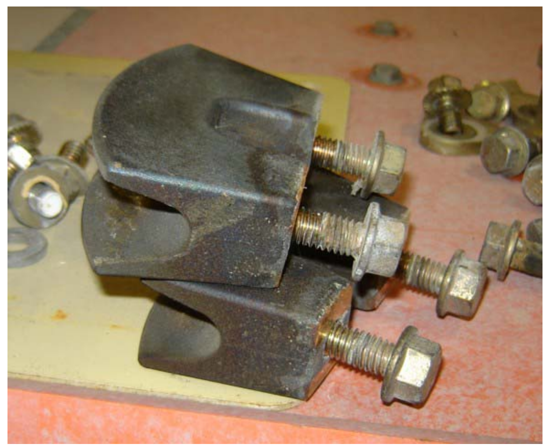


21. Remove the adjustment nuts for the for the outer mid extend cables along with the Broken Cable proximity switch, spring, and adjustment plate.

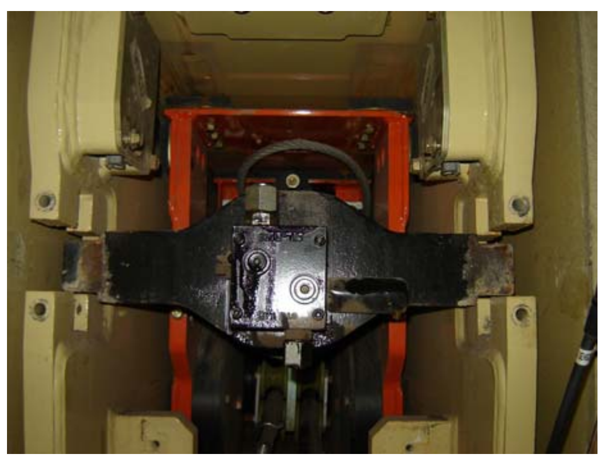
22. Remove the cable mounting plate.



23. Remove the cover plate from the bottom of the boom and remove the sheave blocks.



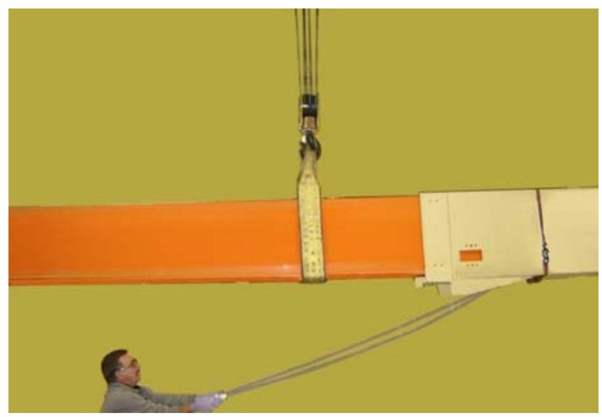
24. Remove the trunnion blocks that secure the telescope cylinder rod to the boom base section.

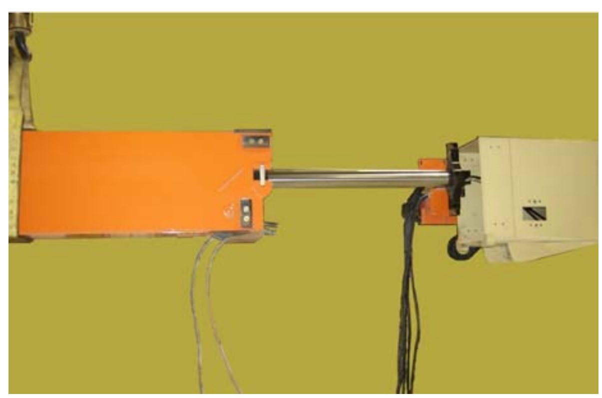


25. Remove the outer mid retract cables from the attachment fixtures at the front of the boom base section.

26. Attach an auxiliary hydraulic power source to the telescope cylinder and extend the cylinder rod enough to turn the trunnion in a vertical position.

27. Pull the inner mid, outer mid, and fly boom sections out of the base boom section. Use additional lifting devices and reposition any lifting straps as necessary as the sections are withdrawn. It will be helpful during this step to pull the outer mid retract cable out from the front of the base section as the other sections are being pulled out. This will prevent the cables from tangling as the sections are withdrawn.



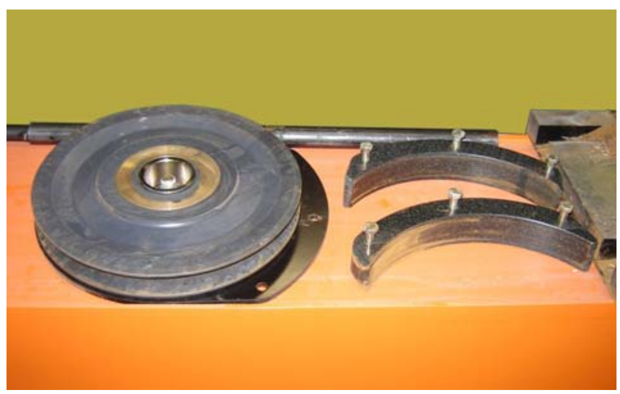


28. Remove the trunnion blocks that secure the telescope cylinder barrel to the inner mid boom section.

29. Attach a lifting device to the telescope cylinder and pull the cylinder, along with the outer mid extend cables out of the inner mid boom section. Reposition the lifting device as necessary to balance the cylinder.

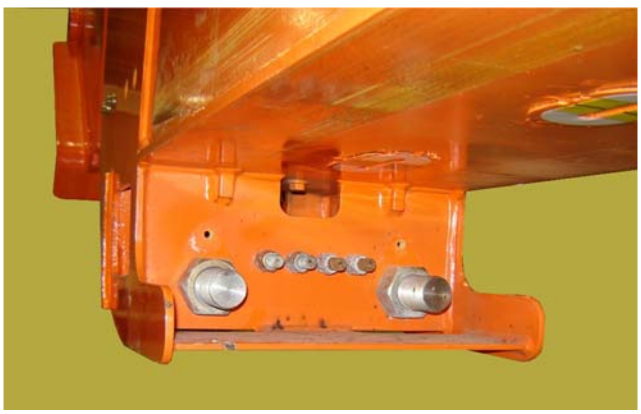
30. Remove the hardware attaching the outer mid extend block and remove the block and outer mid extend cables.

31. Remove the cable retainer plate, cable retainer block, bushing, and sheave.

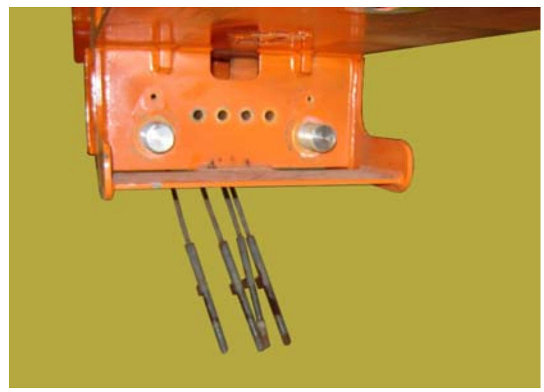


32. Remove the rear bottom wear pad.

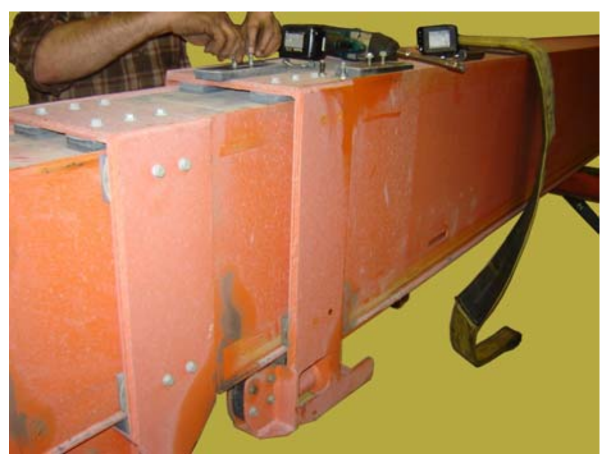
33. Remove the lock plates from the fly boom retract cable adjustment nuts and remove the adjustment nuts from the fly boom retract cables and from the fly boom extend cables at the front of the inner mid boom section.



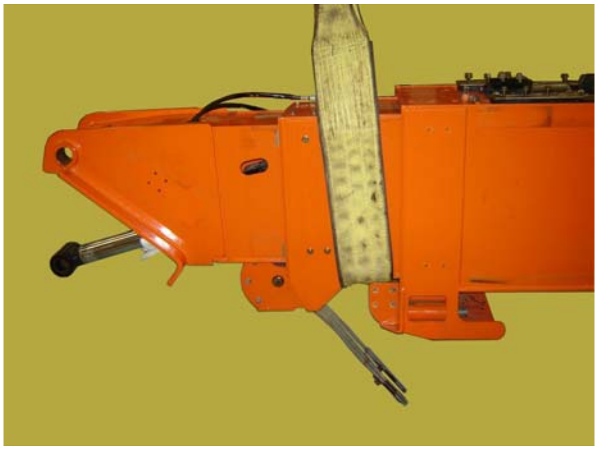
34. Pull the fly boom extend cables from their mounting receptacles.



35. Remove the top, side, and bottom wear pads from the front of the inner mid boom sections.



36. Attach a strap to pull the outer mid and fly boom sections out of the inner mid boom section. Secure the rear of the inner mid boom section so it doesn't move as the other sections are withdrawn.



37. Pull the sections out enough to allow easy removal of the cable retainer blocks and sheave blocks for the fly boom retract cables at the front of the inner mid boom section.

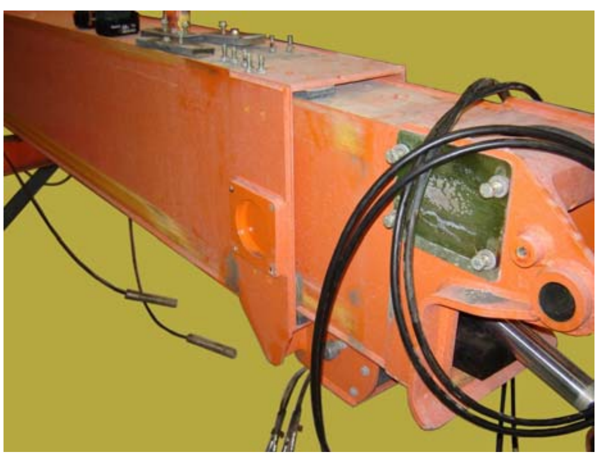
NOTE: *When pulling the outer mid and fly boom sections out of the inner mid boom section, make sure the outer mid retract cables do not catch at the rear of the boom section.*

38. Pull the sections the rest of the way out of the inner mid boom section, pulling the fly boom retract cables out at the same time.

39. Remove the outer mid retract cables from the rear of the inner mid boom section.

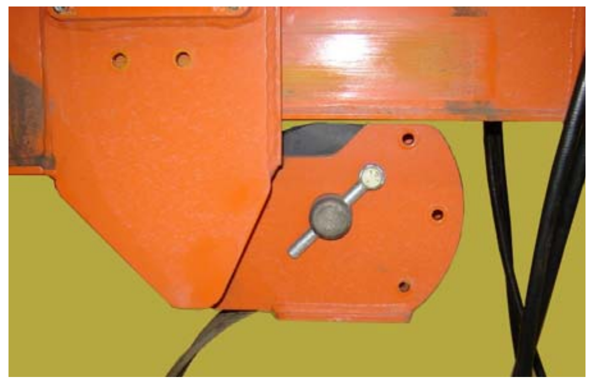
40. Remove the cable retract retainer plates, cable retainer blocks, sheaves, and bushings from the rear of the outer mid boom section.

41. Remove the front wear pads from the outer mid boom section.

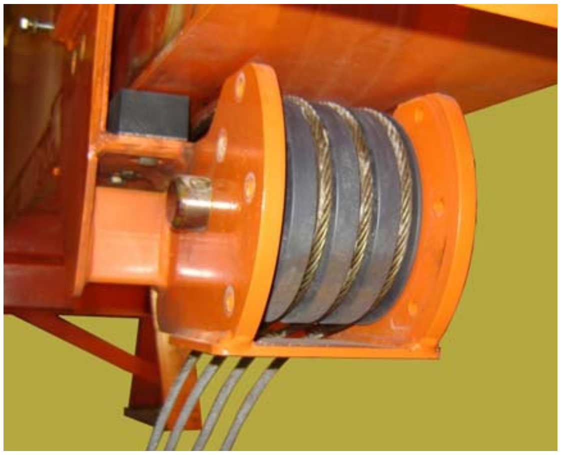


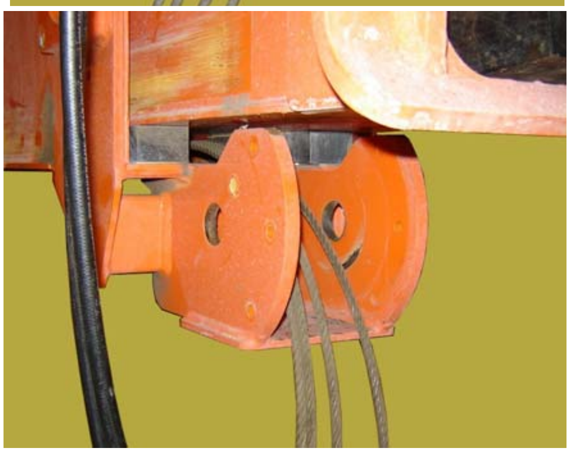
42. Remove the upper rear wear pads from the fly boom section.

43. Remove the cable retainer blocks and shims.



44. Pull the fly boom extend cables out enough to have clearance to remove the sheave, and remove the retaining bolt, keeper pin, pin, bushings, and sheave from the front of the outer mid boom section.



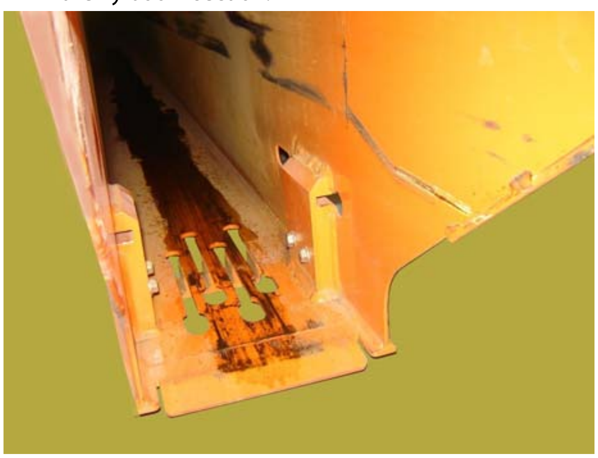


NOTE: *When pulling the fly boom section out of the outer mid boom section, make sure the fly boom retract cables do not catch at the rear of the boom section.*

45. Attach a lifting device to the fly boom section and pull the section and fly boom extend cables from the outer mid boom section. Secure the rear of the outer mid boom section so it doesn't move when the fly boom section is withdrawn.

46. Remove the tape from the fly boom section and remove the fly boom retract cables.

47. Remove the fly boom extend cables from the bottom of the fly boom section.



48. Thoroughly clean the boom sections.

Assembly

WARNING

NEVER HANDLE WIRE ROPE WITH BARE HANDS.

NOTE: *Moderately apply Super Lube JLG Part No. 3020042 to all four inner surfaces of both ends of each boom section to a minimum depth of 3 to 4 feet (1 to 1.25 m). The fly boom section only needs Super Lube applied to the insertion end.*

Super Lube is also to be moderately applied to all outer surfaces of interior wear pads after they are installed to the insertion end of boom sections. Care should be taken to avoid application on exposed painted surfaces of the fully extended boom. Refer to Section 4.3 - Boom Lubrication Application.

NOTICE

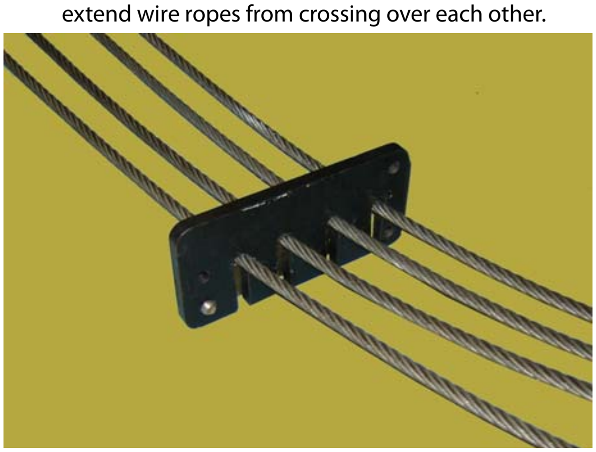
WIRE ROPE NUTS ARE CLOSE IN SIZE AND CAN BE SWITCHED. REFER TO THE JLG PARTS MANUAL. OUTER MID RETRACT NUTS, LOCATED ON BOTTOM OF BASE BOOM, WILL BE BLACK IN COLOR.

NOTICE

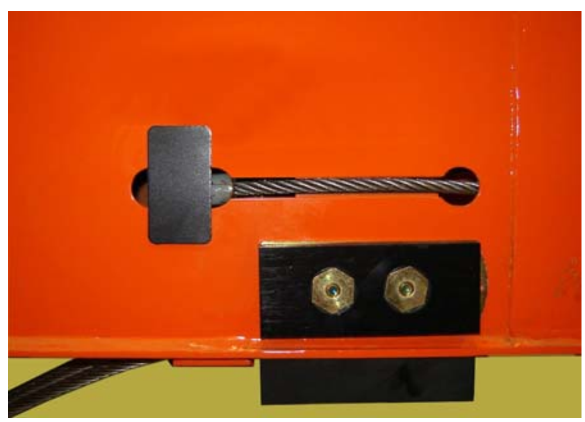
TAKE EXTRA CARE NOT TO CROSS ANY WIRE ROPES DURING THE ASSEMBLY PROCEDURE.

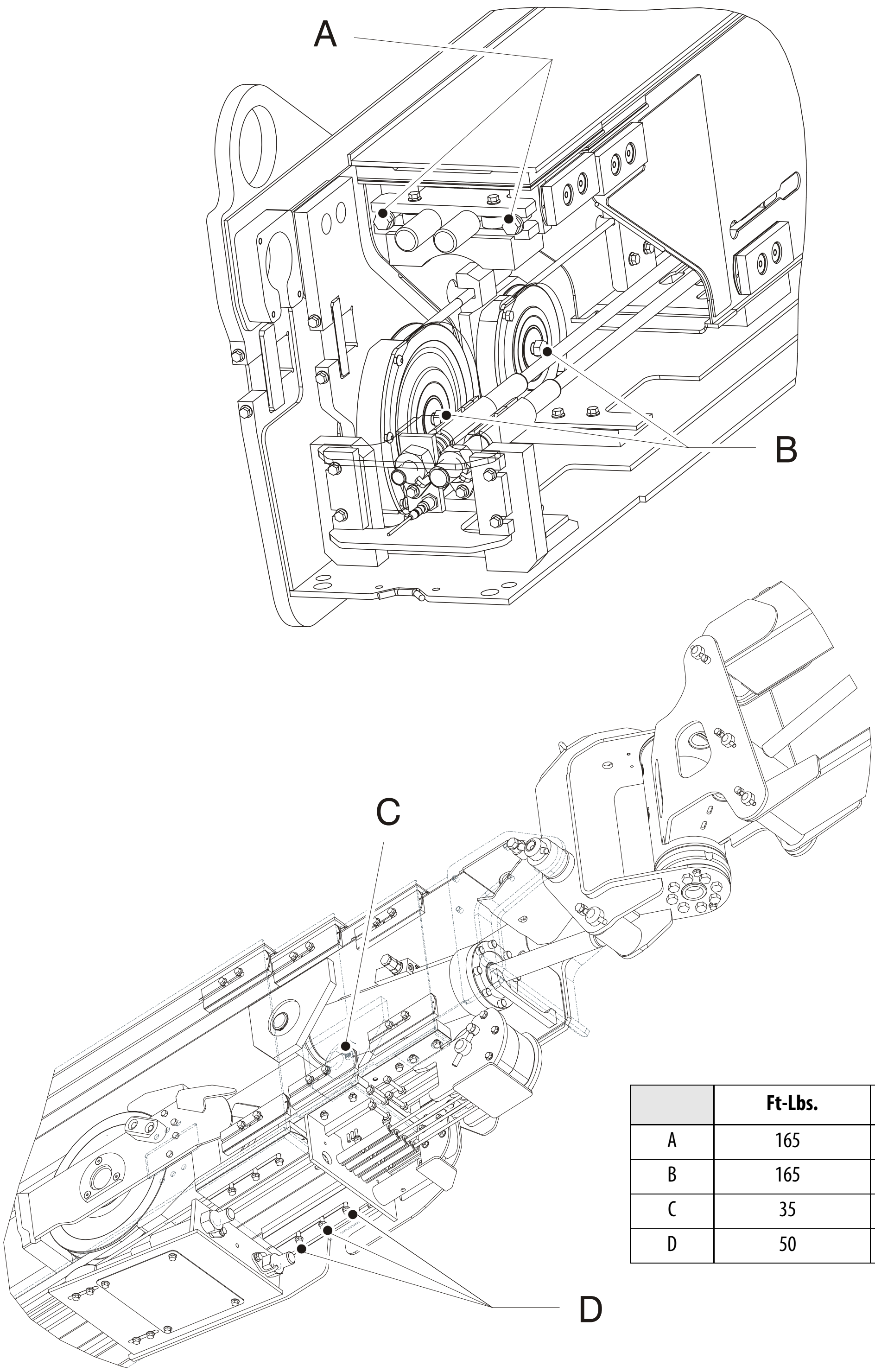
1. Install the fly extend wire rope button ends into the slots on the bottom of the fly boom section. Place tape over the wire ends to keep them in place during assembly.

2. Fabricate a special fixture as shown below to keep four extend wire ropes from crossing over each other.



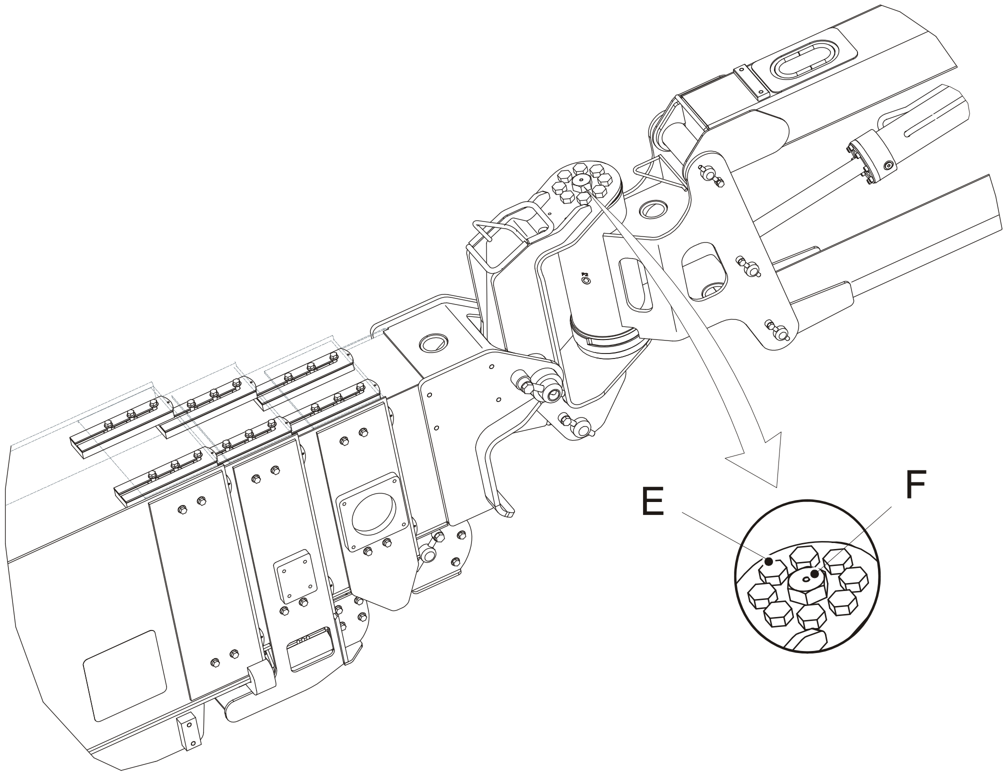
3. Install the fly retract wire rope button ends into the slots in the side of the fly boom, coil the remaining lengths of wire rope and place them into the fly boom, tape the slots to keep the rope from jumping out.



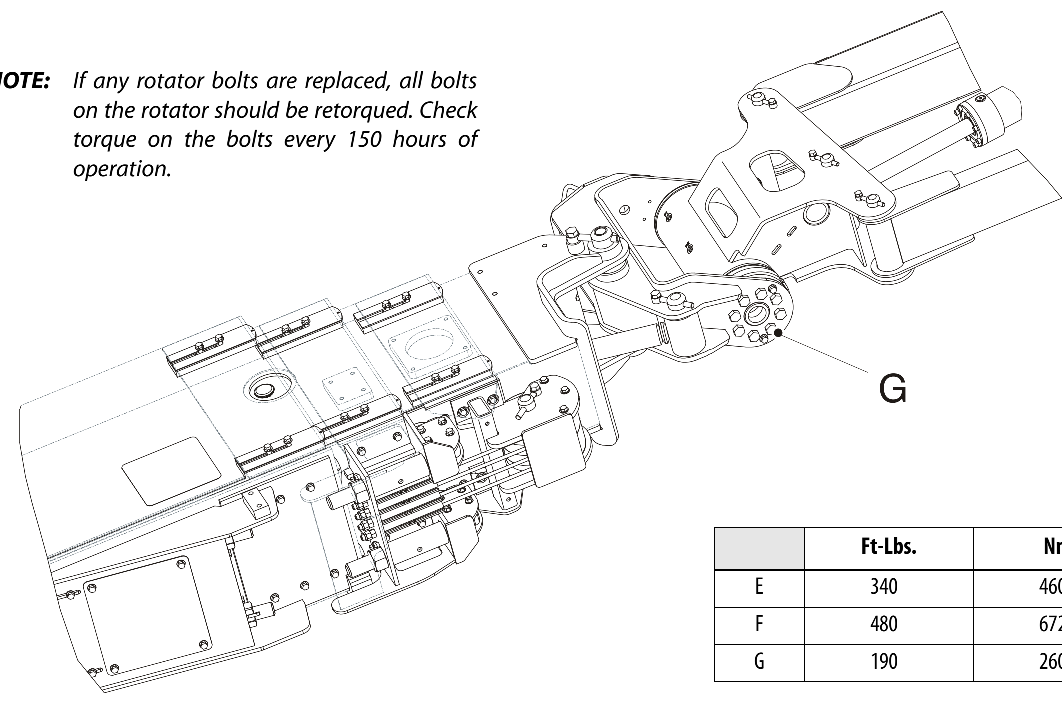


	Ft-Lbs.	Nm
A	165	224
B	165	224
C	35	49
D	50	70

Figure 4-8. Boom Assembly Torque Values - Sheet 1 of 2



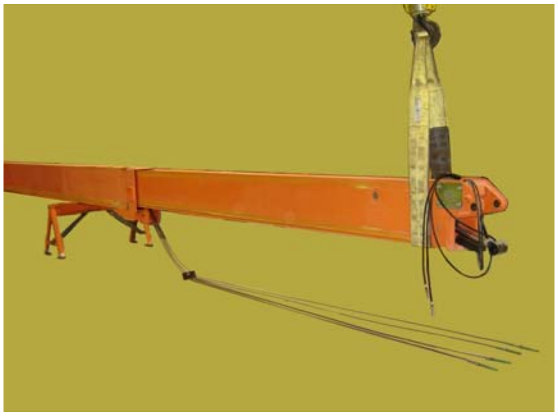
NOTE: *If any rotator bolts are replaced, all bolts on the rotator should be retorqued. Check torque on the bolts every 150 hours of operation.*



	Ft-Lbs.	Nm
E	340	460
F	480	672
G	190	260

Figure 4-9. Boom Assembly Torque Values - Sheet 2 of 2

4. Install the fly boom section partially into the outer mid boom section.



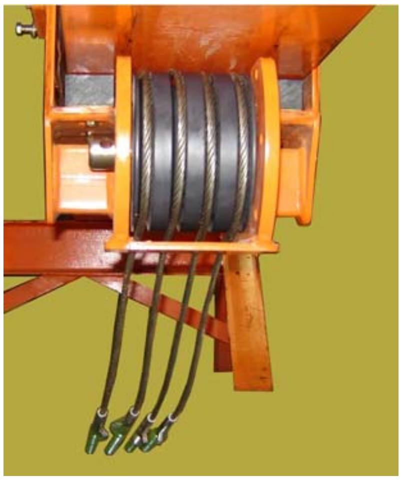
NOTICE

DO NOT ALLOW THE FLY BOOM TO REST ON THE FOUR EXTEND WIRE ROPES WHILE INSERTING IT INTO THE OUTER MID BOOM.

5. Apply JLG Threadlocker P/N 0100011 to the bolts and install the front lower wear pads and shims to the outer mid boom as marked during disassembly. Torque the bolts to 50 ft.lbs. (68 Nm).

6. Install the fly boom section most of the way into the outer mid boom section, leaving enough of the fly out so there is adequate slack in the fly boom extend cables to allow for installation of the front sheave.

7. Install the sheave, bushings, pin, keeper pin, and retaining bolt to the front of the outer mid boom section.



8. Install the cable retainer blocks and shims.

9. Apply JLG Threadlocker P/N 0100011 to the bolts and install the front upper, and side wear pads on the outer mid boom section as marked during disassembly. Torque the bolts to 50 ft.lbs. (68 Nm).

10. Apply JLG Threadlocker P/N 0100011 to the bolts and install the rear upper and side wear pads on the outer mid boom section as marked during disassembly. Torque the bolts to 50 ft.lbs. (68 Nm).

11. Uncoil the fly retract wire ropes from the fly boom. Route the threaded ends of the wire ropes through the holes in the outer mid boom plates at the retract sheave locations.

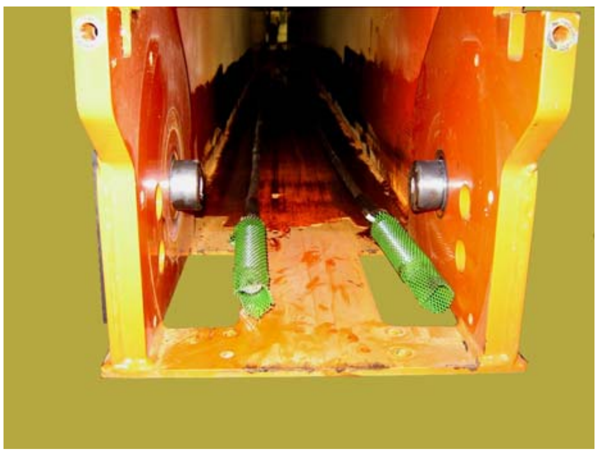
12. Apply a thin coat of moly paste lubricant to the inside diameter of the sheave composite bearings. Install the fly retract sheaves and bushings while guiding the wire ropes into the sheave grooves. Apply moly paste lubricant on the inside diameter of the sheave bushing cup. Ensure the sheaves move freely. Apply JLG Threadlocker P/N 0100019 to the sheave retaining bolts and torque to 165 ft.lbs. (224 Nm). Install the cable retract retainer plates and cable retainer blocks.

13. Apply JLG Threadlocker P/N 0100011 to the bolts and install the lower rear wear pad onto the outer mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).

14. Apply JLG Threadlocker P/N 0100011 to the bolts and install the side and upper wear pads on the rear of the inner mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).

15. Lubricate the wear surfaces on the inside of the inner mid boom section with Super Lube.

16. Feed the fly boom retract cable into the inner mid boom section from the front.

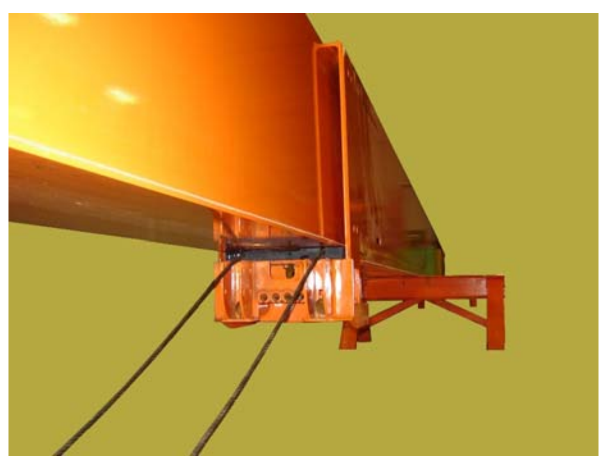


17. Using an adequate lifting device, align the outer mid boom section with the inner mid boom section.

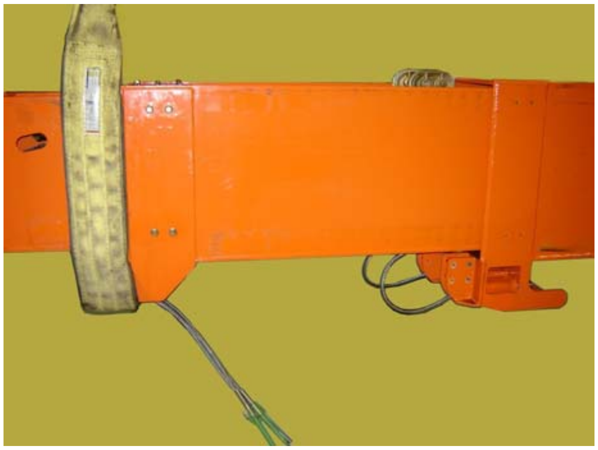
18. Attach the fly boom retract cables in the inner mid boom section to the receptacles at the rear of the outer mid boom section.

19. Put tape over the holes to keep the cable ends from jumping out.

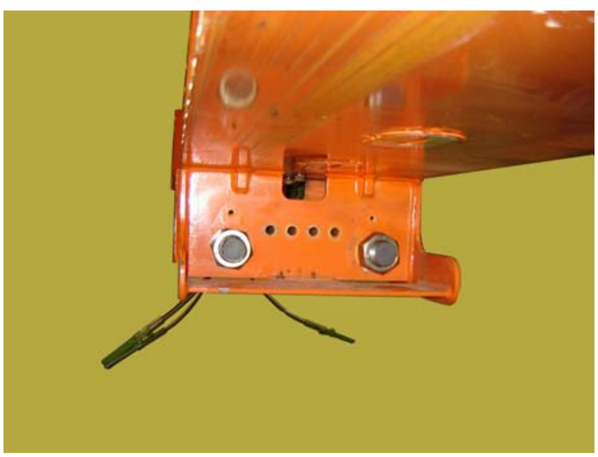
20. Push the outer mid assembly part way into the inner mid boom section. Apply JLG Threadlocker P/N 0100011 to the bolts and install the front bottom wear pad into the inner mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).



21. Push the outer mid assembly into the inner mid while pulling the boom cables out the back fo the inner mid section at the same time. Leave 3 to 4 feet of the outer mid section sticking out of the inner mid section.

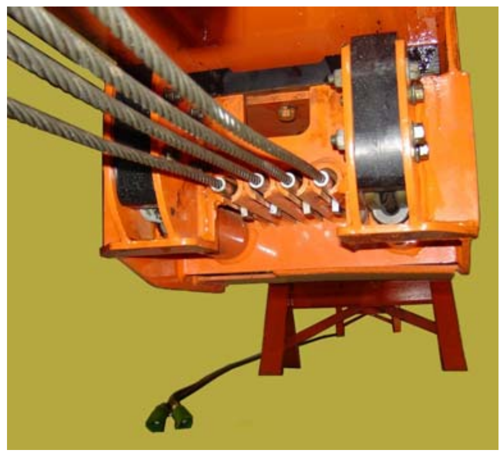


22. Push the retract cable ends into the mounting receptacles and install the cable sheaves and adjustment nuts.



23. Push the outer mid assembly almost completely into the inner mid boom section.

24. Install the cable retainer blocks over the fly boom retract cables and insert the fly boom extend cable into the mounting receptacles.

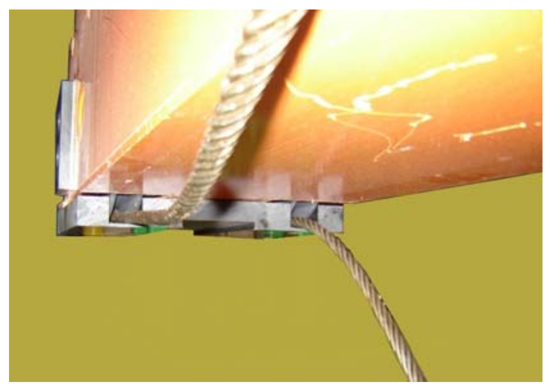


25. Apply JLG Threadlocker P/N 0100011 to the bolts and install the side and top wear pads into the inner mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).

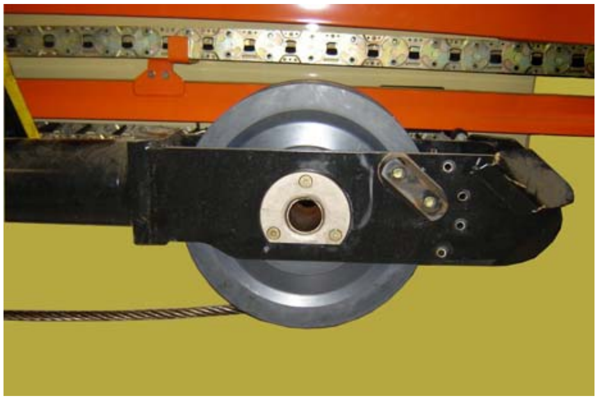
26. Put moly paste on the sheave mounts at the rear of the inner mid boom section and install the sheaves.

27. Apply a thin coat of moly paste lubricant to the inside diameter of the sheave composite bearings. Install the retract sheaves and bushings while guiding the wire ropes into the sheave grooves. Apply moly paste lubricant on the inside diameter of the sheave bushing cup. Ensure the sheaves move freely. Apply JLG Threadlocker P/N 0100019 to the sheave retaining bolts and torque to 165 ft.lbs. (224 Nm). Install the cable retainer blocks and cable retainer plates.

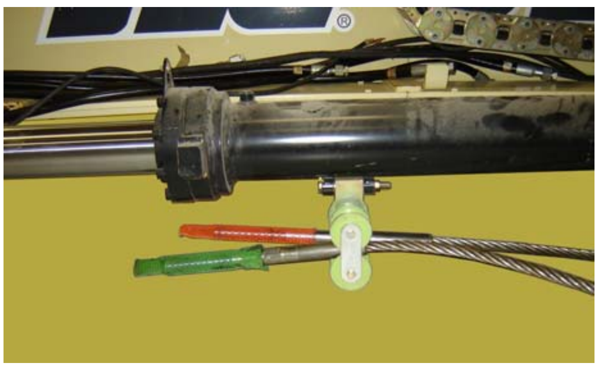
28. Apply JLG Threadlocker P/N 0100011 to the bolts and install the rear bottom wear pad on the rear of the inner mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).



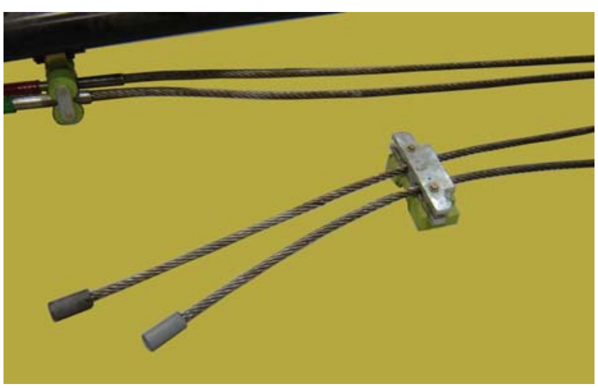
29. Install a new sheave on the telescope cylinder.



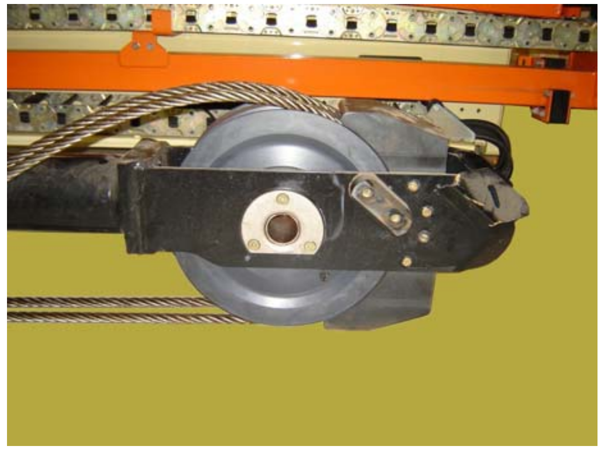
30. Install the outer mid extend cables into the cable pulley at the rod end of the telescope cylinder.



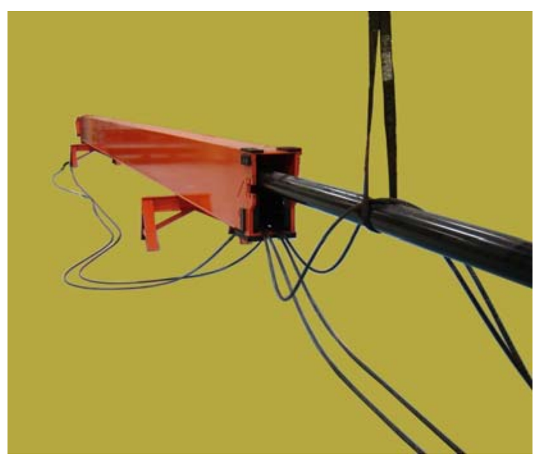
31. Install the other end of the outer mid extend cables into the cable guide block.



32. Route the cables around the sheave on the cylinder and install the cable retainer block.

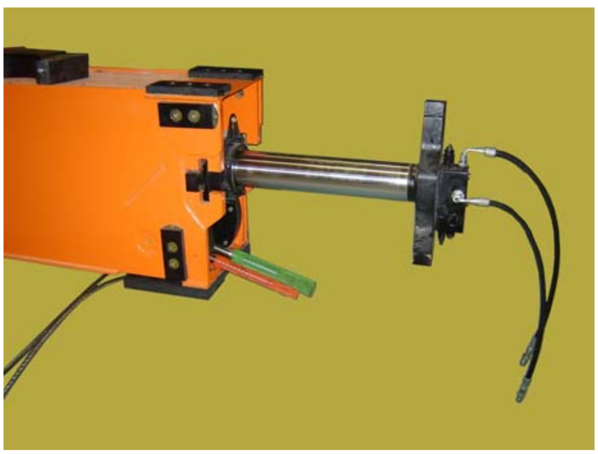


33. Using an adequate lifting device, insert the cylinder and cables part way into the inner mid boom.



34. Apply JLG Threadlocker P/N 0100019 to the bolts and attach the cable guide to the inner mid boom section with the mounting hardware. Torque the bolts to 165 ft.lbs. (224 Nm).

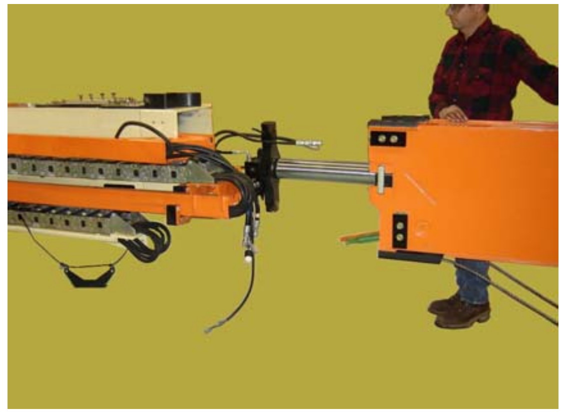
35. Push the cylinder the rest of the way into the inner mid boom assembly.

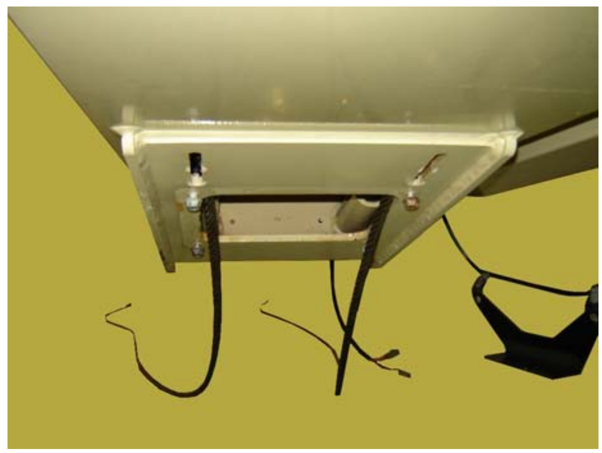


36. Install the cylinder trunnion blocks and shims.

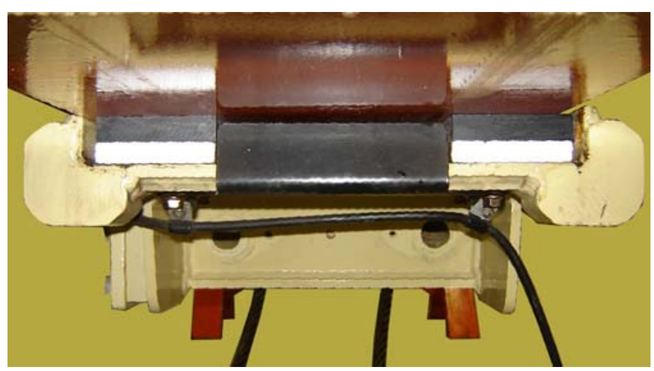
37. Using Super Lube®, lubricate all wear surfaces on the inside of the boom base section and the outside of the inner mid boom section.

38. Insert the inner mid boom section part way into the boom base section enough to be able to pull the outer mid retract cables out through the hole at the bottom front of the boom base section.





39. Apply JLG Threadlocker P/N 0100011 to the bolts and install the front lower wear pads into the boom base section. Torque the bolts to 50 ft.lbs. (68 Nm).



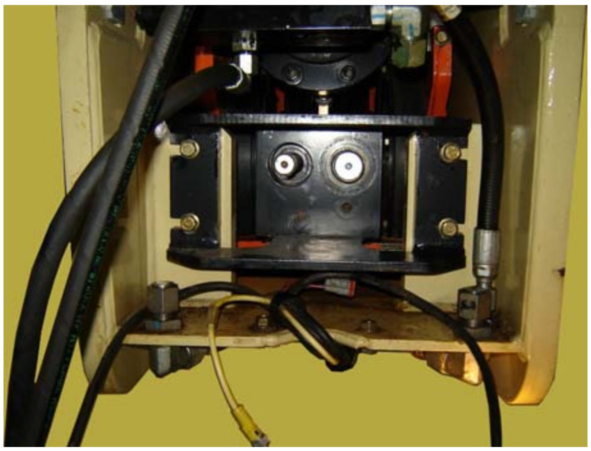
40. Push the inner mid boom assembly the rest of the way into the boom base section, adjusting the lifting device as necessary to keep the weight balanced.

41. Apply JLG Threadlocker P/N 0100011 to the bolts and install the side and upper wear pads into the boom base section. Torque the bolts to 50 ft.lbs. (68 Nm).

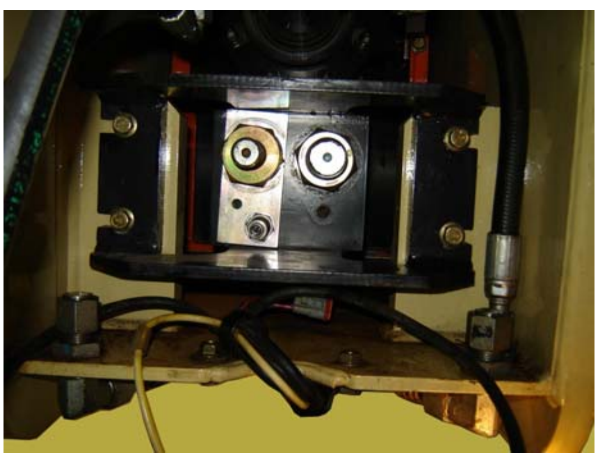
42. Install the boom transport length sensor on the side of the boom base section.

43. Attach the powertrack tubes.

44. If necessary, attach a source of auxiliary hydraulic power and retract the boom enough to allow installation of the cable adjustment plate at the rear of the base boom section and install the plate.

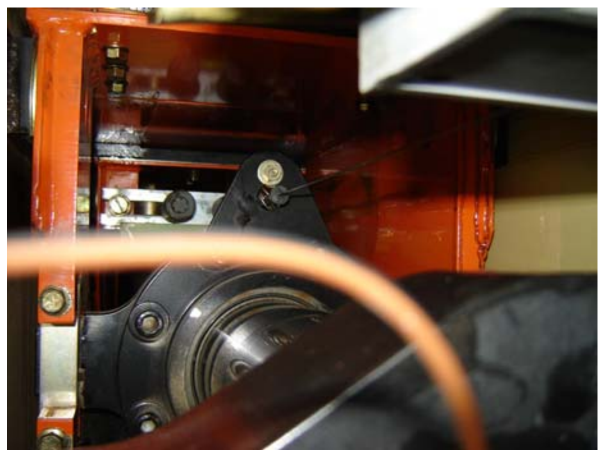


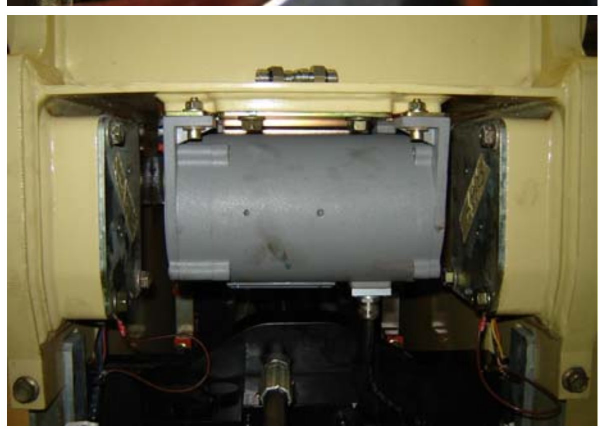
45. Install the broken cable sensor and the outer mid extend cable adjustment nuts.



46. Install the outer mid retract cable adjustment nuts at the front of the boom base section.

47. Install the boom length sensors and angle sensors as tagged during removal.





48. Connect the hydraulic hoses to the telescope cylinder as tagged during removal.

49. Adjust the boom cables. Refer to Section 4.11 - Wire Rope Tensioning Adjustment.

50. Perform a boom calibration as described in Section 6 under Calibrating the Boom Sensors.

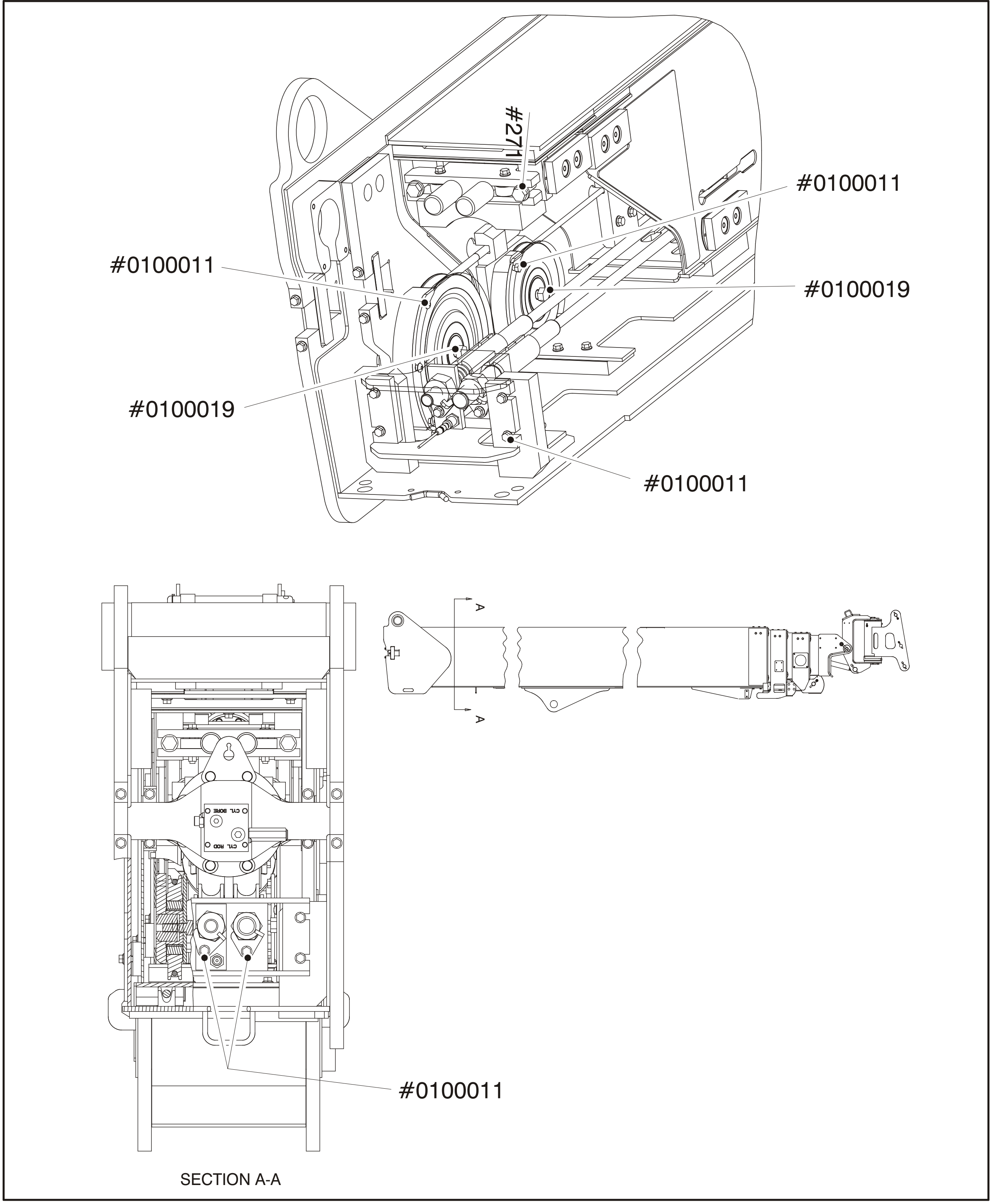


Figure 4-10. Locations for Threadlocker Application - Sheet 1 of 4

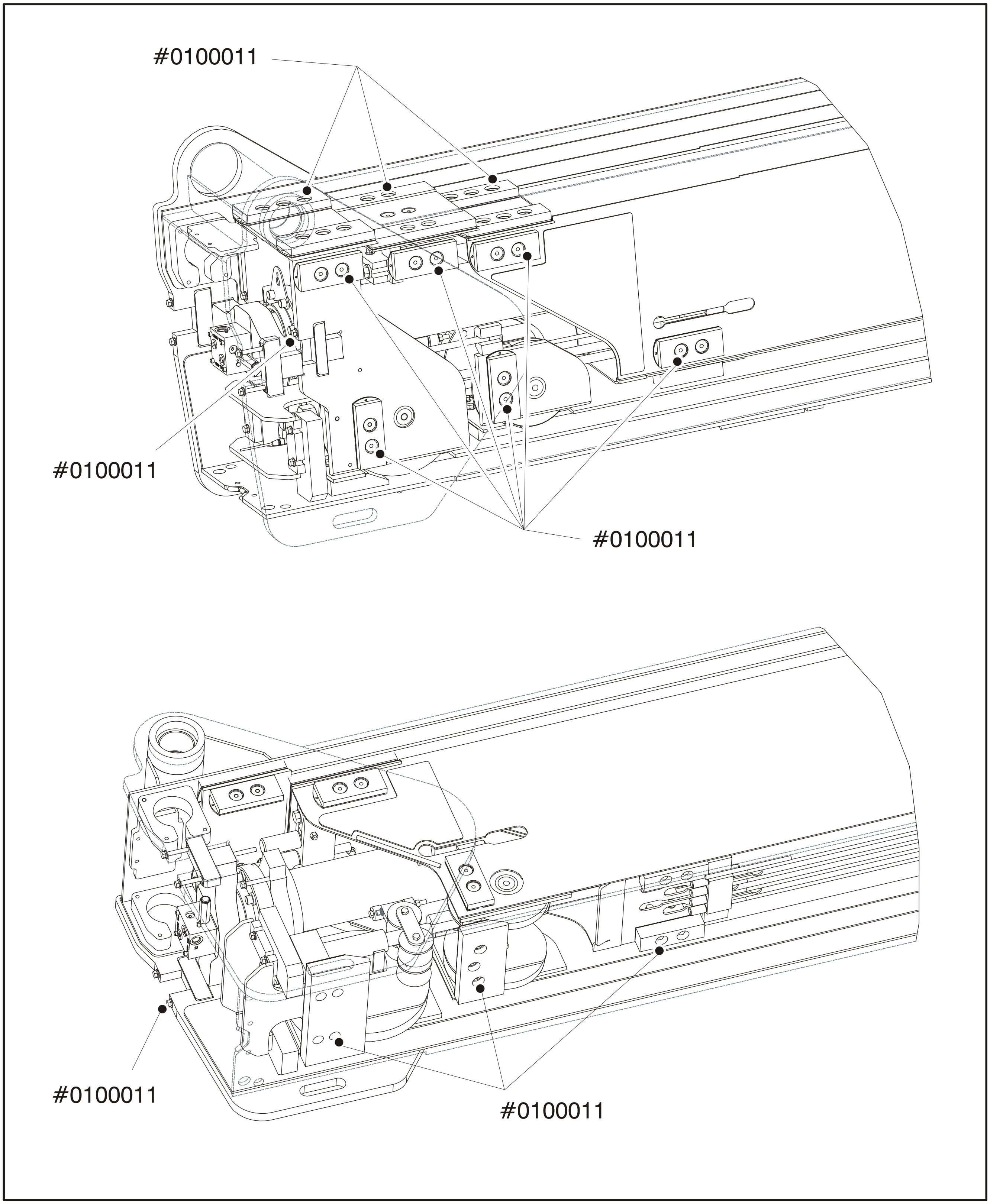


Figure 4-11. Locations for Threadlocker Application - Sheet 2 of 4

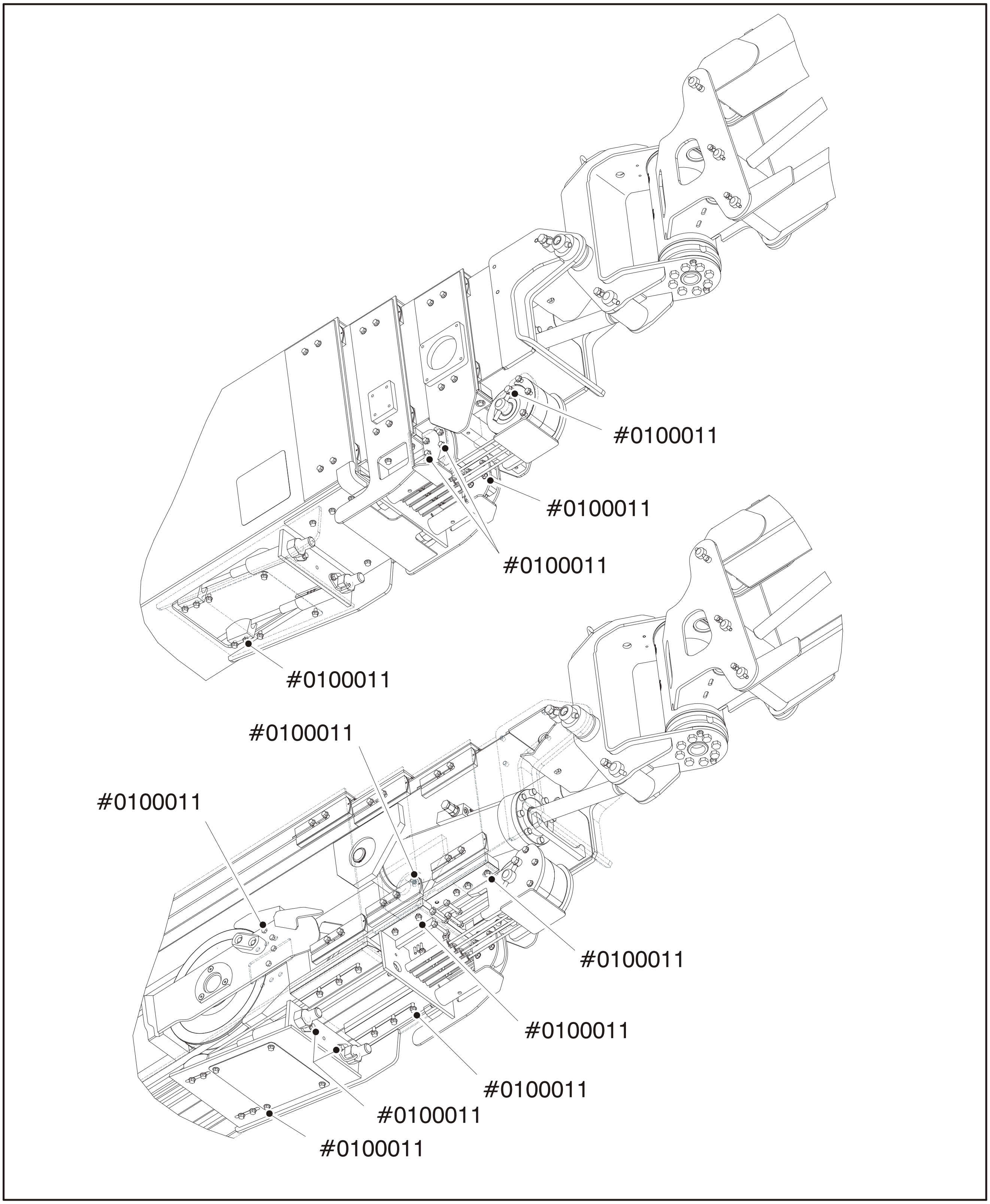


Figure 4-12. Locations for Threadlocker Application - Sheet 3 of 4

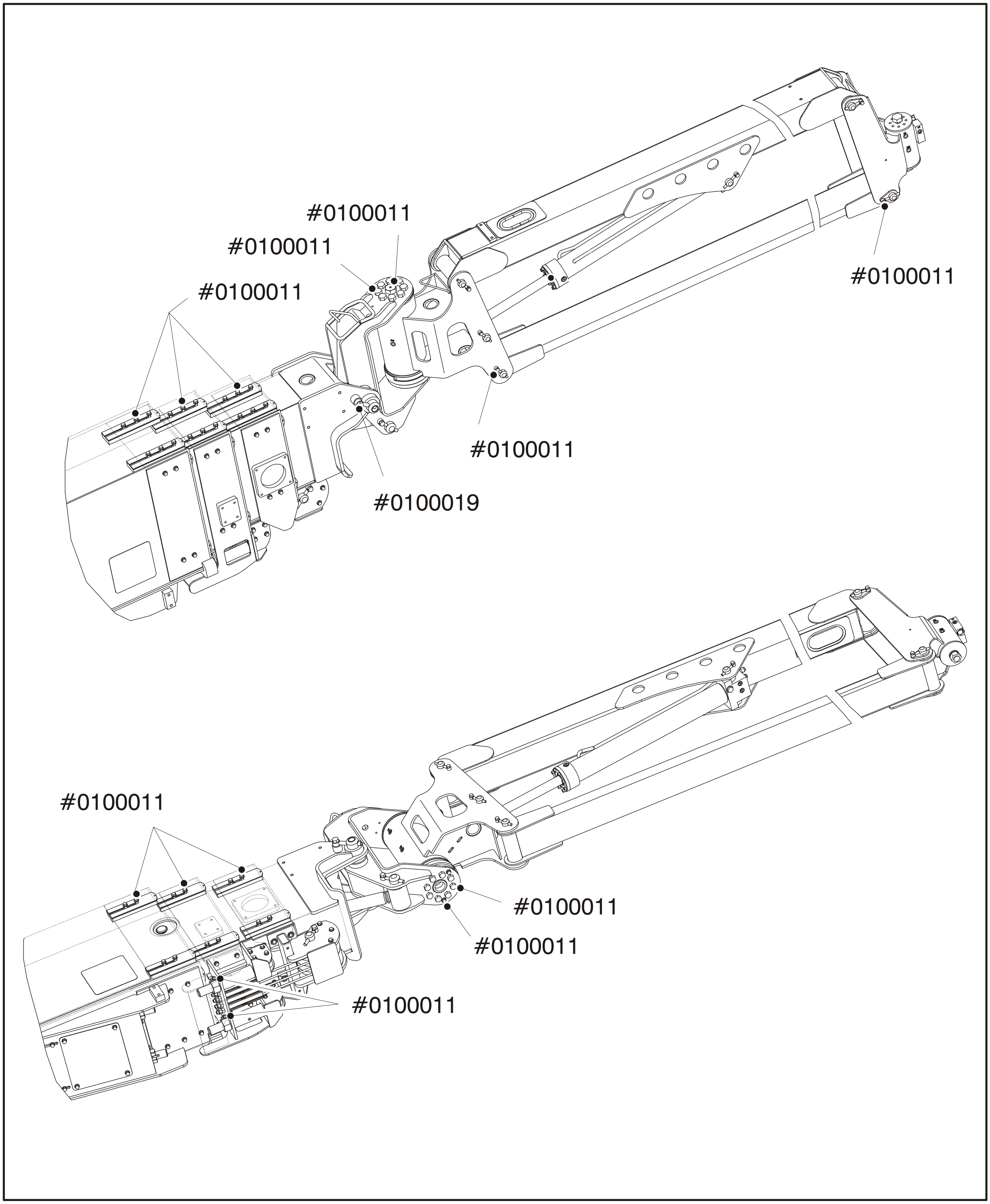


Figure 4-13. Locations for Threadlocker Application - Sheet 4 of 4

4.3 BOOM LUBRICATION APPLICATION

This procedure applies to booms after assembly or during annual application using Super Lube® lubricant (JLG p/n 3020042).

1. Position the boom on the boom rest using the 500lb capacity setting.
2. Telescope main boom section as far as it will extend at this position, approximately 3 ft. (0.9 m).
3. From the front of the machine (boom pivot end), moderately apply lubricant to the interior surfaces of the base boom, inner mid boom, and outer mid boom. To prevent misdiagnosis of hydraulic leaks, take care to prevent excessive application of lubrication.
4. At the rear of the machine, apply lubricant to the side, top and bottom surfaces of the fly boom, outer mid, and inner mid specifically to wear pad contact paths. To prevent misdiagnosis of hydraulic leaks, take care to prevent excessive application of lubrication.
5. After application of the lubricant is complete, cycle the boom through its full range of travel 2 times.

4.4 BOOM SHIMMING PROCEDURE

1. Measure and record the dimension and direction of any sweep found in the fly boom section. Measure and record the inside width and inside height of the outer mid boom opening.

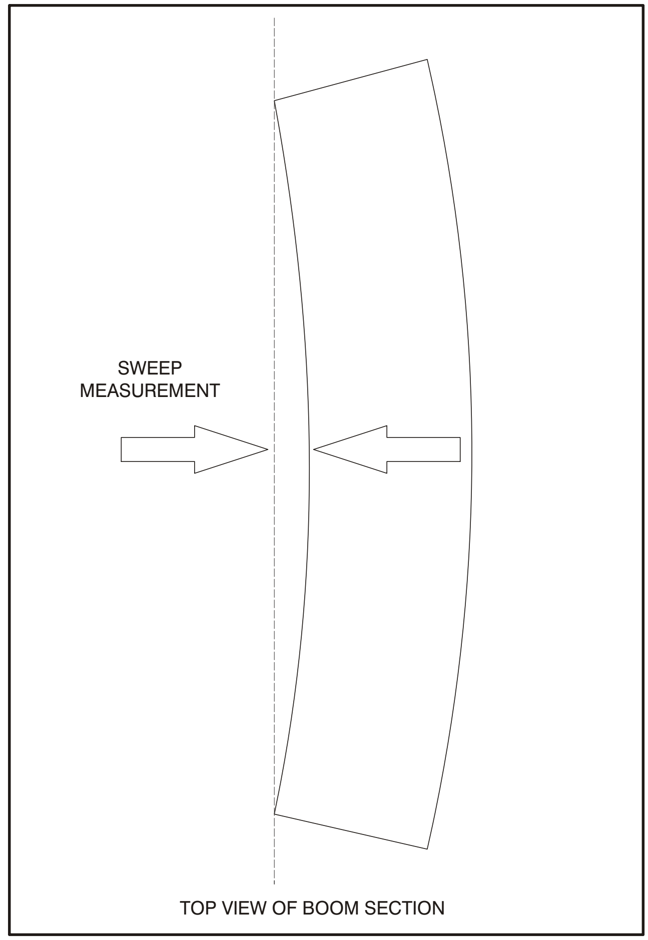


Figure 4-14. Measuring Boom Section Sweep

NOTE: *Wear Pad bolt lengths should be flush to one thread below the surface of the insert. When installing wear pads in the following steps, the wear pad bolt lengths may need to be adjusted as shim thicknesses are adjusted.*

2. Install the side wear pads on the fly boom sides. Shim as necessary to match the outer mid boom dimension recorded in step 1 ± 1/32" (± 0.8 mm). Shims should be divided as evenly as possible between the side pads unless corrections are needed to compensate for sweep recorded in step 1. If the sweep is to the left the internal side pads on the left should have more shims than the right side pads and vise versa.
3. Install the bottom wear pad(s) and shims if applicable on the fly boom.

4. Install the top wear pad(s) on the fly boom and shim as necessary to obtain 0 - 1/16" (0 - 1.6 mm) less than the corresponding dimension recorded in step 2.
5. Slide the fly into the outer mid boom leaving 2 - 6 feet (0.6-1.8 m) exposed.
6. Install the bottom wear pad(s) and shims if necessary into the end of the outer mid boom.
7. Temporarily insert the side pads on one side and slide the fly boom to that side. Insert the other side pads and using shims, measure how many will be required to fill the remaining space. Install the total amount of shims as evenly as possible between the two sides unless corrections are needed to compensate for out-of-square booms or for corrections due to sweep recorded in step 1. Care should be taken to keep the bottom pads evenly loaded while shimming the side pads.

NOTE: *Do not install more shims than will fit because this may result in a boom being shimmed too tight. The use of pry bars or wedges should only be used to finish installing a shim that can be installed by hand more than ½ of its length.*

8. Install the top wear pads and shims into the end of the outer mid boom leaving a gap of 0" to 1/16" between the top of the fly boom and inside of the outer mid boom.
9. Repeat steps 1-7 to install the fly/outer mid assembly into the inner mid boom.
10. Repeat steps 1-7 to assemble the fly/out mid/inner mid assembly into the base boom.
11. Complete the boom assembly. The boom should be functionally tested and evaluated for boom sweep. Boom sweep should be limited to no more than 5/16" (8 mm). If necessary, the boom may be re-shimmed by moving shims from one side to the other to further correct any remaining boom sweep. There may be some instances where no shims are used under a given side pad to pass the criteria for boom sweep at final inspection of machine.

4.5 JIB ROTATOR ORIENTATION

In order for the Jib Rotator to rotate properly, it must be installed with the timing marks running parallel to the flat rotator mounting plate as shown below.

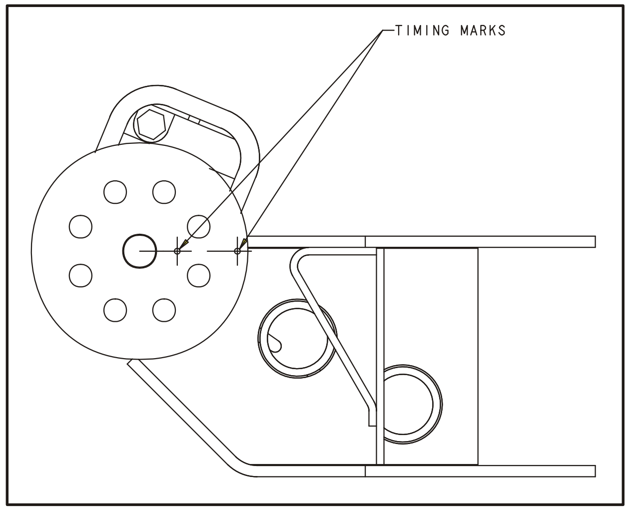


Figure 4-15. Jib Rotator Orientation

4.6 JIB LIFT END OF STROKE DAMPENING

The jib lift cylinder is constructed in a way that causes the jib lift cylinder oil flow to be restricted by an orifice while raising the jib within 5 degrees of maximum elevation. This restriction slows the jib lift speed while raising the jib. The oil flow is not restricted while lowering the jib and therefore the speed is not altered.

4.7 LOAD SENSING PIN REMOVAL AND INSTALLATION

1. Place the machine on a firm, level surface.

NOTE: *Replacing the load sensing pin requires the boom sensors be re-calibrated. Make sure the machine is in an area where this can be accomplished after installation of the new pin.*

2. Swing the engine tray out to gain access to the sensing pin and retaining pin.

NOTE: *The lift cylinder weighs 787 lbs. (357 kg.)*

3. Run a nylon strap capable of supporting the weight of the lift cylinder around the bottom of the cylinder. Lift up on the strap to relieve the weight of the lift cylinder on the load sensing pin.

4. Loosen and remove the bolt that secures the retaining pin and remove the retaining pin.

5. Disconnect the wiring harness from the strain relief connector at the opposite side of the load sensing pin.

6. Use the Load Pin Removal Tool (JLG P/N 4846765) to prevent the pin from being damaged, and use a hammer to remove the pin. To make the tool refer to Figure 4-16., Load Pin Removal Tool, JLG P/N 4846765. If the Load Pin Removal Tool is not available, use an arbor of the proper size (as shown below). If excessive force is necessary to move the pin, it may be necessary to carefully activate lift using the auxiliary power switch to relieve lift cylinder weight from the load sensing pin.

7. When installing a new pin, make sure all of the holes in the turntable and lift cylinder are aligned. If the new load sensing pin does not push 1/2 to 3/4 of the way in by hand, remove the pin and align the holes better. Also make sure the pin is installed with the strain relief connector opposing the pin orientation bar as shown. Refer to Figure 4-22., Pivot Pin Installation.

8. Using an oak block, carefully tap the pin until it is fully installed. Secure the pin in place with the retaining pin and retaining pin bolt.

NOTICE

DO NOT TAP ON THE CENTER OF THE PIVOT PIN.

9. Connect the wiring harness to the strain relief connector and re-calibrate the boom sensors.

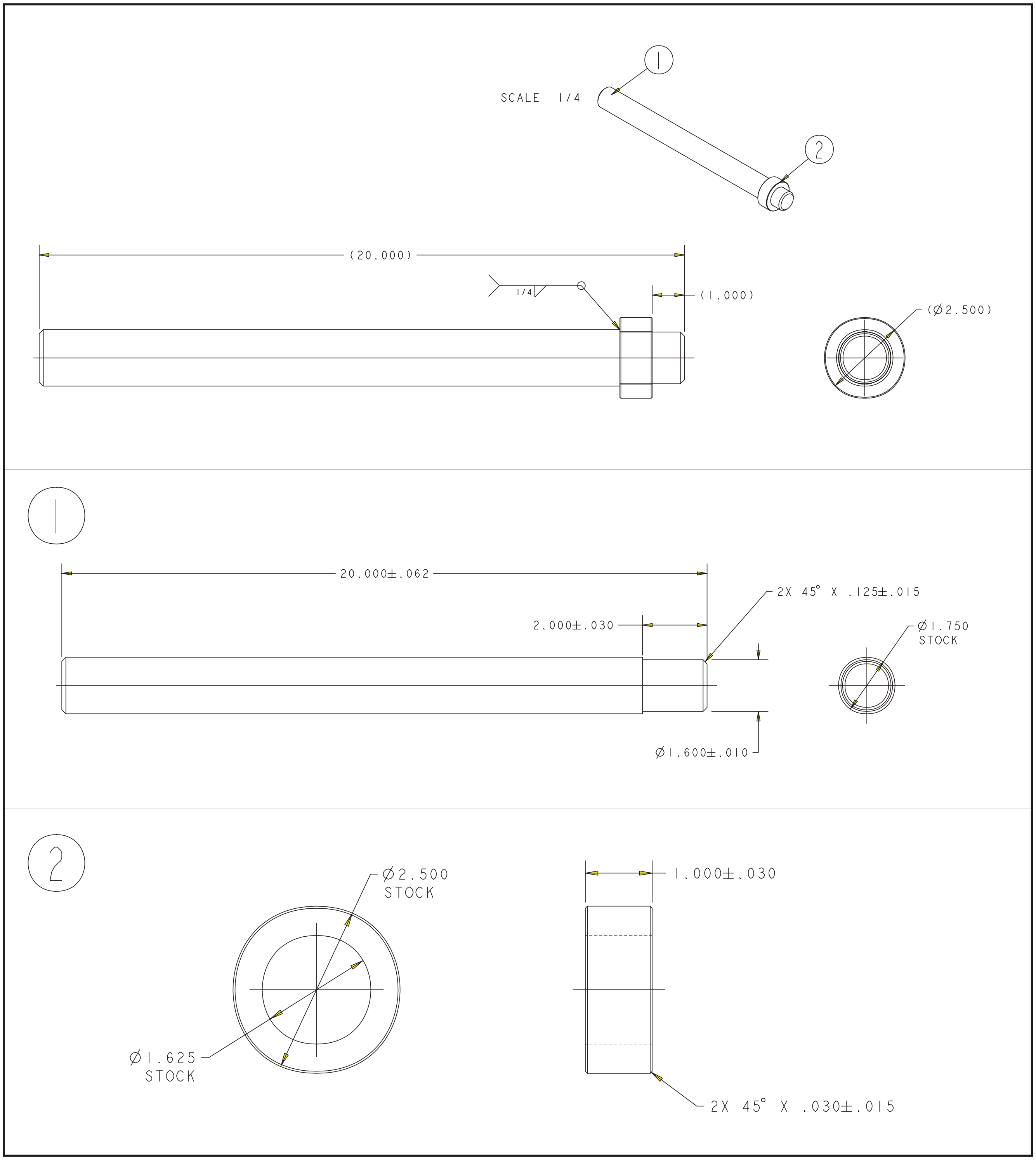


Figure 4-16. Load Pin Removal Tool, JLG P/N 4846765

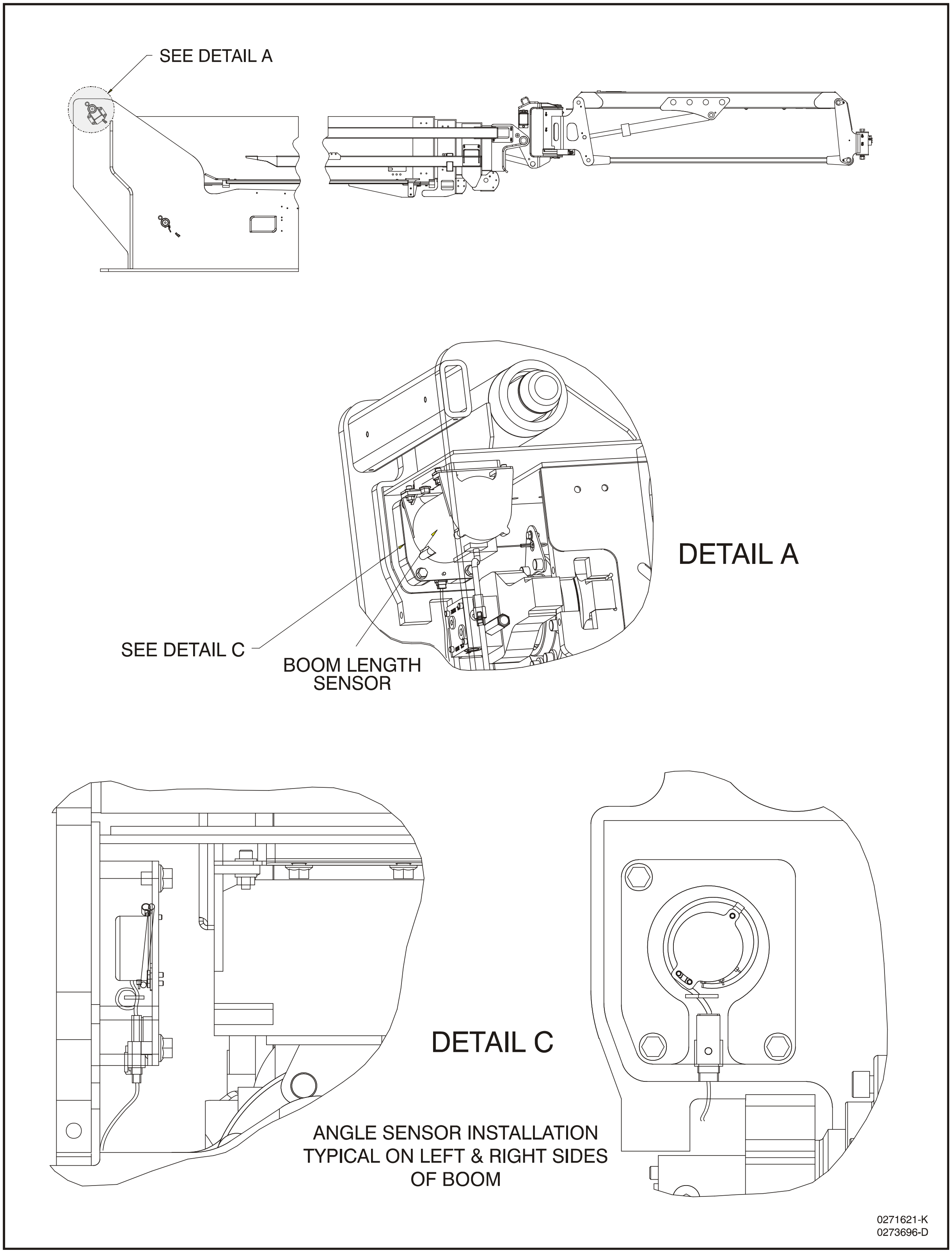
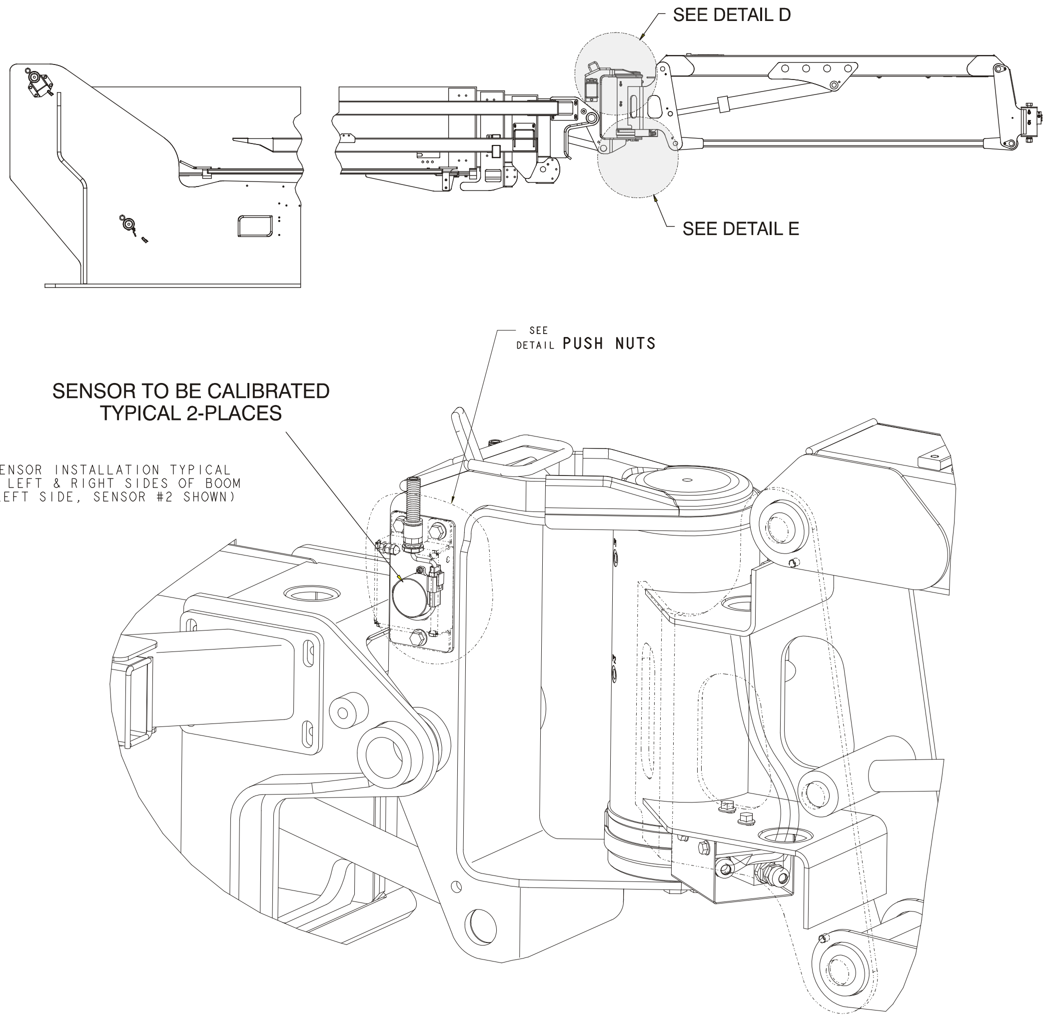


Figure 4-17. Boom/Jib Sensors and Switches Installation - Sheet 1 of 4



SENSOR #1			
PIN #	DESC	SENSOR	HARNESS
PIN #1	POWER	RED	RED
PIN #2	PWM OUT	YELLOW	BLUE
PIN #3	GROUND	BLACK	BLACK

SENSOR #2			
PIN #	DESC	SENSOR	HARNESS
PIN #1	POWER	RED	ORANGE
PIN #2	PWM OUT	YELLOW	YELLOW
PIN #3	GROUND	BLACK	BLACK

PRIOR TO S/N 77470

SENSOR #1			
PIN #	DESC	SENSOR	HARNESS
PIN #1	POWER	RED	RED
PIN #2	PWM OUT	WHITE	BLUE
PIN #3	GROUND	BLACK	BLACK

SENSOR #2			
PIN #	DESC	SENSOR	HARNESS
PIN #1	POWER	RED	ORANGE
PIN #2	PWM OUT	WHITE	YELLOW
PIN #3	GROUND	BLACK	BLACK

S/N 77470 TO PRESENT

DETAIL D

0271621-K
0273696-D

Figure 4-18. Boom/Jib Sensors and Switches Installation - Sheet 2 of 4

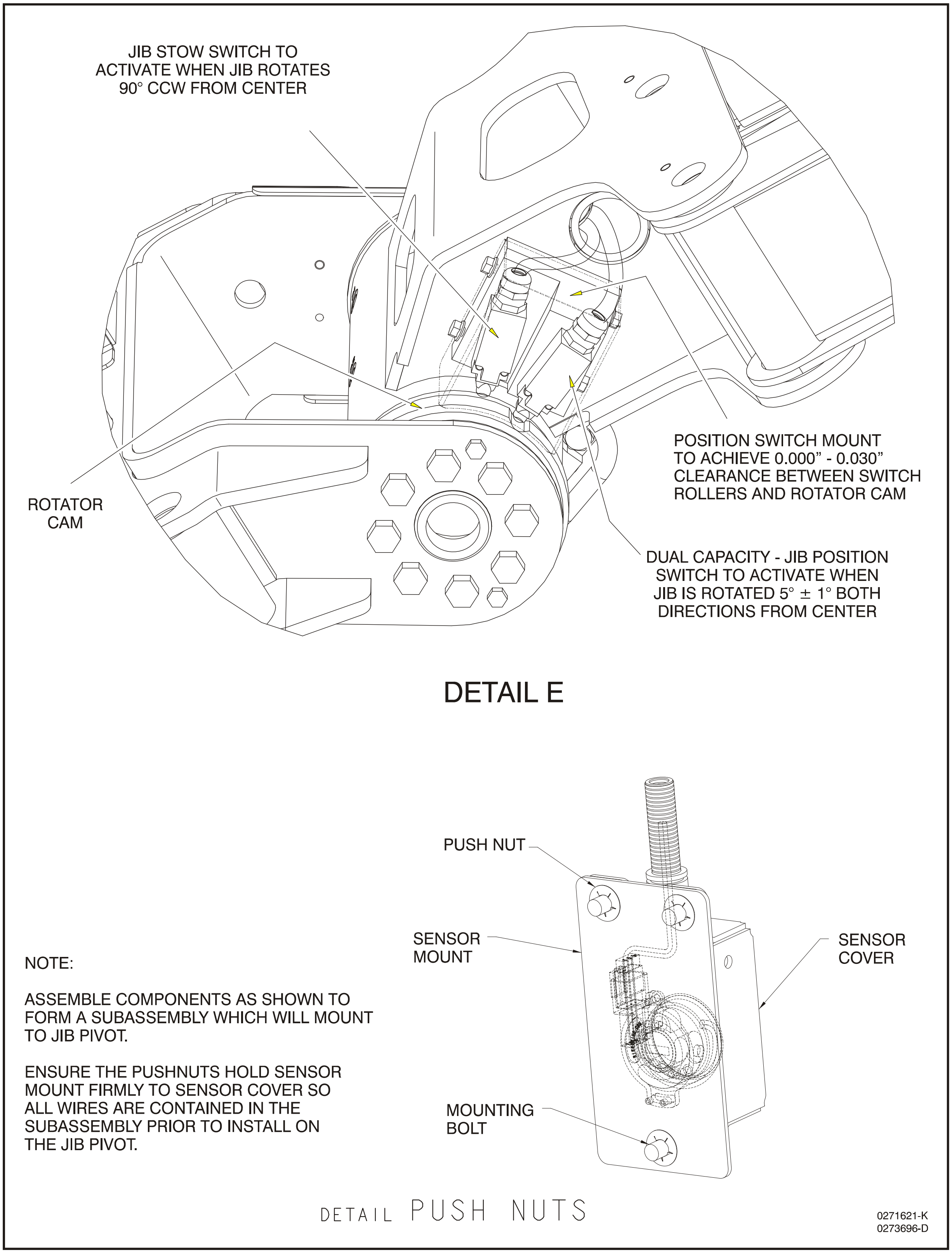


Figure 4-19. Boom/Jib Sensors and Switches Installation - Sheet 3 of 4

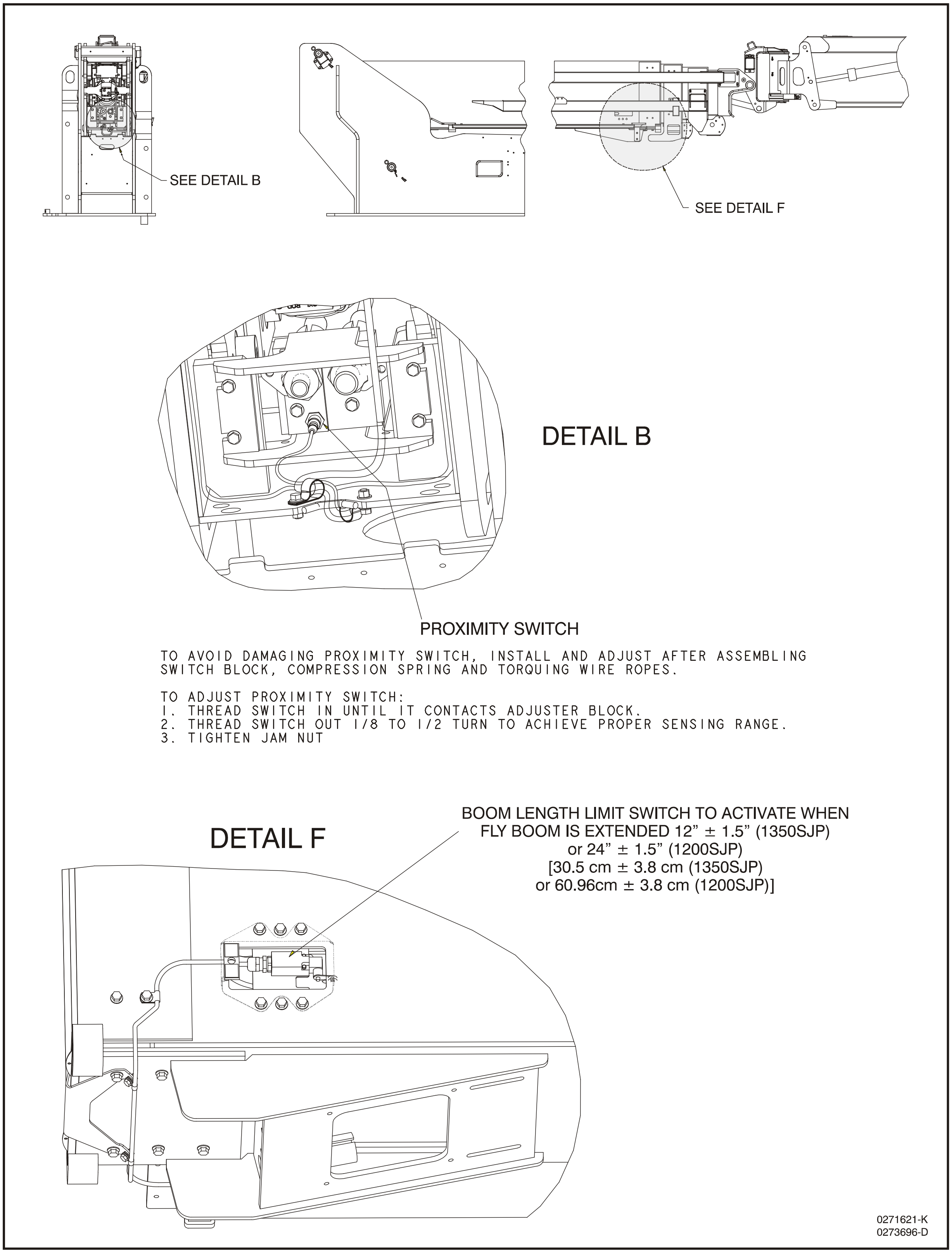
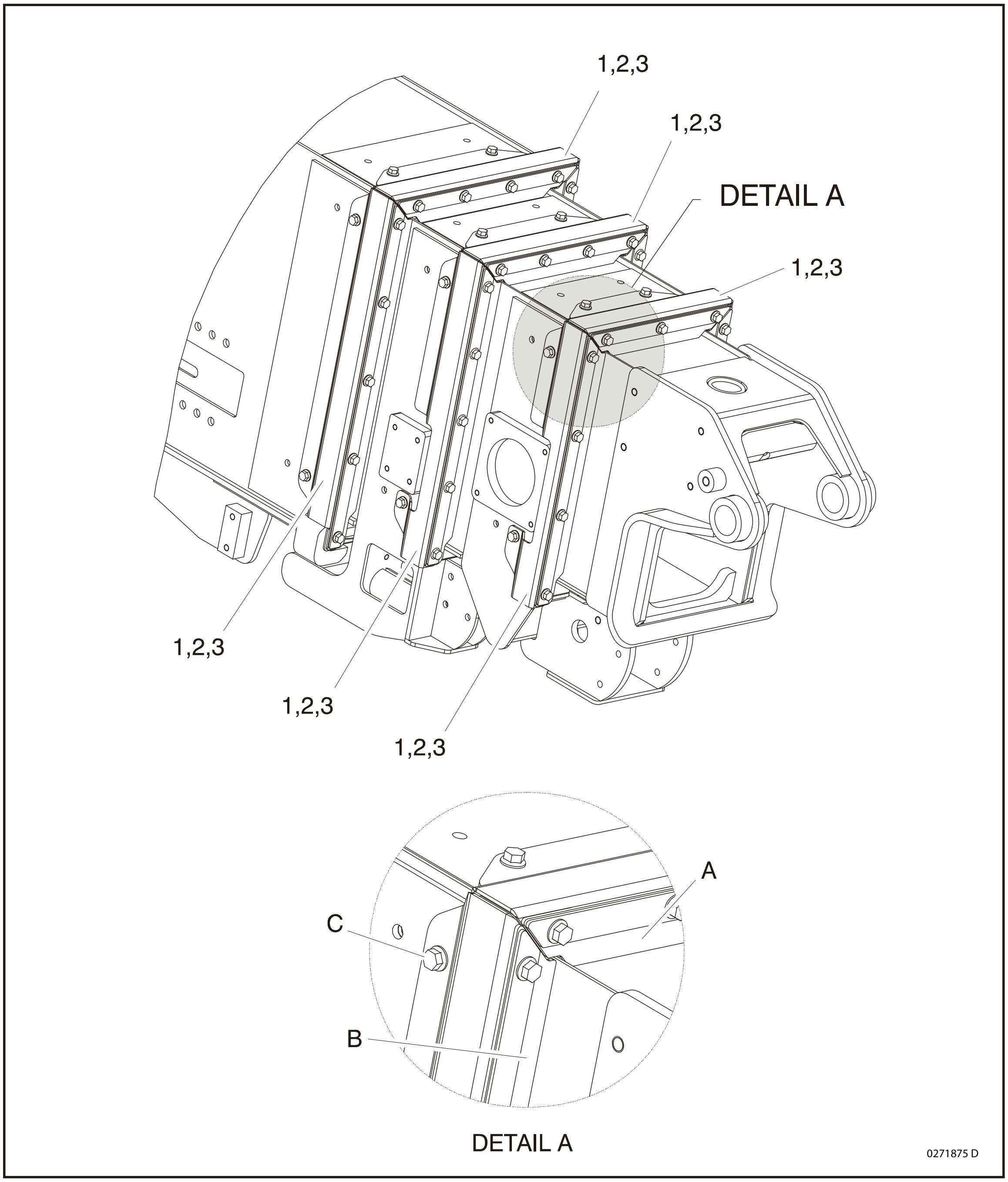


Figure 4-20. Boom/Jib Sensors and Switches Installation - Sheet 4 of 4



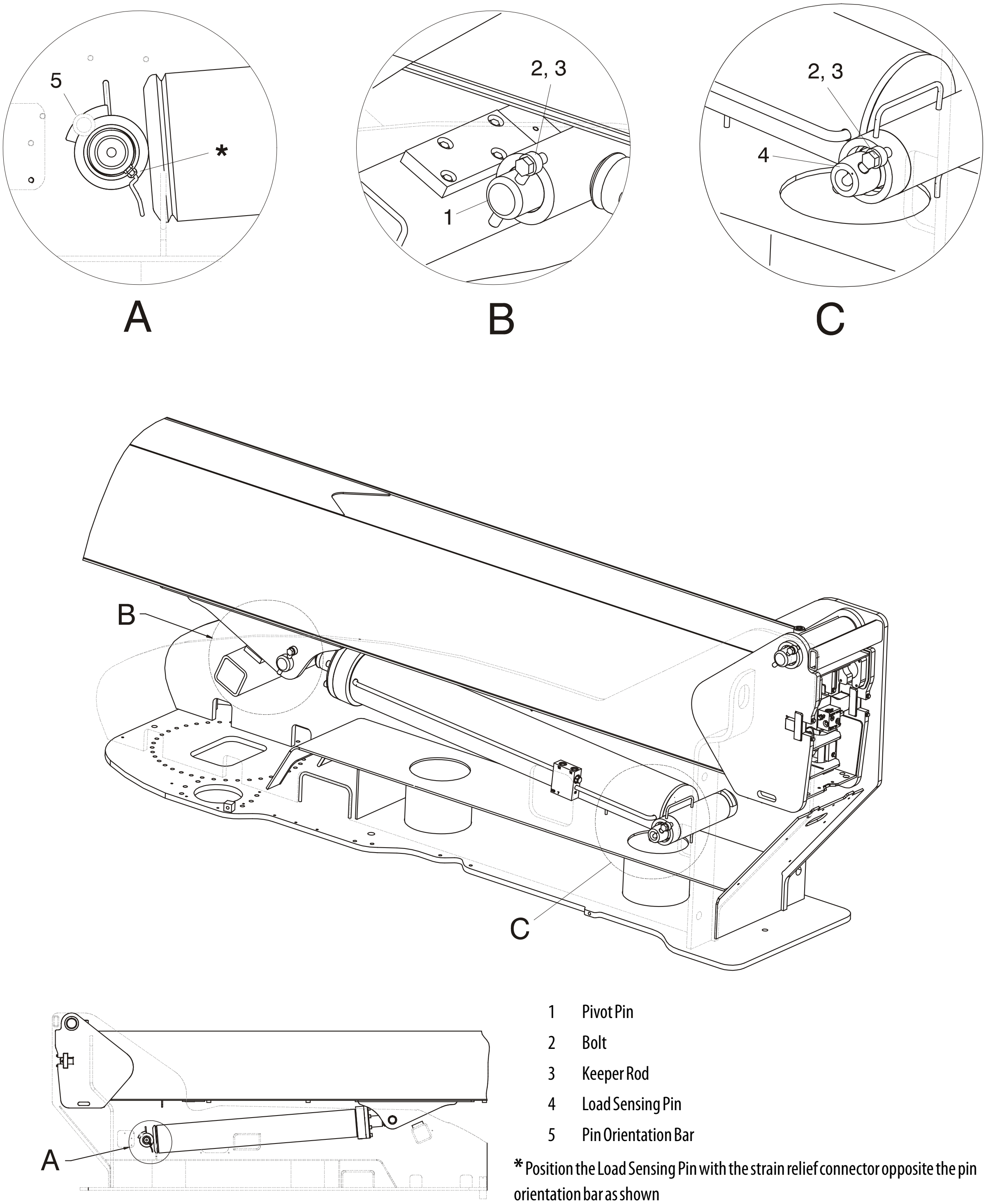
1. Bar
2. Blade
3. Mount

A Adjust top blades 0.000 to 0.063" (0 to 1.6 mm) from top boom plate

B Adjust side blades 0.000 to 0.063" (0 to 1.6 mm) from side boom plate

C Apply Loctite #242 & torque to 50 ft.lbs. (70 Nm)

Figure 4-21. Boom Wiper Installation



1 Pivot Pin

2 Bolt

3 Keeper Rod

4 Load Sensing Pin

5 Pin Orientation Bar

* Position the Load Sensing Pin with the strain relief connector opposite the pin orientation bar as shown

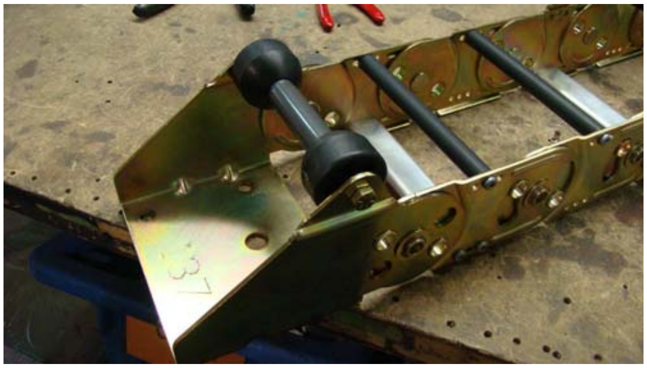
CAUTION: Pounding on the Load Sensing Pin for removal can destroy the internal strain gauge. Use care when removing the pin.

Figure 4-22. Pivot Pin Installation

4.8 POWERTRACK MAINTENANCE

One Piece Bracket Maintenance

1. Place the powertrack on a workbench.

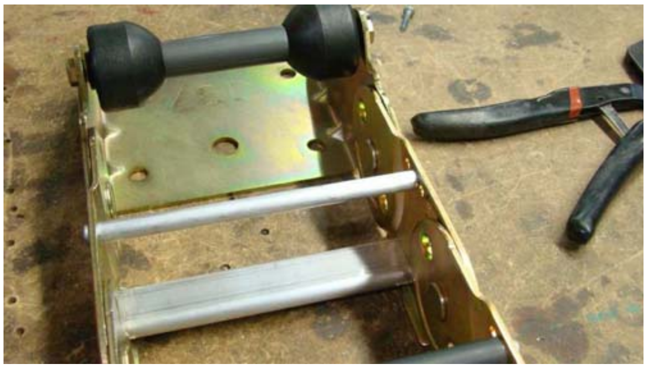


2. Remove the screws from the bars on one side of the powertrack on the first link.

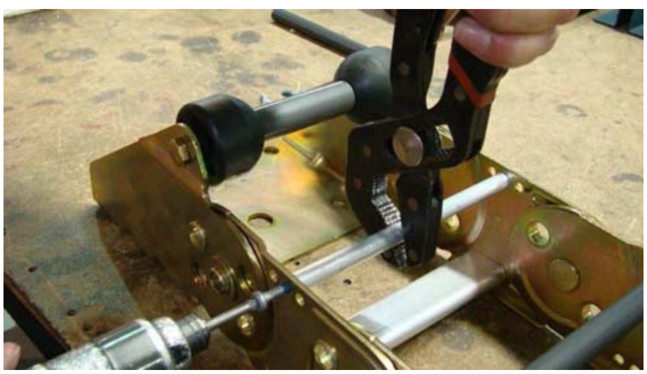
3. Remove the screws from the flat bar on the other side of the powertrack.

4. Pull up on the loose side of the round bar to allow the poly roller to slide off.

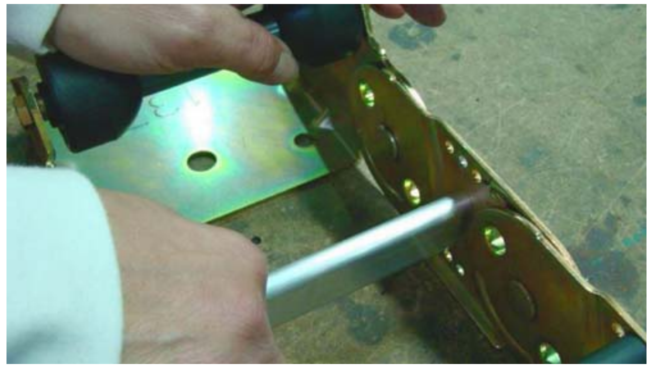
5. Slide the poly roller off of the round bar.

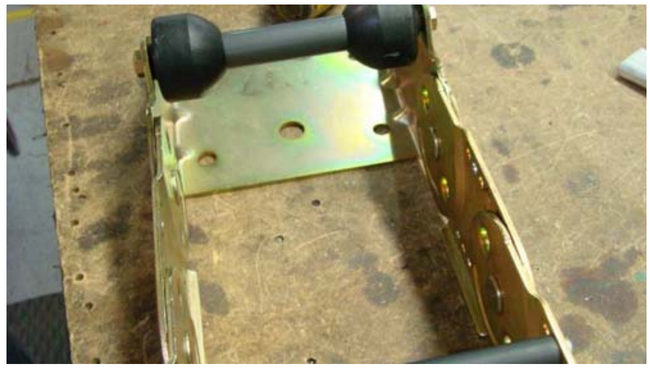


6. Hold the round bar to remove the other screw.

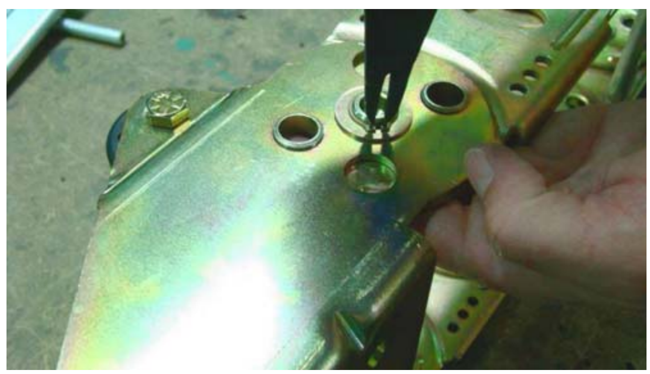


7. Slide the flat bar out.





8. Remove the snap ring from one side of the bracket.



9. Remove the snap ring from the other side of the bracket.

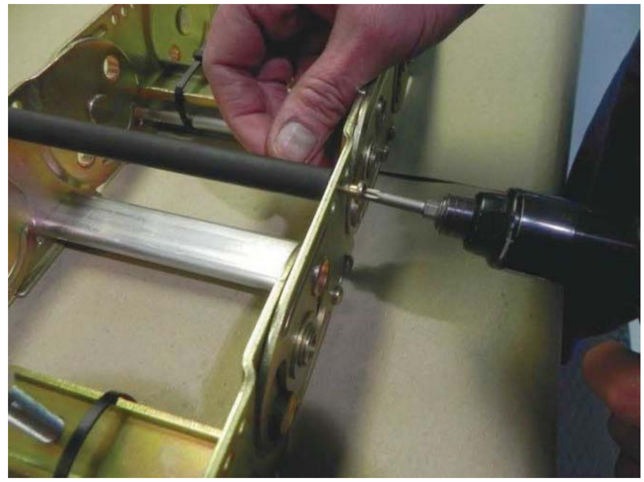
10. Push down with slight pressure on the link and slide the bracket side up and over the extrusion on the link.

11. Repeat the previous step on the other side.

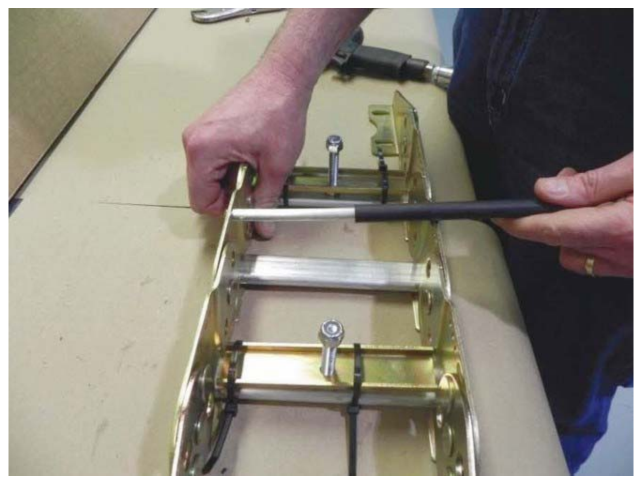
12. Slide the bracket off of the powertrack.

Two Piece Bracket Maintenance

1. Loosen the screw.

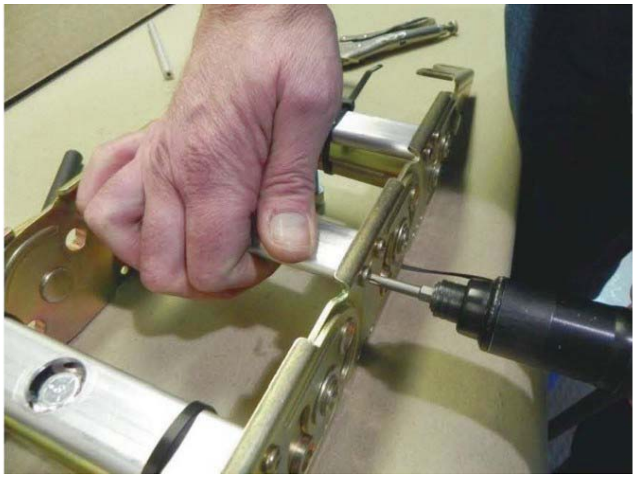


2. Slide the roller off the bar.



3. Hold the bar tightly and remove the other screw.

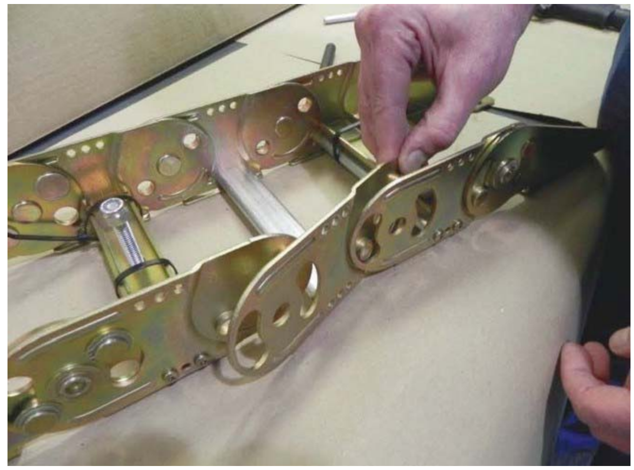
4. Hold the flat bar and remove the screws.



5. Remove the snap rings and pins.

6. Remove the screws from the bar. Remove the snap ring and pin.

7. Slide the link out.

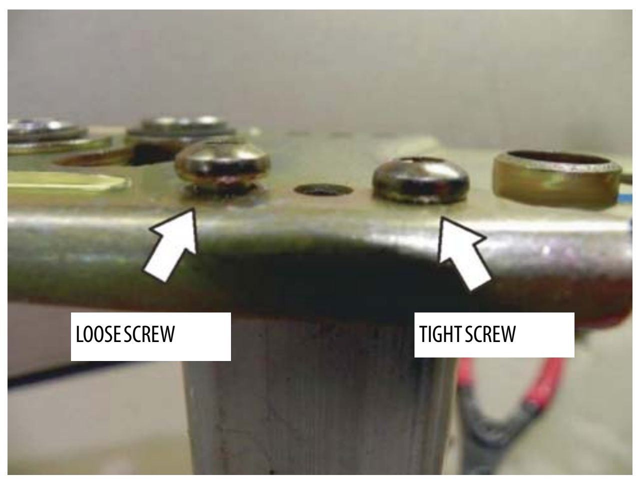


Snap Rings and Screws

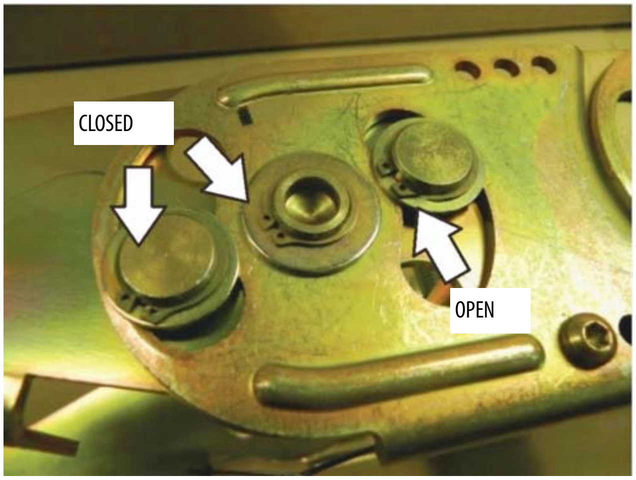
NOTICE

WHEN PERFORMING MAINTENANCE ON THE POWERTRACK, MAKE SURE TO DISCARD AND REPLACE ALL OLD SCREWS.

Make sure screws are tight and installed properly.

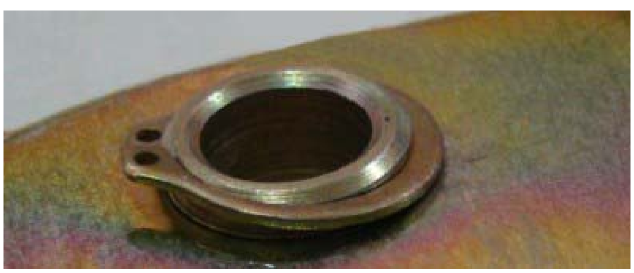


Make sure that all snap rings are closed and seated.



An open snap ring is shown below.

A snap ring that is not seated is shown below.



A seated and closed snap ring is shown below.

10-24 x 0.812 button torx socket head with blue locking patch:

- Tighten to 45-50 in.lbs. (5-5.6 Nm).
- Use T-25 torx bit.
- Do not reuse this screw. After removing replace with a new one.

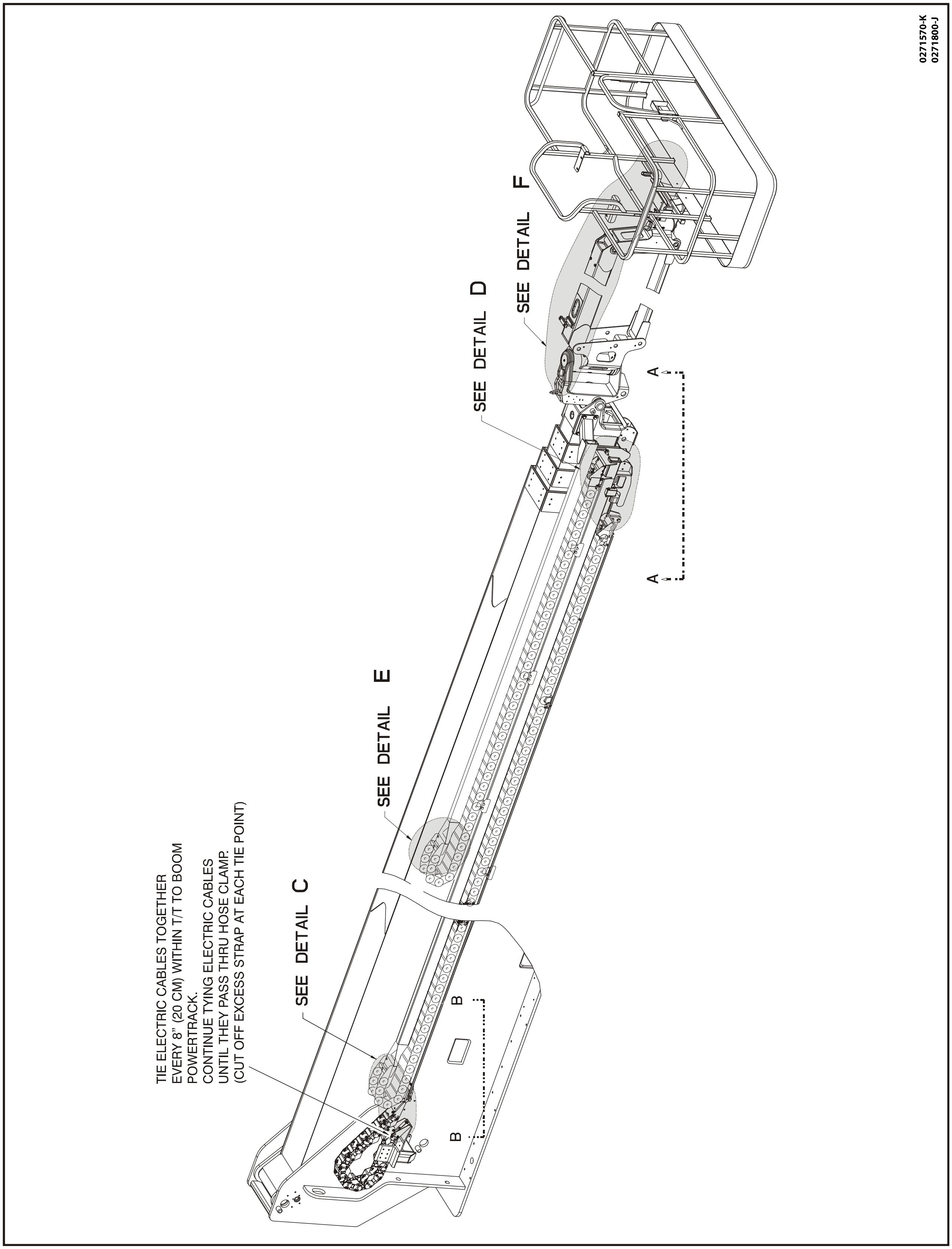


Figure 4-23. Powertrack Installation - Sheet 1 of 6

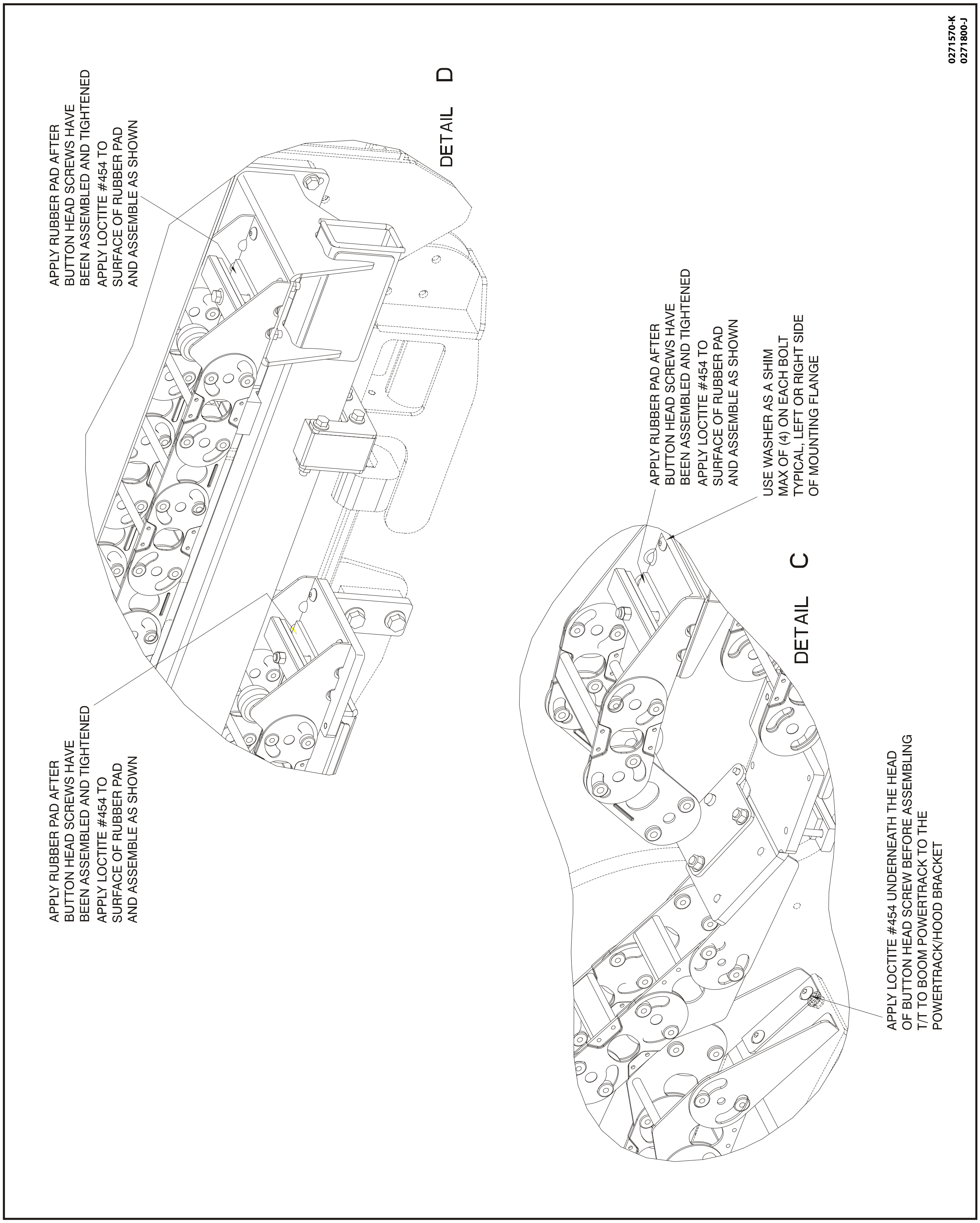


Figure 4-24. Powertrack Installation - Sheet 2 of 6

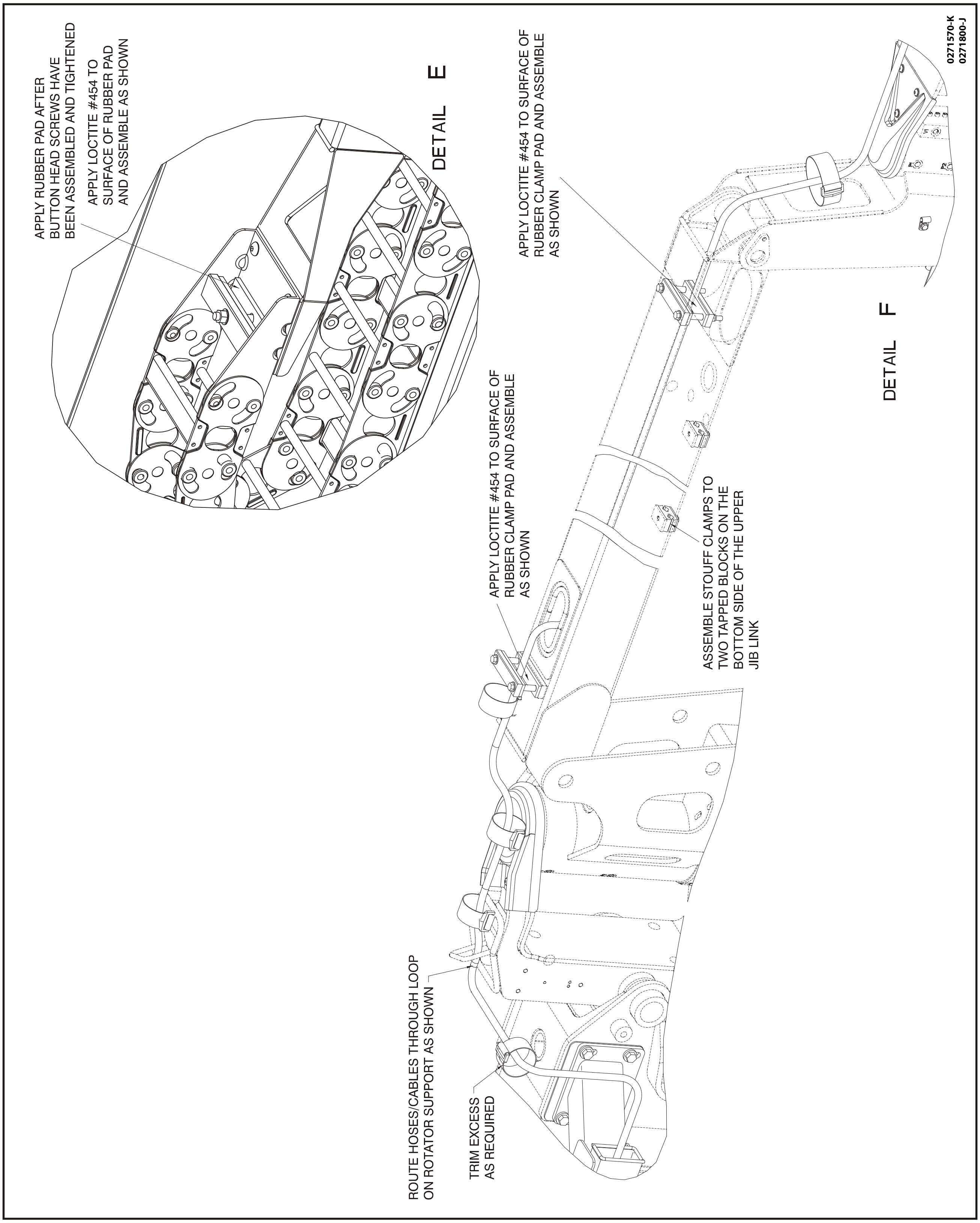


Figure 4-25. Powertrack Installation - Sheet 3 of 6

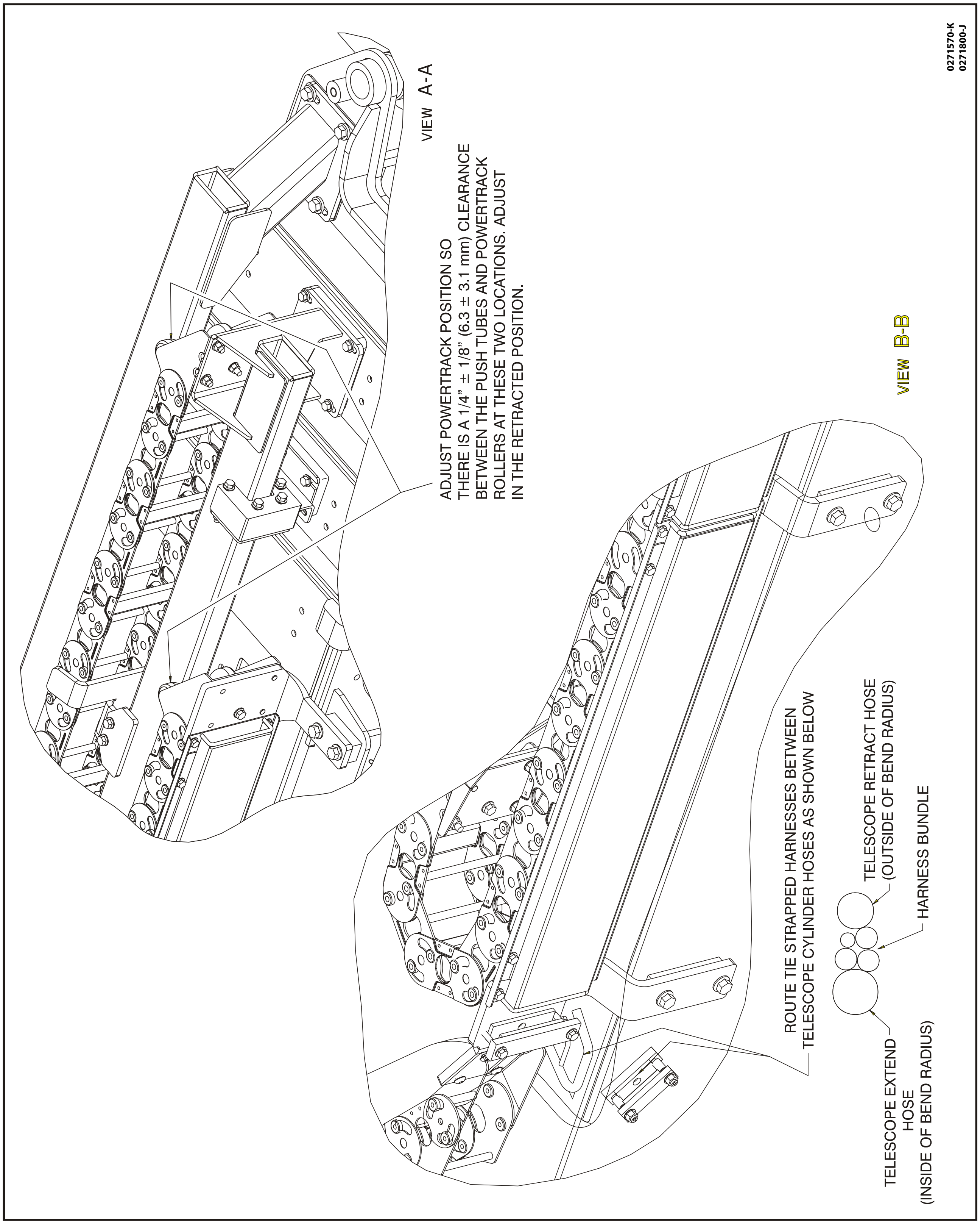


Figure 4-26. Powertrack Installation - Sheet 4 of 6

Table 4-1. Hose/Cable Pull Chart

LETTER	DESCRIPTION	DIM "X"	
		IN.	CM
P	LEVEL UP HOSE (PORT L1)	64	162.5
Q	LEVEL DOWN HOSE (PORT L2)	64	162.5
R	SWING RIGHT HOSE (PORT S1)	64	162.5
S	SWING LEFT HOSE (PORT S2)	64	162.5
T	JIB LIFT UP HOSE (PORT J1)	64	162.5
U	JIB LIFT DOWN HOSE (PORT J2)	64	162.5
NOTE: ALL CABLE/HOSE LENGTHS TO BE ± 1" (2.5 cm)			

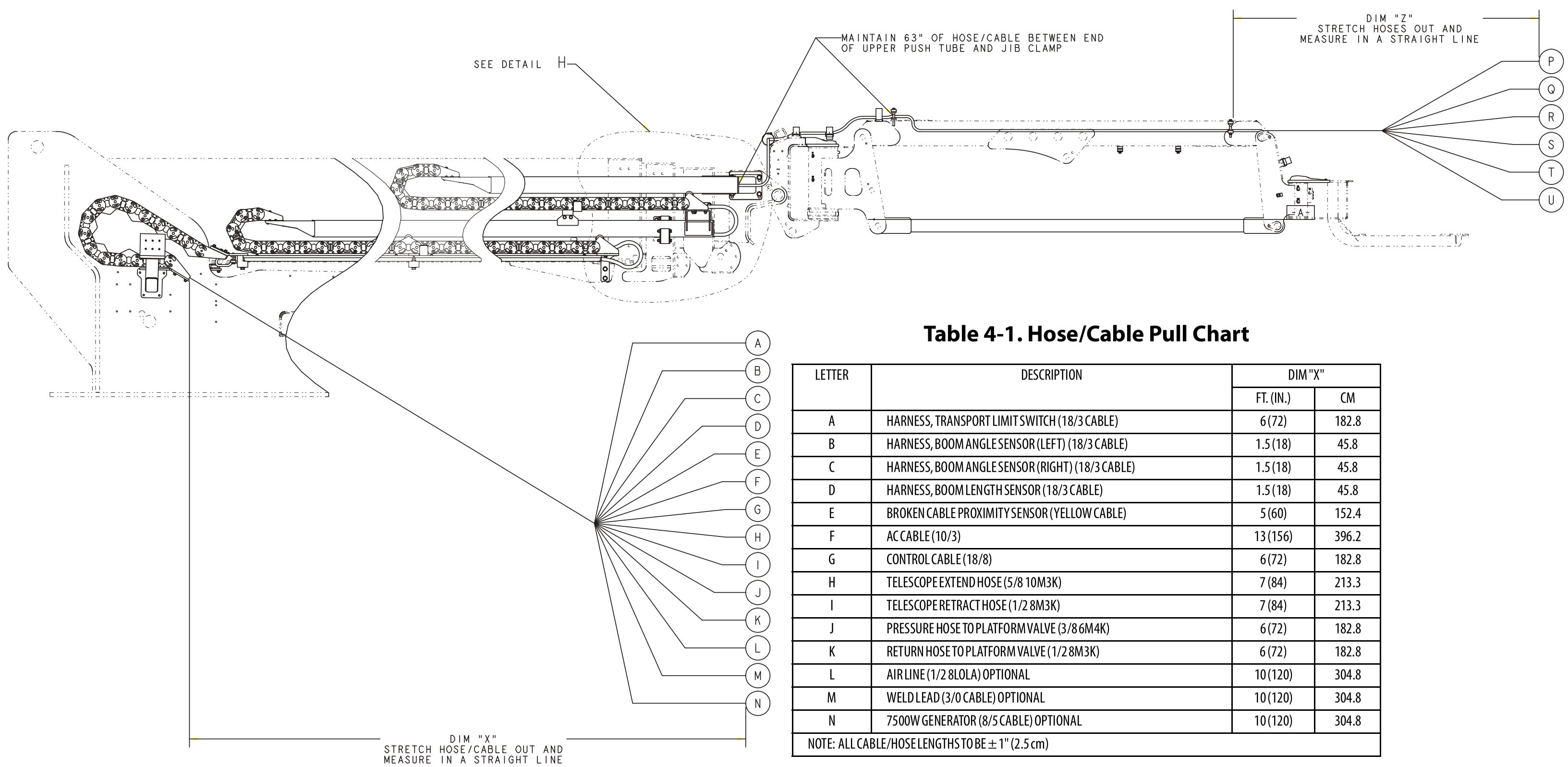


Table 4-1. Hose/Cable Pull Chart

LETTER	DESCRIPTION	DIM "X"	
		FT. (IN.)	CM
A	HARNESS, TRANSPORT LIMIT SWITCH (18/3 CABLE)	6 (72)	182.8
B	HARNESS, BOOM ANGLE SENSOR (LEFT) (18/3 CABLE)	1.5 (18)	45.8
C	HARNESS, BOOM ANGLE SENSOR (RIGHT) (18/3 CABLE)	1.5 (18)	45.8
D	HARNESS, BOOM LENGTH SENSOR (18/3 CABLE)	1.5 (18)	45.8
E	BROKEN CABLE PROXIMITY SENSOR (YELLOW CABLE)	5 (60)	152.4
F	AC CABLE (10/3)	13 (156)	396.2
G	CONTROL CABLE (18/8)	6 (72)	182.8
H	TELESCOPE EXTEND HOSE (5/8 10M3K)	7 (84)	213.3
I	TELESCOPE RETRACT HOSE (1/2 8M3K)	7 (84)	213.3
J	PRESSURE HOSE TO PLATFORM VALVE (3/8 6M4K)	6 (72)	182.8
K	RETURN HOSE TO PLATFORM VALVE (1/2 8M3K)	6 (72)	182.8
L	AIR LINE (1/2 8LOLA) OPTIONAL	10 (120)	304.8
M	WELD LEAD (3/0 CABLE) OPTIONAL	10 (120)	304.8
N	7500W GENERATOR (8/5 CABLE) OPTIONAL	10 (120)	304.8
NOTE: ALL CABLE/HOSE LENGTHS TO BE ± 1" (2.5 cm)			

0271570-K
0271800-J

Figure 4-27. Powertrack Installation - Sheet 5 of 6

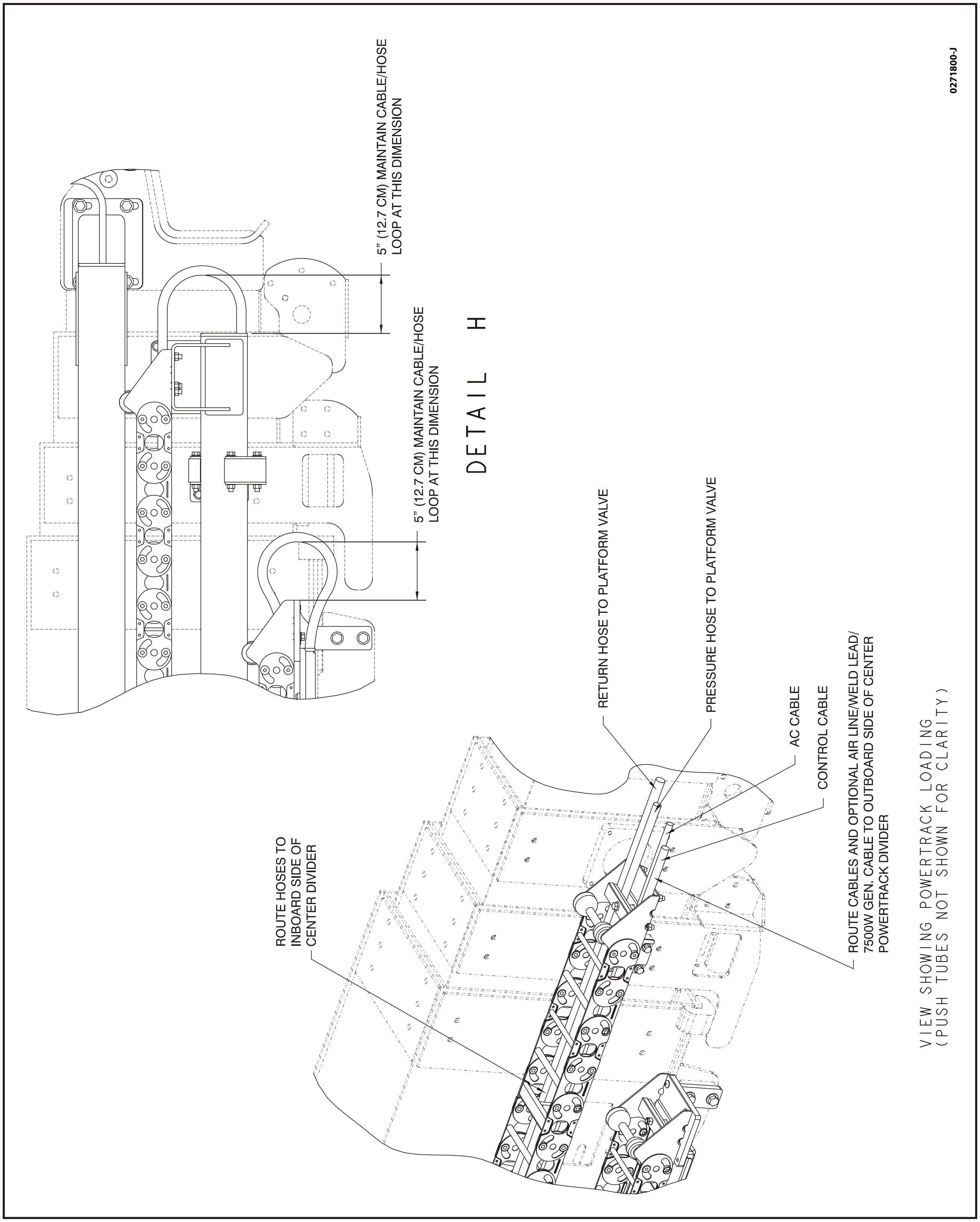


Figure 4-28. Powertrack Installation - Sheet 6 of 6

4.9 HOSE ROUTING PROCEDURE

For proper hose routing and cable wrap placement and clamping, refer to Figure 4-23., Figure 4-24., Figure 4-25., Figure 4-26., Figure 4-27., and Figure 4-28. It is important to periodically inspect hoses, wraps and clamps for proper slack adjustments and clamping integrity (pull check). Any changes as a result of inspection should be verified by performing full strokes of boom functions especially lift, telescope, jib, and platform rotate.

4.10 WIRE ROPE

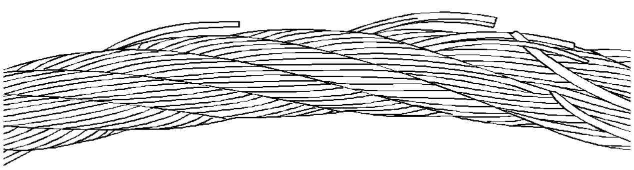
Each day before using the machine:

1. Raise the main boom to approximately horizontal.
2. Extend and retract the boom sections.
3. Check for delayed movement of the fly section, which indicates loose wire ropes.

Inspection

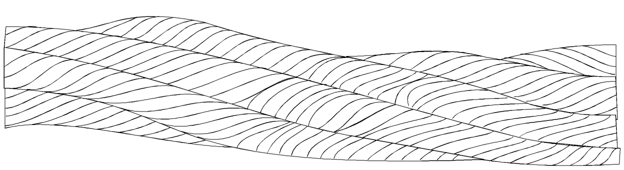
NOTE: *The pictures in this paragraph are just samples to show the replacement criteria of the rope.*

1. Inspect ropes for broken wires, particularly valley wire breaks and breaks at end terminations.



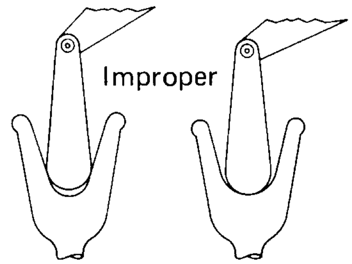
Flexing a wire rope can often expose broken wires hidden in valleys between strands.

2. Inspect ropes for corrosion.
3. Inspect ropes for kinks or abuse.



A kink is caused by pulling down a loop in a slack line during improper handling, installation, or operation.

4. Inspect sheaves for condition of bearings/pins. (See Dimension Of Sheaves for proper dimension.)
5. Inspect sheaves for condition of flanges. (See Dimension Of Sheaves for proper dimension.)
6. Inspect sheaves with a groove wearout gauge for excessive wear.



Observe the groove so that it may be clearly seen whether the contour of the gauge matches the contour of the bottom of the groove.

7. Ropes passing inspection should be lubricated with wire rope lubricant before reassembly.

Three Month Inspection

1. Remove boom covers and visually (with flashlight) inspect the ropes for rust, broken wires, frays, abuse, or any signs of abnormalities.
2. Check rope tension by deflecting the ropes by hand...properly tensioned ropes should have little or no movement.

Eight Year Inspection

1. Mandatory wire rope and sheave replacement.

   Additional inspection required if:

   a. Machine is exposed to hostile environment or conditions.
   b. Erratic boom operation or unusual noise exists.
   c. Machine is idle for an extended period.
   d. Boom is overloaded or sustained a shock load.
   e. Boom exposed to electrical arc...wires may be fused internally.

Replacement Criteria

1. Sheaves and wire rope must be replaced as sets.
2. Rusted or corroded wire ropes.
3. Kinked, “bird caged”, or crushed ropes.
4. Ropes at end of adjustment range.
5. Sheaves failing wearout gage inspection.
6. Ropes with 6 total broken wires in one rope lay, 3 in one strand in one rope lay, 1 valley break, or 1 break at any end termination.

4.11 WIRE ROPE TENSIONING ADJUSTMENT

NOTICE

ANY TIME THE WIRE ROPE TENSIONING HAS BEEN ADJUSTED, BOOM CALIBRATION SHOULD BE PERFORMED IMMEDIATELY AFTERWARD.

Before adjusting wire rope tension, the boom sections must be in the proper position as shown in Figure 4-30., Wire Rope Tensioning. This is so the wire ropes are equalized on both sides of the sheaves and are seated properly in the sheave grooves. This is necessary for proper tensioning of the wire ropes.

This section covers the two major operations in tensioning the wire ropes which are as follows:

- Positioning the boom sections (so that proper tensioning can be achieved).
- Tensioning the wire rope.

Boom Section Re-Positioning

NOTE: *Because the Outer Mid Boom is used to control the movement of the Fly Boom, any repositioning of the Outer Mid Boom section will also affect the position of the Fly Boom section. Correctly position the Outer Mid Boom before repositioning the Fly Boom.*

NOTE: *Use the Telescope function of the machine to position the boom sections. Do not use the wire rope adjustment nuts to position the booms. This may cause damage to the wire rope adjustment threads.*

1. Ensure the machine is placed on firm, level ground.
2. Before making any adjustments, position the boom assembly in the fully retracted position.
3. Take preliminary measurements of the position of each boom section and compare them to Figure 4-30., Wire Rope Tensioning. If the measurements fall within the tolerances in the figure, proceed to Wire Rope Tensioning in this section.

NOTICE

PROPER BOOM POSITIONS DO NOT MEAN THAT THE WIRE ROPE TENSIONS ARE CORRECT.

If the measurements do not fall within the tolerances in Figure 4-30., Wire Rope Tensioning, adjust the booms using the repositioning procedures that follow.

INNER MID BOOM SECTION REPOSITIONING

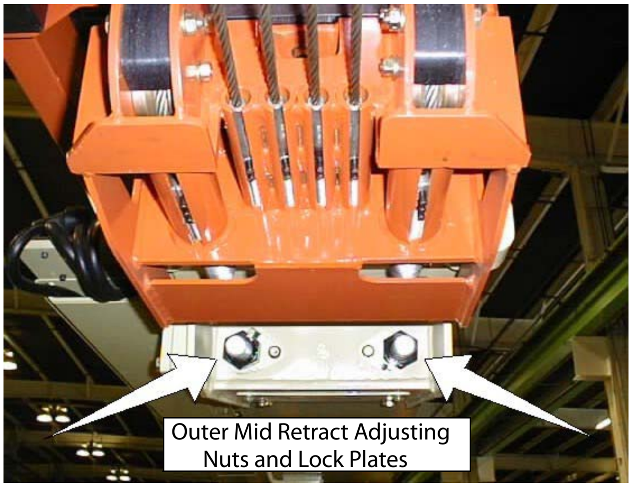
The inner mid section of the boom is positioned by the hydraulic cylinder. No adjustments can be made to this section. The wire ropes within the assembly only control the movement of the Outer Mid Boom and Fly Boom sections.

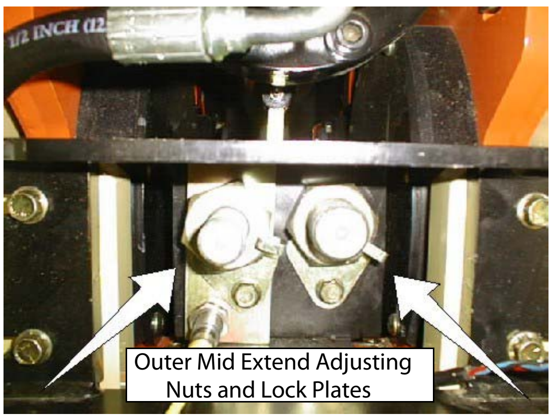
OUTER MID BOOM SECTION REPOSITIONING

If the Outer Mid Boom falls within the dimension and tolerance of Figure 4-30., Wire Rope Tensioning, proceed to the Fly Boom Section Positioning procedure in this section. If the Outer Mid Boom section is outside of the tolerance as shown, perform the following procedure.

1. Extend the boom assembly so the platform moves 5 to 6 feet (1.5 to 1.8 m) from the fully retracted position.
2. Remove any covers necessary to access the wire rope adjustment nuts.

3. Remove the lock plates and nylon collar locknuts from the wire rope adjustment nuts.





4. If the Outer Mid Boom needs to be retracted:
   a. Loosen the Outer Mid Boom Extend Adjustment Nuts by an amount equal to twice the distance the boom needs to move to be in tolerance.
   b. Fully retract the boom.
   c. To remove the slack caused by the previous step, tighten the Outer Mid Boom Extend Adjustment Nuts until they just contact the plate.
5. If the Outer Mid Boom needs to be extended out:
   a. Loosen the Outer Mid Boom Retract Adjustment Nuts by an amount equal to twice the distance the boom needs to move to be in tolerance
   b. Extend the boom 3-4 feet (1-1.5m).
   c. To remove the slack caused by the previous step, tighten the Outer Mid Boom Retract Adjustment Nuts until they just contact the plate.
6. Fully retract the boom sections.
7. Verify that the exposed boom section dimensions meet the dimensions and tolerances of Figure 4-30., Wire Rope Tensioning.
   a. If the Outer Mid Boom still does not fall within the dimension and tolerance of Figure 4-30., repeat the Outer Mid Boom positioning procedure.
   b. If the Outer Mid Boom falls within the dimension and tolerance of Figure 4-30., proceed to the Fly Boom Section Positioning procedure in this section.

NOTE: *Because the Outer Mid Boom is used to control the movement of the Fly Boom, any repositioning of the Outer Mid Boom Section will also affect the position of the Fly Boom section. After repositioning the Outer Mid Boom, always check the Fly Boom position per Figure 4-30.*

FLY BOOM SECTION REPOSITIONING

If the Fly Boom section location and the Outer Mid Boom section location are both within the dimensions and tolerances in Figure 4-30., proceed to the Wire Rope Tensioning Procedure in this section.

If the Fly Boom section is outside of the tolerance as shown in Figure 4-30. while the boom assembly is fully retracted, perform the following procedure:

1. Extend the boom assembly such that the platform moves 5 to 6 feet (1.5-1.8 m) from the fully retracted position.
2. Remove the lock plates and nylon collar locknuts from the wire rope adjustment nuts.
3. If the Fly Boom needs to be retracted farther in:
   a. Loosen the Fly Boom Extend Adjustment Nuts by an amount equal to twice the distance the boom needs to move to be in tolerance.

   b. Fully retract the boom.
   c. To remove the slack caused by the previous step, tighten the Fly Boom Extend Adjustment Nuts until they just contact the plate.

4. If the Fly Boom needs extended:
    a. Loosen the Fly Boom Retract Adjustment Nuts by an amount equal to twice the distance the boom needs to move to be in tolerance.

    b. Extend the boom 3-4 feet (1-1.5m).
    c. To remove the slack caused by the previous step, tighten the Fly Boom Retract Adjustment Nuts until they just contact the plate.
    d. Fully retract the boom sections.
5. Verify that the exposed boom section dimensions meet the dimensions and tolerances of Figure 4-30., Wire Rope Tensioning.
    a. If the Fly Boom still does not fall within the dimension and tolerance of Figure 4-30., repeat the Fly Boom Section Repositioning procedure.
    b. If the Fly Boom falls within the dimension and tolerance of Figure 4-30., proceed to the Wire Rope Tensioning Procedure.

Wire Rope Tensioning Procedure

NOTE: *Verification of the rope tension should be determined by proper function of the boom assembly and by the dimensions and tolerances of Figure 4-30., Wire Rope Tensioning.*

NOTICE

REPEAT WIRE ROPE TENSIONING PROCEDURE ONLY AS NECESSARY TO ACHIEVE PROPER TENSION.

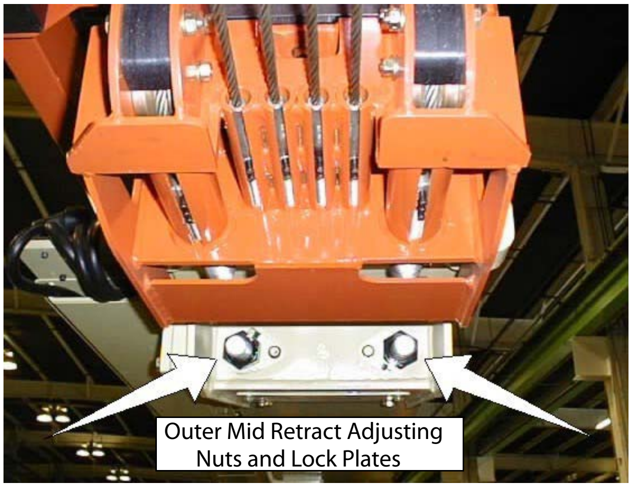
NOTICE

IF THE BOOMS HAVE BEEN PROPERLY POSITIONED AND THERE IS NOT ENOUGH ADJUSTMENT REMAINING ON THE WIRE ROPES TO ACHIEVE TORQUE, THE SERVICE LIFE OF THE WIRE ROPES HAS BEEN CONSUMED. DO NOT PROCEED WITH THE REMAINDER OF THIS PROCEDURE. REPLACE THE WIRE ROPES AND SHEAVES.

1. Remove any covers necessary to access the wire rope adjustment nuts.

2. If not already done, remove the lock plates and nylon collar locknuts from the wire rope adjustment nuts.
3. Position the boom so that it is horizontal within ±5°. If the boom is below horizontal, ensure that the boom is not on the boom rest.
4. Extend the boom so the platform moves 5 to 6 feet (1.5-1.8 m) from the fully retracted position. This is done to position the boom so the ropes to be tensioned are not under load.
5. When extending the boom in the previous step, if the boom reaches the end of travel and then automatically retracts a small amount, the ropes may still be under load. If so, perform the following steps:
    a. Note where the boom hits the end of stroke.
    b. Retract 3-4 feet (1-1.3 m).
    c. Extend the boom and stop just before the boom hits the end of stroke.

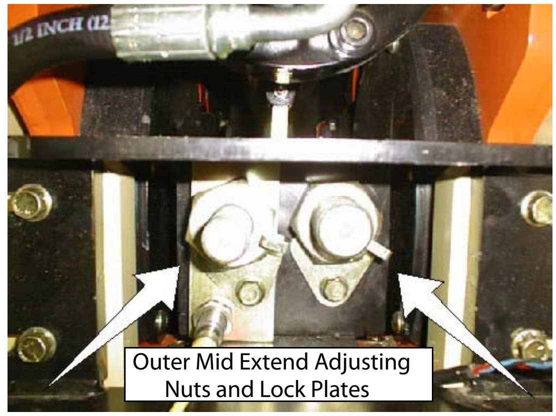
6. Using tool JLG p/n 4120043, torque the Outer Mid Boom Retract Adjustment Nuts to 80 ft-lb (108 Nm), alternating between the two ropes until both maintain the required torque.



7. Using tool JLG p/n 4120043, torque the Fly Boom Retract Adjuster Nuts to 80 ft-lb (108 Nm), alternating between the two ropes until both maintain the required torque.

8. Retract the boom 2-3 feet (0.6-1.0 m). Do not fully retract or bottom out the booms.

9. Using tool JLG p/n 4120043, torque the Outer Mid Boom Extend Adjustment Nuts to 80 ft-lb (108 Newton meters), alternating between the two ropes until both maintain the required torque.



10. Using tool JLG p/n 4120040, torque the Fly Extend Adjustment Nuts to 10 ft-lb (13.5 Nm), starting with the inside ropes and doing the outside ropes last. Refer to Figure 4-29., Torque Sequence for Fly Extend Rope. Alternate between the four ropes until all maintain the required torque.

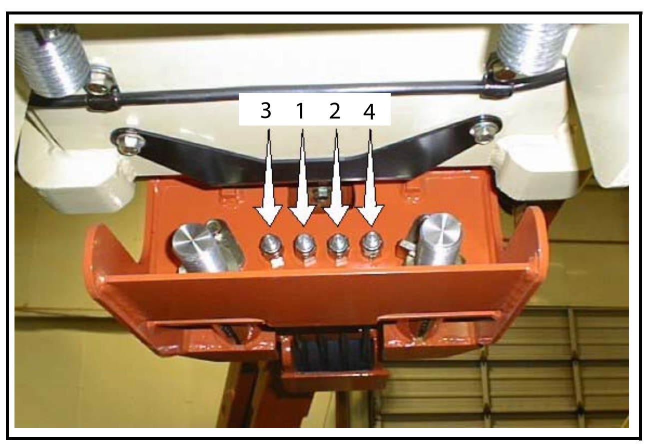


Figure 4-29. Torque Sequence for Fly Extend Rope

11. Repeat the following boom movement steps three times. This is to ensure that the wire rope tension has equalized on both sides of the sheaves and the ropes are seated properly in the sheave grooves.
    a. Fully retract the boom.
    b. Extend the boom such that the platform moves 5 to 6 feet (1.5-1.8 m) from fully retracted position.
12. Verify the Fly Boom and Outer Mid Boom Retract wire rope torques.
    a. If the torque values are not correct, repeat the Wire Rope Tensioning procedure.
    b. If the torque values are correct, proceed to the next step.
13. Retract the boom 2-3 feet (0.5-1 m). Do not fully retract or bottom out the boom.
14. Verify the Fly Boom and Outer Mid Boom Extend wire rope torques.
    a. If the torque values are not correct, repeat the Wire Rope Tensioning procedure.
    b. If the torque values are correct, proceed to the next step.
15. Check for proper function of the boom assembly. When properly torqued and positioned, all three moving boom sections will move simultaneously.
16. Install new nylon collar locknuts to the Fly Boom Extend wire rope fittings. Do not re-use the old nylon collar lock nuts. Torque the locknuts to 10 ft-lb (13.5 Nm)
17. Reinstall the lock plates to the remaining adjuster nuts.
18. Install all covers.

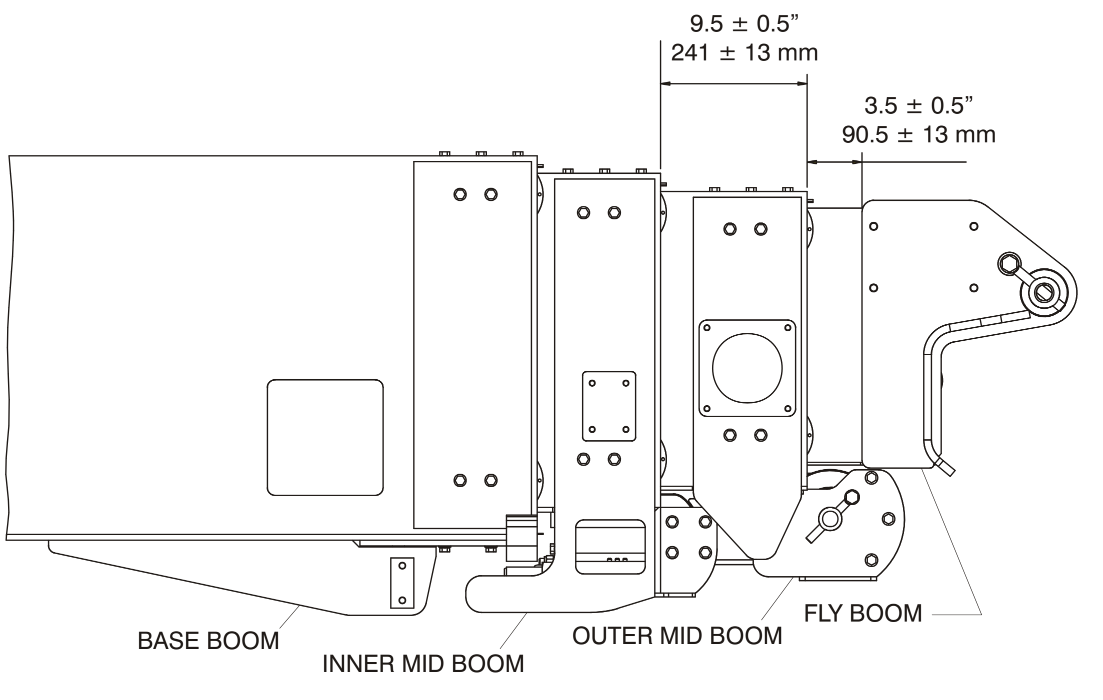


Figure 4-30. Wire Rope Tensioning

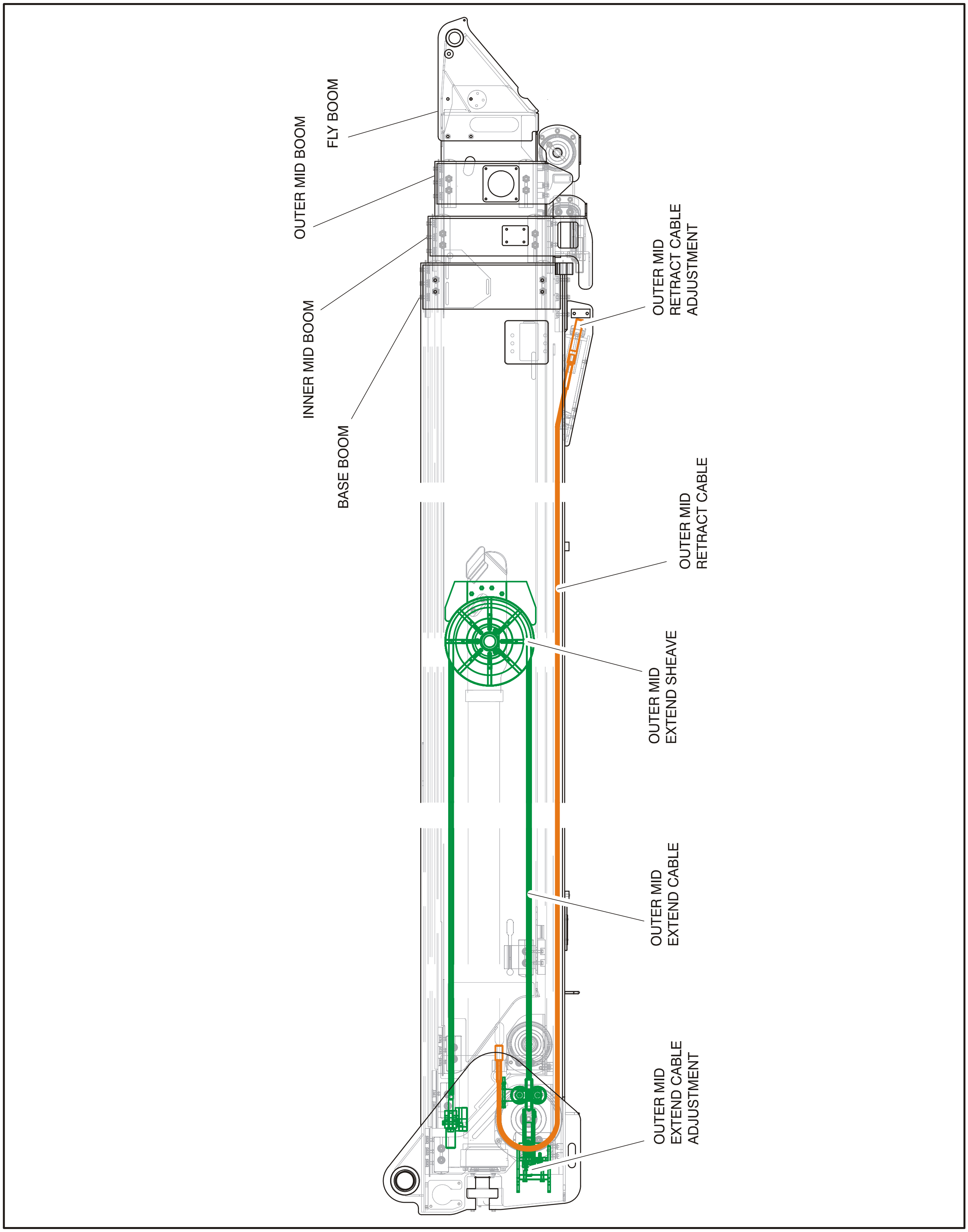


Figure 4-31. Outer Mid Boom Extend/Retract Cables

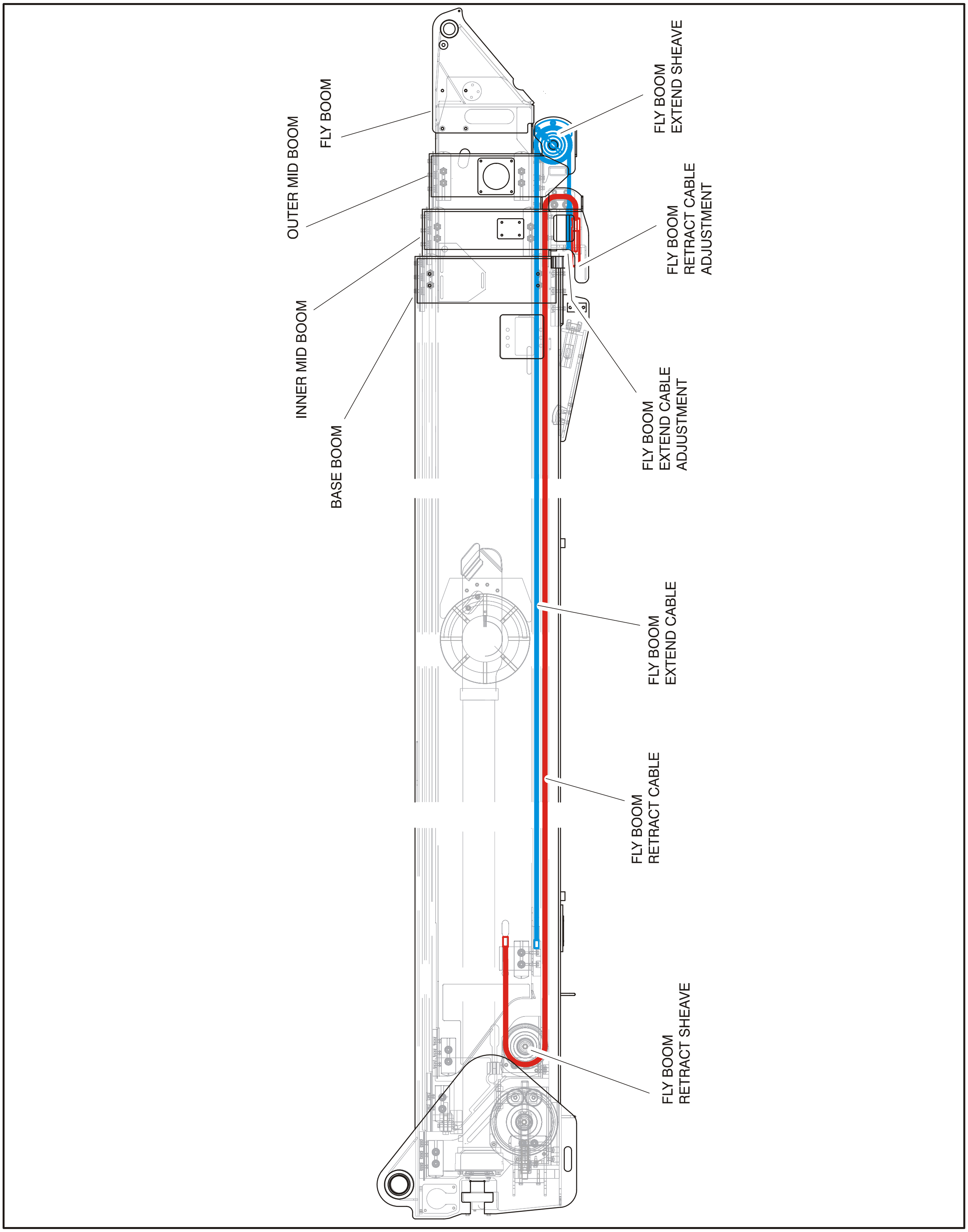
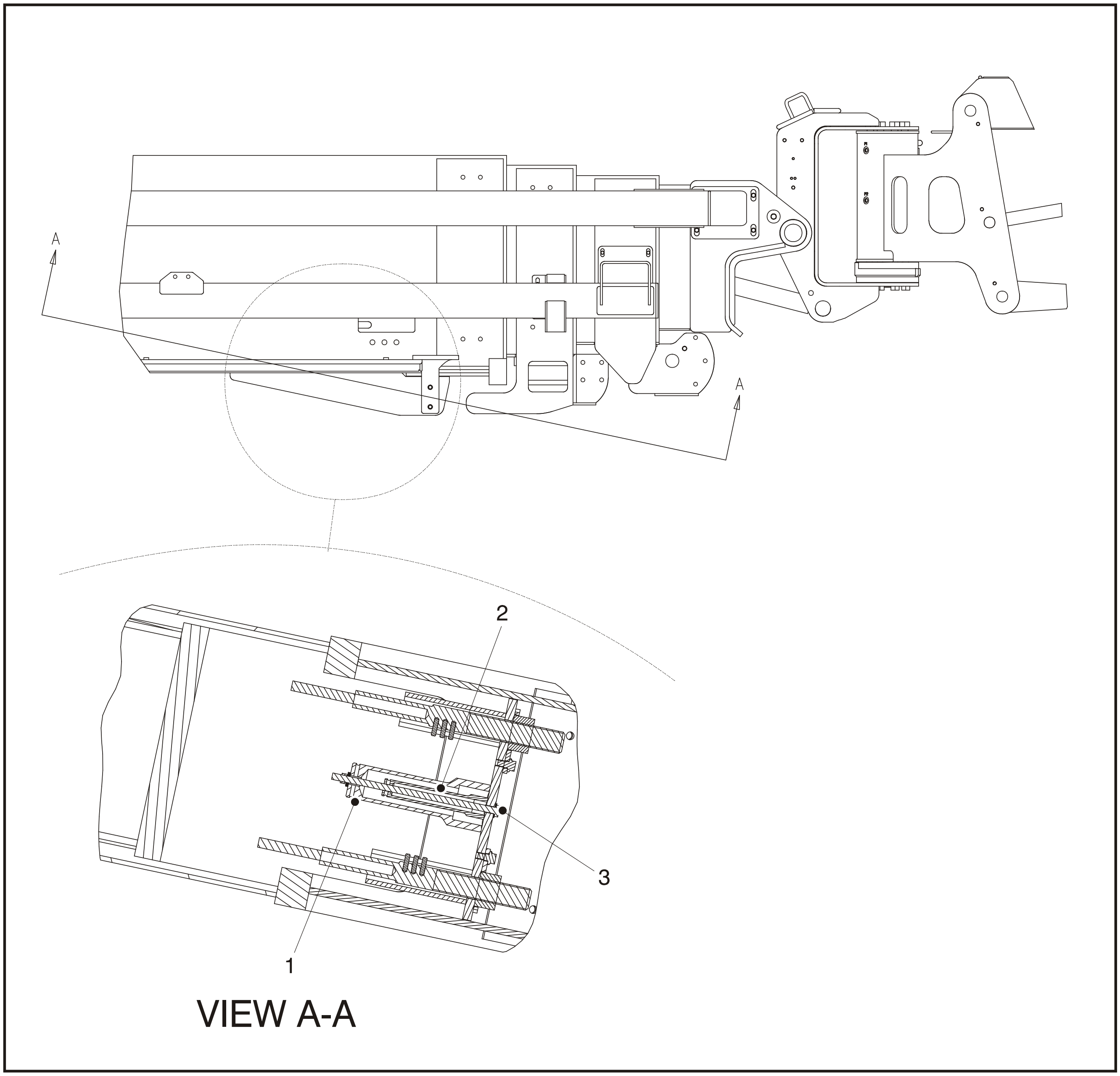


Figure 4-32. Fly Boom Extend/Retract Cables



1. 2" Socket
2. 3/4" Socket
3. Retaining Bolt

Figure 4-33. Wire Rope Adjustment Tools (Optional)

4.12 BROKEN BOOM CABLE PROXIMITY SWITCH

This system uses a proximity switch to detect excessive movement of the cable block. If movement is detected the Cable Break indicator will illuminate in the platform control panel. No restrictions are made to the functionality of the control system. It is the responsibility of the operator to take immediate action.

To avoid damaging the proximity switch, install and adjust after assembling the switch block, compression spring, and torquing the wire ropes.

Adjusting the Proximity Switch

1. Thread the switch in until it contacts the adjuster block.
2. Thread the switch out 1/8 to 1/2 turn to achieve proper sensing range.
3. Tighten the jam nut.

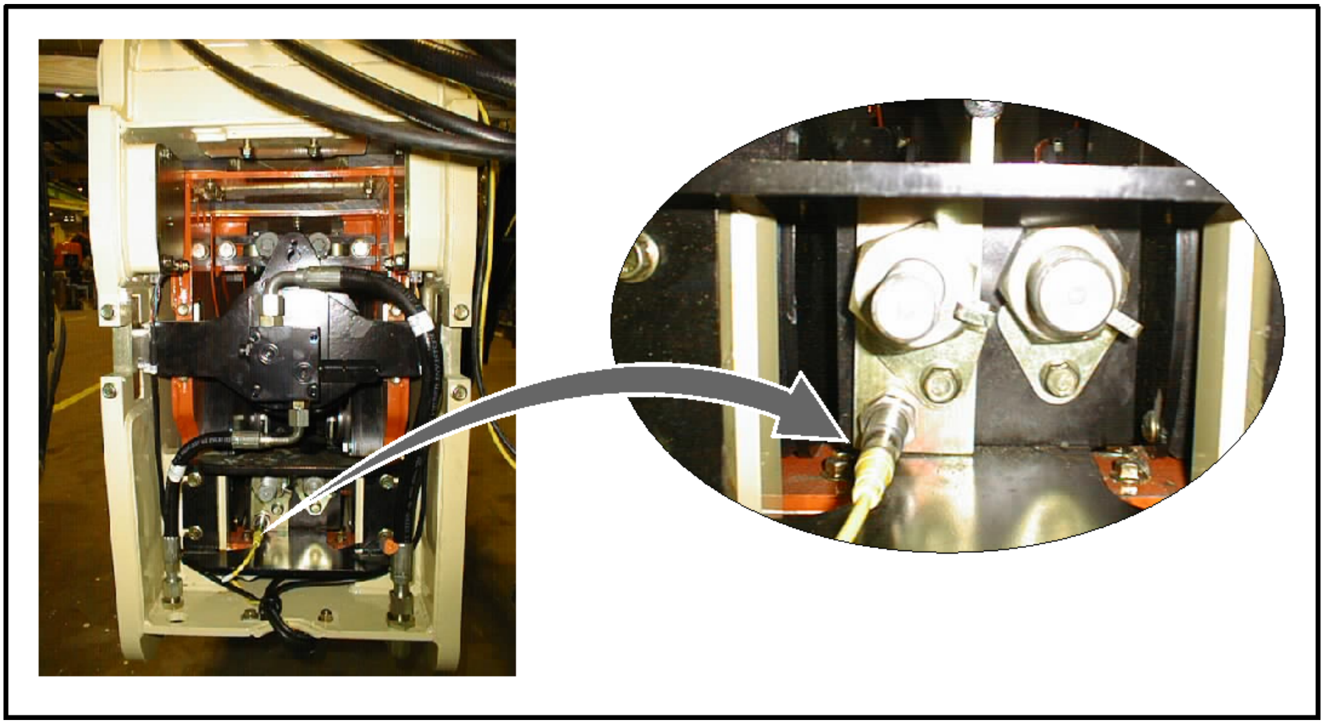


Figure 4-34. Broken Boom Cable Proximity Switch Location

4.13 ELECTRONIC PLATFORM LEVELING

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Description

Electronic platform leveling replaces the conventional hydraulic method of platform leveling.

To control electronic platform leveling the platform is equipped with a pair of tilt sensors, one primary and one secondary, mounted to the non-rotating portion of the platform rotator. The tilt sensors are monitored regularly and the platform level up and down valves are automatically controlled to maintain **set point** as the machine is operated.

PRIMARY AND SECONDARY TILT SENSOR INTERACTION

The secondary tilt sensor is used as a backup to the primary tilt sensor. Any time a tilt **set point** is reset, a value from each sensor shall be set.

If a fault occurs with the primary sensor, control will revert to the secondary sensor. (This is discussed in more detail in the error response section.)

Because of the mounting orientation of the tilt sensors, the primary tilt sensor will output ascending voltage values with increases in positive platform tilt angle. The backup or secondary tilt sensor will output descending voltage values with increases in positive platform angle.

PLATFORM VALVES

The platform specific valves are located in a manifold at the platform.

There are individual proportional control valves that control each of the four platform functions; Platform Level, Platform Rotate, Jib Lift, and Jib Swing.

There is also a Platform Dump Valve, located in the platform valve manifold, which is used to hydraulically isolate the control valves and to improve hydraulic response.

The Ground Module controls this valve to provide manual platform leveling in the event that the Platform Module is inoperable.

In ground mode, the platform dump valve is turned on whenever any platform or jib valve output is turned on. Whenever all platform and jib valves are turned off, the platform dump valve is turned off.

In platform mode, the platform dump valve is turned on whenever the footswitch is depressed.

Normal Operation

AUTOMATIC LEVELING

Two tilt sensors, mounted on either side of the platform support, are used to measure the incline of the platform with respect to gravity and control the automatic leveling function, one is used as the primary sensor and one as a secondary back up sensor.

The level system shall assume a new **fixed set point** (fixed incline of the platform with respect to gravity) each time the control system is powered up (cycling of the EMS).

Automatic platform leveling only functions while operating drive, telescope, lift or swing. It does not operate while operating any other function (e.g. rotate, jib, or steer).

The proportional control for these valves varies. This is dependant on the tilt variance from target as well as on the impact coil temperature is having on the current to the valves.

If a command from the Platform Level Up and Down toggle switch on either the platform or the ground is received, automatic platform leveling will cease and the appropriate output will be commanded to turn on.

When the toggle switch is released, after ¼ second, the current filtered value of tilt angle will be taken as **the new set point**.

In order to obtain acceptable performance while performing all hydraulic functions, five sets of parameters are used. These “zones” allow compensation for differences in how the basket level changes when doing different functions. These zones are as follows:

1. Lift up
2. Lift down
3. Other boom functions
4. Drive
5. Auxiliary

The other boom functions zone includes Swing, Telescope, Jib swing (It is not necessary to level with jib lift, since the mechanical linkage keeps the basket level).

These zones are prioritized when multiple functions are active. The priorities are as follows.

1. Auxiliary power and any other function, zone = auxiliary power
2. Drive and any other function, zone = Drive
3. Lift up and any other function, zone = Lift up
4. Lift down and any other function, zone = Lift down
5. Other boom functions, zone = Other boom functions

During the power-up procedure, function enable, in both Platform and Ground Mode, is delayed during the 1.5 second startup lamp test. During this 1.5 second startup period, the basket level up valve will be energized at 100% duty cycle for 0.5 second, and then the basket level down valve energized at 100% duty cycle for 0.5 second. This will help to keep the valves from sticking.

PLATFORM LEVEL MANUAL OVERRIDE

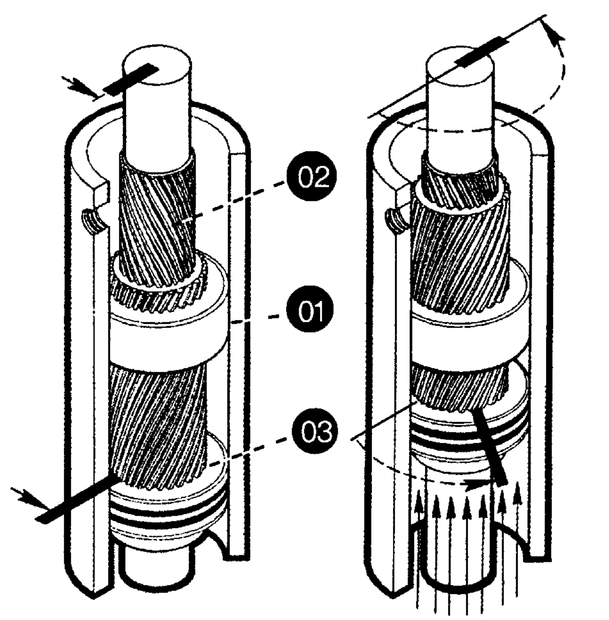
In addition to automatic leveling the operator is able to manually adjust the platform level position by means of the level override switches located at the platform and ground control positions (similar to a Master/Slave hydraulic system).

The level system assumes a **new set point** after a level override switch is operated. In other words the operator can chose a platform level incline other than level with gravity and the system will maintain this set point during automatic leveling.

4.14 ROTARY ACTUATOR

Theory of Operation

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



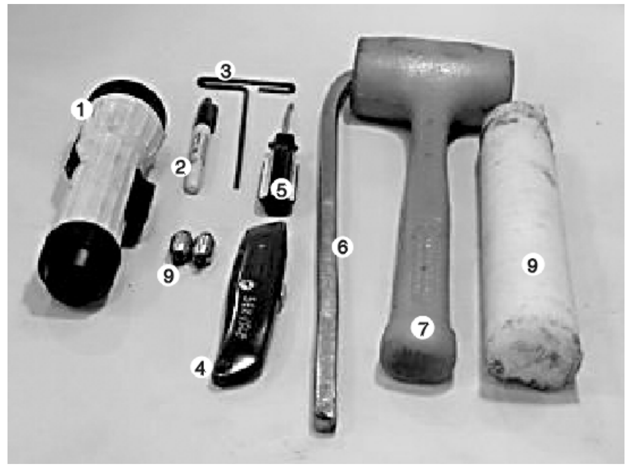
Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.

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

The shaft is supported radially by the large 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.

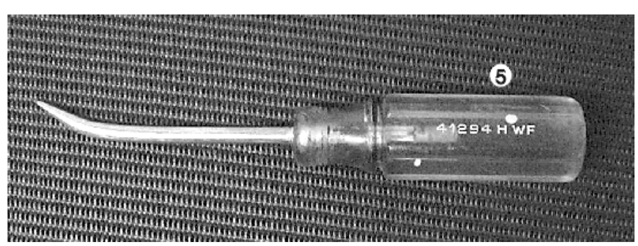
Required Tools

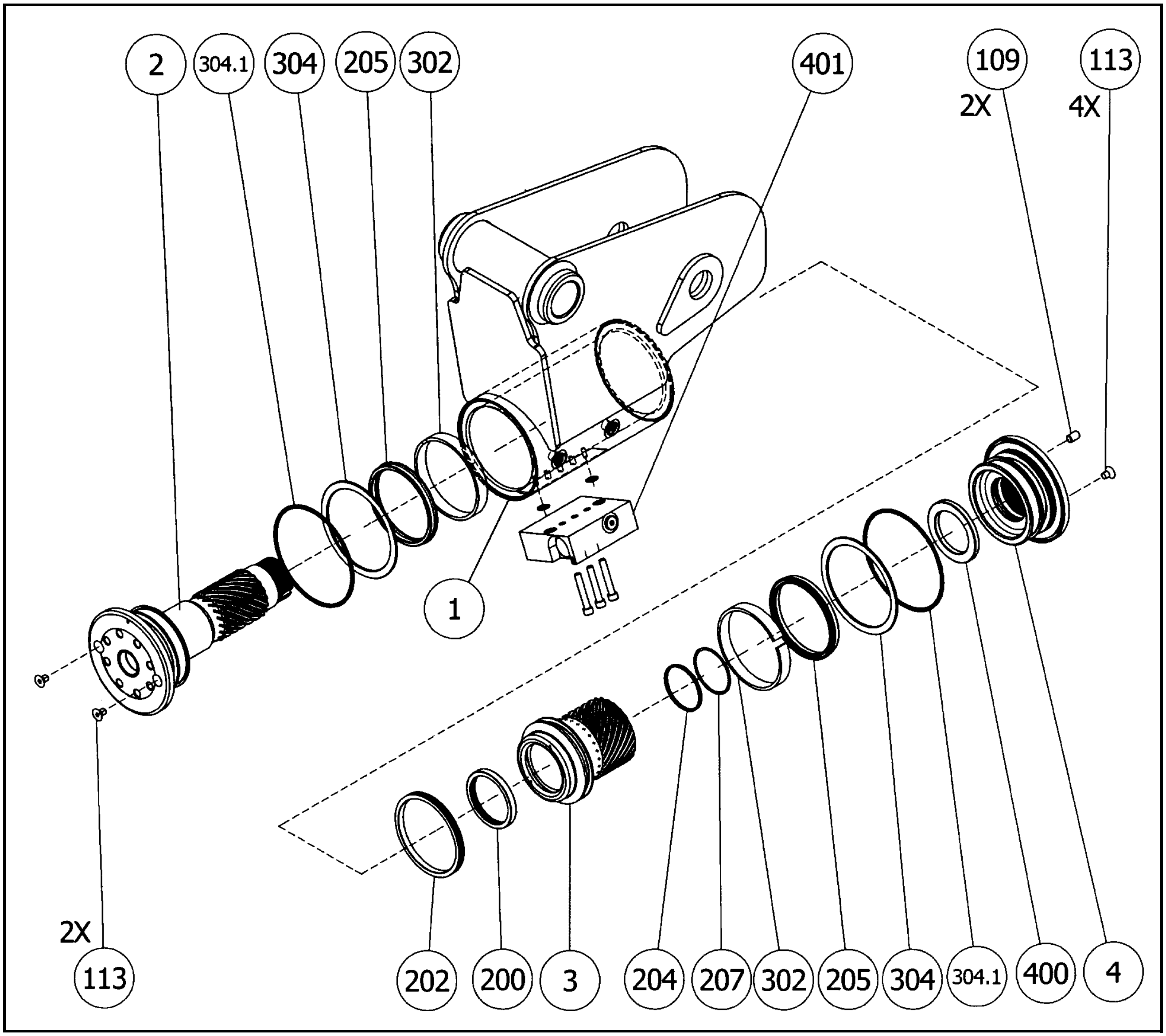
Upon assembly and disassembly of the actuator there are basic tools required. The tools and their intended functions are as follows:



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

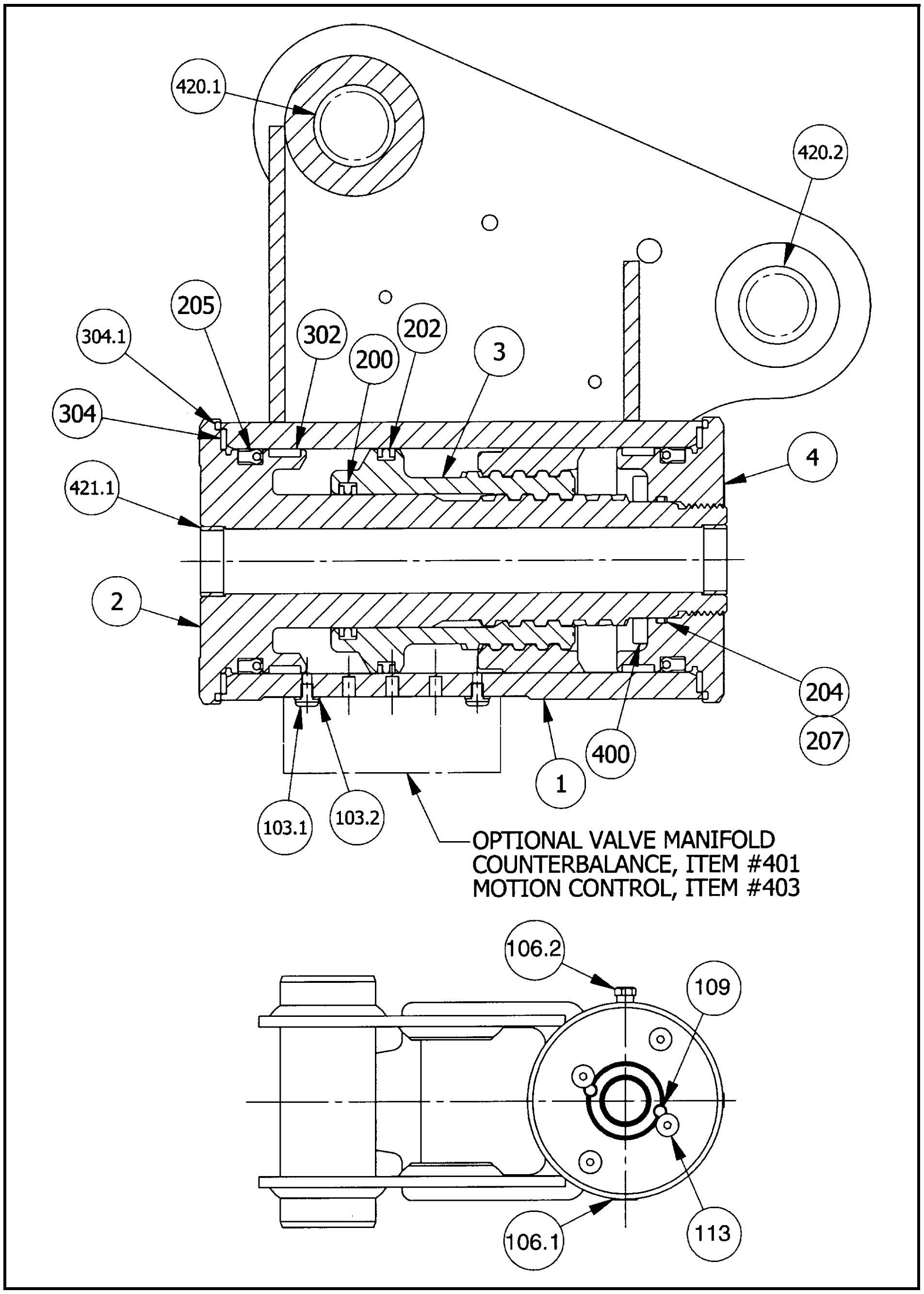
The seal tool is merely a customized standard flat head screwdriver. To make this tool you will need to heat the flat end with a torch. Secure the heated end of the screwdriver in a vice and physically bend the heated end to a slight radius. Once the radius is achieved round off all sharp edges of the heated end by using a grinder. There may be some slight modifications for your own personal preference.





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

Figure 4-35. Rotary Actuator - Exploded View

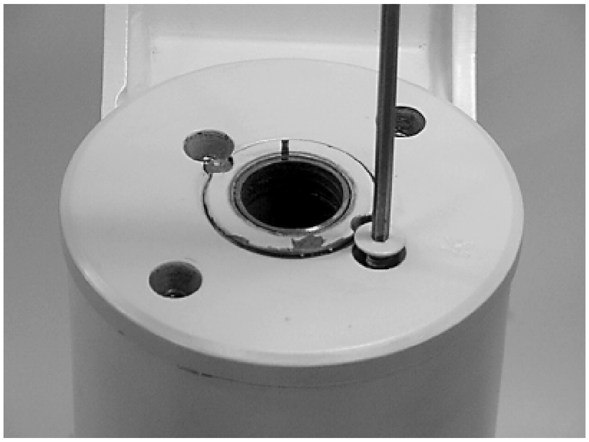


PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109.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

Figure 4-36. Rotary Actuator - Assembly Drawing

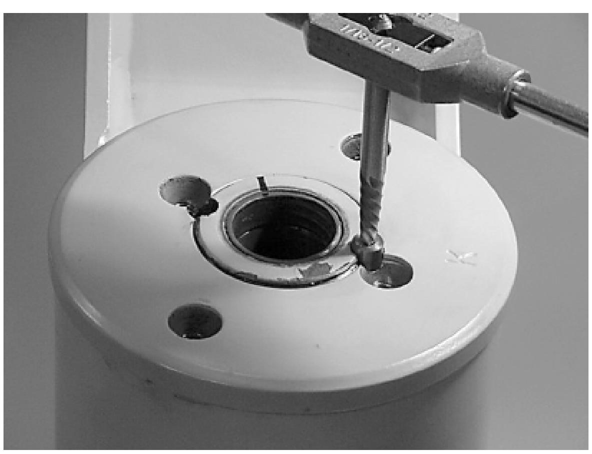
Disassembly

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.

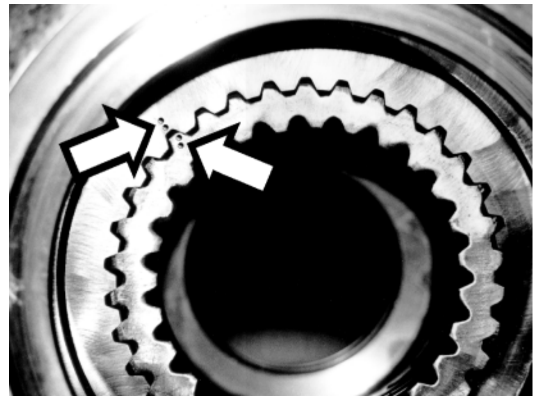
4. Install the end cap (4) removal tools provided with the Helac seal kit.

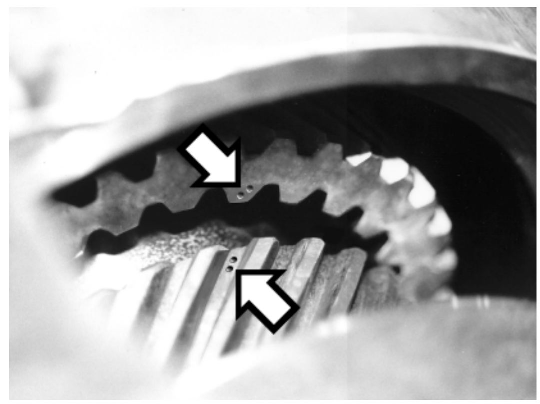
5. Using a metal bar, or something similar, unscrew the end cap (4) by turning it counter clockwise.

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

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

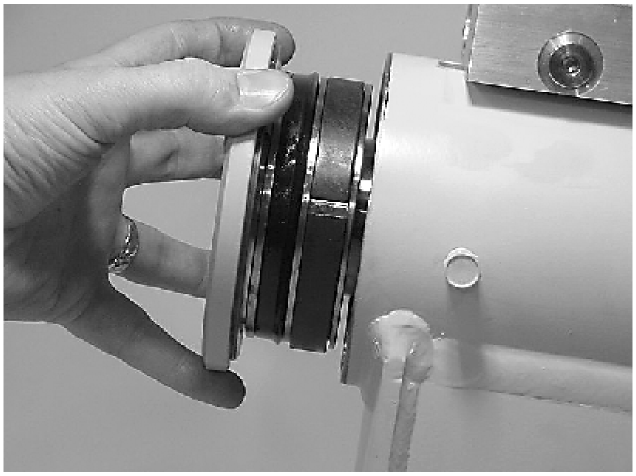
8. Every actuator has timing marks for proper engagement.





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

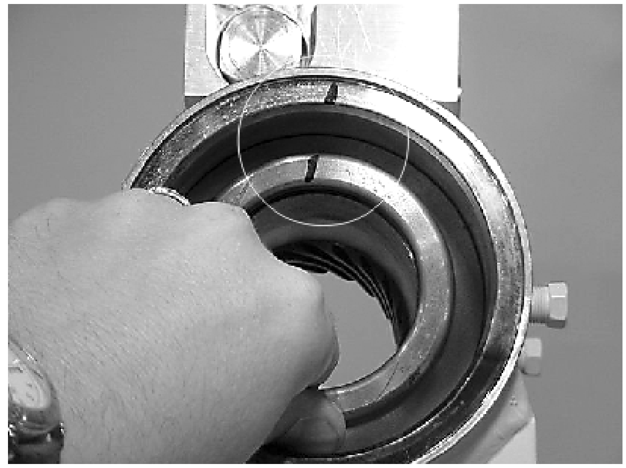
10. Remove the shaft (2). It may be necessary to strike the threaded end of the shaft with a rubber mallet.



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

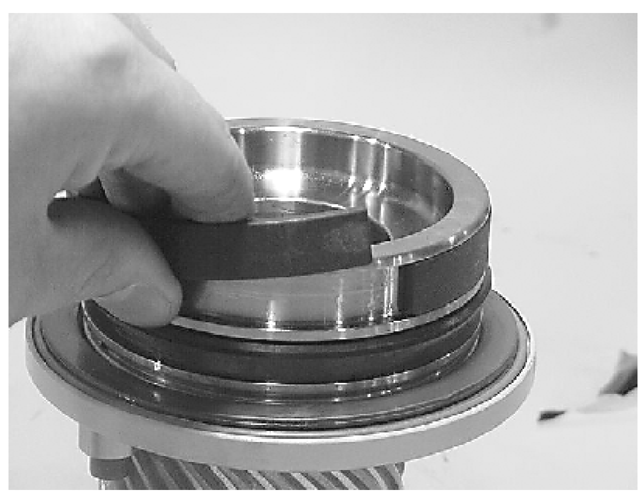
12. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is not damaged.

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

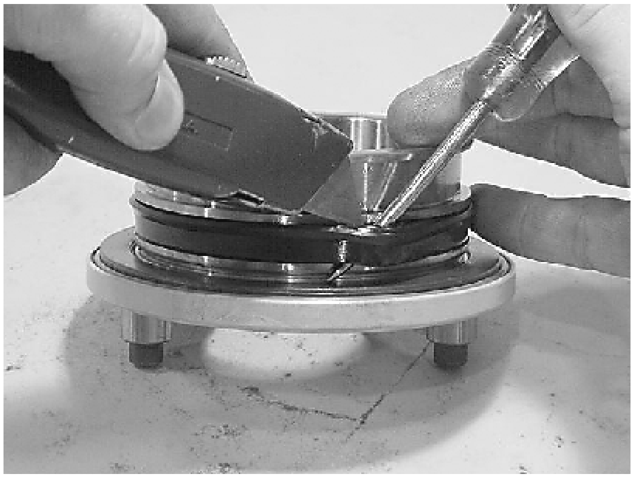


14. Remove the o-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.

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



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



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

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

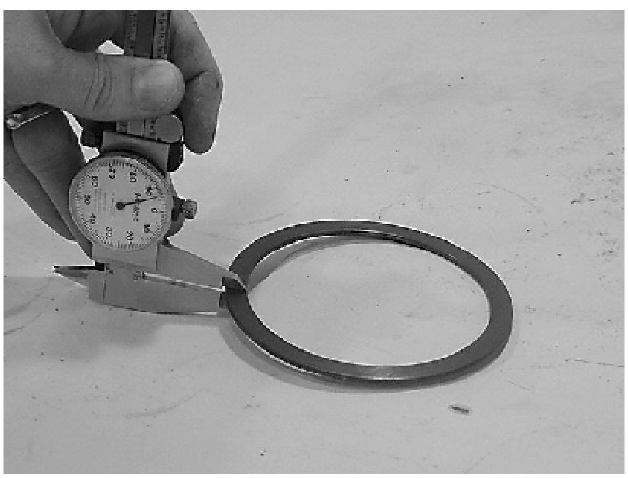
19. Remove the piston O.D. seal (202).

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

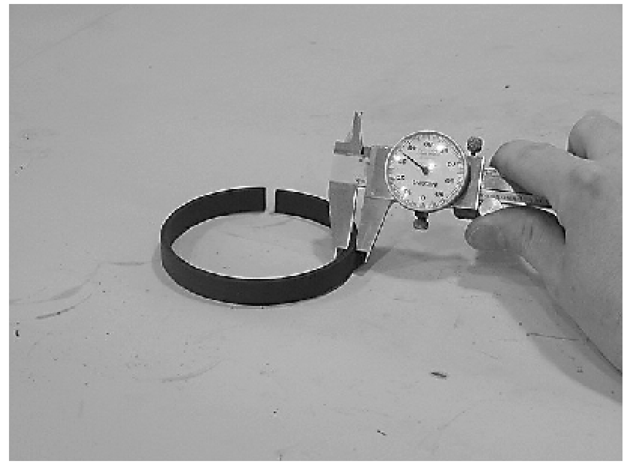
Inspection

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).

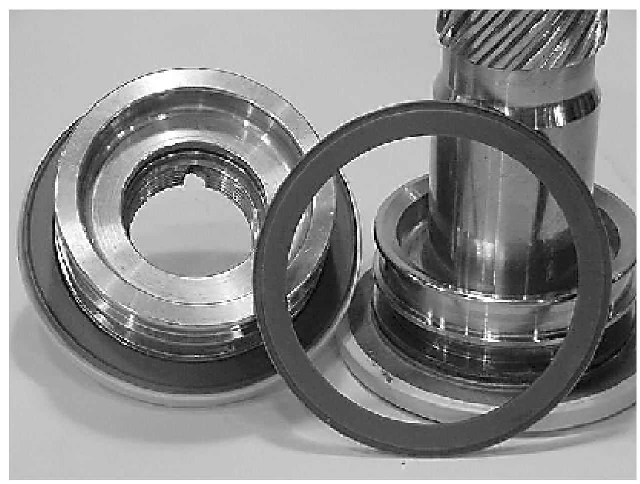


3. Inspect the wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).

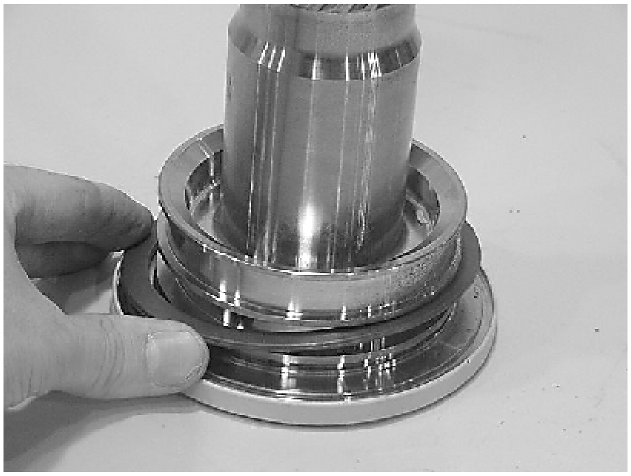


Assembly

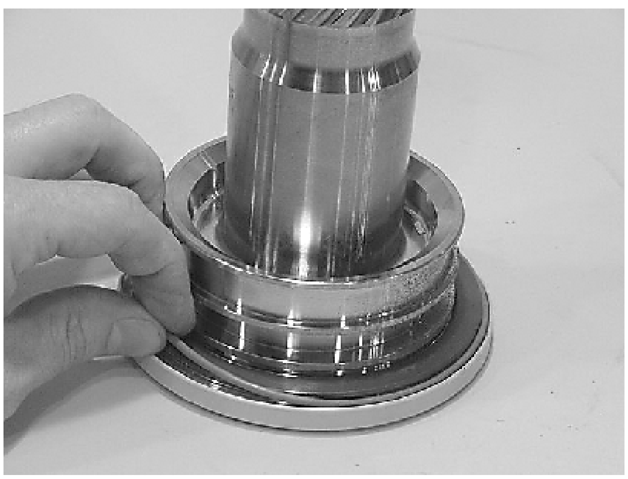
1. Gather all the components and tools into one location prior to re-assembly. Use the cut away drawing to reference the seal orientations.



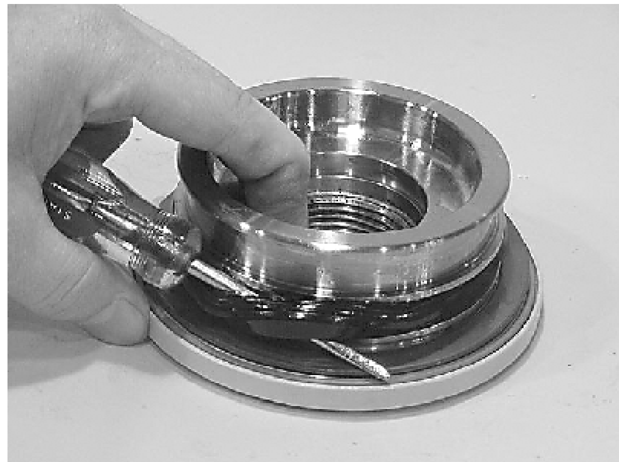
2. Install the thrust washer (304) onto shaft (2) and end cap (4).



3. Install the wiper seal (304.1/green 0-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.



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

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

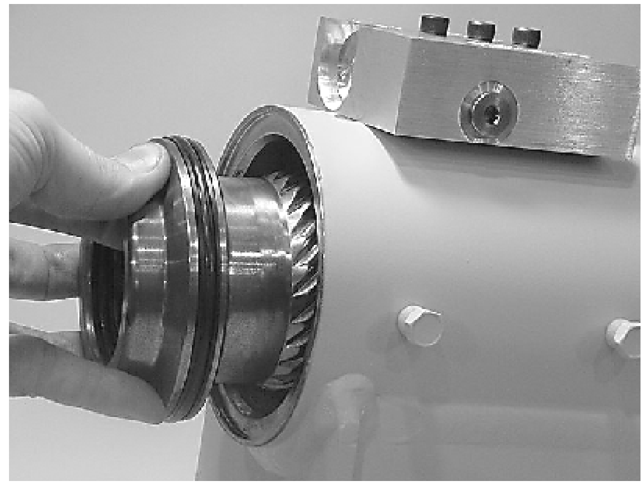
   Install the outer T-seal (202) by stretching it around the groove in a circular motion.

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

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).

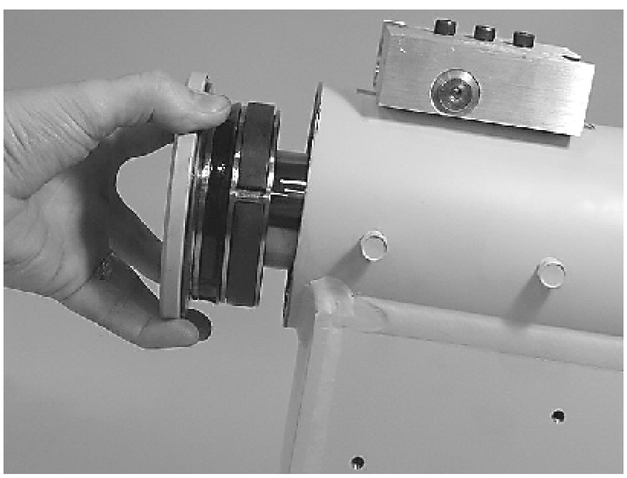
7. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) is touching inside the housing bore.



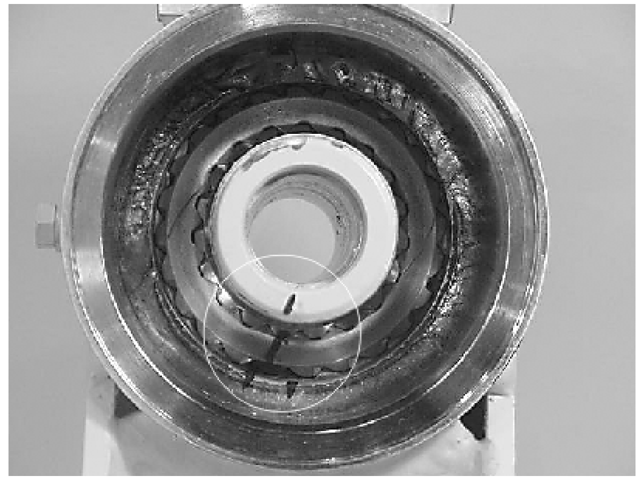
8. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.

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.

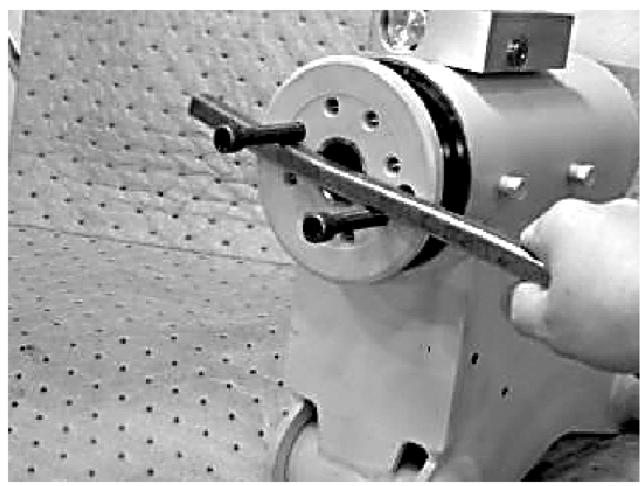
10. Install the shaft (2) into the piston (3). Be careful not to damage the seals. Do not engage the piston gear teeth yet.



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.

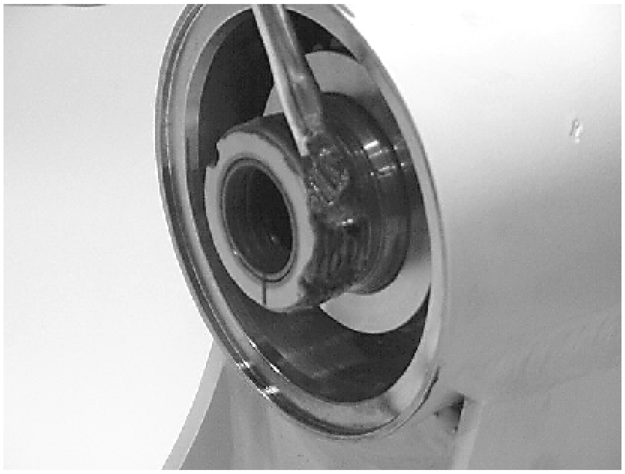


12. Install 2 bolts in the threaded holes in the flange. Using a bar, rotate the shaft in a clockwise direction until the wear guides are seated inside the housing bore.



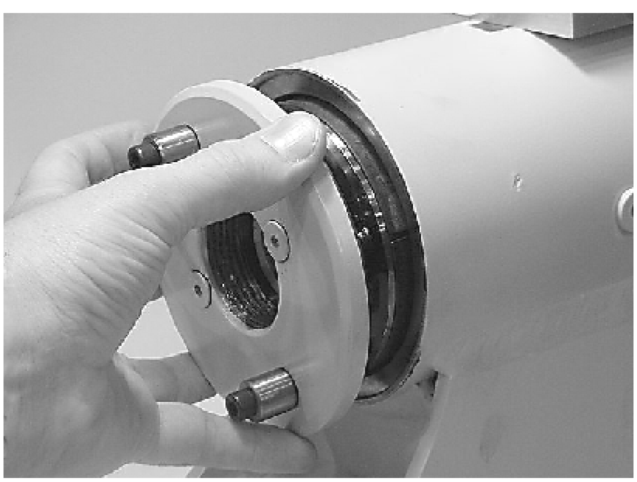
13. Install the stop tube onto the shaft end. Stop tube is an available option to limit the rotation of an actuator.

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

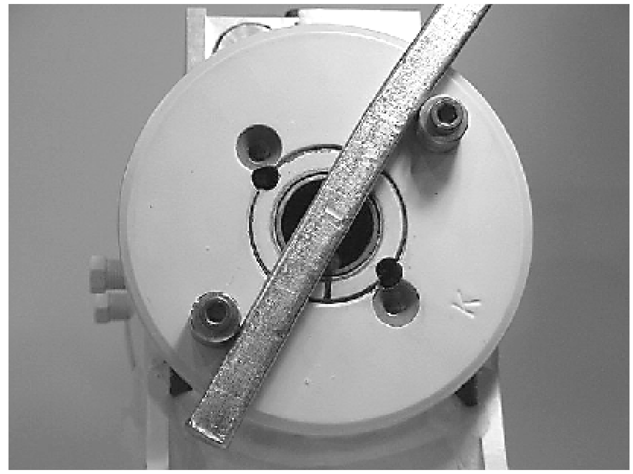


15. Install the 0-ring (204) and back-up ring (207) into the inner seal groove on the end cap (4).

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).

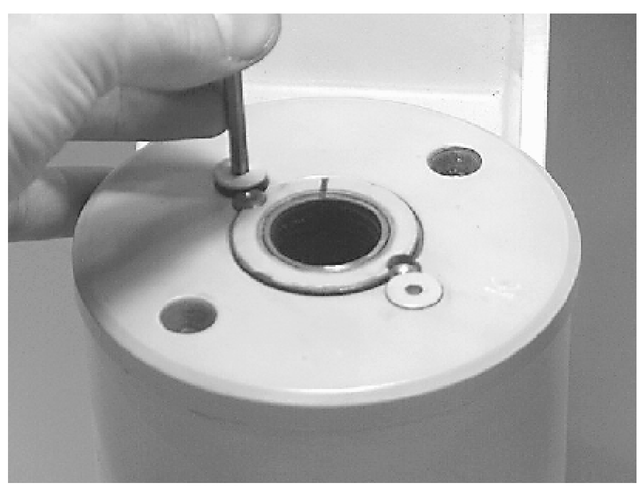


17. Tighten the end cap (4). In most cases the original holes for the lock pins will line up.



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.

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



Installing Counterbalance Valve

Refer to Figure 4-37., 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).

Testing the Actuator

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

TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

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

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

Bleeding After Installation

NOTE: *Bleeding will be necessary if excessive backlash is displayed after the actuator is installed. To do this, bleeder valves must be installed in the actuator at the locations shown below. The following steps are recommended when a minimum of two gallons (8 liters) is purged.*

1. Connect a 5 foot (1.5 m) long 3/16" inside diameter, 5/16" outside diameter clear vinyl drain tube to each of the two bleeder valves. Secure the tubes in place with hose clamps.
2. Place the end of the tubes in a clean 5 gallon (19 L) container to collect the purged oil. The oil can be returned to the reservoir when the procedure is complete.
3. Open both bleeder valves 1/4 turn. Using the hydraulic system, rotate the platform to the end of rotation and maintain hydraulic pressure. Oil with small air bubbles should be seen flowing through the tubes. Allow 1/2 gallon (2 L) of oil to be purged from the actuator.
4. Keep the bleeder valves open and rotate the platform in the opposite direction to the end of rotation. Maintain hydraulic pressure until an additional 1/2 gallon (2 L) of oil is pumped out.
5. Repeat steps 3 and 4. After the last 1/2 gallon (2 L) of oil is purged, close both bleed nipples before rotating away from the end of rotation.

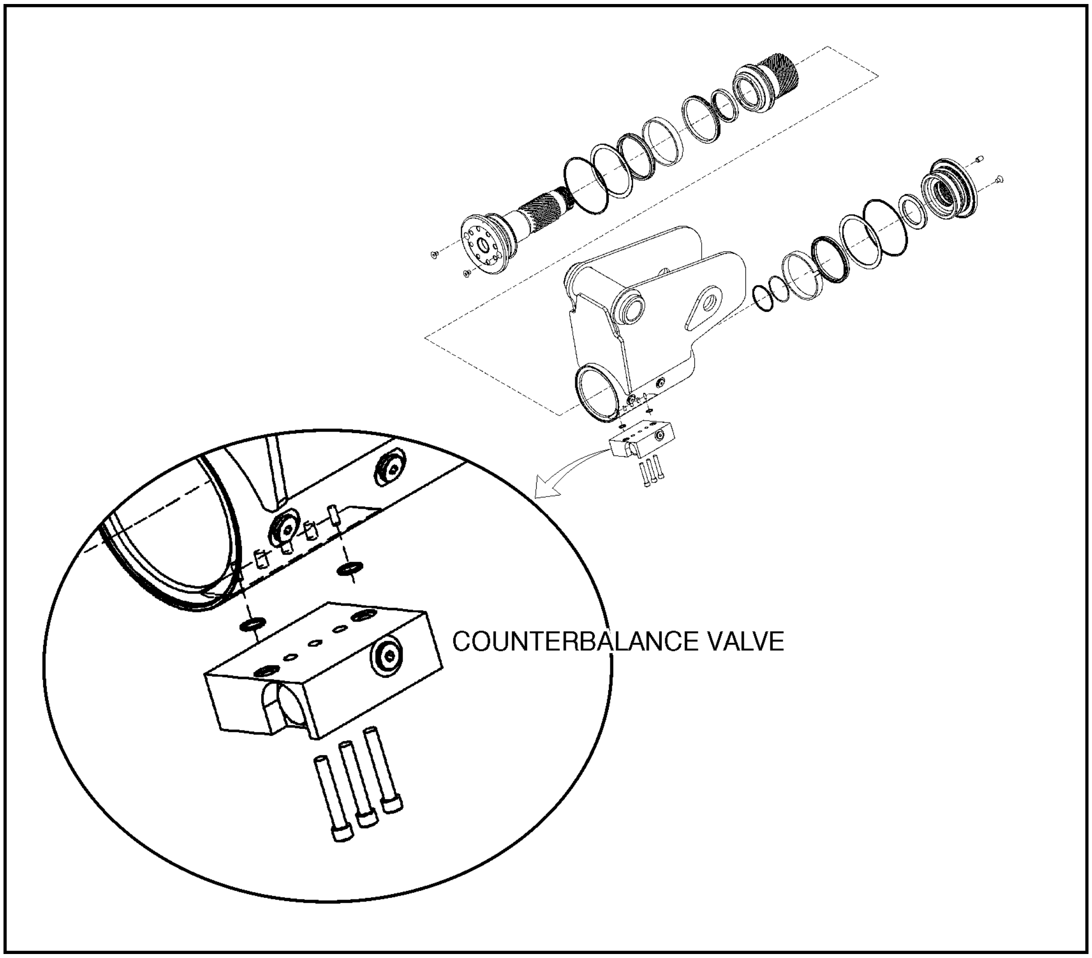
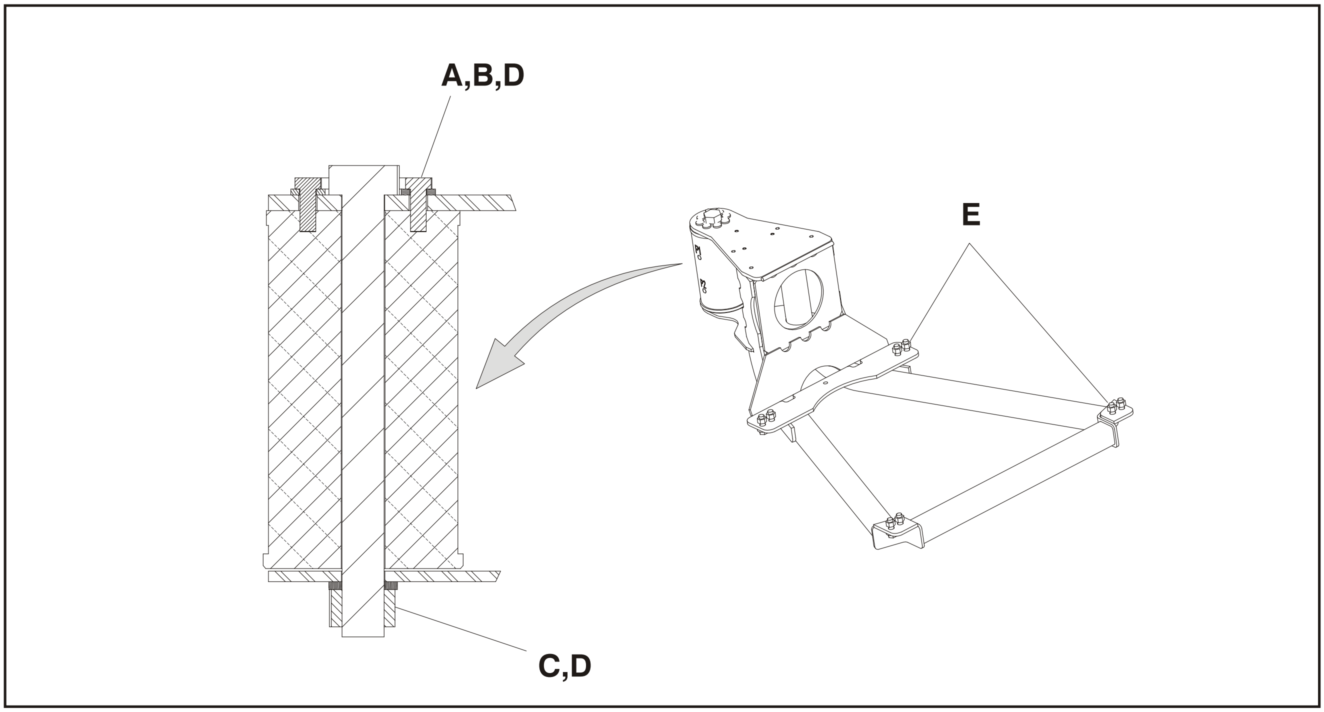


Figure 4-37. Rotator Counterbalance Valve



A Torque to 50 ft.lbs. (68 Nm)
B Loctite #242
C Torque to 480 ft. lbs. (650 Nm)
D Check torque every 150 hours of operation
E Torque to 75 ft. lbs. (102 Nm)

Figure 4-38. Platform Support Torque Values

SECTION 5. HYDRAULICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

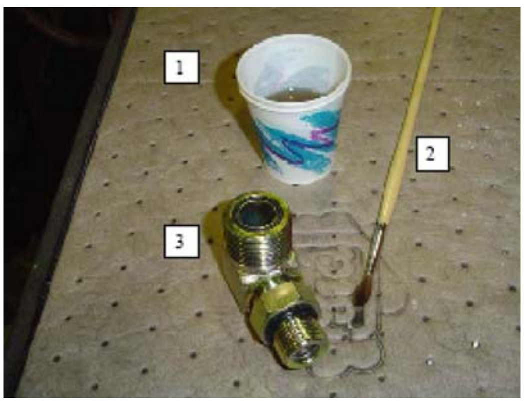
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

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

Cup and Brush

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

- A small container for hydraulic oil
- Small paint brush



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

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

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

Dip Method

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

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

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

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

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

Spray Method

This method requires a pump or trigger spray bottle.

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

Brush-on Method

This method requires a sealed bottle brush.

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

5.2 CYLINDER REPAIR

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.

NOTICE

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.

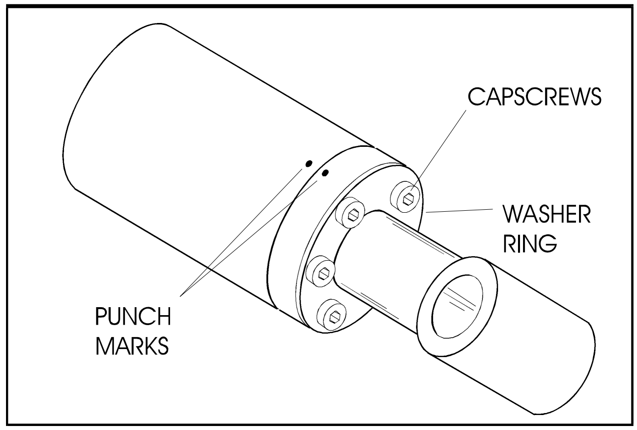


Figure 5-2. Cap Screw Removal

4. Place the cylinder barrel into a suitable holding fixture.

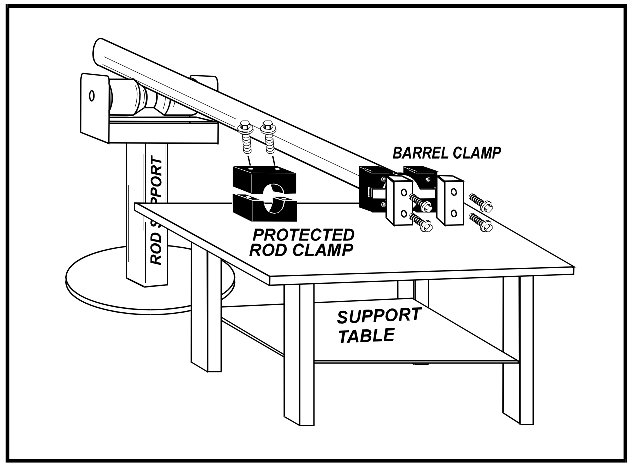
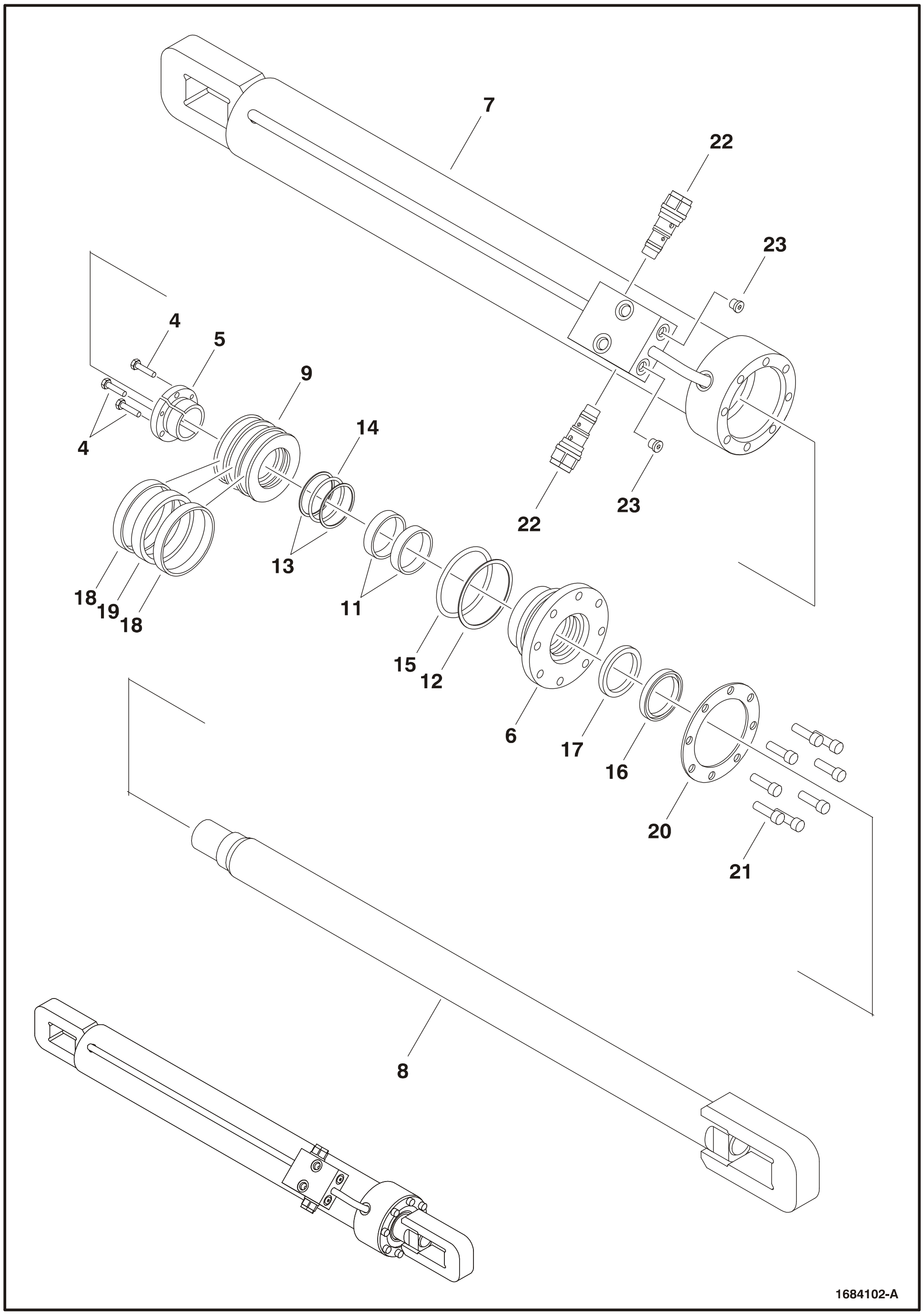


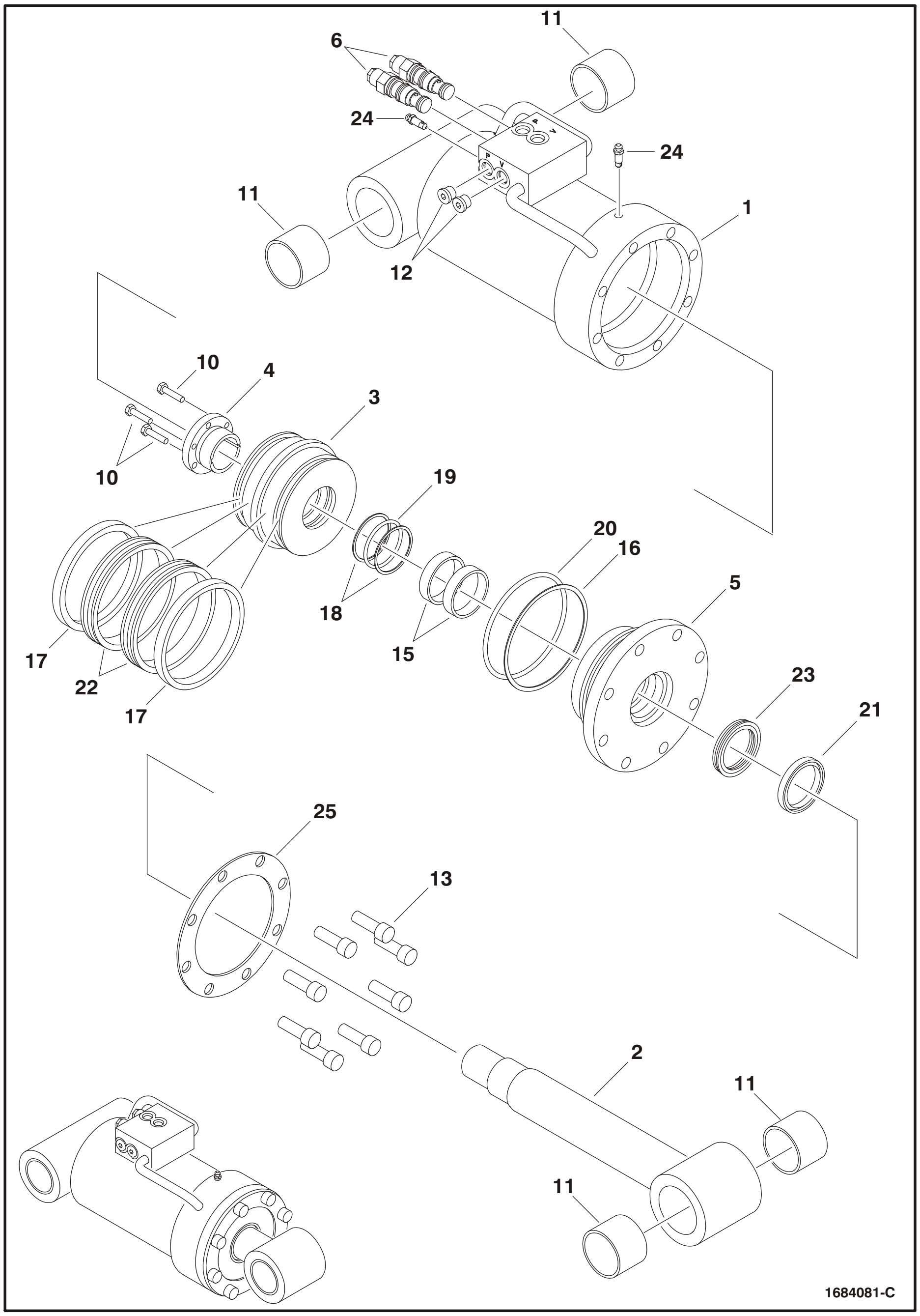
Figure 5-1. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the eight (8) cylinder head retainer cap screws, and remove cap screws from cylinder barrel.
6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.



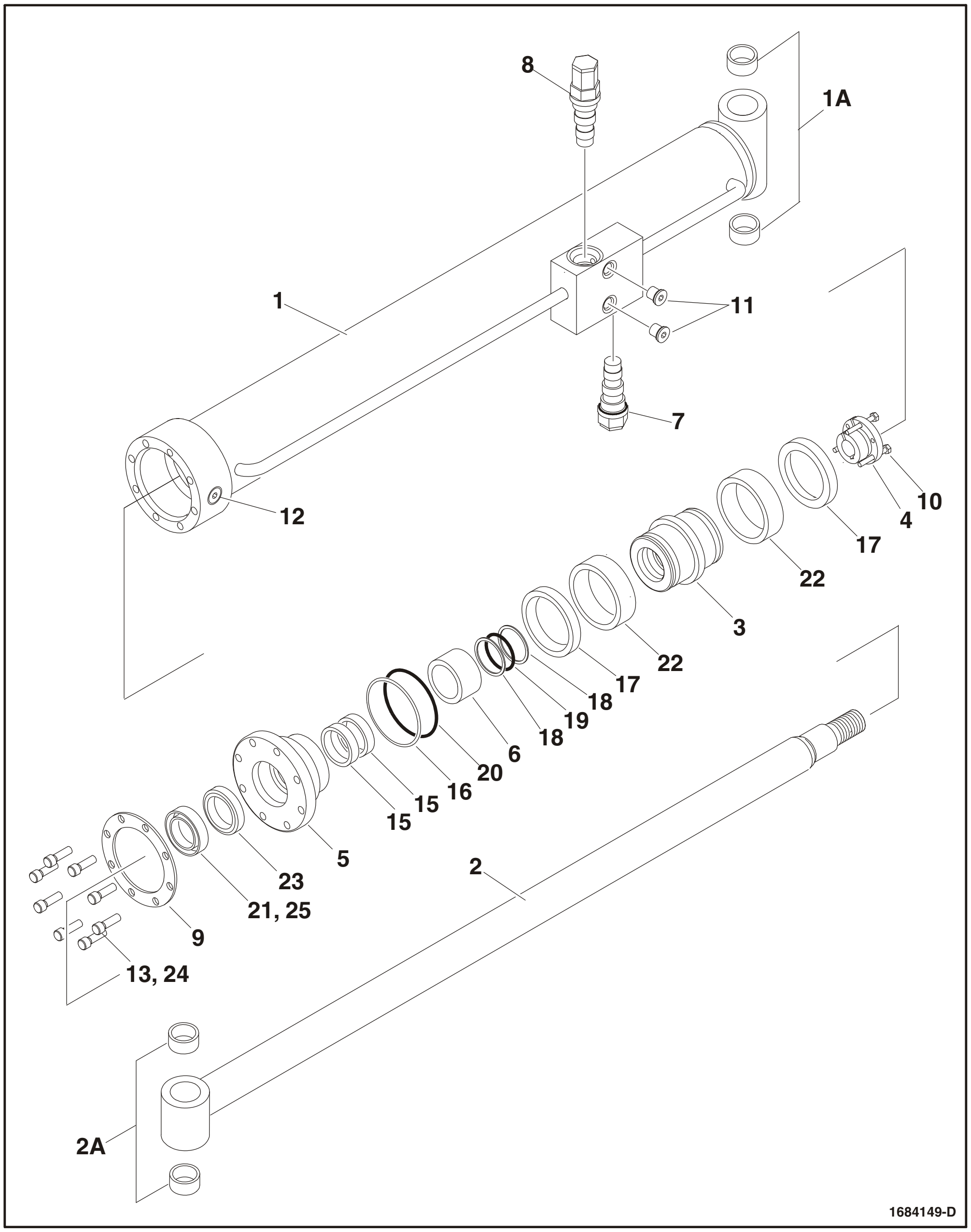
1. Loctite #242 (Not Shown)	7. Barrel	13. Back-Up Ring	19. T-Seal
2. Locking Primer (Not Shown)	8. Rod	14. O-Ring	20. Washer Ring
3. Loctite #RC 609 (Not Shown)	9. Piston	15. O-Ring	21. Bolt
4. Capscrew	10. Not Used	16. Rod Wiper	22. Holding Valve
5. Tapered Bushing	11. Wear Ring	17. Seal	23. O-Ring Plug
6. Head	12. Back-Up Ring	18. Wear Ring	

Figure 5-3. Axle Extension Cylinder



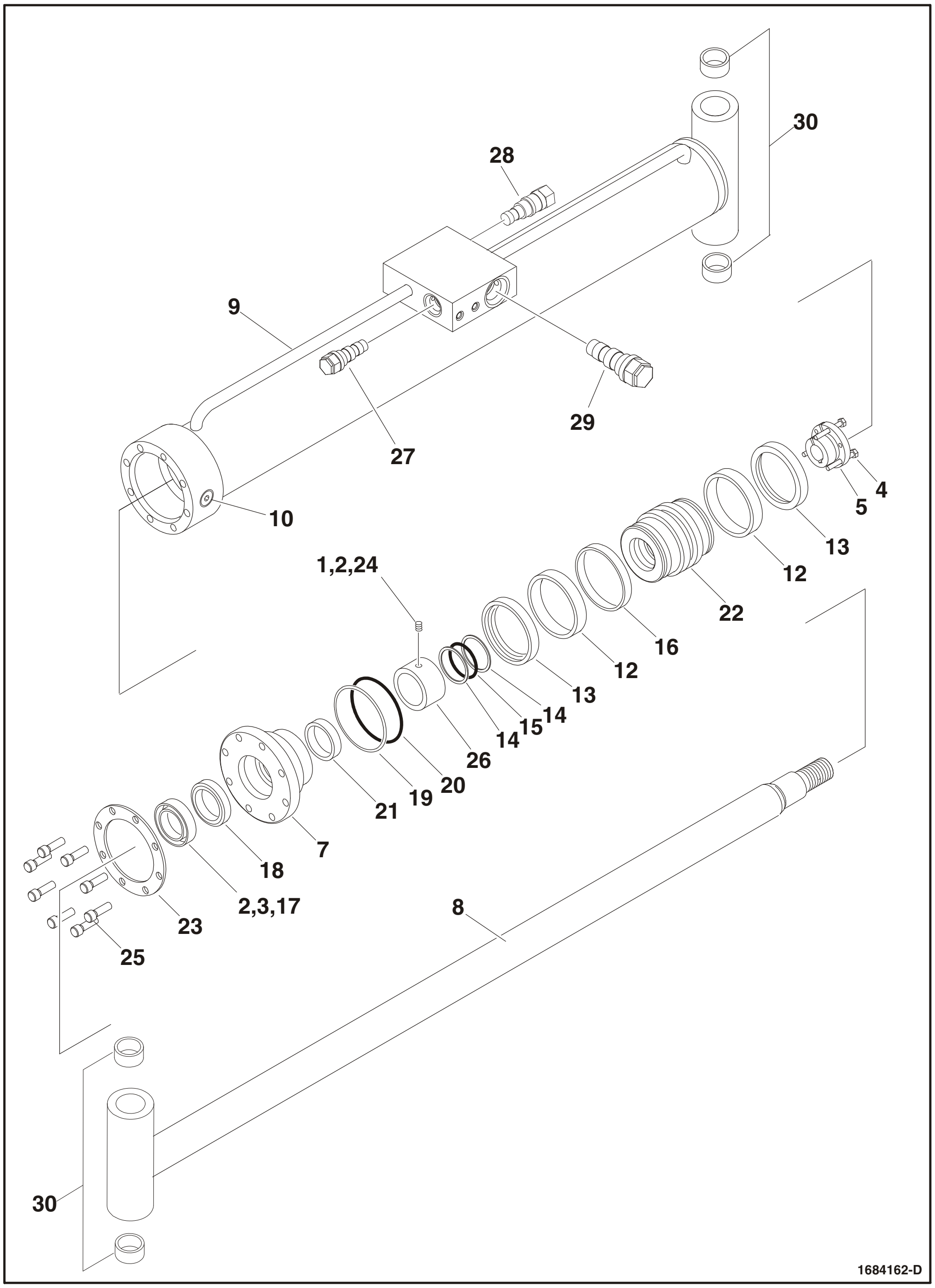
1. Barrel	8. Locking Primer (Not Shown)	14. Not Used	20. O-ring
2. Rod	9. Loctite #RC 609 (Not Shown)	15. Wear Ring	21. Wiper
3. Piston	10. Bolt	16. Backup Ring	22. Seal
4. Bushing	11. Bearing	17. Lock Ring	23. Rod Seal
5. Head	12. O-ring Plug	18. Backup Ring	24. Bleeder Valve
6. Counterbalance Valve	13. Socket Head Bolt	19. O-ring	25. Washer Ring
7. Loctite #242 (Not Shown)			

Figure 5-4. Axle Lockout Cylinder



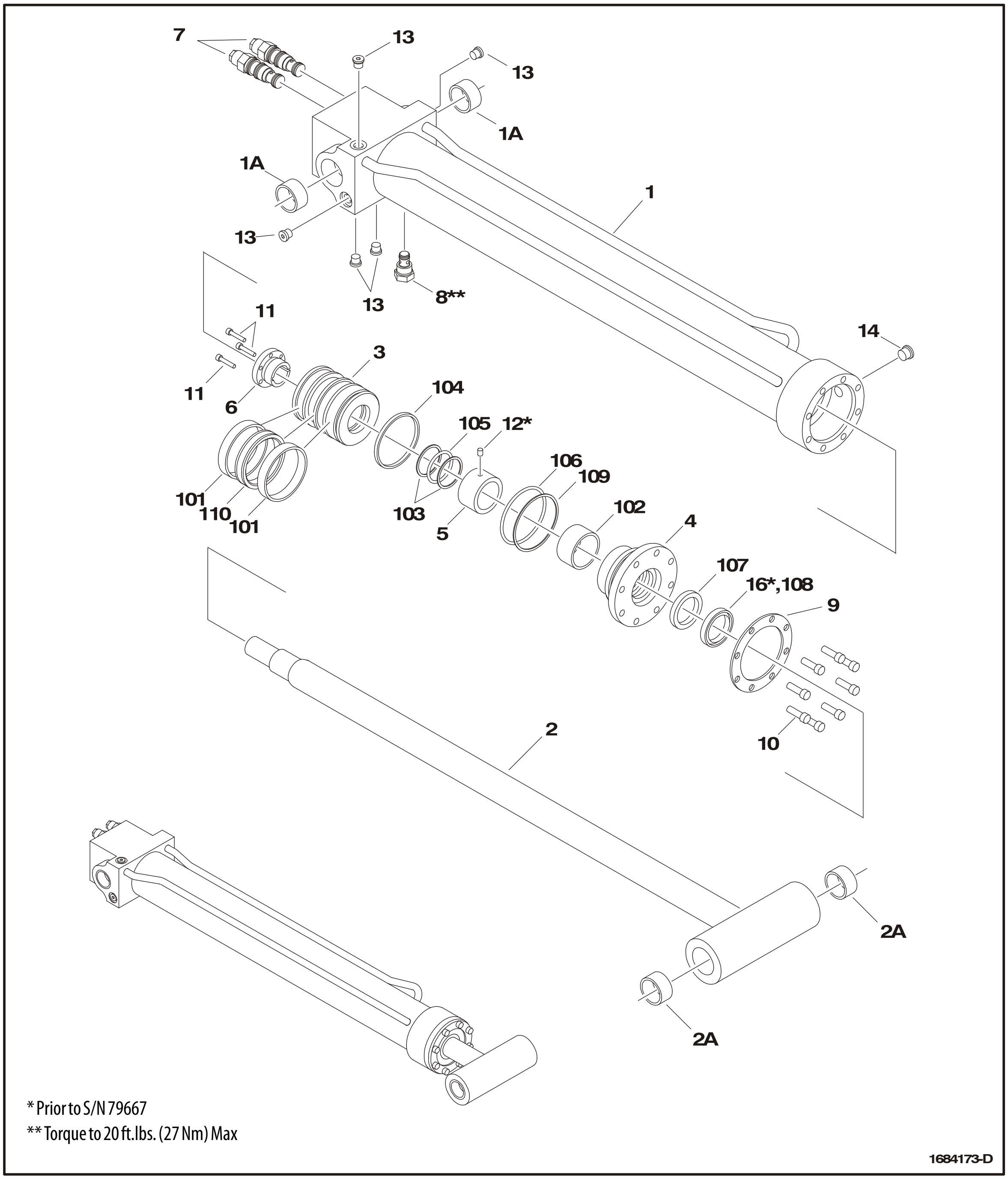
1. Barrel	8. Cartridge, Holding Valve	17. Ring, Lock
1A. Bushing	9. Washer Ring	18. Ring, Back-Up
2. Rod	10. Capscrew	19. O-Ring
2A. Bushing	11. O-Ring Plug	20. O-Ring
3. Piston	12. O-Ring Plug	21. Wiper, Rod
4. Tapered Bushing	13. Capscrew	22. Ring, Guide
5. Head	14. Not Used	23. Seal, Rod
6. Spacer	15. Wear Ring	24. Loctite #242 (Not Shown)
7. Holding Valve	16. Back-Up Ring	25. Loctite #RC 609 (Not Shown)

Figure 5-5. Level Cylinder



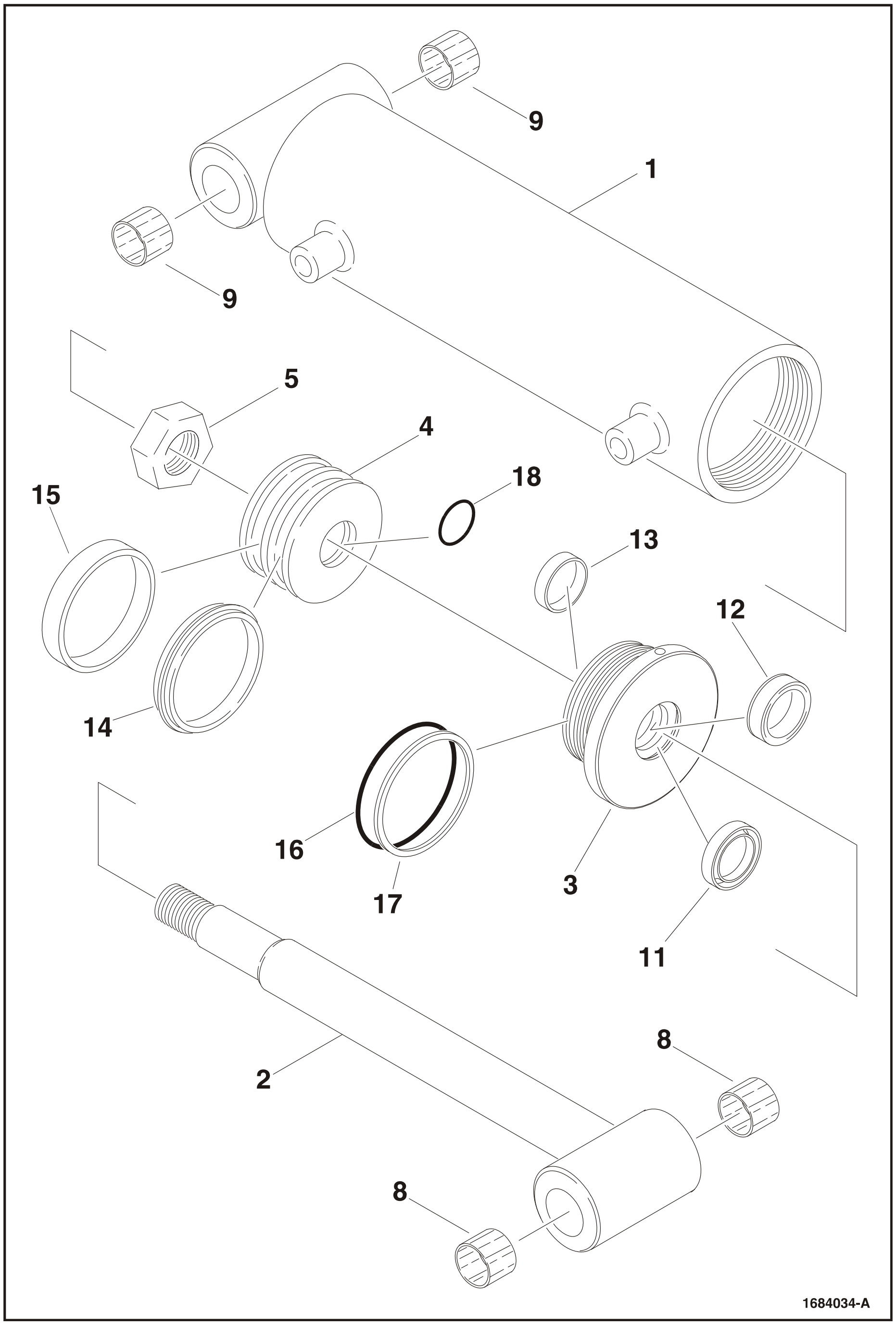
1. Loctite #242	7. Head	13. Lock Ring	19. Backup Ring	25. Capscrew
2. Locking Primer	8. Rod	14. Back Up Ring	20. O-ring	26. Spacer
3. Not Used	9. Barrel	15. O-Ring	21. Wear Ring	27. Check Valve Cartridge
4. Capscrew	10. O-ring Plug	16. Wear Ring	22. Piston	28. Holding Valve Cartridge
5. Tapered Bushing	11. Not Used	17. Rod Wiper	23. Washer Ring	29. Pressure Regulator Valve
6. Not Used	12. Guide Ring	18. Rod Seal	24. Not Used	30. Bushing

Figure 5-6. Lift Cylinder



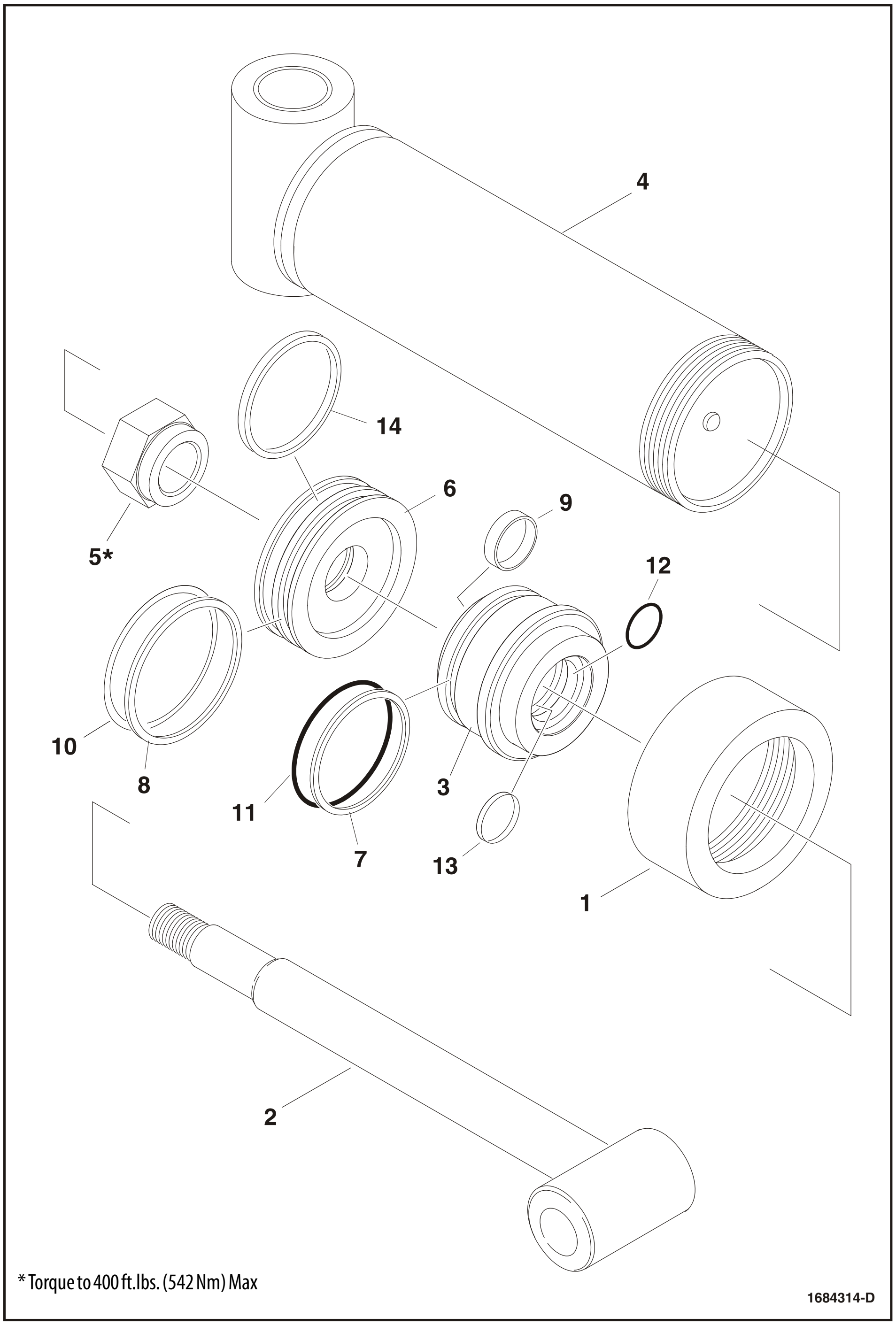
1. Barrel	5. Spacer	11. Capscrew	101. Wear Ring	107. Seal
1A. Bushing	6. Tapered Bushing	12. Not Used	102. Wear Ring	108. Rod Wiper
2. Rod	7. Counterbalance Cartridge	13. O-ring Plug	103. Backup Ring	109. Backup Ring
2A. Bushing	8. Check Valve Cartridge	14. O-ring Plug	104. Seal	110. Seal
3. Piston	9. Washer Ring	15. Loctite #242	105. O-ring	
4. Head	10. Capscrew	16. Not Used	106. O-ring	

Figure 5-7. Jib Cylinder



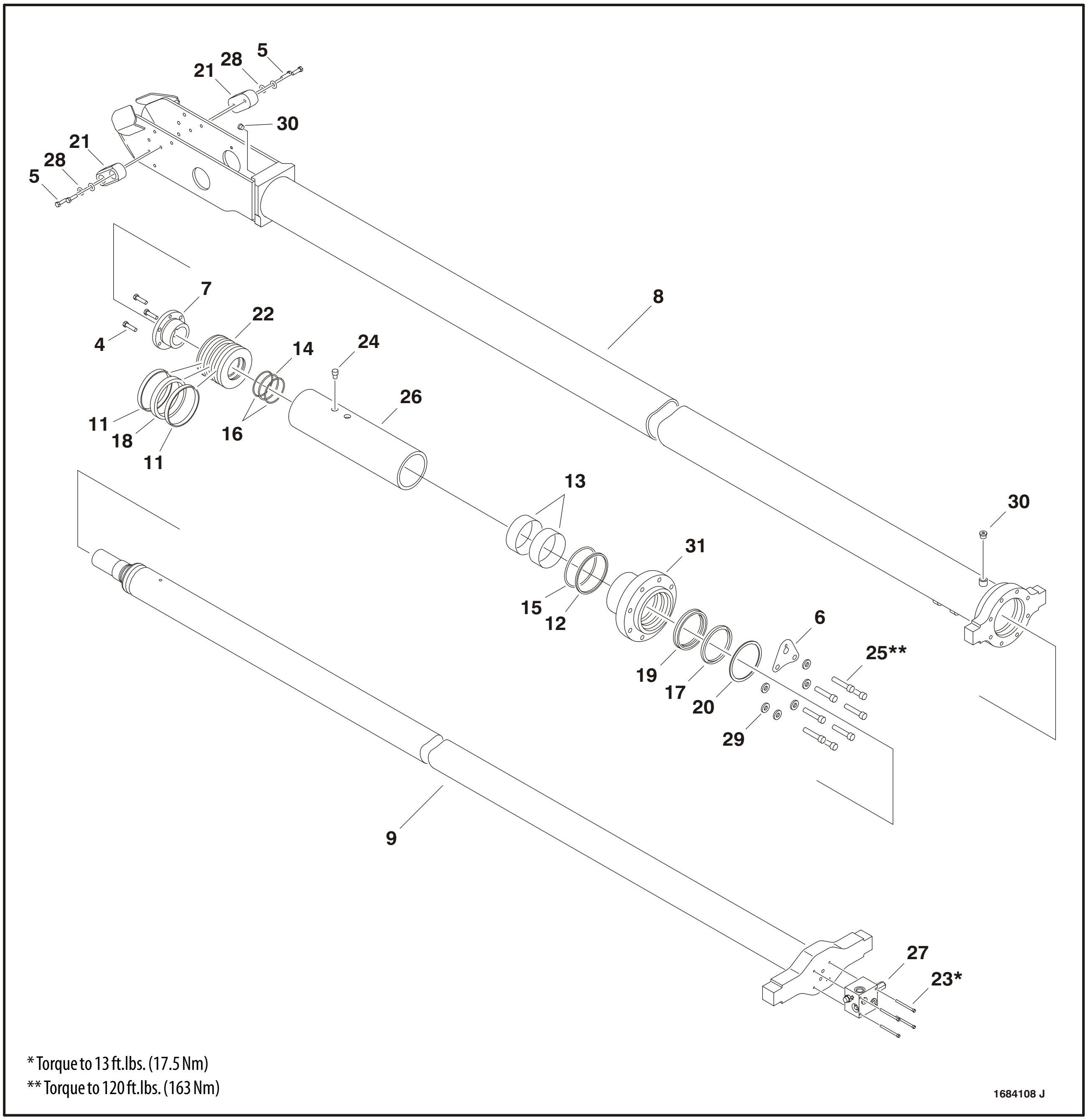
1. Barrel
2. Rod
3. Head
4. Piston
5. Nut
6. Loctite #222 (not shown)
7. Not Used
8. Rod End Bushing
9. Barrel End Bushing
10. Not Used
11. Wiper
12. Rod Seal
13. Wear Ring
14. Piston Seal
15. Wear Ring
16. O-ring
17. Back Up Ring
18. O-ring

Figure 5-8. Steer Cylinder - Prior to S/N 73367



1. Cylinder Cap
2. Rod
3. Head
4. Barrel
5. Nut
6. Piston
7. Backup Ring
8. Wear Ring
9. Wear Ring
10. O-ring
11. O-ring
12. Wiper
13. Piston Seal
14. Loctite #222 (not shown)

Figure 5-9. Steer Cylinder - S/N 73367 to Present



1. Loctite #242
2. Locking Primer
3. Not Used
4. Capscrew
5. Bolt
6. Bracket
7. Tapered Bushing
8. Barrel
9. Rod
10. Not Used
11. Wear Ring
12. Backup Ring
13. Wear Ring
14. O-Ring
15. O-Ring
16. Backup Ring
17. Rod Wiper
18. T-Seal
19. Rod Seal
20. Retaining Ring
21. Wear Pad
22. Piston
23. Capscrew
24. Capscrew
25. Capscrew
26. Spacer
27. Valve Assembly
28. Flatwasher
29. Flatwasher
30. O-Ring Plug
31. Head

Figure 5-10. Telescope Cylinder

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.

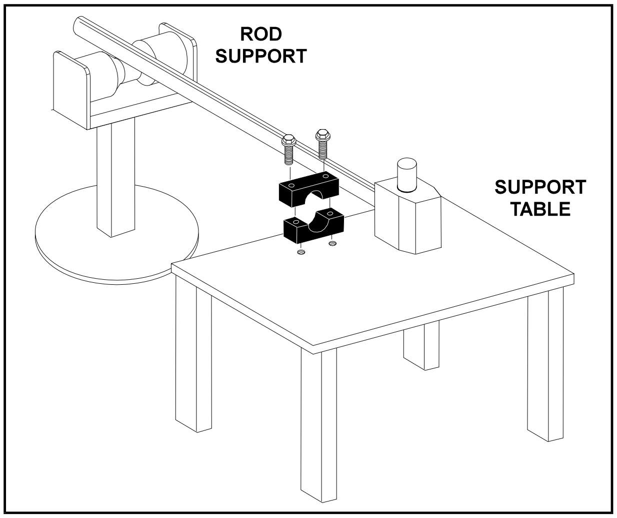


Figure 5-11. Cylinder Rod Support

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

NOTE: *Step 9 applies only to the steer cylinder.*

9. Loosen and remove nut which attaches the piston to the rod, and remove the piston.
10. Loosen and remove the cap screw(s), if applicable, which attach the tapered bushing to the piston.
11. 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.
12. Remove the bushing from the piston.

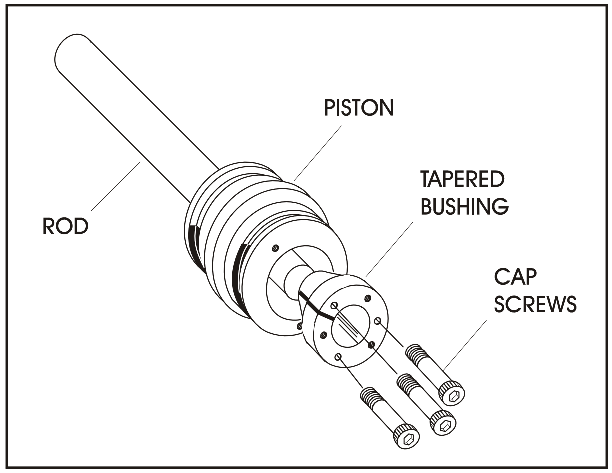


Figure 5-12. Tapered Bushing Removal

13. Screw the piston CCW, by hand, and remove the piston from cylinder rod.
14. Remove and discard the piston o-rings, seal rings, and backup rings.
15. Remove piston spacer, if applicable, from the rod.
16. 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.
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 WD40 prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

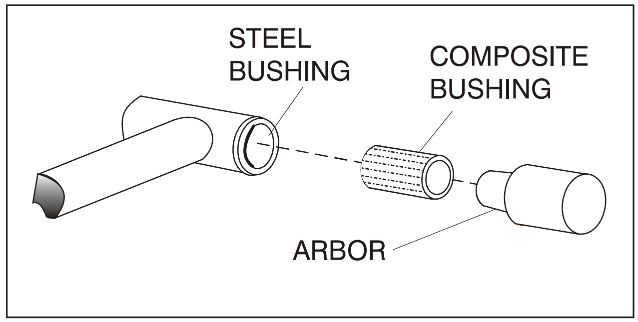


Figure 5-13. Composite Bearing Installation

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.

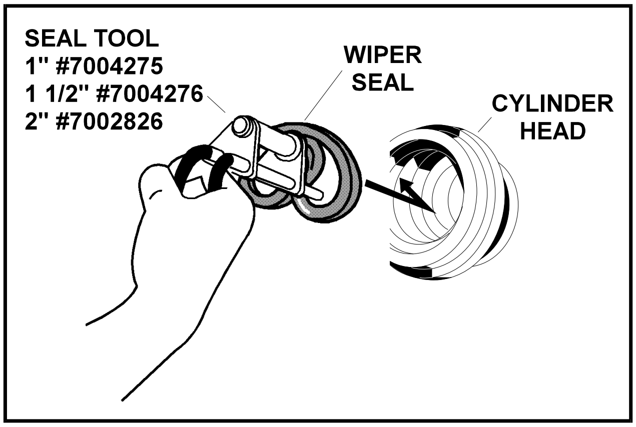


Figure 5-14. Rod Seal Installation

NOTICE

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

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

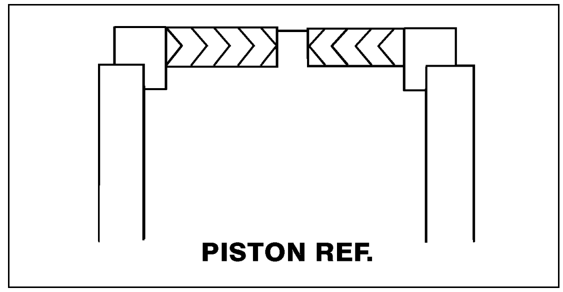


Figure 5-15. Poly-Pak Piston Seal Installation

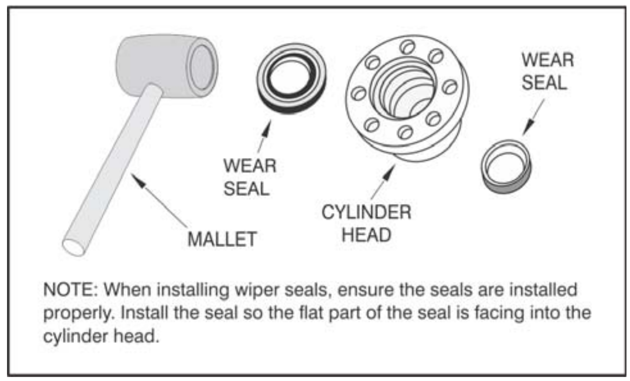


Figure 5-16. Wiper Seal Installation

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

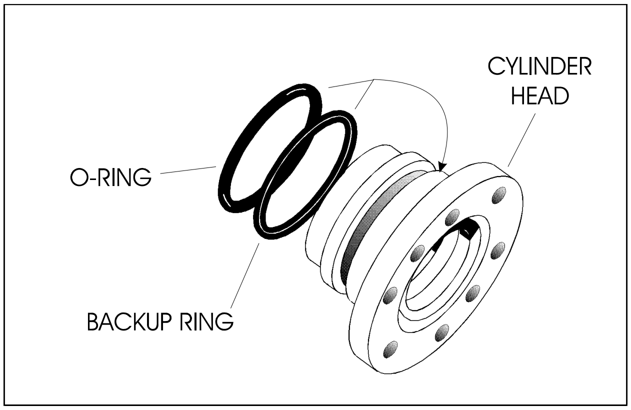


Figure 5-17. Installation of Head Seal Kit

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

5. Carefully slide the piston spacer on the rod.

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

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

7. If applicable, correctly place new seals and guide lock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D.of the piston is recommended to install the solid seal.)

NOTE: *The backup rings for the solid seal have a radius on one side. This side faces the solid seal.(See magnified insert in Figure 5-18.)The split of seals and backup rings are to be positioned so as not to be in alignment with each other.*

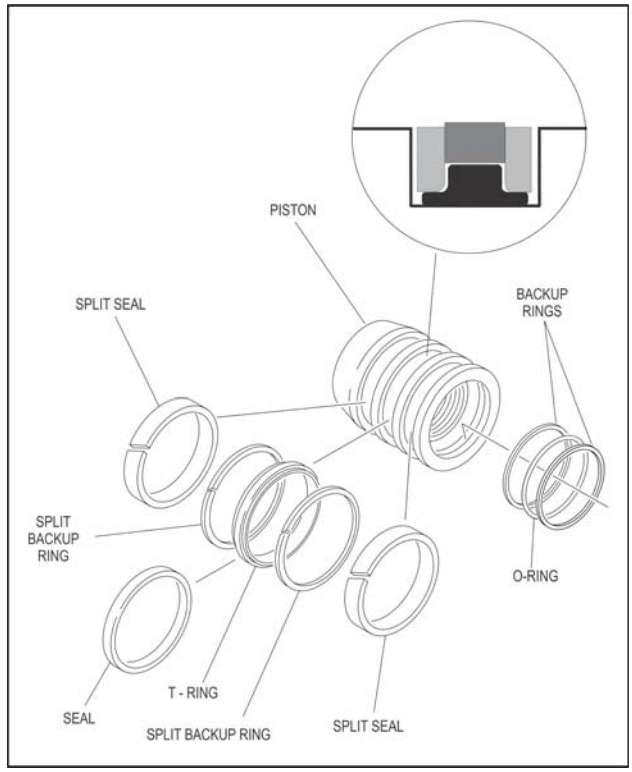


Figure 5-18. Piston Seal Kit Installation

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

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

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

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

NOTICE

WHEN REBUILDING THE TELESCOPE, LIFT, JIB, LEVEL, AXLE LOCKOUT OR AXLE EXTENSION CYLINDERS, TIGHTEN SECURELY. (SEE TABLE 5-1)

11. Assemble the tapered bushing loosely into the piston and insert JLG capscrews (not vendor capscrews) through the drilled holes in the bushing and into the tapped holes in the piston.

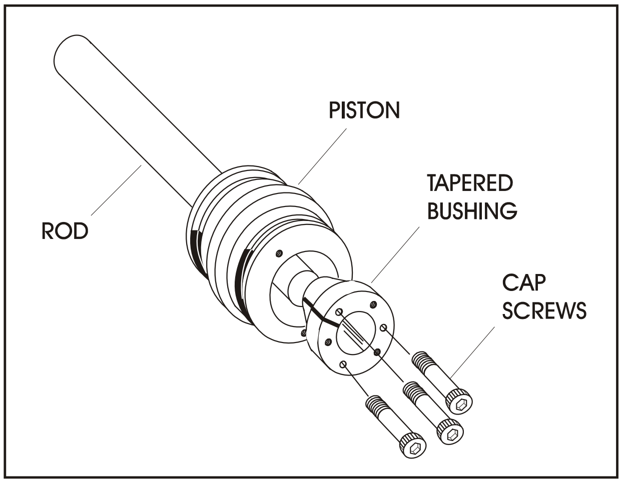


Figure 5-19. Tapered Bushing Installation

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.

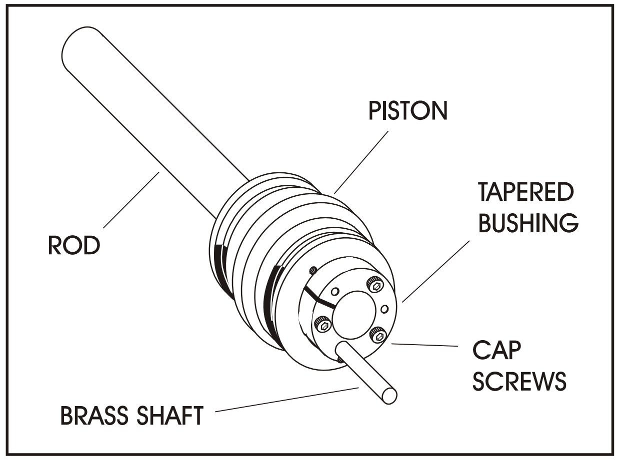


Figure 5-20. Seating the Tapered Bearing

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 5-18., Piston Seal Kit Installation)

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

NOTICE

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

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

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

20. Secure the cylinder head gland using the washer ring and socket head bolts. (See Table 5-1, Cylinder Head and Tapered Bushing Torque Specifications and Table 5-2, Holding Valve Torque Specifications)

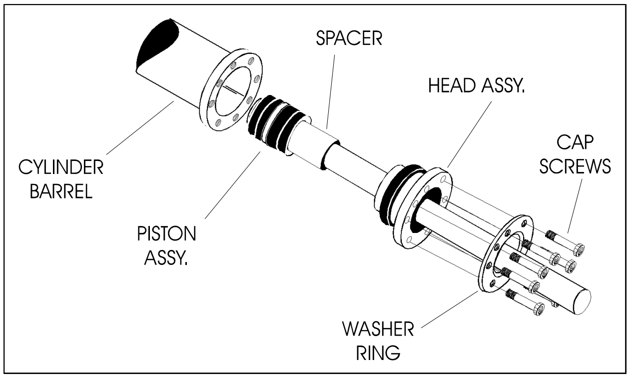


Figure 5-21. Rod Assembly Installation

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.

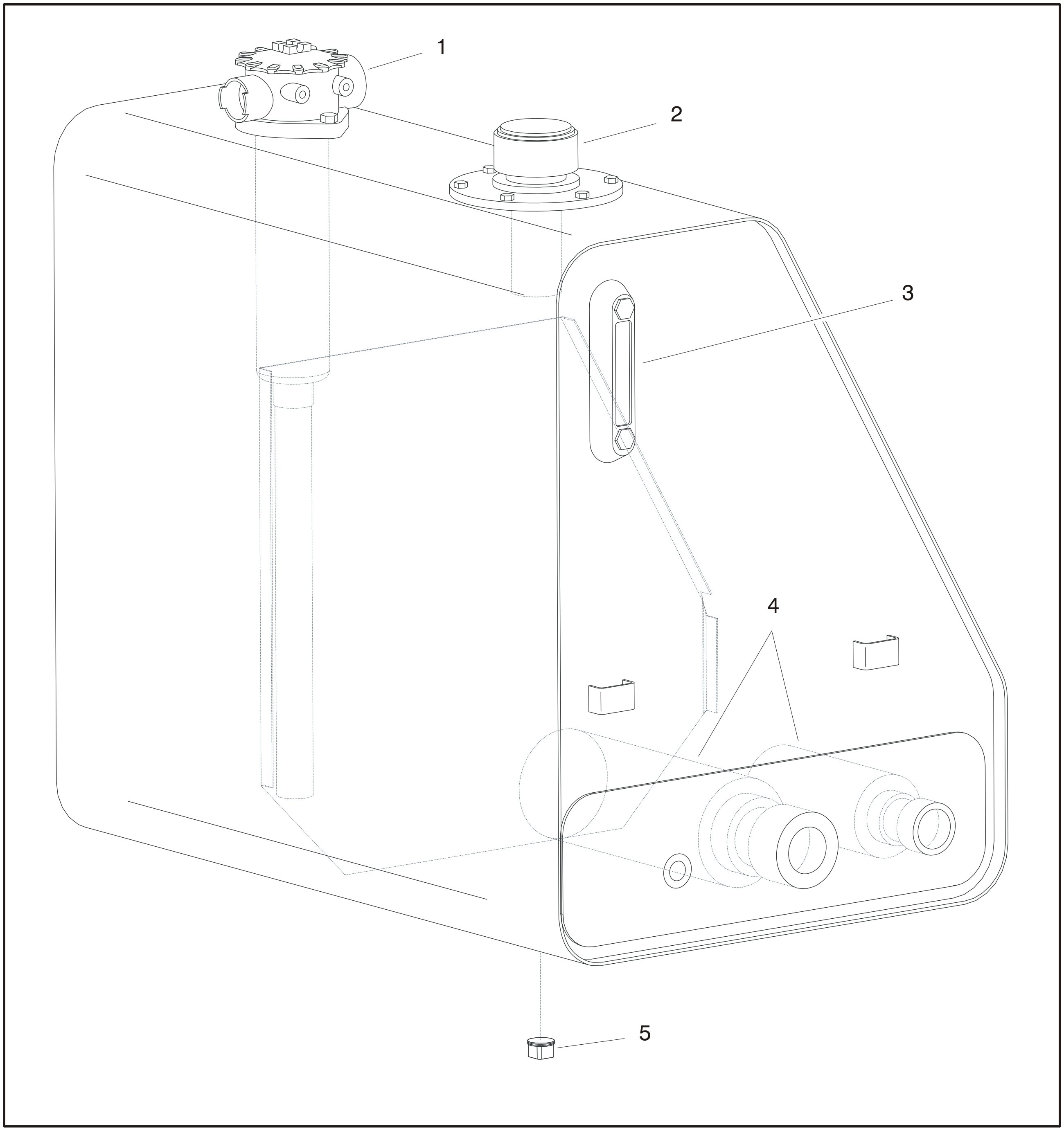
22. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. (See Table 5-2, Holding Valve Torque Specifications).

Table 5-1. Cylinder Head and Tapered Bushing Torque Specifications

Description	Head Torque Value (Wet)	Tapered Bushing Torque Value (Wet)
Tele Cylinder (1200SJP)	120 ft. lbs. (163 Nm)	30 ft. lbs. (40.5 Nm)
Tele Cylinder (1350SJP)	120 ft. lbs. (163 Nm)	45 ft. lbs. (63 Nm)
Level Cylinder	120 ft. lbs. (163 Nm)	9 ft. lb.s (12.6 Nm)
Jib Cylinder	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Lift Cylinder	300 ft. lbs. (410 Nm)	120 ft. lbs. (168 Nm)
Axle Oscillation Cylinder	120 ft. lbs. (163 Nm)	9 ft. lb.s (12.6 Nm)
Axle Extend Cylinder	50 ft. lbs. (70 Nm)	9 ft. lb.s (12.6 Nm)

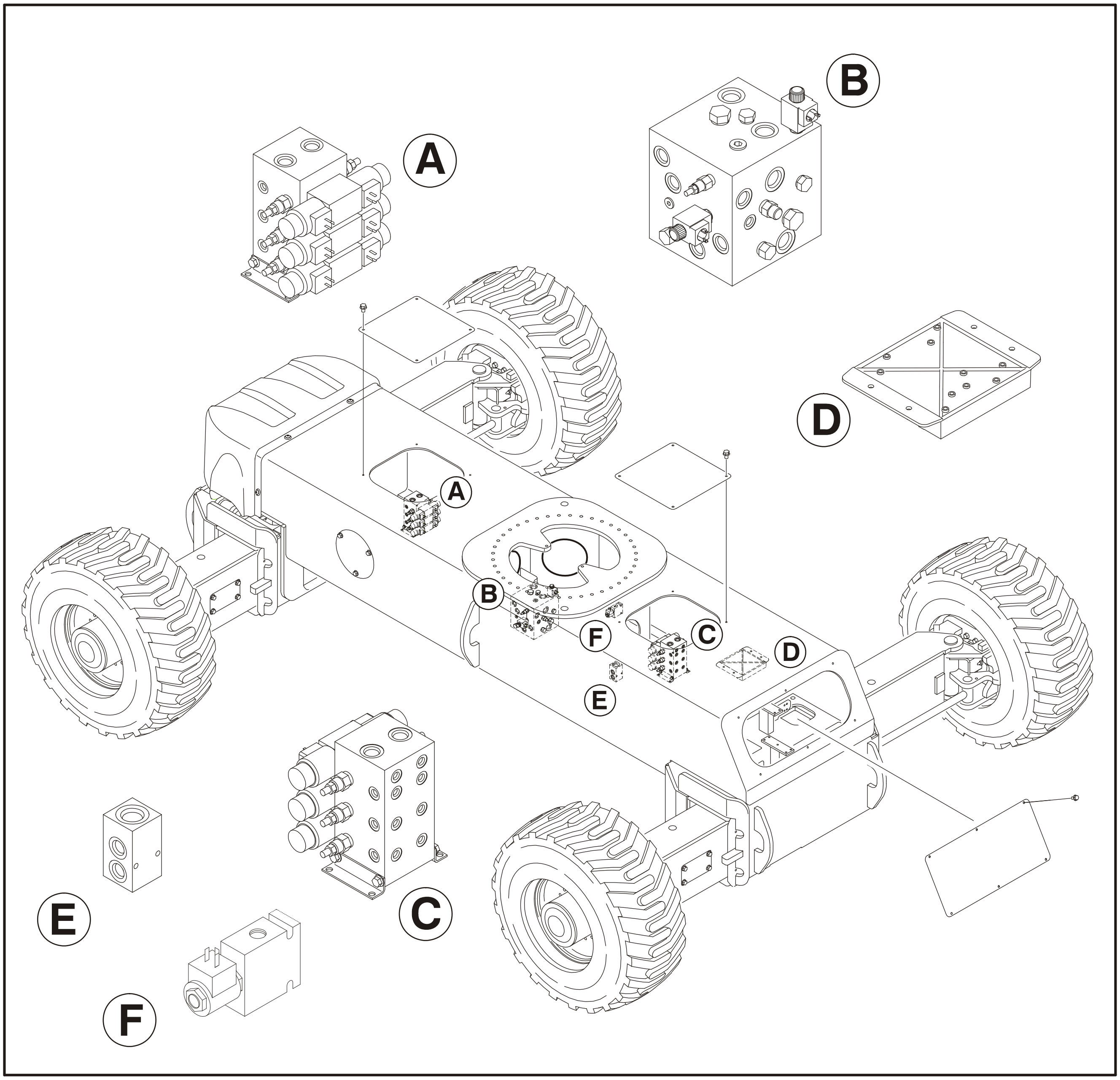
Table 5-2. Holding Valve Torque Specifications

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)



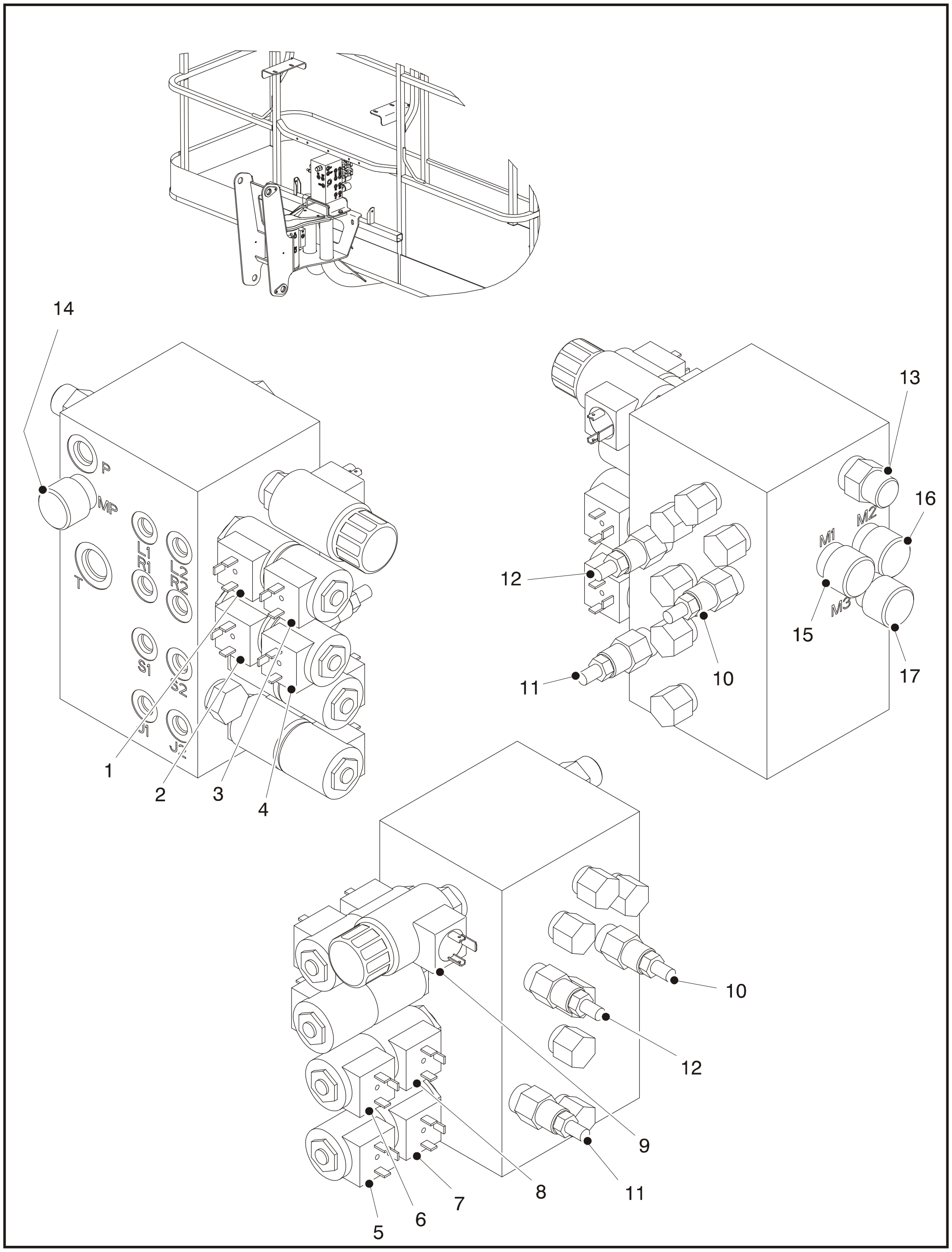
1. Return Filter
2. Vented Fill Cap
3. Sight/Temperature Gauge
4. Suction Strainer
5. Magnetic Drain Plug

Figure 5-22. Hydraulic Tank



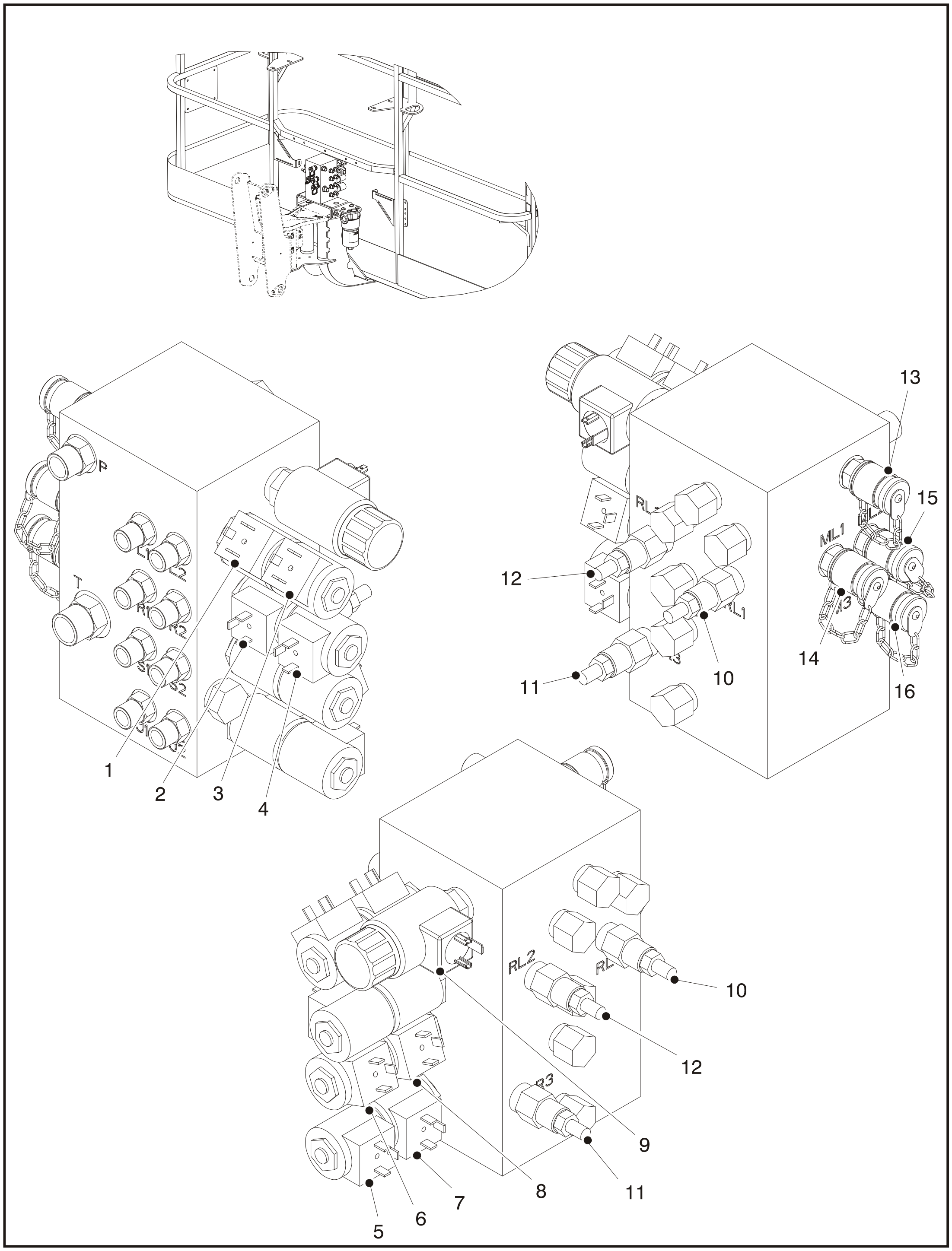
A. Front Steer Valve/Axle Extend
B. Traction Valve
C. Rear Steer Valve/Axle Extend
D. Chassis Module Controller
E. Junction Manifold Valve
F. Axle Oscillation Valve

Figure 5-23. Chassis Control Valve Locations



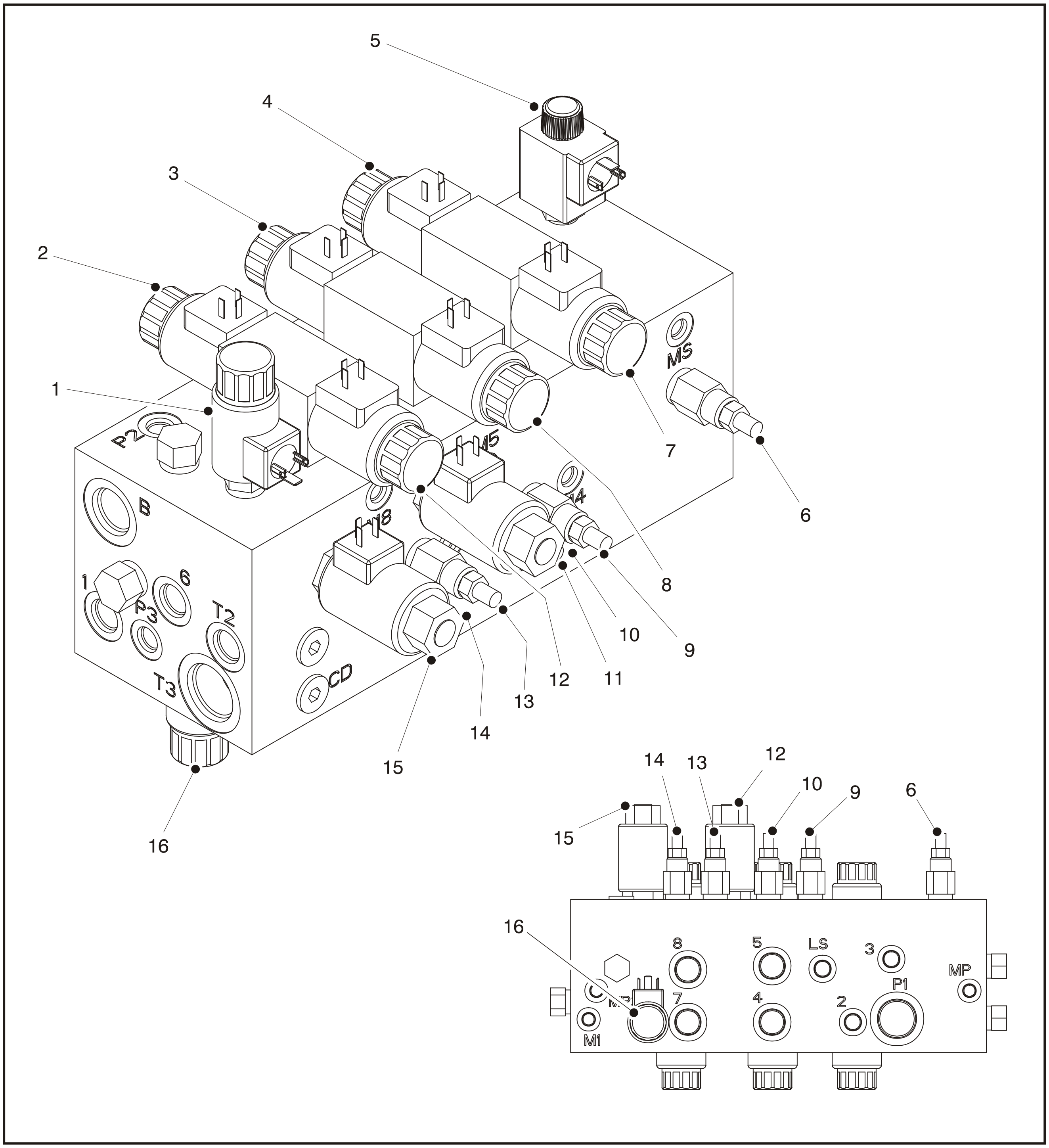
1. Level Up
2. Rotate Right
3. Level Down
4. Rotate Left
5. Jib Down
6. Jib Swing Left
7. Jib Up
8. Jib Swing Right
9. Platform Dump
10. Level Up Relief
11. Jib Up/Down Relief
12. Level Down Relief
13. Filter or Plug
14. Main Pressure Check Port
15. Level Up Test Port
16. Level Down Test Port
17. Jib Up/Down Test Port

Figure 5-24. Platform Valve Identification - JLG P/N 4641266



1.	Level Up	5.	Jib Down	9.	Platform Dump	13.	Main Pressure Check Port
2.	Rotate Right	6.	Jib Swing Left	10.	Level Up Relief	14.	Level Up Test Port
3.	Level Down	7.	Jib Up	11.	Jib Up/Down Relief	15.	Level Down Test Port
4.	Rotate Left	8.	Jib Swing Right	12.	Level Down Relief	16.	Jib Up/Down Test Port

Figure 5-25. Platform Valve Identification - JLG P/N 4641460



1. Aux Lift Down	5. Dump	9. Lift Up Relief	13. Tele Out Relief
2. Tele Out	6. Swing Relief	10. Lift Down Relief	14. Tele In Relief
3. Lift Up	7. Swing Left	11. Lift Flow	15. Tele Flow
4. Swing Right	8. Lift Down	12. Tele In	16. Lift Down/Aux Select

Figure 5-26. Main Valve Identification

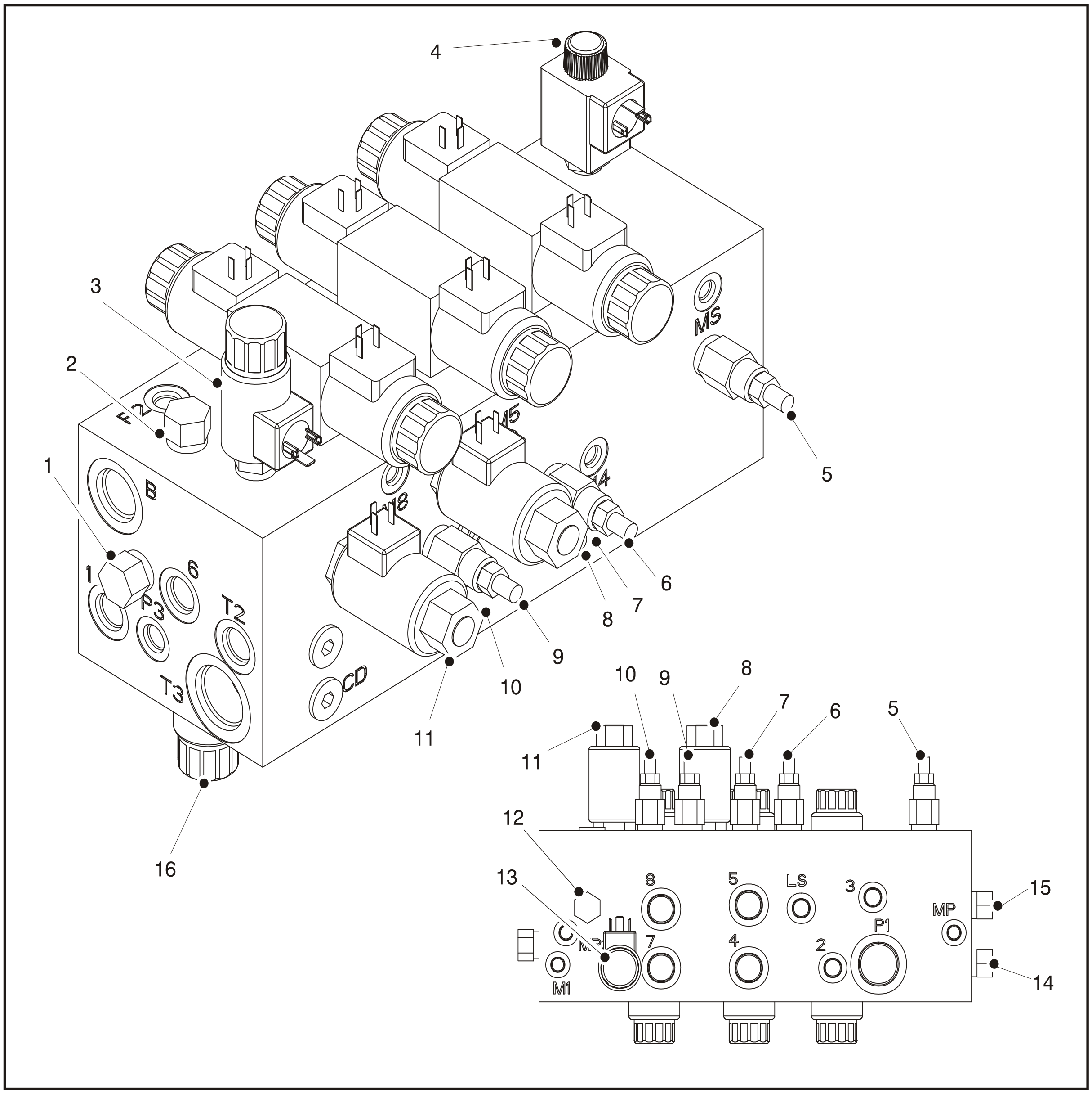


Table 5-3. Cartridge Torque Values

	Ft-Lbs.	Nm		Ft-Lbs.	Nm
1	25-30	33.9-40.6	9	30-35	40.6-47.4
2	25-30	33.9-40.6	10	30-35	40.6-47.4
3	30-35	40.6-47.4	11	30	40.6
4	30-35	40.6-47.4	12	30-35	40.6-47.4
5	30-35	40.6-47.4	13	30-35	40.6-47.4
6	30-35	40.6-47.4	14	30-35	40.6-47.5
7	30-35	40.6-47.4	15	30-35	40.6-47.5
8	30	40.6			

Figure 5-27. Main Valve Cartridge Torque Values

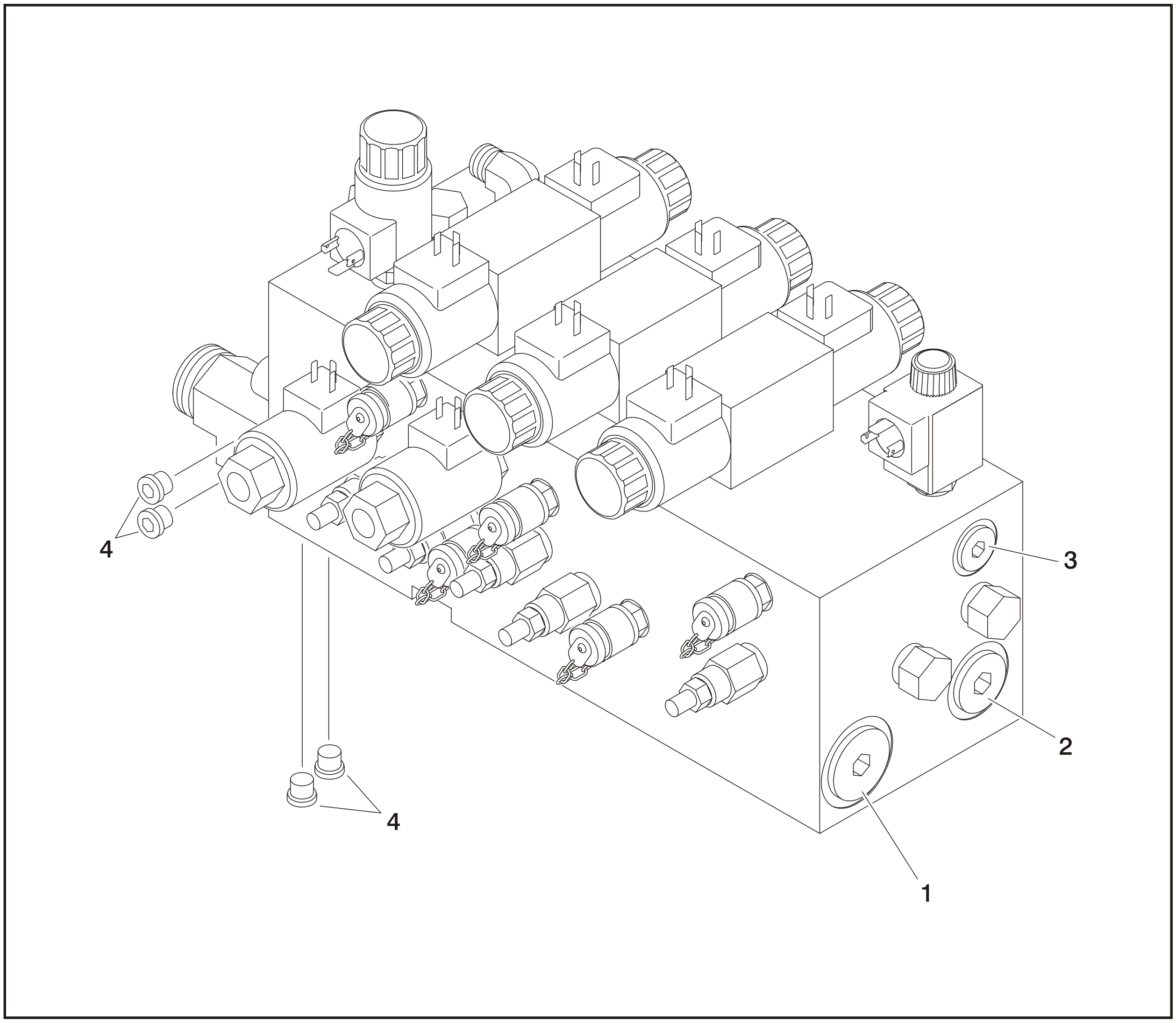


Table 5-4. Plug Torque Values

	Ft-Lbs.	Nm
1	115	156
2	100	135.5
3	40	54
4	13	17.5

Figure 5-27. Main Valve Plug Torque Values

5.3 HYDRAULIC TANK

The hydraulic tank has a capacity of 55 gallons (208 liters) and includes the hydraulic return filter and two suction strainers. It is normal for the oil level to appear low when the boom is raised and should only be checked with the machine on level ground and with the boom fully retracted and lowered. The hydraulic oil should be maintained at the full level as shown by the decal and hydraulic oil level gauge located on the side of the tank as shown in Figure 5-27., Hydraulic Oil Level Gauge. This decal shows the proper full level for both hot and cold oil. Do not fill the hydraulic tank past the appropriate full mark. Overfilling can cause the oil to overflow from the top of the hydraulic tank during emergency lowering operations.

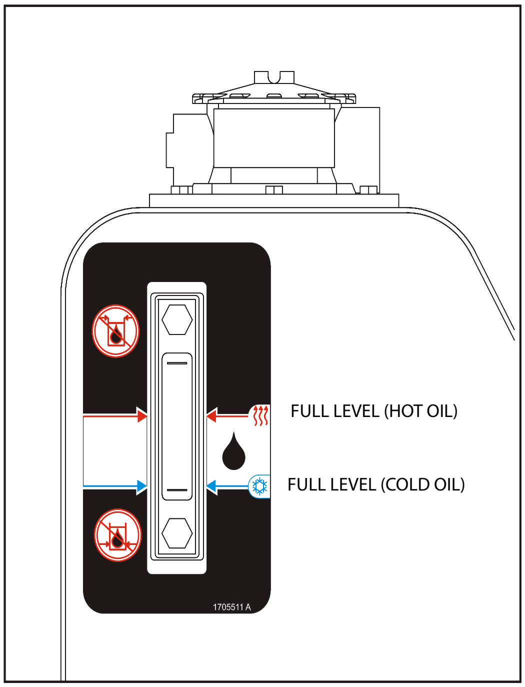


Figure 5-27. Hydraulic Oil Level Gauge

5.4 PRESSURE SETTING PROCEDURE

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

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

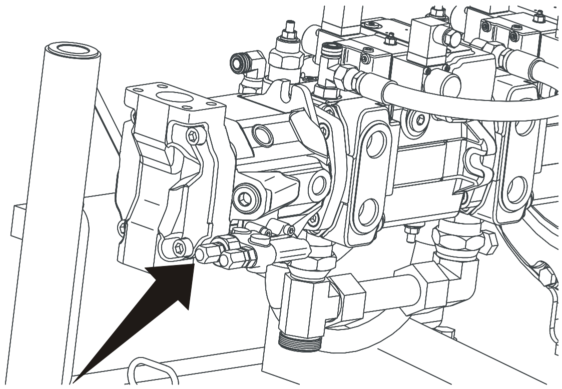
1. All applicable steps in Section 5.7, Drive & Function Pump Start Up Procedures must be followed.
2. Set up of the function pump.
3. Adjustments made at the main valve bank.
4. Adjustments made at the platform valve.

Set Up of the Function Pump

HIGH PRESSURE RELIEF - 3400 PSI (234.4 BAR)

1. Install a high pressure gauge at the MP port of the main valve block.
2. Using a screwdriver, remove the Din connector from the lift down coil.
3. Activate lift down. The gauge should read 3400 psi (234 bar).

4. To make an adjustment to this pressure, go back to the engine compartment to the function pump which is the back pump. The high pressure relief adjustment is the adjustment closest to the pump. Using a 17 mm wrench, remove the cover nut. Be careful not to lose the O-ring washer inside the cover nut.



5. Loosen the jam nut at the setscrew with the 17 mm wrench. Using a 3 mm allen wrench, adjust clockwise to increase, or counterclockwise to decrease.

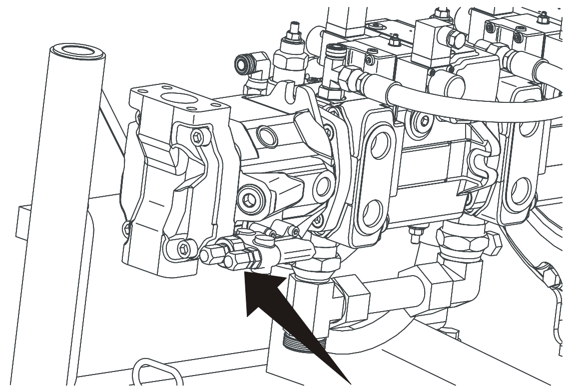
6. After adjusting the pressure, tighten the jam nut and the cover nut. This is the **maximum** relief pressure for all the functions governed by this pump.

STAND BY PRESSURE OR LOW PRESSURE RELIEF - 300 PSI (20.6 BAR)

1. Install a low pressure gauge at port MP of the main valve block capable of reading 300 psi (20.6 bar).

2. Start the engine, the gauge should read 300 psi (20.6 bar).

3. To make an adjustment to this pressure, go to the engine compartment, locate the function pump. The stand by adjustment is the adjustment outside adjustment, closest to the turntable. Use the same tools that were used in the Hi pressure adjustment procedure.



Adjustments made at the Main Valve Bank

LIFT UP - 2750 PSI (189.6 BAR)

1. Install a high pressure gauge at the M5 port of the main valve block. Plug and cap the hose on port 5.

2. Activate lift up. The gauge should read 2750 psi (189.6 Bar).

3. The adjustment cartridge is located below the M5 gauge port. Turn clockwise to increase, counterclockwise to decrease.

LIFT DOWN - 1500 PSI (103.4 BAR)

1. Install a high pressure gauge at the M4 port of the main valve block.

2. Activate lift down to the end of the stroke. The gauge should read 1500 psi (103.4 bar).

3. The adjustment cartridge is located to the left of the M4 gauge port. Turn clockwise to increase, counterclockwise to decrease.

SWING - 1500 PSI (103.4 BAR)

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

1. Install a high pressure gauge at port MS.
2. Lock the turntable pin.
3. Activate swing, the gauge should read 1500 psi (103.4 Bar). The adjustment cartridge is located below the MS gauge port.
4. Turn clockwise to increase, counterclockwise to decrease.

TELESCOPE OUT - 3000 PSI (206.8 Bar)

1. Install a high pressure gauge at the M8 port of the main valve bank. Plug the telescope out hose either at the valve bank (port #8) or at the inlet of the telescope cylinder (V1).
2. Activate telescope out. The gauge should read 3000 psi (206.8 Bar).
3. The adjustment cartridge is located below the M8 gauge port. Turn clockwise to increase, counterclockwise to decrease.

TELESCOPE IN - 3200 PSI (220.6 BAR)

1. Install a high pressure gauge at the M7 port of the main valve block.
2. Activate Telescope In. The gauge should read 3200 psi (220.6 Bar).
3. The adjustment cartridge is located to the left of the M7 gauge port. Turn clockwise to increase, counterclockwise to decrease.

Adjustments Made at the Frame Valve Bank

AXLE EXTEND AND RETRACT, FRONT AND REAR - 2500 PSI (172.3 BAR)

1. To extend the axles, drive the machine back and forth until extended. A machine that cannot be driven must be jacked up.
2. On both the front and rear frame valve banks, install a high pressure gauge on ports MA1 for extend and MA2 for retract. The gauge should read 2500 psi (172.3 Bar) in both directions.
3. The axle extend/retract cylinders are connected hydraulically in parallel. In order to get the correct pressure of the circuit being adjusted, unscrew the solenoid coil from the circuit not being adjusted and pull it away from the valve.
4. Turn clockwise to increase, counterclockwise to decrease.

STEERING, FRONT AND REAR

NOTE: *The following procedure requires 2 people to perform. One is needed for verifying / adjusting pressure readings and wheel spindle alignment the other for operating the steer functions and using the Analyzer from the platform.*

The Analyzer is required to perform the pressure check procedure through access of the calibration menu. The calibration menu will allow for extending and retracting the steer cylinders individually, verifying pressures, and proper steer sensor calibration. Verification of the steer sensor calibration will require one of two types of measuring methods; using a square and ruler or using string as explained in Section 6 - JLG Control System. The purpose of these measuring tools is to assure that the wheel spindle is aligned “straight” with the extended axle weldment.

1. Position the machine with both front and rear axles fully extended.
2. Install the Analyzer in the platform control box and scroll menu’s to Access Level 2 and insert password (33271) to get into Access Level 1.

3. Scroll to the calibration mode. Once in the calibration mode, press “ENTER” and scroll to steer. Once in the steer calibration mode, the Analyzer is going to ask to calibrate the steer sensors, this is going to allow extending and retracting each steer cylinder individually during this process. The JLG control system will ask to calibrate the left front sensor, the left rear sensor, the right front sensor and finally the right rear sensor in that order. During this calibration mode each individual steer cylinder will be extended and retracted to verify correct pressures with the marked MS (Measure Steer) ports on the steer / axle valve that pertains to that steer cylinder. Refer to the Hydraulic Schematic in Section 7 - Schematics.

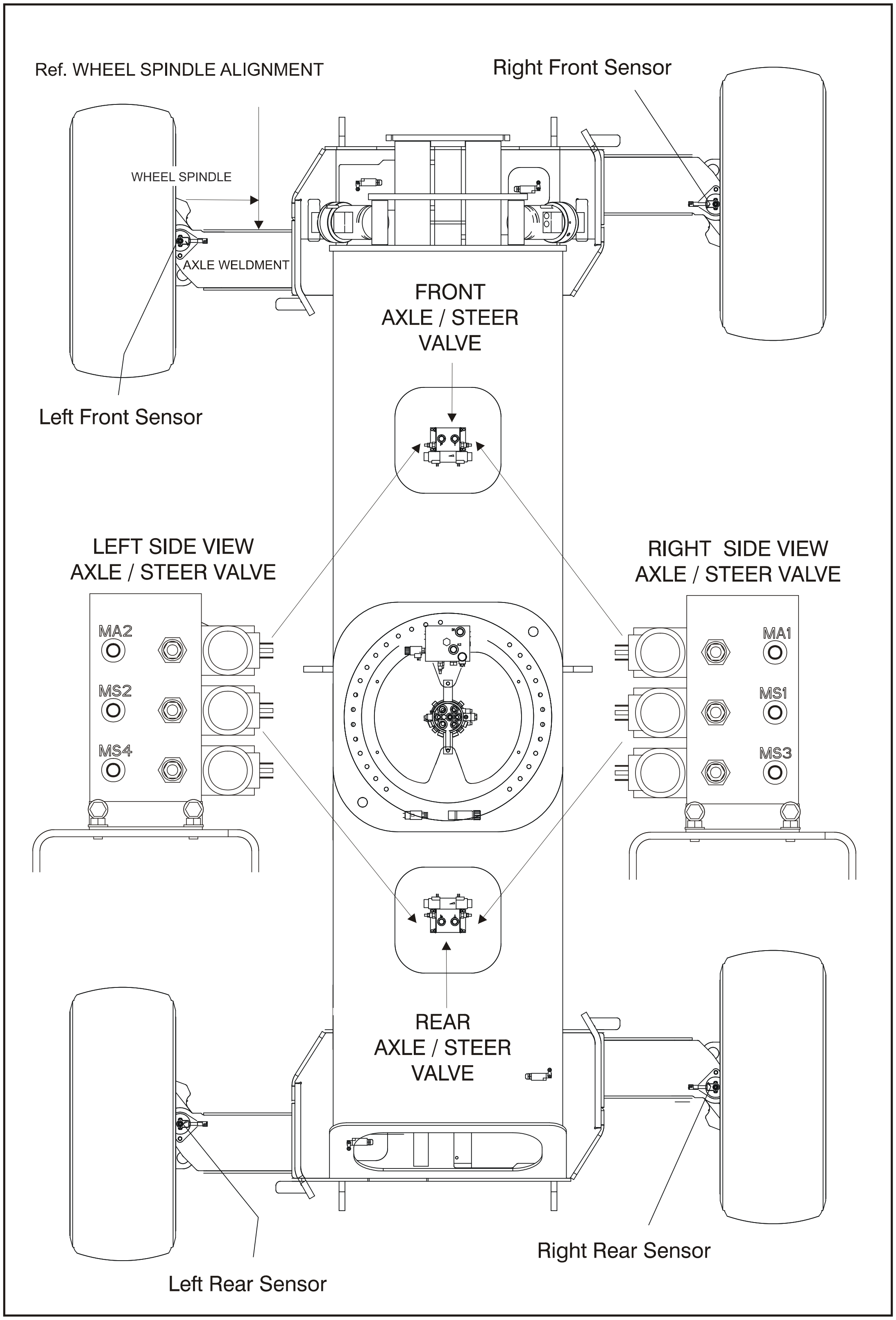
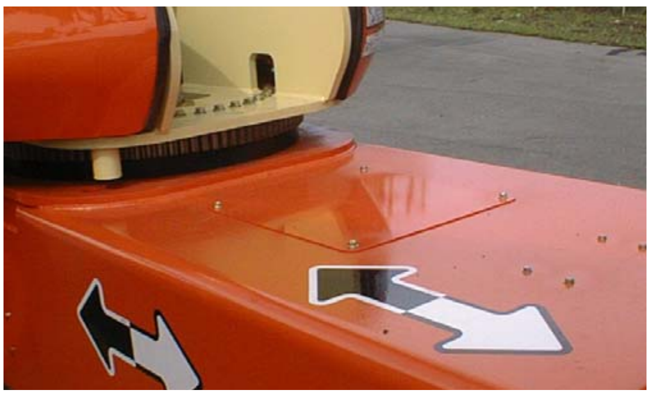
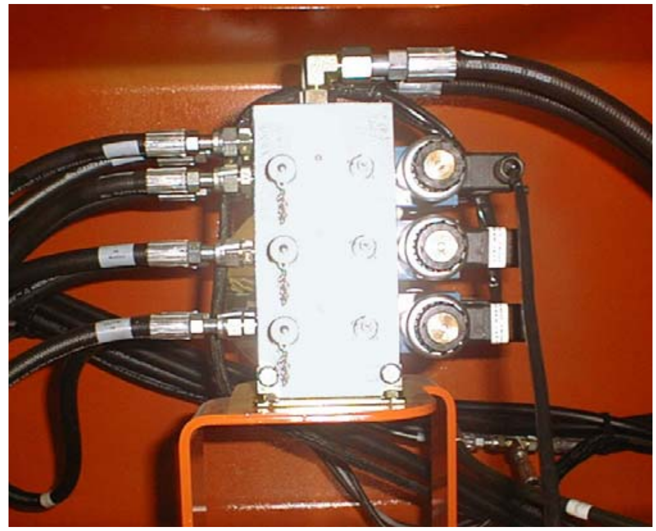


Figure 5-28. Steer Pressure Adjustments

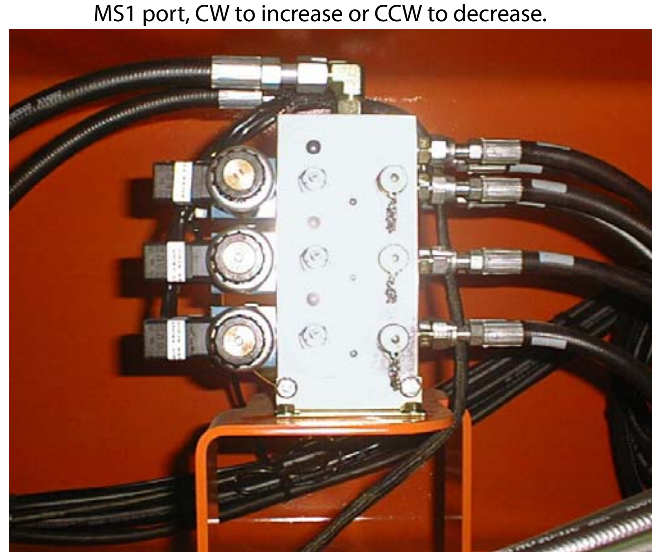
4. Remove the front circular steer/axle access covers at the front of the chassis, and the rear square cover at the top rear of the chassis to gain access to the axle/steer valves.



5. Install a pressure gauge at the front axle/steer valve at MS2 port. This should be located on the left side of the valve closest to the left front wheel spindle. Position the steer switch to activate the left front steer cylinder until the rod is in the fully extended position and hold the switch for a few seconds after the rod has been fully extended. The MS2 port should read 2000 psi (138 Bar). If the pressure is not 2000 psi (138 Bar) adjust relief valve mounted next to the MS2 port, CW to increase or CCW to decrease.

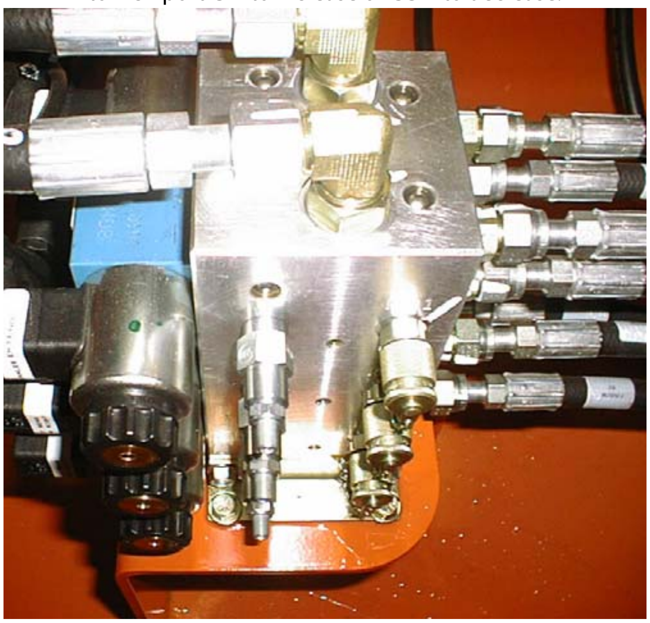


6. Remove the pressure gauge from MS2 port and install on the MS1 port, which is on the right side of the front axle/steer valve, closest to the right front wheel spindle. Position the steer switch to activate the left front steer cylinder until the rod is in the fully retracted position and hold the switch for a few seconds after the rod has stopped. The MS1 port should read 2600 psi (179 Bar). If the pressure is not correct, adjust relief valve next to MS1 port, CW to increase or CCW to decrease.

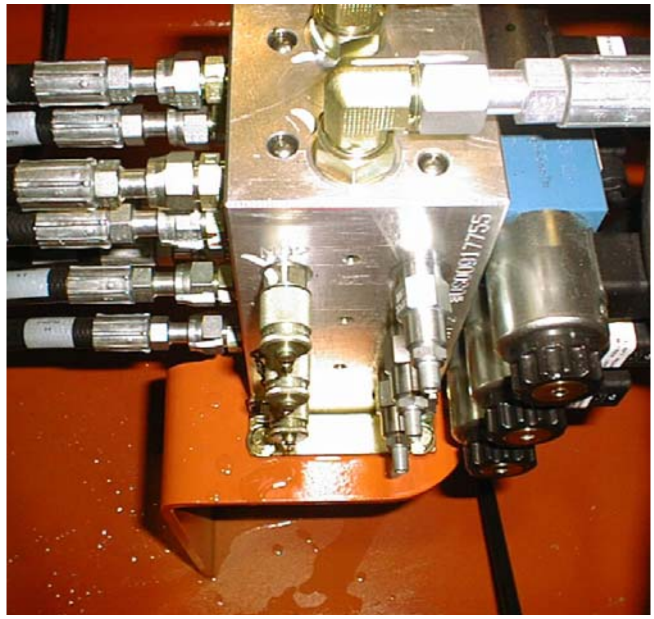


7. This step involves aligning the left front wheel spindle with the axle weldment. Position the left front wheel spindle “straight” using a square and rule or string for proper alignment (Refer to Section 6 - JLG Control System). Once the left front wheel spindle has been properly measured, press “ENTER” on the Analyzer. This is calibrating data to the JLG Control System that the left front steer sensor is centered.

8. Checking the left rear steer cylinder is identical to the procedure for left front steer cylinder, except now we are checking pressures at the rear axle/steer valve location. Install pressure gauge at MS1 port. This should be located on the left side of the valve closest to the left rear wheel spindle. MS1 port should read 2600 psi (179 Bar) when the left rear steer cylinder is activated with the rod in the fully retracted position. If the pressure is not 2600 psi (179 Bar) adjust relief valve mounted next to MS1 port CW to increase or CCW to decrease.



9. Remove the gauge from MS1 port and install on MS2 port, which is on the right side of the rear axle/steer valve, closest to the right rear wheel spindle. Position the steer switch to activate the left rear steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has been fully extended. The MS2 port should read 2000 psi (179 Bar). If the pressure is not correct, adjust the relief valve mounted next to MS2 port CW to increase or CCW to decrease.



10. The next step is identical to the left front step mentioned above. Make sure the left rear wheel spindle is straight and press “ENTER” to accept the new calibration settings, now press “ESC” (escape) and scroll to the right front steer calibration step.

11. Checking the right front steer cylinder is identical to the procedure laid out for the left front steer cylinder, except the pressures are now checked at MS3 port of the front axle/steer valve. This should be at the right side of the valve closest to the right front wheel spindle. Install the gauge at MS3 port. Position the steer switch to activate the right front steer cylinder until the rod is in the fully retracted position and hold the steer switch for a few seconds after the rod has been fully retracted. If the pressure is not 2600 psi (179 Bar), adjust the relief valve mounted next to the MS3 port CW to increase or CCW to decrease.

12. Remove the gauge from MS3 port and install on MS4 port, which is on the left side of the front axle/steer valve, closest to the left front wheel spindle. Position the steer switch to activate the right front steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has stopped extending. The MS4 port should read 2000 psi (138 Bar). If the pressure is not correct, adjust relief valve mounted next to the MS4 port CW to increase or CCW to decrease.

13. The next step is identical to the left front step mentioned above. Make sure the right front wheel spindle is straight and press "ENTER" to accept the new calibration settings. Scroll over to right rear steer calibration step.

14. Checking the right rear steer cylinder is identical to the procedure laid out for the left rear steer cylinder. Install gauge at MS4 port of the rear axle/steer valve. This should be at the right side of the valve closest to the right rear wheel spindle. Position the steer switch to activate the right rear steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has stopped extending. The MS4 port should read 2000 psi (138 Bar. If the pressure is not correct, adjust relief valve next to the MS4 port CCW to increase or CCW to decrease.

15. Remove gauge from MS4 port and install on MS3 port, which is on the left side of the rear axle/steer valve, closest to the left rear wheel spindle. Position the steer switch to activate the right rear steer cylinder until the rod is in the fully retracted position and hold the steer switch for a few seconds after the rod stops retracting. If the pressure is not 2600 psi (179 Bar), adjust the relief valve mounted next to the MS3 port CW to increase or CCW to decrease.

16. The next step is identical to the left front step mentioned above, make sure the right rear wheel spindle is straight and press "ENTER" to accept the new calibration settings, now escape out of the calibration menu and remove the Analyzer and pressure gauge.

Adjustments Made at the Platform Valve Bank

PLATFORM LEVEL UP - 2500 PSI (172.3 BAR)

1. Install a high pressure gauge at the gauge port M1.
2. Activate level up to the end of stroke, it should read 2500 psi (172.3 Bar).
3. All the relief valves are located on the same face. The level up relief valve is located closest to the M1 gauge port. Turn clockwise to increase, counterclockwise to decrease.

PLATFORM LEVEL DOWN - 1500 PSI (103.4 BAR)

1. Install a high pressure gauge at gauge port M2.
2. Activate level down to the end of stroke, it should read 1500 psi (103.4 Bar).
3. The level down relief valve is located to the left of the level up relief valve. Turn clockwise to increase, counterclockwise to decrease.

ARTICULATING JIB UP AND DOWN - 2750 PSI (189.6 BAR)

1. Install a high pressure gauge on gauge port M3. The jib relief valve is located below the level down relief valve. Activate jib up or down, it should read 2750 psi (189.6 Bar). Turn clockwise to increase, counterclockwise to decrease.

5.5 DRIVE PUMPS

Troubleshooting Procedure

To aid in troubleshooting, refer also to the pressure measuring port connections for test gauge installation information as shown on the hydraulic circuit diagram. Procedure assumes proper gauges are installed. (Minimum gauges required: (2) 0-6000 psi, (1) 0-3000 psi & (1) 0-1000 psi [{2} 0-415 bar, {1} 0-210 bar & {1} 0-70 bar]). This procedure was written to aid the troubleshooter in following a logical approach to a hydraulic system fault.

1. Transmission does not propel the machine, diesel engine running properly
   a. Is there oil in the reservoir?
      No - Fill reservoir
      Yes - If yes, proceed to step 1.b
   b. Is the pump input shaft connected to the engine flex plate or rear of forward pump?
      No - Connect pump input shaft
      Yes - If yes, proceed to step 1.c
   c. Are the hydraulic hoses and tubing connected in accordance with the hydraulic circuit diagram?

      No - Correct the hoses/tubing
      Yes - If yes, proceed to step 1.d
   d. Is the pump direction of rotation correct? (clockwise as looking at the shaft)

      No - Fit pump having the correct direction of rotation
      Yes - If yes, proceed to step 1.e
   e. Are there "O"-rings missing from fittings (as example - suction leak), pinched hoses, broken tubing, etc?

      No - Proceed to step 1.f
      Yes - Repair damage or fault
   f. Are the electrical connectors/wiring intact and secure to the pump control solenoids?
      No - Repair damage or fault
      Yes - If yes, proceed to step 1.g
   g. Does the engine "labor" when attempting drive, are the brakes released?
      No - Proceed to step 1.h
      Yes - Check brake release circuit, measure pressure at port "MP" on Traction Control manifold
   h. Are all four wheel drive planetary reduction gearboxes engaged?
      No - Engage wheel drive(s)
      Yes - If yes, proceed to step 2.a
2. Transmission does not propel the machine, diesel engine running properly - Charge Pump/Relief Valve
   a. Is there any charge pressure at port G or indicated by measuring pressure at Ma and Mb?
      No - Proceed to step 2.d
      Yes - Proceed to step 2.b
   b. Is the charge pressure at least 500 psi while running at high engine speed?
      No - Proceed to step 2.c
      Yes - Proceed to step 3.a
   c. Can the charge pressure be raised by removing dirt/debris from charge relief poppet or by adding or removing shims from the charge pressure relief valve mounted in the second pump of the triple?
      No - Proceed to step 2.d
      Yes - Adjust pressure to 500 psi +50 psi, -0 psi (34.4 bar +3.4 bar, -0 bar)

NOTE: *The propulsion circuit uses a hot oil flushing valve to obtain brake release pressure. The hot oil flushing valve cartridge (#120) is mounted in the Traction Control Manifold. The flushing valve receives its oil from the "left side" wheel drive pump; the middle pump of the triple. With the engine running and propelling the machine forward or reverse, the "hot oil flushing valve" and the brake release pressure must be adjusted to 475 psi, +25 psi, -0 psi (32.7 bar, +1.7 bar, -0 bar), as set by adjusting pressure relief cartridge (#130). The brake release pressure must be 25 psi less than the charge pump pressure. Measure pressure at port "MP" using a 0-1000 psi (0 - 70 bar) pressure gauge.*

   d. Is the transmission pumps suction hose pinched shut?
      No - Proceed to step 2e
      Yes - Repair damaged hose
   e. Is the charge pump suction pressure/vacuum within recommended limits? (0.8 bar absolute or 6.3 inches of mercury)
      No - Proceed to step 2.f
      Yes - Proceed to step 2.g
   f. Is the suction strainer inside the reservoir blocked, clogged, restricted?
      No - Proceed to step 2.g
      Yes - Repair/replace with a clean suction strainer
   g. Is the reservoir air breather blocked or restricted?
      No - Proceed to step 2.h
      Yes - Clean or replace air breather

h. Remove charge pressure relief valve from the middle pump and inspect. Is it damaged?
No - Refit cartridge and proceed to step 2.i
Yes - Clean & inspect cartridge, poppet, springs, seals to determine cause of damage. Repair or fit a new cartridge and return to step 2.a

i. Remove and inspect charge pump assemblies. Are they damaged?
No - Proceed to step 2.j
Yes - Repair and/or replace damaged components and return to step 2.a

j. Is the charge pump installed for the clockwise rotation?
No - Refit charge pump. Return to step 2.a
Yes - With proper charge pressure and transmission still does not operate, proceed to step 3.a

3. Transmission does not propel the machine, diesel engine running properly - Pump Control: (Insure Generator Drive option is not turned "on")

a. Are the electrical connectors & wiring connected properly to the pump control solenoids?
No - Connect a ammeter in series with solenoid wiring. Is a current of 400 mA to 1060 mA being applied. (Current signal varies with joystick position)
Yes - Proceed to step 3.b

b. Are all four of the two-speed motors, mounted in the wheel drive planetary reduction gearboxes, shifted to maximum displacement (high torque - low speed)?
No - Select maximum displacement
Yes - Proceed to step 3.c

c. Actuate the pump control in both directions. Do the pumps stroke? Do they go to full stroke?
No - Refer to the pump service manual and then proceed to step 3.d
Yes - Operate the transmission

d. Remove stroking orifices in X_1 and X_2. Install pressure gauges in X_1 and X_2 (0-500 psi [0 - 35 bar]). Stroke the pump in both directions. Do the pressures at X_1 and X_2 alternate between 30 & 250 psi (2 & 17 bar)?
No - Remove the EP control module & replace it with a new unit. Repeat step 3.c
Yes - Proceed to step 3.e.

e. Is the pressure at port "R", case pressure, less than 15 psi (1 bar) gauge pressure?
No - Correct problem restricting case drain oil flow (oil cooler blockage, pinched hoses, etc)
Yes - Proceed to step 3.f

f. Stroke pump in both directions, while measuring pressure at Ma & Mb ports of the pump. Does any pressure greater than charge pressure alternate between ports Ma & Mb?
No - Verify that loading the pump will cause system pressure to increase above charge pressure. Proceed to step 3.a
Yes - Proceed to step 3.g

g. Is it possible to adjust high pressure relief valves using 0-6000 psi (0 - 415 bar) gauges to monitor pressure at Ma & Mb? (Refer to relief valve adjustment)
No - Replace high pressure relief valve and return to step 3.c
Yes - Adjust high pressure relief valves to 5000 psi +50 psi, -0 psi (344.7 bar +3.4 bar, -0 bar)

h. Actuate control in both directions. Does transmission operate?
No - Check that minimum displacement stops on the wheel drive motors are adjusted properly, check that the motors stroke between maximum to minimum.
Yes - Operate the transmission

4. Transmission Drive is Sluggish or Erratic

a. Does the "EP" proportional pump control current vary with joystick movement?
No - Rectify the problem - broken wires, electrical connector, open solenoid coil, etc.
Yes - Proceed to step 4.b

b. Are all four (4) brakes fully released?
No - Check brake release pressure and insure each wheel receives correct release pressure.
Yes - Proceed to step 4.c

c. Are the pumps stroking time orifices installed tight and clean?
No - Remove the Plugs in ports X_1 and X_2. Remove orifices with a 3mm allen wrench. Check that orifices are clean & re-install.
Yes - Proceed to step 4.d

d. Is an motor displacement stroking time orifice plugged or is the two-speed shift hose pinched?
Yes - Inspect and clean stroking orifice, check two-speed hose routing

e. Is a flow divider/combiner cartridge stuck in the Traction Control Manifold? Flow divider/combiner cartridge # 111 controls the right side wheels, # 112 controls the left side wheels. Also check to insure bypass orifices #151 (right side) and # 152 (left side are not plugged.

5. Transmission Drives in one direction only
   a. Are electrical connections to pump control proportional solenoids correct, intact and without defects?
      Yes - Proceed to step 5.b
      No - Rectify the problem
   b. Check hot oil flushing valve cartridge #120 located in the Traction Control Manifold.
      Remove and inspect flushing valve cartridge for stuck spool or damaged cartridge "O"-ring seals & backup rings.
   c. Inspect "Make-Up" check valve cartridges, #190.1-190.4, installed in the Traction Control Manifold. Is a cartridge "stuck" open with debris or is an "O"-ring failed?
      No - Proceed to step 5.d
      Yes - Clean/repair or replace Make-Up check cartridge.
   d. Swap high pressure relief valves in the transmission. Does the transmission drive in the other direction?
      No - Proceed to step 5.e
      Yes - Repair/clean/adjust or replace high pressure relief valve on the non-driving side
   e. Replace "EP" control module. Does pump operate properly?
      No - Replace or repair pump
      Yes - Operate the transmission
6. Transmission Drives in Wrong Direction
   a. Check to see if electrical connectors or wiring have been swapped on the pump.
   b. Check to determine want end of the machine the boom is swung over.
7. Transmission Does Not Find or Hold Neutral
   a. Does pump remain in neutral with electrical connectors removed?
      No - proceed to step 7.b
      Yes - Check electrical system for signal problem
   b. With electrical connectors removed and machines wheels jacked off the ground and engine running, momentarily apply 12 volt DC signal (battery voltage) to a pump control solenoid. Does the pump return to neutral after the 12 volt signal is removed?
      No - Apply 12 volts to opposite solenoid & recheck.
      No - Replace pump control module, repeat step 7.a
      Yes - Possibly dirt was dislodged from control module, re-check thoroughly to determine problem has definitely been resolved.
   c. Check mechanical centering of the pumps
8. Transmission Drives at a High Noise Level
   a. Are the wheel drive planetary reduction gearboxes filled to the correct level and do they have the proper lubricant?
      No - Fill gearbox with correct grade of oil to the prescribed level.
      Yes - Proceed to step 8.b
   b. Is the engine flex plate and drive coupling correctly installed and aligned with the transmission pump?
      No - Install flex plate and bell housing per manufacturer's instructions
      Yes - proceed to step 8.c
   c. Is a rigid item or object contacting the resilient mounted engine/pump assembly?
      No - Proceed to step 8.d
      Yes - Insure no item is contacting the unit, transmitting air borne noise.
   d. Is the suction pressure/vacuum at the charge pumps inlets within recommended limits?
      No - Return to step 1.h
      Yes - Proceed to step 8.e
   e. Is there air in the hydraulic fluid? This may be indicated by foaming or milky colored oil.
      No - Proceed to step 8.f
      Yes - Deaerate the oil and inspect system for cause of air induction. Check for loose or missing "O"-rings on face seal connections.

f. Is a wheel drive hydraulic motor operating at excessive speed?
Yes - Check minimum displacement stop screw adjustments on the motors. Should be 0.433" or 11mm above the stop screw lock nut. Is one or more motors "stuck" at minimum displacement, check for plugged/blocked two-speed stroking orifice(s).

9. Transmission Operates at a Higher than Normal Temperature

a. Is the reservoir temperature above 195°F (90.5° C)?
No - 195°F (90.5° C) is the upper limit. If temperature is over 195°F (90.5° C), the oil cooler may need to be cleaned.
Yes - Proceed to step 9.c

b. Are the hydraulic motor(s) stalling (wheels not turning) intermittently?
No - Proceed to step 9.c
Yes - Hydraulic fluid is being heated through system pressure relief valves. Shut down system and rectify the cause of motor stall.

c. Does oil temperature remain above 195°F (90.5° C), after cleaning the oil cooler?
No - Operate transmission. Check oil cooler more often.
Yes - Proceed to step 8.a

10. Transmission Operates at a Higher than Normal Temperature

a. Check for differential temperature across the oil cooler. Is there a temperature difference?
No - Check to determine if the bypass check valve (10 psi [0.7 bar] crack pressure) is stuck open. Check to determine if the oil cooler is restricted internally, causing oil flow to pass across the bypass check valve.
Yes - Proceed to step 8.b

NOTE: *Oil cooler flow is received from the transmission pumps cases, max. continuous pump case pressure is 15 psi gauge pressure. Higher pressure will prematurely damage pump shaft seals*

b. Disconnect pump case drain from oil cooler & check flow rate from charge pumps. Is the flow rate 3.8 GPM (14.4 LPM) with diesel idle speed of 1200 rpm?
No - Refer to charge pump removal & inspection procedure

11. Transmission Pump(s) Do Not Develop Maximum Horsepower (Flow & Pressure)

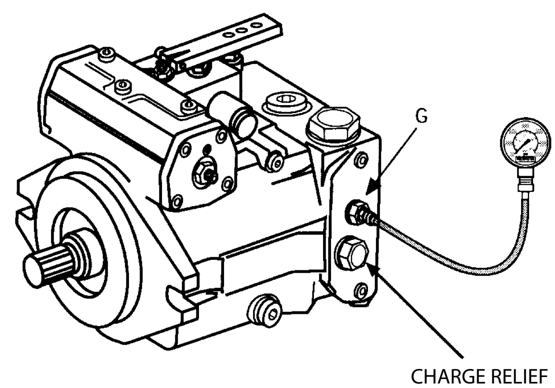
a. Does the charge pump pressure meet specification?
No - Return to step 2.a
Yes - Proceed to step 11.b

b. Does the pump case pressure exceed 15 psi gauge pressure?
No - Proceed to step 11.c
Yes - Check case drain hoses, oil cooler, etc. for pinched or restricted oil flow

c. Are the pump(s) high pressure cross port relief valves adjusted to the required pressure (5000 psi) so they do not bypass prematurely?
No - Inspect/clean/adjust and or replace valve cartridge
Yes - Replace the pump, after blocking the "A" & "B" ports, running the pump and measuring pressure developed at "A" & "B". This must be done to insure that flow & pressure loss in not elsewhere in the system. (motors, swivel coupling, etc)

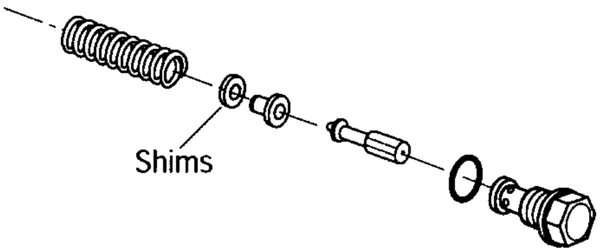
d. Is the diesel engine capable of developing horsepower at design rpm?
Follow recommended troubleshooting procedures to insure the engine is developing full power at specified rpms.

Charge Pressure Relief Valve Adjustment



With a low pressure (0 – 1000 psi [0 - 70 bar]) pressure gauge tee'd into the "G" port or two (2) low pressure gauges installed into "Ma" and "Mb", run pump at engine idle speed. Do not place the pump on stroke – low pressure gauges installed in "Ma" & "Mb" will be damaged! Prior to adjusting pressure, insure charge pressure relief valve is clean of any dirt or debris. The charge pressure relief valve does not wear appreciably over time. If charge pressure was normal and then has decayed, check for other causes of low charge pressure. If pressure is low, remove relief valve and add shim(s). If pressure is high, remove relief valve and take out shim(s).

NOTE: *Shim thickness 1 mm = 56 psi (3.86 bar). Shims are available in 0.3, 0.5, and 1.0 mm thickness.*



Mechanical Centering of Pump

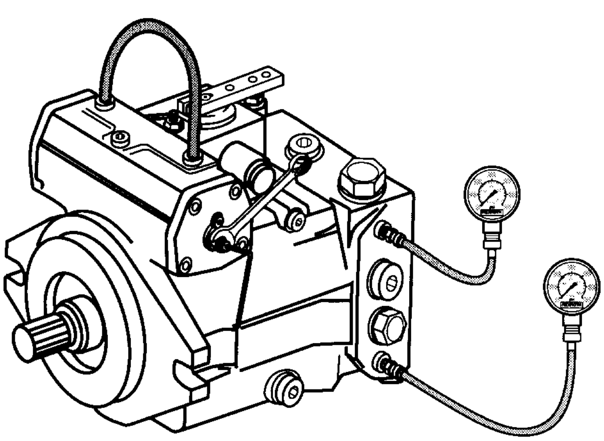
PREPARATION FOR ADJUSTMENT

The control piston has strong centering springs to ensure that once the pump is adjusted for the neutral position it will always return to neutral. If an adjustment is necessary follow the steps listed below.

To ensure there is equal pressure on both sides of the control module during the centering operation, it is necessary to connect the X_1 and X_2 ports together by means of hose or tubing. (No less than a 1/4 inch ID) The port sizes are:

Pump Size	Allen Wrench	Wrench
28	5 mm	17 mm

With pressure gages installed at M_A, and M_B, and with A and B ports blocked (or motor stalled), and with the pump running, loosen the jam nut. Turn the mechanical centering adjusting screw until 1000 psi is read on M_A, or M_B then turn screw opposite direction until 1000 psi is read on other pressure port. Turn the screw back, splitting the distance between the previous two positions. This should be the neutral position. Pressure on M_A, and M_B should be equal.

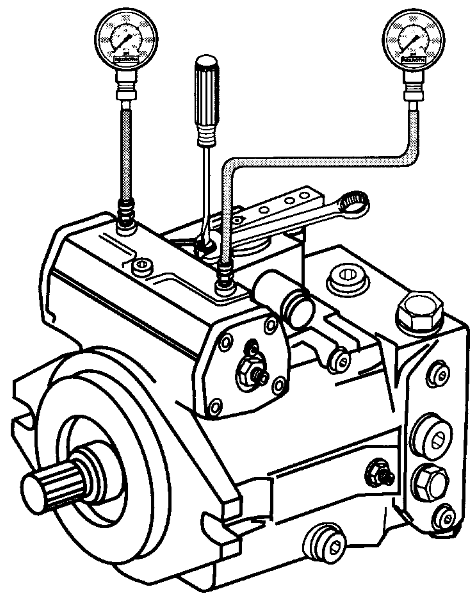


Tighten jam nut, stop the pump drive, remove the hose connecting ports X_1 and X_2.

Hydraulic Centering of Control Modules

PREPARATION FOR ADJUSTMENT

When control modules are exchanged or replaced, it is generally necessary to center the new module. This is done by running the pump with gauges installed at ports X_1, X_2, M_A, and M_B Release the jam nut and turn the adjustment screw on top of the control module valve body.



The adjustment screw is an eccentric, therefore, turning more than 90’ in either direction will have no further centering effect, and could cause damage to the eccentric pin.

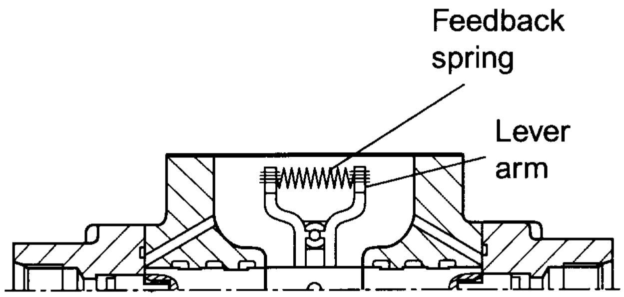
Pump Size	Tool Required	Wrench
28	Screwdriver	10 mm

CENTERING THE EP CONTROL MODULE

With no electrical signal to solenoids A and B, (remove both plug-in connectors), the EP control module is correctly adjusted when any or all of the following conditions exist:

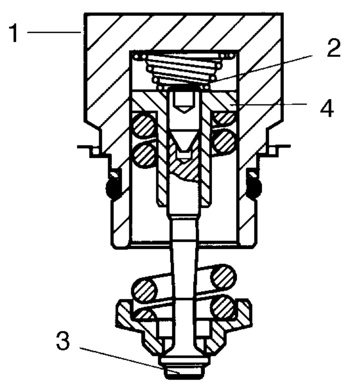
1. Approximately, when equal control pressures are obtained at control pressure ports X_1 and X_2.
2. The hydraulic motor does not turn when the brake is released.
3. Charge pressure is registered equally at ports M_A and M_B, when the flow output of the pump is deadheaded against a locked motor or a valve.

If difficulties are encountered in obtaining neutral position of the HD or EP control modules, check that the ends of the control spring are correctly located in the grooves near the end of the feedback lever arms.



High Pressure Relief Valve Adjustments

1. Remove relief valve cover from pump (ref. item 1).



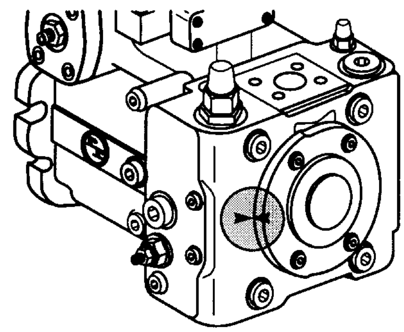
2. Loosen jam screw (ref. item 2).
3. Holding spring loading nut (ref. item 4) rotate valve spindle (ref. item 3). For high range relief valve, one turn equals approximately 630 psi (44 bar). For low range relief valve, one turn equals approximately 377 psi (26 bar).
4. After adjustment is completed torque jam screw (ref. item 4) to 5 ft.lb. (7 Nm).
5. Install relief valve assembly into pump, reinstall cover (ref. item 1) to proper torque.

Table 5-5. Torque Specs for Relief Valves into Port Block

Pump Size	Wrench Size	Torque
28	32 mm	66 ft.lb. (90 Nm)

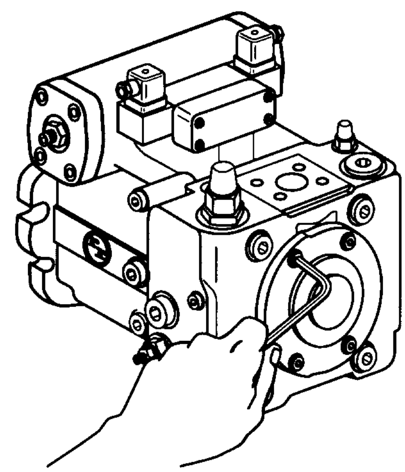
Removal and inspection of charge pump

Before removing cap screws, mark the position of the charge pump housing and separator plate in relation to the port block.

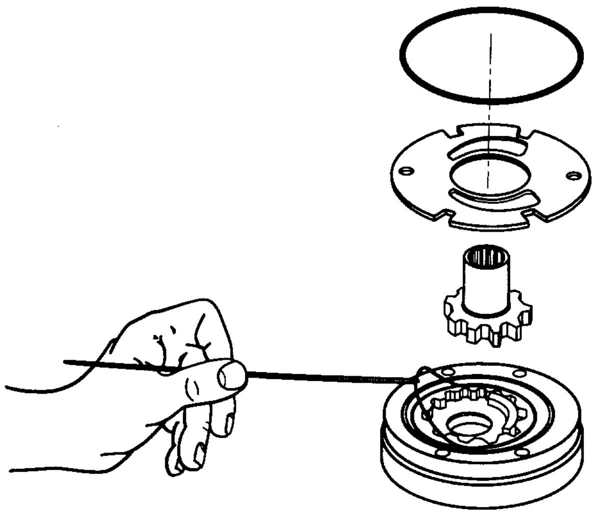


Loosen screws with metric allen wrench.

Pump Size	Allen Wrench
28	8 mm

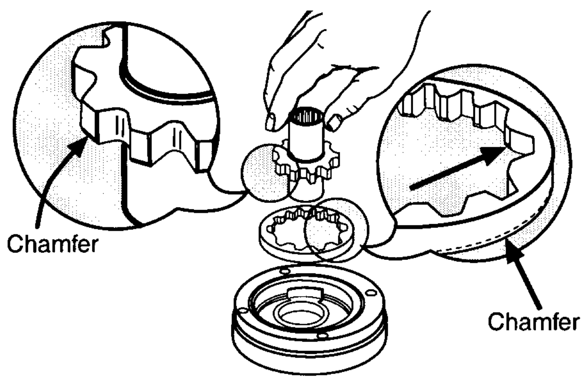


Remove charge pump housing and inspect for wear or damage to gear set and 0-ring seals. Grease 0-rings prior to reassembly. Make sure 0-rings are completely seated in their grooves.



Withdraw pinion shaft and inspect gear teeth and bearing surfaces for abnormal wear.

When reassembling, make sure chamfer (on outer edge of driven gear and drive gear) is installed into housing per illustration.



Torque value for bolts when replacing charge pump.

Pump Size	Torque
28	18 ft.lb. (24 Nm)

NOTE: *If serious wear or damage has occurred to one component, the complete charge pump assembly must be replaced because they are matched components.*

Routine Maintenance

The Variable Displacement Hydrostatic Transmission Pumps are relatively maintenance free. Maintenance work is confined to the system, by way of maintaining hydraulic fluid condition, the "life blood" of the machine. Oil monitoring, changes and filter renewal promote system cleanliness. This will prevent premature breakdown and repairs. Under normal application conditions, the following maintenance intervals are suggested:

1. Renewal of Filter Elements
    a. After commissioning or re-build.
    b. At every 500 operating hours or when filter indicator shows a dirty element.
    c. With the suction strainer, the strainer should be renewed as soon as charge pump inlet pressure is less than -3.2 psi, 6.3"Hg or 0.8 bar absolute.
    d. Only JLG recommended filter elements are to be used. Paper elements cannot be cleaned; use throw-away cartridges.
2. Hydraulic Fluid Change
    a. After 2000 operating hours (1st oil change)
    b. Thereafter, every 2000 operating hours or annually, irrespective of operating hours achieved.
    c. Oil change should be performed with the system in warm running condition. Before re-filling, the reservoir interior should be inspected and cleaned to remove any sludge.
    d. Rags or threaded material must not be used.
    e. This machine has been designed & manufactured to operate on an Exxon-Mobil Oil Co. hydraulic fluid, Mobilfluid #424, Product #52233-4. Consult JLG Industries prior to introducing any other type of fluid to prevent interaction or possible contamination.
    f. The recommended interval between oil changes is based on various factors and should be carried out according to the degree of aging, contamination and water content.

g. Under application conditions with a heavy occurrence of dust or severe temperature fluctuations, the intervals between fluid maintenance should be shortened accordingly.

NOTICE

PRACTICAL EXPERIENCE SHOWS THAT MOST FLUID MAINTENANCE ERRORS OCCUR DURING AN OIL CHANGE DUE TO:

- **USE OF AN UNSUITABLE HYDRAULIC FLUID**
- **USE OF OIL CONTAMINATED DUE TO POOR STORAGE PRACTICES**
- **FAILURE TO CLEAN THE RESERVOIR**
- **INADEQUATE CLEANLINESS WHEN FILLING THE RESERVOIR (DIRTY DRUMS, CONTAINERS, WATER, ETC)**

3. Leakage Inspection

a. After commissioning

b. The complete transmission drive system (pumps, motors, hosing, filters, valves, etc) should be checked for leakage at regular intervals.

c. Leaking joints & connections must only be tightened when pressureless.

4. Cleanliness Inspection

a. The oil tank breather should be regularly cleaned of dirt and dust to prevent clogging. With each cylinder movement, gallons of oil pumped, an equal amount of air exchange occurs across the reservoir breather. A dirty or clogged breather will affect **all** machine functions!

b. The air/oil cooler surfaces and engine radiator should be cleaned at the same time.

c. If hose connections are disassembled, it is imperative that the utmost care be taken that no foreign bodies infiltrate the oil circuit. Catastrophic component failure may occur.

5. Oil Level Inspection

a. Inspect oil level in the reservoir daily.

b. If "topping off" is required, use only the same Mobilfluid #424, Product #52233-4.

c. Do Not Mix Fluids.

6. Hydraulic Fluid - The "Life Blood" of the Machine

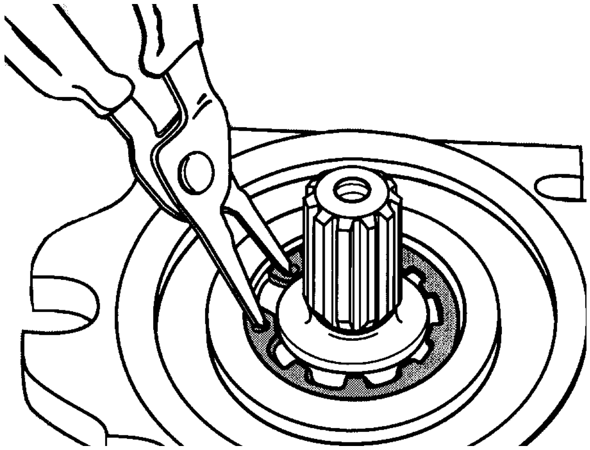
a. The type of hydraulic fluid supplied in the machine from the factory was selected after extensive testing and development. The fluid was selected to perform under "most" applications and conditions. Should this machine be in service for extended time periods at the extremes (hot or cold), JLG should be consulted for assistance in selection of the most suitable fluid type and grade for your application.

b. When operating at temperatures below 0°F, allow a warm-up period, if at all possible, to a temperature of 40°F.

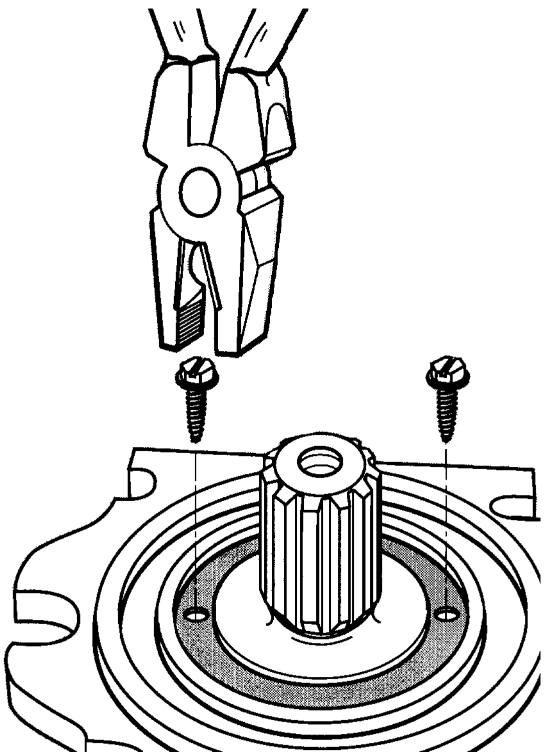
c. When beginning motion of a "cold" machine, operate all functions at reduced speeds until the "cold" oil has circulated out of the drive loop.

Removal and Installation of Shaft Seal

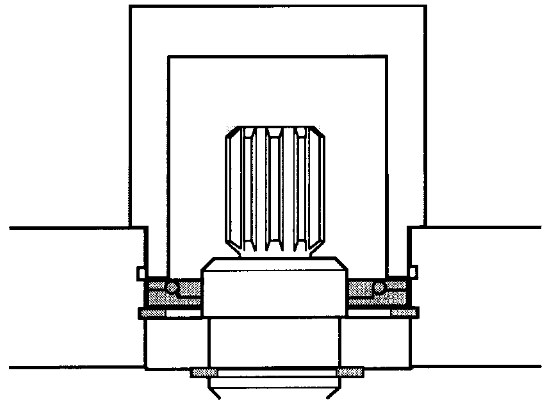
Remove the retaining ring with snap ring pliers.



Screw in sheet metal screw into the holes fitted with rubber. Pull out shaft seal with pliers.



Press in shaft seal with bushing to the stop. Then replace snap ring.



5.6 FUNCTION PUMP

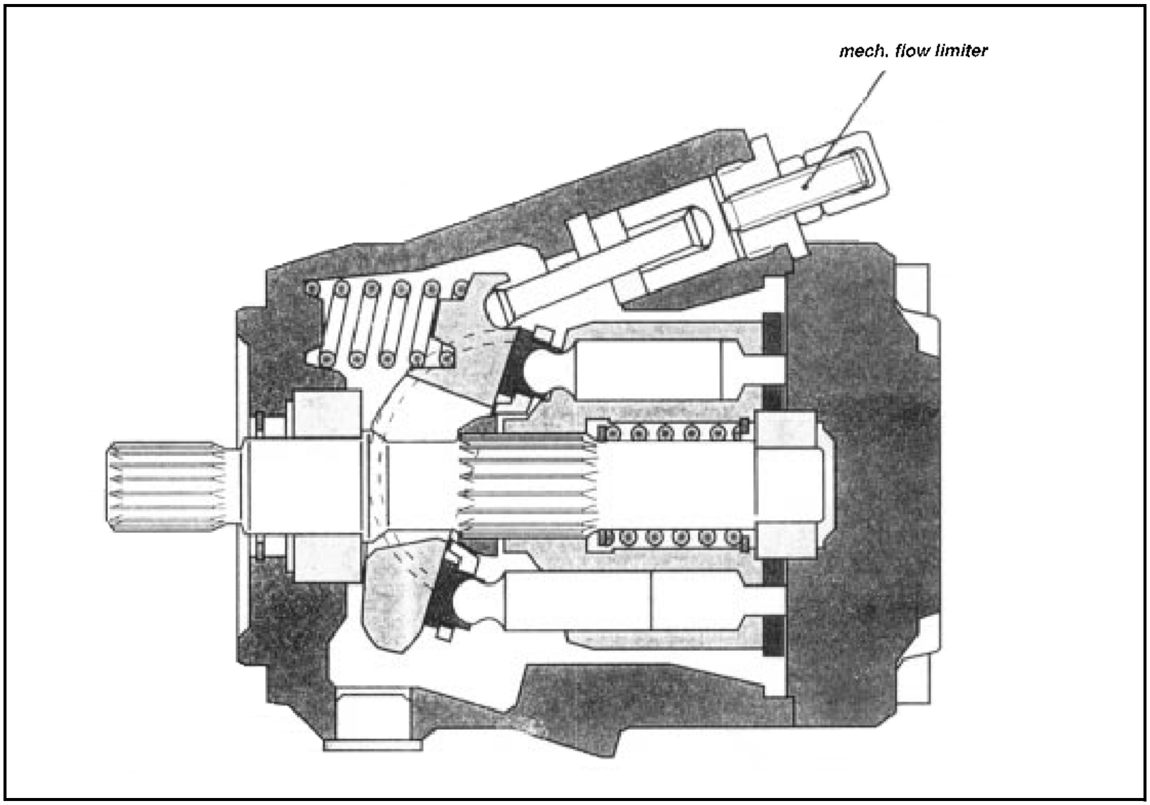
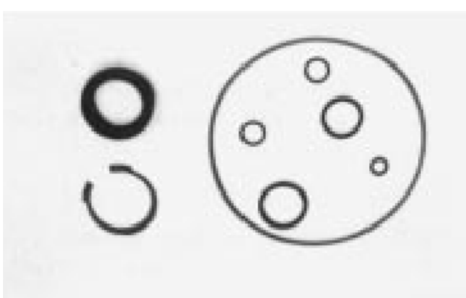


Figure 5-29. Function Pump - Sectional View

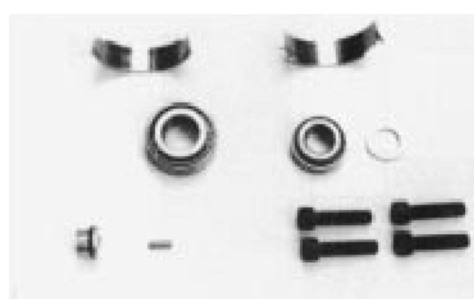
Spare Parts

1. Sealing kit, existing spare parts: shaft sealing ring, o-rings, and a circlip.

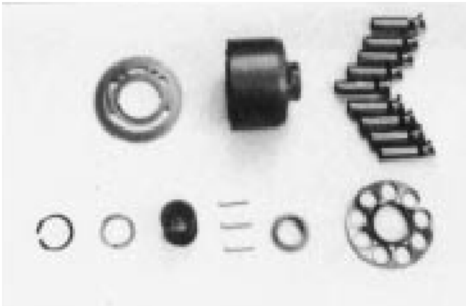


2. Drive Shaft

3. Bearing set, miscellaneous parts.



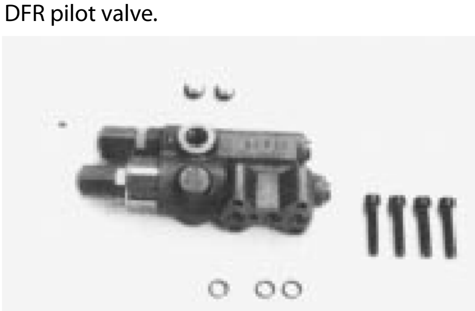
4. Rotary Group complete: 9 pistons, cylinder subassembly, valve plate, retaining plate, and retaining ball.



5. Swash Plate.

6. Parts of the control valve: control piston, piston rod, plug, spring stopper max flow, hex nut, and hex head nut.

7. DFR pilot valve.

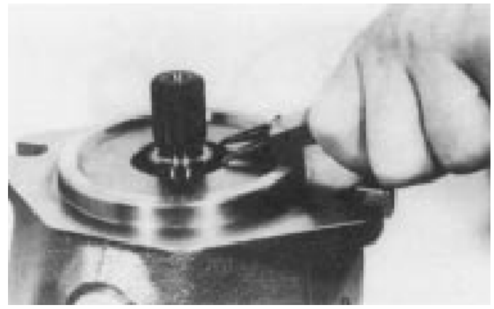


Sealing the Drive Shaft

NOTICE

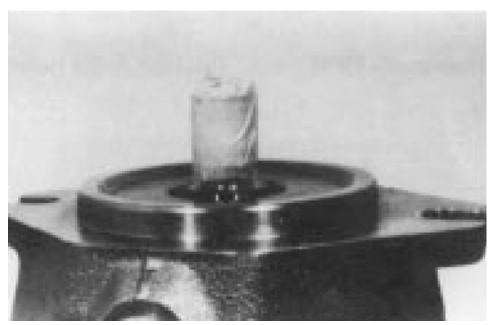
BE VERY CAREFUL SO THE DRIVE SHAFT IS NOT DAMAGED DURING THE REMOVAL OF THE SHAFT SEALING RING.

1. Remove the snap ring.



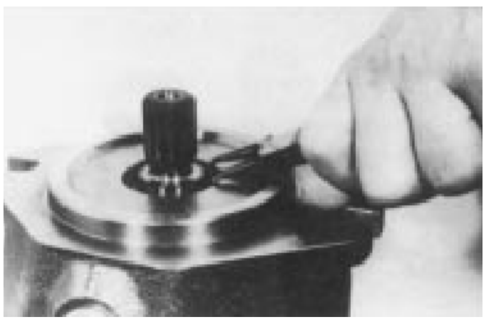
2. Change the shaft seal and check its' sliding surface (drive shaft) and housing. Grease the sealing ring.

3. Be careful while you seal the drive shaft. Use an adhesive tape to prevent the shaft splines from damaging the seal.



4. Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.

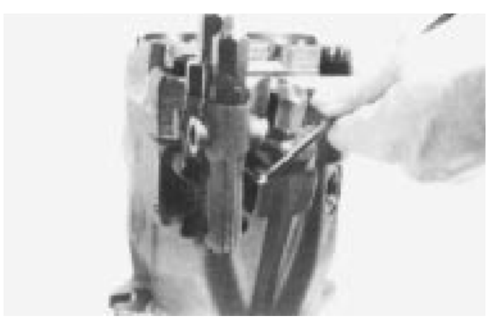
5. Assemble the snap ring.



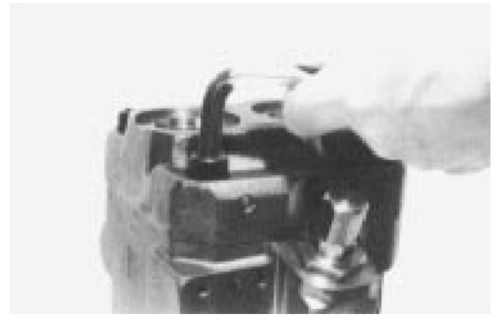
6. Assemble the snap ring in the correct position.

Disassembly and Assembly of the Complete Unit

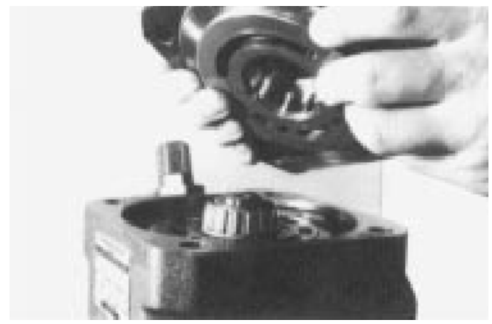
1. Disassemble the pilot valve.



2. Mark the position of the port plate and remove the socket screw of the port plate.



3. Remove the port plate together with the valve plate (hold the valve plate so the plate can't fall down).

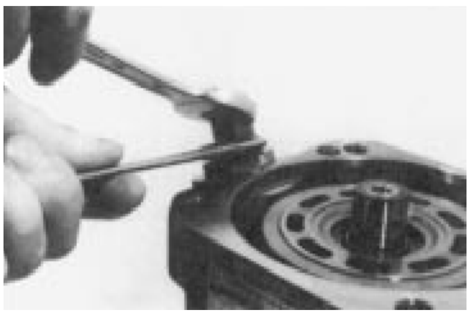


4. Remove the o-ring.

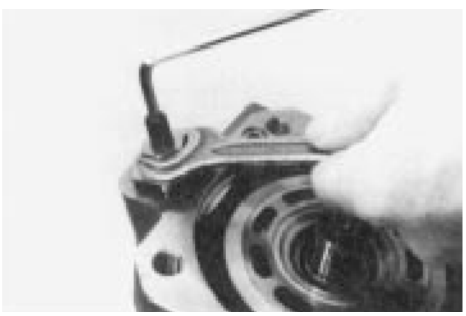
5. Disassemble the taper roller bearing (nearby port plate).

6. Remove the adjustment shim.

7. Unscrew the cap nut and remove it.



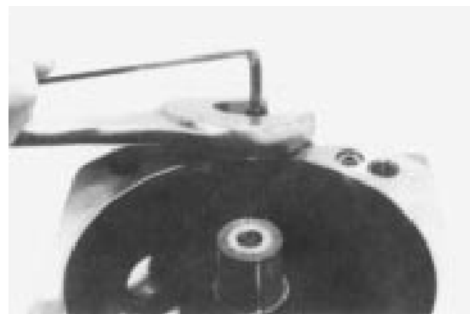
8. Loosen the fixing nut of the stopper max flow and disassemble it.



9. Turn in the stopper max flow to get swivel angle zero.

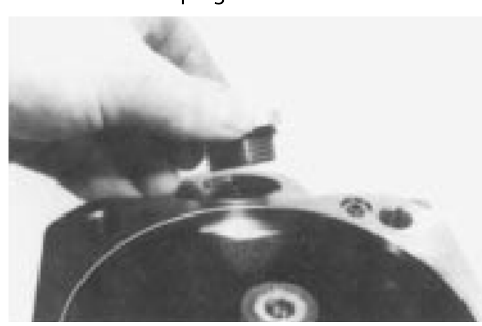
10. Disassemble the rotary group in horizontal position.

11. Disassemble the stopper max flow.

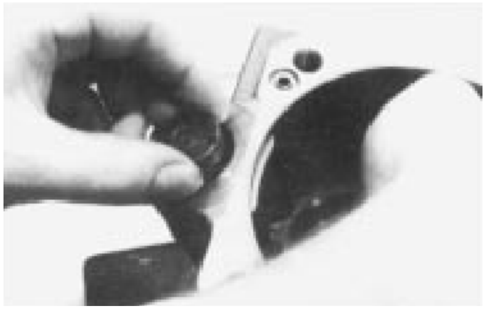


12. Remove the threaded pin.

13. Disassemble the plug.

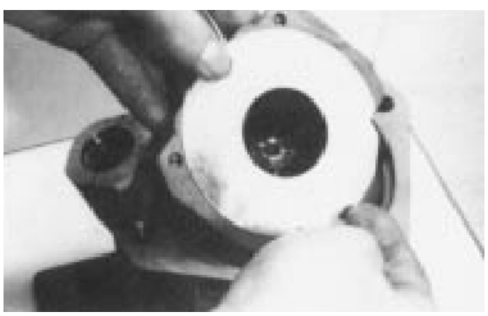


14. Disassemble the control piston while moving the swash plate.



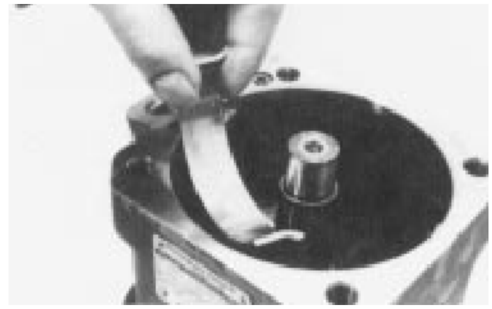
15. The swash plate must be lifted a little bit to disassemble the piston rod.

16. Remove the swash plate.



17. Remove the spring.

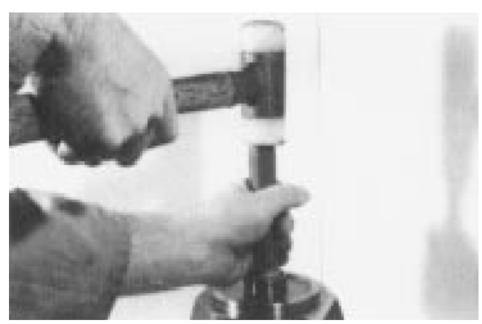
18. Remove both bearing shells.



19. Remove the drive shaft.

20. Disassemble the snap ring.

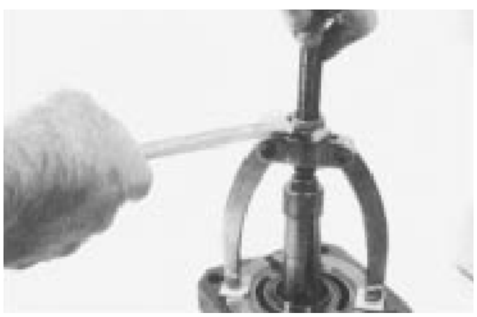
21. Disassemble the sealing ring.



22. The external front bearing ring is pulled out of the pump housing.

23. Remove the o-ring. Lifting of the valve plate isn't shown.

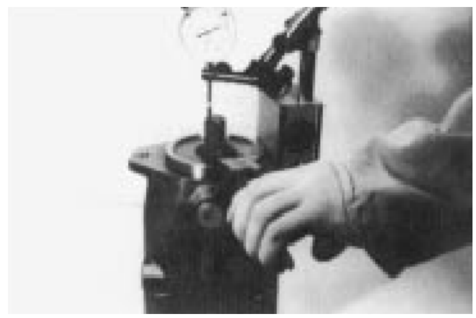
24. A bearing puller is used to disassemble the external bearing ring of the taper roller bearing inside the port plate. Take care of the surface of the port plate.



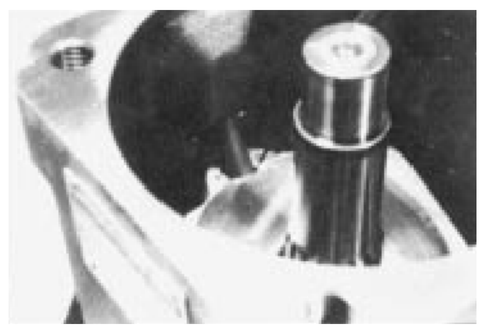
25. The spring has additional pretension while you disassemble the three pressure pins inside the cylinder.

Assembly

1. Measurement of the taper roller bearing pretention.



2. Ensure there is a correct connection of the piston rod and the swash plate.



3. Pumps clockwise driven must have a position of the valve plate 4 degrees out of center in the same direction decentered like drive direction.

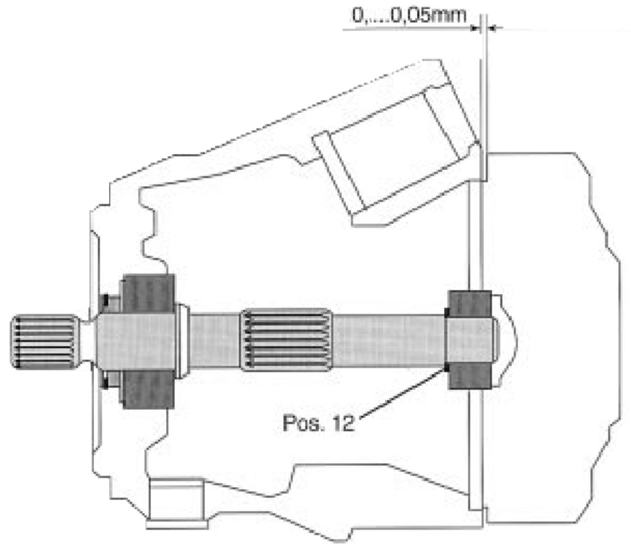
4. Pumps counterclockwise driven must have a position of the valve plate 4 degrees decentered in the ccw position.

5. Note the correct position of the drilling that connects high pressure to the control valve. Check control valve drilling position at the pump housing and fit together.

Adjustments

TAPER ROLLER BEARING INITIAL TENSION

Cast Iron pump housing must have initial tension of the bearings: 0 to 0.05 mm.



MECHANICAL FLOW LIMITER

Differential volume if you are rotating the threaded pin - each rotation is approximately 3.1 cm3.

Tightening Torques

For break-off plugs, use Loctite #601.
For all other parts, use Loctite #242.

Table 5-6. Tightening Torques

	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M30
8.8	2.3	5.0	8.5	21	41	72	115	176	240	350	600	1220
10.9	3.2	7.2	12	29	58	100	165	250	350	490	840	1670
12.9	4.1	8.5	14.5	35	70	121	195	300	410	590	990	2000

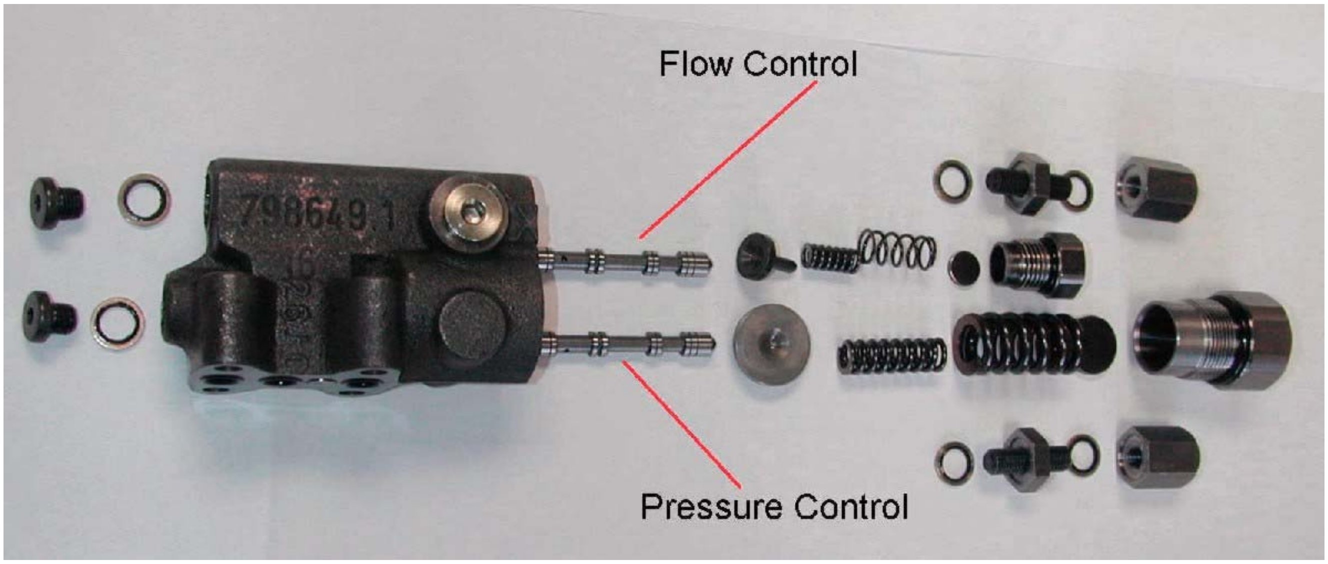


Figure 5-30. Function Pump, Pressure and Flow Control - Sheet 1

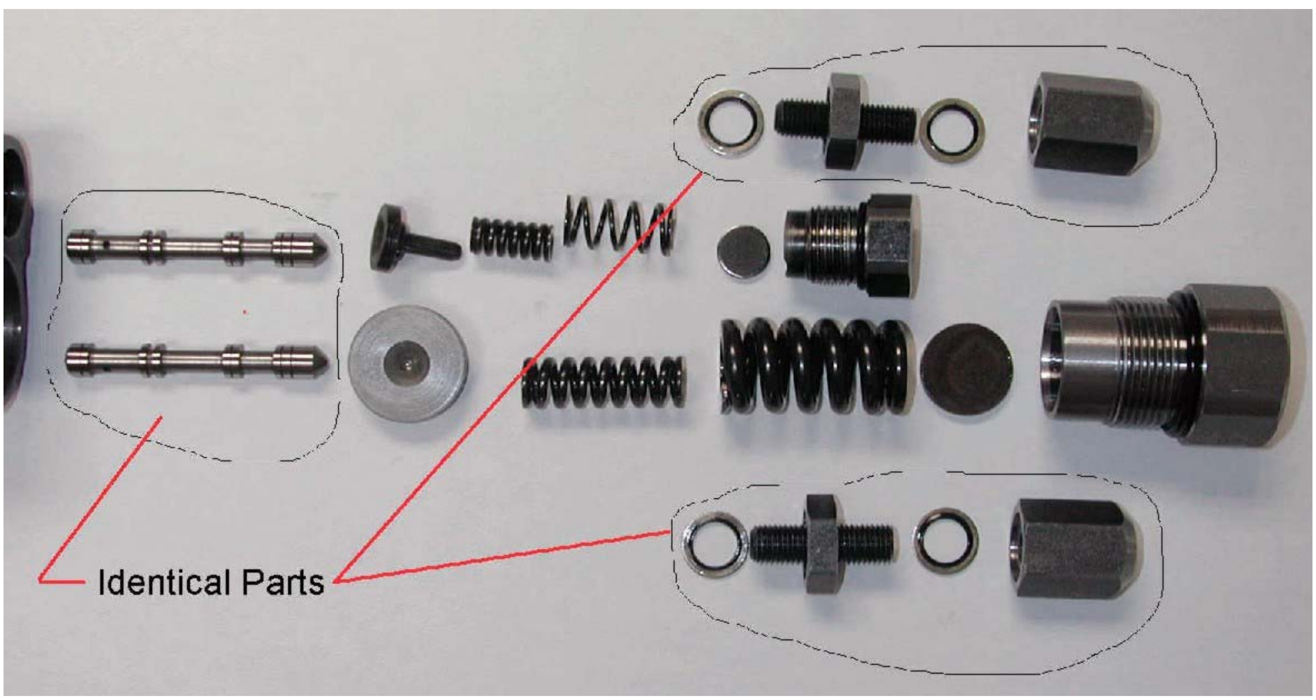


Figure 5-31. Function Pump, Pressure and Flow Control - Sheet 2

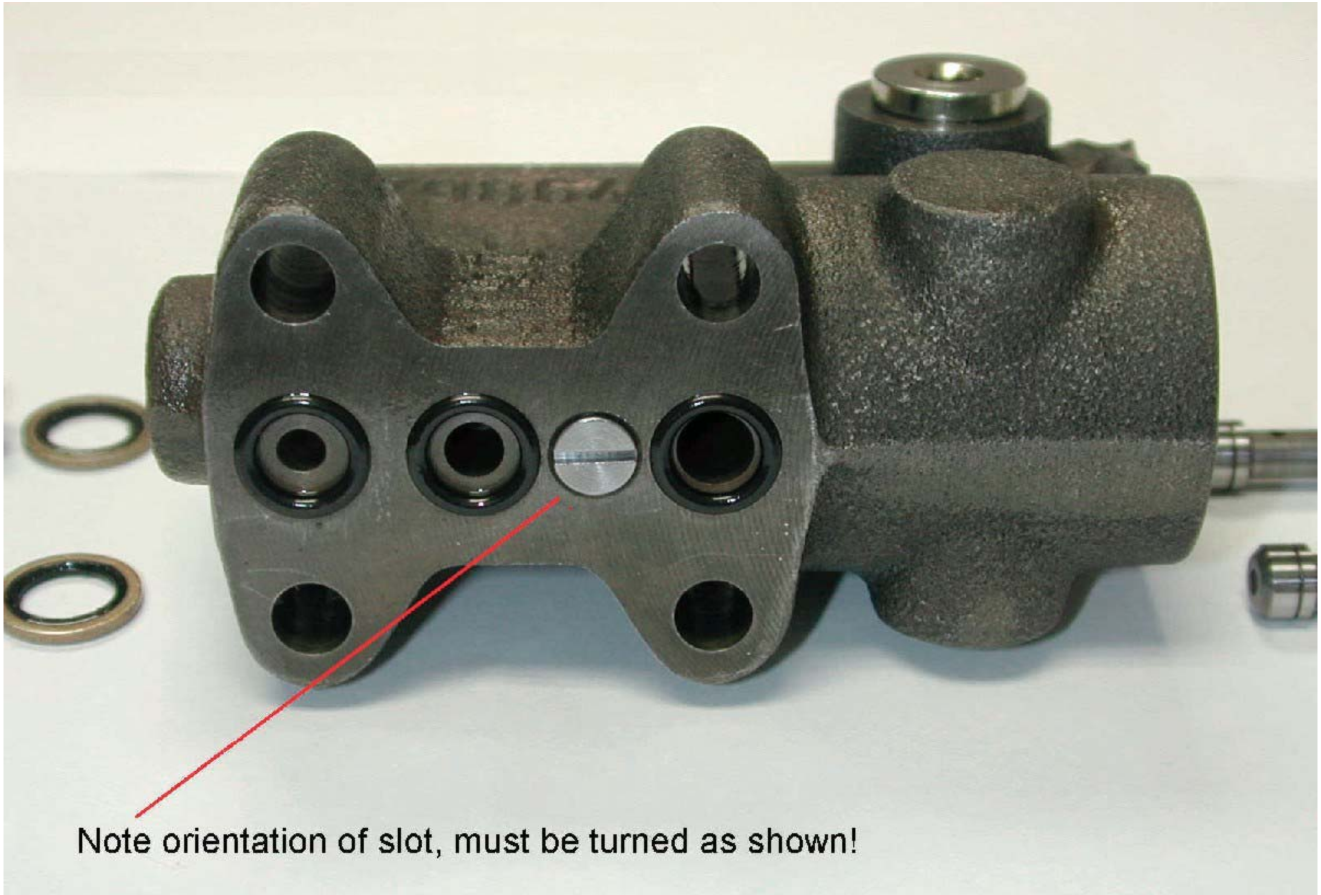


Figure 5-32. Function Pump, Pressure and Flow Control - Sheet 3

Pump Control Disassembly For Cleaning

NOTE: If the Function Pump does not perform correctly after following the pre-start start-up procedures, it is possible that a contaminate particle has lodged in the pump control preventing proper operation. The pump control's internal parts are not provided as spare parts due to the close tolerances required between the mating parts. However, the control can be disassembled, cleaned and placed back in service should the only problem prove to be contamination. Disassembly, inspection, cleaning and reassembly MUST BE done in a clean well-illuminated area.

Pump Control removal:

1. Disconnect plug the hose attached to the pump control Port "X".
2. Remove the four (4) socket head cap screws that attach the control to the pump. Insure that the three (3) "0"-rings are also removed with the control.
3. Hydraulic fluid may drip from the pump. Wiping the surface clean and installing some adhesive tape should prevent oil from seeping from the pump control.
4. Work on a clean, lint free area.

NOTE: *The pump control can be equipped with either O-rings or a sealing plate. These components are NOT interchangeable.*

5. Remove the three (3) "0"-rings (Parker # 2-011, Viton 90 shore)
6. Remove both the adjustment hex caps and bonded seal rings. (17 mm wrench)
7. Remove both the adjustment lock nuts and bonded seal rings. (17 mm wrench)
8. Remove both the adjusting screws. (3-mm Allen wrench)

9. Remove the spring cover hex cap for the ″outer″ flow regulation adjustment this requires a 19-mm wrench.
10. Remove the spring disc.
11. Remove the adjusting springs (two springs, one ″nested″ inside the other) and spring follower.
12. The flow regulation spool should slide from the control housing, (a magnet should aid in removal). If it does not, remove the hollow hex head plug at the rear of the flow regulation spool and carefully push the spool from the housing - do not scratch/mar the spool's bore.
13. Remove the spring cover hex cap for the ″inner″ pressure compensation adjustment – this requires a 30-mm wrench.
14. Remove the spring disc.
15. Remove the adjusting springs (two springs, one ″nested″ inside the other).
16. Remove the spring follower.
17. The pressure compensation spool should slide from the control housing, (a magnet should aid in removal). If it does not, remove the hollow hex head plug at the rear of the flow regulation spool and carefully push the spool from the housing - do not scratch/mar the spool's bore.
18. The spools are identical.
19. Wash the housing and all parts in a clean JLG approved solvent such as non-chlorinated brake cleaner, Stoddard solvent, etc.
20. Blow off all the parts with clean, dry compressed air.
21. Inspect the housing for contamination or plugged orifices. Clean orifices carefully with a dead soft steel wire to insure they are open. Inspect all parts for burrs, scoring, debris, etc.

NOTE: *On the mounting surface of the control housing, between the oil ports is what appears to be a slotted head screw. IT IS NOT A SCREW. This is a bleed orifice, which must be orientated to allow proper control operation. The slot in the head should be oriented to fall in-line with the oil ports, NOT PERPENDICULAR to the oil ports. If the slot is oriented perpendicular to the three ports, the pump pressure will not return from load pressure to stand-by pressure at the end of operating a function! The pump pressure will remain at the last highest pressure generated.)*

22. After all parts are clean and dry, lightly oil a control spool and install in its bore. The spool must slide smoothly and easily within the housing. If it does not, check for contamination. If contamination cannot be found check for ″scoring″ or ″burring″ of the control housing. If the spool does not slide smoothly & freely, the control must be replaced with a new unit.
23. Lightly oil and check operation of the second spool. The spools are installed correctly when there ″pointed″ end faces the spring followers
24. Re-assemble in reverse order.
25. Bench set the pressure adjustments as described in ″C. 4″ of the Operating Instructions.

NOTE: *The pump control can be equipped with either O-rings or a sealing plate. These components are NOT interchangeable.*

26. Re-install on the Function Pump, insure the ″0″-rings are installed properly and tighten the four (4) M6 socket head cap screws to 105 inch pounds.

5.7 DRIVE & FUNCTION PUMP START UP PROCEDURES

Start-Up Procedure

The 1200/1350 Boom Lift utilizes a Triple Combination Pump coupled to the Deutz diesel engine. The pumps are connected in-line to each other as follows:

1. The front hydrostatic transmission pump, or drive pump, is coupled directly to the diesel engine and provides oil flow to operate the machine's right side wheels.
2. The middle hydrostatic transmission pump, or drive pump, is coupled to the back of the front pump and provides oil flow to operate the machine's left side wheels.
3. The third or rear pump is the function pump. It is coupled to the back of the middle pump and provides oil flow to operate the boom, axle, steer and platform functions.

The transmission pumps share some common connections. Each pumps charge oil suction ports are connected by steel tubing, the charge pumps discharge oil flows are connected and flow to a common charge pump inline oil filter, cleaned & filtered oil flows back to the transmission pumps "G" ports. The pumps case drain ports are connected (T1 & T2), oil flow from the middle pumps T1 port also provides flows to the oil cooler. The charge pumps oil pressure is regulated by a single boost oil pressure relief valve installed in the middle pump. The front pump has an orifice cartridge (0.047" diameter) installed in place of a charge oil pressure relief cartridge. This insures that only one valve controls charge pressure & provides an amount of charge oil flow to the front pump's case to insure flushing & removal of hot oil.

Each pump has its own separate electrical proportional directional control valve to control oil flow and direction. The signals or command values to each pump are similar except when steering. During steering and propel of the machine the pump supplying oil to the "inside turning radius" has a command less than the pump supplying oil flow to the "outside turning radius" pump.

"Posi-Traction" control, front to rear on a given side of the machine, is accomplished by a flow divider/combiner cartridge installed in the Traction Control Manifold. There is a flow divider/combiner for each side. Each flow divider/combiner also has a "bleed orifice" to limit the amount of flow splitting or combining.

The middle transmission pump also supplies oil to a hot oil flushing valve cartridge, #120, in the Traction Control Manifold. This cartridge provides a means to obtain brake release oil pressure. The brake release pressure is controlled by a pressure relief valve cartridge # 130 and a solenoid operated brake release directional control cartridge, #170, also located in the Traction Control Manifold. <u>This is important to note as the brake release oil pressure must be set 25 psi (1.7 bar) below the boost oil pressure relief valve. If the brake release pressure is set too low, brake drag and pump control will be affected. If set too high, damage to the wheel drive parking brakes could result. Prior to start, connect appropriate pressure gauges to the unit.</u>

FOR THE START-UP OF NEW OR OVERHAULED INSTALLATIONS:

1. Insure all electrical checks have been performed & the machine is set up correctly with the JLG Analyzer.
2. Insure the machine has all four wheels jacked & blocked off the ground per JLG procedures.
3. Insure the triple pump assembly is installed and connected correctly per the hydraulic circuit diagram.
4. Disconnect the electrical connector from the diesel's throttle actuator, to prevent engine start.
5. Crank the engine until charge pressure reaches 50 psi or more.
6. Re-connect throttle actuator electrical connector and start engine. Allow engine to run at idle speed only for at least 5 minutes. This will allow the hydrostatic system to filled.
7. Listen for any abnormal noises.
8. Check for oil leaks.
9. Check charge pressure (500 psi +50psi, - 0 psi [34.4 bar +3.4 bar, - 0 bar]). Pressure can be measured a pump ports Ma & Mb or by "teeing" into the inlet for the charge oil filter. Charge pressure is checked with the joystick in neutral. A 0-1000 psi (0-70 bar) pressure gauge must be used. (If pressure gauges were installed in Ma & Mb to check charge pressure, disconnect the gauges installed in Ma & Mb, as they will be damaged if loop pressure rises above 1000 psi [34.4 bar].)

10. Operate the drive system in the "turtle mode", forward and reverse.
11. De-aerate the system by bleeding fluid from the Ma & Mb ports.
12. Switch the drive mode speed control from "turtle" to "rabbit". Gradually increase drive speed forward & reverse, still with no load - wheels off the ground.
13. With the joystick in neutral, check for creep in neutral. If evident, most likely dirt is present in the proportional pump control, an incorrect electrical signal is present on the pump's electrical control(s) or the control was not centered properly when overhauled. See service manual for centering instructions.
14. Check that the controls are connected so that the transmissions operate in the correct direction related to control input.
15. Continue to monitor all pressure gauges & correct any irregularities.
16. Remove the brake coil (leaving the electrical connection intact) from the brake release solenoid cartridge located on the Traction Manifold. This disables the machine's ability to release the brakes! Stroke the transmission pumps slightly (less than 20%) and check the setting of the high pressure cross port relief valves. Setting should be 5000 psi +50 psi, - 0 psi (344.7 bar +3.4 bar, -0 bar). Install 0-6000 psi (0 - 415 bar) gauges on Pump ports Ma & Mb.
17. Check oil level & temperature.
18. Remove and inspect charge pressure oil filter, replace with new element.
19. Operate the transmission under no load conditions for about 15 minutes to stabilize the temperature and remove any residual air from the fluid.
20. Set the machine back on the ground. Operate the transmissions under full and normal conditions.
21. Erratic operation may indicate there is still air trapped in the system. By working the pump controls forward and reverse the remaining air can be eliminated. The system is free of air when all functions can be operated smoothly and when the oil in the reservoir is no longer aerated. (Usually less than one hour of operation)

NOTE: *If the transmissions do not perform correctly after following the pre-start & start-up procedures, refer to the relevant sections of the trouble-shooting procedures.*

SECTION 6. JLG CONTROL SYSTEM

6.1 INTRODUCTION

NOTICE

WHEN INSTALLING ANY NEW MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS AND PROPERLY CALIBRATE THE TILT SENSOR.

NOTICE

IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

The main lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer Kit, JLG part no. 2901443) which will display two lines of information at a time, by scrolling through the program.

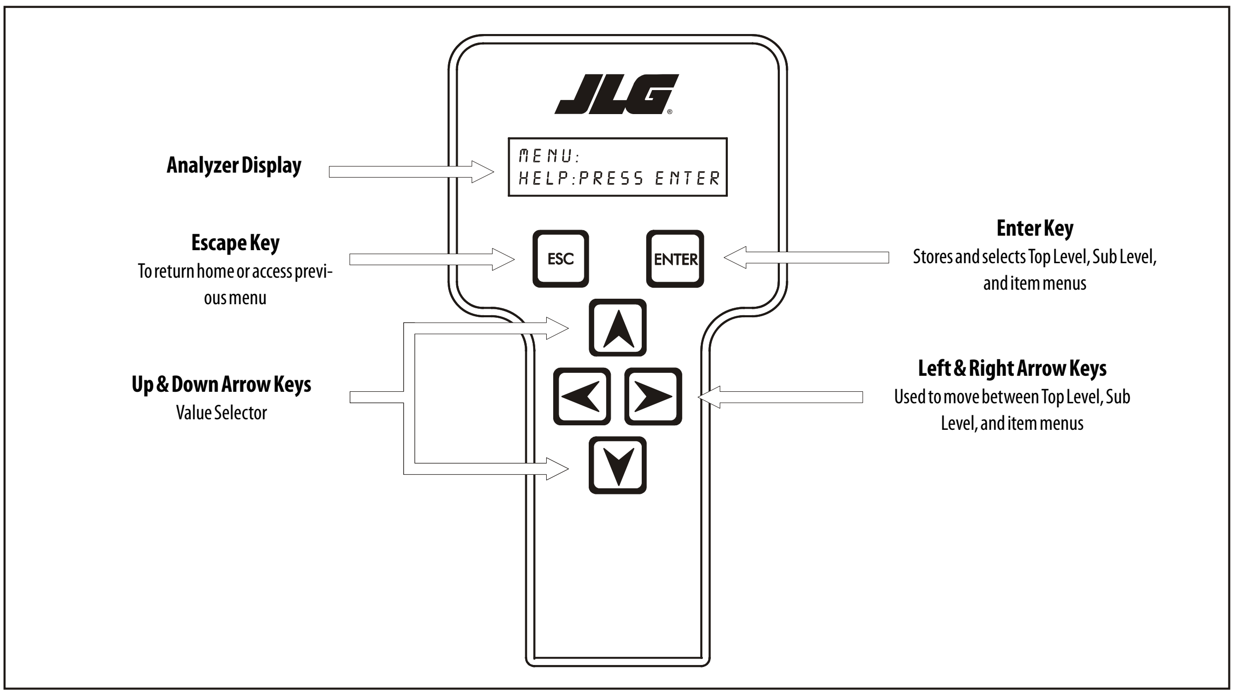


Figure 6-1. Hand Held Analyzer

6.2 CANBUS COMMUNICATIONS

CANbus: CAN (Control Area Network) is a two wire differential serial link between the Platform Module, Ground Module, Boom Length Angle Module and the Chassis Module providing bi-directional communications.

Two-wire: One wire (red) is driven high (5v) and the other low (black) (0v) to send a signal; both wires ”float” (2.5v) when no signal is being sent.

Differential: Any electrical line noise can affect the high or the low wires but never both, so communications is not corrupted.

Serial Link: Messages are being sent bit by bit along the wires; the high bus speed allow all modules to be constantly updated around 20 times per second. Typical traffic is 300 - 500 messages per second.

A complete CANbus circuit is approximately 60 ohms, which can be verified at the ”T” fitting inside the ground station or below the BLAM. Each individual circuit from the modules is approximately 120 ohms.

The GROUND MODULE is the master system controller. Most functions are dispatched and coordinated from this module, all other system modules (PLATFORM, BLAM L CHASSIS) handle sub-tasks. All characterized information (values) are stored into the ground module (i.e., Personalities or Calibrations).

Interlocks: Any device that sends an electrical input. (For an example a limit switch, proximity switch, etc;)

Platform Level: The GROUND MODULE stores the default values and handles interlocks. The PLATFORM MODULE reads the sensors mounted on the platform assembly and controls the Level Up / Down valves to maintain setpoint sent from the GROUND MODULE.

Steer: The GROUND MODULE stores crack points, sends desired drive direction, sends steering mode and sends axle extend / retract commands. The PLATFORM MODULE reports the steering switch position to the GROUND MODULE. The CHASSIS MODULE modulates each steer left / right valve to maintain commanded wheel position.

Drive: The GROUND MODULE stores crack points, sends commands for each drive pump to the BLAM. (Command is computed from drive joystick input, interlocks, wheel angle, etc). BLAM maintains proper current for the drive pumps by modulating PWM outputs.

Lift, Tele, & Swing: The GROUND MODULE stores default values, handles interlocks and calibration information. Lift, Telescope and Swing commands are dependent upon interlocks through out the machine. Boom angle, length and swing are controlled by the GROUND MODULE. The BLAM monitors and communicates (CANbus) to the GROUND MODULE boom angle and boom length via two angle sensors, a length sensor and a load moment pin.

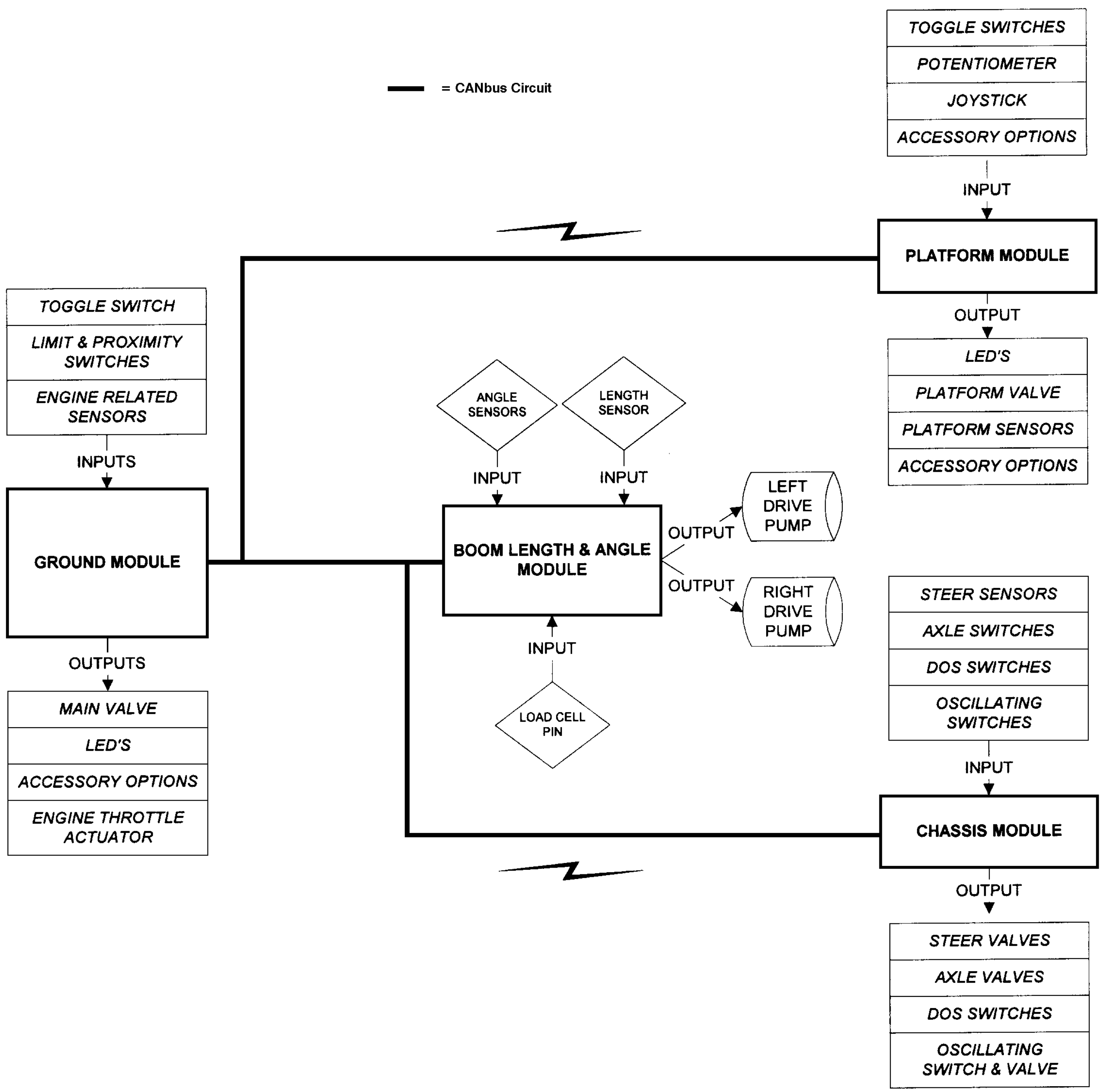


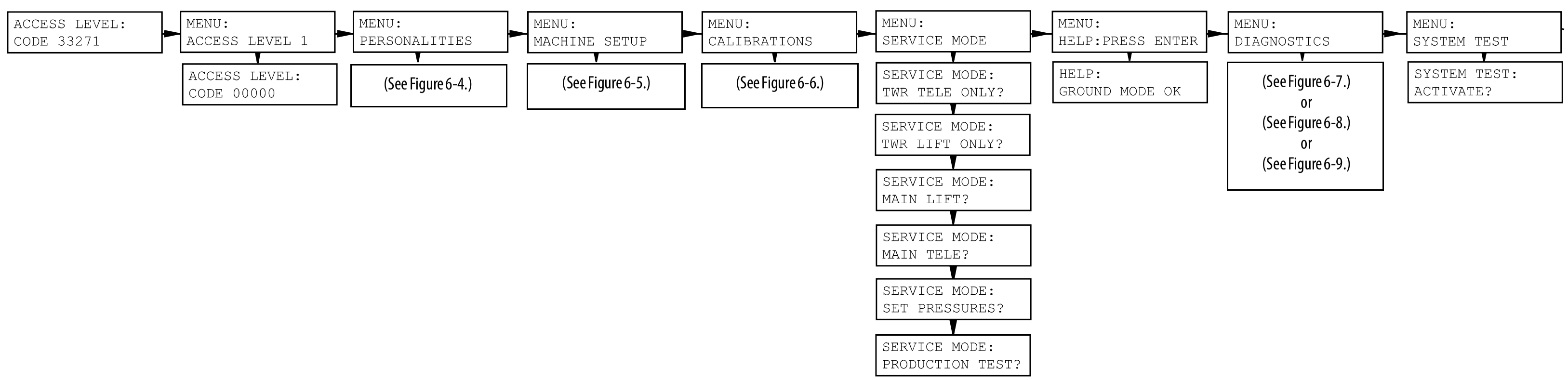
Figure 6-2. Control System Block Diagram

6.3 CALIBRATION INSTRUCTIONS

This machine incorporates a variety of sensors and a high degree of function interaction. For safety and proper machine functionality, the calibration procedures must be repeated for any control module replacement, system calibration related fault, or removal or replacement of any sensors, valves, coils, motors, or pumps. The chart below lists the calibrations required and potential reasons for re-calibration. All calibration procedures are menu driven through the use of the standard analyzer. With the exception of steering calibration, no external tools are required to complete the calibration procedures. The user is prompted to exercise the machine in a specific order to use the machines physical properties to consistently establish sensor response and the interaction of valves, pumps, and motors. Steering calibration also uses the analyzer and is performed on one side of the machine at a time requiring the use of a string or other means to determine when the tires are in line with each other. With the exception of the load control calibration, all calibrations are accessed by connecting the analyzer into the control system inside the main terminal box or on the bottom of the platform control box.

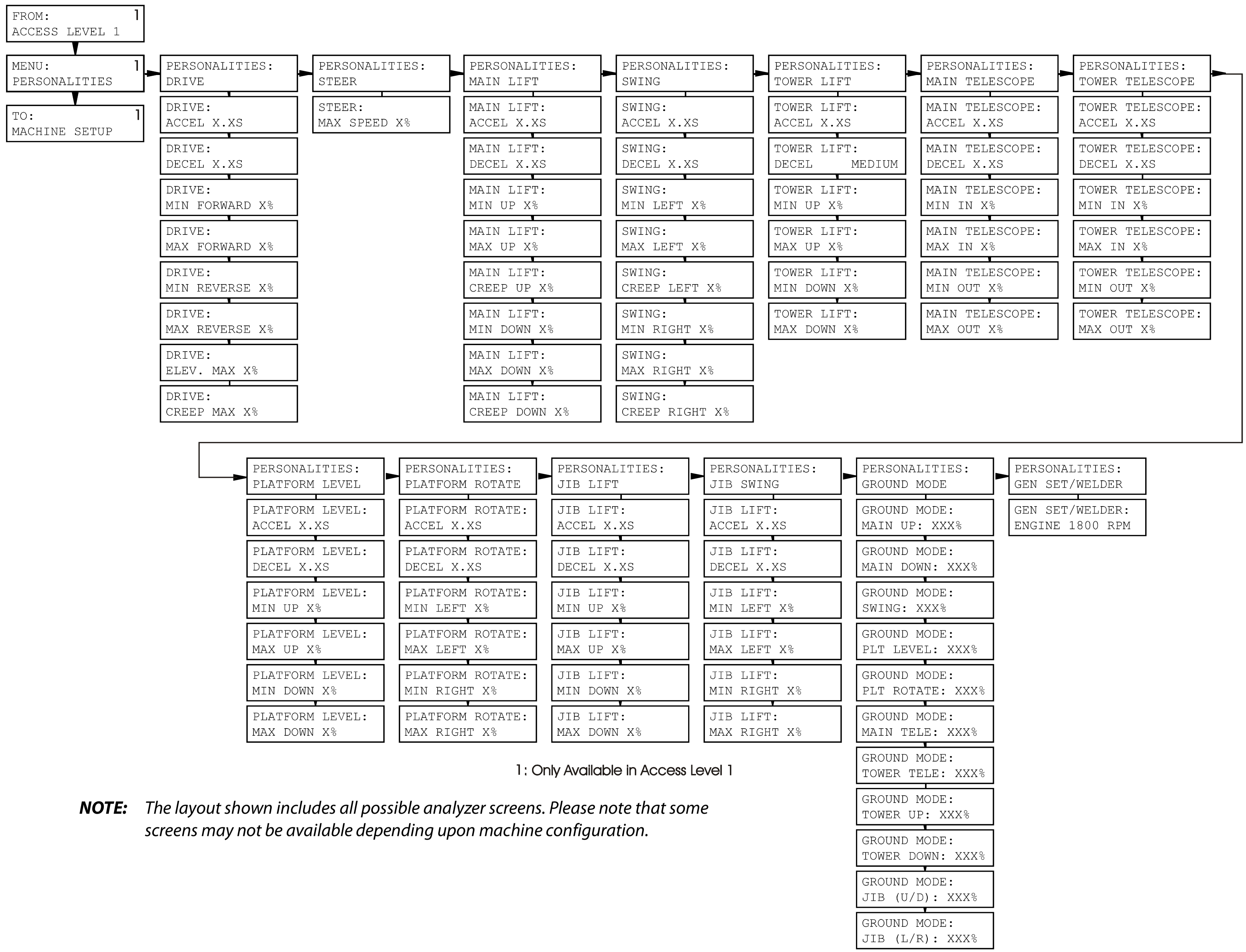
Table 6-1. Calibration Instructions

Calibration Procedure	Reasons for Re-calibration
Steering Calibration	Ground module replacement Chassis module replacement Steer sensor removal or replacement Persistent wheel misalignment
Drive Calibration	Ground module replacement BLAM module replacement Drive pump/coil replacement Drive pulls to one side Drive lugs engine Poor slow speed control
Platform Leveling Calibration	Ground module replacement Platform module replacement Platform level sensor removal or replacement Platform level sensor calibration fault
Platform Level Crack Point Calibration	Platform module replacement Ground module replacement Platform level valve/coil replacement Erratic platform leveling
Lift Crack Point Calibration	Ground module replacement Lift proportional valve/coil replacement Erratic controlled arc operation Erratic controlled boom angle operation
Telescope Crack Point Calibration	Ground module replacement Telescope proportional valve replacement Erratic controlled arc operation Erratic controlled boom angle operation
Chassis Tilt Calibration	Ground module removal or replacement Main terminal box removal or replacement Tilt indication inaccuracy
Boom Sensors Calibration	Ground module removal or replacement BLAM module removal or replacement Boom angle sensor removal or replacement Boom length sensor removal or replacement Moment pin removal or replacement Boom angle sensor calibration fault Boom length sensor calibration fault Moment pin fault Failed BCS functional check Boom control system inaccuracies Installing or removing approved accessories Changing Platform Size



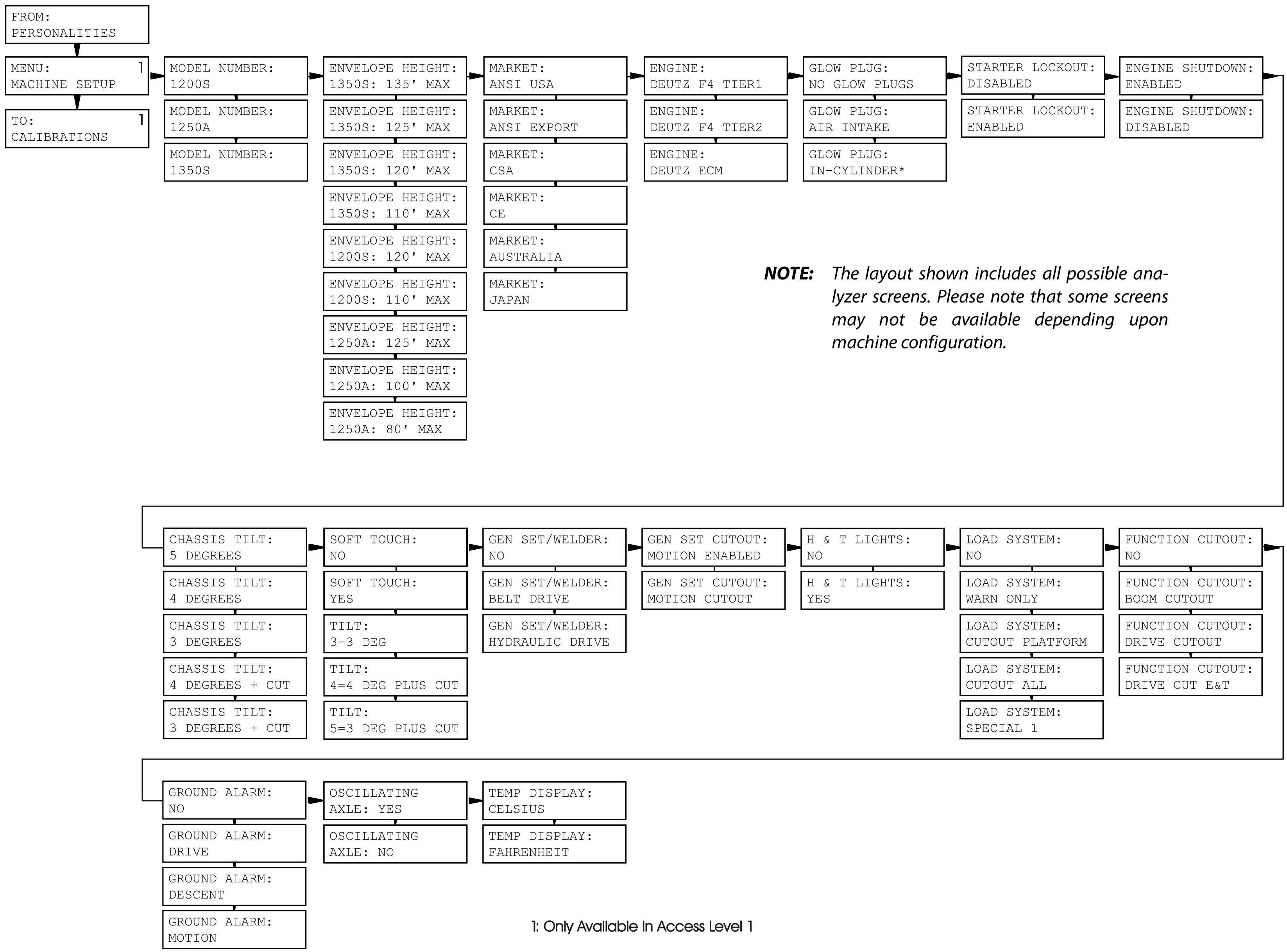
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

Figure 6-3. Analyzer Flow Chart



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

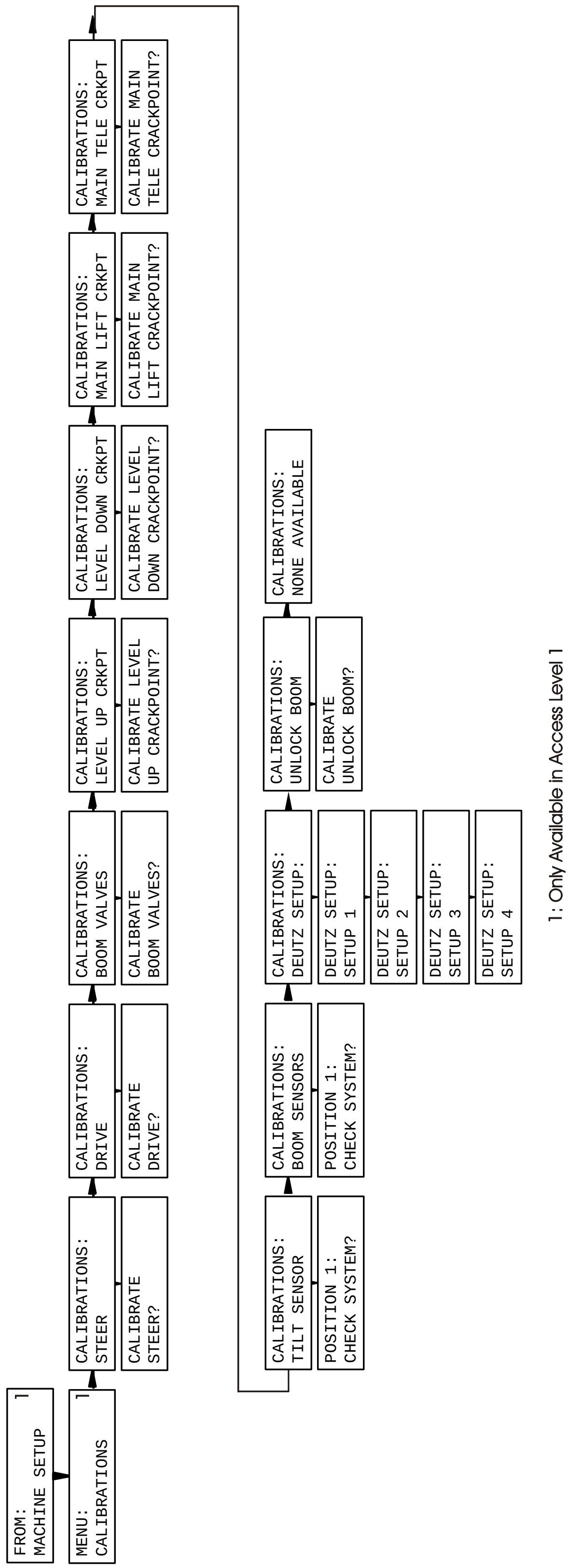
Figure 6-4. Analyzer Flow Chart - Personalities (Software Version 7.X to Present)



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

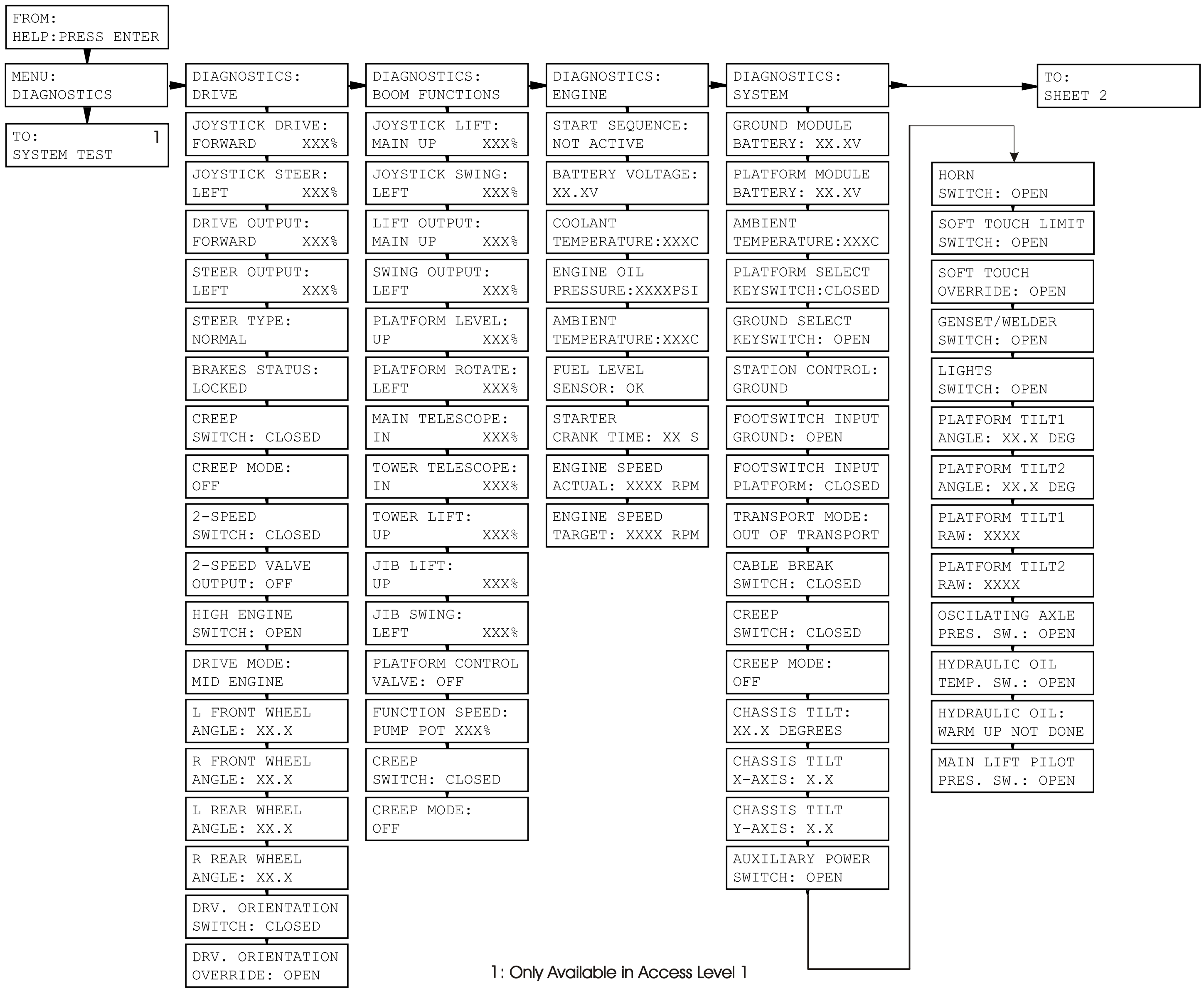
1: Only Available in Access Level 1

Figure 6-5. Analyzer Flow Chart - Machine Setup (Software Version 7.X to Present)



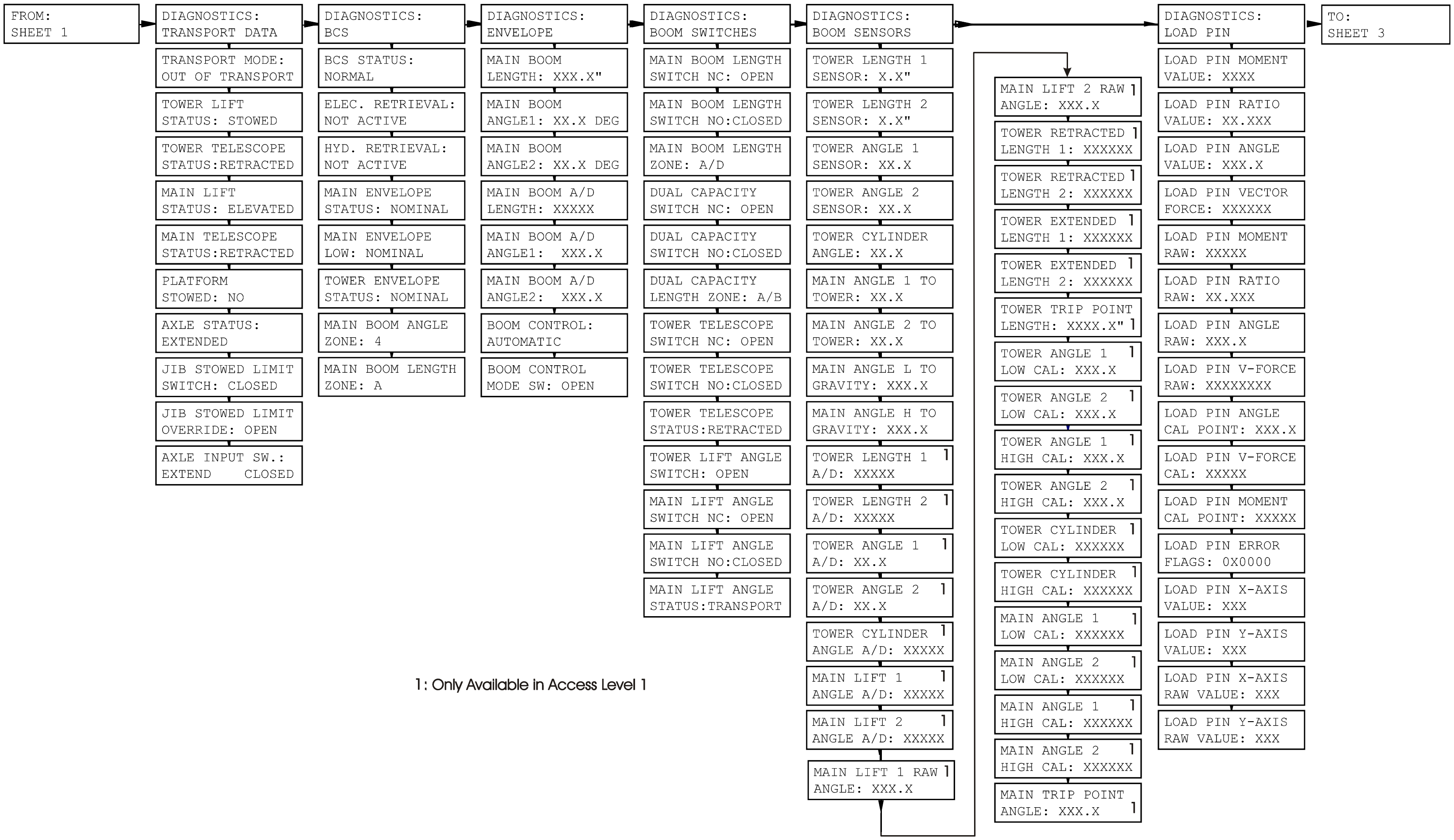
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

Figure 6-6. Analyzer Flow Chart - Calibrations (Software Version 7.X to Present)



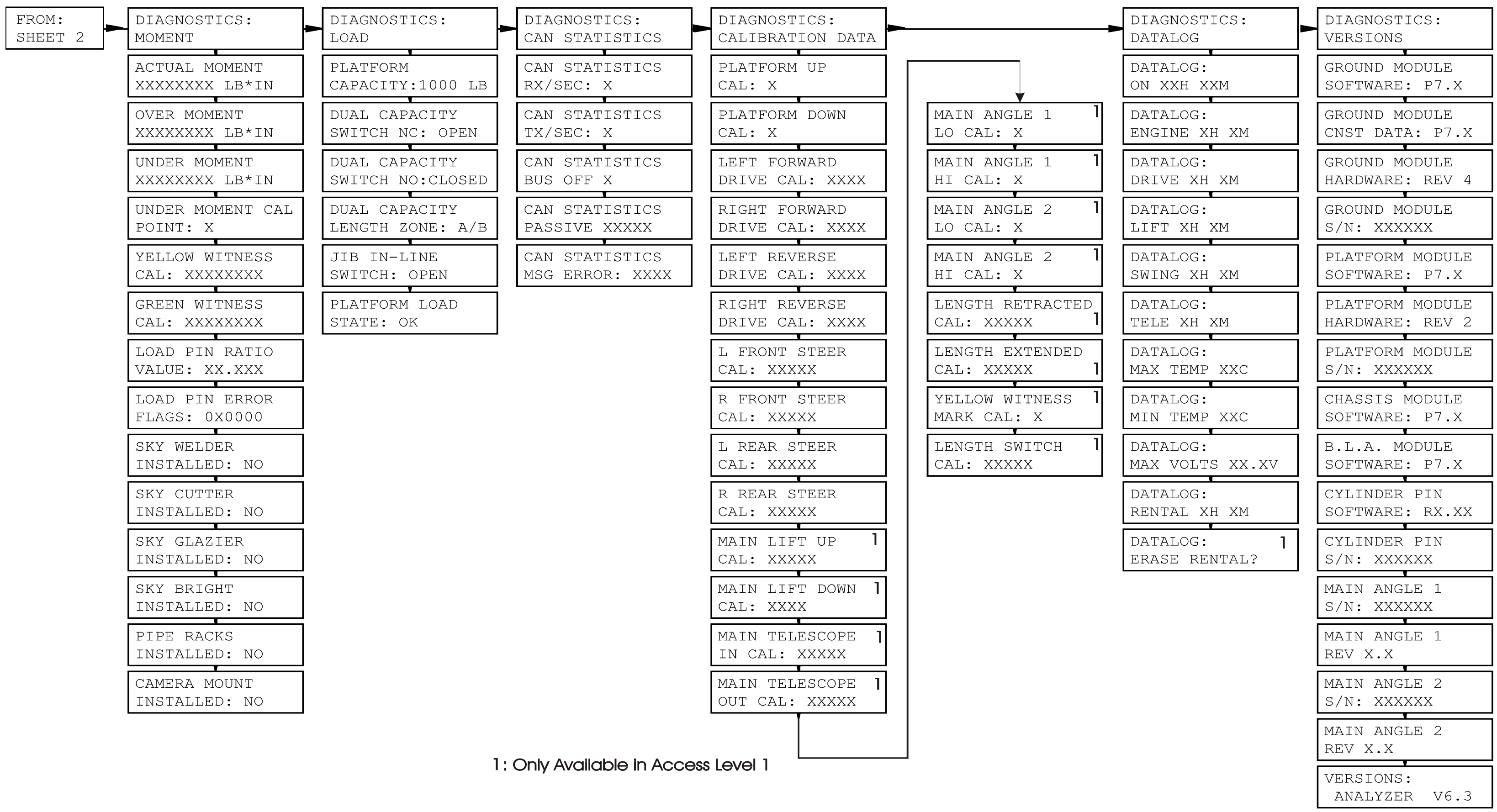
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

Figure 6-7. Analyzer Flow Chart - Diagnostics (Software Version 7.X to Present) - Sheet 1 of 3



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

Figure 6-8. Analyzer Flow Chart - Diagnostics (Software Version 7.X to Present) - Sheet 2 of 3



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

Figure 6-9. Analyzer Flow Chart - Diagnostics (Software Version 7.X to Present) - Sheet 3 of 3

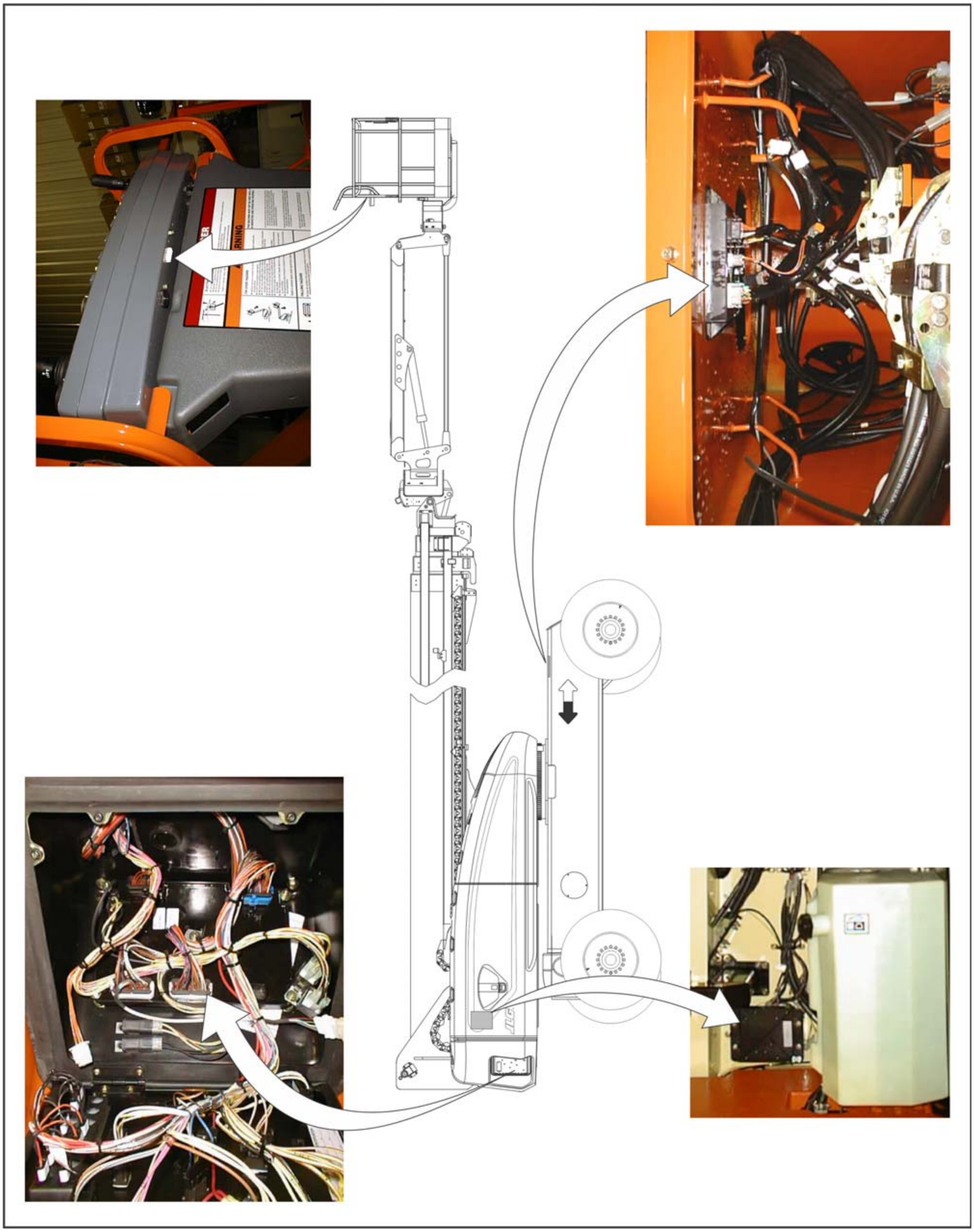


Figure 6-10. Control Module Location

PLATFORM CONNECTION

GROUND CONTROL CONNECTION

Figure 6-11. Analyzer Connecting Points

6.4 TO CONNECT THE JLG CONTROL SYSTEM ANALYZER

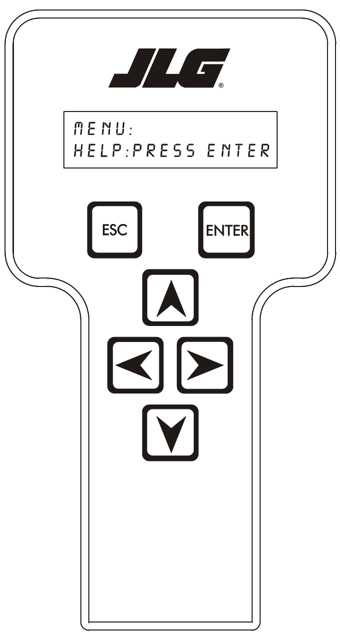
1. Connect the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

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 key to the platform or ground position and pulling both emergency stop buttons on.

6.5 USING THE ANALYZER

With the machine power on and the analyzer connected properly, the analyzer will display the following:



HELP:
PRESS ENTER

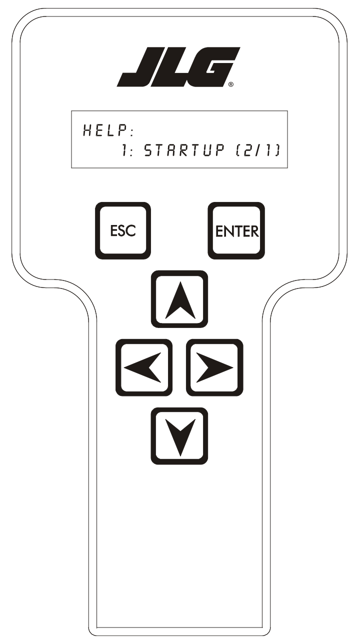
At this point, using the **RIGHT** and **LEFT** arrow keys, you can move between the top level menu items. To select a displayed menu item, press **ENTER**. To cancel a selected menu item, press ESC.; then you will be able to scroll using the right and left arrow keys to select a different menu item.

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.

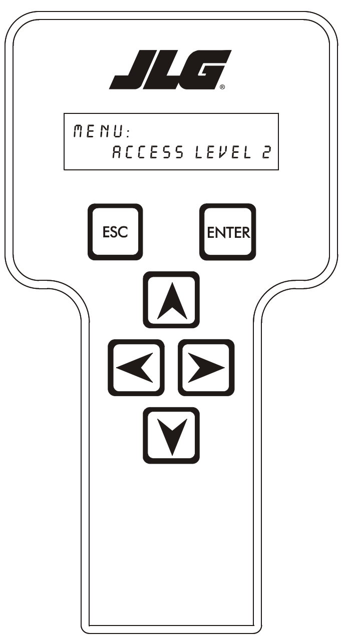
When a top level menu is selected, a new set of menu items may be offered: for example:

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.

6.6 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.

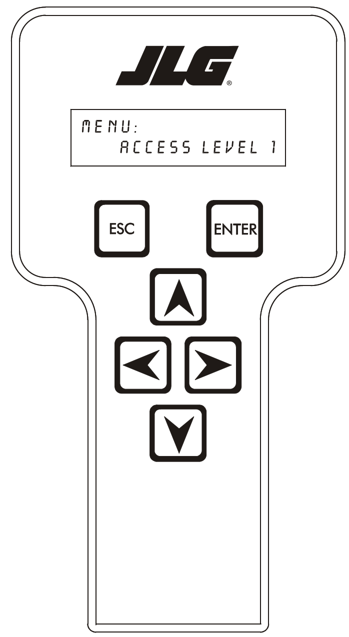
Using the **UP** or **DOWN** arrow keys, enter the first digit of the password, 3.

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.

Continue using the arrow keys until all the remaining digits of the password is shown.

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:

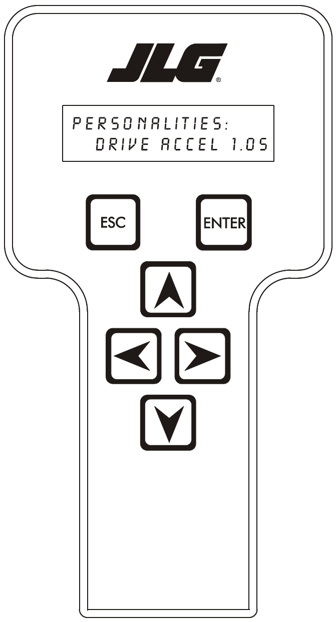


MENU:
ACCESS LEVEL 1

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

6.7 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:

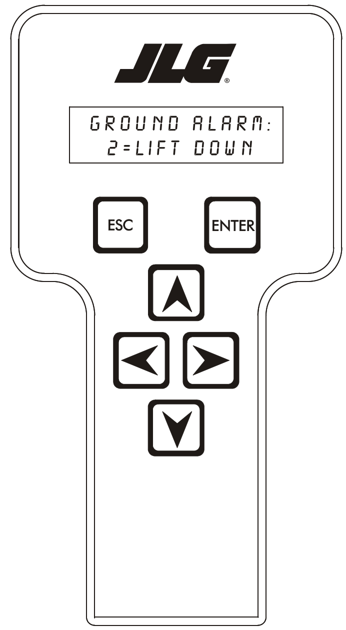


PERSONALITIES:
DRIVE ACCEL 1.0s

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.

6.8 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 6-3, 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

NOTICE

CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.

Table 6-2. Machine Configuration Programming Information - Version P7.X to Present

Configuration Digit	Number	Description	Default Number
NOTE: *The machine configuration must be completed before any personality settings can be changed. Changing the personality settings first and then changing the model number of the machine configuration will cause the personality settings to return to default*			
MODEL NUMBER: 1	**1** 2 3	**1200S** 1250A 1350S	**1**
ENVELOPE HEIGHT: 2	**1** 2 3 4 **5** 6 **7** 8 9	**1350S: 135' MAX** 1350S: 125' MAX 1350S: 120' MAX 1350S: 110' MAX **1200S: 120' MAX** 1200S: 110' MAX **1250A: 125' MAX** 1250A: 100' MAX 1250A: 80' MAX	**5**
Note: The default settings (bold) will vary depending on the model selection with selection # 5 being the initial default setting.			
MARKET: 3	**0** 1 2 3 4 5	**ANSI USA** ANSI EXPORT CSA CE AUSTRALIA JAPAN	**0**
ENGINE: 4	1 2 **3**	DEUTZ F4 TIER1: Deutz BF4M1011 Diesel (Tier 1) DEUTZ F4 TIER2: Deutz BF4M2011 Di**esel (Tier 2)** DEUTZ ECM: Engine Control Module	**3**

Table 6-2. Machine Configuration Programming Information - Version P7.X to Present

Configuration Digit	Number	Description	Default Number
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.	
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	**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.	
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.			
SOFT TOUCH: 9	**0**	**NO: No soft touch system installed.**	**0**
	1	YES: Soft touch system installed.	

Table 6-2. Machine Configuration Programming Information - Version P7.X to Present

Configuration Digit	Number	Description	Default Number
GEN SET/WELDER: 10	0 **1** 2	NO: No generator installed. **BELT DRIVE: Belt driven setup.** HYDRAULIC DRIVE: Hydraulic driven setup.	**1**
GEN SET CUTOUT: 11*	**0** 1	**MOTION ENABLED: Motion enabled when generator is ON.** MOTION CUTOUT: Motion cutout in platform mode only.	**0**
* Only visible if Gen Set / Welder Menu selection is not 0.			
H & T LIGHTS: 12	**0** 1	**NO: No head and tail lights installed.** YES: Head and tail lights installed.	**0**
LOAD SYSTEM: 13*	**0** 1 2 3 4	**NO: No load sensor installed.** WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF). SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	**0**
* Only visible under certain market selections.			
* Certain market selections will limit load system options or alter default setting.			

Table 6-2. Machine Configuration Programming Information - Version P7.X to Present

Configuration Digit	Number	Description	Default Number
FUNCTION CUTOUT: 14*	**0**	**NO: No drive cutout.**	**0**
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive cutout above elevation.	
	3	DRIVE CUT E&T: Drive cutout above elevation and tilted.	
* Only visible under certain market selections.			
* Certain market selections will limit function cutout options or alter default setting.			
GROUND ALARM: 15*	**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).	
* Certain market selections will alter default setting.			
OSCILLATING AXLE: 16	0	NO: No oscillating axle system installed.	**1**
	1	**YES: Oscillating axle system installed.**	
TEMPERATURE: 17*	0	CELSIUS: Celsius unit selection.	**1**
	1	**FAHRENHEIT: Fahrenheit unit selection.**	
* Certain market selections will alter default setting.			

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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.*

1200SJP

	MODEL NUMBER	ENVELOPE HEIGHT	MARKET	ENGINE	GLOW PLUGS			ENGINE SHUTDOWN		TILT					SOFT TOUCH		GEN SET / WELDER			GEN SET CUTOUT		HEAD & TAIL LIGHTS	
ANSI USA	***1***	***5***	***0***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
ANSI EXPORT	***1***	***5***	***1***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
CSA	***1***	***5***	***2***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
CE	***1***	***5***	***3***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
AUSTRALIA	***1***	***5***	***4***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
JAPAN	***1***	***5***	***5***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1

1200SJP

	LOAD SYSTEM					FUNCTION CUTOUT				GROUND ALARM				OSCILLATING AXLE		TEMPERATURE	
ANSI USA	***0***	***X***	***X***	***X***	***X***	***0***	***X***	***X***	***X***	***0***	1	2	3	0	***1***	0	***1***
ANSI EXPORT	***0***	***1***	2	3	4	***0***	1	2	3	***0***	1	2	3	0	***1***	0	***1***
CSA	***0***	***X***	***X***	***X***	***X***	***0***	1	2	3	0	1	2	***3***	0	***1***	***0***	1
CE	0	***X***	***2***	3	***X***	0	***1***	X	X	0	1	2	***3***	0	***1***	***0***	1
AUSTRALIA	***0***	***1***	2	3	4	***0***	1	2	3	***0***	1	2	3	0	***1***	***0***	1
JAPAN	0	***1***	2	3	4	***0***	1	2	3	0	1	2	***3***	0	***1***	***0***	1

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.*

1350SJP	MODEL NUMBER	ENVELOPE HEIGHT	MARKET	ENGINE	GLOW PLUGS			ENGINE SHUTDOWN		TILT					SOFT TOUCH		GEN SET / WELDER			GEN SET CUTOUT		HEAD & TAIL LIGHTS	
ANSI USA	***3***	***1***	***0***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
ANSI EXPORT	***3***	***1***	***1***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
CSA	***3***	***1***	***2***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
CE	***3***	***1***	***3***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
AUSTRALIA	***3***	***1***	***4***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1
JAPAN	***3***	***1***	***5***	***3***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	1	0	***1***	2	***0***	1	***0***	1

1350SJP	LOAD SYSTEM					FUNCTION CUTOUT				GROUND ALARM				OSCILLATING AXLE		TEMPERATURE	
ANSI USA	***0***	***X***	***X***	***X***	***X***	***0***	***X***	***X***	***X***	***0***	1	2	3	0	***1***	0	***1***
ANSI EXPORT	***0***	***1***	2	3	4	***0***	1	2	3	***0***	1	2	3	0	***1***	0	***1***
CSA	***0***	***X***	***X***	***X***	***X***	***0***	1	2	3	0	1	2	***3***	0	***1***	***0***	1
CE	0	***X***	2	***3***	***X***	0	***1***	X	X	0	1	2	***3***	0	***1***	***0***	1
AUSTRALIA	***0***	***1***	2	3	4	***0***	1	2	3	***0***	1	2	3	0	***1***	***0***	1
JAPAN	0	***1***	2	3	4	***0***	1	2	3	0	1	2	***3***	0	***1***	***0***	1

6.9 MACHINE PERSONALITY SETTINGS/FUNCTION SPEEDS

NOTE: *Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.*

Table 6-3. Personality Ranges/Defaults

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PARAMETER (DISPLAYED ON ANALYZER 2ND LINE)	DESCRIPTION	RANGE	DEFAULT VALUES		TIME RANGE (SEC) (SEE SECTION 6.10 FOR MACHINE ORIENTATION WHEN SETTING SPEEDS)	
				1200	1350	1200S	1350S
DRIVE:	ACCEL X.Xs	Displays/adjusts drive acceleration	0.1 to 5.0 sec	2.0	2.0		
	DECEL X.Xs	Displays/adjusts drive deceleration	0.1 to 3.0 sec	1.3	1.3		
	MIN forward XX%	Displays/adjusts minimum forward drive speed	0 to 35%	1	1		
	MAX forward XXX%	Displays/adjusts maximum forward drive speed	0 to 100%	100	100	44-48	44-48
	MIN reverse XX%	Displays/adjusts minimum reverse drive speed	0 to 35%	1	1		
	MAX reverse XXX%	Displays/adjusts maximum reverse drive speed	0 to 100%	100	100	44-48	44-48
	ELEV. MAX XX%	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed	0 to 50%	25	25	93-104	93-104
	CREEP MAX XX%	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active	0 to 50%	35	35	79-87	79-87
STEER:	max SPEED XXX%	Displays/adjusts maximum steer speed.	0 to 100%	100	100		
MAIN LIFT:	ACCEL X.Xs	Displays/adjusts main lift acceleration	0.1 to 5.0 sec	1.0	1.0		
	DECEL X.Xs	Displays/adjusts main lift deceleration	0.1 to 3.0 sec	1.0	1.0		
	MIN Up XX%	Displays/adjusts minimum main lift up speed	0 to 60%	20	20		
	MAX UP XX%	Displays/adjusts maximum main lift up speed	0 to 100%	50	50	75-100	75-100
	MIN DOWN XX%	Displays/adjusts minimum main lift down speed	0 to 60%	10	10		
	MAX DOWN XXX%	Displays/adjusts maximum main lift down speed	0 to 100%	50	50	85-110	85-110
	CREEP UP XX%	Displays/adjusts maximum main lift up speed NOTE: used when creep switch on pump pot is active	0 to 65%	50	50		
	CREEP DOWN XX%	Displays/adjusts maximum main lift down speed NOTE: used when creep switch on pump pot is active	0 to 75%	45	45		

Table 6-3. Personality Ranges/Defaults

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PARAMETER (DISPLAYED ON ANALYZER 2ND LINE)	DESCRIPTION	RANGE	DEFAULT VALUES		TIME RANGE (SEC) (SEE SECTION 6.10 FOR MACHINE ORIENTATION WHEN SETTING SPEEDS)	
				1200	1350	1200S	1350S
SWING:	ACCEL X.Xs	Displays/adjusts swing acceleration	0.1 to 5.0 sec	2.0	2.0		
	DECEL X.Xs	Displays/adjusts swing deceleration	0.1 to 3.0 sec	1.5	1.5		
	MIN LEFT XX%	Displays/adjusts minimum swing left speed	0 to 50%	40	40		
	MAX LEFT XXX%	Displays/adjusts maximum swing left speed	0 to 100%	65	65	115-125	115-125
	MIN RIGHT XX%	Displays/adjusts minimum swing right speed	0 to 50%	40	40		
	MAX RIGHT XXX%	Displays/adjusts maximum swing right speed	0 to 100%	65	65	115-125	115-125
	CREEP LEFT XX%	Displays/adjusts maximum swing left speed NOTE: used when creep switch on pump pot is active	0 to 65%	50	50		
	CREEP RIGHT XX%	Displays/adjusts maximum swing right speed NOTE: used when creep switch on pump pot is active	0 to 65%	50	50		
MAIN TELESCOPE:	ACCEL X.Xs	Displays/adjusts main telescope acceleration	0.1 to 5.0 sec	1.5	1.5		
	DECEL X.Xs	Displays/adjusts main telescope deceleration	0.1 to 3.0 sec	1.0	1.0		
	MIN IN XX%	Displays/adjusts minimum main telescope in speed. Same as Creep speed	0 to 65%	15	15		
	MAX IN XXX%	Displays/adjusts maximum main telescope in speed	0 to 100%	65	65	58-68	65-75
	MIN OUT XX%	Displays/adjusts minimum main telescope out speed. Same as Creep speed	0 to 65%	15	15		
	MAX OUT XXX%	Displays/adjusts maximum main telescope out speed	0 to 100%	60	60	45-55	50-60
BASKET LEVEL:	ACCEL X.Xs	Displays/adjusts basket level acceleration	0.1 to 5.0 sec	1.5	1.5		
	DECEL X.Xs	Displays/adjusts basket level deceleration	0.1 to 3.0 sec	0.5	0.5		
	MIN UP XX%	Displays/adjusts minimum basket level up speed. Same as Creep speed	0 to 65%	40	40		
	MAX UP XXX%	Displays/adjusts maximum basket level up speed	0 to 100%	70	70		
	MIN DOWN XX%	Displays/adjusts minimum basket level down speed. Same as Creep speed	0 to 65%	40	40		
	MAX DOWN XXX%	Displays/adjusts maximum basket level down speed	0 to 100%	70	70		

Table 6-3. Personality Ranges/Defaults

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PARAMETER (DISPLAYED ON ANALYZER 2ND LINE)	DESCRIPTION	RANGE	DEFAULT VALUES		TIME RANGE (SEC) (SEE SECTION 6.10 FOR MACHINE ORIENTATION WHEN SETTING SPEEDS)	
				1200	1350	1200S	1350S
BASKET ROTATE:	ACCEL X.Xs	Displays/adjusts basket rotate acceleration	0.1 to 5.0 sec	1.0	1.0		
	DECEL X.Xs	Displays/adjusts basket rotate deceleration	0.1 to 3.0 sec	0.5	0.5		
	MIN LEFT XX%	Displays/adjusts minimum basket rotate left speed. Same as Creep speed	0 to 100%	60	60		
	MAX LEFT XXX%	Displays/adjusts maximum basket rotate left speed	0 to 100%	60	60	24-30 (180°)	24-30 (180°)
	MIN RIGHT XX%	Displays/adjusts minimum basket rotate right speed. Same as Creep speed	0 to 100%	60	60		
	MAX RIGHT XXX%	Displays/adjusts maximum basket rotate right speed	0 to 100%	60	60	24-30 (180°)	24-30 (180°)
JIB LIFT:	ACCEL X.Xs	Displays/adjusts jib lift acceleration	0.1 to 5.0 sec	1.5	1.5		
	DECEL X.Xs	Displays/adjusts jib lift deceleration	0.1 to 3.0 sec	1.0	1.0		
	MIN UP XX%	Displays/adjusts minimum jib up speed. Same as Creep speed	0 to 65%	40	40		
	MAX UP XXX%	Displays/adjusts maximum jib up speed	0 to 100%	65	65	30-36	30-36
	MIN DOWN XX%	Displays/adjusts minimum jib down speed. Same as Creep speed	0 to 65%	40	40		
	MAX DOWN XXX%	Displays/adjusts maximum jib down speed	0 to 100%	60	60	30-36	30-36
JIB SWING:	ACCEL X.Xs	Displays/adjusts jib swing acceleration	0.1 to 5.0 sec	1.5	1.5		
	DECEL X.Xs	Displays/adjusts jib swing deceleration	0.1 to 3.0 sec	0.5	0.5		
	MIN LEFT XX%	Displays/adjusts minimum jib left speed. Same as Creep speed	0 to 65%	40	40		
	MAX LEFT XXX%	Displays/adjusts maximum jib left speed	0 to 100%	70	70	60-68 (180°)	60-68 (180°)
	MIN RIGHT XX%	Displays/adjusts minimum jib right speed. Same as Creep speed	0 to 65%	40	40		
	MAX RIGHT XXX%	Displays/adjusts maximum jib right speed	0 to 100%	70	70	60-68 (180°)	60-68 (180°)

Table 6-3. Personality Ranges/Defaults

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PARAMETER (DISPLAYED ON ANALYZER 2ND LINE)	DESCRIPTION	RANGE	DEFAULT VALUES		TIME RANGE (SEC) (SEE SECTION 6.10 FOR MACHINE ORIENTATION WHEN SETTING SPEEDS)	
				1200	1350	1200S	1350S
GROUND MODE:	U. LIFT UP XXX%	Displays/adjusts fixed main lift up speed	0 to 100%	60	60		
	U. LIFT DN XXX%	Displays/adjusts main lift down speed	0 to 100%	60	60		
	SWING XXX%	Displays/adjusts fixed swing speed	0 to 100%	60	60		
	BASKET LVL XXX%	Displays/adjusts fixed basket level speed	0 to 100%	75	75		
	BASKET ROT XXX%	Displays/adjusts fixed basket rotate speed	0 to 100%	75	75		
	MAIN TELE XXX%	Displays/adjusts fixed main telescope speed	0 to 100%	60	60		
	TOWER TELE XXX%	Displays/adjusts fixed tower telescope speed Not displayed if TOWER TELE=NO	0 to 100%	100	100		
	T. LIFT UP XXX%	Displays/adjusts fixed tower lift up speed Not displayed if TOWER LIFT=NO	0 to 100%	100	100		
	T. LIFT DN XXX%	Displays/adjusts fixed tower lift down speed Not displayed if TOWER LIFT=NO	0 to 100%	100	100		
	JIB (U/D) XXX%	Displays/adjusts jib lift speed Not displayed if JIB = 0	0 to 100%	60	60		
	JIB (L/R) XXX%	Displays/adjusts jib swing speed Displayed if JIB = 2	0 to 100%	70	70		
GEN SET/WELDER:	ENGINE XXXX RPM	Control generator/welder RPM. Not displayed if GEN SET/WELDER = 0	1200-2800	1800	1800		

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6.10 MACHINE ORIENTATION WHEN SETTING FUNCTION SPEEDS

Lift Up: From platform control, lowest elevation up to maximum elevation, boom retracted.

Lift Down: From platform control, maximum elevation down to minimum elevation, boom retracted.

Swing Right (Max): 360 Degrees, from platform control, boom approximately 45° elevation, boom retracted.

Swing Left (Max): 360 Degrees, from platform control, boom approximately 45° elevation, boom retracted.

Telescope Out: From platform control, boom horizontal, 500 lb. (230 kg) capacity selected.

Telescope In: From platform control, boom horizontal, 500 lb. (230 kg) capacity selected.

Drive Forward (Max): Test should be done on a smooth level surface. High Speed - Low Torque setting, drive 200 ft. (61 m) front wheels to front wheels. Timed after machine has obtained maximum speed.

Drive Reverse (Max): Test should be done on a smooth level surface. High Speed - Low Torque setting, drive 200 ft. (61 m) front wheels to front wheels. Timed after machine has obtained maximum speed.

Drive Forward (Creep Max): Test should be done on a smooth level surface. High Torque - Low Speed setting, platform speed knob at full creep.

Drive Reverse (Creep Max): Test should be done on a smooth level surface. High Torque - Low Speed setting, platform speed knob at full creep.

Drive Forward (Elevated Max - Boom Beyond Transport): Test should be done on a smooth level surface. High speed - Low Torque setting, platform speed knob out of creep, Lift boom above transport, drive forward 50 ft. (15.2 m).

Drive Reverse (Elevated Max - Boom Beyond Transport): Test should be done on a smooth level surface. High speed - Low Torque setting, platform speed knob out of creep, Lift boom above transport, drive forward 50 ft. (15.2 m).

Platform Rotate: Platform level and completely rotated one direction. Rotate the opposite direction, Record Time. Rotate the other direction, Record Time.

Articulating Jib: Platform level and centered with the boom. Start with the Jib down. Jib Up, Record Time. Jib Down, Record Time.

Test Notes

1. Personality settings can be adjusted anywhere within the adjustment range in order to achieve optimum machine performance.
2. Stop watch should be started when the function is activated.
3. Unless noted, all speed tests are run from the platform. These speeds do not reflect the ground control operation.
4. The platform speed knob control must be at full speed (turned clockwise completely).
5. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).

6.11 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. Before proceeding, ensure that the switches on the platform console are in the following positions:

   a. Drive speed switch is in the Middle position. (Turtle Icon)

   b. 4WS switch is in the Middle position. (2WS mode)

   c. Capacity select switch in the 1000 lb. (450 kg) mode.

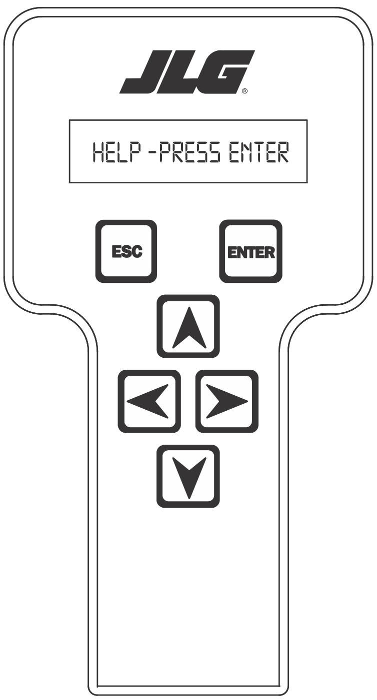
   d. Function speed potentiometer out of creep mode switch.

   e. Generator (if equipped) switched to the off position.

   f. Head and Tail lights (if equipped) switched to the off position.

4. Pull out the Emergency Stop switch and Start the engine.

5. The analyzer screen should read:



6. 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.

7. Follow the flow path in Figure 6-12., 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).

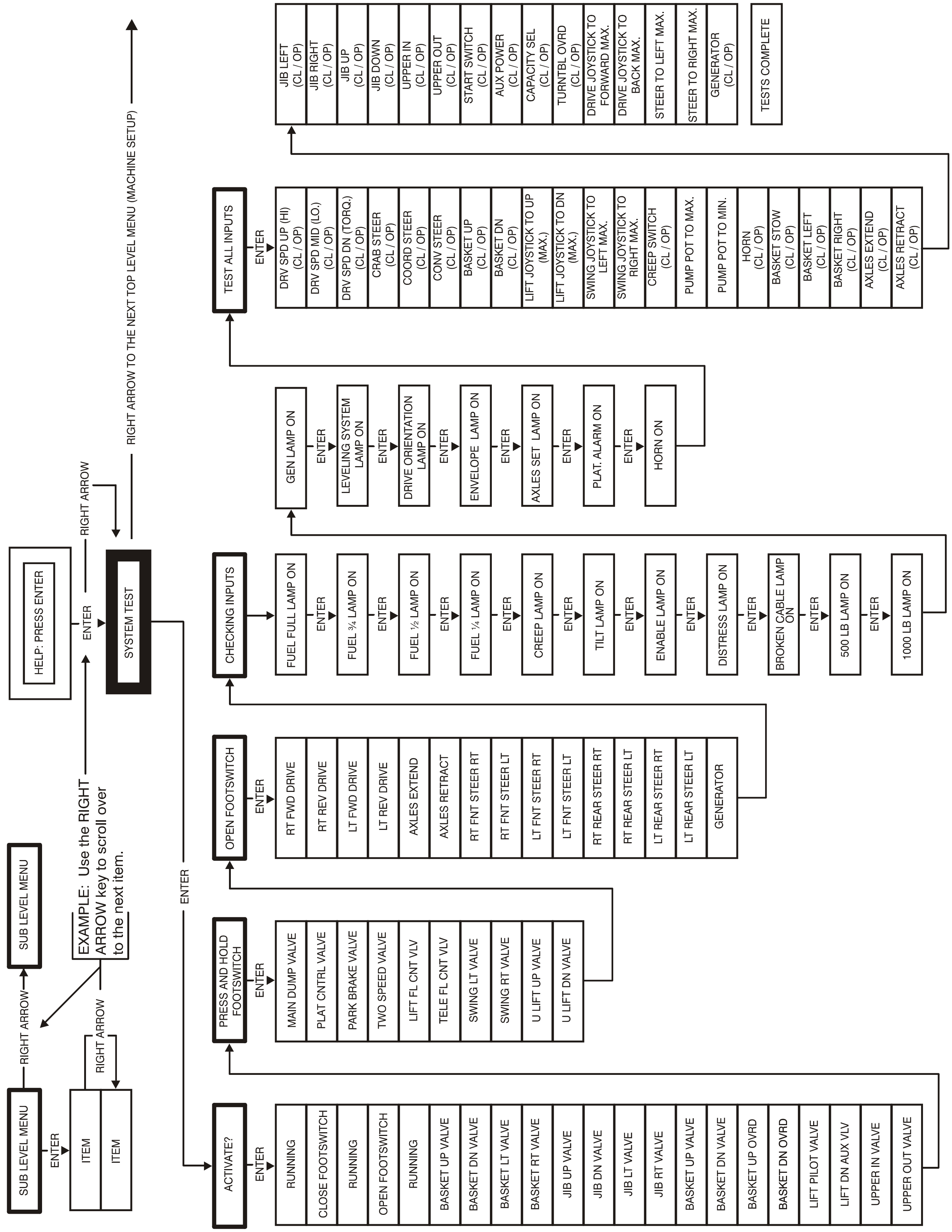


Figure 6-12. System Test Flow Chart - Platform Tests

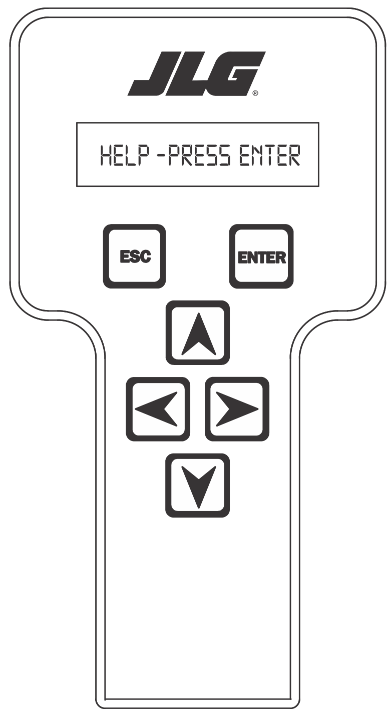
Test from the Ground Station

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 6-13., 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).

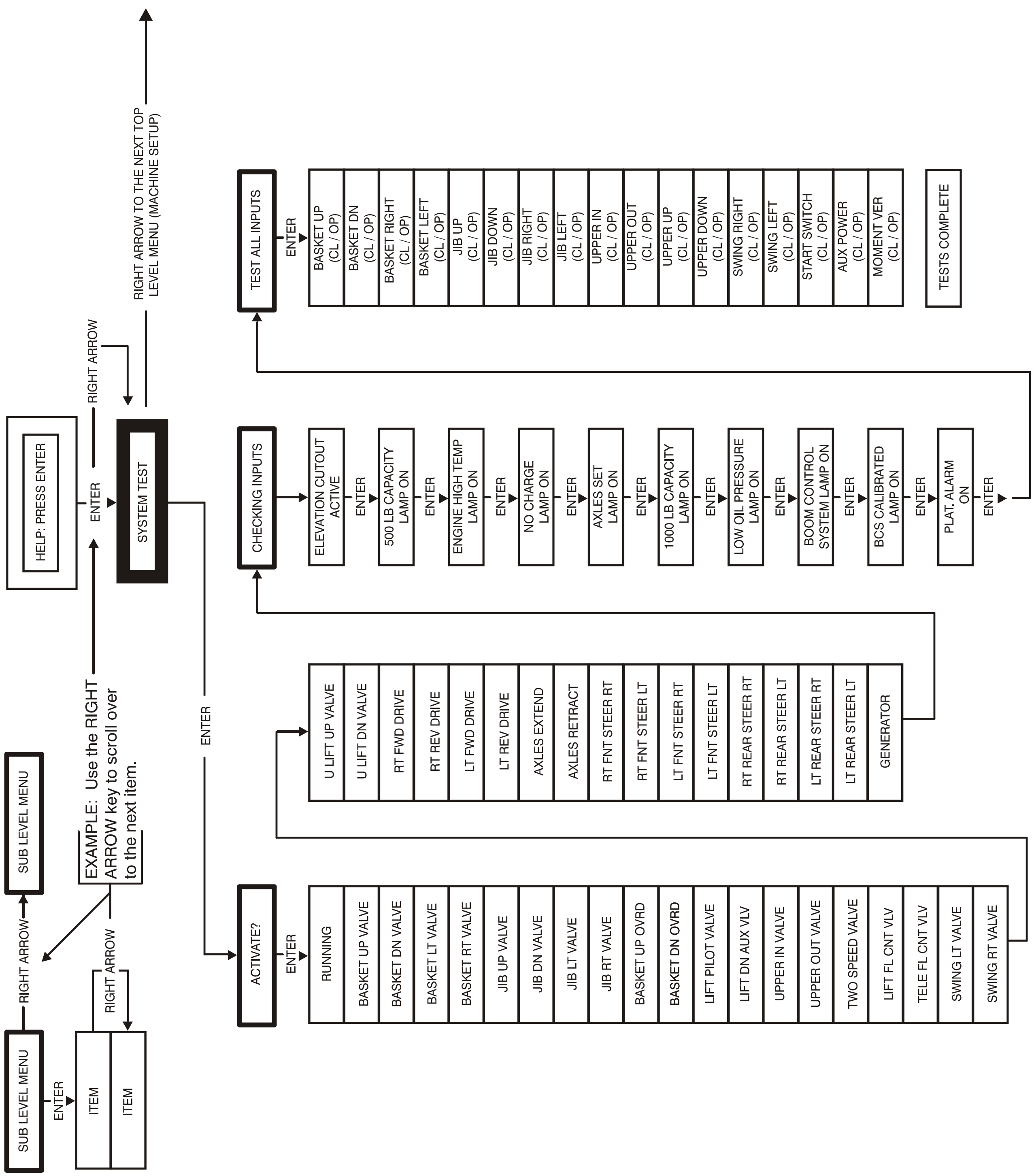


Figure 6-13. System Test Flow Chart - Ground Station Tests

Table 6-4. 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 MUST BE KEPT CLOSED 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.

Table 6-4. System Test Messages

Message Displayed on Analyzer	Message Displayed on Analyzer	Description
TESTING VALVES		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. NOTE: In platform mode, the footswitch must be closed. 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. NOTE: Left/right jib valves are not tested unless JIB = SIDESWING. Problems that can be reported include below messages.
	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		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. In platform mode any non-neutral platform switch or joystick is reported; any active cutouts are reported. In ground mode any non-neutral ground switches is reported; any active cutouts are reported. NOTE: Switches, which are not in use (due to the settings of machine digits), are not checked. NOTE: The pump pot is checked only for a wire-off condition; it can be at any demand from creep to maximum. Problems that can be reported include below messages.
	CHECK XXXXXXX	The named switch is not in its “normal” position. Check switch & wiring.
	CHECK XXXXXXX JOY	The named joystick appears to be faulty. Check joystick.
TESTING LAMPS		Indicates that the lamps test is beginning. Each lamp is energized in turn; a prompt asks for confirmation that the lamp is lit. ENTER must be pressed or clicked to continue the test. NOTE: Lamps, which are not in use (due to the settings of machine digits), are not checked. NOTE: Platform Lamps are only tested in platform mode. NOTE: The GM overload lamp and 500# capacity lamp are not tested. NOTE: Head and tail lamps are tested in both platform and ground mode if enabled by a machine digit.
TESTING ALARMS		Indicates that the alarms test is beginning. Each alarm is energized in turn; a prompt asks for confirmation that the alarm is sounding. ENTER must be pressed or clicked to continue the test. NOTE: The platform alarm and the horn are only tested in platform mode. NOTE: The ground alarm is not tested if GROUND ALARM = NO.

Table 6-4. 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 XXXXXXX	The named switch should be closed.
	OPEN XXXXXXX	The named switch should be opened.
	XXXXXXX XXXXXXX TO MAX	The named joystick should be pushed to its full extent in the named direction.
	XXXXXXX XXXXXXX 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.

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
DRIVE:			
	DRIVE	FOR/REV XXX%	Displays drive joystick direction & demand
	STEER	RIGHT/LEFT XXX%	Displays steer switch direction & demand
	4WS	NORMAL/COOR/CRAB	Displays status of four wheel steer input (Displayed if 4WS = 1)
	BRAKES	LOCKED/RELEASED	Displays brake control system status
	CREEP	ACTIVE/NOT ACTIVE	Displays pump pot creep switch status
	CRP MODE	ACTIVE/NOT ACT	Displays creep mode status
	QPRX1	ACTIVE/NOT ACTIVE	Displays status of Q-Prox sensor in drive joystick (Displayed if JOYSTICK TYPE = 1)
	QPRX2	ACTIVE/NOT ACTIVE	Displays status of Q-Prox sensor in drive joystick (Displayed if JOYSTICK TYPE = 1)
	TWO SPEED	OP/CL	Displays status of two speed switch input if selected model has two speed.
	2 speed mode	ON/OFF	Displays status of two speed valve if selected model has two speed
	high engine	OP/CL	Displays status of high engine switch
	LT F ANG	XX.X	Displays status of left front steer angle (Displayed if MODEL NUMBER = 7 or 8)
	RT F ANG	XX.X	Displays status of right front steer angle (Displayed if MODEL NUMBER = 7 or 8)
	LT R ANG	XX.X	Displays status of left rear steer angle (Displayed if MODEL NUMBER = 7 or 8)
	RT R ANG	XX.X	Displays status of right rear steer angle (Displayed if MODEL NUMBER = 7 or 8)
	DOS LIM sw	OP/CL	Displays status of Drive Orientation System limit switch. (Displayed if MODEL NUMBER = 7 or 8)
	DOS O/R sw	OP/CL	Displays status of Drive Orientation Limit System override switch. (Displayed if MODEL NUMBER = 7 or 8)

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
BOOM:			
	U LIFT	UP/DOWN XXX%	Displays main lift joystick direction & demand
	SWING	RIGHT/LEFT XXX%	Displays swing joystick direction & demand
	QPRX1	ACTIVE/NOT ACTIVE	Displays status of Q-Prox sensor in lift/swing joystick (Displayed if JOYSTICK TYPE = 1)
	QPRX2	ACTIVE/NOT ACTIVE	Displays status of Q-Prox sensor in lift/swing joystick (Displayed if JOYSTICK TYPE = 1)
	LEVEL	UP/DOWN XXX%	Displays basket level switch direction & demand. NOTE: demand is controlled by the pump pot
	ROT.	RIGHT/LEFT XXX%	Displays basket rotate switch direction & demand. NOTE: demand is controlled by the pump pot
	U TELE	IN/OUT XXX%	Displays main telescope switch direction & demand. NOTE: demand is controlled by the pump pot
	T TELE	IN/OUT XXX%	Displays tower telescope switch direction & demand. NOTE: demand is controlled by the pump pot Not displayed if TOWER TELE=NO (machine digit = 0)
	T LIFT	UP/DOWN XXX%	Displays tower lift switch direction & demand. NOTE: demand is controlled by the pump pot Not displayed if TOWER LIFT=NO (machine digit = 0)
	JIB	UP/DOWN XXX%	Displays jib lift switch direction & demand. NOTE: demand is controlled by the pump pot Not displayed if JIB = NO (machine digit = 0)
	JIB	RIGHT/LEFT XXX%	Displays jib swing switch direction & demand. NOTE: demand is controlled by the pump pot Displayed if JIB = SIDESWING (machine digit = 2)
	JIB INLINE	OP/CL	Displays status of jib inline limit switch. Displayed on models equipped with the Jib Stow System
	JIB LIMIT	OP/CL	Displays status of jib right limit switch. Displayed on models equipped with the Jib Stow System
	JIB LIM OVRD	OP/CL	Displays status of jib limit override switch. Displayed on models equipped with the Jib Stow System
	PCV	ON/OFF	Displays status of Platform Control Valve. Displayed on models equipped with Electronic Platform Leveling.
	PUMP POT	XXX%	Displays pump pot demand. Not displayed if MODEL = 601 (machine digit = 4)
	CREEP	ACTIVE/NOT ACTIVE	Displays pump pot creep switch status
	CRP MODE	ACTIVE/NOT ACT	Displays creep mode status

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
ENGINE:			
	START	ACTIVE/NOT ACTIVE	Displays status of the engine start circuit
	AIR FILTER	OP/CL	Displays measured status of air filter by-pass switch. (Not displayed if MODEL NUMBER = 7 or 8)
	BATTERY	XX.XV	Displays measured battery voltage
	COOLANT	XXXC	Displays measured coolant temperature
	OIL PRS	LOW / OK or XXPSI	Displays measured oil pressure
	FUEL SELECT	GAS/LP	Displays status of fuel select switch. (Displayed if MODEL NUMBER = 2)
	AMB. TEMP	XXXC	Displays measured ambient air temperature
	FUEL LEVEL	¼ / ½ / ¾ / FULL or LOW / OK	Displays measured fuel level
	XXXx rpm		Engine RPM

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
SYSTEM:			
	GM BATTERY	XX.XV	Ground module battery voltage
	PM BATTERY	XX.XV	Platform module battery voltage
	AMB. TEMP	XXXC	Ambient temperature
	FSW1	OP/CL	Displays footswitch status. NOTE: FSW1 is wired to the ground module.
	FSW2	OP/CL	Displays footswitch status. NOTE: FSW2 is wired to the platform module.
	ABOVE ELEV.	OP/CL/YES/NO	Displays above elevation cutout switch status or above angle status
	LEN SW 1	OP/CL	Displays status of boom length retracted limit switch (Displayed if MODEL NUMBER = 7 or 8)
	LEN SW 2	OP/CL	Displays status of boom length retracted limit switch (Displayed if MODEL NUMBER = 7 or 8)
	RETRACTED	YES/NO	Displays status of boom length retracted (Displayed if MODEL NUMBER = 7 or 8)
	TRANSPORT	YES/NO	Displays status of transport position
	U LIFT CUTOUT	OP/CL	Displays status of boom length retracted limit switch (Displayed if MODEL NUMBER = 6)
	T LIFT PROX	OP/CL	Displays status of tower lift proximity switch (Displayed if TOWER PROX SWITCHES = 1)
	T TELE PROX	OP/CL	Displays status of tower telescope proximity switch (Displayed if TOWER PROX SWITCHES = 1)
	BR CABLE CUT.	OP/CL	Displays status of broken cable switch (Displayed if BROKEN CABLE SWITCH = 1)
	CREEP	ACTIVE/NOT ACTIVE	Displays pump pot creep switch status. Not displayed if MODEL = 601 (machine digit = 4)
	CRP MODE	ACTIVE/NOT ACT	Displays creep mode status
	SUPER CREEP	ON/OFF	Displays super creep mode status (Displayed if MODEL NUMBER = 7 or 8)
	TILT	XX.X DEG	Displays measured vehicle tilt. (Displayed if internal tilt sensor is configured)
	LO TILTED -	NO/YES	Displays status of lo tilt input. (Displayed if external tilt sensor is configured)

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
	HI TILTED -	NO/YES	Displays status of hi tilt input. (Displayed if external tilt sensor is configured)
	AUX POWER	OP/CL	Displays the status of the auxiliary power switch input
	HORN	OP/CL	Displays the status of the horn input
	R FILTER	OP/CL	Displays the status of the return hydraulic filter by-pass switch. Displayed ONLY if MODEL = 600 (Configuration digit = 3)
	C FILTER	OP/CL	Displays measured status of charge pump filter bypass switch. Displayed ONLY if MODEL = 600 (Configuration digit = 3)
	JIB BLOCK	OP/CL	Displays jib block limit switch status. Not displayed if associated configuration digit = 0
	BASKET STOWD	YES/NO	Displays status of basket stowed mode. (Displayed if MODEL NUMBER = 7 or 8)
	SOFT LIMIT	OP/CL	Displays status of soft touch limit switch. Not displayed if associated configuration digit = 0
	SOFT O/R	OP/CL	Displays status of soft touch override switch. Not displayed if associated configuration digit = 0
	GEN SET/WELDER	OP/CL	Displays generator/welder switch input status. Not displayed if associated configuration digit = 0
	LIGHTS	OP/CL	Displays head and tail light switch input status. Not displayed if associated configuration digit = 0
	BSK TILT1	XX.X	Displays indicated platform tilt angle. Displayed on models equipped with Electronic Platform Leveling.
	BSK TILT2	XX.X	Displays indicated platform tilt angle. Displayed on models equipped with Electronic Platform Leveling.
	AXLE RET SW	OP/CL	Displays status of axle extension user switches. (Displayed if MODEL NUMBER = 7 or 8)
	AXLE EXT SW	OP/CL	Displays status of axle retraction user switches. (Displayed if MODEL NUMBER = 7 or 8)
	AXLE LIM SW	RET/EXT	Displays status of axle extension limit switches. (Displayed if MODEL NUMBER = 7 or 8)
	DOS LIM SW	OP/CL	Displays status of Drive Orientation System Limit Switch. (Displayed if MODEL NUMBER = 7 or 8)
	DOS O/R SW	OP/CL	Displays status of Drive Orientation System Override switch. (Displayed if MODEL NUMBER = 7 or 8)
	CAPACITY SW	500/1000	Displays status of capacity selection switch. (Displayed if MODEL NUMBER = 7 or 8)

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
	OSC AXLE P SW	OP/CL	Displays status of oscillating axle pressure switch. (Displayed if OSCILLATING AXLE = 1)
	SKY WELDER	YES/NO	Displays the status of Sky Welder selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	SKY CUTTER	YES/NO	Displays the status of Sky Cutter selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	SKY GLAZIER	YES/NO	Displays the status of Sky Glazier selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	SKY BRIGHT	YES/NO	Displays the status of Sky Bright selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	PIPE RACKS	YES/NO	Displays the status of Pipe Racks selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	CAMERA MOUNT	YES/NO	Displays the status of Camera Mount selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
LOAD:			Not displayed if LOAD=NO, LENGTH=NO, and ANGLE=NO (machine digits = 0)
	LENGTH	OP /CL	Displays measured length, NOTE: Not displayed if MODEL NUMBER = 7 or 8
	ANGLE	OP / CL	Displays measured angle, NOTE: Not displayed if MODEL NUMBER = 7 or 8
	WEIGHT	XXXX%	Percentage of maximum calibrated weight on the platform. An uncalibrated load cell will read 1000% Displayed if LOAD is not 0 and LOAD TYPE is 0.
		OK/OVERLOADED	Displayed if LOAD is not 0 and LOAD TYPE is 1.

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
MOMENT:			Displayed if MODEL NUMBER = 7 or 8
	(LB-IN) ACTUAL	XXXXXXXX	Displays current moment value
	(LB-IN) OVER	XXXXXXXX	Displays current over moment setpoint.
	(LB-IN) UNDER	XXXXXXXX	Displays current under moment setpoint.
	CAL PT UNDER	XXXXXXXX	Displays the under moment value recorded during boom sensor calibration.
	CAL PT WIT YEL	XXXXXXXX	Displays the yellow witness mark moment value recorded during boom sensor calibration.
	CAL PT WIT GRN	XXXXXXXX	Displays the green witness mark moment value recorded during boom sensor calibration.
	CYL PIN RATIO	X.XXX	Displays the current cylinder moment pin ratio of X and Y forces.
	PIN E FLAGS	0xXXXX	Displays the current error flag status of the cylinder moment pin.
	SKY WELDER	YES/NO	Displays the status of Sky Welder selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	SKY CUTTER	YES/NO	Displays the status of Sky Cutter selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	SKY GLAZIER	YES/NO	Displays the status of Sky Glazier selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	SKY BRIGHT	YES/NO	Displays the status of Sky Bright selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	PIPE RACKS	YES/NO	Displays the status of Pipe Racks selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	CAMERA MOUNT	YES/NO	Displays the status of Camera Mount selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
ENVELOPE:			Displayed if MODEL NUMBER = 7 or 8
	LENGTH	XXXX.X	Displays the current indicated boom length in inches.
	ANGLE 1	XX.X	Displays the current indicated boom angle 1 in degrees.
	ANGLE 2	XX.X	Displays the current indicated boom angle 2 in degrees.
	A/D LNGTH	XXXXX	Displays the current indicated boom length in A/D counts.
	A/D ANG1	XXXXX	Displays the current indicated boom angle 1 in A/D counts or raw angle if calibrated.
	A/D ANG2	XXXXX	Displays the current indicated boom angle 2 in A/D counts or raw angel if calibrated.
CAN STATISTICS:			CAN Statistics as detected by the Ground Module
	RX/SEC	XXX	Displays the number of received messages per second
	TX/SEC	XXX	Displays the number of transmitted messages per second
	BUS OFF	XX	Displays the number of bus off occurrences
	PASSIVE	XX	Displays the number of bus passive occurrences

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
CALIBRATION DATA			
	BASKET UP	XXX	Displays the basket up calibration point
	BASKET DOWN	XXX	Displays the basket down calibration point
	L FWD DRIVE	XXX	Displays the left forward drive calibration point
	R FWD DRIVE	XXX	Displays the right forward drive calibration point
	L REV DRIVE	XXX	Displays the left reverse drive calibration point
	R REV DRIVE	XXX	Displays the right reverse drive calibration point
	F LT STEER	XXX	Displays the forward left steer calibration point
	F RT STEER	XXX	Displays the forward right steer calibration point
	R LT STEER	XXX	Displays the reverse left steer calibration point
	R RT STEER	XXX	Displays the reverse right steer calibration point
	U LIFT UP	XXX	Displays the main lift up calibration point
	U LIFT DOWN	XXX	Displays the main lift down calibration point
	U TELE IN	XXX	Displays the main telescope in calibration point
	U TELE OUT	XXX	Displays the main telescope out calibration point
	BM ANG 1 LO	XXX	Displays the boom angle 1 low calibration point
	BM ANG 1 HI	XXX	Displays the boom angle 1 high calibration point
	BM ANG 2 LO	XXX	Displays the boom angle 2 low calibration point
	BM ANG 2 HI	XXX	Displays the boom angle 2 high calibration point
	LEN RETRACT	XXX	Displays the length sensor retracted calibration point
	LEN EXTEND	XXXXX	Displays the length sensor extended calibration point
	LEN WIT	XXXXX	Displays the witness mark calibration point
	LEN SWITCH	XXXX	Displays the length switch calibration point

Table 6-5. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
DATALOG:			
	ON	XXXXhXXm	Displays total controller on (EMS) time
	ENGINE	XXXXhXXm	Display engine run time
	DRIVE	XXXXhXXm	Displays total controller drive operation time
	LIFT	XXXXhXXm	Displays total controller lift operation time
	SWING	XXXXhXXm	Displays total controller swing operation time
	TELE	XXXXhXXm	Displays total controller telescope operation time
	MAX TEMP	XXC	Displays maximum measured ambient temp.
	MIN TEMP	XXC	Displays minimum measured ambient temp.
	MAX VOLTS	XX.XV	Displays maximum measured battery voltage
	RENTAL	XXXXhXXm	Displays total controller operation time. NOTE: can be reset
	ERASE RENTAL?		Not available at Access Level 2. ENTER resets rental data log time to zero.
VERSIONS:			
	GM SW	PX.X	Displays ground module software version
	GM HW REV	XXXX	Displays ground module hardware revision
	GM SN	XXXXXX	Displays ground module serial number
	PM SW	PX.X	Displays platform module software version
	PM HW REV	XXXX	Displays platform module hardware revision
	PM SN	XXXXXX	Displays platform module serial number
	CM SW	PX.X	Displays chassis module software version
	BM SW	PX.X	Displays BLAM module software version
	C PIN SW		Displayed if cylinder moment load pin transmits software version.
	C PIN SN		Displayed if cylinder moment load pin transmits serial number.
	ANALYZER	VX.XXXX	Displays Analyzer software version

6.12 CALIBRATING STEER

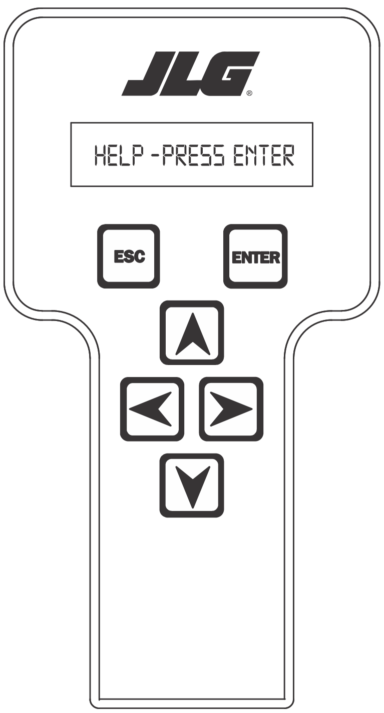
When calibrating steering, each individual wheel must be calibrated in order to make the tire and wheel parallel with the frame. Two methods to help ensure proper calibration are the use of a carpenter's square to square the spindle to the axle or aligning the two wheels on one side using a stretched string.

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:

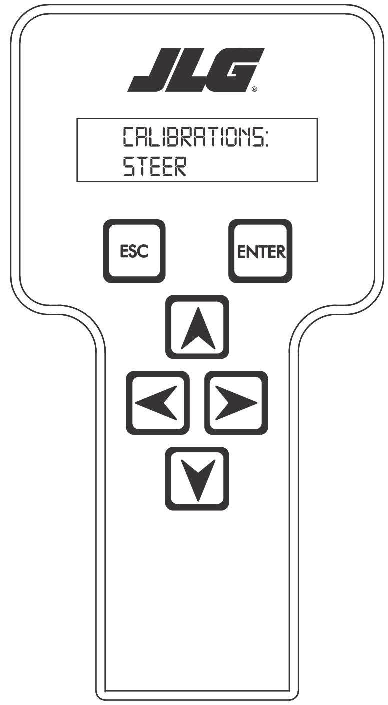


5. Use the arrow button to reach ACCESS LEVEL 2. Hit Enter.

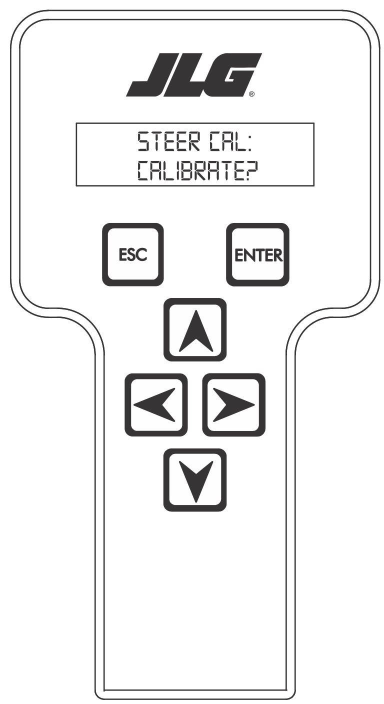
6. Enter the Access Code, 33271.

7. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.

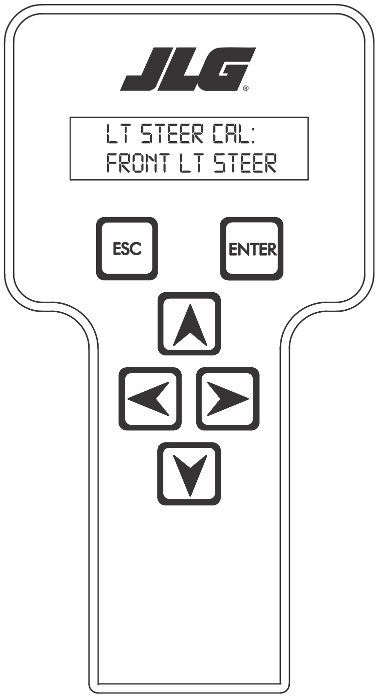
8. Use the arrow keys to reach Steer. The screen will read:



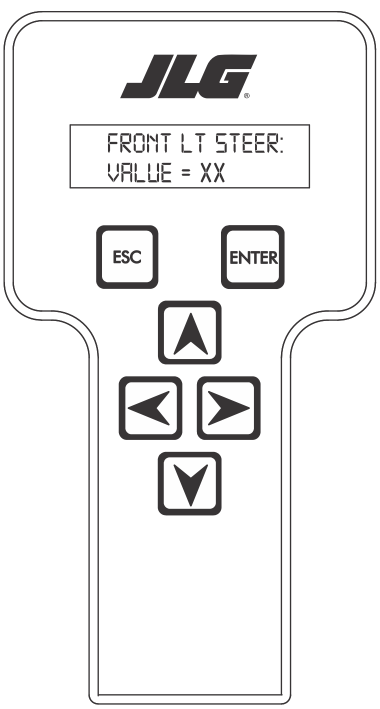
9. Hit Enter. The screen will read:



10. Hit Enter. The screen will read:

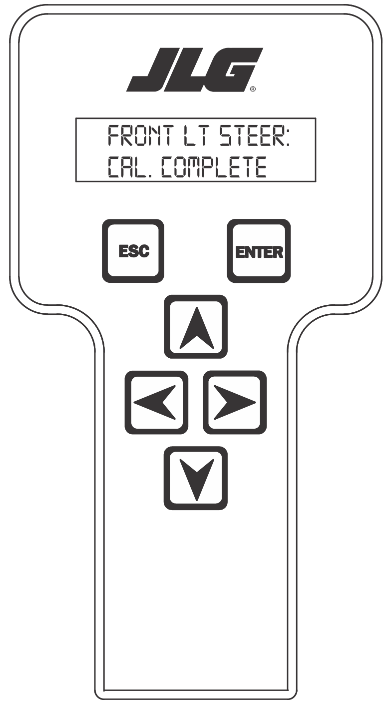


11. Hit Enter again. The screen will read:



12. Activate the steer control until the tire and wheel are straight in relationship with the chassis, then leave off the control. The display will read FRT LEFT = and show the numeric calibration value for that wheel.

13. Hit Enter. The screen will read:



14. Repeat steps 10 thru 12 for left rear steer.

15. Left Rear Steer Calibration will be followed by Right Forward Steer Calibration which will be followed by Right Rear Steer Calibration.

16. After completing all the Steer Calibrations, hit ESC twice to go back to CALIBRATIONS.

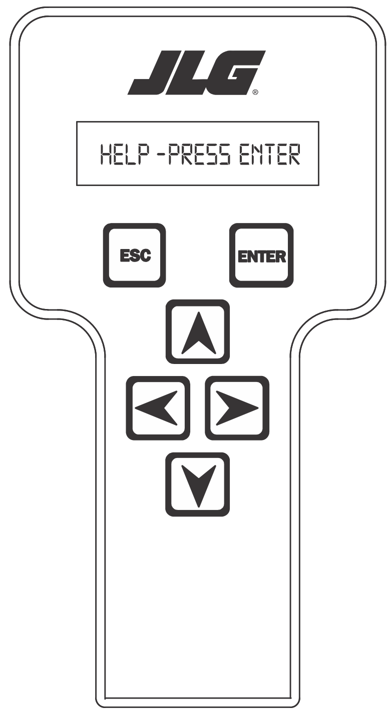
6.13 CALIBRATING DRIVE

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:

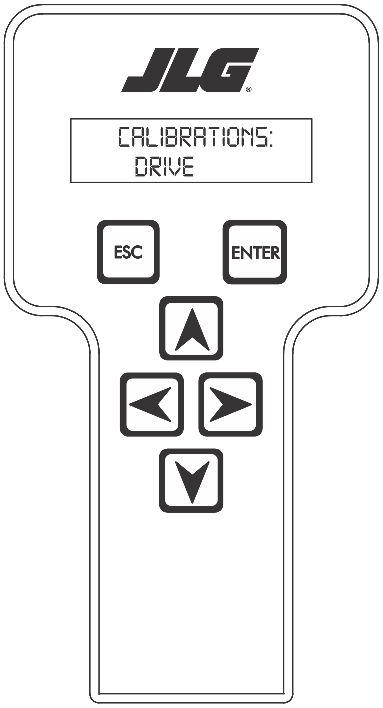


5. Use the arrow button to reach ACCESS LEVEL 2. Hit Enter.

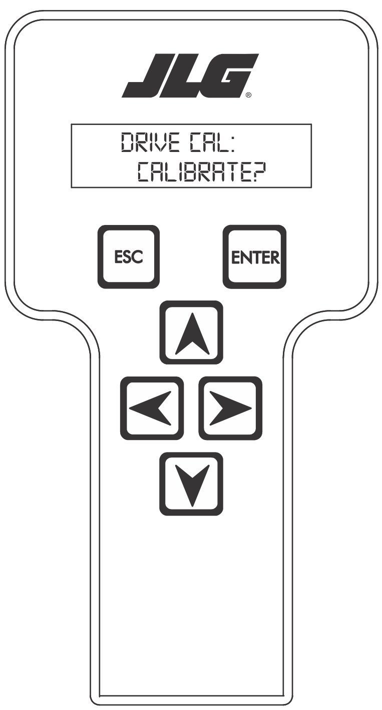
6. Enter the Access Code, 33271.

7. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.

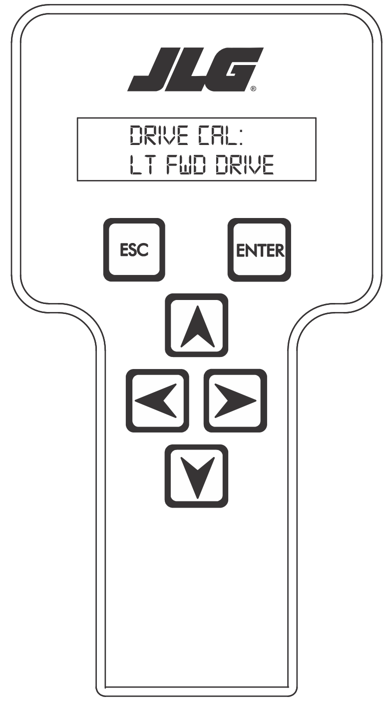
8. Use the arrow keys to reach DRIVE.



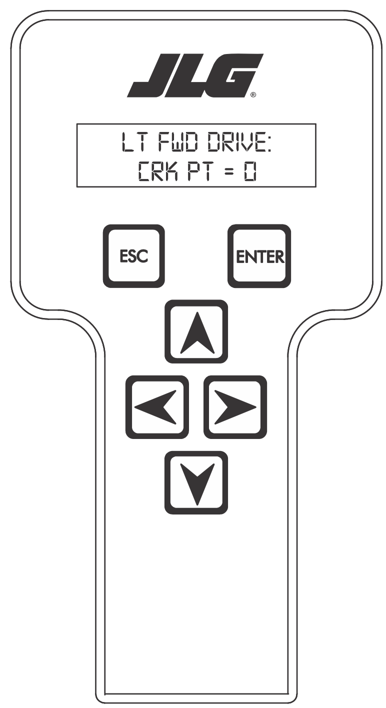
9. Hit Enter. The screen will read:



10. Hit Enter again. The screen will read:

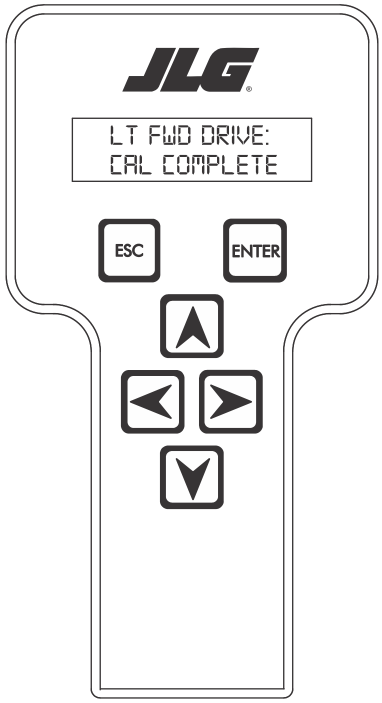


11. Hit Enter again. The screen will read:

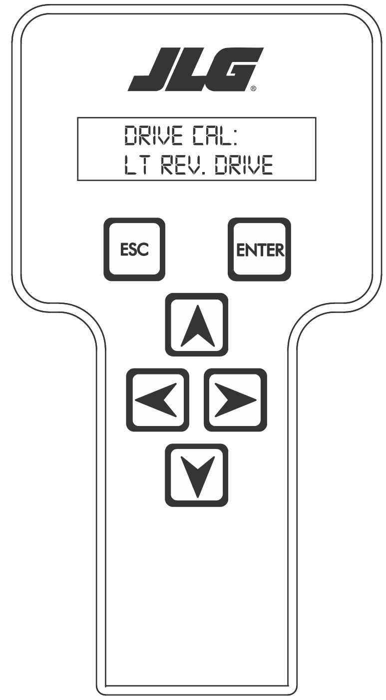


12. Activate the Drive Joystick forward full stroke until the machine just begins to move, then leave off the joystick immediately. The display will read CRK PT = and show the numeric crack point value.

13. Hit Enter. The number displayed will be the value that the crack point is set to. The screen will show:



14. Hit Enter. The screen will read:



15. Repeat steps 10 thru 12 for left reverse drive.

16. Left Reverse Drive Calibration will be followed by Right Forward Drive Calibration which will be followed by Right Reverse Calibration.

17. After completing all the Drive Calibrations, hit ESC twice to go back to CALIBRATIONS.

6.14 ELECTRONIC PLATFORM LEVELING

Platform Leveling Fault Warning

The JLG Control System takes a snapshot of the two sensor values and records the difference once on each power up. The Control system allows a ±5 degree difference from those values. For example, if Sensor 1 is at 5 degrees and Sensor 2 is at 11 degrees, the difference is 6 degrees and the DTC is triggered when the sensors are 1 degree (or less) apart or 11 degrees (or more) apart.

If a fault occurs in the platform leveling system the following will occur:

1. Automatic platform leveling will stop (except when there is a fault in only one sensor automatic leveling will remain active as the control system will use the other sensor to control leveling)
2. The level fault lamp will flash
3. The audible alarm will sound
4. All functions will default to creep speed if the platform is out of the transport position (extended more than 12” [51 cm] 1350SJP; 24" [60.9 cm] 1200SJP, or elevated above the horizontal position).

To reset the fault the emergency stop switch should be recycled.

NOTICE

IF THE FAULT PERSISTS BRING THE PLATFORM TO THE GROUND POSITION, SWITCH THE MACHINE OFF AND CONTACT A QUALIFIED SERVICE REPRESENTATIVE TO INVESTIGATE THE FAULT.

Fault Response

ERROR RESPONSE

If basket level varies from the current **setpoint** by ± 5.5° for more than 1.5 seconds when the platform is not in the transport position, the following events will occur:

1. The platform dump valve will be disabled (level, rotate and jib functions disabled).
2. The level system fault lamp will flash (to indicate that the leveling function has been lost).
3. The platform alarm will sound.
4. A system fault will be logged.
5. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position see below).

When the unit is in the transport position and driving and the current setpoint varies by ± 5.5° for more than 8 seconds the events 1,2,3 & 4 above will occur. (note function speeds will operate normally). Cycling the EMS will clear the fault and allow the operator to operate the machine as a new level **setpoint** is taken.

VALVE DRIVER ERRORS

There are three possible level valve driver errors, short to battery, short to ground, and open circuit.

1. In the case of a **short to ground or an open circuit**, the platform valve cannot be turned on and the following will occur:
   a. All interactions with platform leveling shall cease
   b. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
   c. The platform alarm will sound.
   d. A system fault will be logged.
   e. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position).
2. In the case of a **short to battery** on one of the platform leveling valves, the valve cannot be turned off and the following will occur:
   a. The platform dump valve will be turned off to prevent unintended tilting of the platform.
   b. All interactions with platform leveling shall cease.
   c. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
   d. The platform alarm will sound.
   e. A system fault will be logged.
   f. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position)
3. In the case of a **short to battery on the platform dump valve**, the valve cannot be turned off. The controllability of the platform leveling function will be impaired and the following will occur:
   a. All interactions with platform leveling shall cease.
   b. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
   c. The platform alarm will sound.
   d. A system fault will be logged.
   e. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position).

Lift, swing, drive and telescope will continue to operate

In each of the cases above it shall be necessary to re-cycle the EMS to clear the fault. Operable functions shall be in the creep mode except while below elevation.

TILT SENSOR ERRORS

If the secondary tilt sensor is faulty, the control system will continue to utilize information from the primary sensor.

If the primary sensor is faulty, the control system will switch to the backup sensor for control.

In both cases above the following will occur:

1. The Electronic Leveling System Fault Lamp will flash (to indicate that there is a leveling fault).
2. The platform alarm will sound.
3. A system fault will be logged.
4. All function speeds (lift, swing, telescope, jib and drive) will be placed in creep mode (except when the platform is in the transport position).
5. Automatic leveling remains active.

Lift, swing, drive and telescope will continue to operate.

In each of the cases above it will be necessary to re-cycle the EMS to clear the fault. Operable functions shall be in the creep mode except while below elevation.

When both sensors appear to be working but have measurements that disagree by ±5.5° The following will occur:

1. All interactions with platform leveling shall cease.
2. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
3. The platform alarm will sound.
4. A system fault will be logged.
5. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position)

At this point, the operator must use the level up and down toggle switch to manually level during descent. It shall be necessary to re-cycle the EMS to clear the fault.

CAN Errors

The Ground Module has two direct outputs dedicated to overriding the Platform Module's control of the leveling valves. The Ground Module "Platform Level Up/Down" outputs are used to control the platform level up and down valves.

When in ground mode, if the Ground Module reads a platform leveling switch command, the switch command is communicated over CAN to the Platform Module where it is handled normally.

If Ground Module determines that CAN communication is inoperable, it turns on the platform control valve and the appropriate platform leveling override outputs while the switch is engaged.

If the Platform Module is still running when CAN is down nothing will operate when in platform mode. When the operator switches to ground mode, the platform will not control any of its valve outputs and a CAN error message is signaled.

Additional Platform and Jib Valves

The high side drivers for the platform left and right and the jib up and down valves are be located in the Platform Module and are proportional. Flow through the valves is individually controllable. The individually controlled duty cycle will be the same as would otherwise have been commanded to the flow control valve.

Only one platform or jib function is allowed at one time to limit the amount of current draw, minimizing the voltage drop on the supply to the Platform Module.

The function is enabled first shall remain active until it is released. Any other function commanded while another function is active is ignored.

Platform Leveling Calibration Procedure

STEP 1: SETTING THE PLATFORM VALVE MINIMUMS

1. Put machine into “Ground Mode”.
2. Start machine and plug in Analyzer.
3. Go to the “Access Level 2” screen.
4. Enter “33271” to get into Access Level 1 mode.
5. Go to the "Personalities" menu and adjust the following personalities. Refer to the Personality Ranges/Defaults table in Section 6 - JLG Control System for proper setting values.

   Basket Level Up Min
   Basket Level Up Max
   Basket Level Down Max
   Jib Up Min
   Jib Down Min
6. Recycle EMS.

STEP 2: CALIBRATING THE PLATFORM LEVEL SENSORS

1. Put machine into “Ground Mode”.
2. Start machine and plug in Analyzer.
3. Manually level the platform with the switch on the MTB.
4. Go to the “Access Level 2” screen.
5. Enter “33271” to get into Access Level 1 mode.
6. Go to the “Calibrations” menu and hit ENTER.
7. Use RIGHT ARROW go to “Plat. Leveling” screen.
8. Hit ENTER. “Calibrate?” prompt should appear.
9. Hit ENTER again to calibrate level sensors.
10. When calibration has been successful “Cal. Complete” should appear.
11. Cycle power to the machine.

STEP 3: BLEEDING THE PLATFORM VALVES

1. Put machine into “Ground Mode”.
2. Start machine and plug in Analyzer.
3. Go to the “Access Level 2” screen.
4. Enter “33271” to get into Access Level 1 mode.
5. Go to the "Personalities" menu.
6. Using the left arrow button, go to the "Ground Mode" menu.
7. Hit ENTER.
8. Using the UP/DOWN arrows, adjust the following personalities to 100%.

   Basket Rotate
   Basket Level
   Jib U/D (if configured)

   Start up the machine and exercise each above platform function (from the ground) eight (8) to ten (10) times for 5 seconds in each direction.
9. Return the personality settings back to the values as shown in the Personality Ranges/Defaults table in Section 6 - JLG Control System.
10. Recycle EMS.

STEP 4: CALIBRATING THE PLATFORM LEVEL UP AND DOWN VALVE CRACKPOINTS

1. Put machine into “Ground Mode”.
2. Start machine and plug in Analyzer.
3. Go to the “Access Level 2” screen.
4. Enter “33271” to get into Access Level 1 mode.
5. Go to the “Calibrations” menu and hit ENTER.
6. Go to the “Basket U Crkpt” Screen. Hit ENTER.
7. “Calibrate?” prompt should appear. Hit ENTER again.
8. You will hear engine go to 1800 rpm.
9. Using UP ARROW, increase the value until you see the basket up movement.

10. Hit ENTER again. "Cal. Complete" message should appear
11. Engine should again return to idle.
12. Hit ESC should return to "Basket U Crkpt" screen.
13. Hit RIGHT ARROW to get to the "Basket D Crkpt" screen. Hit ENTER.
14. "Calibrate?" prompt should appear. Hit ENTER again.
15. You will hear engine go to 1800 rpm.

Using UP ARROW, decrease the value until you see the basket down movement.

Hit ENTER again. "Cal. Complete" message should appear

Engine should again return to idle.

Hit ESC to exit.

Cycle power to the machine.

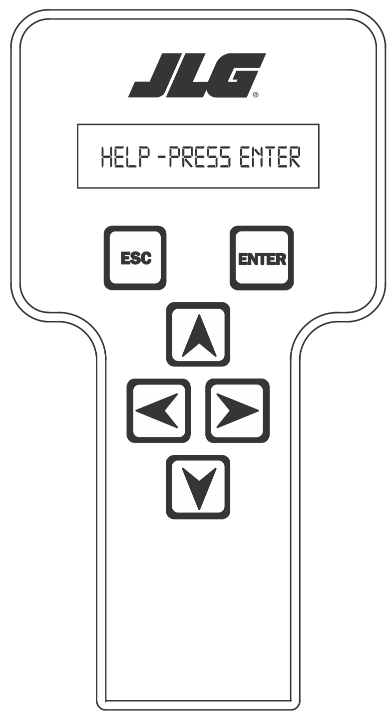
6.15 CALIBRATING PLATFORM LEVEL

STEP 1: SETTING THE PLATFORM VALVE MINIMUMS

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 ACCESS LEVEL 2. Hit Enter.
6. Enter the Access Code, 33271.

7. Use the arrow button to reach PERSONALITIES adjust the following personalities. Refer to the Personality Ranges/Defaults table for proper setting values.

   Basket Level Up Min
   Basket Level Up Max
   Basket Level Down Max
   Jib Up Min
   Jib Down Min

8. Recycle EMS.

STEP 2: CALIBRATING THE PLATFORM LEVEL SENSORS

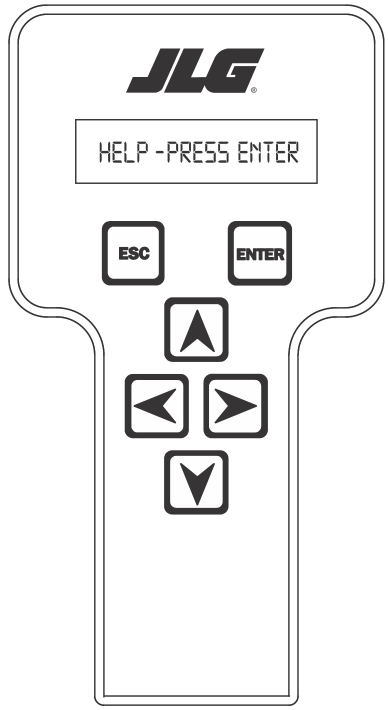
1. Position the Platform/Ground select switch to the Ground position.

2. Plug the analyzer into the connector inside the Ground control box.

3. Pull out the Emergency Stop switch and start the engine.

4. Manually level the platform with the switch on the Main Terminal Box.

5. The analyzer screen should read:



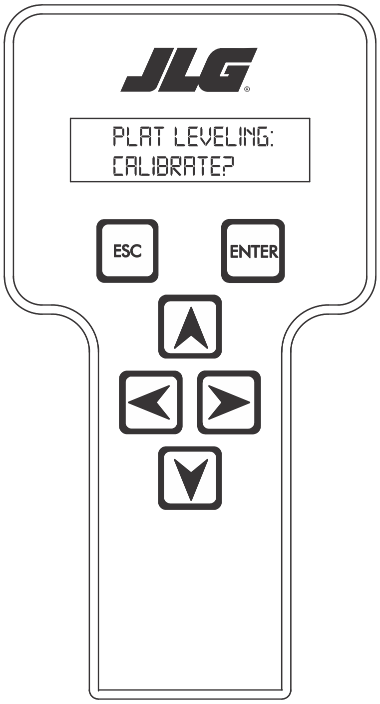
6. Use the arrow button to reach ACCESS LEVEL 2. Hit Enter.

7. Enter the Access Code, 33271.

8. Use the arrow button to reach CALIBRATIONS menu and hit ENTER.

9. Use right arrow go to PLAT. LEVELING screen.

10. Hit ENTER. The screen should read:



11. Hit ENTER again to calibrate level sensors.

12. When calibration has been successful CAL. COMPLETE should appear.

13. Cycle power to the machine.

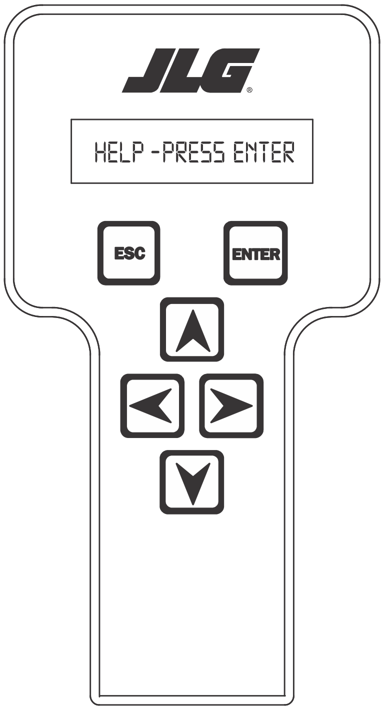
STEP 3: BLEEDING THE PLATFORM VALVES

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 ACCESS LEVEL 2. Hit Enter.
6. Enter the Access Code, 33271.
7. Go to the PERSONALITIES menu.
8. Using the left arrow button, go to the GROUND MODE menu.
9. Hit ENTER.
10. Using the UP/DOWN arrows, adjust the following personalities to 100%.

    Basket Rotate
    Basket Level
    Jib U/D (if configured)

    Start up the machine and exercise each above platform function (from the ground) eight (8) to ten (10) times for 5 seconds in each direction.
11. Return the personality settings back to the values as shown in the Personality Ranges/Defaults table in Section 6 - JLG Control System.
12. Recycle EMS.

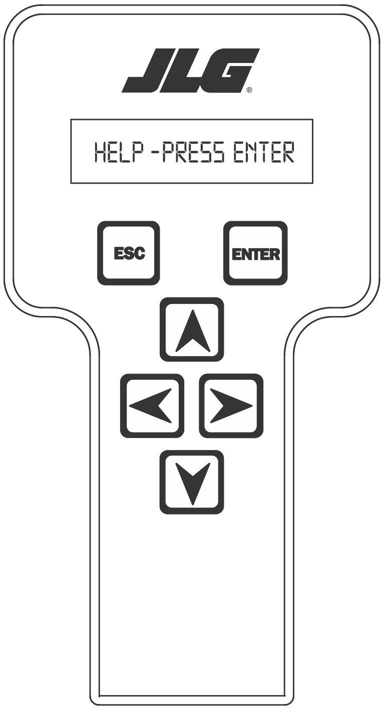
STEP 4: CALIBRATING THE PLATFORM LEVEL UP AND DOWN VALVE CRACKPOINTS

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 ACCESS LEVEL 2. Hit Enter.
6. Enter the Access Code, 33271.
7. Go to the CALIBRATIONS menu and hit ENTER.
8. Go to the BASKET U CRKPT Screen. Hit ENTER.
9. CALIBRATE? prompt should appear. Hit ENTER again.
10. You will hear engine go to 1800 rpm.
11. Using UP ARROW, increase the value until you see the basket up movement.
12. Hit ENTER again. CAL. COMPLETE message should appear
13. Engine should again return to idle.
14. Hit ESC should return to BASKET U CRKPT screen.
15. Hit RIGHT ARROW to get to the "BASKET D CRKPT" screen. Hit ENTER.
16. CALIBRATE? prompt should appear. Hit ENTER again.
17. You will hear engine go to 1800 rpm.

Using UP ARROW, increase the value until you see the basket down movement.

Hit ENTER again. CAL. COMPLETE message should appear

Engine should again return to idle.

Hit ESC to exit.

Cycle power to the machine.

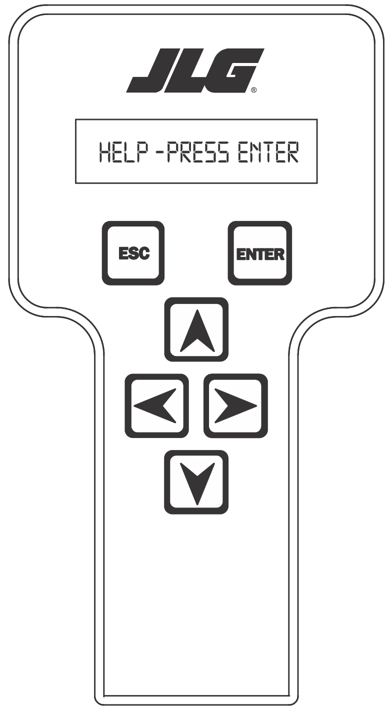
6.16 CALIBRATING LIFT CRACK POINT

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.

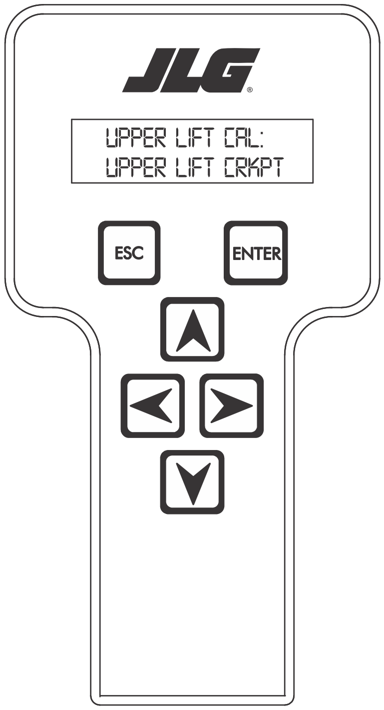
3. Pull out the Emergency Stop switch and Start the engine.

4. The analyzer screen should read:

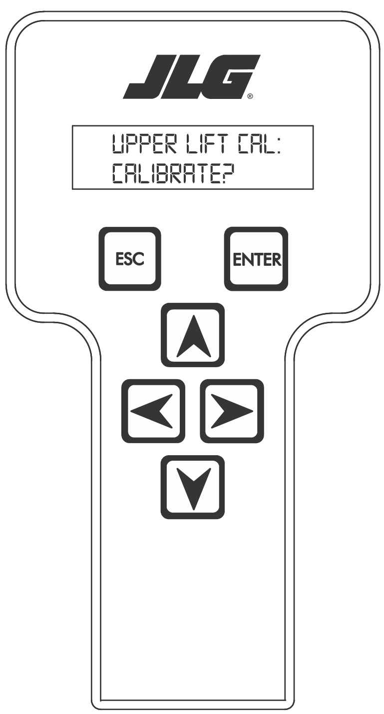


5. Use the arrow button to reach ACCESS LEVEL 2. Hit Enter.
6. Enter the Access Code, 33271.
7. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.

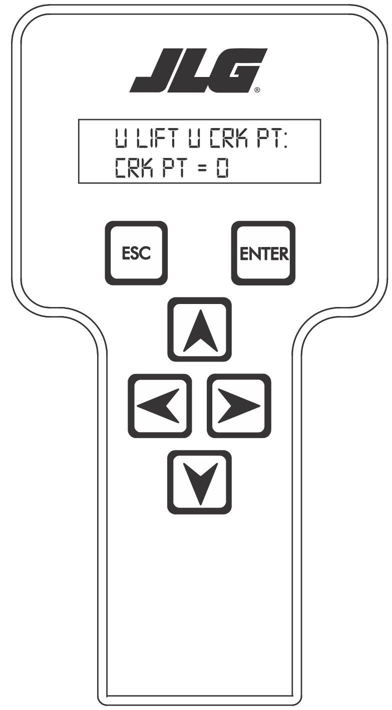
8. Use the arrow keys to reach Upper Lift Crack Point (UPPER LIFT CRKPT). The screen will read:



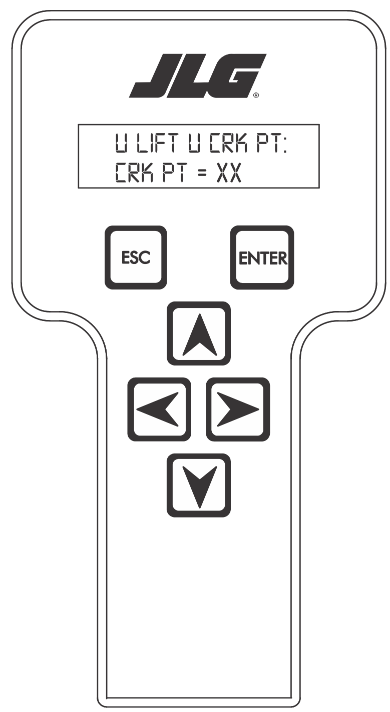
9. Hit enter. The screen will read:



10. Hit Enter. The screen will read:

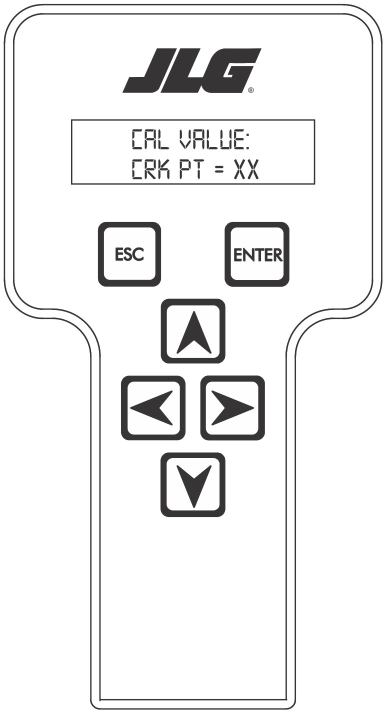


11. Hit Enter again. The screen will read:

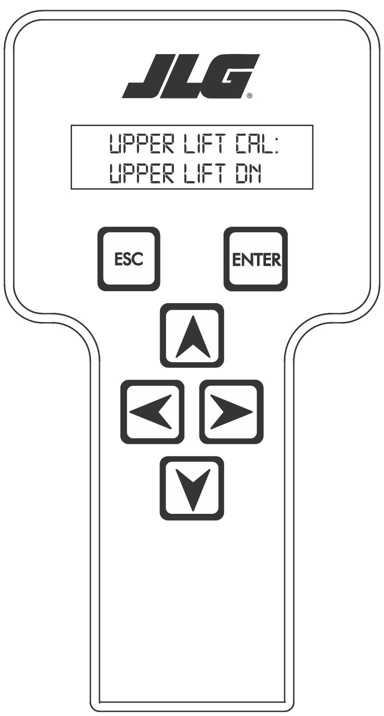


12. Activate the Lift Up function by fully stroking the joystick until the boom starts to move, then leave off immediately. The display will read CRK PT = and show the numeric crack point value.

13. Hit enter. The number displayed will be the value that the crack point is set to. The screen will show:



14. Hit Enter. The screen will read:



15. Repeat steps 10 thru 12 for the Lift Down function.

16. After completing all the Tele Calibrations, hit ESC twice to go back to CALIBRATIONS.

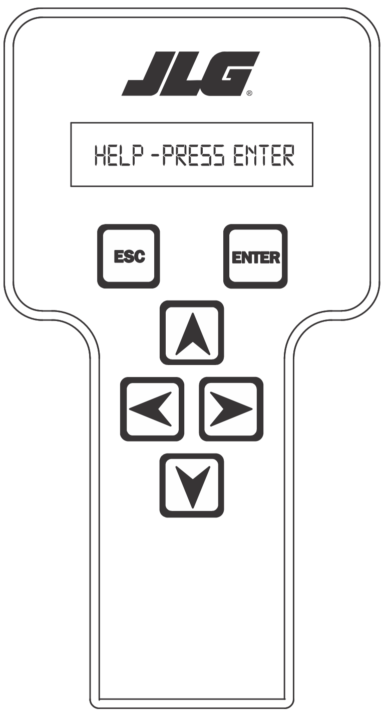
6.17 CALIBRATING TELESCOPE CRACK POINT

1. Position the Platform/Ground select switch to the Platform position.

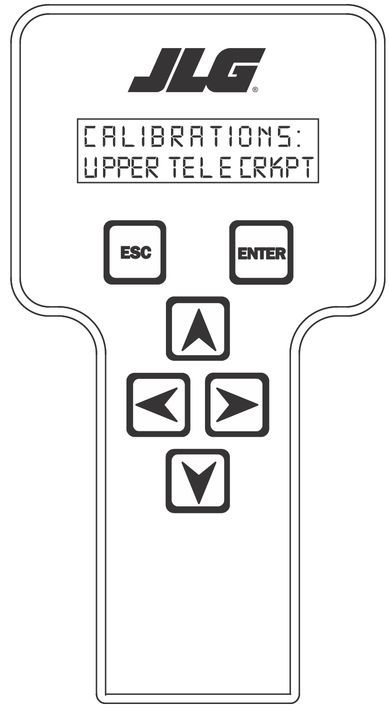
2. Plug the analyzer into the connector at the base of the platform control box.

3. Pull out the Emergency Stop switch and Start the engine.

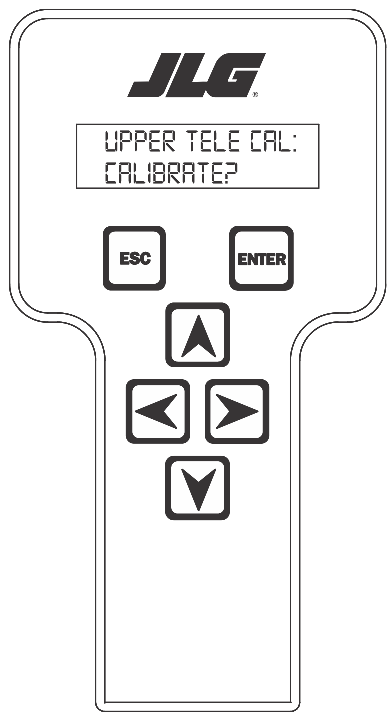
4. The analyzer screen should read:



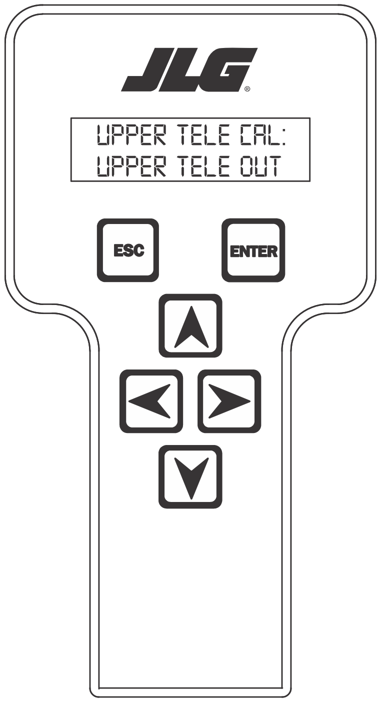
5. Use the arrow button to reach ACCESS LEVEL 2. Hit Enter.
6. Enter the Access Code, 33271.
7. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.
8. Use the arrow keys to reach Upper Telescope Crack Point (UPPER TELE CRKPT). The screen will read:



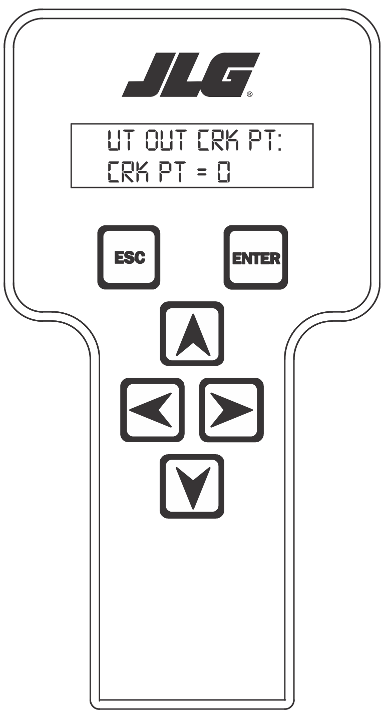
9. Hit Enter. The screen will read:



10. Hit Enter. The screen will read:

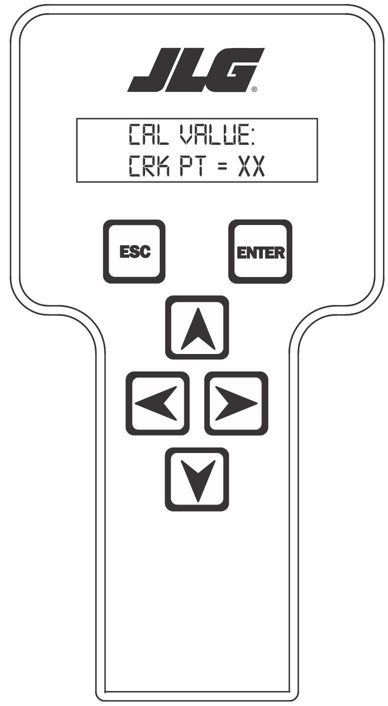


11. Hit enter again. The screen will read:

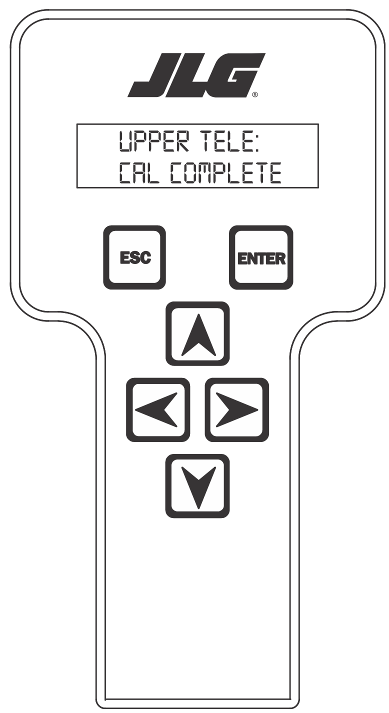


12. Activate the Tele Out function until the boom starts to move, then leave off immediately. The display will read CRK PT = and show the numeric crack point value.

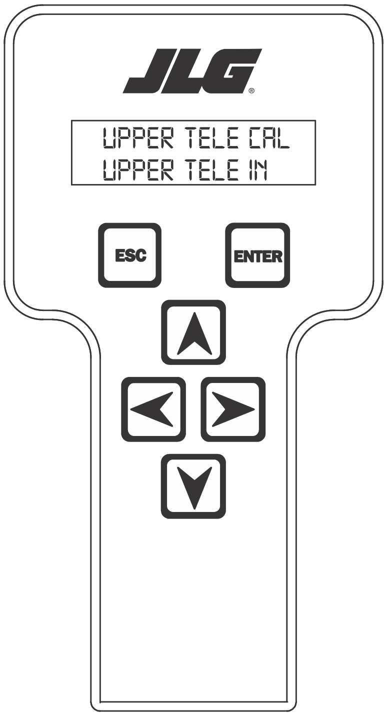
13. Hit enter. The number displayed will be the value that the crack point is set to. The screen will show:



14. Hit Enter. The screen will read:



15. Hit Enter. The screen will read:



16. Repeat steps 10 thru 12 for the Tele In function.

17. After completing all the Tele Calibrations, hit ESC twice to go back to CALIBRATIONS.

6.18 CALIBRATING TILT SENSOR

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.

1. Use the following procedure to calibrate the tilt sensor.

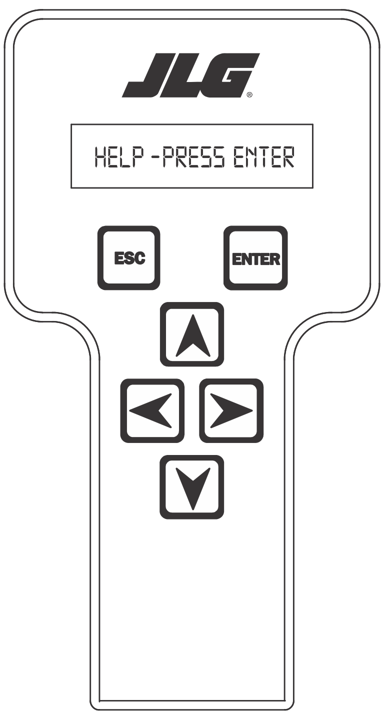
   Before the tilt sensor can be calibrated, the following conditions must be met:

   a. Steering previously calibrated.
   b. Axles extended.
   c. Wheels straight.
   d. Turntable centered.
   e. Boom fully retracted.
   f. Boom angle is less than 45°.
   g. Machine on firm, level ground.

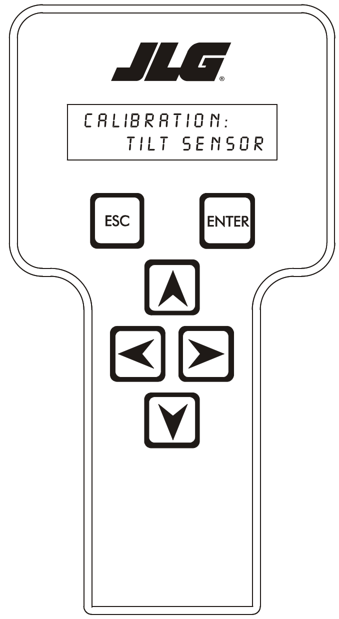
2. Position the Platform/Ground select switch to the Ground position.

3. Plug the analyzer into the connector inside the Ground control box.

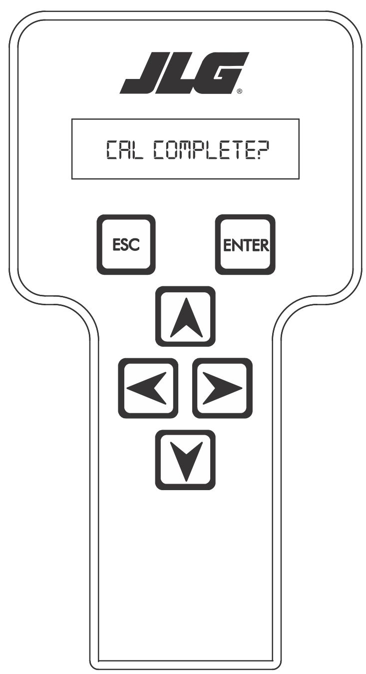
4. Pull out the Emergency Stop switch and start the engine.
5. The analyzer screen should read:



6. Use the arrow button to reach ACCESS LEVEL 2. Hit Enter.
7. Enter the Access Code, 33271.
8. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.
9. Use the arrow keys to reach the TILT SENSOR. The screen should read:



10. Press ENTER.
11. When prompted, swing turntable 180° to opposite end of chassis.
12. Press ENTER. The screen should read:



13. Upon completing swing calibration, swing turntable 180° back to the stowed position.
14. Hit ESC twice to go back to CALIBRATIONS.

6.19 CALIBRATING THE BOOM SENSORS

NOTICE

DURING THE BOOM SENSOR CALIBRATION PROCEDURE, IT IS NORMAL FOR THE REAR WHEEL TO LIFT FROM THE GROUND APPROXIMATELY 1 INCH (2.5 CM). IF THE WHEEL RAISES APPRECIABLY MORE THAN THIS (I.E. 4 INCHES [10 CM] OR MORE), CHECK THE AXLE OSCILLATION SYSTEM FOR PROPER OPERATION OR THE NEED FOR BLEEDING, THEN PROCEED WITH THE BOOM SENSOR CALIBRATION PROCEDURE.

Use the following step-by-step procedure to calibrate the boom sensors.

1. Before the boom sensors can be calibrated, the following conditions must be met:

    a. Steering, telescope crack points, and tilt previously calibrated

    b. Axles Extended

    c. Wheels Straight

    d. Platform Unloaded

    e. Jib Horizontal

    f. Jib Swing Centered

    g. Platform Level

    h. Platform Centered

    i. Turntable Centered

    j. Boom Fully Retracted

    k. Level Ground (within 1.5°)

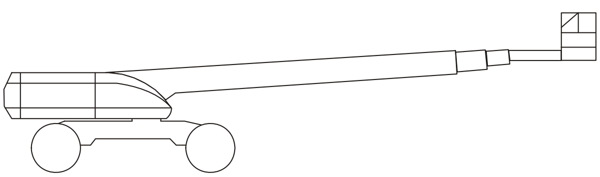


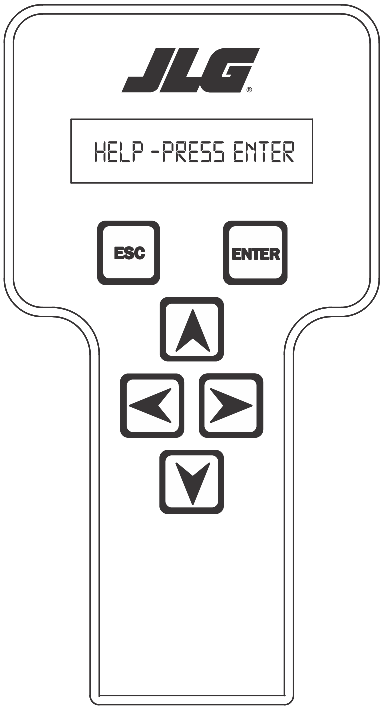
Figure 6-14. Boom Sensor Calibration Position 1

2. Position the Platform/Ground select switch to the Ground position.

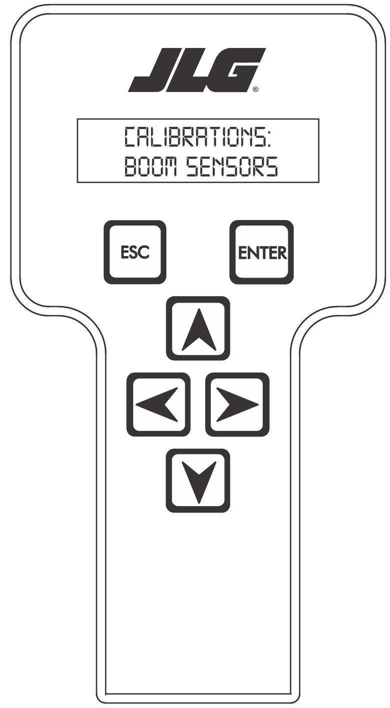
3. Plug the analyzer into the connector inside the Ground control box.

4. Pull out the Emergency Stop switch and start the engine.

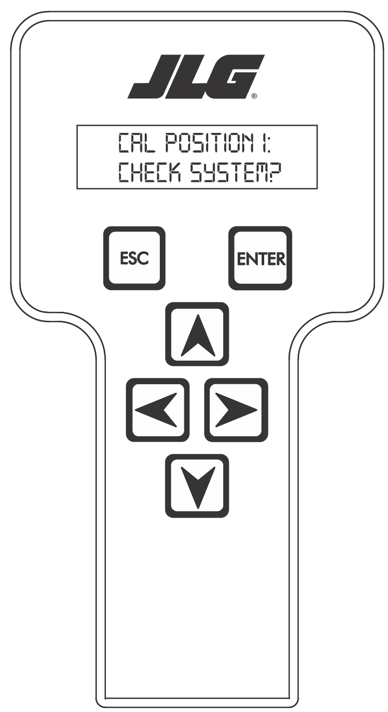
5. The analyzer screen should read:



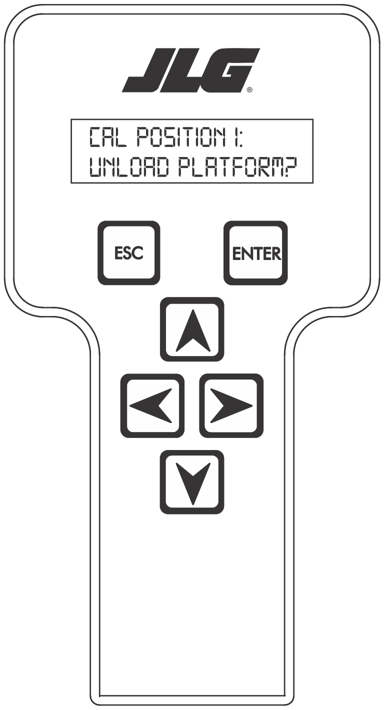
6. Use the arrow button to reach ACCESS LEVEL 2. Hit Enter.
7. Enter the Access Code, 33271.
8. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.
9. Use the arrow keys to reach BOOM SENSORS. The screen should read:



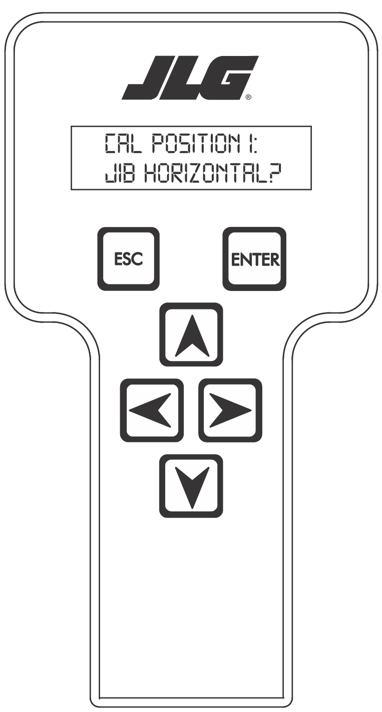
10. Hit Enter. The screen will read:



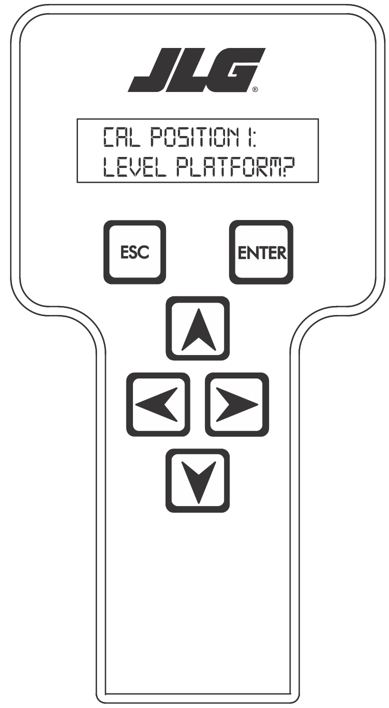
11. After verifying all the conditions listed in step 1 are met, hit Enter. The screen will read:



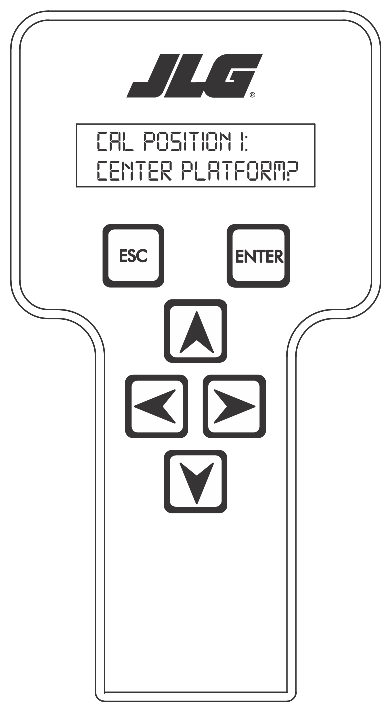
12. After verifying all load (personnel or material) is removed from the platform, hit Enter. The screen will read:



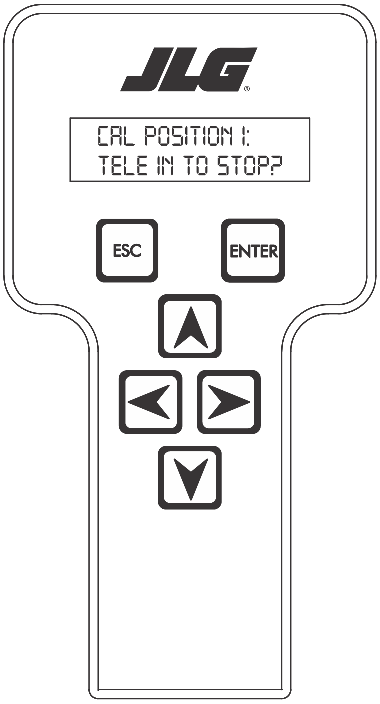
13. After visually verifying that the jib is horizontal, hit Enter. The screen will read:



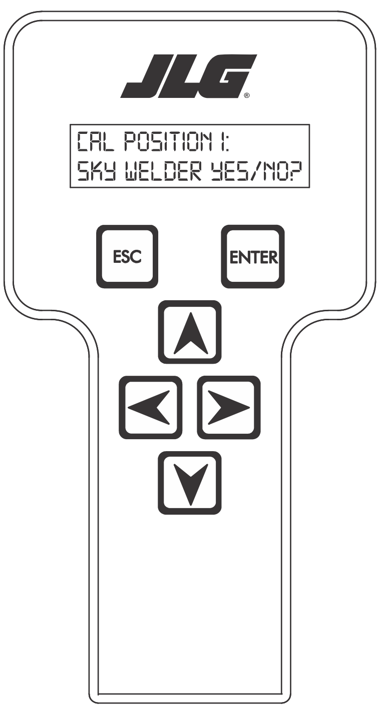
14. After visually verifying the platform is level, hit Enter. The screen will read:



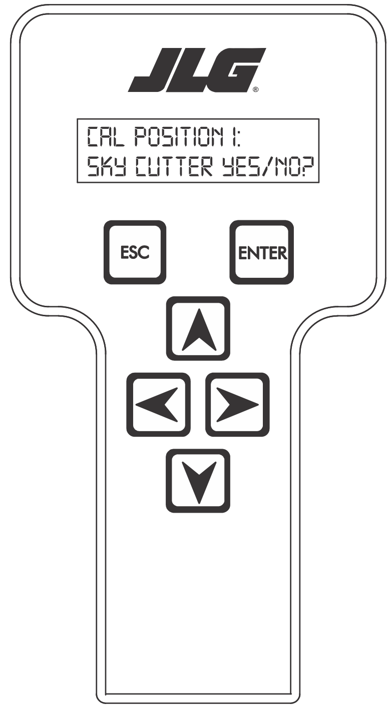
15. After visually verifying the platform is centered, hit Enter. The screen will read:



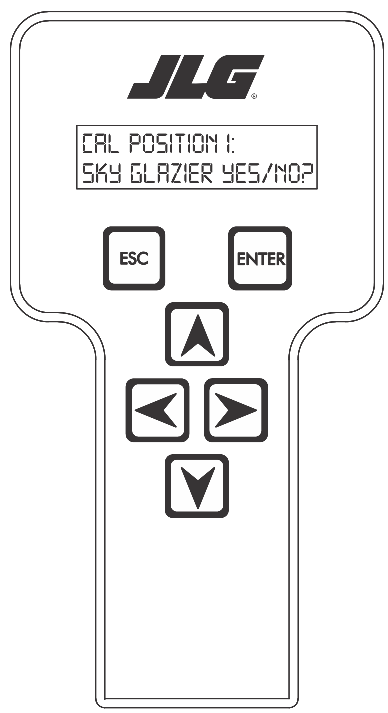
16. After operating telescope in to verify the boom is fully retracted, hit Enter. The screen will read:



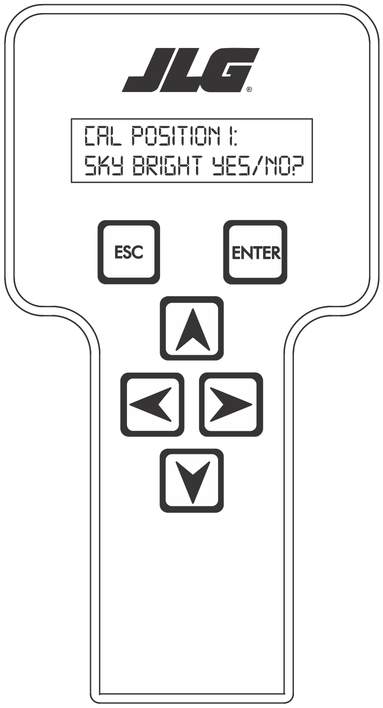
17. Use the up/down arrows to select YES if the accessory is installed, NO if it is not installed and hit enter. The screen will read:



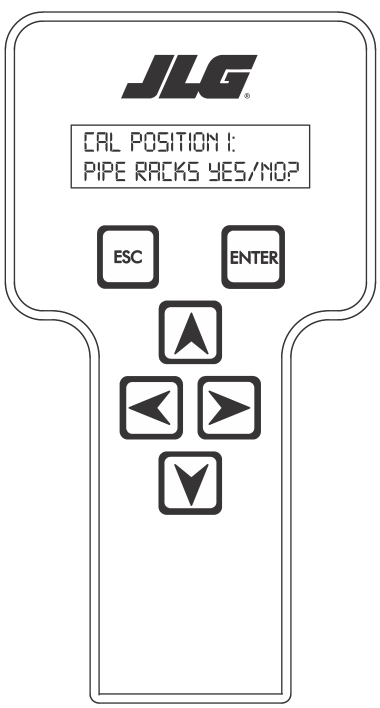
18. Use the up/down arrows to select YES if the accessory is installed, NO if it is not installed and hit enter. The screen will read:



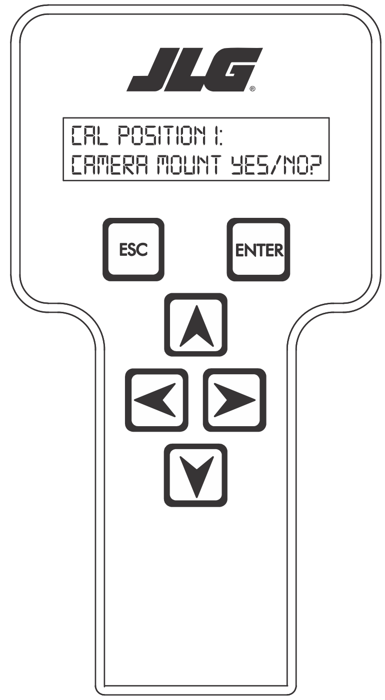
19. Use the up/down arrows to select YES if the accessory is installed, NO if it is not installed and hit enter. The screen will read:



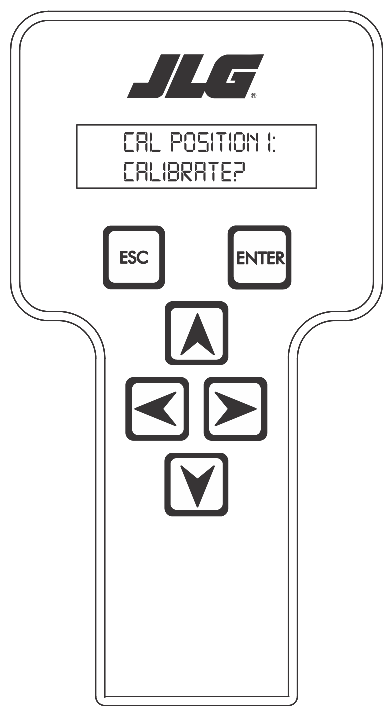
20. Use the up/down arrows to select YES if the accessory is installed, NO if it is not installed and hit enter. The screen will read:



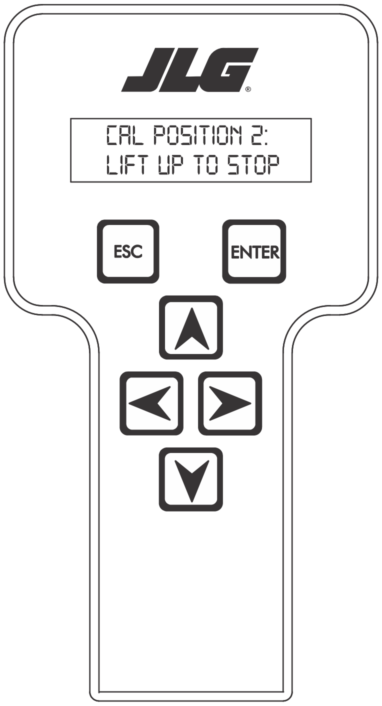
21. Use the up/down arrows to select YES if the accessory is installed, NO if it is not installed and hit enter. The screen will read:



22. Use the up/down arrows to select yes if the accessory is installed, no if it is not installed and hit Enter. The screen will read:



23. After making sure the machine is in Calibration Position 1, hit Enter. The screen will read:



24. Lift up to stop (full stroke of cylinder) for Calibration Position 2. When the machine is in that position, hit Enter.

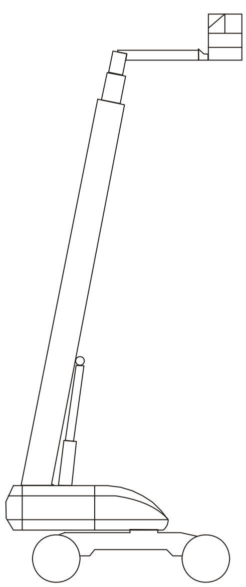
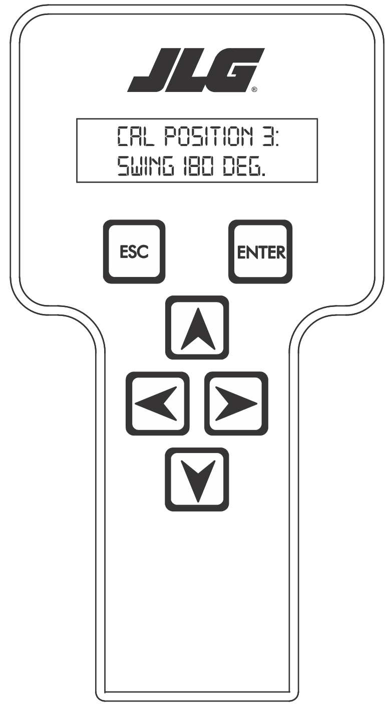


Figure 6-15. Boom Sensor Calibration Position 2

The screen will read:



25. Swing 180 degrees (centered over opposite end of chassis) for Calibration Position 3.

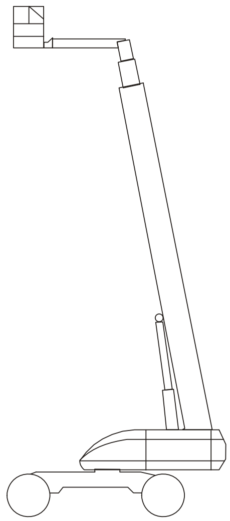
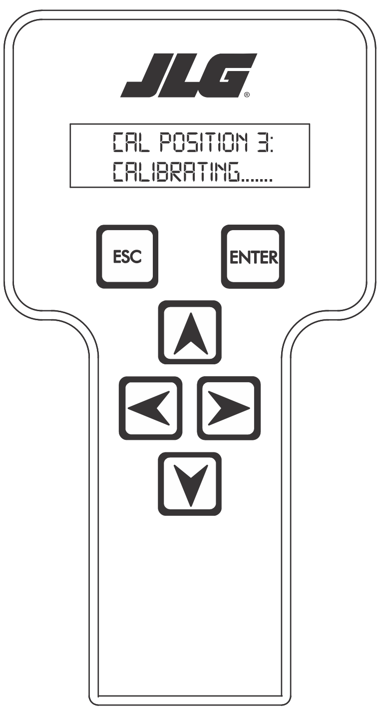
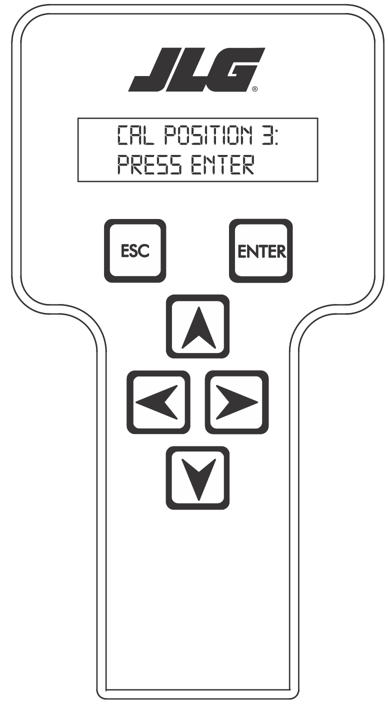


Figure 6-16. Boom Sensor Calibration Position 3

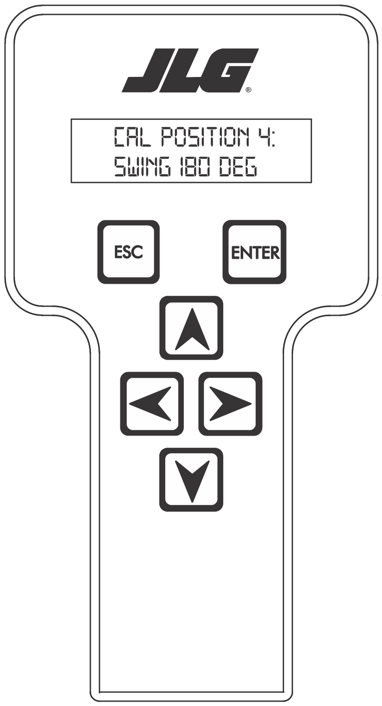
When the machine is in the proper position, hit Enter. The screen will read:



When Position 3 calibrating is complete the screen will read:



26. Press Enter. The screen will read:



Swing the machine back 180 degrees (centered over original end of chassis) for Calibration Position 4.

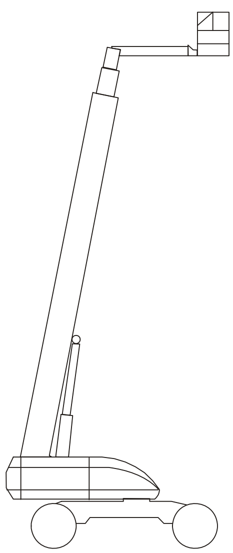
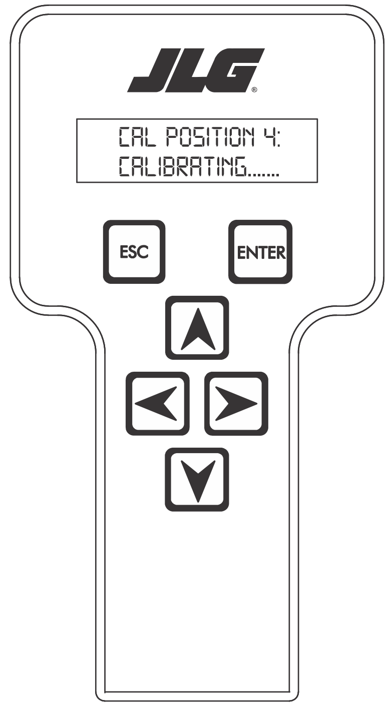
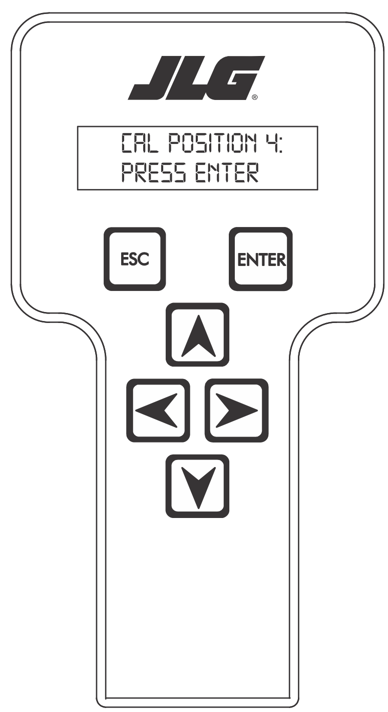


Figure 6-17. Boom Sensor Calibration Position 4

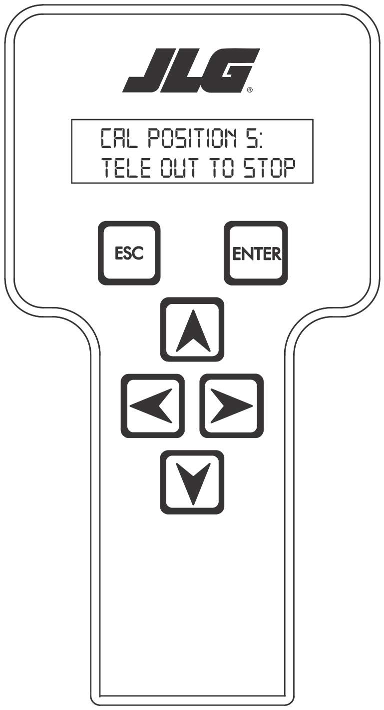
When the machine is in the proper position, hit Enter. The screen will read:



When Position 4 calibrating is complete, the screen will read:



27. Press Enter. The screen will read:



Telescope out to stop (boom must be fully extended) for Calibration Position 5.

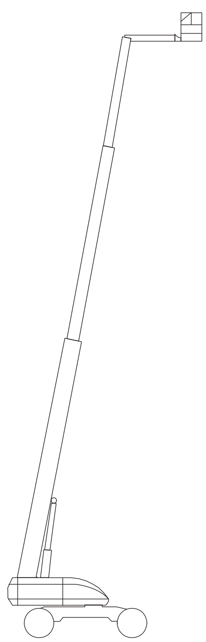
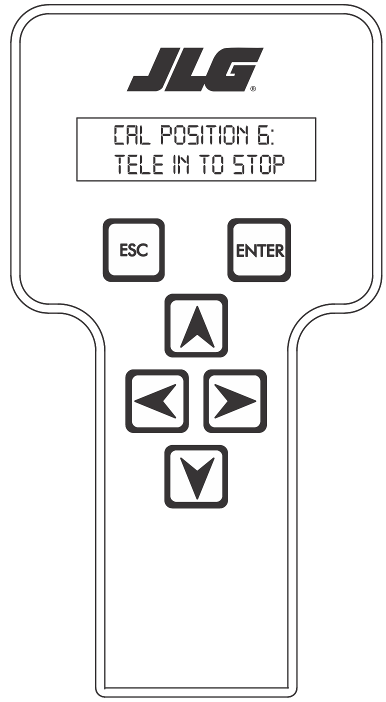


Figure 6-18. Boom Sensor Calibration Position 5

When the machine is in the proper position, hit Enter. The screen will read:



28. Retract to stop (boom must be fully retracted) for Calibration Position 6.

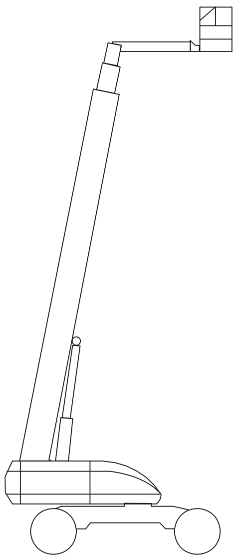
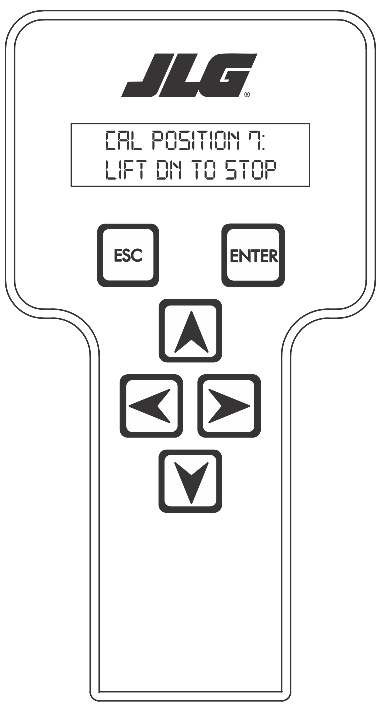


Figure 6-19. Boom Sensor Calibration Position 6

When the machine is in the proper position, hit Enter. The screen will read:



29. Lift down to stop (boom must be on boom rest) for Calibration Position 7.

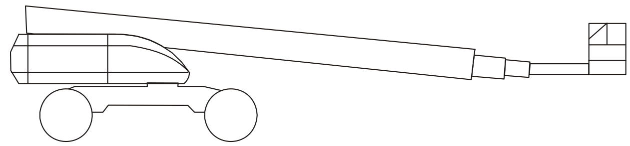
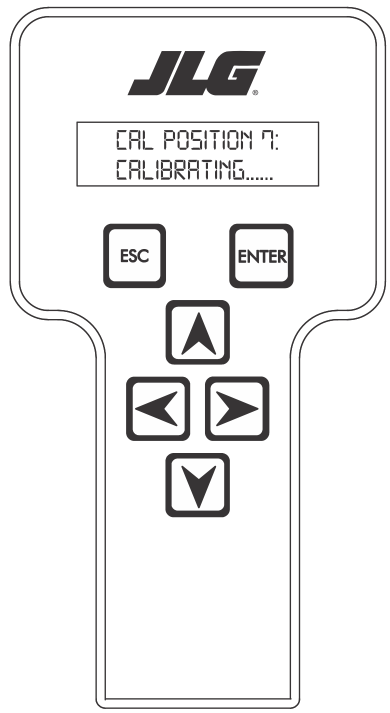
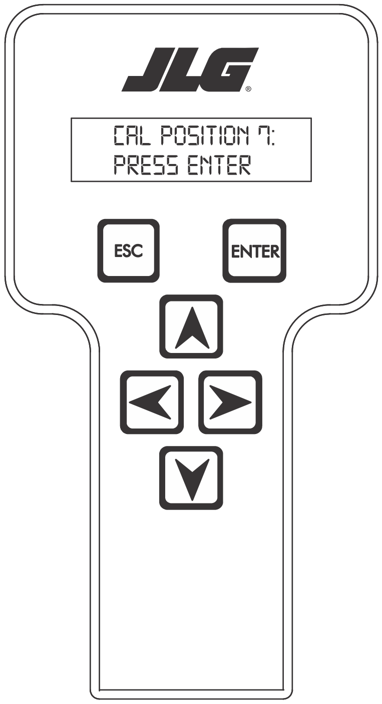


Figure 6-20. Boom Sensor Calibration Position 7

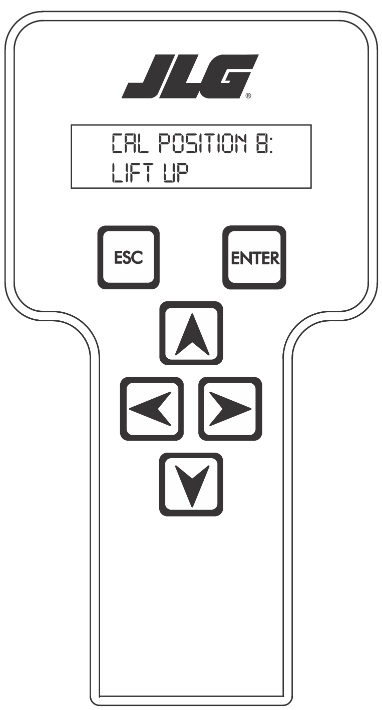
When the machine is in the proper position, hit Enter. The screen will read as follows:



When Position 7 Calibrating is complete, the screen will read:



Press Enter. The screen will read:



30. Lift until the function stops (controller will stop at 5 degrees above horizontal) for Calibration Position 8.

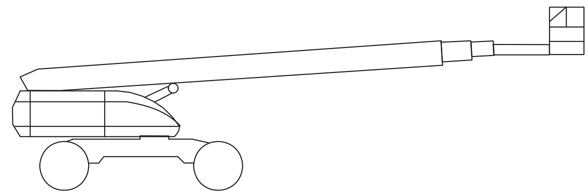
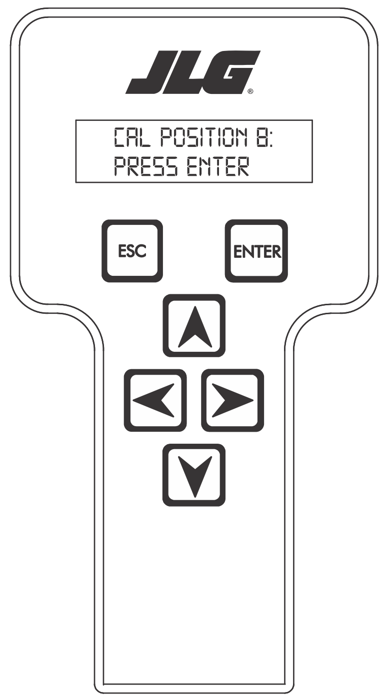
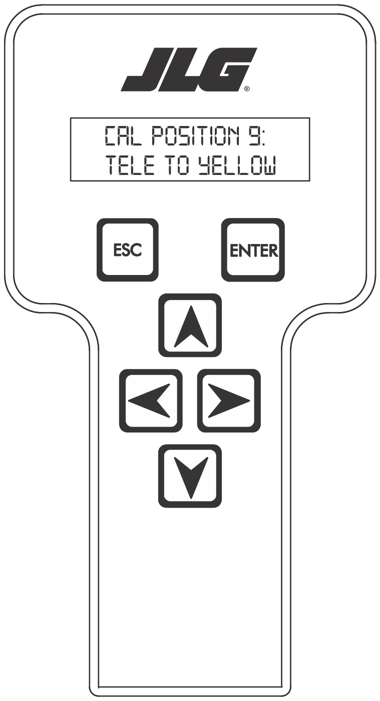


Figure 6-21. Boom Sensor Calibration Position 8

When the machine is in the proper position, hit Enter. The screen will read:



Press Enter. The screen will read:



31. Telescope to the yellow witness mark (controller will be close - operator must position the pointer to center line on decal within 0.25" [6 mm]) for Calibration Position 9.

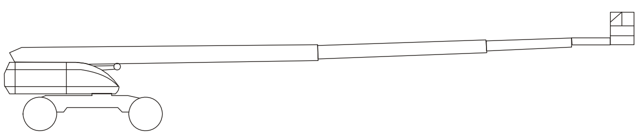
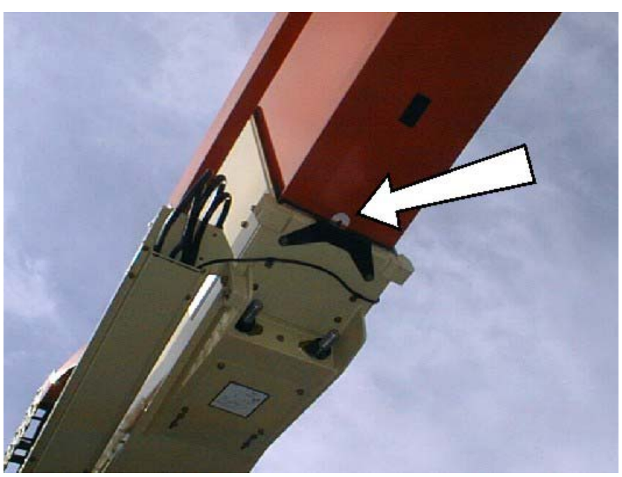
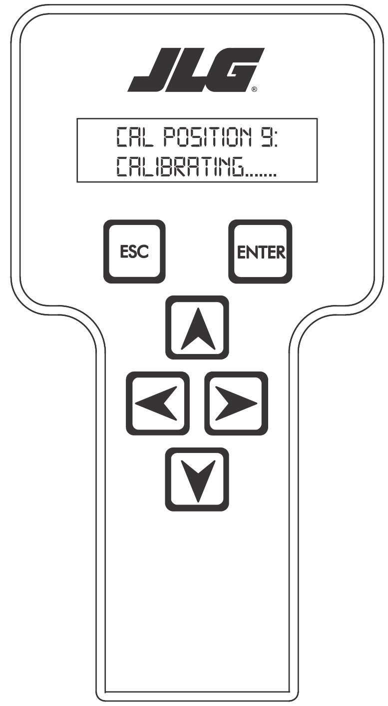


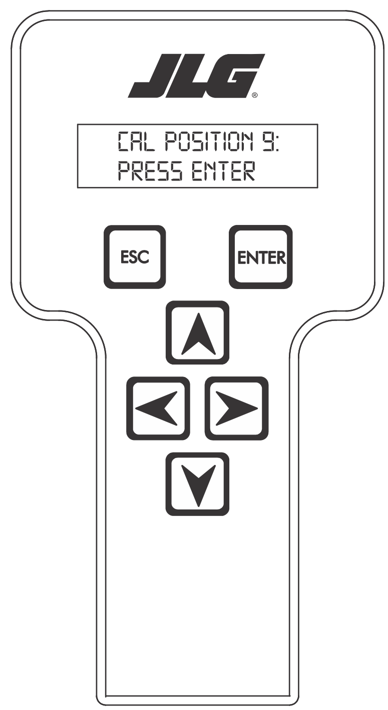
Figure 6-22. Boom Sensor Calibration Position 9



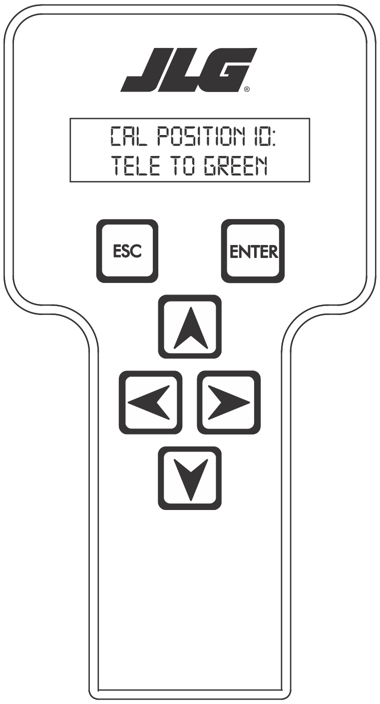
When the boom is in the proper position, hit Enter. The screen will read:



When Position 9 calibrating is complete, the screen will read:



Press Enter. The screen will read:



32. Telescope in to green witness mark (controller will find the position - operator must visually verify the position).

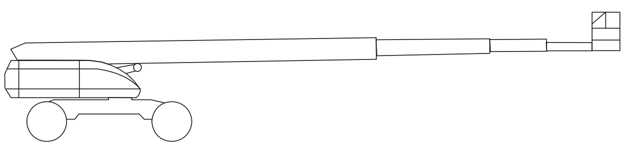
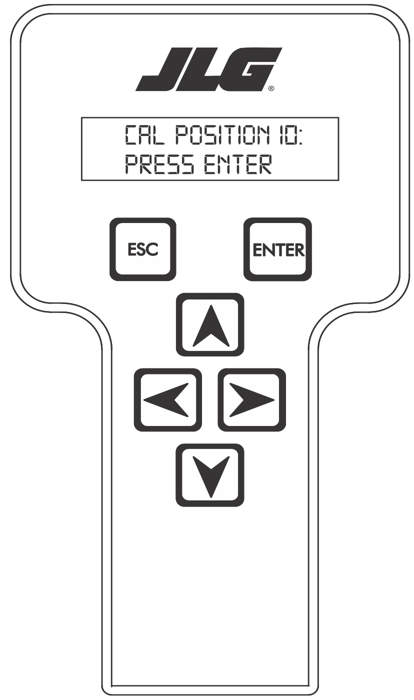
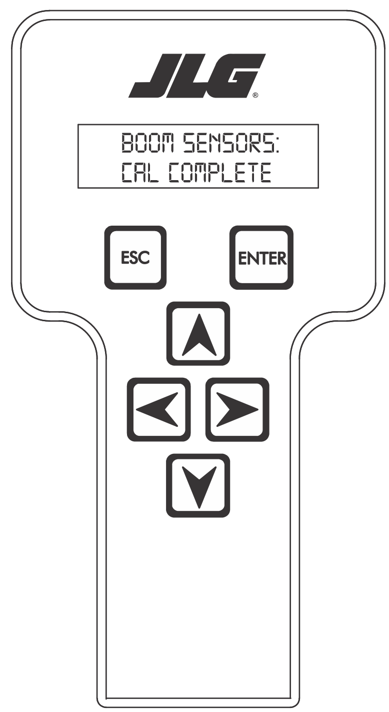


Figure 6-23. Boom Sensor Calibration Position 10

When the boom is in the proper position, the screen will read:



Press Enter. The screen will read:



33. After completing all the Boom Sensors Calibrations, hit ESC twice to go back to Calibrations.

34. Cycle the emergency stop switch.

Boom Control System Check Procedure

Perform the following check with no load (personnel or material) in the platform from the ground control station.

1. With the boom fully retracted, raise the boom off the boom rest to horizontal.
2. Position the jib horizontal, jib straight, and platform level.
3. Extend the boom until it stops.
4. Boom must stop on colored stripe matching the capacity indicator. If the boom does not stop on the correct stripe, the system must be repaired by JLG authorized Service Personnel before the machine can be used.
5. Push and hold the gray Boom Control System Test Button on the ground control panel. The lighting of the green Boom Control System Calibrated indicator indicates the system is functioning properly. No indicator light or the lighting of the red Boom Control System Warning indicator indicates the system must be repaired by JLG authorized Service Personnel before the machine can be used.

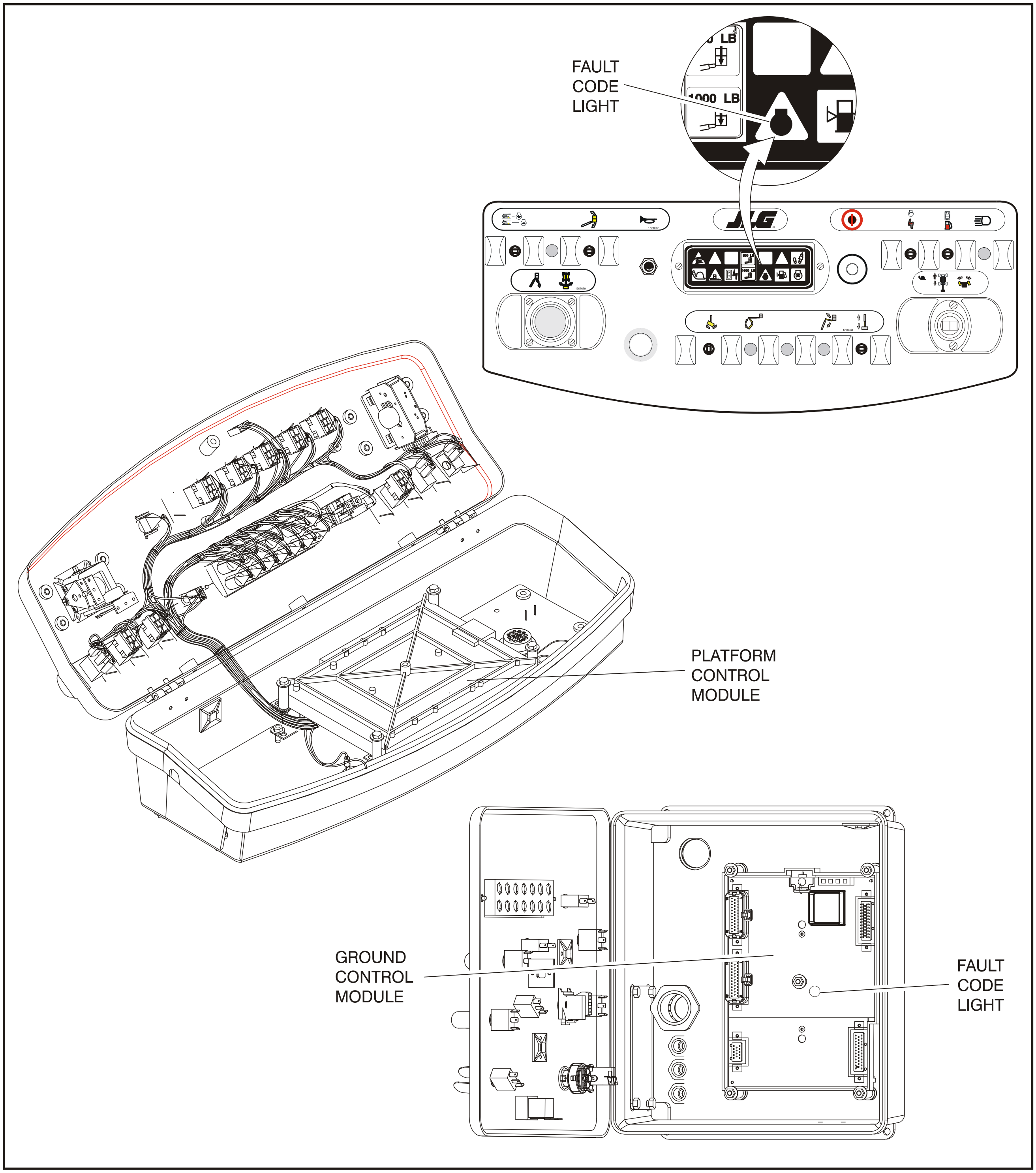


Figure 6-24. Fault Code Light Location

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
001	00	1	EVERYTHING OK	The normal help message in Platform Mode.	
002	00	2	GROUND MODE OK	The normal help message in Ground Mode.	
0010	00	10	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION	Drive speed is limited to "ELEVATED MAX" while the vehicle is out of transport position.	
000	**00**	**0**	**<<< HELP COMMENT >>>**		
0011	00	11	FSW OPEN	A drive / boom function was selected with the Footswitch open.	
0012	00	12	RUNNING AT CREEP - CREEP SWITCH OPEN	All functions at creep while the Creep Switch is open.	
0013	00	13	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	All functions at creep while the Platform is elevated and the Chassis is tilted.	
0014	00	14	CHASSIS TILT SENSOR OUT OF RANGE	The Chassis is tilted > 19 degrees for more then 4 seconds.	- Not reported during power-up.
0015	00	15	LOAD SENSOR READING UNDER WEIGHT	The Load Sensing System indicates > 20% under calibrated zero point.	- Not reported during power-up. - May occur if the Platform is resting on the ground.
0016	00	16	ENVELOPE ENCROACHED - HYDRAULICS SUSPENDED	There is an envelope violation.	- Envelope control system equipped vehicle only.
0017	00	17	OVER MOMENT - HYDRAULICS SUSPENDED	There is an over moment violation.	- Envelope control system equipped vehicle only.
0018	00	18	UNDER MOMENT - HYDRAULICS SUSPENDED	There is an under moment violation.	- Envelope control system equipped vehicle only.
0019	00	19	MAIN ENVELOPE ENCROACHED - HYDRAULICS SUSPENDED	There is a main envelope violation.	- Main envelope system equipped vehicle only.
0020	00	20	TOWER ENVELOPE ENCROACHED - HYDRAULICS SUSPENDED	There is a tower envelope violation.	- Tower envelope system equipped vehicle only.
210	**21**	**0**	**<<< POWER-UP >>>**		
211	21	1	POWER CYCLE	The normal help message is issued at each power cycle.	
212	21	2	KEYSWITCH FAULTY	Both Platform and Ground modes are selected simultaneously.	
213	21	3	FSW FAULTY	Both Footswitches are closed for more then one second.	
220	**22**	**0**	**<<< PLATFORM CONTROLS >>>**		
227	22	7	STEER SWITCHES FAULTY	Both Steer Left and Steer Right inputs are closed simultaneously.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
2211	22	11	FSW INTERLOCK TRIPPED	The Footswitch was closed for more then seven seconds.	- Can be reported during power-up.
2212	22	12	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A drive function was selected with Footswitch open.	- Can be reported during power-up.
2213	22	13	STEER LOCKED - SELECTED BEFORE FOOTSWITCH	A steer function was selected with Footswitch open.	
2215	22	15	D/S JOY. OUT OF RANGE LOW	The D/S Joystick reference voltage is low.	- Resistive joysticks, these faults do not occur.
2216	22	16	D/S JOY. OUT OF RANGE HIGH	The D/S Joystick reference voltage is > 8.1V.	- Resistive joysticks. - If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2217	22	17	D/S JOY. CENTER TAP BAD	The D/S Joystick center tap voltage is < 3.08V or > 3.83V.	- Resistive joysticks. - There is a +/- .1V range. around these values due to resistor tolerances
2218	22	18	L/S JOY. OUT OF RANGE LOW	The L/S Joystick reference voltage is low.	- Resistive joysticks, these faults do not occur.
2219	22	19	L/S JOY. OUT OF RANGE HIGH	The L/S Joystick reference voltage is > 8.1V.	- Resistive joysticks. - If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2220	22	20	L/S JOY. CENTER TAP BAD	The L/S Joystick center tap voltage is < 3.08V or > 3.83V.	- Resistive joysticks. - There is a +/- .1V range. around these values due to resistor tolerances
2221	22	21	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A lift / swing function was selected with Footswitch open.	
2222	22	22	WAITING FOR FSW TO BE OPEN	The Footswitch was closed during Platform selection.	- Can be reported during power-up.
2223	22	23	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE	A boom function was selected with Footswitch open.	
2224	22	24	FOOTSWITCH SELECTED BEFORE START	The Footswitch was closed during engine start.	
230	**23**	**0**	**<<< GROUND CONTROLS >>>**		
234	23	4	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	A boom function has both directions selected together.	
235	23	5	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER	A boom function was selected before aux power.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
236	23	6	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH	A boom function was selected before engine start.	
237	23	7	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH	The Start Switch was closed during power-up.	
250	**25**	**0**	**<<< FUNCTION PREVENTED >>>**		
259	25	9	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS	The model selection has been changed.	
2513	25	13	GENERATOR MOTION CUTOUT ACTIVE	Driving is not possible while the vehicle generator is running AND is configured to prevent drive.	
2514	25	14	BOOM PREVENTED - DRIVE SELECTED	Boom functions are not possible while the vehicle is being driven AND is configured to not allow simultaneous drive & boom operation.	
2515	25	15	DRIVE PREVENTED - BOOM SELECTED	Driving is not possible while the vehicle above elevation AND is configured to prevent drive while above elevation.	
2516	25	16	DRIVE PREVENTED - ABOVE ELEVATION	Driving is not possible while Boom functions are selected AND is configured to not allow simultaneous drive & boom operation.	
2517	25	17	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	Driving is not possible while the vehicle is tilted and above elevation AND is configured to prevent drive while tilted and above elevation.	
2521	25	21	JIB SWING PREVENTED - IN 1000# MODE	JIB Swing is not possible while the vehicle is in 1000 LB Mode.	
2522	25	22	CAN DONGLE ATTACHED - HYDRAULICS NOT RESTRICTED	CAN Dongle attached. Very limited restrictions for all hydraulics systems.	
2523	25	23	BACKUP BLAM COMMUNICATIONS ACTIVE	RS232 serial backup communications link to the BLAM is active.	
2524	25	24	DISCONNECT ANALYZER AND CYCLE EMS TO PERFORM BOOM RETRIEVAL	RS232 serial backup communications link to the BLAM is needed but an analyzer is connected.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
330	**33**	**0**	**<<< GROUND OUTPUT DRIVER >>>**		
331	33	1	BRAKE - SHORT TO BATTERY	There is a Short to Battery to the Brake Valve.	
332	33	2	BRAKE - OPEN CIRCUIT	There is an Open Circuit to the Brake Valve.	
3311	33	11	GROUND ALARM - SHORT TO BATTERY	There is a Short to Battery to the Ground Alarm.	- Ground Alarm equipped vehicles only.
3316	33	16	RIGHT FORWARD DRIVE PUMP - SHORT TO GROUND	There is a Short to Ground to the Right Forward Drive Valve.	- Chassis Module equipped vehicles only.
3317	33	17	RIGHT FORWARD DRIVE PUMP - OPEN CIRCUIT	There is an Open Circuit to the Right Forward Drive Valve.	- Chassis Module equipped vehicles only.
3318	33	18	RIGHT FORWARD DRIVE PUMP - SHORT TO BATTERY	There is a Short to Battery to the Right Forward Drive Valve.	- Chassis Module equipped vehicles only.
3320	33	20	RIGHT REVERSE DRIVE PUMP - SHORT TO GROUND	There is a Short to Ground to the Right Reverse Drive Valve.	- Chassis Module equipped vehicles only.
3321	33	21	RIGHT REVERSE DRIVE PUMP - OPEN CIRCUIT	There is an Open Circuit to the Right Reverse Drive Valve.	- Chassis Module equipped vehicles only.
3322	33	22	RIGHT REVERSE DRIVE PUMP - SHORT TO BATTERY	There is a Short to Battery to the Right Reverse Drive Valve.	- Chassis Module equipped vehicles only.
3324	33	24	LEFT FORWARD DRIVE PUMP - SHORT TO GROUND	There is a Short to Ground to the Left Forward Drive Valve.	- Chassis Module equipped vehicles only.
3325	33	25	LEFT FORWARD DRIVE PUMP - OPEN CIRCUIT	There is an Open Circuit to the Left Forward Drive Valve.	- Chassis Module equipped vehicles only.
3326	33	26	LEFT FORWARD DRIVE PUMP - SHORT TO BATTERY	There is a Short to Battery to the Left Forward Drive Valve.	- Chassis Module equipped vehicles only.
3328	33	28	LEFT REVERSE DRIVE PUMP - SHORT TO GROUND	There is a Short to Ground to the Left Reverse Drive Valve.	- Chassis Module equipped vehicles only.
3329	33	29	LEFT REVERSE DRIVE PUMP - OPEN CIRCUIT	There is an Open Circuit to the Left Reverse Drive Valve.	- Chassis Module equipped vehicles only.
3330	33	30	LEFT REVERSE DRIVE PUMP - SHORT TO BATTERY	There is a Short to Battery to the Left Reverse Drive Valve.	- Chassis Module equipped vehicles only.
3336	33	36	ALTERNATOR/ECM POWER - SHORT TO GROUND	There is a Short to Ground to the Alternator/ECM.	
3338	33	38	ALTERNATOR POWER - OPEN CIRCUIT	There is an Open Circuit to the Alternator.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3339	33	39	ALTERNATOR POWER - SHORT TO BATTERY	There is a Short to Battery to the Alternator	
3340	33	40	AUX POWER - SHORT TO GROUND	There is a Short to Ground to the Auxiliary Power Pump Relay.	
3341	33	41	AUX POWER - OPEN CIRCUIT	There is an Open Circuit to the Auxiliary Power Pump Relay.	
3342	33	42	AUX POWER - SHORT TO BATTERY	There is a Short to Battery to the Auxiliary Power Pump Relay.	
3343	33	43	COLD START ADVANCE SOLENOID - SHORT TO GROUND	There is a Short to Ground to the Cold Start Advance Solenoid.	- CAT engines only.
3344	33	44	COLD START ADVANCE SOLENOID - OPEN CIRCUIT	There is an Open Circuit to the Cold Start Advance Solenoid.	- CAT engines only.
3345	33	45	COLD START ADVANCE SOLENOID - SHORT TO BATTERY	There is a Short to Battery to the Cold Start Advance Solenoid.	- CAT engines only.
3349	33	49	ELECTRIC PUMP - SHORT TO GROUND	There is a Short to Ground to the Pump Relay.	- CAT engines only.
3350	33	50	ELECTRIC PUMP - OPEN CIRCUIT	There is an Open Circuit to the Pump Relay.	- CAT engines only.
3351	33	51	ELECTRIC PUMP - SHORT TO BATTERY	There is a Short to Battery to the Pump Relay.	- CAT engines only.
3358	33	58	MAIN DUMP VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Dump Valve.	
3359	33	59	MAIN DUMP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Dump Valve.	
3360	33	60	MAIN DUMP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Dump Valve.	
3361	33	61	BRAKE - SHORT TO GROUND	There is a Short to Ground to the Brake Valve.	
3362	33	62	START SOLENOID - SHORT TO GROUND	There is a Short to Ground to the Start Relay.	- Diesel engines only.
3363	33	63	START SOLENOID - OPEN CIRCUIT	There is an Open Circuit to the Start Relay.	- Diesel engines only.
3364	33	64	START SOLENOID - SHORT TO BATTERY	There is a Short to Battery to the Start Relay.	- Diesel engines only.
3368	33	68	TWO SPEED VALVE - SHORT TO GROUND	There is a Short to Ground to the Two Speed Valve.	
3369	33	69	TWO SPEED VALVE - OPEN CIRCUIT	There is an Open Circuit to the Two Speed Valve.	
3370	33	70	TWO SPEED VALVE - SHORT TO BATTERY	There is a Short to Battery to the Two Speed Valve.	
3371	33	71	GROUND ALARM - SHORT TO GROUND	There is a Short to Ground to the Ground Alarm.	- Ground Alarm equipped vehicles only.

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3372	33	72	GROUND ALARM - OPEN CIRCUIT	There is an Open Circuit to the Ground Alarm.	- Ground Alarm equipped vehicles only.
3373	33	73	GEN SET/WELDER - SHORT TO GROUND	There is a Short to Ground to the Generator Relay.	- Generator / Welder equipped vehicles only.
3374	33	74	GEN SET/WELDER - OPEN CIRCUIT	There is an Open Circuit to the Generator Relay.	- Generator / Welder equipped vehicles only.
3375	33	75	GEN SET/WELDER - SHORT TO BATTERY	There is a Short to Battery to the Generator Relay.	- Generator / Welder equipped vehicles only.
3376	33	76	HEAD TAIL LIGHT - SHORT TO GROUND	There is a Short to Ground to the Head Light Relay.	- Head Light equipped vehicles only.
3377	33	77	HEAD TAIL LIGHT - OPEN CIRCUIT	There is an Open Circuit to the Head Light Relay.	- Head Light equipped vehicles only.
3378	33	78	HEAD TAIL LIGHT - SHORT TO BATTERY	There is a Short to Battery to the Head Light Relay.	- Head Light equipped vehicles only.
3379	33	79	HOUR METER - SHORT TO GROUND	There is a Short to Ground to the Hour Meter.	
3380	33	80	HOUR METER - OPEN CIRCUIT	There is an Open Circuit to the Hour Meter.	- Can be reported during power-up.
3381	33	81	HOUR METER - SHORT TO BATTERY	There is a Short to Battery to the Hour Meter.	
3385	33	85	PLATFORM LEVEL UP OVERRIDE VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Override Valve.	- Electronic leveling system equipped vehicles only.
3386	33	86	PLATFORM LEVEL UP OVERRIDE VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Up Override Valve.	- Electronic leveling system equipped vehicles only.
3387	33	87	PLATFORM LEVEL UP OVERRIDE VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Up Override Valve.	- Electronic leveling system equipped vehicles only.
3391	33	91	PLATFORM LEVEL DOWN OVERRIDE VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Down Override Valve.	- Electronic leveling system equipped vehicles only.
3392	33	92	PLATFORM LEVEL DOWN OVERRIDE VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Down Override Valve.	- Electronic leveling system equipped vehicles only.
3393	33	93	PLATFORM LEVEL DOWN OVERRIDE VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Down Override Valve.	- Electronic leveling system equipped vehicles only.
3394	33	94	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Left Valve.	
3395	33	95	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Left Valve.	
3396	33	96	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Left Valve.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3397	33	97	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Right Valve.	
3398	33	98	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Right Valve.	
3399	33	99	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Right Valve.	
33100	33	100	JIB LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Up Valve.	
33101	33	101	JIB LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Up Valve.	
33102	33	102	JIB LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Up Valve.	
33103	33	103	JIB LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Down Valve.	
33104	33	104	JIB LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Down Valve.	
33105	33	105	JIB LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Down Valve.	
33118	33	118	SWING RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Right Valve.	
33119	33	119	SWING RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Right Valve.	
33120	33	120	MAIN TELESCOPE IN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Telescope In Valve.	
33121	33	121	SWING RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Swing Right Valve.	
33122	33	122	SWING LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Left Valve.	
33123	33	123	MAIN TELESCOPE OUT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Telescope Out Valve.	
33130	33	130	THROTTLE ACTUATOR - SHORT TO GROUND	There is a Short to Ground to the Throttle Actuator.	
33131	33	131	THROTTLE ACTUATOR - OPEN CIRCUIT	There is an Open Circuit to the Throttle Actuator.	
33132	33	132	THROTTLE ACTUATOR - SHORT TO BATTERY	There is a Short to Battery to the Throttle Actuator.	
33133	33	133	PLATFORM CONTROL VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Control Valve.	- Electronic leveling system equipped vehicles only.
33134	33	134	PLATFORM CONTROL VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Control Valve.	- Electronic leveling system equipped vehicles only.

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33135	33	135	PLATFORM CONTROL VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Control Valve.	- Electronic leveling system equipped vehicles only.
33136	33	136	MAIN LIFT APU VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Lift APU Valve.	- 1250AJP only.
33137	33	137	MAIN LIFT APU VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Lift APU Valve.	- 1250AJP only.
33138	33	138	MAIN LIFT APU VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Lift APU Valve.	- 1250AJP only.
33139	33	139	MAIN LIFT PILOT - PRESSURE FAILURE	The Main Lift Pilot has a Pressure Failure.	- 1250AJP only.
33140	33	140	MAIN LIFT PILOT - NO PRESSURE	The Main Lift Pilot has No Pressure.	- 1250AJP only.
33141	33	141	MAIN LIFT PILOT - PRESSURE SWITCH FAILURE	The Main Lift Pilot has a Pressure Switch Failure.	- 1250AJP only.
33142	33	142	TOWER LIFT APU VALVE - STUCK OPEN	The Tower Lift APU Valve is Stuck Open	- 1250AJP only.
33143	33	143	TOWER LIFT ENABLE VALVE - STUCK OPEN	The Tower Lift Enable Valve is Stuck Open	- 1250AJP only.
33144	33	144	TOWER LIFT ENABLE VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift Enable Valve.	- 1250AJP only.
33145	33	145	TOWER LIFT ENABLE VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift Enable Valve.	- 1250AJP only.
33146	33	146	TOWER LIFT ENABLE VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift Enable Valve.	- 1250AJP only.
33147	33	147	TOWER TELESCOPE APU VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope APU Valve.	- 1250AJP only.
33148	33	148	TOWER TELESCOPE APU VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Telescope APU Valve.	- 1250AJP only.
33149	33	149	TOWER TELESCOPE APU VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope APU Valve.	- 1250AJP only.
33150	33	150	LIFT PILOT VALVE - SHORT TO GROUND	There is a Short to Ground to the Lift Pilot Valve.	- Gravity Lift Down equipped vehicles only.
33151	33	151	LIFT PILOT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Lift Pilot Valve.	- Gravity Lift Down equipped vehicles only.
33152	33	152	LIFT PILOT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Lift Pilot Valve.	- Gravity Lift Down equipped vehicles only.
33153	33	153	LIFT DOWN AUX VALVE - SHORT TO GROUND	There is a Short to Ground to the Lift Down Auxiliary Valve.	- Gravity Lift Down equipped vehicles only.

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33154	33	154	LIFT DOWN AUX VALVE - OPEN CIRCUIT	There is an Open Circuit to the Lift Down Auxiliary Valve.	- Gravity Lift Down equipped vehicles only.
33155	33	155	LIFT DOWN AUX VALVE - SHORT TO BATTERY	There is a Short to Battery to the Lift Down Auxiliary Valve.	- Gravity Lift Down equipped vehicles only.
33156	33	156	TOWER LIFT APU VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift APU Valve.	- 1250AJP only.
33157	33	157	TOWER LIFT APU VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift APU Valve.	- 1250AJP only.
33158	33	158	TOWER LIFT APU VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift APU Valve.	- 1250AJP only.
33159	33	159	MAIN LIFT ENABLE VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Lift Enable Valve.	- 1250AJP only.
33160	33	160	MAIN LIFT ENABLE VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Lift Enable Valve.	- 1250AJP only.
33161	33	161	MAIN LIFT ENABLE VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Lift Enable Valve.	- 1250AJP only.
33162	33	162	TOWER TELESCOPE APU VALVE - STUCK OPEN	The Tower Telescope APU Valve is Stuck Open	- 1250AJP only.
33163	33	163	TOWER TELESCOPE ENABLE VALVE - STUCK OPEN	The Tower Telescope Enable Valve is Stuck Open	- 1250AJP only.
33164	33	164	TOWER TELESCOPE ENABLE VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope APU Valve.	- 1250AJP only.
33165	33	165	TOWER TELESCOPE ENABLE VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Telescope APU Valve.	- 1250AJP only.
33166	33	166	TOWER TELESCOPE ENABLE VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope APU Valve.	- 1250AJP only.
33167	33	167	PVG ENABLE VALVE - SHORT TO GROUND	There is a Short to Ground to the PVG Valve.	- 1250AJP only.
33168	33	168	PVG ENABLE VALVE - OPEN CIRCUIT	There is an Open Circuit to the PVG Valve.	- 1250AJP only.
33169	33	169	PVG ENABLE VALVE - SHORT TO BATTERY	There is a Short to Battery to the PVG Valve.	- 1250AJP only.
33173	33	173	RESTRICTED TO TRANSPORT - AXLE LOCKOUT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Axle Lockout Valve.	
33174	33	174	RESTRICTED TO TRANSPORT - BRAKE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Brake.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33175	33	175	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Left Valve.	
33176	33	176	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Left Valve.	
33177	33	177	JIB ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Left Valve.	
33178	33	178	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Right Valve.	
33179	33	179	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Right Valve.	
33180	33	180	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Right Valve.	
33181	33	181	MAIN LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Lift Up Valve.	
33183	33	183	MAIN LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Lift Up Valve.	
33184	33	184	MAIN LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Lift Down Valve.	
33185	33	185	MAIN LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Lift Down Valve.	
33186	33	186	MAIN TELESCOPE OUT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope Out Valve.	
33188	33	188	MAIN TELESCOPE OUT VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope Out Valve.	
33189	33	189	MAIN TELESCOPE IN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope In Valve.	
33190	33	190	MAIN TELESCOPE IN VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope In Valve.	
33207	33	207	HORN - OPEN CIRCUIT	There is an Open Circuit to the Horn.	
33208	33	208	HORN - SHORT TO BATTERY	There is a Short to Battery to the Horn.	
33209	33	209	HORN - SHORT TO GROUND	There is a Short to Ground to the Horn.	
33279	33	279	GLOWPLUG - OPEN CIRCUIT	There is an Open Circuit to the Glow Plugs.	- Glowplugs equipped vehicles only.
33280	33	280	GLOWPLUG - SHORT TO BATTERY	There is a Short to Battery to the Glow Plugs.	- Glowplugs equipped vehicles only.
33281	33	281	GLOWPLUG - SHORT TO GROUND	There is a Short to Ground to the Glow Plugs.	- Glowplugs equipped vehicles only.
33295	33	295	SWING LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Left Valve.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33306	33	306	SWING LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Swing Left Valve.	
33307	33	307	MAIN TELESCOPE FLOW CONTROL VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope Flow Control Valve.	
33308	33	308	MAIN TELESCOPE FLOW CONTROL VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope Flow Control Valve.	
33309	33	309	MAIN TELESCOPE FLOW CONTROL VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Telescope Flow Control Valve.	
33310	33	310	MAIN LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Lift Down Valve.	
33311	33	311	MAIN LIFT FLOW CONTROL VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Lift Flow Control Valve.	
33312	33	312	MAIN LIFT FLOW CONTROL VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Lift Flow Control Valve.	
33313	33	313	MAIN LIFT FLOW CONTROL VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Lift Flow Control Valve.	
33329	33	329	MAIN LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Lift Up Valve.	
340	**34**	**0**	**<<< PLATFORM OUTPUT DRIVER >>>**		
343	34	3	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Valve.	
344	34	4	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Up Valve.	- Electronic leveling system equipped vehicles only.
347	34	7	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Down Valve.	
348	34	8	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Down Valve.	- Electronic leveling system equipped vehicles only.
430	**43**	**0**	**<<< ENGINE >>>**		
431	43	1	FUEL SENSOR SHORT TO BATTERY	The Fuel Sensor reading is > 4.3V.	
432	43	2	FUEL SENSOR SHORT TO GROUND	The Fuel Sensor reading is < 0.2V.	
433	43	3	OIL PRESSURE SHORT TO BATTERY	The Oil Pressure Sensor reading is > 6.6V.	- Deutz engine only.

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
434	43	4	OIL PRESSURE SHORT TO GROUND	The Oil Pressure Sensor reading is < 0.1V for more then 5 seconds.	- Deutz engine only. - Not reported during engine start.
435	43	5	COOLANT TEMPERATURE SHORT TO GROUND	The Coolant Temperature Sensor reading is < 0.1V.	- Deutz engine only.
437	43	7	ENGINE TROUBLE CODE	Displays engine SPN FMI code.	
438	43	8	HIGH ENGINE TEMP	(Ford engine only) The engine temperature is > 117 C. (Deutz engine only) The engine temperature is > 130 C.	- Ford / Deutz engine only.
439	43	9	AIR FILTER BYPASSED	The Air Filter is clogged.	
4310	43	10	NO ALTERNATOR OUTPUT	Battery voltage is < 11.5 volts for more then 15 seconds after engine start.	
4311	43	11	LOW OIL PRESSURE	(Ford engine only) The ECM has reported a low oil pressure fault. (Deutz engine only) Oil pressure is < 8 PSI for more then 10 seconds after engine start.	- Ford / Deutz engine only.
4313	43	13	THROTTLE ACTUATOR FAILURE	The engine RPM is > XXX for more then XX seconds.	
4314	43	14	WRONG ENGINE SELECTED - ECM DETECTED	A ECM was detected with a non-ECM type engine selected.	
4322	43	22	LOSS OF ENGINE SPEED SENSOR	The engine RPM sensor indicates 0 RPM AND the Oil Pressure Sensor indicates > 8 PSI for three seconds.	- Diesel engine only.
4323	43	23	SPEED SENSOR READING INVALID SPEED	The engine RPM sensor indicates > 4000 RPM.	- Diesel engine only.
440	**44**	**0**	**<<< BATTERY SUPPLY >>>**		
441	44	1	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN	Battery voltage is < 9V.	
442	44	2	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN	Battery voltage is > 16V.	
445	44	5	BATTERY VOLTAGE LOW	Battery voltage is < 11V for more then 5 seconds.	
450	**45**	**0**	**<<< CAN CONTROLLED VALVES >>>**		
451	45	1	MAIN LIFT PVG VALVE - INTERNAL FAULT	The Main Lift PVG Valve has an internal fault.	- 1250AJP only.
452	45	2	TOWER LIFT PVG VALVE - INTERNAL FAULT	The Tower Lift PVG Valve has an internal fault.	- 1250AJP only.
453	45	3	TOWER TELESCOPE PVG VALVE - INTERNAL FAULT	The Tower Telescope PVG Valve has an internal fault.	- 1250AJP only.

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
454	45	4	MAIN LIFT PVG VALVE - HIGH VOLTAGE	The Main Lift PVG Valve supply voltage is high.	- 1250AJP only.
455	45	5	TOWER LIFT PVG VALVE - HIGH VOLTAGE	The Tower Lift PVG Valve supply voltage is high.	- 1250AJP only.
456	45	6	TOWER TELESCOPE PVG VALVE - HIGH VOLTAGE	The Tower Telescope PVG Valve supply voltage is high.	- 1250AJP only.
457	45	7	MAIN LIFT PVG VALVE - LOW VOLTAGE	The Main Lift PVG Valve supply voltage is low.	- 1250AJP only.
458	45	8	TOWER LIFT PVG VALVE - LOW VOLTAGE	The Tower Lift PVG Valve supply voltage is low.	- 1250AJP only.
459	45	9	TOWER TELESCOPE PVG VALVE - LOW VOLTAGE	The Tower Telescope PVG Valve supply voltage is low.	- 1250AJP only.
4510	45	10	MAIN LIFT PVG VALVE - STUCK NEUTRAL	The Main Lift PVG Valve is stuck in its neutral position.	- 1250AJP only.
4511	45	11	TOWER LIFT PVG VALVE - STUCK NEUTRAL	The Tower Lift PVG Valve is stuck in its neutral position.	- 1250AJP only.
4512	45	12	TOWER TELESCOPE PVG VALVE - STUCK NEUTRAL	The Tower Telescope PVG Valve is stuck in its neutral position.	- 1250AJP only.
4513	45	13	MAIN LIFT PVG VALVE - STUCK EXTENDED	The Main Lift PVG Valve is stuck in its extended position.	- 1250AJP only.
4514	45	14	TOWER LIFT PVG VALVE - STUCK EXTENDED	The Tower Lift PVG Valve is stuck in its extended position.	- 1250AJP only.
4515	45	15	TOWER TELESCOPE PVG VALVE - STUCK EXTENDED	The Tower Telescope PVG Valve is stuck in its extended position.	- 1250AJP only.
4516	45	16	MAIN LIFT PVG VALVE - STUCK RETRACTED	The Main Lift PVG Valve is stuck in its retracted position.	- 1250AJP only.
4517	45	17	TOWER LIFT PVG VALVE - STUCK RETRACTED	The Tower Lift PVG Valve is stuck in its retracted position.	- 1250AJP only.
4518	45	18	TOWER TELESCOPE PVG VALVE - STUCK RETRACTED	The Tower Telescope PVG Valve is stuck in its retracted position.	- 1250AJP only.
4519	45	19	MAIN LIFT PVG VALVE - OBSTRUCTED	The Main Lift PVG Valve is obstructed	- 1250AJP only.
4520	45	20	TOWER LIFT PVG VALVE - OBSTRUCTED	The Tower Lift PVG Valve is obstructed	- 1250AJP only.
4521	45	21	TOWER TELESCOPE PVG VALVE - OBSTRUCTED	The Tower Telescope PVG Valve is obstructed	- 1250AJP only.
4522	45	22	MAIN LIFT PVG VALVE - COMMAND IMPROPER	The Main Lift PVG Valve command is improper.	- 1250AJP only.
4523	45	23	TOWER LIFT PVG VALVE - COMMAND IMPROPER	The Tower Lift PVG Valve command is improper.	- 1250AJP only.

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
4524	45	24	TOWER TELESCOPE PVG VALVE - COMMAND IMPROPER	The Tower Telescope PVG Valve command is improper.	- 1250AJP only.
4525	45	25	MAIN LIFT PVG VALVE - TIMEOUT	The Main Lift PVG Valve has timed out.	- 1250AJP only.
4526	45	26	TOWER LIFT PVG VALVE - TIMEOUT	The Tower Lift PVG Valve has timed out.	- 1250AJP only.
4527	45	27	TOWER TELESCOPE PVG VALVE - TIMEOUT	The Tower Telescope PVG Valve has timed out.	- 1250AJP only.
4528	45	28	MAIN LIFT PVG VALVE - SETUP FAULT	The Main Lift PVG Valve has a setup fault.	- 1250AJP only.
4529	45	29	TOWER LIFT PVG VALVE - SETUP FAULT	The Tower Lift PVG Valve has a setup fault.	- 1250AJP only.
4530	45	30	TOWER TELESCOPE PVG VALVE - SETUP FAULT	The Tower Telescope PVG Valve has a setup fault.	- 1250AJP only.
4531	45	31	MAIN LIFT PVG VALVE - SENT UNRECOGNIZED FAULT	The Main Lift PVG Valve has an unrecognized fault.	- 1250AJP only.
4532	45	32	TOWER LIFT PVG VALVE - SENT UNRECOGNIZED FAULT	The Tower Lift PVG Valve has an unrecognized fault.	- 1250AJP only.
4533	45	33	TOWER TELESCOPE PVG VALVE - SENT UNRECOGNIZED FAULT	The Tower Telescope PVG Valve has an unrecognized fault.	- 1250AJP only.
4534	45	34	MAIN LIFT PVG VALVE - PARAMETERS INCORRECT	The Main Lift PVG Valve parameters are incorrect.	- 1250AJP only.
4535	45	35	TOWER LIFT PVG VALVE - PARAMETERS INCORRECT	The Tower Lift PVG Valve parameters are incorrect.	- 1250AJP only.
4536	45	36	TOWER TELESCOPE PVG VALVE - PARAMETERS INCORRECT	The Tower Telescope PVG Valve parameters are incorrect.	- 1250AJP only.
4537	45	37	MAIN LIFT PVG VALVE - LOCATION IMPROPER	The Main Lift PVG Valve is in the wrong location.	- 1250AJP only.
4538	45	38	TOWER LIFT PVG VALVE - LOCATION IMPROPER	The Tower Lift PVG Valve is in the wrong location.	- 1250AJP only.
4539	45	39	TOWER TELESCOPE PVG VALVE - LOCATION IMPROPER	The Tower Telescope PVG Valve is in the wrong location.	- 1250AJP only.
4540	45	40	MAIN LIFT PVG VALVE - WIRING INCORRECT	The Main Lift PVG Valve has incorrect wiring.	- 1250AJP only.
4541	45	41	TOWER LIFT PVG VALVE - WIRING INCORRECT	The Tower Lift PVG Valve has incorrect wiring.	- 1250AJP only.
4542	45	42	TOWER TELESCOPE PVG VALVE - WIRING INCORRECT	The Tower Telescope PVG Valve has incorrect wiring.	- 1250AJP only.
4543	45	43	MAIN LIFT PVG VALVE - SPOOL CANNOT REACH NEUTRAL	X	- 1250AJP only.
4544	45	44	TOWER LIFT PVG VALVE - SPOOL CANNOT REACH NEUTRAL	X	- 1250AJP only.
4545	45	45	TOWER TELESCOPE PVG VALVE - SPOOL CANNOT REACH NEUTRAL	X	- 1250AJP only.

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
660	**66**	**0**	**<<< COMMUNICATION >>>**		
662	66	2	CANBUS FAILURE - PLATFORM MODULE	Platform Module CAN communication lost.	
666	66	6	CANBUS FAILURE - ENGINE CONTROLLER	Engine Control Module CAN communication lost.	- ECM equipped engine only.
667	66	7	CANBUS FAILURE - MAIN LIFT PVG	Main Lift PVG CAN communication lost.	- 1250AJP only.
668	66	8	CANBUS FAILURE - TOWER LIFT PVG	Tower Lift PVG CAN communication lost.	- 1250AJP only.
669	66	9	CANBUS FAILURE - TOWER TELESCOPE PVG	Tower Telescope PVG CAN communication lost.	- 1250AJP only.
6610	66	10	CANBUS FAILURE - BLAM	BLAM CAN communication lost.	- BLAM equipped vehicles only.
6611	66	11	CANBUS FAILURE - CHASSIS MODULE	Engine Control Module CAN communication lost.	- ECM equipped engine only.
6612	66	12	CANBUS FAILURE - CYLINDER LOAD PIN	Cylinder Load Pin CAN communication lost.	- Cylinder Load Pin equipped engine only.
6613	66	13	CANBUS FAILURE - EXCESSIVE CANBUS ERRORS	There has been > 500 Bus Off errors or >500 Bus Passive Errors.	
6614	66	14	CANBUS FAILURE - MAIN ANGLE SENSOR #1	Angle Sensor #1 CAN communication lost.	- 1250AJP only.
6615	66	15	CANBUS FAILURE - MAIN ANGLE SENSOR #2	Angle Sensor #2 CAN communication lost.	- 1250AJP only.
6622	66	22	CANBUS FAILURE - TCU MODULE	Machine Setup/ Telematics=YES, No device heartbeat for 30 sec	
6623	66	23	CANBUS FAILURE - GATEWAY MODULE	Machine Setup/ Telematics=YES, No device heartbeat for 30 sec	
6629	66	29	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH	X	-Telematics only
680	**68**	**0**	**<<< TELEMATICS >>>**		
681	68	1	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP	X	-Telematics only
810	**81**	**0**	**<<< TILT SENSOR >>>**		
813	81	3	CHASSIS TILT SENSOR NOT CALIBRATED	The Chassis Tilt Sensor has not been calibrated.	
815	81	5	CHASSIS TILT SENSOR DISAGREEMENT	X	
820	**82**	**0**	**<<< PLATFORM LOAD SENSE >>>**		
825	82	5	LSS HAS NOT BEEN CALIBRATED	The Load Sensing System Module has not been calibrated.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
826	82	6	RUNNING AT CREEP - PLATFORM OVERLOADED	All functions at creep, the Load Sensing System indicates the Platform is overloaded AND is configured to warn only while the Platform is overloaded.	
827	82	7	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED	Driving and boom functions are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent drive and boom functions while the Platform is overloaded.	
828	82	8	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED	Lift up and telescope out are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent Lift up and telescope out while the Platform is overloaded.	
830	**83**	**0**	**<<< PLATFORM LEVELING >>>**		
831	83	1	PLATFORM LEVELING OVERRIDE ON	Platform Leveling forced on with Access Level 0 selection.	
832	83	2	PLATFORM LEVELING OVERRIDE OFF	Platform Leveling forced off with Access Level 0 selection.	
833	83	3	PLATFORM LEVEL UP CRACKPOINT - NOT CALIBRATED	The Platform Level Up Valve Crackpoint has not been calibrated.	- Electronic leveling system equipped vehicles only.
834	83	4	PLATFORM LEVEL DOWN CRACKPOINT - NOT CALIBRATED	The Platform Level Down Valve Crackpoint has not been calibrated.	- Electronic leveling system equipped vehicles only.
837	83	7	PLATFORM LEVEL SENSOR #1 - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Sensor #1.	- Electronic leveling system equipped vehicles only.
838	83	8	PLATFORM LEVEL SENSOR #1 - SHORT TO GROUND OR OPEN CIRCUIT	There is a Short to Ground or an Open Circuit to the Platform Level Sensor #1.	- Electronic leveling system equipped vehicles only.
8311	83	11	PLATFORM LEVEL SENSOR #2 - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Sensor #2.	- Electronic leveling system equipped vehicles only.
8312	83	12	PLATFORM LEVEL SENSOR #2 - SHORT TO GROUND OR OPEN CIRCUIT	There is a Short to Ground or an Open Circuit to the Platform Level Sensor #2.	- Electronic leveling system equipped vehicles only.

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
8313	83	13	PLATFORM LEVEL SENSOR #1 - REFERENCE VOLTAGE OUT OF RANGE	Platform Level Sensor #1 reverence voltage is outside acceptable range (4.9 to 5.1 volts).	- Electronic leveling system equipped vehicles only.
8314	83	14	PLATFORM LEVEL SENSOR #2 - REFERENCE VOLTAGE OUT OF RANGE	Platform Level Sensor #2 reverence voltage is outside acceptable range (4.9 to 5.1 volts).	- Electronic leveling system equipped vehicles only.
8315	83	15	PLATFORM LEVELING SENSOR - DISAGREEMENT	The Control System reads the sensor values at power-up. The fault is triggered when there is a ± 5 degree difference from the initial reading.	- Electronic leveling system equipped vehicles only.
8316	83	16	PLATFORM LEVEL SENSOR #1 - COMMUNICATIONS LOST	Platform Level Sensor #1 serial communication lost.	- 1200S and 1350S only.
8317	83	17	PLATFORM LEVEL SENSOR #2 - COMMUNICATIONS LOST	Platform Level Sensor #2 serial communication lost.	- 1200S and 1350S only.
8318	83	18	PLATFORM LEVELING SYSTEM TIMEOUT	The Platform was unable to maintain desired level within range for the allotted time.	
840	**84**	**0**	**<<< ENVELOPE >>>**		
841	84	1	BOOM ANGLE SENSOR DISAGREEMENT	There is a disagreement between the Boom Angle Sensors.	- Envelope Control equipped vehicles only.
842	84	2	BOOM LENGTH SWITCH FAILED	The Boom Length Switches are reporting the same state.	- Envelope Control equipped vehicles only.
843	84	3	BOOM LENGTH SWITCH/SENSOR DISAGREEMENT	There is a disagreement between the Boom Length Switch and the Boom Length Sensor.	- Envelope Control equipped vehicles only.
844	84	4	BOOM LENGTH SENSOR NOT DETECTING LENGTH CHANGE	The Boom Length Sensor is not changing during a boom telescope command.	- Envelope Control equipped vehicles only.
845	84	5	BOOM LENGTH SENSOR - OUT OF RANGE HIGH	Boom Length Sensor out of range high.	- Envelope Control equipped vehicles only. -1200/1350 only
846	84	6	BOOM LENGTH SENSOR - OUT OF RANGE LOW	Boom Length Sensor out of range low.	- Envelope Control equipped vehicles only. -1200/1350 only
847	84	7	BOOM LENGTH SENSOR - VALUE OUT OF RANGE HIGH	Boom Length out of range high.	- Envelope Control equipped vehicles only. -1200/1350 only
848	84	8	BOOM LENGTH SENSOR - VALUE OUT OF RANGE LOW	Boom Length out of range low.	- Envelope Control equipped vehicles only. -1200/1350 only

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
849	84	9	BOOM ANGLE SENSOR #1 - COMMUNICATIONS FAULT	Boom Angle Sensor #1 communications lost.	- Envelope Control equipped vehicles only.
8410	84	10	BOOM ANGLE SENSOR #2 - COMMUNICATIONS FAULT	Boom Angle Sensor #2 communications lost.	- Envelope Control equipped vehicles only.
8411	84	11	BOOM ANGLE SENSOR #1 - INVALID ANGLE	Boom Angle Sensor #1 out of range.	- Envelope Control equipped vehicles only.
8412	84	12	BOOM ANGLE SENSOR #2 - INVALID ANGLE	Boom Angle Sensor #2 out of range.	- Envelope Control equipped vehicles only.
8413	84	13	WRONG TELESCOPE RESPONSE	Boom telescope is moving in the opposite direction of the command.	- Envelope Control equipped vehicles only.
8414	84	14	WRONG LIFT RESPONSE	Boom lift is moving in the opposite direction of the command.	- Envelope Control equipped vehicles only.
8415	84	15	TOWER ANGLE SENSOR DISAGREEMENT	There is a disagreement between the Tower Angle Sensors.	- Envelope Control equipped vehicles only. -1250
8416	84	16	TOWER LENGTH SENSOR DISAGREEMENT	There is a disagreement between the Tower Length Sensors.	- Envelope Control equipped vehicles only. -1250
8417	84	17	MAIN ANGLE SENSOR DISAGREEMENT	There is a disagreement between the Main Boom Angle Sensors.	- Envelope Control equipped vehicles only. -1250
8418	84	18	TOWER LENGTH SENSOR #1 - OUT OF RANGE HIGH	Tower Boom Angle Sensor #1 out of range high.	- Envelope Control equipped vehicles only. -1250
8419	84	19	TOWER LENGTH SENSOR #1 - OUT OF RANGE LOW	Tower Boom Angle Sensor #1 out of range low.	- Envelope Control equipped vehicles only. -1250
8420	84	20	TOWER LENGTH SENSOR #2 - OUT OF RANGE HIGH	Tower Boom Angle Sensor #2 out of range high.	- Envelope Control equipped vehicles only. -1250
8421	84	21	TOWER LENGTH SENSOR #2 - OUT OF RANGE LOW	Tower Boom Angle Sensor #2 out of range low.	- Envelope Control equipped vehicles only. -1250
8422	84	22	TOWER LENGTH SENSOR - NOT DETECTING LENGTH CHANGE	The Tower Length Sensor is not changing during a tower telescope command.	- Envelope Control equipped vehicles only. -1250
8423	84	23	TOWER LENGTH MOVEMENT WITHOUT COMMAND	The Tower Length Sensor is changing without a tower telescope command.	- Envelope Control equipped vehicles only. -1250
8424	84	24	TOWER LENGTH SENSOR #1 - OUT OF RANGE HIGH	Tower Boom Angle Sensor #1 out of range high.	- Envelope Control equipped vehicles only. -1250
8425	84	25	TOWER LENGTH SENSOR #1 - OUT OF RANGE LOW	Tower Boom Angle Sensor #1 out of range low.	- Envelope Control equipped vehicles only. -1250

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
8426	84	26	TOWER LENGTH SENSOR #2 - OUT OF RANGE HIGH	Tower Boom Angle Sensor #2 out of range high.	- Envelope Control equipped vehicles only. -1250
8427	84	27	TOWER LENGTH SENSOR #2 - OUT OF RANGE LOW	Tower Boom Angle Sensor #2 out of range low.	- Envelope Control equipped vehicles only. -1250
8428	84	28	TOWER ANGLE SENSOR #1 - INVALID ANGLE	Tower Boom Angle Sensor #1 out of range.	- Envelope Control equipped vehicles only. -1250
8429	84	29	TOWER ANGLE SENSOR #2 - INVALID ANGLE	Tower Boom Angle Sensor #2 out of range.	- Envelope Control equipped vehicles only. -1250
8430	84	30	TOWER ANGLE SENSOR #1 - INVALID MODEL	Wrong Tower Boom Angle Sensor #1 installed.	- Envelope Control equipped vehicles only. - 1250AJP Only - Must be a Rieker Sensor, not a Spectron Sensor.
8431	84	31	TOWER ANGLE SENSOR #2 - INVALID MODEL	Wrong Tower Boom Angle Sensor #2 installed.	- Envelope Control equipped vehicles only. - 1250AJP Only - Must be a Rieker Sensor, not a Spectron Sensor.
8432	84	32	MAIN ANGLE SENSOR #1 - INVALID ANGLE	Main Boom Angle Sensor #1 out of range.	- Envelope Control equipped vehicles only. -1250
8433	84	33	MAIN ANGLE SENSOR #2 - INVALID ANGLE	Main Boom Angle Sensor #2 out of range.	- Envelope Control equipped vehicles only. -1250
8434	84	34	MAIN ANGLE SENSOR - NOT DETECTING ANGLE CHANGE	The Main Boom Angle Sensor is not changing during a main lift command.	- Envelope Control equipped vehicles only. -1250
8435	84	35	MAIN ANGLE MOVEMENT WITHOUT CMD	The Main Boom Angle Sensor is changing without a main lift command.	- Envelope Control equipped vehicles only. -1250
8436	84	36	WRONG TOWER TELESCOPE RESPONSE	Tower telescope is moving in the opposite direction of the command.	- Envelope Control equipped vehicles only. -1250
8437	84	37	WRONG TOWER LIFT RESPONSE	Tower lift is moving in the opposite direction of the command.	- Envelope Control equipped vehicles only. -1250
8438	84	38	TOWER CYLINDER ANGLE SENSOR - OUT OF RANGE HIGH	The Tower Cylinder Angle Sensor is < 4721 A/D counts.	- Envelope Control equipped vehicles only. -1250
8439	84	39	TOWER CYLINDER ANGLE SENSOR - OUT OF RANGE LOW	The Tower Cylinder Angle Sensor is > 29535 A/D counts.	- Envelope Control equipped vehicles only. -1250
8440	84	40	TOWER CYLINDER ANGLE SENSOR - NOT DETECTING CHANGE	The Tower Cylinder Angle Sensor is not changing during a tower lift command.	- Envelope Control equipped vehicles only. -1250

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
8441	84	41	TOWER CYLINDER ANGLE MOVEMENT WITHOUT COMMAND	The Tower Cylinder Angle Sensor is changing without a tower lift command.	- Envelope Control equipped vehicles only. -1250
8442	84	42	MAIN TRANSPORT ANGLE SWITCH FAILED	The Main Boom Angle Switch is bad.	- Envelope Control equipped vehicles only. -1250
8443	84	43	TWR TRANSPORT SWITCH DISAGREEMENT	There is a disagreement between the Tower Boom Length Switch and the Tower Length Sensor.	- Envelope Control equipped vehicles only. -1250
8444	84	44	TRANSPORT DUAL CAPACITY SWITCHES BAD	Both the Dual Capacity Switch and the Transport Switch are bad.	- Envelope Control equipped vehicles only. -1250
8445	84	45	TRANSPORT DUAL CAPACITY BAD TRANSITION	The Dual Capacity Switch and the Transport Switch changed state out of order.	- Envelope Control equipped vehicles only. -1250
8446	84	46	MAIN TRANSPORT LENGTH SWITCH DISAGREEMENT	There is a disagreement between the Main Boom Transport Length Switches.	- Envelope Control equipped vehicles only. -1250
8447	84	47	MAIN DUAL CAPACITY LENGTH SWITCH DISAGREEMENT	There is a disagreement between the Main Boom Dual Capacity Length Switches.	- Envelope Control equipped vehicles only. -1250
8448	84	48	MAIN TRANSPORT ANGLE SWITCH/SENSOR DISAGREEMENT	There is a disagreement between the Main Boom Angle Switch and the Main Boom Angle Sensor.	- Envelope Control equipped vehicles only. -1250
8449	84	49	TOWER CYLINDER ANGLE SWITCH/SENSOR DISAGREEMENT	There is a disagreement between the Tower Boom Angle Switch and the Tower Cylinder Angle Sensor.	- Envelope Control equipped vehicles only. -1250
8450	84	50	NEW MAIN ANGLE SENSOR #1 DETECTED	A new Main Angle Sensor 1 has been detected.	-1250
8451	84	51	NEW MAIN ANGLE SENSOR #2 DETECTED	A new Main Angle Sensor 2 has been detected.	-1250
8452	84	52	TOWER LENGTH SWITCH/SENSOR DISAGREEMENT	There is a disagreement between the Tower Length Switch and the Tower Length Sensor.	- Envelope Control equipped vehicles only. -1250
8453	84	53	WRONG MAIN TELE RESPONSE	Main telescope is moving in the opposite direction of the command.	- Envelope Control equipped vehicles only. -1250
8454	84	54	WRONG MAIN LIFT RESPONSE	Main lift is moving in the opposite direction of the command.	- Envelope Control equipped vehicles only. -1250
8482	84	82	TOWER ENVELOPE MASSIVELY ENCROACHED	X	
8483	84	83	TOWER ENVELOPE MULTIPLE ENCROACHMENTS	X	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
8484	84	84	BCS VIOLATION - BOOM LOCKED	X	
8485	84	85	BCS - HYDRAULIC RETRIEVAL ACTIVE	X	
8486	84	86	BCS - ELECTRICAL RETRIEVAL ACTIVE	X	
8487	84	87	BCS - MULTIPLE FAILURES ACTIVE	X	
850	**85**	**0**	**<<< MOMENT / LOAD PINS >>>**		
851	85	1	MOMENT PIN - HORIZONTAL FORCE OUT OF RANGE	The Moment Pin horizontal force is out of range.	
852	85	2	MOMENT PIN - VERTICAL FORCE OUT OF RANGE	The Moment Pin vertical force is out of range.	
853	85	3	LOAD PIN - HORIZONTAL FORCE OUT OF RANGE	The Load Pin horizontal force is out of range.	-1250
854	85	4	LOAD PIN - VERTICAL FORCE OUT OF RANGE	The Load Pin vertical force is out of range.	-1250
855	85	5	MOMENT PIN - SENSOR FAULT	The Moment Pin has reported a fault.	
856	85	6	LOAD PIN - SENSOR FAULT	The Load Pin has reported a fault.	-1250
857	85	7	NEW MOMENT PIN DETECTED	A new Moment Pin has been detected.	
858	85	8	NEW LOAD PIN DETECTED	A new Load Pin has been detected.	-1250
859	85	9	LOAD PIN/TOWER LIFT CYLINDER ANGLE DISAGREEMENT	There is a disagreement between the Load Pin and the Tower Lift cylinder Angle.	-1250
8510	85	10	LOAD PIN - FORCE VALUES NOT CHANGING	The Load Pin is not changing.	-1250
8511	85	11	LOAD PIN - FORCE TOO LOW OVER TOWER ANGLE CHANGE	X	-1250
8512	85	12	LOAD PIN - FORCE TOO LOW OVER MAIN ANGLE CHANGE	X	-1250
8513	85	13	LOAD PIN - FORCE TOO LOW OVER MAIN LENGTH TRANSITION	X	-1250
860	**86**	**0**	**<<< STEERING / AXLE >>>**		
861	86	1	RESTRICTED TO TRANSPORT - OSCILLATING AXLE PRESSURE SWITCH DISAGREEMENT	The Oscillating Axle Pressure Switch indicates pressure while not driving or does not indicate pressure while driving and restricted to transport.	- Electrically released Oscillated Axles equipped vehicles only.
862	86	2	AXLE EXTEND VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Axle Extend Valve.	
863	86	3	AXLE EXTEND VALVE - SHORT TO GROUND	There is a Short to Ground to the Axle Extend Valve.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
864	86	4	AXLE RETRACT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Axle Retract Valve.	
865	86	5	AXLE RETRACT VALVE - SHORT TO GROUND	There is a Short to Ground to the Axle Retract Valve.	
866	86	6	RIGHT FRONT STEER RIGHT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Right Front Steer Right Valve.	
867	86	7	RIGHT FRONT STEER RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Right Front Steer Right Valve.	
868	86	8	RIGHT FRONT STEER LEFT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Right Front Steer Left Valve.	
869	86	9	RIGHT FRONT STEER LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Right Front Steer Left Valve.	
8610	86	10	LEFT FRONT STEER RIGHT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Left Front Steer Right Valve.	
8611	86	11	LEFT FRONT STEER RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Left Front Steer Right Valve.	
8612	86	12	LEFT FRONT STEER LEFT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Left Front Steer Left Valve.	
8613	86	13	LEFT FRONT STEER LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Left Front Steer Left Valve.	
8614	86	14	RIGHT REAR STEER RIGHT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Right Rear Steer Right Valve.	
8615	86	15	RIGHT REAR STEER RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Right Rear Steer Right Valve.	
8616	86	16	RIGHT REAR STEER LEFT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Right Rear Steer Left Valve.	
8617	86	17	RIGHT REAR STEER LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Right Rear Steer Left Valve.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
8618	86	18	LEFT REAR STEER RIGHT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Left Rear Steer Right Valve.	
8619	86	19	LEFT REAR STEER RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Left Rear Steer Right Valve.	
8620	86	20	LEFT REAR STEER LEFT VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Left Rear Steer Left Valve.	
8621	86	21	LEFT REAR STEER LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Left Rear Steer Left Valve.	
8622	86	22	FRONT RIGHT STEER SENSOR - DECOUPLED	The Front Right Steer Sensor has become decoupled.	
8623	86	23	FRONT LEFT STEER SENSOR - DECOUPLED	The Front Left Steer Sensor has become decoupled.	
8624	86	24	REAR RIGHT STEER SENSOR - DECOUPLED	The Rear Right Steer Sensor has become decoupled.	
8625	86	25	REAR LEFT STEER SENSOR - DECOUPLED	The Rear Left Steer Sensor has become decoupled.	
8626	86	26	FRONT LEFT STEER SENSOR - NOT RESPONDING	The Front Right Steer Sensor is not responding to steer commands.	
8627	86	27	FRONT RIGHT STEER SENSOR - NOT RESPONDING	The Front Left Steer Sensor is not responding to steer commands.	
8628	86	28	REAR LEFT STEER SENSOR - NOT RESPONDING	The Rear Right Steer Sensor is not responding to steer commands.	
8629	86	29	REAR RIGHT STEER SENSOR - NOT RESPONDING	The Rear Left Steer Sensor is not responding to steer commands.	
8630	86	30	FRONT RIGHT STEER SENSOR - SHORT TO GROUND OR OPEN CIRCUIT	There is a Short to Ground or an Open Circuit to the Front Right Steer Sensor.	
8631	86	31	FRONT RIGHT STEER SENSOR - SHORT TO BATTERY	There is a Short to Battery to the Front Right Steer Sensor.	
8632	86	32	FRONT LEFT STEER SENSOR - SHORT TO GROUND OR OPEN CIRCUIT	There is a Short to Ground or an Open Circuit to the Front Left Steer Sensor.	
8633	86	33	FRONT LEFT STEER SENSOR - SHORT TO BATTERY	There is a Short to Battery to the Front Left Steer Sensor.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
8634	86	34	REAR RIGHT STEER SENSOR - SHORT TO GROUND OR OPEN CIRCUIT	There is a Short to Ground or an Open Circuit to the Rear Right Steer Sensor.	
8635	86	35	REAR RIGHT STEER SENSOR - SHORT TO BATTERY	There is a Short to Battery to the Rear Right Steer Sensor.	
8636	86	36	REAR LEFT STEER SENSOR - SHORT TO GROUND OR OPEN CIRCUIT	There is a Short to Ground or an Open Circuit to the Rear Left Steer Sensor.	
8637	86	37	REAR LEFT STEER SENSOR - SHORT TO BATTERY	There is a Short to Battery to the Rear Left Steer Sensor.	
8651	86	51	ENGINE SHUTDOWN - AXLE LOCKOUT VALVE FAULT	Engine Start is prevented while there is an Oscillating Axle fault and vehicle is out of transport position	
990	**99**	**0**	**<<< HARDWARE >>>**		
998	99	8	EEPROM FAILURE - CHECK ALL SETTINGS	The Ground Module has reported an EEPROM failure.	
9910	99	10	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	The Platform Module software version is not compatible with the rest of the system.	
9914	99	14	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	The Platform Module software requires an updated.	
9915	99	15	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	The Chassis Tilt Sensor gain calibration has been lost.	
9916	99	16	CHASSIS TILT SENSOR GAIN OUT OF RANGE	The Chassis Tilt Sensor gain calibration has become corrupted.	
9917	99	17	HIGH RESOLUTION A2D FAILURE - INTERRUPT LOST	The Platform Module has reported that its ADS1213 chip has stopped asserting its interrupt.	
9918	99	18	HIGH RESOLUTION A2D FAILURE - REINIT LIMIT	The Platform Module has reported that its ADS1213 chip had to be reset 3 or more times.	
9919	99	19	GROUND SENSOR REF VOLTAGE OUT OF RANGE	The Ground Module has reported that its sensor reference voltage is outside acceptable range.	- Not reported during power-up.
9920	99	20	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	The Platform Module has reported that its sensor reference voltage is outside acceptable range.	- Not reported during power-up.

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
9921	99	21	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY	The Ground Module has reported that its high side driver cutout failed.	
9922	99	22	PLATFORM MODULE FAILURE - HWFS CODE 1	The Platform Module has reported that the V(Low) FET has failed.	
9923	99	23	GROUND MODULE FAILURE - HWFS CODE 1	The Ground Module has reported that the V(Low) FET has failed.	
9925	99	25	FUNCTIONS LOCKED OUT - CHASSIS MODULE SOFTWARE VERSION IMPROPER	The Chassis Module software version is not compatible with the rest of the system.	
9926	99	26	FUNCTIONS LOCKED OUT - BLAM MODULE SOFTWARE VERSION IMPROPER	The BLAM software version is not compatible with the rest of the system.	
9927	99	27	GROUND MODULE CONSTANT DATA UPDATE REQUIRED	The Ground Module constant data requires an updated.	
9928	99	28	ENVELOPE CONTROL DISABLED	Envelope Control has been disabled by the user from Access Level 0.	- Envelope Control equipped vehicles only.
9929	99	29	MOMENT CONTROL DISABLED	Moment Control has been disabled by the user from Access Level 0.	- Envelope Control equipped vehicles only.
9930	99	30	STEER SENSORS NOT CALIBRATED	The Steer Sensors have not been calibrated.	- Chassis Module equipped vehicles only.
9931	99	31	BOOM SENSORS NOT CALIBRATED	The Boom Sensors have not been calibrated.	- BLAM equipped vehicles only.
9932	99	32	LIFT CRACKPOINTS NOT CALIBRATED	The Lift Valves have not been calibrated.	- 1200S and 1350S only.
9933	99	33	TELESCOPE CRACKPOINTS NOT CALIBRATED	The Telescope Valves have not been calibrated.	- 1200S and 1350S only.
9934	99	34	DRIVE CRACKPOINTS NOT CALIBRATED	The Drive Valves have not been calibrated.	- 1200S and 1350S only.
9935	99	35	BLAM SENSOR SUPPLY OUT OF RANGE HIGH	The Boom Angle Sensors supply voltage is high.	- BLAM equipped vehicles only.
9936	99	36	BLAM SENSOR SUPPLY OUT OF RANGE LOW	The Boom Angle Sensors supply voltage is low.	- BLAM equipped vehicles only.
9937	99	37	LENGTH SENSOR REF VOLTAGE HIGH	The Boom Length Sensors supply voltage is high.	
9938	99	38	LENGTH SENSOR REF VOLTAGE LOW	The Boom Length Sensors supply voltage is low.	
9939	99	39	BLAM HIGH RES A/D FAILURE	The BLAM high resolution analog to digital converter has failed.	- BLAM equipped vehicles only.
9940	99	40	CHASSIS SENSOR SUPPLY OUT OF RANGE HIGH	The Chassis Sensors supply voltage is high.	

Table 6-6. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
9941	99	41	CHASSIS SENSOR SUPPLY OUT OF RANGE LOW	The Chassis Sensors supply voltage is low.	
9942	99	42	BLAM BACKUP COMMUNICATIONS LINK FAULTY	The BLAM backup communications link test was activated at startup, but no communication connection established/maintained.	- BLAM equipped vehicles only. -1250
9943	99	43	BLAM BACKUP COMMUNICATIONS LOST - HYDRAULICS SUSPENDED	The BLAM backup communications link was activated, but no communication connection established/maintained.	- BLAM equipped vehicles only. -1250
9944	99	44	CURRENT FEEDBACK GAINS OUT OF RANGE	The factory set current feedback gains are out of range.	
9945	99	45	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	The factory set current feedback checksum is not correct.	
9975	99	75	LOAD PIN NOT CALIBRATED	The Load Pin has not been calibrated.	-1250
9979	99	79	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER	Temporary fault for the telematics project. The model needs to be a 600S or 1350S if not this fault will be generated and Platform controls will be prevented. This fault was to insure that the software will only work for these two models.	

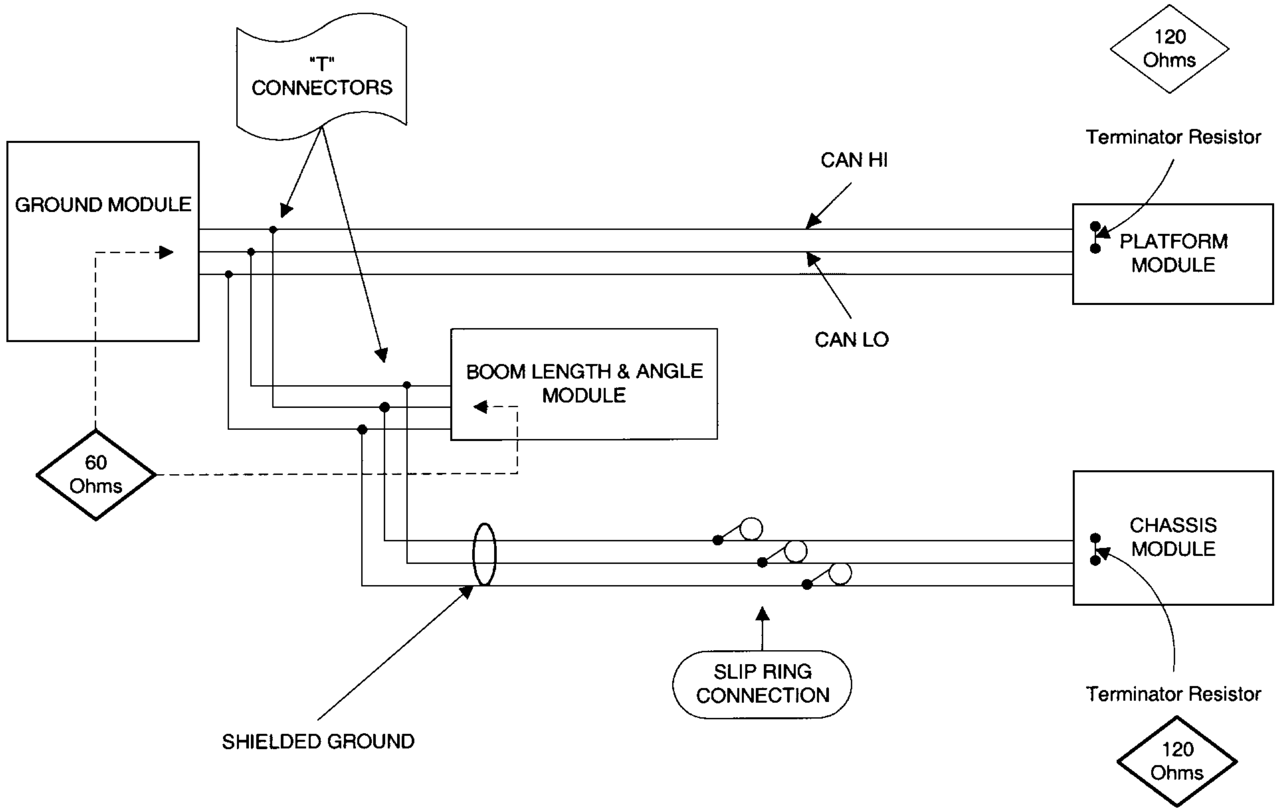
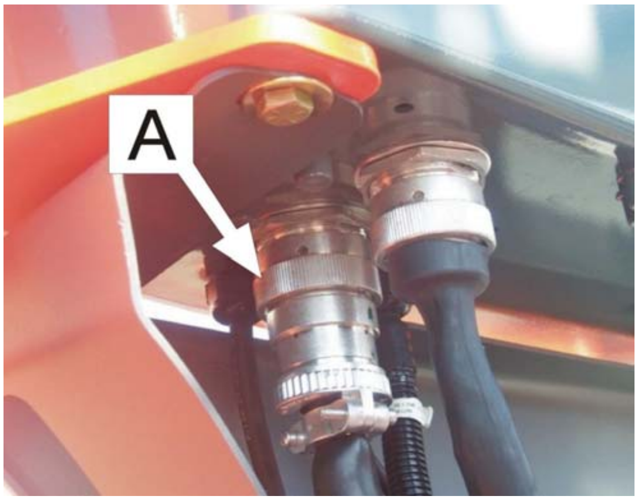
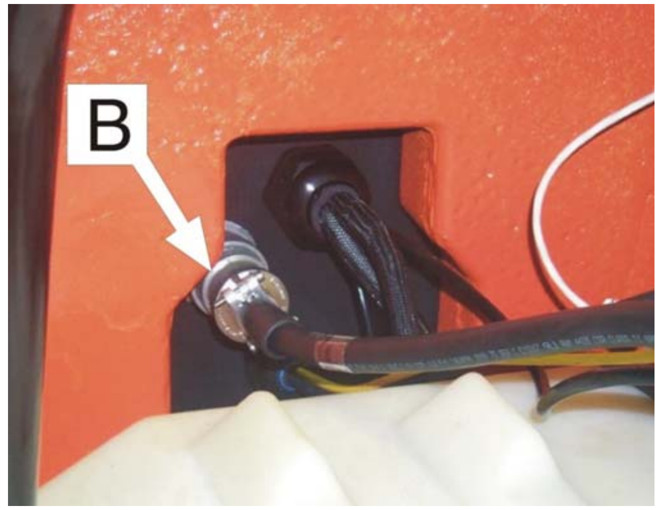


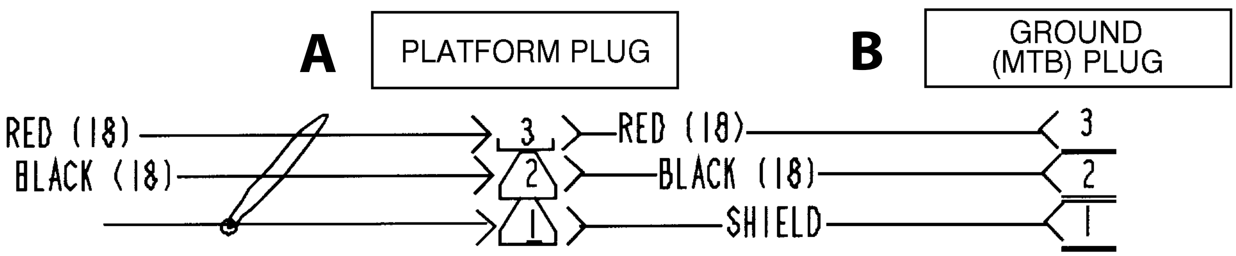
Figure 6-25. CANbus Connections Diagram

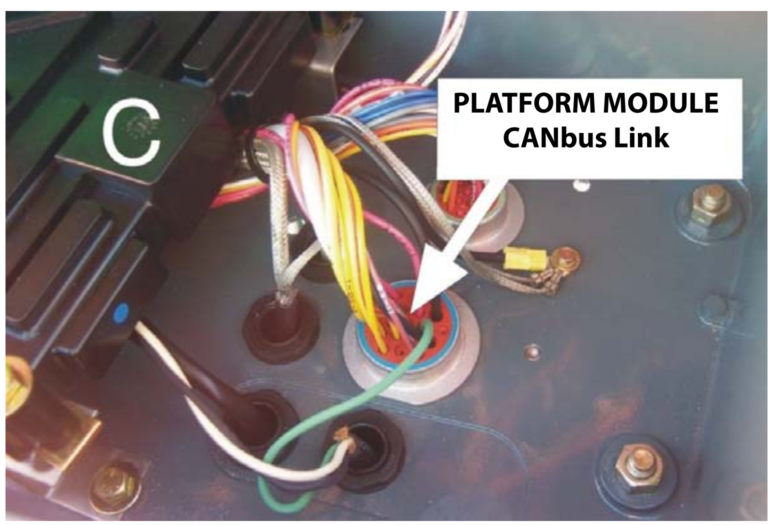
6.20 CANBUS TROUBLESHOOTING

The PLATFORM MODULE and the CHASSIS MODULE have ″Terminator Resistors″ located inside the modules, these resistors squelch high speed signal reflections in the CANbus transmission lines. The value of the terminators is determined by wire properties, this includes the type of insulation and geometry, combined to determine the perfect value for bus termination. Improper values or missing terminators allow bus ringing. A complete CANbus circuit (wired in parallel) is approximately 60 Ohms at the ″T″ fitting inside the Ground Station or at the Boom Length & Angle Module. Each individual circuit from their respective Module should read approximately 120 Ohm. For CANbus connections, refer to Figure 6-25., Figure 6-26., Figure 6-27., Figure 6-28., Figure 6-29., and Figure 6-30.









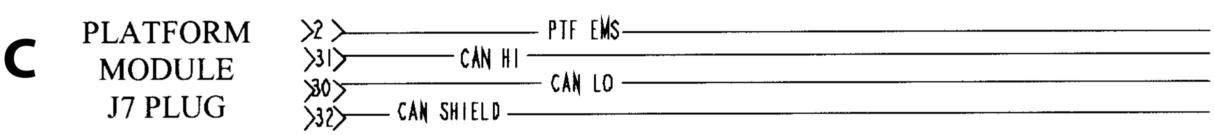
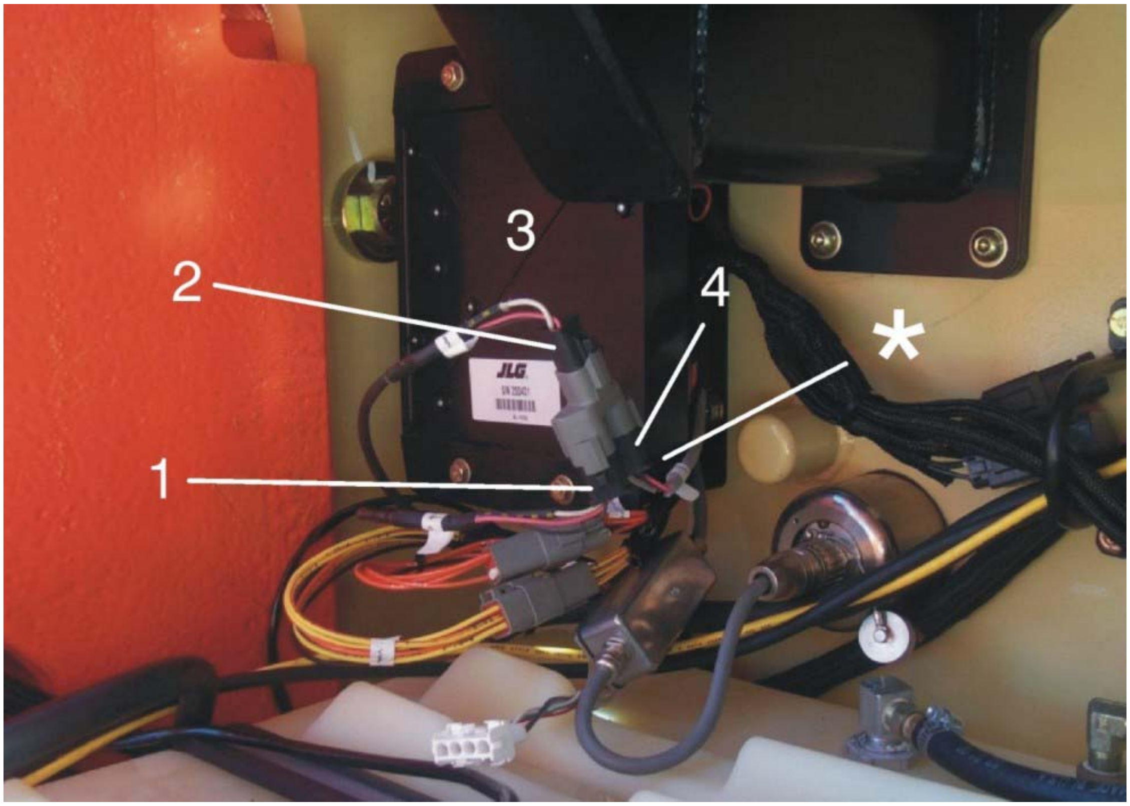
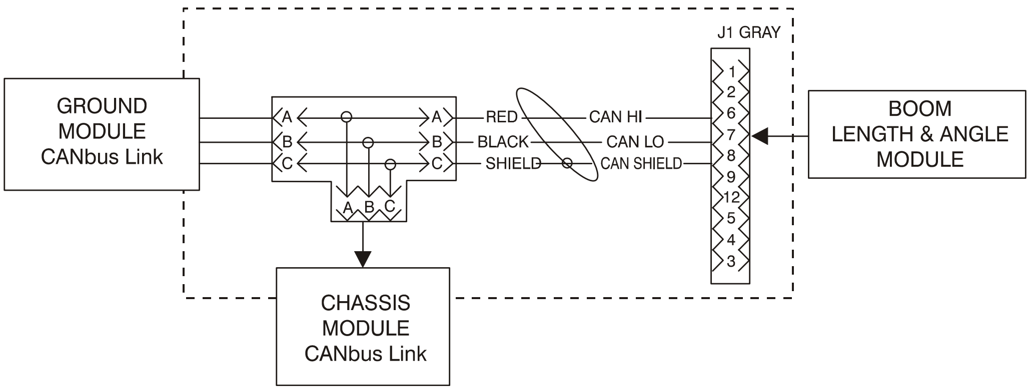
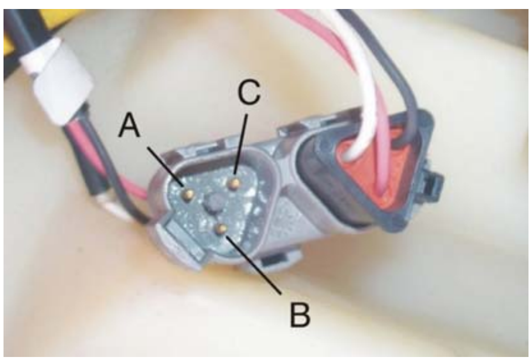


Figure 6-26. CANbus Connections - Sheet 1 of 5



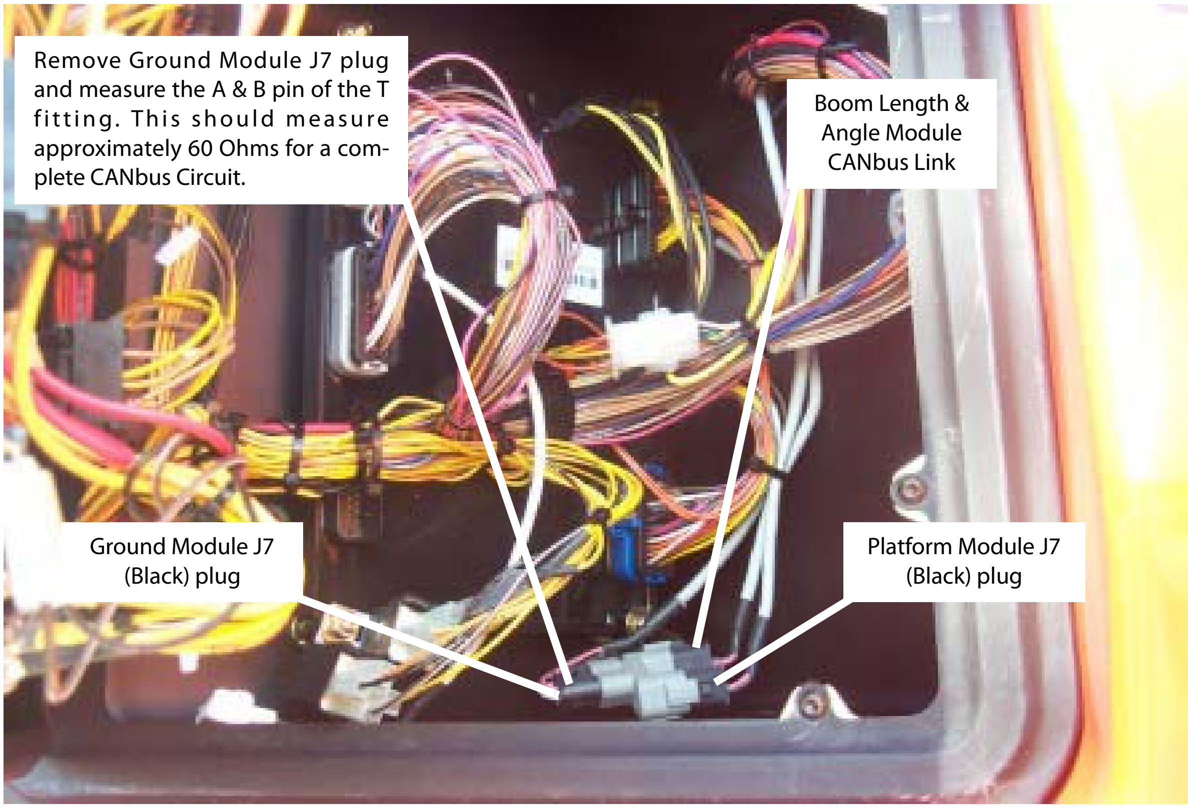




1. Chassis Module CANbus Link
2. Ground Module CANbus Link
3. Boom Length & Angle Module
4. BLAM J1 (Gray) Plug

* Remove BLAM J1 Plug and measure the A & B pin of the T fitting. This should measure approximately 60 Ohms for a complete CANbus Circuit.

Figure 6-27. CANbus Connections - Sheet 2 of 5



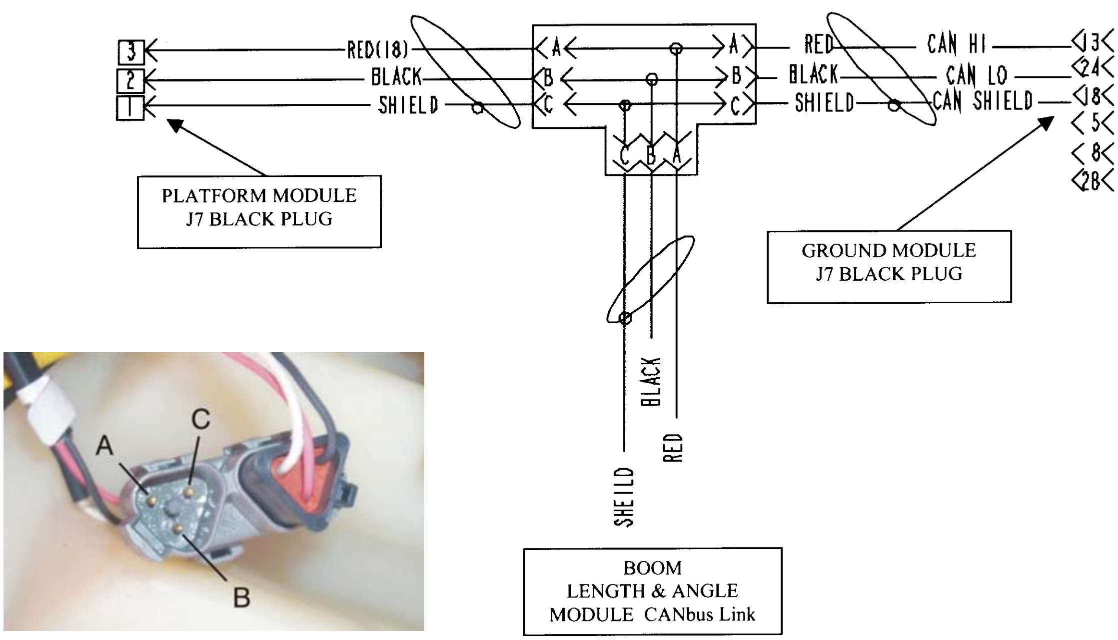
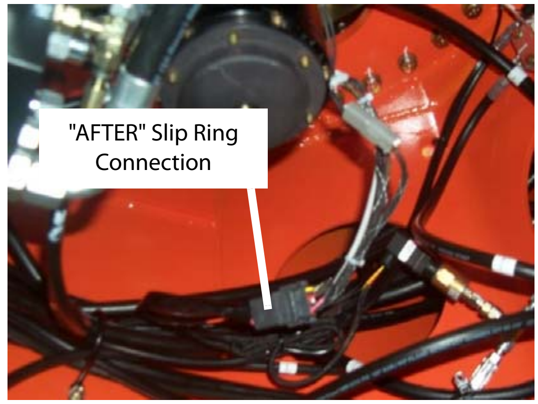


Figure 6-28. CANbus Connections - Sheet 3 of 5



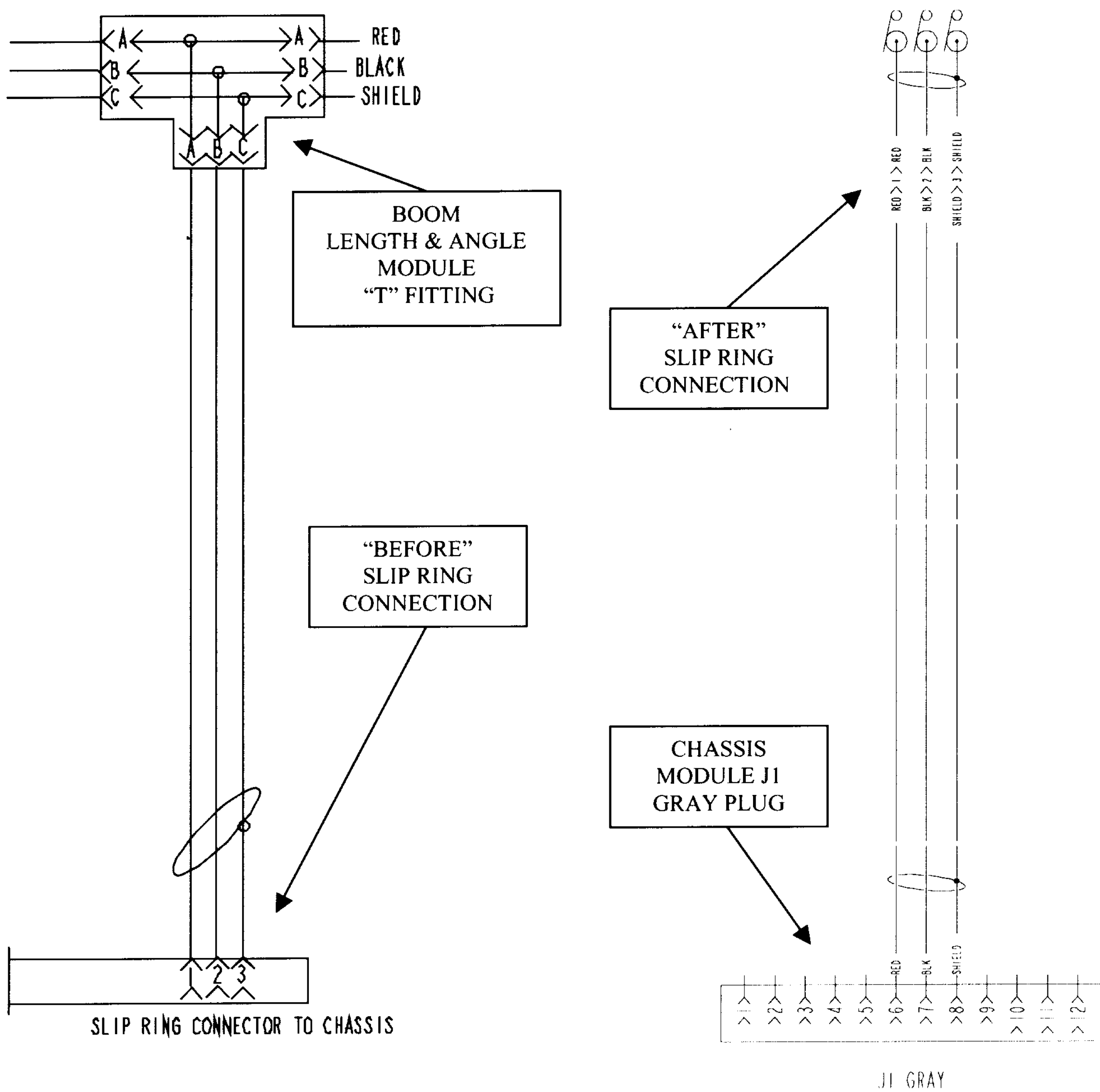


Figure 6-29. CANbus Connections - Sheet 4 of 5

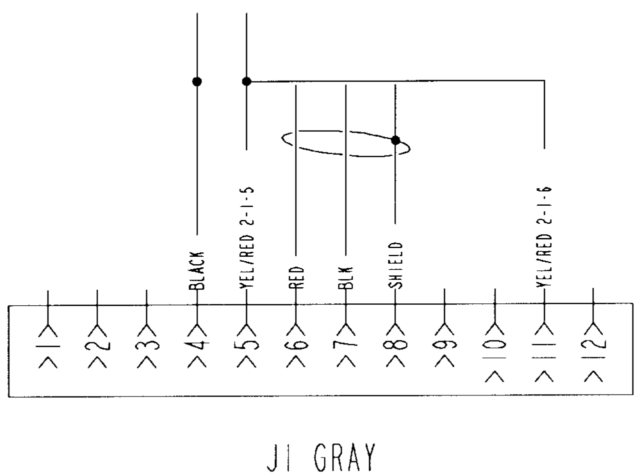


Figure 6-30. CANbus Connections - Sheet 5 of 5

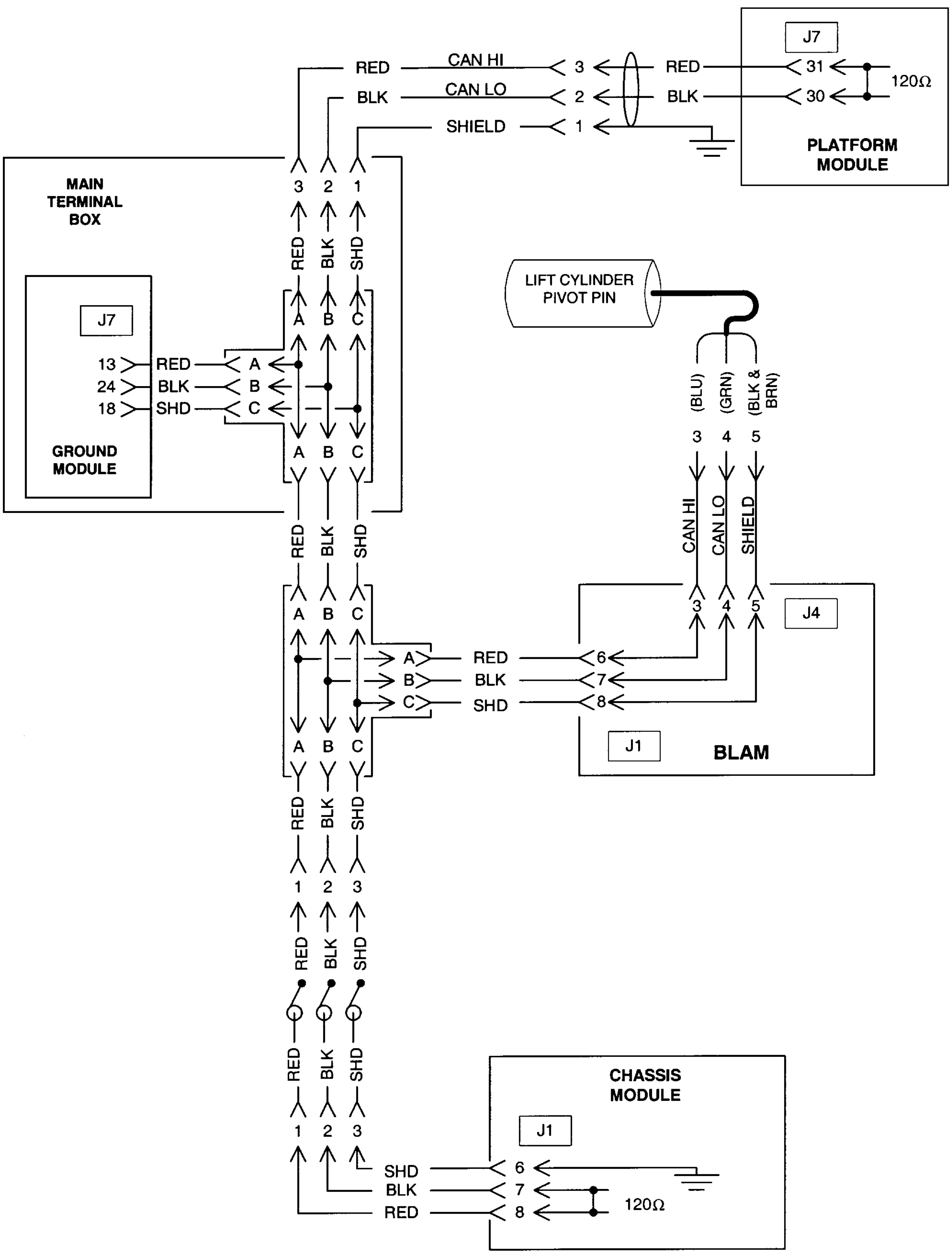


Figure 6-31. CANbus Circuit

CANbus Communication Failure

If a problem in the CANbus system is suspected, use the following step-by-step procedure to verify which part of the CANbus communication system has failed.

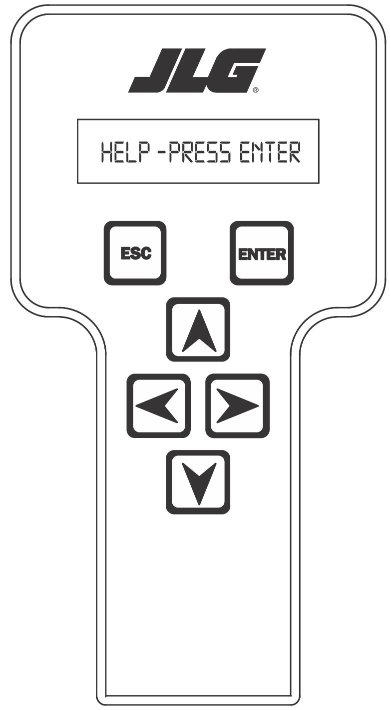
CANBUS LINK FROM THE PLATFORM MODULE LOST

1. Position the Platform/Ground select switch to the Ground position.

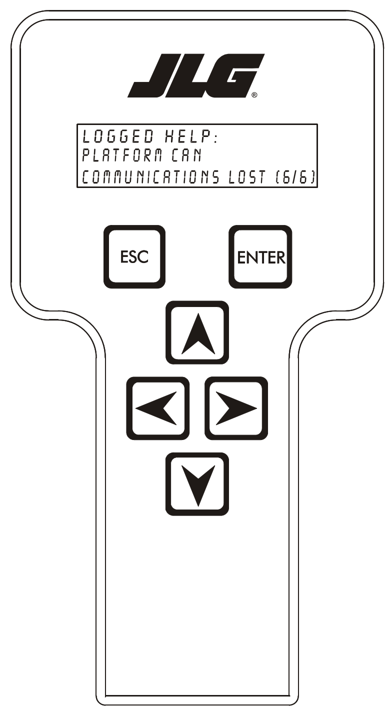
2. Plug the analyzer into the connector inside the Ground control box.

3. Pull out the Emergency Stop switch.

4. The analyzer screen should read:

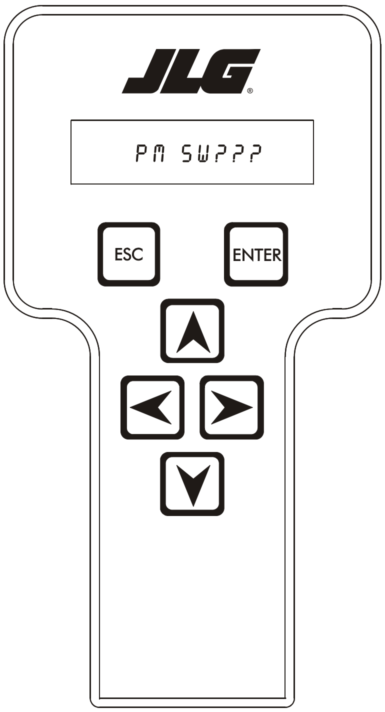


5. Press enter twice to reach Logged Help. The screen will read:

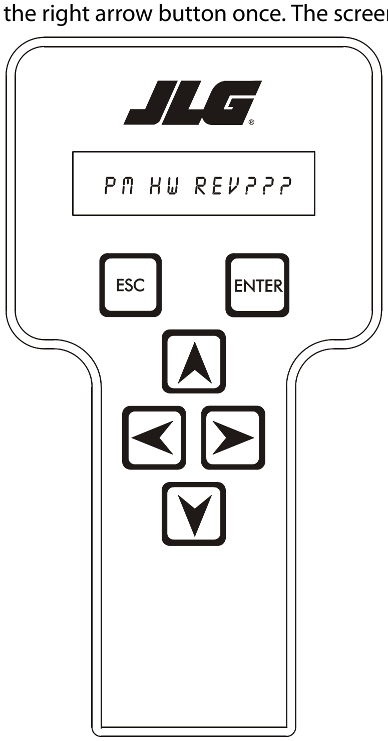


6. Hit ESC to get back to the HELP screen and then use the arrow button to reach VERSIONS. Hit Enter.

7. If the CANbus link from the platform module is lost, you will see the Ground Module SW version, Ground Module HW version, Ground Module SN, BM SW version, Chassis SW version, Platform Module SN, but you will not see the Platform Module SW version or the Platform Module HW version. The Analyzer screen will read:



8. Hit the right arrow button once. The screen will read:



TROUBLESHOOTING: PLATFORM CAN COMMUNICATIONS LOST

NOTE: *PLATFORM CAN COMMUNICATIONS LOST (6/6) (Help Fault Code 6-6) basically means all communication linked to the Platform Module is lost. This does not mean that the Platform Module Link only is affected, this means the communication link between the Platform Module down to the Chassis Module has been broken, therefore all Canbus links have to be checked. Remember this link is wired in parallel, so the Ground Module has lost all MSA communication.*

Table 6-7. Troubleshooting: Platform Can Communications Lost

STEP	ACTION REQUIRED	SPEC	YES	NO
1	Install the Analyzer at the ground station, scroll to the "Diagnostics" sub level menu, press "enter" then scroll to the "Versions" menu item press "enter" and view the screen, reference the Diagnostics / Version Chart to assist you in determining which module has lost it's communication link. In some cases the module that shows up with a question may be defective if all other CANbus links check OK.	See Diagnostics / Version Chart	See step 2	See step 2
2	Disconnect the Ground Module J7 deutsche plug connection at the "T" fitting inside of the ground control station. Perform an ohms check at the "A" and "B" pins of the "T" fitting. Inspect the shield wire "C" for shorts.	Approximately 60 ohms.	CANbus circuit is complete. Platform Module suspected defective	Reconnect plug and go to step 3
3	Make sure the CANbus link wires are installed correctly at the Platform Module.	See Electrical Schematic in Section 7	Go to step 4	Wire per Electrical Schematic
4	Disconnect the platform cannon plug and ground cannon plug that holds the CANbus link. Red (3) Black (2) and Shield (1) perform a continuity test.	Continuity	Reconnect plug and go to step 5	Repair or replace platform harness.
5	Disconnect the deutsche plug connection from the Platform Module at the "T" fitting inside of the ground station. Perform an ohms check at the "A" and "B" sockets of the deutsche plug. Inspect the shield wire "C" for shorts.	Approximately 120 ohms.	Reconnect plug and go to step 6	Suspected defective Platform Module.
6	Inspect the Platform Module harness connection at the ground cannon plug and at the "T"' fitting inside of the ground control station.	Continuity	Reconnect harness and go to step 7	Repair or replace harness inside the ground control station.
7	Disconnect the deutsche plug connection from the Boom Length & Angle Module at the "T' fitting inside of the ground station. Perform an ohms check at the "A" and "B" sockets of the deutsche plug. Inspect the shield wire "C" for shorts.	Approximately 120 ohms	Reconnect plug and go to step 8	Verify step 7, inspect the BLAM to Ground Module harness connection s at both "T" fitting connections for proper continuity and correct wiring per Electrical schematic.
8	Disconnect all deutsche plug connections at the "T" fitting in the ground station and the BLAM, perform a continuity test on all "A" "B" and "C" pins use the singular end of the fitting and cross probe the corresponding letters of the other two connections.	Continuity (NO OHM VALUES)	Reconnect all deutsche plugs at the "T" fitting and go to step 9	Replace defective "T" fitting plug.
9	Disconnect the Chassis Module deutsche plug at the "T' fitting below the Boom Length & Angle Module. Perform an ohms check at the "A" and "B" sockets of the deutsche plug. Inspect the shield wire "C" for shorts.	Approximately 120 ohms	Reconnect deutsche plug and go to step 10	Inspect the harness from the "T" fitting at the BLAM to the Chassis Module plug connection at the battery. Assure proper continuity and correct wiring per Electrical Schematic.

Table 6-7. Troubleshooting: Platform Can Communications Lost

STEP	ACTION REQUIRED	SPEC	YES	NO
10	Disconnect the Chassis Module connection at the right side of the battery at the turntable lock pin. Perform an ohms check at the #1 and #2 connections of the plug. Inspect shield wire #3 for possible short.	Approximately 120 ohms	Reconnect plug and go to step 11	Inspect the harness from the slip ring connections at the top and bottom plug connections of the swivel. Assure proper continuity and correct wiring per Electrical Schematic.
11	Disconnect the Chassis Module connection below the swivel under the machine. Perform an ohms check at the #1 and #2 connections of the plug that is routed to the Chassis Module. Inspect shield wire #3 for possible short.	Approximately 120 ohms	Reconnect plug and go to step 12	Inspect the harness from the bottom of the swivel into the Chassis Module. Assure proper continuity and wiring r schematic 1870149A.
12	Make sure the Chassis Module CANbus link wires are installed correctly at the plug near the battery, the plug below the swivel and 31 plug at the Chassis Module.	Electrical Schematic	Stop	Replace the Chassis Module.

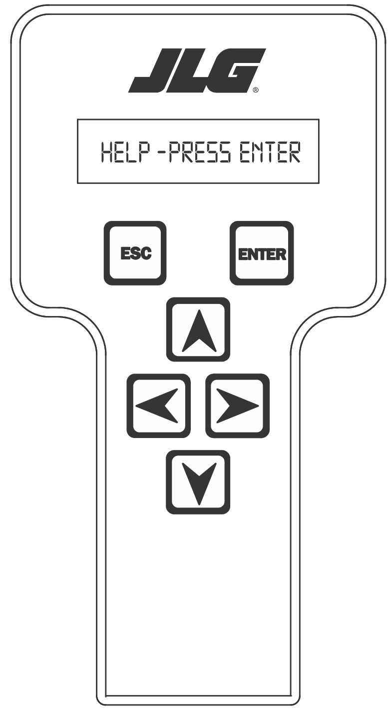
CANBUS LINK FROM THE GROUND MODULE LOST

1. Position the Platform/Ground select switch to the Ground position.

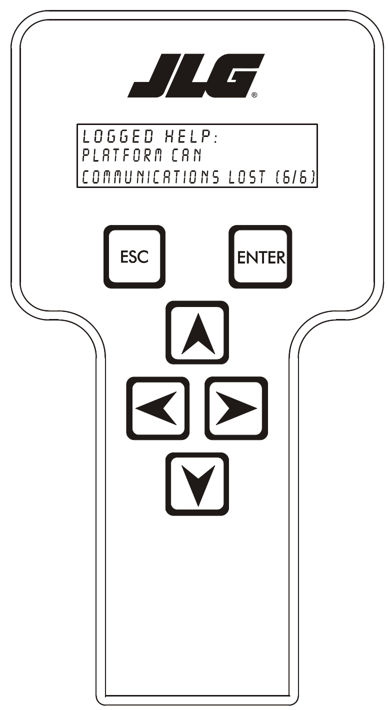
2. Plug the analyzer into the connector inside the Ground control box.

3. Pull out the Emergency Stop switch.

4. The analyzer screen should read:

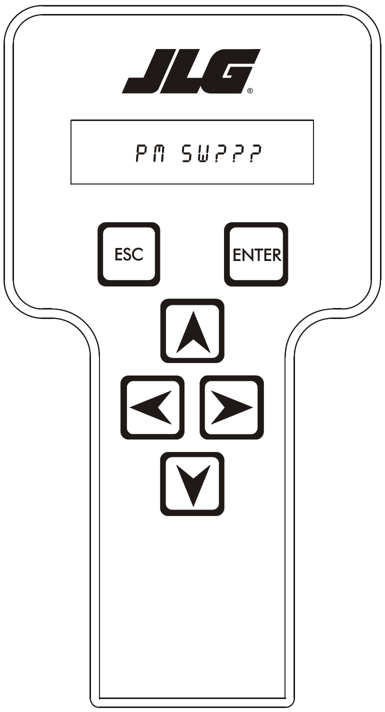


5. Press enter twice to reach Logged Help. The screen will read:

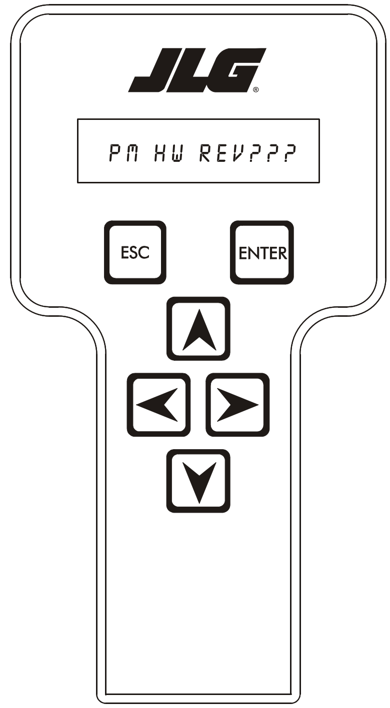


6. Hit ESC to get back to the HELP screen and then use the arrow button to reach VERSIONS. Hit Enter.

7. If the CANbus link from the ground module is lost, you will see the Ground Module SW version, Ground Module HW version, Ground Module SN, BM SW version, Chassis SW version, Platform Module SN, but you will not see the Platform Module SW version or the Platform Module HW version. The Analyzer screen will read:



8. Hit the right arrow button once. The screen will read:



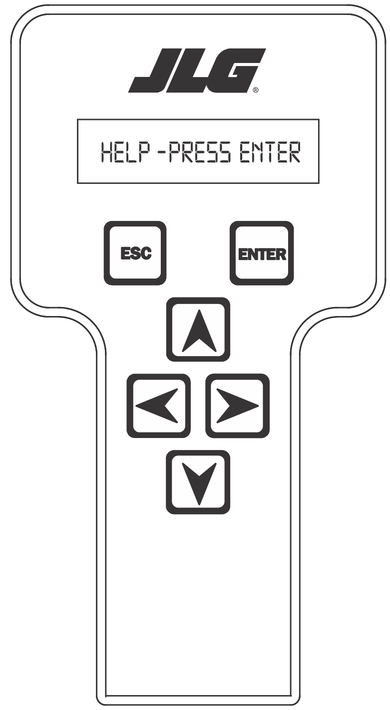
CANBUS LINK FROM THE BOOM LENGTH & ANGLE MODULE (BLAM) LOST

1. Position the Platform/Ground select switch to the Ground position.

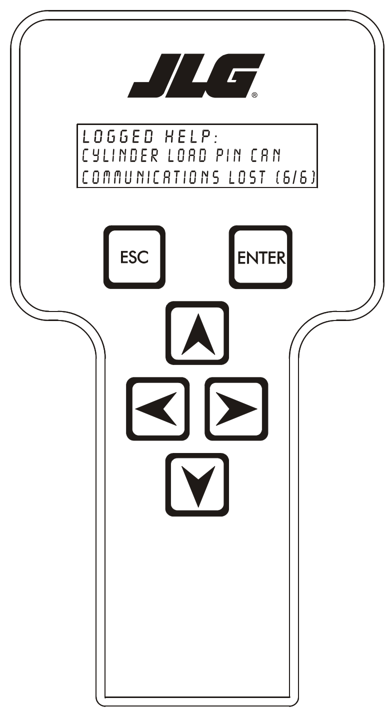
2. Plug the analyzer into the connector inside the Ground control box.

3. Pull out the Emergency Stop switch.

4. The analyzer screen should read:

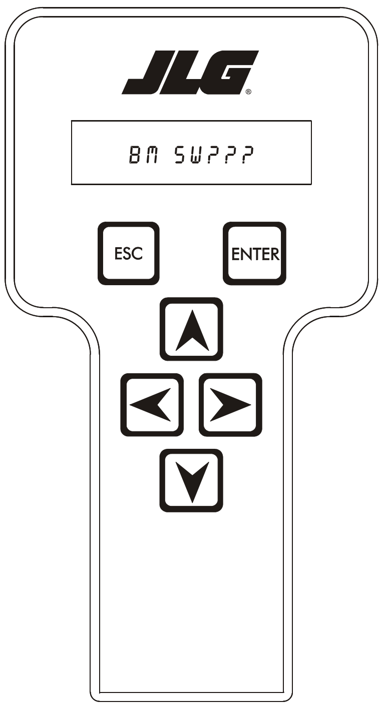


5. Press enter twice to reach Logged Help. The screen will read:



6. Hit ESC to get back to the HELP screen and then use the arrow button to reach VERSIONS. Hit Enter.

7. If the CANbus link from the Boom Length & Angle Module is lost, you will see the Platform Module SW version, Platform Module HW Rev, Platform Module SN, Ground Module SW version, Ground Module HW Revision, Ground Module SN, Chassis SW version, but you will not see the Boom Length & Angle Module SW revision. The Analyzer screen will read:



TROUBLESHOOTING: BLAM CAN COMMUNICATIONS LOST

NOTE: *BLAM CAN COMMUNICATIONS LOST (6/6) (Help Fault Code 6-6) basically means all communication linked from the Ground Module to the Boom Length &: Angle Module is lost. This also includes the lift cylinder load moment pin as well.*

Table 6-8. Troubleshooting: BLAM Can Communications Lost

STEP	ACTION REQUIRED	SPEC	YES	NO
1	Install the Analyzer at the ground station, scroll to the "Diagnostics" sub level menu, press "enter" then scroll to the "Versions" menu item press "enter" and view the screen, reference the Diagnostics / Version Chart to assist you in determining which module has lost it's communication link. In some cases the module that shows up with a question may be defective if all other CANbus links check OK.	See Diagnostics / Version Chart	See step 2	See step 2
2	Disconnect the BLAM **J1** deutsche plug connection at the "T" fitting just above the fuel tank. Perform an ohms check at the "A" and "B" pins of the "T" fitting. Inspect the shield wire "C" for possible short.	Approximately 60 ohms.	CANbus circuit is complete. BLAM suspected defective.	Reconnect plug and go to step 3
3	Disconnect the Ground Module deutsche plug from "T" fitting at the BLAM above the fuel tank. Perform an ohm check at the "A" and "B" sockets of the deutsche plug. Inspect the shield wire "C" for possible short.	Approximately 120 Ohms	Reconnect harness and go to step 4	Repair or replace the Ground Module to BLAM harness.
4	Verify the CANbus link signal wires are installed correctly at the 'T" fitting at the Ground Module.	Electrical Schematic	Reconnect plug and go to step 5	Wire per Electrical Schematic
5	Verify the lift cylinder load moment harness has good continuity and wired correctly at the J4 plug on the BLAM.	Continuity	Reconnect plug and go to step 6	Repair or replace Chassis Module harness.
6	Disconnect the Chassis Module plug connection at the battery and perform an ohm check at the #1 and #2 socket of the deutsche plug. Inspect the shield wire #3 for possible short.	Approximately l 20 Ohms	Reconnect plug and stop	Inspect harness and connections to the Chassis Module.

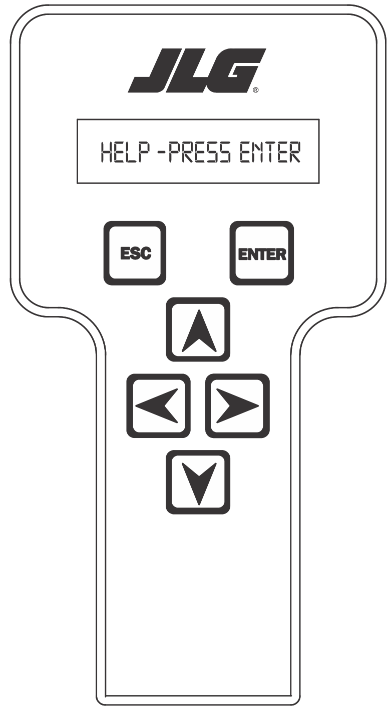
CANBUS LINK FROM THE CHASSIS MODULE LOST

1. Position the Platform/Ground select switch to the Ground position.

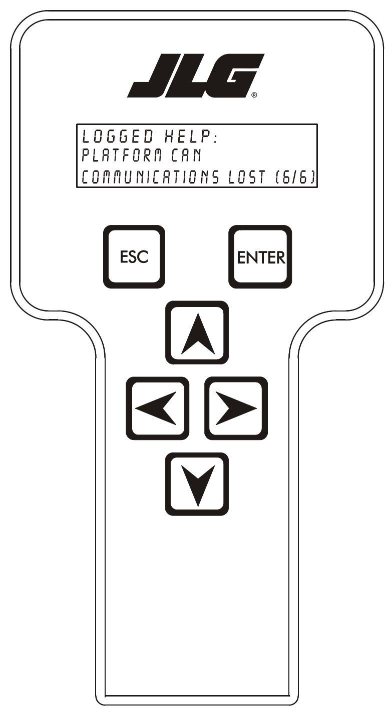
2. Plug the analyzer into the connector inside the Ground control box.

3. Pull out the Emergency Stop switch.

4. The analyzer screen should read:

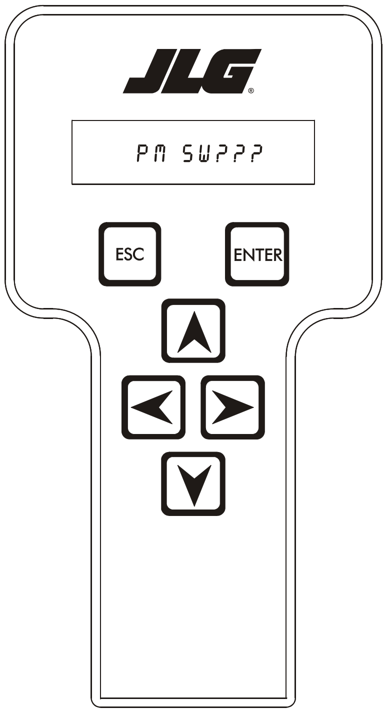


5. Press enter twice to reach Logged Help. The screen will read:

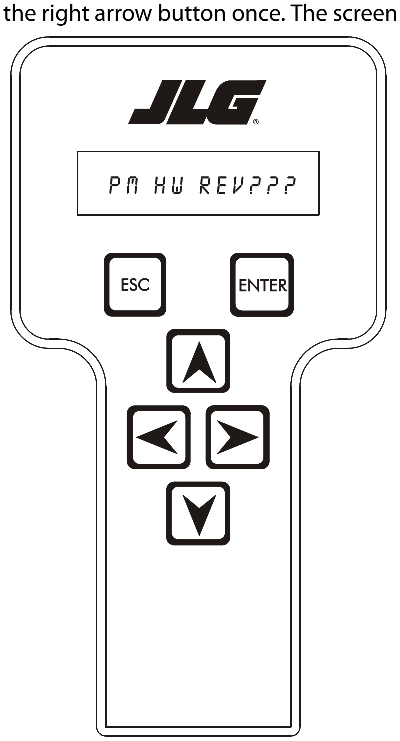


6. Hit ESC to get back to the HELP screen and then use the arrow button to reach VERSIONS. Hit Enter.

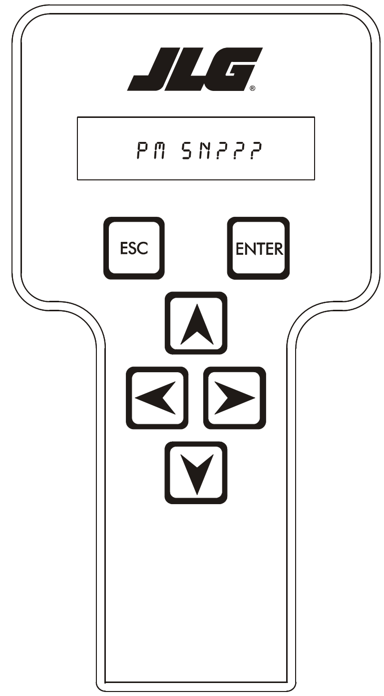
7. If the CANbus link from the Chassis Module is lost, you will NOT see the Platform Module SW version, Platform Module HW rev, Platform Module SN, Chassis SW version, Boom Length & Angle Module SW version, but you WILL see the Ground Module SW version, Ground Module HW rev, and the Ground Module SN. The analyzer screen will read:



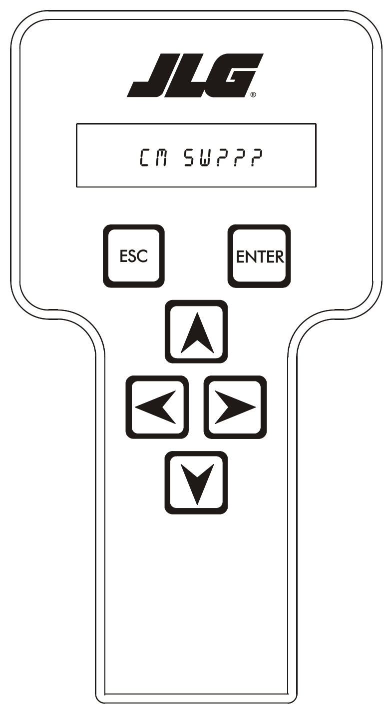
8. Hit the right arrow button once. The screen will read:



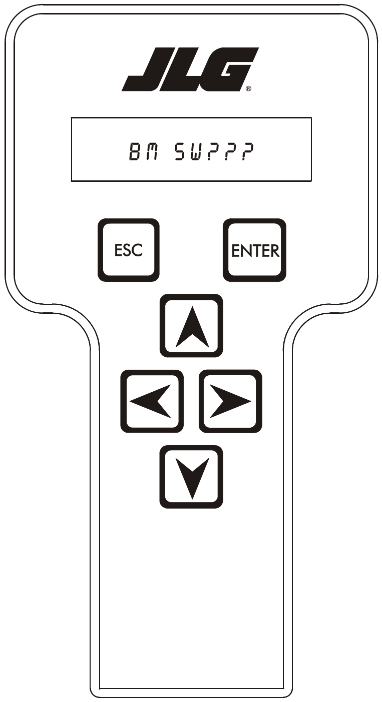
9. Hit the right arrow button once. The screen will read:



10. Hit the right arrow button once. The screen will read:



11. Hit the right arrow button once. The screen will read:



TROUBLESHOOTING: CHASSIS CAN COMMUNICATIONS LOST

NOTE: *CHASSIS CAN COMMUNICATIONS LOST (6/6) (Help Fault Code 6-6) basically means all communication linked from the Ground Module to the Chassis Module is lost.*

Table 6-9. Troubleshooting: Chassis Can Communications Lost

STEP	ACTION REQUIRED	SPEC	YES	NO
1	Install the Analyzer at the ground station, scroll to the "Diagnostics" sub level menu, press "enter" then scroll to the "Versions" menu item press "enter" and view the screen, reference the Diagnostics / Version Chart to assist you in determining which module has lost it's communication link. In some cases the module that shows up with a question may be defective if all other CANbus links check OK.	See Diagnostics / Version Chart	See step 2	See step 2
2	Disconnect the BLAM J1 deutsche plug connection at the "T" fitting just above the fuel tank. Perform an ohms check at the "A" and "B" pins of the "T" fitting. Inspect the shield wire "C" for possible short.	Approximately 60 ohms.	CANbus circuit is complete. Chassis Module suspected defective.	Reconnect plug and go to step 3
3	Disconnect the Chassis Module communication harness from the BLAM "T" fitting and Chassis Module plug connection at the battery. Perform a continuity test.	Continuity	Reconnect harness and go to step 4	Repair or replace BLAM and Chassis Module harness.
4	Verify the CANbus link signal wires are installed correctly at the Chassis Module plug connection at the battery and at the plug below the swivel.	Electrical Schematic	Reconnect plug and go to step 6	Wire per Electrical Schematic
5	Verify continuity at the Chassis Module harness from the plug connection at the battery down to the plug connection below the swivel.	Continuity	Reconnect plug and go to step 6	Repair or replace Chassis Module harness.
6	Disconnect the Chassis Module plug connection below the swivel and perform an ohms check at the #1 and #2 of the plug. Inspect the shield wire #3 plug connection for possible short.	Approximately 120 Ohms	Stop	Replace Chassis Module

Load Moment Pin Troubleshooting

The following Troubleshooting Charts outline diagnostic measures to be taken to diagnose problems within the Load Moment Pin portion of the JLG Control System. If necessary, refer to Section 4 for information concerning replacement of the Load Moment Pin.

Table 6-10. Load Moment Pin Troubleshooting: Can Communications Lost

STEP	FAULT CODE/SYMPTOM	REPAIR	YES	NO
1	6/6 CYLINDER LOAD PIN CAN COMMUNICATIONS LOST	Check for correct and tight wire connections at the deutsch and phoenix connectors of the Load Sensing Pin harness and perform a continuity check.	Go to step 2	Replace harness. (4922826)
2		Check for loose pins in the potting of the Boom Length & Angle Module J4 connection.	Replace the BLAM & Perform the Boom Sensor calibration process.	Go to step 3
3		Inspect the CANbus link "T" fitting connections at the BLAM & Ground Module. Are the fittings dry?	Go to step 4	Replace "T" fitting connector. (4460945)
4		Inspect the CANbus link "T" fitting connections at the BLAM & Ground Module. Perform a continuity check.	Go to step 5	Replace "T" fitting connector. (4460945)
5		Check the J1 and J4 plug connections on the BLAM, make sure the notched plugs line up with the plug sockets correctly.	Go to step 6	Position plug correctly.
6		Use the Analyzer, scroll – + to the DIAGNOSTICS menu, press ENTER, then scroll to the MOMENT menu, and press ENTER, check to see i f Actual / Over / Under moment values are registering on the screen display.	Go to step 6	Replace the load moment pin. & Perform the Boom Sensor calibration process.
7		If they are, refer to Figure 6-32., Moment Chart for comparable values, if the values are not close, try boom sensor calibration to see if the values come within the chart.	If the problem still exists, verify steps 1-7 again before contacting the JLG Service Dept.	Replace the load moment pin. & Perform the Boom Sensor calibration process.

Table 6-11. Load Moment Pin Troubleshooting: Moment Pin Horizontal Force Out of Range

STEP	FAULT CODE/SYMPTOM	REPAIR	YES	NO
1	8/6 MOMENT PIN HORIZONTAL FORCE OUT OF RANGE The horizontal force is out of allowed range.	Check to see if the platform is overloaded in the vertical position. Check the rated capacity requirement.	Remove excess weight	Go to step 2
2		Check to see if any additional accessories have been added to the platform without proper calibration.	Perform the Boom Sensor calibration process.	Go to step 3
3		Perform the BCS daily check procedure to make sure the boom sections are stopping correctly at the witness marks matching their capacity selection.	Go to step 4	Perform the Boom Sensor calibration process.
4		Inspect the job the machine is performing, making sure that there is no additional force applied when the boom sections are in the horizontal position. Also consider weather conditions (Wind).	Go to step 5	Position machine correctly.
5		Use the Analyzer, scroll to the DIAGNOSTICS menu, press ENTER, then scroll to the MOMENT menu, and press ENTER, check to see if Actual / Over / Under moment values are registering on the screen display.	Go to step 6	Replace the load moment pin. & Perform the Boom Sensor calibration process.
6		If they are, refer to Figure 6-32., Moment Chart for comparable values, if the values are not close, try boom sensor calibration to see if the values come within the chart.	If the problem still exists, verify steps 1-6 again before contacting the JLG Service Dept.	Replace the load moment pin. & Perform the Boom Sensor calibration process.

Table 6-12. Load Moment Pin Troubleshooting: Moment Pin Vertical Force Out of Range

STEP	FAULT CODE/SYMPTOM	REPAIR	YES	NO
1	8/6 MOMENT PIN VERTICAL FORCE OUT OF RANGE The vertical force is out of allowed range.	Check to see if the platform is overloaded in the vertical position. Check the rated capacity requirement.	Remove excess weight	Go to step 2
2		Check to see if any additional accessories have been added to the platform without proper calibration.	Perform the Boom Sensor calibration process.	Go to step 3
3		Perform the BCS daily check procedure to make sure the boom sections are stopping correctly at the witness marks matching their capacity selection.	Go to step 4	Perform the Boom Sensor calibration process.
4		Inspect the job the machine is performing, making sure that there is no additional force applied when the boom sections are in the horizontal position. Also consider weather conditions (Wind).	Go to step 5	Position machine correctly.
5		Use the Analyzer, scroll to the DIAGNOSTICS menu, press ENTER, then scroll to the MOMENT menu, and press ENTER, check to see if Actual / Over / Under moment values are registering on the screen display.	Go to step 6	Replace the load moment pin. & Perform the Boom Sensor calibration process.
6		If they are, refer to Figure 6-32., Moment Chart for comparable values, if the values are not close, try boom sensor calibration to see if the values come within the chart.	If the problem still exists, verify steps 1-6 again before contacting the JLG Service Dept.	Replace the load moment pin. & Perform the Boom Sensor calibration process.

Table 6-13. Load Moment Pin Troubleshooting: Moment Pin Sensor Fault

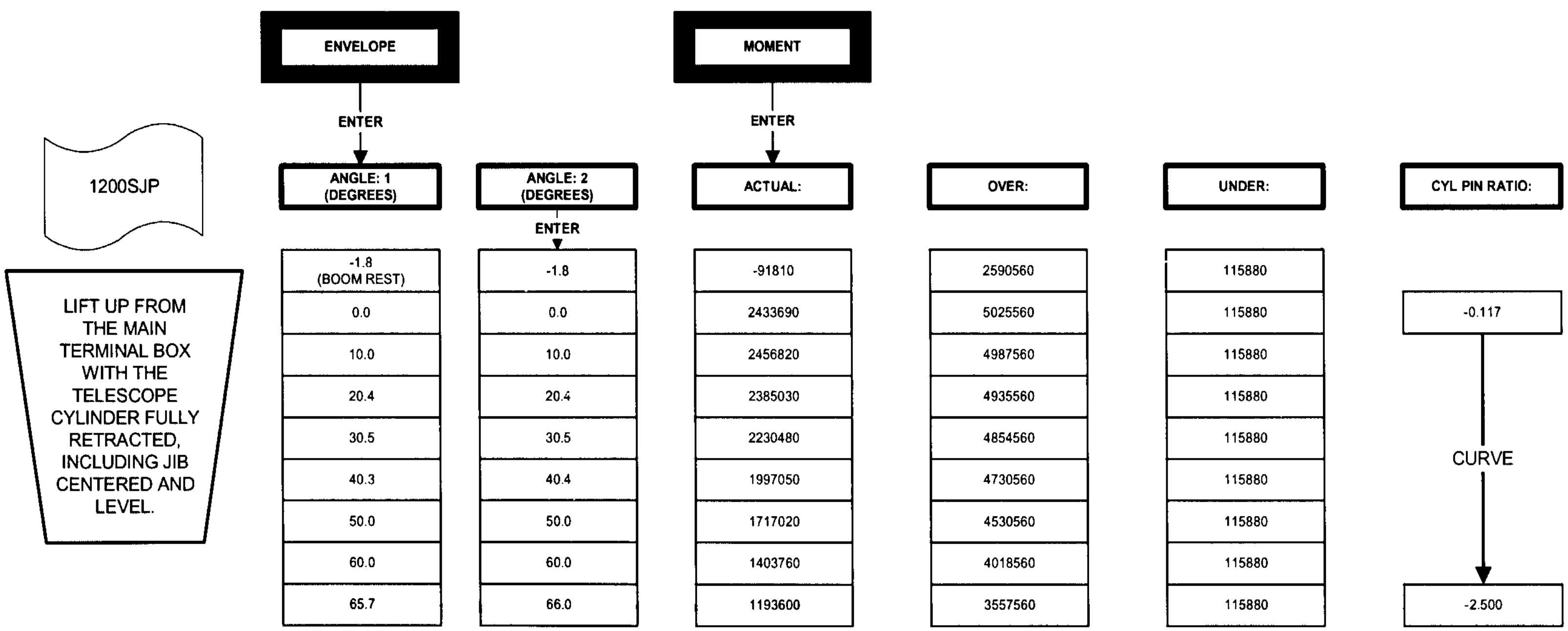
STEP	FAULT CODE/SYMPTOM	REPAIR	YES	NO
1	8/6 MOMENT PIN SENSOR FAULT The moment pin has reported a fault flag	Use the Analyzer, scroll to the DIAGNOSTICS menu, press ENTER, then scroll to the MOMENT menu, and press ENTER, check to see if PIN E FLAGS has any numbers on the screen display.	Replace load moment pin & Perform the Boom Sensor calibration process	Contact JLG Service Dept.

Table 6-14. Load Moment Pin Troubleshooting: New Moment Pin Detected Fault

STEP	FAULT CODE/SYMPTOM	REPAIR	YES	NO
1	8/6 NEW MOMENT PIN DETECTED FAULT A moment pin was detected on the system different from the one used to calibrate the machine.	Perform the Boom Sensor calibration process to accept the new load moment pin.	Verify BCS check and review all faults prior to contacting JLG Service Dept.	Contact JLG Service Dept.

MOMENT CHART

THE FOLLOWING READINGS WERE TAKEN FROM A NEWLY MANUFACTURED MACHINE MODEL 1200SJP, POSITIONED ON LEVEL TERRAIN (<1.5 DEGREE), 75 DEGREE TEMPERATURE AND NO WIND. THE CAPACITY SELECTOR SWITCH WAS POSITIONED ON 500 LB. WITH NO WEIGHT INSIDE THE PLATFORM OR ACCESSORY EQUIPPED! A/D ANGLE AND A/D LENGTH ARE ANALOG DIGITAL CONVERTED COUNTS, THESE COUNTS ARE A MATHEMATICAL FIGURE EQUAL TO VOLTAGE BEING SENSED AT THE GROUND MODULE FROM THE ANGLE SENSORS AND LENGTH SENSOR. WEATHER, TERRAIN AND AGE OF THE MACHINE WILL AFFECT THE FOLLOWING READINGS, KEEP IN MIND THESE READINGS WILL FLUXUATE WHEN VIEWING ON THE ANALYZER SCREEN. TO READ MOMENT VALUES YOU MUST SCROLL BACK TO THE ENVELOPE SUB LEVEL MENU TO VIEW THE BOOM ANGLES, THEN PRESS ESCAPE AND SCROLL TO THE MOMENT SUB LEVEL MENU TO VIEW ACTUAL, OVER, UNDER AND CYLINDER PIN RATIO.



ANGLE: 1 (DEGREES)	ANGLE: 2 (DEGREES)	ACTUAL:	OVER:	UNDER:	CYL PIN RATIO:
-1.8 (BOOM REST)	-1.8	-91810	2590560	115880	
0.0	0.0	2433690	5025560	115880	-0.117
10.0	10.0	2456820	4987560	115880	
20.4	20.4	2385030	4935560	115880	
30.5	30.5	2230480	4854560	115880	CURVE
40.3	40.4	1997050	4730560	115880	
50.0	50.0	1717020	4530560	115880	
60.0	60.0	1403760	4018560	115880	
65.7	66.0	1193600	3557560	115880	-2.500

Figure 6-32. Moment Chart

SECTION 7. BASIC ELECTRICAL INFORMATION, ELECTRICAL & HYDRAULIC 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. This manual assumes reasonable measuring device accuracy (at least 1%).

Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

Min/Max

Use of the "Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read the Voltage applied to a solenoid when it is only operational while a switch, far from the solenoid and meter, is held down.

Polarity

Getting a negative Voltage or current reading when expecting a positive reading frequently means the leads are reversed. Check what reading is expected, the location of the signal and that the leads are connected to the device under test correctly. Also check that the lead on the "COM" port goes to the Ground or negative side of the signal and the lead on the other port goes to the positive side of the signal.

Scale

M = Mega = 1,000,000 * (Displayed Number)

k = kilo = 1,000 * (Displayed Number)

m = milli = (Displayed Number) / 1,000

μ = micro = (Displayed Number) / 1,000,000

Example: 1.2 kW = 1200 W
Example: 50 mA = 0.05 A

Voltage Measurement

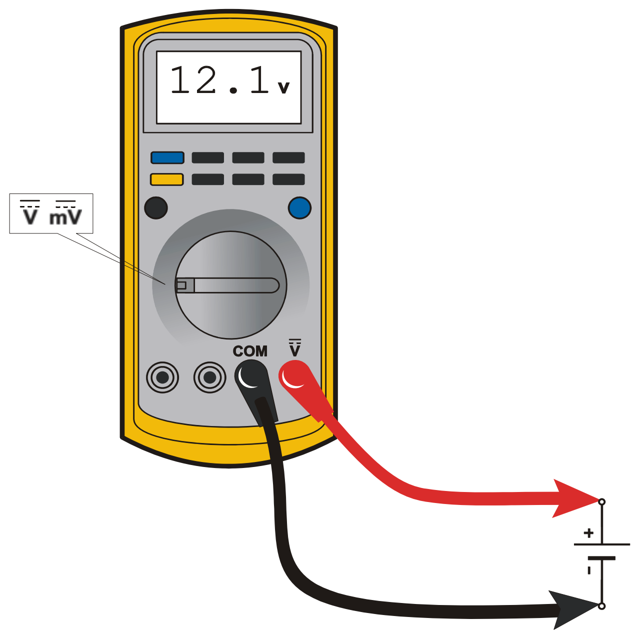


Figure 7-1. Voltage Measurement (DC)

- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)
- Use firm contact with meter leads

Resistance Measurement

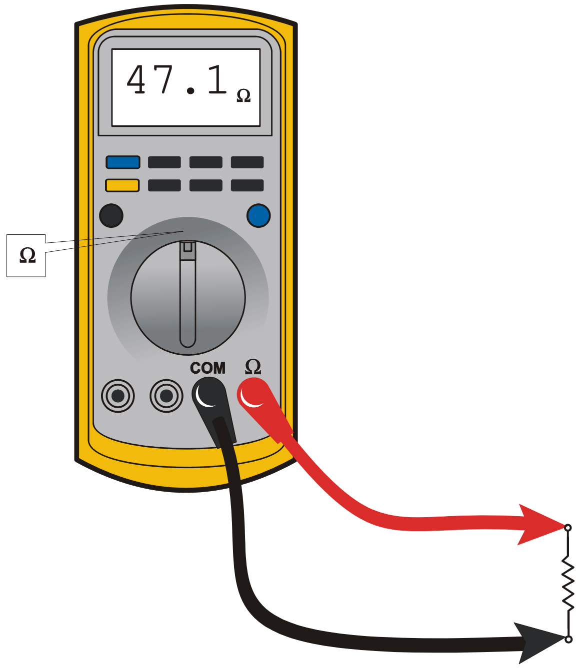


Figure 7-2. Resistance Measurement

- First test meter and leads by touching leads together. Resistance should read a short circuit (very low resistance)
- Circuit power must be turned OFF before testing resistance
- Disconnect component from circuit before testing
- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)
- Use firm contact with meter leads

Continuity Measurement

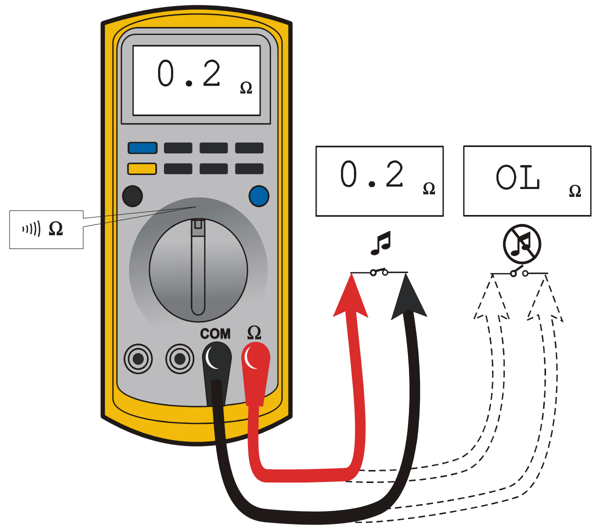


Figure 7-3. Continuity Measurement

- Some meters require a separate button press to enable audible continuity testing
- Circuit power must be turned OFF before testing continuity
- Disconnect component from circuit before testing
- Use firm contact with meter leads
- First test meter and leads by touching leads together. Meter should produce an audible alarm, indicating continuity

Current Measurement

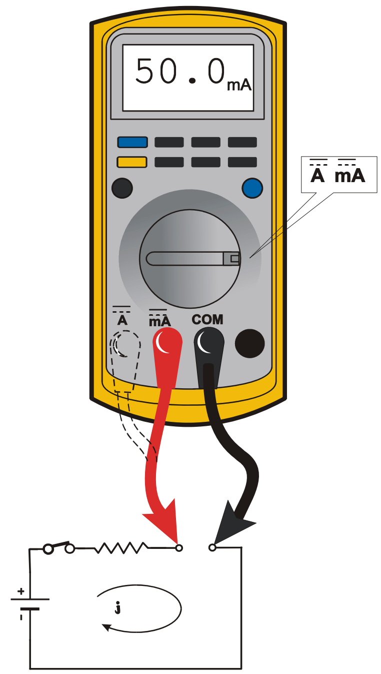


Figure 7-4. Current Measurement (DC)

- Set up the meter for the expected current range
- Be sure to connect the meter leads to the correct jacks for the current range you have selected
- If meter is not auto ranging, set it to the correct range (See multi meter's operation manual)
- Use firm contact with meter leads

7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

Silicone Dielectric Compound must be used on all electrical 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. This procedure applies to all plug connections not enclosed in a box. Silicone grease should not be applied to connectors with external seals.

1. To prevent oxidation, silicone grease must be packed completely around male and female pins on the inside of the connector prior to assembly. This is most easily achieved by using a syringe.

NOTE: *Over a period of time, oxidation increases electrical resistance at the connection, eventually causing circuit failure.*

2. To prevent shorting, silicone grease must be packed around each wire where they enter the outside of the connector housing. Also, silicone grease must be applied at the joint where the male and female connectors come together. Any other joints (around strain reliefs, etc.) where water could enter the connector should also be sealed.

NOTE: *This condition is especially common when machines are pressure washed since the washing solution is much more conductive than water.*

3. Anderson connectors for the battery boxes and battery chargers should have silicone grease applied to the contacts only.

NOTE: *Curing-type sealants might also be used to prevent shorting and would be less messy, but would make future pin removal more difficult.*

7.4 AMP CONNECTOR

Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on the inside of the connector after the mating of the housing to the header. This is easily achieved by using a syringe to fill the header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling the housing to the header, it is possible that the housing will become air locked, thus preventing the housing latch from engaging.
2. Pierce one of the unused wire seals to allow the trapped air inside the housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 7-5.). Proceed as follows:

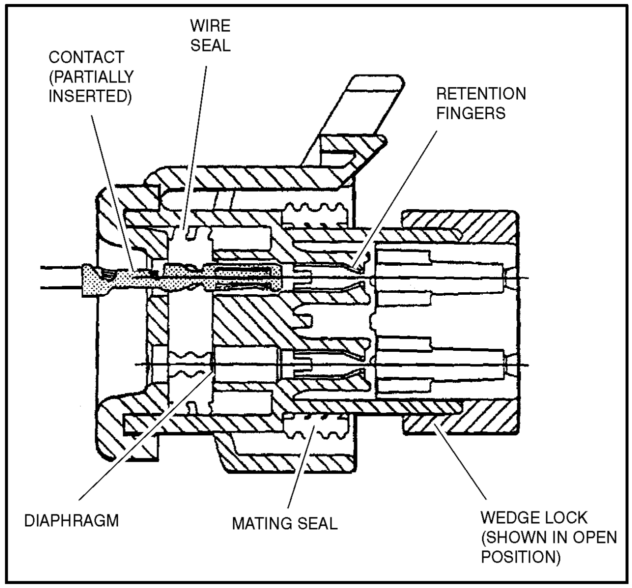


Figure 7-5. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-7.).
2. Pull back on the contact wire with a force of 1 or 2 lbs. to be sure the retention fingers are holding the contact (See Figure 7-7.).

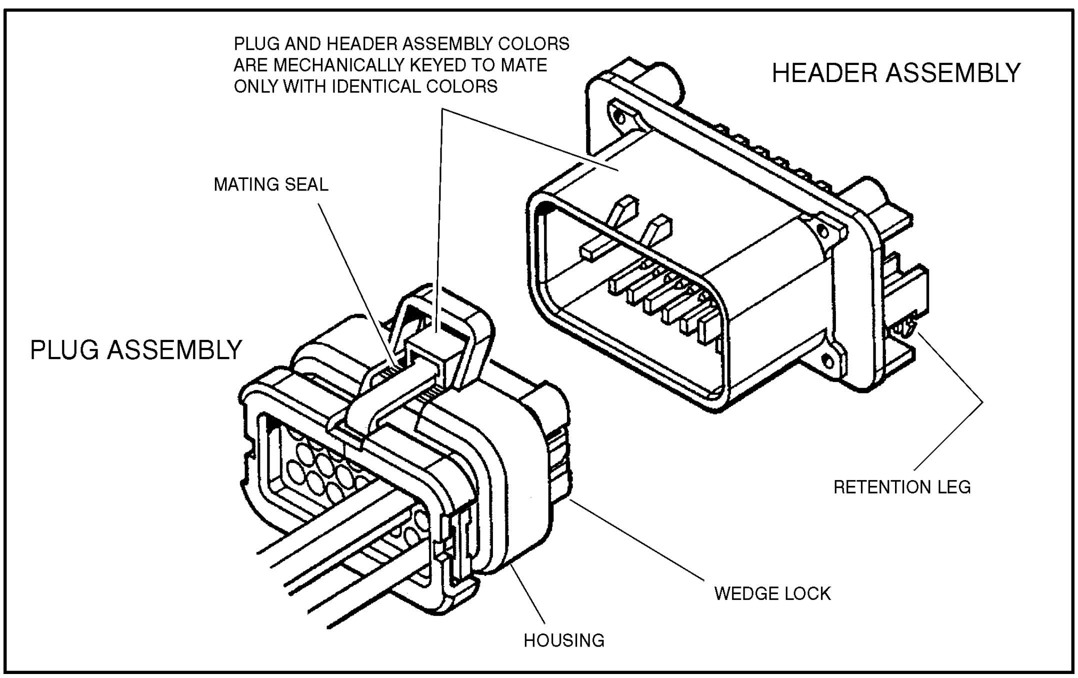


Figure 7-6. AMP Connector

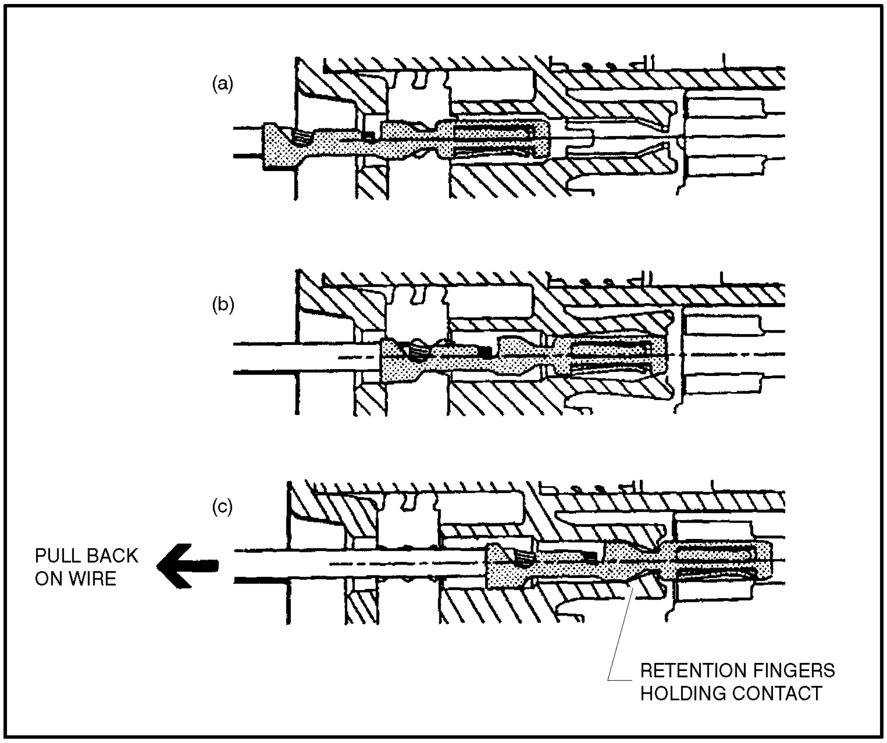


Figure 7-7. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (See Figure 7-8.).

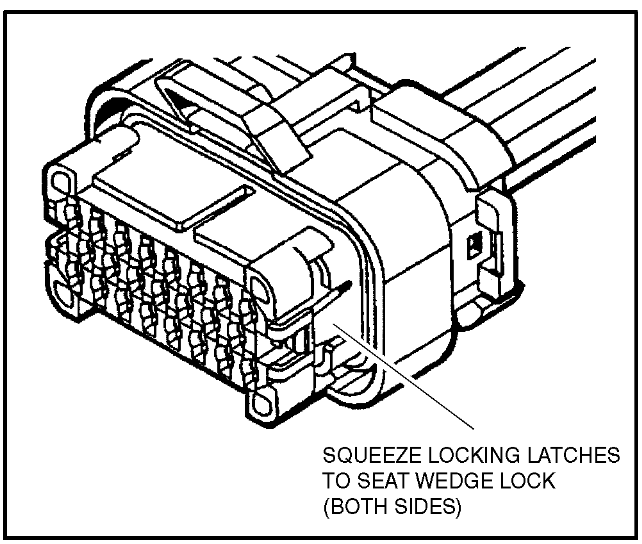


Figure 7-8. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-9.).

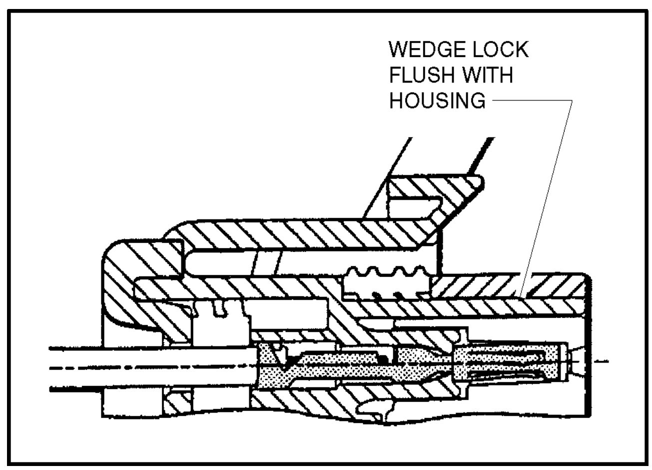


Figure 7-9. Connector Assembly Figure 4

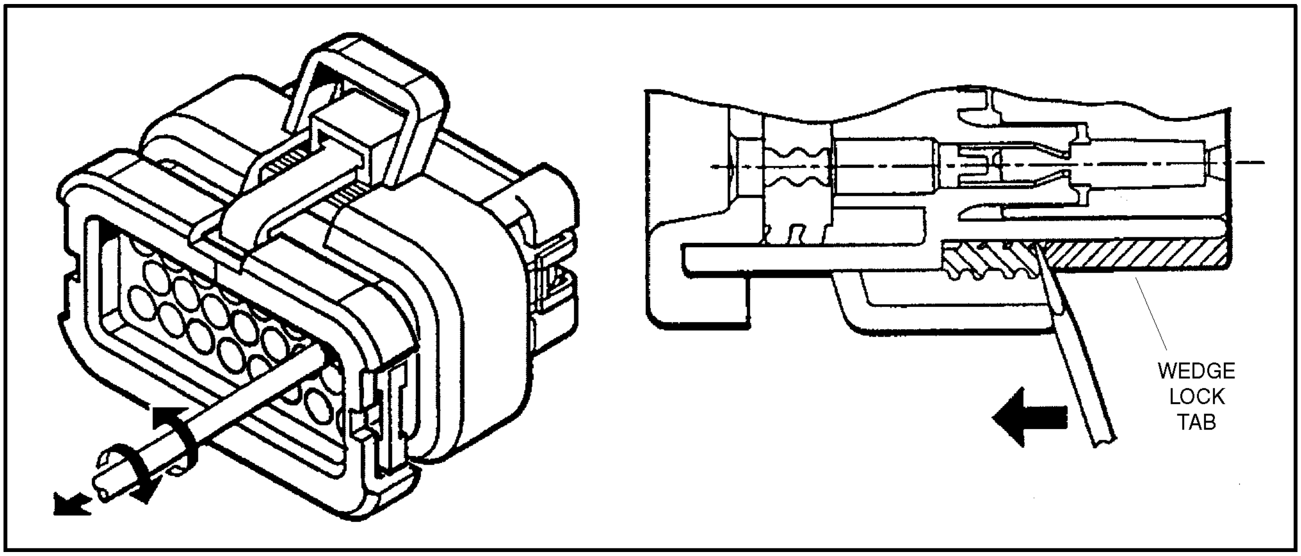


Figure 7-10. Connector Disassembly

Disassembly

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

DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

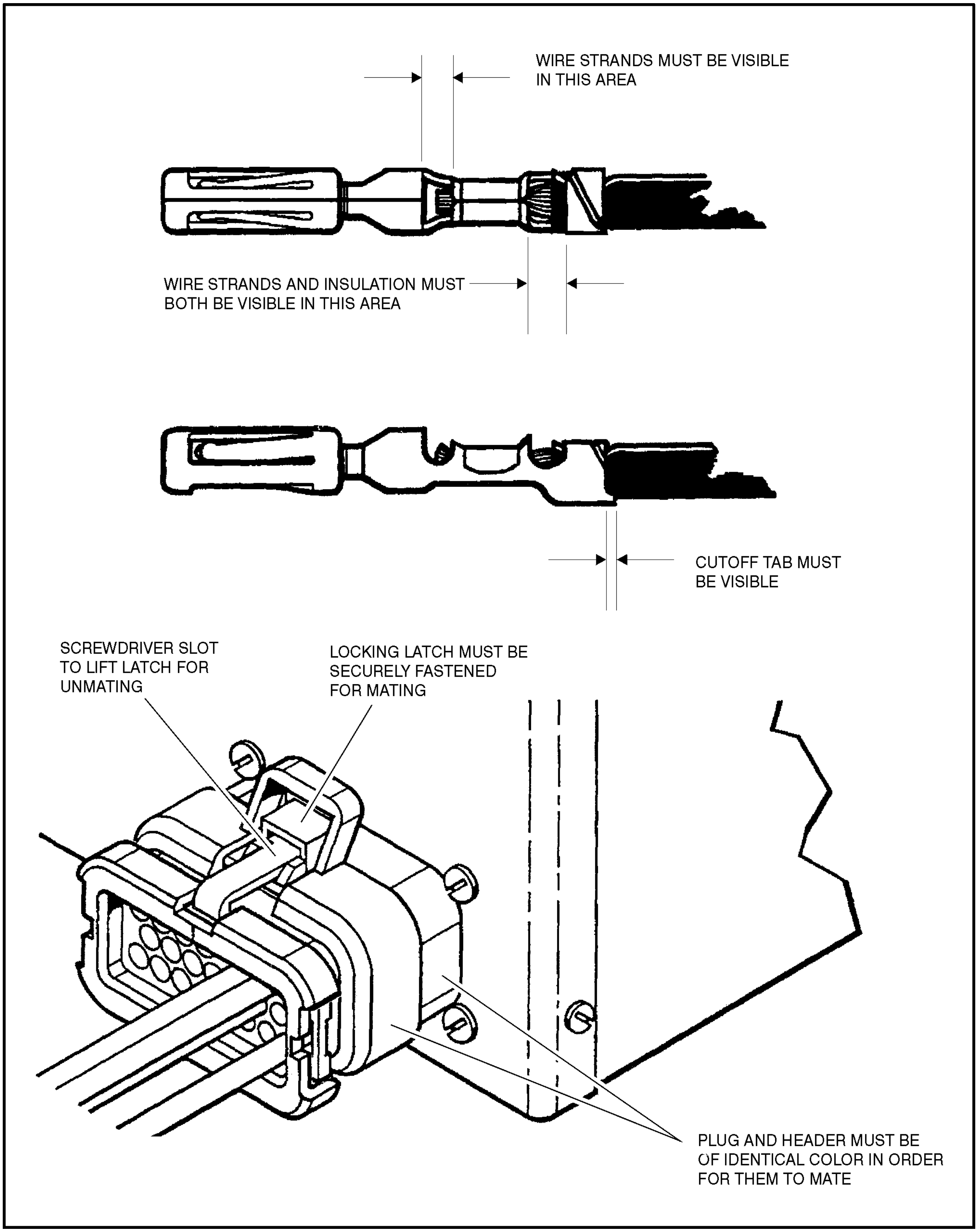


Figure 7-11. Connector Installation

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly


A


B


C


D

Figure 7-12. DT/DTP Contact Installation

1. Grasp crimped contact about 25mm behind the contact barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that it is properly locked in place.
4. Once all contacts are in place, insert wedgelock with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. Thy may go in either way.

NOTE: *The receptacle is shown - use the same procedure for plug.*

DT/DTP Series Disassembly


A


B


C

Figure 7-13. 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

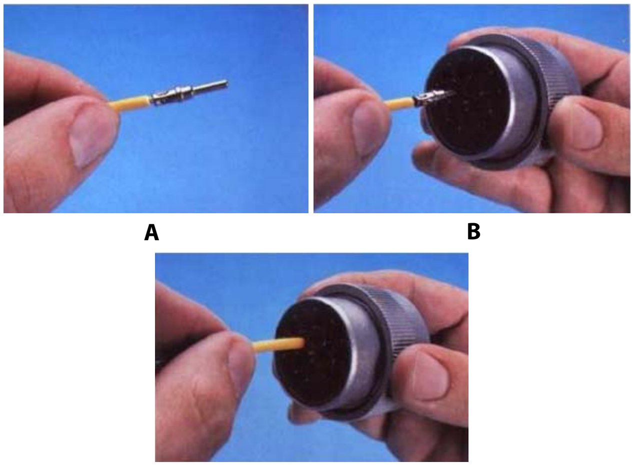


Figure 7-14. HD/HDP Contact Installation

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.

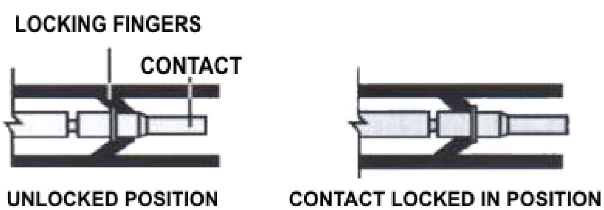


Figure 7-15. HD/HDP Locking Contacts Into Position

NOTE: *For unused wire cavities, insert sealing plugs for full environmental sealing*

HD30/HDP20 Series Disassembly

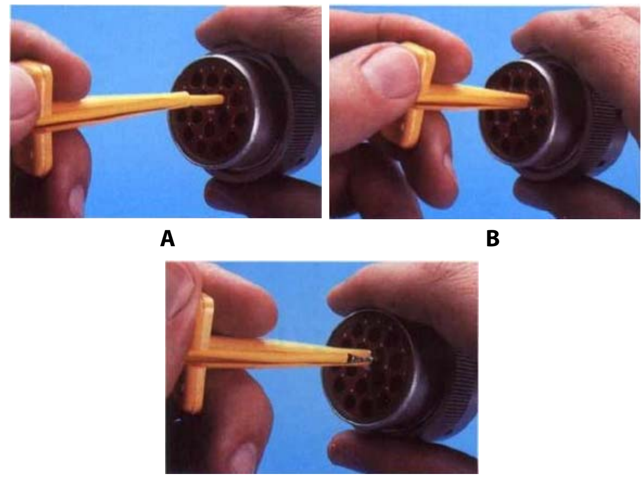


Figure 7-16. HD/HDP Contact Removal

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

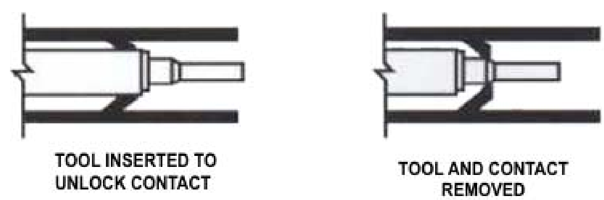


Figure 7-17. HD/HDP Unlocking Contacts

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

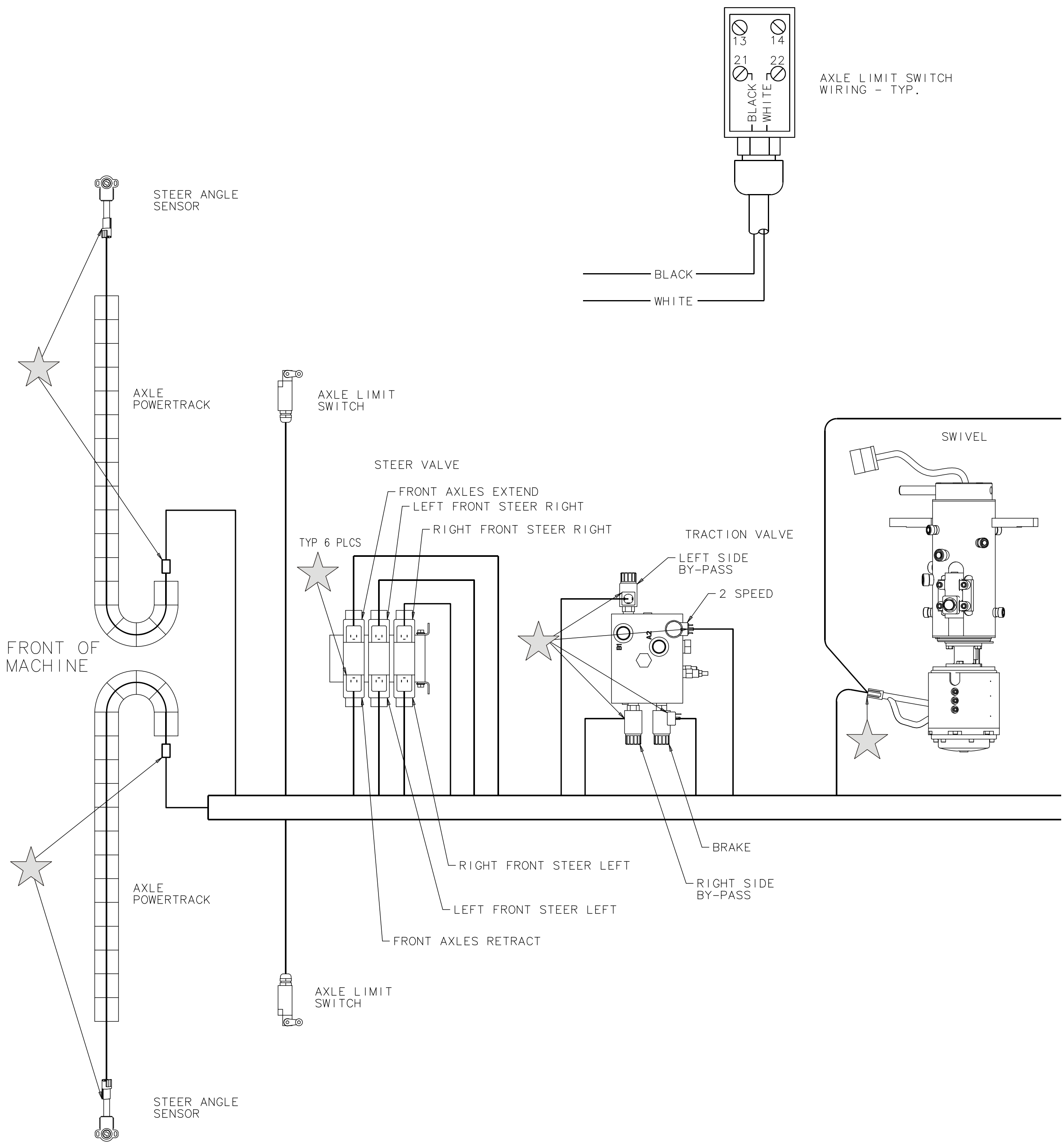


Figure 7-18. Chassis Electrical Components - Sheet 1 of 2

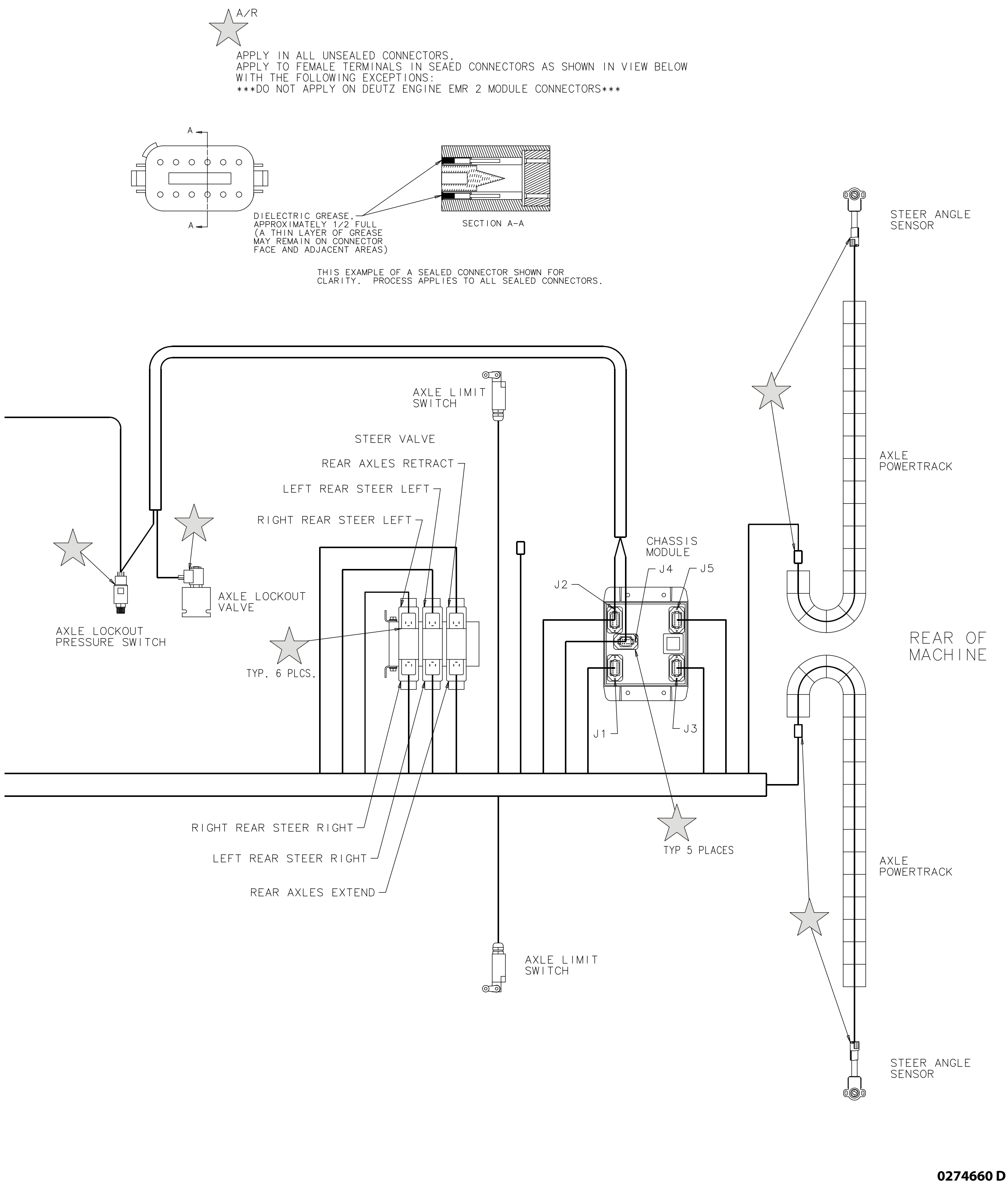


Figure 7-19. Chassis Electrical Components - Sheet 2 of 2

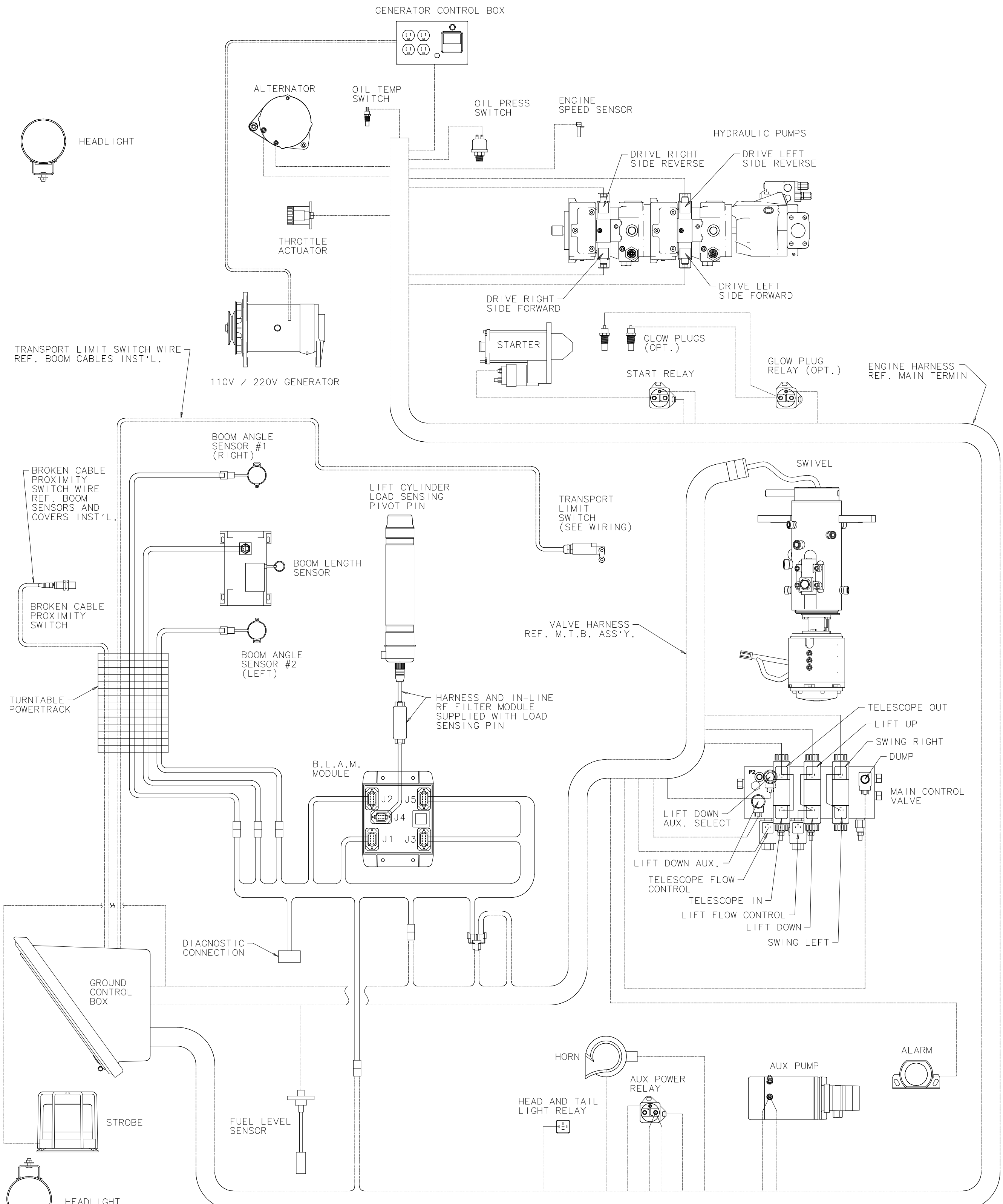


Figure 7-20. Turntable Electrical Components - Prior to S/N 87579 - Sheet 1 of 2

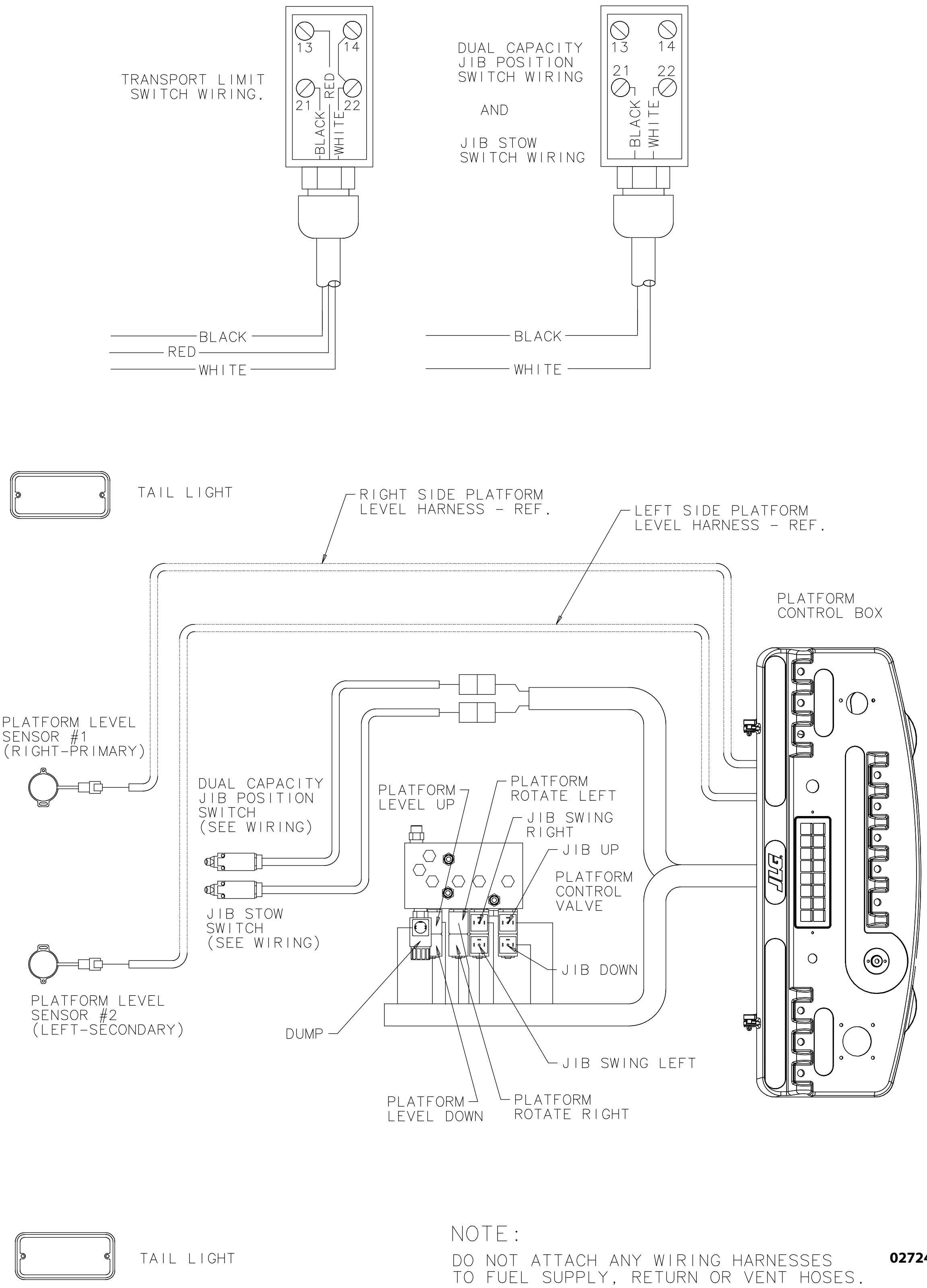


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Figure 7-21. Turntable Electrical Components - Prior to S/N 87579 - Sheet 2 of 2

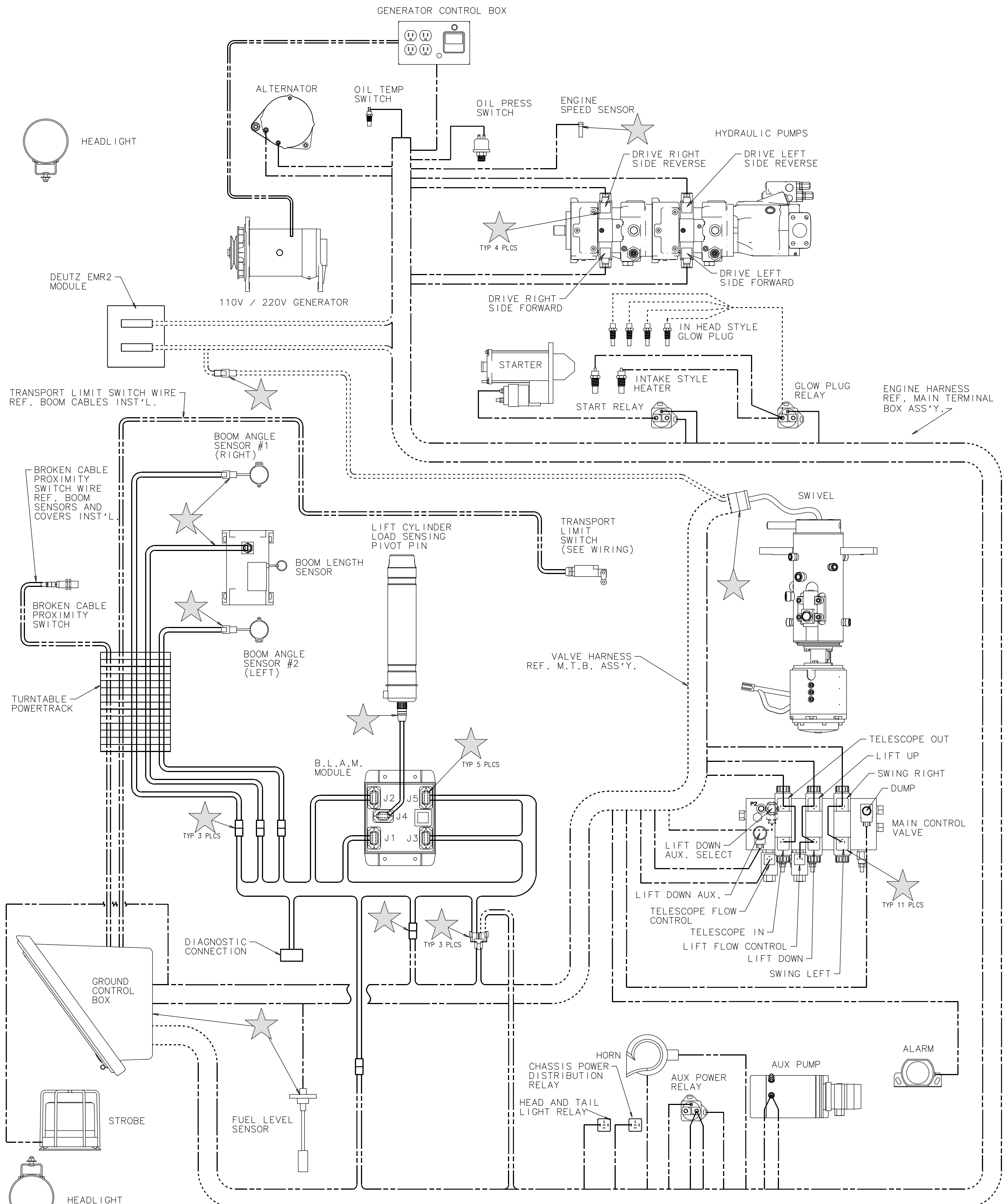

Figure 7-22. Turntable Electrical Components - S/N 87579 to Present - Sheet 1 of 2

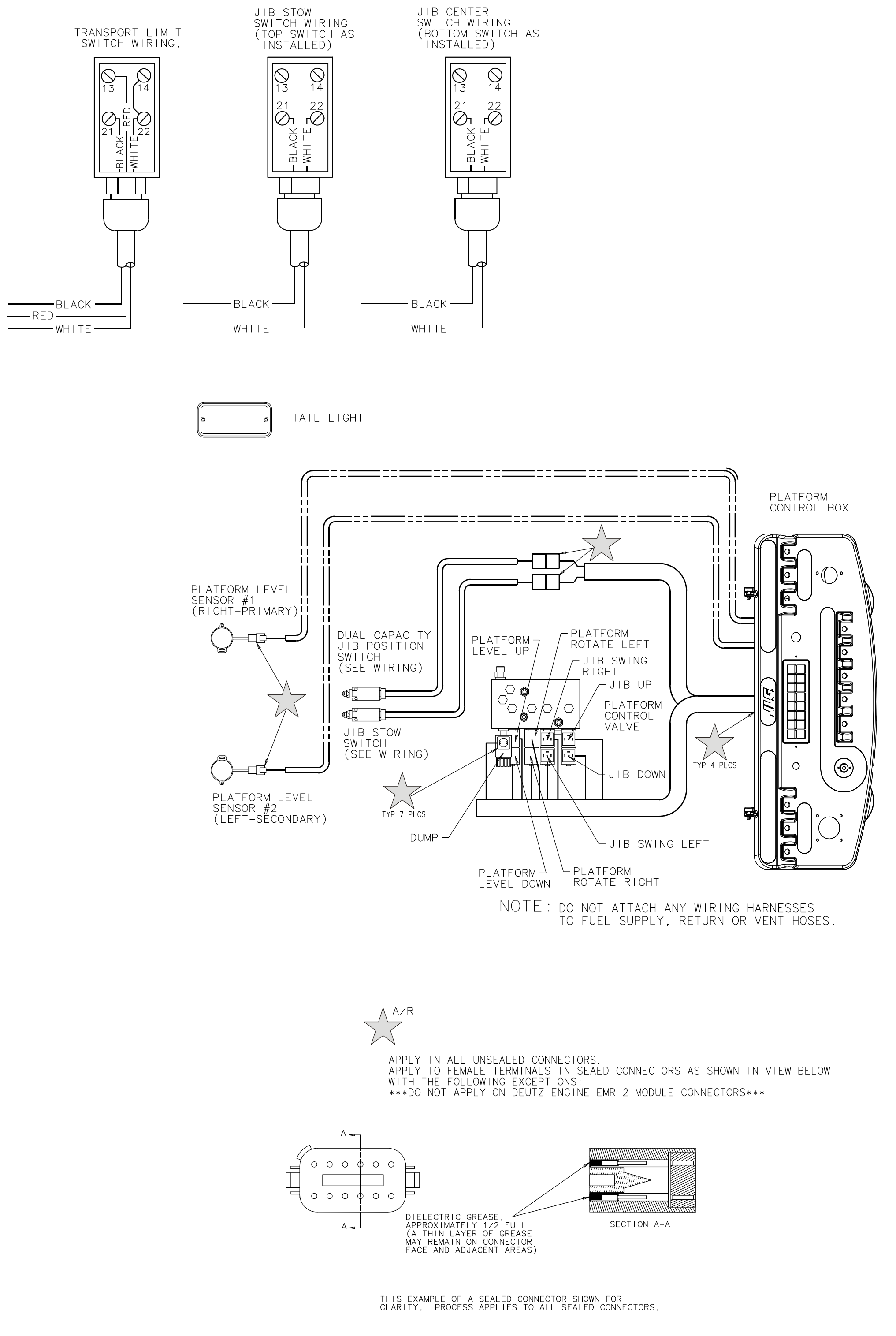

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Figure 7-23. Turntable Electrical Components - S/N 87579 to Present - Sheet 2 of 2

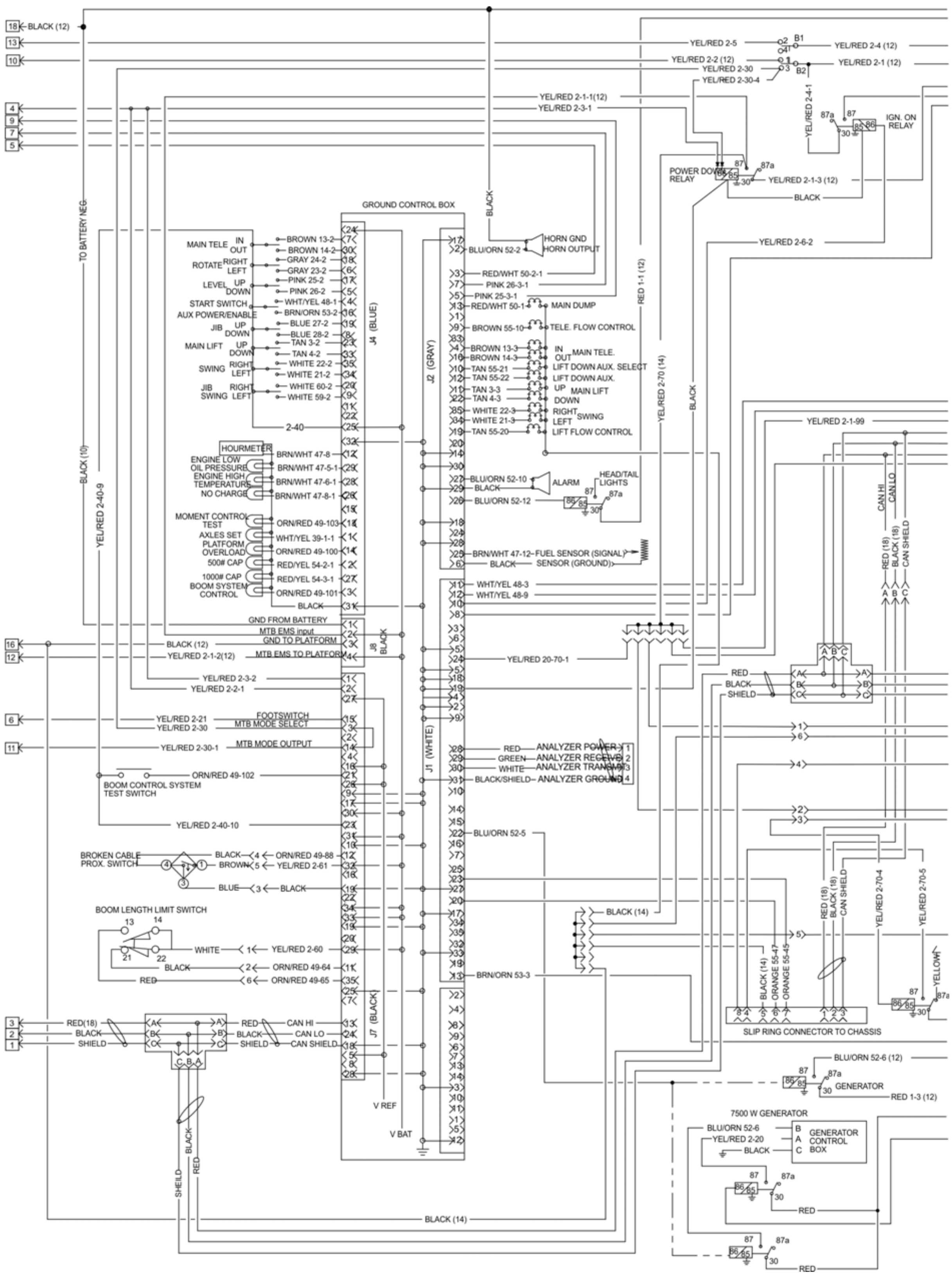

Figure 7-24. Electrical Schematic - Deutz EMR2 - Sheet 1 of 6

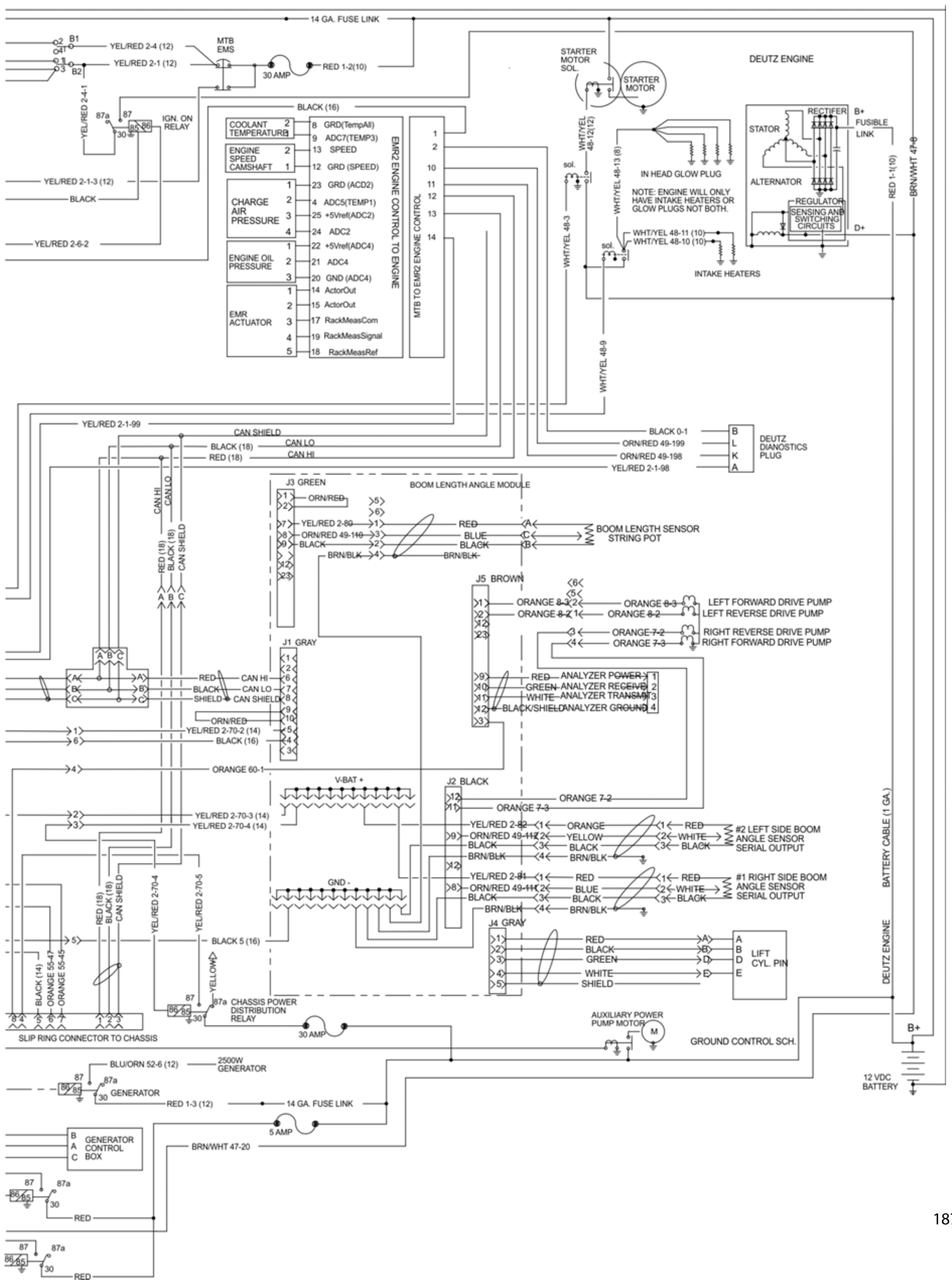

Figure 7-25. Electrical Schematic - Deutz EMR2 - Sheet 2 of 6

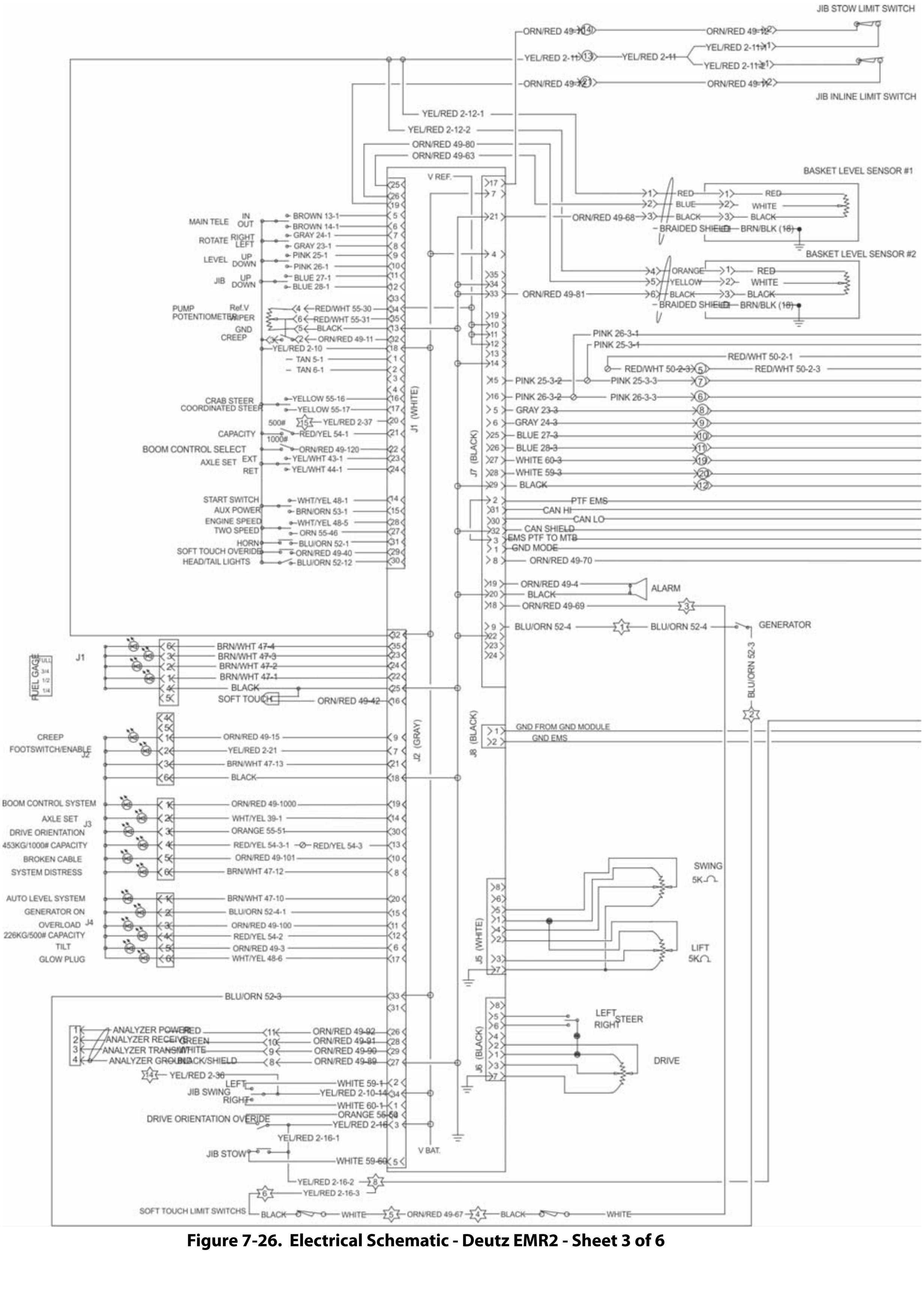

Figure 7-26. Electrical Schematic - Deutz EMR2 - Sheet 3 of 6

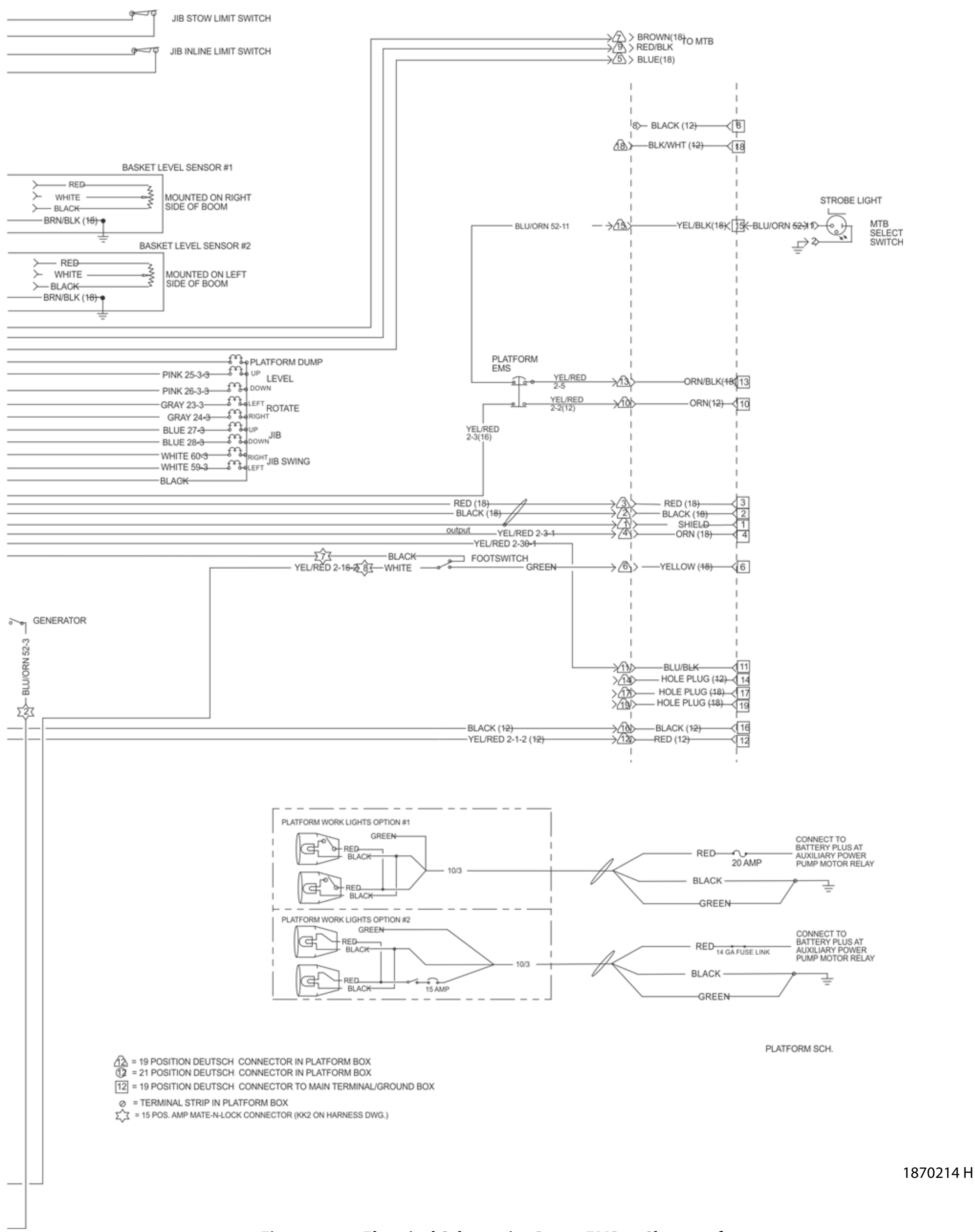

Figure 7-27. Electrical Schematic - Deutz EMR2 - Sheet 4 of 6

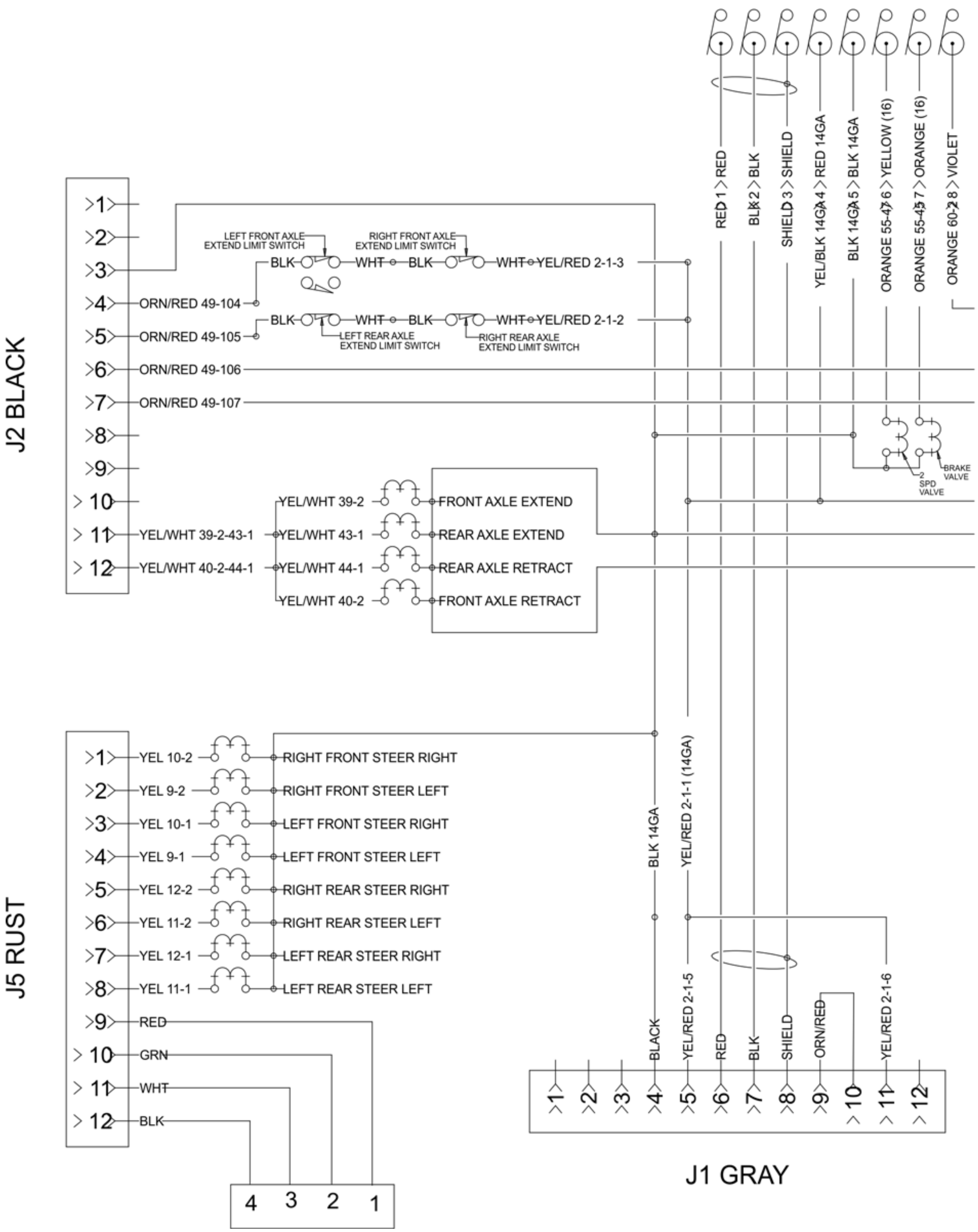

Figure 7-28. Electrical Schematic - Deutz EMR2 - Sheet 5 of 6

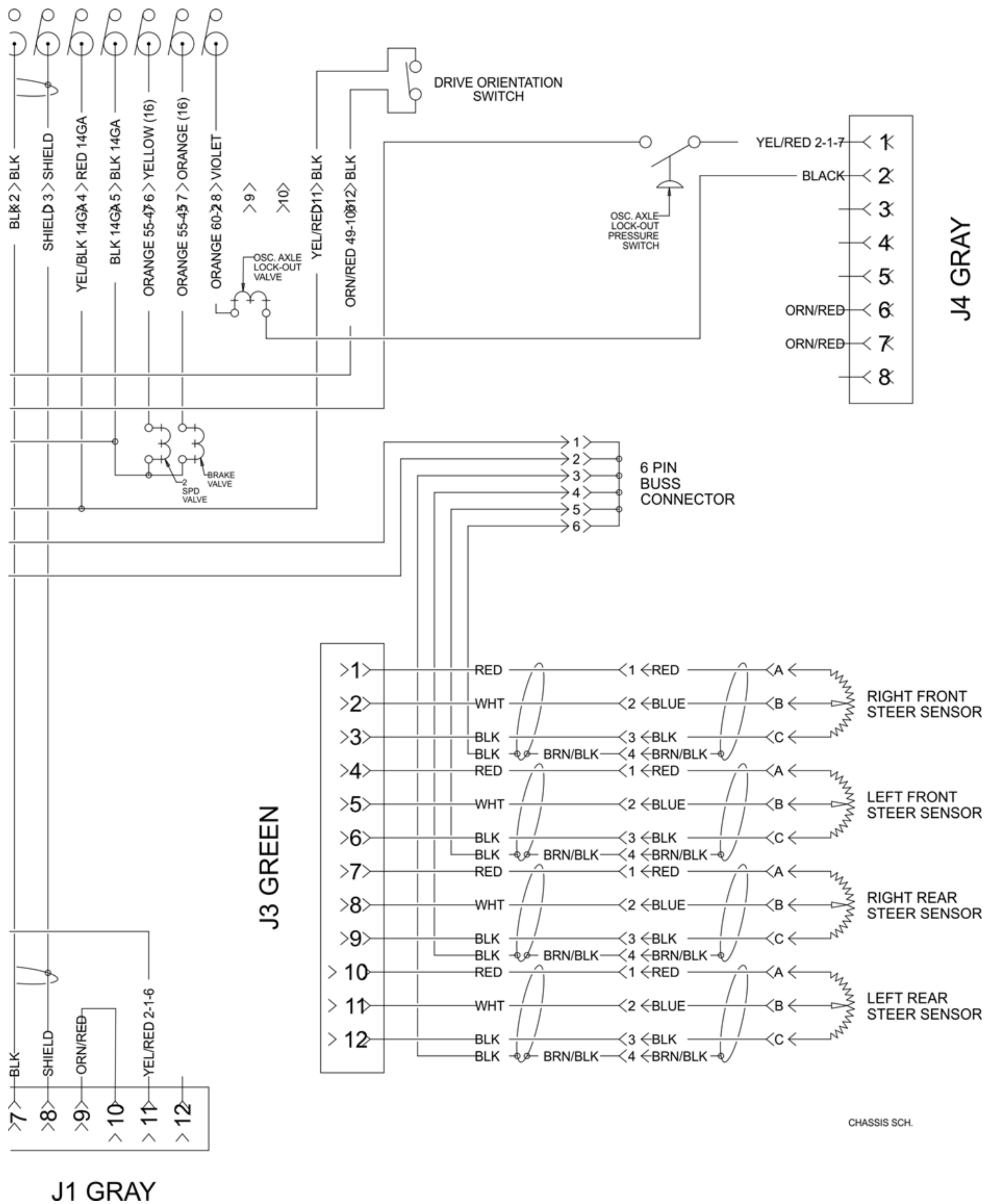

Figure 7-29. Electrical Schematic - Deutz EMR2 - Sheet 6 of 6

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Figure 7-30. Electrical Schematic - Sheet 1 of 13

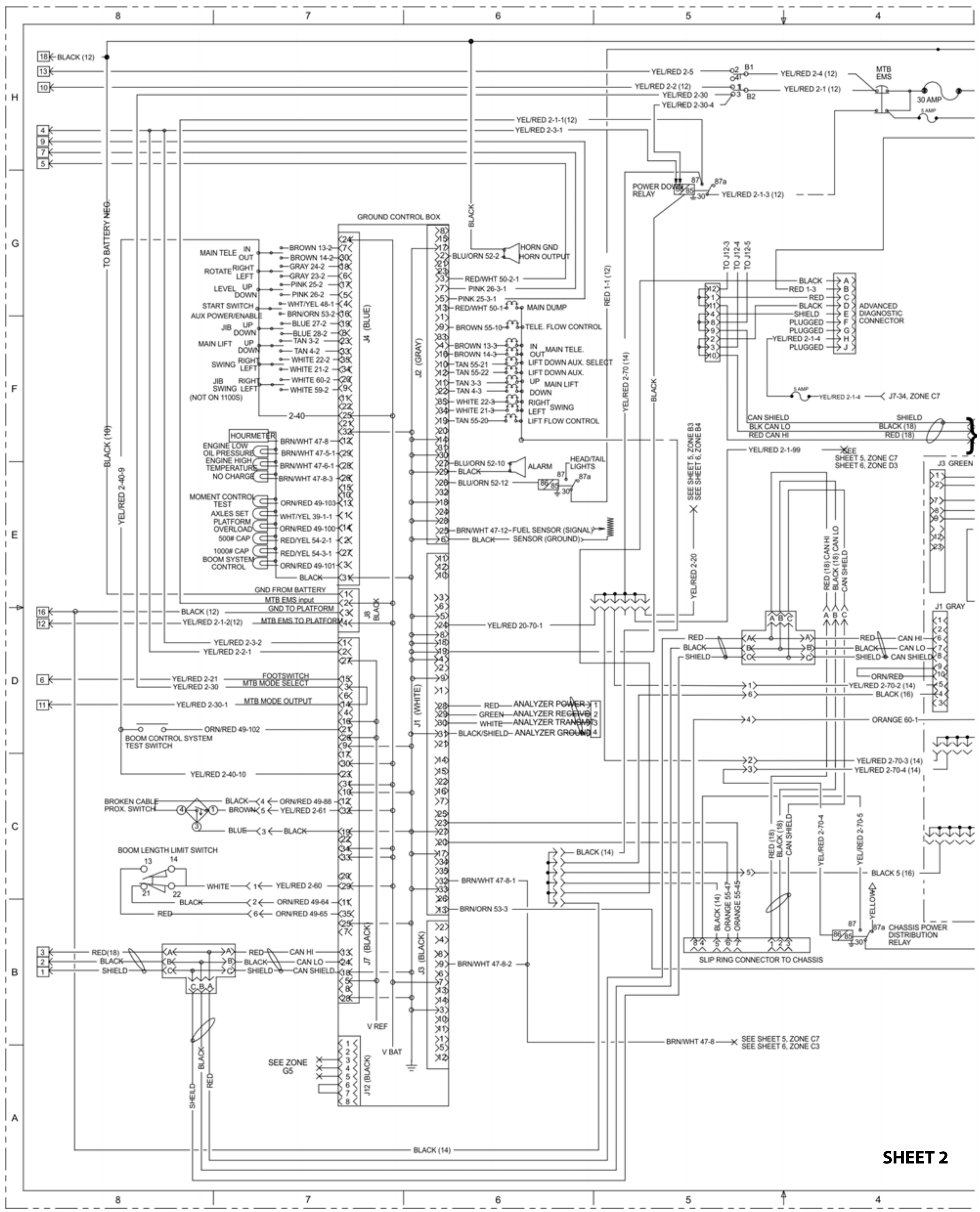

Figure 7-31. Electrical Schematic - Sheet 2 of 13

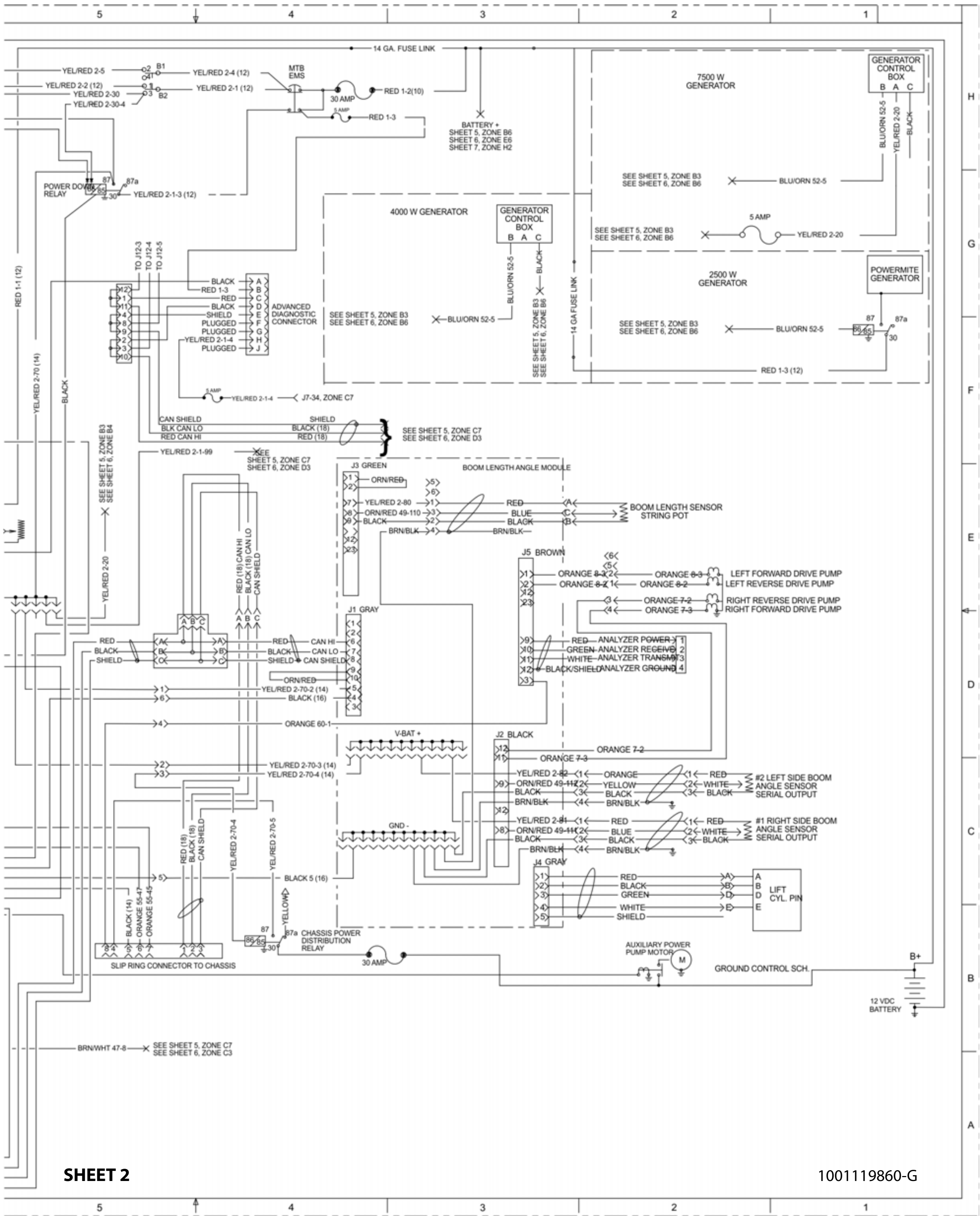

Figure 7-32. Electrical Schematic - Sheet 3 of 13

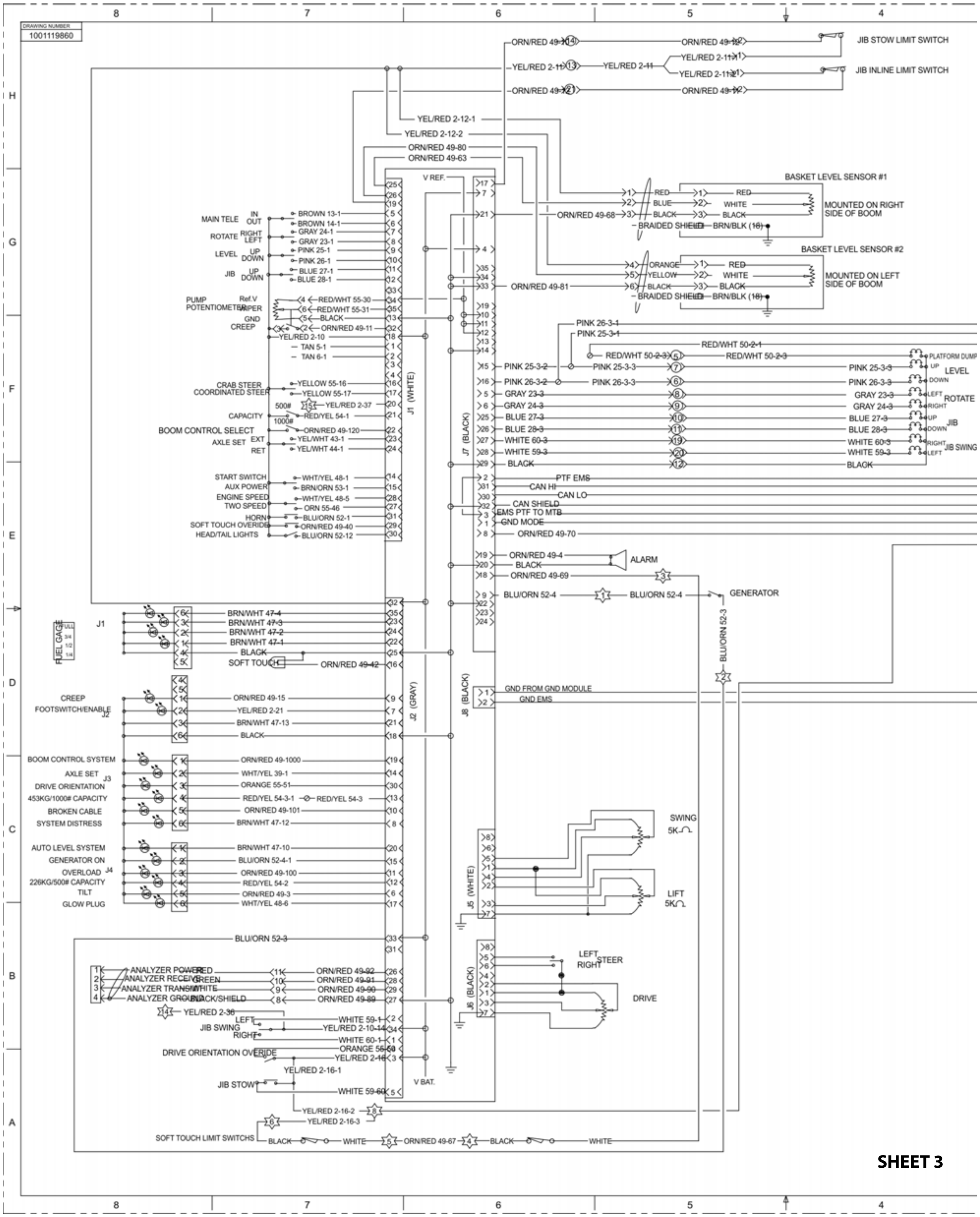

Figure 7-33. Electrical Schematic - Sheet 4 of 13

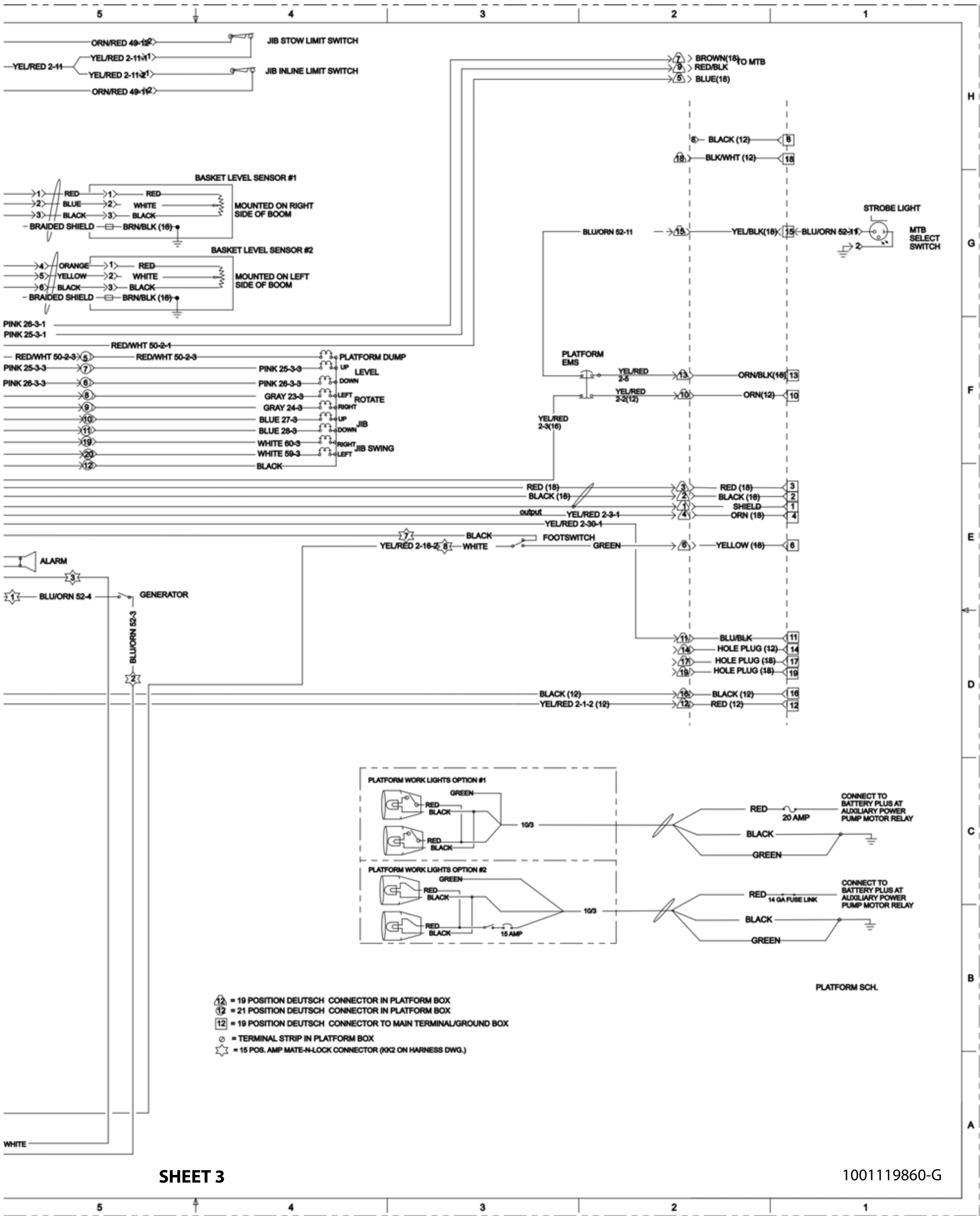

Figure 7-34. Electrical Schematic - Sheet 5 of 13

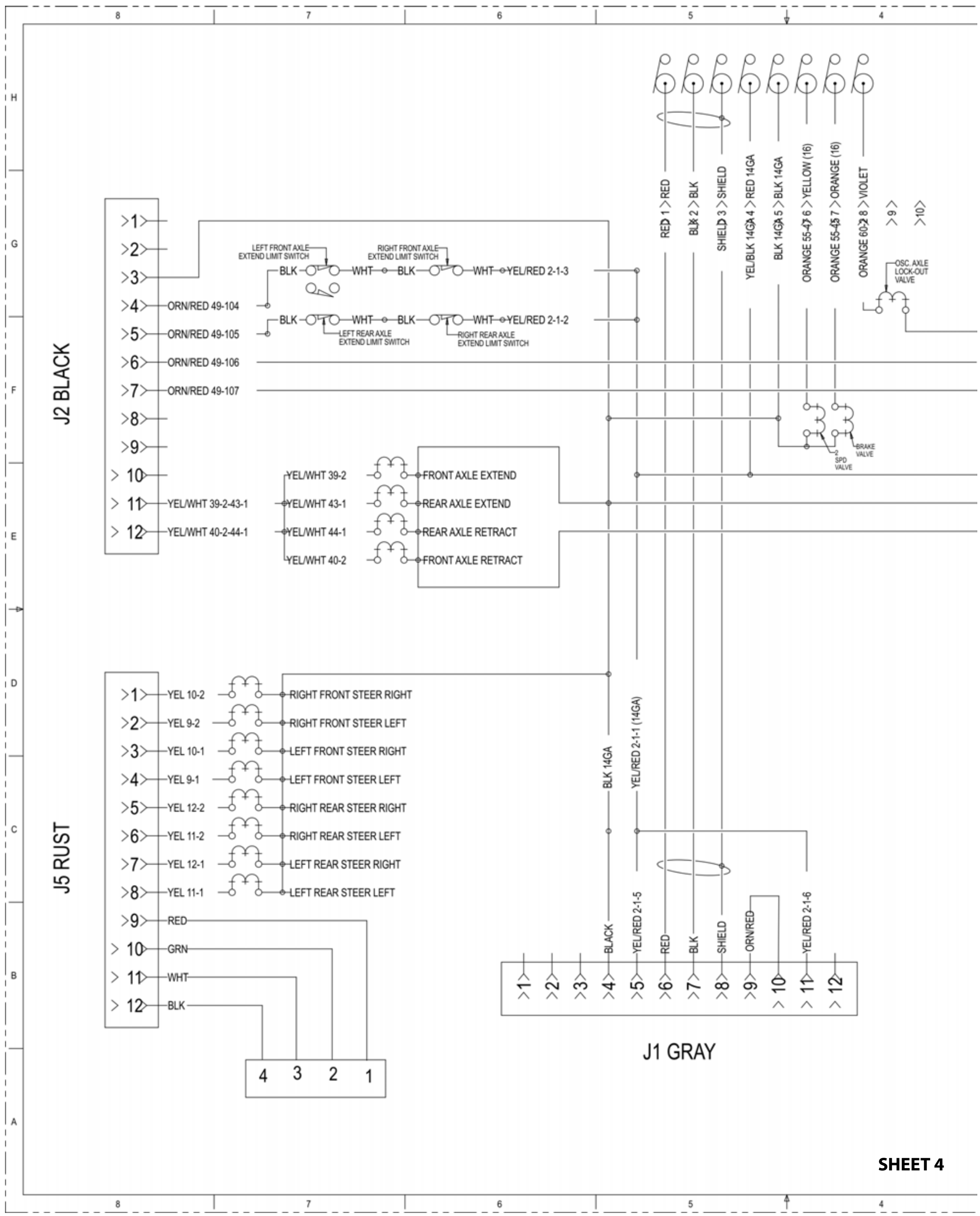

Figure 7-35. Electrical Schematic - Sheet 6 of 13

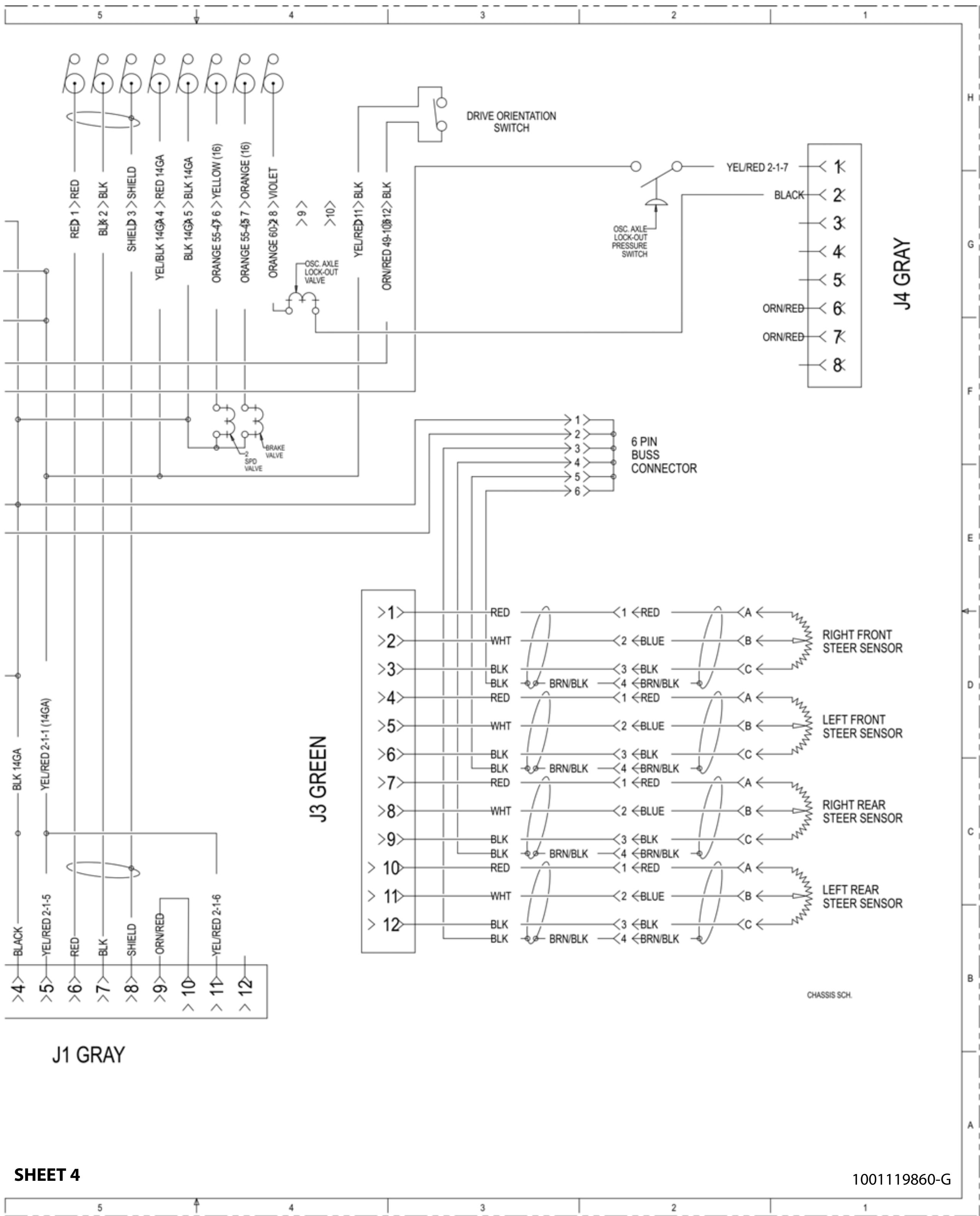

Figure 7-36. Electrical Schematic - Sheet 7 of 13

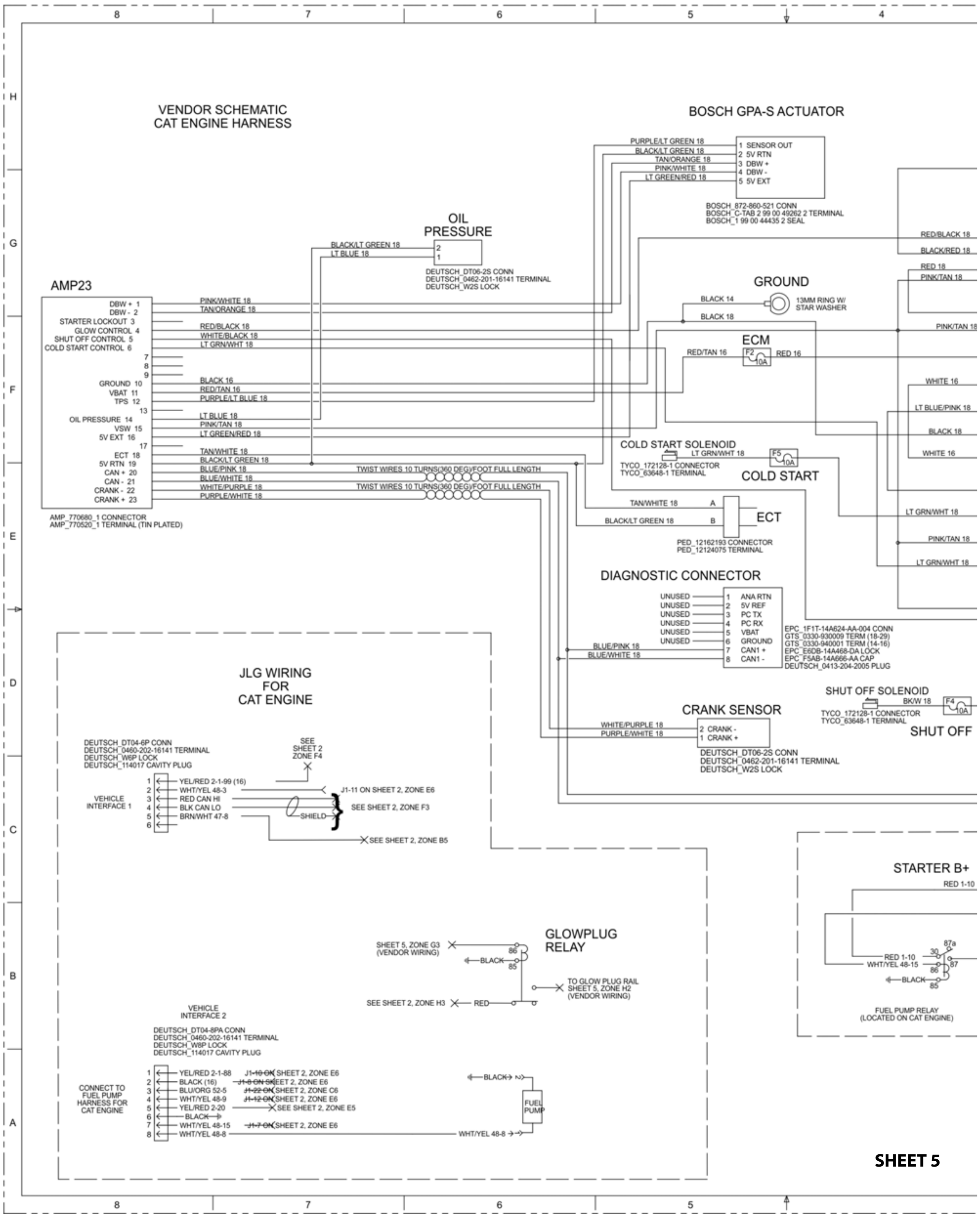

Figure 7-37. Electrical Schematic - Sheet 8 of 13

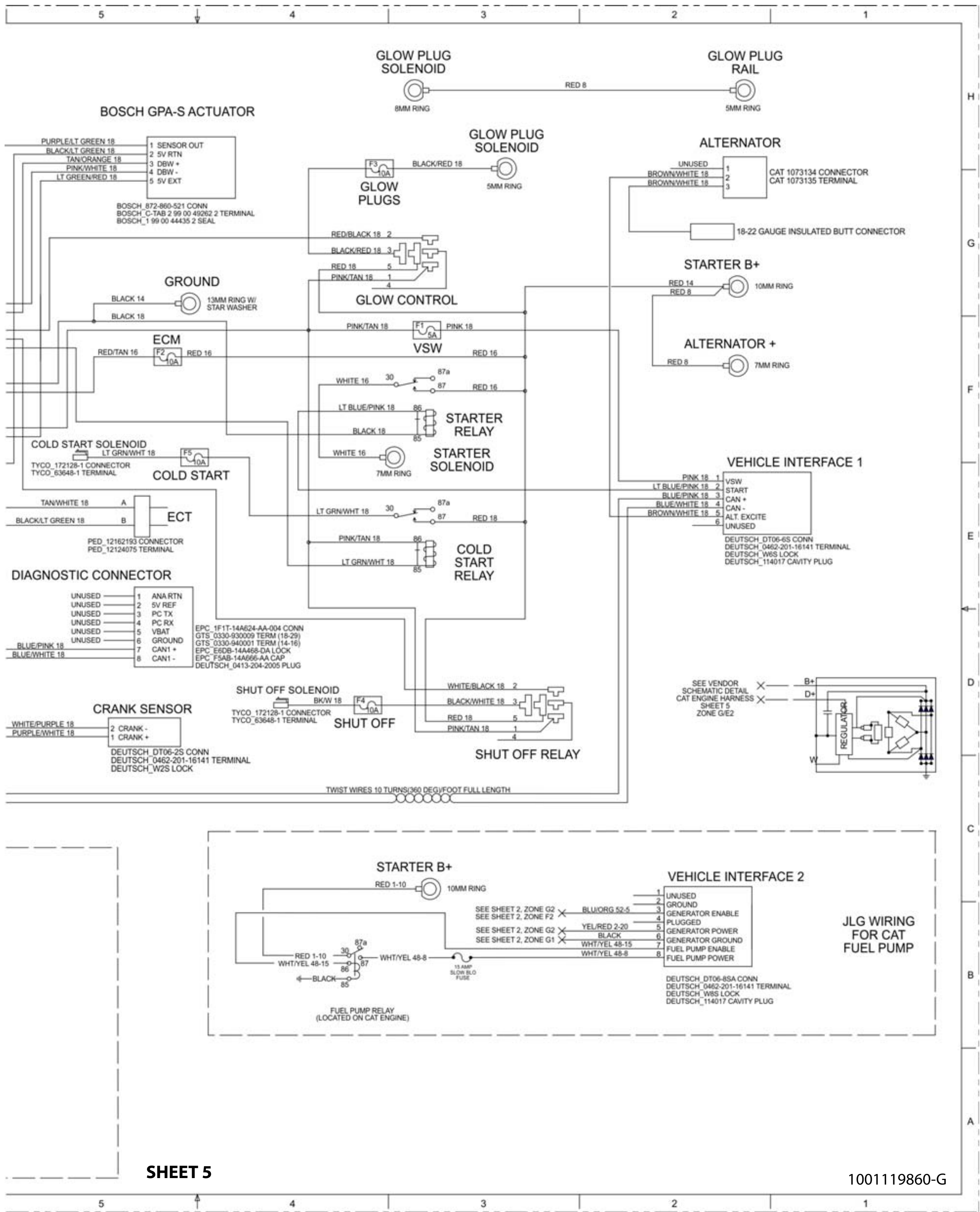

Figure 7-38. Electrical Schematic - Sheet 9 of 13

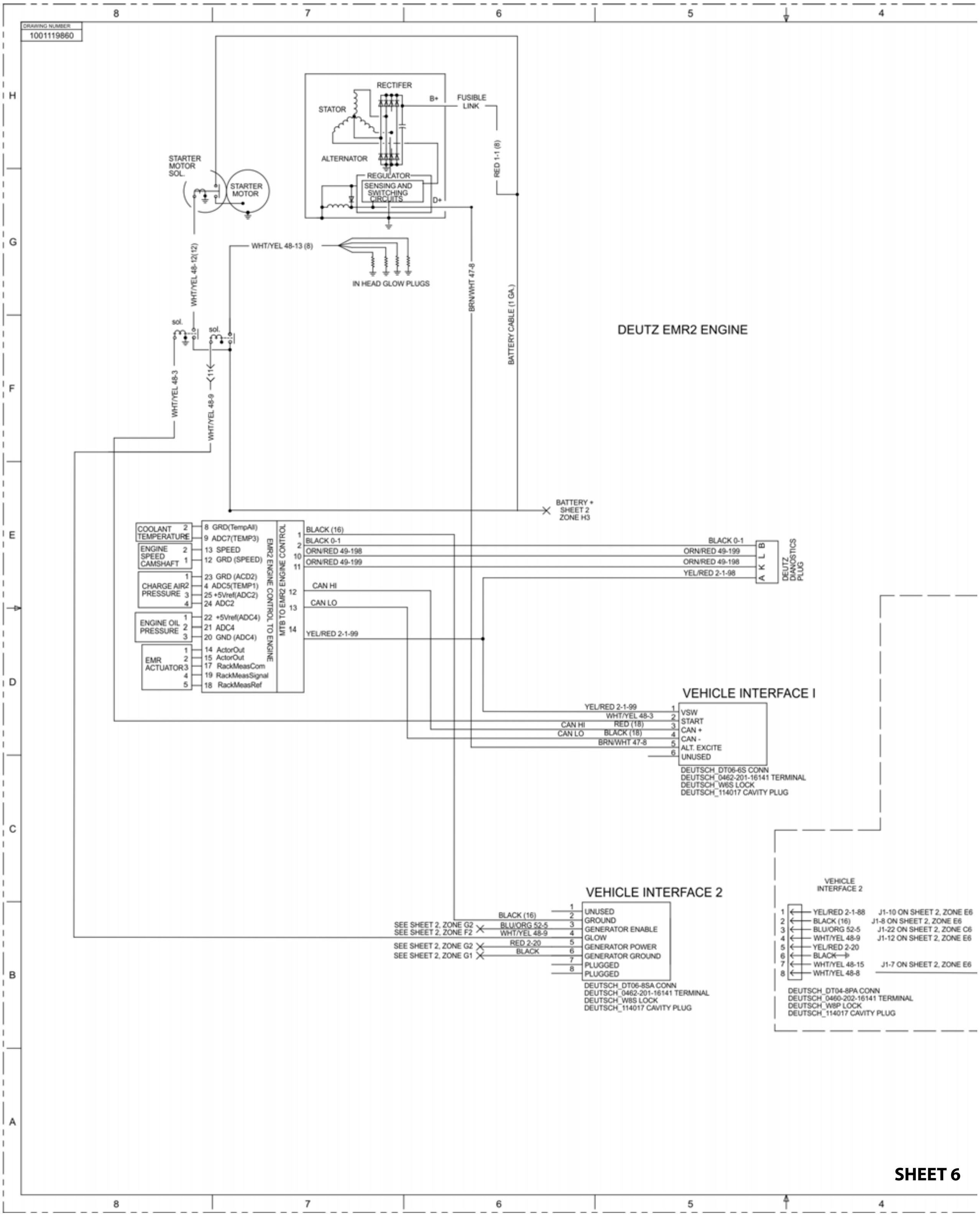

Figure 7-39. Electrical Schematic - Sheet 10 of 13

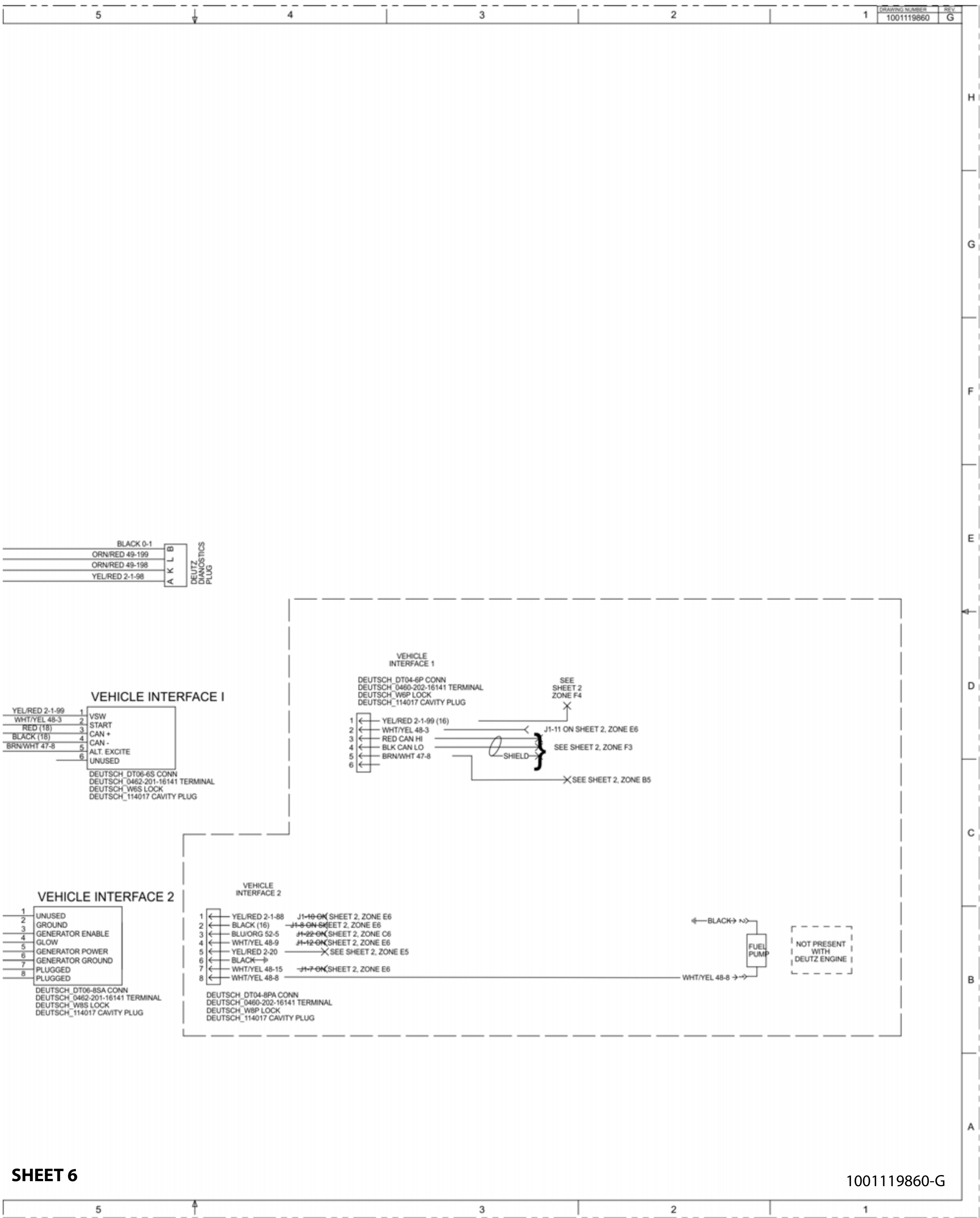

Figure 7-40. Electrical Schematic - Sheet 11 of 13

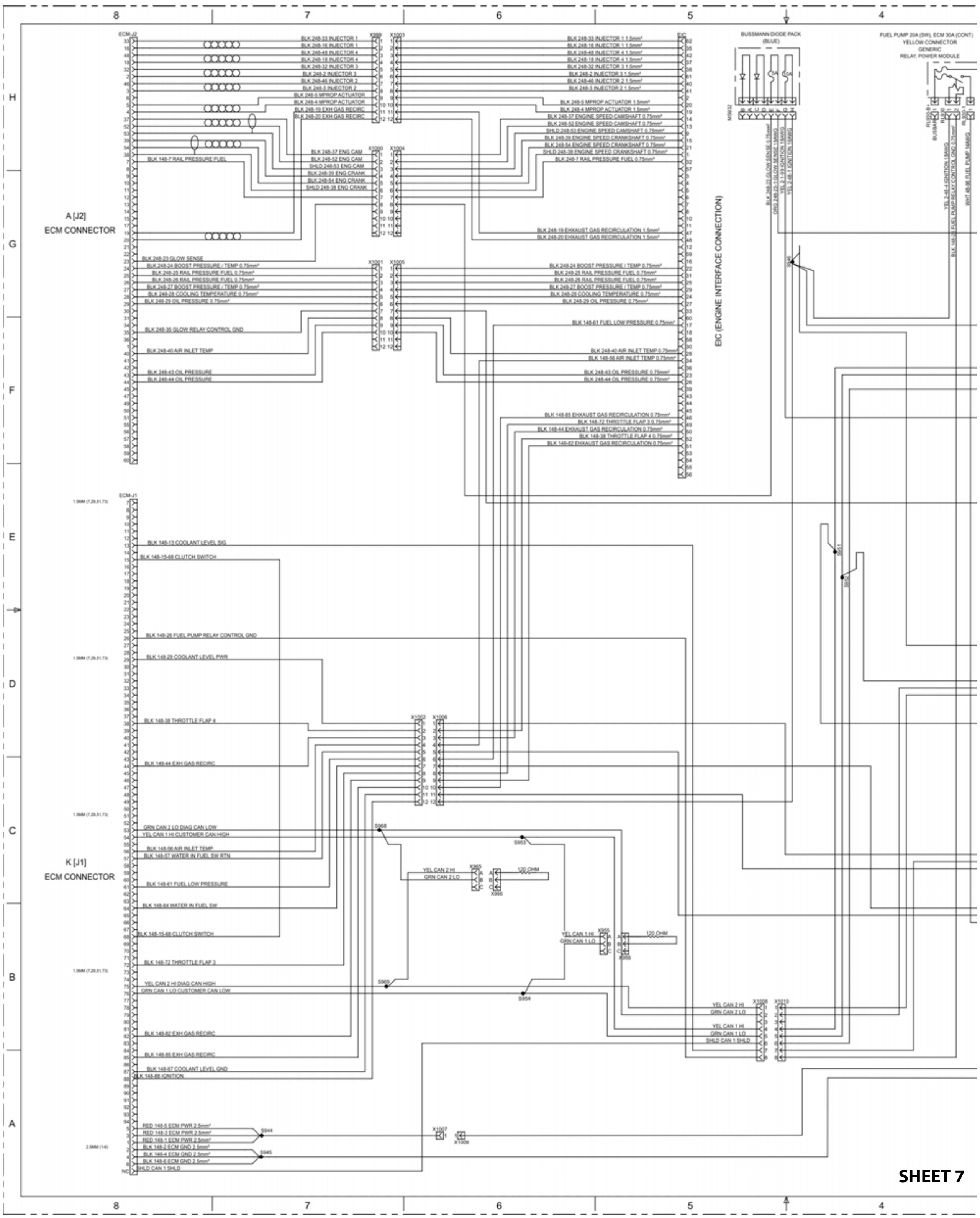

Figure 7-41. Electrical Schematic - Sheet 12 of 13

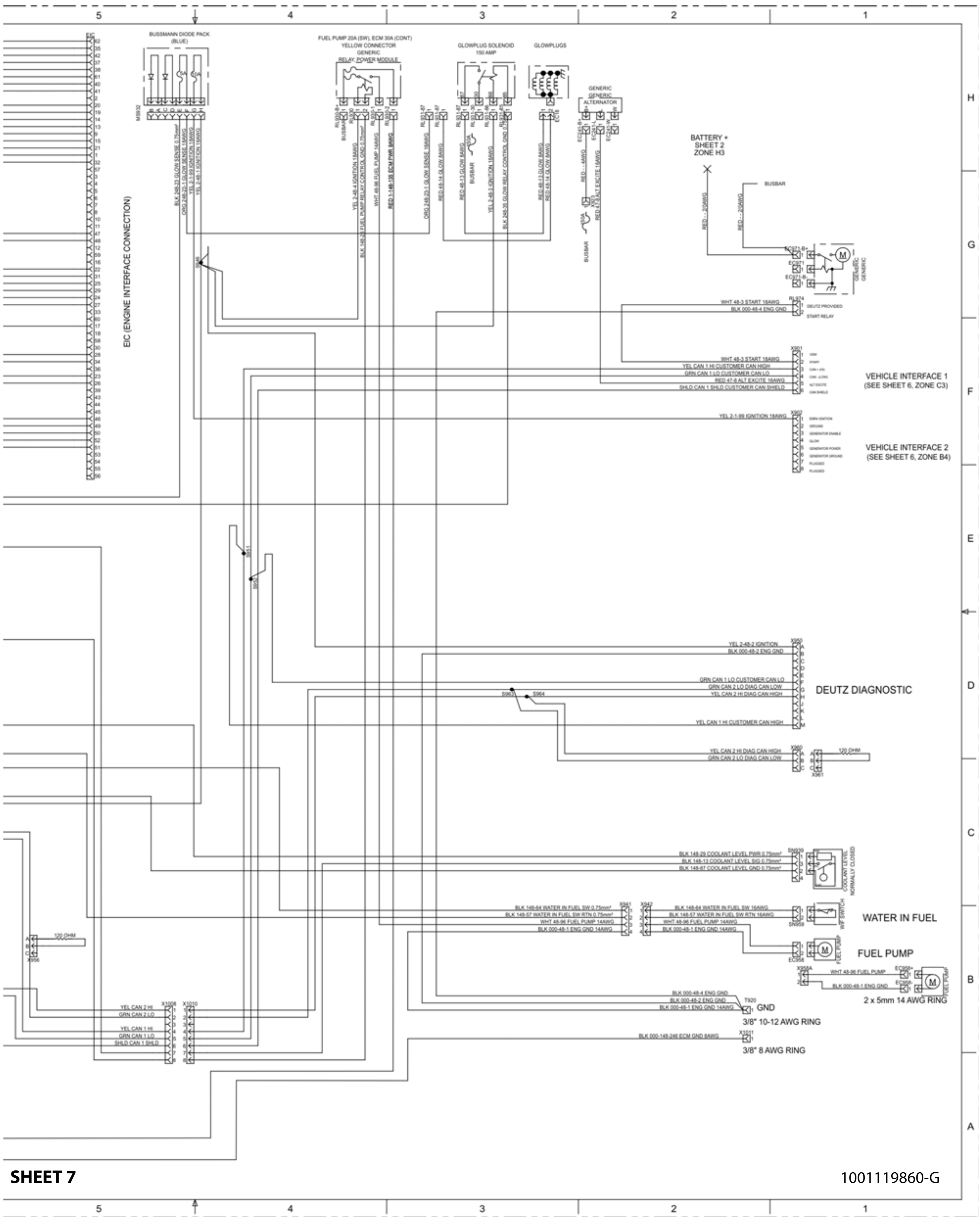

Figure 7-42. Electrical Schematic - Sheet 13 of 13

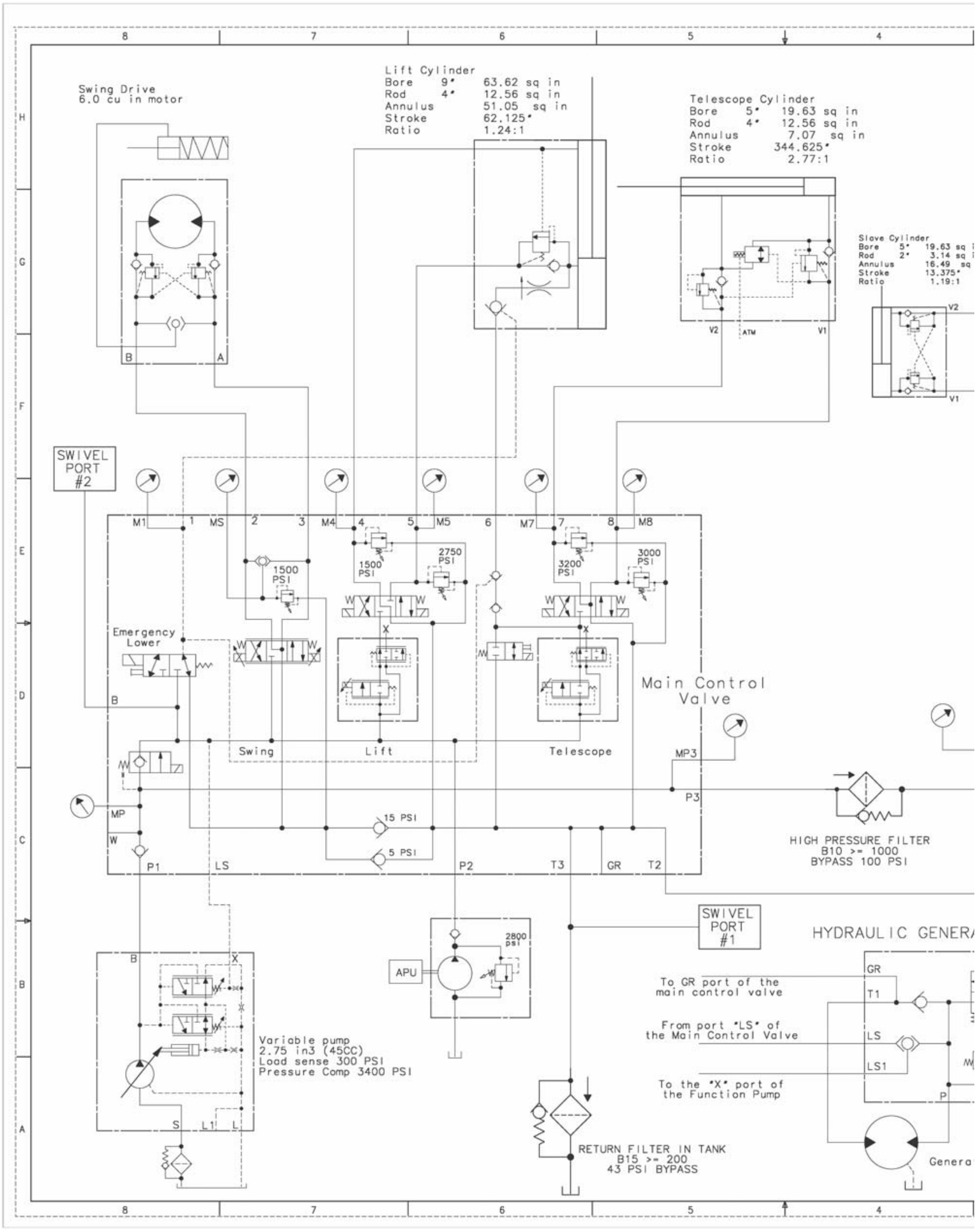

Figure 7-43. Hydraulic Schematic - Boom Functions - Sheet 1 of 2

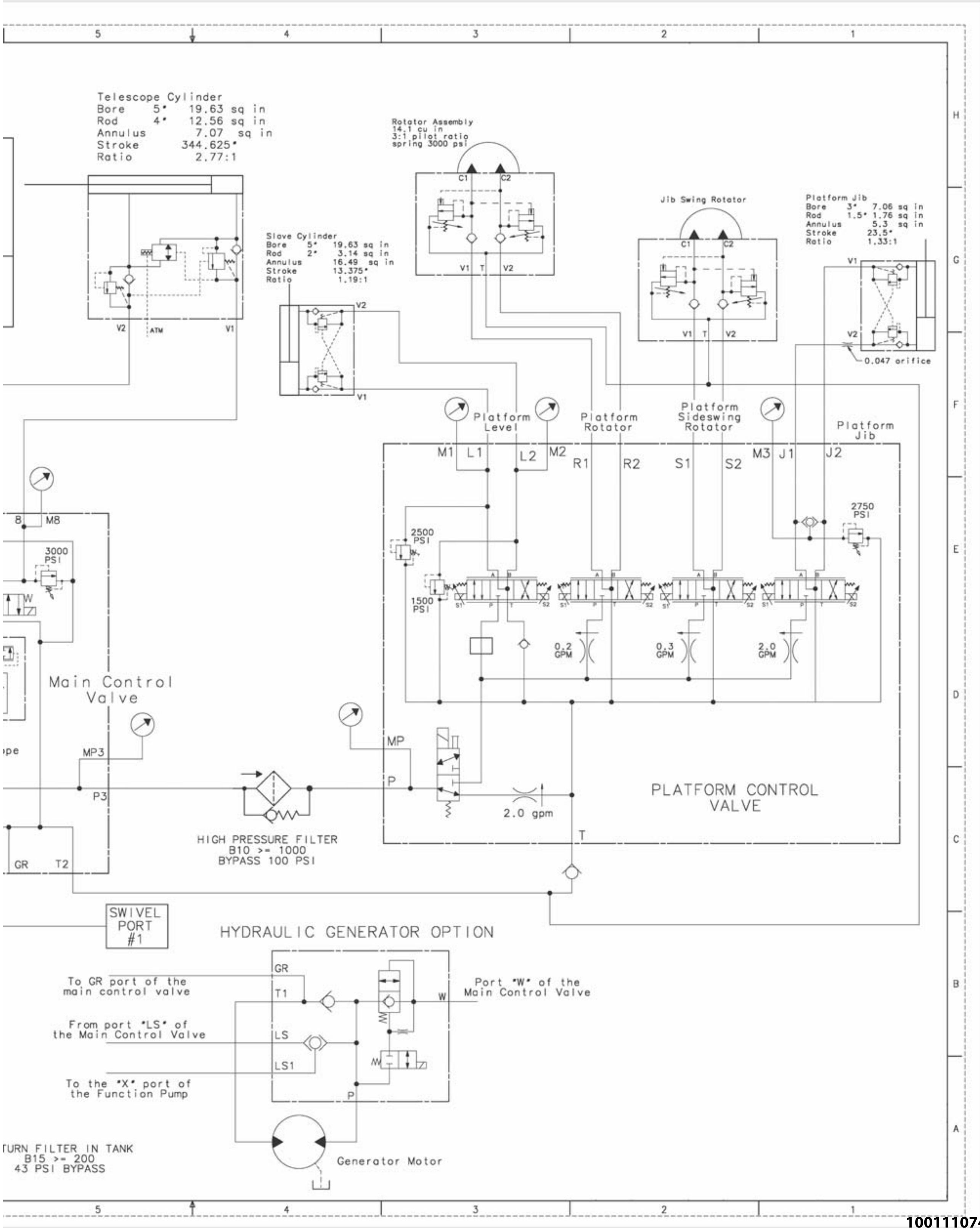

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Figure 7-44. Hydraulic Schematic - Boom Functions - Sheet 2 of 2

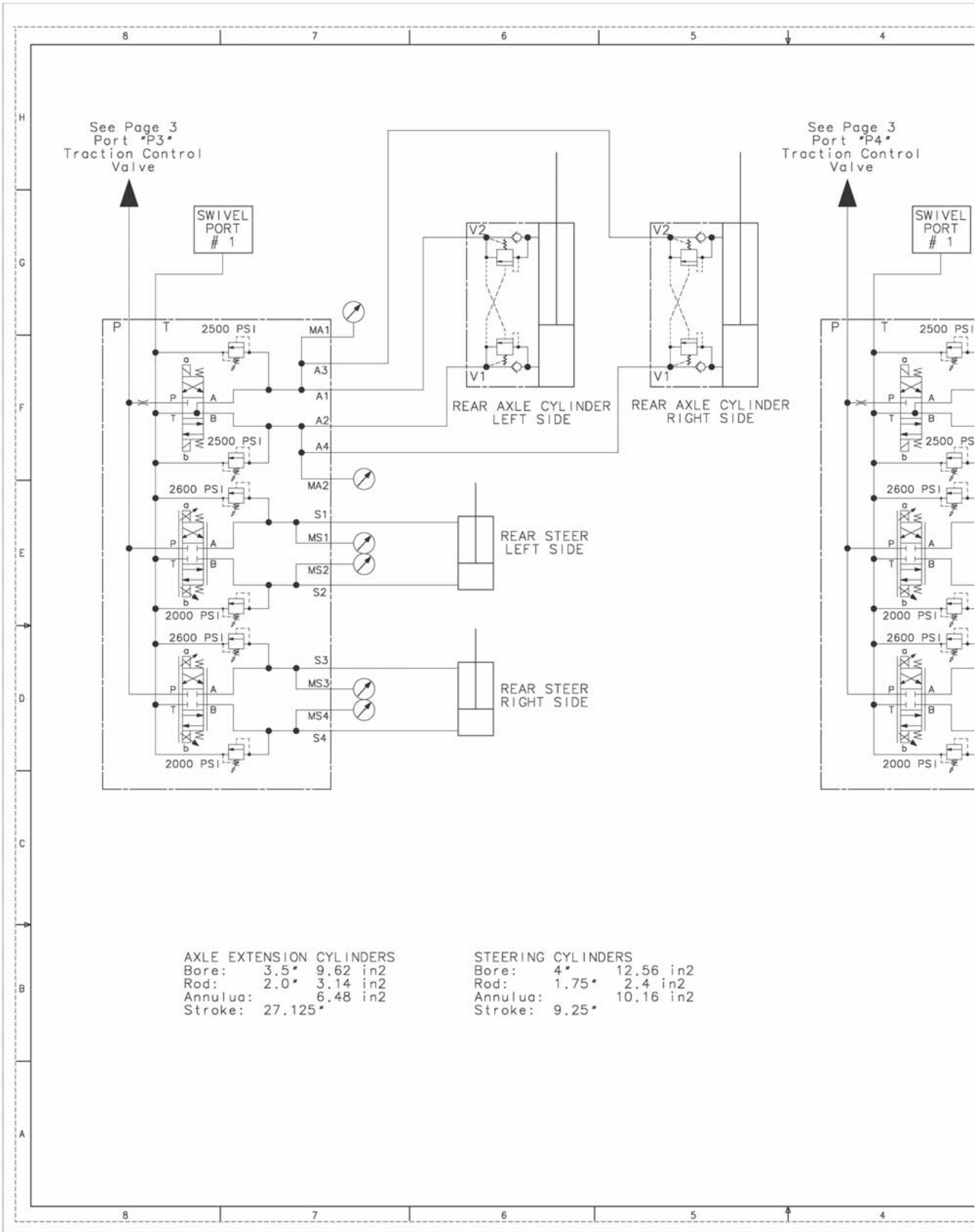

Figure 7-45. Hydraulic Schematic - Axle/Steer Control - Sheet 1 of 2

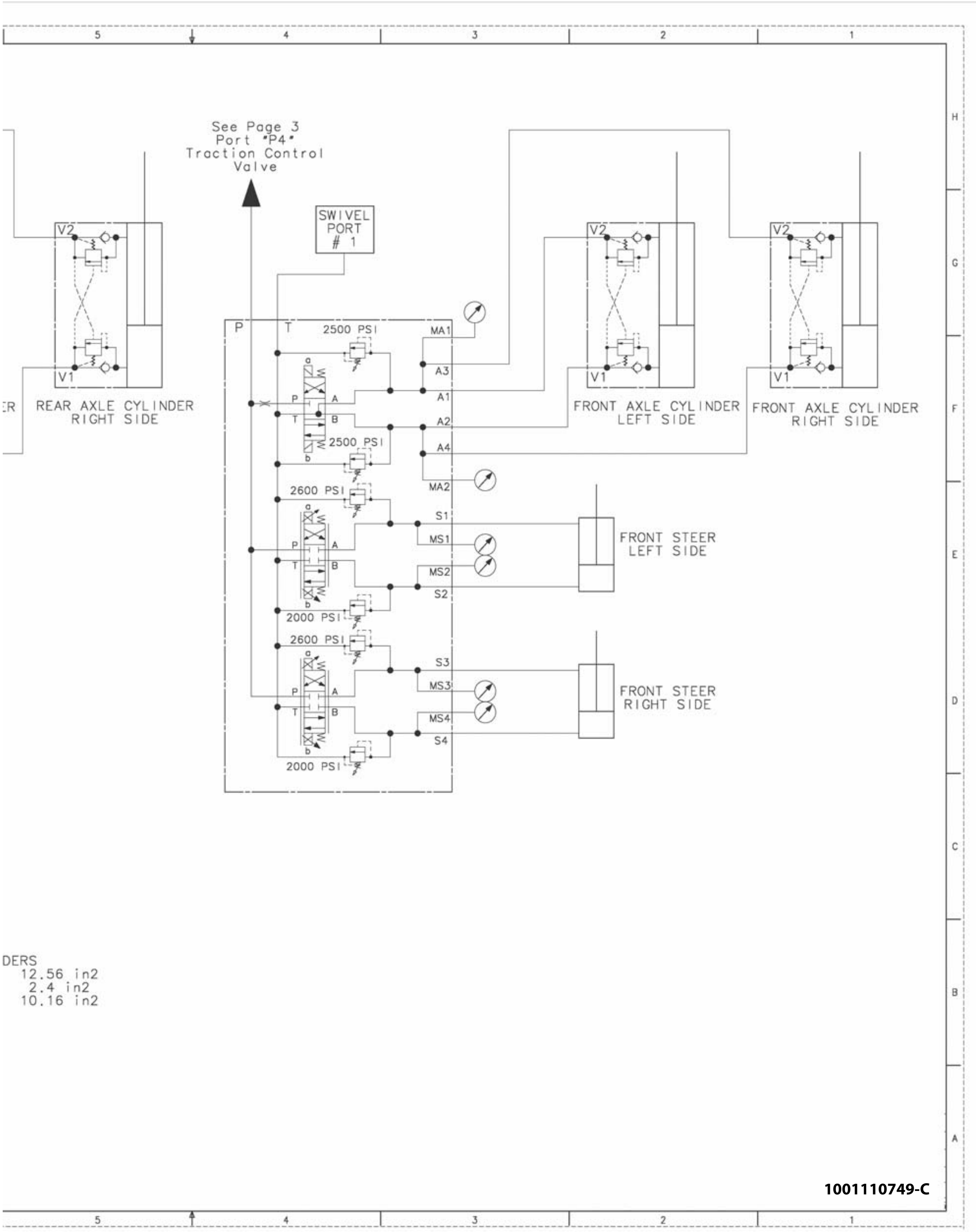

Figure 7-46. Hydraulic Schematic - Axle/Steer Control - Sheet 2 of 2

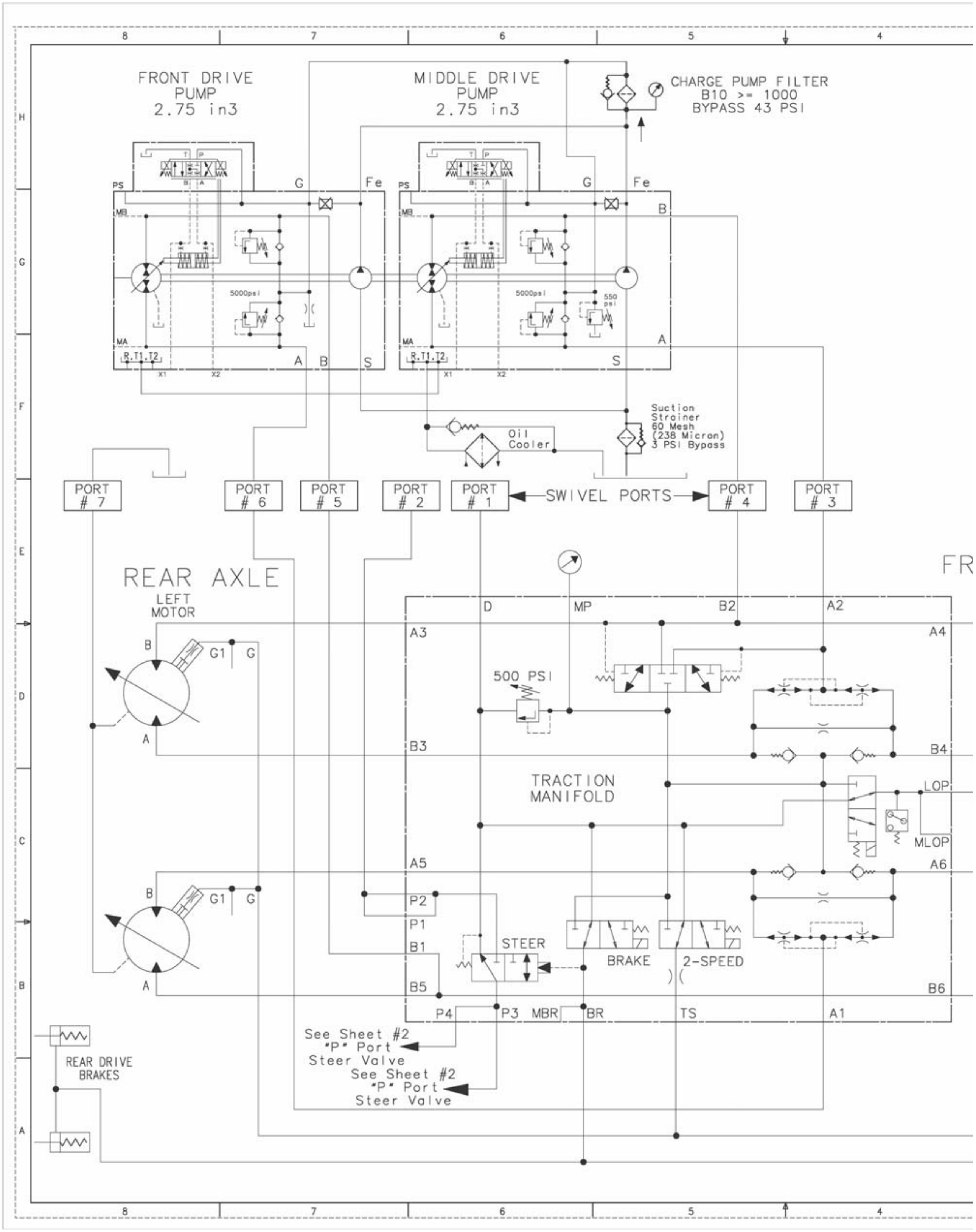

Figure 7-47. Hydraulic Schematic - Drive System Bosch/Rexroth Pumps - Sheet 1 of 2

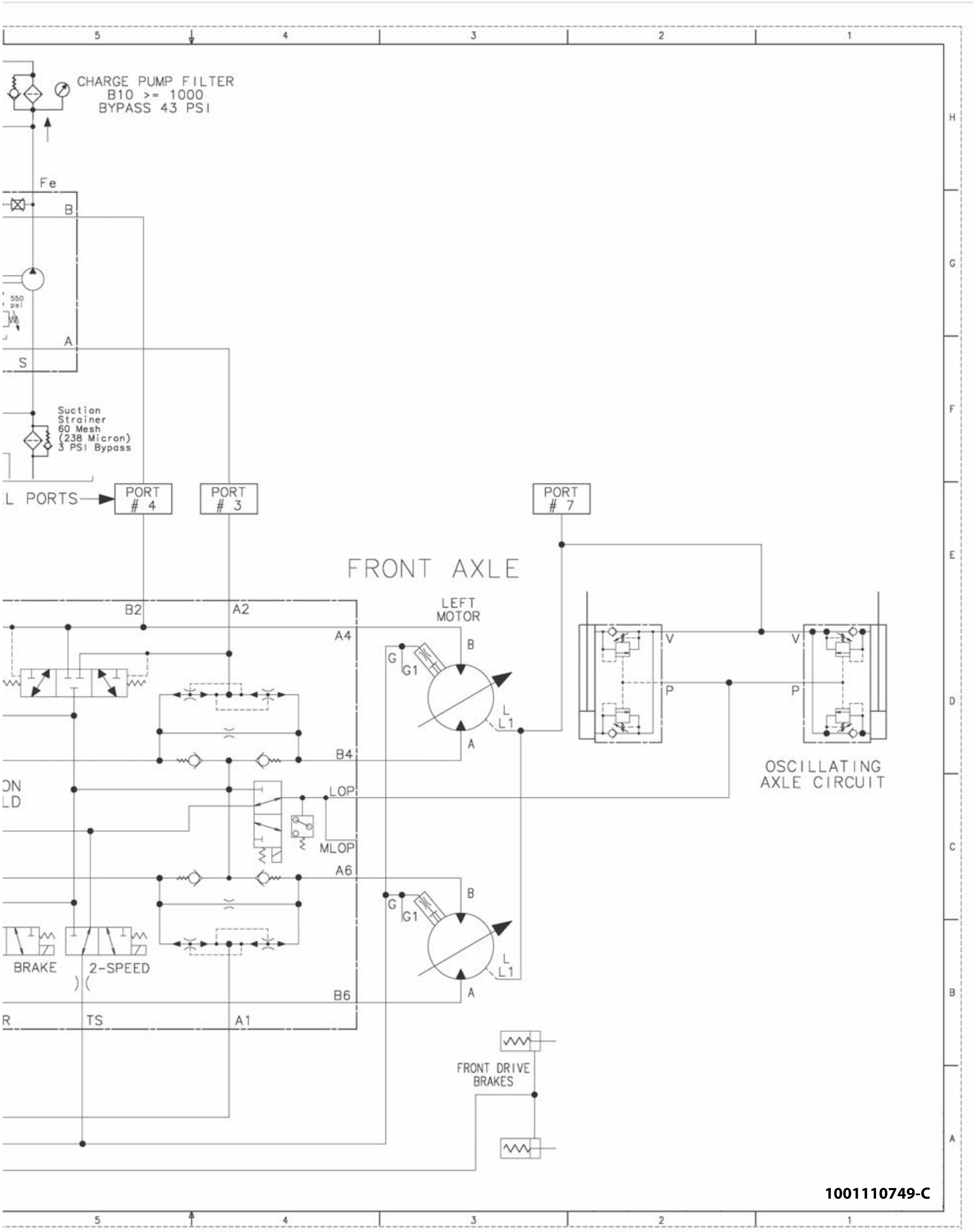

Figure 7-48. Hydraulic Schematic - Drive System Bosch/Rexroth Pumps - Sheet 2 of 2

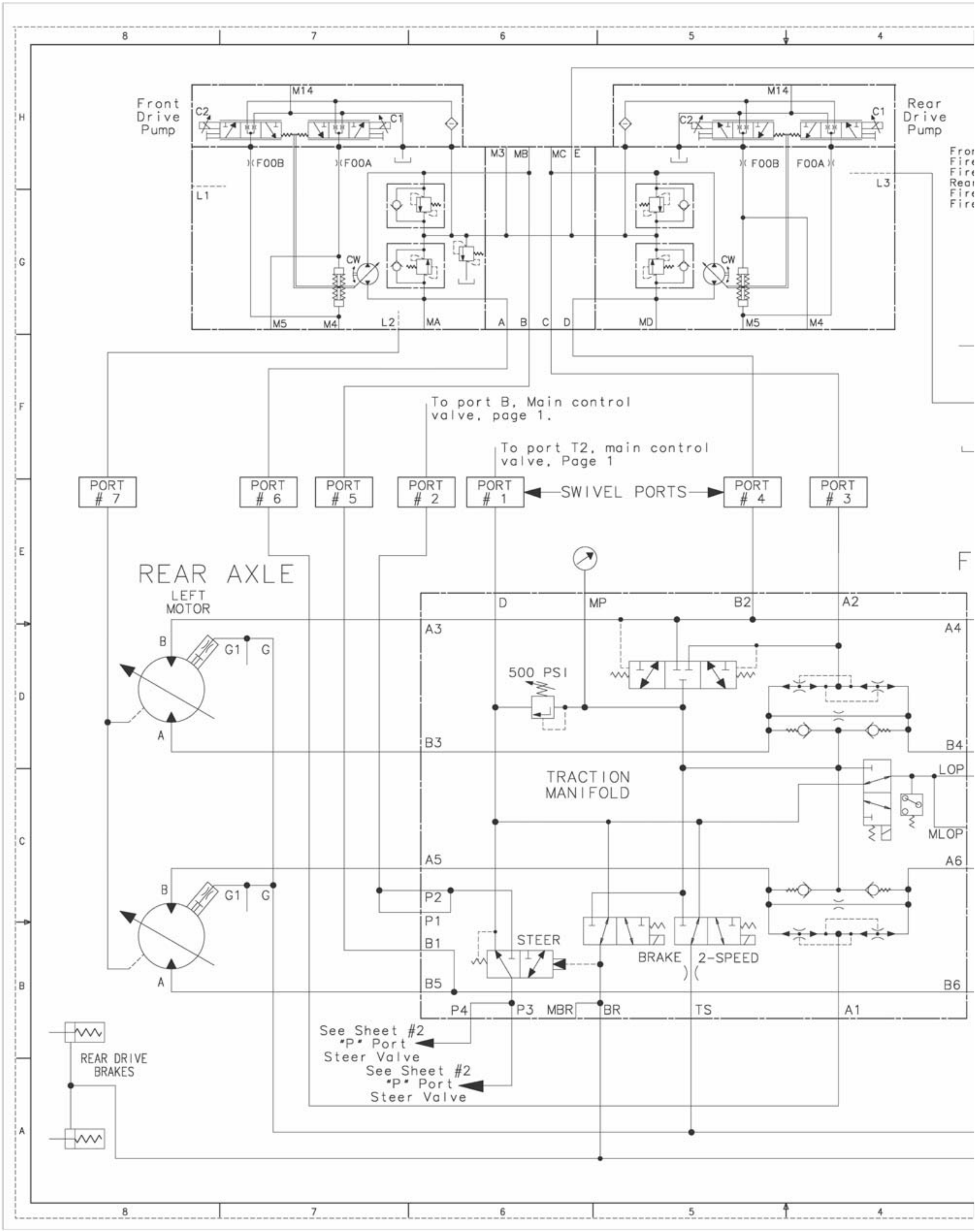

Figure 7-49. Hydraulic Schematic - Drive System Sauer/Danfoss Pumps - Sheet 1 of 2

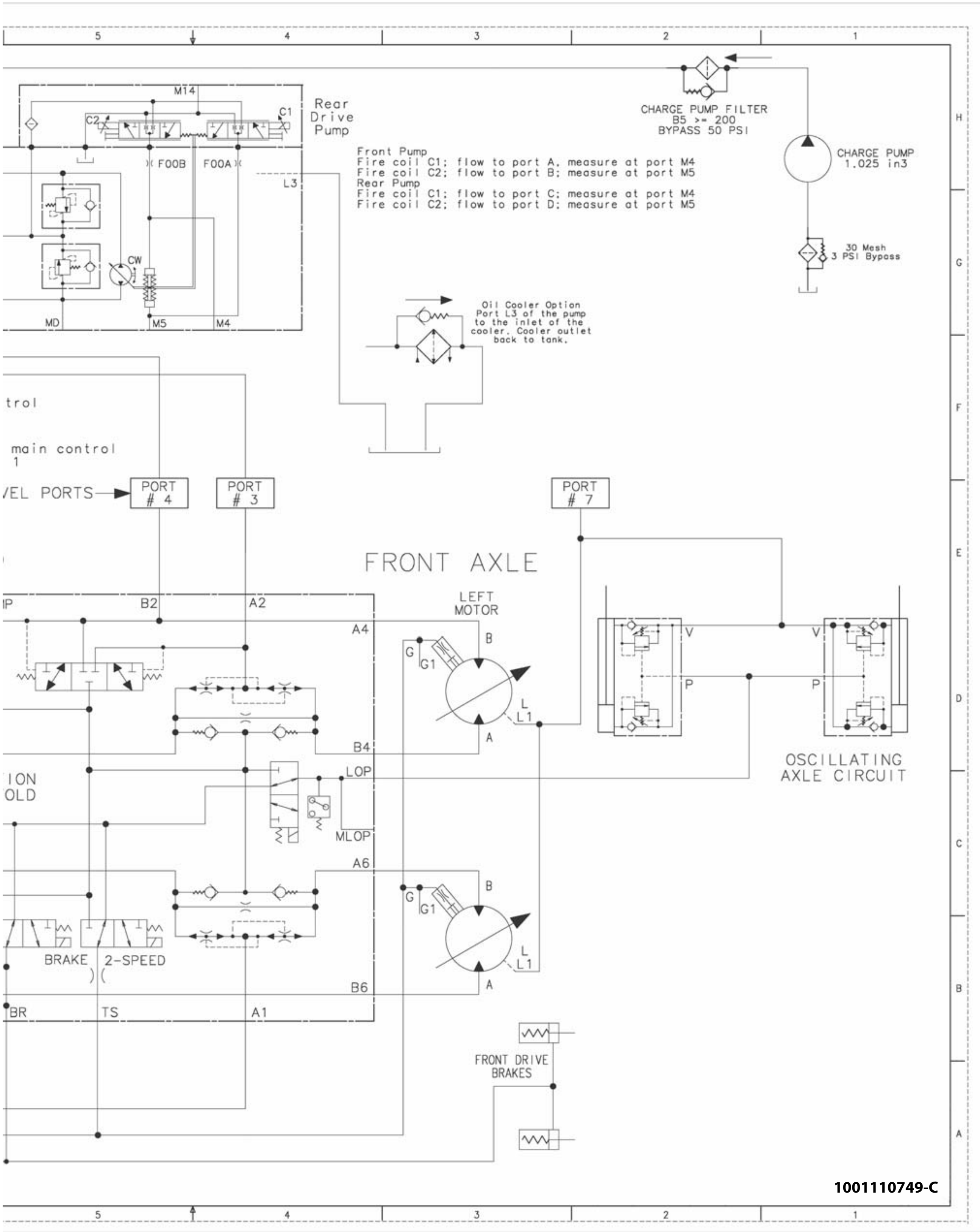

Figure 7-50. Hydraulic Schematic - Drive System Sauer/Danfoss Pumps - Sheet 2 of 2

NOTES:

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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