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Service and Maintenance Manual

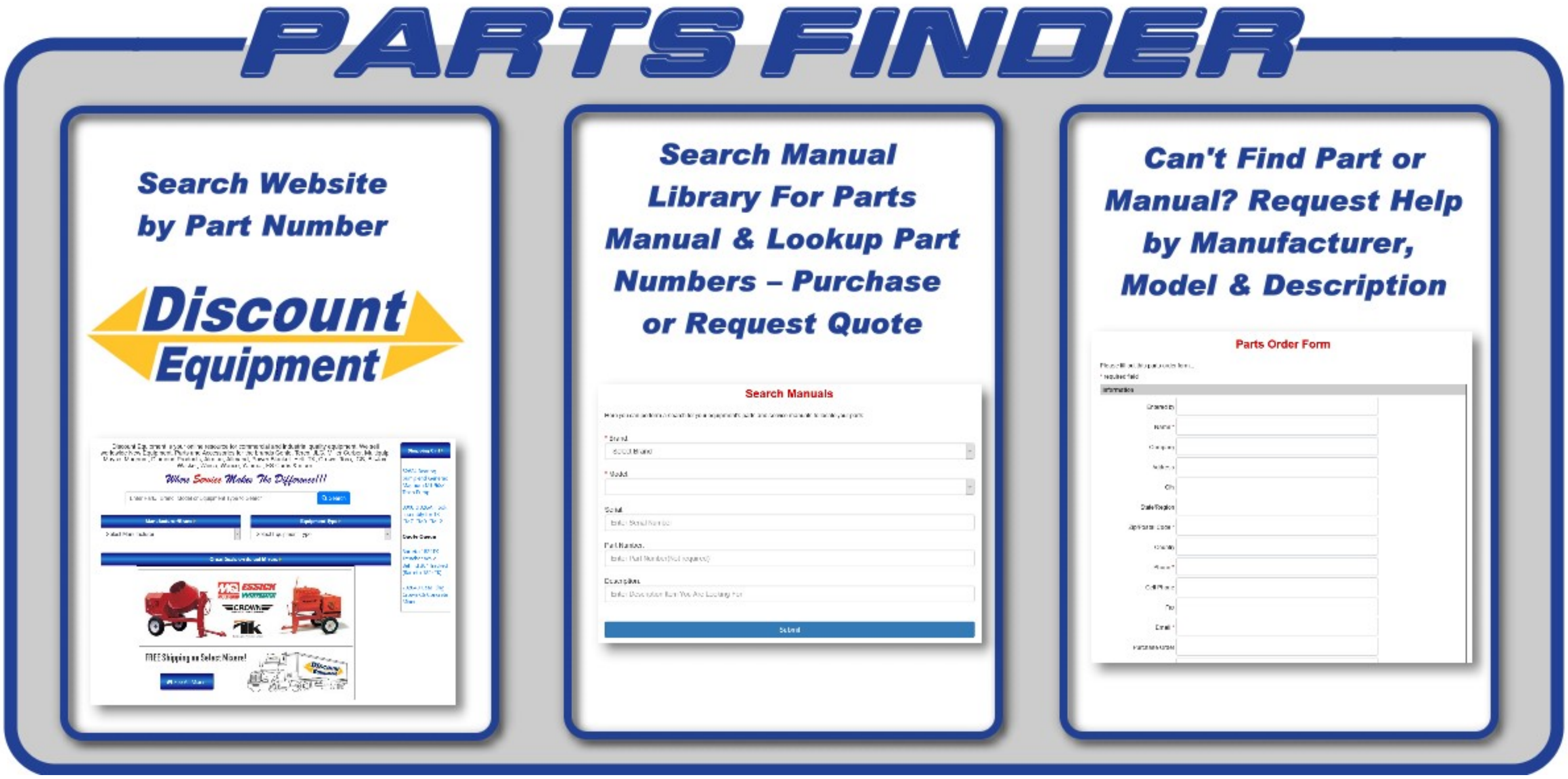
Model
600SC
660SJC

S/N 0300074875 to
S/N 0300174703

P/N - 3121157

November 22, 2016

ANSI



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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.

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

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

WARNING

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

B HYDRAULIC SYSTEM SAFETY

It should be noted 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 DISCONNECTED-DURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

REVISON LOG

Original Issue	December 4, 2003
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SECTION 4 - CAT CHASSIS (PRIOR TO S/N 0300128000)

SECTION 5 - CAT CHASSIS (S/N 0300128000 TO S/N 0300174703)

SECTION 6 - TURNTABLE

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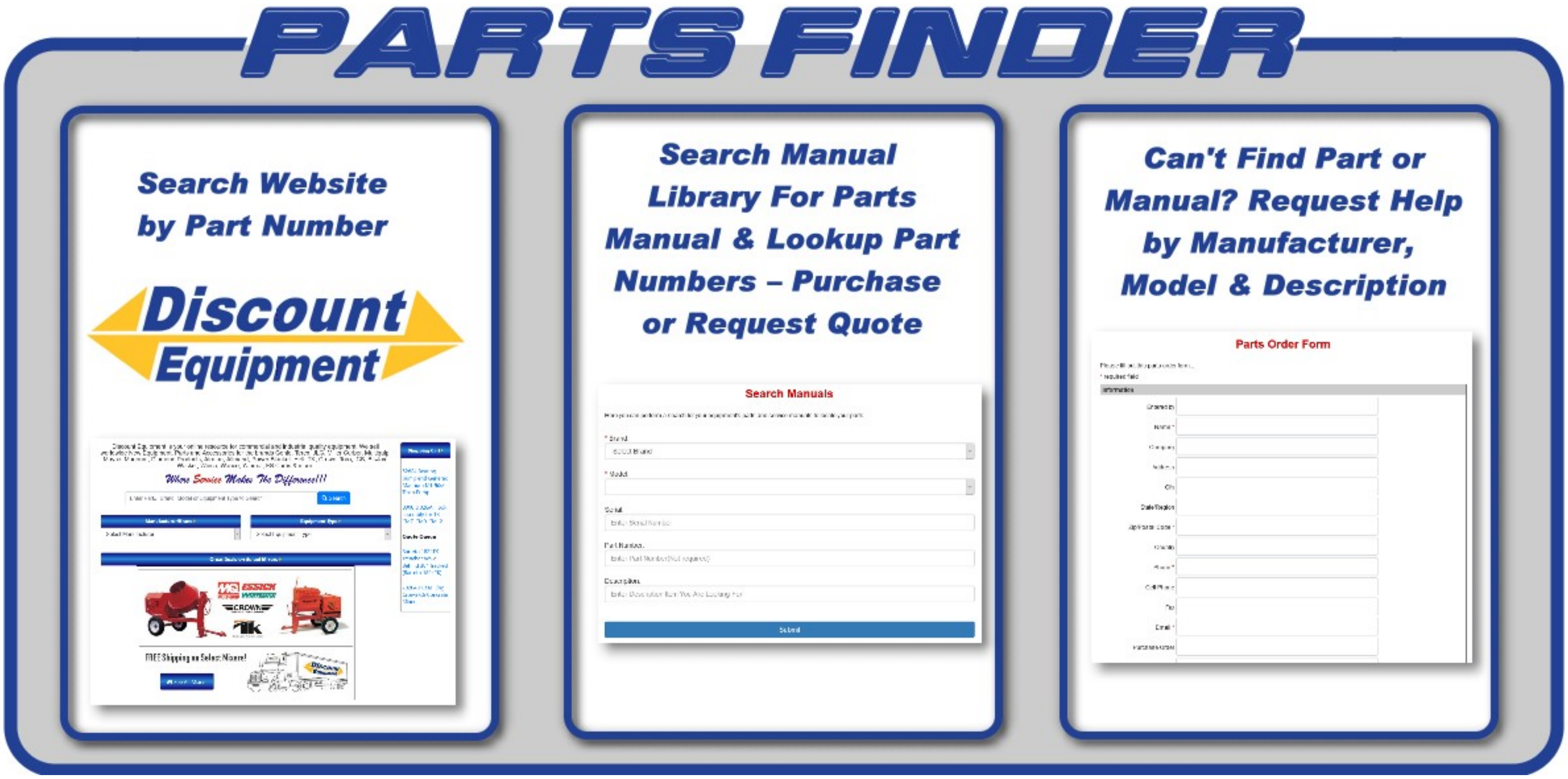
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SECTION 1. SPECIFICATIONS

1.1 OPERATING SPECIFICATIONS

Table 1-1. Operating Specifications

Maximum Work Load (Capacity) Unrestricted: Restricted - 600SC Restricted - 660SJC	 500 lb. (230 kg) 1000 lb. (450 kg) 500 lb. (230 kg)
Maximum Travel Grade (Gradeability) *	55%
Maximum Travel Grade (Side Slope) *	5°
Max.Vertical Platform Height: 600SC 660SJC	 60 ft. 3 in. (18.36 m) 66 ft. 8 in. (20.32 m)
Max.Horizontal Platform Reach: 600SC 660SJC	 49 ft. 6 in. (15.09 m) 56 ft. 9 in. (17.3 m)
Turning Radius - Inside	0
Turning Radius - Outside	8 ft. (2.4 m)
Maximum Ground Bearing Pressure 600SC 660SJC	 5.45 psi (0.383 kg/cm^2) 6.5 psi (0.457 kg/cm^2)
Maximum Drive Speed:	1.6 mph (2.6 kph)
Max. Hydraulic System Pressure	4500 psi (310 Bar)
Maximum Wind Speed	28 mph (12.5 m/s)
Maximum Manual Force	101 lb. (450 N)
Electrical System Voltage	12 Volts
Gross Machine Weight (Platform Empty) 600SC 660SJC	 22,500 lb. (10,205 kg) 27,100 lb. (12,292 kg)

* With boom in stowed position.

1.2 CAPACITIES

Table 1-2. Capacities

Fuel Tank	39 US. Gallons (147.6 L)
Hydraulic Oil Tank	31 U.S. Gallons (117.3 L)
Hydraulic System (Including Tank)	37.2 U.S. Gallons (140.8 L)
Engine Crankcase Deutz w/Filter Caterpillar (w/filter)	 11 quarts (10.5 L) 10.6 quarts (10 L)

1.3 ENGINE DATA

Table 1-3. Deutz F4M1011F/F4M2011 Specifications

Fuel	Diesel
Oil Capacity Cooling System Crankcase Total Capacity	 5 Quarts (4.5 L) 11 Quarts (10.5 L) w/Filter 16 Quarts (15 L)
Idle RPM	1000
Low RPM	1800
High RPM	2800
Alternator	60 Amp, belt drive
Battery	1000 Cold Cranking Amps, 210 Minutes Reserve Capacity, 12 VDC
Fuel Consumption Low RPM High RPM	 1.90 GPH (7.19 lph) 2.50 GPH (9.46 lph)
Horsepower	65 @ 3000 RPM, full load

Table 1-4. Deutz D2011L04 Specifications

Fuel	Diesel
Oil Capacity Cooling System Crankcase Total Capacity	 5 Quarts (4.5 L) 11 Quarts (10.5 L) w/Filter 16 Quarts (15 L)
Idle RPM	1000
Low RPM	1800
High RPM	2600
Alternator	60 Amp, belt drive
Battery	1000 Cold Cranking Amps, 210 Minutes Reserve Capacity, 12 VDC
Fuel Consumption Low RPM High RPM	 1.90 GPH (7.19 lph) 2.50 GPH (9.46 lph)
Horsepower	64 @ 2600 RPM, full load

Table 1-5. Caterpillar 3044C/Caterpillar 3.4

Type	Four Stroke Cycle
Cylinders	4 in-line
Bore	3.70 inch (94 mm)
Stroke	4.72 inch (120 mm)
Aspiration	turbocharged
Compression ratio	19:1
Displacement	203 in^3 (3.33 L)
Firing Order	1-3-4-2
Rotation (viewed from fly-wheel)	Counterclockwise
Oil Capacity (w/filter)	10.6 quarts (10 L)
Cooling System (Engine Only)	5.8 quarts (5.5 L)
Idle RPM	1000
Low RPM	1800
High RPM - 3044C	2600
High RPM - 3.4	2500
Horsepower	63
Alternator	60 Amp, belt drive
Battery	930 Cold Cranking Amps, 205 Minutes Reserve Capacity, 12 VDC

1.4 COMPONENT DATA

Swing System

Table 1-6. Swing System

Swing Motor Displacement	4.62 cu. in. (75 cm^3)
Swing Brake	Automatic spring applied hydraulically released disc brakes.
Swing Hub Ratio - 50:1	Swing Hub Ratio - 50:1
Gear Pump @ 1800 rpm	7.9 GPM (29.90 lpm)
Pump Displacement	1.02 cu. in. (16 cm^3)
Rotation	Clockwise

Auxiliary Power Pump

Table 1-7. Auxiliary Power Pump

Output	2.6 GPM (9.8 lpm) @ 1200 PSI (82.7 BAR)
Pump Displacement	0.244 cu. in. (14 cm^3)
Motor Type	DC
Rotation	Clockwise

Hydraulic Filters

Table 1-8. Hydraulic Filters

Hydraulic Filter Location	In-line
Return Filter Type	Bypass Type
Return Filter Rating	10 Microns Absolute
Charge Filter Rating	10 Microns Absolute
Strainer Rating (In Tank)	30 Microns

1.5 PERFORMANCE DATA

Function Speeds

Table 1-9. Function Speeds

Main Boom Speed - Lift	Up 46 - 60 Seconds Down 33 - 43 Seconds
Swing Speed 360° Note 1	Left 79 - 101 Seconds Right 79 - 101 Seconds
Main Boom Speed - Telescope	Out 50 - 67 Seconds In 22 - 33 Seconds
Rotator Speed Note 4	Left 16-25 Seconds Right 16-25 Seconds
Jib Boom Speed - Lift	Up 22 - 34 Seconds Down 16 - 26 Seconds
Drive (Horizontal) Note 2	Forward & Reverse 85-90
Drive (Out of Transport) Note 3	Forward & Reverse 80-85
Note 1: No more than 10% difference between swing left and right. Note 2: 200 ft. (61 m) course Note 3: 50 ft. (15.2 m) course Note 4: No more that 15% difference between rotator left and right.	

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Dimensions

Table 1-10. Dimensions

Boom Elevation - 600SC	+60 ft. 2 13/16 in. (18.36 m) -6 ft. 1 11/16 in. (1.87 m)
Boom Elevation - 600SCJ	+60 ft. 5 3/4 in. (18.43 m) -9 ft. 9 3/16 in. (2.98 m)
Boom Elevation - 660SCJ	+66 ft. 7 5/8 in. (20.31 m) -11 ft. 5 1/4 in. (3.49 m)
Machine Height (Stowed)	Steel Track - 8'4" (2.54 m) Rubber Track - 8'6" (2.59 m)
Machine Length (Stowed)	35' 6" (10.8 m)
Machine Width	8 ft. (2.4 m)

1.6 TORQUE REQUIREMENTS

Table 1-11. Torque Requirements

Description	Torque Value (Dry)	Interval Hours
Bearing To Chassis	240 ft. lbs. (326 Nm) See Note	50/600*
Bearing To Turntable	240 ft. lbs. (326 Nm) See Note	50/600*
Wire Rope	15 ft.lbs. (20 Nm)	150
M16 Travel Motor mounting bolts	175 ±30 ft.lbs. (240±40 Nm)	As required
M20 Final Drive mounting bolts	390 ±50 ft.lbs. (530±70 Nm)	As required
M20 Track Roller mounting bolts	340 ±44 ft.lbs. (460±60 Nm)	As required
M24 Carrier Roller mounting bolts	600 ±70 ft.lbs. (800±100 Nm)	As required
*Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter. (See paragraph on Swing Bearing in Section 2.)		
NOTE: *When maintenance becomes necessary or a fastener has loosened, refer to the Torque Chart to determine proper torque value.*		

1.7 PRESSURE SETTINGS

Table 1-12. Pressure Settings

Main Relief	3000 PSI (206.85 Bar)
Upper Boom Lift Down	1500 PSI (103.4 Bar)
Swing	1700 PSI (117.2 Bar)
Platform Level - Forward	2800 PSI (193.06 Bar)
Platform Level - Backward	1800 PSI (124.11 Bar)
Jib Boom - Up	1500 PSI (103 Bar)
Jib Boom - Down	1200 PSI (82.7 Bar)

1.8 CYLINDER SPECIFICATIONS

Table 1-13. Cylinder Specifications

	BORE		STROKE		ROD DIA.	
	660SJ	600S	660SJ	600S	660SJ	600S
Lift	6.00 (152.4)	6.00 (152.4)	44.6875 (1135.1)	44.6875 (1135.1)	3 (76.2)	3 (76.2)
Telescope	3.5 (88.9)	3.5 (88.9)	168.437 (4278.3)	177.75 (4514.9)	2.5 (63.5)	2.5 (63.5)
Master	3.5 (88.9)	3 (76.2)	13.0625 (331.8)	8.5 (215.9)	1.5 (38.1)	1.5 (38.1)
Slave Level	3.5 (88.9)	3 (76.2)	13.0625 (331.8)	8.5 (215.9)	1.5 (38.1)	1.5 (38.1)
Lift (Jib Boom)	3 (76.2)	N/A	25.5 (647.7)	N/A	1.5 (38.1)	N/A

1.9 MAJOR COMPONENT WEIGHTS

Table 1-14. Major Component Weights

	660SJ		600S	
	LB.	KG.	LB.	KG.
Platform Control Console	250	113	250	113
Platform Level Cylinder	60	27	46	21
Main Boom (Includes Lift Cyl., Rotator, and Support)	3783	1716	3527	1600
Turntable Complete (including engine)	9065	4112	7315	3318

1.10 SERIAL NUMBER LOCATIONS

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

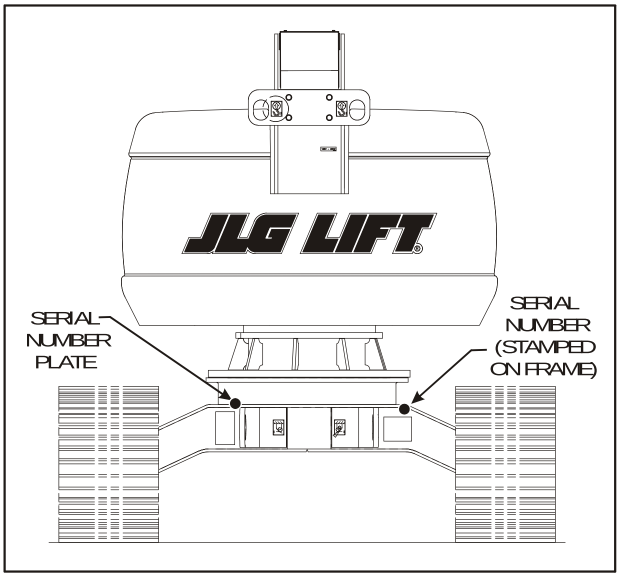


Figure 1-1. Serial Number Locations

1.11 HYDRAULIC OIL

Table 1-15. Hydraulic Oil

HYDRAULIC SYSTEM OPERATING TEMPERATURE RANGE	SAE VISCOSITY GRADE
+0° to +180° F (-18° C to +83° C)	10W
+0° F to +210° F (-18° C to +99° C)	10W-20, 10W-30
+50° F to +210° F (+10° C to +210° 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 below 20° F (-7 degrees C), JLG Industries recommends the use of Mobil DTE 13M.*

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 1-16. 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 1-17. 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

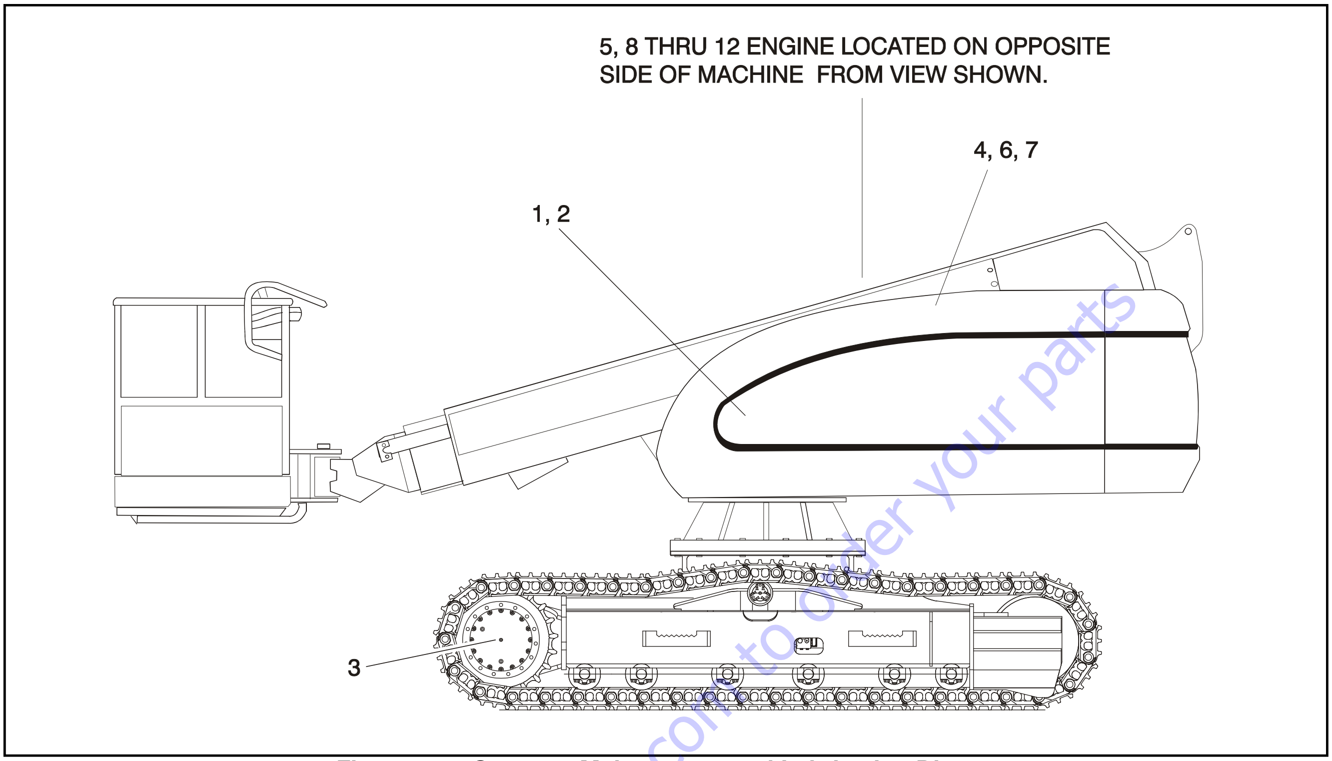


Figure 1-2. Operator Maintenance and Lubrication Diagram

1.12 OPERATOR MAINTENANCE AND LUBRICATION

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

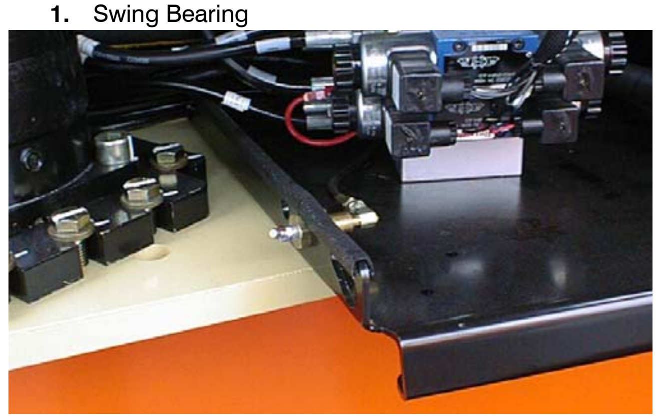
Table 1-18. Lubrication Specifications

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

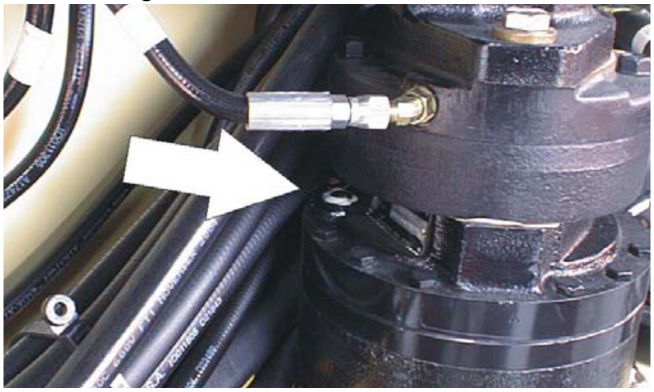
LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

1. Swing Bearing



Lube Point(s) - 2 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
Comments - Remote Access

2. Swing Drive Hub

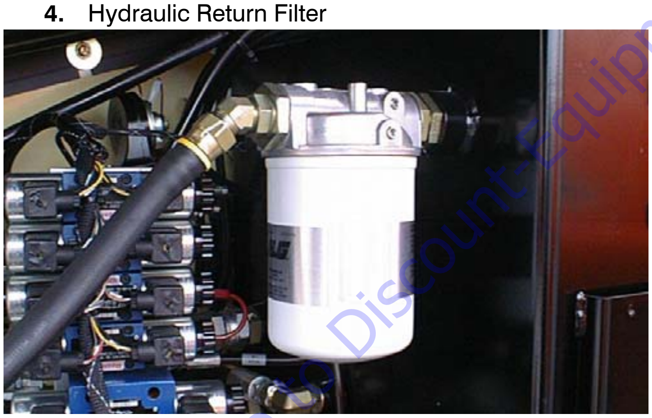


Lube Point(s) - Level/Fill Plug
Capacity - 17 oz. (1/2 Full)
Lube - EPGL
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation

3. Final Drive Hub

Lube Point(s) - Level/Fill Plug
Capacity - 2.1 gal.(7.9 L); 1/2 Full
Lube - EPGL
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation

4. Hydraulic Return Filter

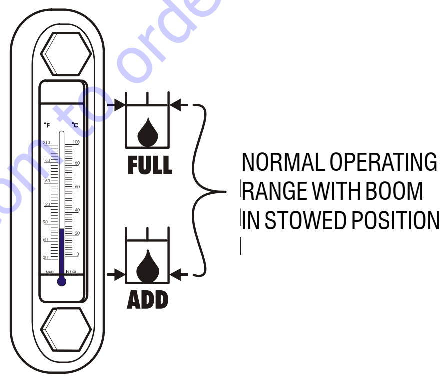


Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

5. Hydraulic Charge Filter

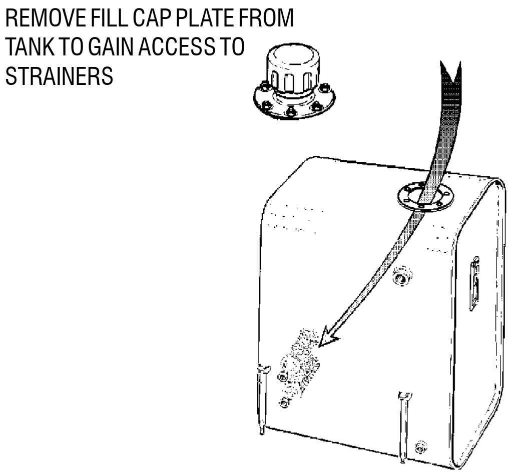
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

6. Hydraulic Tank



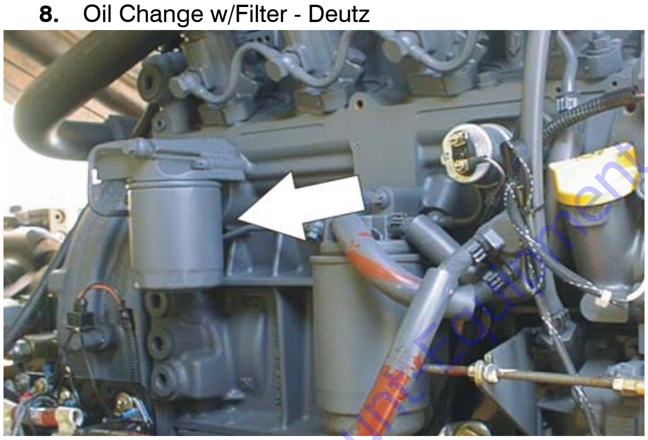
Lube Point(s) - Fill Cap
Capacity - 30.6 gal. Tank; 32.7 gal. System
Lube - HO
Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

7. 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.

8. Oil Change w/Filter - Deutz

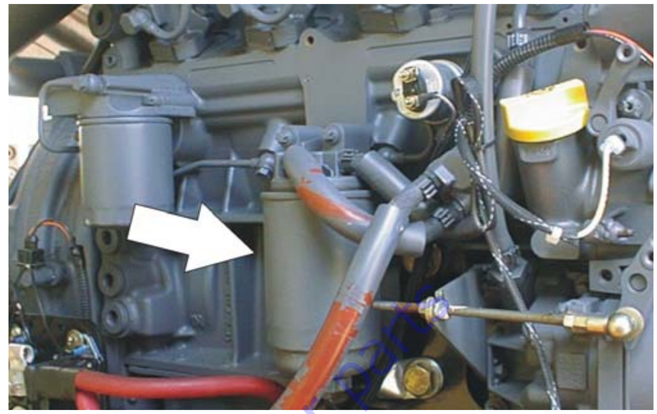


Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 11 Quarts Crankcase; 5 Quarts Cooler
Lube - EO
Interval - Every Year or 1200 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

9. Oil Change w/Filter - Caterpillar

Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 10.6 Quarts
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

10. Fuel Filter - Deutz

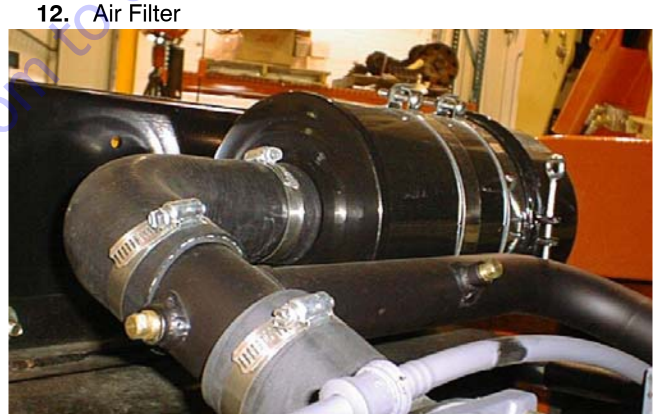


Lube Point(s) - Replaceable Element
Interval - Every Year or 600 hours of operation

11. Fuel Filter - Caterpillar

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

12. Air Filter



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

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

NO. 5000059 REV. J

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

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

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

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

NO. 5000059 REV. J

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

Figure 1-4. Torque Chart (SAE Fasteners - Sheet 2 of 7)

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

NO. 5000059 REV. J

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

Figure 1-5. Torque Chart (SAE Fasteners - Sheet 3 of 7)

SOCKET HEAD CAP SCREWS

Zinc Yellow Chromate Fasteners (Ref 4150707)*

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

NO. 5000059 REV. J

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

Figure 1-6. Torque Chart (SAE Fasteners - Sheet 4 of 7)

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

NO. 5000059 REV. J

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

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

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

NO. 5000059 REV. J

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

Figure 1-8. Torque Chart (METRIC Fasteners - Sheet 6 of 7)

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

NO. 5000059 REV. J

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

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

SECTION 2. GENERAL

2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

General

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

Preparation, Inspection, and Maintenance

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

Pre-Start Inspection

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

Pre-Delivery Inspection and Frequent Inspection

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

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

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

Annual Machine Inspection

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

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

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

Preventative Maintenance

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

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

Table 2-1. Inspection and Maintenance

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

2.2 SERVICE AND GUIDELINES

General

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

Safety and Workmanship

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

Cleanliness

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

2. At any time when air, fuel, or oil lines are disconnected, clear adjacent areas as well as the openings and fittings themselves. As soon as a line or component is disconnected, cap or cover all openings to prevent entry of foreign matter.

3. Clean and inspect all parts during servicing or maintenance, and assure that all passages and openings are unobstructed. Cover all parts to keep them clean. Be sure all parts are clean before they are installed. New parts should remain in their containers until they are ready to be used.

Components Removal and Installation

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

Component Disassembly and Reassembly

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

Pressure-Fit Parts

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

Bearings

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

Gaskets

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

Bolt Usage and Torque Application

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

Hydraulic Lines and Electrical Wiring

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

Hydraulic System

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

Lubrication

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

Battery

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

Lubrication and Servicing

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

2.3 LUBRICATION AND INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g., using inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up or leaks in the pump supply (suction) lines.
2. The design and manufacturing tolerances of the component working parts are very close, therefore, even the smallest amount of dirt or foreign matter entering a system can cause wear or damage to the components and generally results in faulty operation. Every precaution must be taken to keep hydraulic oil clean, including reserve oil in storage. Hydraulic system filters should be checked, cleaned, and/or replaced as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.
3. Cloudy oils indicate a high moisture content which permits organic growth, resulting in oxidation or corrosion. If this condition occurs, the system must be drained, flushed, and refilled with clean oil.
4. It is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. Good grade mineral oils, with viscosities suited to the ambient temperatures in which the machine is operating, are recommended for use.

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

Hydraulic Oil

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

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

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

Changing Hydraulic Oil

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

2. Use every precaution to keep the hydraulic oil clean. If the oil must be poured from the original container into another, be sure to clean all possible contaminants from the service container. Always clean the mesh element of the filter and replace the cartridge any time the system oil is changed.

3. While the unit is shut down, a good preventive maintenance measure is to make a thorough inspection of all hydraulic components, lines, fittings, etc., as well as a functional check of each system, before placing the machine back in service.

Lubrication Specifications

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

2.4 CYLINDER DRIFT TEST

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

Platform Drift

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

Cylinder Drift

Table 2-2. Cylinder Drift

Cylinder Bore Diameter		Max. Acceptable Drift in 10 Minutes	
inches	mm	inches	mm
3	76.2	0.026	0.66
3.5	89	0.019	0.48
4	101.6	0.015	0.38
5	127	0.009	0.22
6	152.4	0.006	0.15
7	177.8	0.005	0.13
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 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						
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						
Torque Hubs				11	11	
Functions/Controls	9					

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
Platform Controls	5	5		6	6	
Ground Controls	5	5		6	6	
Function Control Locks, Guards, or Detents	1,5	1,5		5	5	
Footswitch	1,5			5	5	
Emergency Stop Switches (Ground & Platform)	5			5	5	
Function Limit or Cutout Switch Systems				5	5	
Capacity Indicator					5	
Drive Brakes				5		
Swing Brakes				5		
Boom Synchronization/Sequencing Systems					5	
Manual Descent or Auxiliary Power				5	5	
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	

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
Capacity Decals Installed, Secure, Legible	21			21	21	
All Decals/Placards Installed, Secure, Legible	21			21	21	
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	

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

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

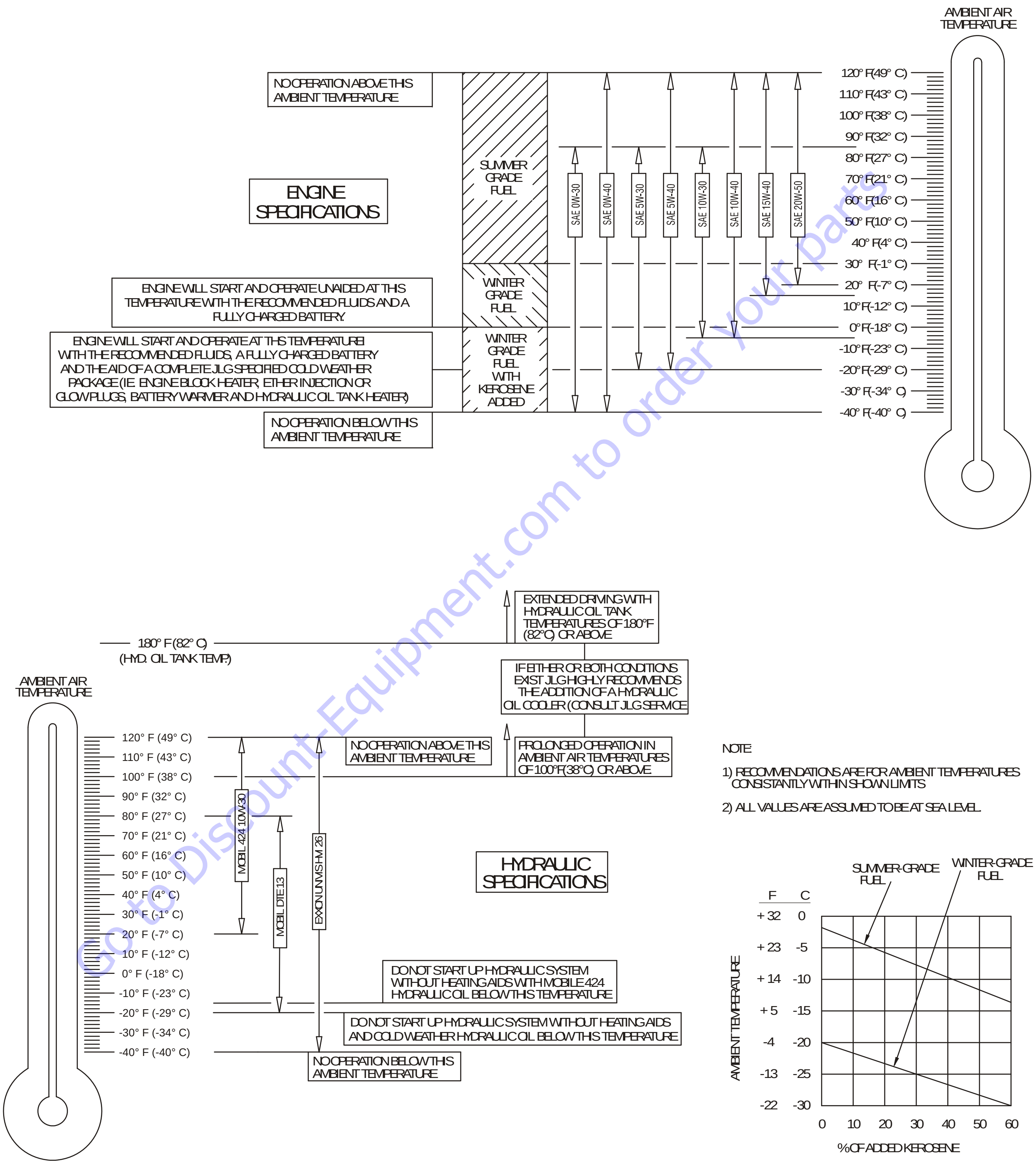


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Figure 2-1. Engine Operating Temperature Specifications - Deutz

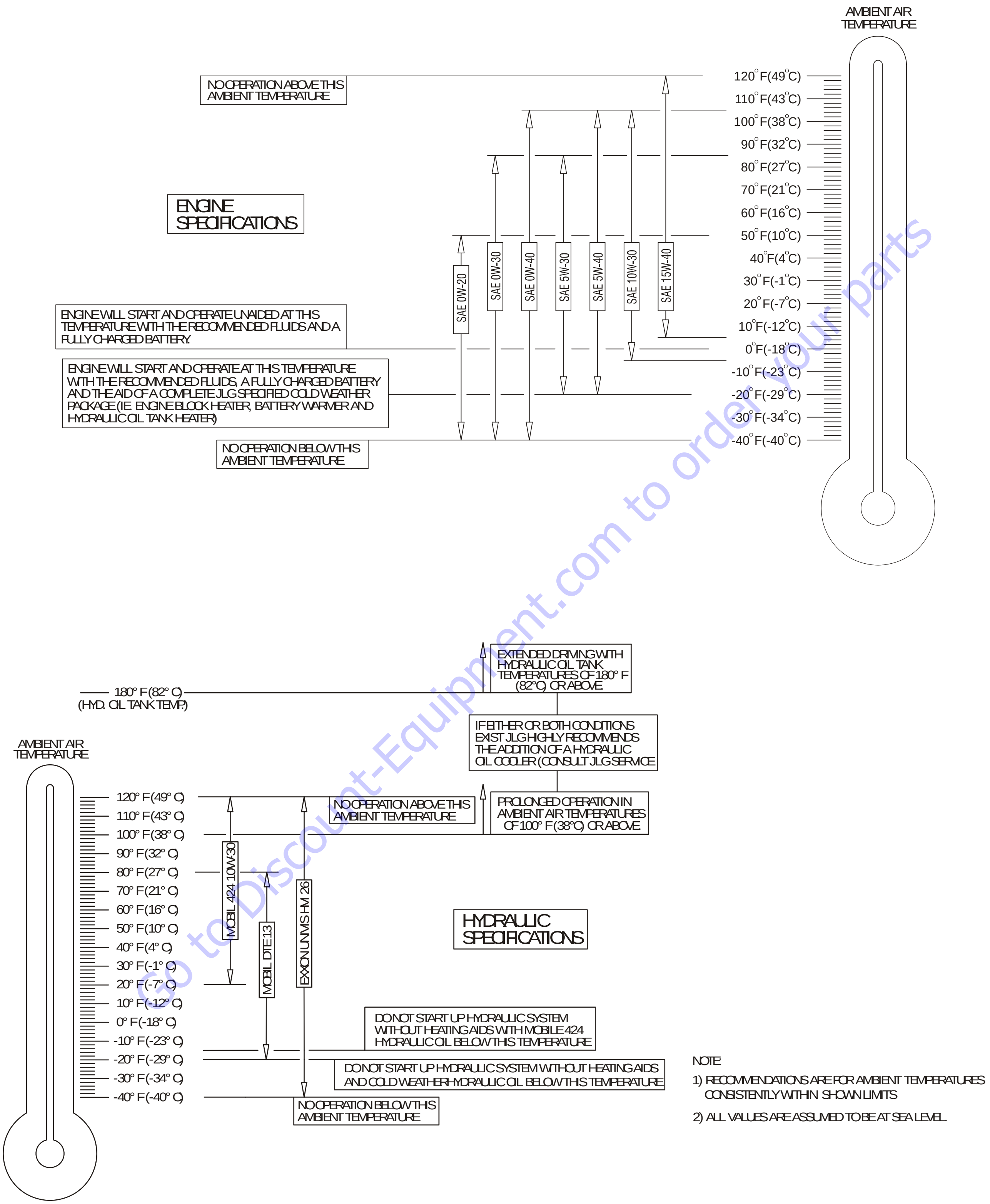

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Figure 2-2. Engine Operating Temperature Specifications - Caterpillar

SECTION 3. GRADALL CHASSIS

3.1 ASSEMBLY

1. Place frame into upside down position.
2. Make sure roller mounting rails are clean.
3. With air gun, blow out all 48 roller mounting holes. Wipe mounting surfaces clean with rag. verify all threads are clean of grease & oil.
4. Using crane, position and align (12) rollers, (6) per side. Assemble with hardware and loctite. torque (48) bolts to 200 ft.-lbs, +15-0 (280 Nm, +21 -0).

5. Using brush and solvent container, wash both inside and out on both motor mounts areas. Using dry rags, wipe motor mount area dry, inside and outside.
6. Clean the machined mounting surfaces on each drive motor.
7. Get hardware for mounting drive motors and place washers onto each bolt and add loctite.
8. Lift the drive assembly into place using an adequate lifting device and nylon straps. Level, check, and fill (if needed) the oil content. Apply Never Seez to motor mount area. Re-align the motor in the nylon straps as needed & assemble to carbody. Secure with bolts using impact wrench. Torque to 230 ft-lbs, +15-0 (322 Nm, +21 -0).

9. Repeat process to opposite side:
10. Clean machined mounting surface (one side only) with solvent rags.

NOTE: *Sprockets are not directional.*

11. Apply never seez to sprocket mounting area. Hook to crane using strap and alignment pin. lift up and onto motor drive. Secure with bolts and loctite. torque to 230 ft-lbs, +15-0 (322 Nm, +21 -0).

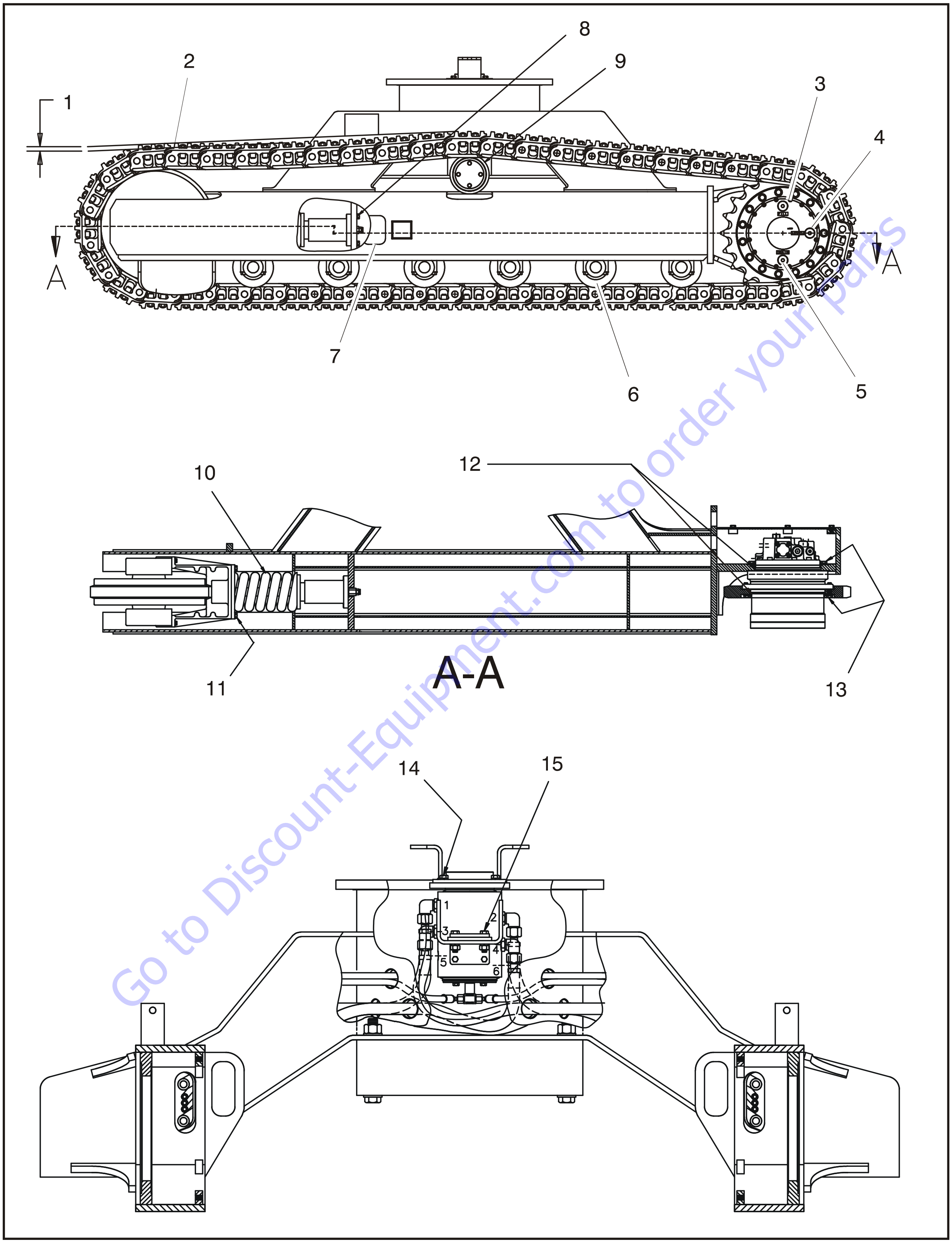
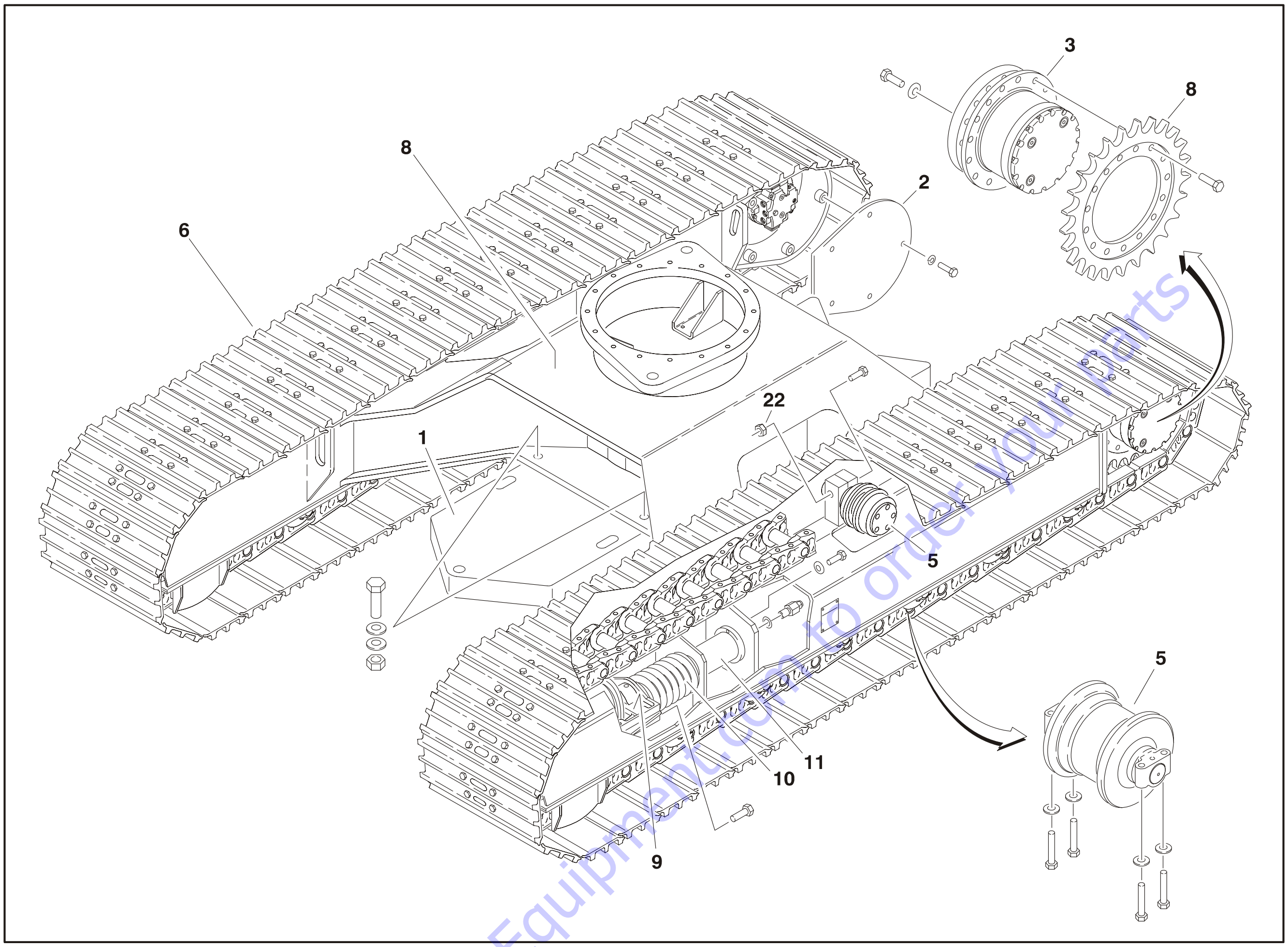


Figure 3-1. Chassis Service Notes - Sheet 1 of 2

1	Track tension adjustment to be made between the idler and carrier roller - 0.781 inches (19.8 mm)
2	Never-Seez to be used on master link pin before assembly. Torque Pad bolts over master link to 65 ft-lbs +6,-6 then tighten 1/3 (120°)turn further.
3	Fill Plug
4	Check oil level of left & right crawler drives (0.69 gal. [2.6 L] grade 90 Gear Oil)
5	Drain Plug
6	Torque to 200 ft-lbs, +15 -0 (280 Nm, +21 -0)
7	Use Gradall 8381-3109 Large Button Head Grease Fitting Adapter to Adjust Tracks
8	Torque to 65 ft-lbs, +10 -0 (91 Nm, +15 -0)
9	Torque to 340 ft-lbs, +25 -0 (476 Nm, +35 -0)
10	Offset in Idler Spring from centerline of Idler to be oriented down.
11	Torque to 165 ft-lbs, +15 -0 (231 Nm, +21 -0)
12	Add Never-Seez to both mounting pilots Drive Motors
13	Torque to 230 ft-lbs, +15 -0 (322 Nm, +21 -0)
14	Torque to 93 ft-lbs, +10 -0 (130 Nm, +14 -0)
15	Torque to 53 ft-lbs, +5 -0 (74 Nm, +7 -0)

Figure 3-2. Chassis Service Notes - Sheet 2 of 2



1. Counterweight
2. Cover Plate
3. Drive Assembly
4. Bottom Track Roller
5. Carrier Track Roller
6. Track Assembly
7. Drive Sprocket
8. Frame
9. Idler Assembly
10. Spring Assembly
11. Shock Assembly

Figure 3-3. Chassis Components

12. Repeat process to opposite side:

13. Assemble fitting and fitting seal into the end of each shock assembly. Torque to chart specifications.

14. Assemble shock assembly into position. Secure with bolts, washers, and loctite. Torque to 65 ft-lbs, +10-0 (91 Nm, +15 -0).

15. Repeat process to the opposite side.

16. Using an adequate lifting device, lift & turn over the frame. Position the left and right frame sides on plywood and idler ends on 4 x 4 blocks.

17. Using an adequate lifting device, pick up spring assembly upright onto idler assembly. Install using bolts, washers, and loctite. Torque to 165 ft-lbs (+15-0 (231 Nm, +21 -0). (Repeat for the other idler assembly.)

18. Repeat process for opposite side.

19. Reference offset in idler spring from centerline of idler (to be oriented down). Using gantry crane and sling, pick up and slide spring / idler assembly into pre-greased slider area, using nylon sledge hammer lightly to assemble. Repeat for other side.

20. Repeat process for opposite side:

21. Push idler assembly against the seat. Using the special adapter, pump in grease to start expanding shock assembly; just enough to inspect for proper assembly prior to track installation.

22. Repeat process to opposite side:

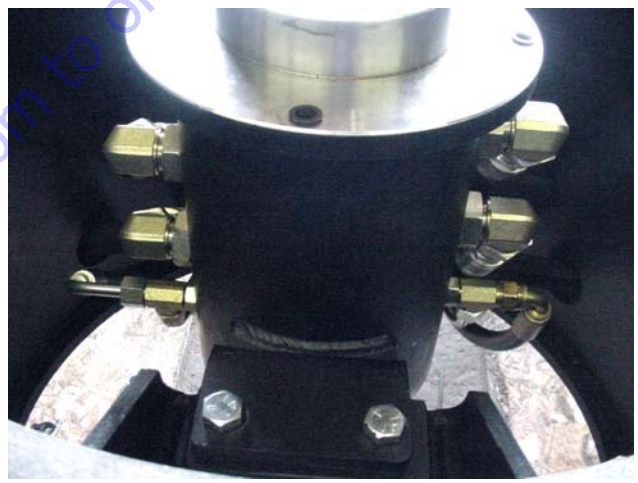
23. Assemble fittings for hoses to both drive motors finger tight until correct positioning is established.

24. Install swivel supports with hardware and loctite. Torque supports to 53 ft-lbs, +5-0 (74 Nm, +7 -0).

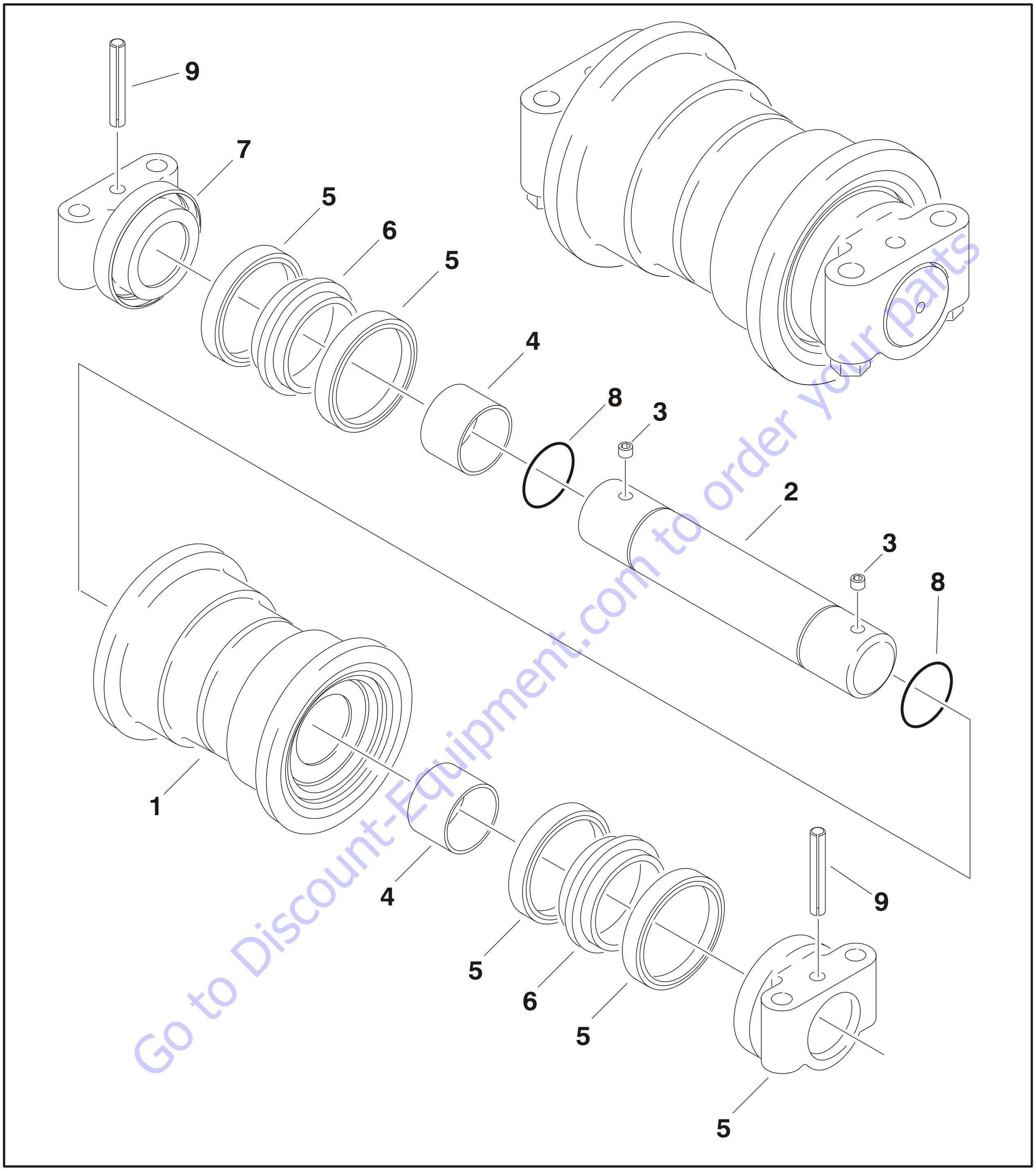
25. Lift swivel using supports previously installed, and assemble to frame. Use loctite with bolts to help secure. Torque to 68 ft-lbs.(95 Nm).

26. Guide in hoses from swivel area through each side frame. Make initial connections for hoses from swivel to drive motors.

27. Route brake, shift, and drain hoses through rh side frame. Lubricate o-rings, and hand tighten hoses to RH drive motor fittings.

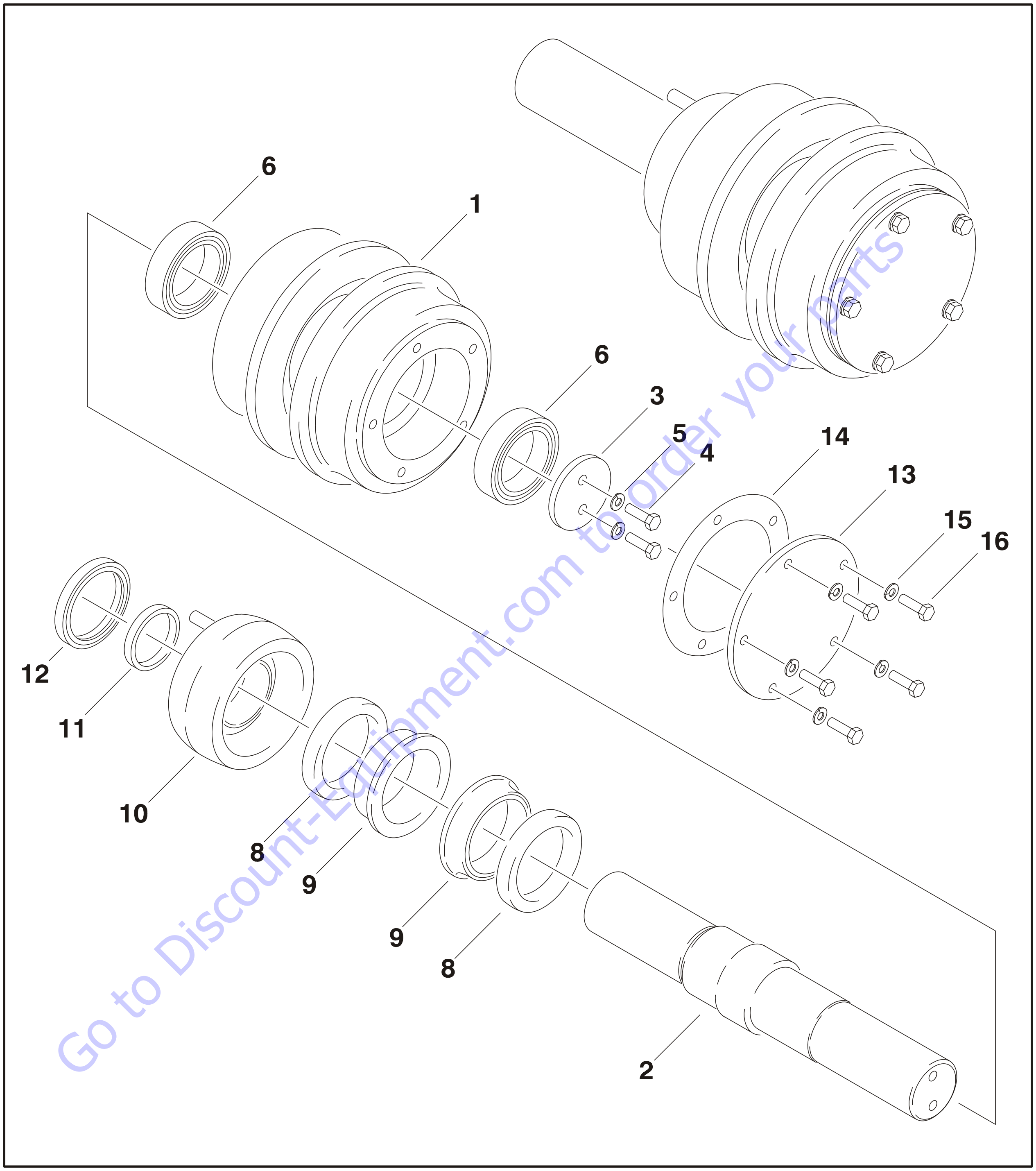


28. Repeat hose routing process on LH side frame with correct hoses to drive motor.



1. Guide Roller	4. Bearing	7. Mounting Bracket
2. Shaft	5. Ring	8. O-ring
3. Plug	6. Seal	9. Roll Pin

Figure 3-4. Bottom Track Roller Assembly



1. Guide Roller	5. Washer	9. Tension Ring	13. Cover
2. Shaft	6. Roller Bearing	10. Collar	14. Cover Seal
3. Internal Cover	7. Not Used	11. Packing Ring	15. Lockwasher
4. Bolt	8. Seal Ring	12. Seal Ring	16. Bolt

Figure 3-5. Carrier Track Roller Assembly

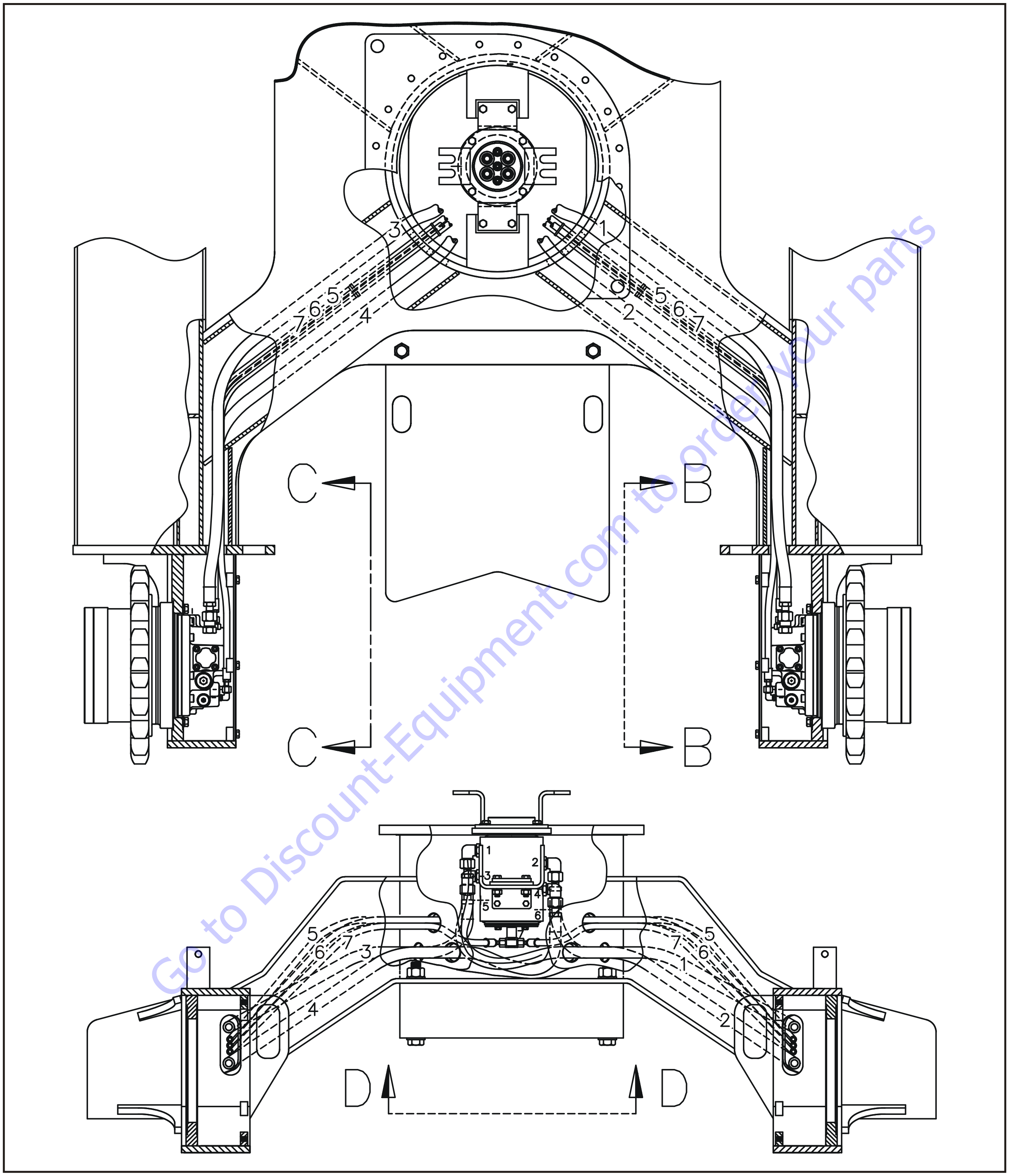


Figure 3-6. Hose Routing - Sheet 1 of 2

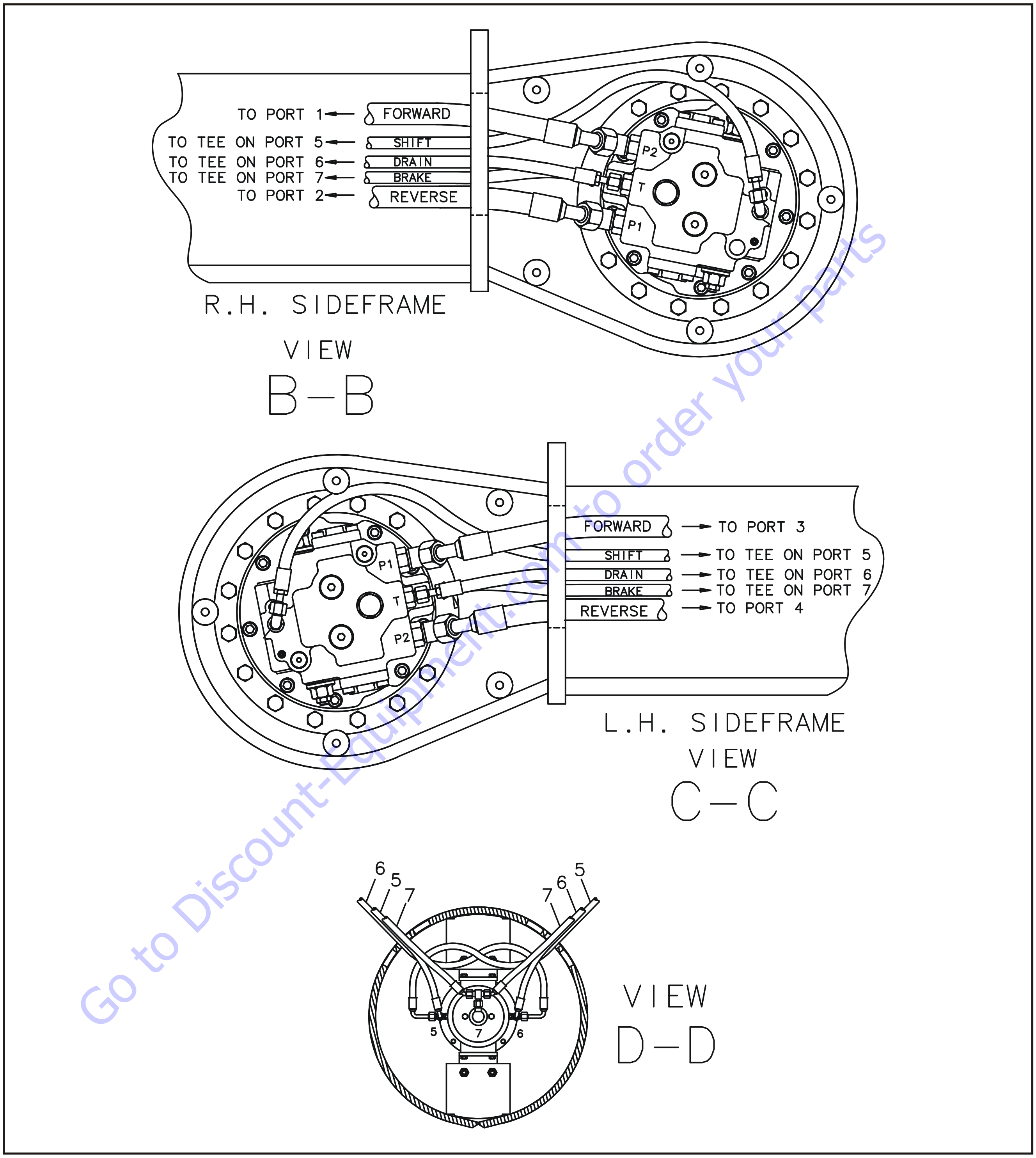
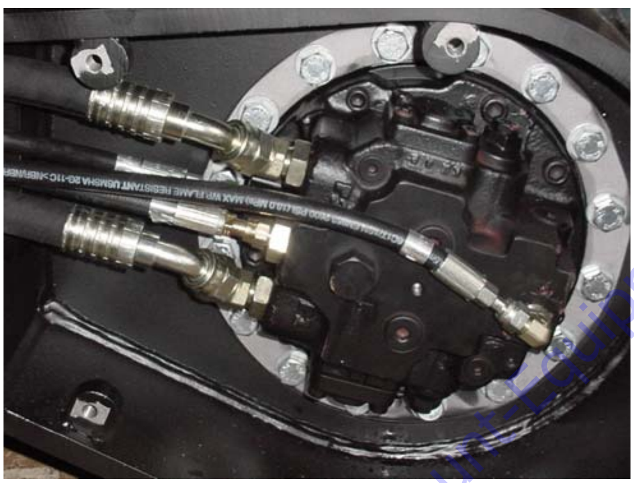


Figure 3-7. Hose Routing - Sheet 2 of 2

29. Route reverse & forward hoses through frame one at a time. Lubricate o-rings, and hand tighten to drive motor fittings.



30. Assemble tee fittings in bottom ports '5' & '6'. Torque per chart specs. route and connect, shift, & drain hoses. Torque hoses according to chart specifications.

31. Assemble swivel tee fitting in bottom port '7'. Route and connect brake hose. Torque hose & fitting according to chart specifications.

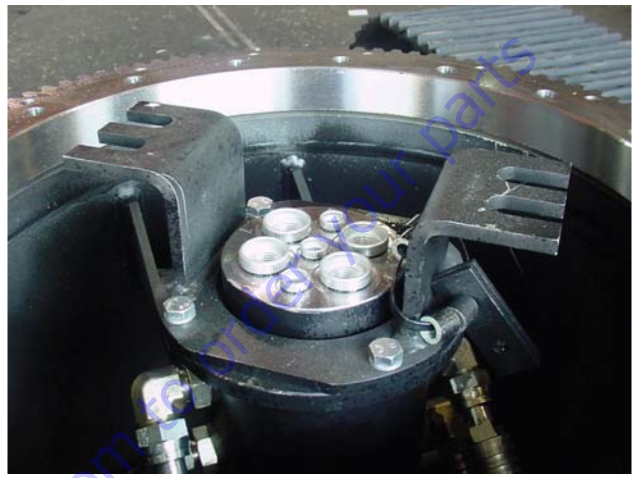
32. Assemble fittings to center pin for reverse hoses, ports '3' & '4'. Torque according to chart specifications. Route and connect hoses to fittings. Torque hoses according to chart specifications.

33. Assemble fittings to center pin for forward hoses, ports '1' & '2'. Torque according to chart specifications. Route and connect hoses to fittings. Torque hoses according to chart specifications.

34. Move to drive motors. Starting with brake hose for easy access, torque (3) small hoses on both sides of the drive motor according to torque chart specifications.

35. Torque (2) large hoses on each drive motor according to torque chart specifications.

36. Install the swivel stabilizer and secure With Loctite. Torque to 93 ft-lbs, +10-0 (130 Nm, +14 -0).



37. Clean split post on each side of the frame, and wipe off grease from roller assembly. Apply Never-Seez. Slide roller assembly into split post hole and secure with nut, bolt, and loctite. Torque to 340 ft-lbs, +25-0 (476 Nm, +35 -0)on both sides.

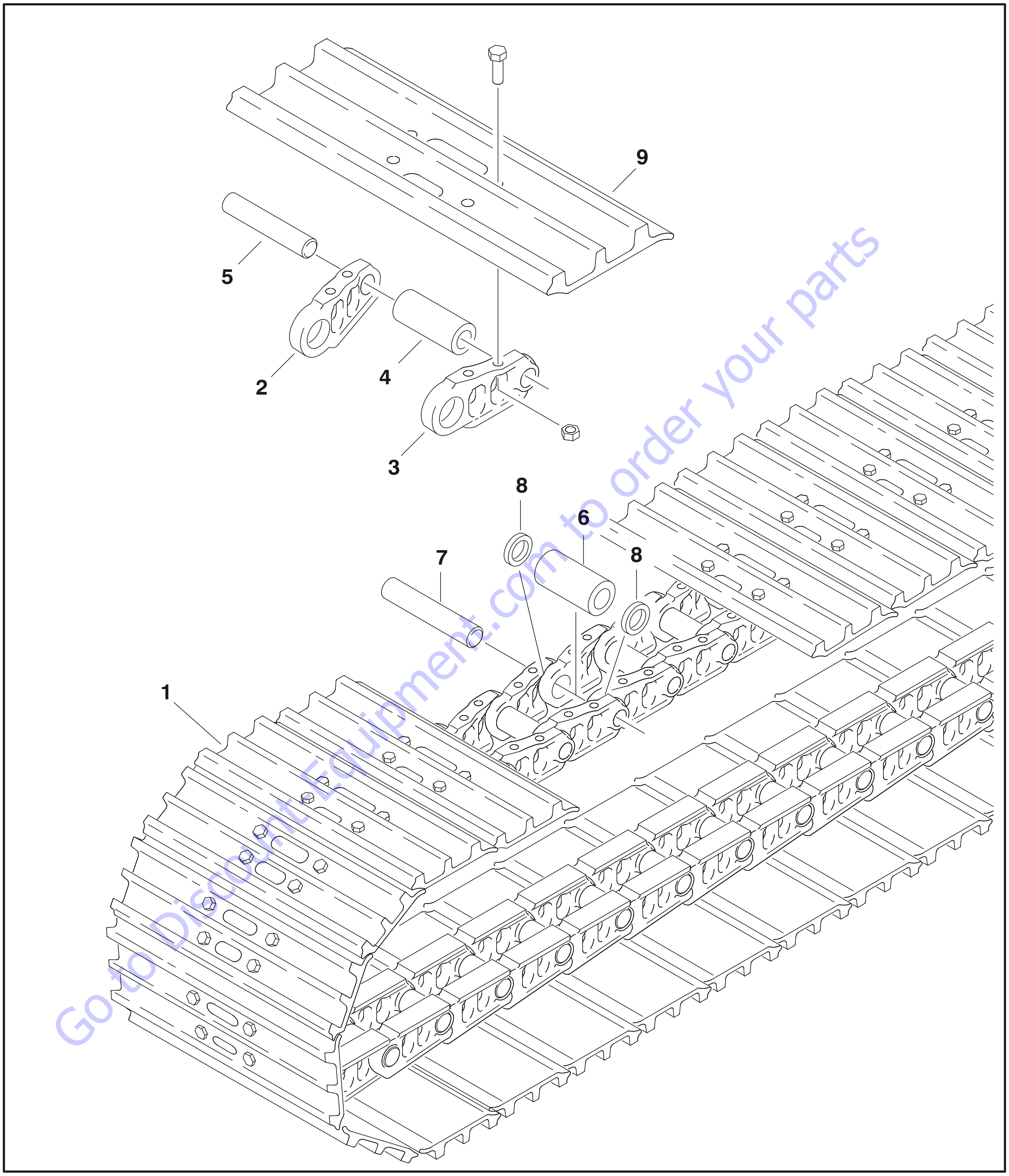
38. Place washers on cover plate retaining bolts and apply loctite on each bolt. Install the cover plates and torque bolts according to chart specifications.

39. Using overhead crane, set the tracks in position on the shop floor. Unroll track completely by crane lifting and pushing along. Using bolt cutters to cut wire securing track pin. Unwrap pin and discard in trash. repeat for second track.

40. Hook up crane to end of track and curl both ends of both tracks inwards (for track pad accessibility).

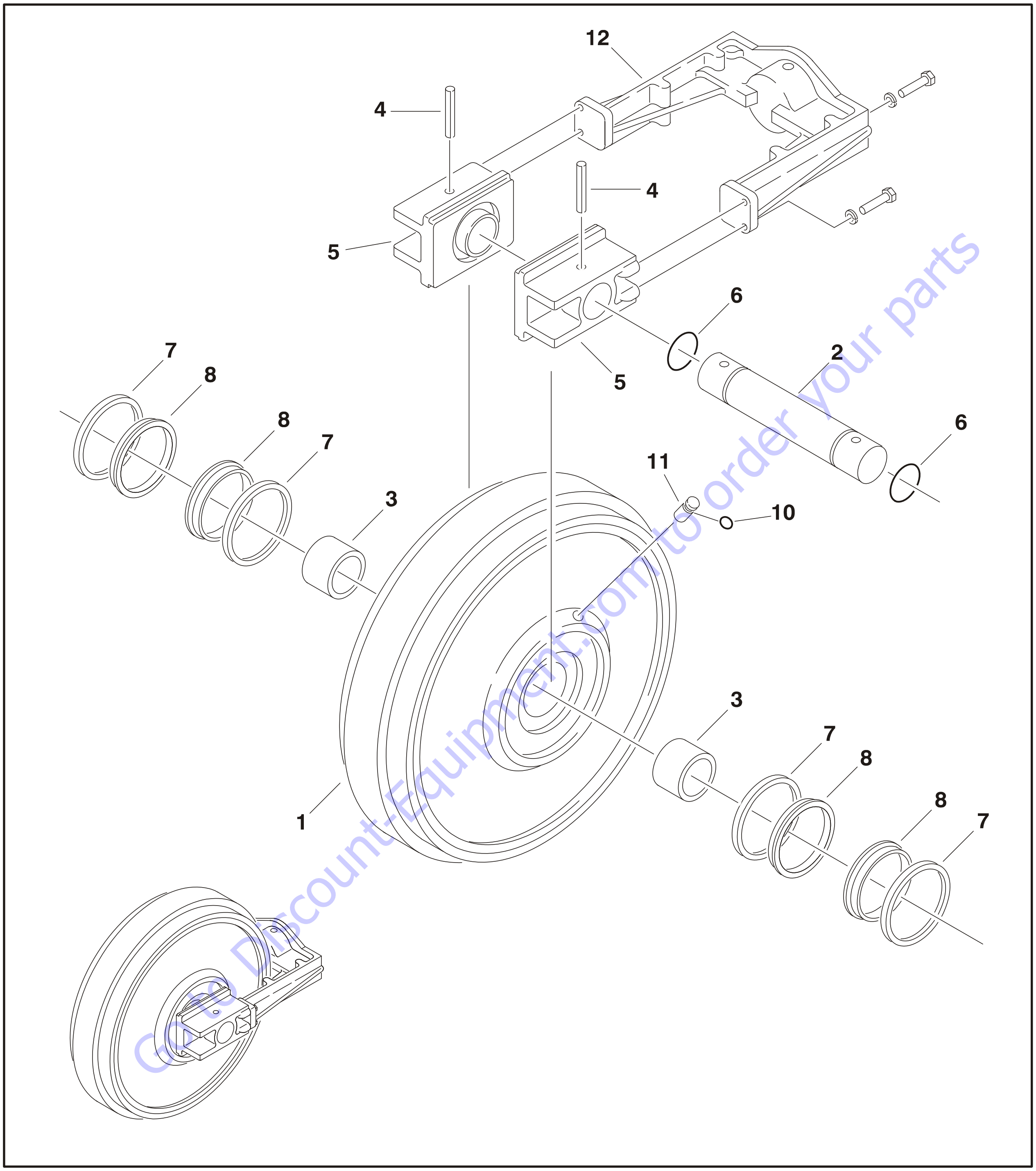
41. Using an impact wrench, remove (4) track pads; one on each end of each track. Set them aside with the (4) bolts and nuts in each pad.

42. Using long pry bar, roll back each end of both tracks flat onto the floor. Measure distance between both tracks. Mark spacing on floor with chalk. use pry bar to move track to mark and correct spacing.



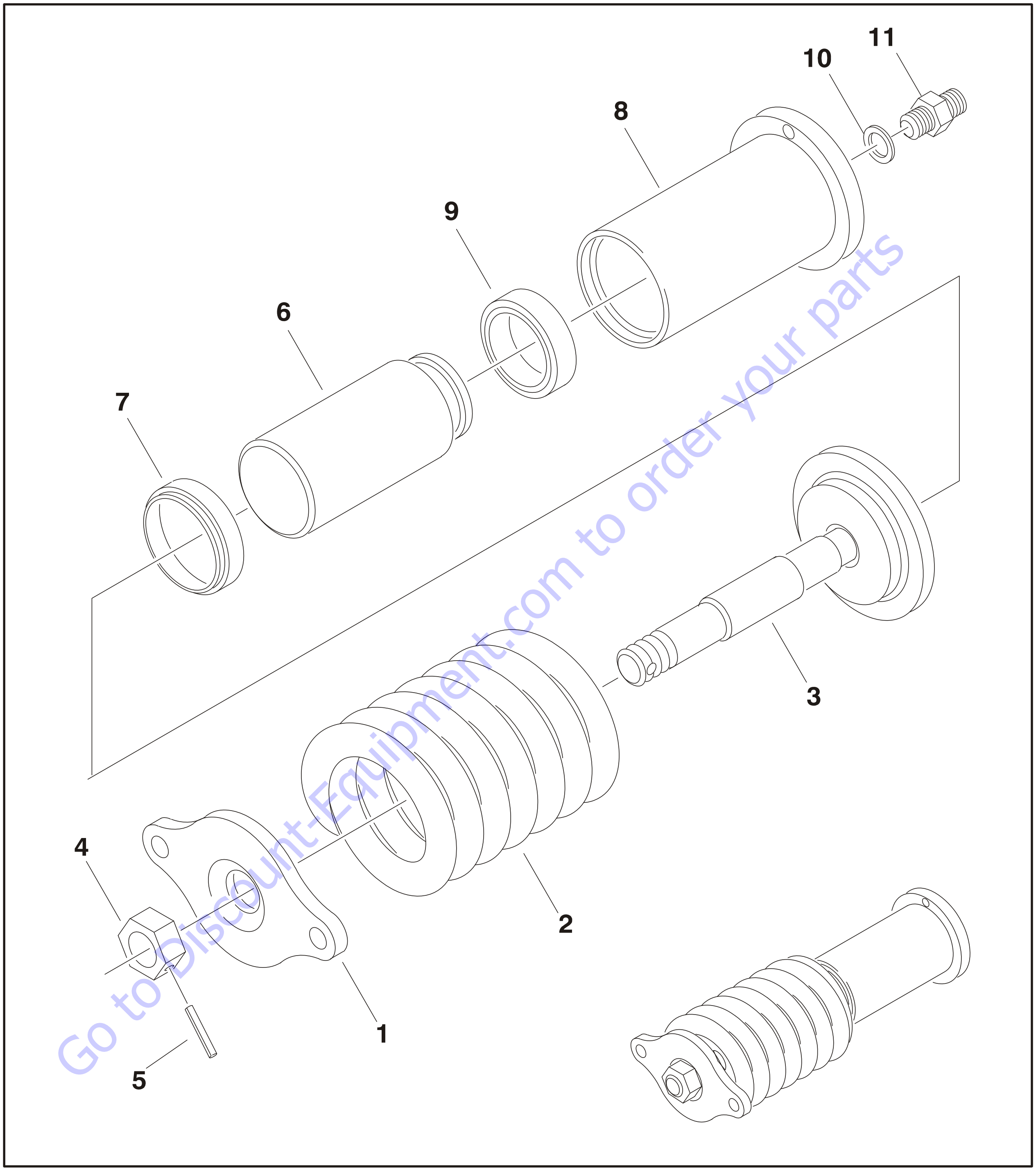
1. Chain Assembly	4. Bearing	7. Splice Hinge Pin
2. Left Link	5. Hinge Pin	8. Spacer
3. Right Link	6. Bearing Splice	9. Track Cleat

Figure 3-8. Track Chain Assembly



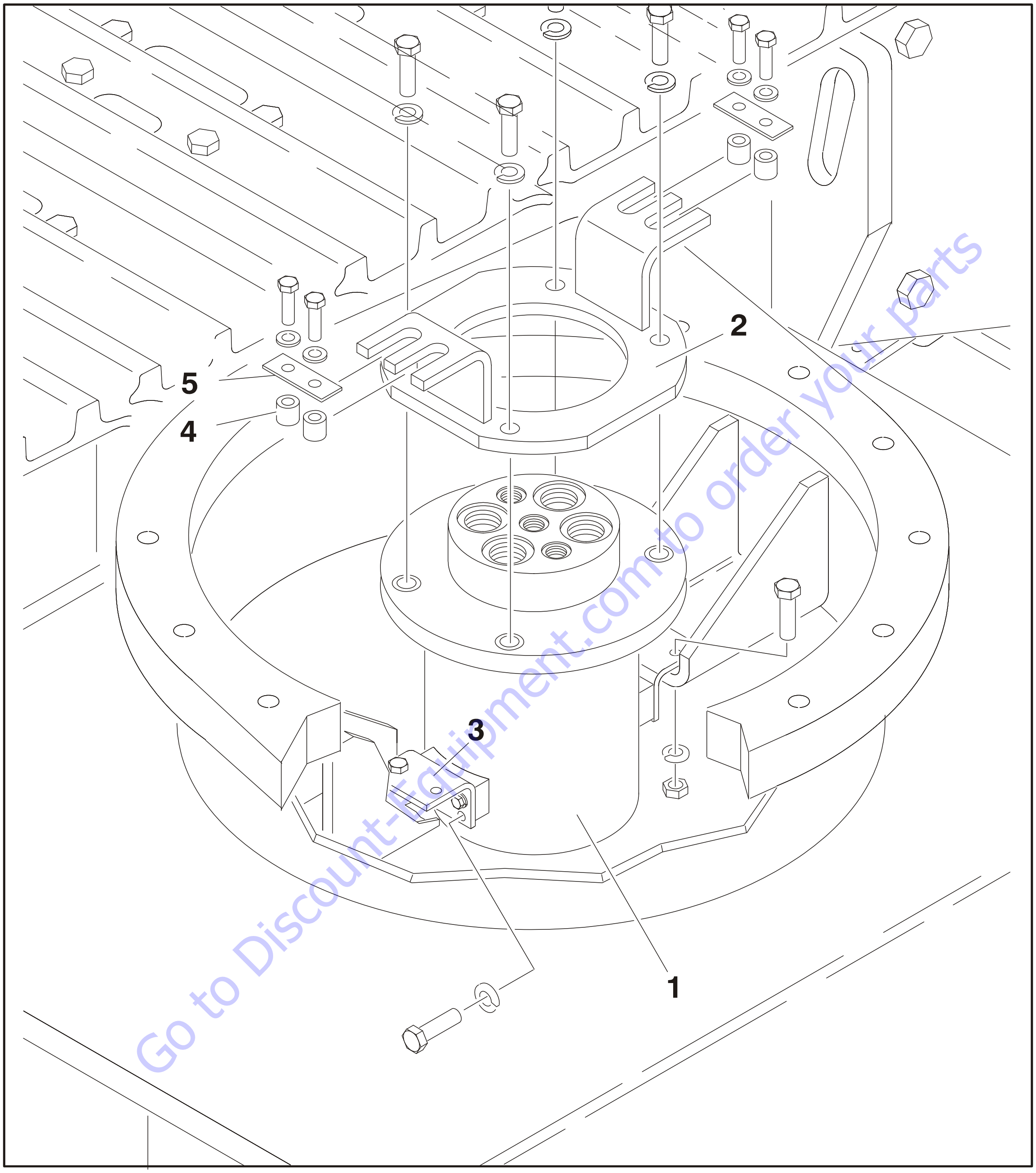
1. Idler	5. Mounting Bracket	9. Not Used
2. Shaft	6. Seal	10. O-ring
3. Bearing	7. Seal	11. Plug
4. Roll Pin	8. Seal Holder	12. Bracket

Figure 3-9. Idler Assembly



1. Mounting Flange	5. Roll Pin	9. Seal
2. Spring	6. Piston/Rod	10. Seal
3. Base Plate	7. Wiper	11. Fitting
4. Locknut	8. Barrel	

Figure 3-10. Spring & Shock Assembly



1. Coupling
2. Stabilizer
3. Support
4. Spacer
5. Keeper

Figure 3-11. Rotary Coupling Installation

43. Get overhead crane and slings, then connect to the carbody assembly. Have crane man lift up while assisting with orientation and move it to the laid out tracks. Position and align onto tracks and unhook crane.

44. Start the tracking process:

45. Using overhead crane, hook up and lift and curl track up over carbody side frame. Perform step to both ends of track. Align chain and c-clamp spacer in two places on chain. Hammer in chain link aligning pin hole. Insert special alignment pin through hole to temporarily hold track together.

46. Position wood blocks to frame rail for tracks to lay onto when connecting track ends to get proper extension for connecting end links.

47. Apply never seez to pin. Line up end links. start pin in hole by driving with a hammer. Place portable power pin press over track and pin. place washers in press ends. Actuate switch to operate press, then carefully press in track pin.

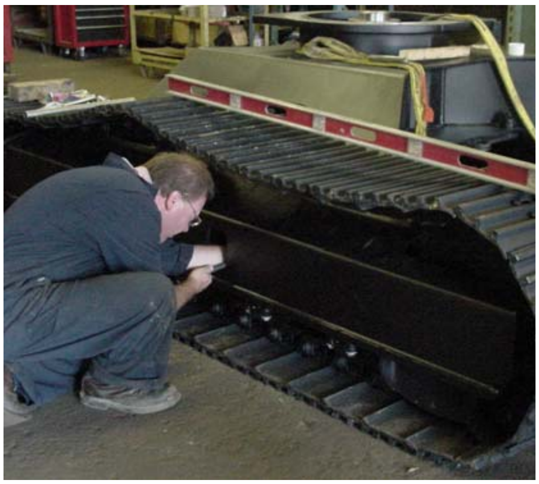
48. Repeat tracking process to opposite side of frame.

49. Using overhead crane connect top of track to crane. Lift slightly and remove wooden blocking used to curl in tracks. Repeat on opposite side.

50. Re-assemble (4) track pads to assembled links.

51. Torque track pad bolts to 65 ft-lbs, +6 (91 Nm, +8.4), then tighten 1/3 turn (120°) further.

52. In special grease fitting, pump in grease to add tension to track. Check for proper adjustment between idler & carrier roller with "level" and gage (0.781in. [19.8 mm]). Remove special fitting.



53. Repeat process on opposite side.

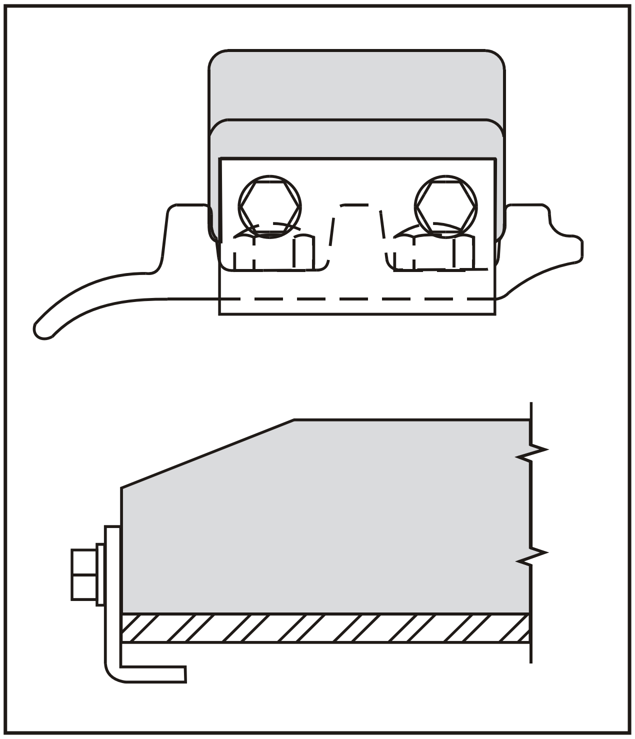
3.2 TRACK TENSIONING

1. Using special grease fitting tool (P/N 83813109), pump in grease to add tension to track. Check for proper adjustment between idler & carrier roller with "level" and gage (0.781in. [19.8 mm]). Remove special fitting.

2. Repeat process on opposite side:

3. In special grease fitting, pump in grease to add tension to track. Check for proper adjustment between idler & carrier roller with "level" and gage (0.781). Remove special fitting.

3.3 RUBBER TRACK PAD INSTALLATION



1. Seat the rubber track pad over the center rib of the steel track pad.
2. Apply Loctite #242 to the steel retaining plate bolts. Install the bolts and flat washers to the end of the rubber pad.
3. Torque the bolts to 70 ft-lbs. (97 Nm).

SECTION 4. CAT CHASSIS (PRIOR TO S/N 0300128000)

4.1 DUO-CONE CONVENTIONAL SEALS

Installation

When the Duo-Cone Seals are installed and assembled, you must use the correct procedures. The Duo-Cone Seal may fail from one or more mistakes that are made during assembly or during installation of the seal components.

Table 4-1. Duo-Cone Required Tools - Installation

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	6V-3075	Dial Indicator	1
	6V-6167	Contact Point	1
	3P-1565	Collet Assembly	1
	165-8958	Dial Indicator Base	1
B	169-0503	Installation Kit	1

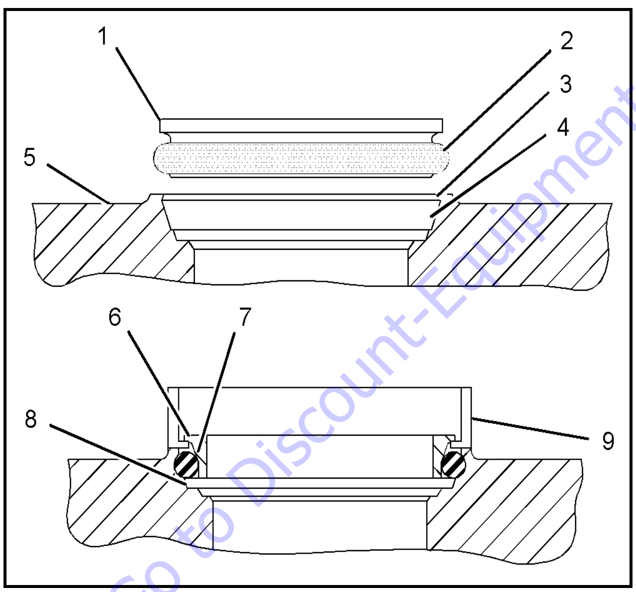


Figure 4-1. Correct Assembly of Conventional Duo-Cone Seals

Assembly and Installation

WARNING

AVOID PROLONGED SKIN CONTACT WITH ISOPROPYL ALCOHOL. AVOID BREATHING THE VAPORS IN ENCLOSED AREAS WITHOUT ADEQUATE VENTILATION AND DO NOT SMOKE.

ISOPROPYL ALCOHOL IS FLAMMABLE. DO NOT USE NEAR OPEN FLAME, WELDING OPERATIONS, OR AROUND HEATED SURFACES EXCEEDING 482°C (900°F).

1. Remove any film, dust or other foreign matter from the following components:

    a. Rubber toric ring (2)

    b. Housing ramp (4)

    c. Seal ring ramp (7)

    d. Housing retaining lip (3)

    e. Seal ring retaining lip (8)

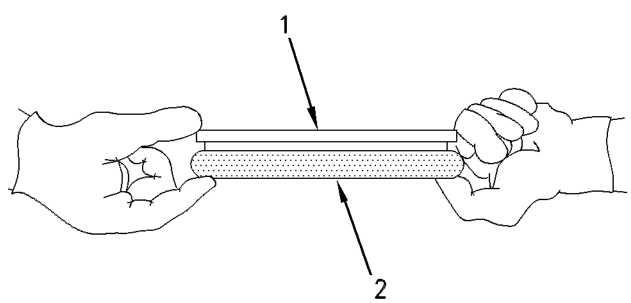
    f. Seal ring housing (5)

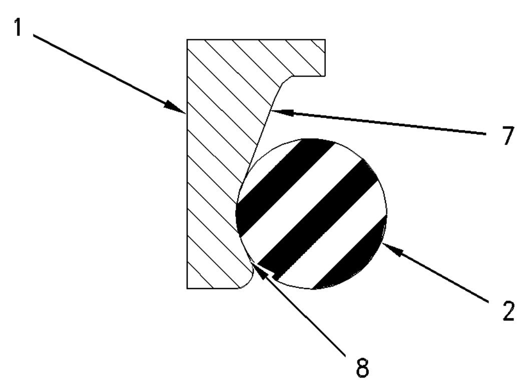
NOTE: *Seal rings have very sharp edges. Protective gloves should be worn in order to prevent injury.*

Use the cleaning agents in Tooling (B) or use isopropyl alcohol or other approved cleaning agents. Use a clean lint free cloth for wiping. All components should be completely dry before proceeding.

NOTE: *Never permit oil to contact rubber toric ring (2), housing ramp (4) or seal ring ramp (7) before both seal rings (1) are assembled in the final position.*

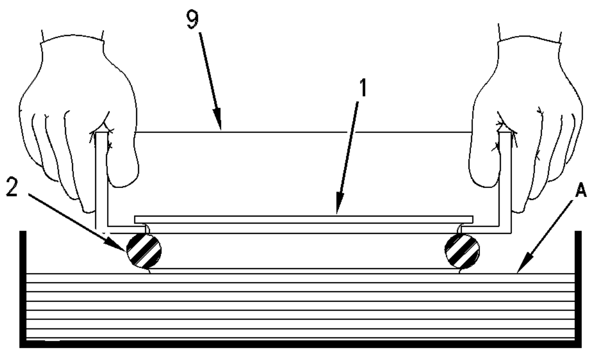
2. Put rubber toric ring (2) on seal ring (1). Make sure that the rubber toric ring is positioned at the bottom of seal ring ramp (7). The rubber toric ring must rest against retaining lip (8). The rubber toric ring must be straight in the seal ring. The rubber toric ring must not be twisted.





NOTE: *Be careful when you are working on the rubber toric ring. Nicks, cuts or scratches may cause leaks.*

3. Use towels or a mat (A) that is made of foam to aid with installing the toric ring (2).



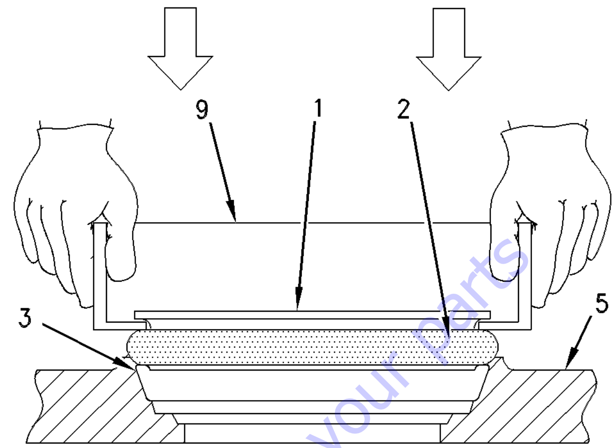
4. Install rubber toric ring (2) on seal ring (1) with installation tool (9). Lightly dampen the lower half of rubber toric ring (2) with an appropriate lubricant. Refer to Acceptable Lubricants for Assembly for additional information. Use the following techniques in order to dampen the rubber toric ring:

   a. Wipe the seal with a lint free cloth.

   b. Place towels or a mat that is made of foam at the bottom of a container. Soak the towels or the mat with the lubricant. Dip the rubber toric seal in the container.

NOTE: *Periodically inspect the installation tool for damage. If necessary, replace the installation tool.*

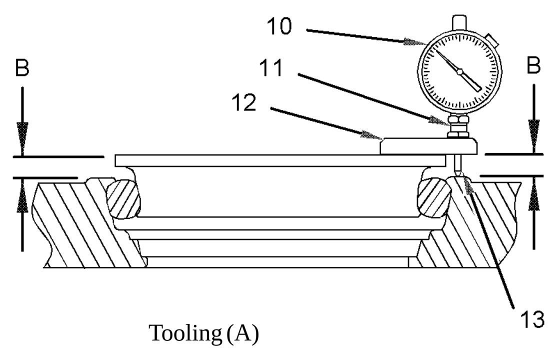
5. Make sure that the lower half of rubber toric ring (2) is still wet. Use installation tool (9) in order to position seal ring (1) and rubber toric ring (2) squarely against seal ring housing (5). Make sure that you use sudden pressure and even pressure when you press a toric ring that has a small diameter. Press rubber toric ring (2) under housing retaining lip (3) that is part of seal ring housing (5). Use the following steps in order to install a rubber toric ring that has a large diameter:



   a. Push the rubber toric ring over the seal ring retaining lip on one side.

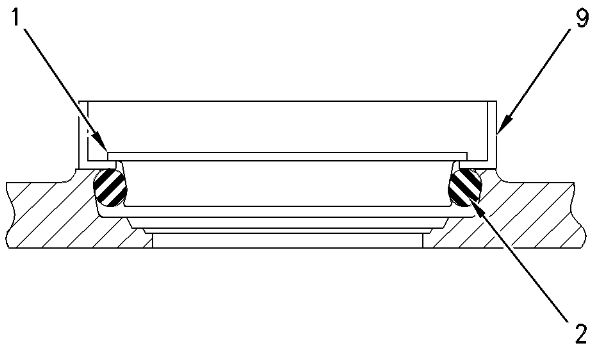
   b. Tap the installation tool with a rubber mallet on the opposite side of the rubber toric ring. Tap until the rubber toric ring is past the seal ring retaining lip of the housing.

6. Use Tooling (A) to check the assembled height (B) at four locations that are 90 degrees from each other. The difference in height must not exceed 1.0 mm (0.04 inch). Refer to the illustration below.



Tooling (A)
(B) Assembled height
(10) Dial indicator
(11) Collet assembly
(12) Dial indicator base (plastic)

7. Do not adjust the seal ring (1) by pushing on the seal ring or by pulling on the seal ring. Use installation tool (9) in order to push down on the seal.



8. Rubber toric ring (2) may twist during installation if the seal is not completely wet or if there are burrs or fins on housing retaining lip (3) that is part of seal ring housing (5). Misalignments, twists and bulges of the rubber toric ring will cause Duo-Cone Seal failures. If correct installation is not obvious, remove the toric ring from the housing and repeat the installation procedure.

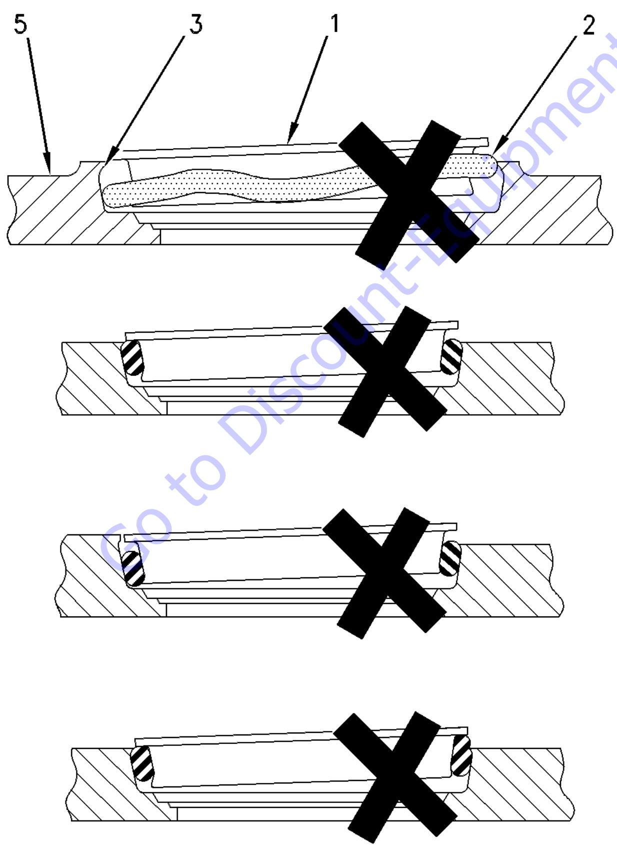
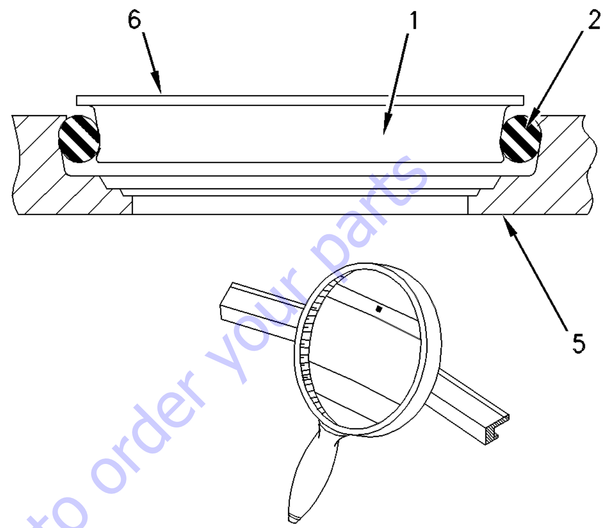


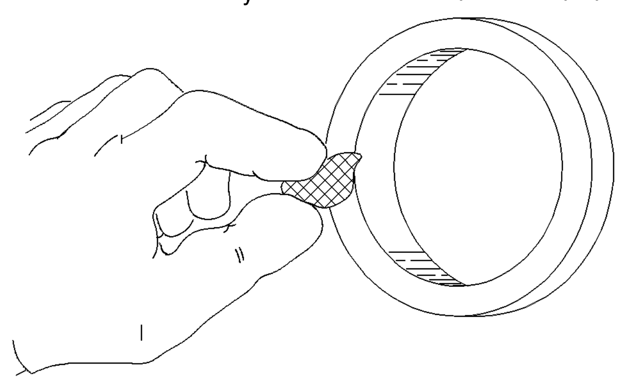
Figure 4-2. Examples of incorrect assembly

9. Wipe seal ring face (6) that is part of seal rings (1) by using a lint free cloth. No particles of any kind are permissible on the sealing surfaces. A small piece of paper from a paper towel can force apart the seal ring face, which will cause a leak.

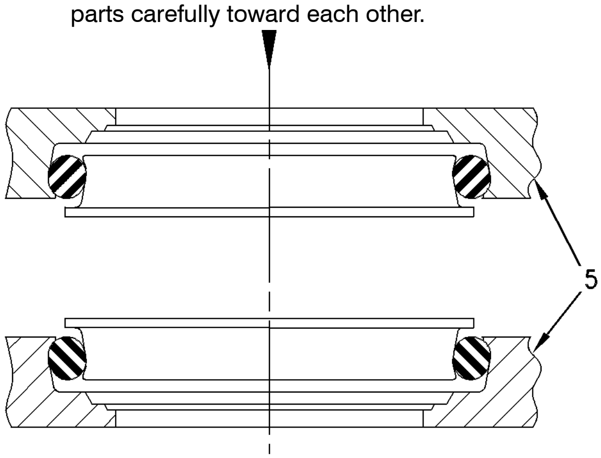


NOTE: *Rubber toric ring (2) must never slip on the ramps of seal ring (1) or the ramps of seal ring housing (5). In order to prevent slippage, allow adequate time for evaporation of the lubricant before proceeding with the procedure. Once the rubber toric ring is correctly positioned, the rubber toric ring must roll only on the ramps.*

10. Apply a thin film of clean oil on the entire seal ring face of one or both seals. Use a lint free cloth or brush in order to distribute the oil evenly. Be careful not to get any oil on the rubber toric rings. Lubricate the seal faces by using the same oil that was used during assembly. Dye may have been used in the oil that was used during assembly. Use the same kind of oil without dye in order to lubricate the seal faces.



11. Make sure that both seal ring housings (5) are in correct alignment and that the seal ring housings are concentric. Move the parts slowly and move the parts carefully toward each other.



NOTE: *Do not force the seal ring and the seal ring housing together in a sudden manner. The seal component could be scratched or the seal component could be broken if the components are slammed together.*

12. Tighten the bolts after the components are in the correct position.

Acceptable Lubricants for Assembly

⚠ WARNING

AVOID PROLONGED SKIN CONTACT WITH ISOPROPYL ALCOHOL. AVOID BREATHING THE VAPORS IN ENCLOSED AREAS WITHOUT ADEQUATE VENTILATION AND DO NOT SMOKE.

ISOPROPYL ALCOHOL IS FLAMMABLE. DO NOT USE NEAR OPEN FLAME, WELDING OPERATIONS, OR AROUND HEATED SURFACES EXCEEDING 482°C (900°F).

NOTE: *Do not use any liquid that leaves an oil film. Do not use any liquid that does not evaporate quickly. All of the guidelines for safety and all of the guidelines for disposal must be followed when you use a flammable liquid. The following liquids are acceptable lubricants for assembly:*

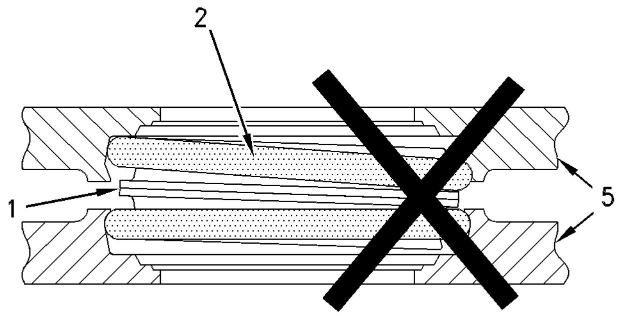
- *Quaker Solvo Clean 68-0*
- *Houghto-Grind 60 CT*
- *Isopropyl alcohol*

Some seal kits come with silicone toric rings. As an option to using liquid lubricants to install silicone toric rings, the rings can be chilled for easier installation. This will allow the toric ring to contract for easier installation.

If chilling is desired, Seals should be placed in a freezer for 5 minutes prior to installation. Temperature in the freezer should be between -40°C (-40°F) to -18°C (0°F). Contraction will be sufficient to allow installation. The seals should be allowed to warm to room temperature prior to further assembly.

RESULT OF INCORRECT ASSEMBLY

The slipping of the rubber toric ring on the housing ramp or on the seal ring ramp may result in uneven pressure on the seal face. Uneven pressure on the seal face causes galling, scoring, and leakage.

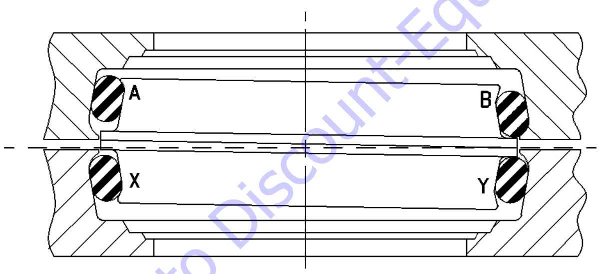


If the rubber toric ring slips at one location but not all the way around the seal ring, the toric ring will twist.

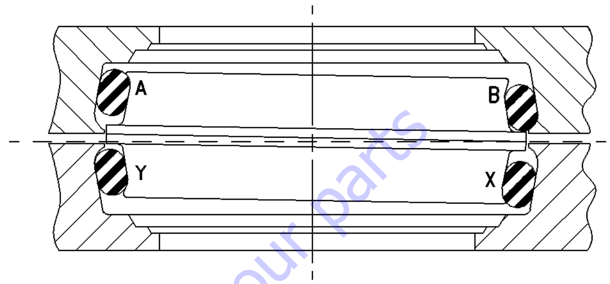
The twisted toric ring could be cocked. Seals that are cocked will cause uneven pressure on the seal face. Seals that are cocked may also cause possible galling, scoring, and leakage.

The twisted toric ring could oscillate when the ring is rotated. Seals that oscillate may allow dirt into the seal joint. This is caused by the pumping action that is created by the toric ring that is oscillating.

The illustration below shows a toric ring that is assembled incorrectly. The upper housing is stationary. The lower housing is rotating.



The illustration below shows the same seal after the lower housing has rotated 180 degrees. In this position, there will be high pressure at Point (B) and at Point (X). These points of high pressure may result in galling of the toric rings. There will be low pressure at Point (A) and at Point (Y) which will result in possible leakage.



4.2 SYSTEM PRESSURE - RELEASE

Procedure for Releasing Pressure

The release of hydraulic pressure in a hydraulic circuit is required before service is performed to that hydraulic circuit. Release the pressure in the following hydraulic circuits before any hydraulic lines are disconnected or removed from that hydraulic circuit.

- Boom hydraulic circuit
- Swing hydraulic circuit
- Drive hydraulic circuit
- Pilot hydraulic circuit
- Return hydraulic circuit

NOTE: *Refer to the applicable section in this manual for additional information concerning service of the components of specific hydraulic circuits.*

Release Of Hydraulic Pressure From A Single Hydraulic Circuit

⚠ WARNING

PERSONAL INJURY CAN RESULT FROM HYDRAULIC OIL PRESSURE AND HOT OIL.

HYDRAULIC OIL PRESSURE CAN REMAIN IN THE HYDRAULIC SYSTEM AFTER THE ENGINE HAS BEEN STOPPED. SERIOUS INJURY CAN BE CAUSED IF THIS PRESSURE IS NOT RELEASED BEFORE ANY SERVICE IS DONE ON THE HYDRAULIC SYSTEM.

MAKE SURE ALL OF THE ATTACHMENTS HAVE BEEN LOWERED TO THE GROUND, AND THE OIL IS COOL BEFORE REMOVING ANY COMPONENTS OR LINES. REMOVE THE OIL FILLER CAP ONLY WHEN THE ENGINE IS STOPPED, AND THE FILLER CAP IS COOL ENOUGH TO TOUCH WITH YOUR BARE HAND.

CARE MUST BE TAKEN TO ENSURE THAT FLUIDS ARE CONTAINED DURING PERFORMANCE OF INSPECTION, MAINTENANCE, TESTING, ADJUSTING AND REPAIR OF THE PRODUCT. BE PREPARED TO COLLECT THE FLUID WITH SUITABLE CONTAINERS BEFORE OPENING ANY COMPARTMENT OR DISASSEMBLING ANY COMPONENT CONTAINING FLUIDS.

DISPOSE OF ALL FLUIDS ACCORDING TO LOCAL REGULATIONS AND MANDATES.

Perform the following steps in order to release the hydraulic pressure from a single hydraulic circuit of the main hydraulic system.

1. Position the machine on level ground.
2. Fully retract the stick cylinder rod. Adjust the position of the bucket so that the bucket is parallel to the ground. Lower the boom until the bucket is flat on the ground.
3. Shut off the engine.
4. Turn the engine start switch to the ON position without starting the engine.
5. Place the hydraulic activation control lever in the UNLOCKED position.
6. Move only the joysticks or the pedals of the hydraulic circuit that requires service to the FULL STROKE positions. This will release the high pressure only in that single hydraulic circuit. This will also release any pressure that might be present in the pilot hydraulic circuit.

NOTE: *If the desired hydraulic circuit that requires service requires the activation of a switch for operation, activate the necessary switches for the operation of the hydraulic circuit.*

7. Place the hydraulic activation control lever in the LOCKED position.
8. Turn the engine start switch to the OFF position.
9. Slowly loosen the filler plug on the hydraulic tank and release the pressure from the hydraulic tank. Leave the filler plug loose for a minimum of 45 seconds. This will release the pressure that may be present in the return hydraulic circuit.
10. Tighten the filler plug on the hydraulic tank to the specified torque.
11. The pressure in the single hydraulic circuit that requires service is now released and lines and components can be disconnected or removed from that hydraulic circuit.

Release Of Hydraulic Pressure From Multiple Hydraulic Circuits

⚠ WARNING

PERSONAL INJURY CAN RESULT FROM HYDRAULIC OIL PRESSURE AND HOT OIL.

HYDRAULIC OIL PRESSURE CAN REMAIN IN THE HYDRAULIC SYSTEM AFTER THE ENGINE HAS BEEN STOPPED. SERIOUS INJURY CAN BE CAUSED IF THIS PRESSURE IS NOT RELEASED BEFORE ANY SERVICE IS DONE ON THE HYDRAULIC SYSTEM.

MAKE SURE ALL OF THE ATTACHMENTS HAVE BEEN LOWERED TO THE GROUND, AND THE OIL IS COOL BEFORE REMOVING ANY COMPONENTS OR LINES. REMOVE THE OIL FILLER CAP ONLY WHEN THE ENGINE IS STOPPED, AND THE FILLER CAP IS COOL ENOUGH TO TOUCH WITH YOUR BARE HAND.

CARE MUST BE TAKEN TO ENSURE THAT FLUIDS ARE CONTAINED DURING PERFORMANCE OF INSPECTION, MAINTENANCE, TESTING, ADJUSTING AND REPAIR OF THE PRODUCT. BE PREPARED TO COLLECT THE FLUID WITH SUITABLE CONTAINERS BEFORE OPENING ANY COMPARTMENT OR DISASSEMBLING ANY COMPONENT CONTAINING FLUIDS.

DISPOSE OF ALL FLUIDS ACCORDING TO LOCAL REGULATIONS AND MANDATES.

Perform the following Steps in order to release the hydraulic pressure from multiple hydraulic circuits of the main hydraulic system.

1. Position the machine on level ground.
2. Fully retract the stick cylinder rod. Adjust the position of the bucket so that the bucket is parallel to the ground. Lower the boom until the bucket is flat on the ground.
3. Shut off the engine.
4. Turn the engine start switch to the ON position without starting the engine.
5. Place the hydraulic activation control lever in the UNLOCKED position.
6. Move only the joysticks or the pedals of the hydraulic circuit that requires service to the FULL STROKE positions. This will release the high pressure only in that hydraulic circuit. This will also release any pressure that might be present in the pilot hydraulic circuit.

NOTE: *If the hydraulic circuit that requires service requires the activation of a switch for operation, activate the necessary switches for the operation of the hydraulic circuit.*

7. Place the hydraulic activation control lever in the LOCKED position.
8. Start the engine.
9. Place the hydraulic activation control lever in the UNLOCKED position. Do not move any joysticks or pedals from the NEUTRAL position during this step. Do not activate any switches during this Step.
10. Return the hydraulic activation control lever to the LOCKED position.
11. Shut off the engine.
12. Repeat Steps 4 through 11 for each additional hydraulic circuit that requires service.
13. After releasing the hydraulic pressure in each of the desired hydraulic circuits, place the hydraulic activation control lever in the LOCKED position.
14. Turn the engine start switch to the OFF position.
15. Slowly loosen the filler plug on the hydraulic tank and release the pressure. Leave the filler plug loose for a minimum of 45 seconds. This will release the pressure that may be present in the return hydraulic circuit.
16. Tighten the filler plug on the hydraulic tank to the specified torque.
17. The pressure in the multiple hydraulic circuits that require service is now released and lines and components can be disconnected or removed from those hydraulic circuits.

4.3 TRACK CARRIER ROLLER

Removal

Table 4-2. Track Carrier Roller Required Tools - Removal

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	8T-5255	Hydraulic Jack	1

WARNING

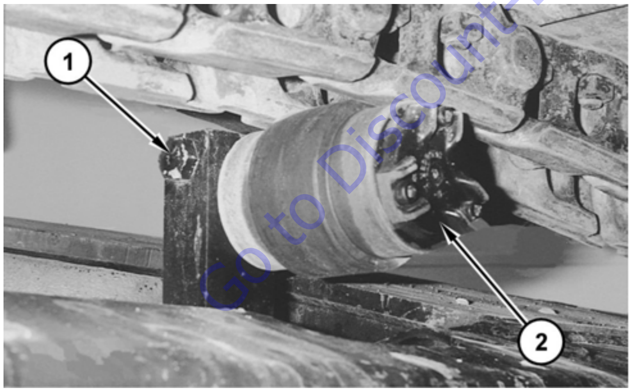
PERSONAL INJURY OR DEATH CAN RESULT FROM GREASE AND OIL COMING OUT OF THE RELIEF VALVE.

GREASE AND OIL ARE UNDER HIGH PRESSURE COMING OUT OF THE RELIEF VALVE AND CAN PENETRATE THE BODY.

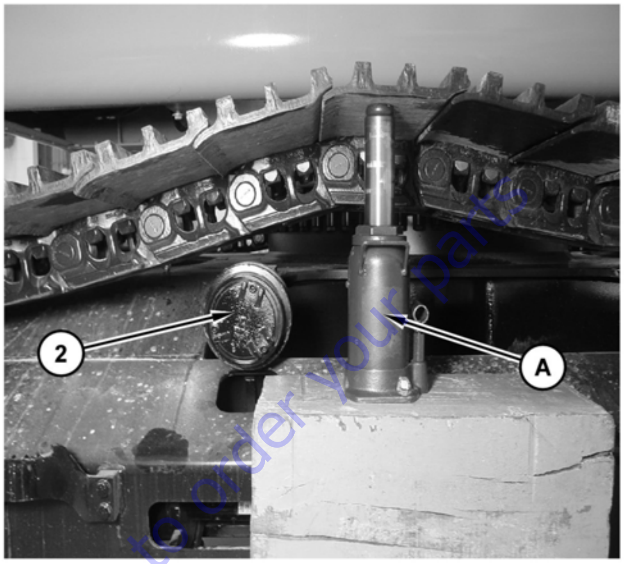
DO NOT WATCH THE RELIEF VALVE TO SEE IF GREASE IS ESCAPING. WATCH THE TRACK OR TRACK ADJUSTMENT CYLINDER TO SEE IF THE TRACK IS BEING LOOSENED.

MAKE SURE THE VENT HOLES ARE CLEAN BEFORE THE TENSION IS RELEASED ON THE TRACK.

1. Start the engine. Park the machine on a hard, level surface. Shut off the engine.
2. Release the tension on the track. Refer to Section 4.12, Track Adjustment.
3. Loosen bolt (1) that holds track carrier roller (2) to the mounting bracket on the undercarriage frame.



4. Use suitable cribbing and Tooling (A) in order to lift the track from track carrier roller (2). Remove track carrier roller (2). The weight of track carrier roller (2) is approximately 14 kg (30 lb).



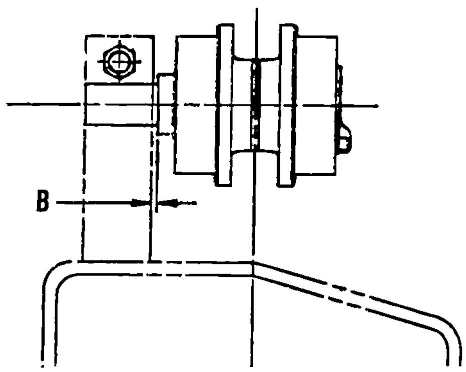
Installation

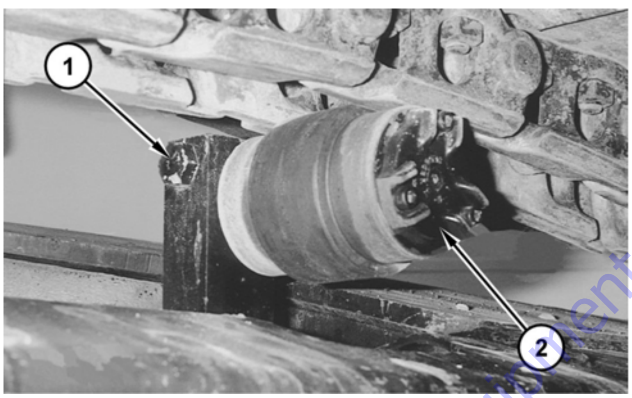
Table 4-3. Track Carrier Roller Required Tools - Installation

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	8T-5255	Hydraulic Jack	1

1. Be sure that the shaft of the track carrier roller and the bore in the mounting bracket on the undercarriage frame are clean and free of dirt.

2. Position track carrier roller (2) in the mounting bracket. The weight of track carrier roller (2) is approximately 14 kg (30 lb). Adjust track carrier roller (2) until Dimension (B) is achieved. Dimension (B) is 4.5 ± 0.5 mm (0.18 ± 0.02 inch).





3. After adjusting the position of the carrier roller in the mounting bracket, tighten bolt (1).

4. Be sure that the carrier roller rotates smoothly by hand. Slowly lower the track assembly to track carrier roller (2) with Tooling (A).

5. Tighten the tension of the track. Refer to Section 4.12, Track Adjustment.

4.4 TRACK ROLLER

Removal

Table 4-4. Track Roller Required Tools - Removal

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	8S-7611	Tube Assembly	2
	8S-7615	Pin	2
	8S-7640	Stand	2
B	183-4797	Track Roller Lifting Fork	1

NOTE: *There is a track guide on each side of the machine. The procedure that follows removes the track roller and the track guide.*

1. Start the engine. Park the machine on a hard, level surface. Stop the engine.

⚠ WARNING

PERSONAL INJURY OR DEATH CAN RESULT FROM GREASE AND OIL COMING OUT OF THE RELIEF VALVE.

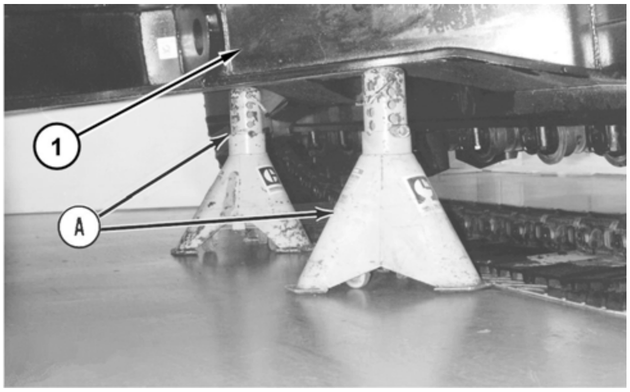
GREASE AND OIL ARE UNDER HIGH PRESSURE COMING OUT OF THE RELIEF VALVE AND CAN PENETRATE THE BODY.

DO NOT WATCH THE RELIEF VALVE TO SEE IF GREASE IS ESCAPING. WATCH THE TRACK OR TRACK ADJUSTMENT CYLINDER TO SEE IF THE TRACK IS BEING LOOSENED.

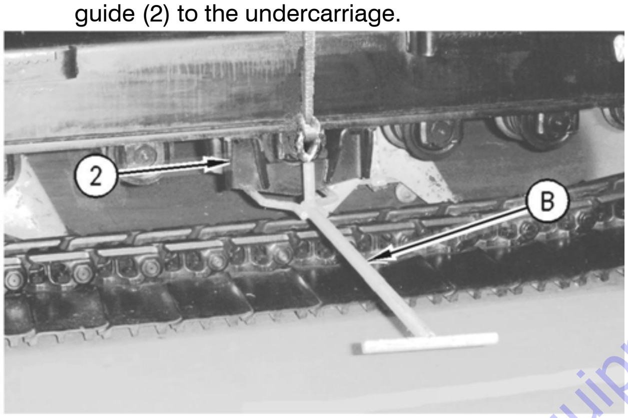
MAKE SURE THE VENT HOLES ARE CLEAN BEFORE THE TENSION IS RELEASED ON THE TRACK.

2. Release the tension on the track. Refer to the Section 4.12, Track Adjustment.

3. Lift the side of the machine. Install Tooling (A) under undercarriage (1), as shown. Adjust the height of Tooling (A) in order to have sufficient clearance for the removal of the track rollers.

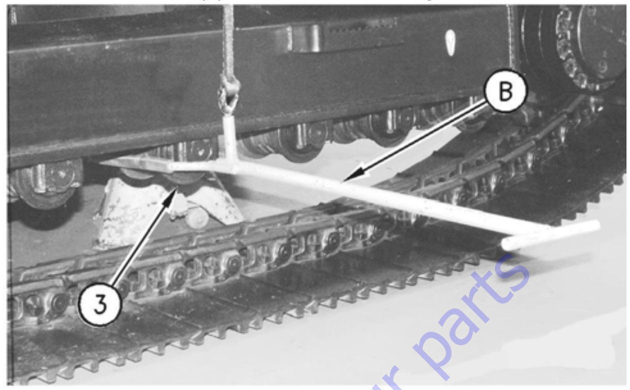


4. Loosen but do not remove the bolts that hold track guide (2) to the undercarriage.



5. Attach a suitable lifting device to Tooling (B). Position Tooling (B) under track guide (2), as shown. Remove the bolts that secure the track guide. Remove track guide (2). The weight of track guide (2) is approximately 18 kg (40 lb).

6. Loosen but do not remove the bolts that secure track roller (3) to the undercarriage.



7. Attach a suitable lifting device to Tooling (B).

8. Position Tooling (B) under track roller (3).

9. Remove the bolts that secure track roller (3). Remove track roller (3). The weight of track roller (3) is approximately 25 kg (55 lb).

Installation

Table 4-5. Track Roller Required Tools - Installation

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	8S-7611	Tube Assembly	2
	8S-7615	Pin	2
	8S-7640	Stand	2
B	183-4797	Track Roller Lifting Fork	1

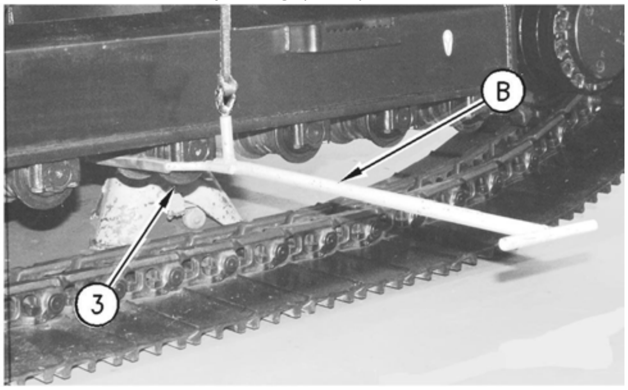
NOTE: *There is a track guide on each side of the machine. The procedure which follows is for the installation of the track roller and the track guide.*

1. Make sure that all the mounting surfaces on the following components are clean and free of debris before the following components are installed:

- Track Roller
- Track Guide

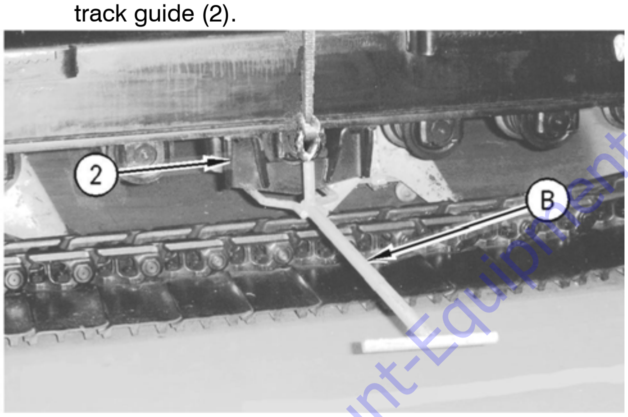
NOTE: *Make sure that the fill/drain plug in the roller faces toward the outside of the undercarriage.*

2. Use Tooling (B) in order to position track roller (3) on the undercarriage. The weight of track roller (3) is approximately 25 kg (55 lb).



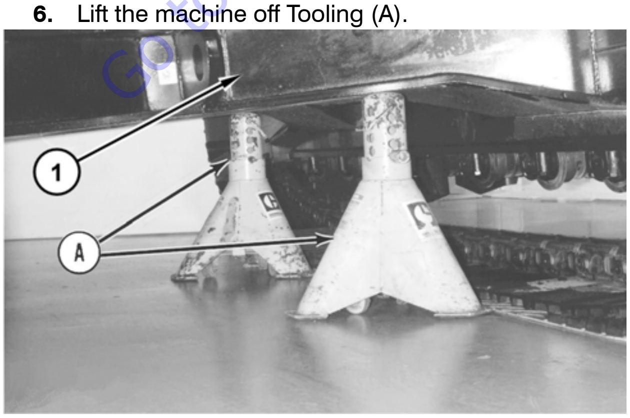
3. Install the bolts that hold track roller (3) in position. Tighten the bolts for track roller (3) to a torque of 270 ± 40 Nm (200 ±30 lb ft).

4. Use Tooling (B) in order to position track guide (2) on the undercarriage. Install the bolts that secure track guide (2).



5. Prior to lowering the machine to the ground and tightening the track, make sure that all of the track rollers rotate smoothly by manually turning the track rollers.

6. Lift the machine off Tooling (A).



7. Remove Tooling (A) from the machine. Lower undercarriage (1) to the ground.

8. Tighten the track to the proper tension. Refer to Section 4.12, Track Adjustment.

4.5 TRACK

Separation

Table 4-6. Track Required Tools - Separation

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	5P-6214	Track Block Assembly	1

⚠ WARNING

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DO NOT WATCH THE RELIEF VALVE TO SEE IF GREASE IS ESCAPING. WATCH THE TRACK OR TRACK ADJUSTMENT CYLINDER TO SEE IF THE TRACK IS BEING LOOSENED.

MAKE SURE THE VENT HOLES ARE CLEAN BEFORE THE TENSION IS RELEASED ON THE TRACK.

⚠ WARNING

PERSONAL INJURY CAN RESULT FROM THE TRACK COMING OFF OF THE ROLLER FRAME.

THE TRACK CAN MOVE OFF THE TRACK ROLLER FRAME VERY QUICKLY WHEN A SEPARATION OF THE TRACK IS MADE.

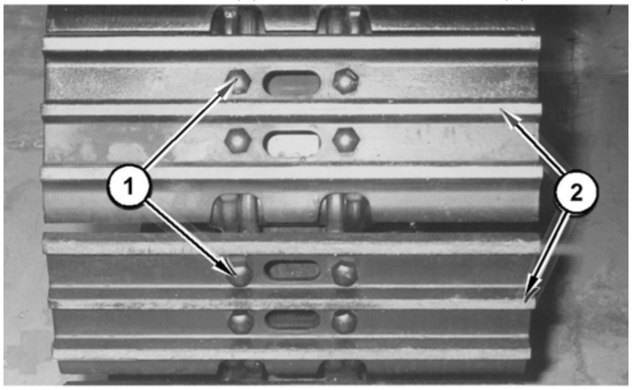
KEEP AWAY FROM THE FRONT OF THE MACHINE WHEN THE TRACK IS REMOVED FROM THE TRACK ROLLER FRAME.

1. Park the machine on a flat, level surface.

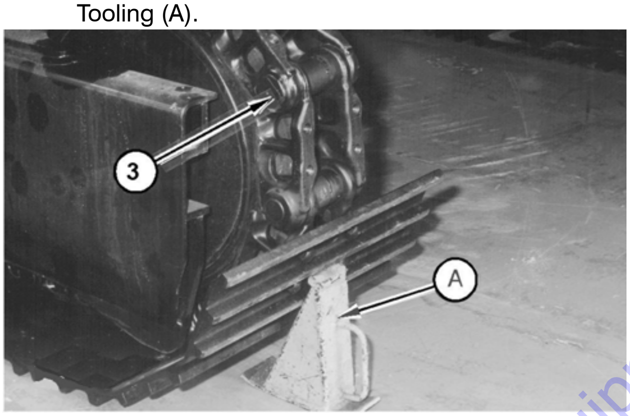
2. Position the master pin in a horizontal line through the center of the idler.

3. Release the tension on the track assembly. Refer to Section 4.12, Track Adjustment.

4. Remove bolts (1). Remove track shoes (2).

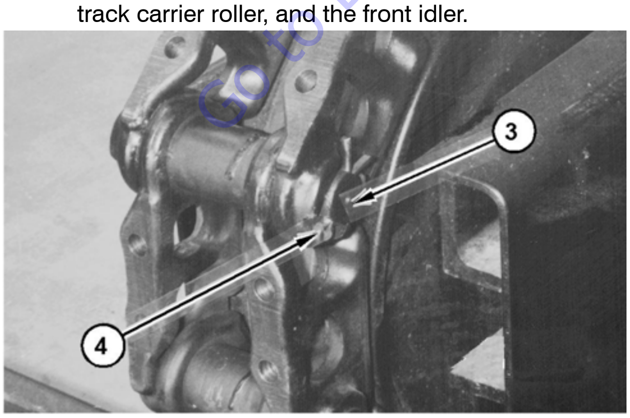


5. Move the track assembly until master pin (3) is in the approximate position. Position Tooling (A) under the track grouser, as shown. Position the track onto Tooling (A).



NOTE: *The two spacers and the seals may fall out of the track links when the track assembly is separated.*

6. Remove cotter pin (4) from master pin (3). Remove master pin (3) from the track links. Separate the track links, and locate the two spacers and the seals. Slowly, move the machine in reverse in order to move the track assembly off the sprocket, the track carrier roller, and the front idler.



7. Attach a suitable lifting device to the track assembly. Raise the track assembly off Tooling (A). Remove Tooling (A) from the track assembly and lower the track assembly to the floor.

Connection

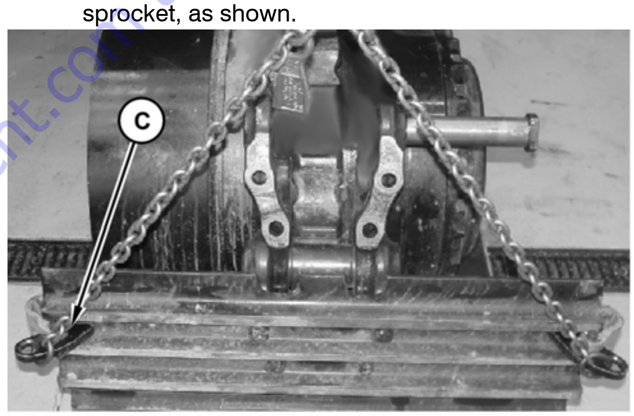
Table 4-7. Track Required Tools - Connection

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	5P-6214	Track Block Assembly	1
B	5P-0960	Molybdenum Grease	-
C	260-9412	Chain As	1
D	1P-3533	Carrier Bar	1

Start By:

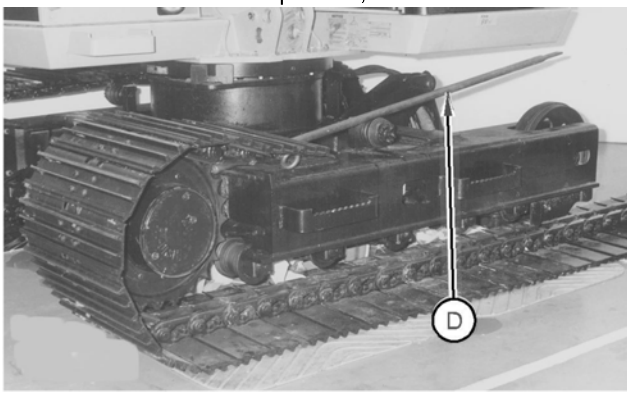
a. Thoroughly clean the track assembly, the sprocket, and the track rollers prior to connecting the track assembly.

1. Install Tooling (C) in the track link and on the sprocket, as shown.



2. Slowly move the sprocket forward until the track assembly is pulled up on the sprocket. Move the sprocket forward until the end of the track assembly is past a vertical line through the center of the sprocket. Remove Tooling (C).

3. Install Tooling (D) between the first bushing in the track link and the sprocket, as shown.

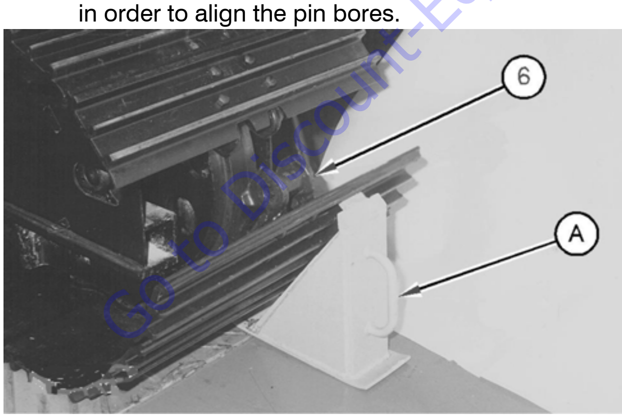


4. Move the sprocket forward. Use Tooling (D) to guide the track assembly over the carrier roller and the front idler.

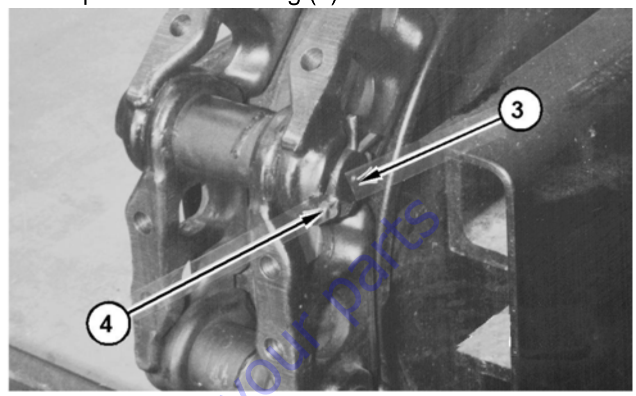
5. Slowly move the machine forward until the separation in the track assembly is below a horizontal line through the center of the front idler.

6. Put Tooling (B) on spacers (6) in order to hold spacers (6) and the seals in place. Install spacers (6) and the seals in the track links.

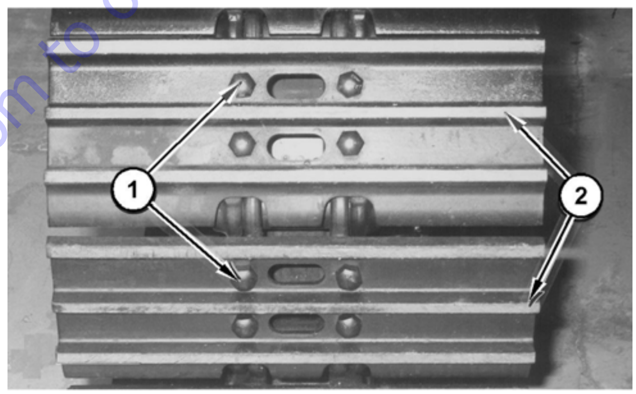
7. Raise the front of the track assembly, and install Tooling (A) under the track assembly. Slowly move the machine forward until the separation in the track assembly closes, and the pin bores in each end of the track assembly are in alignment with each other. The machine may need to be moved back and forth in order to align the pin bores.



8. Put Tooling (B) in the master pin bores in the track assembly and on master pin (3). Install master pin (3). Install cotter pin (4) in order to retain the master pin. Remove Tooling (A).



9. Install track shoes (2) over the master pin on the track assembly. Tighten bolts (1) to a torque of 175 ± 40 Nm (130 ± 30 lb ft). Tighten bolts (1) by an additional 120°.



10. Adjust the track tension. Refer to Section 4.12, Track Adjustment.

4.6 FRONT IDLER AND RECOIL SPRING

Removal

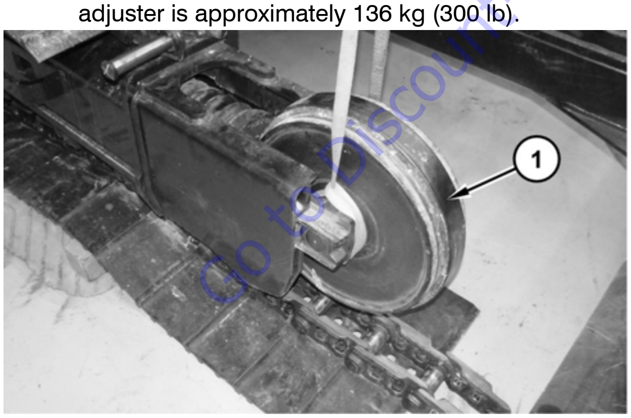
Table 4-8. Front Idler & Recoil Spring Required Tools - Remove

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	180-3033	Jack Stand Gp	1

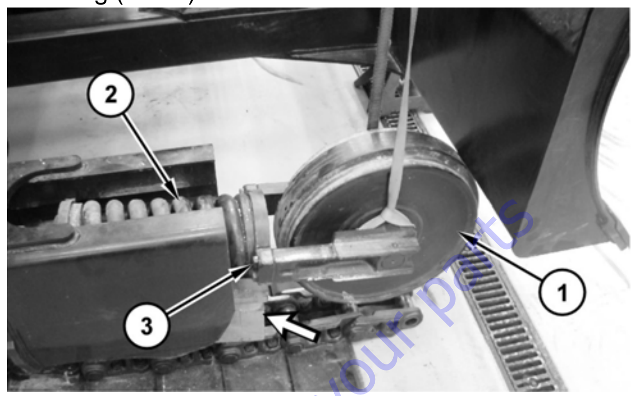
1. Position the machine onto suitable cribbing in order to raise the track idler off the ground.

2. Separate the track. Refer Section 4.5, Track.

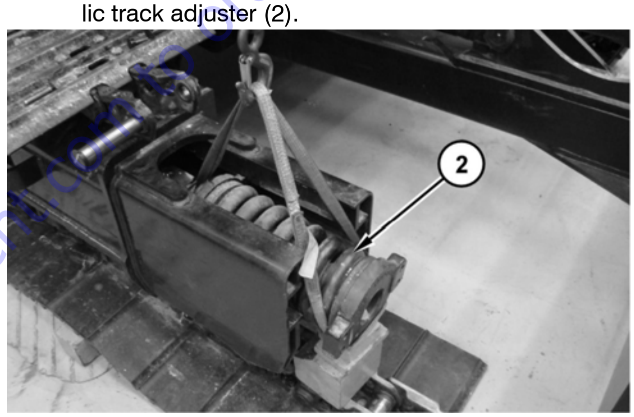
3. Attach a suitable lifting device onto front idler (1). Slide front idler (1) and the hydraulic track adjuster out of the undercarriage frame. The combined weight of front idler (1) and the hydraulic track adjuster is approximately 136 kg (300 lb).



4. Position suitable cribbing under hydraulic track adjuster (2). Remove bolts (3). Remove front idler (1). The weight of front idler (1) is approximately 68 kg (150 lb).



5. Attach a suitable lifting device on hydraulic track adjuster (2). The weight of hydraulic track adjuster (2) is approximately 68 kg (150 lb). Remove hydraulic track adjuster (2).



4.7 RECOIL SPRING

Disassembly

Table 4-9. Track Required Tools - Connection

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	4C-9540	Bench	1
B	8S-7172	Hydraulic Cylinder	1
	3S-6224	Electric Hydraulic Pump	1
	8T-0820	Pressure Gauge	1
	3B-7722	Bushing	2
	1P-2376	Coupler Assembly	2
	1P-2377	Plug	2
	8F-0024	Hose Assembly	2
C	4C-6629	Ram Adapter	1
D	4C-8217	55 mm Socket	1

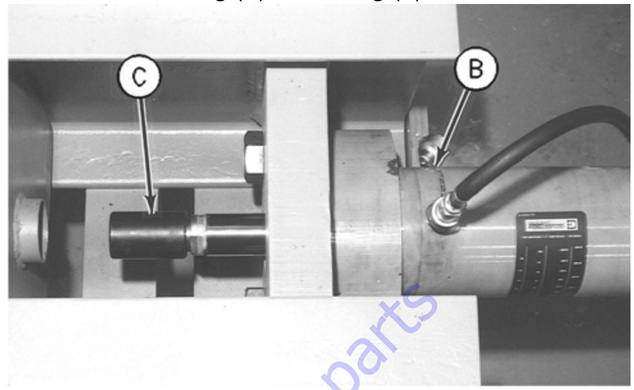
Start By:

a. Remove the track adjuster. Refer to Section 4.9, Track Adjuster.

1. Prior to disassembling and assembling the recoil spring assembly, make sure that Tooling (A) is on a level surface.

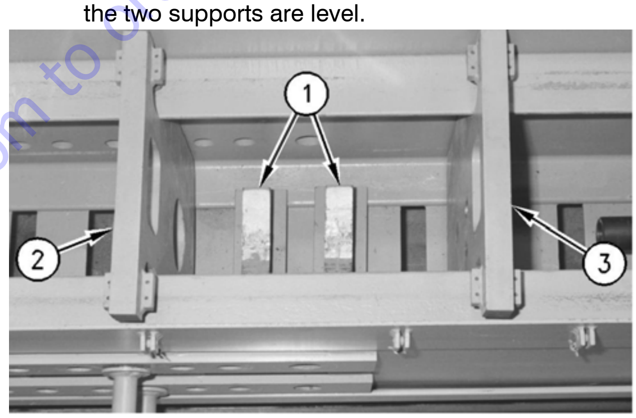
2. Thoroughly clean the outside surface of the recoil spring assembly prior to disassembly.

3. Install Tooling (C) on Tooling (B), as shown.



NOTE: *Two adjustable supports (1), reaction plate (2), and movable plate (3) are part of Tooling (A).*

4. Position two supports (1) of Tooling (A) in order to support the recoil spring assembly. Make sure that the two supports are level.



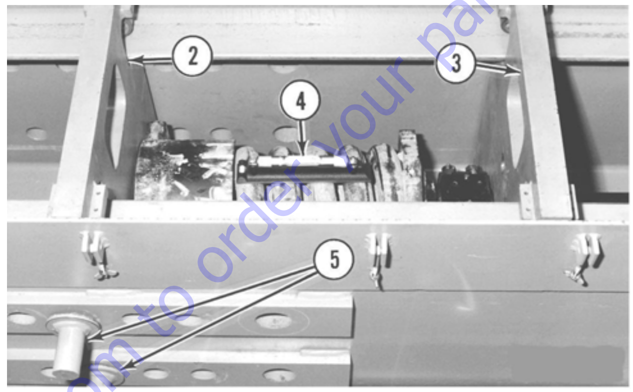
5. Adjust the spacing between reaction plate (2) and movable plate (3) so that the spacing is approximately the same length as the recoil spring assembly at free length.

NOTE: *Do not remove the lifting device from the recoil spring assembly until the unit is leveled, centered, and locked in Tooling (A).*

NOTE: *The recoil spring assembly may be installed in Tooling (A) from the end. In this case, reaction plate (2) must be removed. Then reinstall reaction plate (2) after the recoil spring assembly is in place on two adjustable supports (1).*

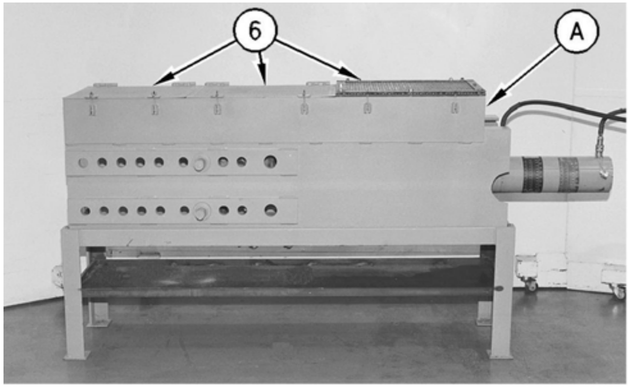
6. The weight of the recoil spring assembly is approximately 53 kg (117 lb). Fasten a suitable lifting device to the recoil spring assembly. Put the recoil spring assembly in position on two adjustable supports (1) in Tooling (A). Adjust two adjustable supports (1) until the centerline of the recoil spring assembly and the centerline of Tooling (A) are aligned.

7. Put a level gauge (4) on the recoil spring assembly. Reposition the recoil spring assembly until the recoil spring assembly is level. Reposition the recoil spring assembly until the retaining rod for the recoil spring and the nut for the recoil spring assembly are centered in the hole in reaction plate (2). After the recoil spring assembly is leveled and centered, install two pins (5) on the back side of reaction plate (2), as shown. Operate Tooling (B) enough to hold the recoil spring assembly in position between reaction plate (2) and movable plate (3). Make sure that the recoil spring assembly is level and centered.



NOTE: *The lifting device is removed from the recoil spring assembly for photographic purposes.*

8. Close covers (6) on Tooling (A). Use Tooling (B) to compress the recoil spring assembly slightly.



⚠ WARNING

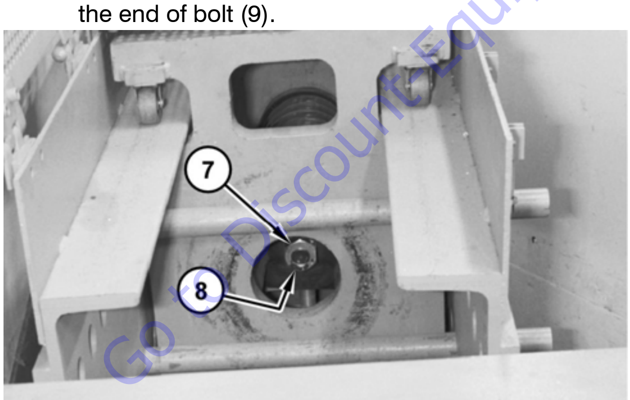
PERSONAL INJURY OR DEATH CAN RESULT FROM RECOIL SPRING FORCE.

RECOIL SPRING FORCE, IF NOT RELIEVED, CAN RESULT IN PERSONAL INJURY OR DEATH.

RELIEVE SPRING FORCE BEFORE REMOVING THREADED RETAINER, PERFORMING REPAIRS ON RECOIL SPRING HOUSING, OR REMOVING RECOIL SPRING.

SEE SERVICE MANUAL FOR DISASSEMBLY INSTRUCTIONS. MAXIMUM PRESSURE IS 20 700 KPA (3,000 PSI).

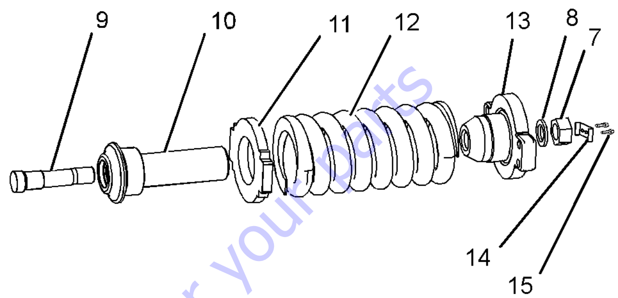
9. Remove bolts (15) and strip (14) from nut (7). Use Tooling (D) to remove nut (7) and washer (8) from the end of bolt (9).



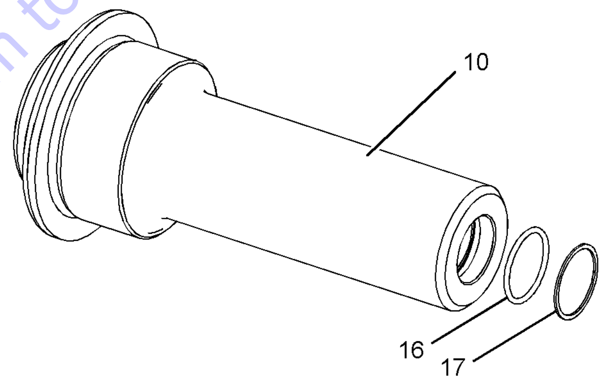
NOTE: *Slowly release the pressure on Tooling (B) in order to allow spring (12) to relax.*

10. Open the covers on Tooling (A). Fasten a suitable lifting device to the disassembled recoil spring assembly. Remove the reaction plate in order to remove the recoil spring assembly from Tooling (A).

11. Separate bolt (9), cylinder (10), plate (11), spring (12), and support (13).



12. Remove O-ring seal (16) and backup ring (17) from cylinder (10).

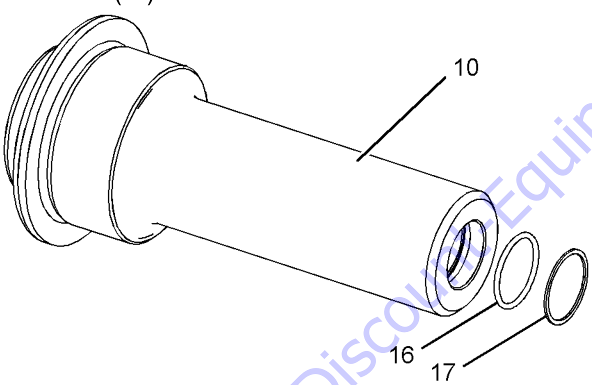


Assembly

Table 4-10. Recoil Spring Required Tools - Assembly

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	4C-9540	Bench	1
B	8S-7172	Hydraulic Cylinder	1
	3S-6224	Electric Hydraulic Pump	1
	8T-0820	Pressure Gauge	1
	3B-7722	Bushing	2
	1P-2376	Coupler Assembly	2
	1P-2377	Plug	2
	8F-0024	Hose Assembly	2
C	4C-6629	Ram Adapter	1
D	4C-8217	55 mm Socket	1
E	5P-3931	Anti-Seize Compound	-
F	4C-4030	Thread Lock Compound	-

1. Install backup ring (17) and O-ring seal (16) into cylinder (10).



⚠ WARNING

PERSONAL INJURY OR DEATH CAN RESULT FROM RECOIL SPRING FORCE.

RECOIL SPRING FORCE, IF NOT RELIEVED, CAN RESULT IN PERSONAL INJURY OR DEATH.

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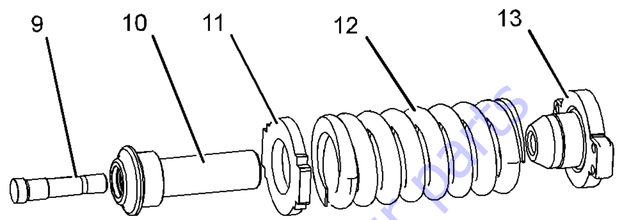
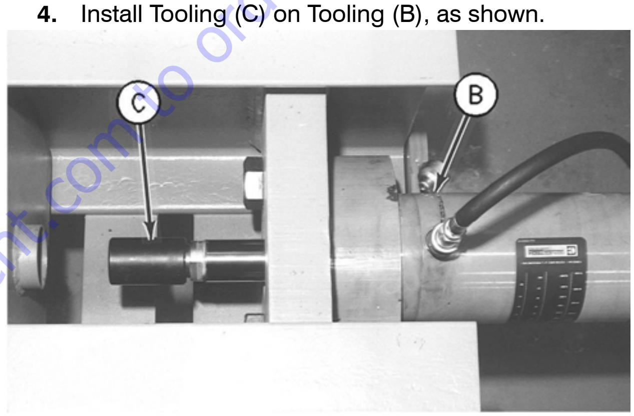
SEE SERVICE MANUAL FOR DISASSEMBLY INSTRUCTIONS. MAXIMUM PRESSURE IS 20 700 KPA (3,000 PSI).

2. Check the condition of the threads on bolt (9) and nut (7). If any of the threads are worn or damaged, install new parts.

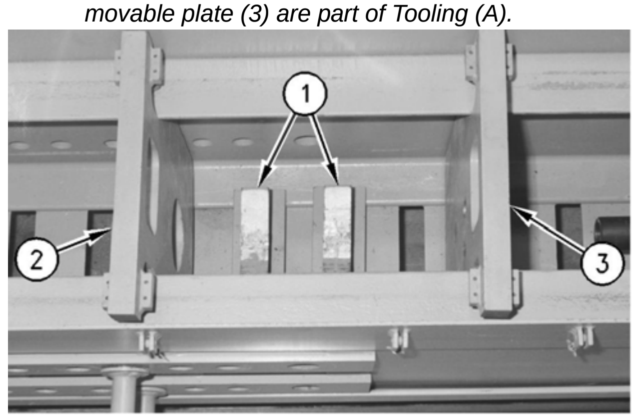
3. Loosely assemble bolt (9), cylinder (10), plate (11), spring (12), and support (13).



4. Install Tooling (C) on Tooling (B), as shown.



NOTE: *Two adjustable supports (1), reaction plate (2) and movable plate (3) are part of Tooling (A).*



5. Position two supports (1) of Tooling (A) in order to support the recoil spring assembly. Make sure that the two adjustable supports (1) are level.

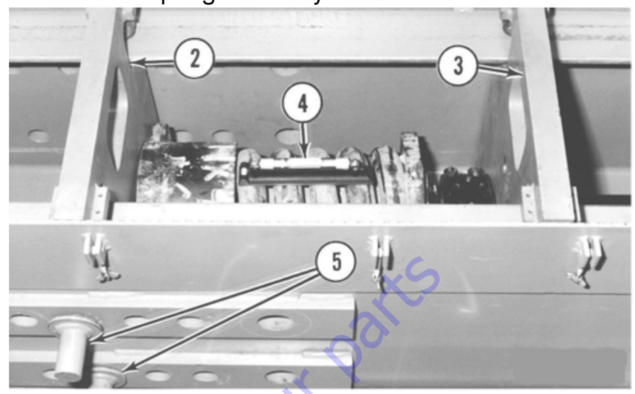
6. Adjust the spacing between reaction plate (2) and movable plate (3) so that the spacing is approximately the same length as the recoil spring assembly.

NOTE: *Do not remove the lifting device from the recoil spring assembly until the unit is leveled, centered and locked in Tooling (A).*

NOTE: *The recoil spring assembly may be installed in Tooling (A) from the end. In this case, reaction plate (2) must be removed. Then reinstall reaction plate (2) after the recoil spring assembly is in place on two adjustable supports (1).*

7. The weight of the recoil spring assembly is approximately 53 kg (117 lb). Put the recoil spring assembly in position on two adjustable supports (1) in Tooling (A). Adjust adjustable supports (1) until the centerline of the recoil spring assembly and the centerline of Tooling (A) are aligned.

8. Put a level gauge (4) on the recoil spring assembly. Reposition the recoil spring assembly until the recoil spring assembly is level. Reposition the recoil spring assembly until the retaining rod for the recoil spring and the nut for the recoil spring assembly are centered in the hole in reaction plate (2). After the recoil spring assembly is leveled and centered, install two pins (5) on the back side of reaction plate (2), as shown. Operate Tooling (B) enough to hold the recoil spring assembly in position between reaction plate (2) and movable plate (3). Make sure that the recoil spring assembly is level and centered.



NOTE: *The lifting device is removed for photographic purposes.*

⚠ WARNING

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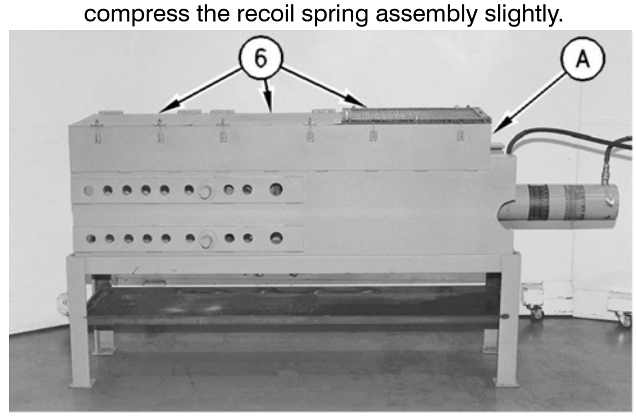
RECOIL SPRING FORCE, IF NOT RELIEVED, CAN RESULT IN PERSONAL INJURY OR DEATH.

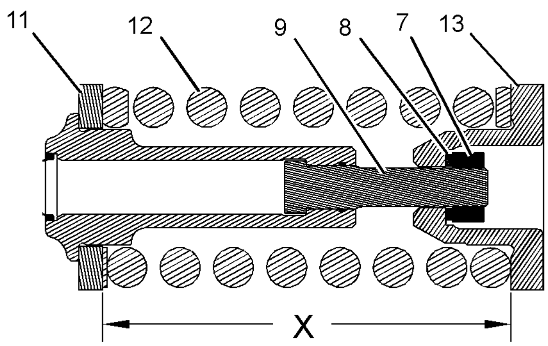
RELIEVE SPRING FORCE BEFORE REMOVING THREADED RETAINER, PERFORMING REPAIRS ON RECOIL SPRING HOUSING, OR REMOVING RECOIL SPRING.

SEE SERVICE MANUAL FOR DISASSEMBLY INSTRUCTIONS. MAXIMUM PRESSURE IS 20 700 KPA (3,000 PSI).

9. Close covers (6) on Tooling (A). Use Tooling (B) to compress the recoil spring assembly slightly.



10. Open the covers (6) on Tooling (A). Measure Dimension (X). Dimension (X) equals 377.0 ± 0.7 mm (14.84 ± 0.03 inch). If the compressed length of Dimension (X) is not correct, close covers (6) on Tooling (A) and adjust the length with Tooling (B). Adjust the length of Dimension (X) until the compressed length of Dimension (X) is correct.



11. Apply Tooling (E) to the threads of rod (9). Install washer (8) and nut (7). Tighten nut (7) until there is sufficient clearance in order to install strip (14) (not shown).

12. Apply Tooling (F) to the threads of bolts (15) (not shown). Install strip (14) (not shown) and bolts (15) (not shown).

13. Fasten a suitable lifting device to the recoil spring assembly. The weight of the recoil spring assembly is approximately 53 kg (117 lb). Remove the recoil spring assembly from Tooling (A).

End By:

a. a. Install the track adjuster. Refer to Section 4.9, Track Adjuster.

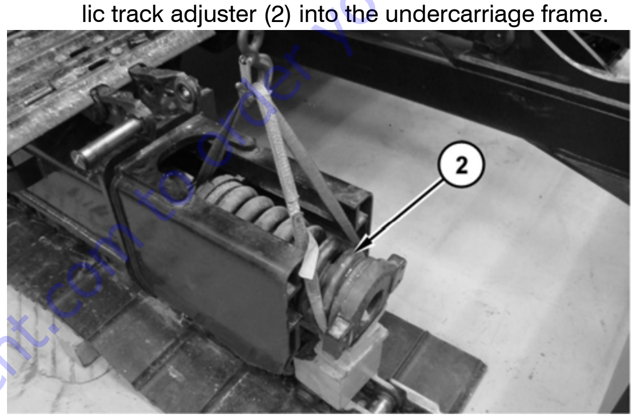
4.8 FRONT IDLER AND RECOIL SPRING

Installation

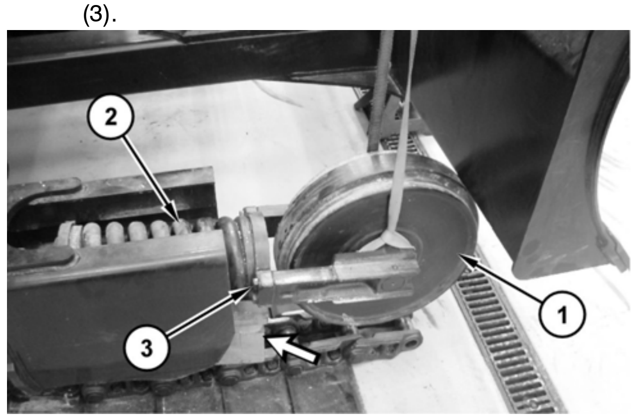
Table 4-11. Front Idler & Recoil Required Tools - Installation

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	180-3033	Jack Stand Gp	1

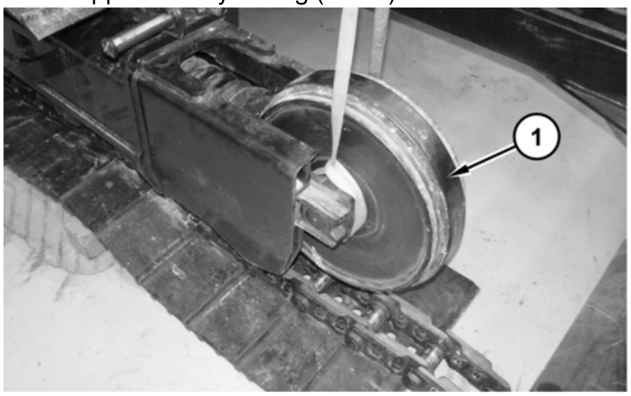
1. Attach a suitable lifting device onto hydraulic track adjuster (2). The weight of hydraulic track adjuster (2) is approximately 68 kg (150 lb). Position hydraulic track adjuster (2) into the undercarriage frame.



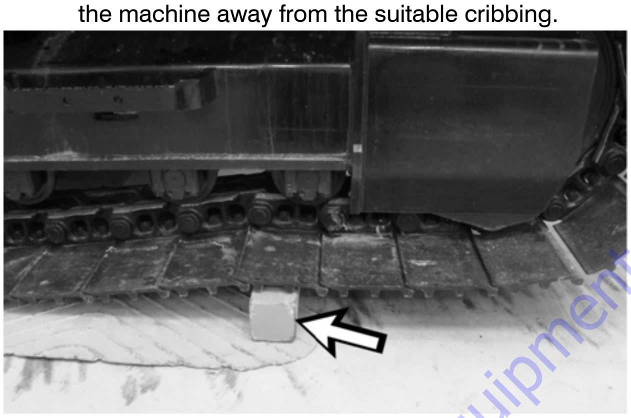
2. Position suitable cribbing under hydraulic track adjuster (2). Attach a suitable lifting device onto front idler (1). Position front idler (1). The weight of front idler (1) is approximately 68 kg (150 lb). Install bolts (3).



3. Slide front idler (1) and the hydraulic track adjuster into the undercarriage frame. The combined weight of front idler (1) and the hydraulic track adjuster is approximately 136 kg (300 lb).



4. Connect the track. Refer to Section 4.5, Track. Move the machine away from the suitable cribbing.



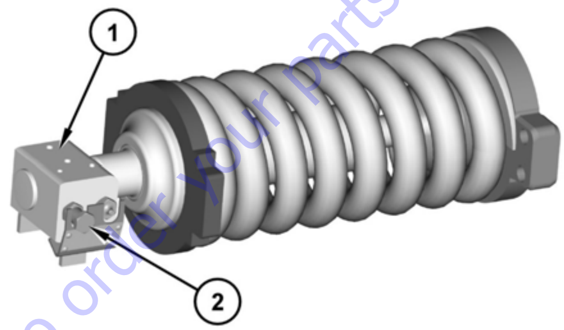
4.9 TRACK ADJUSTER

Removal

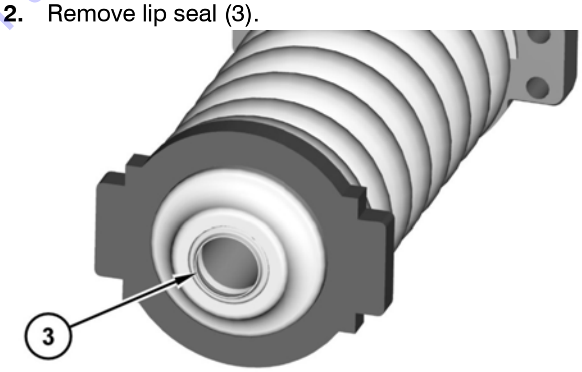
Start By:

a. Remove the front idler and the recoil spring. Refer to Section 4.6, Front Idler and Recoil Spring.

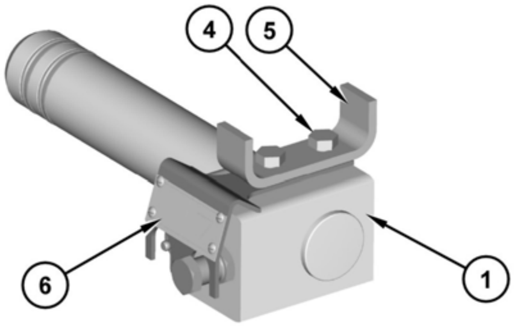
1. Loosen relief valve (2). Remove piston assembly (1).



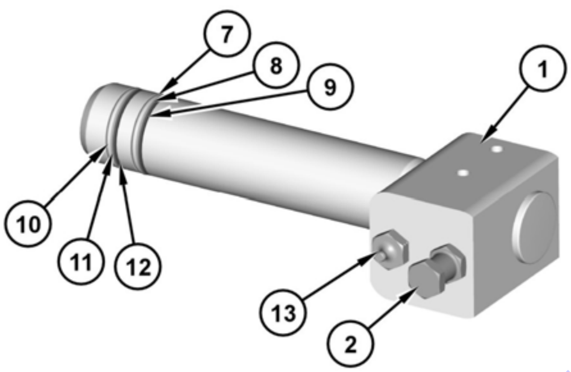
2. Remove lip seal (3).



3. Remove bolts (4), plate (5), and plate assembly (6) from piston assembly (1).



4. Remove O-ring seals (7) and (10). Remove backup rings (8), (9), (11), and (12) from piston assembly (1).

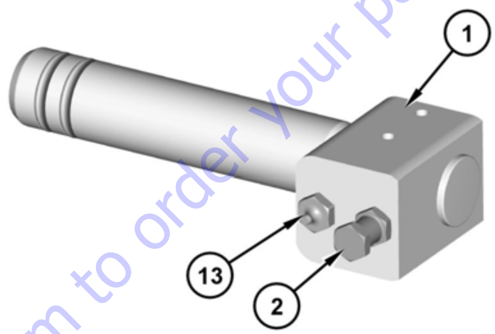


5. Remove fill valve (13) and relief valve (2) from piston assembly (1).

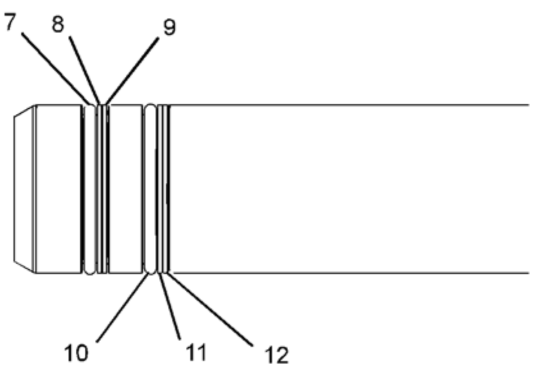
Installation

Table 4-12. Track Adjuster Required Tools - Installation

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	1P-0520	Driver Group	1
B	5P-0960	Molybdenum Grease	-



NOTE: *O-ring seals and backup rings must be installed in the correct position in order to ensure the correct operation of the hydraulic track adjuster. Backup rings are distinguished by the color of the ring. Backup rings (9) and (12) are black in color. Backup rings (8) and (11) are brown in color.*

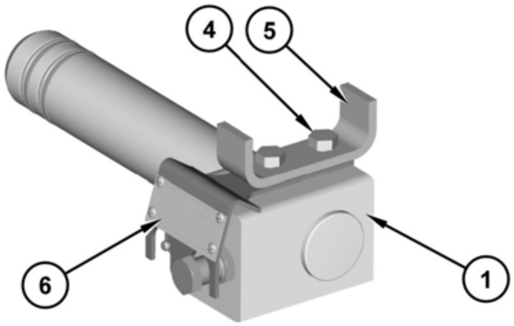


1. Completely fill the seal grooves in piston (1) with Tooling (B). Tooling (B) will displace air when the O-ring seals and the backup rings are installed. Install backup rings (9) and (12). Install backup rings (8), and (11).

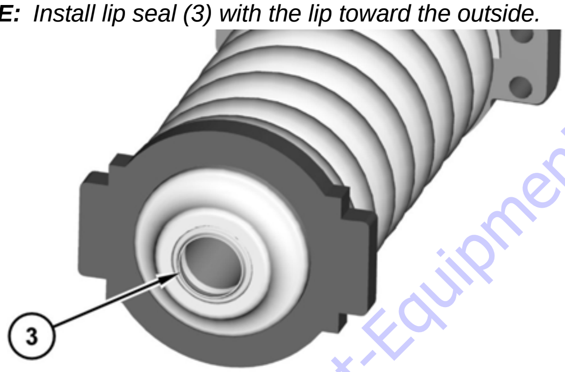
2. Replace O-ring seals (7) and (10) with new O-ring seals. Install O-ring seals (7) and (10).

3. Install fill valve (13) and relief valve (2) to piston assembly (1). Do not tighten fill valve (13) and relief valve (2).

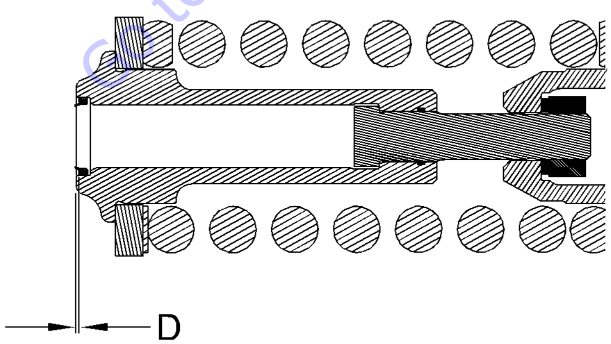
4. Position plate assembly (6) and plate (5) and install bolts (4) on piston assembly (1).



NOTE: *Install lip seal (3) with the lip toward the outside.*

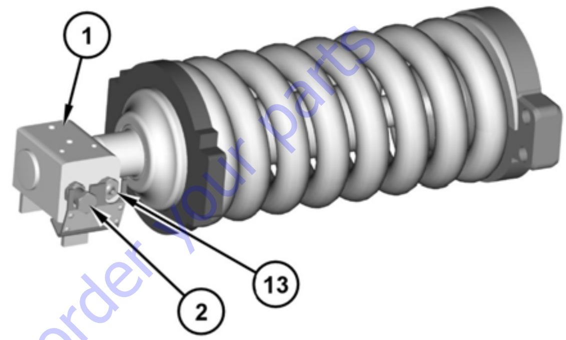


5. Apply Tooling (B) in the groove for lip seal (3). Use Tooling (A) to install lip seal (3). Install lip seal (3) to Dimension (D). Dimension (D) equals 0.5 ± 0.5 mm (0.02 ± 0.02 inch).



6. Put a small amount of Tooling (B) on the sliding surface of piston (1). Put a minimum of 60 cc (4 in3) of Tooling (B) on the end of piston (1). This will prevent air from displacing grease in the cylinder during the installation of the piston. Make sure that the grease covers the backup rings and the O-ring seals.

7. Center piston (1) in the cylinder. Insert piston (1) into the cylinder.



NOTE: *It may be necessary to use a soft faced hammer to install piston (1) into the cylinder.*

8. Tighten fill valve (13) to a torque of 34 ± 5 Nm (25 ± 4 lb ft).

9. Fill the cavity of the piston with Tooling (B).

10. Make sure that all of the passages in the piston are filled with Tooling (B). Make sure that air is not trapped in the passages in the piston.

11. Tighten relief valve (2) to a torque of 34 ± 5 Nm (25 ± 4 lb ft).

End By:

a. a. Install the front idler and the recoil springs. Refer to Section 4.8, Front Idler and Recoil Spring.

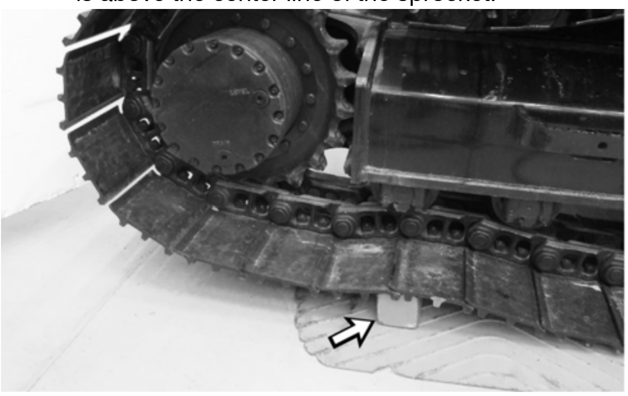
4.10 SPROCKET

Removal

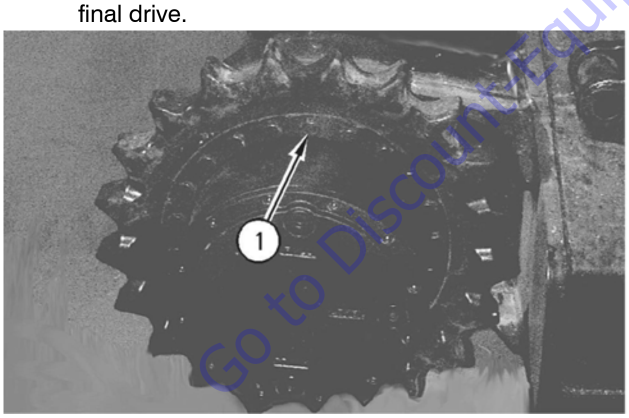
Table 4-13. Sprocket Required Tools - Removal

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	138-7574	Link Bracket	1

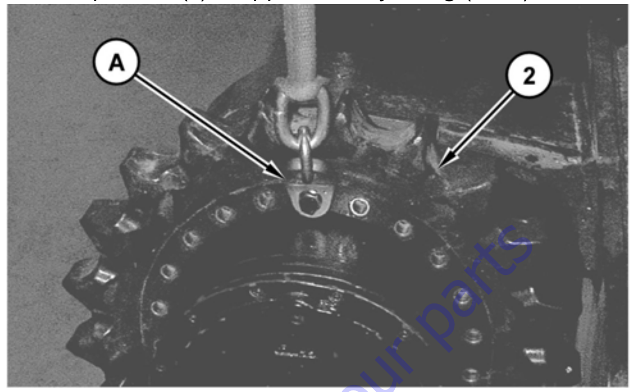
1. Position the machine onto suitable cribbing below the first roller, as shown. Ensure that the master pin is above the center line of the sprocket.



2. Separate the track assembly. Refer to Section 4.5, Track.
3. Remove bolts (1) which fasten sprocket (2) to the final drive.



4. Attach Tooling (A) and a suitable lifting device to sprocket (2). Remove sprocket (2). The weight of sprocket (2) is approximately 38 kg (85 lb).

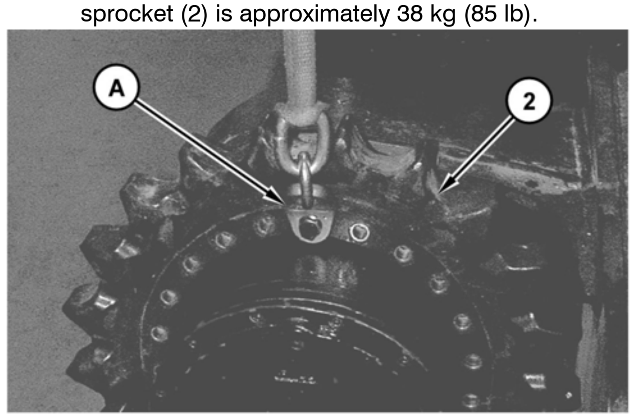


Installation

Table 4-14. Sprocket Required Tools - Installation

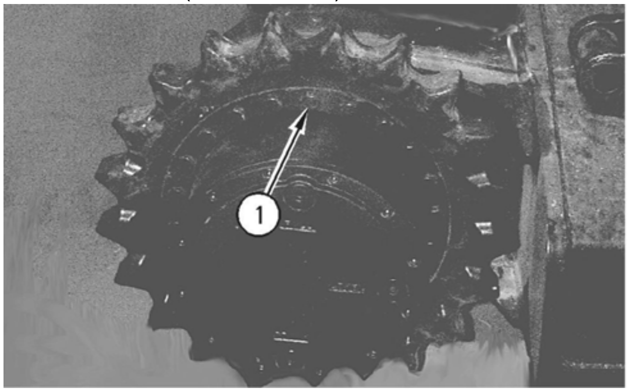
Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	138-7574	Link Bracket	1

1. Thoroughly clean the mating surfaces of the sprocket and the final drive prior to installation of the sprocket.
2. Attach Tooling (A) and a suitable lifting device to sprocket (2). Position sprocket (2). The weight of sprocket (2) is approximately 38 kg (85 lb).



3. Remove Tooling (A) and the suitable lifting device from sprocket (2).

4. Install bolts (1). Tighten bolts (1) to a torque of 270 ± 40 Nm (200 ± 30 lb ft).



5. Connect the track assembly. Refer to Section 4.5, Track.

6. Remove the cribbing from the front roller.

4.11 FINAL DRIVE AND TRAVEL MOTOR

Removal

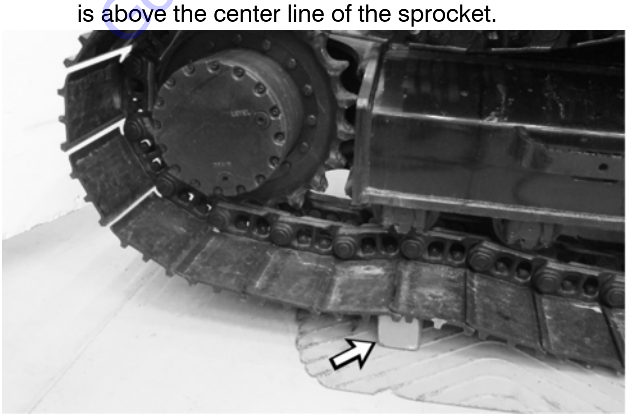
Table 4-15. Final Drive Required Tools - Removal

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	FT-2674	Vacuum Cap	1

CARE MUST BE TAKEN TO ENSURE THAT FLUIDS ARE CONTAINED DURING PERFORMANCE OF INSPECTION, MAINTENANCE, TESTING, ADJUSTING AND REPAIR OF THE PRODUCT. BE PREPARED TO COLLECT THE FLUID WITH SUITABLE CONTAINERS BEFORE OPENING ANY COMPARTMENT OR DISASSEMBLING ANY COMPONENT CONTAINING FLUIDS.

DISPOSE OF ALL FLUIDS ACCORDING TO LOCAL REGULATIONS AND MANDATES.

1. Position the machine onto suitable cribbing below the first roller, as shown. Ensure that the master pin is above the center line of the sprocket.

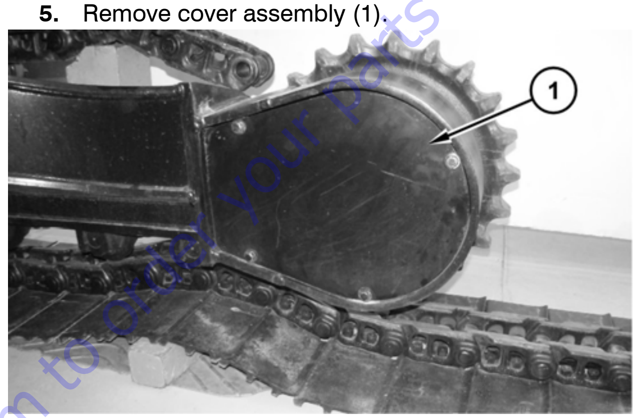


2. Release the hydraulic system pressure. Refer to Section 4.2, System Pressure - Release.

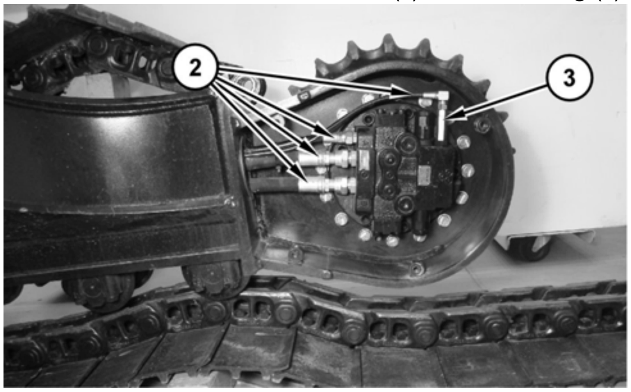
3. Remove the cap from the hydraulic tank. Install Tooling (A) onto the hydraulic tank. Attach an air supply hose to Tooling (A). Apply 276 to 414 kPa (40 to 60 psi) of air. This procedure will pull vacuum on the hydraulic system.

4. Separate the track assembly. Refer to Section 4.5, Track.

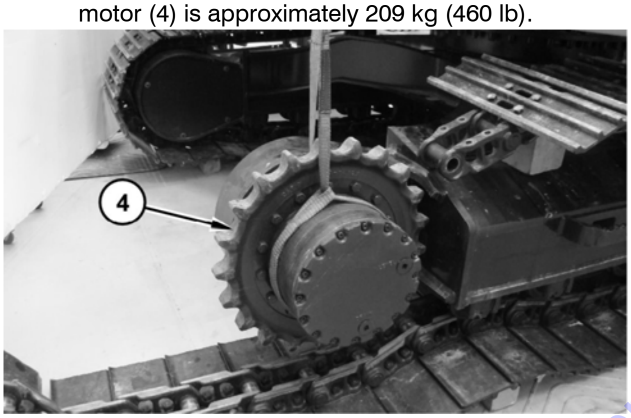
5. Remove cover assembly (1).



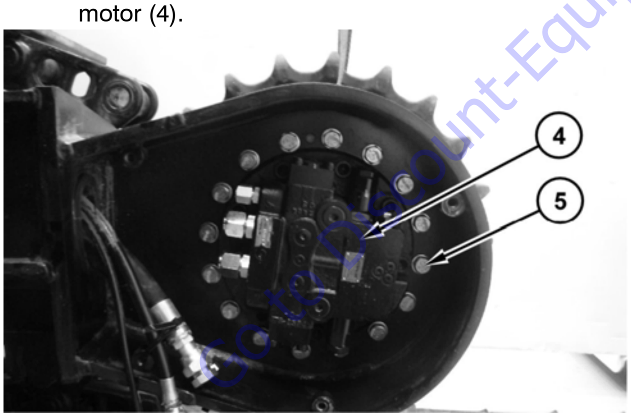
6. Disconnect hose assemblies (2). Remove fitting (3).



7. Attach a suitable lifting device to final drive and travel motor (4). The weight of final drive and travel motor (4) is approximately 209 kg (460 lb).



8. Remove bolts (5). Remove final drive and travel motor (4).

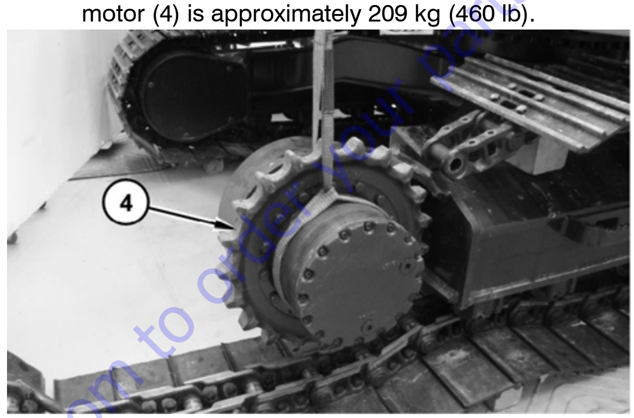


Installation

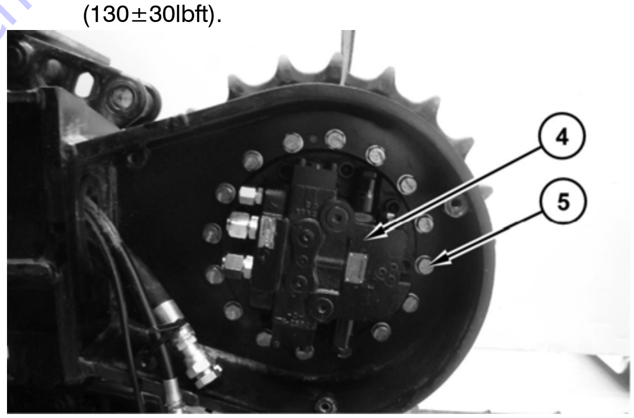
Table 4-16. Final Drive Required Tools - Installation

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty.**
A	FT-2674	Vacuum Cap	1

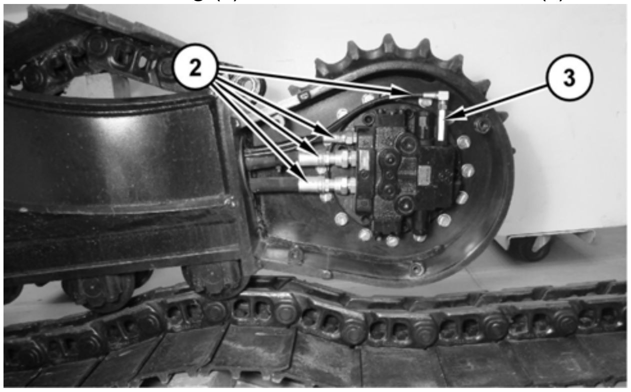
1. Attach a suitable lifting device to final drive and travel motor (4). The weight of final drive and travel motor (4) is approximately 209 kg (460 lb).



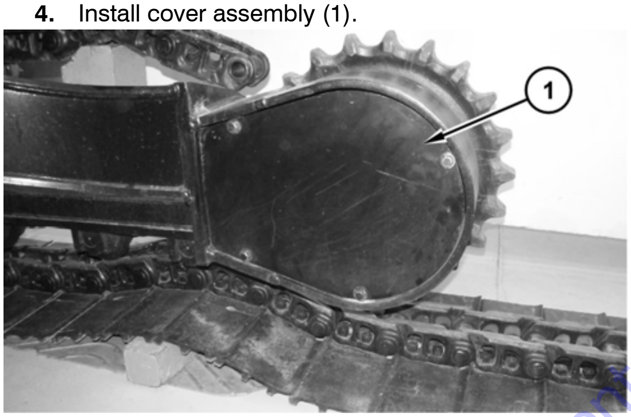
2. Position final drive and travel motor (4) and install bolts (5). Tighten bolts (5) to a torque of 175±40Nm (130±30lbft).



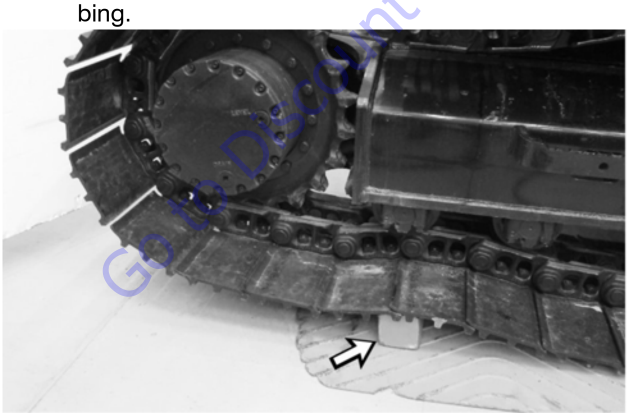
3. Install fitting (3). Connect hose assemblies (2).



4. Install cover assembly (1).



5. Remove Tooling (A). Install the cap onto the hydraulic tank.
6. Connect the track assembly. Refer Section 4.5, Track.
7. Reposition the machine away from the suitable cribbing.



4.12 TRACK ADJUSTMENT

⚠ WARNING

PERSONAL INJURY OR DEATH CAN RESULT FROM GREASE UNDER PRESSURE.

GREASE COMING OUT OF THE RELIEF VALVE UNDER PRESSURE CAN PENETRATE THE BODY CAUSING INJURY OR DEATH.

DO NOT WATCH THE RELIEF VALVE TO SEE IF GREASE IS ESCAPING. WATCH THE TRACK OR TRACK ADJUSTMENT CYLINDER TO SEE IF THE TRACK IS BEING LOOSENED.

LOOSEN THE RELIEF VALVE ONE TURN ONLY.

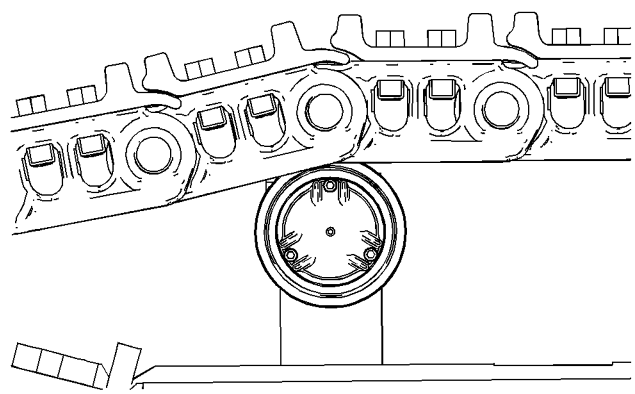
IF TRACK DOES NOT LOOSEN, CLOSE THE RELIEF VALVE AND CONTACT YOUR JLG DEALER.

KEEPING THE TRACK PROPERLY ADJUSTED WILL INCREASE THE SERVICE LIFE OF THE TRACK AND DRIVE COMPONENTS.

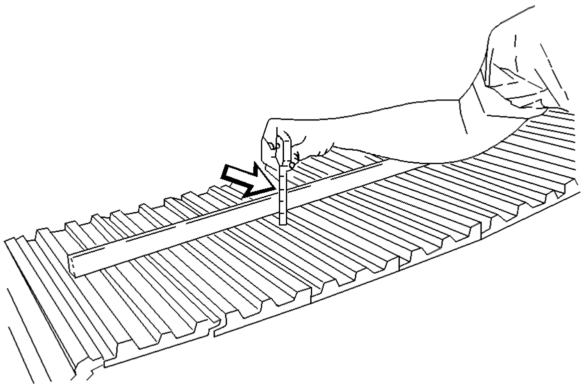
NOTE: *The track tension must be adjusted according to the current operating conditions. Keep the track as slack as possible if the soil is heavy.*

Measuring Track Tension

1. Operate the machine in the direction of the idlers.
2. Stop with one track pin directly over the front carrier roller. Park the machine and turn off the engine.

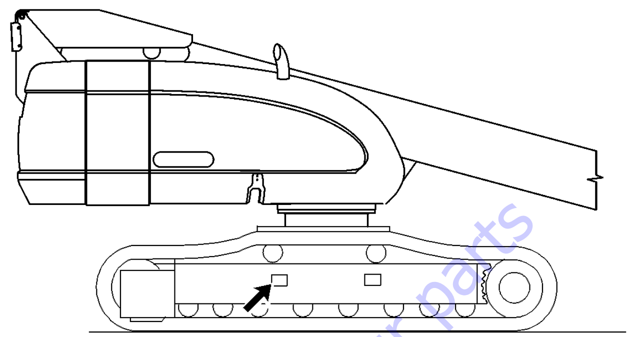


3. Place a straight edge on top of the track grousers between the front carrier roller and the idler. The straight edge should be long enough to reach from the front carrier roller to the idler.



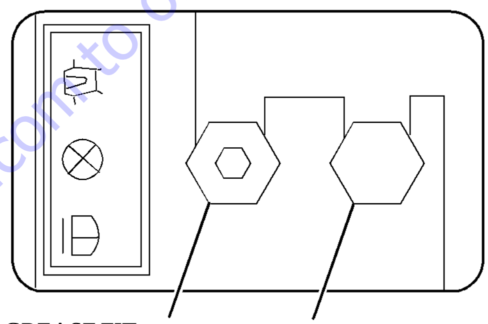
4. Measure the maximum amount of sag in the track. The sag is measured from the highest point of the track grouser to the bottom of the straight edge. A track that is properly adjusted will have a sag of 40.0 to 55.0 mm (1.57 to 2.17 inch).
5. If the track is too tight, or if the track is too loose, adjust the track tension according to the appropriate procedure below.

Adjusting Track Tension



The track adjuster is located on the track frame.

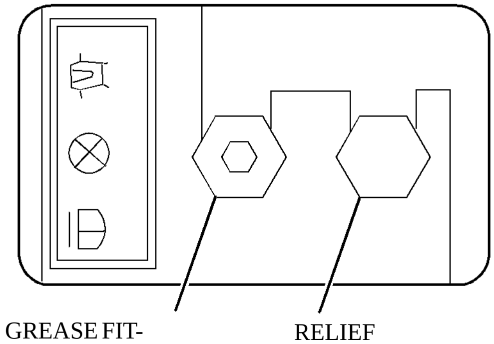
TIGHTENING THE TRACK



WIPE THE FITTING BEFORE YOU ADD GREASE.

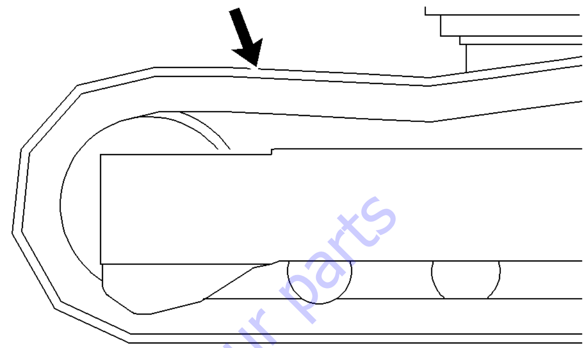
1. Add grease through grease fitting (1) until the correct track tension is reached.
2. Operate the machine back and forth in order to equalize the pressure.
3. Check the amount of sag. Adjust the track, as needed.

LOOSENING THE TRACK



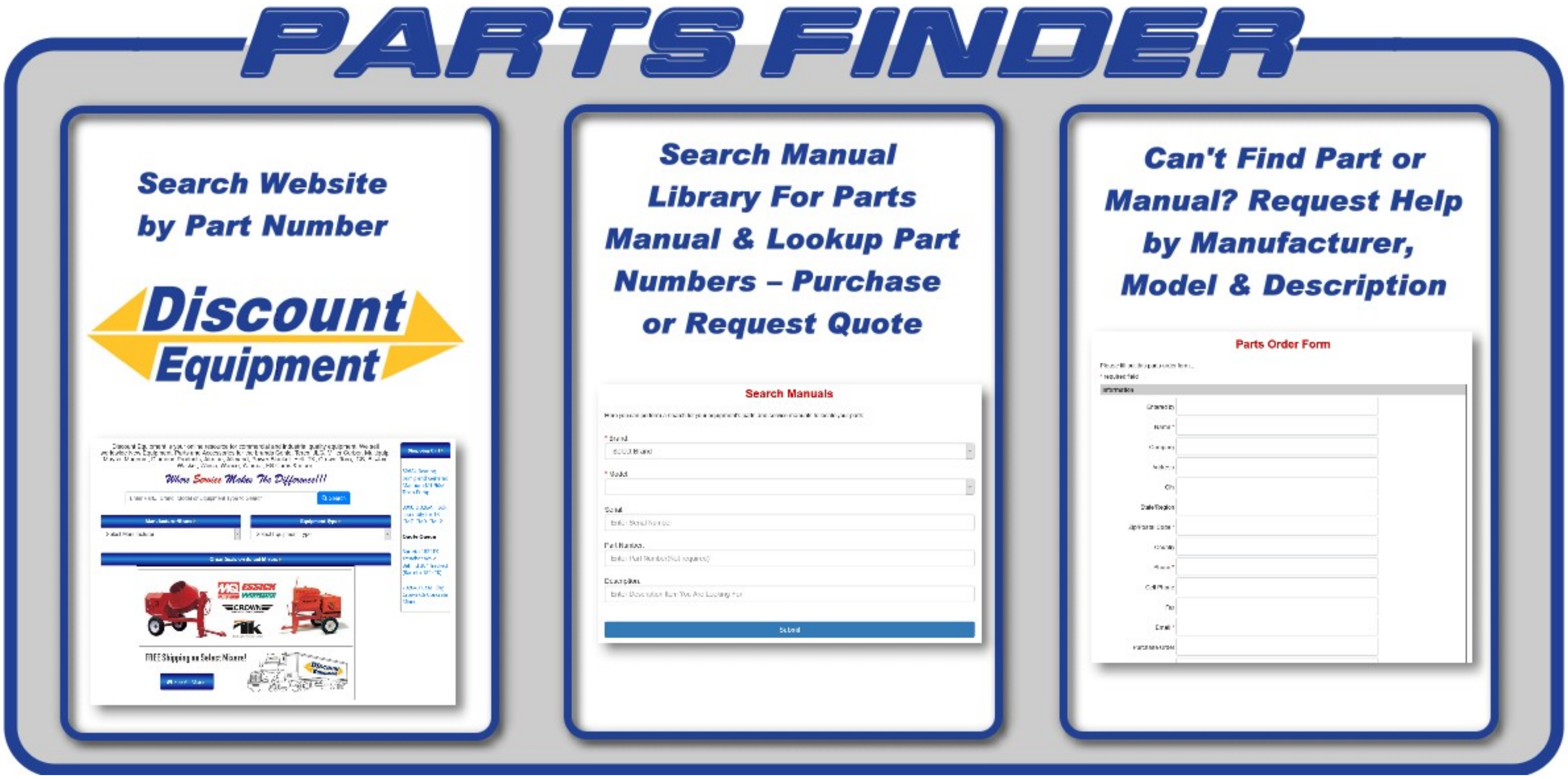
1. Loosen relief valve (2) carefully until the track begins to loosen. One turn should be the maximum.
2. Tighten relief valve (2) to 34 ± 5 Nm (25 ± 4 lb ft) when the desired track tension is reached.
3. Operate the machine back and forth in order to equalize the pressure.
4. Check the amount of sag. Adjust the track, as needed.

Track Adjustment - Inspect



Check the track adjustment. Check the track for wear and for excessive dirt buildup.

If the track appears to be too tight or too loose, readjust as necessary.



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SECTION 5. CAT Chassis (S/N 0300128000 to S/N 0300174703)

5.1 PRECAUTIONS FOR USE

General

WARNING

REMOVE THE MOTOR FROM THE MACHINE BEFORE DISASSEMBLY AND REASSEMBLY OF THE MOTOR. DISASSEMBLY WHILE THE MOTOR IS INSTALLED TO THE MACHINE MAY CAUSE RUNAWAY OF THE MACHINE.
DO NOT DISASSEMBLE OR REASSEMBLE THE MOTOR IF IT IS HOT. DOING SO WILL RESULT IN BURNS.

CAUTION

FOLLOW THE MAINTENANCE MANUAL AND USE SPECIFIED TOOLS TO DISASSEMBLE AND REASSEMBLE THE MOTOR.

Installation

CAUTION

WHEN INSTALLING THE MOTOR, BE SURE TO OBSERVE INSTRUCTIONS DESCRIBED IN THE OPERATING MANUAL.
DO NOT PLACE RADIAL LOAD AND THRUST LOAD EXCEEDING THE PERMISSIBLE VALUES ON THE OUTPUT SHAFT. EXCESSIVE LOAD MAY CAUSE EARLY BREAKAGE OF BEARINGS. USE THE MACHINE WITHIN THE PERMISSIBLE RANGE, REFERRING TO THE LIFE CURVE OF THE BEARINGS IN THE CATALOG.
WHEN INSTALLING, MAKE THE ECCENTRIC AMOUNT TO THE DRIVEN SHAFT AT 0.1 MM (FIR) OR LESS. LARGE ECCENTRICITY MAY CAUSE EARLY BREAKAGE OF THE BEARINGS AND BREAKAGE OF THE INSIDE OF THE MOTOR.

Hydraulic System

DANGER

SET THE HYDRAULIC PRESSURE TANK SO THAT ITS OIL LEVEL IS ABOVE THE MOTOR. IF THE OIL LEVEL OF THE HYDRAULIC PRESSURE TANK IS BELOW THE MOTOR, INSTALL A CHECK VALVE IN THE PIPING TO PREVENT OIL FROM COMING OUT OF THE MOTOR CIRCUIT.
IF OIL COMES OUT OF THE MOTOR CIRCUIT, AERATION WILL OCCUR IN THE MOTOR CIRCUIT. THIS IS VERY DANGEROUS, AS LIFTED LOAD MAY DROP SUDDENLY.
IF NO OIL REMAINS IN THE MAIN PIPING, AERATION WILL OCCUR IN THE MOTOR CIRCUIT DURING OPERATION, CAUSING DAMAGE TO THE EQUIPMENT. IN ADDITION, A RUNAWAY PHENOMENON OCCURS IN THE MOTOR CIRCUIT, LEADING TO A SUDDEN DROP OF LIFTED LOAD. IN SOME CASES, THE MOTOR BECOMES IMPOSSIBLE TO CONTROL, WHICH IS VERY DANGEROUS.

DANGER

WHEN THE MACHINE IS NOT OPERATED FOR AN EXTENDED PERIOD OF TIME, BE SURE TO FILL THE MOTOR CIRCUIT WITH HYDRAULIC FLUID BEFORE OPERATION.
WHEN THE MACHINE IS NOT OPERATED FOR AN EXTENDED PERIOD OF TIME, AERATION MAY OCCUR IN THE MOTOR CIRCUIT DUE TO LEAKS FROM THE HYDRAULIC MOTOR AND COUNTER BALANCE VALVE. INSTALL A SELF-PRIMING CIRCUIT TO PREVENT AERATION.
OPERATION WITH AERATION IN THE MOTOR CIRCUIT WILL GENERATE CAVITATION, CAUSING DAMAGE TO THE EQUIPMENT. IN ADDITION, A RUNAWAY PHENOMENON OCCURS IN THE HYDRAULIC MOTOR, LEADING TO A SUDDEN DROP OF LIFTED LOAD.

WARNING

CHECK FOR INFLOW DIRECTION OF OIL AND ROTATION DIRECTION OF THE MOTOR BEFORE PERFORMING PIPING WORK. FOR INFLOW DIRECTION OF OIL AND ROTATION DIRECTION OF THE MOTOR, REFER TO THE OUTLINE DRAWING.
PERFORMING PIPING WORK WITHOUT CHECKING FOR INFLOW DIRECTION OF OIL AND ROTATION DIRECTION OF THE MOTOR IS VERY DANGEROUS, AS THE MOTOR MAY ROTATE IN A DIRECTION NOT INTENDED BY AN OPERATOR.

CAUTION

WHEN PIPING EACH PORT, BE SURE TO OBSERVE INSTRUCTIONS DESCRIBED IN THE OPERATING MANUAL.

CAUTION

TAKE OUT DRAIN PIPING FROM THE DRAIN PORT (DR) ON THE UPPERMOST POSITION, AND PLACE IT HIGHER THAN THE TOP END OF THE MOTOR. THEN, RETURN IT DIRECTLY INTO OIL IN THE TANK.
NO OIL IN THE MOTOR CASE MAY CAUSE SEIZURE ON EACH SLIDING SURFACE, LEADING TO AN INABILITY OF THE MOTOR TO OPERATE.

CAUTION

KEEP DRAIN PRESSURE IN THE CASING AT 0.2 MPA OR LESS (WORKING CONDITION) AS PERMISSIBLE PRESSURE, AND BE SURE TO RETURN THE PIPING END INTO OIL.
IF DRAIN PRESSURE EXCEEDS THE PERMISSIBLE VALUE, DAMAGE TO OIL SEALS AND OIL LEAKS MAY BE CAUSED.

Hydraulic Fluid

CAUTION

KEEP THE CONTAMINATION LEVEL OF HYDRAULIC FLUID BELOW NAS CLASS 9. INSTALL FILTERS GRADATION OF WHICH IS NOT

GREATER THAN 10 □M IN THE HYDRAULIC CIRCUIT.
THE CONTAMINATION LEVEL OF HYDRAULIC FLUID HAS A GREAT INFLUENCE ON LIFE-SPAN OF A MOTOR. POOR CONTROL OF CLEANLINESS OF HYDRAULIC FLUID MAY CAUSE SEIZURE AND EARLY WEAR IN EACH SLIDING SURFACE, RESULTING IN AN INABILITY OF THE MOTOR TO OPERATE.

⚠ CAUTION

FOR TYPE OF HYDRAULIC FLUID IN USE, USE RECOMMENDED HYDRAULIC FLUIDS. KEEP THE TEMPERATURE AND VISCOSITY OF HYDRAULIC FLUID IN USE WITHIN THE USAGE CONDITION LIMIT.
USE OF HYDRAULIC FLUID WITH THE TEMPERATURE AND VISCOSITY BEYOND THE USAGE CONDITION LIMIT MAY CAUSE EARLY WEAR OF EACH SLIDING SURFACE AND SEIZURE, RESULTING IN AN INABILITY OF THE MOTOR TO OPERATE.

⚠ CAUTION

IF YOU USE FIRE-RESISTANT HYDRAULIC FLUID, OR USE HYDRAULIC FLUID BEYOND THE PERMISSIBLE OIL TEMPERATURE, PLEASE CONTACT US.
USAGE AREA OF THE MOTOR MAY BE LIMITED.

Lubricating Oil for Reduction Gears

For lubricating oil for reduction gears, use recommended lubricant, and change lubricant according to the following interval.

Recommended lubricant: Diamond Hypoid Gear Oil #90 from Mitsubishi Oil (equivalent to API category GL-4#90)

Interval of oil change

- Initial oil change: 100 - 250 hours of operation
- Succeeding oil change: every 1000 - 1500 hours of operation

Periodic oil change extends life-span of reduction gears, and ensures stable performance.

Hydraulic fluids with the oil of different property should not be mixed. When changing hydraulic fluid type, flush the reduction gears.

⚠ CAUTION

KEEP TEMPERATURE OF LUBRICANT FOR REDUCTION GEAR WITHIN THE USAGE CONDITION LIMIT. FAILURE TO DO SO WILL DRASTICALLY SHORTEN THE LIFE-SPAN OF THE REDUCTION GEAR, CAUSING EARLY BREAKAGE.

Motor Operation

⚠ DANGER

DO NOT GENERATE CAVITATION. EXCESSIVE ROTATION SPEED OF MOTOR MAY CAUSE SEIZURE ON EACH SLIDING SURFACE. AS PRESSURE IN THE CIRCUIT BECOMES NEGATIVE, THE INSIDE MAY FAIL.
AS PRESSURE IN THE CIRCUIT BECOMES NEGATIVE, THE MOTOR CANNOT BE CONTROLLED, WHICH MAY LEAD TO A SUDDEN DROP OF LIFTED LOAD OR RUNAWAY.

⚠ CAUTION

WHEN OPERATING THE MOTOR, BE SURE TO OBSERVE INSTRUCTIONS DESCRIBED IN THE OPERATING MANUAL.

⚠ CAUTION

OPERATE THE MOTOR WITHIN THE SPECIFICATION RANGE. IF THE MOTOR IS OPERATED BEYOND THE SPECIFICATION RANGE, PLEASE CONTACT US.

⚠ CAUTION

BEFORE OPERATING THE MOTOR, LUBRICATE HYDRAULIC FLUID INTO THE MOTOR CASE FROM DRAIN PORT ON THE UPPER SIDE.

OPERATION OF MOTOR WITH MOTOR CASE EMPTY MAY CAUSE BREAKAGE OF THE INSIDE OF THE MOTOR, LEADING TO AN INABILITY OF THE MOTOR TO OPERATE.

⚠ CAUTION

KEEP THE PRESSURE WITHIN THE USAGE CONDITION LIMIT.
FAILURE TO DO SO MAY NOT ONLY SHORTEN THE LIFE-SPAN OF THE MOTOR DRASTICALLY, BUT ALSO BREAK STRUCTURAL COMPONENTS.

⚠ CAUTION

KEEP ROTATION SPEED IN USE WITHIN PRODUCT SPECIFICATION RANGE. KEEP FLOW RATE WITHIN USAGE CONDITION LIMIT. FAILURE TO DO SO MAY CAUSE SEIZURE ON EACH SLIDING SURFACE, RESULTING IN BREAKAGE OF THE INSIDE OF THE MOTOR.

⚠ CAUTION

KEEP REVERSE INPUT TORQUE WITHIN USAGE CONDITION LIMIT. FAILURE TO DO SO MAY CAUSE BENDING BREAKAGE OF REDUCTION GEARS AND FAILURE OF STRUCTURAL COMPONENTS.

⚠ CAUTION

APPLY EXTERNAL RADIAL LOAD ON THE SPECIFIED LOCATION. DO NOT APPLY LOAD EXCEEDING PERMISSIBLE RANGE. FAILURE TO DO SO WILL DRASTICALLY SHORTEN REDUCTION GEAR LIFE-SPAN AND BREAKAGE OF MAIN BEARING WILL OCCUR.

⚠ CAUTION

DO NOT APPLY AN AXIAL LOAD. AXIAL LOADS MAY CAUSE EARLY WEAR OF REDUCTION GEAR

Parking Brake

DANGER

RELEASE PARKING BRAKE TO OPERATE MOTOR. IF MOTOR IS OPERATED WITH PARKING BRAKE ENGAGED, A DISK FOR THE PARKING BRAKE MAY WEAR QUICKLY, RESULTING IN PARKING BRAKE FAILURE. A PARKING BRAKE FAILURE WILL LEAD TO A DROP OF LIFTED LOAD OR RUNAWAY, WHICH IS VERY DANGEROUS.

DANGER

DO NOT USE THE PARKING BRAKE FOR CONTROLLING ROTATION OF THE MOTOR. EARLY BREAKAGE OF THE DISK FOR THE PARKING BRAKE LEADS TO A PARKING BRAKE FAILURE. AS A RESULT, LIFTED LOAD MAY DROP, WHICH IS VERY DANGEROUS.

EXCESSIVE TORQUE EXERTED ON THE MOTOR SHAFT AND DRIVE GEAR SHAFT OF THE REDUCTION GEAR WILL CAUSE BREAKAGE OF THE MOTOR SHAFT AND DRIVE GEAR SHAFT OF THE REDUCTION GEAR. THE RESULT WILL LEAD TO A DROP OF LIFTED LOAD DURING OPERATION, WHICH IS VERY DANGEROUS.

DANGER

WHEN STOPPING THE MOTOR, BE SURE TO APPLY THE PARKING BRAKE. FAILURE TO DO SO IS VERY DANGEROUS BECAUSE LIFTED LOAD MAY DROP OR MOTOR MAY RUNAWAY.

Overrun Prevention

CAUTION

DEPENDING ON PIPING VOLUME FROM HYDRAULIC SUPPLY TO HYDRAULIC MOTOR, AND PROPERTY OF THE COUNTER BALANCE VALVE, THE HYDRAULIC MOTOR MAY OVERRUN, RESULTING IN EARLY BREAKAGE OF THE HYDRAULIC MOTOR. THEREFORE, PREVENT THE MOTOR FROM OVERRUNNING FOR PROTECTION OF THE EQUIPMENT AND USE FOR AN EXTENDED PERIOD OF TIME (ESPECIALLY DURING WINDING DOWN). IF OCCURRENCE OF OVERRUN CANNOT BE FULLY PREVENTED, ADJUST SO THAT THE MAXIMUM ROTATION SPEED OF THE MOTOR WHEN OVERRUN OCCURS BECOMES WITHIN THE ROTATION SPEED RANGE OF THE EQUIPMENT SPECIFICATIONS.

Setting Self-Priming Circuit

DANGER

LEAKS FROM THE HYDRAULIC MOTOR AND COUNTER BALANCE VALVE MAY CAUSE AERATION IN THE HYDRAULIC MOTOR CIRCUIT, LEADING TO CAVITATION AND TRAVEL MOVEMENT OF THE HYDRAULIC MOTOR. INSTALLATION OF A SELF-PRIMING CIRCUIT IS NECESSARY TO PREVENT CAVITATION AND TRAVEL MOVEMENT OF THE HYDRAULIC MOTOR.

DANGER

ESPECIALLY AFTER A LONG PERIOD OF QUIESCENT OPERATION, IT IS ESSENTIAL TO FILL HYDRAULIC MOTOR CIRCUIT WITH HYDRAULIC FLUID. THUS, INSTALL THE SELF-PRIMING CIRCUIT, CONSIDERING LOCATION RELATIONSHIP BETWEEN HYDRAULIC MOTOR AND THE OIL LEVEL OF THE HYDRAULIC PRESSURE TANK. EXERT PRESSURE OF 0.3 TO 0.5 MPA ON THE SELF-PRIMING CIRCUIT TO PREVENT CAVITATION DURING HALTS OF MOTOR ROTATION.

DANGER

IF THE HYDRAULIC MOTOR IS POSITIONED LOWER THAN THE OIL LEVEL OF THE HYDRAULIC PRESSURE TANK, AND THE CONTROL VALVE OPERATES FROM A TO B, AND TO T OPEN, NO INSTALLATION OF THE SELF-PRIMING CIRCUIT IS NECESSARY IN PRINCIPLE.

Hydraulic Circuit

CAUTION

SET BACK PRESSURE VALUE SO NO CAVITATION OCCURS.

CAUTION

IF HYDRAULIC MOTOR IS POSITIONED HIGHER THAN OIL LEVEL IN HYDRAULIC TANK, FILL HYDRAULIC MOTOR CIRCUIT WITH HYDRAULIC FLUID BEFORE OPERATING HYDRAULIC MOTOR.

CAUTION

PROVIDE THE SELF-PRIMING CIRCUIT.

CAUTION

PLEASE CONTACT US IF ANY CIRCUIT OTHER THAN THE ONES DESCRIBED IN ATTACHED PAPERS IS USED.

5.2 GENERAL

This manual describes specifications, structure and handling method of the motor MAG-85VP series for closed loop in order to assure reliable performance for a long period of time and to prevent it from improper use.

Description

Design of Drive Motor:

The drive motor is a swash plate type axial piston motor integrated with a reduction gear, consisting of seven functions; swash plate axial piston motor, shuttle valves, crossover relief valves, low pressure relief valves, two-speed changeover system, parking brake, and reduction gear. The piston motor converts fluid energy of pressurized oil delivered from a hydraulic pump to mechanical energy, and transfers high speed and low torque power to the reduction gear. The reduction gear changes the high speed and low torque power to low speed and high torque power, and transfers the power to a drum.

Features:

1. The motor is light-weight and compact unit, equipped with shuttle valves, crossover relief valves, low pressure relief valves, swash plate type axial piston motor, and reduction gear as one package.
2. The reduction gear is of casing rotation type to ensure sufficient durability.
3. A double stage planetary reduction gear ensures high efficiency and long life.
4. The integrated parking brake prevents the machine from slipping on a slope, and securely engages the mechanical brake when it is parked or stopped.

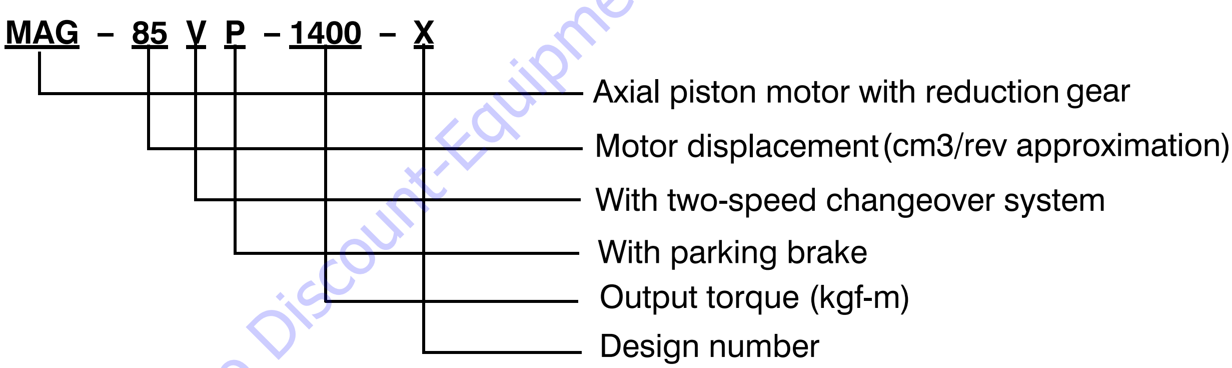
Design Type:

Axial piston motor - Swash plate piston motor (2-speed changeover system, integrated parking brake)

Valve function - Low pressure shuttle function, low pressure relief function, high pressure relief function (installed on cross-line)

Reduction gear - Double stage planetary pinion gear system

Model Code Identification:



5.3 CONSTRUCTION AND FUNCTION

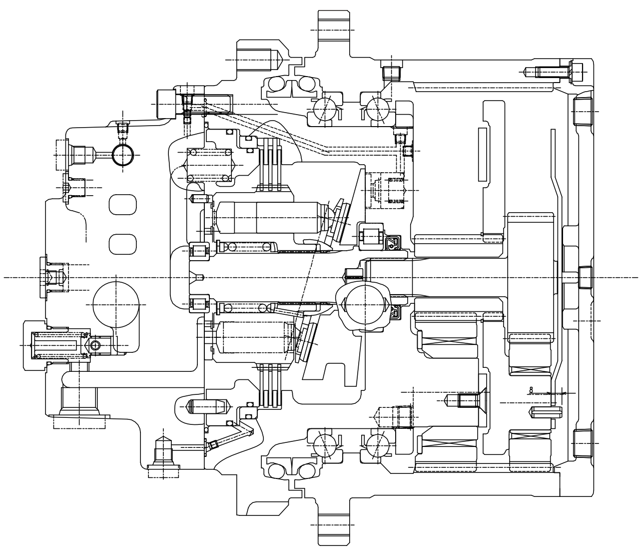


Figure 5-1. Structure of Drive Motor

The drive motor consists of swash plate type axial piston motor, shuttle valves, crossover relief valves, low pressure relief valves, and reduction gear as one component.

Working Principle of Swash Plate Type Axial Piston Motor

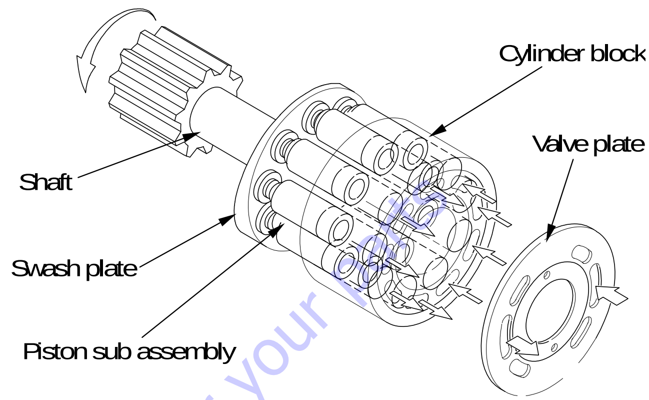


Figure 5-2. Structure of Swash Plate Type Axial Piston Motor

Nine piston sub assemblies are assembled in the cylinder block. The end of the cylinder block is adjacent to the valve plate with two half moon shaped ports, B and C (high and low pressure ports). When supplying pressure fluid (pressure P) to B port, the force of piston sub assemblies having F=PEA (A: Piston pressure area) pushes the swash plate. The piston sub assemblies receive reaction force from it, and reaction force (Ft) in rotating direction is produced. The total force of high pressure side piston sub assemblies in rotating direction produces a rotating force in the cylinder block, and the force through a spline conveys the torque to the shaft, which causes the shaft to rotate.

According to the above working principle, the output torque and rotating speed of the piston motor are determined by supply pressure (P) and flow rate (Q), and are calculated by the following formula.

$$T = \frac{P \times D \times \eta_m}{2 \times \pi \times 10^3} \quad \left\{ T = \frac{P \times D \times \eta_m}{2 \times \pi \times 10^2} \right\}$$

$$N = \frac{Q \times 10^3 \times \eta_V}{D}$$

T: output torque KN-m {kgf-m}
N: speed of rotation rpm
P: working pressure MPa {kgf/cm2}
Q: flow rate L/min
D: theoretical displacement cm3/rev
η m: mechanical efficiency
η v: volumetric efficiency

Working Principle of Shuttle Valve

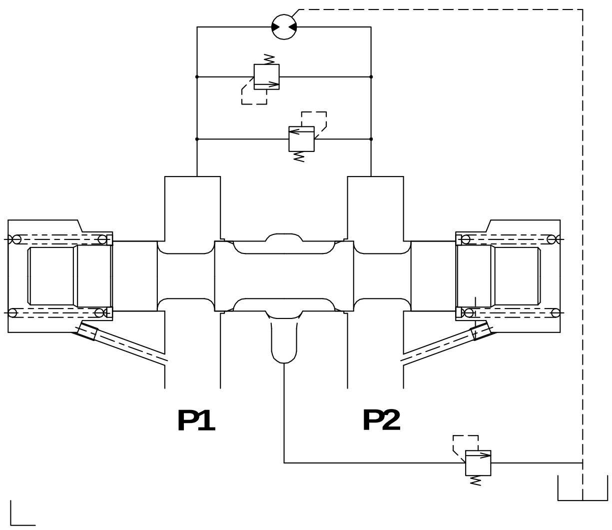


Figure 5-3. Structure of Shuttle Valve

The shuttle valve prevents the axial piston motor from overheating. When the control valve is in neutral position, no pressure exists at ports P1 and P2. Thus, the plunger is in neutral state, blocking the oil passage to the low pressure relief valve.

Shuttle Valve Action

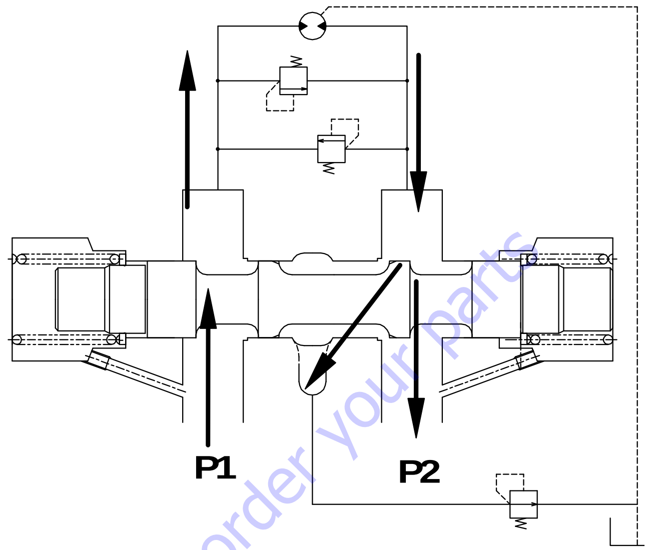


Figure 5-4. Shuttle Valve (Shuttle)

When the hydraulic fluid discharged from the hydraulic pump is directed to port P1 of the shuttle valve through the control valve, the hydraulic fluid passes orifice, acts on the end of the plunger, and tries to push the plunger rightward with the force in proportion to pressure against spring on the opposite side.

When the hydraulic pressure rises to a certain pressure, the plunger starts moving rightward, and oil passage to the low pressure relief valve on port P2 opens. The hydraulic fluid at port P2 passes through the notch of the outer circular of the plunger, and acts on the low pressure relief valve.

Working Principle of Relief Valve

Relief valve which determines driving and braking forces on traveling for the vibrating roller or carrier is mounted on the cross-line.

The structure of relief valve is differential surface direct acting type, as is shown in Figure 5-5.

DANGER

REFRAIN FROM ADJUSTING UNLESS ANY MALFUNCTION IS FOUND.

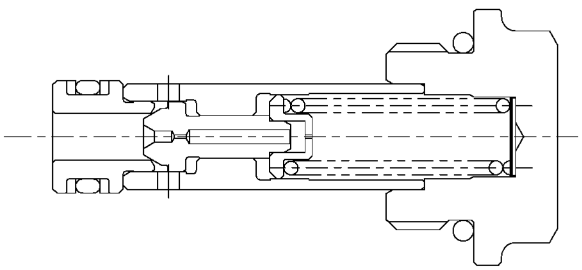


Figure 5-5. Structure of Relief Valve

Working of Relief Valve

When the piston motor is driven or braked by operation of the control valve, pressurized oil in the fore side of the poppet passes orifice and acts on the spring chamber. Thus, pressurized surface of the poppet becomes a differential surface (S1-S2). S1 and S2 are poppet seat surface and poppet sliding diameter surface, respectively.

Therefore, when the pressure P at full surface of the poppet becomes P = F/(S1 - S2), the poppet lifts, releasing pressurized oil from the high pressure side to the low pressure side.(Refer to Fig.5-1.) F: Spring set load

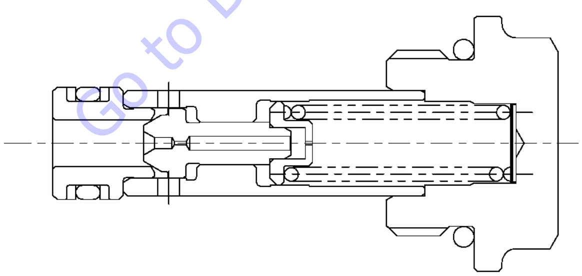


Figure 5-6. Structure of Relief Valve

Working Principle of Low Pressure Relief Valve

The low pressure relief valve keeps charge pressure of the charge pump at necessary pressure level. The low pressure relief valve is of direct acting type, as shown in Figure 5-7.

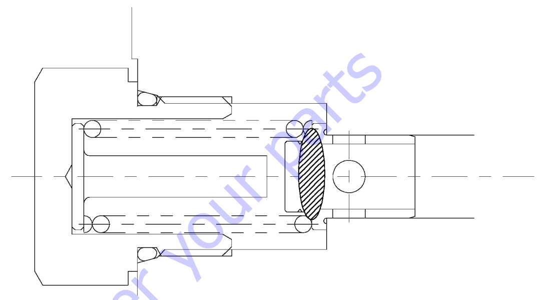


Figure 5-7. Structure of Low Pressure Relief Valve

Pressurized surface of the low pressure valve becomes poppet seat surface (S1). Therefore, when pressure P which passes through the notch of outer circular of the plunger and acts on the fore side of the poppet reaches P = F/S1, the relief valve operates, releasing pressurized oil in the low pressure side of the motor circuit to drain. F: Spring set load

Two-Speed Changeover System

Structure of two-speed changeover system

Swash plate has three faces, "A" through "C" as shown in Figure 5-8., and is held against the flange holder by two steel balls in a tiltable state. The two-speed changeover valve is installed inside the base plate.

Operation of Two-Speed System

Refer to Figure 5-9.

If pilot pressure for changeover is exerted on the 2-speed changeover valve from port Ps, the 2-speed changeover valve is changed as in the figure, with motor driving pressure exerting on the 2-speed control piston. This pushes up the swash plate, which tilts and rolls to a position where the resultant of thrust of piston sub assembly and spring force is balanced with thrust of the 2-speed control piston. The swash plate is settled when its side B contacts the flange holder. The swash plate inclination becomes ß, obtaining speed two (high speed) rotation for the motor.

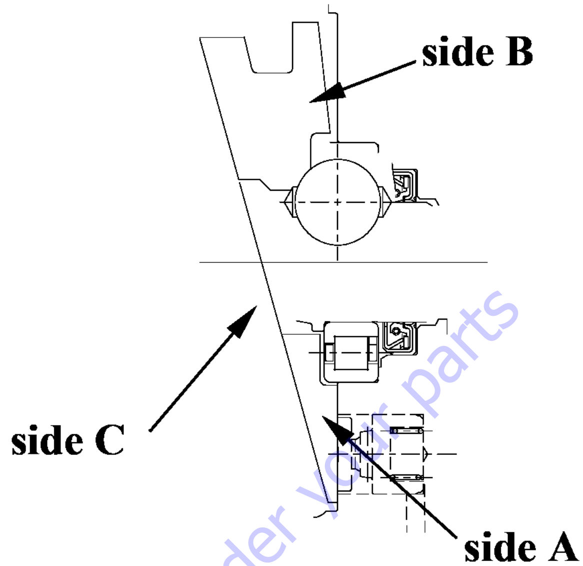


Figure 5-8. Structure of Two Speed Changeover System

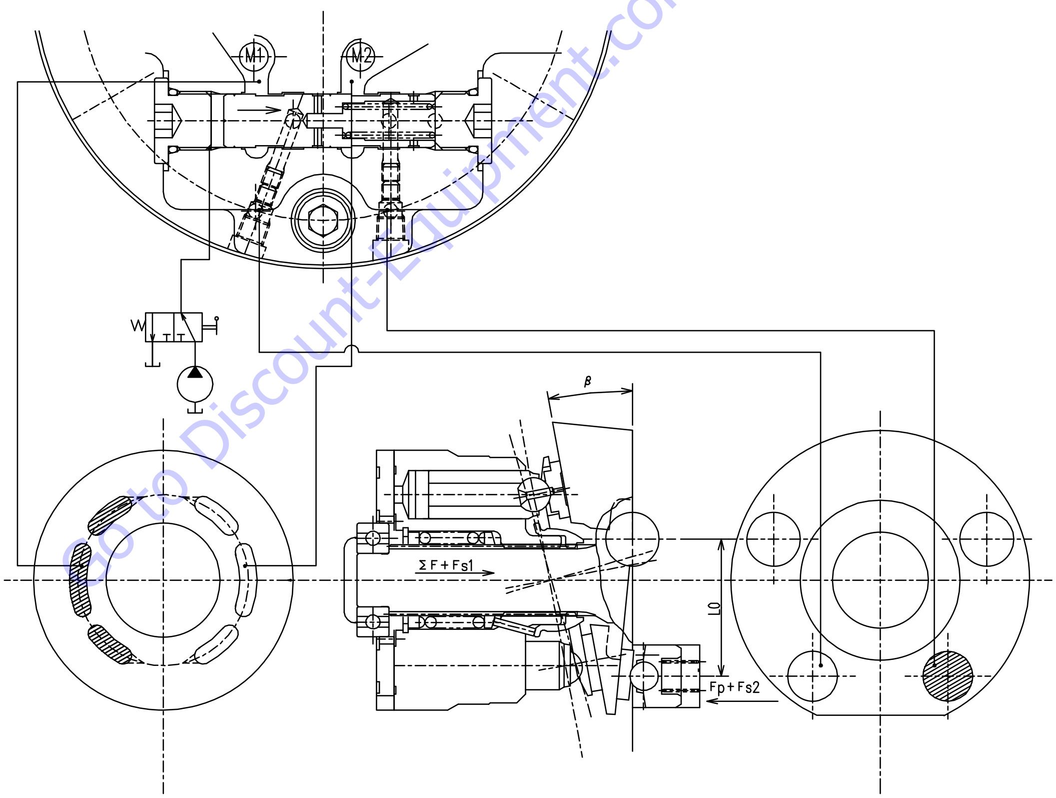


Figure 5-9. Structure of Two Speed Changeover System at High Speed

If exertion of pilot pressure for changeover is stopped, the 2-speed changeover valve is changed as in the figure. The 2-speed control piston chamber is connected to drain in the motor case. The swash plate is pushed by the resultant of thrust of piston sub assembly and spring force, and is settled when its side A contacts the flange holder. The swash plate inclination becomes a, obtaining speed one (low speed) rotation for the motor.

While the engine stops, the swash plate is pushed by spring force, and its side A contacts the flange holder. The swash plate inclination becomes a, obtaining speed one (low speed) rotation for the motor.

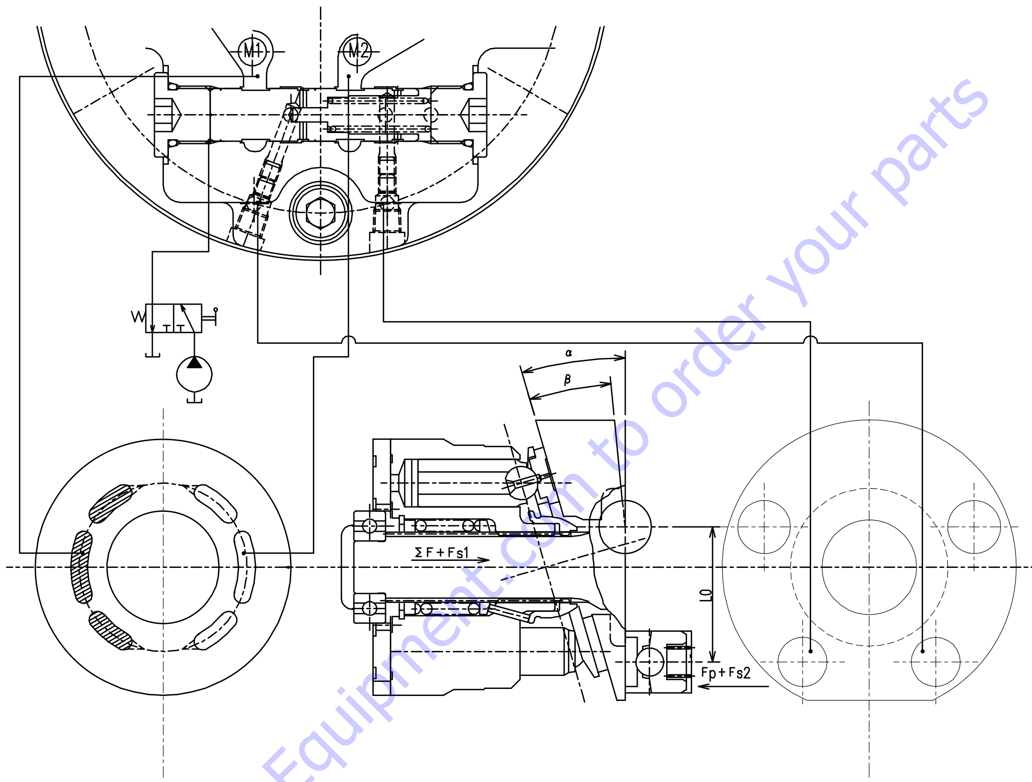


Figure 5-10. Structure of Two Speed Changeover System at Low Speed

Working Principle of Parking Brake

Parking brake is a negative brake consisting of a rotating disk (frictional material), brake piston and spring. Refer to the Figure 5-11.

Pressurized oil, when acting on parking brake release port (Pp), is directed to cylinder chamber for parking brake release, and pushes up brake piston with thrust corresponding to the pressure surface area of brake piston. This force overcomes spring force, pushing up brake piston and releasing parking brake. When parking brake release port (Pp) is connected to the tank, pressurized oil in cylinder chamber for parking brake release is released into the tank, and brake piston pushed by spring force activates the parking brake.

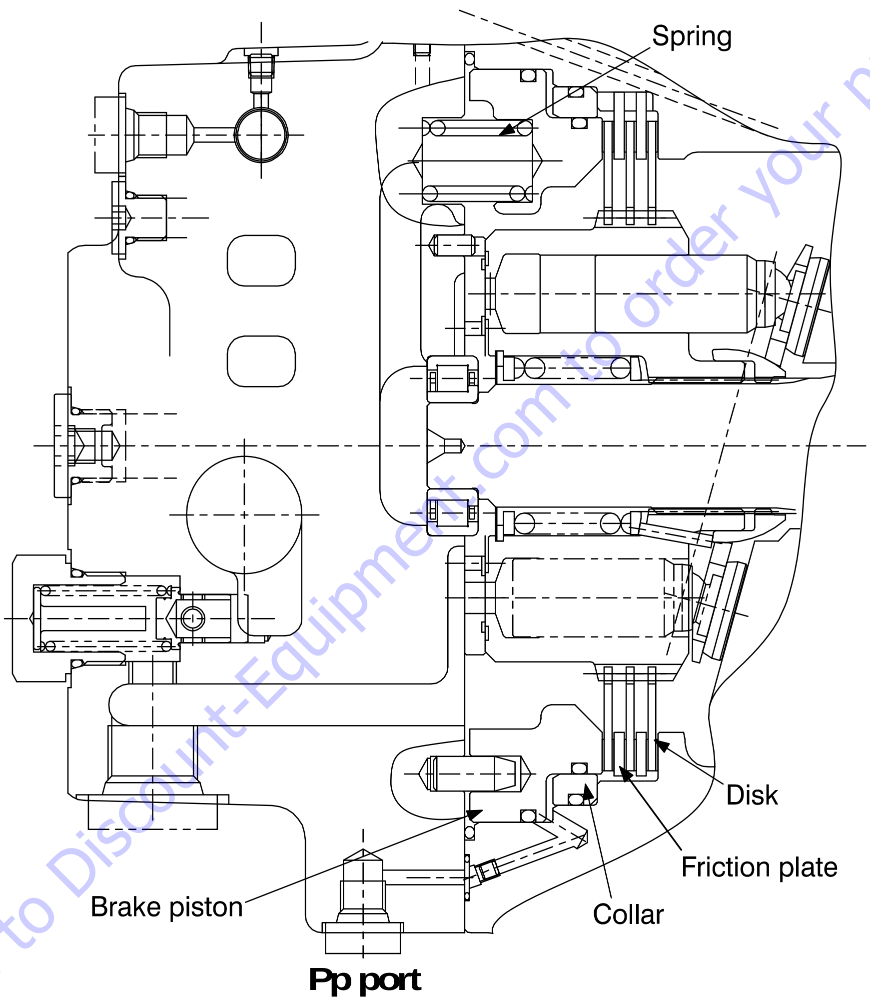


Figure 5-11. Parking Brake System

Procedures for manually releasing parking brake *(This mechanism is optional.)*

1. Remove blind plugs in PF1/4 of parking brake release ports. (Refer to Figure 5-12. and Figure 5-13.)
2. Install socket head bolts (M10 x 1.5 x 110 L) for parking brake manual release and flat washers (for M10) in two locations of parking brake manual release ports. (Refer to Figure 5-14.)
3. When socket head bolts for parking brake manual release are evenly screwed, and parking brake piston is pulled up, parking brake disk and friction plate become in a free state, and parking brake is released. (Refer to Figure 5-15.)

NOTE: *Some of motors do not have lubricating ports or parking manual release ports on baseplate.*

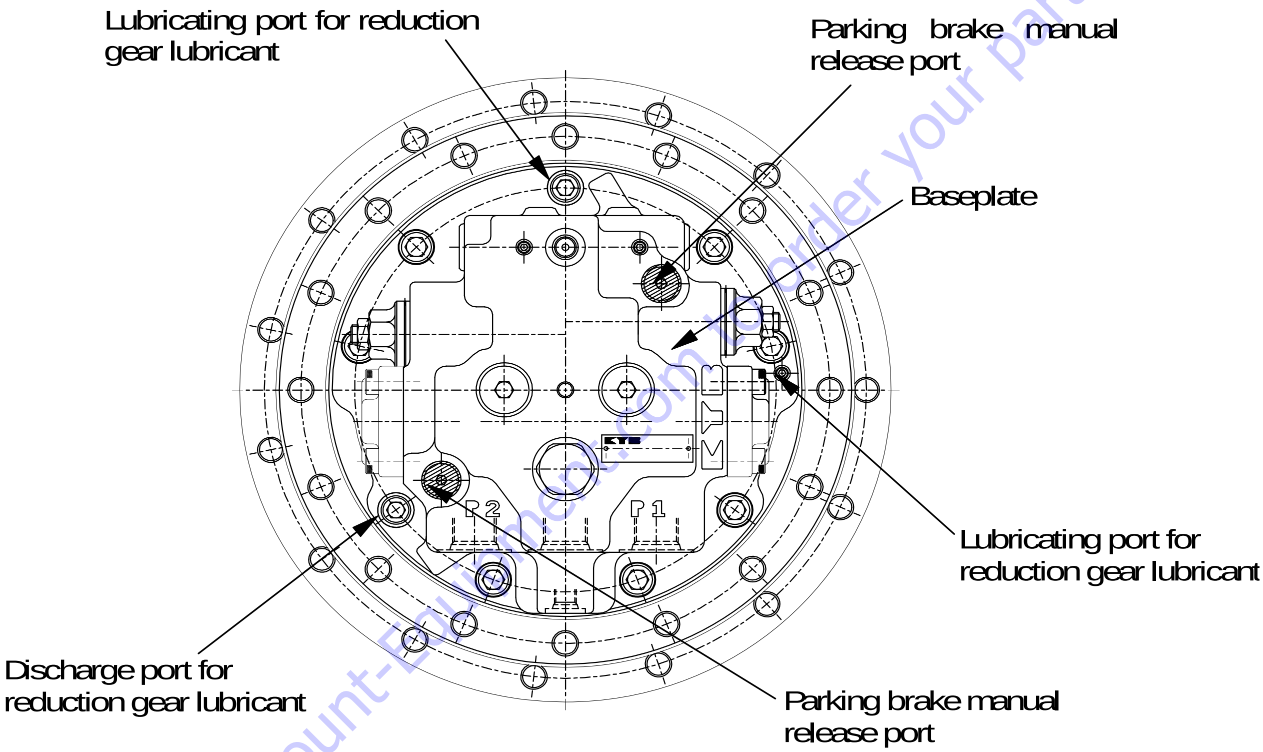


Figure 5-12. Position of Parking Brake Manual Release Ports

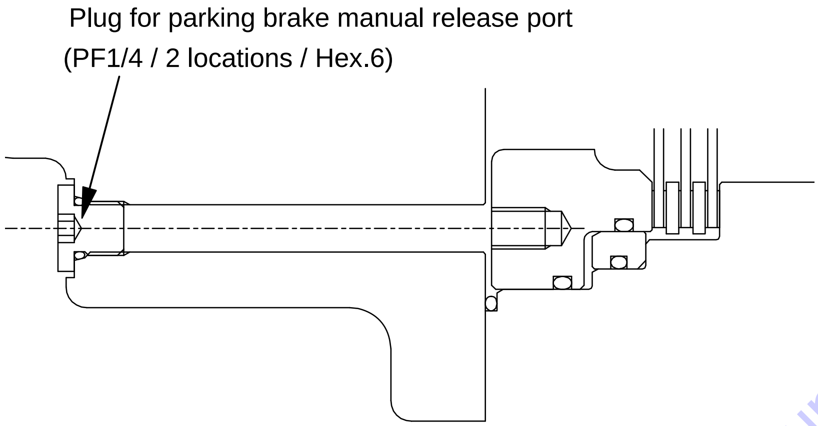


Figure 5-13. Procedures for Manually Releasing Parking Brake (step 1)

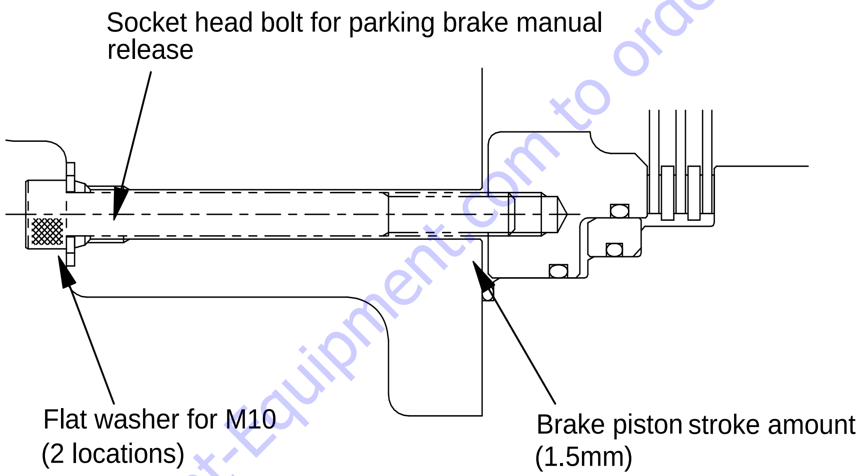


Figure 5-14. Procedures for Manually Releasing Parking Brake (step 2)

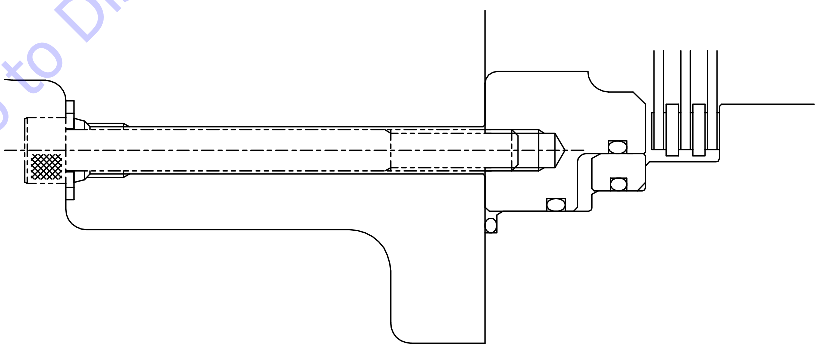


Figure 5-15. Procedures for Manually Releasing Parking Brake (step 3)

Reduction Gears

Reduction gears consist of a double stage planetary pinion gear system.

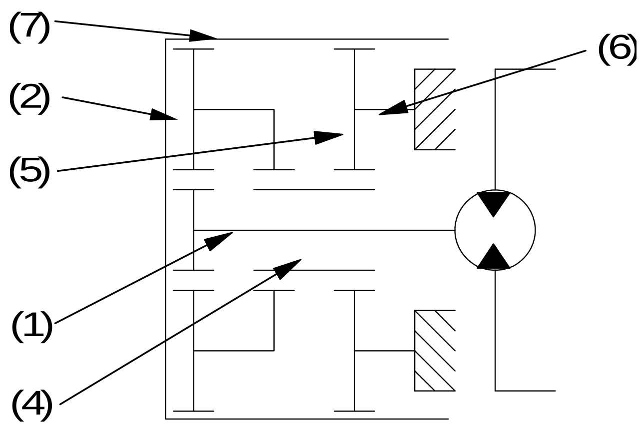


Figure 5-16. Structure of Reduction Gear

Drive gear (1) is engaged with the primary planetary gear (2), secondary sun gear (4) with secondary planetary gear (5). Secondary planetary carrier (6) is fixed to the machine body. Planetary gears (2) and (5) are engaged with ring gear (7) (housing).

Driving force of 1st stage is transferred from piston motor to drive gear (1) with the speed reduced by each gear. The final driving force is transferred from 1st stage one to ring gear (7) through planetary gear (5) of planetary carrier (6) fixed on the machine body. (Driving force is also transferred from primary planetary gear {2}.) Direction of input rotation and that of output rotation are reverse.

Reduction gear ratio "i" is shown as follows by primary and secondary reduction gear ratios "i1" and "i2".

* *Reduction Gear Ratio (i)*

$$i = i1 \times i2 - 1 = \left(\frac{Z1 + Z3}{Z1} \times \frac{Z4 + Z6}{Z4} - 1\right)$$

z1: number of drive gear tooth

z3: number of ring gear tooth

z4: number of sun gear tooth

z6: number of ring gear tooth

* *Reduction Gear Output Torque (T)*

$$T = TM \times i \times \eta_m$$

TM : input torque (motor output torque)

i : reduction gear ratio

h_m: mechanical efficiency

* *Reduction Gear Output Rotating Speed (N)*

$$N = \frac{NM}{i}$$

NM: input speed of rotation (output motor speed)

5.4 PRECAUTIONS AND WARNINGS

Inspection

Check the following points before installing the motor.

1. Are there any portions of the motor missing or damaged by transportation?
2. Is there any looseness in the tightening portions?
3. Are port flange faces and drain ports completely sealed to prevent debris from entering into the motor?

Direction of Rotation

The relation between the flow direction of hydraulic fluid and the direction of rotation is shown in the following table.

OIL INLET PORT	OIL OUTLET PORT	DIRECTION OF ROTATION (VIEW FROM B SIDE EDGE OF REDUCTION GEAR)
P1	P2	Counterclockwise Rotation
P2	P1	Clockwise Rotation

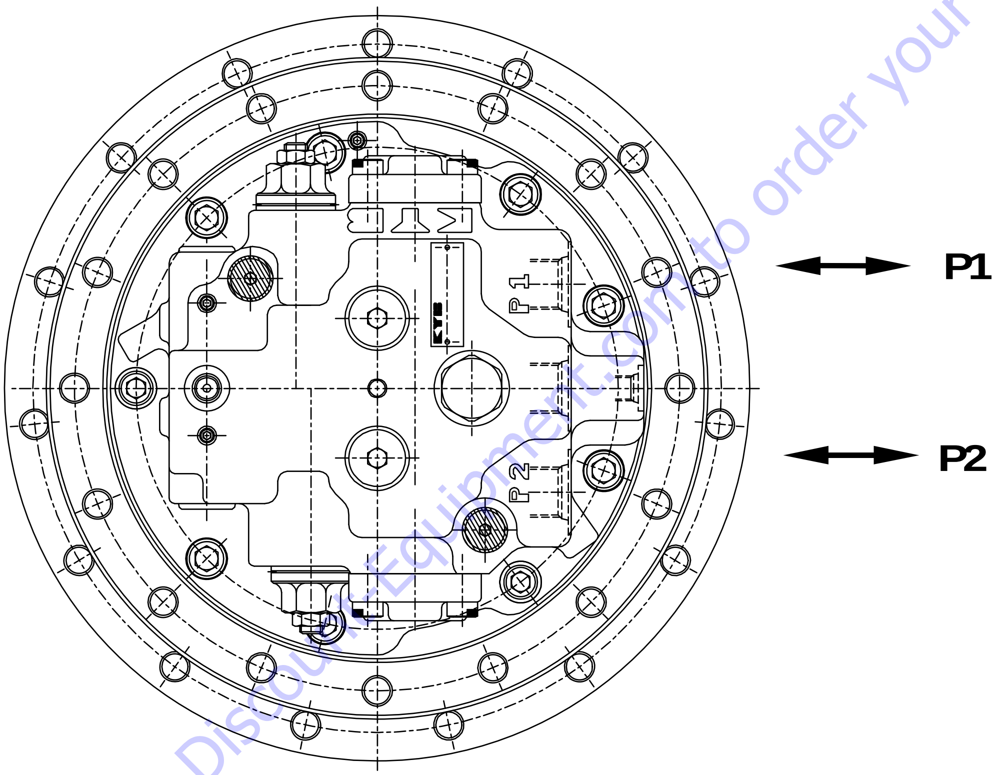


Figure 5-17. Direction of Rotation

Hydraulic Fluid

1. Hydraulic fluid is an important factor for transmission of power and lubrication of hydraulic components. Selection and handling of the hydraulic fluid have a great influence on the performance and life-span of hydraulic equipment.

   Lubricating oil having superior quality is generally used as hydraulic fluid. It must be excellent in lubricating ability, oxidization stability, corrosion protection and anti-emulsification. It must not be erosive to packing and sealing materials. Hydraulic fluids with the oil of different property should not be mixed.

2. Range of Viscosity

	VISCOSITY	EQUIVALENT OIL TEMPERATURE (DEG)
Optimum Range of Viscosity	25 to 100	+22 to +55
Practical Range of Viscosity	20 to 500	−3 to +63

(Idemitsu Daphne Hydraulic Fluid 46WR)

When starting up in low temperature, operate hydraulic equipment in idle with no load.

Filters

The piston motor and the shuttle valve are so designed that each of its parts is high in accuracy, clearance among parts is very much limited, and parts are much sensitive to foreign matters, such as sludge, iron powder, rust, filings, grinding powder, etc.

Performance degradation of the piston motor and the shuttle valves, and wear in sliding parts may be avoided by keeping the oil clean.

Therefore, adequate filters are required to keep hydraulic fluid in the hydraulic system clean, durable and reliable for long term services with less maintenance and inspection. The contamination level should be **below NAS Class 9.**

Filters should be placed at the discharge side of hydraulic pump or at the return side of piston motor. Filter gradation should be smaller than 10 microns (nominal). Use filter(s) with a visual indicator by which the clogging is found from the outside, and with a relief valve which by-passes the oil depending on the clogged condition when the filter element is clogged.

It is recommended that the contamination level of hydraulic fluid should be below NAS Class 9.

Piping Work

1. Do acid-cleaning and remove scales inside the tubes thoroughly before the assembly.
2. Ensure that foreign articles will not enter into the piston motor case from each port during the piping work.
3. Flush the pipes thoroughly upon completion of piping work.
4. The drain piping should be separate and connected directly to the tank.

DRAIN PRESSURE IN PISTON MOTOR CASE	
Constant	at 0.2 MPa or less
Intermittent	at 0.5 MPa or less

5. It is recommended that the piston motor case be constantly filled with oil to maintain satisfactory lubrication.

Lubricating Oil for Reduction Gears

The following products are recommended.

Mitsubishi Diamond Hypoid Gear Oil #90 (Equivalent to GL-4)

BRAND	MANUFACTURER
(*)Diamond Hypoid Gear Oil #90	Mitsubishi Oil
Apolloil Gear HE90	Idemitsu Kosan
Shell Hypoid Gear Oil CT90	Shell Oil
Cosmo Gear GL-490	Cosmo Oil
Gear Lub SP90	Nippon Oil

Notes:

1. Gear oil marked (*) is filled at the time of shipment from our factory.
2. Use the same brand,if the oil is supplied.
3. Select any of the above listed products at time of oil change.

Cautions in Using Parking Brake

This motor is equipped with parking brake. (Refer to Figure 5-11. for working principle of parking brake.)

The parking brake is so designed as to operate when the machine is stopped or parked. If the parking brake is used as a brake during traveling of the machine (for braking motor rotation), the motor shaft or reduction gear drive gear may break as well as the disk plate may quickly wear. This will result in brake failure, leading to personal injuries by runaway of the machine.

Therefore, never use the parking brake as a brake while the machine is traveling (for braking motor rotation).

5.5 OPERATING STEPS AND PRECAUTIONS

Precautions at Startup

After installation of a new or serviced drive motor on the machine, prepare for inspection and startup using the following procedures.

1. Fill the piston motor case with hydraulic fluid. (See Figure 5-18.) Remove air from the hydraulic circuit.

NOTE: *When a hand-operated or electrically operated pump in small capacity is used, carefully check to see that the internal pressure of the motor case does not exceed 0.3 MPa.*

2. Fill the reduction gear case with the lubricating oil up to the specified level. (See Figure 5-19.) Remove the plugs of lubricating and gauging ports, and add lubricant until it flows out of the gauging port. Reinstall and tighten the plug of each port after making sure that lubricant flows out. (Standard Lubricant Quantity: 2600 cm2)

NOTE: *The reduction gear box has been fully lubricated up to the specified level at the time of shipment from our factory.*
Some of motors do not have lubricating ports or parking manual release ports on base-plate.

Initial Operation

Repeat the initial operations at low speed. Residual air in the circuit may cause unusual noise at the valve, but continue the operation at low speed. Ensure that there is no oil leakage around the equipment. Ensure that the residual air is purged and there is no oil leakage and that there is no unusual noise or vibration caused by the drive motor under loaded conditions, prior to start of working operations.

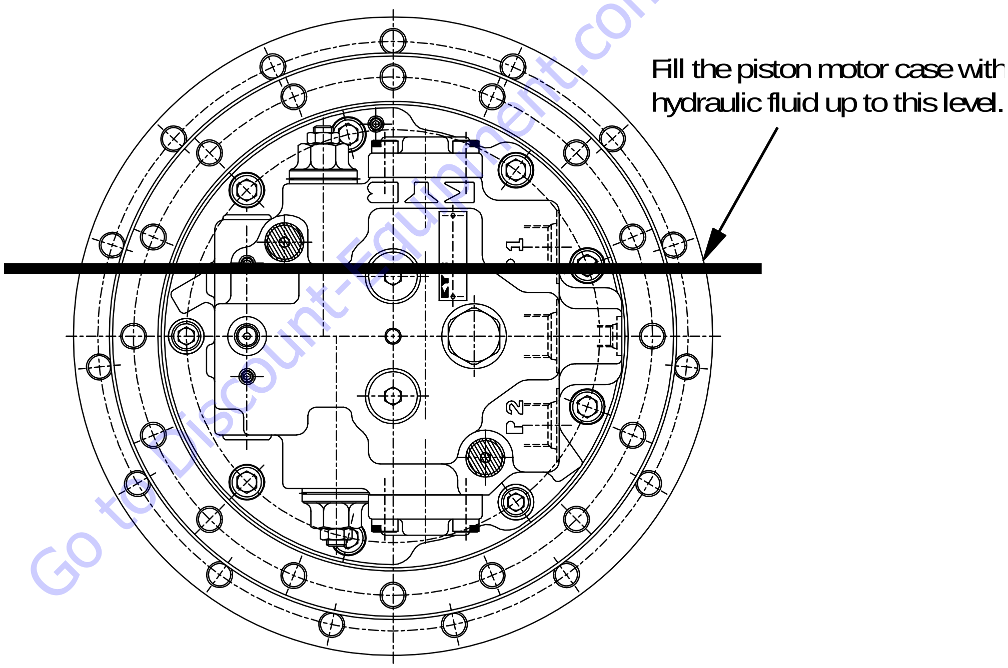


Figure 5-18. Oil level of hydraulic fluid at the initial stage

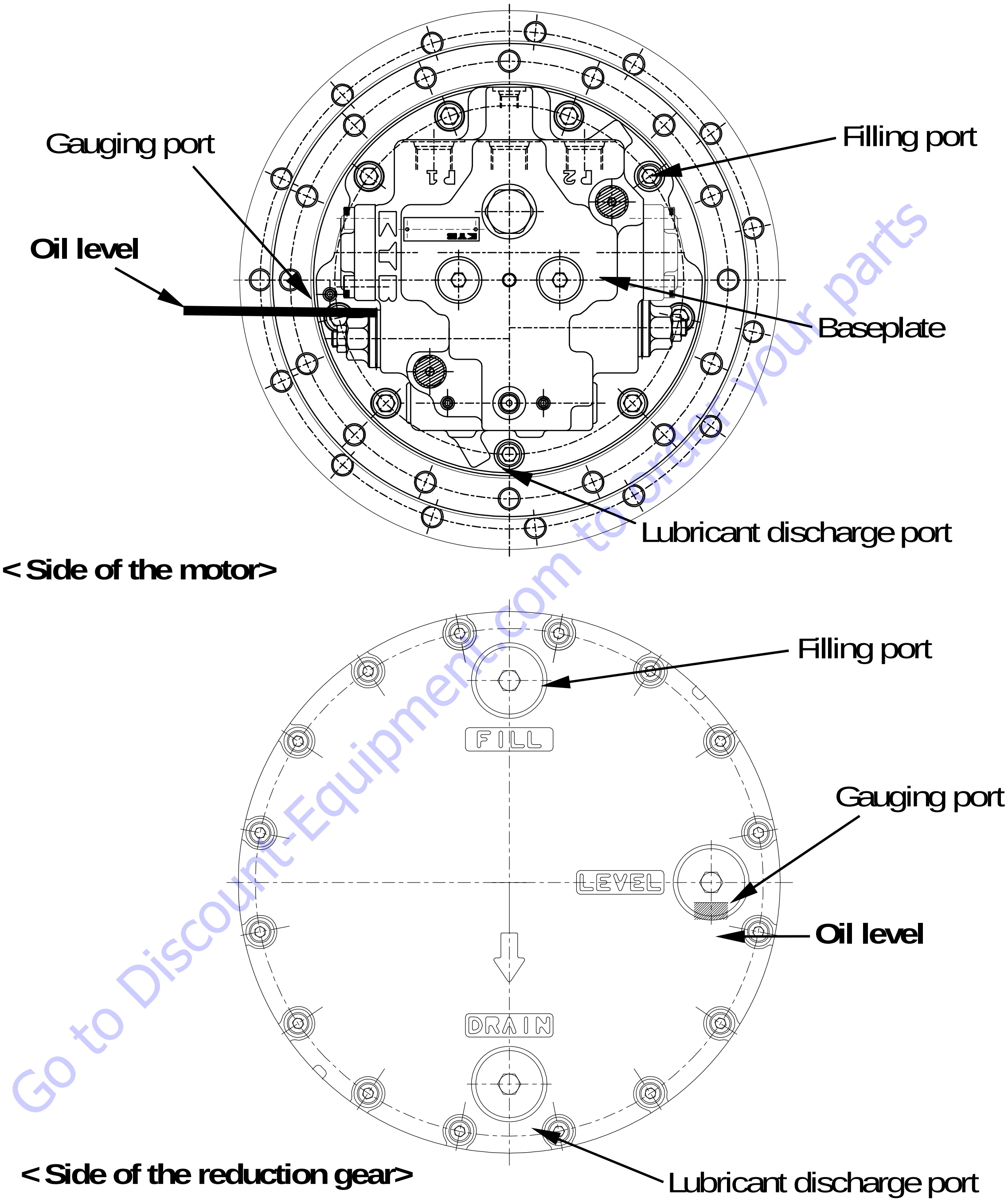


Figure 5-19. Lubricant Change

Hydraulic Fluid Temperature during Operation

Temperature control of the hydraulic fluid is very important in the hydraulic system. Higher temperature may degrade the anti-oxidant resistivity and accelerate deterioration of the hydraulic fluid. Therefore, take the following precautions:

1. Maintain the temperature during continuous operation within the range from +10 to +80 degree.
2. Minimum start-up temperature should be at minus +20 degree or higher. Maximum allowable temperature is +100 degree only for a short time (total accumulative operating time under 100 degree should be within 100h). These temperatures have been established in consideration of degradation to viscosity and anti-oxidant resistivity of the hydraulic fluid and to the O-ring and oil seals. The motor life will be shortened if the motor is continuously run at temperature of +80 degree or higher.

Maintenance and Inspection

Perform maintenance and inspection of the motor for the following check points unless a malfunction is detected:

1. Is there any oil leakage at flange connections and joints of the equipment?
2. Is there any looseness in tightened bolts?
3. Is there any damage on the appearance?
4. Is there contamination in the lubricant?

5.6 PERIODIC INSPECTION AND CHANGE CRITERIA

Hydraulic Fluid

Although the hydraulic oil is clean at first, it will be dirtied with sediment such as sludge in the circuit and the tank after a long operation, and it may cause damage to hydraulic components. The hydraulic fluid will also be degraded and will result in wear of the sliding components. Therefore, it is necessary to check the hydraulic fluid periodically and to change the fluid depending on the state of degradation. However, it may be difficult to judge quantitatively on site whether the fluid is degraded or not. The following table is provided for information to be used as a basis of visual inspection.

It is recommended to replace the oil with new after the first 500-hours of operation.

When hydraulic fluid is replaced, deposits such as deteriorated hydraulic fluid and sludge, and water are contained in the circuit and tank. If left as they are, they will cause operation failure of the motor and shorten its life-span. Be sure to clean the tank and flush piping before replacing with new hydraulic fluid.

APPEARANCE *	SMELL	JUDGMENT	COUNTERMEASURES
Transparent (no discoloration)	Good	Good	Use as is
Transparent (but dark spots are noted)	Good	Foreign substances mixed	Use after filtration
Discolored (milky)	Good	Water contained	Change oil
Discolored (darkish)	Bad	Oxidized	Change oil
* Visual Inspection Method (Compare the old and new fluids in the test tubes)			

Filters

Filtration effectivity is lowered if filter elements are clogged. Periodic inspections are essential to maintain the filters in good conditions.

Filters should be replaced with new ones after the first 50 hours of running, and checked after every 250 hours of running. Where a differential pressure gauge is not provided, the filters should be replaced with new ones after the first 50 hours and every 250 hours thereafter. The filters must be replaced with new ones when the hydraulic fluid is replaced with new.

Lubricating Oil for Reduction Gears

1. Inspection of Contaminated Lubricating Oil

   Check for metal powder or any other foreign substances deposited in the fluid at the time of oil change.

2. Frequencies of Oil Change

Initial Oil Change	100 - 250 hrs
Succeeding Oil Change	every 1000 - 1500 hrs

Gauging Procedure

Motor with the lubricating port on base-plate.

Remove socket head bolt for lubricating port (50) on the base-plate (32) and plug for gauging port, and make sure that lubricant flows out of the oil level detection port (45). (Refer Figure 5-19.)

Motor with/without the lubricating port on base-plate.

Remove plug for lubricating port (1-8) on the cover (1-27) and plug for gauging port, and make sure that lubricant flows out of the oil level detection port (1-8). (Refer Figure 5-19.)

New Lubricant Replacement Procedure

Motor with the lubricating port on base-plate.

Discharge old lubricant completely by removing socket head bolts for lubricating port (50) and discharge port on the base-plate (32) and plug for gauging port (45). Then, lubricate new lubricant until lubricant flows out of the gauging port. (Refer Figure 5-19.)

Motor with/without the lubricating port on base-plate.

Discharge old lubricant completely by removing plugs for lubricating port (1-8) and discharge port on the cover (1-27) and plug for gauging port (1-8).

Then, lubricate new lubricant until lubricant flows out of the gauging port.(Refer Figure 5-19.)

Inspection for Hydraulic Fluid and Lubricant Leaks, and Torque of Bolts and Plugs

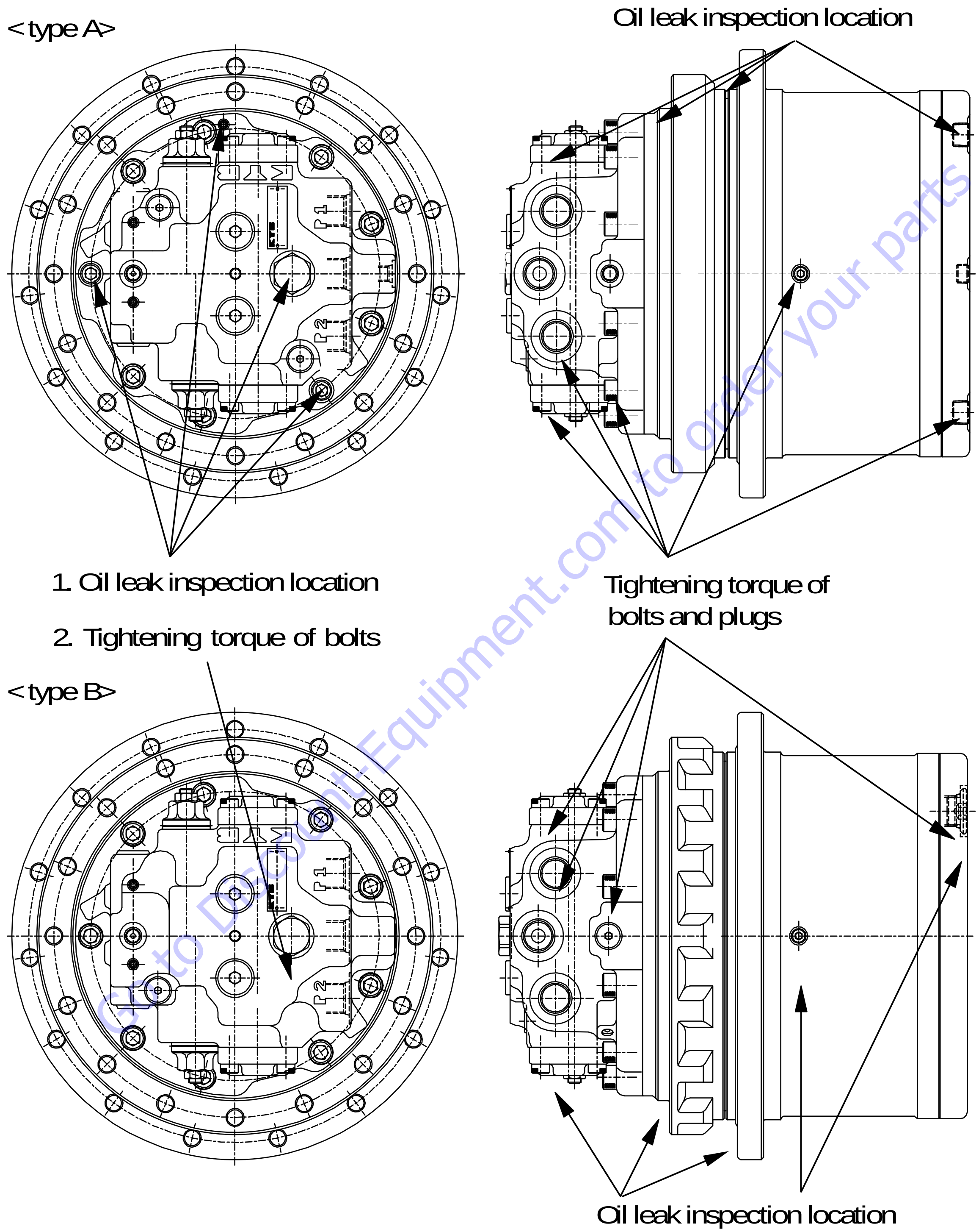


Figure 5-20. Inspection of oil leak, bolts and plugs

5.7 TROUBLESHOOTING

In the event a failure occurs while in operation, refer to the following troubleshooting list for the causes of failure and necessary actions.

Troubleshooting for Piston Motor

TROUBLES (TYPE OF FAILURE)	POSSIBLE CAUSES	CORRECTIVE ACTIONS
Motor does not rotate.	The components other than piston motor and reduction gear do not work properly.	Check to see if the inlet of motor is pressurized or not, and provide necessary corrections.
	Sliding components of the motor are excessively worn and pressurized oil is leaked.	Replace excessively worn parts with new ones. Remove scratches or burrs, clean all parts thoroughly, and reassemble them.
	Major parts of the motor are damaged. In this case, the motor produces abnormal noises.	Disassemble the motor and replace all damaged parts with new ones. Clean up all parts and reassemble them.
	Motor load is so great that relief valve operates.	Check for load condition, and operate motor under load corresponding to relief set pressure.
Motor speed is low.	Insufficient inflow caused by oil pump and pressure control valve	Check to see if there is necessary flow at the inlet of motor. Provide necessary repairs.
	Required rpm is not obtained because of lowered volumetric efficiency of the motor.	Disassemble the motor and check all sliding parts for excessive wear. Repair or replace worn parts as necessary.
Motor rotates at unstable speed.	Pressurized oil in large amount leaking from drain port caused by wear of motor sliding surface results in a reduction or variations in speed of rotations. Or, motor speed is affected by wear of bearings.	Disassemble the motor for excessive wear. Replace all worn parts with new ones. Clean up all the parts, and reassemble them.
	Motor load is so great that automatic 2-speed system operates.	Check for load condition, and operate motor under load corresponding to automatic 2-speed set pressure.
Oil leakage	Damaged oil seals or O-rings have caused oil leakage.	Replace damaged oil seals and O-rings with new ones. When inserting oil seals, take sufficient care not to damage lips. Oil seals and O-rings can be safely used up to 80° C. If the hydraulic fluid temperature in the motor rises above 80° C , measures such as setting a cooler in the hydraulic circuit are necessary.
	Pressurized motor case caused by (1-2) and (3-1) damages oil seals, resulting in oil leakage. * Pressure resistance of oil seals Working: 0.2 MPa Intermittent maximum: 0.5 MPa	Repair the motor in the same procedures as in (1-2) and (3-1), and replace oil seals with new ones. When inserting oil seals, pay full attention not to damage lips.
	Clogged drain piping by foreign substances or narrow, long piping makes supply pressure high, which causes damage to oil seals and results in oil leaks. *Pressure resistance of oil seals Working: 0.2 MPa Intermittent maximum: 0.5 MPa	Clean clogging of drain piping. Review the piping system and lessen piping resistance. With above measures, prevent pressure greater than 0.3 MPa from being exerted on oil seals, and replace oil seals with new ones. When inserting oil seals, pay full attention not to damage lips.
Abnormal noise, and variations in rotation and pressure caused by cavitation are remarkable.	When motor performs pump operation, when closed loop is used, when boost is low (standard: 0.4 to 0.5 MPa), boost pressure lowers with set pressure of low pressure relief lowered, causing cavitation.	Provide proper boost pressure by reviewing hydraulic circuit and replacing low pressure relief with new one. Then, disassemble the motor, and replace abnormally worn parts and damaged parts. Clean all the parts before reassembly.

Troubleshooting for Parking Brake

TROUBLES (TYPE OF FAILURE)	POSSIBLE CAUSES	CORRECTIVE ACTIONS
Shortage of braking force or one-sided braking	Brake disk is worn.	Replace the worn disk with new one. Remove foreign substances thoroughly, repair damaged parts, and reassemble them after cleaning.
	Deterioration or poor contact of disk surfaces	Polish and correct the surface. Clean it before reassembly. If it is too much degraded, replace it with new one.
	Worn or damaged springs	Replace the spring with new one. Remove foreign substances thoroughly, and clean it before reassembly.
	The bolt for manually releasing brake is mounted.	Remove the bolt for manually releasing brake, and install a blind plug.
	Pilot pressure for releasing brake is in operation.	Check to see if pressurized oil in the pilot for releasing brake is ON or OFF, and then, provide each equipment with necessary inspection and maintenance.
Abnormal heating due to brake dragging	Brake release failure: 1) Oil leakage due to O-ring breakage 2) Clogged orifice 3) Pressurized oil in the pilot for releasing brake is not in operation. 4) Pilot pressure for releasing brake is low.	- Replace the damaged O-ring with new one. - Wash the orifice before reassembly. - Check to see if the pilot port is pressurized or not, and provide equipment with necessary inspection and maintenance.
Parking brake cannot be manually released.	Tightening of bolts for manual release is uneven.	Tighten the bolts evenly.

Troubleshooting for High Pressure Relief Valve

TROUBLES (TYPE OF FAILURE)	POSSIBLE CAUSES	CORRECTIVE ACTIONS
Motor does not rotate or rotates slowly.	Relief valve receipt malfunctions; 1) Foreign articles are jammed in. 2) Spring is broken.	- Remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones. - Replace spring with new one. Then, remove foreign articles thoroughly.
	Cracking pressure of the relief valve is lowered; 1) Spring wear-out 2) Clogged poppet orifice	- Replace relief valve sub assembly with new one. - Wash and clean the clogged orifice prior to reassembly.
2. Motor does not stop or stops slowly.	Relief valve receipt malfunctions; 1) Foreign articles are jammed in. 2) Spring is broken.	- Remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones. - Replace spring with new one.
	Cracking pressure of the relief valve is lowered; 1) Spring wear-out 2) Clogged poppet orifice	- Replace relief valve sub assembly with new one. - Wash and clean the clogged orifice prior to reassembly.

Troubleshooting for Low Pressure Shuttle Valve

TROUBLES (TYPE OF FAILURE)	POSSIBLE CAUSES	CORRECTIVE ACTIONS
Motor rotates slowly.	Operation failure of plunger; 1) Foreign substances are jammed between plunger and body. 2) Spring is broken.	- Remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones. - Replace spring with new one.
Motor does not stop or stops slowly.	Plunger does not return; 1) Foreign substances are jammed. 2) Spring is broken. 3) Spring is not assembled.	- Remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones. - Replace spring with new one. - Install spring in proper position.
Rise in oil temperature of circuit	Operation failure of plunger 1) Foreign substances are jammed. 2) Orifice is clogged.	- Remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones. - Wash the orifice before reassembly.

Troubleshooting for 2-speed Controls

TROUBLES (TYPE OF FAILURE)	POSSIBLE CAUSES	CORRECTIVE ACTIONS
The machine does not go straight.	Plunger is not shifted; 1) Foreign substances are bitten between plunger and body. 2) Spring is not installed in place. 3) Spring is broken.	- Remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones. - Install spring in proper position. - Replace spring with new one. Then, remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones.
	Oil leaks by abnormal wear on 2-seed control piston.	Replace 2-speed control piston with new one. Remove foreign substances thoroughly, and wash the parts before reassembly.
	2-speed control piston is not installed in place.	Install 2-speed control piston in proper location.
	Steel balls are excessively worn.	Replace steel balls with new ones. Then, remove foreign articles thoroughly. Repair damaged parts, and clean the parts before reassembly.
	Orifice in oil passage of 2-speed control piston chamber is different.	Check for orifice diameter.
	Orifice in oil passage of 2-speed control piston chamber is clogged.	Wash orifice before reassembly.
	Plunger is installed backward.	Check plunger for installing direction, and install it in a proper direction.
Speed Two cannot be engaged.	Plunger is not shifted; Foreign substances are bitten between plunger and body.	Remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones. Wash the orifice before reassembly.
	Oil leaks due to abnormal wear on 2-seed control piston.	Replace 2-speed control piston with new one. Remove foreign substances thoroughly, and wash the parts before reassembly.
	2-speed control piston is not installed in place.	Install 2-speed control piston in proper location.
	Orifice in oil passage of 2-speed control piston chamber is clogged.	Wash orifice before reassembly.
	Plunger is installed backward.	Check plunger for installing direction, and install it in a proper direction.
3. Speed One cannot be engaged.	Spring is not set in place.	Install spring in proper position.
	Spring is broken.	Replace spring with new one. Then, remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones.
	Plunger is installed backward.	Check plunger for installing direction, and install it in a proper direction.

Troubleshooting for Low Pressure Relief Valve

TROUBLES (TYPE OF FAILURE)	POSSIBLE CAUSES	CORRECTIVE ACTIONS
1. Rise in circuit temperature	Operation failure of relief valve; Spring is broken.	- Replace spring with new one. Then, remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones.
2. Abnormal noises such as cavitation	Lowered set pressure of relief valve; 1) Seat failure due to foreign substance jamming 2) Spring is broken. 3) Wear-out of spring 4) Lack of necessary parts	- Remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones. - Replace spring with new one. Then, remove foreign articles thoroughly. Repair damaged parts, and reassemble the parts after cleanup. If deep scratches or more than normal wear are found on the parts, the parts should be replaced with new ones. - Replace spring with new one. - Check the parts again.

5.8 MAINTENANCE AND REPAIR PROCEDURES

Tools for Disassembly and Reassembly

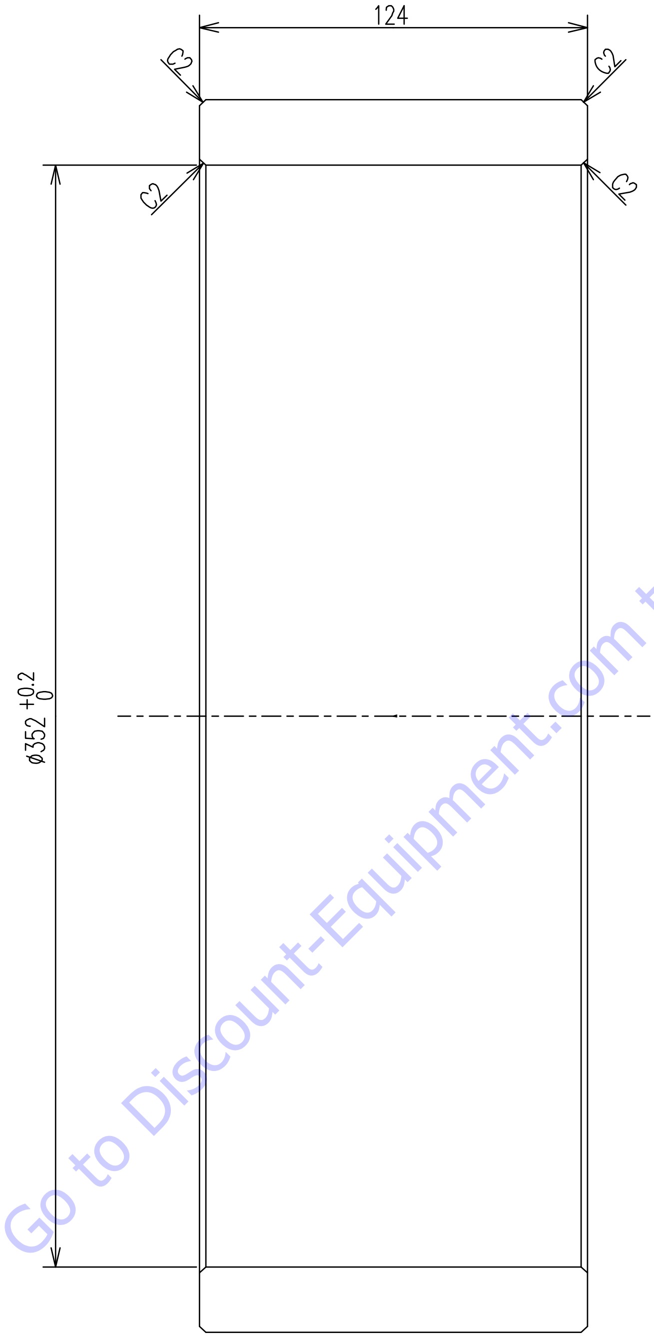
Table 5-1. List of Standard Tools

NO.	PARTS NAME	STANDARD	TYPE AND DIMENSIONS	APPLICABLE COMPONENTS OR PARTS
1	Torque wrench (Preset type)	JIS B 4650	Nominal size 60 [2 to 6 N-m]	(19),(29)
2			Nominal size 230 [7 to 2.3 N-m]	(1-7),(1-30), (45)
3			Nominal size 900 [20 to 90 N-m]	(1-5),(1-14), (1-29),(60), (64),(65)
4			Nominal size 2800 [60 to 280 N-m]	(1-8),(41), (55)
5			Nominal size 4200 [100 to 420 N-m]	(38)
6	Ratchet handle for socket wrench	JIS B 4641		
7	Socket for socket wrench	JIS B 4636	Width across flats 27	(38)
8			Width across flats 32	(55)
9	Hexagonal bit for socket wrench		Width across flats 2.5	(19),(29)
10			Width across flats 4	(1-30),(45)
11			Width across flats 6	(1-7),(1-29), (64)
12			Width across flats 8	(1-5),(60)
13			Width across flats 10	(41)
14			Width across flats 12	(1-8),(47)
15	Spanner		Width across flats 27	(38)
16			Width across flats 32	(55)
17	Hexagonal rod spanner	JIS B 4636	Width across flats 2.5	(19),(29)
18			Width across flats 4	(1-30),(45)
19			Width across flats 6	(1-7),(1-29), (64)
20			Width across flats 8	(1-5),(60)
21			Width across flats 10	(41)
22			Width across flats 12	(1-8),(47)
23	Long-nose pliers	JIS B 4631		(38)
24	Snap ring pliers		S-2 type	(11)
25	Punch		Approx. 10 mm	"(9),(27),(29) "
26	Flatblade screwdriver	JIS B 4633		(32)
27	Pliers	JIS B 4623	Nominal size 150	(1-21),(23) (27)
28	Hand hammer	JIS B 4613	OF-05 nominal size #1	
29	Plastic hammer			
30	Parallel vise			

Table 5-2. List of Special Purpose Tools

No.	Parts Name	Standard	Type and Dimensions	Applicable Components or Parts
1	Angular bearing disassembly jig		20946-99388	(1-3)
2	Angular bearing outer ring press fitting jig		20946-99387	(1-3)
3	Angular bearing inner ring press fitting jig		20946-99390	(1-3)
4	Ring nut disassembly and tightening jig			(1-4)
5	Brake piston positioning jig		20468-99903	(17)
6	Oil seal press fitting jig			(4)
7	Snap ring assembly jig			(11)
8	Bearing assembly jig			(28)
9	Floating seal assembly jig			(1-2)
10	Screw disassembly and assembly jig	JIS B 1015 ISO 10664	Drive size of Hexalobular driving feature for screw is T50(No.50)	(1-14)
11	Crane		Lifting load 200 kgf	
12	Eyebolt		For PT 1/2	
13			For M16	
14	Chain string (wire)			
NOTE: *No.8: TORX T-shaped drive T50 (manufactured by Saga Tekkou)*				

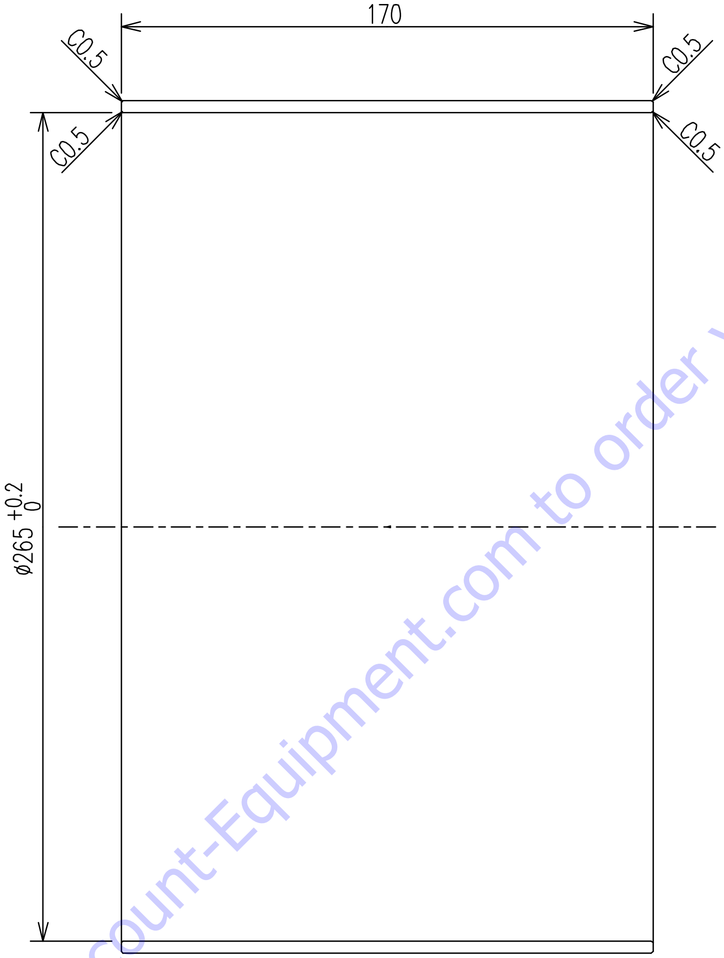
Tool - Angular Bearing Disassembly



MODEL	RGC-85VP-SERIES
NAME	Angular bearing disassembly jig
PART No.	20946-99388

KAYABA INDUSTRY CO., LTD.

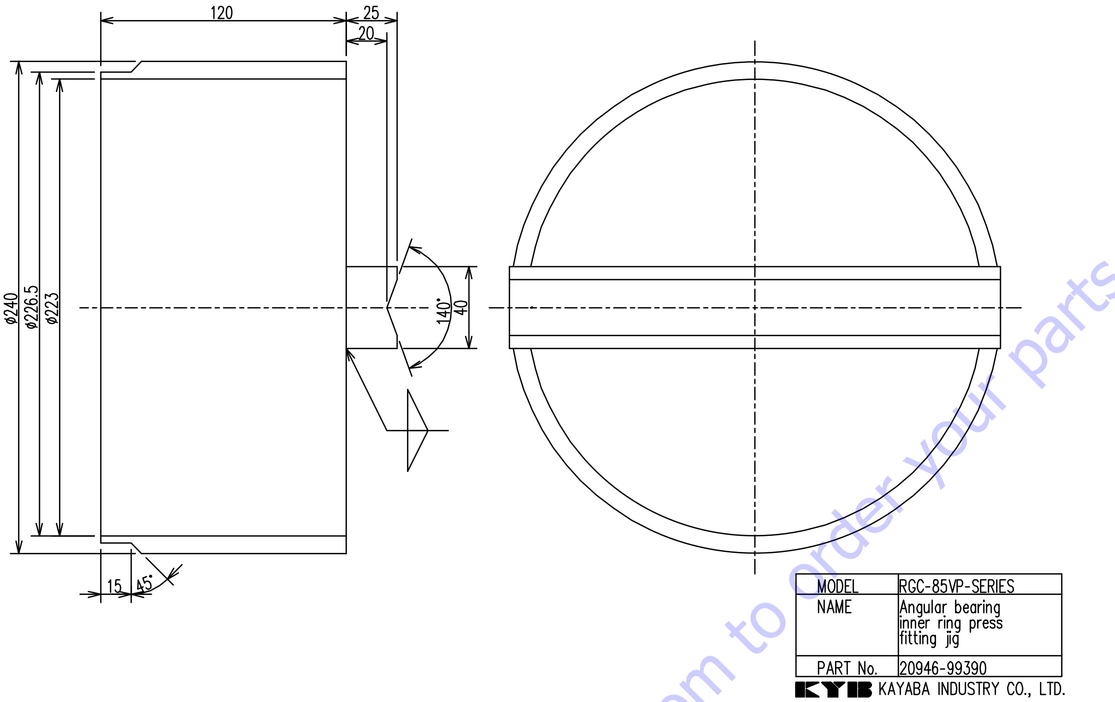
Tool - Angular Bearing Outer Ring Press Fitting



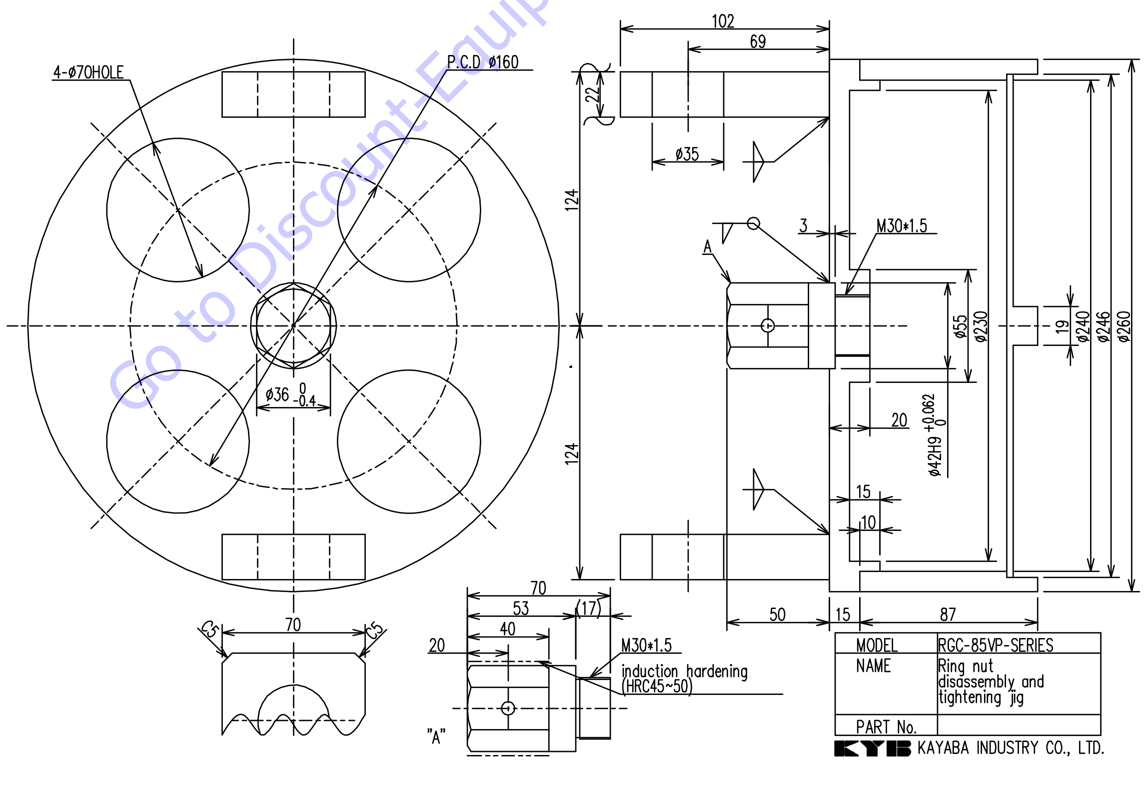
MODEL	RGC-85VP-SERIES
NAME	Angular bearing outer ring press fitting jig
PART No.	20946-99387

KAYABA INDUSTRY CO., LTD.

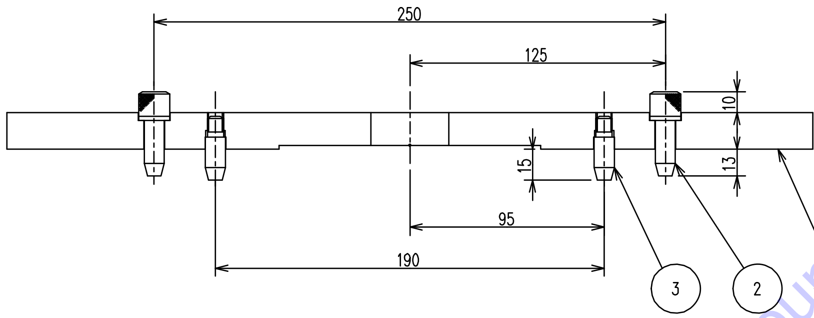
Tool - Angular Bearing Inner Ring Press Fitting



Ring Nut Disassembly and Tightening



Brake Piston Positioning

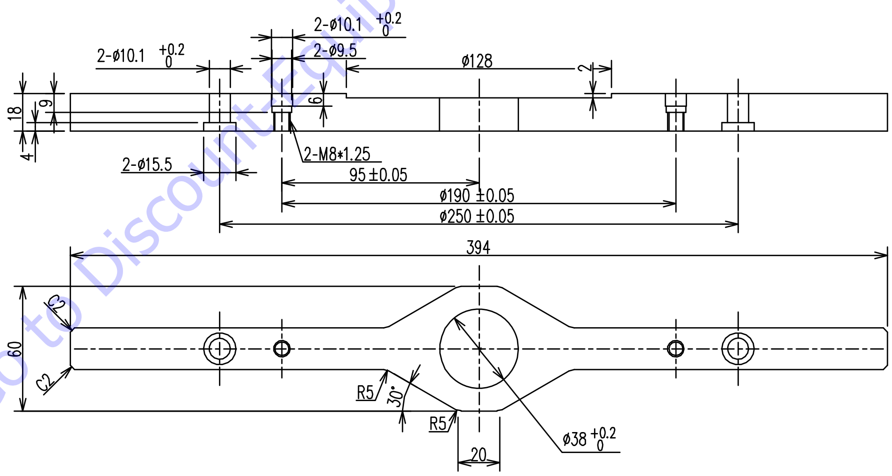


NO.	PART No.	NAME	QTY
3	20466-99516	PIN	2
2	20466-99515	PIN	2
1	20466-99514	PLATE	1

MODEL	MAG-85VP-SERIES
NAME	Brake piston positioning jig
PART No.	20468-99903

KYB KAYABA INDUSTRY CO., LTD.

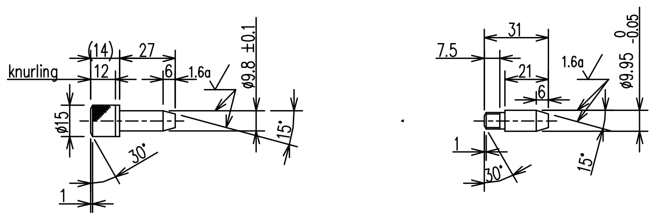
Brake Piston Positioning (PLATE)



MODEL	MAG-85VP-SERIES
NAME	Brake piston positioning jig (PLATE)
PART No.	20466-99514

KYB KAYABA INDUSTRY CO., LTD.

Brake Piston Positioning (PIN)



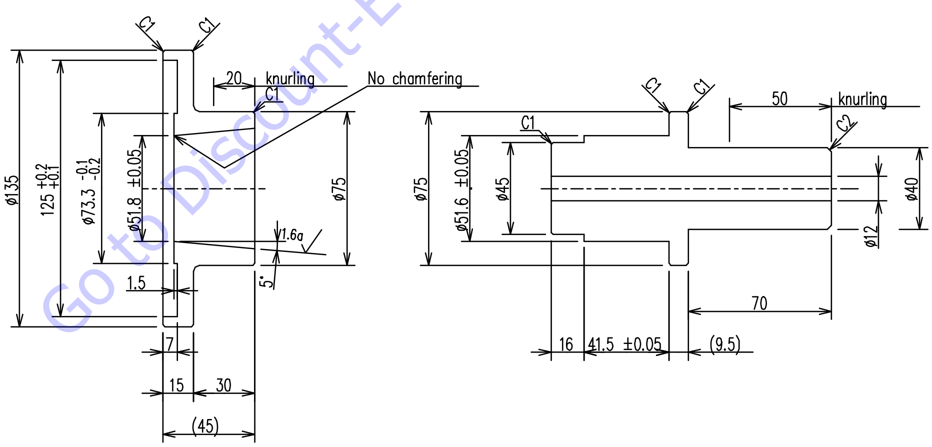
P/N: 20466-99515

P/N: 20466-99516

MODEL	MAG-85VP-SERIES
NAME	Brake piston positioning jig (PIN)
PART No.	20466-99515,99516

KYB KAYABA INDUSTRY CO., LTD.

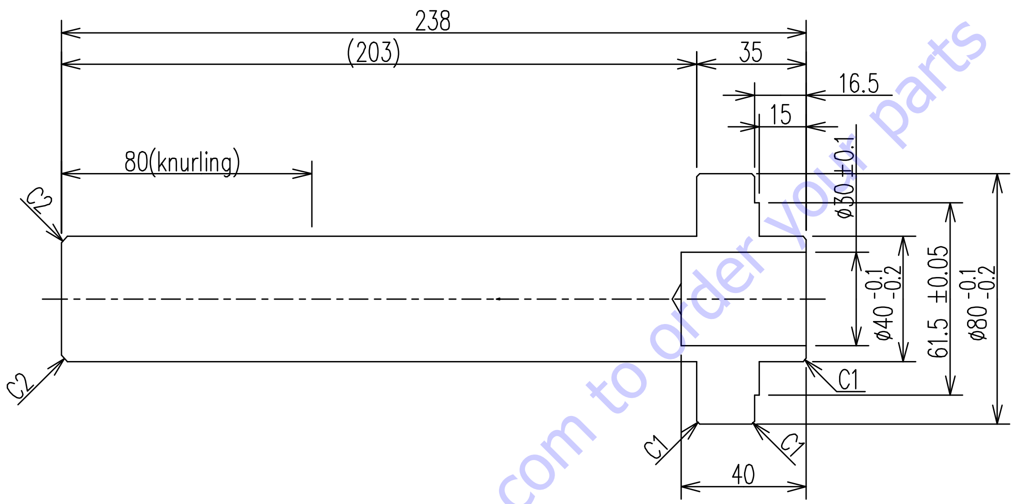
Snap Ring Assembly



MODEL	MAG-85VP-SERIES
NAME	Snap ring assembly jig
PART No.	

KYB KAYABA INDUSTRY CO., LTD.

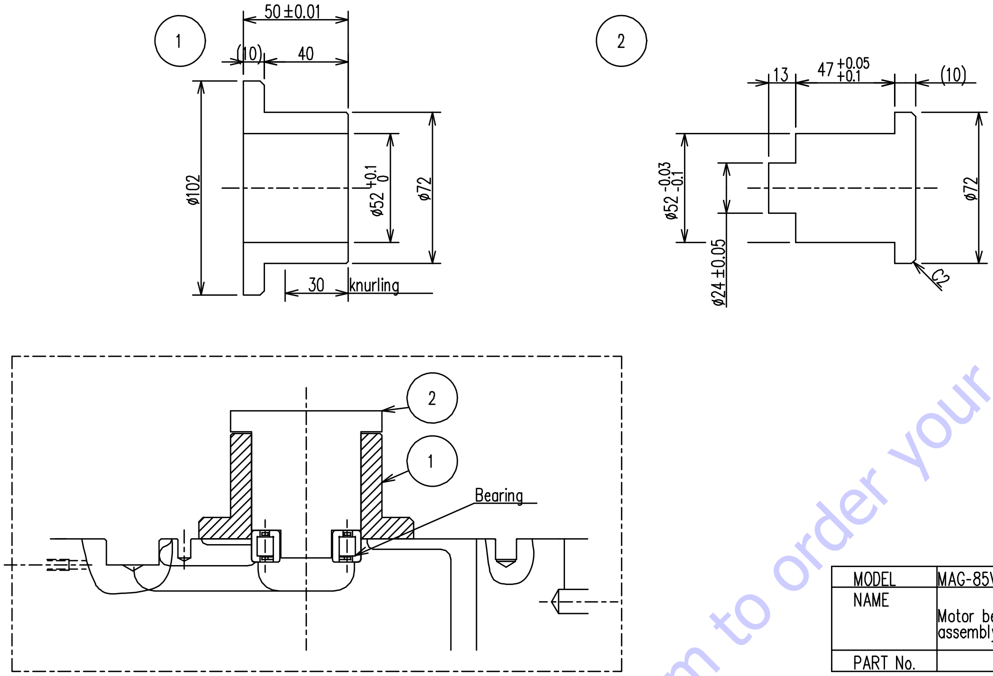
Tool - Angular Bearing Outer Ring Press Fitting



MODEL	MAG-85VP-SERIES
NAME	Oil seal press fitting jig
PART No.	

KAYABA INDUSTRY CO., LTD.

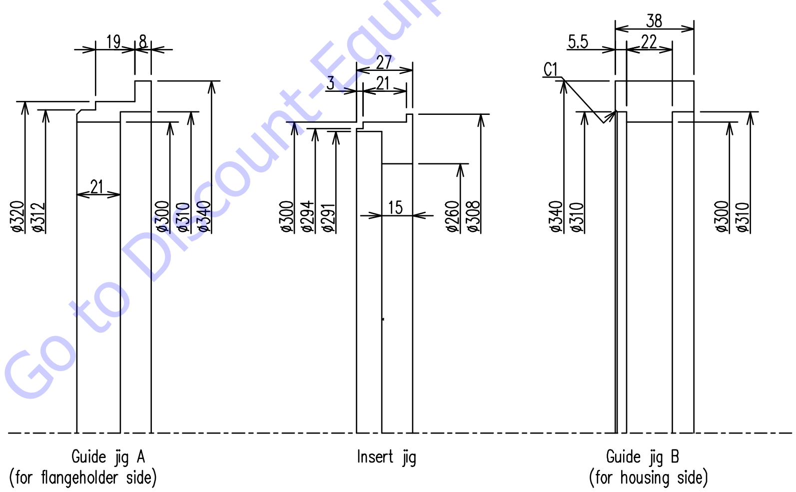
Motor Bearing Assembly



MODEL	MAG-85VP-SERIES
NAME	Motor bearing assembly jig
PART No.	

KAYABA INDUSTRY CO., LTD.

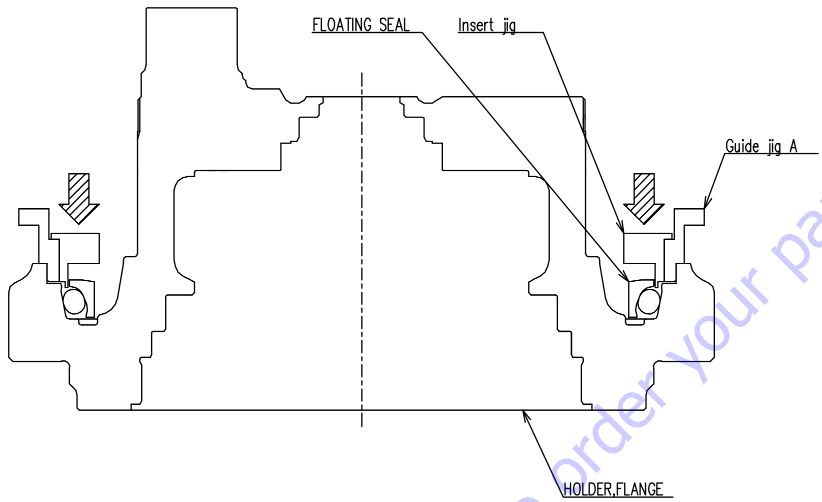
Floating Seal Assembly



MODEL	RGC-85VP-SERIES
NAME	Floating seal assembly jig
PART No.	

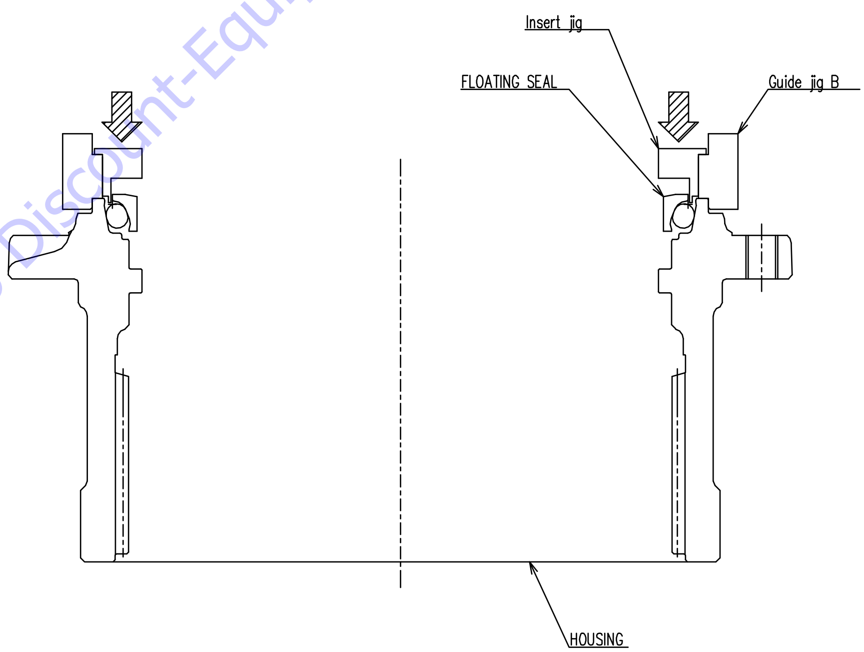
KAYABA INDUSTRY CO., LTD.

Floating Seal #1 - Assembly



Notes: Press the whole of O-ring uniformly by using Insert jig.

Floating Seal #2 - Assembly



Notes: Press the whole of O-ring uniformly by using Insert jig.

Table 5-3. List of Subsidiary Material

No.	Parts Name	Standard	Type and Dimensions	Applicable Components or Parts
1	Spring balance		196 N-m or more	(1-1), (1-4)
2	Seal tape			(1-7), (1-8), (45)
3	Engine oil		Equivalent to SAE 30CD class	
4	Refined kerosene	JIS K 2203	Equivalent to No.2	
5	Thinner			
6	Lapping plate		For correcting sliding surfaces	(5), (7), (15), (26)
7	Lapping agent		#1000	(5), (7), (15), (26)
8	Copper plate			(32), (33)
9	Grease		Shell Albania Grease 2	(1-2), (1-28), (4), (18), (20), (21), (22), (26), (30), (31), (38-7), (38-14), (38-17), (38-18), (42), (61)
10	Tube brush		For washing inside of bore	(7), (32)
11	Bamboo brush		For washing	
12	Oil pan		For receiving hydraulic fluid	
13	Plastic container		Containing grease	
14	Waste cloth			

Table 5-4. List of Tightening Torque

Parts Name	Nominal Size	Hexagon Width Across Flats (mm)	Tightening Torque	Applicable Components or Parts(1)
Plug	PT 3/8	8	25 ft lb (± 3) 34.3 N-m (±4.9)	(1-5)
Plug	PT 1/4	6	9 ft lb (± 1) 12.3 N-m (±2.5)	(1-7)
Plug	PT 1/2	10	32 ft lb (±3) 44.1 N-m (±4.9)	(1-8)
Plug	PF 3/4	12	115 ft lb (± 5) 157 N-m (±8)	(1-8)
Screw	M10	Special type	25 ft lb (± 3) 34.3 N-m (±4.9)	(1-14)
Socket head bolt	M8	6	21 ft lb (± 1) 29.4 N-m (±2.0)	(1-29)
Plug	NPTF1/16	3.96	7 ft lb (±0.7) 9.8 N-m (±1.0)	(1-30), (45)
Orifice	M5*0.8*5L	2.5	2 ft lb (±0.36) 2.45 N-m (±0.49)	(19), (36)
Plug		27	275 ft lb (±15) 373 N-m (±20)	(38-6)

Table 5-4. List of Tightening Torque

Parts Name	Nominal Size	Hexagon Width Across Flats (mm)	Tightening Torque	Applicable Components or Parts(1)
Nut	M12	17	29 ft lb (± 3) 39.2 N-m (±4.9)	(38-16)
Plug	PF 1/2	10	87 ft lb (±3) 118 N-m (±4.9)	(41)
Socket head bolt	M14*2.0*40L	12	140 ft lb (±11) 191 N-m (±15)	(47)
Socket head bolt	M12*1.75*40L	10	80 ft lb (±7) 108 N-m (±10)	(50)
Plug		31.75	61 ft lb (±3) 83.4 N-m (±4.9)	(55)
Socket head bolt	M10*1.5*30L	8	43 ft lb (±3) 58.8 N-m (±4.9)	(60)

NOTE: *(1) Refer to Figure 5-21. and Figure 5-22. exploded views.*

5.9 PRECAUTIONS FOR DISASSEMBLY

1. Since all parts are precisely machined, extreme care should be taken so the parts may be neither dented nor scratched by drop and/or contact of such parts.
2. Do not try to hit or wrench when the parts are tightly fastened. Perform works carefully and patiently, as hitting or wrenching will cause burrs or damage to parts, resulting in inability of reassembly, oil leaks and degradation of performance.
3. Do not leave the parts disassembled. Parts may be soiled or may be rusted when exposed to damp air or dusts. When work must be discontinued, provide an adequate cover to protect the parts from rusts or dusts.
4. Wash the surface of the motor thoroughly.
5. Drain all hydraulic fluids in piston motor case and oil passage ports.
6. Select a clean working place to prevent parts from soil or dusts.

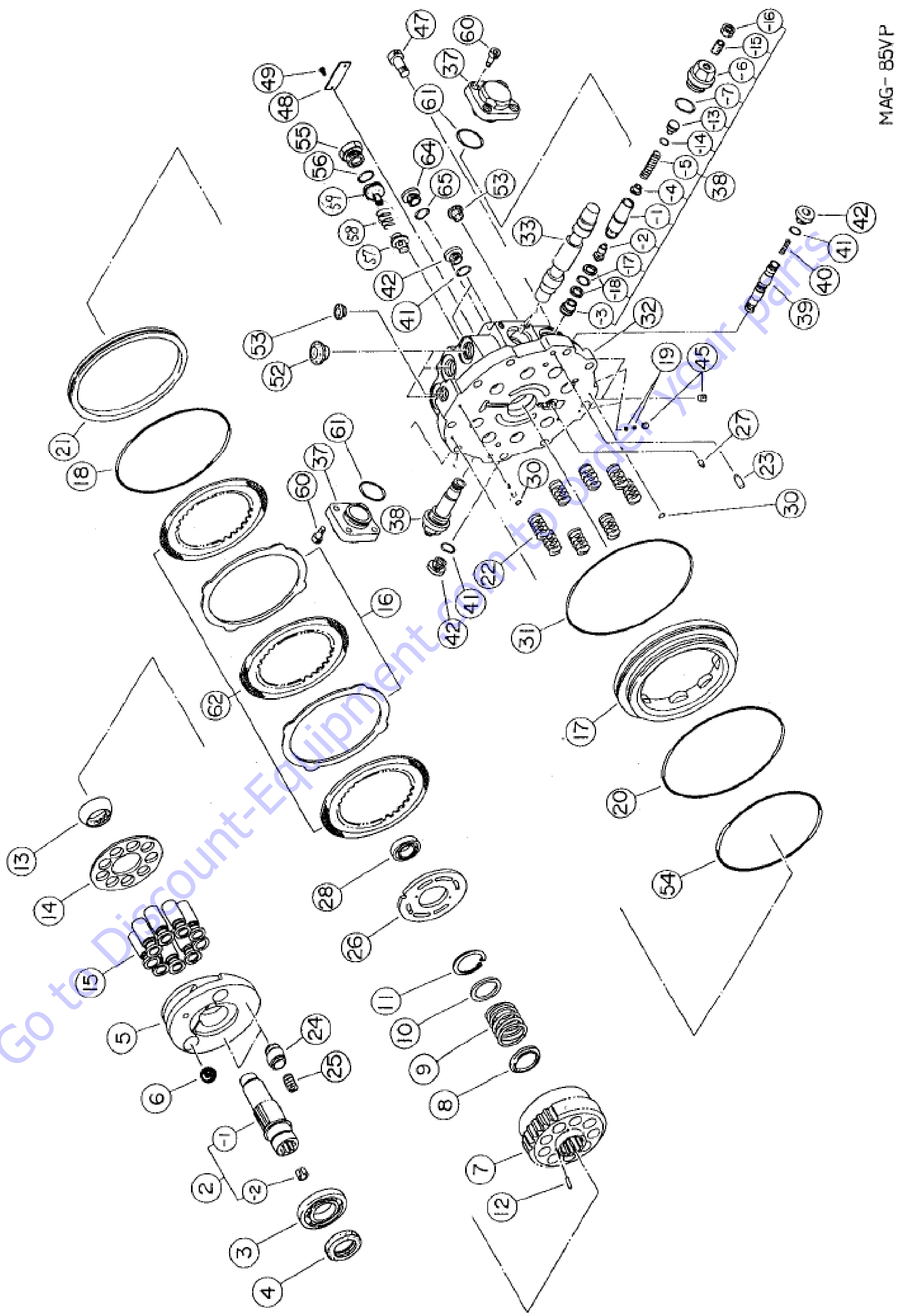


Figure 5-21. Exploded View of Motor

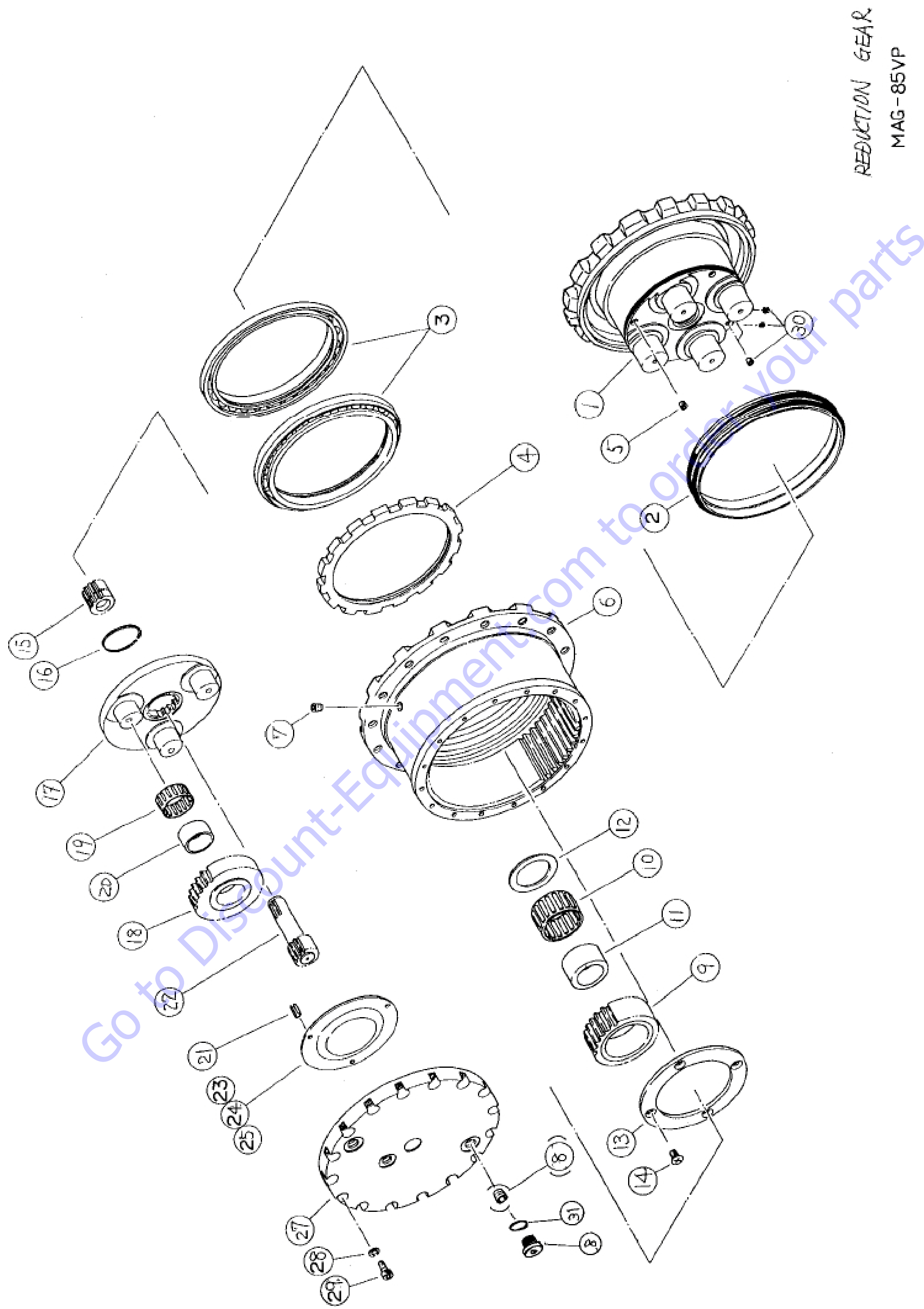
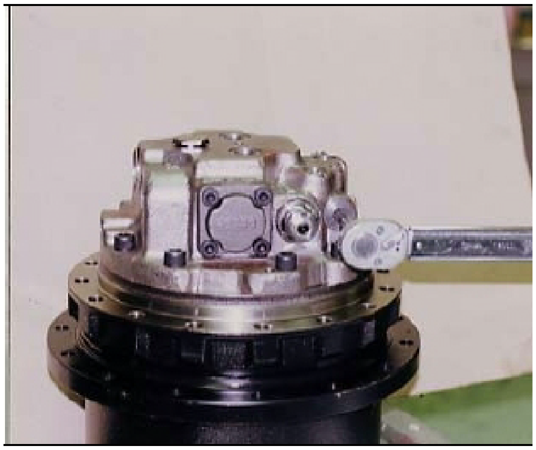


Figure 5-22. Exploded View of Reduction Gear Assembly

5.10 DISASSEMBLY INSTRUCTIONS

Perform disassembly in accordance with the following procedures. Reference exploded views of assembly Figure 5-21. and Figure 5-22., if necessary.

Motor Disassembly



1. Loosen plug (41), and remove spool (39) and spring (40).

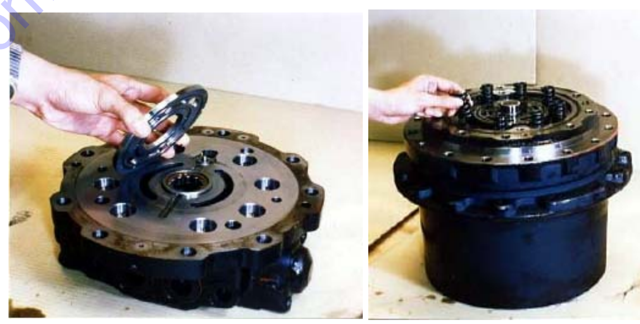
NOTE: *Pull out the spool slowly while turning it. Be careful not to damage the circumference.*

2. Loosen plug (38-6), and remove relief valve (38). Plug (38-6) and relief housing sub assembly (38-1) are lightly press fitted. If they come off, remove them while turning by pinching the circumference of relief housing sub assembly (38-1) with long nose pliers.

NOTE: *Do not loosen set screw (38-15) nut (38-16). Do not disassemble relief valve unless necessary. wrap housing with waste cloth before pinching housing sub assembly with long nose pliers.*

3. Loosen socket head bolts (47), (50) to remove base plate (32). If it is tight to remove, lightly tap it with a plastic hammer in the pulling direction.
   If it is still tight, remove it by lightly prying with a screwdriver.

NOTE: *Be careful that cylinder block will not pull out.*



4. Remove valve plate (26) and O-ring (31), and pull out pins (23), (27) with pliers. Remove also spring (22).

NOTE: *When pulling out pins, protect the circumference with waste cloth to prevent damage to it.*

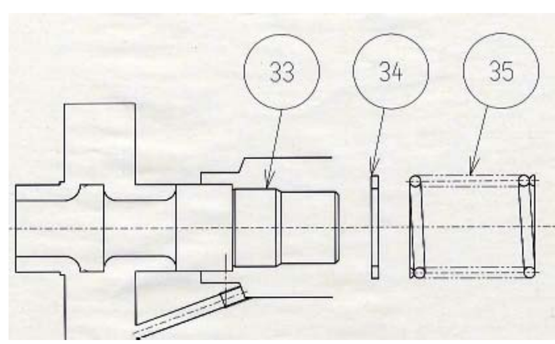
5. Remove brake piston (17) by blowing compressed air from oil passage of parking brake release port. Remove also collar (21) using a jig.

6. Pull out cylinder block (7), pin (12), retainer holder (13), retainer plate (14), and piston sub assembly (15).

NOTE: *Be careful not to damage sliding surface of cylinder block.*

7. Remove swash plate (5), steel balls (6), piston (24), and spring (25).

8. Grip the base plate (32) with vise. Loosen socket head bolts (60) to remove flange (37).



9. Remove spring (35) and spring seat (34).

10. Pull out plunger sub assembly (33).

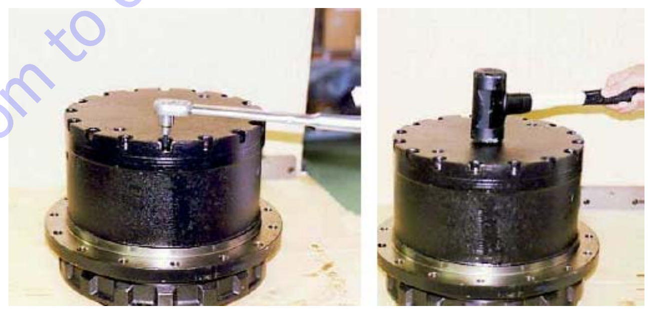
NOTE: *Slowly pull it out while turning it. Be careful not to damage the circumference.*

11. Loosen plug (55), and pull out spring seat (59), spring (58), and poppet (57).

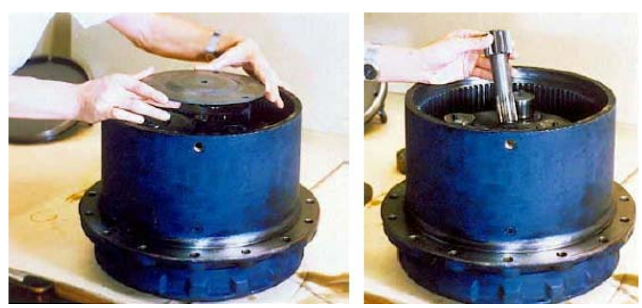
12. After removing pin (12), retainer holder (13), retainer plate (14), and piston sub assembly (15), remove snap ring (11) by making spring (9) flex using a jig or press.

13. Remove collar (10), spring (9), and collar (8).

Reduction Gear Disassembly



14. Remove plugs (1-8), (1-5) and bolt (1-29). Tap the center of cover (1-27) with plastic hammer. When cover (1-27) starts to float up, remove cover (1-27).



15. Remove thrust plate (1-23) and drive gear (1-22).


16. Remove planetary gear A (1-18) and needle bearing (1-1), and then remove holder (1-17).


17. Remove sun gear B, and loosen screw (1-14) to remove thrust plate (1-13).

18. Remove planetary gear B (1-9), needle bearing (1-10), floating bushing (1-11), and thrust washer (1-12).

19. Loosen plug (1-5), and remove ring nut (1-4) using a jig.

20. Secure reduction gears (1) to angular bearing disassembly jig, and place plate on flange holder (1-1). Then, pull out press fit of angular bearing (1-3) by pushing flange holder (1-1) with a press.

21. Remove angular bearing inner ring sub assembly (1-3) and floating seal (1-2).

The disassembly procedure is now complete.

Maintenance Standards For Disassembled Parts

Wash all parts disassembled in treated oil, and dry them with compressed air. Perform maintenance including replacement or corrections in accordance with the following criterion.

Motor Maintenance

Parts Name	Appearance	Standard Value	Allowance	Replacement Parts
Piston sub assembly (15)	When remarkable flaws or high surface roughness are found on each sliding surface	***	***	Cylinder block kit
	When clearance between piston sub assembly and cylinder block bore is great	0.03	0.06	
	When looseness in shoe ball parts is great	0.15	0.4	
Cylinder block (7)	When remarkable flaws or high surface roughness are found on each sliding surface	Roughness 0.2 a	There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	Cylinder block kit / Perform lapping (#1000). Replace if flaws cannot be completely removed.
	When wear inside bore is great	***	***	
	When abnormal wear and breakage develop on mating teeth	***	***	
Valve plate - 26	When remarkable flaws or high surface roughness are found on each sliding surface	Roughness 0.2 a	Roughness 0.8 a There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	Cylinder block kit / Perform lapping (#1000). Replace if flaws cannot be completely removed.
Retainer plate (14) / Retainer holder (13)	When remarkable flaws or high surface roughness are found on each sliding surface	Roughness 0.2 a	Roughness 0.8 a	Retainer plate kit
Swash plate (5)	When remarkable flaws or high surface roughness are found on each sliding surface	Roughness 0.2 a	Roughness 0.8 a There should be no remarkable flaws (over 0.02 mm in thickness).	Swash plate / Steel ball / Perform lapping (#1000). Replace if flaws cannot be completely removed.
	When remarkable flaws or seizure are found on contact surface with steel balls (10)	Ball depth 14.3	14.5	
Shaft (2)	When remarkable flaws or high surface roughness are found on sliding surface of oil seal (21)	Roughness 0.8 a	Roughness 1.6 a	Shaft
	When abnormal wear and breakage develop on mating teeth	***	***	
Brake piston (17)	When remarkable flaws or high surface roughness are found in each sliding surface	Wear amount 0 Roughness 1 a	0.3 2.5a	Brake piston / Friction plate
Disk plate (16)	When remarkable flaws or abrasion are found on disks (friction material)	Thickness 3.5	3.2	Disk plate

Parts Name	Appearance	Standard Value	Allowance	Replacement Parts
Roller bearing (3) / Roller bearing (28)	When flaking and abrasion develop on rolling surface	***	***	Roller bearing
	When indentation is found on rolling surface	***	***	
	When abnormality is found in rotation (abnormal noise, irregular rotation)	***	***	
Piston sub assembly (15)	When remarkable flaws or high surface roughness are found on each sliding surface	***	***	Piston sub assembly / Case
	When clearance to case is great	0.020	0.040	
	When looseness in shoe ball parts is great	0.5	1.0	
Steel ball (6)	When seizure is found on contact surface with swash plate (9)	***	***	Swash plate/ Steel ball
Plunger (33)	When clearance to base plate (2-1) is great	0.020	0.060	Base plate sub assembly
Base plate (32)	When remarkable flaws or high surface roughness are found on sliding surface	***	***	Base plate sub assembly
	When flaws which may cause oil leaks are found	***	***	
Spool (39)	When remarkable flaws or high surface roughness are found on sliding surface	***	***	Base plate sub assembly
	When clearance to base plate (32) is great	0.025	0.050	
Poppet (57)	When remarkable flaws or high surface roughness are found on sliding surface	***	***	Base plate sub assembly
	When clearance to base plate (32) is great	***	***	
	When remarkable flaws or high surface roughness are found on seat surface	***	***	
	When breakage or deformation is great	Free length		Each spring
Spring (9)		52.2	50.7	
Spring (22)		37.7	36.2	
Spring (25)		24.0	22.5	
Spring (35)		51.7	50.2	
Spring (40)		40.0	38.5	
Spring (58)		45.0	43.5	

Reduction Gear Maintenance

Parts Name	Appearance	Standard Value	Allowance	Replacement Parts
Drive gear (1-22) / Sun gear B (1-15) / Housing (1-6)	When pitching (note 1) and abrasion develop on gear tooth surface	***	***	Drive gear (1-22) / Sun gear B (1-15) / Housing (1-6)
Planetary gear A (1-18) / Planetary gear B (1-9)	When pitching (note 1) and abrasion develop on gear tooth surface	***	***	Planetary gear A (1-18) / Planetary gear B (1-9)
	When flaking and abrasion develop on rolling surface of needle bearing	***	***	
Needle bearing (1-19) / Inner race (1-20) / Needle bearing (1-10) / Floating bushing (1-11)	When flaking and abrasion develop on needle and rolling surface	***	***	Needle bearing (1-19) / Inner race (1-20) / Needle bearing (1-10) / Floating bushing (1-11)
	When indentation is found on needle and rolling surface	***	***	
	When abnormality is found in rotation of bearings (abnormal noise, irregular rotation)	***	***	
Thrust washer (1-12)		3.5	3.4	Thrust washer (1-12)
Thrust plate (1-23)		2.6 3.0 3.4	2.5 2.9 3.3	Thrust plate (1-23)
Ring nut (1-4)			When replaced	Ring nut (1-4) / Plug (1-5)
Floating seal (1-2)	When flaws that may cause oil leaks develop on sliding surface			Floating seal (1-2)
Thrust plate (1-13)	When remarkable deformation is found	6	5.6	Thrust plate (1-13)

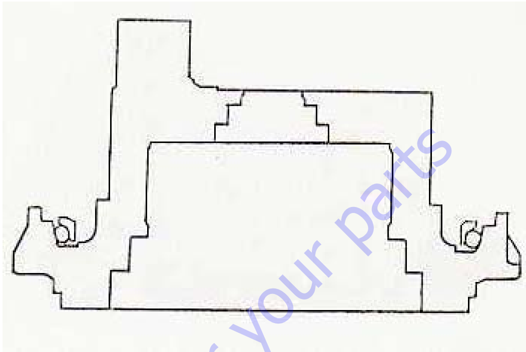
NOTE: *Pitching in this instance refers to a case where pitching occurs in more than 10% of engagement area per tooth surface.*

5.11 PRECAUTIONS FOR REASSEMBLY

1. Wash all parts in treated oil, and remove metal pieces and foreign substances. Ensure that there are no burrs or bruise.
2. Replace seals, bearings and pins with new ones in principle.
3. Take care not to damage seals at time of reassembly. (Apply a small amount of grease prior to installation.)
4. Protect all cleaned parts from dusts, flaws and other damages. Handle them with extreme care.
5. Tighten bolts to specified torque.
6. After reassembly, plug all ports with shipping plugs to prevent dusts from entering.

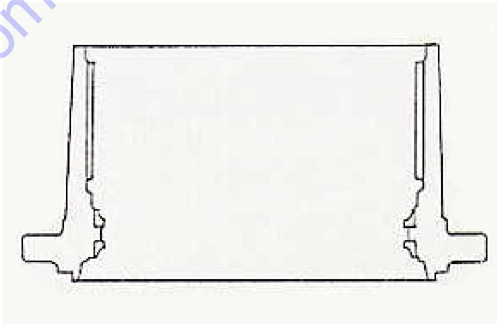
5.12 REASSEMBLY

Perform reassembly in accordance with the following procedures. Reference exploded views of assembly Figure 5-21. and Figure 5-22., if necessary.

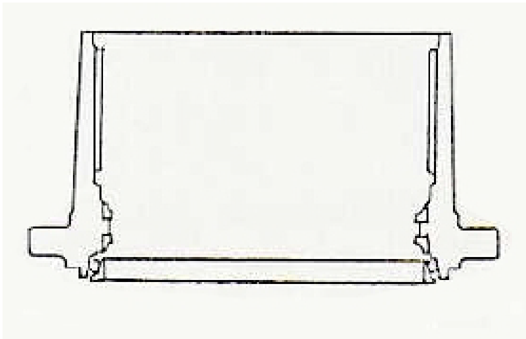


1. Apply grease to floating seal (1-2) and install it on flange holder (1-1).

NOTE: *Apply grease or gear oil to seal surface.*

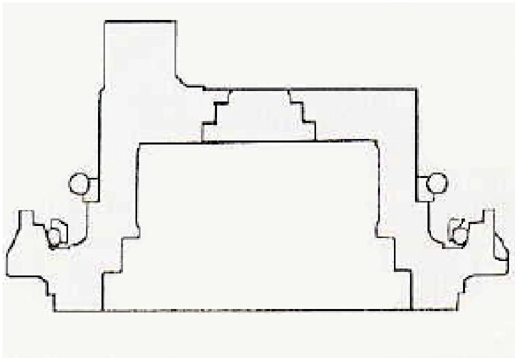


2. Press fit both outer rings of angular bearing (1-3) to housing (1-6).

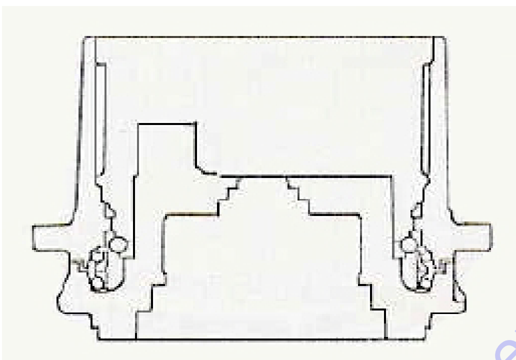


3. Apply grease to the second floating seal (1-2) and install it on housing (1-6).

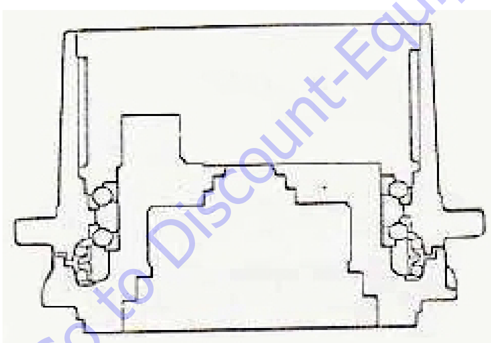
NOTE: *Apply grease or gear oil to seal surface.*



4. Install inner ring sub assembly of the second angular bearing (1-3) on flange holder (1-1).



5. Install housing (1-6) on flange holder (1-1).



6. Install the second inner ring sub assembly of angular bearing (1-3) on flange holder (1-1).

7. Fasten ring nut (1-4). Install ring nut between angular bearings and flange holder, and tightly fasten the ring nut until there is no gap between the angular bearings and flange holder. Measure the startup load at the housing mounting screw (M16) after a couple of times rotation. This startup load is called F [N]. Fasten ring nut so as to adjust the startup load to be equal to F + (108 to 127) [N]. Tighten plug (1-5). Do not apply seal tape to the plug. Caulk the plug by punching at two diametrically opposed locations to prevent the plug (1-5) from loosening.

8. Install thrust washer (1-12), floating bushing (1-11), needle bearing (1-10) and planetary gear (1-9) to the flange holder (1-1) in this order.

9. Place thrust plate (1-13) and tightly fasten screw (1-14) applied with Loctite #262.

NOTE: *Degrease all parts prior to application of Loctite and hardening agent.*

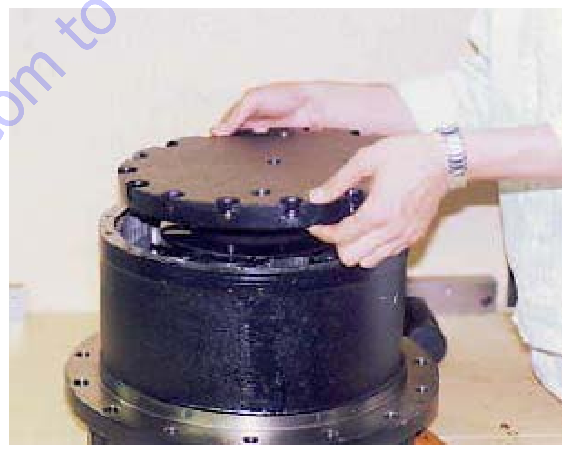
10. Assemble sun gear B (1-15) mounted with snap ring (1-16).

11. Assemble holder (1-17) mounted with inner race (1-20) and spring pin (1-21).

12. Assemble needle bearing (1-19) and planetary gear A (1-18) in this order, and then assemble drive gear (1-22).

13. Assemble thrust plate (1-23).

NOTE: *Note: Before installation, select a thrust plate so that A dimension will be 0.3 to 0.8 mm.*



14. Apply liquid gasket (ThreeBond 11041) evenly to the circumference of contact surface of cover (1-27) and housing (1-6), and assemble cover so that bolt holes will align.

15. Apply Loctite #262 (16 locations) to bolt (1-29), and tighten it to specified torque. Apply seal tape to plugs (1-8), (1-5) and tighten them to specified torque.

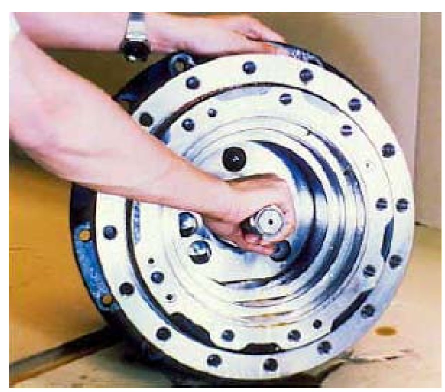
16. Assemble collar (8), spring (9) and collar (10) on cylinder block (7) in this order, and then assemble snap ring (11).

17. Apply grease to pins (12) and insert each pin into three holes on cylinder block (7). Then, assemble retainer holder (13).

18. Assemble piston sub assembly (15) on retainer plate (14), and assemble it on cylinder block (7).

NOTE: *Apply hydraulic fluid to the circumference of piston sub assembly and nine holes on cylinder block.*

19. Press oil seal (4) to flange holder (1-1), and assemble outer ring sub-assembly of roller bearing (3).



20. Assemble shaft (2) press fitted with inner ring of roller bearing (3), engaging it with spline at tip of drive gear (1-22).

NOTE: *Apply grease to lips of oil seals. Insert shaft while lightly turning it, taking care not to damage lips.*

21. Assemble steel ball (6), spring (25) and piston sub assembly (24), and then assemble swash plate (5).

NOTE: *Align hole on sphere of swash plate with steel ball. After assembly, make sure, using aluminum rod, that swash plate tilts and rolls smoothly with steel balls as fulcrum and that it does not rotate.*

22. Assemble cylinder block sub assembly which have been assembled in foregoing sections 16, 17 and 18, using spline of shaft as a guide. Then, assemble disk (16) and friction plate (62).

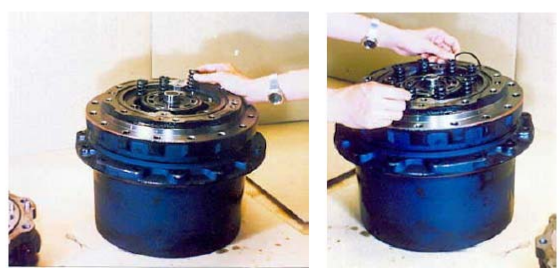
NOTE: *Apply hydraulic fluid to swash plate. Make sure that cylinder block sub assembly rotates smoothly and that piston sub assembly moves freely.*

23. Assemble greased O-rings (18), (20) and back-up rings (21), (54) on brake piston (17). Assemble greased O-ring (54) on collar (21).

24. Assemble collar (21) on brake piston (17), and then assemble it on flange holder (1-1).

NOTE: *Make two pin holes on brake piston in line with two pin holes on flange holder.*

25. Place a positioning jig, and insert brake piston by lightly tapping jig head evenly with a plastic hammer.



26. Assemble spring (22) (8 pieces) on brake piston (17), and O-rings (30), (31) on flange holder (1-1).

27. Grip base plate (32) with vise, and assemble plunger sub assembly (33).

NOTE: *Insert plunger sub assembly while slowly turning it.*

28. Assemble spring seat (34) and spring (35) in this order. After assembling flange (37), tighten socket head bolts (60) to specified torque.

29. Secure base plate (32) on workbench, and assemble outer ring sub assembly (27) of roller bearing (28), pin (27), pins (23) (4 pieces) and O-rings (43) (2 pieces), and then assemble valve plate (26).

NOTE: *Apply grease to non-sliding surface of valve plate and to base plate. Be careful not to damage sliding surface of valve plate.*

30. Assemble base plate on reduction gear.

NOTE: *Apply hydraulic fluid to sliding surface of cylinder block. Pay attention to assembling direction of base plate. Align pins with pin holes.*

31. Tighten socket head bolts (47) to specified torque.

NOTE: *Note: Tighten the bolts evenly, as base plate is pushed by spring.*

32. Assemble relief valve sub assembly (38) on base plate (32), and tighten it to specified torque. Assemble poppet (57), spring (58) and spring seat (59) in this order, and tighten plug (41) to specified torque.

33. Insert spool (39) and spring (40) into base plate, and assemble plugs (41), (43) mounted with O-rings (42), (43), and then tighten them to specified torque. Assemble poppet (57), spring (58) and spring seat (59) in this order, and tighten plug (41) to specified torque.

34. Assemble bonded seal (51) and socket head bolt (50) in this order. Lubricate one location of socket head bolt (50) with specified amount (2600 cc) of tightening lubricant, and then tighten remaining plug (45) and socket head bolt (50).

NOTE: *Apply seal tape to plug (45).*

The reassembly process is now complete.

5.13 QUALITY CHECK AFTER REASSEMBLY

1. Air Leak Test of Reduction Gear Assembly

   Remove one plug (1-8) of the reduction gear assembly and apply compressed air (0.03 MPa) through tapped hole of plug in water for two minutes, and observe that there are no bubbles.

2. Air Leak Test of Motor

   Seal all piping ports on the motor except one port with plugs, and apply compressed air (0.3 MPa) through open port in water. Observe that there are no bubbles.

3. Upon completion of leak tests in subparagraphs (1) and (2) above, fill the motor case with fresh hydraulic fluid. Run the motor crosswise for two minutes filling hydraulic fluid at flow rate of 20 liters per minute. Verify that there is no excessive heat, vibration or noise during running.

SECTION 6. TURNTABLE

6.1 SWING HUB

Adjustment Procedures

1. Ensure swing drive is located on bearing gear max eccentric tooth (high spot).
2. With mounting free to slide, shim between pinion and bearing gear teeth to achieve 0.008 - 0.012 backlash.
3. Install a pry bar into hole in turntable base plate and pry swing hub back tight against shim and bearing.
4. Torque bolts according to the torque chart in Section 1.

6.2 SWING BEARING

Turntable Bearing Mounting Bolt Condition Check

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

1. Check the frame to bearing. Attach bolts as follows:
   a. Elevate the fully retracted boom to 70 degrees (full elevation).
   b. At the positions indicated on Figure 2-45. try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
   c. Assure 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 boom to 70 degrees (full elevation).
   b. At the positions indicated on Figure 2-45. try and 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.

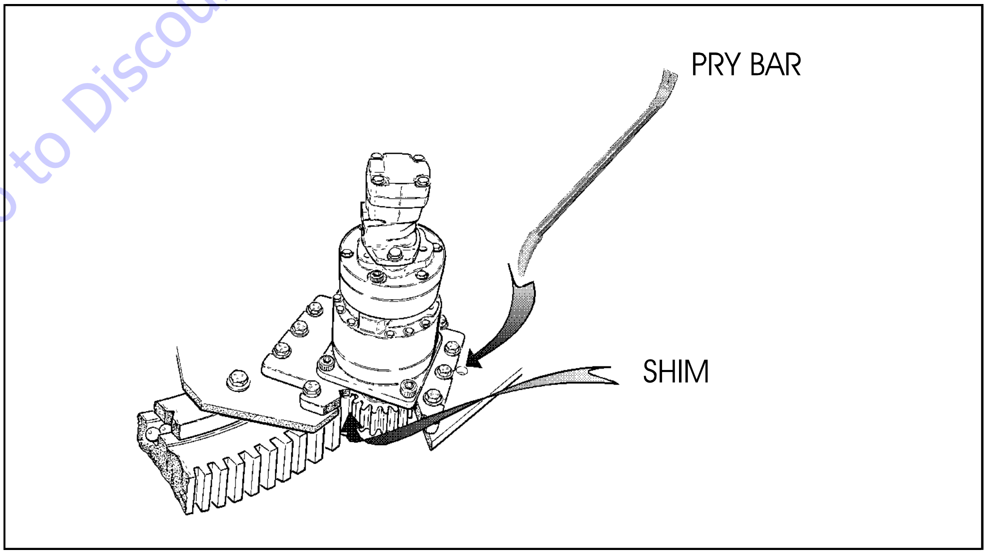


Figure 6-1. Swing Torque Hub Adjustment

d. At the position indicated on figure 2-45. try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.

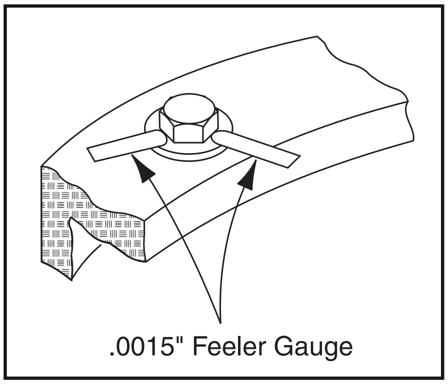


Figure 6-2. Swing Bearing Bolt Feeler Gauge Check

Wear Tolerance

1. From the underside of the machine, at rear center, with the boom fully elevated and fully retracted, as shown in A, Figure 6-4., Swing Bearing Tolerance Boom Placement, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. (See Figure 6-3., Swing Bearing Tolerance Measuring Point.)
2. At the same point, with the boom at horizontal and fully extended, and the tower boom fully elevated as shown in (Figure 6-4., Swing Bearing Tolerance Boom Placement) B, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. (See Figure 6-3., Swing Bearing Tolerance Measuring Point.)
3. If a difference greater than 0.079 in. (2.00 mm) is determined, the swing bearing should be replaced.
4. If a difference less than 0.079 in. (2.00 mm) is determined, 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.

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.

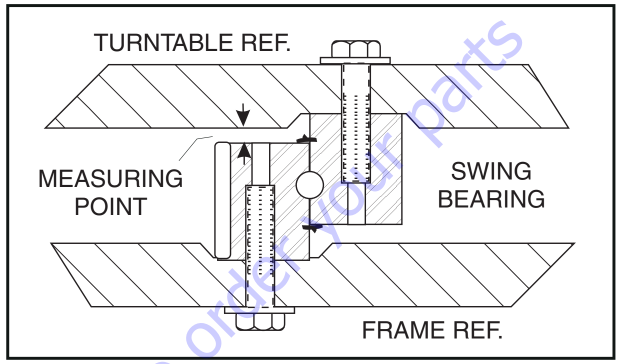


Figure 6-3. Swing Bearing Tolerance Measuring Point

Swing Bearing Replacement

1. Removal.

   a. From Ground Control station, operate the boom adequately to provide access to frame opening or, if equipped, to rotary coupling.

WARNING

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

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

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

NOTICE

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

   d. 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.

   e. Attach suitable overhead lifting equipment to the base of the turntable weldment.

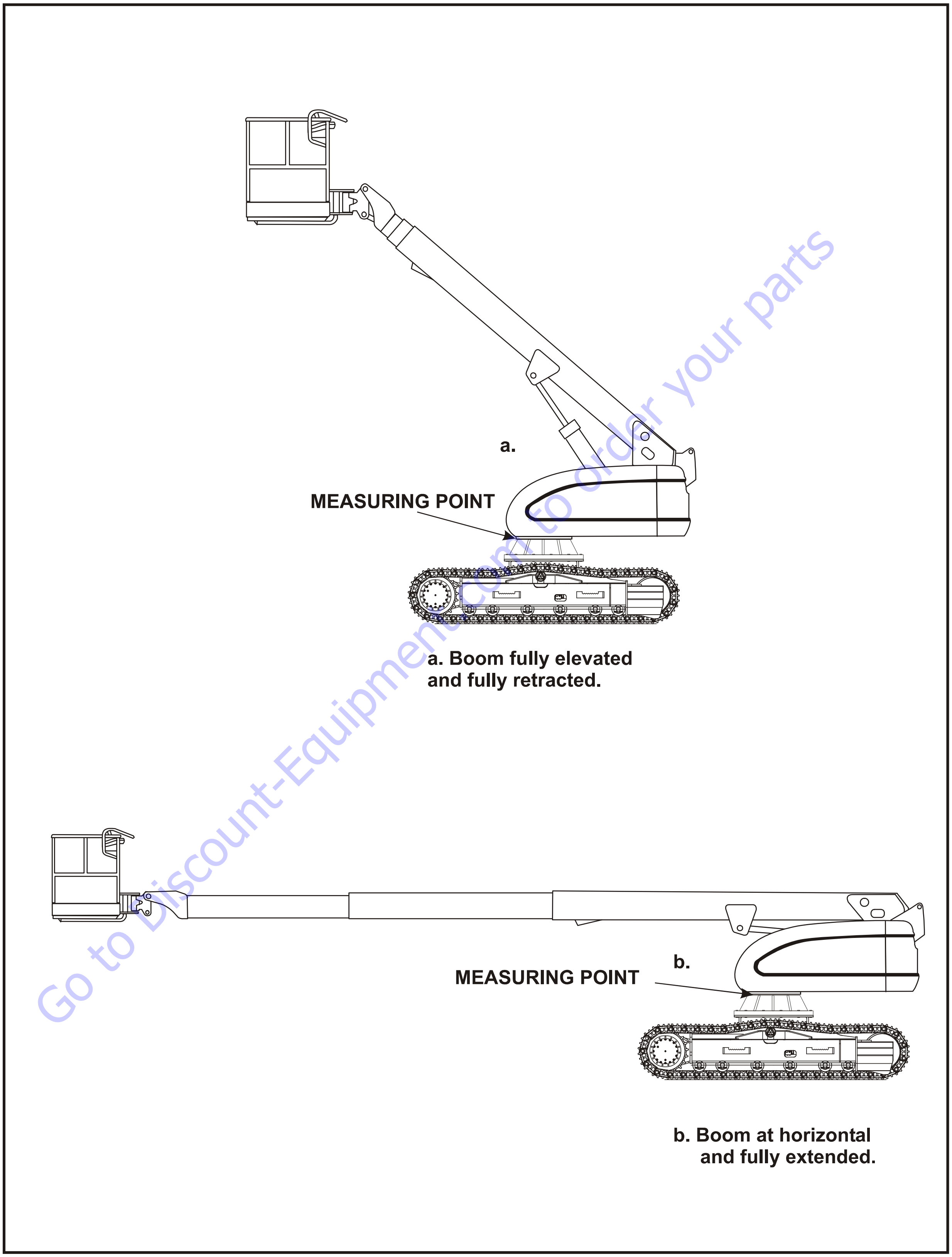


Figure 6-4. Swing Bearing Tolerance Boom Placement

f. 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.

g. 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.

h. Carefully place the turntable on a suitably supported trestle.

i. 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.

2. Installation.

a. 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 filler plug fitting is at 90 degrees from the fore and aft center line of the frame.

CAUTION

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.

b. 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.

c. Refer to the Torque Sequence diagram as shown in Figure 6-5., 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 240 FT. LBS. (326 Nm) w/Loctite.

d. Remove the lifting equipment from the bearing.

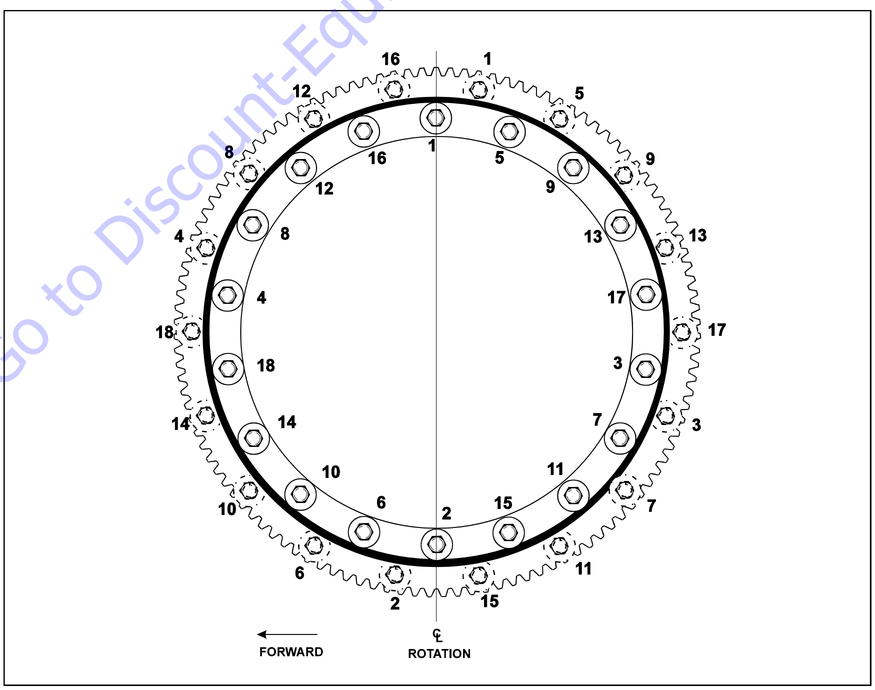


Figure 6-5. Swing Bearing Torque Sequence

e. Using suitable lifting equipment, carefully position the turntable assembly above the machine frame.

f. 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.

g. 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.

h. Following the Torque Sequence diagram shown in Figure 6-5., Swing Bearing Torque Sequence, tighten the bolts to a torque of 240 ft. lbs. (326 Nm) w/Loctite.

i. Remove the lifting equipment.

j. 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.

k. Connect the hydraulic lines to the rotary coupling as tagged prior to removal.

l. At ground control station, use boom lift control to lower boom to stowed position.

m. 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 - 240 ft. lbs. (326 Nm) w/Loctite.
2. Inner Race - 240 ft. lbs. (326 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.

6.3 SWING BRAKE - MICO

Disassembly

1. With shaft protrusion downward, remove end cover (13) by removing capscrews (12).

⚠ CAUTION

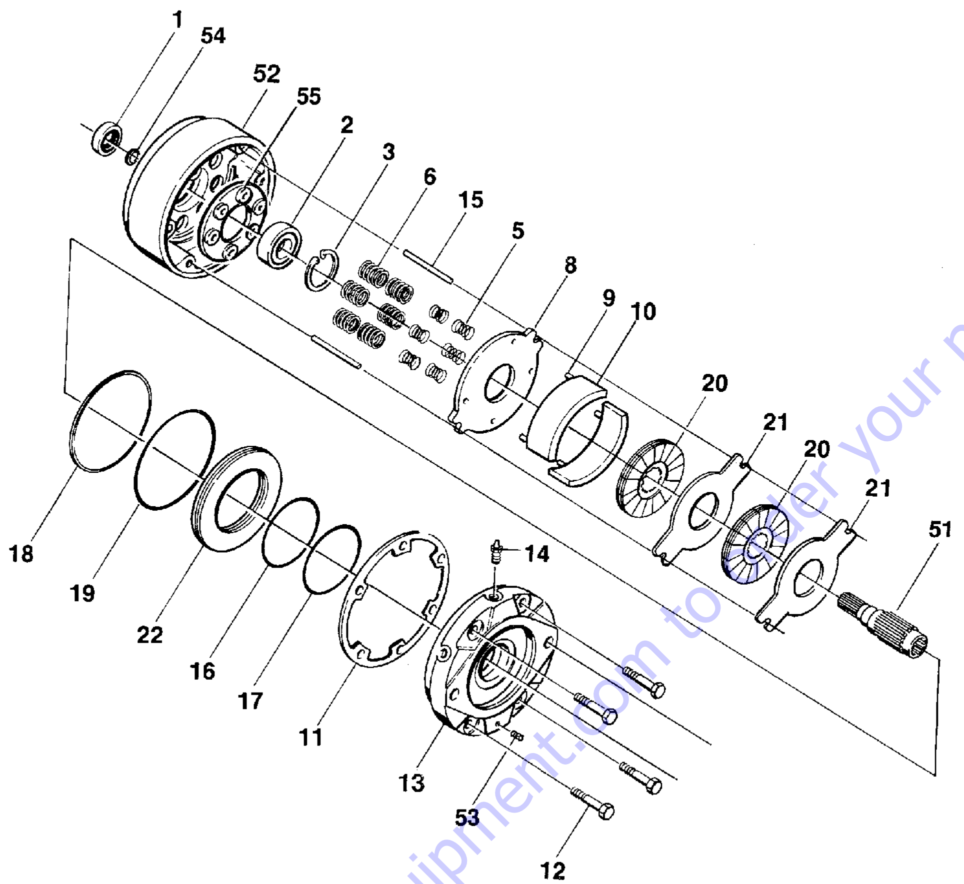
END COVER IS UNDER SPRING TENSION OF APPROXIMATELY 2000 POUNDS (681 KG). THE FOUR CAPSCREWS SHOULD BE LOOSENED EVENLY TO RELIEVE THIS FORCE. IF A HYDRAULIC PRESS IS AVAILABLE (3000 LBS (1362 KG) MAXIMUM), THE COVER CAN BE HELD IN POSITION WHILE REMOVING THE CAPSCREWS AND LOCKWASHERS.

2. Remove case seal (11) from housing (7) then remove bleeder screw (14) from end cover (52).
3. Remove piston (22) from end cover (13).
4. Remove o-ring (17), back-up ring (16), o-ring (19) and back-up ring (18) from piston (22).
5. Remove separators (10) from housing (52).
6. Remove stack assembly, consisting of discs (21), return plate (8) and friction discs (20) from housing (52).
7. Remove dowel pins (15), springs (5 & 6) from housing (52).
8. Remove retaining ring (3) from housing (52).
9. Remove shaft by pressing or using a soft mallet on male end of shaft (51).
10. Remove retaining ring (54) bearing (2) from shaft (51).
11. Press rotary seal (1) from housing (51).

Inspection

1. Clean all parts thoroughly.
2. Closely inspect all parts for excessive wear, cracks and chips. Replace parts as necessary.
3. Discard seals and o-rings.
4. Closely inspect bearings and bearing contact surfaces. Replace as necessary.

NOTE: *Bearings may be reused if, after thorough inspection, they are found to be in good condition.*



1. Oil Seal
2. Bearing
3. Retaining Ring
51. Shaft
5. Spring
6. Spring
52. Housing
8. Return Plate
9. Pin
10. Separator
11. Case Seal
12. Bolt
13. Cover
14. Bleeder Screw
15. Dowel Pin
16. Backup Ring
17. O-Ring
18. Back-up Ring
19. O-Ring
20. Rotor
21. Stator
22. Piston
53. Pipe Plug
54. Retaining Ring
55. Spring Guide

Figure 6-6. Swing Brake Assembly (Mico)

Assembly

NOTE: *Lubricate all seals and o-rings with clean hydraulic oil prior to assembly.*

1. Press new rotary seal (1) into housing (52). Note the direction of seal.
2. Install new bearing (2) on shaft (51).
3. Install shaft assembly and retaining ring (3) into housing (52).
4. Install dowel pins (15), spring retainer (55), and springs (5 & 6) into housing (52).

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

5. Position new large diameter return plate (8) in housing with tabs guided by dowel pins (15) until disc rests on springs (5 & 6).

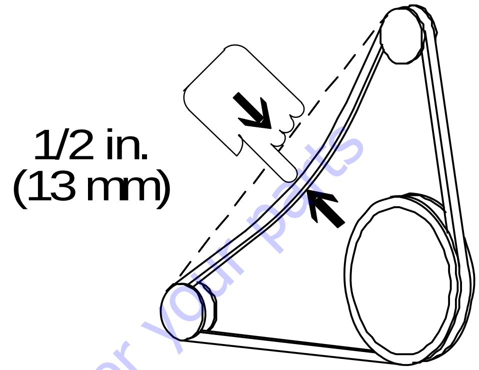
NOTE: *Discs (21 & 8) and friction discs (20) should remain dry during installation. Oil will contaminate disc surfaces.*

6. Place new disc (20) on shaft (51) until it contacts return plate (8).
7. Add additional discs (21) as required to complete assembly.
8. Insert separators (10) in holes of return plate (8).
9. Install new o-ring (17), new back-up ring (16), new o-ring (19) and new back-up ring (18) on piston (22). Insert piston (22) into end cover (13), being careful not to shear o-rings or back-up rings.
10. Install new case seal (11) in housing (52), then install bleeder screw (14) in end cover.
11. Position end cover (13) on housing (52), aligning dowel pins (15) with holes in end cover.
12. Insert capscrews (12) and tighten evenly to draw end cover (13) to housing (52). Torque capscrews to 55 ft. lbs. (75 Nm).

6.4 GENERATOR

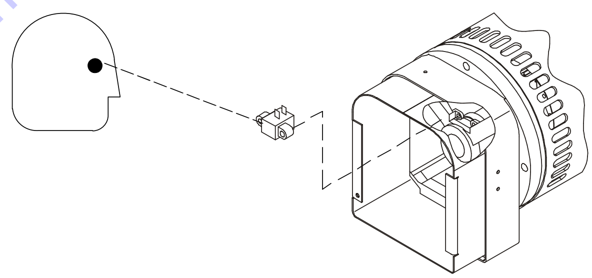
Every 250 hours

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

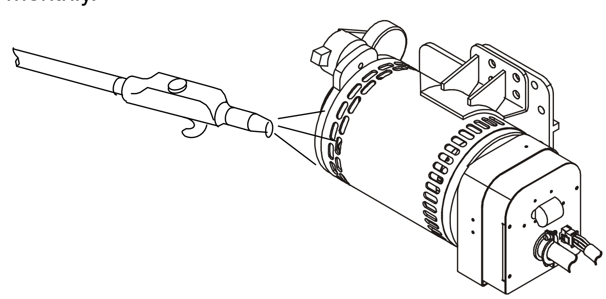


Every 500 hours

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.

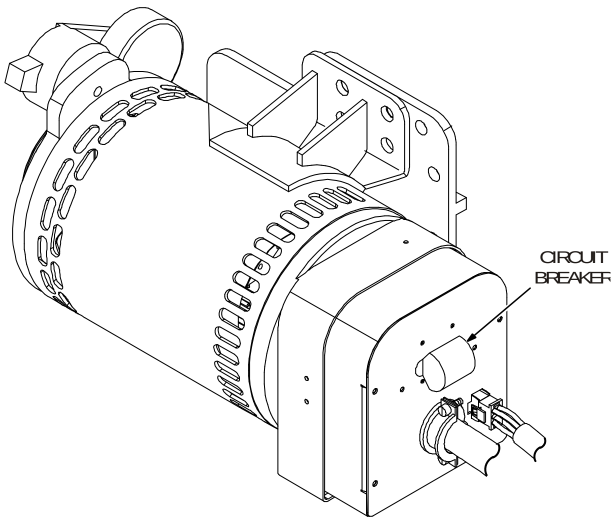


Overload Protection

CAUTION

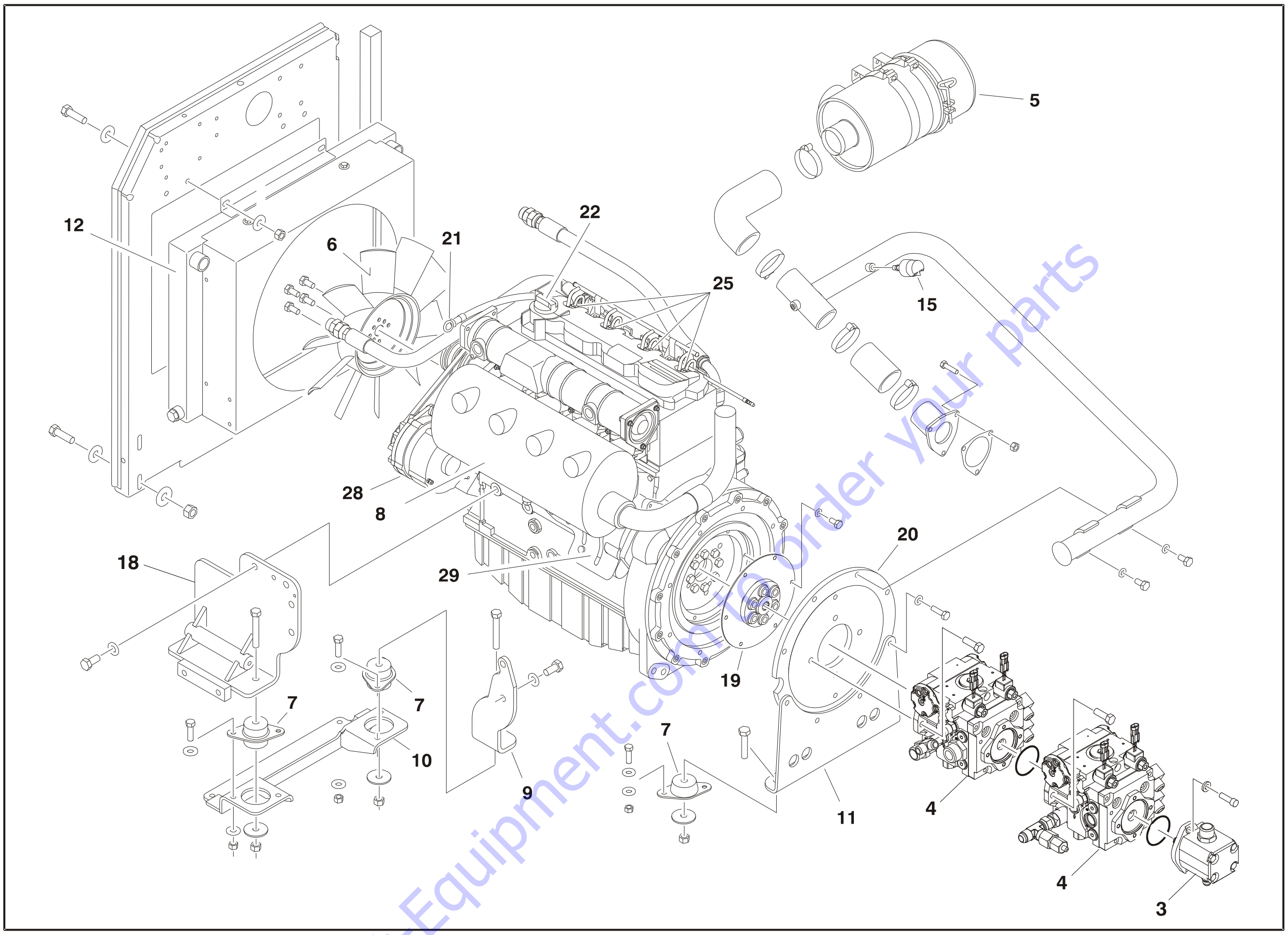
STOP THE ENGINE WHENEVER CHECKING OR INSPECTING THE CIRCUIT BREAKER.

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.



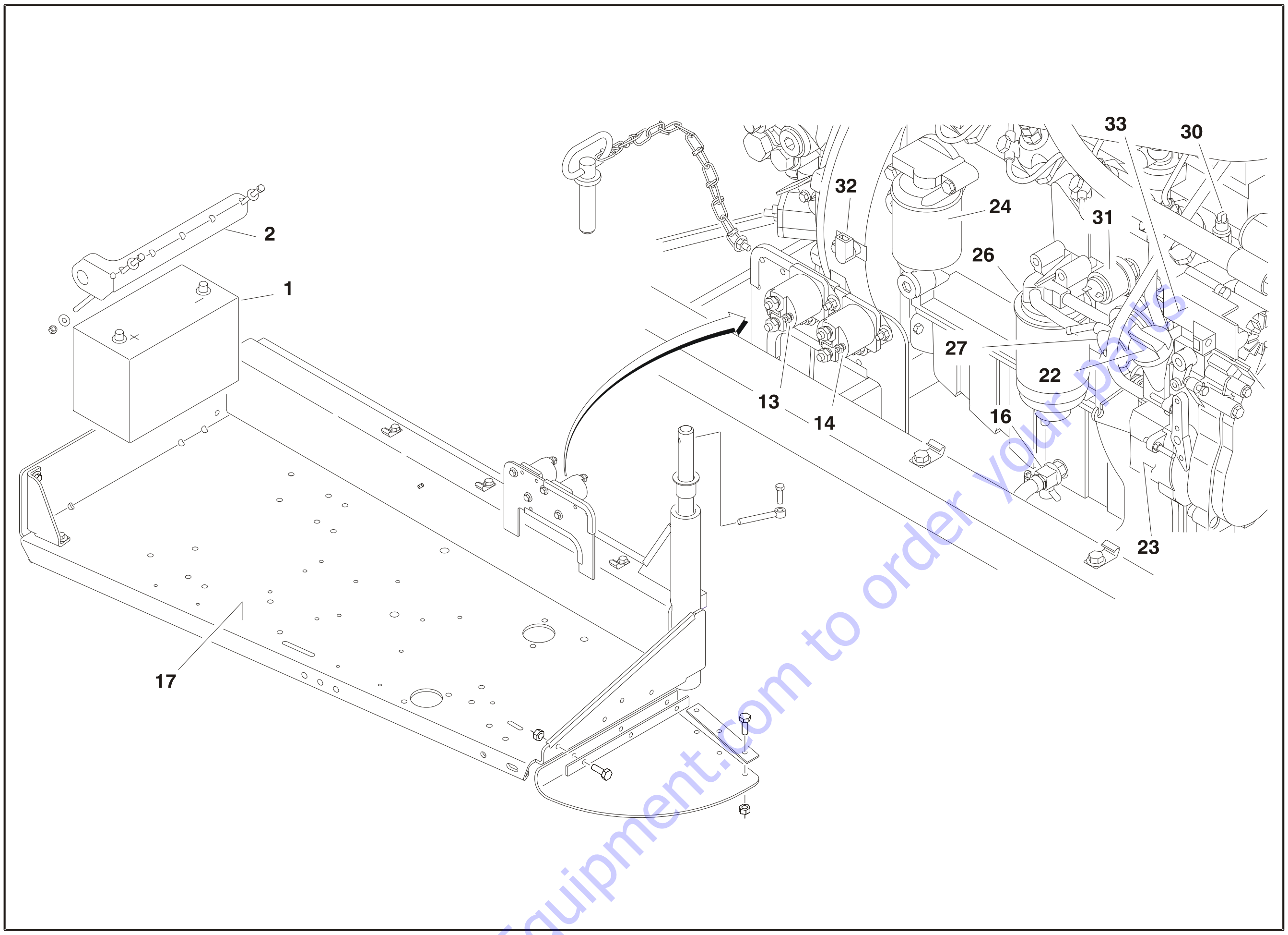
6.5 SPARK ARRESTER CLEANING INSTRUCTIONS

1. Remove the cleanout plug in the bottom of spark arrester (muffler).
2. Without causing deformation (or any type of damage to the spark arrester) repeatedly tap on the arrester near the cleanout plug. This may be enough to begin drainage of the spark trap.
3. An industrial vacuum cleaner can do a complete job at this point.
   a. Or, IN A SAFE AREA, start the engine. Then alternate between low idle and high idle for two to three minutes.
   b. Or, operate the engine as required by the application for two to three minutes.
4. Install the cleanout plug. (See Table 2-4. Preventive Maintenance and Inspection Schedule.)



1. Battery
2. Battery Holddown
3. Gear Pump
4. Piston Pump
5. Air Cleaner
6. Fan
7. Motor Mount
8. Muffler
9. Front Right Engine Mounting Plate
10. Front Bottom Engine Mounting Plate
11. Rear Engine Mounting Plate
12. Radiator
13. Starter Relay
14. Aux Pump Relay
15. Restriction Indicator
16. Oil Drain Valve

Figure 6-7. Deutz Engine Installation - Sheet 1 of 2



17. Engine Tray
18. Engine Mounting Plate
19. Hayes Coupling
20. Pump Adapter Plate
21. Dipstick
22. Filler Cap
23. Oil Lube Pump
24. Oil Filter
25. Injector Pump
26. Fuel Filter
27. Fuel Supply Pump
28. Alternator
28. Starter
29. Temperature Sender
30. Oil Pressure Sensor
31. Speed Sensor
32. Throttle Actuator

Figure 6-8. Deutz Engine Installation - Sheet 2 of 2

6.6 DEUTZ EMR 2 (S/N 85110 TO PRESENT)

The EMR2 consists of the sensors, the control unit and the actuator. Engine-side controls as well as the JLG Control System are connected by means of separate cable harnesses to the EMR control unit.

The sensors attached to the engine provide the electronics in the control unit with all the relevant physical parameters In accordance with the information of the current condition of the engine and the preconditions (throttle position etc.), the EMR2 controls an actuator that operates the control rod of the injection pump and thus doses the fuel quantity in accordance with the performance requirements.

The exact position of the regulating rod is reported back and, if necessary, is corrected, by means of the control rod travel sensor, situated together with the rotation magnets in a housing of the actuator.

The EMR2 is equipped with safety devices and measures in the hardware and software in order to ensure emergency running (Limp home) functions.

In order to switch the engine off, the EMR2 is switched in a de-energized fashion over the ignition switch. A strong spring in the actuator presses the control rod in the de-energized condition into the zero position. As a redundancy measure, an additional solenoid serves for switching off and this, independently of the actuator, also moves the control rod in the de-energized condition into the zero position.

After the programming, that is carried out over the ISO9141 interface, the EMR2 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.

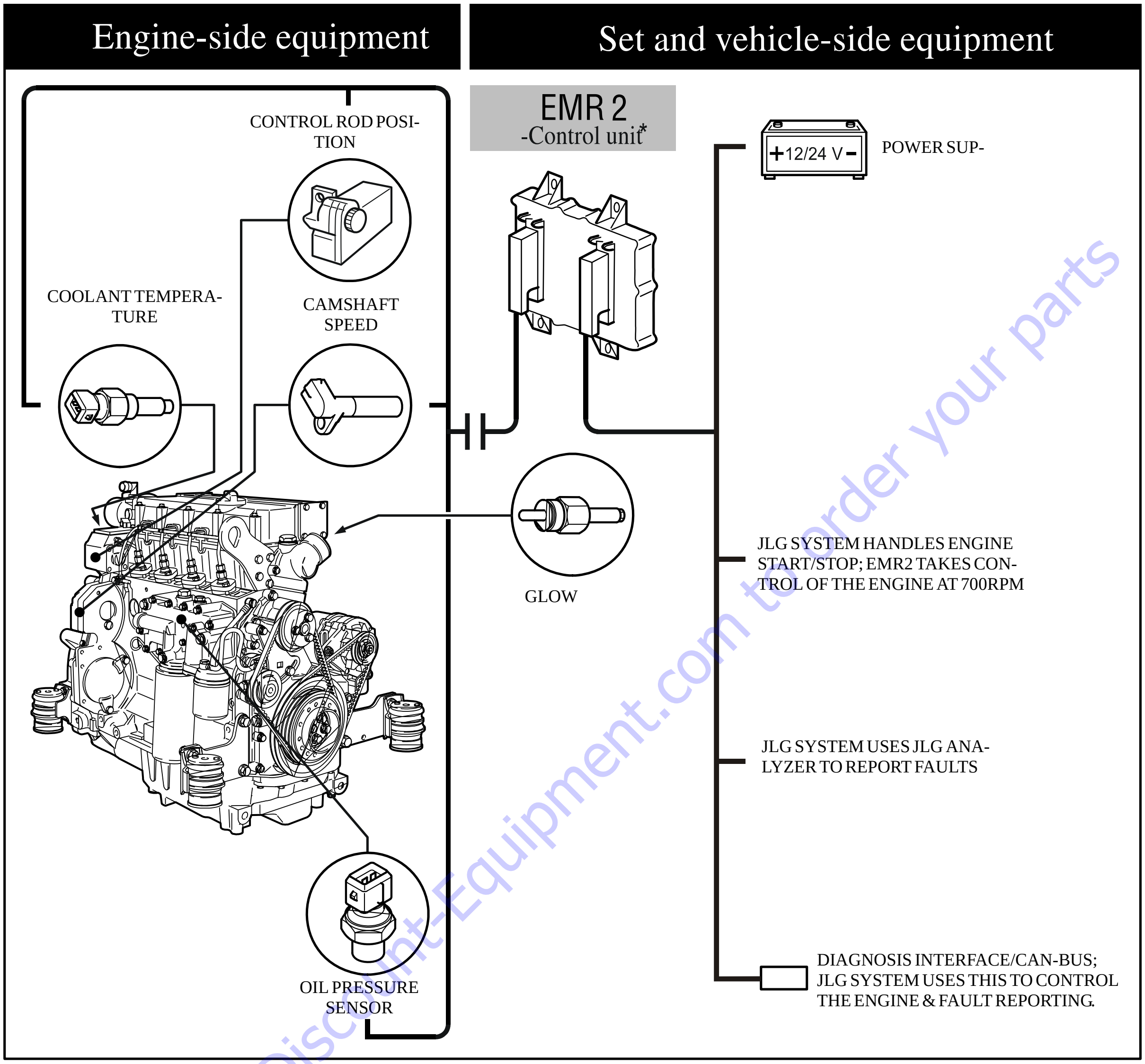


Figure 6-9. EMR 2 Engine Side Equipment

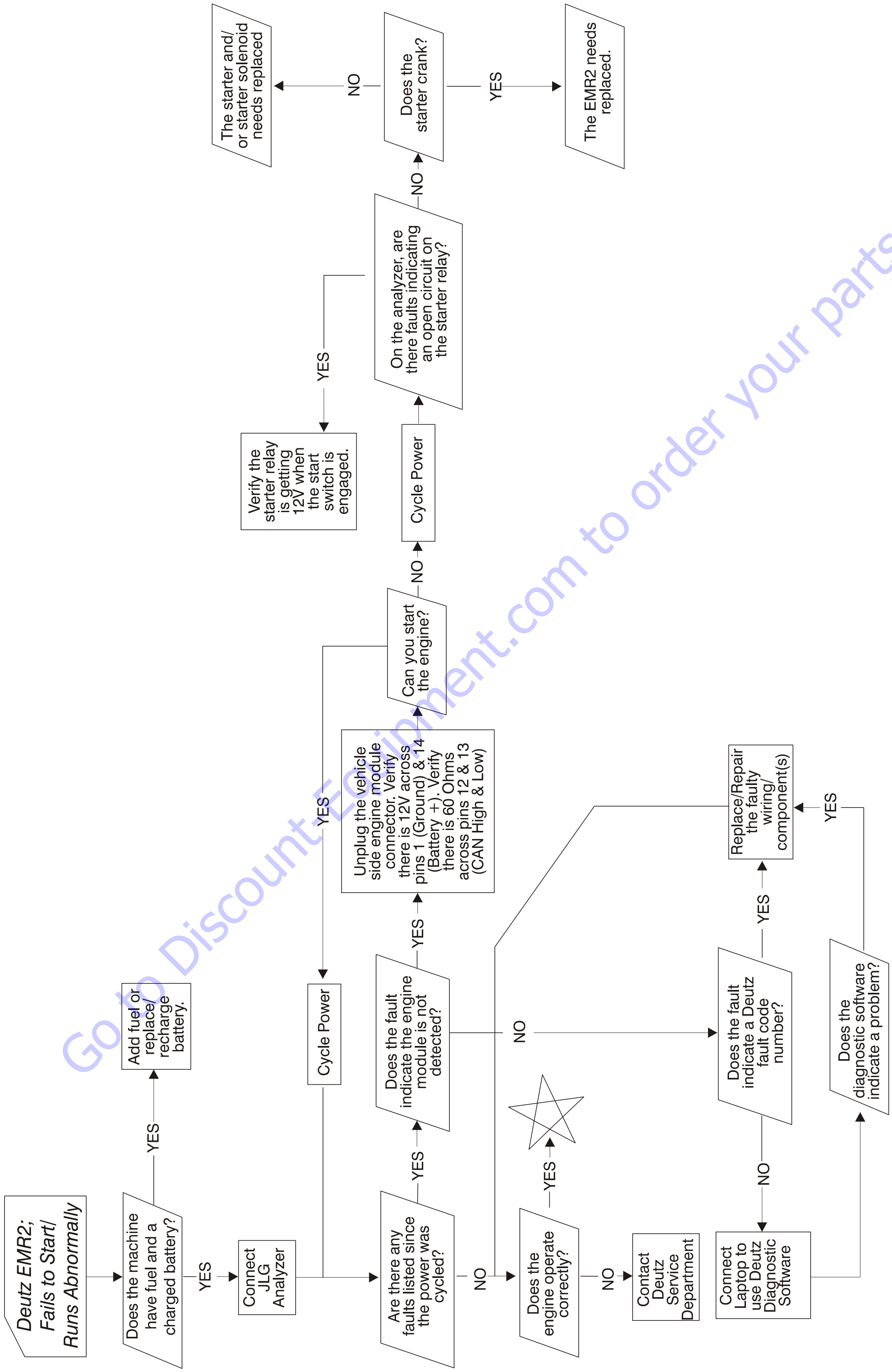


Figure 6-10. Deutz EMR 2 Troubleshooting Flow Chart

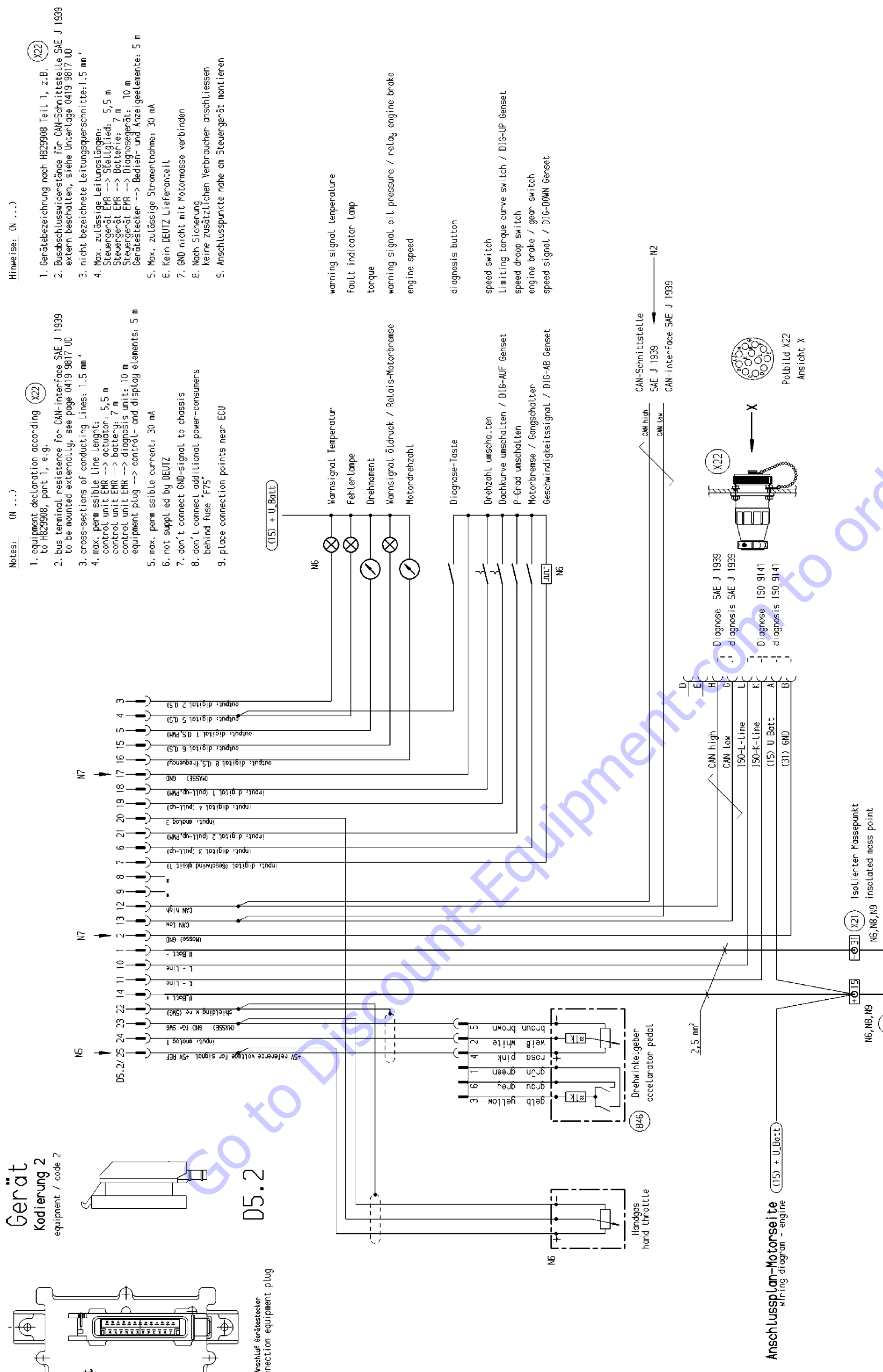


Figure 6-11. Deutz EMR 2 Vehicle Side Connection Diagram

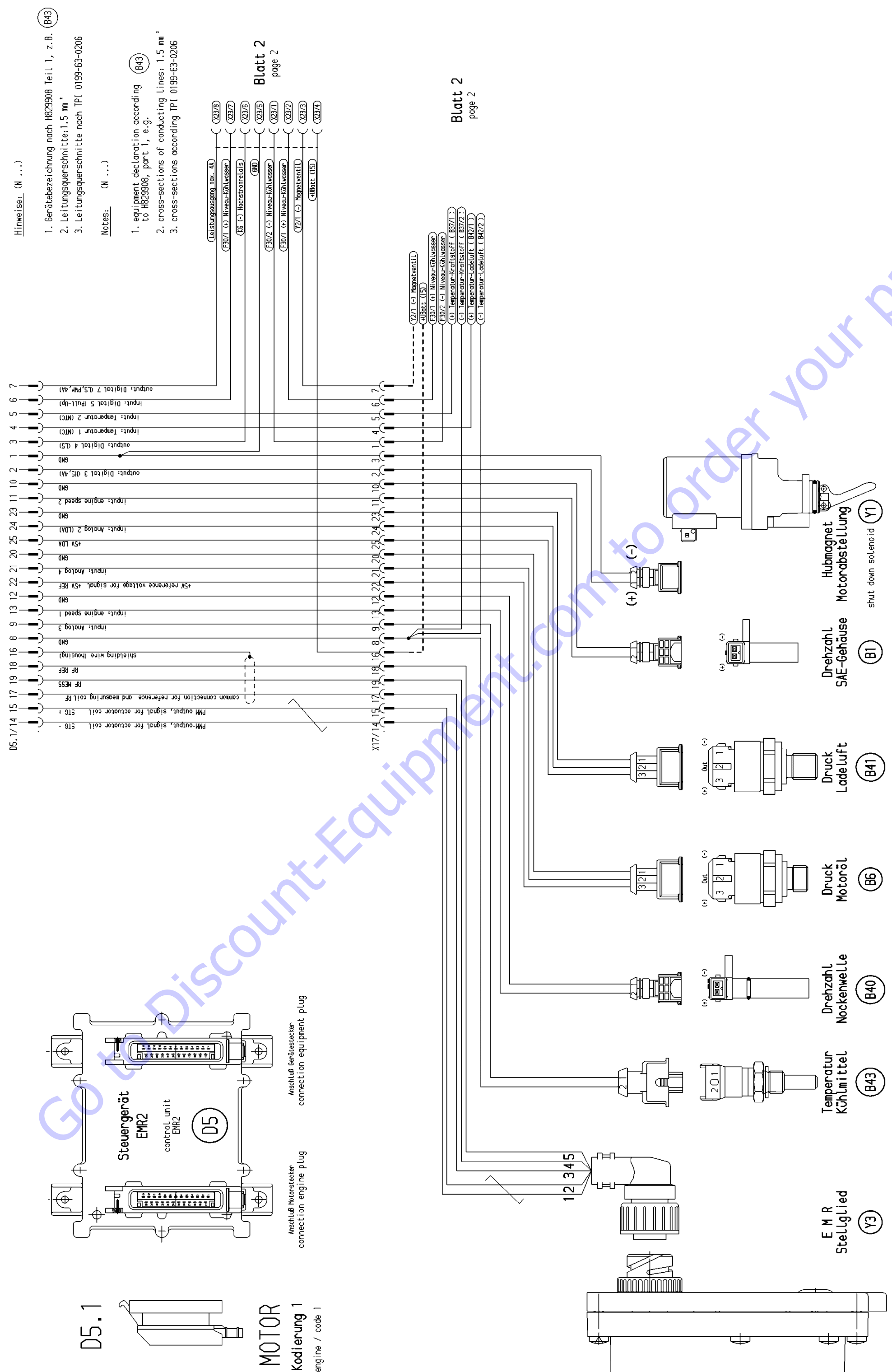


Figure 6-12. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

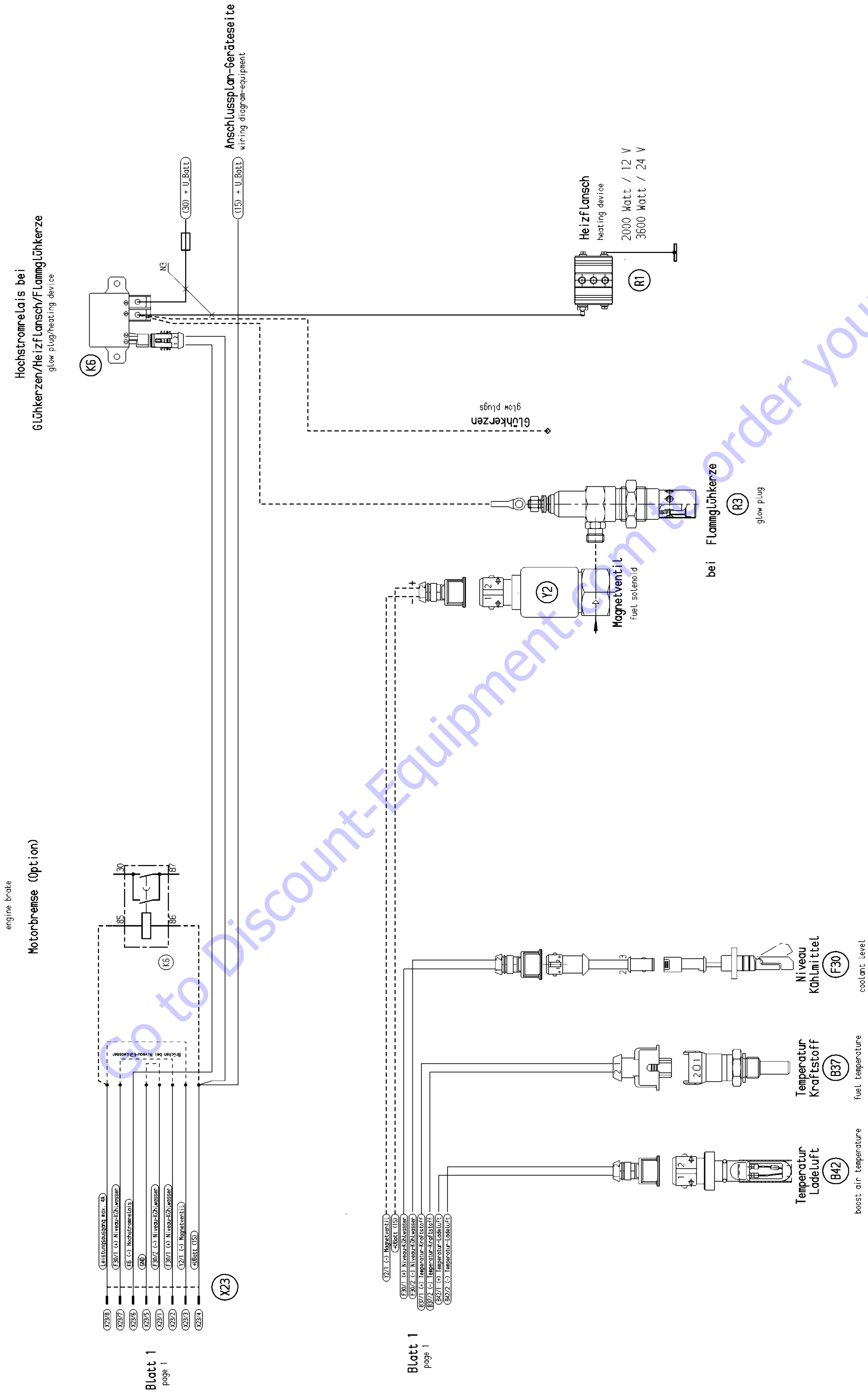
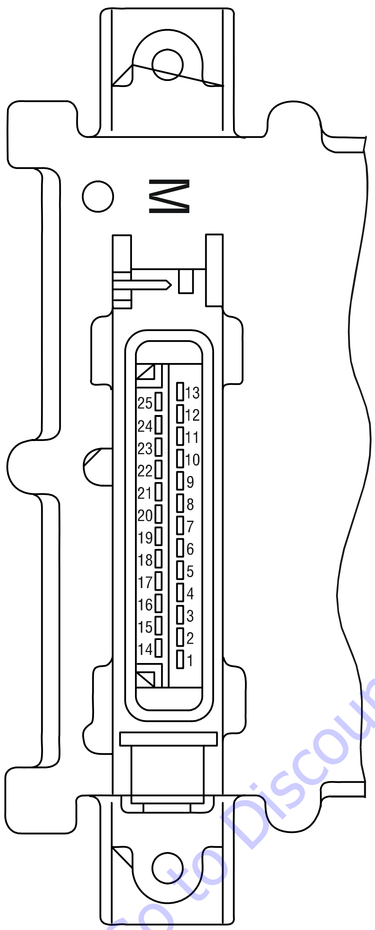


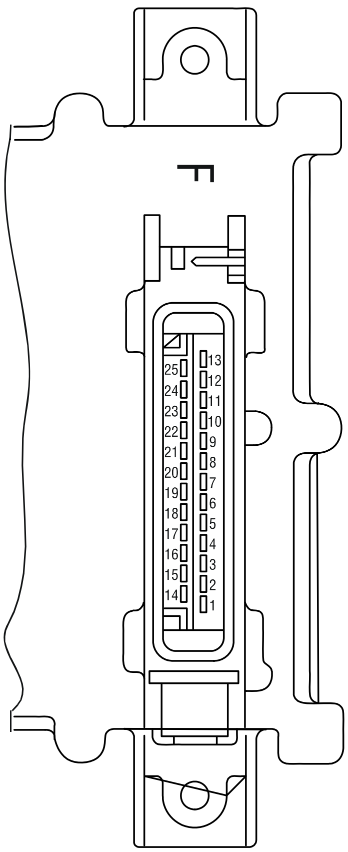
Figure 6-13. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2



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 6-14. 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 6-15. EMR 2 Vehicle Plug Pin Identification

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Zero error display	-	No faults	524287	31	No **active** faults present		
Revolutions / speed acquisition	01	Speed sensor 1	190	8	Sensor failure. Distance from gear too far. Additional fault impulses. Cable joint interrupted.	Governor in emergency operation (if sensor 2 available). Emergency switch-off (if sensor 2 not available or failed). Governor in emergency operation (with sensor 1) Emergency switch-off (if sensor 1 not available or failed).	Check distance. Check cable connection. Check sensor and replace if required.
	03	Speed sensor	84	8	Tacho failed. Additional fault impulses. Cable connection interrupted.	Governor in emergency operation.	Check cable connection and Tacho. Replace if required.
	04	Excess speed switch-off	190	0	Speed was/is in excess of limit.e. Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator (impulse on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.	Engine stop.	Check parameter (21). Check speed settings.
Sensors	07	Charge air pressure	102	2	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 6-16. 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 6-17. 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 6-18. 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.

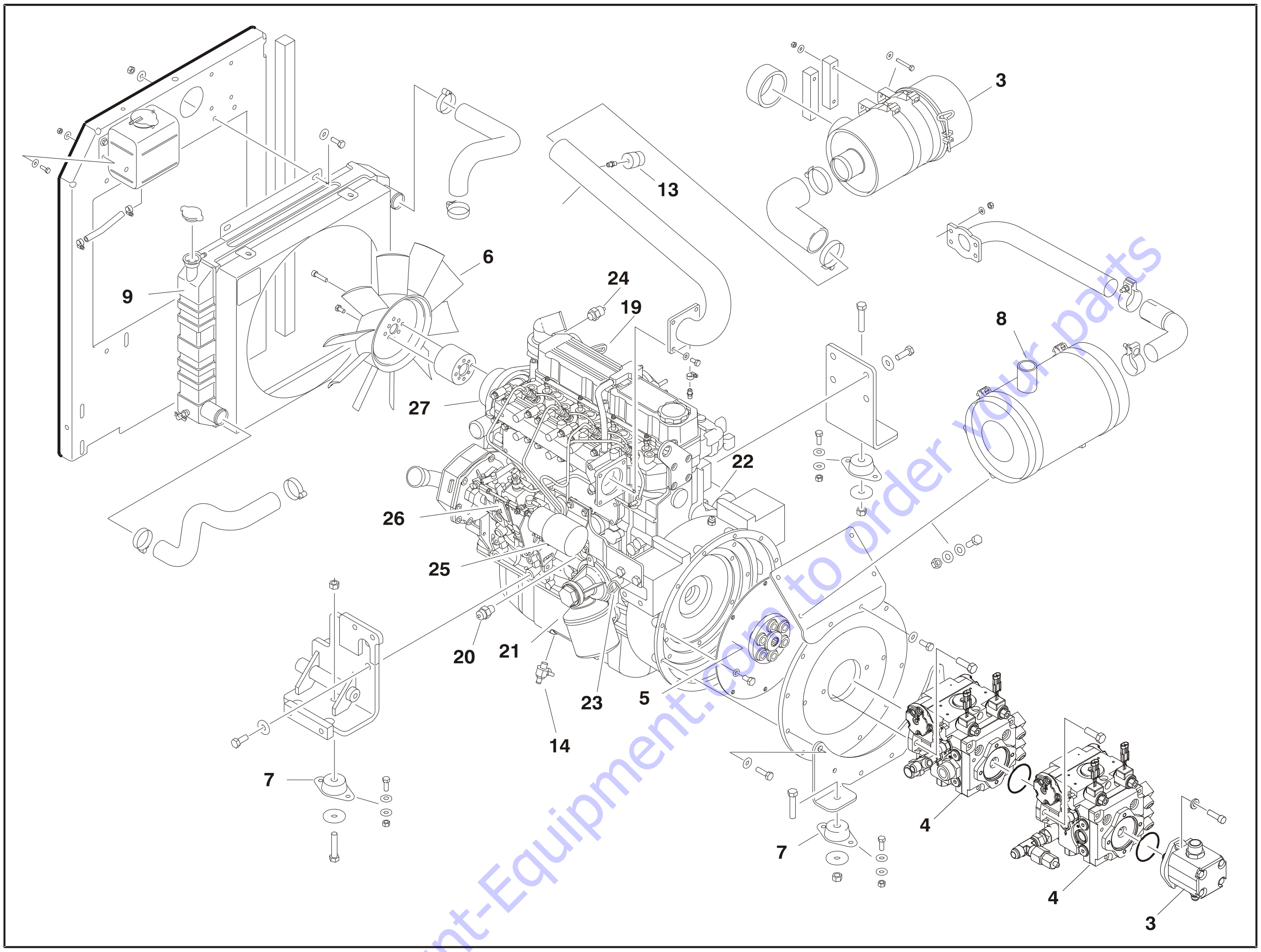
NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 6-19. 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			

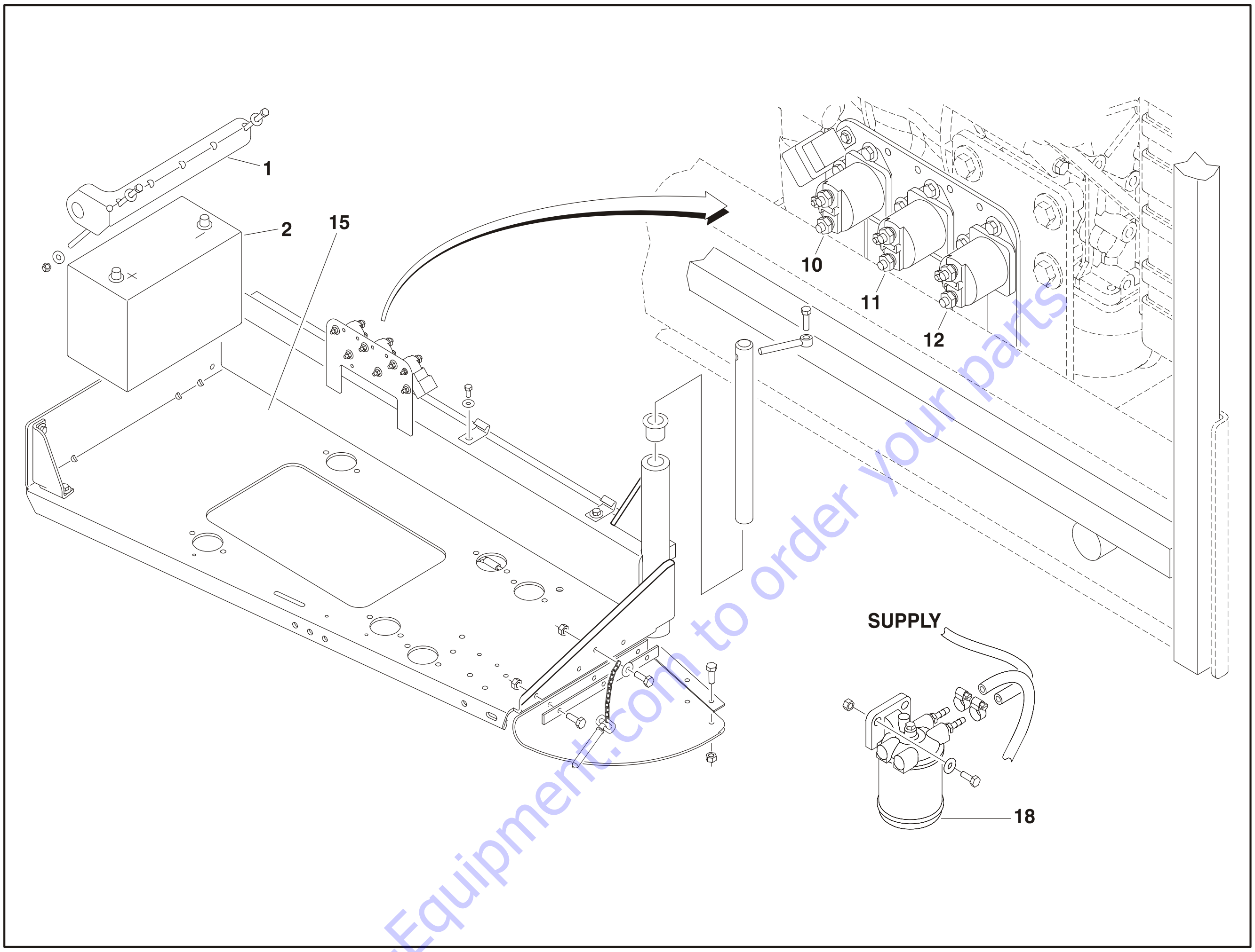
NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 6-20. EMR2 Fault Codes - Sheet 5 of 5



1. Battery Hold-down
2. Battery
3. Air Cleaner
4. Coolant Overflow Container
5. Pump Coupling
6. Fan
7. Engine Mount
8. Muffler
9. Radiator
10. Starter Relay
11. Glow Plug Relay
12. Aux Power Relay
13. Restriction Indicator
14. Oil Drain Valve

Figure 6-21. Caterpillar Engine Installation - Sheet 1 of 2



15. Engine Tray
16. Piston Pump
17. Gear Pump
18. Fuel Filter
19. Alternator
20. Oil Pressure Switch
21. Oil Filter
22. Starter
23. Dipstick
24. Engine Temperature Sender
25. Throttle Actuator
26. Fuel Supply Pump
27. Water Pump

Figure 6-22. Caterpillar Engine Installation - Sheet 2 of 2

6.7 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 6-23.) then:

2nd Page of Diagnostic Information for a Given Fault (See Figure 6-24.)

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

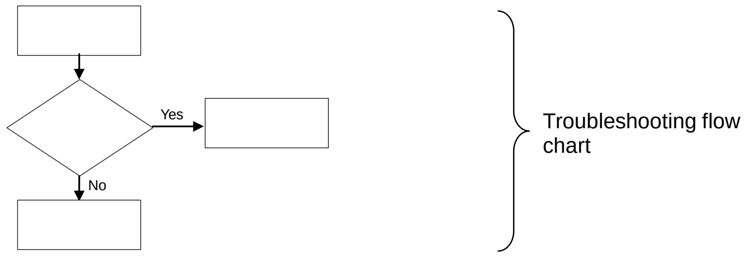
Text to identify the circuit of interest and its use for control.

Text to describe the conditions that cause the fault to set.

Figure 6-23. 1st page of Diagnostic Information for a Given Fault

DTC XXXX- Diagnostic Condition

Note: Helpful tips used to aid troubleshooting



Diagnostic Aids

- Tip #1
- Tip #2 …

Figure 6-24. 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 6-1.

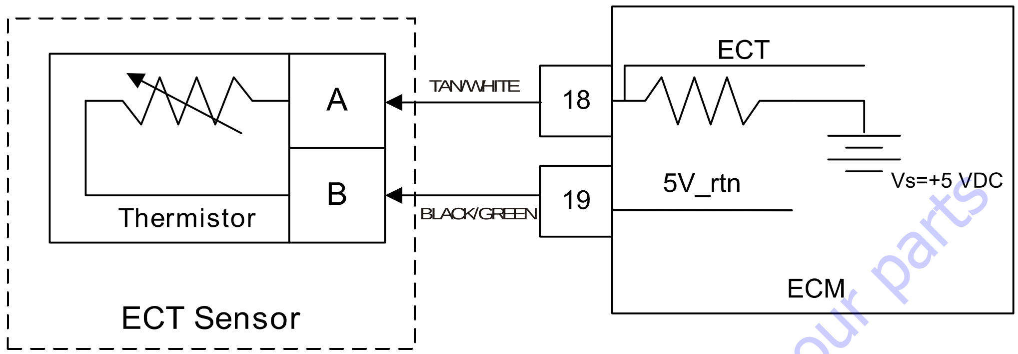
Table 6-1. J1939 Diagnostic Lamp Configuration

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."

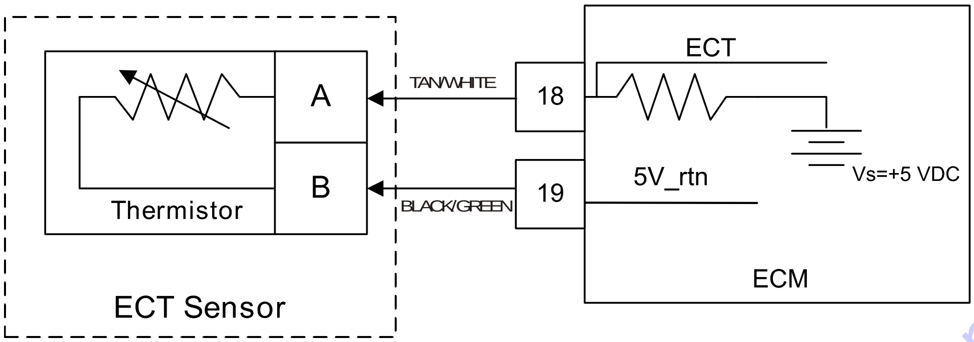
If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:

- 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

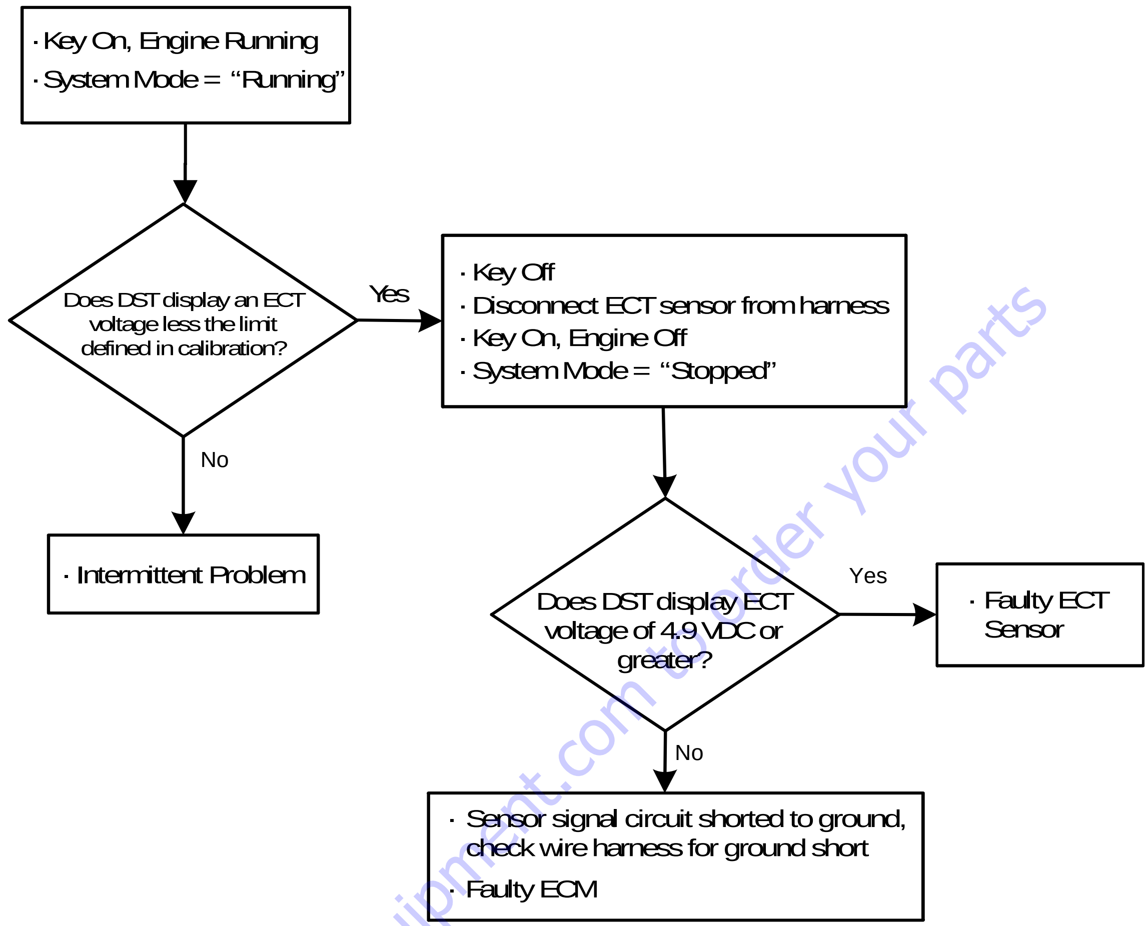
DTC 117- ECT/CHT Low Voltage



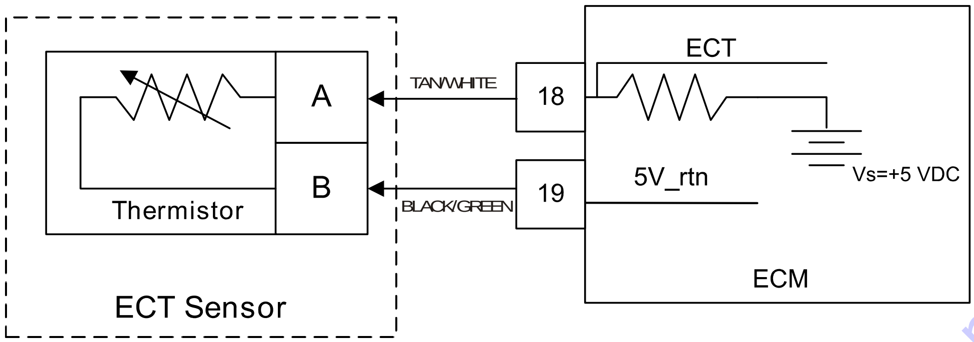
- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-CHT/ECT sensor voltage less than the limit defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during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

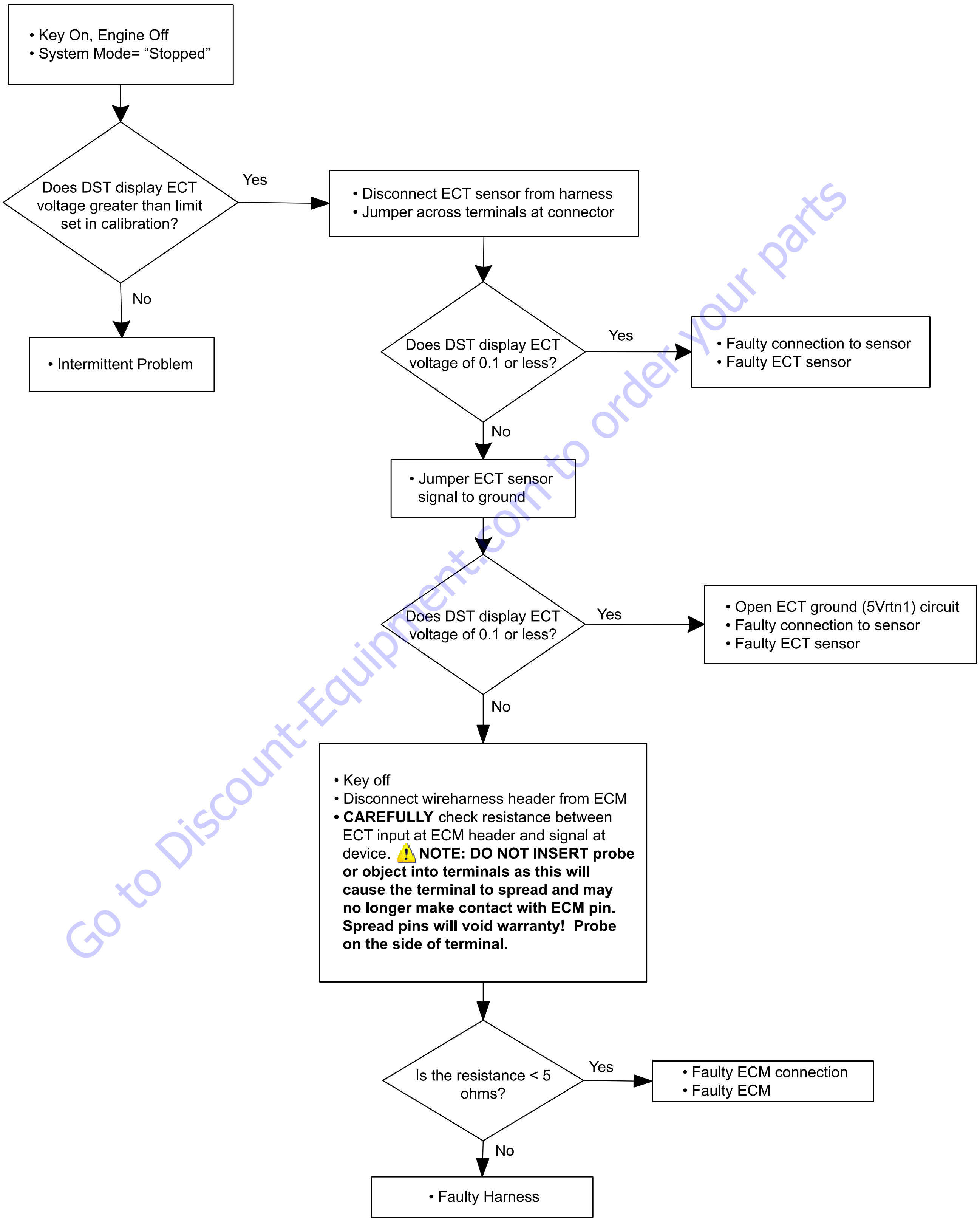
DTC 118- ECT/CHT High Voltage



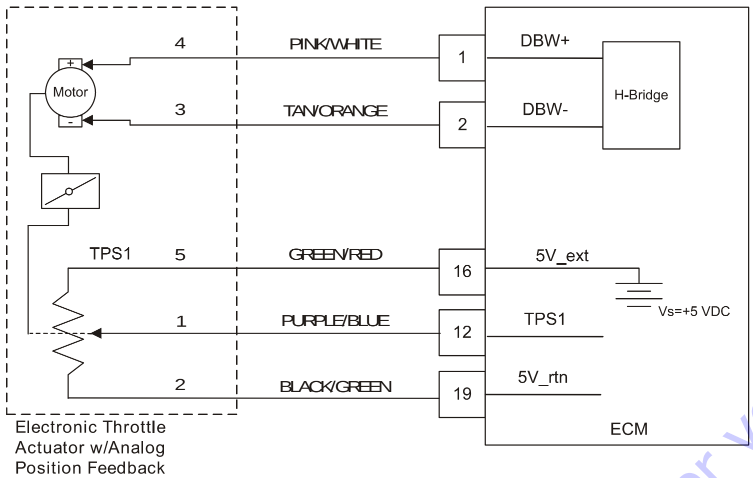
- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-CHT/ECT sensor voltage higher than the limit defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during 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
No
• Intermittent Problem
• Disconnect ECT sensor from harness
• Jumper across terminals at connector
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.

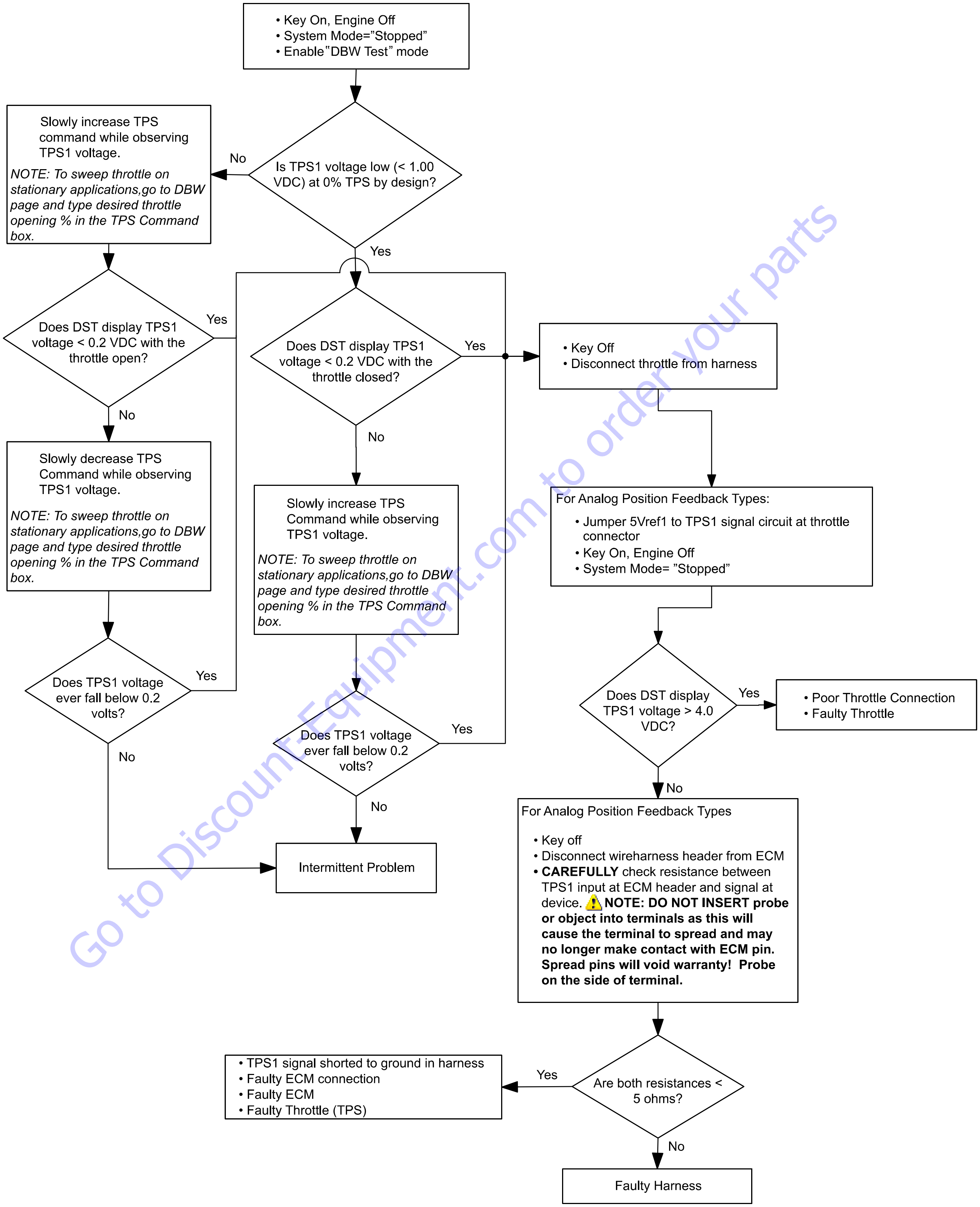
There are two types of throttle actuators;

1) actuator with analog position feedback and

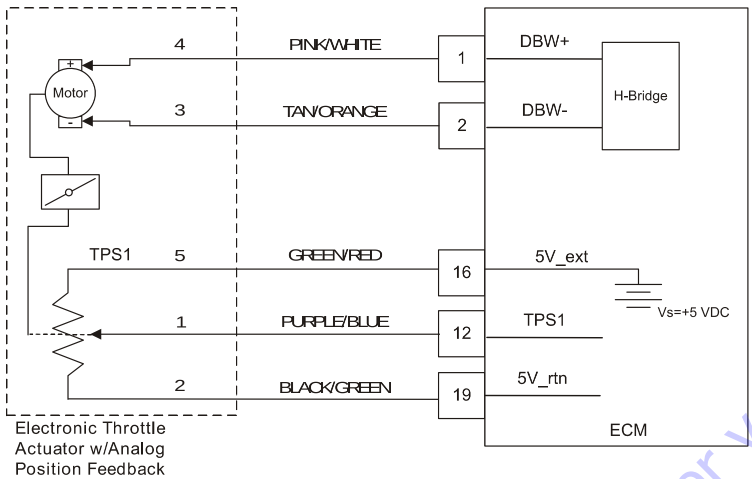
2) actuator with digital position feedback

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
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.
Yes
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.

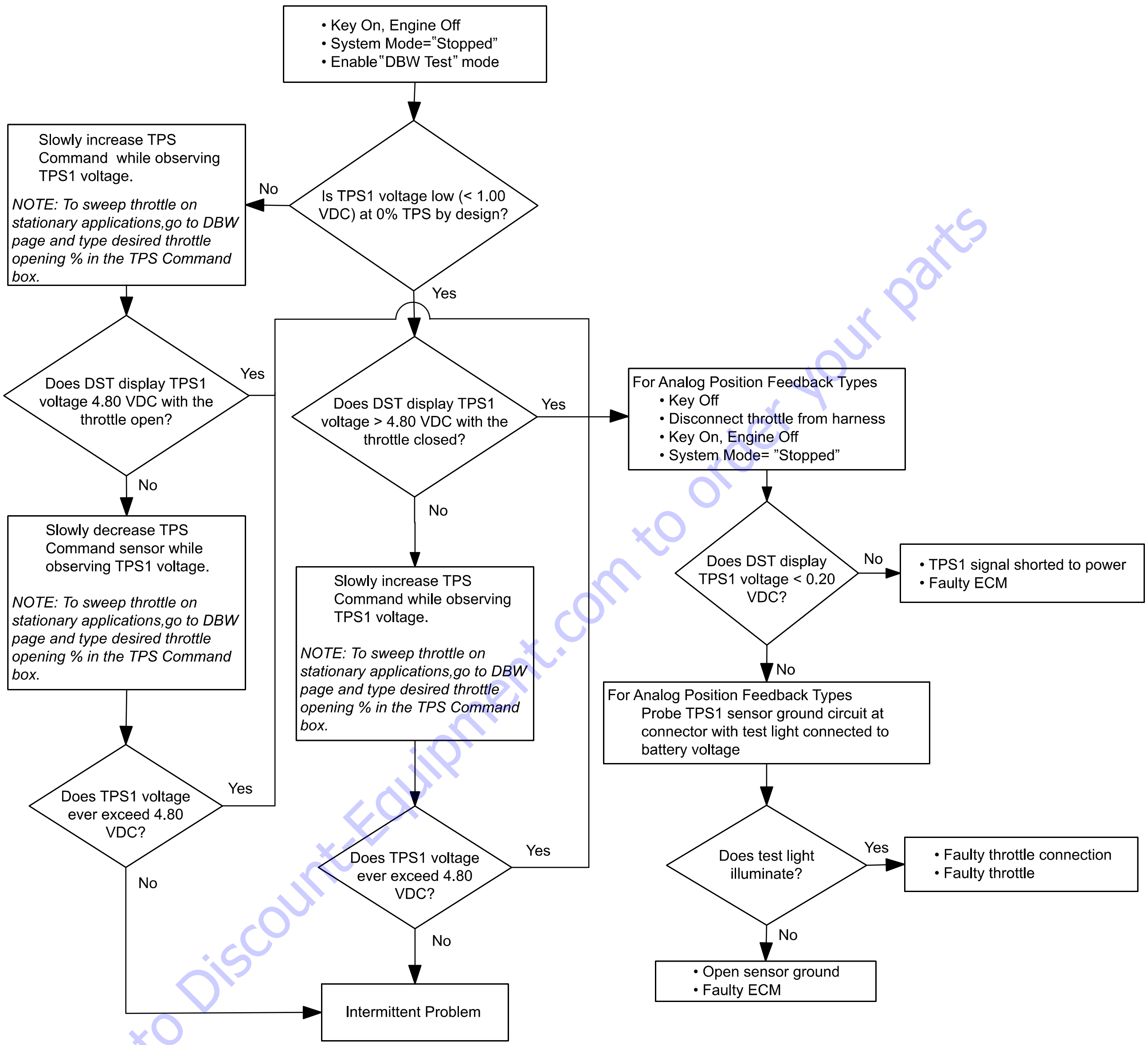
The Throttle Position Sensor uses either;

1) a variable resistor and voltage divider circuit or

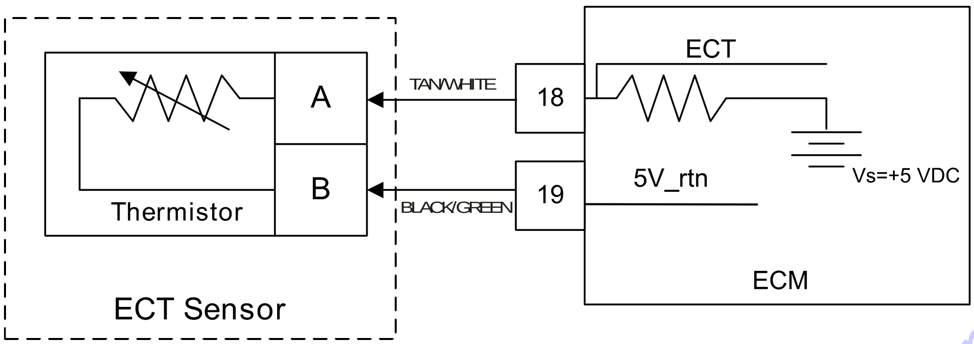
2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

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."

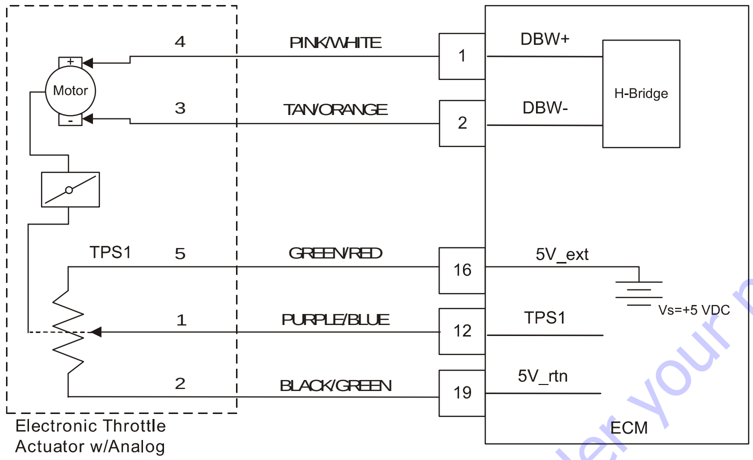
If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:

- 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.

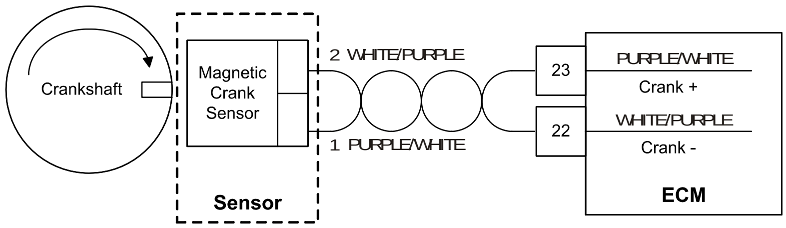
DTC 219- RPM Higher Than Max Allowed Governed Speed (continued)

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

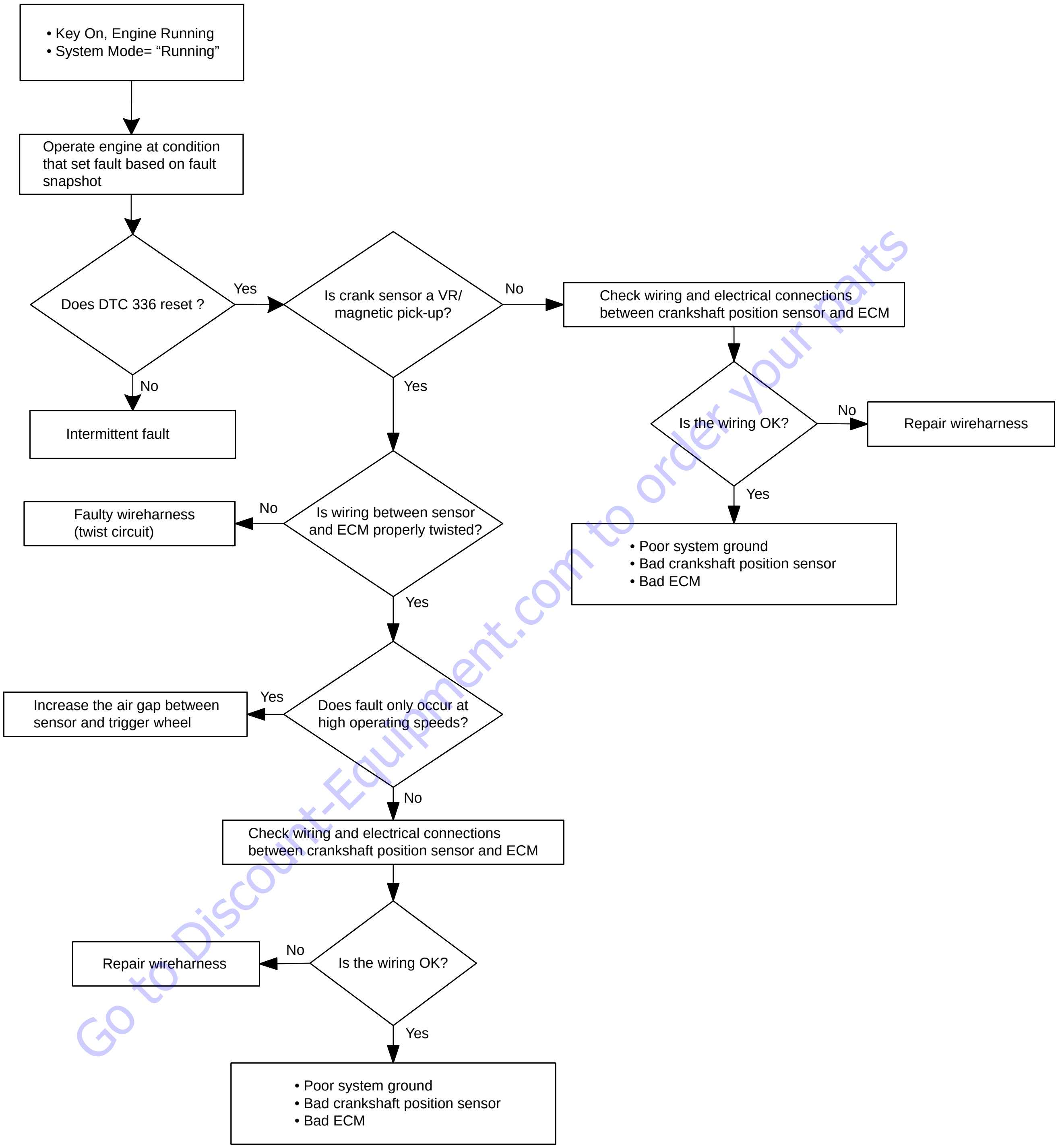


- Crankshaft Position sensor
- Check Condition- Key On, Engine On
- Fault Condition- Electrical noise or irregular crank pattern detected causing x number of crank resynchronization events as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or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

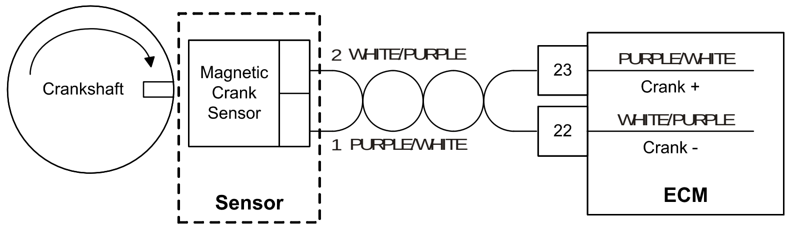
The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or halleffect) installed in the engine block adjacent to a "coded" trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder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

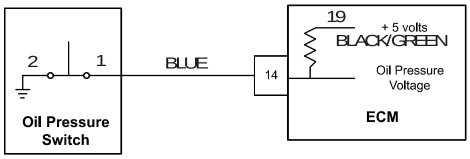
The ECM must see a valid crankshaft position signal while running. If no signal is present while x cam pulses continue the fault will set. The engine typically stalls or dies as a result of this fault condition due to the lack of crankshaft speed input resulting in the inability to control ignition timing.

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

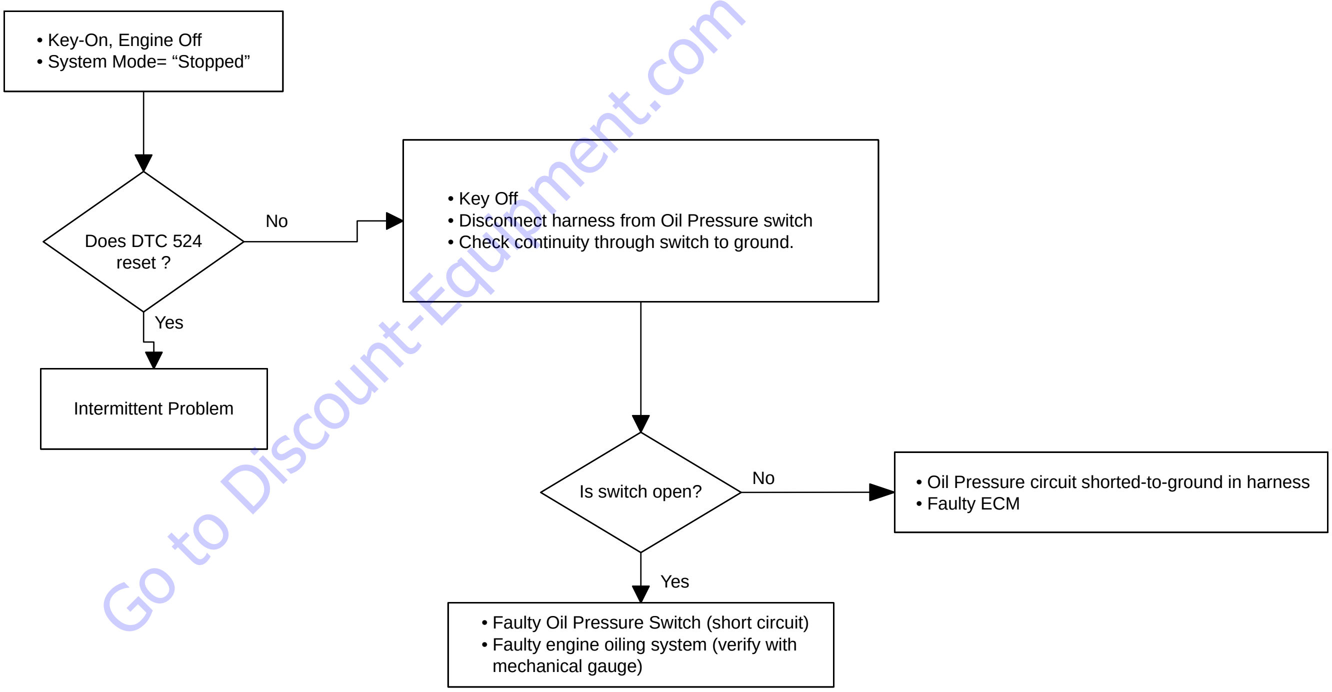
- Engine Oil Pressure
- Check Condition- Key on, Engine on (or Engine off)
- Fault Condition- For sender types, oil pressure higher than x psia while engine speed is greater that y RPM. For switch types, oil pressure is indicating high when the engine has been stopped for more than n seconds.
- Corrective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

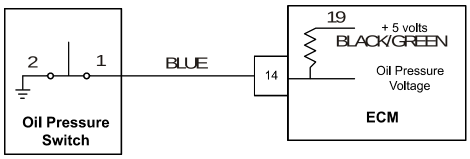
Additionally for normally-open type oil pressure switches, a high pressure indication while the engine is off is a symptom of a failed oil pressure switch. The ECM can monitor oil pressure indication when the engine is stopped for this failure mode.

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



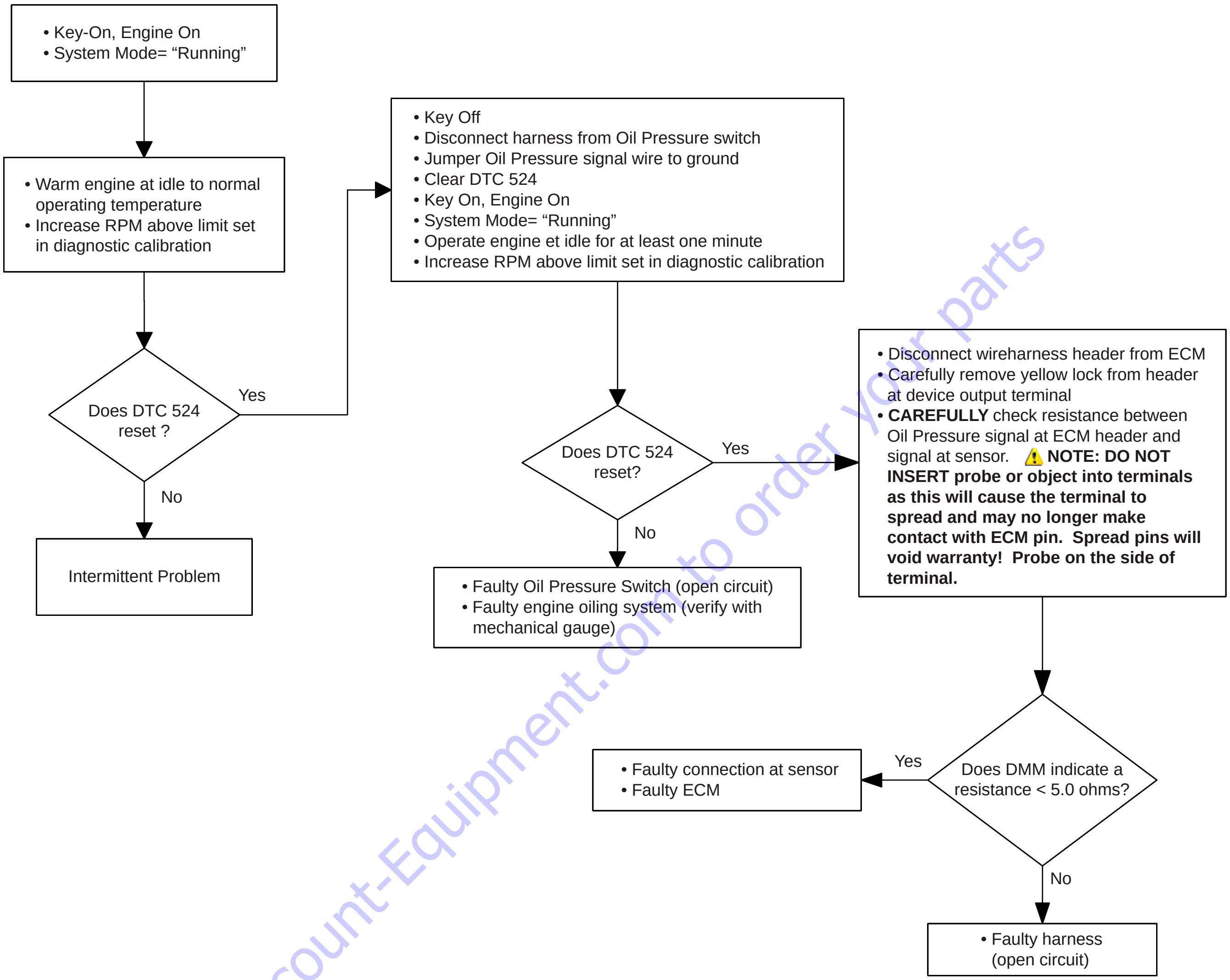
Normally-Closed
Switch-Type

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

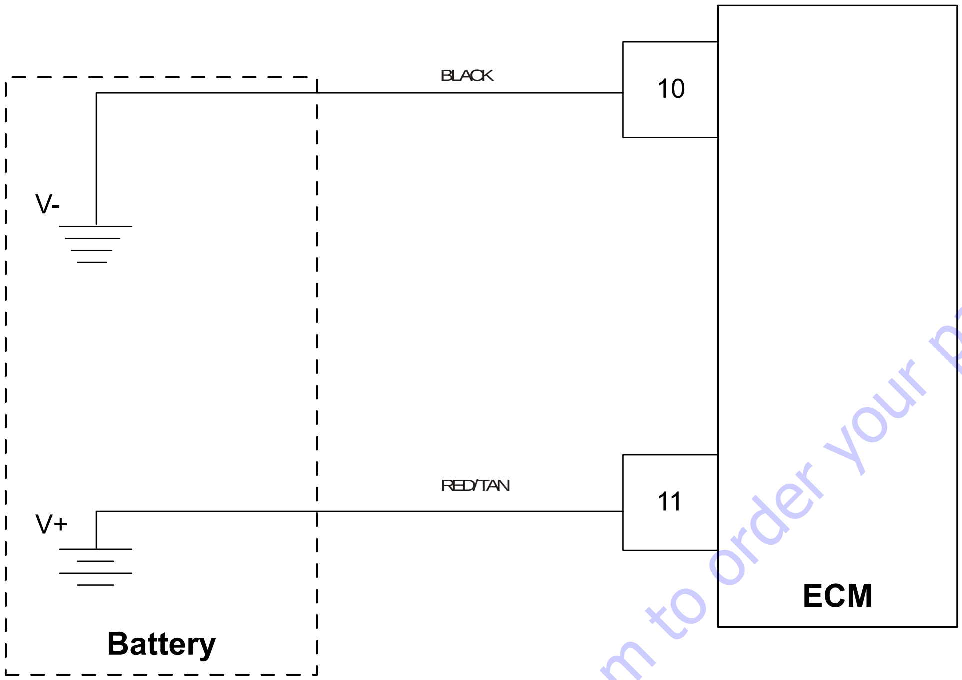
The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

For systems that use a transducer, this fault sets if the engine oil pressure is less than 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



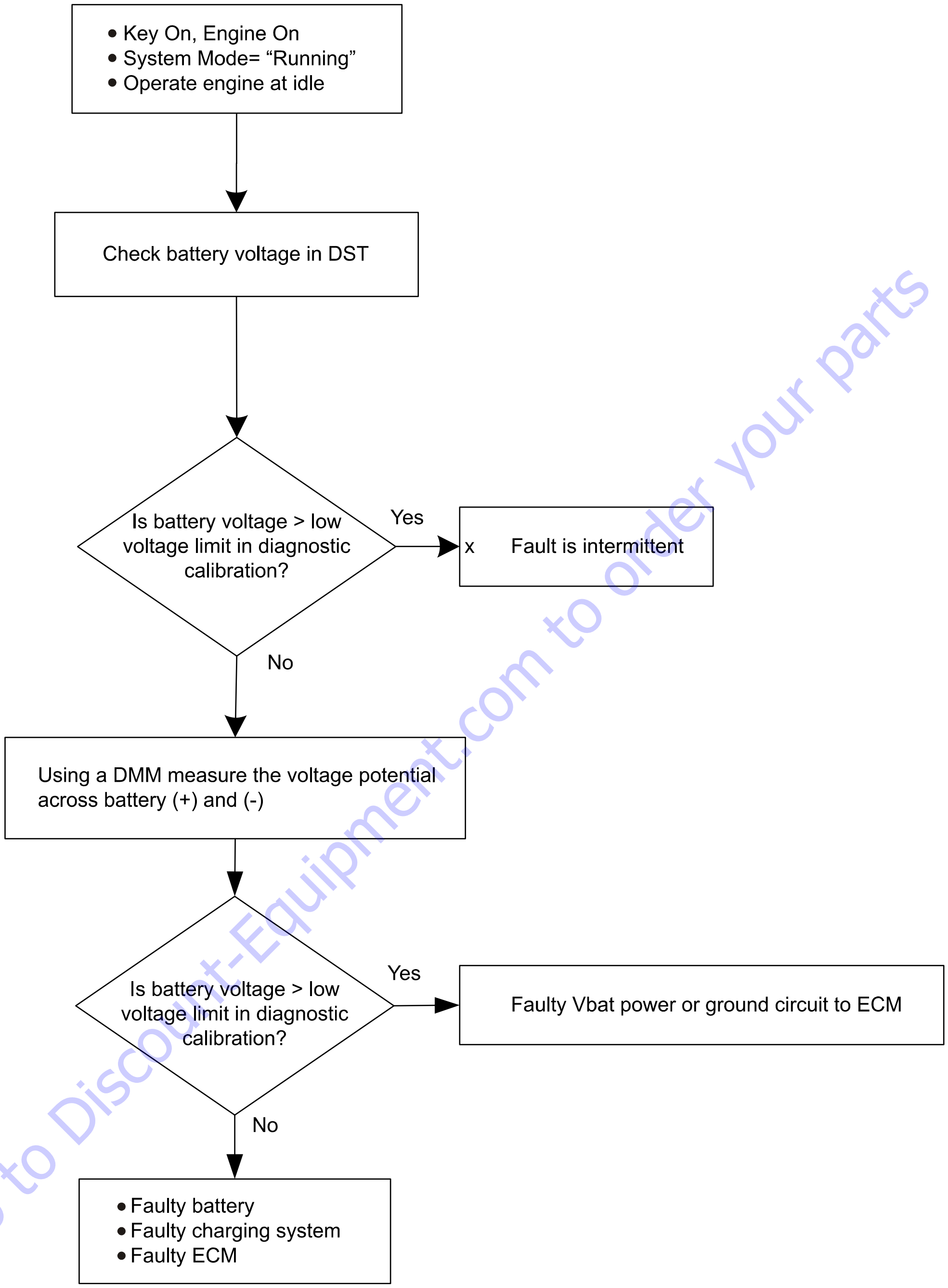
DTC 562- Battery Voltage (VBat) Low



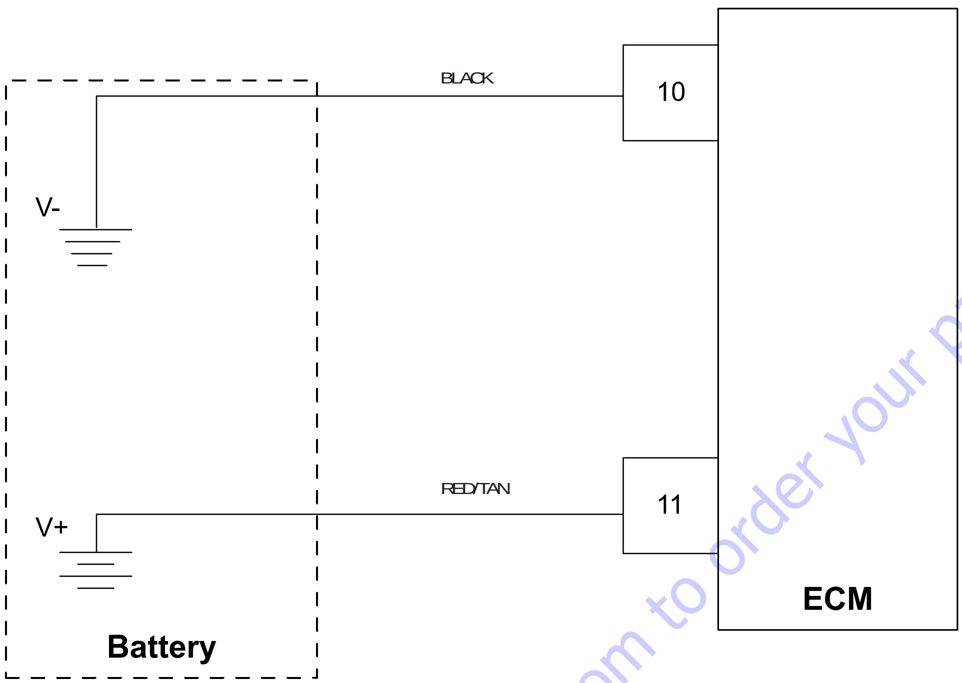
- System voltage to ECM
- Check Condition- Key on, Engine on
- Fault Condition- Battery voltage to ECM less than x volts while the engine is operating at y RPM or greater as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary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

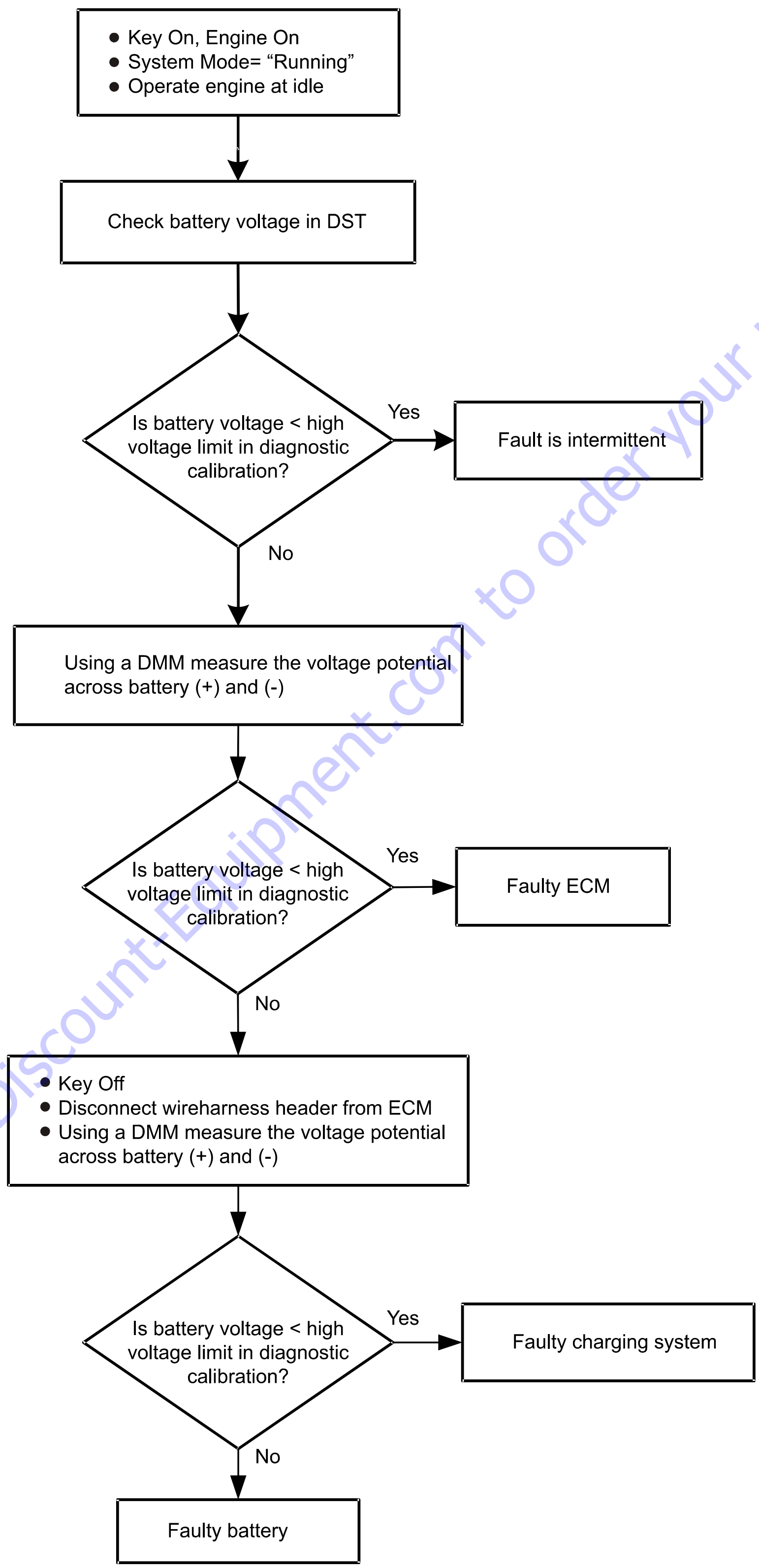
DTC 563- Battery Voltage (VBat) High



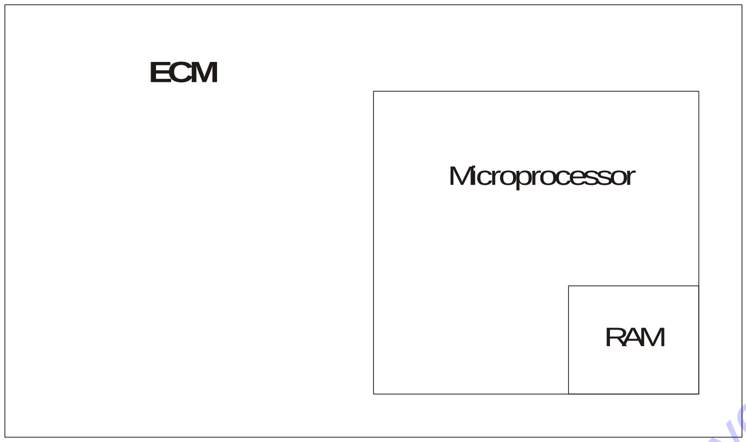
- System voltage to ECM
- Check Condition- Key on, Engine Cranking or Running
- Fault Condition- Battery voltage to ECM greater than x volts while the engine is running as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary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

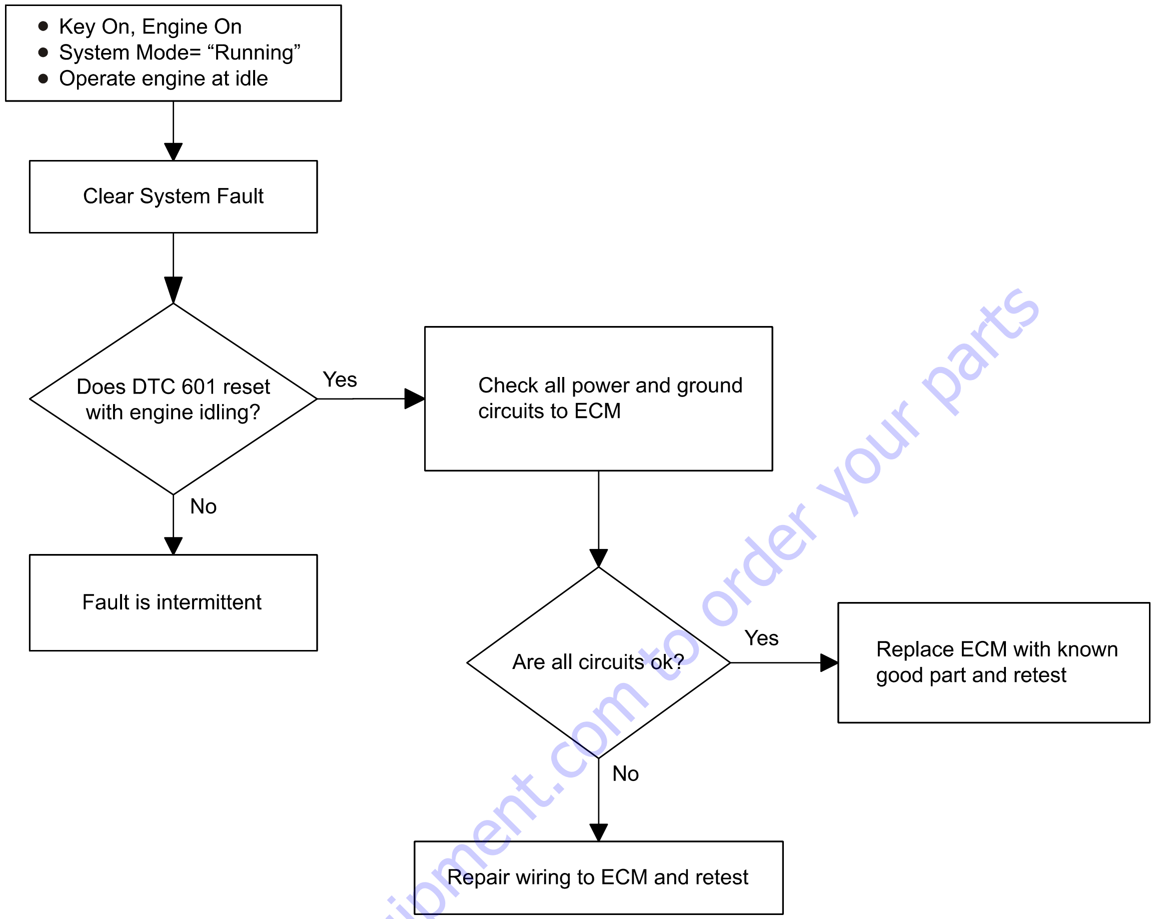
DTC 601- Microprocessor Failure - FLASH



- 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

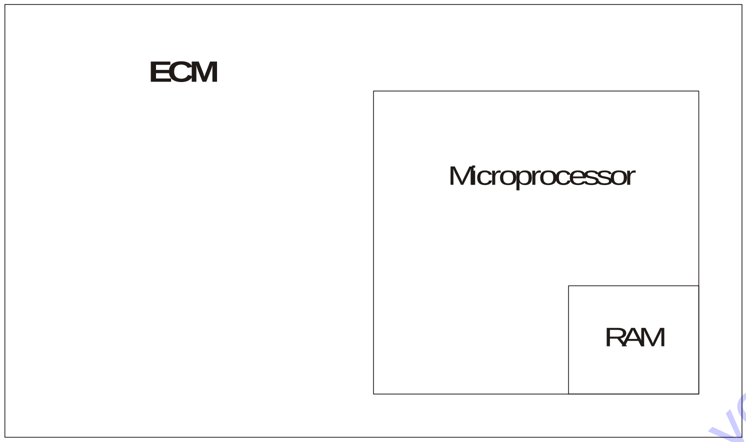
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

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

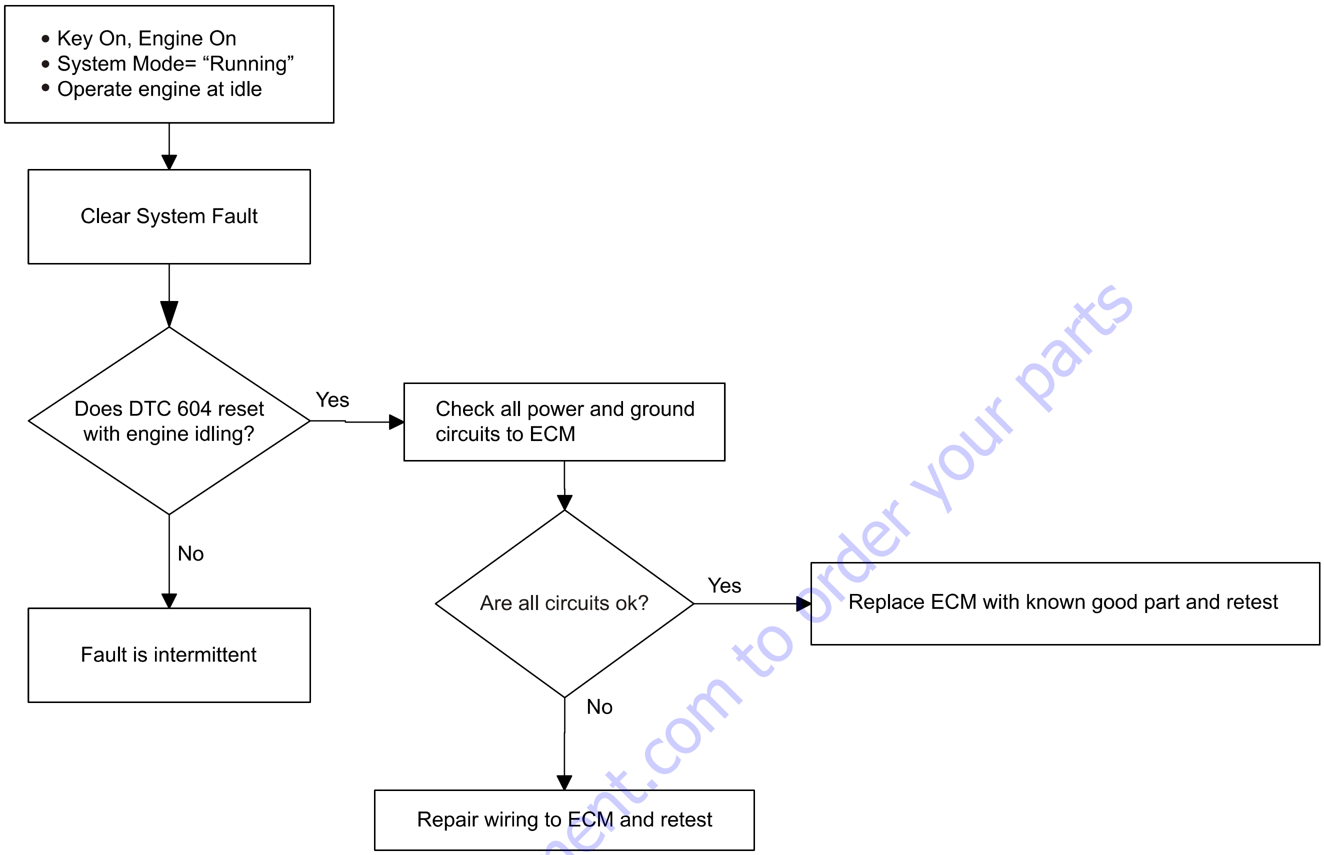
DTC 604- Microprocessor Failure - RAM



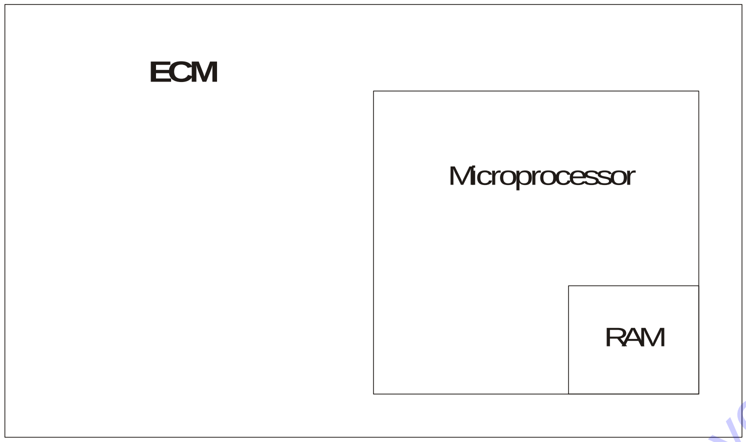
- Engine Control Module- Random Access Memory
- Check Condition- Key on
- Fault Condition- Internal ECM microprocessor memory access failure
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key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

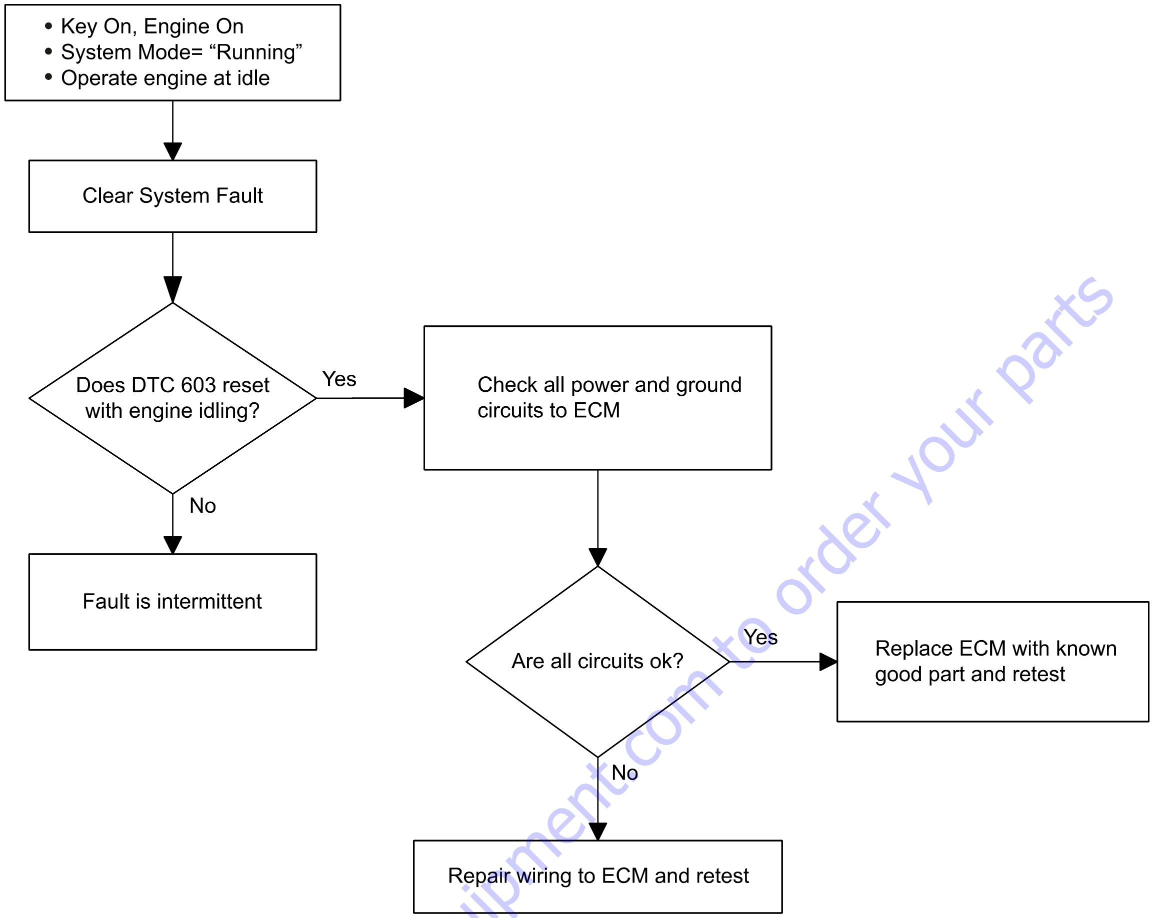
DTC 606- Microprocessor Failure - COP



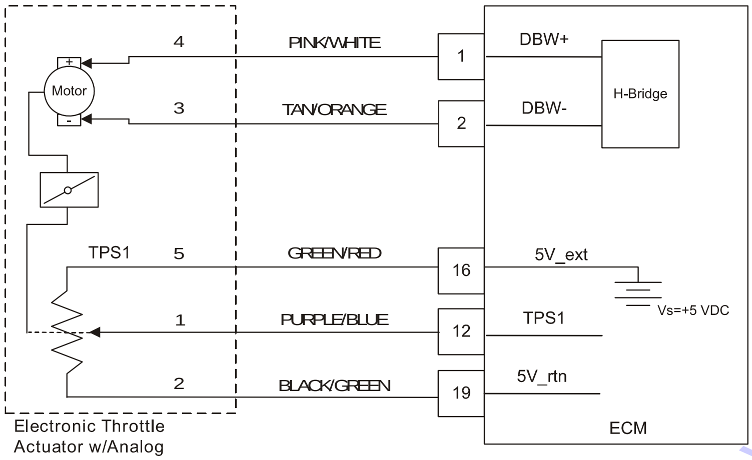
- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- Corrective Action(s) - Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle, recommend power derate 2 and low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

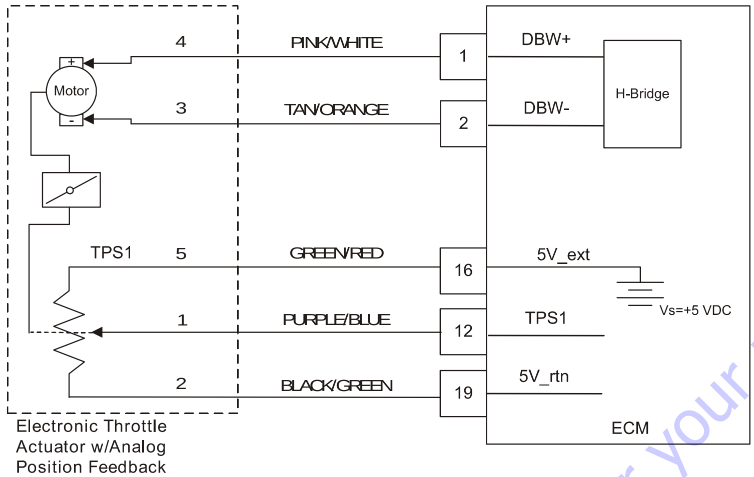
The ECM supplies 5-volt power to sensors, switches, and actuators external to the ECM. By supplying the power to these devices, the ECM can accurately measure their output relative to its own ground reference. The ECM can also control when the devices are active and put the devices in a low or no power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

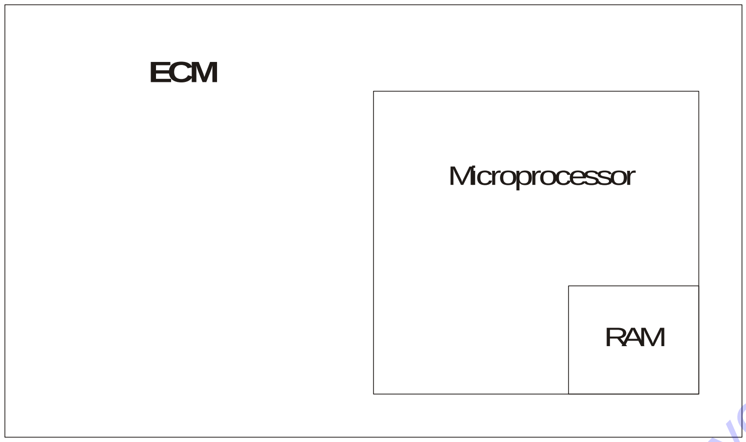
The ECM supplies 5-volt power to sensors, switches, and actuators external to the ECM. By supplying the power to these devices, the ECM can accurately measure their output relative to its own ground reference. The ECM can also control when the devices are active and put the devices in a low or no power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

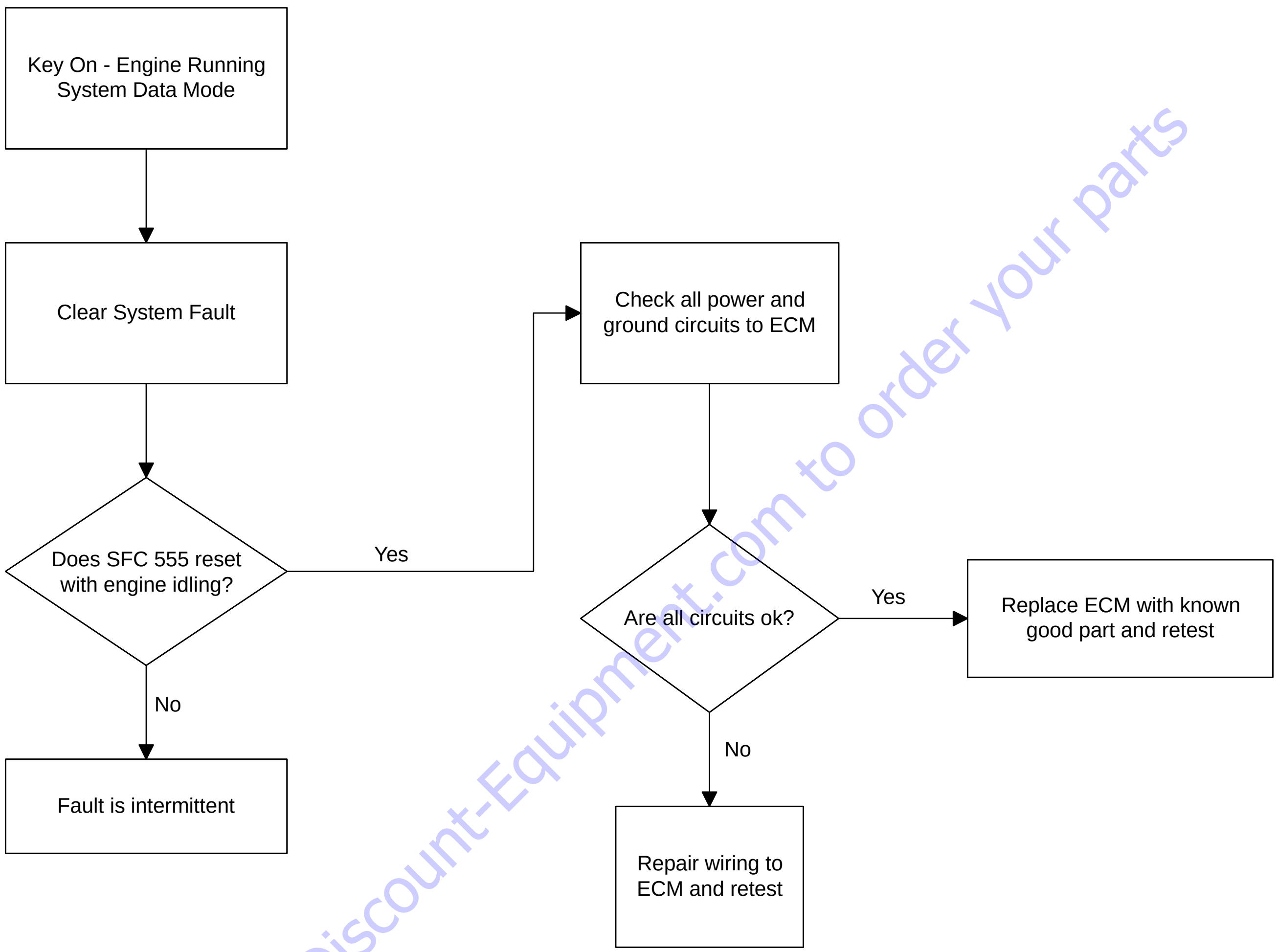
DTC 1613- Microprocessor Failure - RTI 2

- 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)

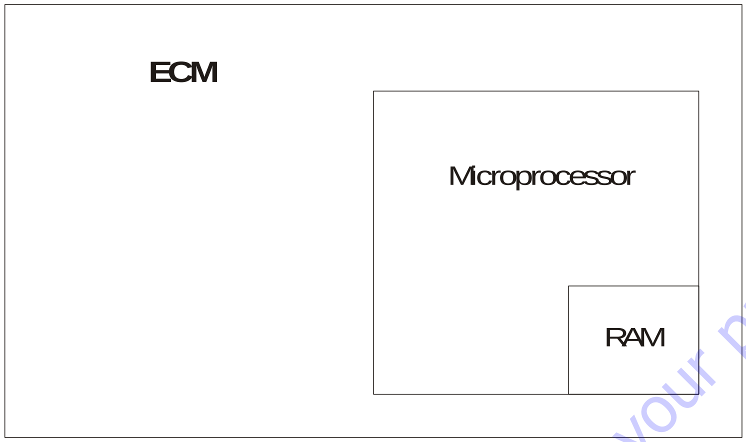
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased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

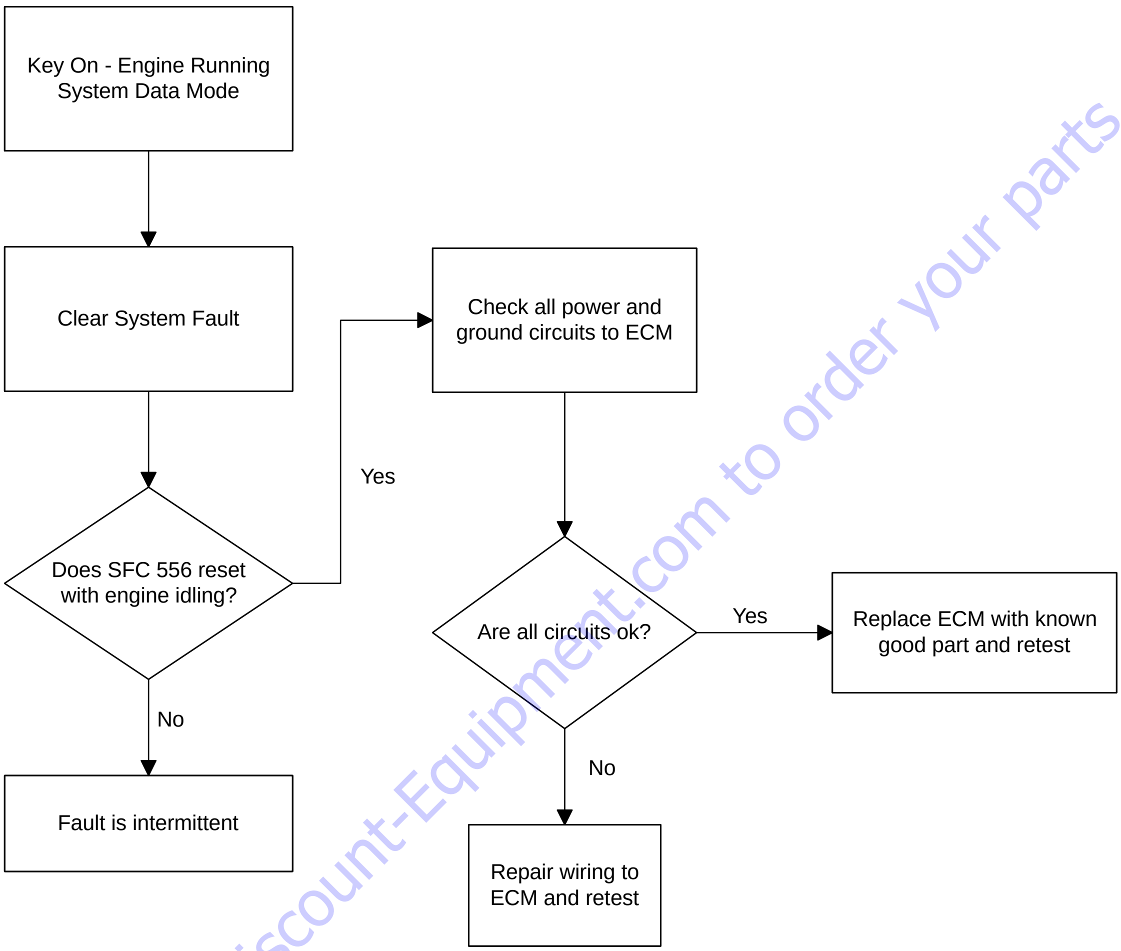


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

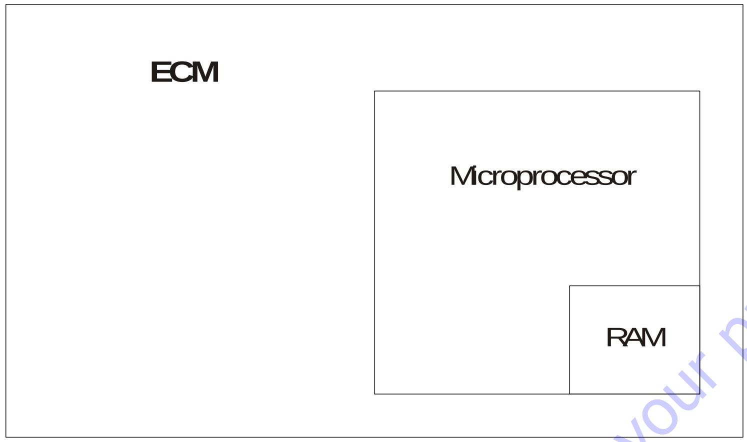
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased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

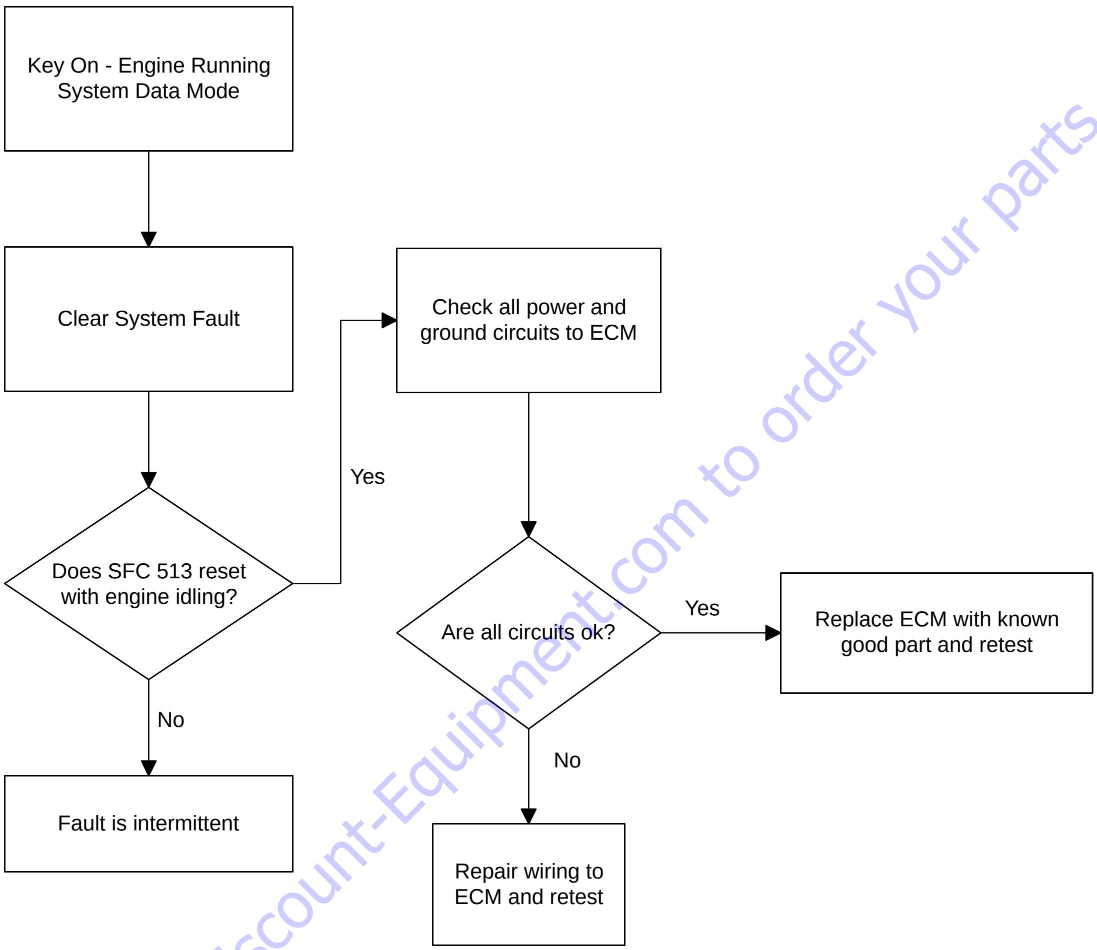


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

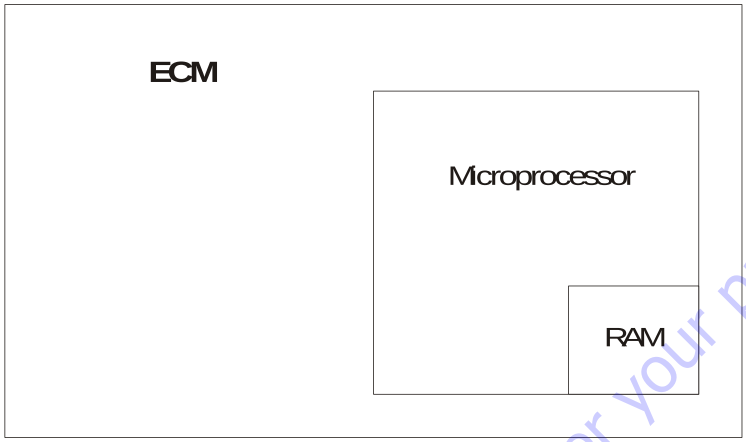
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased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

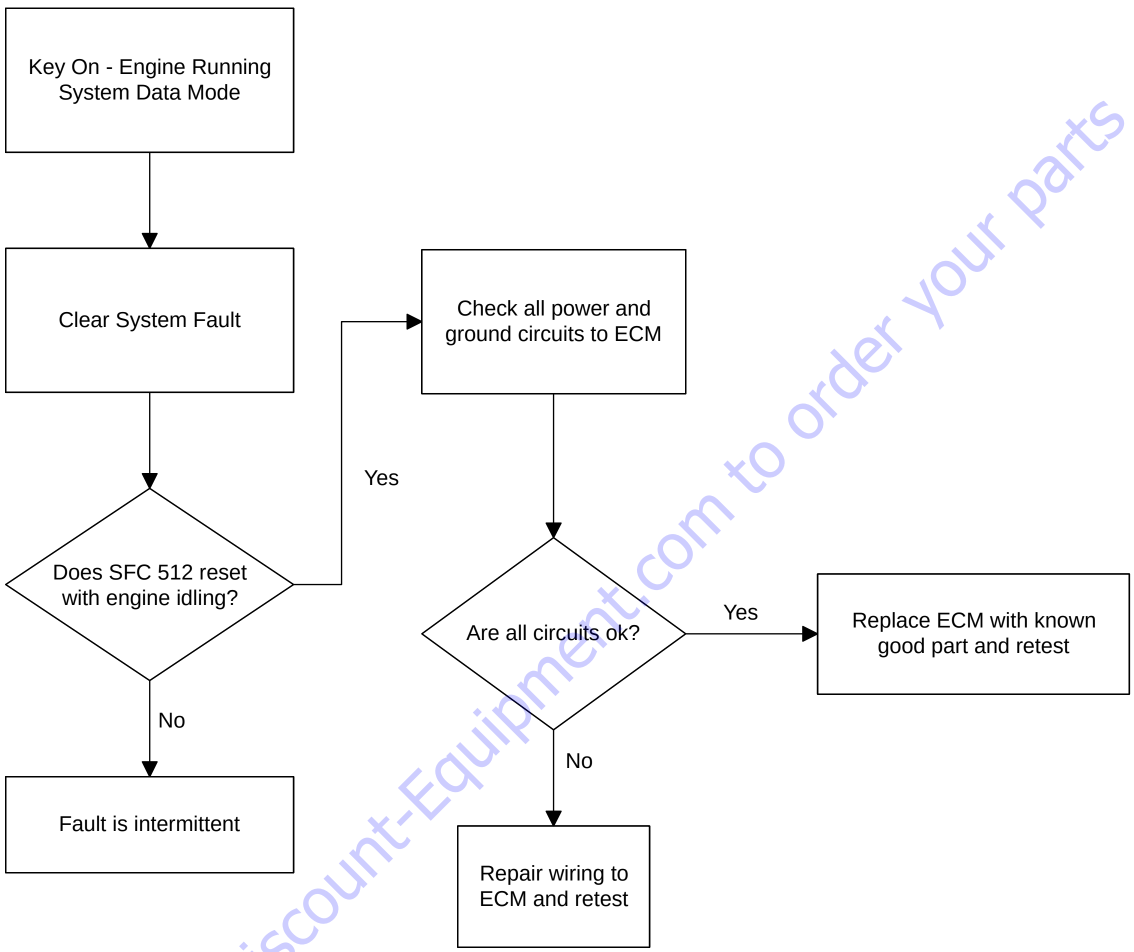


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

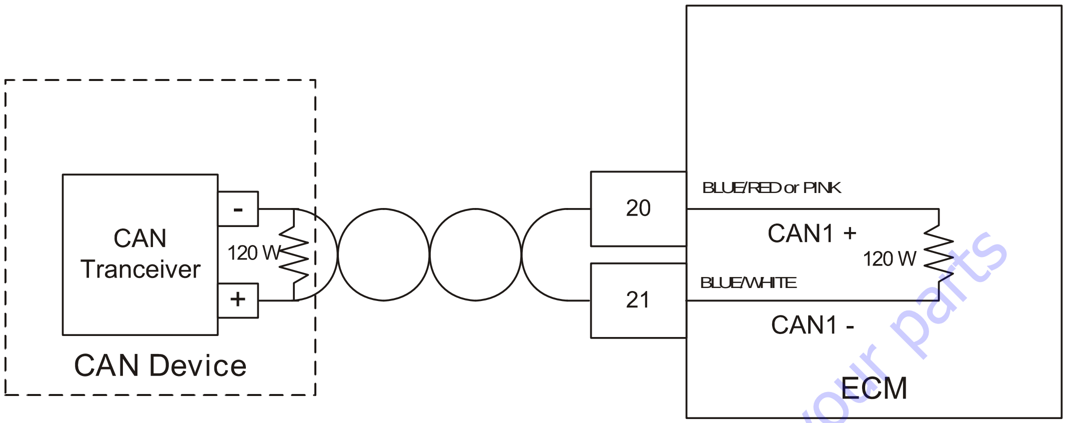
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased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

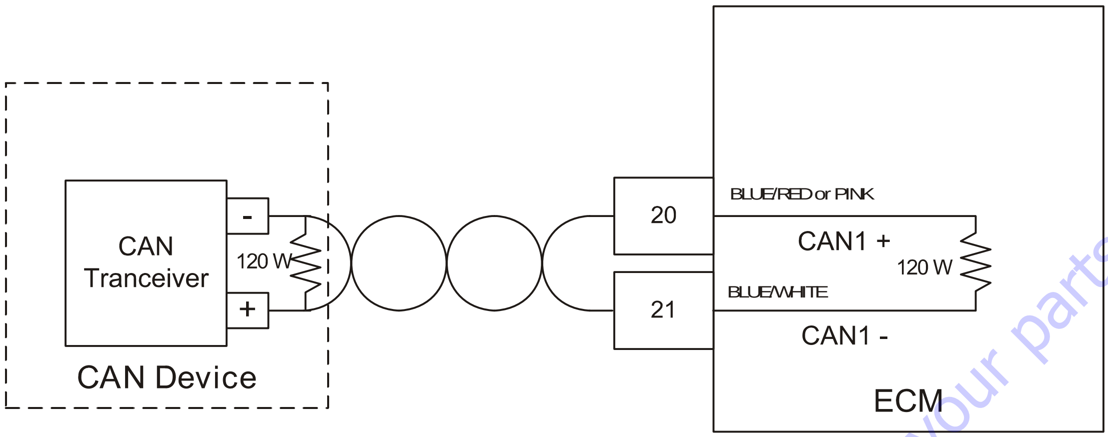
In some situations, external controllers may send a request to the ECM to shutdown engine operation and stop the engine. This request may be sent in response to a safety related condition in the vehicle.

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

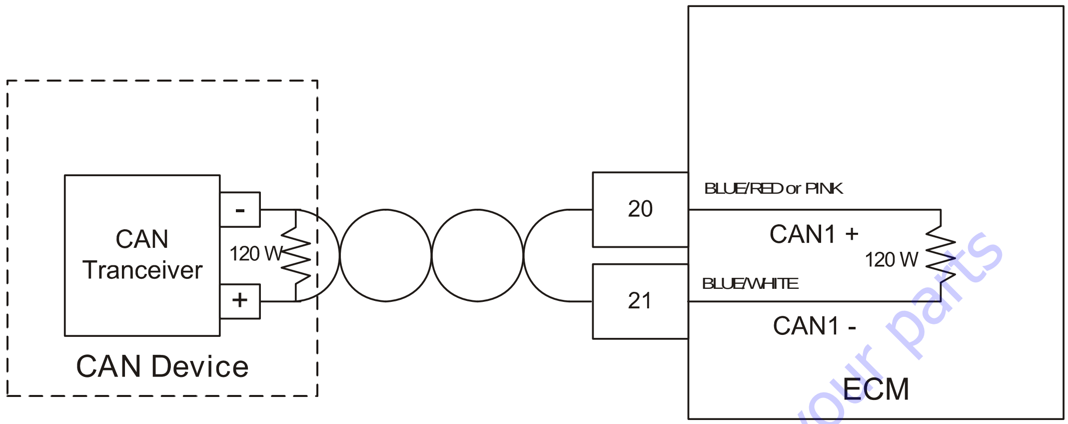
The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators, smart sensors, dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller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

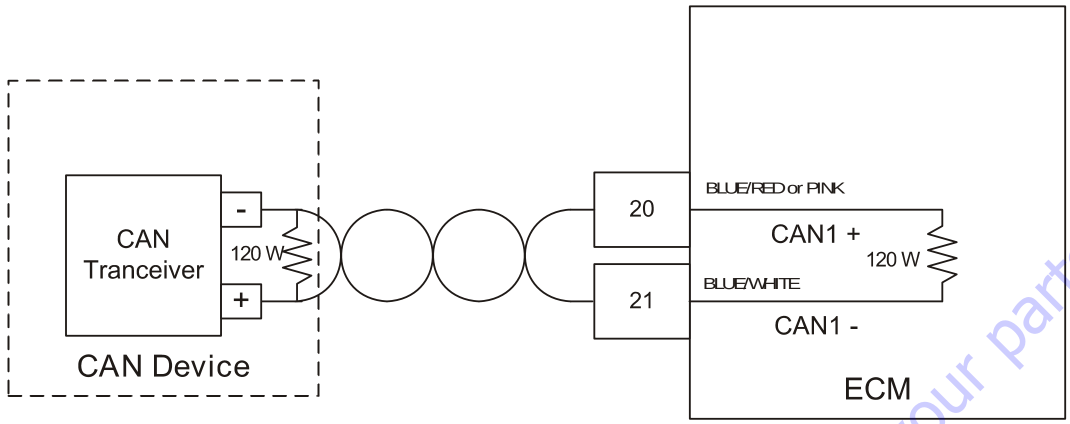
The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators, smart sensors, dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller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

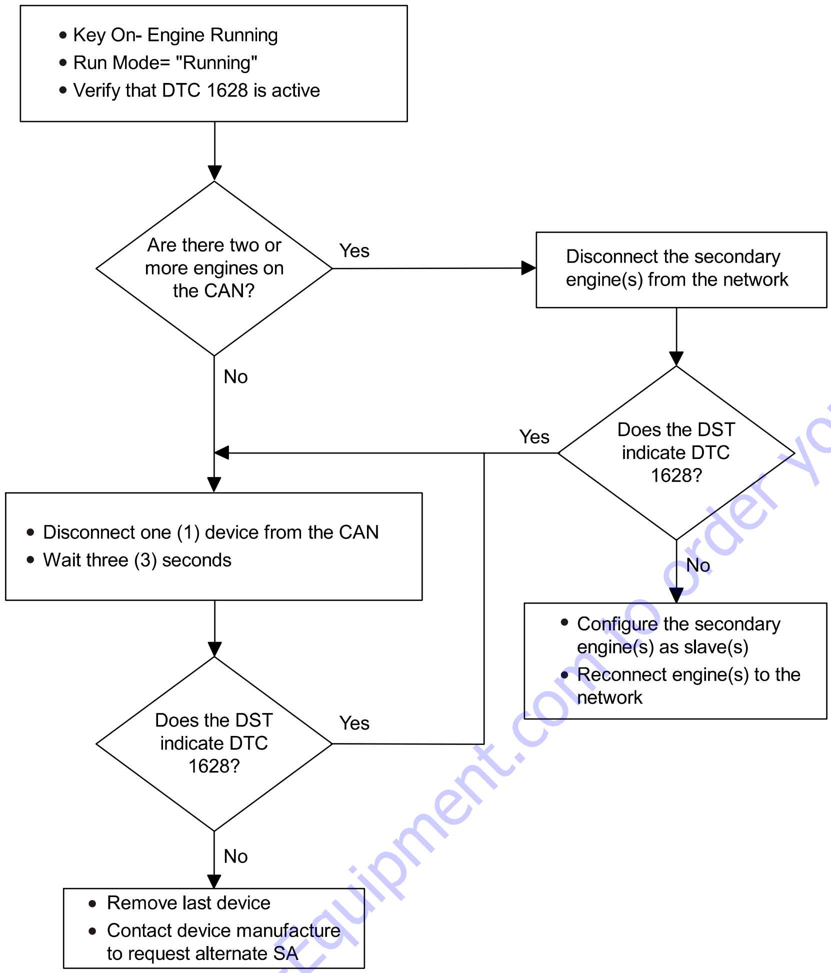
DTC 1628- CAN Address Conflict Failure



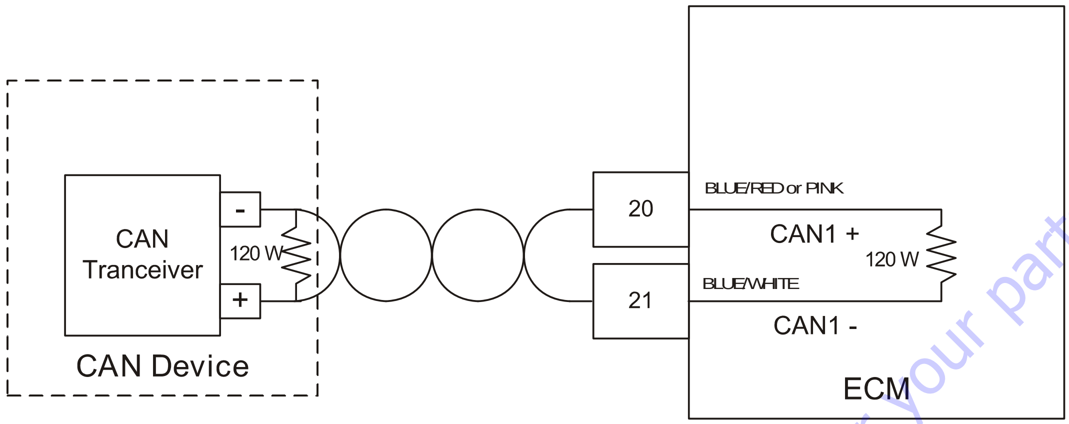
- CAN device(s)
- Check Condition- Key On, Engine on
- Fault Condition- two or more devices on the network that contain the same SA
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

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
Does the DST indicate DTC 1628?
Yes
• 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

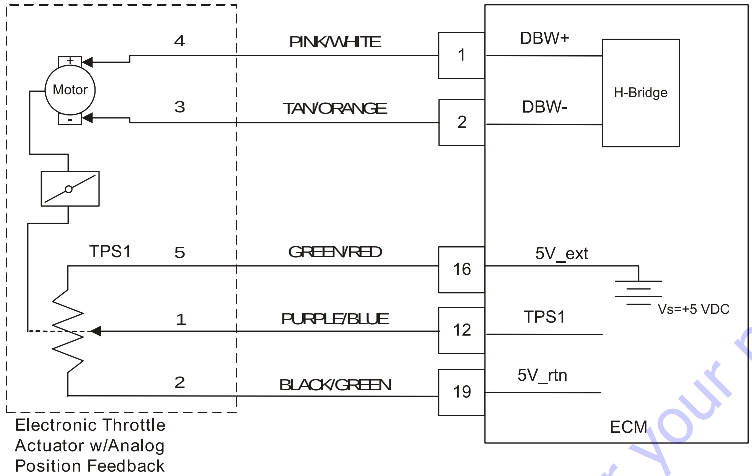
J1939 TSC1 may be used to send a commanded (or desired) engine speed to the ECM. If configured, the ECM will govern the engine speed to this commanded speed if possible. When operating in this mode, the ECM expects to receive TSC1 messages on a regular interval. When this message is not received, the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

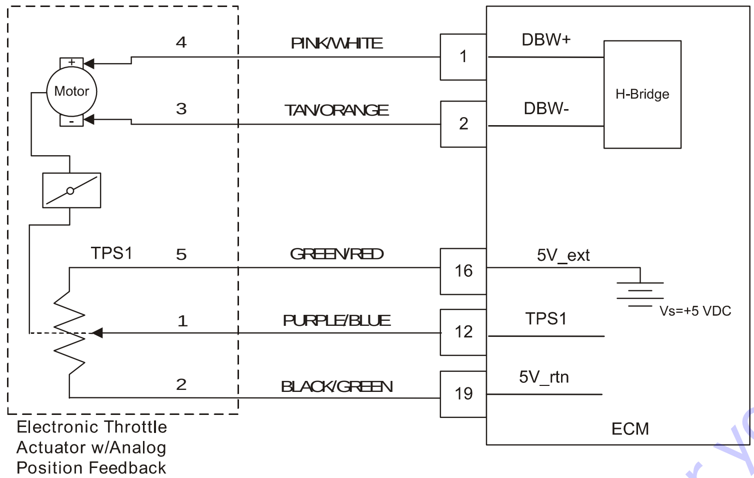
In the case of a throttle actuator with serial/digital position feedback, the ECM receives a constant data stream from the throttle actuator. If the communication is absent or interrupted, the ECM can no longer control the position of the throttle.

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

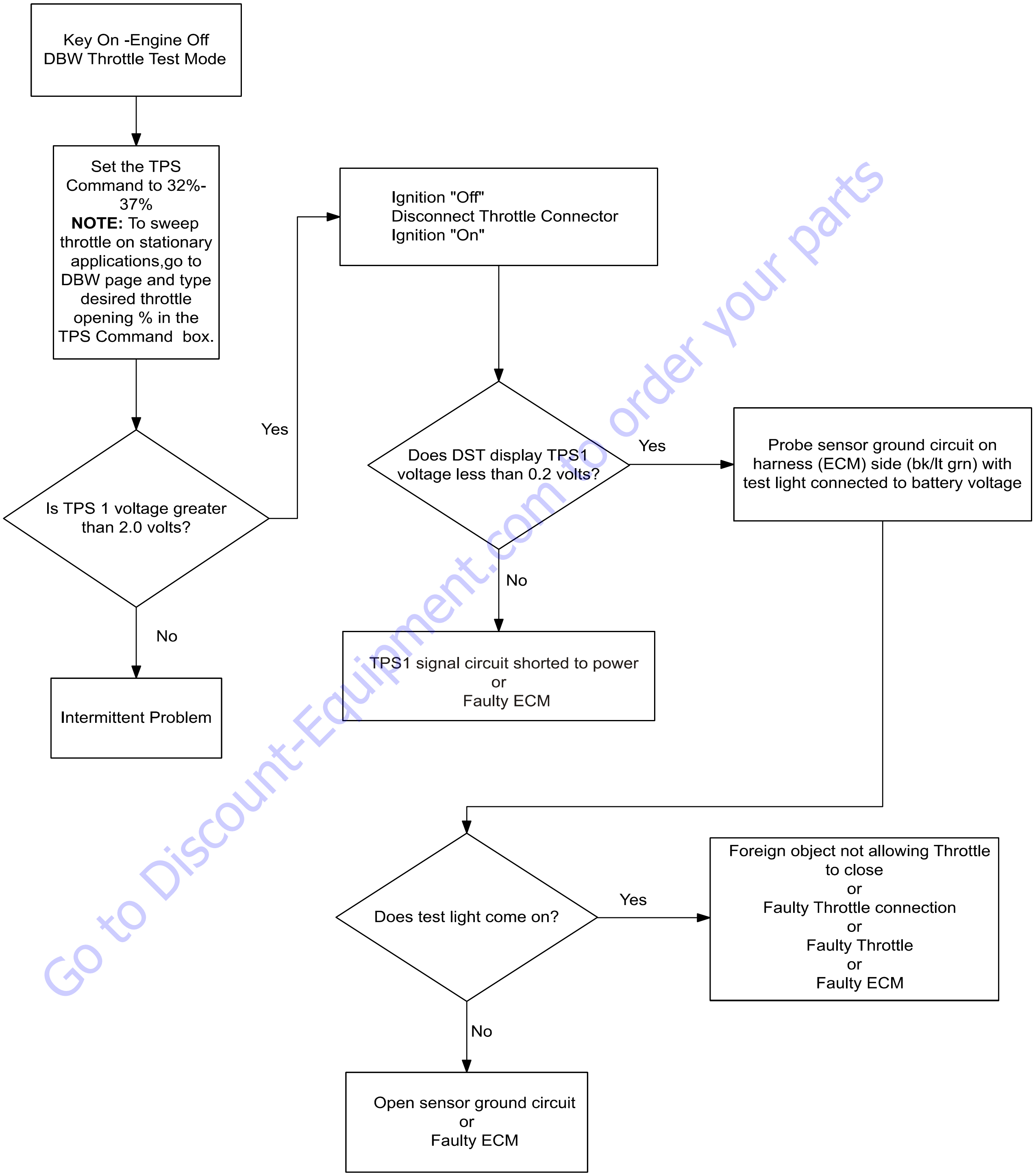
In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS,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

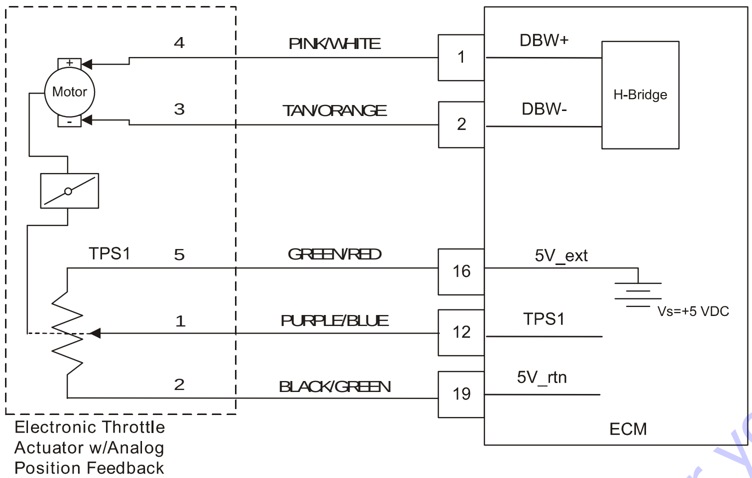
There are two types of throttle actuators, 1) actuator with analog position feedback and 2) actuator with digital position feedback. The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position. The second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

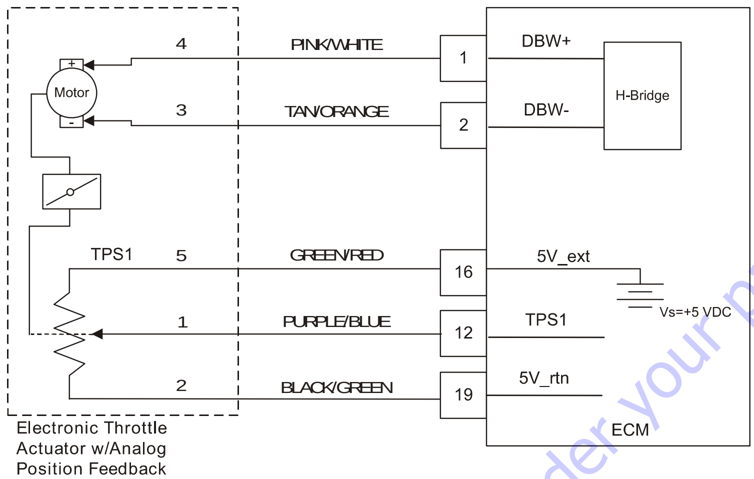
In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, 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 7. BOOM & PLATFORM

7.1 PLATFORM

Platform Sections Replacement

The platform is made up of five sections: floor, right side, left side, back (console box mounting.) and gate. The sections are secured with huck magna grip fastener and collars. Replace damaged platform sections as follows:

1. Support the huck collar with a sledge hammer or other suitable support.
2. Using a hammer and chisel, remove the collar from the fastener as shown in the diagram below.

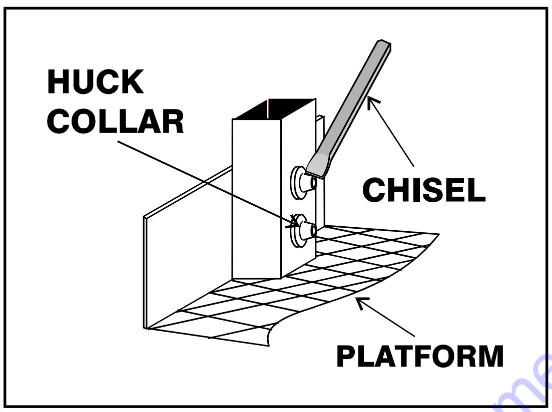


Figure 7-1. Platform Section Replacement

3. When installing new section of platform replace huck fasteners with 1/4 x 20 NC x 2 1/4" grade 5 bolts, flatwashers and locknuts.
4. When installing a new gate to platform, replace rivets with 1/4 x 20 NC x 2 “grade 5 bolts, flatwashers and locknuts.

7.2 BOOM ROPE TORQUING PROCEDURES

Torque Procedures

1. Position boom in fully down and fully retracted position.

Model	600S	600SJ/660SJ
Dim. A	10.4" (26.5 cm)	19.1" (48.6 cm)
Dim. B (ref. only)	9" (23 cm)	9" (23 cm)

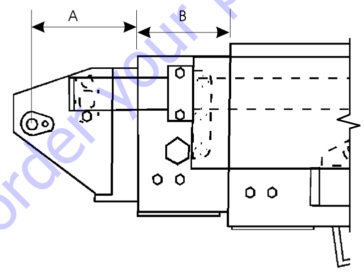


Figure 7-2. Dimensions of Boom Sections

2. Clamp both threaded ends of wire rope to prevent rotation.

NOTE: *Do not clamp on threads.*

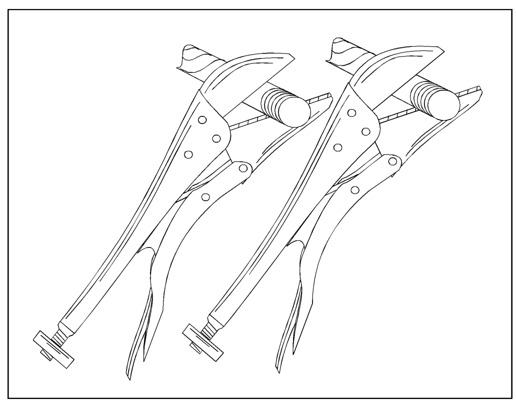


Figure 7-3. Clamping Wire Ropes

3. Install adjusting nuts (or remove nylon collar locknuts if re-adjusting) to both retract and extend wire ropes.
4. Torque retract adjusting nuts (platform end) to 15 ft. lbs. (20 Nm) alternating between the two wire ropes and keeping approximately the same amount of thread beyond the adjusting nut.

NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

5. Repeat the torque procedure in step #4 to the extend wire ropes (turntable end).
6. Extend the boom 2 - 3 feet using the telescope function. Repeat step #4.
7. Retract the boom 1 - 2 feet using the telescope function. Do not bottom out telescope cylinder. Repeat step #5.
8. Extend the boom approximately 2 - 3 feet again and check torque on the retract wire ropes.
9. Retract the boom without bottoming out telescope cylinder and check torque on the extend wire ropes.

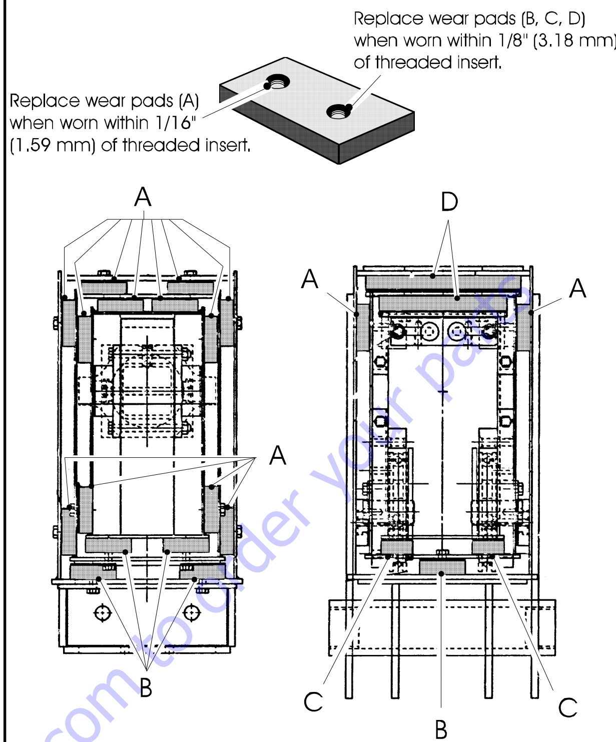
NOTE: *Step #8 and #9 may need to be repeated to equalize the torque on all 4 wire ropes.*

10. After all wire ropes have been properly torqued, install nylon collar locknuts. Remove all clamping devices and install all covers and guards. Check the boom for proper function.

7.3 WEAR PADS

Main Boom

1. Shim up wear pads to within 1/32 inch (.79 mm) tolerance between wear pad and adjacent surface.
2. Replace wear pads when worn within 1/16 inch (1.59 mm) and 1/8 inch (3.18 mm) - B, C, D of threaded insert. See Location and Thickness Of Wear Pads.
3. Adjusting wear pads, removing or adding shims, bolt length must also be changed.
   a. When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   b. When shims are removed, shorter bolts must be used so bolt does not protrude from insert and come into contact with boom surface.



PAD	THICKNESS OF NEW PAD	REPLACE WHEN WORN TO:
A	5/8"	9/16"
B	3/4"	5/8"
C	3/4"	5/8"
D	3/4"	5/8"

NOTE

Wear Pads are made of polyethylene; these pads run on polyurethene painted surfaces with no paint removed and no lubrication applied.

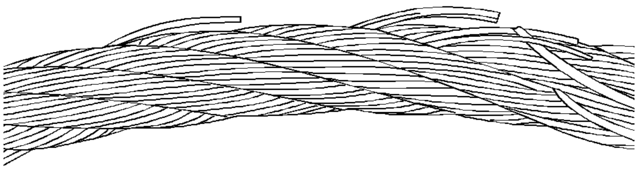
Figure 7-4. Location and Thickness of Wear Pads

7.4 WIRE ROPE

NOTE: *The pictures in this paragraph are just samples to show the replacement criteria of the rope.*

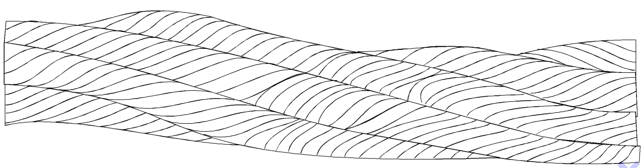
Inspection

1. Inspect ropes for broken wires, particularly valley wire breaks and breaks at end terminations.



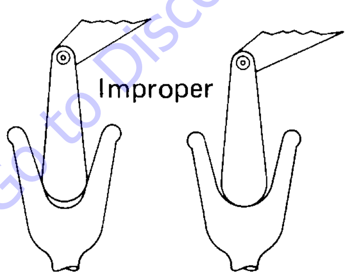
Flexing a wire rope can often expose broken wires hidden in valleys between strands.

1. Inspect ropes for corrosion.
2. 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.

1. Inspect sheaves for condition of bearings/pins. (See Dimension Of Sheaves for proper dimension.)
2. Inspect sheaves for condition of flanges. (See Dimension Of Sheaves for proper dimension.)
3. 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.

1. 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.

12 Year or 7000 Hour Replacement

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.

Additional 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.

7.5 BOOM MAINTENANCE

Removal

1. Remove the platform/support as follows:

   a. Disconnect electrical cable from control console.

   b. Remove the eight (8) bolts securing the platform to the platform support, then remove the platform.

   c. Using an overhead crane or suitable lifting device, strap support the platform support.

   d. Remove the six (6) bolts and locknuts securing the support to the rotator.

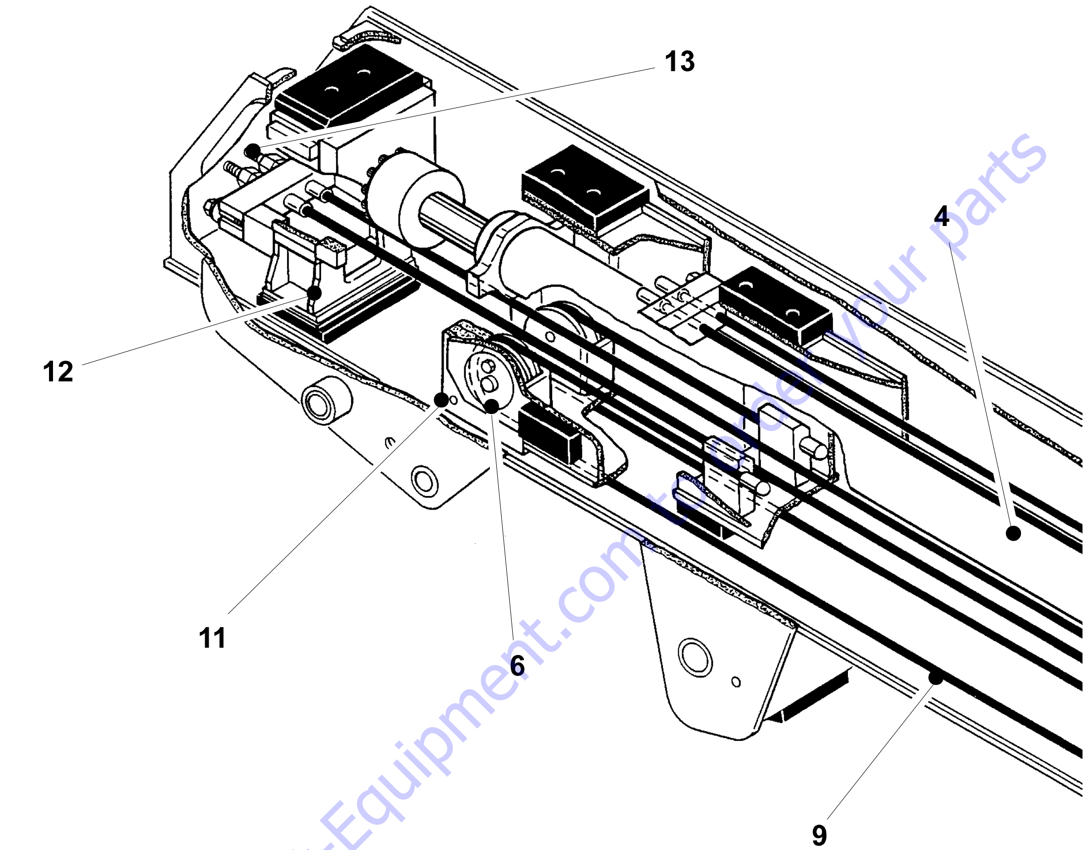


Figure 7-5. Boom Assembly Cutaway - Sheet 1 of 3

1. Base Boom
2. Mid Boom
3. Fly Boom
4. Telescope Cylinder
5. Extend Sheave
6. Retract Sheave
7. Sheave Block
8. Extend Cable
9. Retract Cable
10. Extend Sheave Guard
11. Retract Sheave Guard
12. Wear Pad Support
13. Extend Cable Adjustment
14. Retract Cable Adjustment

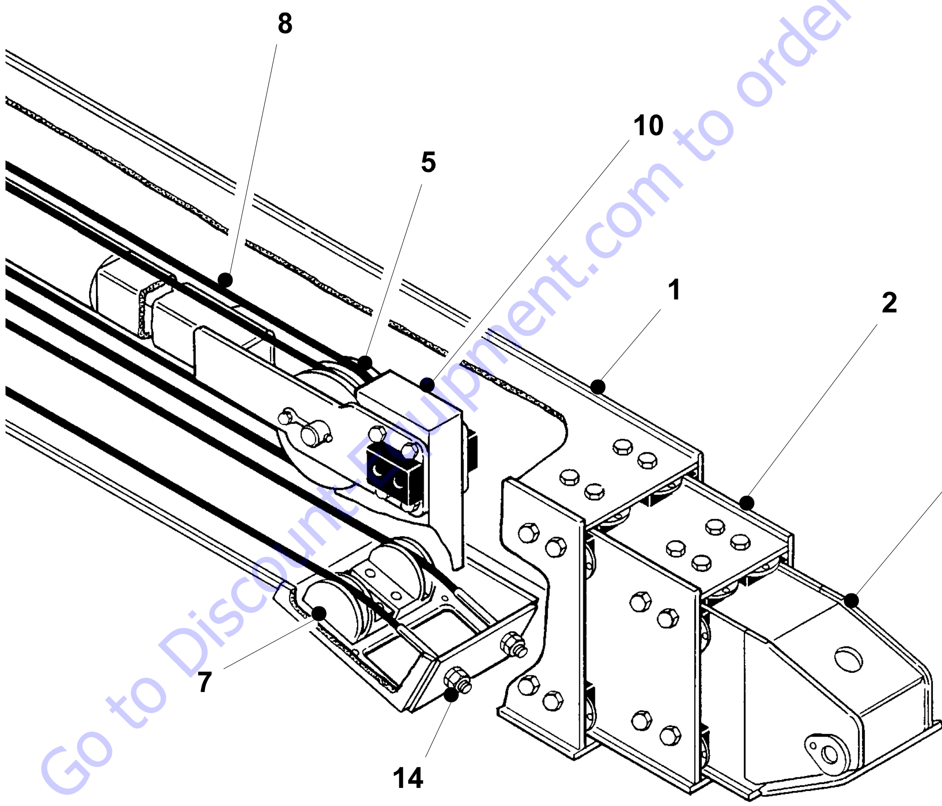


Figure 7-6. Boom Assembly Cutaway - Sheet 2 of 3

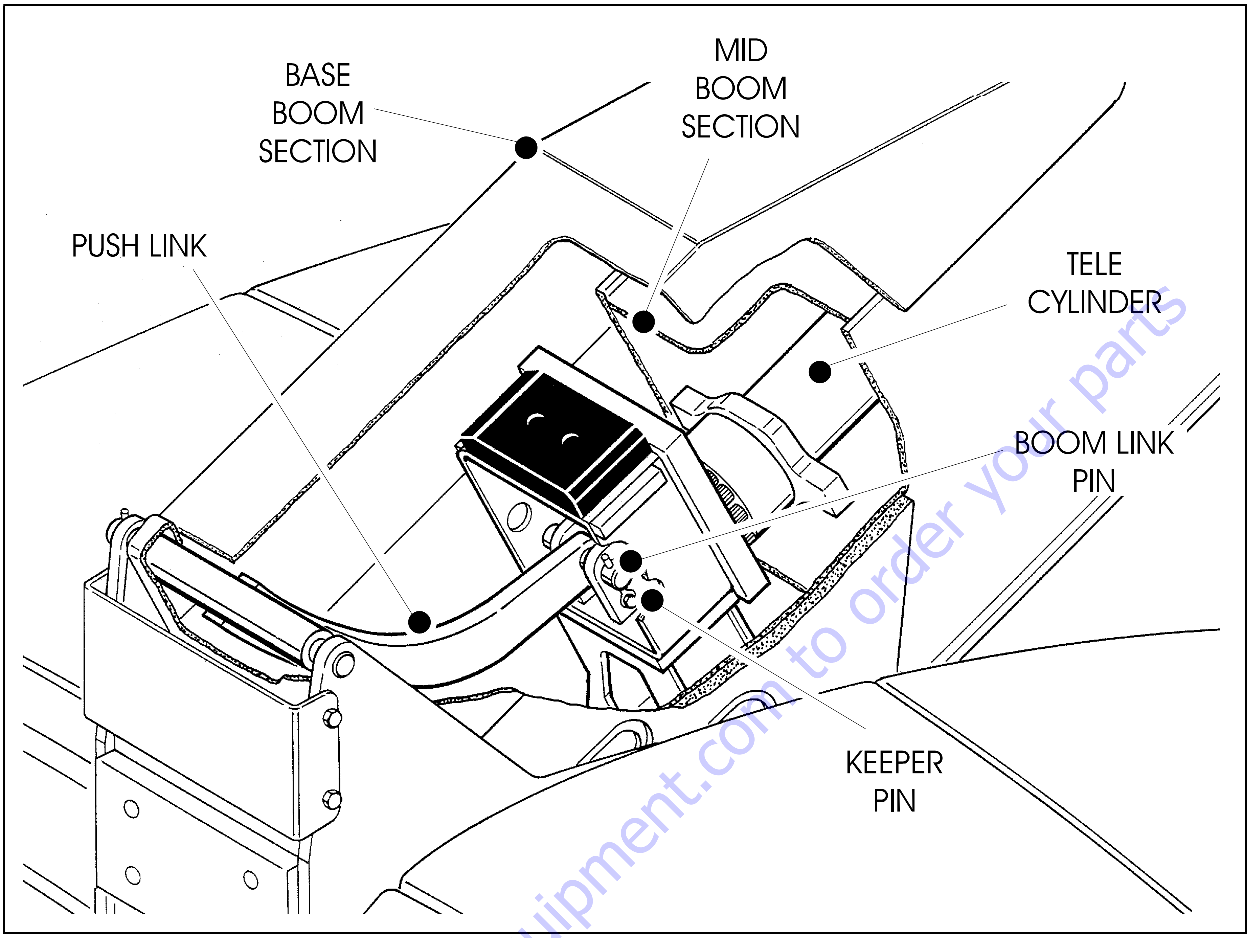


Figure 7-7. Boom Assembly Cutaway - Sheet 3 of 3

e. Using a suitable brass drift and hammer, remove the rotator shaft, then remove the support from the rotator.

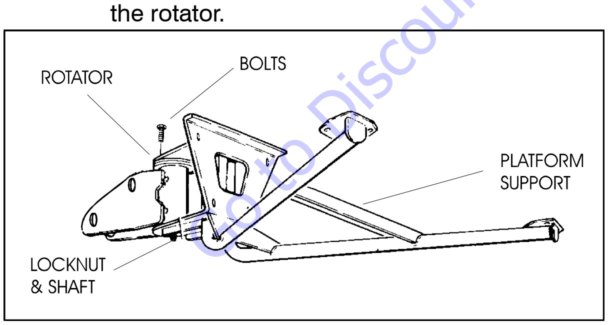


Figure 7-8. Location of Components - Platform Support

2. Remove the rotator and slave level cylinder from the fly boom as follows:

a. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.

b. Remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1 from the fly boom.

c. Supporting the rotator, remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 from the fly boom and remove the rotator.

d. Telescope the fly section out approximately 20 inches (50.8 cm) to gain access to the slave leveling cylinder.

e. Supporting the slave, cylinder remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the fly boom.

f. Tag and disconnect hydraulic lines to the slave leveling cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the slave cylinder.

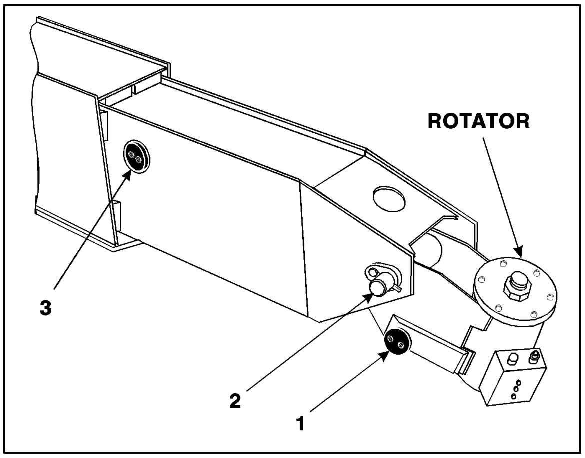


Figure 7-9. Location of Components - Rotator and Leveling Cylinder

3. Remove the powertrack from the boom as follows:

   a. Disconnect wiring harness from ground control box.

NOTICE

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

   b. Tag and disconnect hydraulic lines from boom to control valve. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.

   c. Disconnect the dual capacity indicator limit switch from side of boom section.

   d. Remove hydraulic lines and electrical cables from powertrack.

   e. Using a suitable lifting equipment, adequately support powertrack weight along entire length.

   f. Remove bolts #1 securing the push tube on the fly boom section.

   g. Remove bolts #2 securing the push tube on the mid boom section.

   h. With powertrack support and using all applicable safety precautions, remove bolts #3 and #4 securing rail to the base boom section. Remove powertrack from boom section.

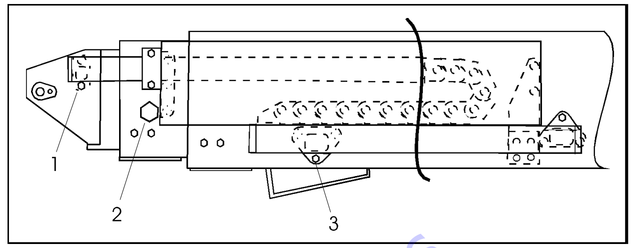


Figure 7-10. Location of Components - Boom Pow-

4. Remove boom assembly from machine as follows:

   a. Using suitable lifting equipment, adequately support boom assembly weight along entire length.

NOTICE

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

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

   c. Remove hardware securing the lift cylinder rod end to the base boom section.

   d. Using a suitable brass drift and hammer, remove the lift cylinder pin from the base boom.

   e. Remove hardware securing the master cylinder rod end to the base boom section.

   f. Using a suitable brass drift and hammer, remove the master cylinder pin from the base boom.

   g. Remove hardware securing the pushbar to the turntable upright.

NOTICE

WHEN REMOVING PIN FROM PUSHBAR. CARE MUST BE TAKEN NOT TO DROP THE PUSHBAR ONTO THE WIRE ROPE ADJUSTMENT THREADS. FAILURE TO DO SO WILL RESULT IN DAMAGING THREADS.

   h. Using a suitable brass drift and hammer, remove the push bar pin from the turntable upright.

   i. Remove hardware securing the boom pivot pin to the turntable upright.

   j. Using a suitable brass drift and hammer, remove the pivot pin from the turntable upright.

   k. Using all applicable safety precautions, carefully lift boom assembly clear of turntable and lower to ground or suitably supported work surface.

Disassembly of Boom Sections

1. Remove hardware securing the push bar to aft end of the telescope cylinder, then remove pin from cylinder.
2. Remove hardware securing the cover plate on the bottom front of the base boom section.

NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

3. Clamp both threaded ends of wire rope to prevent rotation. Note: Do not clamp on threads. Remove jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.
4. Remove hardware securing the wire rope adjustment block to aft end of the base boom section and remove the block.
5. Remove hardware securing the telescope cylinder to aft end of the mid boom section.

NOTICE

WHEN REMOVING THE TELESCOPE CYLINDER FROM THE BOOM, IT MAY BE NECESSARY AT SOME POINT IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY FROM THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

6. Remove bolts securing wire rope attach bar to top of fly boom section.
7. Pull the telescope cylinder and wire ropes partially from aft end of the base boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.
8. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.
   a. Remove hardware from the wear pads; remove wear pads from cylinder.
   b. Remove hardware from the wire rope guard; remove guard from cylinder.
   c. Remove hardware from the sheave pin; remove pin and sheave from cylinder.

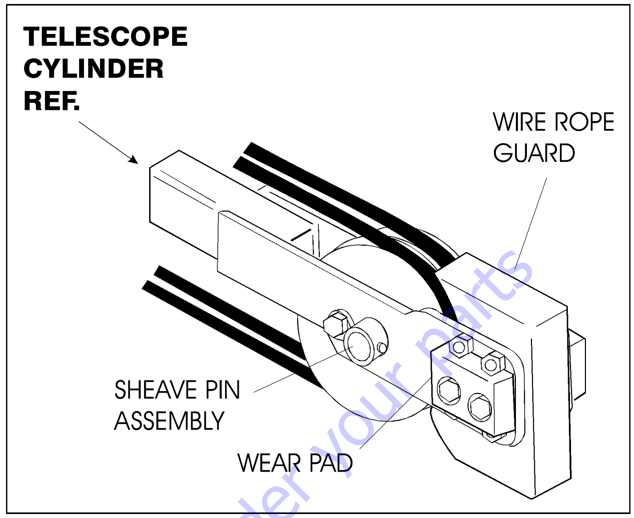


Figure 7-11. Disassembly of Sheave Assembly

9. Remove hardware which secures the wear pads to the front of base boom section; remove wear pads from the top, sides and bottom of the base boom section.
10. Using an overhead crane or suitable lifting device, remove mid and fly boom sections from base section. Note: When removing mid and fly boom sections from base boom section, retract wire rope must be dragged along with boom sections.
11. Remove hardware which secures the wear pads to the aft end of mid boom section; remove the wear pads from the top, sides and bottom of the mid boom section.
12. Remove hardware which secures the sheave guards and sheave assemblies to mid boom section, remove sheave assemblies from mid boom section.
13. Remove hardware which secures the wear pads to the front of mid boom section; remove wear pads from the top, sides and bottom of the mid boom section.
14. Using an overhead crane or suitable lifting device, remove fly boom section from mid section. Note: When removing fly boom section from mid boom section, retract wire rope must be dragged along with fly boom section.
15. Remove hardware which secures the wear pads to the aft end of fly boom section; remove wear pads from the top, sides and bottom of the fly boom section.

16. When removing wire rope from fly boom section, push the cable into fly boom. Route wire rope back through holes in the side of the fly boom section.

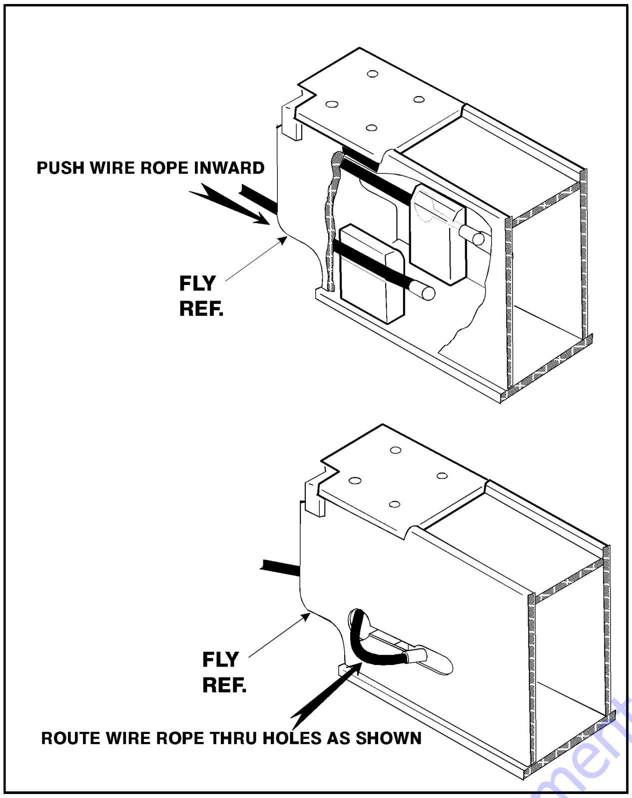


Figure 7-12. Disassembly Wire Rope Routing Proce-

Inspection

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

1. Inspect all sheaves (extend and retract wire ropes and telescope cylinder) for excessive groove wear, burrs or other damage. Replace sheaves as necessary.

NOTE: *To check the size, contour and amount of wear, a groove gauge is used. Replace the sheave if worn as shown in the following drawing.*

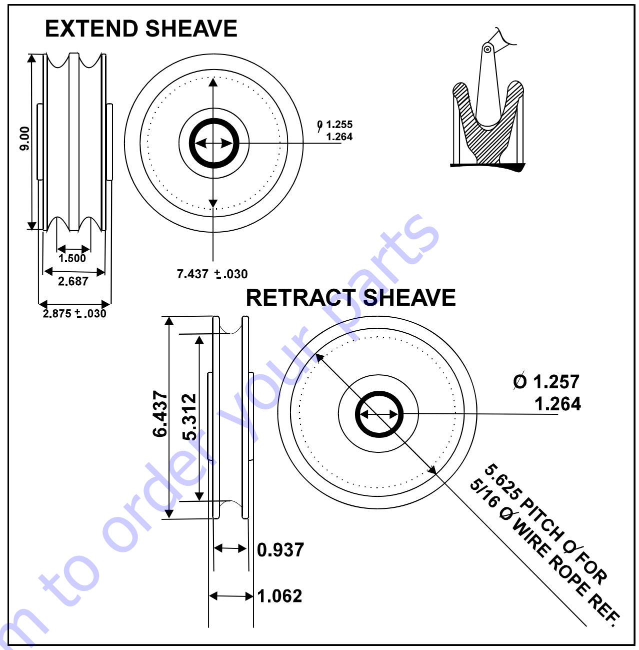


Figure 7-13. Dimension of Sheaves When New

2. Inspect extend and retract wire rope sheave bearings for wear, scoring, or other damage, and for ovality.

3. Inspect extend wire rope and retract wire rope sheave pins for scoring, tapering and ovality. Replace pins as necessary.

4. Inspect telescope cylinder sheave pin for scoring, tapering and ovality. Replace pins as necessary.

5. Inspect boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.

6. Inspect telescope cylinder attach point for scoring, tapering and ovality. Replace pins as necessary.

7. Inspect upper lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.

8. Inspect inner diameter of boom pivot bushing for scoring, distortion, wear, or other damage. Replace bearing as necessary.

9. Inspect all wear pads for excessive wear or other damage. Replace pads when worn to within 1/8 inch (3.2 mm) of threaded insert.

10. Inspect extend and retract wire rope attach point components for cracks, stretching, distortion, or other damage. Replace components as necessary.
11. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
12. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Assembly

NOTE: *When installing fly section wear pads, install same number and thickness of shims as were removed during disassembly.*

1. Measure inside dimensions of the base and mid sections to determine the number of shims required for proper lift.
2. Measure inside dimensions of the mid section to determine the number of shims required for proper lift.
3. Install side, top and bottom wear pads to the aft end of fly section; shim evenly to the measurements of the inside of mid section.
4. Install retract wire ropes into aft end of fly section, route wire ropes thru holes in side of fly boom section and pull into slot.

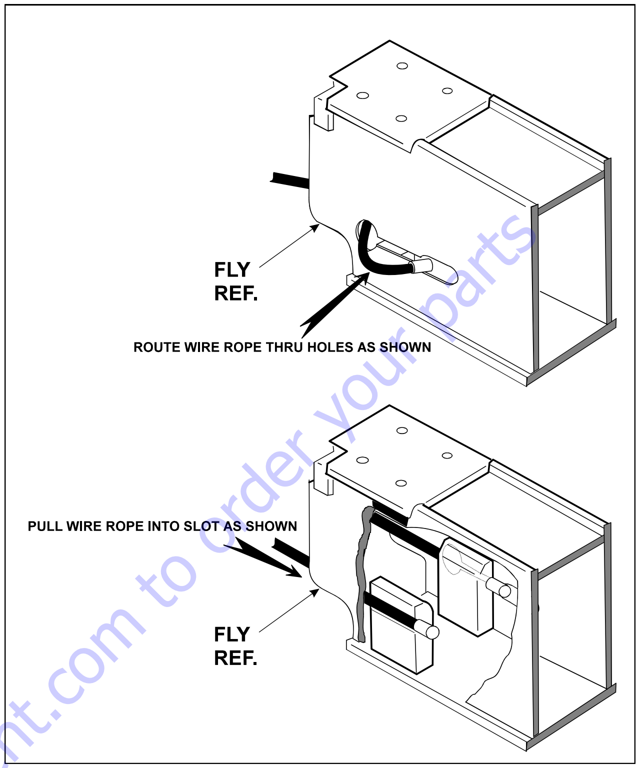


Figure 7-14. Routing Installation of Retract Wire Ropes

5. Install side, top and bottom wear pads to the aft end of mid section; shim evenly to the measurements of the inside of mid section.

NOTICE

WHEN ASSEMBLING BOOM SECTIONS, ENSURE THAT THE BOOM SLIDING TRAJECTORIES HAVE BEEN CLEARED OF CHAINS, TOOLS, AND OTHER OBSTRUCTIONS.

6. Shim the insides of the boom sections for a total of 1/16 inch (0.062) clearance (if the action is centered, there will be 1/32 clearance on each side).
7. Slide fly boom section into the mid boom section. Shim boom, if necessary, for a total of 1/16 inch (0.062) clearance.
8. Install wear pads into the forward position of the mid boom section. Shim boom, if necessary, for a total of 2/10 inch (0.20 m) clearance.
9. Properly position the retraction wire rope sheaves assemblies at the aft end of the mid boom section; ensure all sheave-to-mounting block attachment holes align. Install the sheave pins and secure them with mounting hardware. Position retract wire ropes onto the sheaves.

10. Install sheave guards to aft end of mid boom section and secure with mounting hardware.
11. Slide mid boom section into the base boom section. Allow the retraction wire ropes to trail between the bottom surfaces of boom sections. Shim boom, if necessary, for a total of 1/16 inch (0.062) clearance.
12. Install wear pads into the forward position of the base boom section. Shim boom, if necessary, for a total of 2/10 inch (0.20) clearance.
13. Install sheave block to bottom of base boom section and adjust block so that retract wire ropes do not come into contact with boom surfaces.
14. Install wire rope threaded ends thru attachment holes in the bottom of base boom section. Loosely install nuts and jam nuts onto the threaded ends of wire ropes.
15. Align the telescope cylinder barrel-to-sheave attachment point. Install extend sheave pin through the telescope cylinder barrel and sheave assembly; secure pin with mounting hardware.
16. Route extend wire ropes around extend sheave and secure wire ropes to the telescope cylinder.
17. Install extend wire rope mounting blocks to threaded ends of wire ropes. Loosely install nuts and jam nuts onto the threaded ends of wire ropes.

NOTE: *When installing wire ropes, care must be taken not to twist or cross the wire ropes.*

18. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.

NOTICE

WHEN INSERTING THE TELESCOPE CYLINDER INTO THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO POSITION. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

19. Align the cylinder with the slots at aft end of mid boom section, then secure cylinder with mounting hardware.
20. Align holes in aft end of the fly boom section with holes in wire rope mounting block, then secure with mounting hardware.
21. Align holes in aft end of the mid boom section with holes in wire rope mounting block, then secure with mounting hardware.

NOTE: *Boom wire ropes must be torqued after installation of the boom assembly.*

22. Align holes in rod end of the telescope cylinder with holes in push bar. Install push bar pin and secure with mounting hardware.
23. Install the hydraulic lines and electrical cables, and the harnessing powertrack components as follows:
    a. Align holes in powertrack rail with attachment holes in side of the base boom section. Secure the rail with mounting hardware.
    b. Install powertrack to rail with mounting hardware.
    c. Attach push tube bracket to the side of the mid boom section with mounting hardware.

NOTE: *Do not over tighten attach bolt on push tube bracket. It should pivot freely.*

    d. Install slide block and wear pads to the powertrack rail with mounting hardware.
    e. Install powertrack to push tube with mounting hardware.
    f. Carefully feed the hoses and electrical cables through the aft end of the powertrack rail, powertrack and push tube.
    g. Ensure all hoses and cables are properly routed through the powertrack rail, powertrack and push tube. Tighten or install all clamping or securing apparatus to the hoses or cables, as necessary.
    h. Install powertrack cover and push tube rods with mounting hardware.

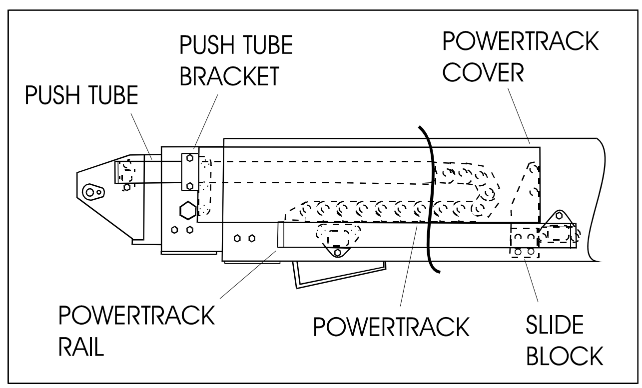


Figure 7-15. Reassembly of Components - Boom Powertrack Assembly

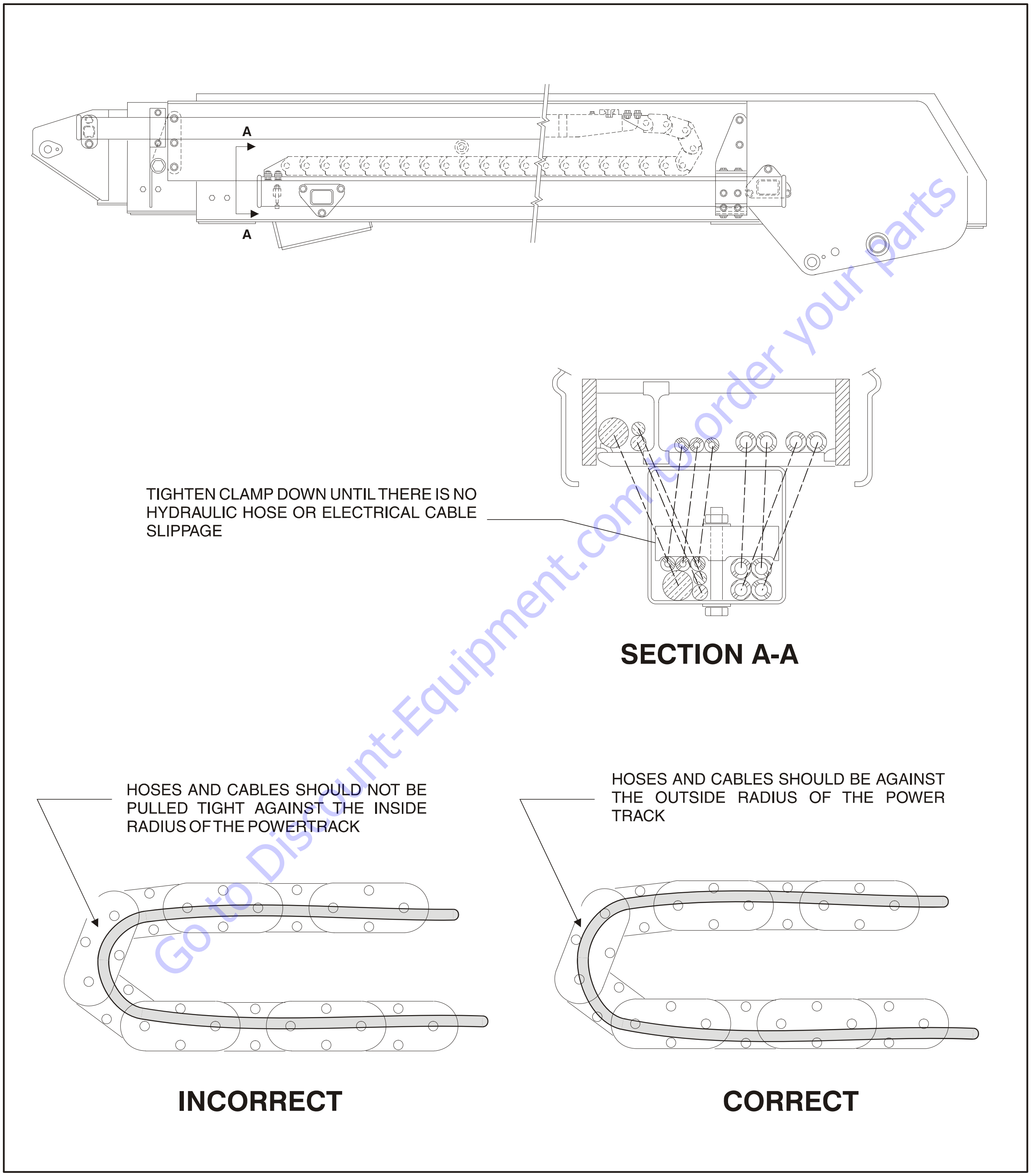


Figure 7-16. Boom Powertrack Installation

Installation

1. Using a suitable lifting device, position boom assembly on turntable so that the pivot holes in both boom and turntable are aligned.
2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on turntable.
3. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.
4. Align push bar pivot hole with pivot holes in turntable. Install push bar pivot pin, ensuring that location of hole in pin is aligned with attach point on turntable.
5. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.
6. Connect all wiring to the ground control box.
7. Connect all hydraulic lines running along side of boom assembly.
8. Using all applicable safety precautions, operate lifting device in order to position boom lift cylinder so that holes in the cylinder rod end and boom structure are aligned. Insert the lift cylinder pin, ensuring that location of hole in pin is aligned with attach point on boom.
9. Align holes in boom structure with hole in master cylinder. Insert the master cylinder pin, ensuring that location of hole in pin is aligned with attach point on boom.
10. Adjust retract and extend cables to the proper torque. Refer to paragraph 2-6, boom cable torque procedures.
11. Using all applicable safety precautions, operate machine systems and raise and extend boom fully, noting the performance of the extension cycle.
12. Retract and lower boom, noting the performance of the retraction cycle.

7.6 ARTICULATING JIB BOOM

Removal

1. For platform/support removal see platform/support removal diagram. See Section 7.5, Boom Maintenance.
2. Position the articulating jib boom level with ground.
3. Remove mounting hardware from slave leveling cylinder pin #1. Using a suitable brass drift and hammer, remove the cylinder pin from articulating jib boom.

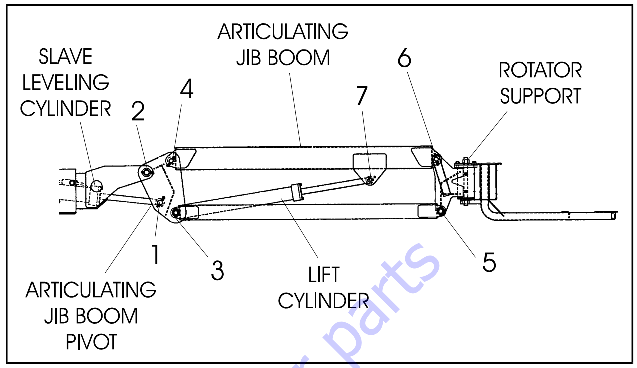


Figure 7-17. Location of Components - Articulating Jib Boom

4. Remove mounting hardware from articulating jib boom pivot pin #2. Using a suitable brass drift and hammer, remove the pivot pin from boom assembly.

Disassembly

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

Inspection

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

1. Inspect articulating fly boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
2. Inspect articulating fly boom pivot attach points for scoring, tapering and ovality, or other damage. Replace pins as necessary.
3. Inspect inner diameter of articulating fly boom pivot bearings for scoring, distortion, wear, or other damage. Replace bearings as necessary.
4. Inspect lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.

5. Inspect inner diameter of rotator attach point bearings for scoring, distortion, wear, or other damage. Replace bearing as necessary.
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of articulating jib boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Assembly

NOTE: *For location of components See Section 7-17., Location of Components - Articulating Jib Boom.*

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

7.7 LIMIT SWITCH ADJUSTMENT

Adjust switches and cam valve as shown in Limit Switches Adjustment.

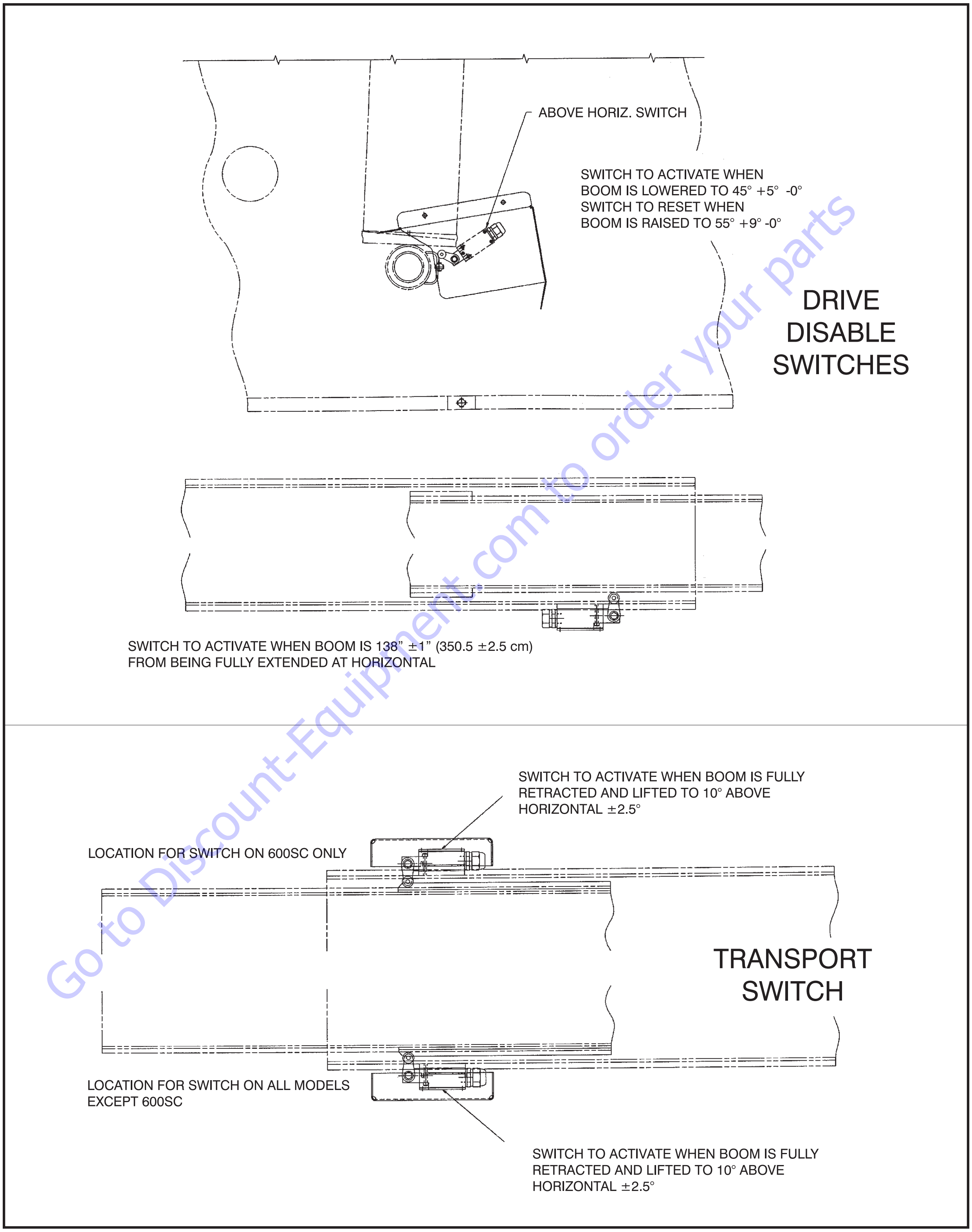


Figure 7-18. Limit Switches Adjustments

7.8 ROTATOR - HELAC (PRIOR TO S/N 0300132437)

Disassembly

1. Place actuator on a clean workbench.
2. Remove all hydraulic fittings.
3. Using a suitable hammer and chisel remove the portion of end cap securing setscrew.

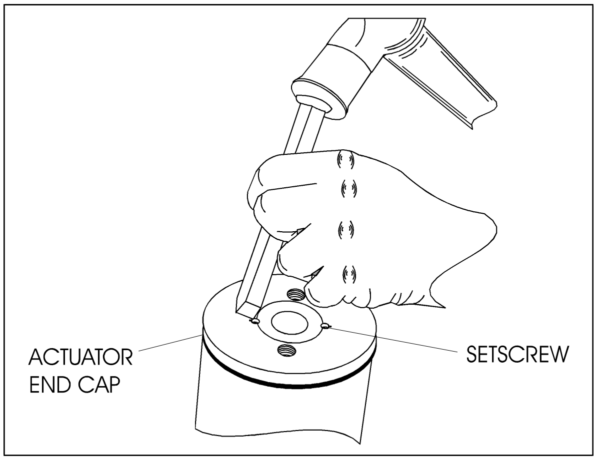


Figure 7-20. Removing Portion of End Cap

4. Using a torch, apply heat to the setscrews on the bottom of actuator.

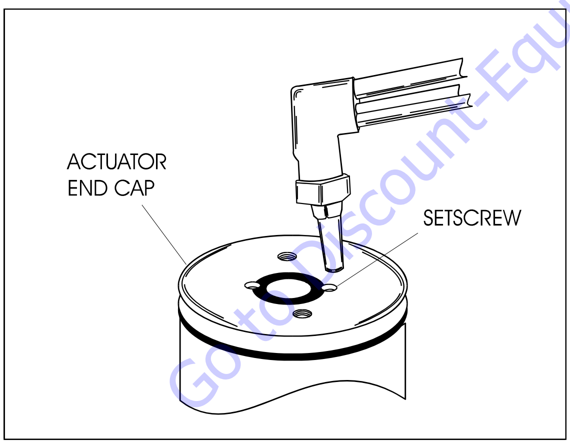


Figure 7-21. Heating Setscrew

5. Remove the two (2) setscrew (4) from bottom of actuator (1). Discard setscrew.

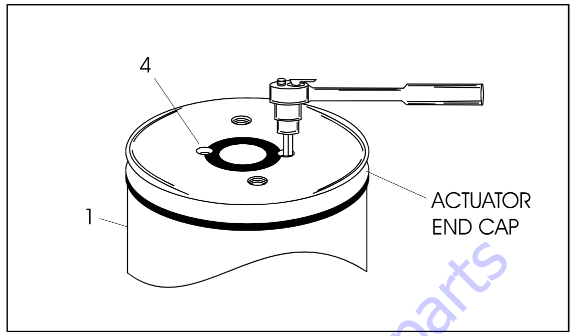


Figure 7-22. Removing Setscrew

6. Place two (2) 3/8"x16NC bolts in threaded holes in bottom of the actuator. Using a suitable bar, unscrew the end cap (5). Remove the end cap from actuator (1).

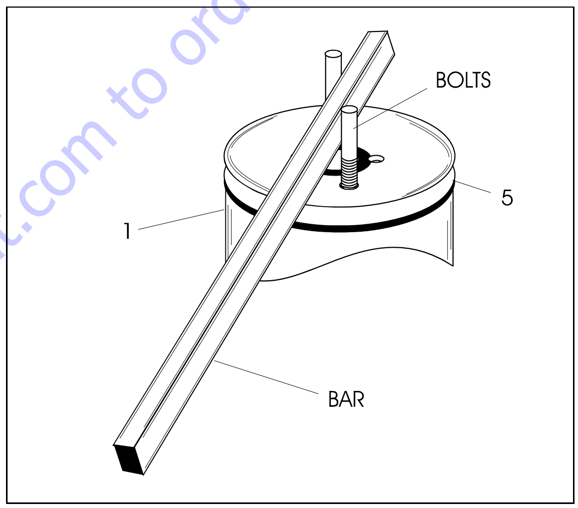
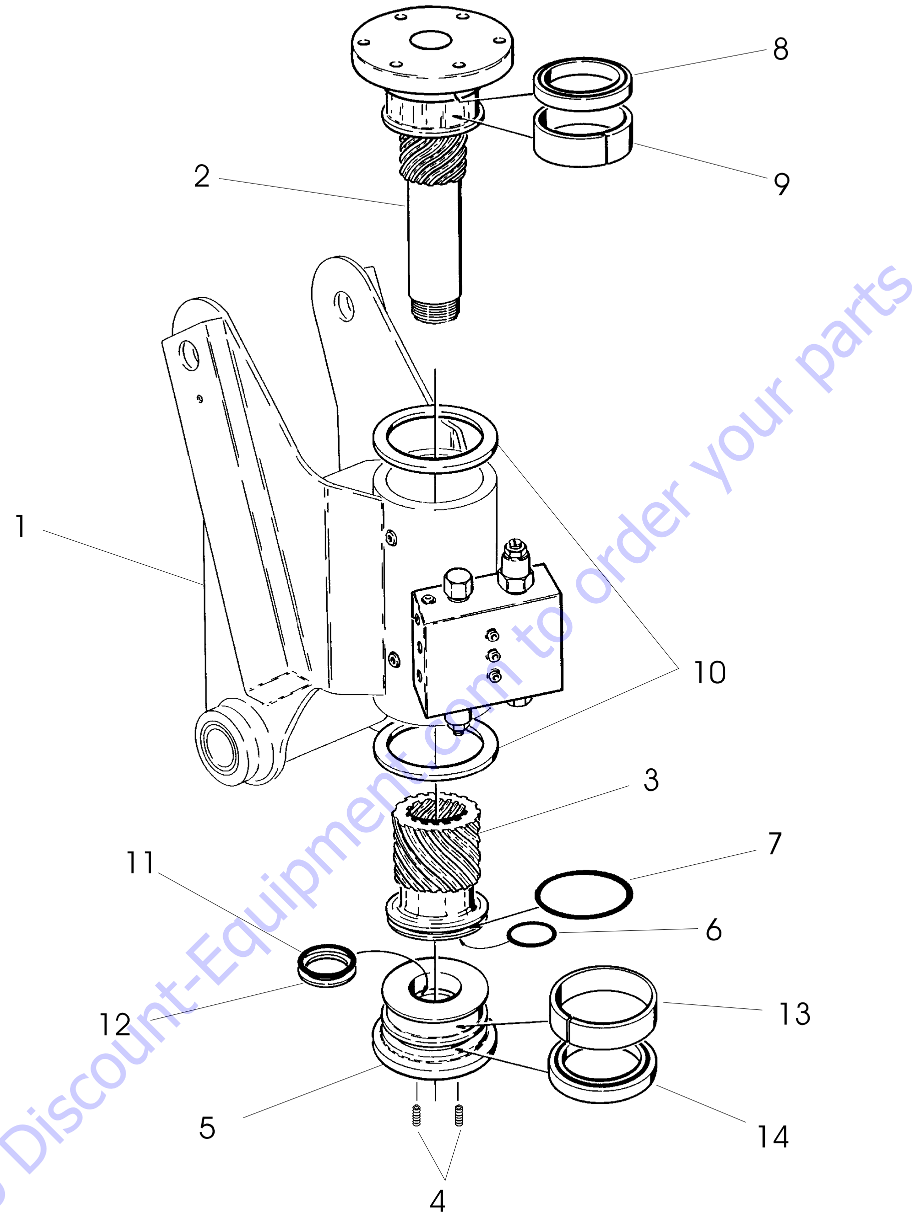


Figure 7-23. Removing End Cap



1. Housing/Ring Gear Assembly
2. Shaft
3. Piston/Sleeve Assembly
4. Setscrews
5. End Cap
6. Rod Seal
7. Piston Seal
8. Bearing Packing
9. Shaft Bearing
10. Thrust Ring
11. Cap Seal
12. Back-up Ring
13. Cap Bearing
14. Bearing Packing

Figure 7-19. Rotator Assembly (Helac)

7. Remove the shaft (2) from piston sleeve (3) and the actuator housing (1).

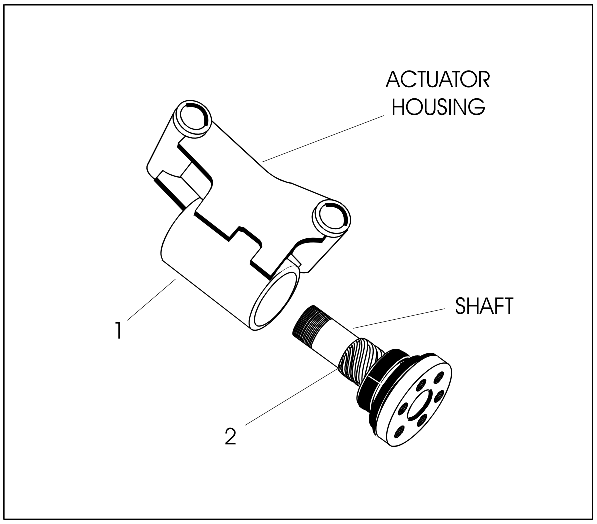


Figure 7-24. Removing Shaft from Housing

8. Remove piston sleeve (3) from housing (1).

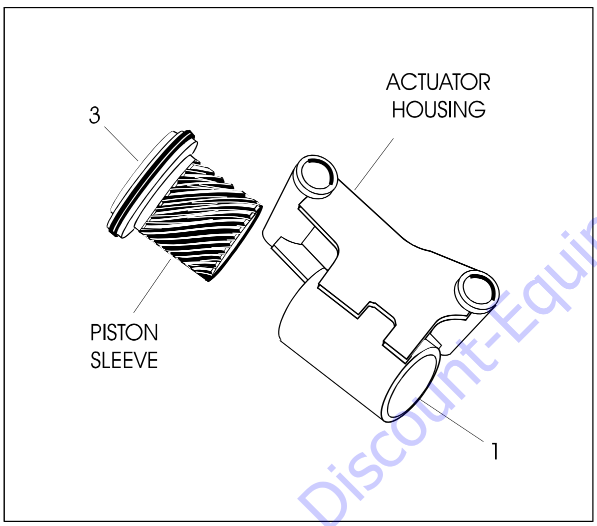


Figure 7-25. Removing Sleeve from Housing

9. Remove all seals and bearings from grooves. Discard seals.

Inspection

1. Clean all parts thoroughly.
2. Closely inspect all parts for excessive wear, cracks and chips. Replace parts as necessary.

NOTE: *A small amount of wear in the spline teeth will have little effect on the actuator strength. New spline sets are manufactured with a backlash of about 0.005 in. per mating set. After long service, a backlash of about 0.015 per set may still be acceptable in most cases, depending on the required accuracy of the application.*

3. Check the ring gear for wear and weld damage to the pins.
4. Inspect the cylinder bore for wear and scratches.

Assembly

NOTE: *Lubricate all seals and o-rings with clean hydraulic oil prior to assembly.*

1. Install new seal (7) and bearing (6) on the piston sleeve (3).

NOTE: *Apply a coat of grease to the thrust ring before sliding onto the shaft.*

2. Install new seal (8), thrust ring (10) and bearing (9) on shaft (2).

NOTE: *Apply a coat of grease to the thrust ring before sliding onto the end cap.*

3. Install new seals (11), back-up ring (12), cap bearing (13), bearing packing (14) and thrust ring (10) on end cap (5).
4. Place the actuator in the vertical position, install the piston sleeve (3) in timed relation to the housing (1).

NOTICE

DO NOT MISALIGN THE SLEEVE TOO MUCH ANY ONE WAY, AS IT WILL MARK THE CYLINDER BORE.

NOTE: *The timing marks (the small punch marks on the face of each gear), must be aligned for proper shaft orientation. (See Actuator Timing.)*

5. Install the shaft (2) into housing (1) by aligning the proper punched timing marks. (See Actuator Timing.)
6. Temporarily tape the threaded portion of the shaft will help installation past the shaft seals (masking tape).
7. The end cap (5) is torqued to 40 - 50 ft. lbs. (54 - 68 Nm), such that the actuator begins rotation at approximately 100 psi (6.895 Bar) pressure.

8. The end cap must be secured against the shaft by installing axial set screws (4).

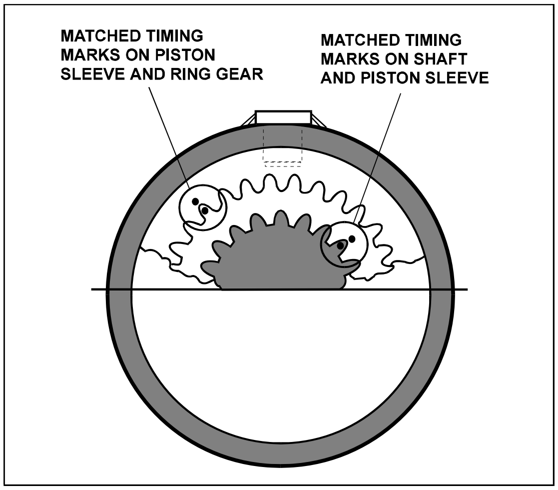
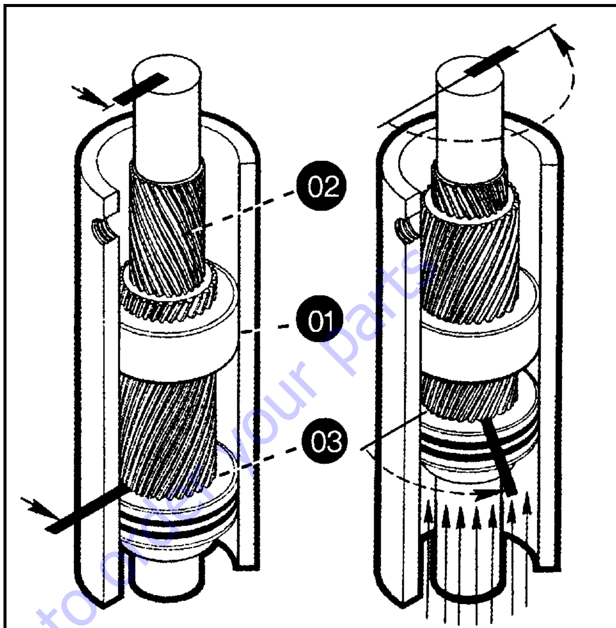


Figure 7-26. Actuator Timing

7.9 ROTARY ACTUATOR (S/N 0300132437 TO PRESENT)

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.



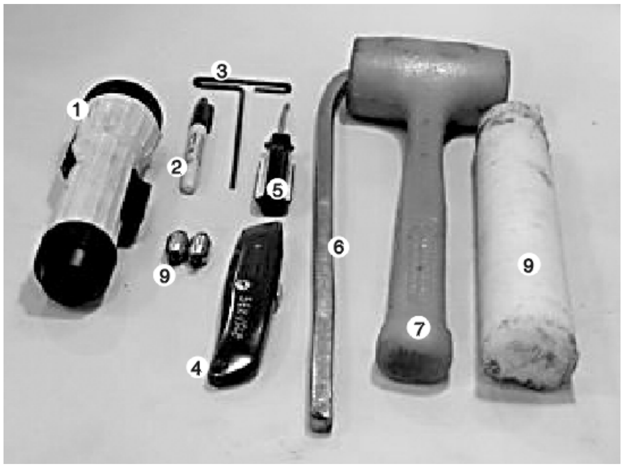
Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.

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.

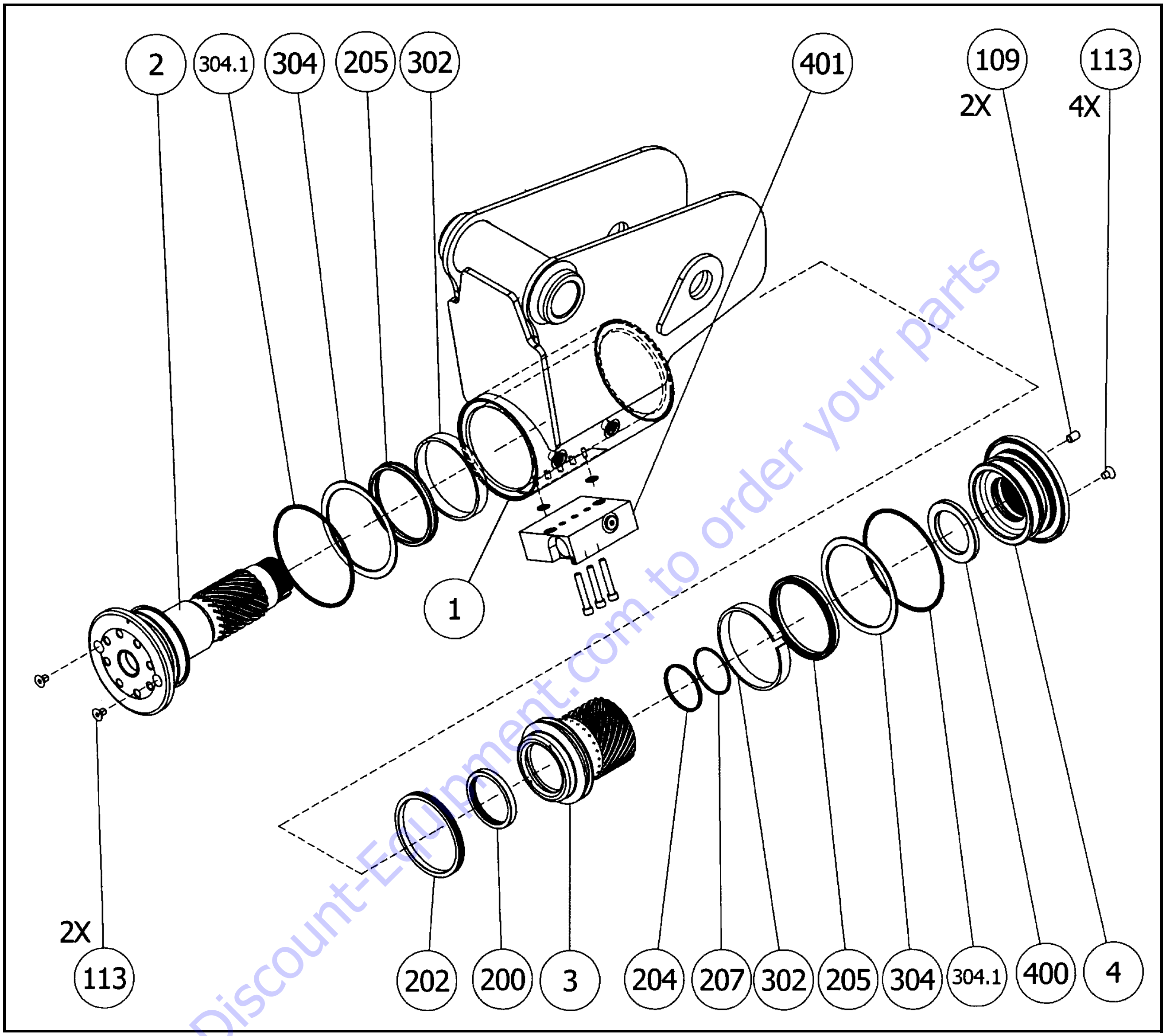
Required Tools

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



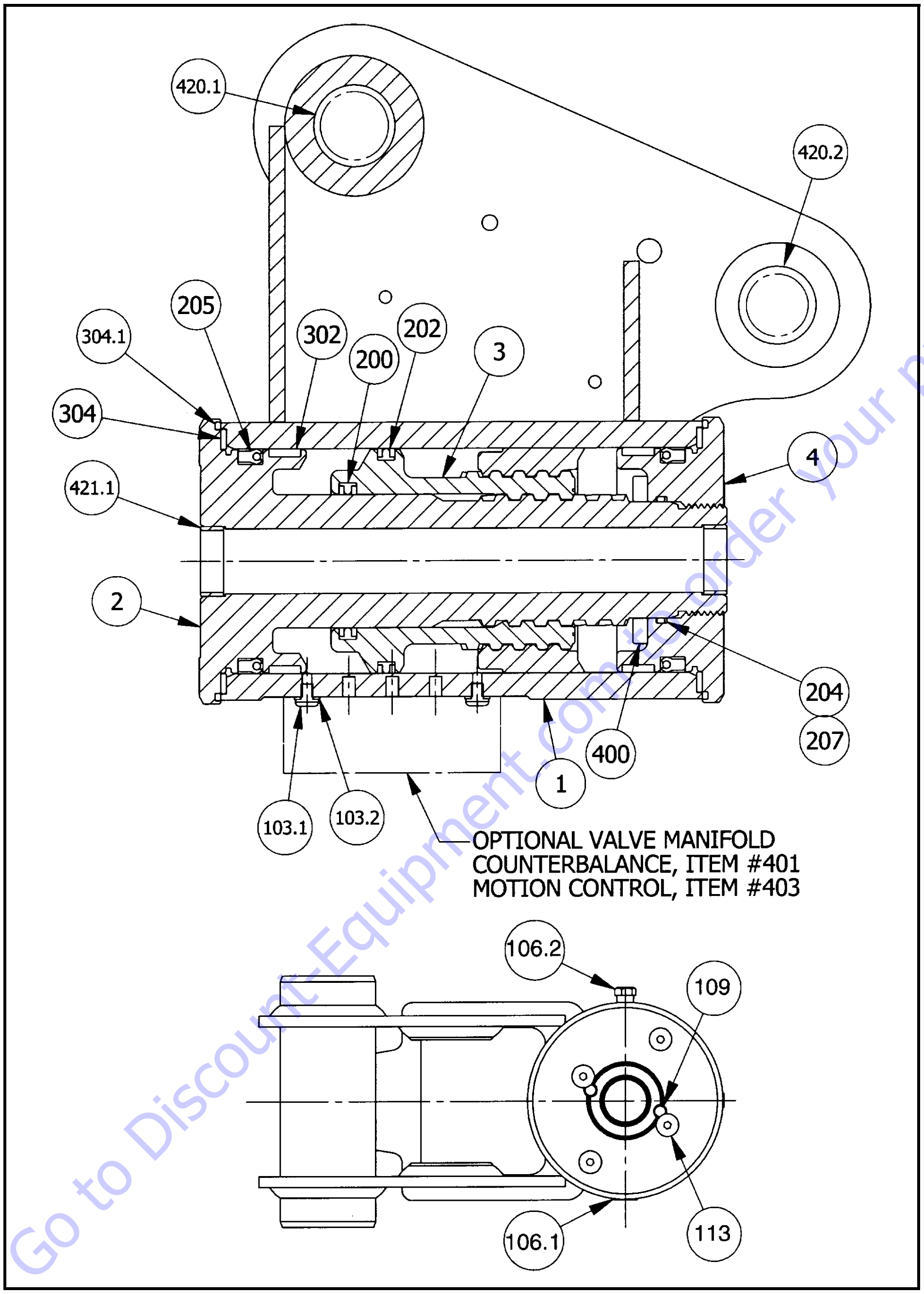
1. Flashlight - helps examine timing marks, component failure and overall condition.
2. Felt Marker - match mark the timing marks and outline troubled areas.
3. Allen wrench - removal of port plugs and set screws.
4. Box knife - removal of seals.
5. Seal tool - assembly and disassembly of seals and wear 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 7-27. Rotary Actuator - Exploded View

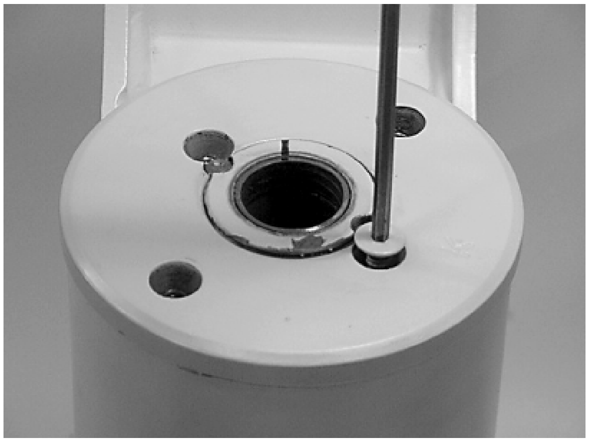


PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2 . Washer	202. T-Seal	304. Thrust	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring	Washer	420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109 .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

Figure 7-28. Rotary Actuator - Assembly Drawing

Disassembly

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



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

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

If the pin will not come out with the ”Easy Out”, use 5/1 6” drill bit to a depth of 1/2” (12.7mm) to drill out the entire pin.

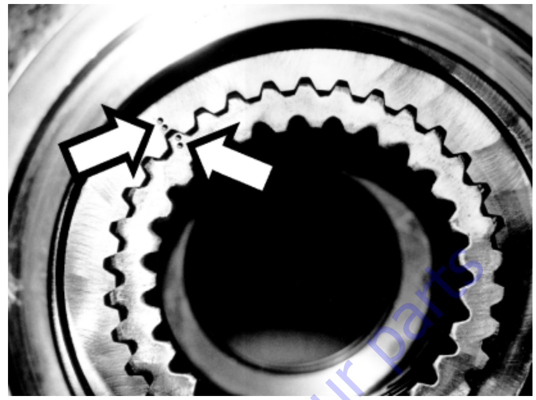
4. Install the end cap (4) removal tools provided with the Helac seal kit.

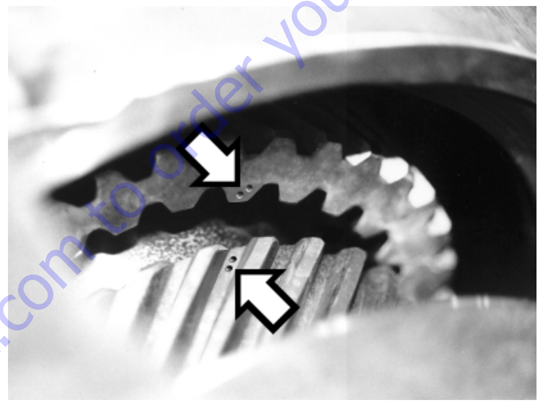
5. Using a metal bar, or something similar, unscrew the end cap (4) by turning it counter clockwise.

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.

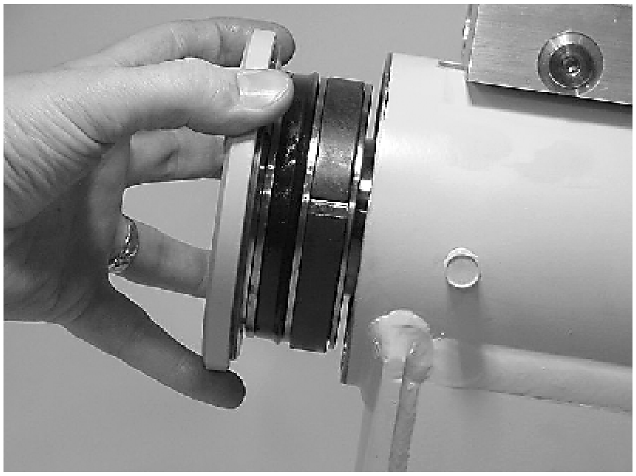
8. Every actuator has timing marks for proper engagement.





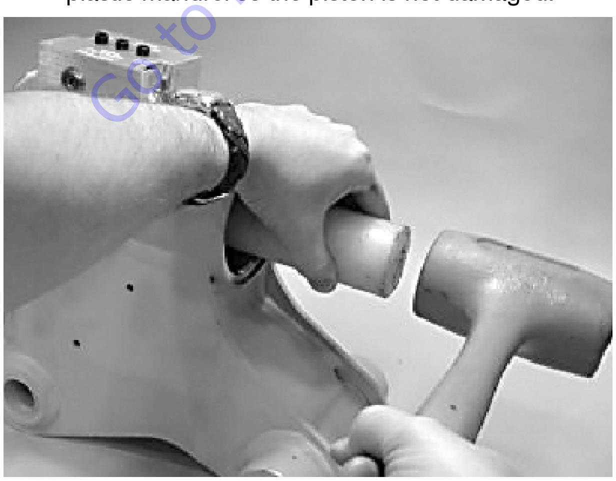
9. Prior to removing the shaft, (2), use a felt marker to clearly indicate the timing marks between shaft and piston. This will greatly simplify timing during assembly.

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

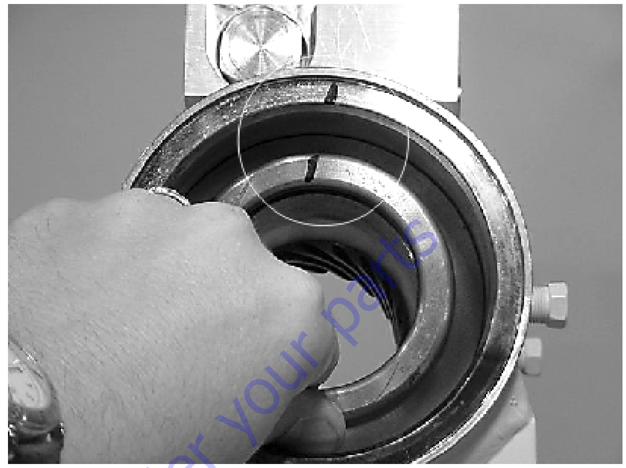


11. Before removing the piston (3), mark the housing (1) ring gear in relation to the piston O.D. gear. There should now be timing marks on the housing (1) ring gear, the piston (3) and the shaft (2).

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



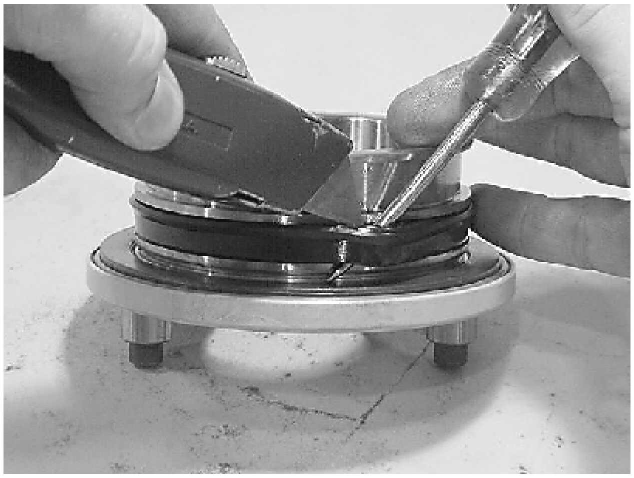
13. At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.



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).

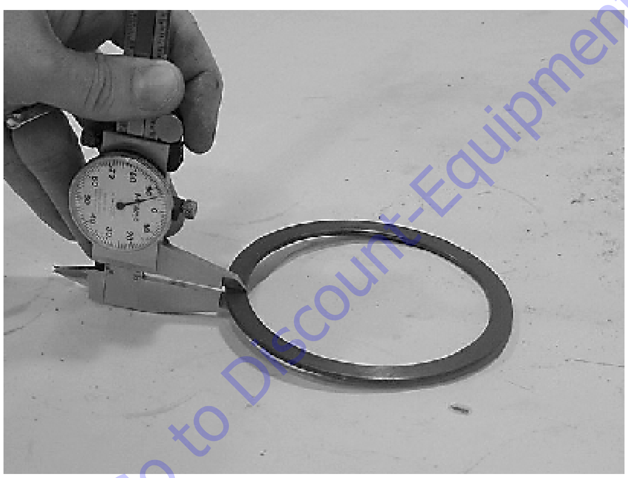
19. Remove the piston O.D. seal (202).

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.

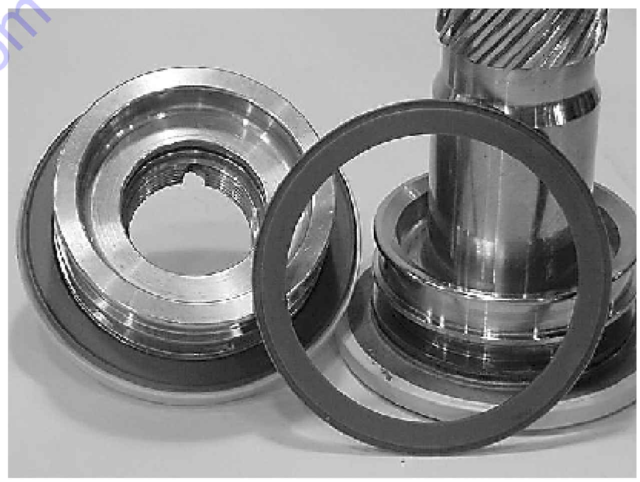
2. Inspect the thrust washers (304) for rough or worn edges and surfaces. Measure it's thickness to make sure it is within specifications (Not less than 0.092" or 2.34 mm).



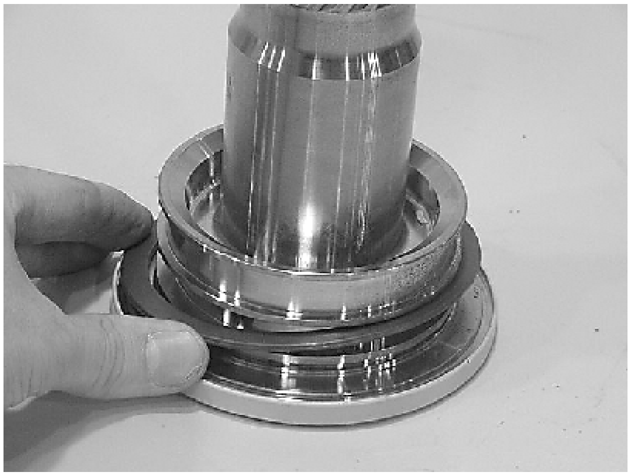
3. Inspect the wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).

Assembly

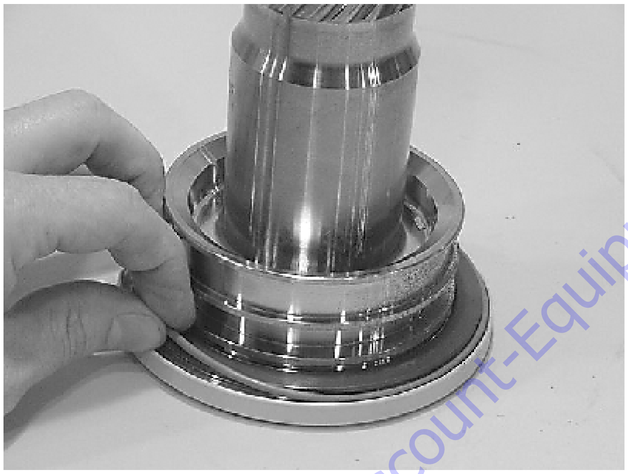
1. Gather all the components and tools into one location prior to re-assembly. Use the cut away drawing to reference the seal orientations.



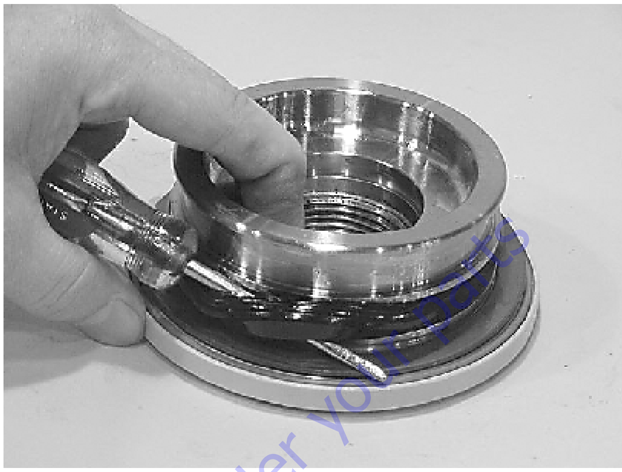
2. Install the thrust washer (304) onto shaft (2) and end cap (4).



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.

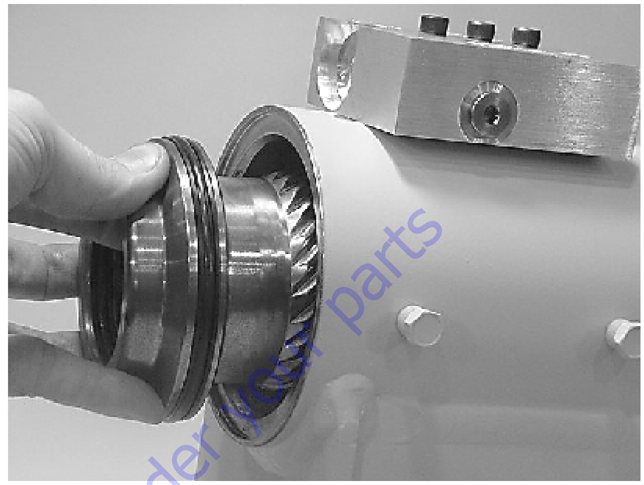
   Install the outer T-seal (202) by stretching it around the groove in a circular motion.

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

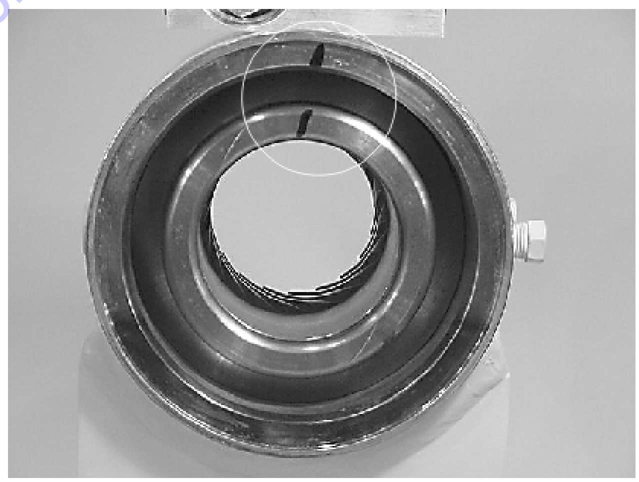
Beginning with the inner seal (200) insert one end of b/u ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly.

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.

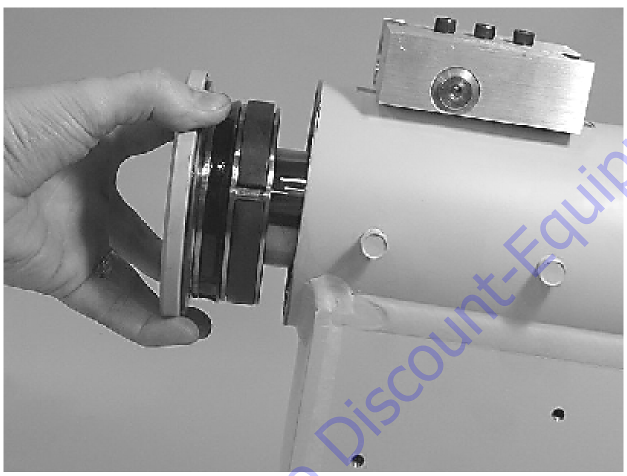


8. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.



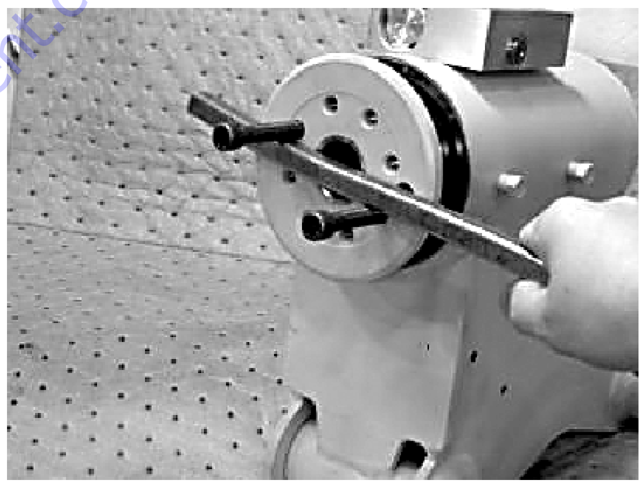
9. Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.

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



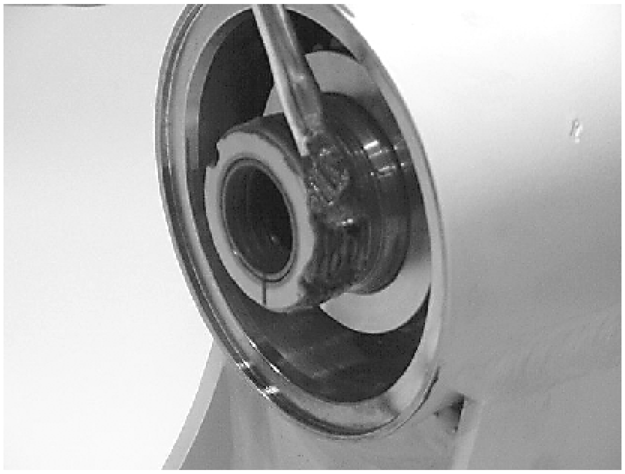
11. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.

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.



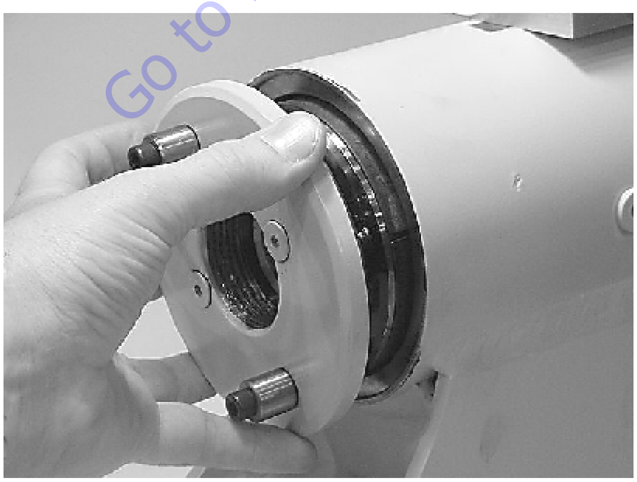
13. Install the stop tube onto the shaft end. Stop tube is an available option to limit the rotation of an actuator.

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).

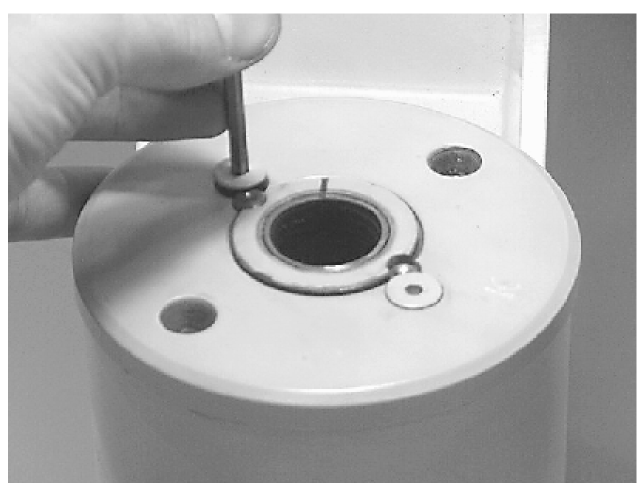
16. Thread the end cap (4) onto the shaft (2) end. Make sure the wear guide stays in place on the end cap as it is threaded into the housing (1).



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 7-29., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old Loctite.
2. Make sure the new valve has the O-rings in the counterbores of the valve to seal it to the actuator housing.
3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. Loctite #242 should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4-inch bolts 110 to 120 inch pounds (12.4 to 13.5 Nm). Do not torque over 125 inch pounds (14.1 Nm). Torque the 5/16-inch bolts 140 inch pounds (15.8 Nm). Do not torque over 145 inch pounds (16.3 Nm).

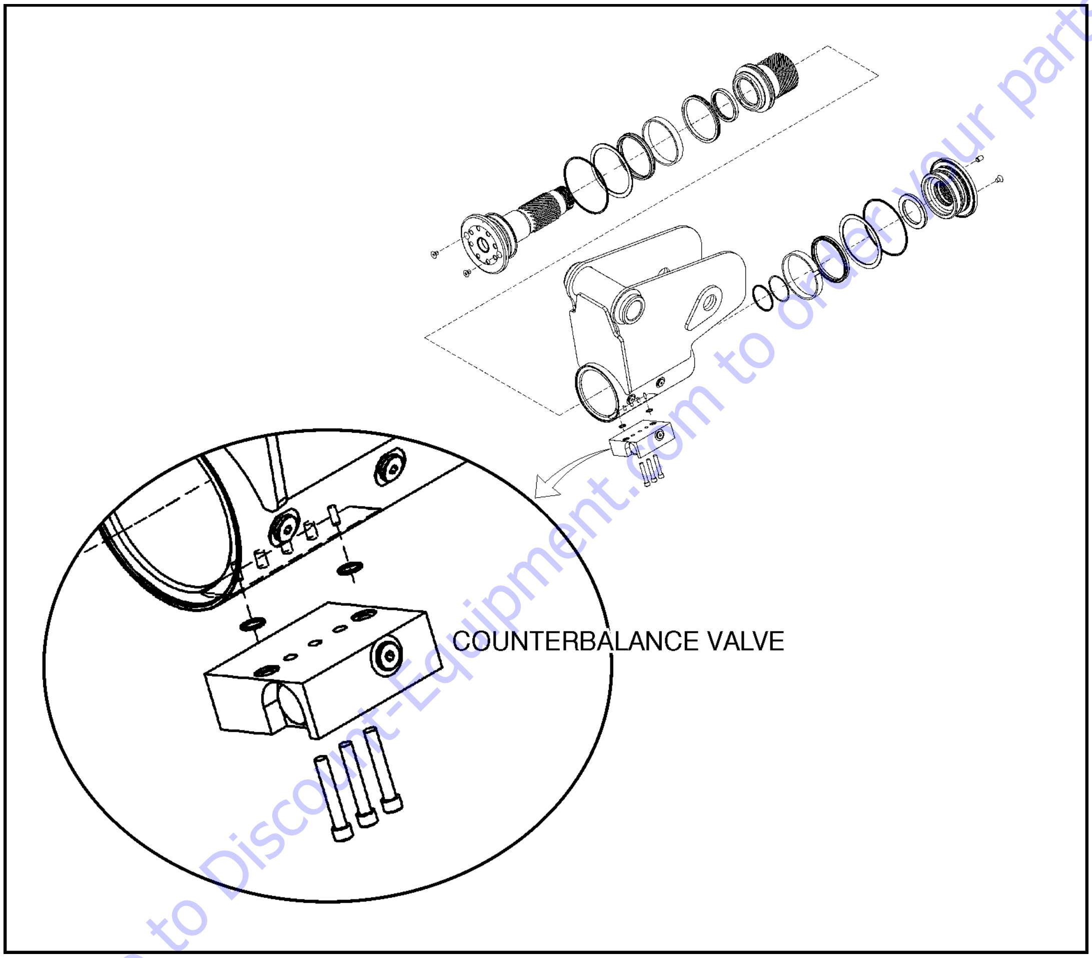
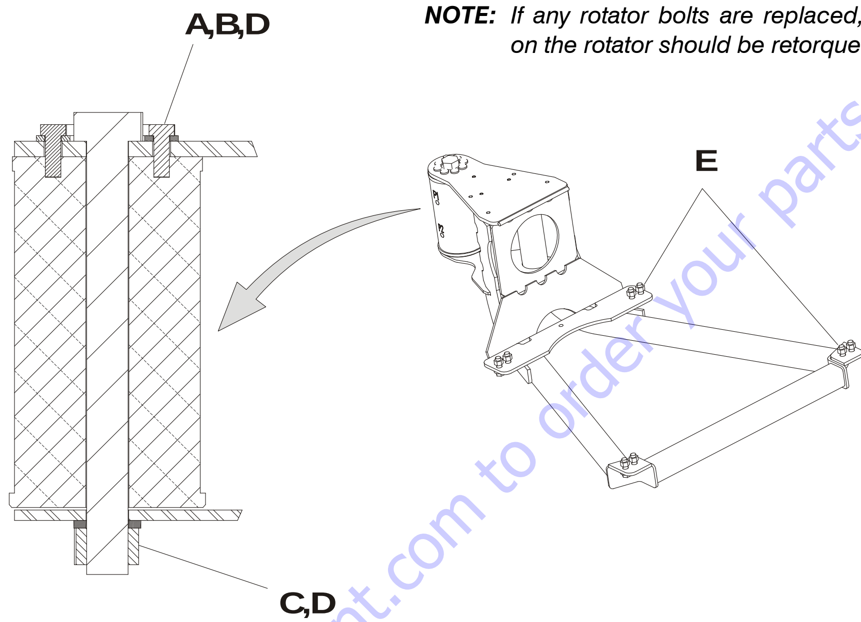


Figure 7-29. Rotator Counterbalance Valve

7.10 FOOT SWITCH ADJUSTMENT

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

NOTE: *If any rotator bolts are replaced, all bolts on the rotator should be retorqued.*



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 85 ft. lbs. (115 Nm)

Figure 7-30. Platform Support Torque Values

SECTION 8. HYDRAULICS & HYDRAULIC SCHEMATICS

8.1 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.

8.2 VALVES - THEORY OF OPERATION

Solenoid Control Valve

Control valves used are four-way three-position solenoid valves of the sliding spool design. When a circuit is activated and the control valve solenoid energizes, the spool is shifted and the corresponding work port opens to permit oil flow to the component in the selected circuit with the opposite work port opening to reservoir. Once the circuit is deactivated (control returned to neutral) the valve spool returns to neutral (center) and oil flow is then directed through the valve body and returns to reservoir. A typical control valve consist of the valve body, sliding spool, and two solenoid assemblies. The spool is machine fitted in the bore of the valve body. Lands on the spool divide the bore into various chambers, which, when the spool is shifted, align with corresponding ports in the valve body open to common flow. At the same time other ports would be blocked to flow. The spool is spring loaded to center position, therefore when the control is released, the spool automatically returns to neutral, prohibiting any flow through the circuit.

Relief Valves

Relief valves are installed at various points within the hydraulic system to protect associated systems and components against excessive pressure. Excessive pressure can be developed when a cylinder reaches its limit of travel and the flow of pressurized fluid continues from the system control. The relief valve provides an alternate path for the continuing flow from the pump, thus preventing rupture of the cylinder, hydraulic line or fitting. Complete failure of the system pump is also avoided by relieving circuit pressure. The relief valve is installed in the circuit between the pump outlet (pressure line) and the cylinder of the circuit, generally as an integral part of the system valve bank. Relief pressures are set slightly higher than the load requirement, with the valve diverting excess pump delivery back to the reservoir when operating pressure of the component is reached.

8.3 CYLINDERS - THEORY OF OPERATION

Systems Incorporating Double Acting Cylinders

Cylinders are of the double acting type. Systems incorporating double acting cylinders are as follows: Slave Level, Master Level, Lift, Telescope, Articulating Jib Boom Lift. A double acting cylinder is one that requires oil flow to operate the cylinder rod in both directions. Directing oil (by actuating the corresponding control valve to the piston side of the cylinder) forces the piston to travel toward the rod end of the barrel, extending the cylinder rod (piston attached to rod). When the oil flow is stopped, movement of rod will stop. By directing oil to the rod side of the cylinder, the piston will be forced in the opposite direction and the cylinder rod will retract.

Systems Incorporating Holding Valves

Holding valves are used in the - Lift, Telescope, Lockout, Slave Level and Articulating Jib Boom Lift circuits to prevent retraction of the cylinder rod should a hydraulic line rupture or a leak develop between the cylinder and its related control valve.

8.4 CYLINDER CHECKING PROCEDURE

NOTE: *Cylinder check must be performed anytime a system component is replaced or when improper system operation is suspected.*

Cylinders Without Counterbalance Valves

Master Cylinder and Steer Cylinder

1. Using all applicable safety precautions, activate engine and fully extend cylinder to be checked. Shut down engine.
2. Carefully disconnect hydraulic hoses from retract port of cylinder. There will be some initial weeping of hydraulic fluid which can be caught in a suitable container. After the initial discharge, there should be no further drainage from the retract port.
3. Activate engine and extend cylinder.
4. If cylinder retract port leakage is less than 6-8 drops per minute, carefully reconnect hose to port and retract cylinder. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repair must be made.
5. With cylinder fully retracted, shut down engine and carefully disconnect hydraulic hose from cylinder extend port.
6. Activate engine and retract cylinder. Check extend port for leakage.

7. If extend port leakage is less than 6-8 drops per minute, carefully reconnect hose to extend port, than activate cylinder through one complete cycle and check for leaks. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repairs must be made.

Cylinders With Single Counterbalance Valve

Lift Cylinder

NOTICE

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

1. Using all applicable safety precautions, activate hydraulic system.

⚠ WARNING

WHEN WORKING ON THE MAIN LIFT CYLINDER, RAISE THE BOOM TO HORIZONTAL AND PLACE A BOOM PROP APPROXIMATELY 1 INCH (2.54 CM) BELOW THE MAIN BOOM. DO NOT WORK ON THE CYLINDER WITHOUT A SUITABLE PROP IN PLACE.

2. Shut down hydraulic system and allow machine to sit for 10-15 minutes. If machine is equipped with bang-bang or proportional control valves, turn IGNITION SWITCH to ON, move control switch or lever for applicable cylinder in each direction, then turn IGNITION SWITCH to OFF. If machine is equipped with hydraulic control valves, move control lever for applicable cylinder in each direction. This is done to relieve pressure in the hydraulic lines. Carefully remove hydraulic hoses from appropriate cylinder port block.

3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should be no further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, the counterbalance valve is defective and must be replaced.

4. To check piston seals, carefully remove the counterbalance valve from the retract port. After initial discharge, there should be no further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, the piston seals are defective and must be replaced.

5. If no repairs are necessary or when repairs have been made, replace counterbalance valve and carefully connect hydraulic hoses to cylinder port block.

6. If used, remove lifting device from upright or remove prop from below main boom, activate hydraulic system and run cylinder through one complete cycle to check for leaks.

Cylinders With Dual Counterbalance Valves

Articulating Jib Boom Lift, and Slave), Slave Level, Telescope

NOTICE

OPERATE ALL FUNCTIONS FROM GROUND CONTROLS ONLY.

1. Using all applicable safety precautions, activate hydraulic system.

⚠ WARNING

IF WORKING ON THE PLATFORM LEVEL CYLINDER, STROKE PLATFORM LEVEL CYLINDER FORWARD UNTIL PLATFORM SITS AT A 45 DEGREE ANGLE.

2. Shut down hydraulic system and allow machine to sit for 10-15 minutes. If machine is equipped with bang-bang or proportional control valves, turn IGNITION SWITCH to ON, move control switch or lever for applicable cylinder in each direction, then turn IGNITION SWITCH to OFF. If machine is equipped with hydraulic control valves, move control lever for applicable cylinder in each direction. This is done to relieve pressure in the hydraulic lines. Remove hoses from appropriate cylinder port block.

3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should be no further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, the counterbalance valve is defective and must be replaced.

4. To check piston seals, carefully remove the counterbalance valve from the retract port. After initial discharge, there should be no further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, the piston seals are defective and must be replaced.

5. If no repairs are necessary or when repairs have been made, replace counterbalance valve and carefully connect hydraulic hoses to cylinder port block.

6. If used, remove lifting device from upright or remove prop from below main boom, activate hydraulic system and run cylinder through one complete cycle to check for leaks.

8.5 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.

⚠ WARNING

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

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

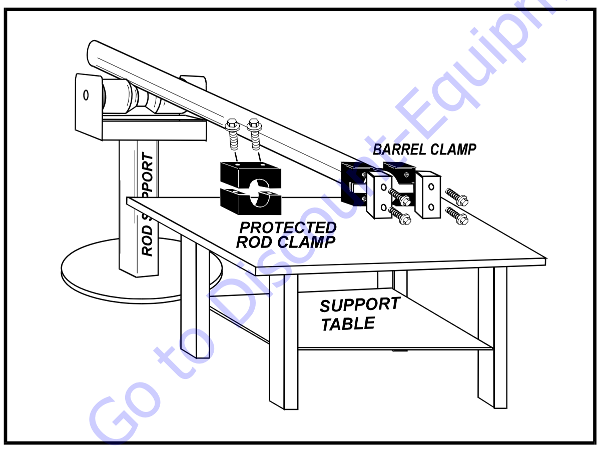


Figure 8-1. Cylinder Barrel Support

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.

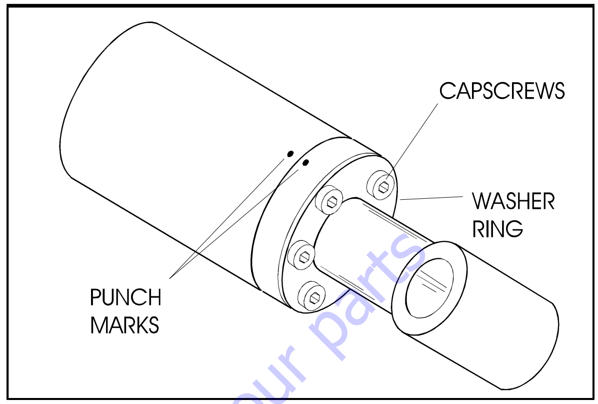


Figure 8-2. Cap Screw Removal

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

NOTICE

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

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

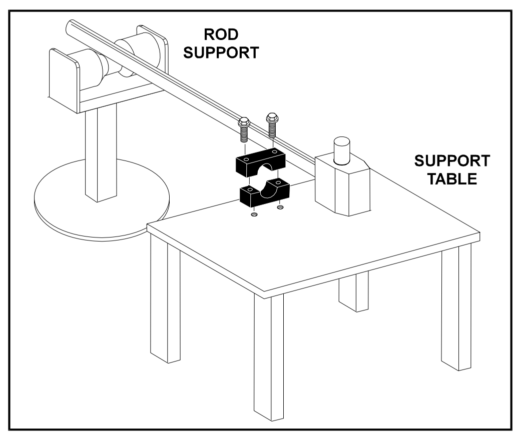


Figure 8-3. Cylinder Rod Support

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

9. Loosen and remove the cap screw(s), if applicable, which attach the tapered bushing to the piston.
10. Insert the cap screw(s) in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the cap screw(s) until the bushing is loose on the piston.
11. Remove the bushing from the piston.

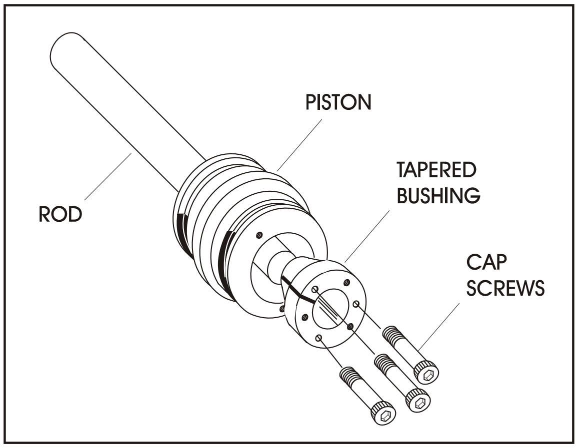


Figure 8-4. Tapered Bushing Removal

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

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing with WD40 prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

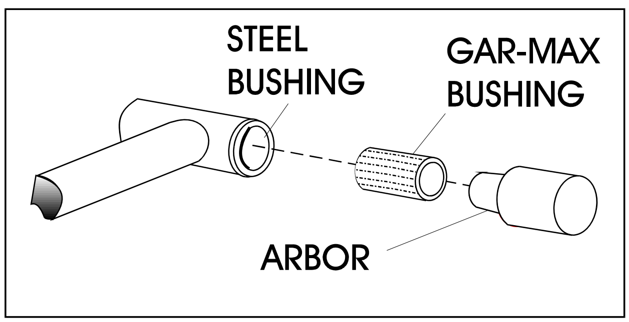


Figure 8-5. Composite Bearing Installation

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.

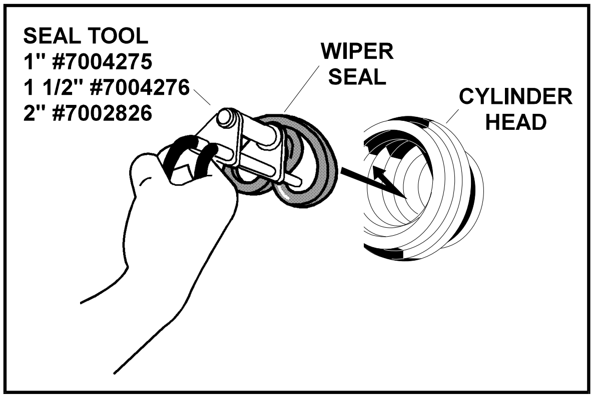


Figure 8-6. Rod Seal Installation

NOTICE

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

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

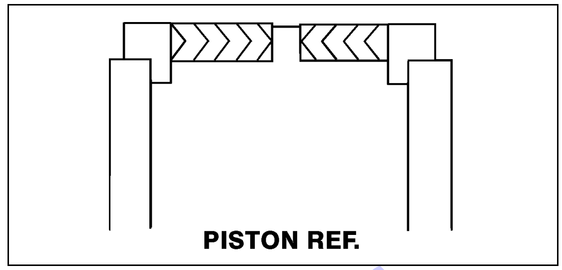


Figure 8-7. Poly-Pak Piston Seal Installation

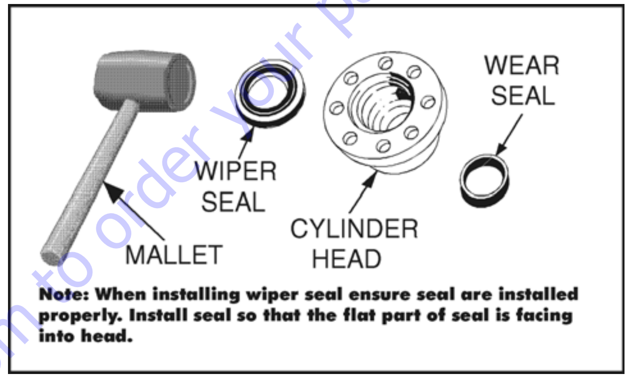


Figure 8-8. Wiper Seal Installation

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

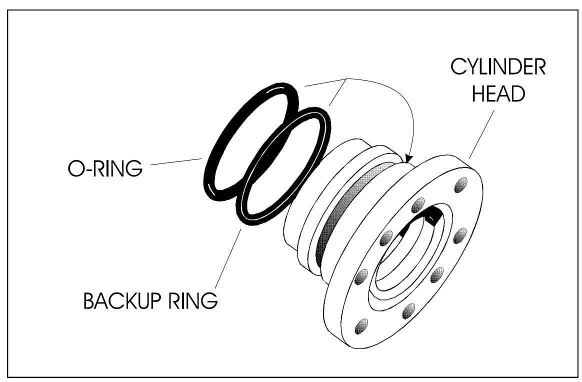


Figure 8-9. Installation of Head Seal Kit

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

5. Carefully slide the piston spacer on the rod.

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

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

7. If applicable, correctly place new seals and guide lock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D.of the piston is recommended to install the solid seal.)

NOTE: *The backup rings for the solid seal have a radius on one side. This side faces the solid seal.(See magnified insert in Figure 8-10.)The split of seals and backup rings are to be positioned so as not to be in alignment with each other.*

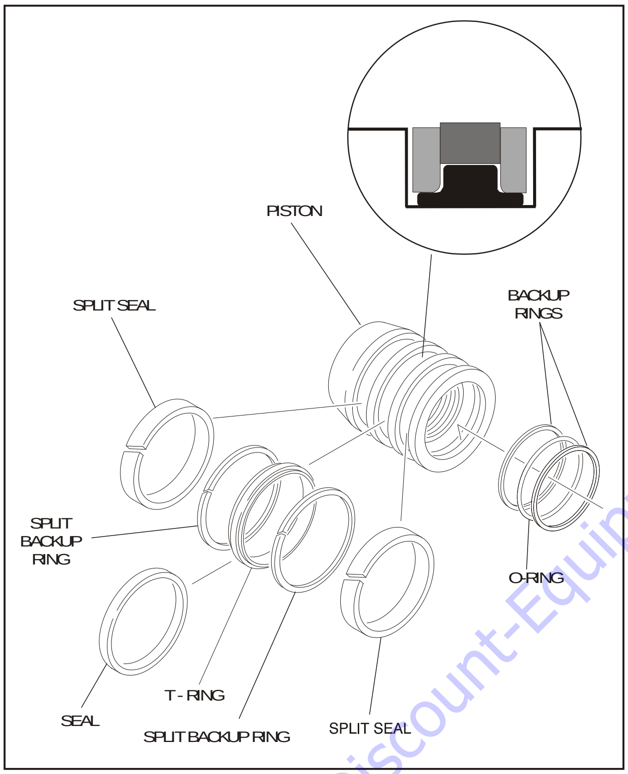


Figure 8-10. Piston Seal Kit Installation

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

9. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and 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.*

⚠ WARNING

TIGHTEN THE CAPSCREWS FOR THE TAPERED BUSHING SECURELY. (SEE TABLE 8-1, CYLINDER HEAD AND TAPERED BUSHING TORQUE SPECIFICATIONS.)

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.

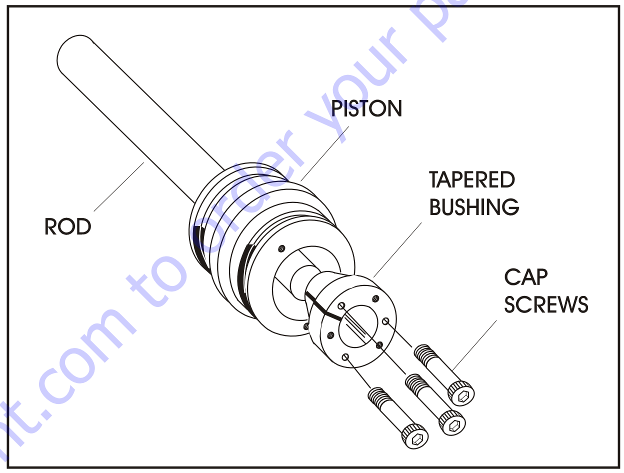


Figure 8-11. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to the specified torque value. (See Table 8-1, 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.

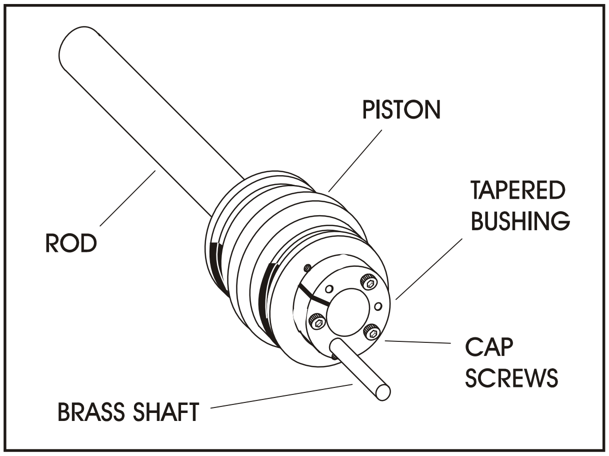


Figure 8-12. Seating the Tapered Bearing

14. Retorque the capscrews evenly and progressively in rotation to the specified torque value. (See Table 8-1, 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 8-10.)

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

NOTICE

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

18. With 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 8-1.)

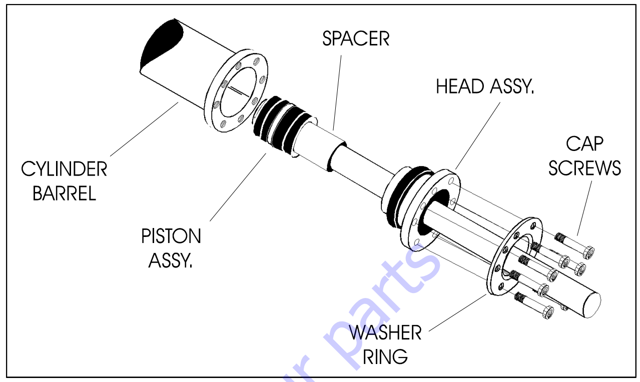


Figure 8-13. Rod Assembly Installation

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 8-2, Holding Valve Torque Specifications).

Table 8-1. Cylinder Head and Tapered Bushing Torque Specifications.

Description	Head Torque Value (Wet)	Tapered Bushing Torque Value (Wet)
Lift Cylinder	240 ft. lbs. (325 Nm)	30 ft. lbs. (41 Nm)
Articulating Lift Cylinder	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Slave Cylinder	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Master Cylinder	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Telescope Cylinder	50 ft. lbs. (68 Nm)	9 ft. lbs. (12 Nm)
Lockout Cylinder	80 ft. lbs. (109 Nm)	N/A
Articulating Slave Cylinder	50 ft. lbs. (68 Nm)	9 ft. lbs. (12 Nm)
Articulating Master Cylinder	50 ft. lbs. (68 Nm)	9 ft. lbs. (12 Nm)

Table 8-2. 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)

CAUTION

IF THE CYLINDER IS TO BE TESTED PRIOR TO INSTALLATION ON THE MACHINE, EXTREME CARE SHOULD BE USED TO INSURE THAT THE OUTER END OF THE ROD IS SUPPORTED. USE EITHER A TRAVELING OVERHEAD HOIST, FORK-LIFT, OR OTHER MEANS TO SUPPORT THE OVERHANGING WEIGHT OF THE EXTENDING ROD.

8.6 CYLINDER REMOVAL AND INSTALLATION

Main Boom Telescope Cylinder Removal

1. Place machine on a flat and level surface, with main boom in the horizontal position.
2. Shut down engine. Support main boom basket end with a prop. (See Figure 8-14., Boom Positioning and Support, Cylinder Repair).

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 hydraulic lines to telescope cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
4. Remove the hardware securing cover plate on bottom of the base boom section and remove cover.

NOTE: *Do not allow cable to rotate. This may damage the cable.*

5. Clamp both threaded ends of cable to prevent rotation. Note: Do not clamp on threads. Remove jam nuts and loosen adjustment nuts so there is slack in the cables. Remove the hardware securing push bar to turntable and telescope cylinder.
6. Using a suitable brass drift, carefully drive the push bar pins from the telescope cylinder rod and turntable.
7. Remove hardware securing cable adjustment block to aft end of the base boom section and remove block.
8. Remove hardware securing telescope cylinder to aft end of the mid boom section.

NOTICE

WHEN REMOVING THE TELESCOPE CYLINDER FROM THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO POSITION: DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

9. Remove bolts securing cable attach bar to top of fly boom section.
10. Pull the telescope cylinder and cables partially from aft end of the base boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.
11. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.

Main Boom Telescope Cylinder Installation

1. Route extend cables around extend sheave and secure cables to the telescope cylinder.
2. Install extend cables mounting blocks to threaded ends of cables. Loosely install nuts and jam nuts onto the threaded end of cables.

NOTE: *When installing cables care must be taken not to twist or cross the cables.*

3. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.

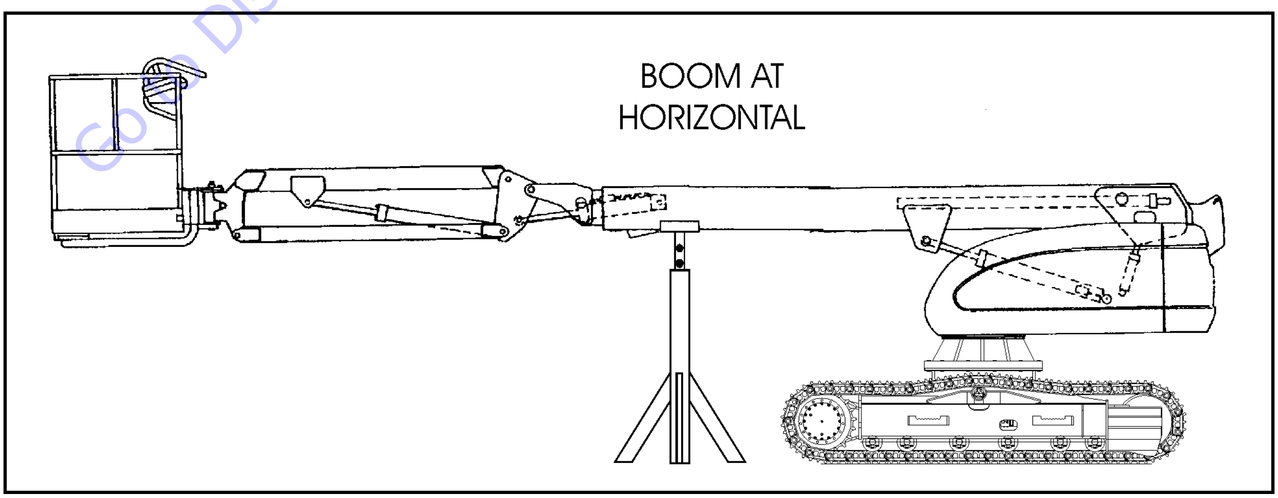


Figure 8-14. Boom Positioning and Support, Cylinder Repair

4. Install extend cable mounting blocks to threaded ends of cables. Loosely install nuts and jam nuts onto the threaded ends of cables.

NOTE: *When installing cables, care must be taken not to twist or cross the cables.*

5. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.

NOTICE

WHEN INSERTING THE TELESCOPE CYLINDER INTO THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO POSITION: DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

6. Carefully install the telescope cylinder barrel end support into slots in mid boom and secure with blocks and bolts. Use Loctite #242 on bolts.
7. Align holes in aft end of the fly boom section with holes in cable mounting block, then secure with mounting hardware.
8. Align holes in aft end of the base boom section with holes in cable mounting block, then secure with mounting hardware.
9. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.
10. Align holes in rod end of the telescope cylinder with holes in push bar. Install push bar pin and secure with mounting hardware.
11. Align holes in push bar with holes in turntable. Install push bar pin and secure with mounting hardware.

NOTE: *Boom cables must be torqued after installation of the telescope cylinder. (See Section 4 - Boom & Platform)*

Main Boom Lift Cylinder Removal

1. Place the machine on a flat and level surface. Start the engine and place the main boom in the horizontal position. Shut down engine and prop the boom. (See Figure 8-14., Boom Positioning and Support, Cylinder Repair).
2. Remove the hardware retaining the cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.
3. Using auxiliary power, retract the lift cylinder rod completely.
4. Disconnect, cap and tag the main boom lift cylinder hydraulic lines and ports.
5. Remove barrel end attach pin retaining hardware. Using a suitable brass drift drive out the barrel end attach pin from the turntable.
6. Remove the cylinder from the turntable and place in a suitable work area.

Main Boom Lift Cylinder Installation

1. Install lift cylinder in place using suitable slings or supports, aligning attach pin mounting holes on the turntable.
2. Using a suitable drift, drive the barrel end attach pin through the mounting holes in the lift cylinder and the turntable. Secure in place with the pin retaining hardware.
3. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.
4. Using auxiliary power, extend the cylinder rod until the attach pin hole aligns with those in the boom. Using a suitable soft mallet, drive the cylinder rod attach pin through the boom and lift cylinder. Secure the pin in place with attaching hardware.
5. Remove boom prop and overhead crane. Activate hydraulic system.
6. Using all applicable safety precautions, operate the boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
7. Check fluid level of hydraulic tank and adjust as necessary.

8.7 PRESSURE SETTING PROCEDURES

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

Main Relief

1. Install pressure gauge at quick disconnect on port MP on main valve.
2. With the aid of an assistant, activate telescope in.
3. While monitoring pressure gauge, adjust main relief to 3000 PSI (206.85 Bar). Turn the adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

Lift Down

1. Install pressure gauge at quick disconnect on port MP on main valve.
2. With the aid of an assistant, activate lift down.
3. While monitoring pressure gauge, adjust the lift down relief to 1500 PSI (103 Bar). Turn the adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

Swing

NOTE: *Left and right swing pressures are set with one adjustment.*

1. Install pressure gauge at quick disconnect on port MP on main valve.
2. Lock the turntable using the turntable lock.
3. With the aid of an assistant, activate swing left or right
4. While monitoring pressure gauge, adjust the swing relief to 1700 PSI (117 Bar). Turn the adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

Platform Level Up

NOTICE

PRESSURE IS TRAPPED AT PORT M3.

1. Install pressure gauge at quick disconnect on port M3 on main valve after releasing the pressure. To release the pressure, activate level down to the end of the stroke. This will release the pressure and allow installation of a pressure gauge.
2. With the aid of an assistant, activate level up.
3. While monitoring pressure gauge, adjust the level up relief to 2800 PSI (193 Bar). Turn the adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

Platform Level Down

NOTICE

PRESSURE IS TRAPPED AT PORT M4.

1. Install pressure gauge at quick disconnect on port M4 on main valve after releasing the pressure. To release the pressure, activate level up to the end of the stroke. This will release the pressure and allow installation of a pressure gauge.
2. With the aid of an assistant, activate level down.
3. While monitoring pressure gauge, adjust the level up relief to 1800 PSI (124 Bar). Turn the adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

Jib Up

1. Install pressure gauge on the M port on the jib block.
2. With the aid of an assistant, activate jib up.
3. While monitoring pressure gauge, adjust the jib up relief to 1500 PSI (103 Bar). Turn the adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

Jib Down

1. Install pressure gauge on the M port on the jib block.
2. With the aid of an assistant, activate jib down.
3. While monitoring pressure gauge, adjust the jib down relief to 1200 PSI (82 Bar). Turn the adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

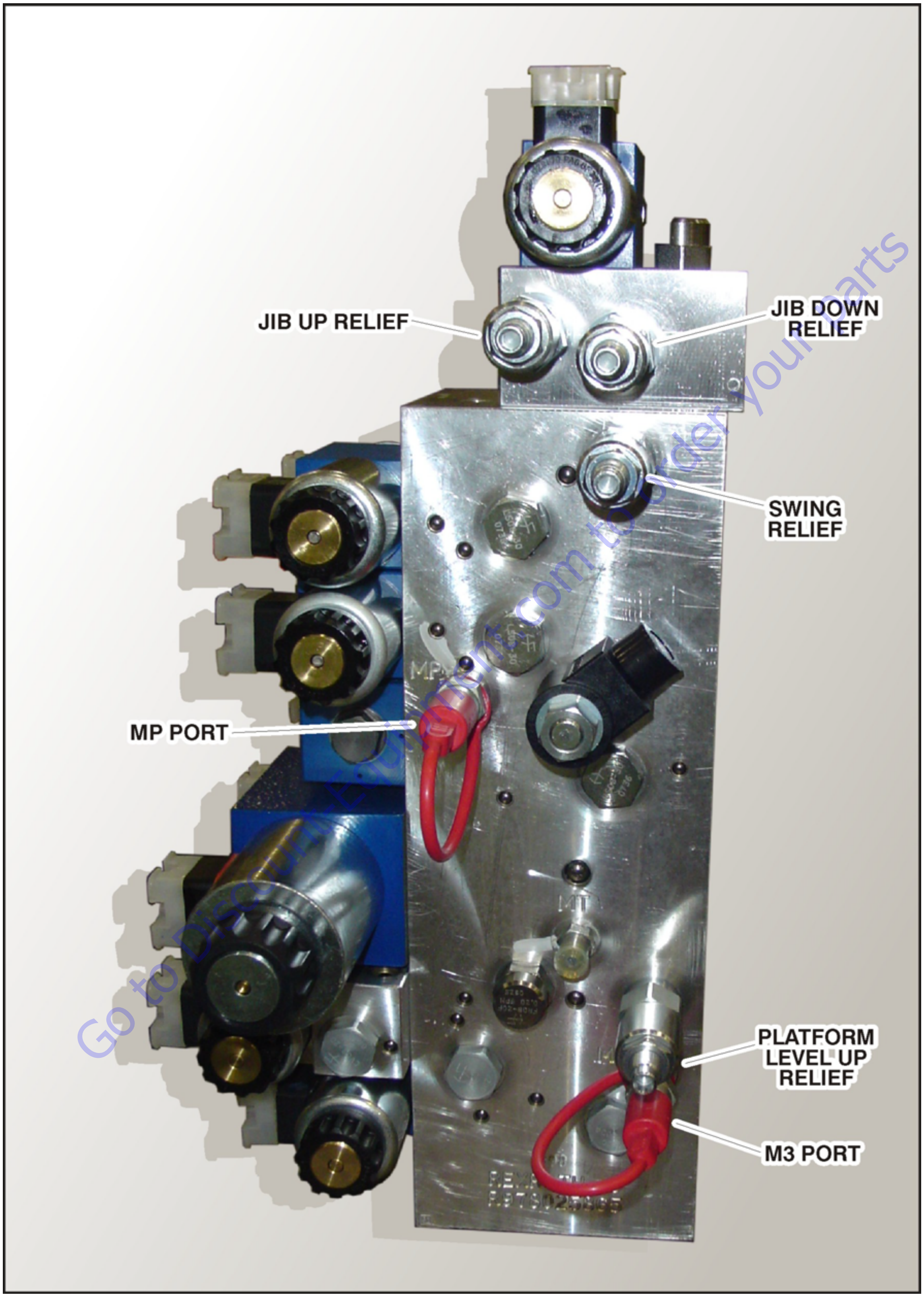


Figure 8-15. Pressure Setting Adjustments - Sheet 1 of 2

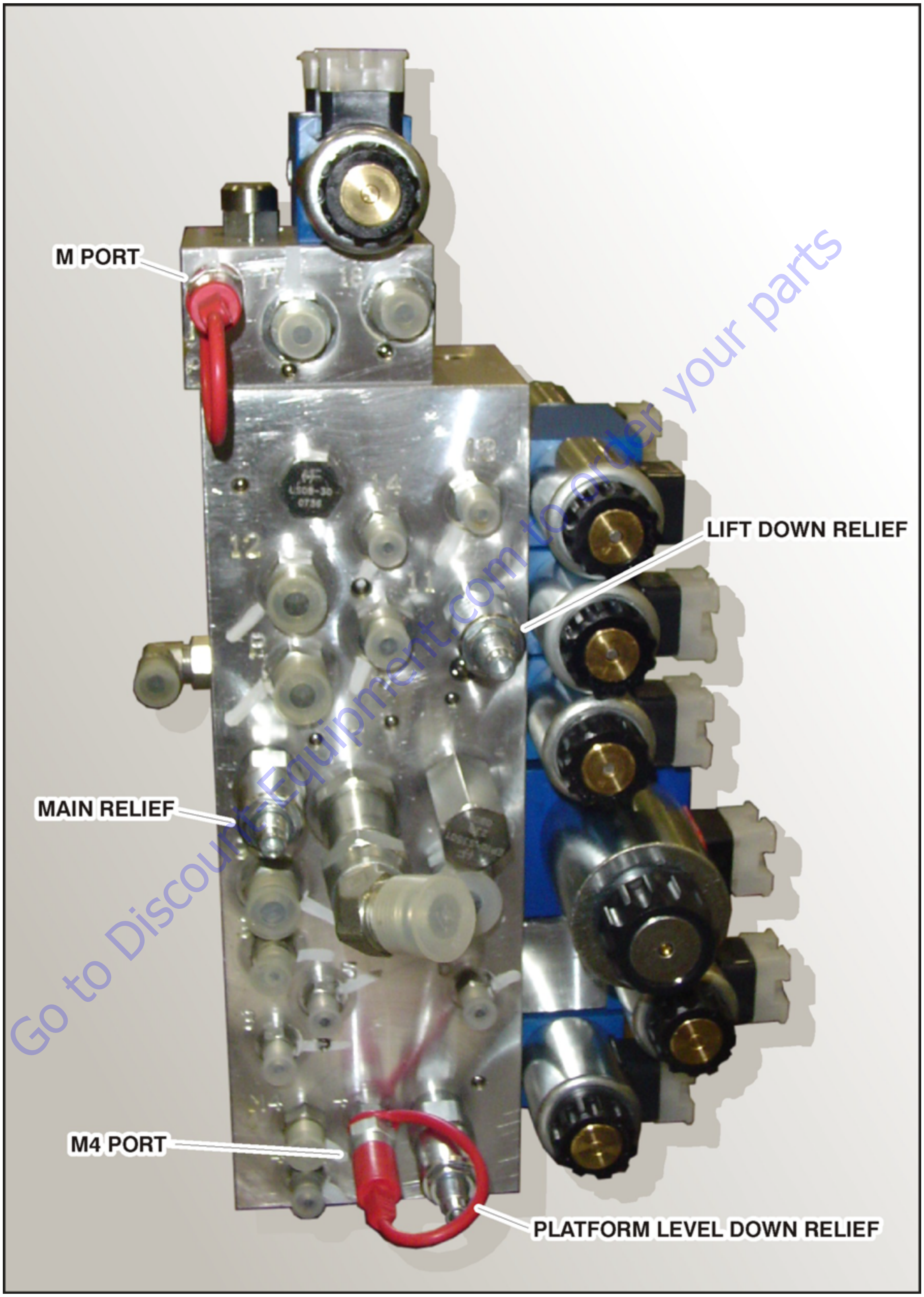
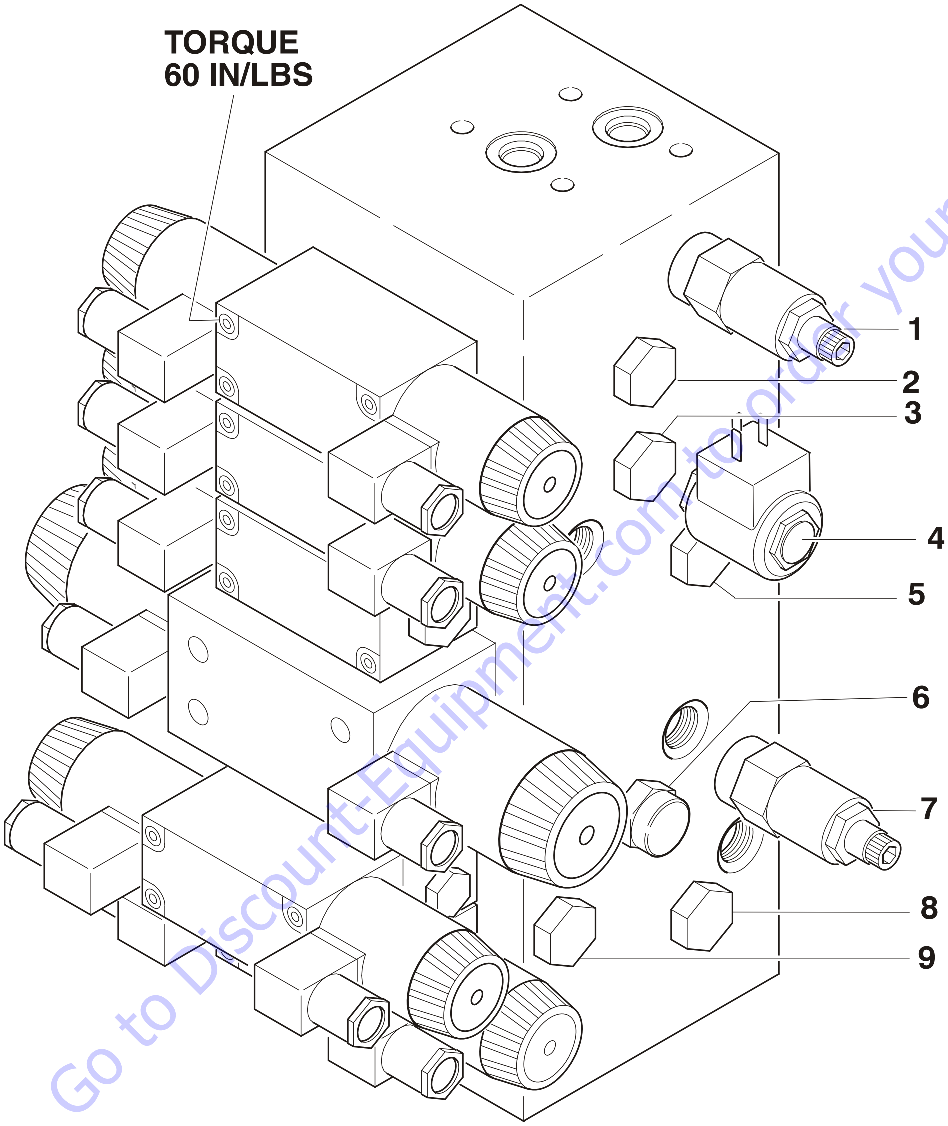
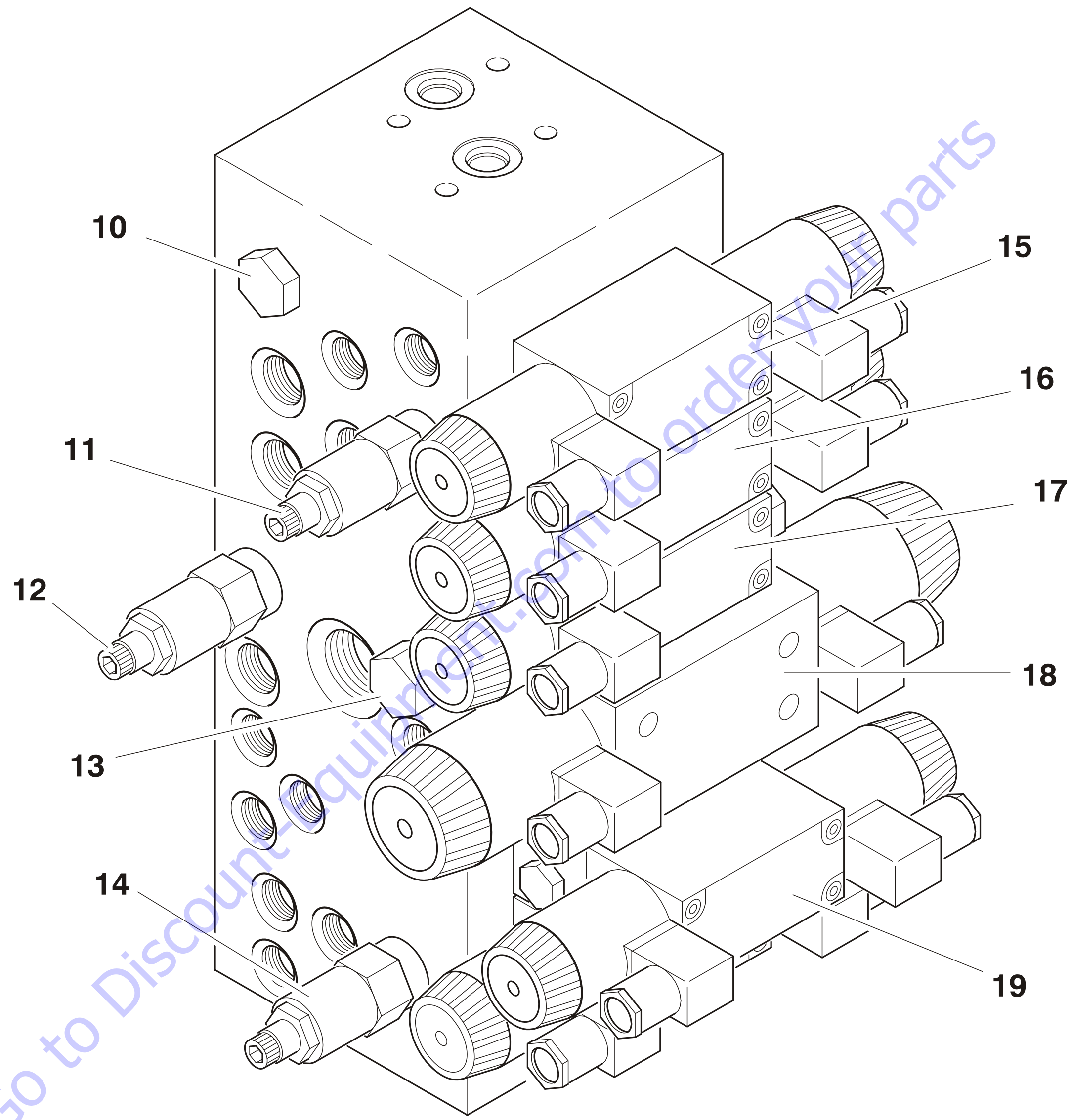


Figure 8-16. Pressure Setting Adjustments - Sheet 2 of 2



1. Relief Valve
2. Shuttle Cartridge
3. Shuttle Cartridge
4. Cartridge
5. Shuttle Cartridge
6. Flow Control Cartridge
7. Platform Level Relief
8. Platform Level Check
9. Platform Level Check

Figure 8-17. Location of Components - Main Control Valve (Sheet 1 of 2)



10. Shuttle Cartridge
11. Relief Valve
12. Main Relief Valve
13. Pressure Sensing Cartridge
14. Relief Valve
15. Swing Valve
16. Upper Lift Valve
17. Flow Control Valve
18. Upper Tele Valve
19. Platform Rotate Valve

Figure 8-18. Location of Components - Main Control Valve (Sheet 2 of 2)

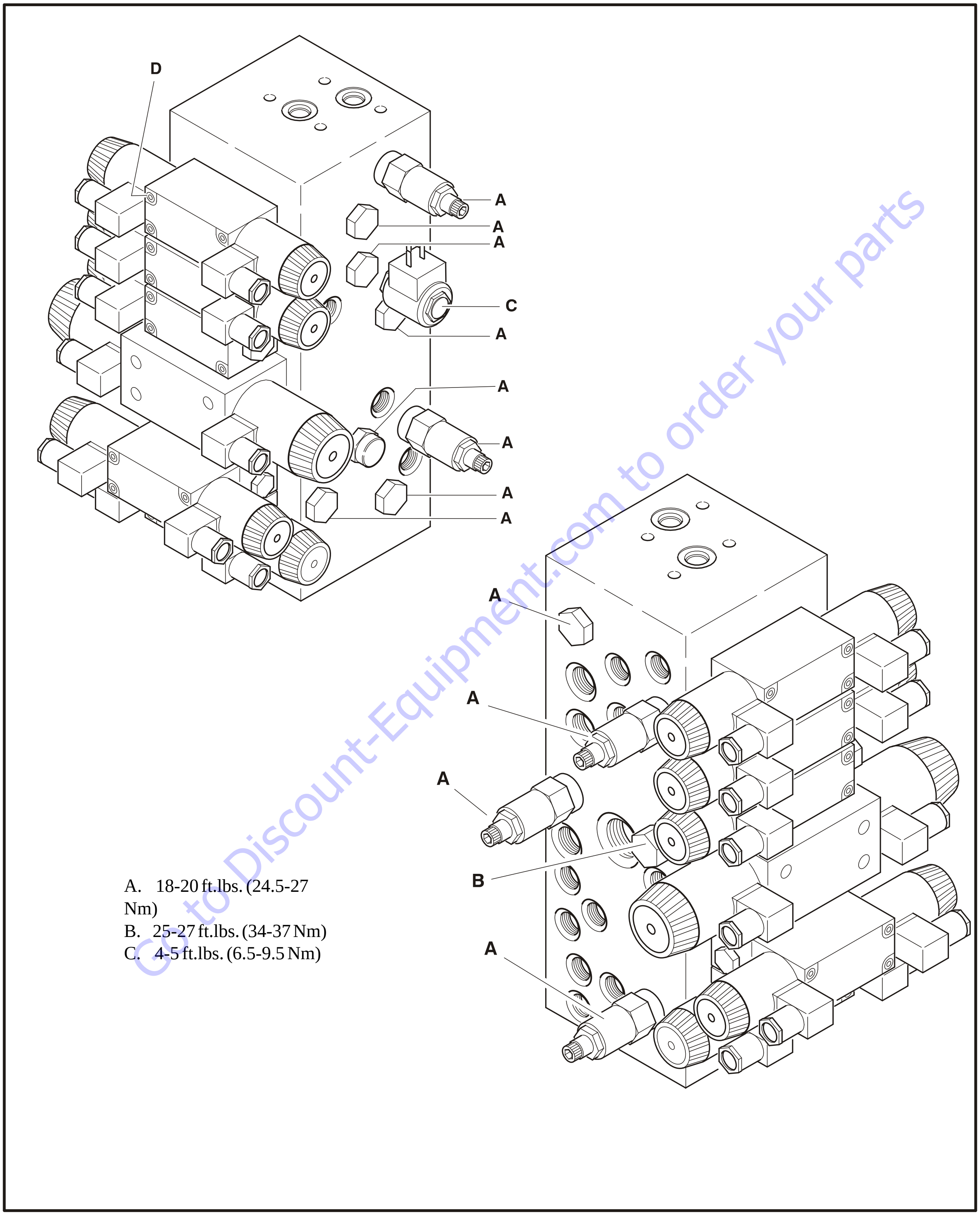
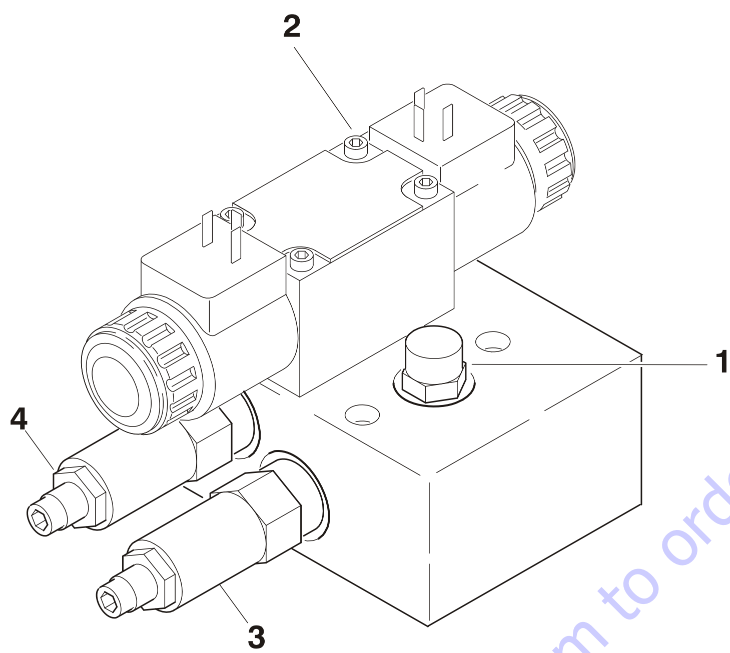
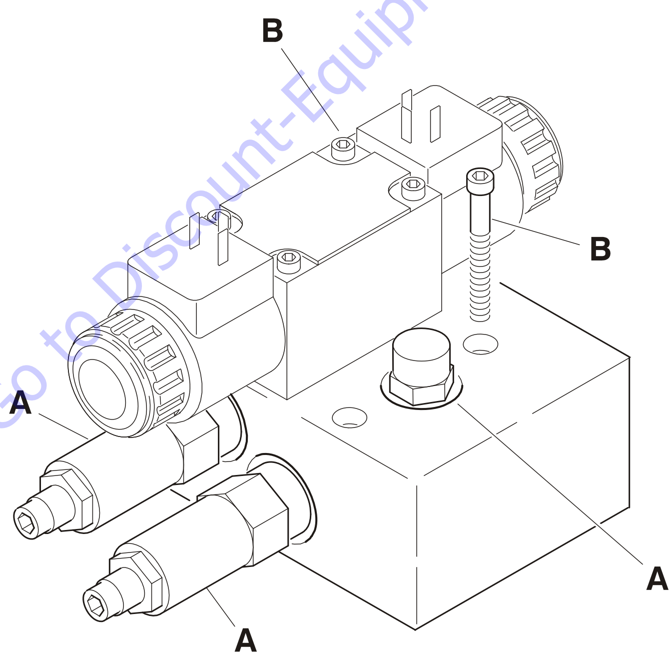


Figure 8-19. Main Control Valve Torque Values



1. Flow Control Cartridge
2. Directional Control Valve
3. Relief Cartridge

Figure 8-20. Platform Valve Identification



A. 18-20 ft.lbs. (24.5-27 Nm)

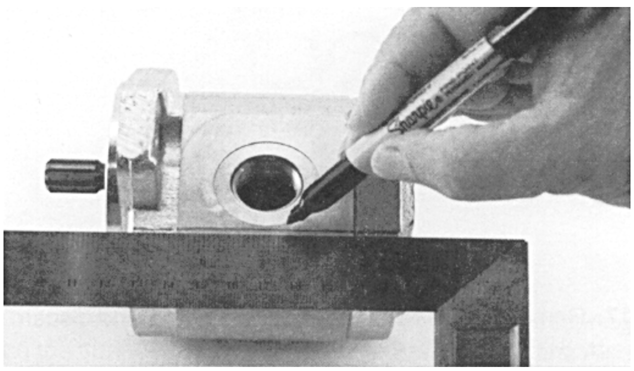
Figure 8-21. Platform Valve Torque Values

8.8 HYDRAULIC PUMP (GEAR)

Disassembly

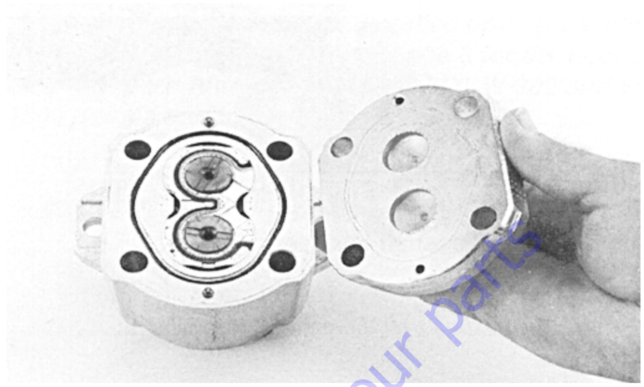
NOTE: *The following general instructions also apply to multiple section gear pumps, the only extra parts are the coupling between the drive shafts and the center distance plate which divides the two pump sections. This repair procedure also applies to the "W" series Gear Motors.*

1. It is very important to work in a clean work area when repairing hydraulic products. Plug ports and wash exterior of pump with a proper cleaning solvent before continuing.
2. Remove port plugs and drain oil from pump.



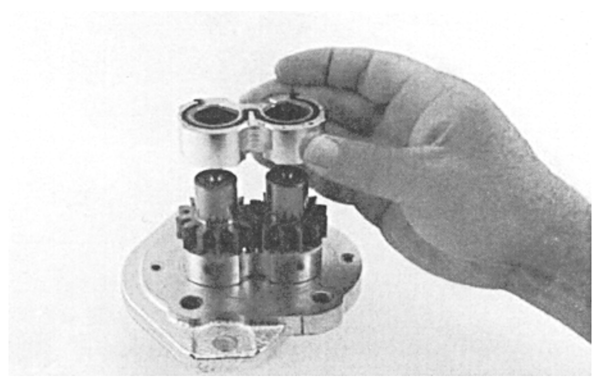
3. Use a permanent marker pen to mark a line across the mounting flange, gear housing and end cover. This will assure proper reassembly and rotation of pump.
4. Remove key from drive shaft if applicable.

5. Clamp the mounting flange in a protected jaw vise with the pump shaft facing down.
6. Loosen the four metric hex head bolts.
7. Remove pump from vise and place on clean work bench, remove the four hex head bolts and spacers if applicable.

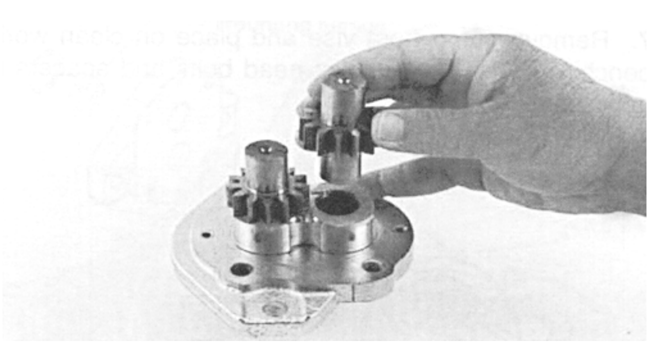


8. Lift and remove end cover.

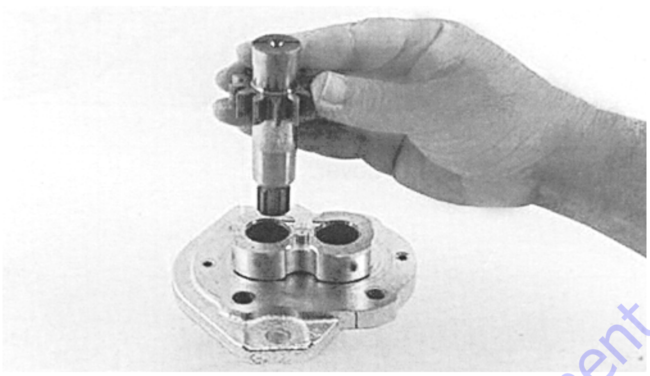
9. Carefully remove gear housing and place on work bench. Make sure the rear bearing block remains on the drive and idler shafts.



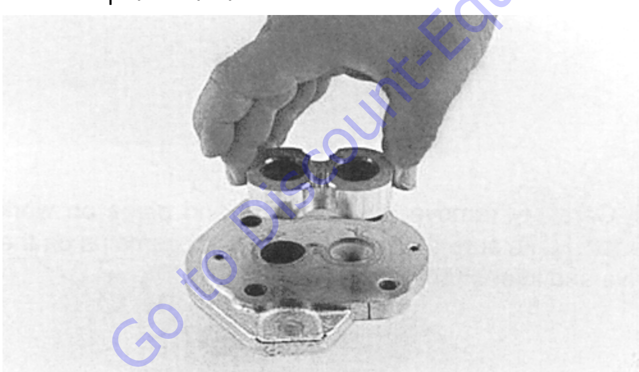
10. Remove rear bearing block from drive and idler shafts.



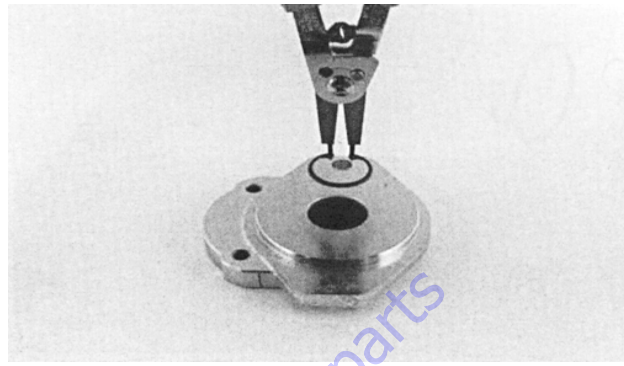
11. Remove idler shaft from bearing block.



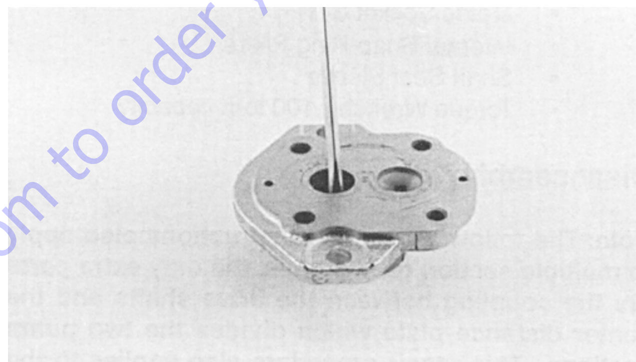
12. Remove drive shaft from mounting flange. There is no need to protect the shaft seal as it will be replaced as a new item.



13. Remove the front bearing block.



14. Turn the mounting flange over, with the shaft seal up, and remove the retaining ring with proper snap ring pliers.



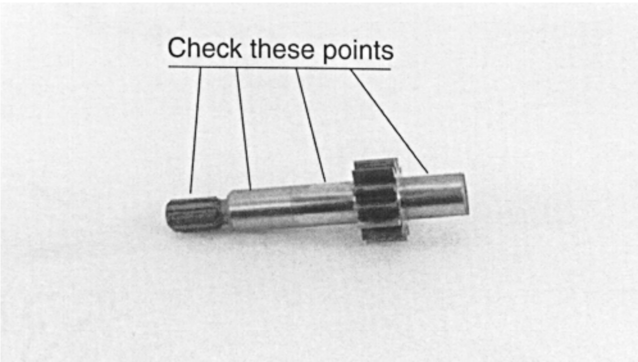
15. Remove the oil seal from mounting flange, be careful not to mar or scratch the seal bore.

16. Remove the dowel pins from the gear housing. Do not lose pins.

17. Remove seals from both bearing blocks and discard.

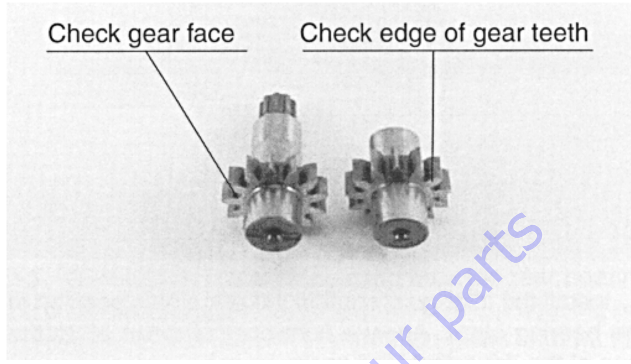
Inspect Parts For Wear

18. Clean and dry all parts thoroughly prior to inspection. It is not necessary to inspect the seals as they will be placed as new items.

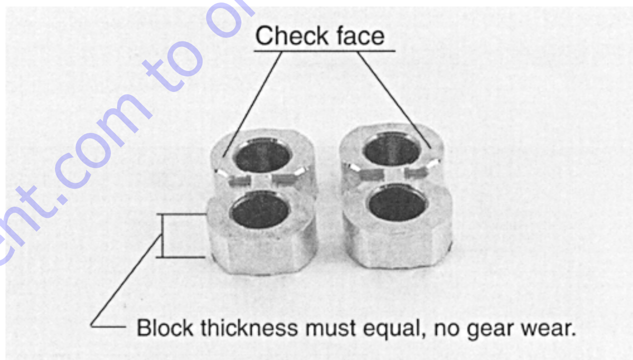


19. Check drive shaft spine for twisted or broken teeth, check keyed drive shaft for broken or chipped keyway. No marks or grooves on shaft in seal area, some discoloration of shaft is allowable.

20. Inspect both the drive gear shaft and idler gear shafts at the bearing points and seal area for rough surfaces and excessive wear.



21. Inspect gear face for scoring or excessive wear. If the face edge of gear teeth are sharp, they will mill into the bearing blocks. If wear has occurred, the parts are unusable.



22. Inspect bearing blocks for excessive wear or scoring on the surfaces which are in contact with the gears. Also inspect the bearings for excessive wear or scoring.

23. Inspect the area inside the gear housing. It is normal for the surface inside the gear housing to show a clean "wipe" on the inside surface on the intake side. There should not be excessive wear or deep scratches and gouges.

General Information

It is important that the relationship of the mounting flange, bearing blocks and gear housing is correct. Failure to properly assemble this pump will result with little or no flow at rated pressure.

Reverse Shaft Rotation of Pump

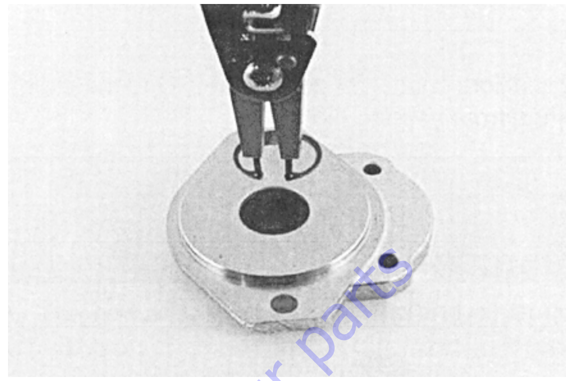
NOTE: *This pump is not bi-rotational, if the shaft rotation must be changed the following procedure must be followed.*

Reversing the shaft rotation of the "W" series gear pump may be accomplished by rotating, as a group, the two bearing blocks and the gear housing 180° in relationship to the remaining parts of the pump. This procedure will place the pressure port on the opposite side of the pump from its original position.

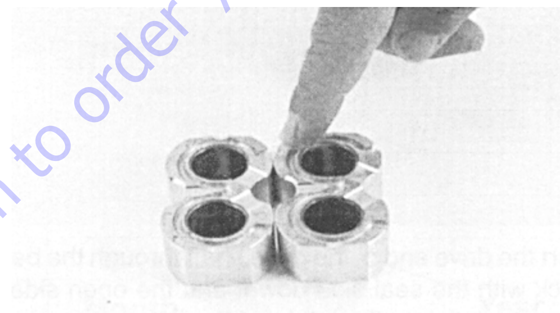
Assembly

NOTE: *New seals should be installed upon reassembly of pump or motor. deter to page 8 for the necessary kit part numbers for the W-600, W-900 and W-1500 pumps and motors.*

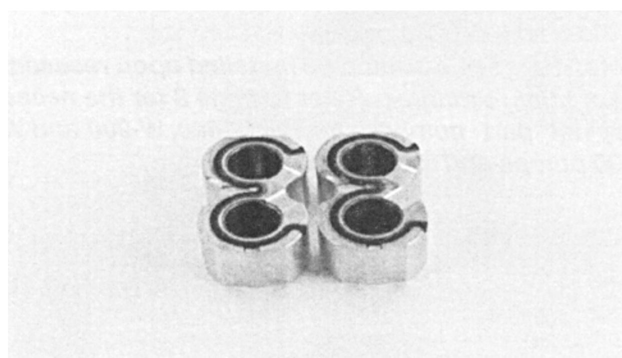
1. Install new shaft seal in mounting flange with part lumber side facing outboard. Press the seal into the seal lore until the seal reaches the bottom of the bore. Uniform pressure must be used to prevent misalignment or damage to the seal.



2. Install retaining ring in groove in seal bore of mounting flange.

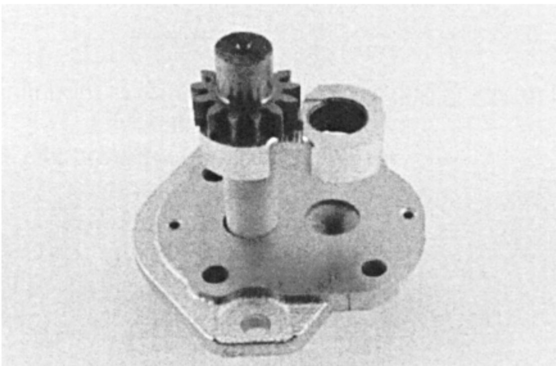


3. Place front and back bearing blocks on a clean surface with the E-seal grooves facing up. Apply a light coating of petroleum jelly in the grooves. Also coat the E-seal and backup with the petroleum jelly, this will help keep the seals in place during reassembly.

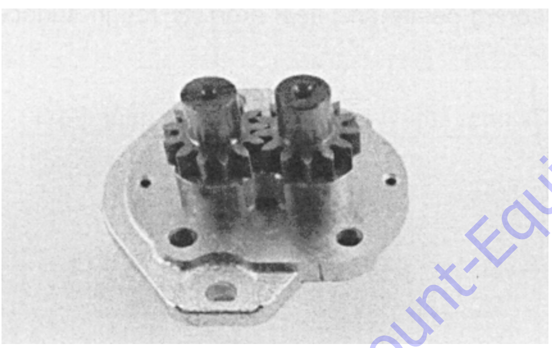


4. Place the E-seals, *flat side outward,* into the grooves in both bearing blocks. Follow by *carefully* placing the backup ring, *flat side outward,* in the groove made by the E-seal and the groove in the bearing block. *(Note: in the W900 series pump, in the center of the backup ring and E-seal there is a notch make sure that these notches line up so the backup ring will set flush with the E-seal).* The backup ring in the W1500 pump is symmetrical.

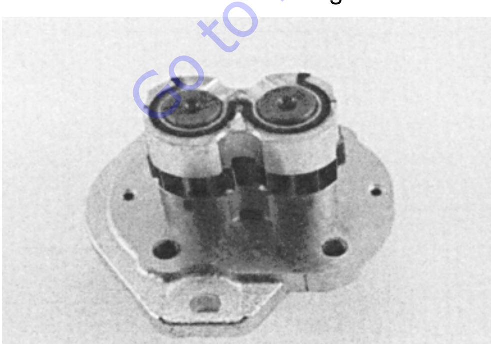
5. Place mounting flange, with shaft seal side down, on a clean flat surface.
6. Apply a light coating of petroleum jelly to the exposed face of the front bearing block.



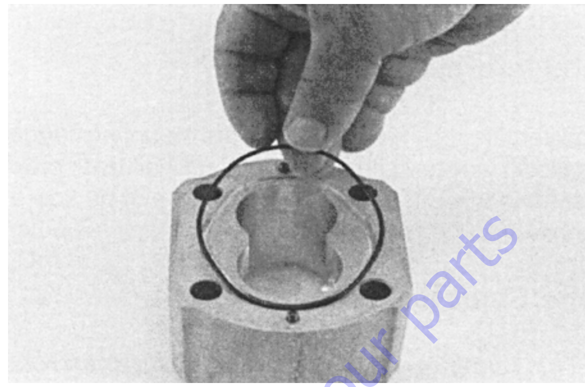
7. Insert the drive end of the drive shaft through the bearing block with the seal side down, and the open side of the E-seal pointing to the intake side of the pump.
8. Install the seal sleeve over the drive shaft and carefully slide the drive shaft through the shaft seal. Remove the seal sleeve from shaft.



9. Install the idler gear shaft in the remaining position in the bearing block. Apply a light coat of clean oil to the face of the drive and idler gears.



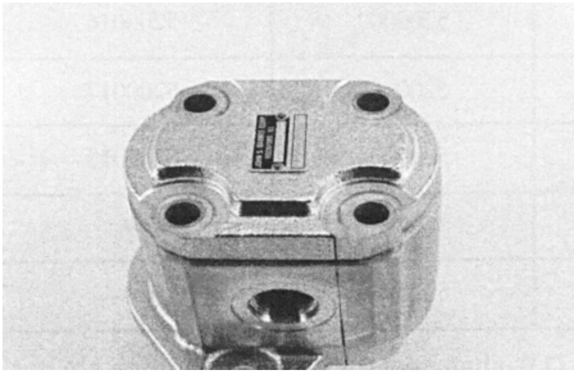
10. Pick up the rear bearing block, with seal side up and with open end of the E-seal facing the intake side of the pump, place over the drive and idler gear shafts.
11. Install two dowel pins in the holes in the mounting flange or two long dowel pins through gear housing if pump is a multiple section pump.



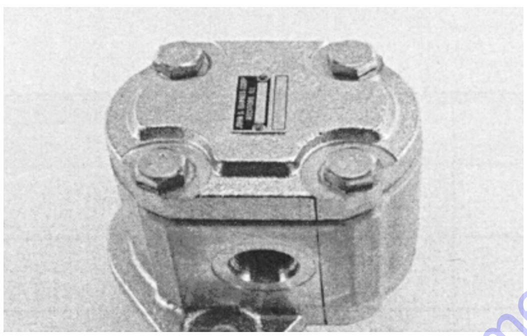
12. To install the O-rings in the gear housing, apply a light coating of petroleum jelly in the grooves on both sides of the gear housing. Also coat the new O-rings and install them in the grooves.

13. Gently slide the gear housing over the rear bearing block assembly, slide housing down until the housing engages the dowel pins. Press firmly in place with hands, do not force or use any tool. Check to make sure the in-take port in the housing is on the same side as the open end of the E-seal and that the marked lines on the mounting flange and gear housing are in alignment.
14. The surface of the rear bearing block should be slightly below the face of the gear housing. If the bearing block sits higher then the rear face of the gear housing then the E-seal or o-ring have shifted

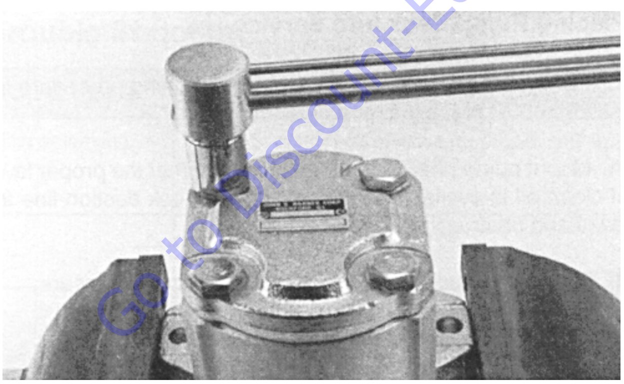
out of the groove. If this is the case, remove the gear housing and check for proper seal installation.



15. Install the two remaining dowel pins in the rear of the gear housing, if applicable, and place the end cover over the back of the pump.



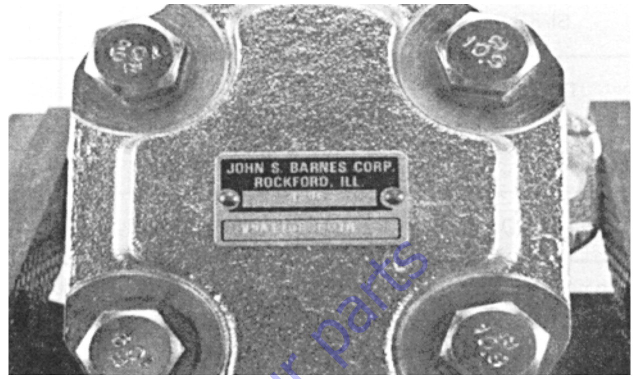
16. Install the four spacers, if applicable, and hex head bolts through the bolt holes in the end cover, hand tighten.



17. Place mounting flange of the pump back in the protected jawed vise and alternately torque the bolts to the torque specifications in the torque chart. All torque figures are for "dry torque" bolts.

18. Remove pump from vise.

19. Place a small amount of clean oil in the inlet of the pump and rotate the drive shaft away from the inlet one revolution. If the drive shaft binds, disassemble the pump and check for assembly problems, then reassemble the pump.



20. The name plate located on the end cover contains the build date code and the model number. Please refer to this information when corresponding with the J.S. Barnes Service Department.

Table 8-3.Hydraulic Pump Bolt Torque Chart

Pump Series	Thread Size	Torque Values, Black Oxide End Cover	Torque Values, Zinc Plated End Cover
W-600	M 8 x 1.25	18-21 ft.lb. 24-30 Nm	16-18 ft.lb. 21.7-24.4 Nm
W-900	M 10 x 1.5	50-55 ft.lb. 68-75 Nm	38-43 ft.lb. 51.5-58.3 Nm
W-1500	M 12 x 1.75	80-85 ft.lb. 108-115 Nm	68-73 ft.lb. 92.2-99 Nm

Placing Pump Back Into Service

1. *If shop test stand is available,* the following procedure for testing rebuilt pumps is recommended:

   a. Mount pump on test stand making sure that the proper level of clean oil is available in the reservoir. Check suction line for leaks and obstructions.

   b. Start pump and run for three minutes at zero pressure.

   c. Intermittently load pump to 500 P.S.I. for three minutes.

   d. Intermittently load pump to 1000 P.S.I. for three minutes.

   e. Intermittently load pump to 2000 P.S.I. for three minutes.

   f. Remove pump from test stand and check for freeness of drive shaft. Check pump for signs of external leakage.

2. *If shop test stand is not available,* the following procedure for testing rebuilt pumps is recommended:

   a. *For engine driven pumps,* mount pump on equipment and run pump at 1/2 engine speed at zero pressure for three minutes.

   b. By operating control valve, build pressure intermittently for three minutes.

   c. Increase engine speed to full throttle and build pressure intermittently for three minutes.

   d. Stop engine and check pump for external leaks.

8.9 VARIABLE PUMP

Ports and Pressure Gauges

Proper servicing of pumps and motors requires that pressure be measured and monitored at various points in the hydraulic circuit. The Series 42 pump has several locations at which to take these measurements. The following outlines show the locations of the various gauge ports. The following table shows the recommended gauge size and the fitting size for each port.

Table 8-4. Recommended Gauge Size

Gauge Port Name	Pressure Measured	Recommended Gauge Size		Fitting
		PSI	Bar	
M1 & M2	System Pressure Ports A & B	10000	600	9/16-18 ORF
M3	Charge	1000	60	3/4-16 ORF
M4 & M5	Servo	1000	60	9/16-18 ORF
L1 & L2	Case	500	35	1-1/16-12 ORF
S	Charge Pump Inlet Vacuum	30 in. Hg Vac.	1	1-1/16-12 ORF

NFPE Control

The 3-position FNR control and the electric and hydraulic non-feedback proportional (NFPE and NFPH) controls are non-feedback type controls. The FNR and NFPE controls consist of modules mounted on the pump housing. The hydraulic input for NFPH is received through ports on the top of the pump [9/16–18 SAE O-ring fitting].

The non-feedback controls are set at the factory. The control modules can be removed to clean the ports and change the O-rings.

The orifice plugs for the FNR and NFPE are located inside the servo piston covers. The orifice plugs for the NFPH are located in the NFPH ports. Orifice plugs may be cleaned or replaced.

Removal and Installation of FNR and NFPE Modules

1. Clean pump and module housings.
2. Remove four (4) screws retaining module to housing [4 mm Int. Hex], and remove module from pump housing.
3. Remove O-rings from the control ports. Examine ports for cleanliness.
4. Clean sealing surfaces.
5. Replace locator pin.
6. Install new O-rings.
7. Replace screws [4.7-6.1 Nm (3.5-4.5 ft•lbf].

Removal and Installation of FNR and NFPE Control Orifices

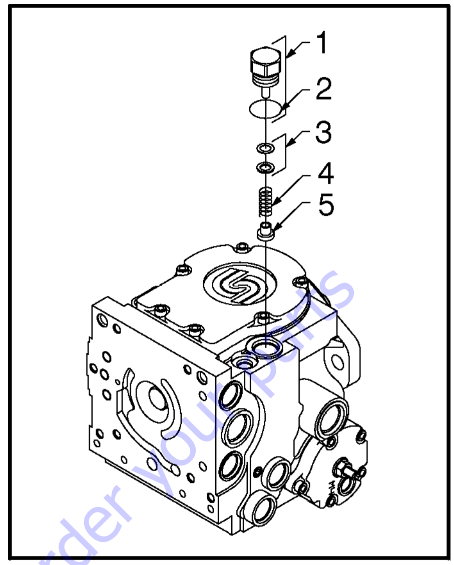
NOTE: *Future models may contain an orifice plate between module and pump housing. This will take the place of the orifice plugs beneath the servo piston cover.*

1. Remove servo piston cover.
2. Remove orifice plug [1/8 in Int. Hex].
3. Examine orifice and port for cleanliness.
4. Install orifice plug [2.0-3.4 Nm (1.5-2.5 ft•lbf)].

Charge Relief Valve

The charge relief valve may be removed for cleaning and installation of fresh O-rings. The pressure setting may be changed. However, note that the setting will vary for different charge flows which depends on charge pump size and pump speed. The factory setting is set relative to case pressure at 1800 rpm. The actual charge pressure will vary at different speeds.

SHIM ADJUSTABLE STYLE

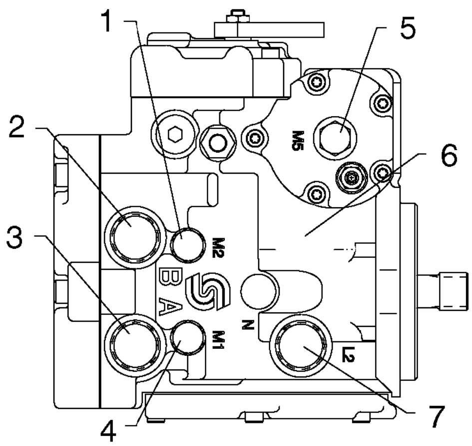


1. Plug
2. O-ring
3. Shims
4. Spring T-Seal
5. Poppet

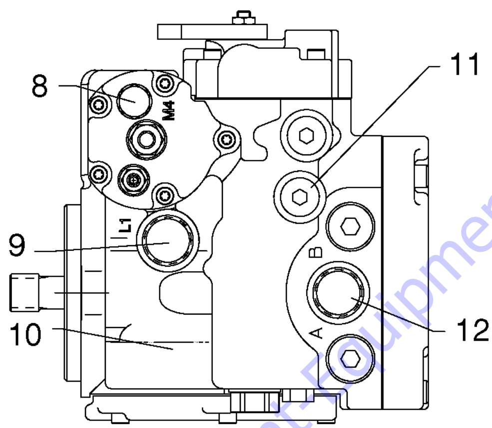
Figure 8-22. Shim Adjustable Charge Relief Valve Components

1. Remove the shim adjustable charge relief valve plug [1 in Hex] from the pump housing. Remove the O-ring from the plug.
2. Remove the spring and poppet from the housing.
3. Do not alter the shims which may be installed between the spring and valve plug, or interchange parts with another valve. Inspect the poppet and mating seat in the housing for damage or foreign material.
4. If desired, the charge relief valve setting can be changed. An approximate rule of thumb is 4 bar / 1.25 mm (58 psi / 0.050 in). The effective setting will vary.

   To confirm the charge relief valve setting, measure charge pressure (port M3) with the pump in stroke. The charge pressure should level off when the relief setting is reached.



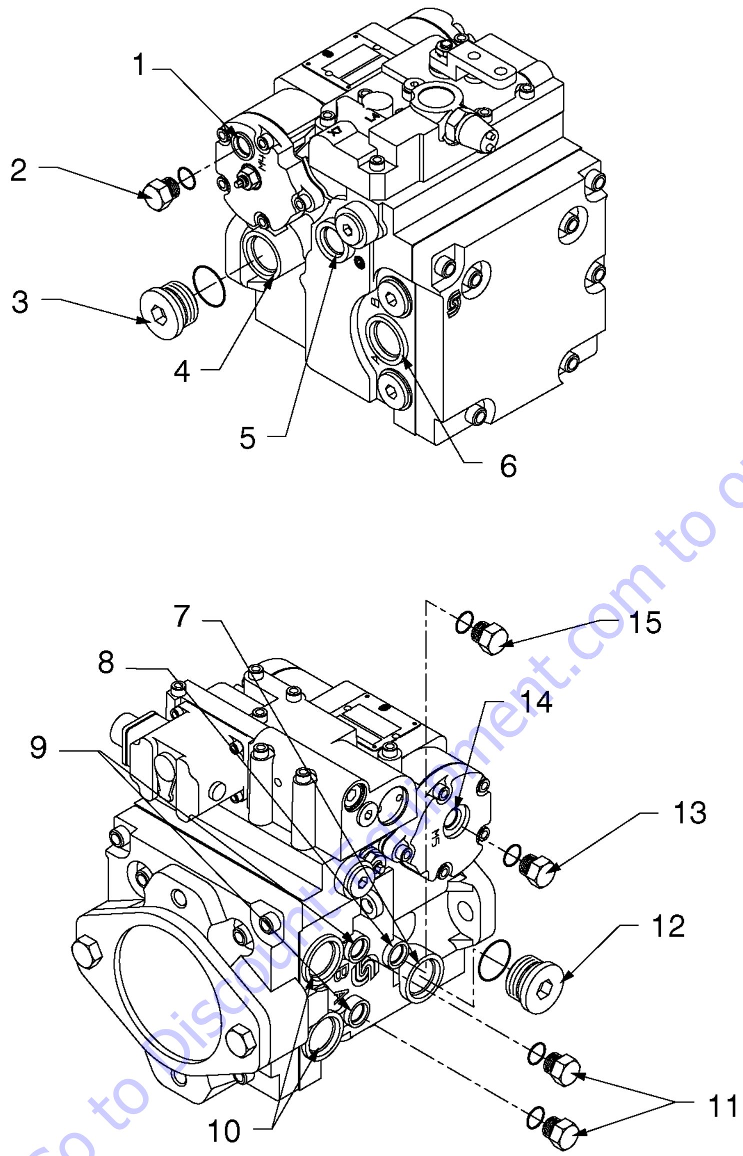
LEFT SIDE



RIGHT SIDE

1. System Pressure Gauge Port M2
2. System Pressure Port B
3. System Pressure Port A
4. System Pressure Gauge Port M1
5. Servo Pressure Gauge Port M5
6. Case Drain Port L2 (non-feed-back)
7. Case Drain Port L2
8. Servo Pressure Gauge Port L4
9. Case Drain Port L1
10. Case Drain Port L1 (non-feed-back)
11. Charge Pressure Gauge
12. Charge Pump Inlet Port S

Figure 8-23. Gauge Port Locations

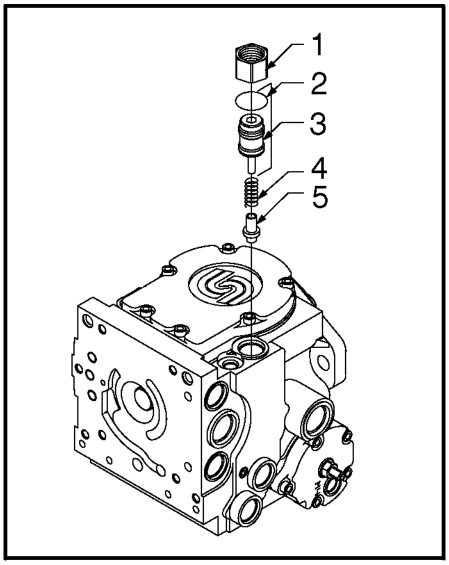


#	Plug/ Fitting	Torque lb. ft.	Torque Nm
1	Servo Gauge Port M4	N/A	N/A
2	11/16	20-35	27-47
3	9/16	70-100	95-135
4	Case Drain Port L1	N/A	N/A
5	Charge Pressure Gauge M3	N/A	N/A
6	Charge Pump Inlet Port S	85	115
7	Case Drain Port L2	N/A	N/A
8	Port N	N/A	N/A
9	System Gauge M1 & M2	N/A	N/A
10	System Ports A&B	85	115
11	11/16	20-35	27-47
12	9/16	70-100	95-135
13	11/16	20-35	27-47

Figure 8-24. Plugs/Fittings Size & Torque

5. Install a new O-ring on the valve plug. Reinstall the poppet, spring, and plug (with shims and O-ring) into the pump housing [55-135 Nm (40-100 ft•lbf)].

SCREW ADJUSTABLE STYLE



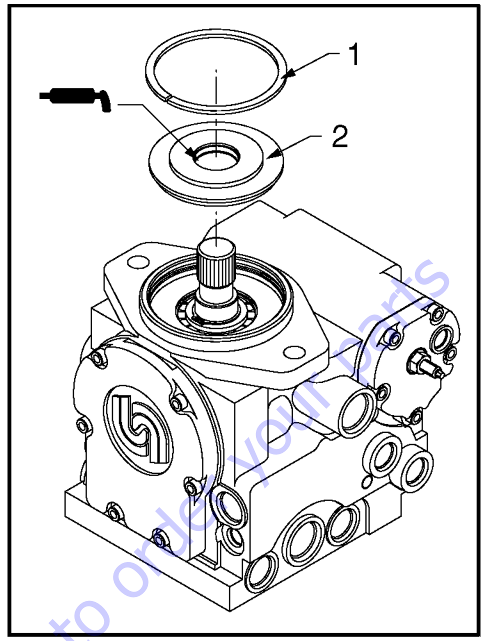
1. Lock Nut
2. O-ring
3. Plug
4. Spring T-Seal
5. Poppet

Figure 8-25. Screw Adjustable Charge Relief Valve Components

1. Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and housing so as to approximately maintain the original adjustment when assembling, Remove the screw adjustable charge relief valve plug by loosening the lock nut [1-1/16 in Hex] and unscrewing the plug [8 mm Int. Hex]. Remove the O-ring from the plug.
2. Remove the spring and poppet from the housing.
3. Inspect the poppet and mating seat in the housing for damage or foreign material.
4. Install a new O-ring on the valve plug. Reinstall the poppet and spring. Reinstall the plug with its lock nut [47-57 Nm (34-42 ft•lbf)], aligning the marks made at disassembly.
5. Check and adjust, if necessary, the charge pressure. For screw adjustable "anti-stall" charge relief valves, an approximate rule of thumb is 2.8 bar / quarter turn (40 psi / quarter turn).

   To confirm the charge relief valve setting, measure charge pressure (port M3) with the pump in stroke. The charge pressure should level off when the relief setting is reached.

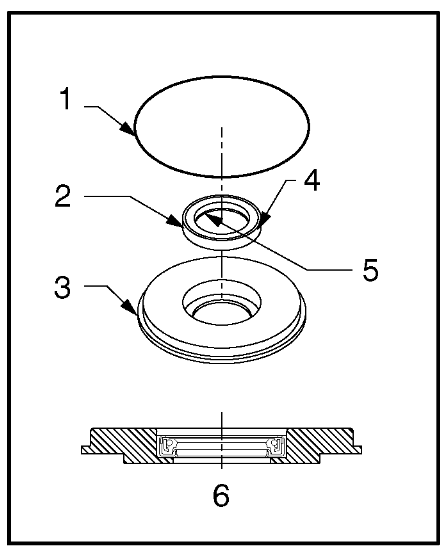
Shaft Seal and Shaft Replacement



1. Retaining Ring
2. Seal Carrier Assembly

Figure 8-26. Shaft Seal Components

A lip type shaft seal is used in Series 42 pumps. This seal and/or the shaft can be replaced without major disassembly of the unit. Replacement generally requires removal of the pump from the machine.



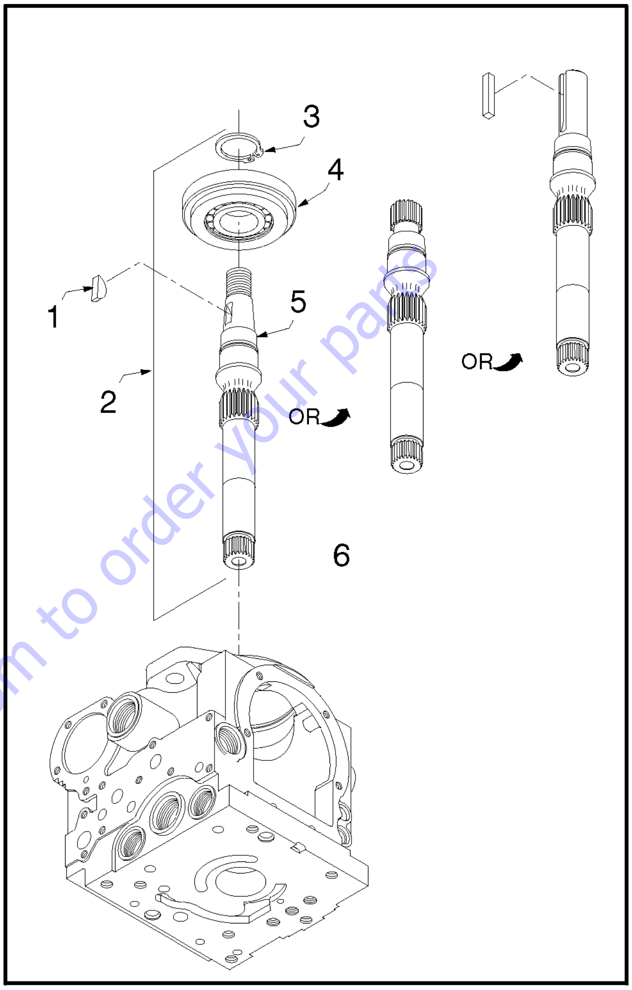
1. O-ring
2. Seal
3. Seal Carrier
4. Sealant may be used on outside diameter
5. Inside Lip (face down)
6. Press Seal to Bottom of Seal Carrier

Figure 8-27. Installation of Shaft Seal

1. Position the pump with the shaft facing up.

NOTE: *If the unit is positioned horizontally when the shaft is removed, the cylinder block could move out of place, making shaft installation difficult.*

2. Remove the retaining ring from the housing.
3. Pull out seal carrier assembly.
4. Remove the O-ring from the seal carrier. To install a new shaft only, proceed to step 8.
5. Place the seal carrier in an arbor press with the shaft bearing side down, and press out the old seal. An appropriately sized pipe spacer or socket wrench can be used as a press tool. Once removed, the seal is not reusable.
6. Inspect the seal carrier and the new seal for damage. Inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.
7. Press the new seal into the shaft bearing side of the seal carrier. The seal lip must face the outside of the pump. Be careful not to damage the seal. The outside diameter of the seal may be coated with a sealant (e.g. Loctite High Performance Sealant #59231) prior to installation. This aids in preventing leaks caused by damage to the seal bore in the seal carrier. If the shaft is not being replaced proceed to step 11.



1. Key
2. Shaft Assembly
3. Retaining Ring
4. Roller Bearing
5. Shaft

8. Remove the shaft and roller bearing assembly from the pump or motor. The bearing assembly can be transferred to the new shaft (steps 9 and 10).
9. Remove the retaining ring that secures roller bearing assembly with a snap ring plier. Remove the roller bearing assembly. Place roller bearing assembly on new shaft and secure with the retaining ring.
10. Place roller bearing assembly on new shaft and secure with the retaining ring.
11. Wrap the spline or key end of shaft with thin plastic to prevent damage to the seal lip during installation. 64 Lubricate the inside diameter of the shaft seal with petroleum jelly.

12. Place the O-ring onto the shaft bearing and lubricate with petroleum jelly.
13. Slide the seal carrier assembly over the shaft and into the housing bore. Press against O-ring. Hold inward pressure against the shaft to compress the cylinder block spring while pressing the seal carrier into place.
14. Install the retaining ring.

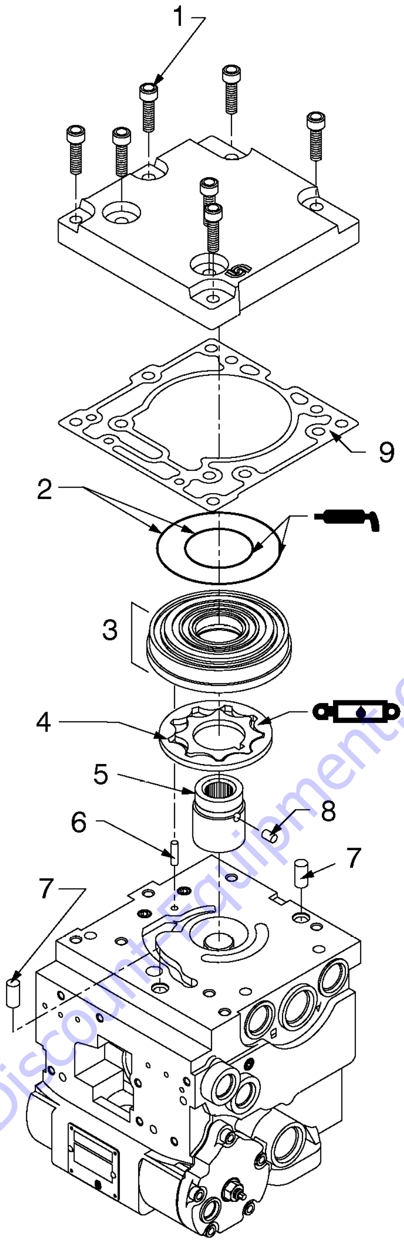
Charge Pump

The charge pump may be disassembled to inspect and clean, or to change the auxiliary shaft drive coupling.

1. Remove auxiliary pump, if necessary.
2. Remove the screws retaining the charge pump cover to the pump housing [Torx T45] (seven (7) screws are used with the "no pad" or SAE "A" auxiliary mounting pad charge pump cover, while six (6) screws are used with the SAE "B" auxiliary mounting pad charge pump cover). Remove the charge pump cover, gasket, and the cover locating pins.
3. Remove the gerotor cover assembly from the charge pump cover or the back of the pump housing. Remove the gerotor cover O-rings. Two (2) O-rings are used on the gerotor cover of all pumps. (An additional O-ring was used on the gerotor cover of very early production pumps with the SAE "A" pad option.)
4. Remove the gerotor assembly from the gerotor cover or pump housing.
5. Remove the gerotor drive pin and drive coupling. Remove the gerotor cover locating pin from the pump housing.
6. Each part should be inspected separately if they are to be reused. If either of the gerotor assembly parts needs to be replaced, they must both be replaced. Always replace the O-rings and charge pump cover gasket. Inspect the journal bearing in the gerotor cover for excessive wear.
7. Prior to assembly, lubricate the gerotor assembly with clean hydraulic oil.
8. Install the gerotor drive pin into the hole in the drive coupling, and retain with grease or petroleum jelly.
9. Install the drive coupling onto the pump shaft with the smaller outside diameter oriented away from the pump shaft. Different couplings are used with the different auxiliary pad options.
10. Install the gerotor assembly onto the coupling.
11. Install the gerotor cover locating pin into the pump housing. Install the gerotor cover assembly over the gerotor. The locating pin must engage the slot in the gerotor cover.

NOTE: *The charge pump rotation is determined by the location of the gerotor recess and pressure balance hole in the gerotor cover. Different gerotor covers are used for clockwise and counterclockwise rotation pumps.*

12. Install new pressure balance O-rings onto the gerotor cover and retain with petroleum jelly or grease. (An additional O-ring was used on the gerotor cover of very early production pumps with the SAE "A" pad option.)
13. Install the charge pump cover locating pins and a new charge pump cover gasket.
14. Install the charge pump cover. The cover must engage the gerotor cover and the locating pins. Install the charge pump cover screws and torque evenly [36-43 Nm (26-32 ft•lbf)].
15. If necessary, reinstall auxiliary pump.



1 Cover Retaining Screw

2 O-ring

3 Gerotor Cover

4 Gerotor Assembly

5 Drive Coupling

6 Gerotor Cover Locating Pin

Figure 8-29. Charge Pump Components

8.10 HYDRAULIC PUMP W/HAYES PUMP DRIVE COUPLING LUBRICATION

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

8.11 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

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

⚠ WARNING

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

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

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

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

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

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

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

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

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

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

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

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

⚠ WARNING

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

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

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

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

WARNING

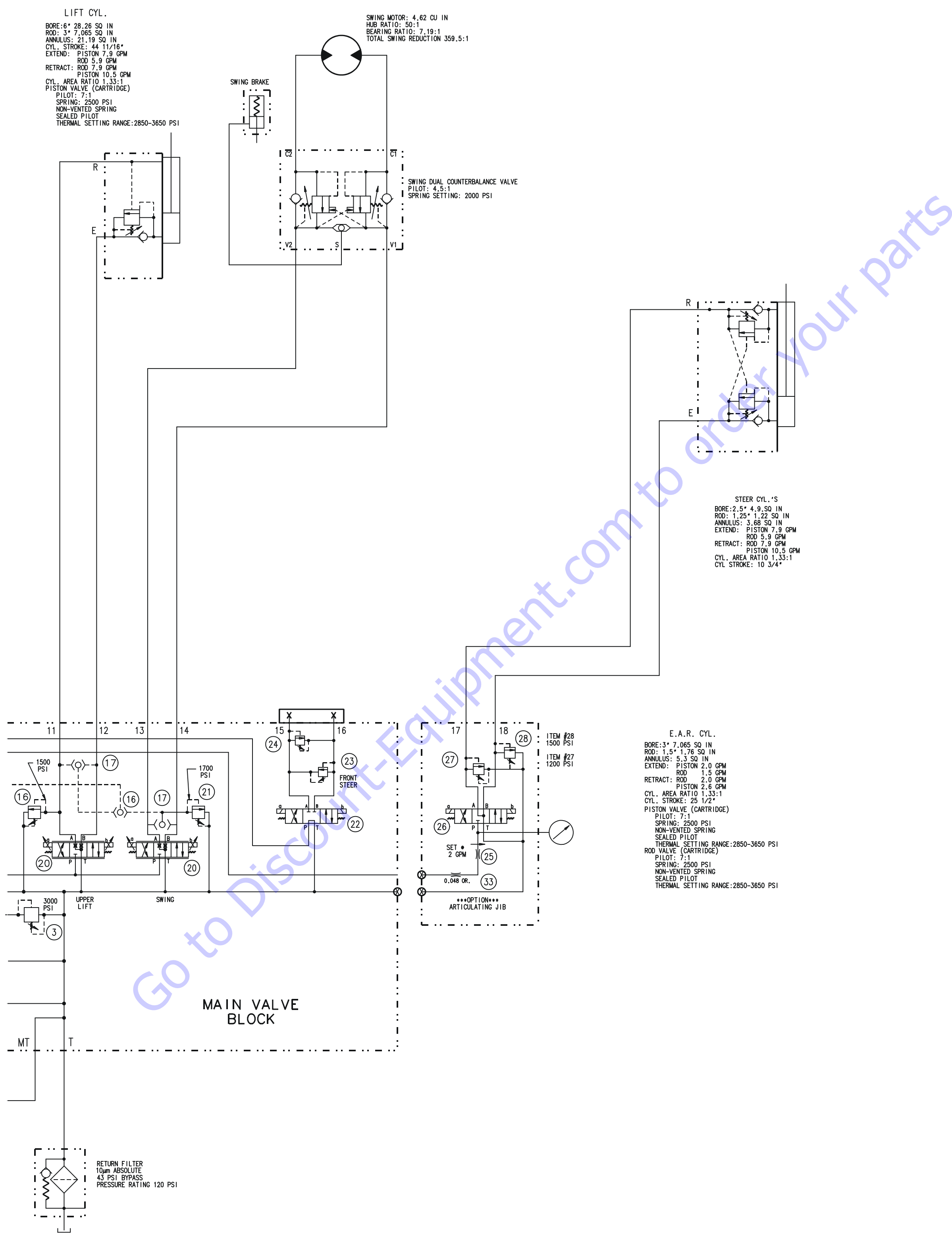
INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATOR'S ABILITY TO CONTROL THE MACHINE.

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

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

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

Machine is now ready for operation.



2792593-C

Figure 8-30. Hydraulic Schematic - Gradall Chassis - Sheet 2 of 4

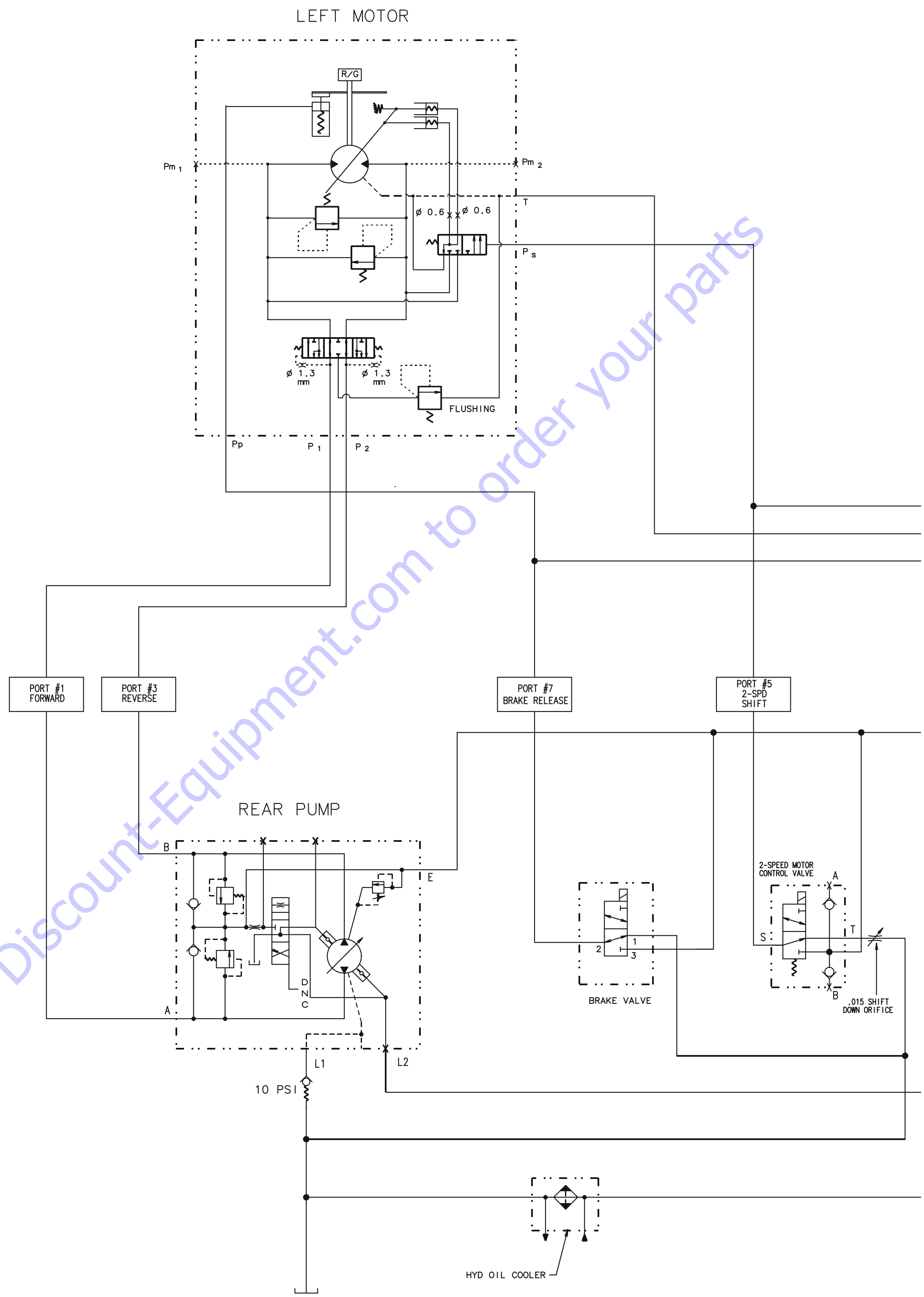
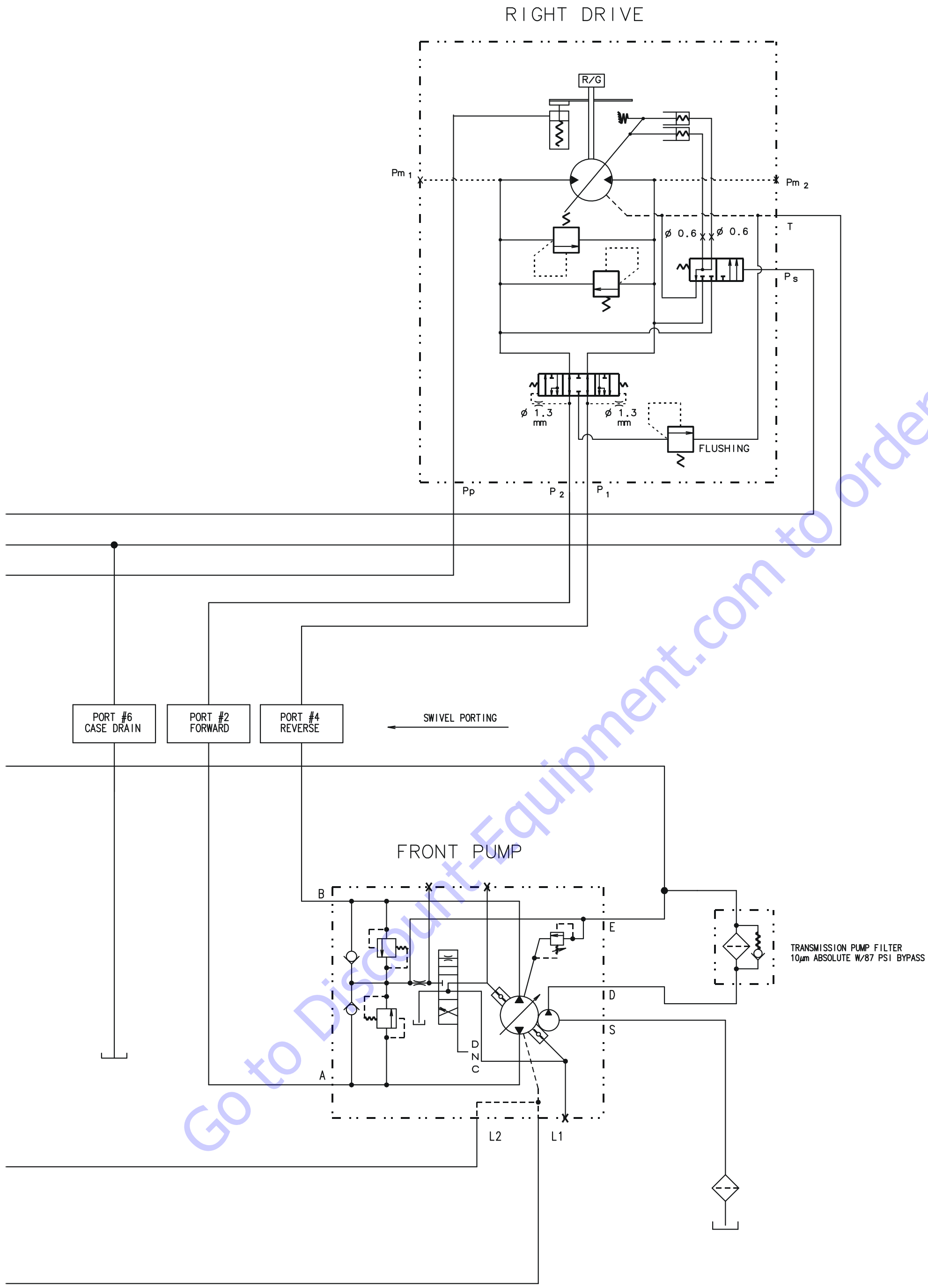


Figure 8-31. Hydraulic Schematic - Gradall Chassis - Sheet 3 of 4



2792593-C

Figure 8-32. Hydraulic Schematic - Gradall Chassis - Sheet 4 of 4

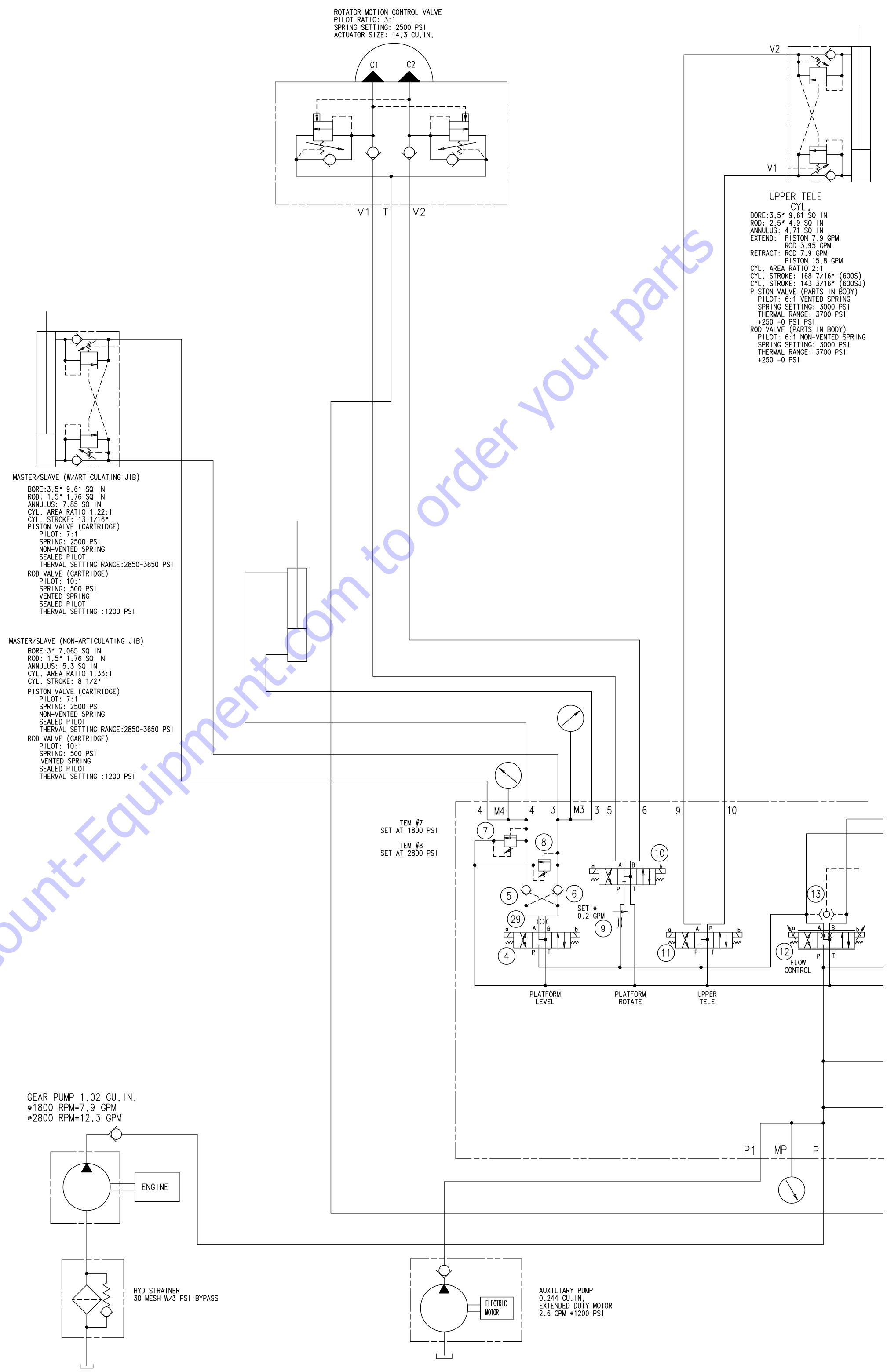
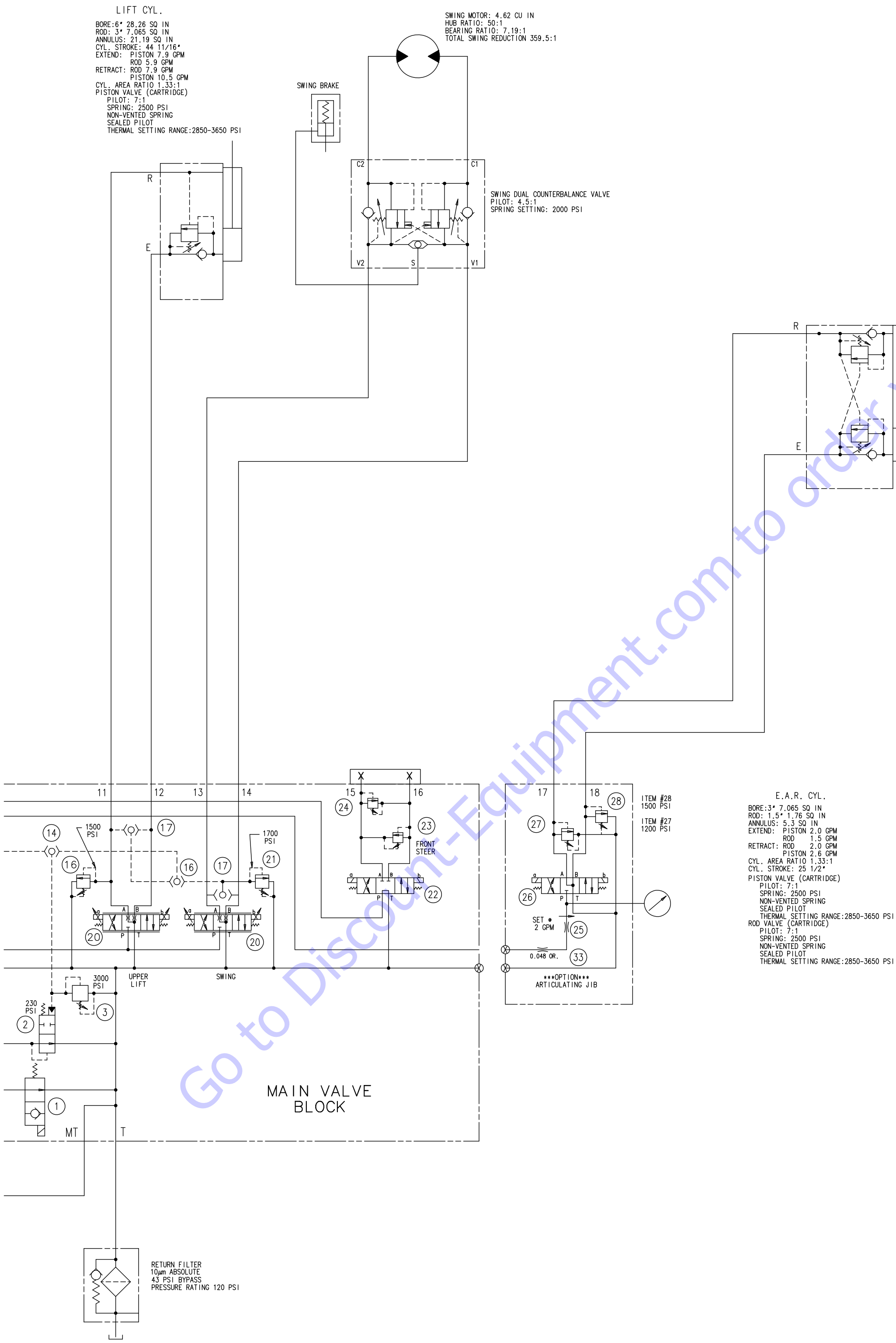


Figure 8-33. Hydraulic Schematic - CAT Chassis - Sheet 1 of 4



1001107109-A

Figure 8-34. Hydraulic Schematic - CAT Chassis - Sheet 2 of 4

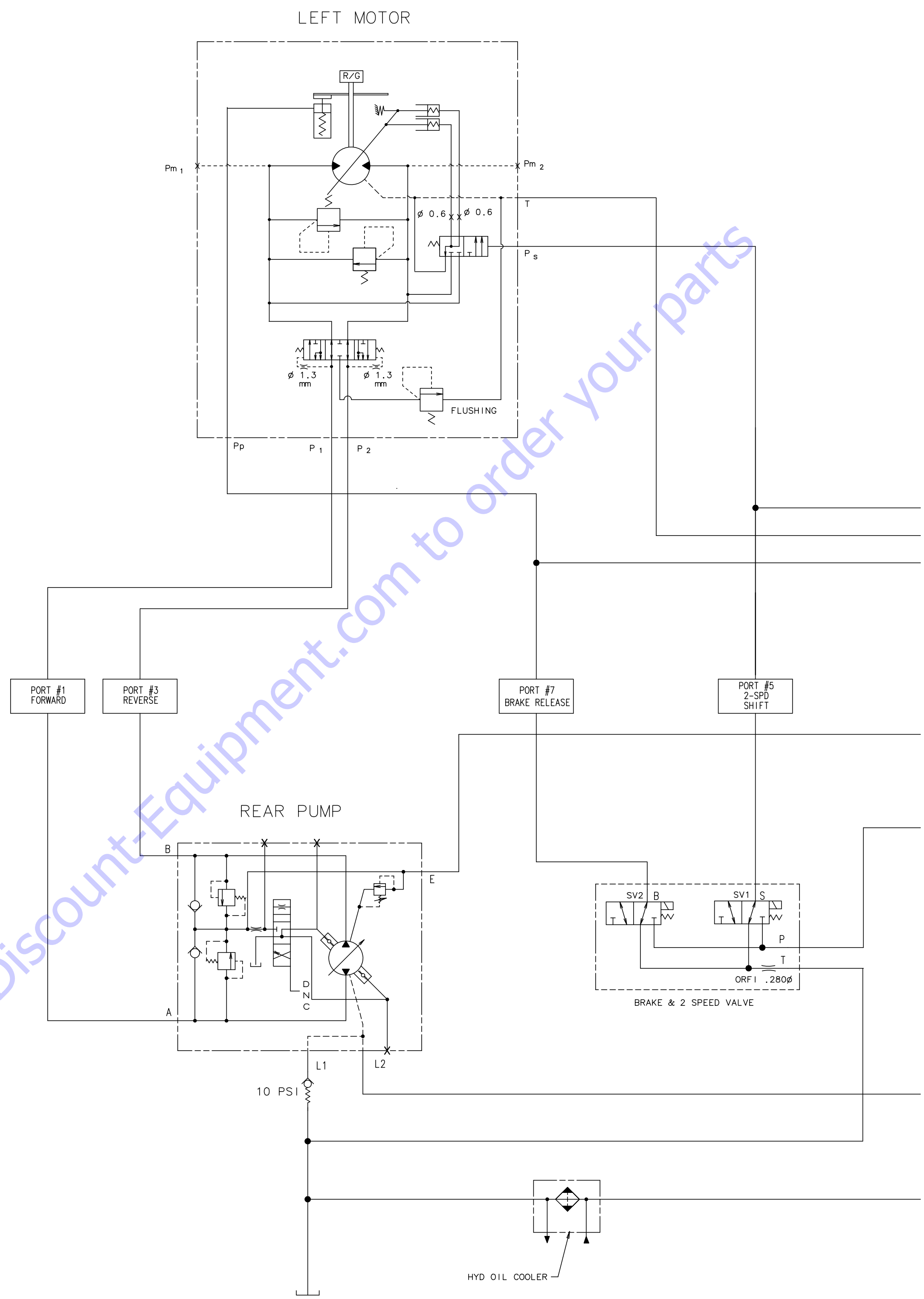
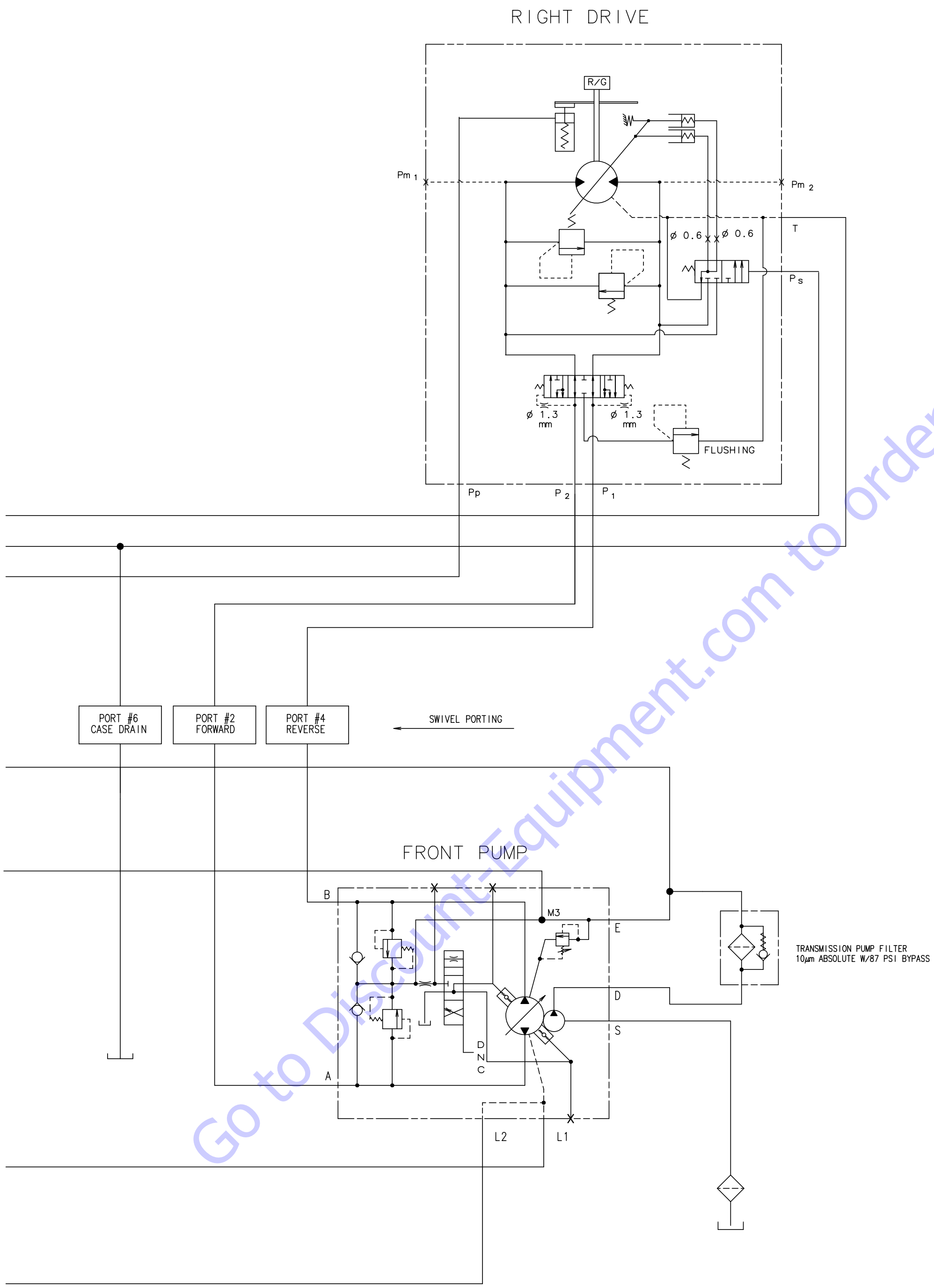


Figure 8-35. Hydraulic Schematic - CAT Chassis - Sheet 3 of 4



1001107109-A

Figure 8-36. Hydraulic Schematic - CAT Chassis - Sheet 4 of 4

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Click on this link: **http://www.discount-equipment.com/category/5443-parts/** and choose one of the options to help get the right parts and equipment you are looking for. Please have the machine model and serial number available in order to help us get you the correct parts. If you don't find the part on the website or on once of the online manuals, please fill out the request form and one of our experienced staff members will get back to you with a quote for the right part that your machine needs.

We sell worldwide for the brands: Genie, Terex, JLG, MultiQuip, Mikasa, Essick, Whiteman, Mayco, Toro Stone, Diamond Products, Generac Magnum, Airman, Haulotte, Barreto, Power Blanket, Nifty Lift, Atlas Copco, Chicago Pneumatic, Allmand, Miller Curber, Skyjack, Lull, Skytrak, Tsurumi, Husquvarna Target, , Stow, Wacker, Sakai, Mi-T- M, Sullair, Basic, Dynapac, MBW, Weber, Bartell, Bennar Newman, Haulotte, Ditch Runner, Menegotti, Morrison, Contec, Buddy, Crown, Edco, Wyco, Bomag, Laymor, Barreto, EZ Trench, Bil-Jax, F.S. Curtis, Gehl Pavers, Heli, Honda, ICS/PowerGrit, IHI, Partner, Imer, Clipper, MMD, Koshin, Rice, CH&E, General Equipment, ,AMida, Coleman, NAC, Gradall, Square Shooter, Kent, Stanley, Tamco, Toku, Hatz, Kohler, Robin, Wisconsin, Northrock, Oztec, Toker TK, Rol-Air, Small Line, Wanco, Yanmar

SECTION 9. JLG CONTROL SYSTEM

9.1 INTRODUCTION

NOTICE

WHEN INSTALLING A NEW GROUND MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

NOTICE

IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based motor control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

The upper lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer Kit, JLG part no. 2901443) which will display two lines of information at a time, by scrolling through the program.

NOTE: *Each module has a label with the JLG part number and a serial number which contains a date code.*

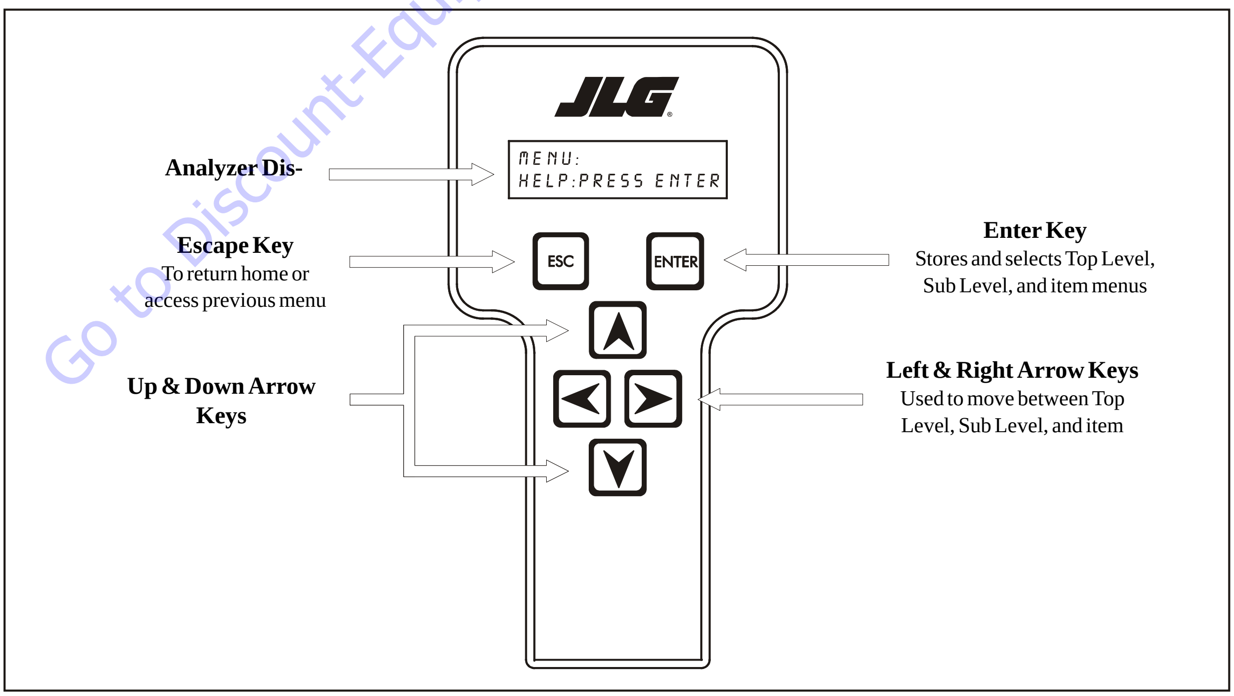


Figure 9-1. Hand Held Analyzer

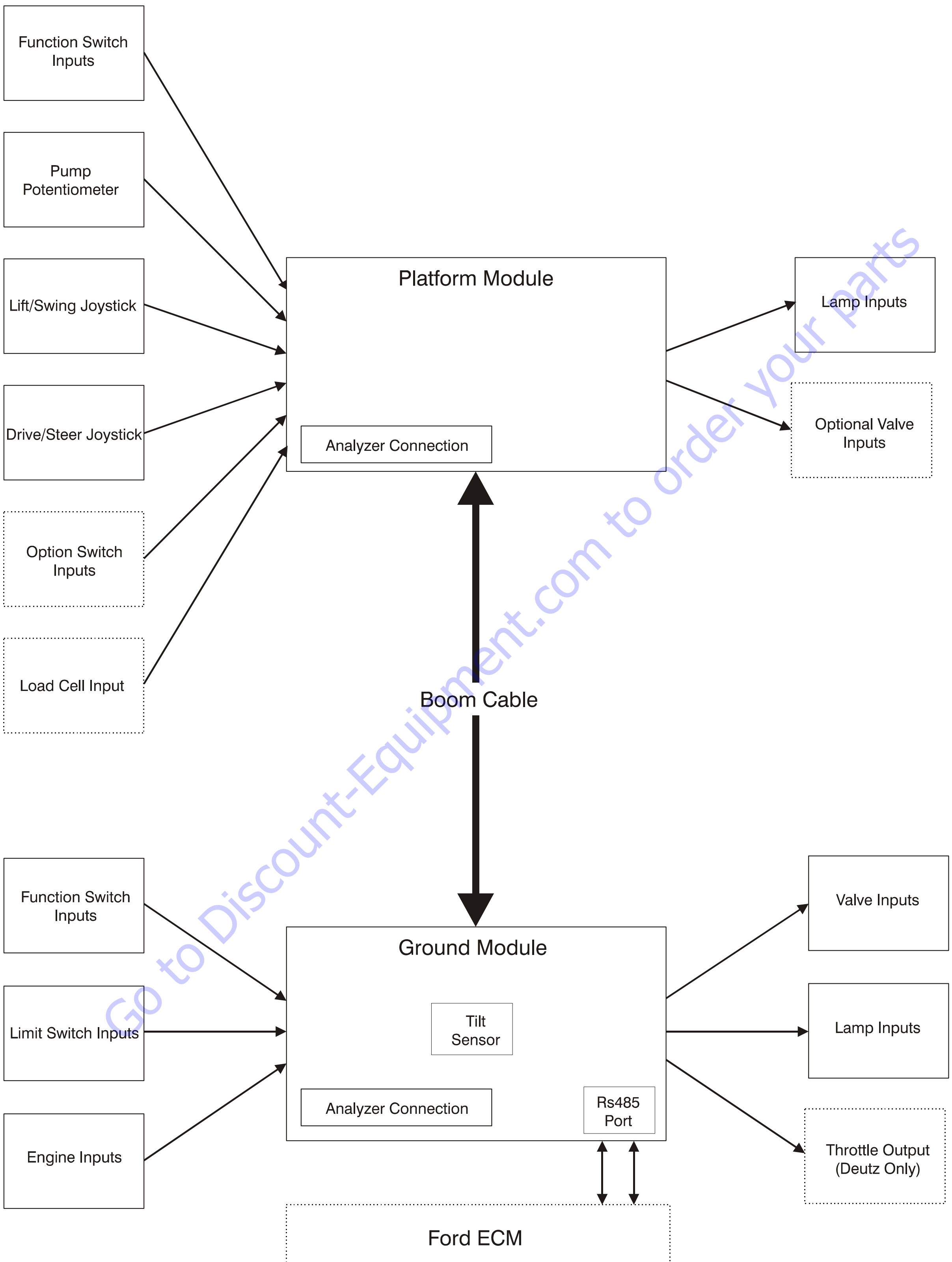


Figure 9-2. ADE Block Diagram

9.2 TO CONNECT THE JLG CONTROL SYSTEM ANALYZER

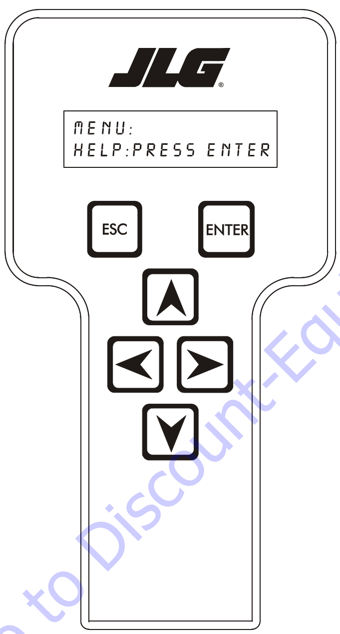
1. Connect the four pin end of the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

NOTE: *The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.*

2. Power up the Control System by turning the lower key to the platform or ground position and pulling both emergency stop buttons on.

9.3 USING THE ANALYZER

With the machine power on and the analyzer connected properly, the analyzer will display the following:



HELP:
PRESS ENTER

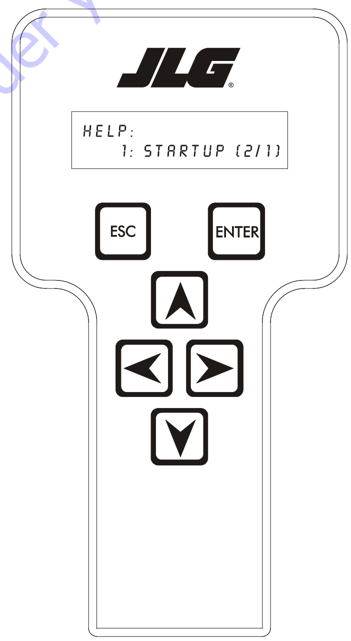
At this point, using the **RIGHT** and **LEFT** arrow keys, you can move between the top level menu items. To select a displayed menu item, press **ENTER**. To cancel a selected menu item, press ESC.; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

HELP
DIAGNOSTICS
SYSTEM TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
CALIBRATIONS (view only)

If you press **ENTER**, at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display will scroll the fault across the screen. If there was no fault detected, the display will read: **HELP: EVERYTHING OK.** If powered up at the ground station, the display will read: **GROUND OK.**

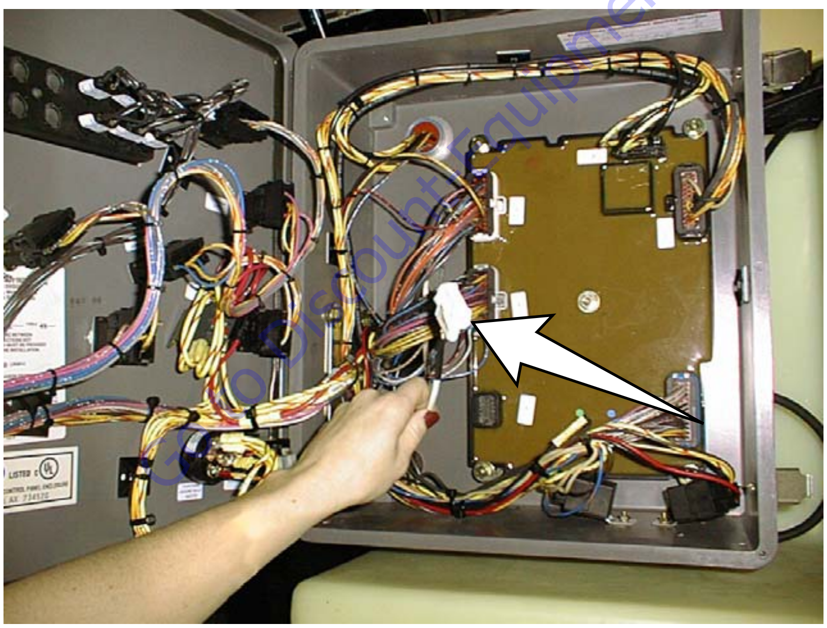
If **ENTER** is pressed again, the display moves to the following display:



LOGGED HELP
1: POWER CYCLE (0/0)

At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESC.** two times. **POWER CYCLE (0/0)** indicates a power up.

PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 9-3. Analyzer Connecting Points

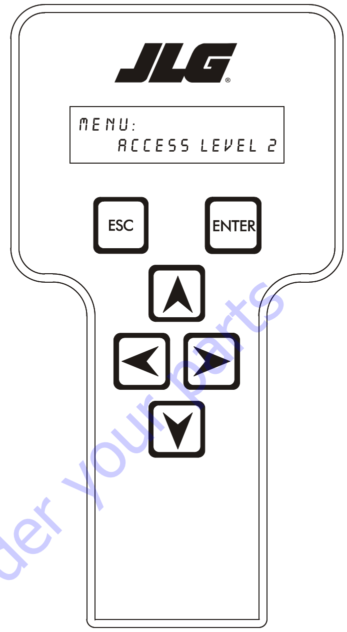
When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

Pressing **ENTER** with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected menu item by pressing the **ESC.** key.

9.4 CHANGING THE ACCESS LEVEL OF THE HAND HELD ANALYZER

When the analyzer is first connected, you will be in access level 2 which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change the access level, the correct password must be entered. To enter the password, scroll to the **ACCESS LEVEL** menu. For example:



MENU:
ACCESS LEVEL 2

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

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

Then using the **RIGHT** arrow key, position the cursor to the right one space to enter the second digit of the password.

Use the **UP** or **DOWN** arrow key to enter the second digit of the password which is 33271.

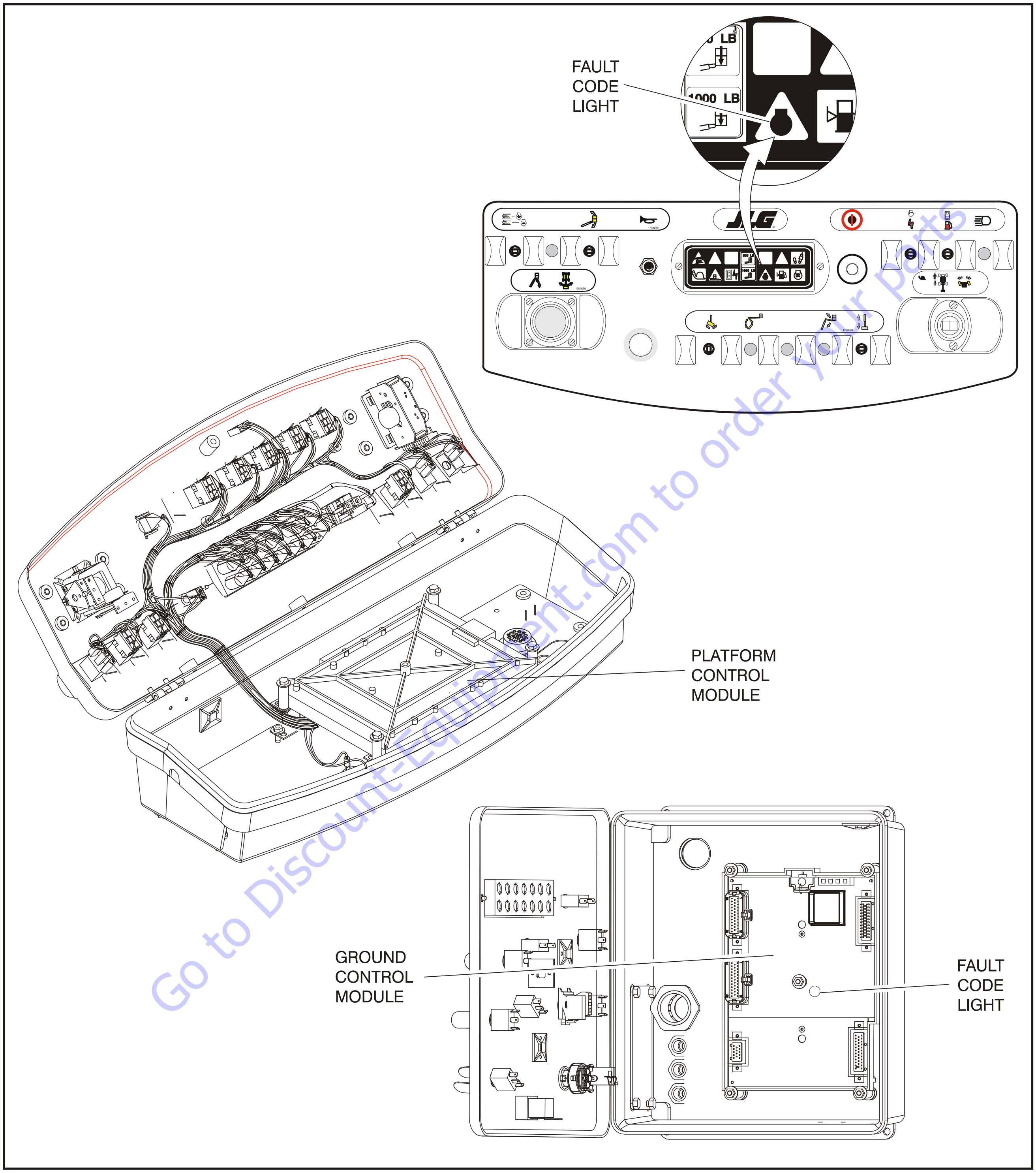
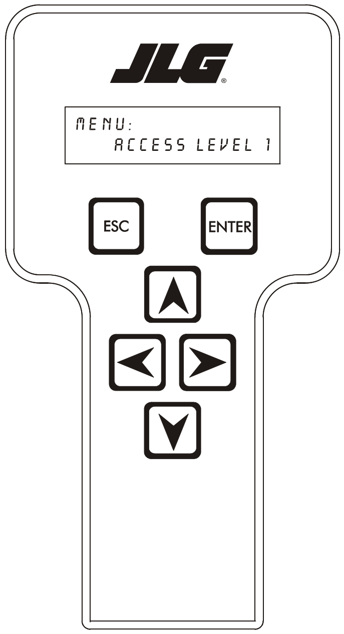


Figure 9-4. Control Module Location

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:

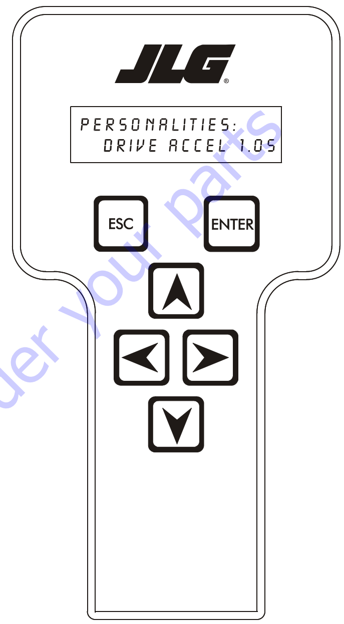


MENU:
ACCESS LEVEL 1

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

9.5 ADJUSTING PARAMETERS USING THE HAND HELD ANALYZER

Once you have gained access to level 1, and a personality item is selected, press the UP or DOWN arrow keys to adjust its value, for example:

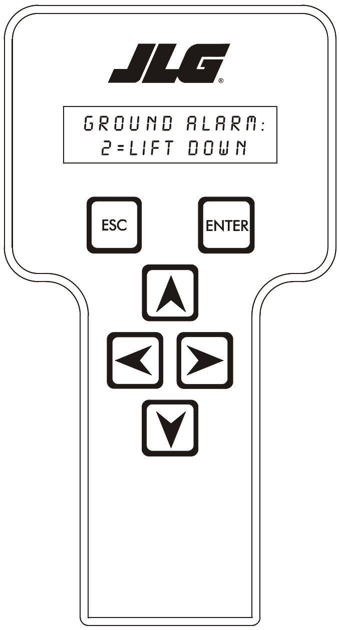


PERSONALITIES:
DRIVE ACCEL 1.0s

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and won arrows, check the access level to ensure you are at access level 1.

9.6 MACHINE SETUP

When a machine digit item is selected, press the UP or DOWN arrow keys to adjust its value, for example:



GROUND ALARM:
2 = LIFT DOWN

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when lifting down. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

NOTE: *Refer to Table 9-1, Personality Ranges/Defaults, and in this Service Manual for the recommended factory settings.*

NOTE: *Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.*

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

ELEVATION CUTBACK

WARNING

CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.

NOTICE

ITS IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

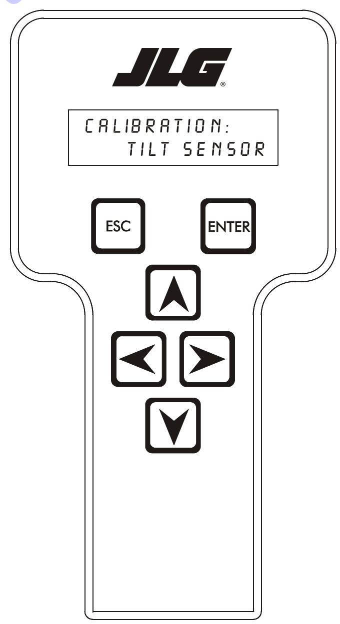
9.7 LEVEL VEHICLE DESCRIPTION

NOTICE

A NEW TILT MODULE WILL ACT AS IF IT IS TILTED ALL OF THE TIME UNTIL THE FOLLOWING PROCEDURE IS PERFORMED.

WARNING

DO NOT CALIBRATE THE LEVEL SENSOR EXCEPT ON A LEVEL SURFACE.



Place machine in stowed position with the boom between the rear wheels.

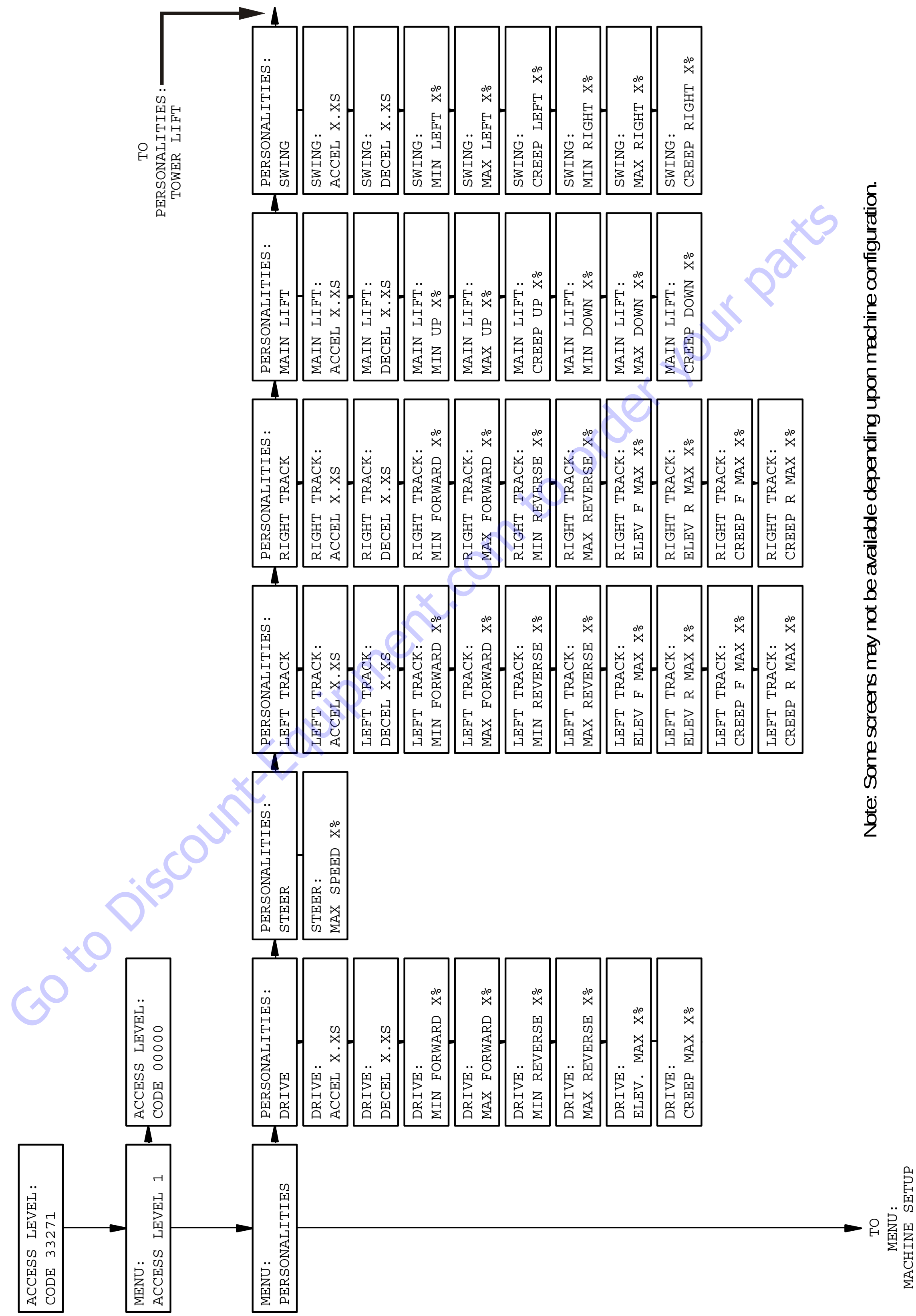
To level machine chose:

CALIBRATION:
TILT SENSOR

Press ENTER.

When prompted, swing machine 180°

Press ENTER.



Note: Some screens may not be available depending upon machine configuration.

Figure 9-5. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 1 of 4

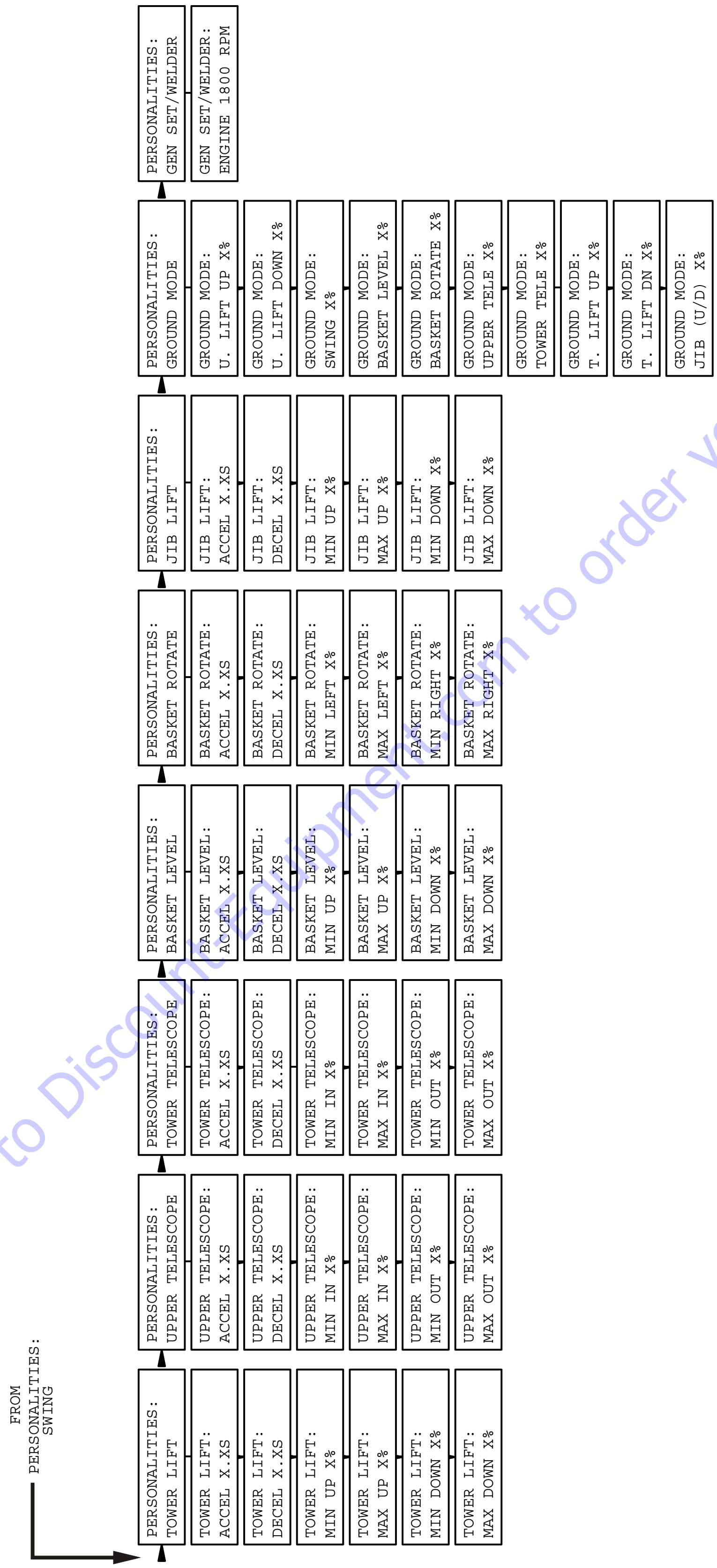


Figure 9-6. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 2 of 4

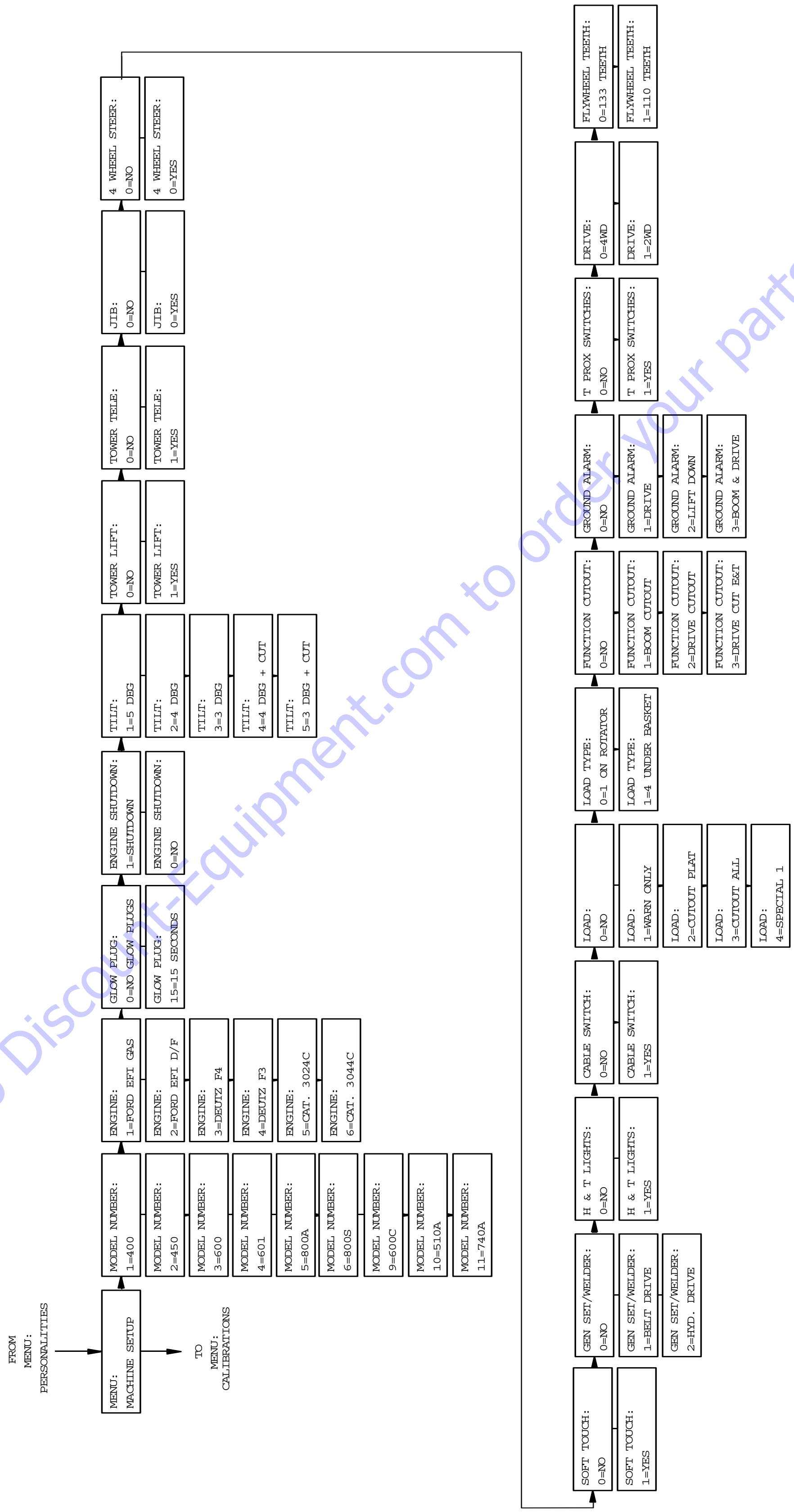


Figure 9-7. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 3 of 4

Figure 9-8. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 4 of 4

NOTE: *Some screens may not be available depending upon machine configuration.*

Figure 9-9. Analyzer Flow Chart, Version 5.X Software - Sheet 1 of 4

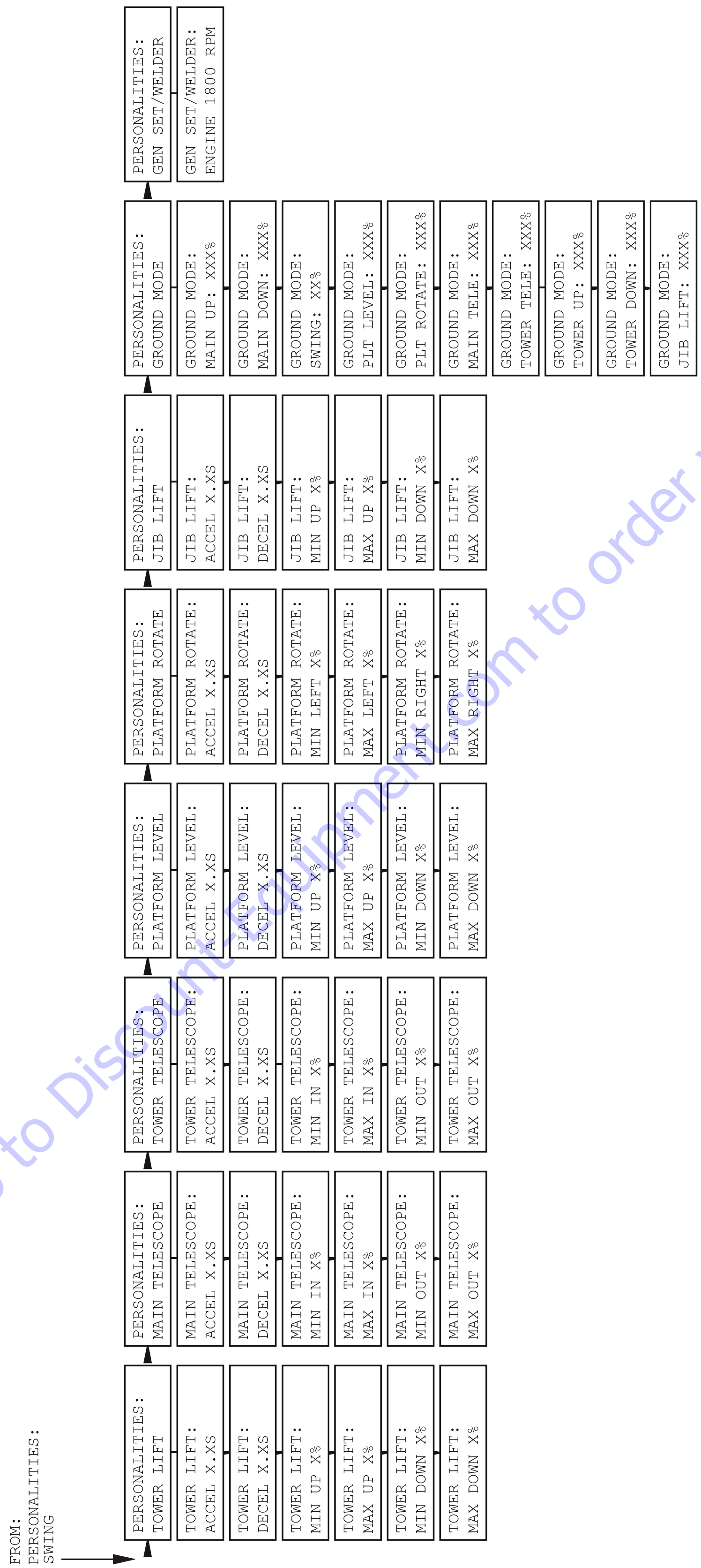


Figure 9-10. Analyzer Flow Chart, Version 5.X Software - Sheet 2 of 4

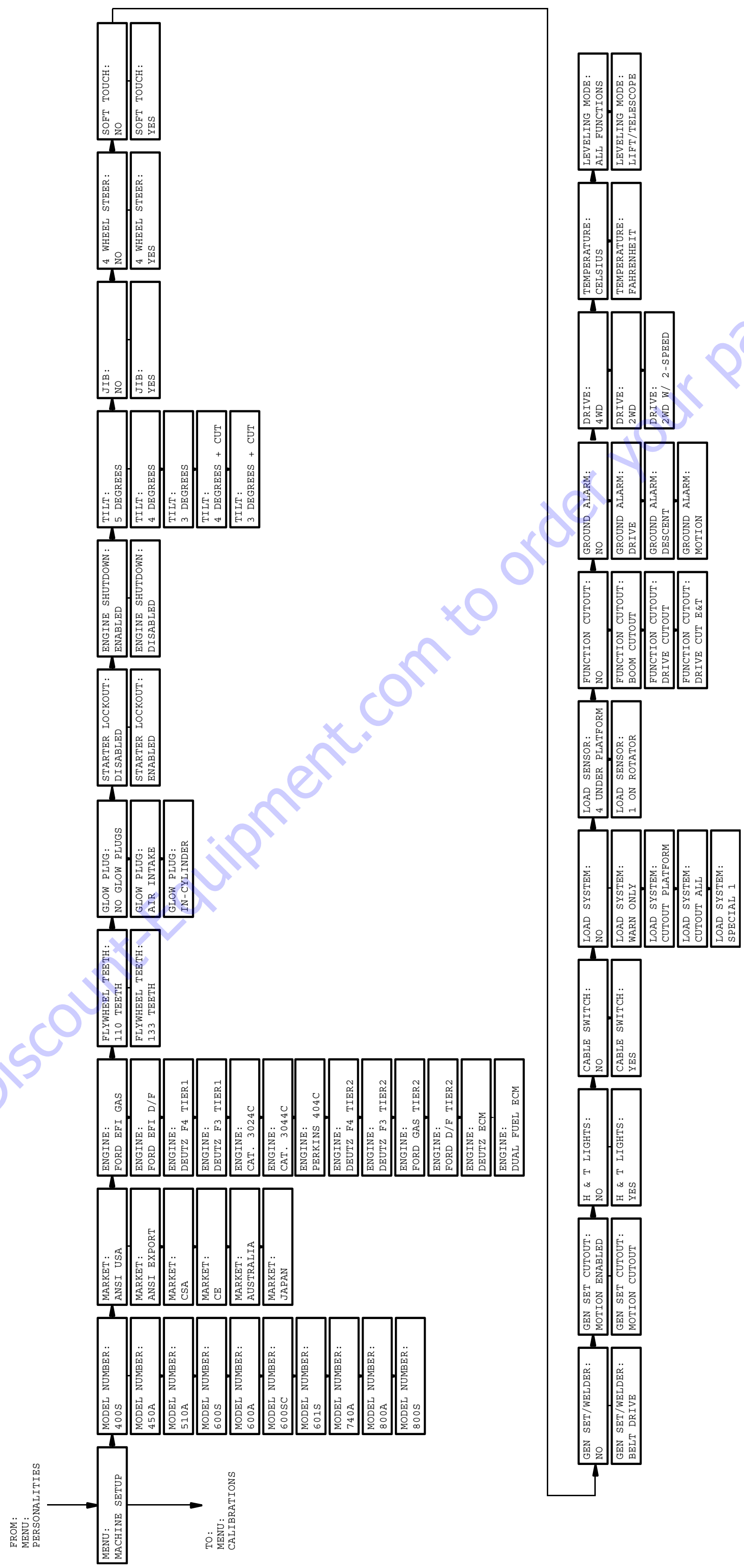


Figure 9-11. Analyzer Flow Chart, Version 5.X Software - Sheet 3 of 4

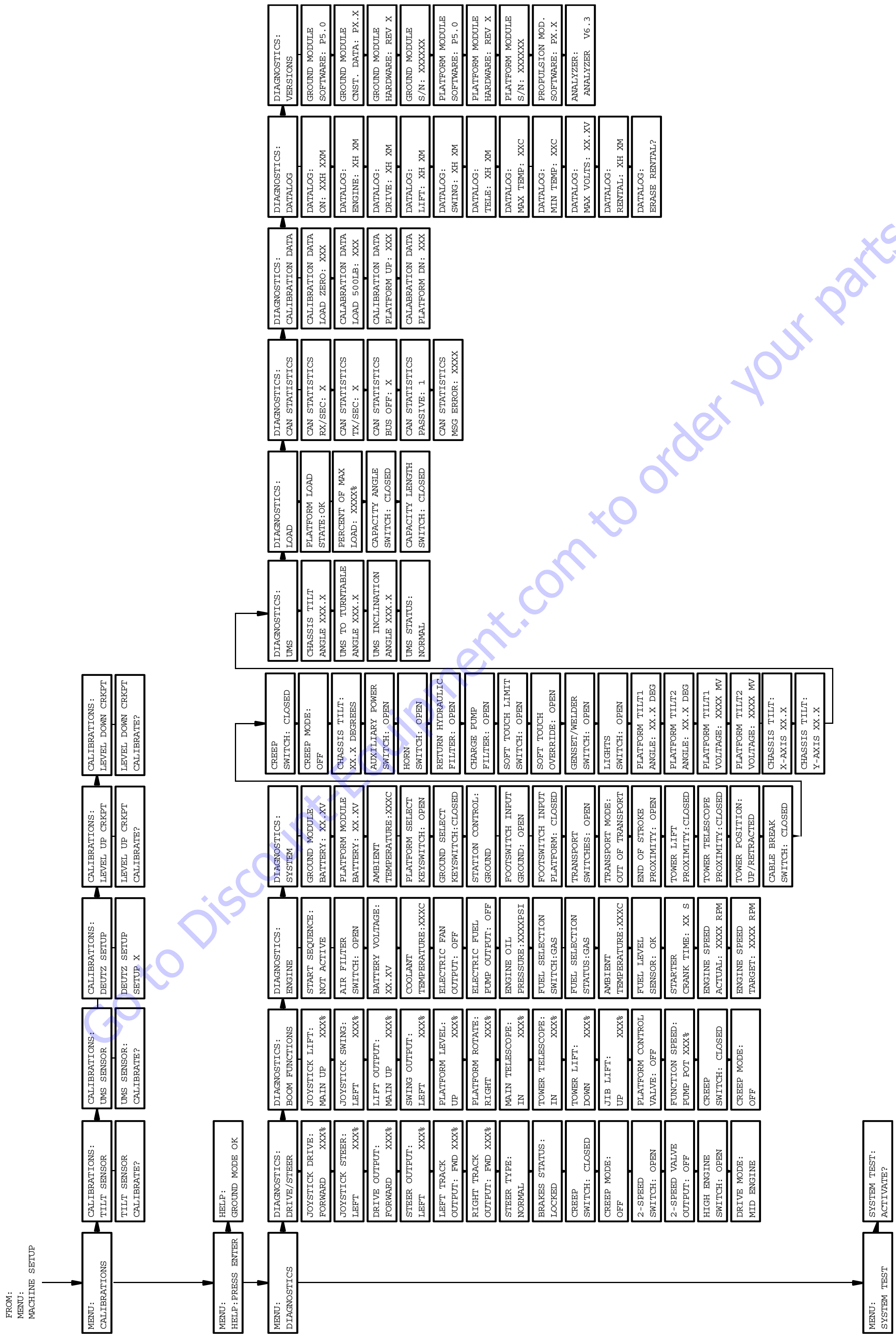


Figure 9-12. Analyzer Flow Chart, Version 5.X Software - Sheet 4 of 4

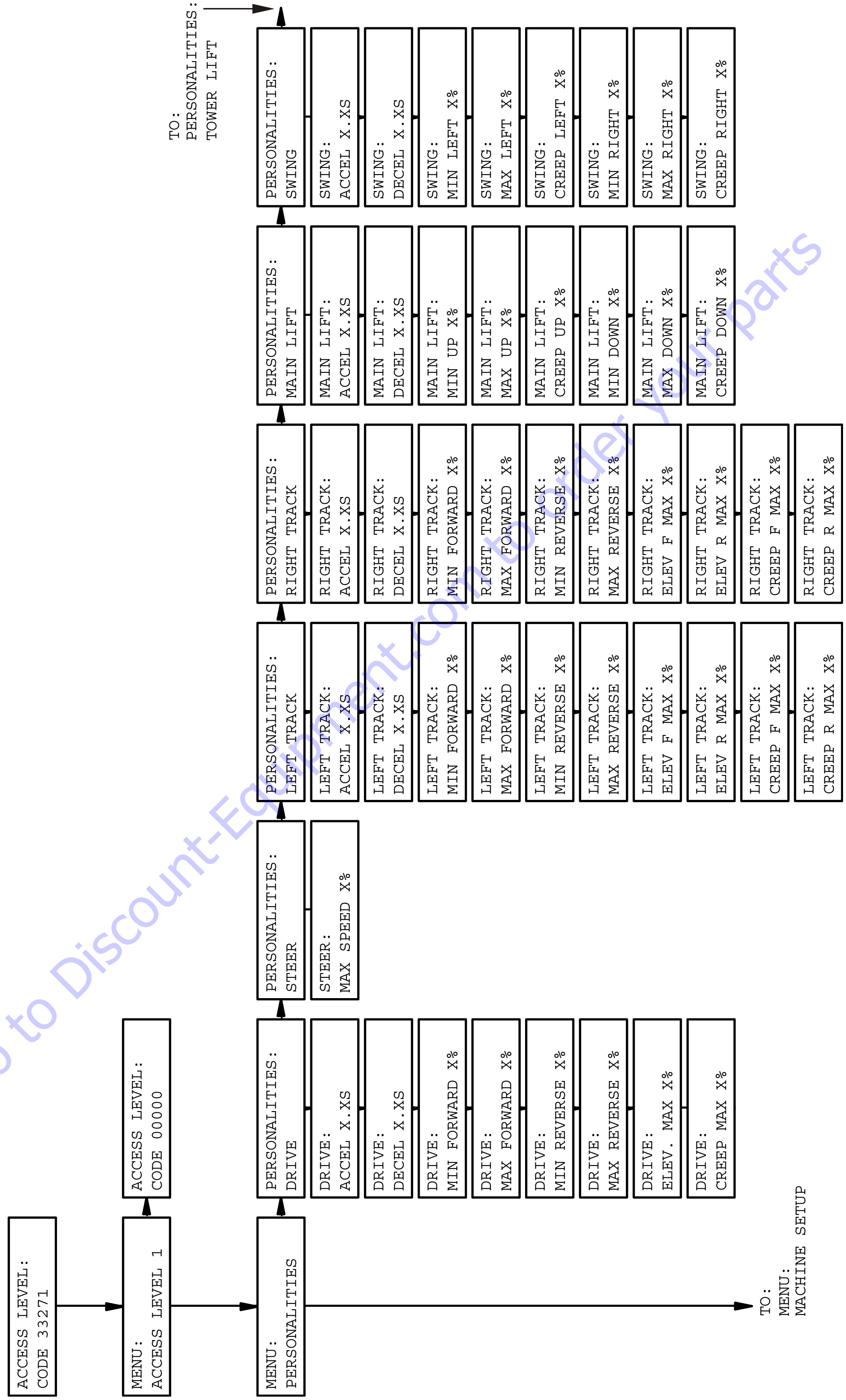


Figure 9-13. Analyzer Flow Chart, Version 6.X Software - Sheet 1 of 6

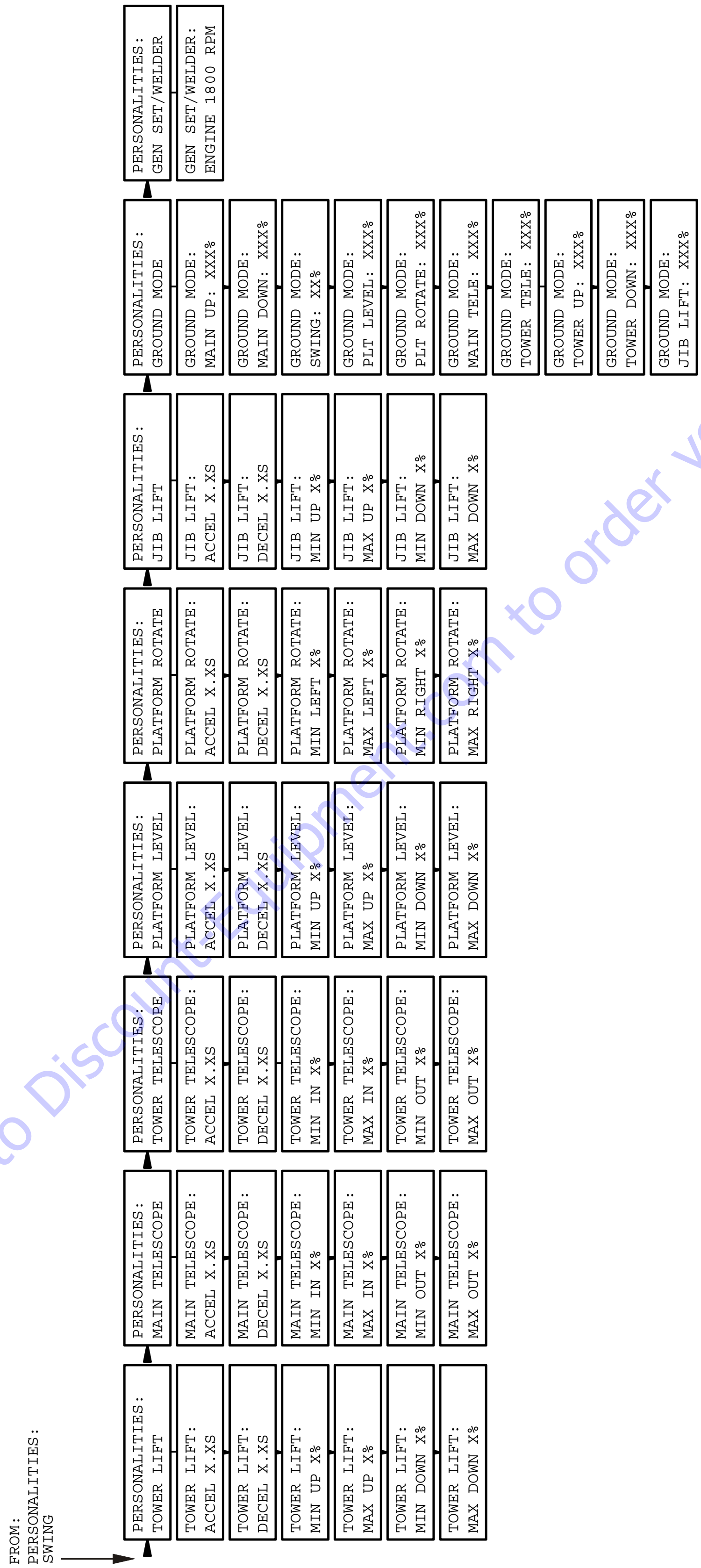


Figure 9-14. Analyzer Flow Chart, Version 6.X Software - Sheet 2 of 6

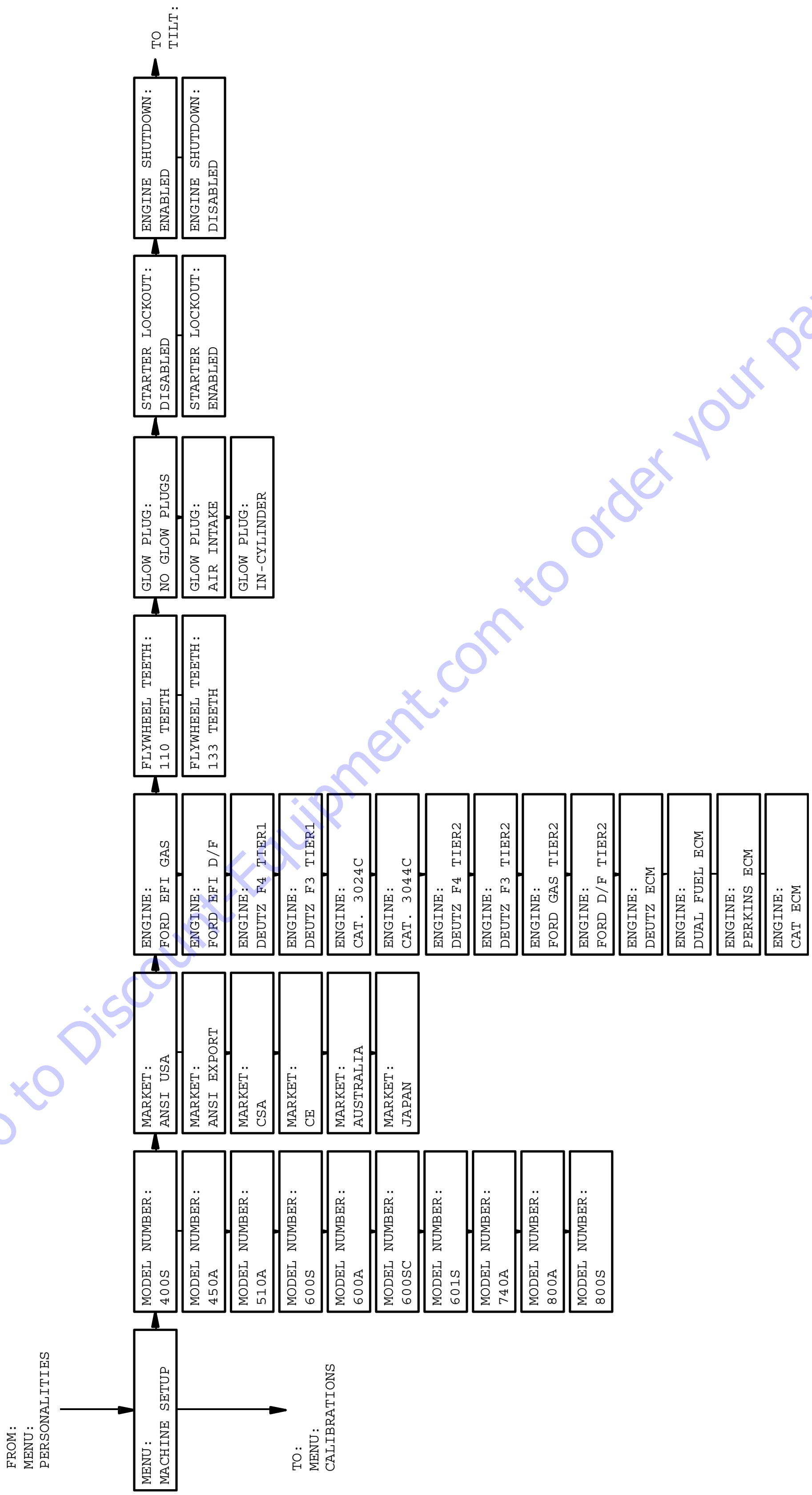


Figure 9-15. Analyzer Flow Chart, Version 6.X Software - Sheet 3 of 6

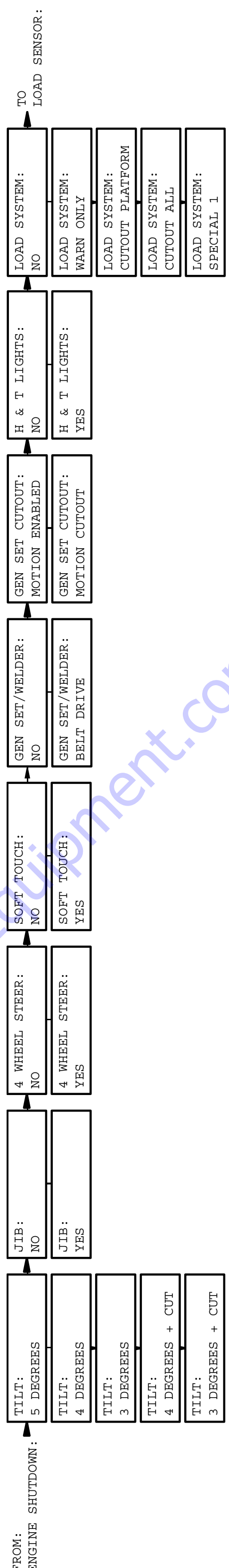


Figure 9-16. Analyzer Flow Chart, Version 6.X Software - Sheet 4 of 6

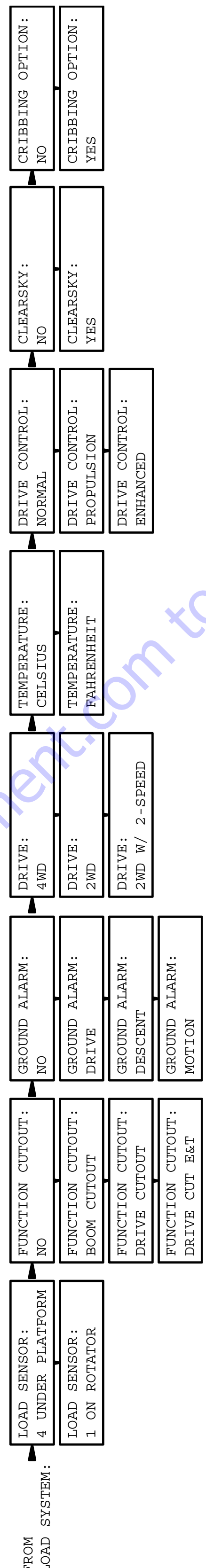


Figure 9-17. Analyzer Flow Chart, Version 6.X Software - Sheet 5 of 6

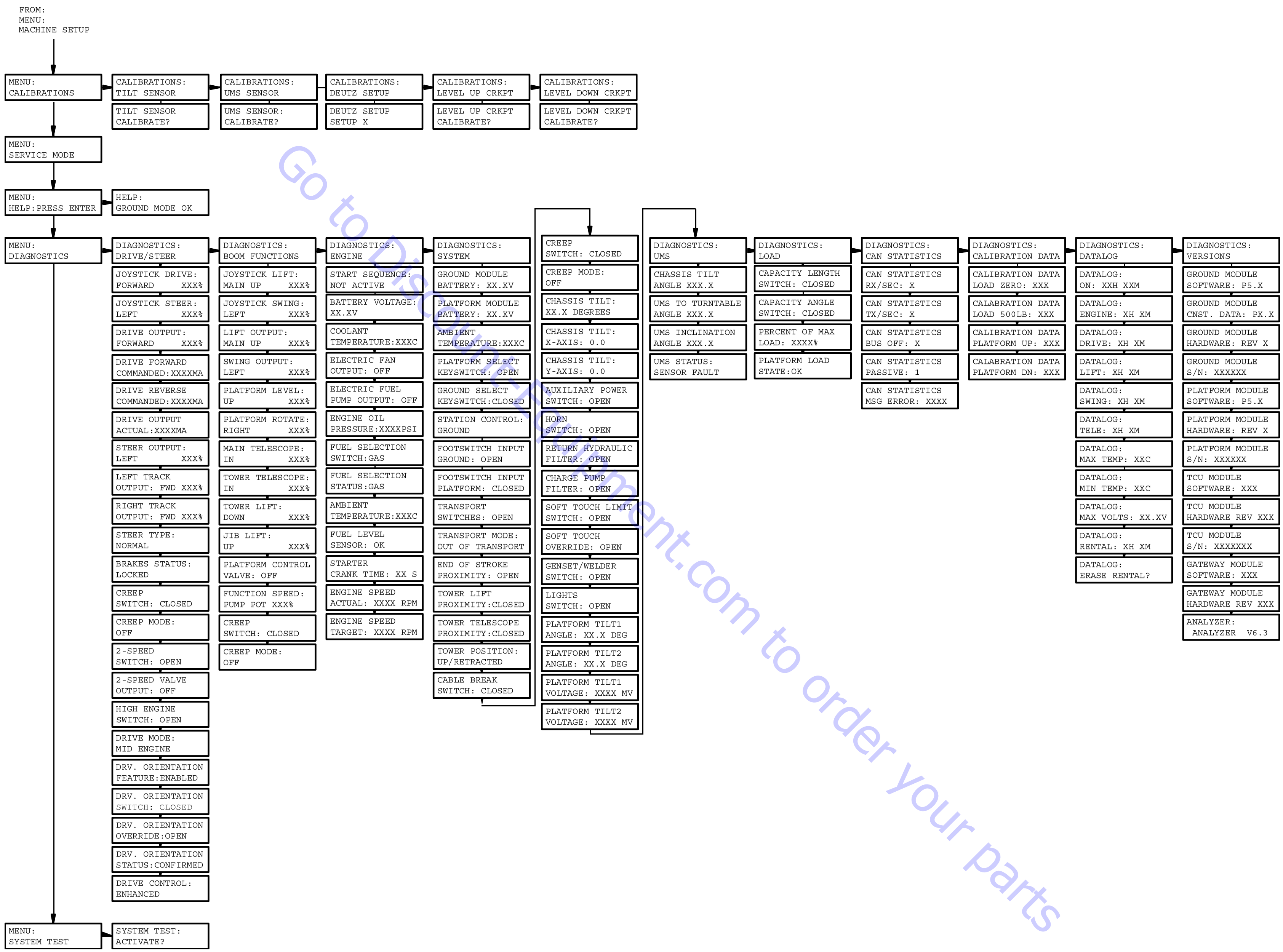


Figure 9-18. Analyzer Flow Chart, Version 6.X Software - Sheet 6 of 6

9.8 MACHINE PERSONALITY SETTINGS

NOTE: *Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.*

Table 9-1. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 600SC
DRIVE	Acceleration	0.1s to 5.0 sec	N/A
	Deceleration	0.1s to 3.0 sec	N/A
	Forward Minimum Speed	0 to 35%	N/A
	Forward Maximum Speed	0 to 100%	N/A
	Reverse Minimum Speed	0 to 35%	N/A
	Reverse Maximum Speed	0 to 100%	N/A
	Elevated Maximum Speed	0 to 50%	N/A
	Creep Maximum Speed	0 to 50%	N/A
	Engine RPM	800 to 2900	N/A
LEFT TRACK	Accel	0.1 to 5.0 sec	2.0
	Decel	0.1 to 3.0 sec	0.7
	For. Min.	0 to 100%	15
	For. Max.	0 to 100%	39
	Rev. Min.	0 to 100%	13
	Rev. Max.	0 to 100%	38
	Elevated Fwd. Max.	0 to 100%	31
	Elevated Rev. Max.	0 to 100%	30
	Creep Fwd. Max	0 to 100%	22
	Creep Rev. Max	0 to 100%	22
	Engine RPM	1200 to 1600	1800

Table 9-1. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 600SC
RIGHT TRACK	Accel	0.1 to 5.0 sec	2.0
	Decel	0.1 to 3.0 sec	0.7
	For. Min.	0 to 100%	12
	For. Max.	0 to 100%	36
	Rev. Min.	0 to 100%	19
	Rev. Max.	0 to 100%	45
	Elevated Fwd. Max.	0 to 100%	29
	Elevated Rev. Max.	0 to 100%	35
	Creep Fwd. Max	0 to 100%	19
	Creep Rev. Max	0 to 100%	28
	Engine RPM	1200 to 1600	1800
TOWER LIFT	Accel	0.1 to 5.0 sec	N/A
	Decel	0.1 to 3.0 sec	N/A
	Mlnimum Up Speed	0 to 60%	N/A
	Maximum Up Speed	0 to 100%	N/A
	Minimum Down Speed	0 to 60%	N/A
	Maximum Down Speed	0 to 100%	N/A
	Engine RPM	800 to 2900	N/A
UPPER LIFT	Accel	0.1 to 5.0 sec	2.0
	Decel	0.1 to 3.0 sec	0.7
	Mlnimum Up Speed	0 to 60%	40
	Maximum Up Speed	0 to 100%	66
	Creep Maximum Up Speed	0 to 65%	55
	Minimum Down Speed	0 to 60%	40
	Maximum Down Speed	0 to 100%	85
	Creep Maximum Down Speed	0 to 75%	55
	Engine RPM	800 to 2900	1800

Table 9-1. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 600SC
SWING	Accel	0.1 to 5.0 sec	2.0
	Deceleration	0.1 to 3.0 sec	1.8
	Minimum Left Speed	0 to 50%	30
	Maximum Left Speed	0 to 100%	65
	Creep Maximum Left Speed	0 to 65%	45
	Minimum Right Speed	0 to 50%	30
	Maximum Right Speed	0 to 100%	65
	Creep Maximum Right Speed	0 to 65%	45
	Engine RPM	800 to 2900	1800
TELESCOPE UPPER	Accel	0.1 to 5.0 sec	3.5
	Deceleration	0.1 to 3.0 sec	0.8
	Minimum In Speed	0 to 65%	53
	Maximum In Speed	0 to 100%	80
	Minimum Out Speed	0 to 65%	55
	Maximum Out Speed	0 to 100%	75
	Engine RPM	800 to 2900	1800
TELESCOPE TOWER	Accel	0.1 to 5.0 sec	N/A
	Deceleration	0.1 to 3.0 sec	N/A
	Minimum In Speed	0 to 65%	N/A
	Maximum In Speed	0 to 100%	N/A
	Minimum Out Speed	0 to 65%	N/A
	Maximum Out Speed	0 to 100%	N/A
	Engine RPM	800 to 2900	N/A
BASKET LEVEL	Accel	0.1 to 5.0 sec	2.5
	Deceleration	0.1 to 3.0 sec	0.5
	Minimum Up Speed	0 to 65%	48
	Maximum Up Speed	0 to 100%	52
	Mlnimum Down Speed	0 to 65%	45
	Maximum Down Speed	0 to 100%	50
	Engine RPM	800 to 2900	1500

Table 9-1. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 600SC
BASKET ROTATE	Acceleration	0.1 to 5.0 sec	1.8
	Deceleration	0.1 to 3.0 sec	0.7
	MInimum Left Speed	0 to 65%	42
	Maximum Left Speed	0 to 100%	50
	Minimum Right Speed	0 to 65%	42
	Maximum Right Speed	0 to 100%	50
	Engine RPM	800 to 2900	1800
JIB LIFT	Acceleration	0.1 to 5.0 sec	5.0
	Deceleration	0.1 to 3.0 sec	1.0
	Minimum Up Speed	0 to 65%	46
	Maximum Up Speed	0 to 100%	54
	Minimum Down Speed	0 to 65%	46
	Maximum Down Speed	0 to 100%	54
	Engine RPM	800 to 2900	1800
STEER	MAXimum speed	0 to 100%	N/A
	Engine RPM	800 to 2900	N/A
GROUND MODE	Tower Lift Up Speed	0 to 100%	N/A
	Tower Lift Down Speed	0 to 100%	N/A
	Upper Lift Up	0 to 100%	60
	Upper Lift Down	0 to 100%	60
	Swing Speed	0 to 100%	60
	Upper Telescope Speed	0 to 100%	70
	Tower Telescope Speed	0 to 100%	N/A
	Basket Rotate Speed	0 to 100%	50
	Basket Level Speed	0 to 100%	50
	Jib Lift Speed	0 to 100%	50
	Jib Swing	0 to 100%	N/A

NOTE: *Personality settings can be adjusted anywhere within the adjustment range in order to achieve optimum machine performance.*

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Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
None		**No flash code is indicated for the following help messages. They are intended to hint at a possible problem if the vehicle is not behaving as expected.**	1
	EVERYTHING OK	The "normal" help message in platform mode	
	GROUND MODE OK	The "normal" help message in ground mode	
	FSW OPEN	A drive or boom function has been selected but footswitch is open.	
	RUNNING AT CREEP – CREEP SWITCH OPEN	All function speeds are limited to creep because the creep switch is open.	
	RUNNING AT CREEP – TILTED AND ABOVE ELEVATION	All boom function speeds are limited to creep because the vehicle is tilted and above elevation.	
	RUNNING AT CUTBACK – ABOVE ELEVATION	Drive speed is limited to "ELEVATED MAX" because the vehicle is above elevation.	
	TILT SENSOR OUT OF RANGE	The tilt sensor has indicated a tilt angle greater than 19 degrees for more than 4 seconds. Not reported during 2 second power-up.	
	LOAD SENSOR READING UNDER WEIGHT	The load sensor is reading 20% or more under the calibrated zero point. This fault may occur if the basket is resting on the ground. Not reported during 2 second power-up.	
1/1		**Flash code 1/1 indicates a "sleep" mode.** **NOT REQUIRED**	
2/1		**Flash code 2/1 indicates problems with footswitch.**	2
	FSW FAULTY	The two footswitch inputs have read the same state for more than one second.	
	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously	
2/2		**Flash code 2/2 indicates problems with drive & steer selection. Except where noted, these faults are not reported during 2 second power-up sequence.**	3
	DRIVE LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Drive was selected before and during footswitch closure. Can be reported during power-up sequence.	
	FSW INTERLOCK TRIPPED	Footswitch was closed for seven seconds with no function selected. Can be reported during power-up sequence.	
	STEER LOCKED – SELECTED BEFORE FOOTSWITCH	Steer was selected before and during footswitch closure.	
	STEER SWITCHES FAULTY	Both steer switches are active together.	
	DRIVE / STEER WITH NO QPROX	This fault only occurs with inductive joysticks. It occurs if the joystick is moved out of the neutral position with no Qprox sensors active.	
	D/S JOY. QPROX BAD	These faults only occur with inductive joysticks. They indicate that the Q-Prox sensor is reading above 3.18 volts.	
	D/S JOY. OUT OF RANGE LOW	Resistive joysticks: These faults do not occur. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is less than the centertap voltage minus half the center tap voltage minus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered below 1.05 volts. If the centertap is at the low end of the range, these faults will be triggered below 0.79 volts.	

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	D/S JOY. OUT OF RANGE HIGH	Resistive joysticks: These faults do not occur if the Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is more than the centertap voltage plus half the centertap voltage plus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered above 4.35 volts. If the centertap is at the low end of the range, these faults will be triggered above 3.8 volts.	
	D/S JOY. CENTER TAP BAD	Resistive joysticks: These faults occur when the center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated. Inductive joysticks: These faults occur when the center tap voltage is not between 2.18 volts and 2.70 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	
	WAITING FOR FSW TO BE OPEN	Footswitch was closed when platform mode was selected. Can be reported during power-up sequence.	
2/3		**Flash code 2/3 indicates problems with boom function selection.**	**3**
	LIFT/SWING LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Platform upper lift or swing was selected before and during footswitch closure.	
	PUMP SWITCHES FAULTY – CHECK DIAGNOSTICS/ BOOM	A boom function (lower lift, telescope, basket level, basket rotate, jib) has both directions selected together.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE FOOTSWITCH	A platform boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before key switch or footswitch closure.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE AUX POWER	A ground boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before aux power.	
	LIFT / SWING WITH NO QPROX	This fault only occurs with inductive joysticks. It occurs if the joystick is moved out of the neutral position with no Qprox sensors active.	
	l/s joy. qprox bad	These faults only occur with inductive joysticks. They indicate that the Q-Prox sensor is reading above 3.18 volts.	
	l/s joy. out of range low	Resistive joysticks: These faults do not occur. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is less than the centertap voltage minus half the center tap voltage minus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered below 1.05 volts. If the centertap is at the low end of the range, these faults will be triggered below 0.79 volts.	
	l/s joy. out of range high	Resistive joysticks: These faults do not occur if the Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is more than the centertap voltage plus half the centertap voltage plus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered above 4.35 volts. If the centertap is at the low end of the range, these faults will be triggered above 3.8 volts.	

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	l/s joy. center tap bad	Resistive joysticks: These faults occur when the center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated. Inductive joysticks: These faults occur when the center tap voltage is not between 2.18 volts and 2.70 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE START SWTICH	This fault occurs when a hydraulic function switch is closed before the start switch is closed.	
	FOOTSWITCH SELECTED BEFORE START	The user attempted to start the machine with the footswitch engaged.	
2/4		**Flash code 2/4 indicates that steering digital inputs are faulty. NOT REQUIRED**	
2/5		**Flash code 2/5 indicates that a function is prevented due to a cutout.**	4
	BOOM PREVENTED – DRIVE SELECTED	A boom function is selected while a drive function is selected and drive cut-out is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED – ABOVE ELEVATION	Drive is selected while above elevation and drive cutout is configured to prevent drive.	
	DRIVE PREVENTED – BOOM SELECTED	Drive is selected while a boom function is selected and drive cutout is con-figured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED – TILTED & ABOVE ELEVATION	Drive is selected while tilted and above elevation and tilt is configured to cutout drive.	
	MODEL CHANGED – HYDRAULICS SUSPENDED – CYCLE EMS	User changed the model number using the analyzer. User must cycle power before the hydraulics system will be active again.	11
2/7		**Flash code 2/7 indicates that the accelerator input is faulty. NOT REQUIRED**	
2/8		**Flash code 2/8 indicates a problem with a hydraulic filter. Not reported during 2 second power-up.**	5
	RETURN FILTER BYPASSED	Hydraulic return filter clogged	
	charge pump filter bypassed	Charge pump filter clogged	
3/1		**Flash code 3/1 indicates that a contactor did not close when ener-gized. NOT REQUIRED**	
3/2		**Flash code 3/2 indicates that a contactor did not open when ener-gized. NOT REQUIRED**	
3/3		**Flash code 3/3 indicates a driver problem. All driver faults are detected in a similar manner. Open circuit faults are detected when the analog feedback reads too high and the output is commanded off. Short to ground is detected when the analog feedback reads low and the output is commanded on. Short to battery is detected when the analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up.**	6
	ALTERNATOR/ECM POWER SHORT TO GROUND		
	HOUR METER SHORT TO GROUND		

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	HOUR METER SHORT TO BATTERY		
	HORN SHORT TO GROUND		
	HORN OPEN CIRCUIT		
	HORN SHORT TO BATTERY		
	AUX POWER SHORT TO GROUND		
	AUX POWER OPEN CIRCUIT		
	AUX POWER SHORT TO BATTERY		
	GLOW PLUG SHORT TO GROUND		
	GLOW PLUG OPEN CIRCUIT		
	GLOW PLUG SHORT TO BATTERY		
	LP LOCK SHORT TO GROUND		
	LP LOCK OPEN CIRCUIT		
	LP LOCK SHORT TO BATTERY		
	LP START ASSIST SHORT TO GROUND		
	LP START ASSIST OPEN CIRCUIT		
	LP START ASSIST SHORT TO BATTERY		
	MAIN DUMP SHORT TO GROUND		
	MAIN DUMP OPEN CIRCUIT		
	MAIN DUMP SHORT TO BATTERY		
	PARKING BRAKE SHORT TO GROUND		
	PARKING BRAKE OPEN CIRCUIT		
	PARKING BRAKE SHORT TO BATTERY		
	START SOLENOID SHORT TO GROUND		
	START SOLENOID OPEN CIRCUIT		
	START SOLENOID SHORT TO BATTERY		
	STEER DUMP SHORT TO GROUND		

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	STEER DUMP OPEN CIRCUIT		
	STEER DUMP SHORT TO BATTERY		
	TWO SPEED SHORT TO GROUND		
	TWO SPEED OPEN CIRCUIT		
	TWO SPEED SHORT TO BATTERY		
	GROUND ALARM SHORT TO GROUND		
	GROUND ALARM OPEN CIRCUIT		
	GROUND ALARM SHORT TO BATTERY		
	GENERATOR SHORT TO GROUND		
	GENERATOR OPEN CIRCUIT		
	GENERATOR SHORT TO BATTERY		
	WELDER SHORT TO GROUND		
	WELDER OPEN CIRCUIT		
	WELDER SHORT TO BATTERY		
	HEAD TAIL LIGHT SHORT TO GROUND		
	HEAD TAIL LIGHT OPEN CIRCUIT		
	HEAD TAIL LIGHT SHORT TO BATTERY		
	BASKET UP OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.	
	BASKET UP OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.	
	BASKET UP OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.	
	BASKET UP SHORT TO GROUND		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	BASKET DOWN OPEN CIRCUIT		

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	BASKET DOWN SHORT TO BATTERY		
	BASKET DOWN OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.	
	BASKET DOWN OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.	
	BASKET DOWN OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.	
	BASKET LEFT OPEN CIRCUIT		
	BASKET LEFT SHORT TO BATTERY		
	BASKET LEFT SHORT TO GROUND		
	BASKET RIGHT SHORT TO GROUND		
	BASKET RIGHT OPEN CIRCUIT		
	BASKET RIGHT SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB DOWN SHORT TO GROUND		
	JIB DOWN OPEN CIRCUIT		
	JIB DOWN SHORT TO BATTERY		
	JIB LEFT SHORT TO GROUND		
	JIB LEFT OPEN CIRCUIT		
	JIB LEFT SHORT TO BATTERY		
	JIB RIGHT SHORT TO GROUND		
	JIB RIGHT OPEN CIRCUIT		
	JIB RIGHT SHORT TO BATTERY		
	TOWER UP SHORT TO GROUND		
	TOWER UP OPEN CIRCUIT		
	TOWER UP SHORT TO BATTERY		
	TOWER DOWN SHORT TO GROUND		

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	TOWER DOWN OPEN CIRCUIT		
	TOWER DOWN SHORT TO BATTERY		
	TOWER IN SHORT TO GROUND		
	TOWER IN OPEN CIRCUIT		
	TOWER IN SHORT TO BATTERY		
	TOWER OUT SHORT TO GROUND		
	TOWER OUT OPEN CIRCUIT		
	TOWER OUT SHORT TO BATTERY		
	UPPER IN SHORT TO GROUND		
	UPPER IN OPEN CIRCUIT		
	UPPER IN SHORT TO BATTERY		
	UPPER OUT SHORT TO GROUND		
	UPPER OUT OPEN CIRCUIT		
	UPPER OUT SHORT TO BATTERY		
	LIFT UP DUMP SHORT TO GROUND		
	LIFT UP DUMP OPEN CIRCUIT		
	LIFT UP DUMP SHORT TO BATTERY		
	LIFT DOWN HOLDING SHORT TO GROUND		
	LIFT DOWN HOLDING OPEN CIRCUIT		
	LIFT DOWN SHORT TO BATTERY		
	HOUR METER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.	
	FORD ECM POWER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.	
	FORD ECM POWER SHORT TO BATTERY	This fault cannot be detected during normal operation. It may be reported during self test.	

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
3/4		**Flash code 3/4 indicates a driver problem on a platform valve block valve driver. All driver faults are detected in a similar manner. Open circuit faults are detected when the analog feedback reads too high and the output is commanded off. Short to ground is detected when the analog feedback reads low and the output is commanded on. Short to battery is detected when the analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up.**	**6**
	BASKET UP SHORT TO BATTERY		
	BASKET UP SHORT TO GROUND		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling	
	BASKET DOWN SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	bASKET DOWN OPEN CIRCUIT		
	BASKET DOWN SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling.	
	BASKET LEFT SHORT TO BATTERY		
	BASKER LEFT SHORT TO GROUND		
	BASKET LEFT OPEN CIRCUIT		
	BASKET RIGHT SHORT TO BATTERY		
	BASKET RIGHT SHORT TO GROUND		
	BASKET RIGHT OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB DOWN SHORT TO BATTERY		
	JIB DOWN SHORT TO GROUND		
	JIB DOWN OPEN CIRCUIT		
	JIB LEFT SHORT TO BATTERY		
	JIB LEFT SHORT TO GROUND		

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	JIB LEFT OPEN CIRCUIT		
	JIB RIGHT SHORT TO BATTERY		
	JIB RIGHT SHORT TO GROUND		
	JIB RIGHT OPEN CIRCUIT		
	PLATFORM CONTROL VALVE SHORT TO BATTERY	Only occurs on machines with electronic basket leveling	
	PLATFORM CONTROL VALVE SHORT TO GROUND	Only occurs on machines with electronic basket leveling	
	PLATFORM CONTROL VALVE OPEN CIRCUIT	Only occurs on machines with electronic basket leveling	
3/5		**Flash code 3/5 indicates a brake pressure problem. NOT REQUIRED**	
4/2		**Flash code 4/2 indicates that the engine is over temperature. NOT REQUIRED**	
4/3		**Flash code 4/3 indicates problems with the engine. Except where noted, these faults are not reported during 2 second power-up sequence.**	**9**
	high engine temp	Occurs when the engine temperature is above 117 degrees Celsius for the Ford engines, and above 130 degrees Celsius for the Deutz engines.	
	AIR FILTER BYPASSED	Air filter clogged	
	NO aLTERNATOR OUTPUT	The engine has been running for 15 seconds or more and the battery voltage is still below 12.5 volts.	
	LOW Oil PrESSURE	If a Deutz engine is installed, the oil pressure is below 8 PSI and the engine has been running for at least 10 seconds. If a Ford engine is installed, the Ford ECM has reported a low oil pressure fault.	
	OIL PRESSURE SHORT TO BATTERY	If a Deutz engine is installed, this indicates that the oil pressure sensor is reading above 6.6 volts.	
	OIL PRESSURE SHORT TO GROUNd	If a Deutz engine is installed, this indicates that the oil pressure sensor is reading below 0.1 volts for more than 5 seconds. This fault is not detected during crank.	
	COOLANT TEMPERATURE SHORT TO GROUND	If a Deutz engine is installed, this indicates that the coolant temperature is reading below 0.1 volts.	
	FORD FAULT CODE ##	All Ford fault codes except 63 are simply passed through from the FORD ECM. They only occur if a Ford engine is selected in the machine configuration digits. Can be reported during power-up sequence.	
	FORD FAULT CODE UNKNOWN	An unrecognized Ford ECM fault code has been received. Can be reported during power-up sequence.	
	485 communications lost	This fault only occurs with a Ford engine. It occurs when no responses are received from the ECM for 2.5 seconds. Can be reported during power-up sequence.	
	FUEL SENSOR SHORT TO BATTERY	Indicates that the fuel sensor is reading above 4.3 volts.	
	FUEL SENSOR SHORT TO GROUND	Indicates that the fuel sensor is reading below 0.2 volts.	

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
4/4		**Flash code 4/4 indicates problems with the battery supply. Not reported during 2 second power-up.**	7
	BATTERY LOW	Battery voltage is below 11V for more than 5 seconds. This fault is not detected during crank. This is a warning – the controller does not shut down.	
	BATTERY TOO HIGH – SYSTEM SHUT DOWN	Battery voltage is above 16V. EMS recycle required.	
	BATTERY TOO LOW – SYSTEM SHUT DOWN	Battery voltage is below 9V.	
5/5		**Flash code 5/5 indicates problems with vehicle engine RPM or the encoder. Not reported during 2 second power-up.**	8
	SPEED SENSOR READING INVALID SPEED	This fault is detected with diesel engines only. The RPM pickup is indicating a speed that greater than 4000 RPM or approximately 8875 Hz.	
	SPEED INPUT LOST	This fault is detected with diesel engines only. It occurs if there is no RPM detected and the oil pressure input is reading above 8 PSI for more than three seconds. This is probably due to wiring problems at the ground module or a faulty speed sensor.	
6/6		**Flash code 6/6 indicates problems with the CAN bus.**	10
	CAN BUS FAILURE:	The ground module or platform module is not receiving CAN messages. This is probably due to wiring problems between the platform and ground modules.	
7/7		**Flash code 7/7 indicates problems with a motor.** **NOT REQUIRED**	
9/9		**Flash code 9/9 indicates problems with the controller.**	11
	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	Platform module code is too old to support the EIM or BPE load sensor and the machine is configured to use one of these two sensors. The PM code must be updated to a newer version.	
	HIGH RESOLUTION A2D FAILURE –INTERRUPT LOST	The ADS1213 chip in the platform module has stopped asserting its interrupt(DRDY) line for some reason. An EMS cycle is required.	
	HIGH RESOLUTION A2D FAILURE-REINIT LIMIT	The ADS1213 has needed to be reset 3 or more times.	
	PLATFORM MODULE FAILURE: hwfs CODE 1	Platform module V(Low) FET has failed	
	GROUND MODULE FAILURE: hwfs CODE 1	Ground module V(Low) FET has failed	
	GROUND SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.	
	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.	
	EEPROM FAILURE – CHECK ALL SETTINGS	A critical failure occurred with the EEPROM. Personalities, machine configuration digits, etc. may be reset to default values and should be checked.	

Table 9-2. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	Indicates that the chassis tilt sensor calibration information has been lost. Machine will indicate that it is tilted at all times. This calibration data is programmed into the unit at the factory.	
	CHASSIS TILT SENSOR GAIN OUT OF RANGE	Indicates that the chassis tilt sensor calibration has become corrupted.	

Table 9-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Numbe r	Description	Default Number
MODEL NUMBER: 1	1 2 3 4 5 6 7 8 9 10	400S 450A 510A 600S 600A 600SC 601S 740A 800A 800S	1
MARKET: 2	0 1 2 3 4 5	ANSI USA ANSI EXPORT CSA CE AUSTRALIA JAPAN	0
ENGINE: 3* * Engine selections vary depending on model selection.	1 2 3 4 5 6 7 8 9 10 11	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1) FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1) DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1) DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1) CAT. 3024C: CAT 3024C Diesel (Tier 2) CAT. 3044C: CAT 3044C Diesel (Tier 2) DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2) DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2) FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2) FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2) DEUTZ ECM: Engine Control Module - ECM	11
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0 1	133 TEETH: 133 flywheel teeth. 110 TEETH: 110 flywheel teeth.	1

Table 9-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0 1 2	NO GLOW PLUGS: No glow plugs installed. W/O STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow. W/ STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	1
ENGINE SHUT-DOWN: 6	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 psi.	1
TILT: 7* * Certain market selections will limit tilt options.	1 2 3 4 5	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. 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 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 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. 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.*	1
JIB: 8* * Only visible under certain model selections	0 1	NO: No jib installed. YES: Jib installed which has up and down movements only.	0
4 WHEEL STEER: 9* * Only visible under certain model selections.	0 1	NO: No four-wheel steer installed. YES: Four-wheel steer installed.	0
SOFT TOUCH: 10* * Only visible under certain model selections.	0 1	NO: No soft touch system installed. YES: Soft touch system installed.	0
GEN SET/WELDER: 11	0 1	NO: No generator installed. BELT DRIVE: Belt driven setup.	0

Table 9-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GEN SET CUTOUT: 12* * Only visible if Gen Set / Welder Menu selection is not 0.	0	MOTION ENABLED: Motion enabled when generator is ON.	0
	1	MOTION CUTOUT: Motion cutout in platform mode only.	
H & T LIGHTS: 13	0	NO: No head and tail lights installed.	0
	1	YES: Head and tail lights installed.	
CABLE SWITCH: 14* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0	NO: No broken cable switch installed.	0
	1	YES: Broken cable switch installed.	
LOAD SYSTEM: 15* * Only visible under certain model selections. * Certain market selections will limit load system options or alter default setting.	0	NO: No load sensor installed.	0
	1	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	2	CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
	4	SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	
LOAD SENSOR: 16* * Only visible if Load Sensor Menu selection is not 0. * Market selections will limit certain load sensor options.	0	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	
FUNCTION CUTOUT: 17* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0	NO: No drive cutout.	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive cutout above elevation.	
	3	DRIVE CUT E&T: Drive cutout above elevation and tilted.	

Table 9-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GROUND ALARM: 18* * Certain market selections will alter default setting.	0 1 2 3	NO: No ground alarm installed. DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). MOTION: Motion alarm sounds when any function is active (Option).	0
DRIVE: 19* * Only visible under certain model selections.	0 1 2	4WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	0
TEMPERATURE: 20	0 1	CELSIUS: Celsius unit selection. FAHRENHEIT: Fahrenheit unit selection.	1
LEVELING MODE: 21* * Only visible on 800S models.	0 1	ALL FUNCTIONS: Platform level with all functions. LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	0

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Table 9-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	

Table 9-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
ENGINE: 3* * Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	7
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0	133 TEETH: 133 flywheel teeth.	1
	1	110 TEETH: 110 flywheel teeth.	
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	IN-CYLINDER: Glow plugs installed in each cylinder.	
STARTER LOCKOUT: 6	0	DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.	0
	1	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	

Table 9-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
ENGINE SHUT-DOWN: 7	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.	1
TILT: 8* * Certain market selections will limit tilt options and alter default setting. *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.*	1 2 3 4 5	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. 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 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 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. 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.	1
JIB: 9* * Only visible under certain model selections.	0 1	NO: No jib installed. YES: Jib installed which has up and down movements only.	0
4 WHEEL STEER: 10* * Only visible under certain model selections.	0 1	NO: No four-wheel steer installed. YES: Four-wheel steer installed.	0
SOFT TOUCH: 11* * Only visible under certain model selections.	0 1	NO: No soft touch system installed. YES: Soft touch system installed.	0
GEN SET/WELDER: 12	0 1	NO: No generator installed. BELT DRIVE: Belt driven setup.	0

Table 9-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Numbe r	Description	Default Number
GEN SET CUTOUT: 13* * Only visible if Gen Set / Welder Menu selection is not 0.	0 1	MOTION ENABLED: Motion enabled when generator is ON. MOTION CUTOUT: Motion cutout in platform mode only.	0
H & T LIGHTS: 14	0 1	NO: No head and tail lights installed. YES: Head and tail lights installed.	0
CABLE SWITCH: 15* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0 1	NO: No broken cable switch installed. YES: Broken cable switch installed.	0
LOAD SYSTEM: 16* * Only visible under certain market selections. * Certain market selections will limit load system options or alter default setting.	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
LOAD SENSOR: 17* * Only visible if Load Sensor Menu selection is not 0 and under certain market selections. * Certain market selections will limit load sensor options.	0 1	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module. 4 UNDER PLATFORM: Use the EIM for load sensing.	1

Table 9-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
FUNCTION CUTOUT: 18* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0 1 2 3	NO: No drive cutout. BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive & steer cutout above elevation. DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	0
GROUND ALARM: 19* * Certain market selections will alter default setting.	0 1 2 3	NO: No ground alarm installed. DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). MOTION: Motion alarm sounds when any function is active (Option).	3
DRIVE: 20* * Only visible under certain model selections.	0 1 2	4WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	0
TEMPERATURE: 21* * Certain market selections will alter default setting.	0 1	CELSIUS: Celsius unit selection. FAHRENHEIT: Fahrenheit unit selection.	1
LEVELING MODE: 22* * Only visible on 800S models.	0 1	ALL FUNCTIONS: Platform level with all functions. LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	0

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Table 9-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Numbe r	Description	Default Number
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	

Table 9-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
ENGINE: 3* * Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	14
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	14	PERKINS ECM	
	15	CAT ECM	
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0	133 TEETH: 133 flywheel teeth.	1
	1	110 TEETH: 110 flywheel teeth.	
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	IN-CYLINDER: Glow plugs installed in each cylinder.	

Table 9-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
STARTER LOCKOUT: 6	0 1	DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow. ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	0
ENGINE SHUT-DOWN: 7	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.	1
TILT: 8* * Certain market selections will limit tilt options and alter default setting. *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.*	1 2 3 4 5	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. 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 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 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. 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.	1
JIB: 9* * Only visible under certain model selections.	0 1	NO: No jib installed. YES: Jib installed which has up and down movements only.	0
4 WHEEL STEER: 10* * Only visible under certain model selections.	0 1	NO: No four-wheel steer installed. YES: Four-wheel steer installed.	0

Table 9-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Numbe r	Description	Default Number
SOFT TOUCH: 11* * Only visible under certain model selections.	0 1	NO: No soft touch system installed. YES: Soft touch system installed.	0
GEN SET/WELDER: 12	0 1	NO: No generator installed. BELT DRIVE: Belt driven setup.	0
GEN SET CUTOUT: 13* * Only visible if Gen Set / Welder Menu selection is not 0.	0 1	MOTION ENABLED: Motion enabled when generator is ON. MOTION CUTOUT: Motion cutout in platform mode only.	0
H & T LIGHTS: 14	0 1	NO: No head and tail lights installed. YES: Head and tail lights installed.	0
CABLE SWITCH: 15* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0 1	NO: No broken cable switch installed. YES: Broken cable switch installed.	0
LOAD SYSTEM: 16* * Only visible under certain market selections. * Certain market selections will limit load system options or alter default setting.	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

Table 9-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
LOAD SENSOR: 17* * Only visible if Load Sensor Menu selection is not 0 and under certain market selections. * Certain market selections will limit load sensor options.	0 1	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module. 4 UNDER PLATFORM: Use the EIM for load sensing.	1
FUNCTION CUTOUT: 18* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0 1 2 3	NO: No drive cutout. BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive & steer cutout above elevation. DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	0
GROUND ALARM: 19* * Certain market selections will alter default setting.	0 1 2 3	NO: No ground alarm installed. DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). MOTION: Motion alarm sounds when any function is active (Option).	3
DRIVE: 20* * Only visible under certain model selections.	0 1 2	4WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	0
TEMPERATURE: 21* * Certain market selections will alter default setting.	0 1	CELSIUS: Celsius unit selection. FAHRENHEIT: Fahrenheit unit selection.	1

Table 9-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Numbe r	Description	Default Number
LEVELING MODE: 22* * Only visible on 800S models.	0 1	ALL FUNCTIONS: Platform level with all functions. LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	0
DRIVE CONTROL: 23	0 1 2	NORMAL: Drive coils are energized from the Ground Module. PROPULSION: Drive coils are energized from the Propulsion Module. ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.	2
CLEARSKY: 24	0 1	NO: Clearsky (telematics) option is disabled. YES: Clearsky (telematics) option is enabled.	0
CRIBBING OPTION: 25	0 1	NO: Cribbing Option is disabled. YES: Cribbing Option is enabled.	0

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	MODEL NUMBER	MARKET	ENGINE	GLOW PLUGS			ENGINE SHUTDOWN		TILT					JIB	4 WHEEL STEER	SOFT TOUCH		GEN SET / WELDER		GEN SET CUTOUT		HEAD & TAIL LIGHTS		CABLE BREAK SWITCH	
ANSI USA	***6***	***0***	***11***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	***0***	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
ANSI EXPORT	***6***	***1***	***11***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	***0***	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
CSA	***6***	***2***	***11***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	***0***	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
CE	***6***	***3***	***11***	0	***1***	2	0	***1***	***X***	***X***	***3***	***X***	5	***0***	***0***	***0***	1	***0***	1	***0***	1	***0***	1	0	***1***
AUSTRALIA	***6***	***4***	***11***	0	***1***	2	0	***1***	***X***	***X***	***3***	***X***	5	***0***	***0***	***0***	1	***0***	1	***0***	1	***0***	1	0	***1***
JAPAN	***6***	***5***	***11***	0	***1***	2	0	***1***	***1***	2	3	4	5	***0***	***0***	***0***	1	***0***	1	***0***	1	***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.*

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	LOAD SYSTEM					LOAD SENSOR		FUNCTION CUTOUT				GROUND ALARM				DRIVE TYPE			TEMPERATURE		LEVELING MODE	
ANSI USA	***0***	***X***	***X***	***X***	***X***	***0***	***1***	***0***	***X***	***X***	***X***	***0***	1	2	3	***0***	1	2	0	***1***	***0***	1
ANSI EXPORT	***0***	**1**	2	3	4	0	***1***	***0***	1	2	3	***0***	1	2	3	***0***	1	2	0	***1***	***0***	1
CSA	***0***	***X***	***X***	***X***	***X***	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1
CE	0	***X***	***2***	3	***X***	0	***1***	0	***1***	***X***	***X***	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1
AUSTRALIA	***0***	**1**	2	3	4	0	***1***	***0***	1	2	3	***0***	1	2	3	***0***	1	2	***0***	1	***0***	1
JAPAN	0	***1***	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	***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.*

600SJC																							
	MODEL NUMBER	MARKET	ENGINE	GLOW PLUGS			ENGINE SHUTDOWN		TILT					JIB	4 WHEEL STEER	SOFT TOUCH		GEN SET / WELDER		GEN SET CUTOUT		HEAD & TAIL LIGHTS	
ANSI USA	***6***	***0***	*11*	0	***1***	2	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1	***0***	1
ANSI EXPORT	***6***	***1***	*11*	0	***1***	2	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1	***0***	1
CSA	***6***	***2***	*11*	0	***1***	2	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1	***0***	1
CE	***6***	***3***	*11*	0	***1***	2	0	***1***	X	X	***3***	X	5	***1***	***0***	***0***	1	***0***	1	***0***	1	***0***	1
AUSTRALIA	***6***	***4***	*11*	0	***1***	2	0	***1***	X	X	***3***	X	5	***1***	***0***	***0***	1	***0***	1	***0***	1	***0***	1
JAPAN	***6***	***5***	*11*	0	***1***	2	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1	***0***	1

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Italic, underlined numbers indicate the default when the option is factory installed.*

660SJC																								
	CABLE BREAK SWITCH		LOAD SYSTEM					LOAD SENSOR		FUNCTION CUTOUT				GROUND ALARM				DRIVE TYPE			TEMPERATURE		LEVELING MODE	
ANSI USA	***0***	1	***0***	***X***	***X***	***X***	***X***	0	***1***	***0***	X	X	X	***0***	1	2	3	***0***	1	2	0	***1***	***0***	1
ANSI EXPORT	***0***	1	***0***	***1***	2	3	4	0	***1***	***0***	1	2	3	***0***	1	2	3	***0***	1	2	0	***1***	***0***	1
CSA	***0***	1	***0***	***X***	***X***	***X***	***X***	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1
CE	0	***1***	0	***X***	***2***	3	***X***	0	***1***	0	***1***	***X***	***X***	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1
AUSTRALIA	0	***1***	***0***	***1***	2	3	4	0	***1***	***0***	1	2	3	***0***	1	2	3	***0***	1	2	***0***	1	***0***	1
JAPAN	***0***	1	***0***	1	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Italic, underlined numbers indicate the default when the option is factory installed.*

Table 9-6. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
OK	0	0	CLEARS WHEN FAULT IS REMOVED
DRIVING AT CREEP - TILTED	0	0	CLEARS WHEN FAULT IS REMOVED
FSW OPEN	0	0	CLEARS WHEN FAULT IS REMOVED
RUNNING AT CREEP - CREEP SWITCH OPEN	0	0	CLEARS WHEN FAULT IS REMOVED
RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	0	0	CLEARS WHEN FAULT IS REMOVED
RUNNING AT CUTBACK - ABOVE ELEVATION	0	0	CLEARS WHEN FAULT IS REMOVED
TILT SENSOR OUT OF RANGE	0	0	CLEARS WHEN FAULT IS REMOVED
LOAD SENSOR READING UNDER WEIGHT	0	0	CLEARS WHEN FAULT IS REMOVED
FSW FAULTY	2	1	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
KEYSWITCH FAULTY	2	1	CLEARS WHEN FAULT IS REMOVED
DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOT-SWITCH	2	2	CLEARS WHEN FAULT IS REMOVED
FSW INTERLOCK TRIPPED	2	2	CLEARS WHEN FAULT IS REMOVED
STEER LOCKED - SELECTED BEFORE FOOTSWITCH	2	2	CLEARS WHEN FAULT IS REMOVED
STEER SWITCHES FAULTY	2	2	CLEARS WHEN FAULT IS REMOVED
D/S JOY. QPROX BAD	2	2	CLEARS WHEN FAULT IS REMOVED
L/S JOY. QPROX BAD	2	3	CLEARS WHEN FAULT IS REMOVED
D/S JOY. OUT OF RANGE LOW	2	2	CLEARS WHEN FAULT IS REMOVED
D/S JOY. OUT OF RANGE HIGH	2	2	CLEARS WHEN FAULT IS REMOVED
L/S JOY. OUT OF RANGE LOW	2	3	CLEARS WHEN FAULT IS REMOVED
L/S JOY. OUT OF RANGE HIGH	2	3	CLEARS WHEN FAULT IS REMOVED
D/S JOY. CENTER TAP BAD	2	2	CLEARS WHEN FAULT IS REMOVED
L/S JOY. CENTER TAP BAD	2	3	CLEARS WHEN FAULT IS REMOVED
WAITING FOR FSW TO BE OPEN	2	2	CLEARS WHEN FAULT IS REMOVED
PUMP POT FAULTY	2	3	CLEARS WHEN FAULT IS REMOVED
PUMP SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	2	3	CLEARS WHEN FAULT IS REMOVED
PUMP SWITCHES LOCKED - SELECTED BEFORE FOOT-SWITCH	2	3	CLEARS WHEN FAULT IS REMOVED
PUMP SWITCHES LOCKED - SELECTED BEFORE START SWITCH	2	3	CLEARS WHEN FAULT IS REMOVED
FOOTSWITCH SELECTED BEFORE START	2	3	CLEARS WHEN FAULT IS REMOVED
BOOM PREVENTED - DRIVE SELECTED	2	5	CLEARS WHEN FAULT IS REMOVED
DRIVE PREVENTED - ABOVE ELEVATION	2	5	CLEARS WHEN FAULT IS REMOVED

Table 9-6. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
DRIVE PREVENTED - TILTED & ABOVE ELEVATION	2	5	CLEARS WHEN FAULT IS REMOVED
DRIVE PREVENTED - BOOM SELECTED	2	5	CLEARS WHEN FAULT IS REMOVED
FORD ECM POWER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 9-6. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
PARKING BRAKE SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 9-6. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
HEAD TAIL LIGHT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HOUR METER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HOUR METER SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 9-6. Fault Code Listing

HELP MESSAGE	FAULT	FAULT REMOVAL
JIB DOWN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER UP SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER UP OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER UP SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 9-6. Fault Code Listing

HELP MESSAGE	FAULT	FAULT REMOVAL
UPPER IN OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
FUEL SENSOR SHORT TO BATTERY	3 3	CLEARS WHEN FAULT IS REMOVED
FUEL SENSOR SHORT TO GROUND	3 3	CLEARS WHEN FAULT IS REMOVED
OIL PRESSURE SHORT TO BATTERY	4 3	CLEARS WHEN FAULT IS REMOVED
OIL PRESSURE SHORT TO GROUND	4 3	CLEARS WHEN FAULT IS REMOVED
COOLANT TEMPERATURE SHORT TO GROUND	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 12	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 13	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 14	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 15	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 21	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 22	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 23	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 24	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 25	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 26	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 31	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 32	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 33	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 34	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 35	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 36	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 41	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 42	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 43	4 3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 44	4 3	CLEARS WHEN FAULT IS REMOVED

Table 9-6. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
FORD FAULT CODE 45	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 46	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 51	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 52	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 53	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 54	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 55	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 56	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 57	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 61	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 62	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 63	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 64	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE UNKNOWN	4	3	CLEARS WHEN FAULT IS REMOVED
RETURN FILTER BYPASSED	2	8	CLEARS WHEN FAULT IS REMOVED
CHARGE PUMP FILTER BYPASSED	2	8	CLEARS WHEN FAULT IS REMOVED
BATTERY LOW	4	4	CLEARS WHEN FAULT IS REMOVED
BATTERY TOO HIGH - SYSTEM SHUT DOWN	4	4	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BATTERY TOO LOW - SYSTEM SHUT DOWN	4	4	CLEARS WHEN FAULT IS REMOVED
SPEED SENSOR READING INVALID SPEED	5	5	CLEARS WHEN FAULT IS REMOVED
SPEED INPUT LOST	5	5	CLEARS WHEN FAULT IS REMOVED
ENGINE TEMP HIGH	4	3	CLEARS WHEN FAULT IS REMOVED
AIR FILTER BYPASSED	4	3	CLEARS WHEN FAULT IS REMOVED
NO ALTERNATOR OUTPUT	4	3	CLEARS WHEN FAULT IS REMOVED
OIL PRESSURE LOW	4	3	CLEARS WHEN FAULT IS REMOVED
485 COMMUNICATIONS LOST	4	3	CLEARS WHEN FAULT IS REMOVED
CAN BUS FAILURE	6	6	CLEARS WHEN FAULT IS REMOVED
LOAD SENSOR NOT CALIBRATED	9	9	CLEARS WHEN FAULT IS REMOVED
TILT SENSOR NOT CALIBRATED	9	9	CLEARS WHEN FAULT IS REMOVED
EEPROM FAILURE - CHECK ALL SETTINGS	9	9	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PLATFORM MODULE FAILURE: HWFS CODE 1	9	9	CLEARS WHEN FAULT IS REMOVED
GROUND MODULE FAILURE: HWFS CODE 1	9	9	CLEARS WHEN FAULT IS REMOVED

9.9 ANALYZER DIAGNOSTICS MENU STRUCTURE

In the following structure descriptions, an intended item is selected by pressing ENTER; pressing ESC steps back to the next outer level. The LEFT/RIGHT arrow keys move between items in the same level. The UP/DOWN arrow keys alter a value if allowed

Table 9-7. Adjustments - Personality Descriptions

DRIVE	
ACCEL ...	Displays/adjusts drive acceleration
DECEL ...	Displays/adjusts drive deceleration
MIN FORWARD ...	Displays/adjusts minimum forward drive speed
MAX FORWARD ...	Displays/adjusts maximum forward drive speed
MIN REVERSE ...	Displays/adjusts minimum reverse drive speed
MAX REVERSE ...	Displays/adjusts maximum reverse drive speed
ELEVATED MAX ...	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed
CREEP MAX ...	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active
STEER MAX ...	Displays/adjusts the maximum steer speed
LIFT	
ACCEL ...	Displays/adjusts upper lift acceleration
DECEL ...	Displays/adjusts upper lift deceleration
MIN UP ...	Displays/adjusts minimum upper lift up speed
MAX UP ...	Displays/adjusts maximum upper lift up speed
CREEP UP ...	Displays/adjusts maximum upper lift up speed NOTE: used when creep switch on pump pot is active
MIN DOWN ...	Displays/adjusts minimum upper lift down speed
MAX DOWN ...	Displays/adjusts maximum upper lift down speed
CREEP DOWN ...	Displays/adjusts maximum upper lift down speed NOTE: used when creep switch on pump pot is active

Table 9-7. Adjustments - Personality Descriptions

SWING	
ACCEL ...	Displays/adjusts swing acceleration
DECEL ...	Displays/adjusts swing deceleration
MIN LEFT ...	Displays/adjusts minimum swing left speed
MAX LEFT ...	Displays/adjusts maximum swing left speed
CREEP LEFT ...	Displays/adjusts maximum swing left speed NOTE: used when creep switch on pump pot is active
MIN RIGHT ...	Displays/adjusts minimum swing right speed
MAX RIGHT ...	Displays/adjusts maximum swing right speed
CREEP RIGHT ...	Displays/adjusts maximum swing right speed NOTE: used when creep switch on pump pot is active
UPPER TELESCOPE	
ACCEL ...	Displays/adjusts telescope acceleration
DECEL ...	Displays/adjusts telescope deceleration
MIN IN ...	Displays/adjusts minimum telescope in speed
MAX IN ...	Displays/adjusts maximum telescope in speed
MIN OUT ...	Displays/adjusts minimum telescope out speed
MAX OUT ...	Displays/adjusts maximum telescope out speed
BASKET LEVEL	
ACCEL ...	Displays/adjusts basket level acceleration
DECEL ...	Displays/adjusts basket level deceleration
MIN UP ...	Displays/adjusts minimum basket level up speed
MAX UP ...	Displays/adjusts maximum basket level up speed
MIN DOWN ...	Displays/adjusts minimum basket level down speed
MAX DOWN ...	Displays/adjusts maximum basket level down speed
BASKET ROTATE	
ACCEL ...	Displays/adjusts basket rotate acceleration
DECEL ...	Displays/adjusts basket rotate deceleration
MIN LEFT ...	Displays/adjusts minimum basket rotate left speed
MAX LEFT ...	Displays/adjusts maximum basket rotate left speed
MIN RIGHT ...	Displays/adjusts minimum basket rotate right speed
MAX RIGHT ...	Displays/adjusts maximum basket rotate right speed

Table 9-7. Adjustments - Personality Descriptions

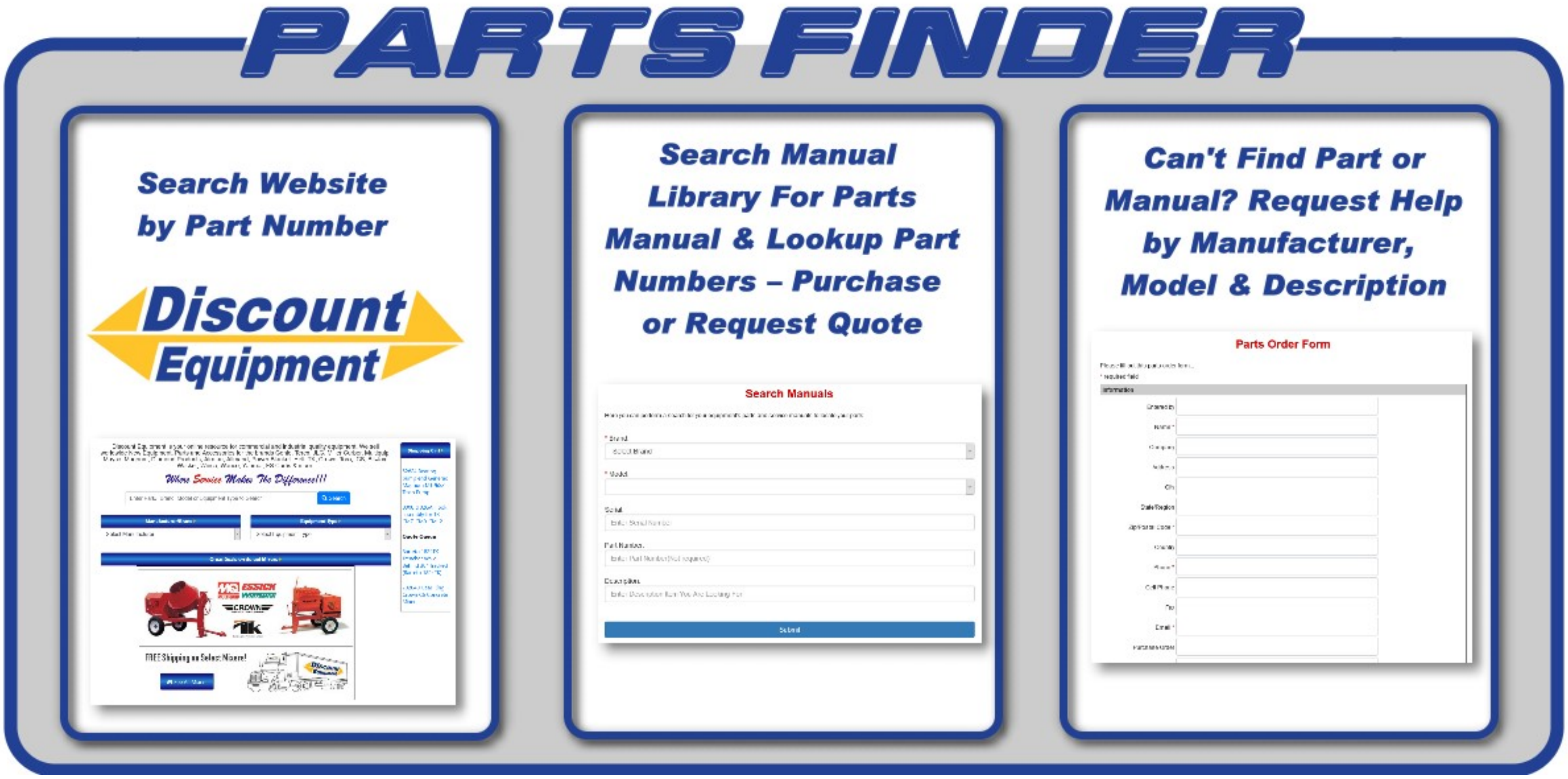
JIB LIFT	Not displayed if JIB = NO
ACCEL …	Displays/adjusts jib acceleration
DECEL …	Displays/adjusts jib deceleration
MIN UP …	Displays/adjusts minimum jib up speed
MAX UP …	Displays/adjusts maximum jib up speed
MIN DOWN …	Displays/adjusts minimum jib down speed
MAX DOWN …	Displays/adjusts maximum jib down speed
MIN LEFT …	Displays/adjusts minimum jib left speed
MAX LEFT …	Displays/adjusts maximum jib left speed
MIN RIGHT …	Displays/adjusts minimum jib right speed
MAX RIGHT …	Displays/adjusts maximum jib right speed
STEER	
MAX SPEED …	Displays/adjusts maximum steer speed, which applies when vehicle speed is at minimum
GROUND MODE	
LIFT UP …	Displays/adjusts fixed lift up speed
LIFT DOWN …	Displays/adjusts fixed lift down speed
SWING …	Displays/adjusts fixed swing speed
TELE …	Displays/adjusts fixed telescope speed
BASKETLEVEL …	Displays/adjusts fixed basket level speed
BASKETROTATE …	Displays/adjusts fixed basket rotate speed
JIB (U/D) …	Displays/adjusts jib lift speed Not displayed if JIB = NO
JIB (L/R)…	Displays/adjusts jib swing speed Not displayed if JIB = NO

Table 9-8. Diagnostic Menu Descriptions

DRIVE	
DRIVE FOR …	Displays drive joystick direction & demand
STEER …	Displays steer switch direction & demand NOTE: steer demand is inversely proportional to vehicle speed
BRAKES …	Displays brake control system status
CREEP …	Displays pump pot creep switch status
TWO SPEED ...	Displays two speed switch status
2 SPEED MODE	Displays status of two speed valve
HIGH ENGINE	Displays high engine switch status
BOOM	
U LIFT UP …	Displays lift joystick direction & demand
SWING LEFT …	Displays swing joystick direction & demand
LEVEL UP …	Displays basket level switch direction & demand NOTE: demand is controlled by the pump pot
ROT. LEFT …	Displays basket rotate switch direction & demand NOTE: demand is controlled by the pump pot
U TELE IN …	Displays telescope switch direction & demand NOTE: demand is controlled by the pump pot
JIB UP …	Displays jib lift switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
JIB LEFT …	Displays jib swing switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
PUMP POT …	Displays pump pot demand
ENGINE	
START …	Displays start switch status
AIR FILTER …	Displays air filter status
BATTERY …	Displays measured battery voltage
COOLANT …	Displays coolant temperature
OIL PRS …	Displays oil pressure status
FUEL SELECT …	Displays selected fuel (Dual Fuel only)
FUEL LEVEL …	Displays fuel level status
RPM	Displays Engine RPM
GM BATTERY	Displays battery voltage at ground module

Table 9-8. Diagnostic Menu Descriptions

PM BATTERY ...	Displays battery voltage at platform module
TEMP ...	Displays ground module temperature
ELEV. CUTOUT ...	Displays elevation cutout switch status
FUNC. CUTOUT ...	Displays function cutout switch status
CREEP...	Displays creep switch status
TILT ...	Displays measured vehicle tilt
AUX POWER ...	Displays status of auxiliary power switch
HORN ...	Displays status of horn switch
R FILTER ...	Displays status of return filter switch
C FILTER ...	Displays status of charge pump filter
LOAD LENGTH ...	Displays length switch status
ANGLE ...	Displays angle switch status
LOAD ...	Displays load sensor value NOTE: Not displayed if load = 0.
DATALOG	
ON ...	Displays total controller on (EMS) time
ENGINE ...	Displays engine run time
DRIVE ...	Displays total controller drive operation time
LIFT ...	Displays total controller lift operation time
SWING ...	Displays total controller swing operation time
TELE ...	Displays total controller tele operation time
MAX.TEMP ...	Displays maximum measured heatsink temp.
MIN.TEMP ...	Displays minimum measured heatsink temp.
MAX.VOLTS ...	Displays maximum measured battery voltage
RENTAL ...	Displays total controller operation time NOTE: can be reset
ERASE RENTAL	Not available at password level 2
YES:ENTER, NO:ESC	ENTER resets rental datalog time to zero
VERSIONS	
GROUND ...	Displays ground module software version
PLATFORM ...	Displays platform module software version
ANALYSER ...	Displays Analyzer software version



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SECTION 10. BASIC ELECTRICAL INFORMATION & ELECTRICAL SCHEMATICS

10.1 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.

10.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

Min/Max

Use of the "Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read the Voltage applied to a solenoid when it is only operational while a switch, far from the solenoid and meter, is held down.

Polarity

Getting a negative Voltage or current reading when expecting a positive reading frequently means the leads are reversed. Check what reading is expected, the location of the signal and that the leads are connected to the device under test correctly. Also check that the lead on the "COM" port goes to the Ground or negative side of the signal and the lead on the other port goes to the positive side of the signal.

Scale

M = Mega = 1,000,000 * (Displayed Number)

k = kilo = 1,000 * (Displayed Number)

m = milli = (Displayed Number) / 1,000

μ = micro = (Displayed Number) / 1,000,000

Example: 1.2 kΩ = 1200 Ω
Example: 50 mA = 0.05 A

Voltage Measurement

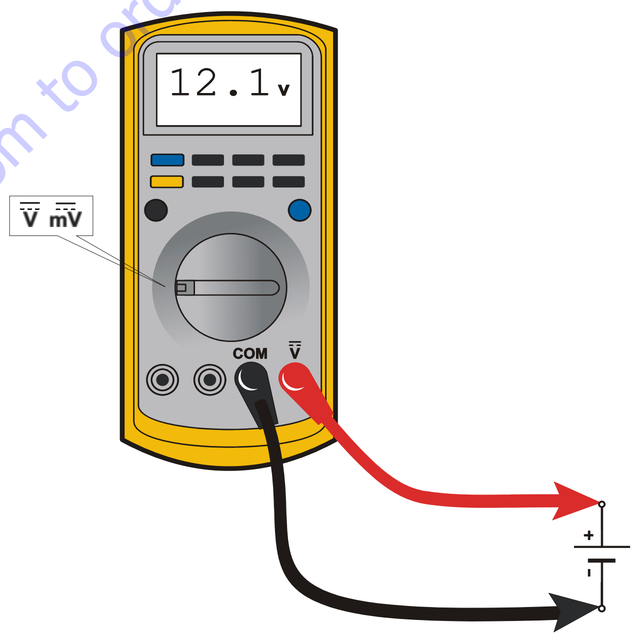


Figure 10-1. Voltage Measurement (DC)

- 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

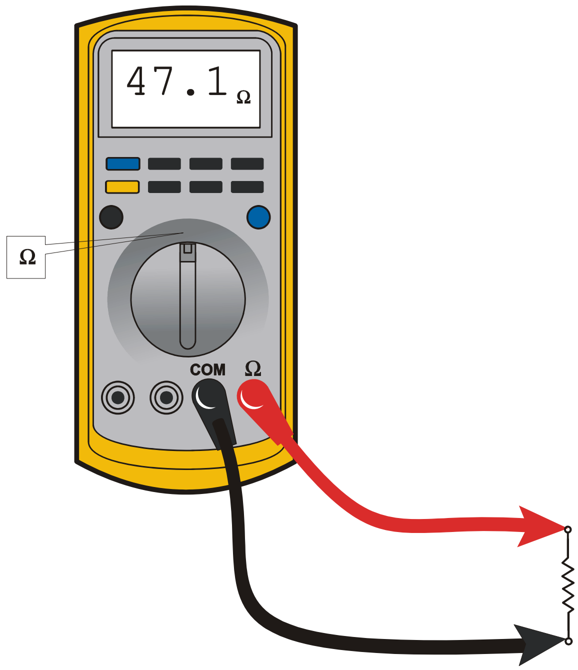


Figure 10-2. Resistance Measurement

- 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

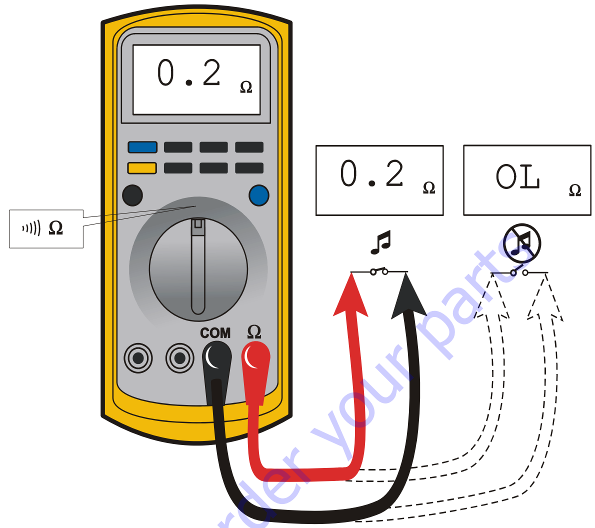


Figure 10-3. Continuity Measurement

- 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

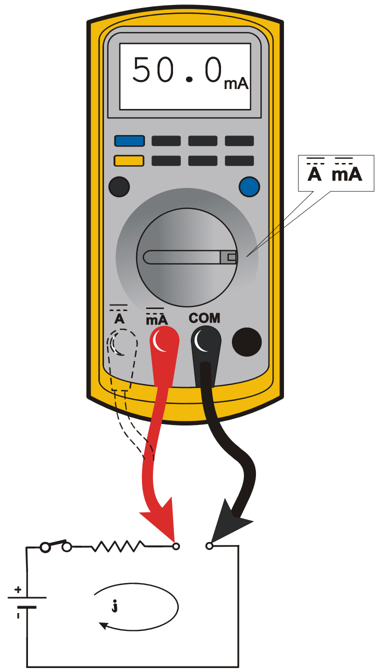


Figure 10-4. Current Measurement (DC)

- 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

10.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

NOTE: *This section is not applicable for battery terminals.*

NOTICE

JLG P/N 0100048 DIELECTRIC GREASE (NOVAGARD G661) IS THE ONLY MATERIAL APPROVED FOR USE AS A DIELECTRIC GREASE.

NOTE: *Do NOT apply dielectric grease to the following connections:*

- Main Boom Rotary sensor connections (on Celesco Sensor),
- LSS Modules connections,
- Deutz EMR 2 ECM connection.

Silicone Dielectric Compound must be used on all electrical connections except for those mentioned above for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors. This procedure applies to all plug connections not enclosed in a box. Silicone grease should not be applied to connectors with external seals.

1. To prevent oxidation, silicone grease must be packed completely around male and female pins on the inside of the connector prior to assembly. This is most easily achieved by using a syringe.

NOTE: *Over a period of time, oxidation increases electrical resistance at the connection, eventually causing circuit failure.*

2. To prevent shorting, silicone grease must be packed around each wire where they enter the outside of the connector housing. Also, silicone grease must be applied at the joint where the male and female connectors come together. Any other joints (around strain reliefs, etc.) where water could enter the connector should also be sealed.

NOTE: *This condition is especially common when machines are pressure washed since the washing solution is much more conductive than water.*

3. Anderson connectors for the battery boxes and battery chargers should have silicone grease applied to the contacts only.

NOTE: *Curing-type sealants might also be used to prevent shorting and would be less messy, but would make future pin removal more difficult.*

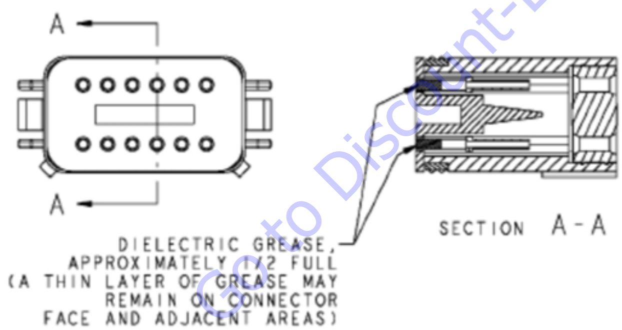
When applied to electrical connections, dielectric grease helps to prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from the application of dielectric grease.

Dielectric grease shall be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

Installation of Dielectric Grease

Before following these instructions, refer to excluded connector types (See Exclusions below).

1. Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
2. Apply dielectric grease to the female contact (fill it approximately ½ full; see example below)
3. Leave a thin layer of dielectric grease on the face of the connector
4. Assemble the connector system immediately to prevent moisture ingress or dust contamination
5. Pierce one of the unused wire seals prior to assembly if the connector system tends to trap air (i.e. AMP Seal) and then install a seal plug.



Deutsch HD, DT, DTM, DRC Series

The Deutsch connector system is commonly used for harsh environment interconnect. Follow the installation instructions.

AMP Seal

The AMP Seal connector system is used on the Control ADE Platform and Ground Modules.

Apply dielectric grease to the female contact. If trapped air prevents the connector from latching, pierce one of the unused wire seals. After assembly, install a seal plug (JLG #4460905) in that location to prevent moisture ingress.

Note that seal plugs may be installed by the wire harness manufacturer if an unused wire seal becomes compromised (wire inserted in the wrong cavity during assembly and then corrected).

Figure 10-5. Application to Female Contacts

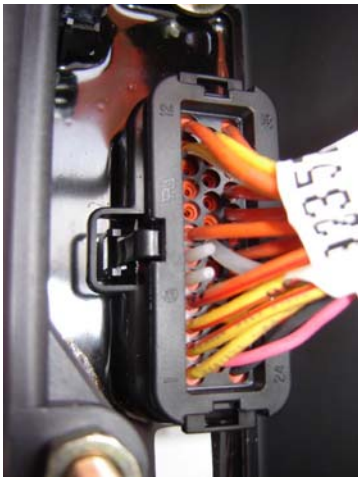
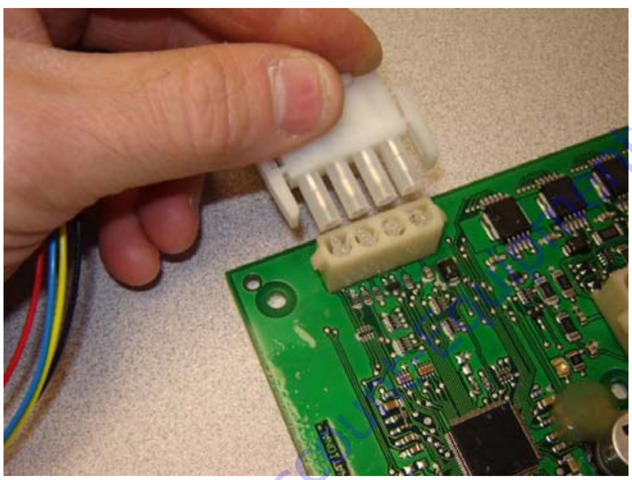


Figure 10-6. Use of Seal Plugs

AMP Mate-N-Lok

Follow the installation instructions.



DIN Connectors

This connector is typically used on hydraulic valves. Follow the installation instructions.

Exclusions

A limited number of connectors do not benefit from dielectric grease, or may be permanently damaged by application. Dielectric grease may not be required in properly sealed enclosures.

BRAD HARRISON / PHOENIX CONTACT M12

The connector uses gold contact material to resist corrosion and an o-ring seal for moisture integrity. If dielectric grease is mistakenly applied to this connector system, the low-force contacts cannot displace the grease to achieve electrical contact. Once contaminated, there is no practical way to remove the dielectric grease (replacement of female contacts required). The JLG Load Sensing System and 1250AJP Rotary Angle Sensors are examples of components with the M12 connector system.

AMP JUNIOR TIMER

This type of connector uses back-seals for moisture integrity. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease. The EMR2 engine control module from Deutz employs this connector system (for example).

SEALED ENCLOSURES

Application of dielectric grease is not required in properly sealed enclosures. To meet criteria, the enclosure must be rated to at least IP66 (dust tight; protected from powerful jets of water). The enclosure must be fitted with a high quality, continuous gasket and all wiring must pass through cable entrances.

MIL-C-5015 SPEC CONNECTORS

Crown Connector Inc's recommendation is to not use dielectric grease for this series connector. For similar model series connectors, the manufacturer should be contacted for confirmation before applying dielectric grease. A typical application for this connector is on David Clark Intercom connections in Aerial Work Platforms.

10.4 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 10-7.). Proceed as follows:

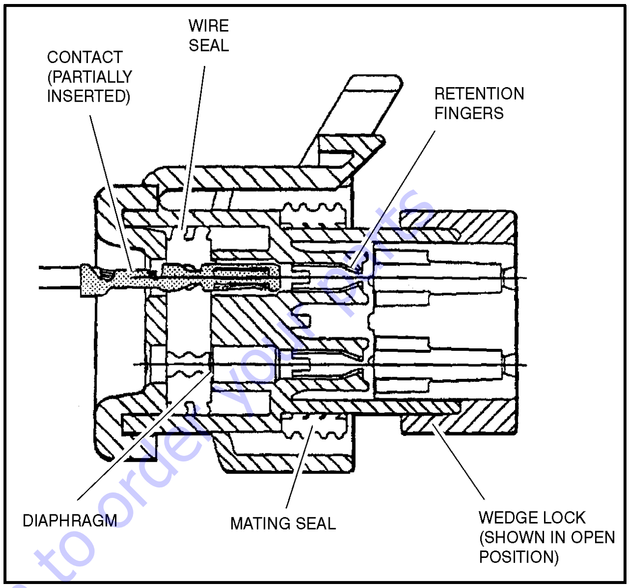


Figure 10-7. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 10-9.).

2. Pull back on the contact wire with a force of 1 or 2 lbs. to be sure the retention fingers are holding the contact (See Figure 10-9.).

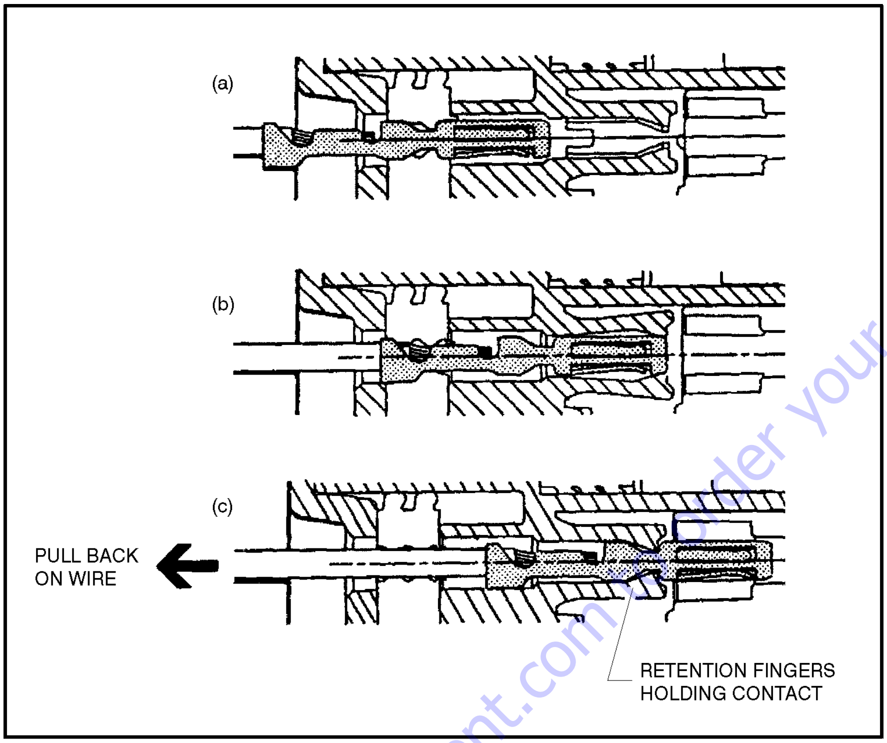


Figure 10-9. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position.

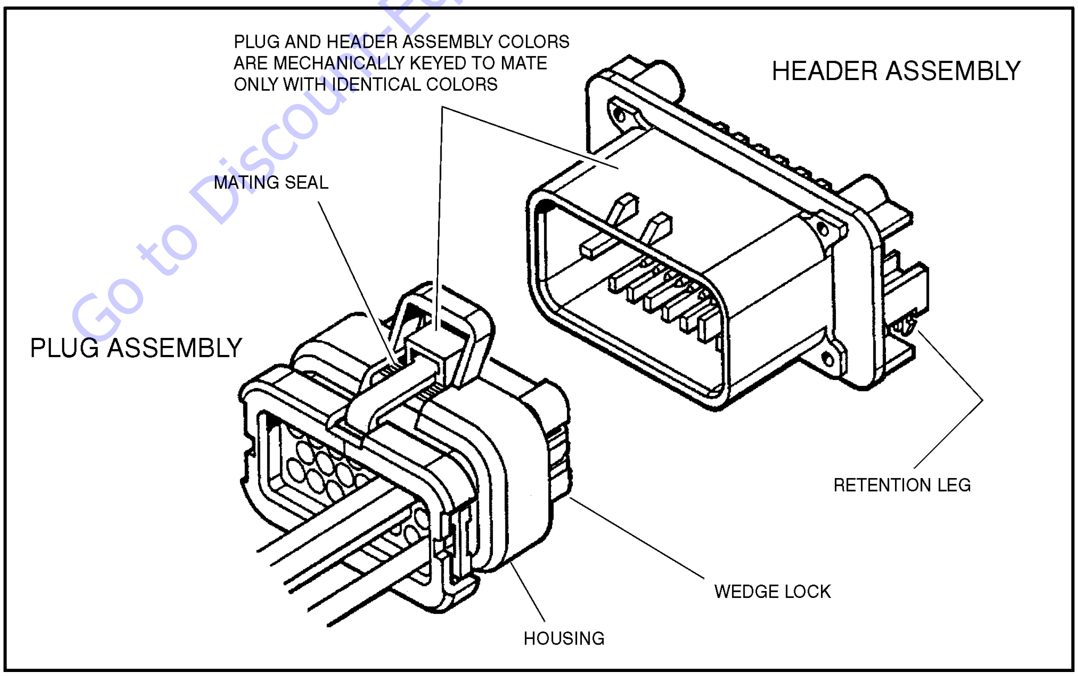


Figure 10-8. AMP Connector

Release the locking latches by squeezing them inward (See Figure 10-10.).

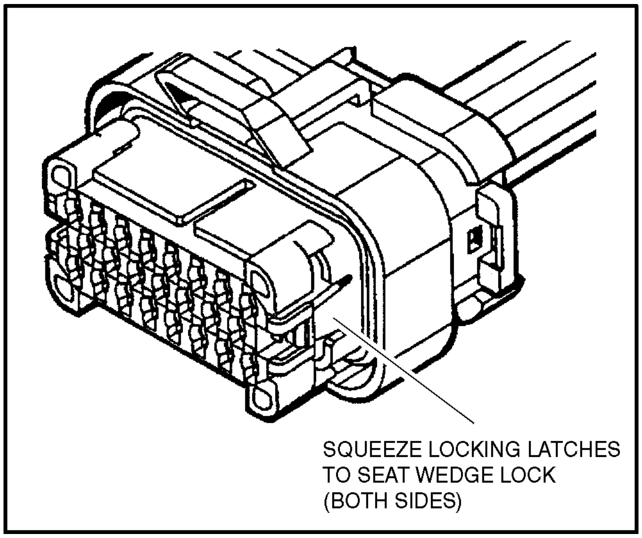


Figure 10-10. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 10-11.).

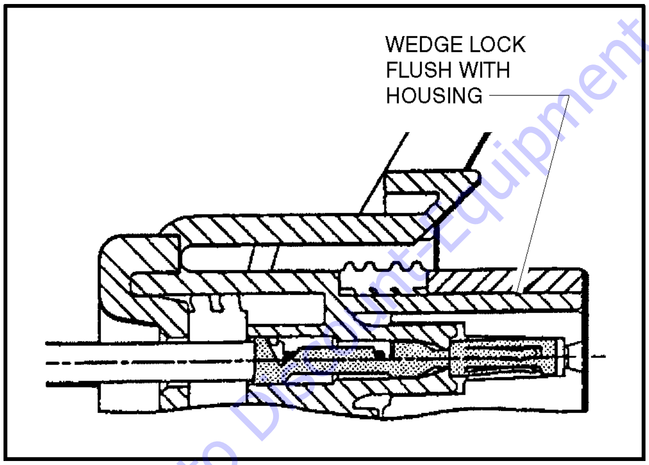


Figure 10-11. Connector Assembly Figure 4

Disassembly

1. Insert a 4.8 mm (3/16") wide screwdriver blade between the mating seal and one of the red wedge lock tabs.
2. Pry open the wedge lock to the open position.
3. While rotating the wire back and forth over a half turn (1/4 turn in each direction), gently pull the wire until the contact is removed.

NOTE: *The wedge lock should never be removed from the housing for insertion or removal of the contacts.*

Wedge Lock

The wedge lock has slotted openings in the forward, or mating end. These slots accommodate circuit testing in the field, by using a flat probe such as a pocket knife. DO NOT use a sharp point such as an ice pick.

Service - Voltage Reading

CAUTION

DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

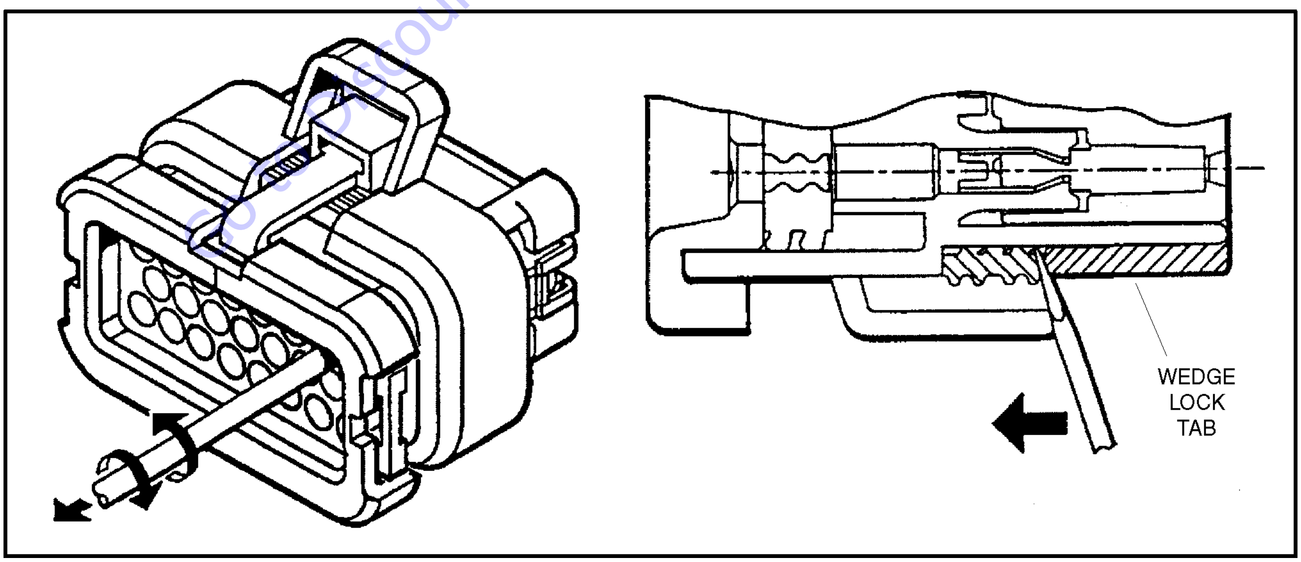


Figure 10-12. Connector Disassembly

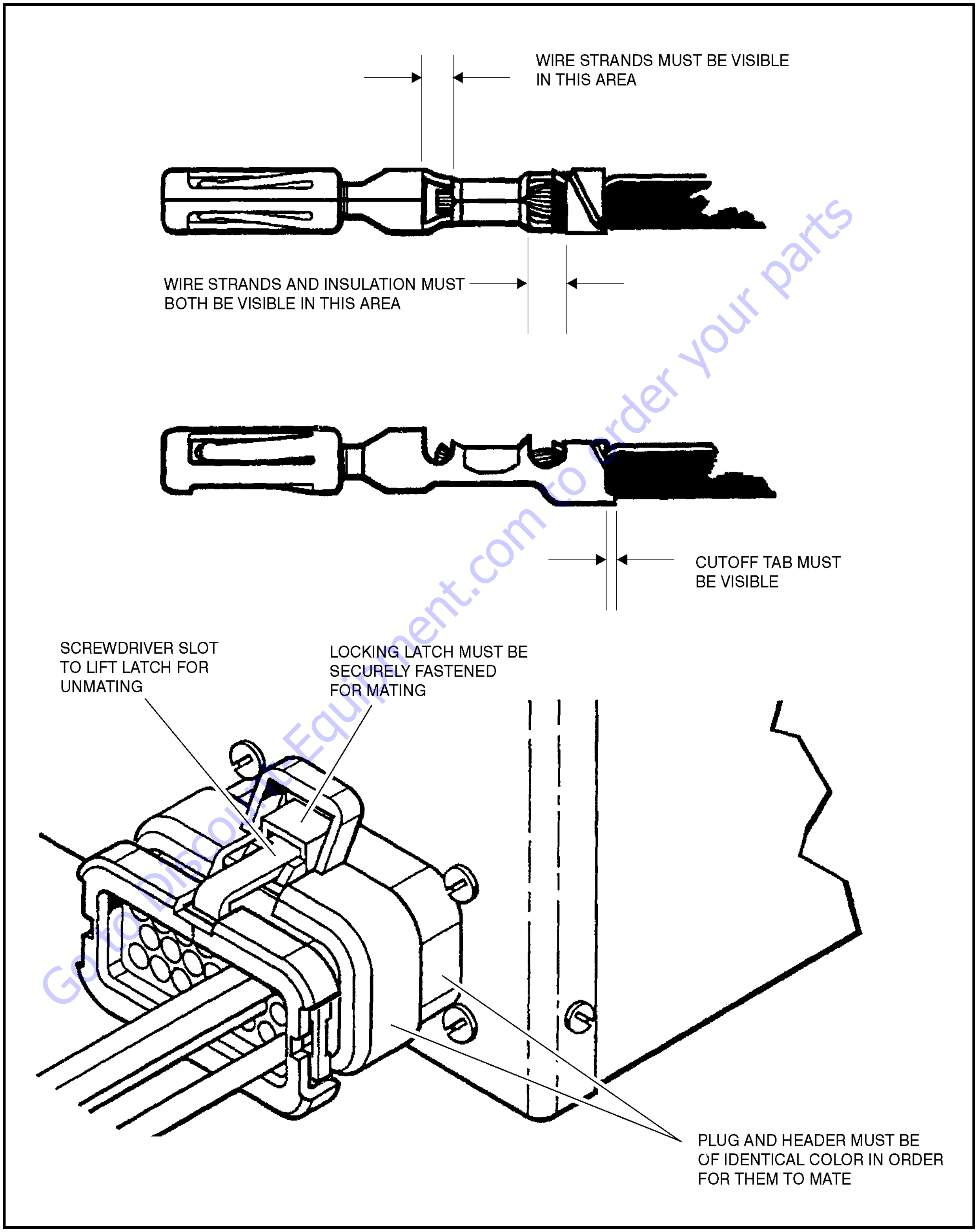


Figure 10-13. Connector Installation

10.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

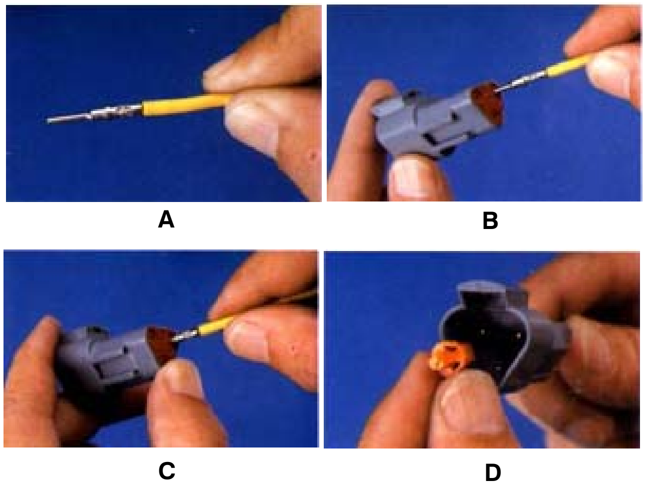


Figure 10-14. DT/DTP Contact Installation

1. Grasp crimped contact about 25mm behind the contact barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that it is properly locked in place.
4. Once all contacts are in place, insert wedgelock with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. Thy may go in either way.

NOTE: *The receptacle is shown - use the same procedure for plug.*

DT/DTP Series Disassembly

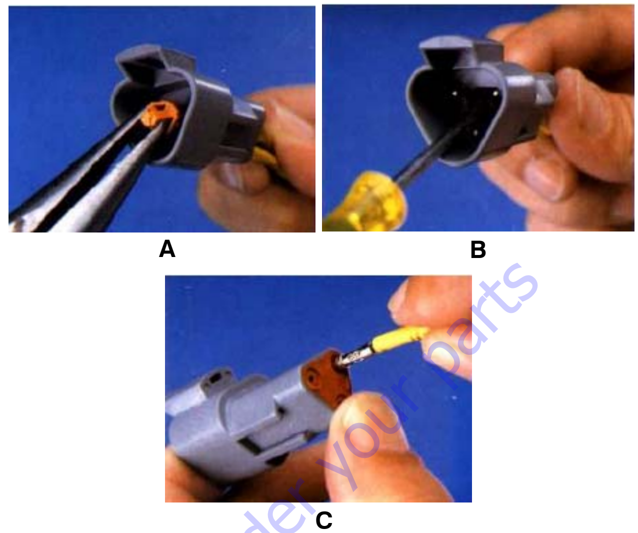


Figure 10-15. DT/DTP Contact Removal

1. Remove wedgelock using needlenose pliers or a hook shaped wire to pull wedge straight out.
2. To remove the contacts, gently pull wire backwards, while at the same time releasing the locking finger by moving it away from the contact with a screwdriver.
3. Hold the rear seal in place, as removing the contact may displace the seal.

HD30/HDP20 Series Assembly

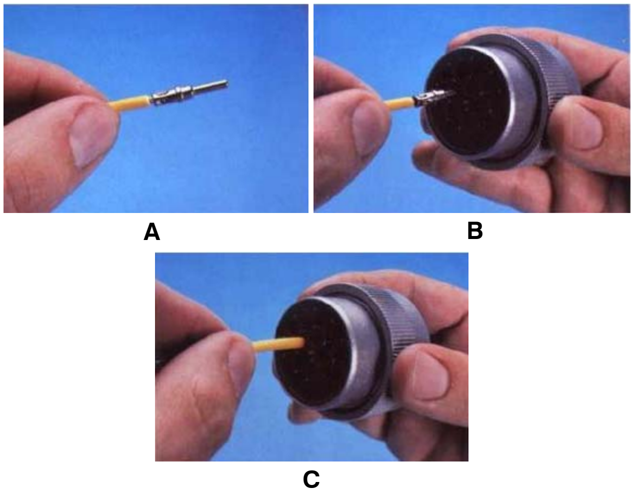


Figure 10-16. HD/HDP Contact Installation

1. Grasp contact about 25mm behind the contact crimp barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm that it is properly locked in place.

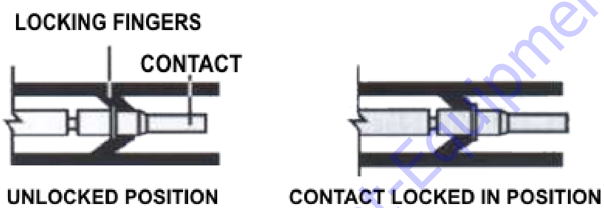


Figure 10-17. HD/HDP Locking Contacts Into Position

NOTE: *For unused wire cavities, insert sealing plugs for full environmental sealing*

HD30/HDP20 Series Disassembly

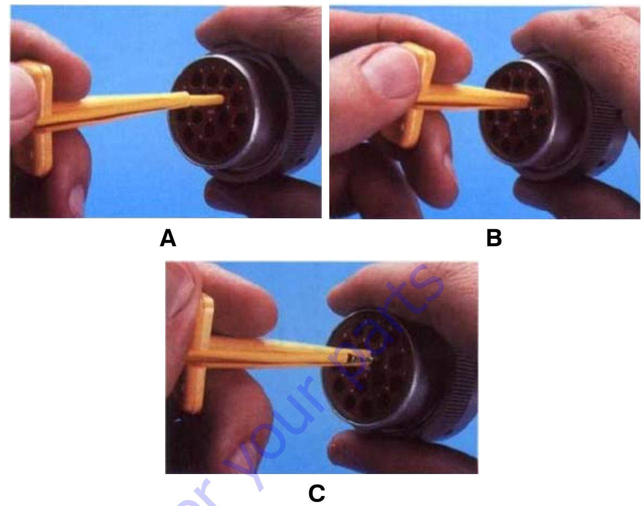


Figure 10-18. HD/HDP Contact Removal

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

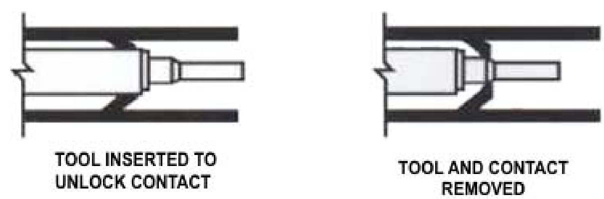


Figure 10-19. HD/HDP Unlocking Contacts

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

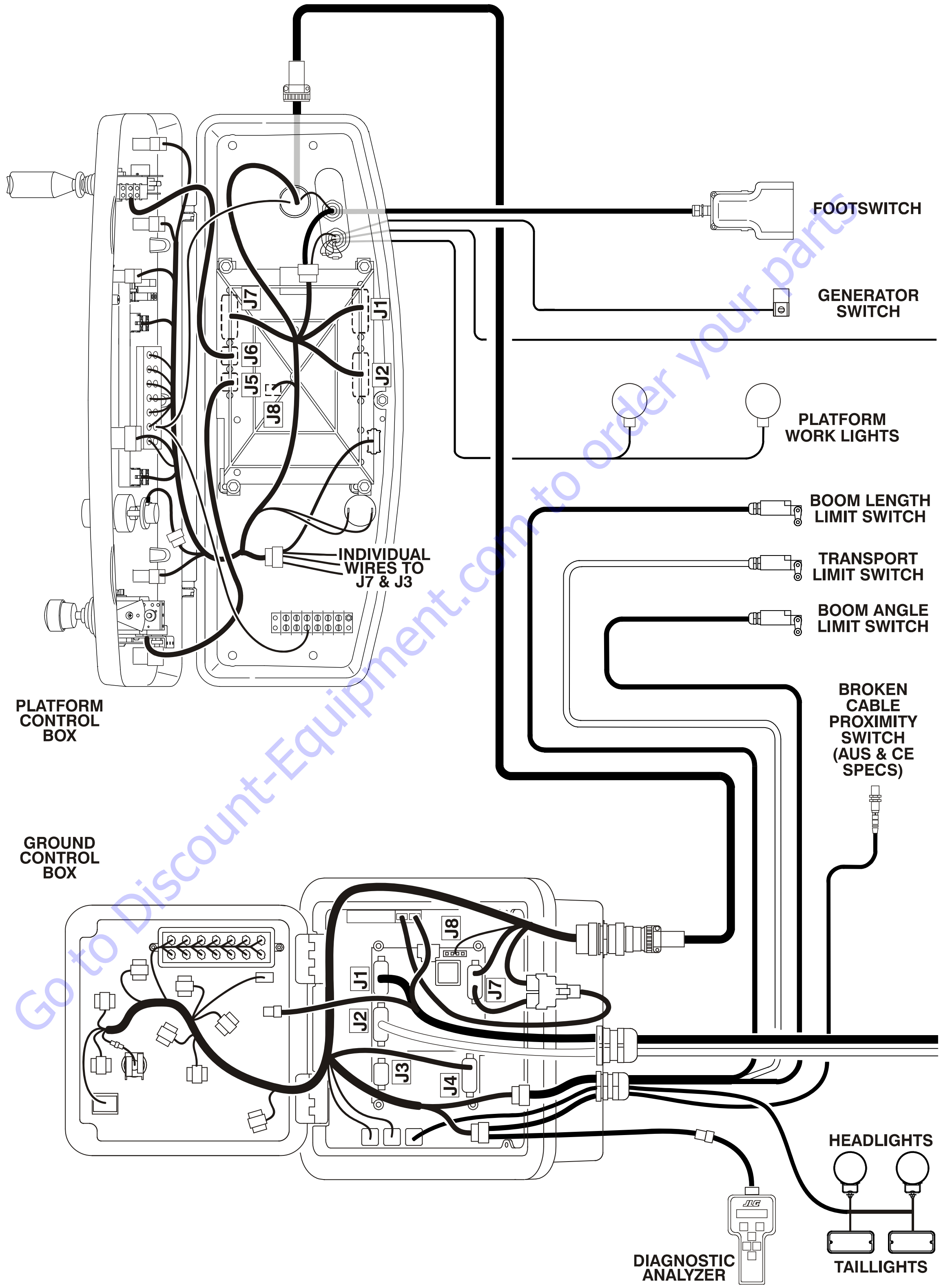


Figure 10-20. Electrical Components - Sheet 1 of 2

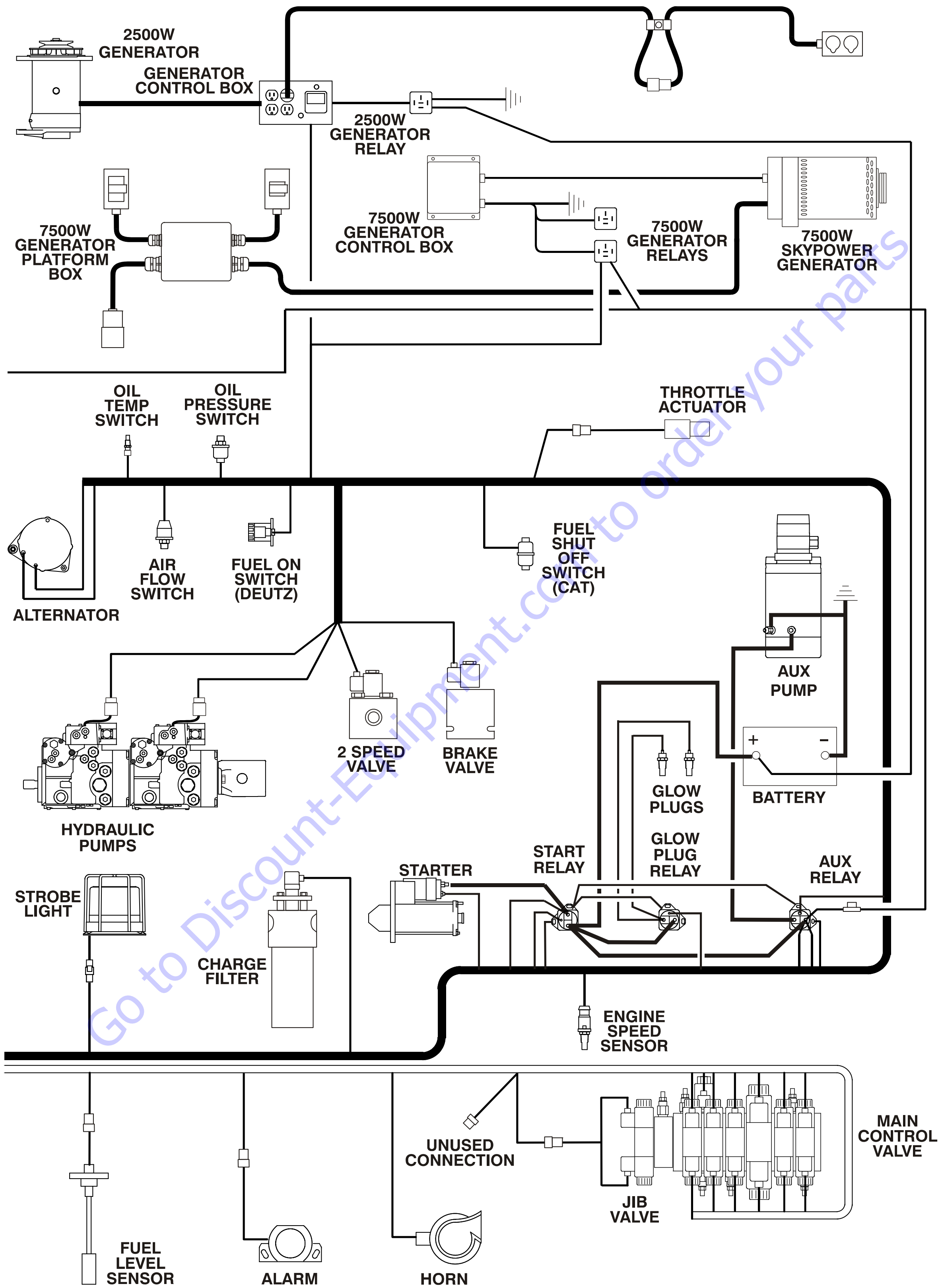


Figure 10-21. Electrical Components - Sheet 2 of 2

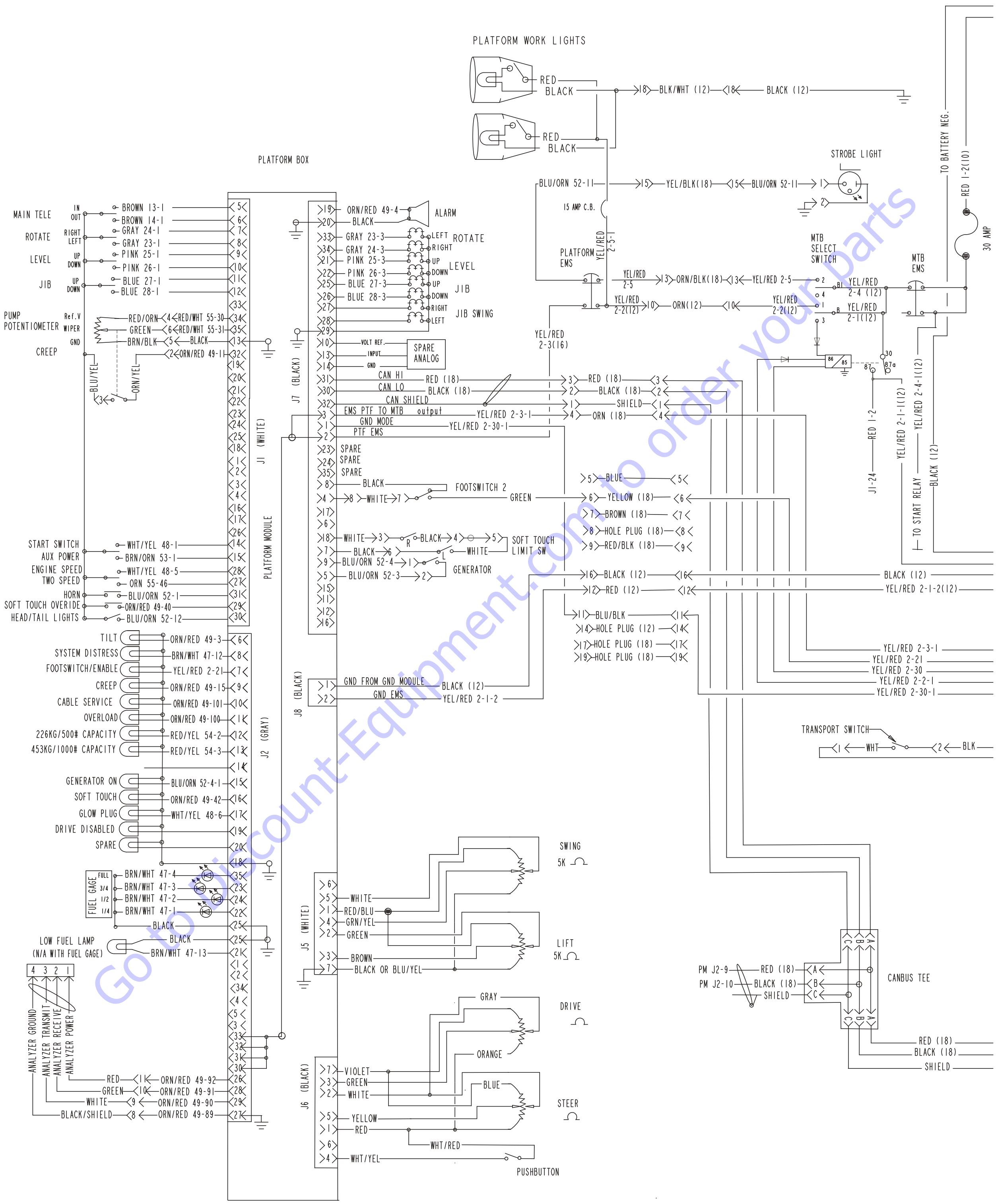


Figure 10-22. Electrical Schematic - Pre EMR2 Deutz, Caterpillar - Sheet 1 of 2

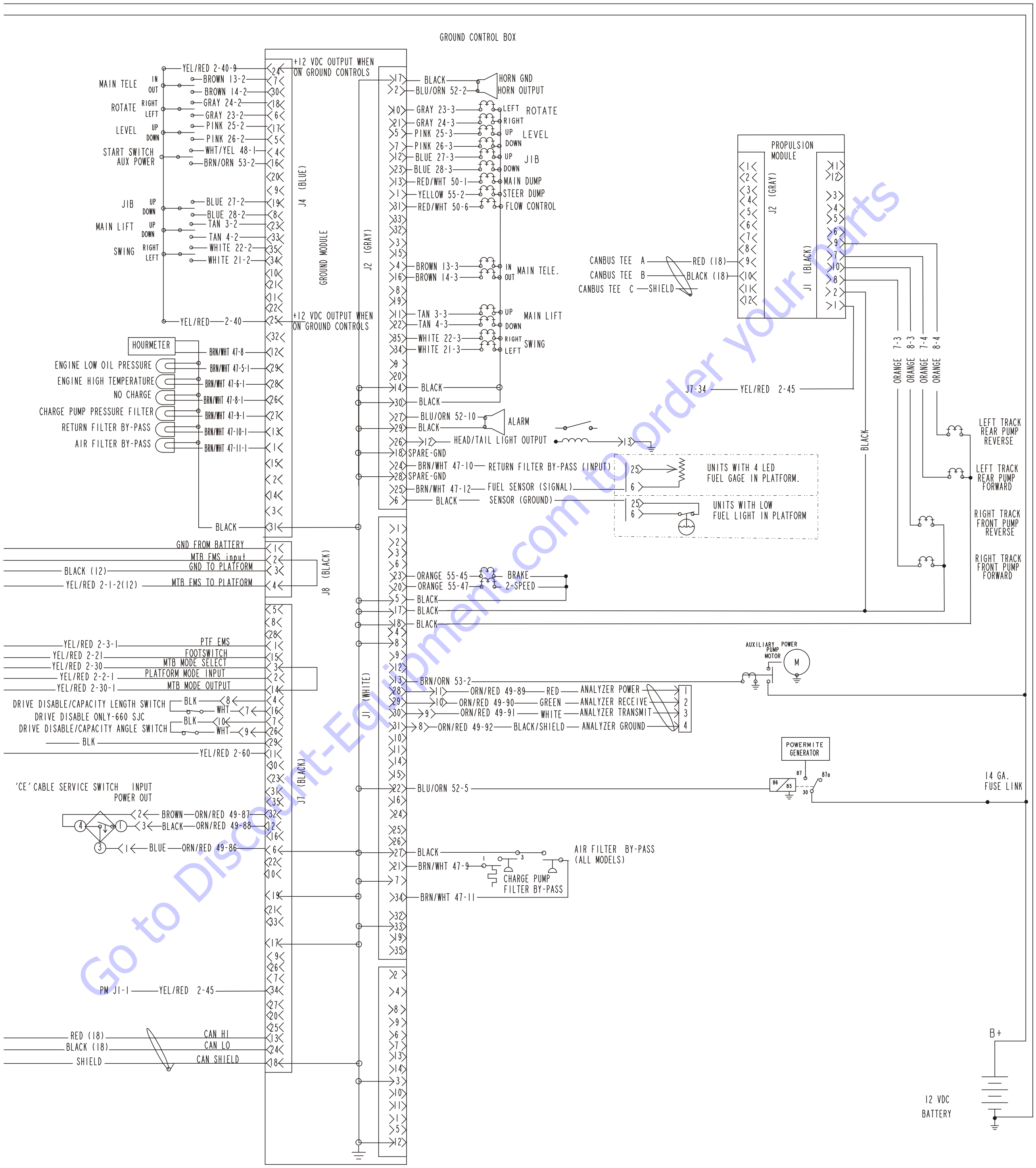


Figure 10-23. Electrical Schematic - Pre EMR2 Deutz, Caterpillar - Sheet 2 of 4

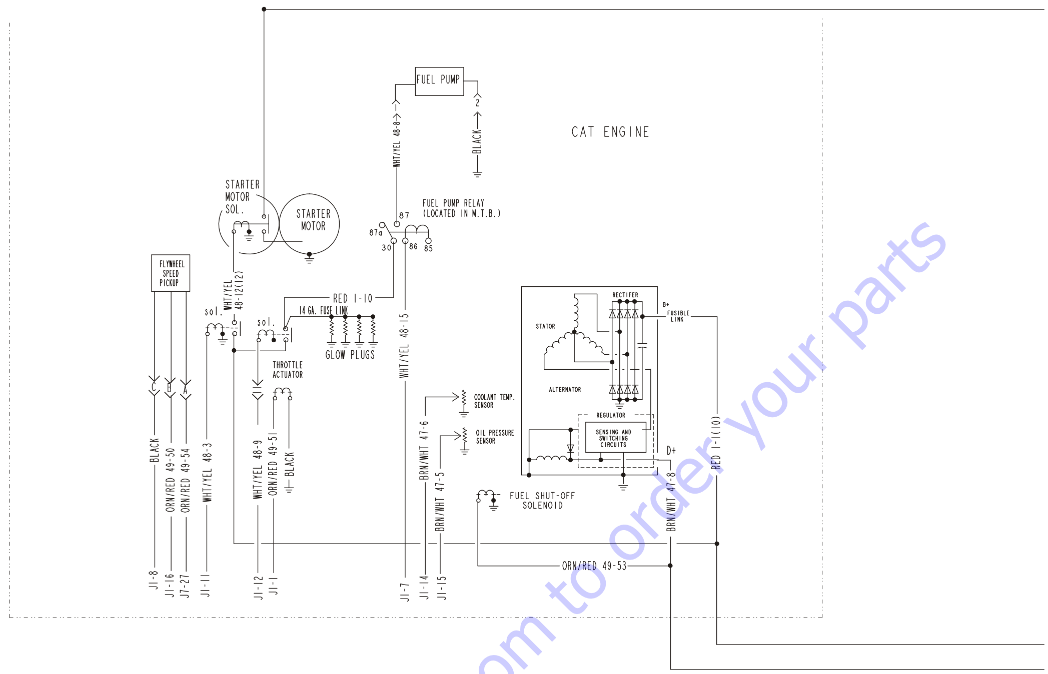


Figure 10-24. Electrical Schematic - Pre EMR2 Deutz, Caterpillar - Sheet 3 of 4

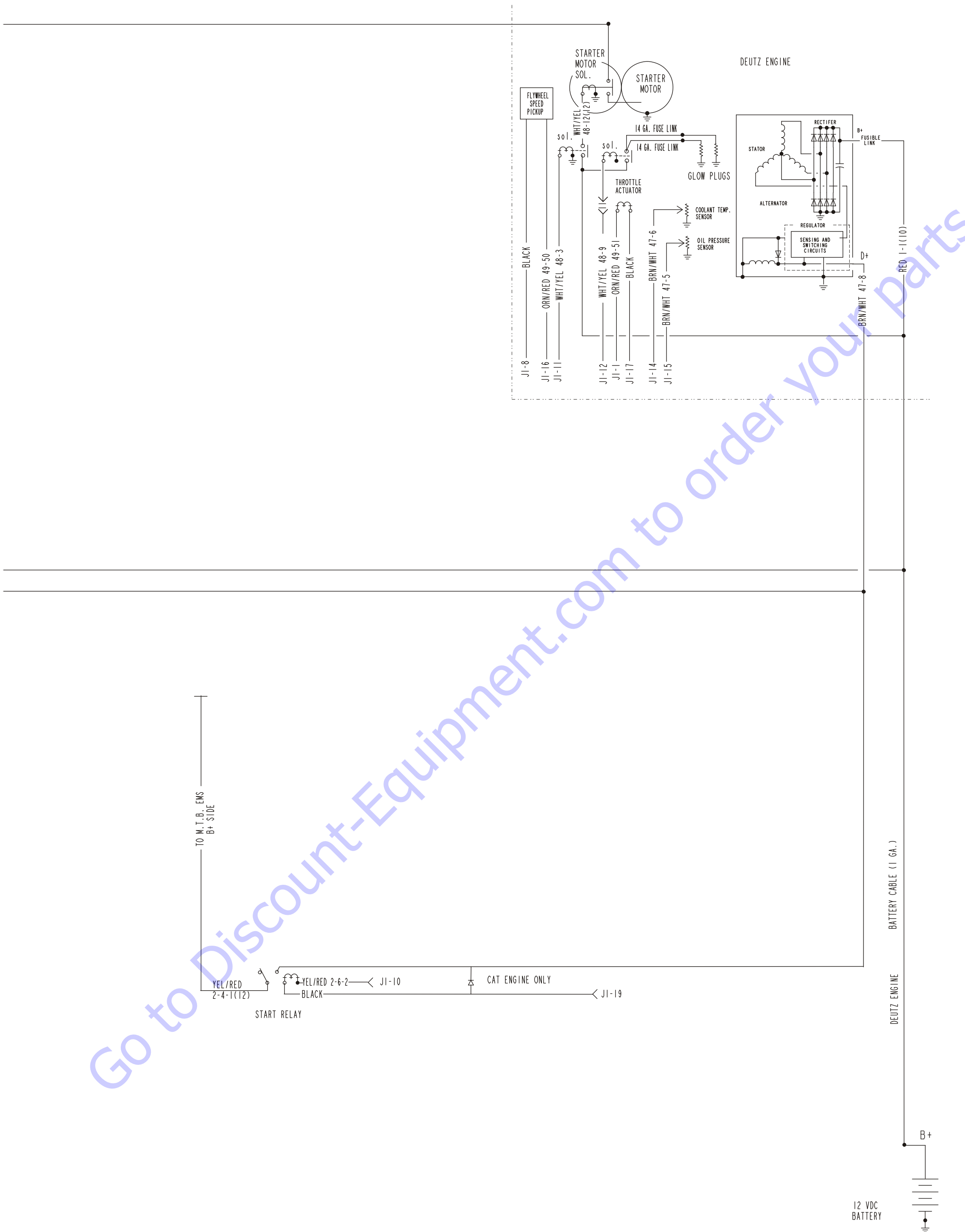


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Figure 10-25. Electrical Schematic - Pre EMR2 Deutz, Caterpillar - Sheet 4 of 4

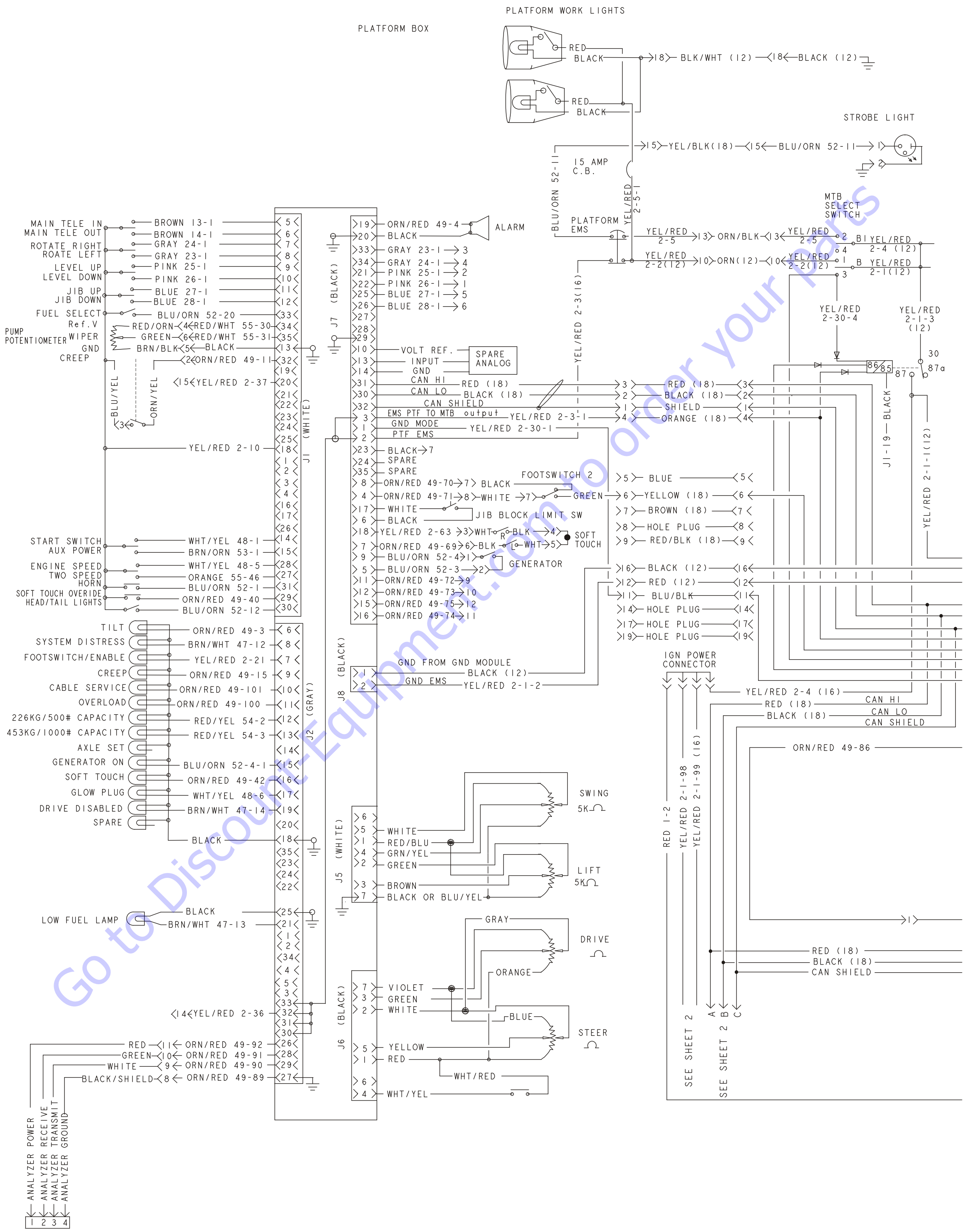
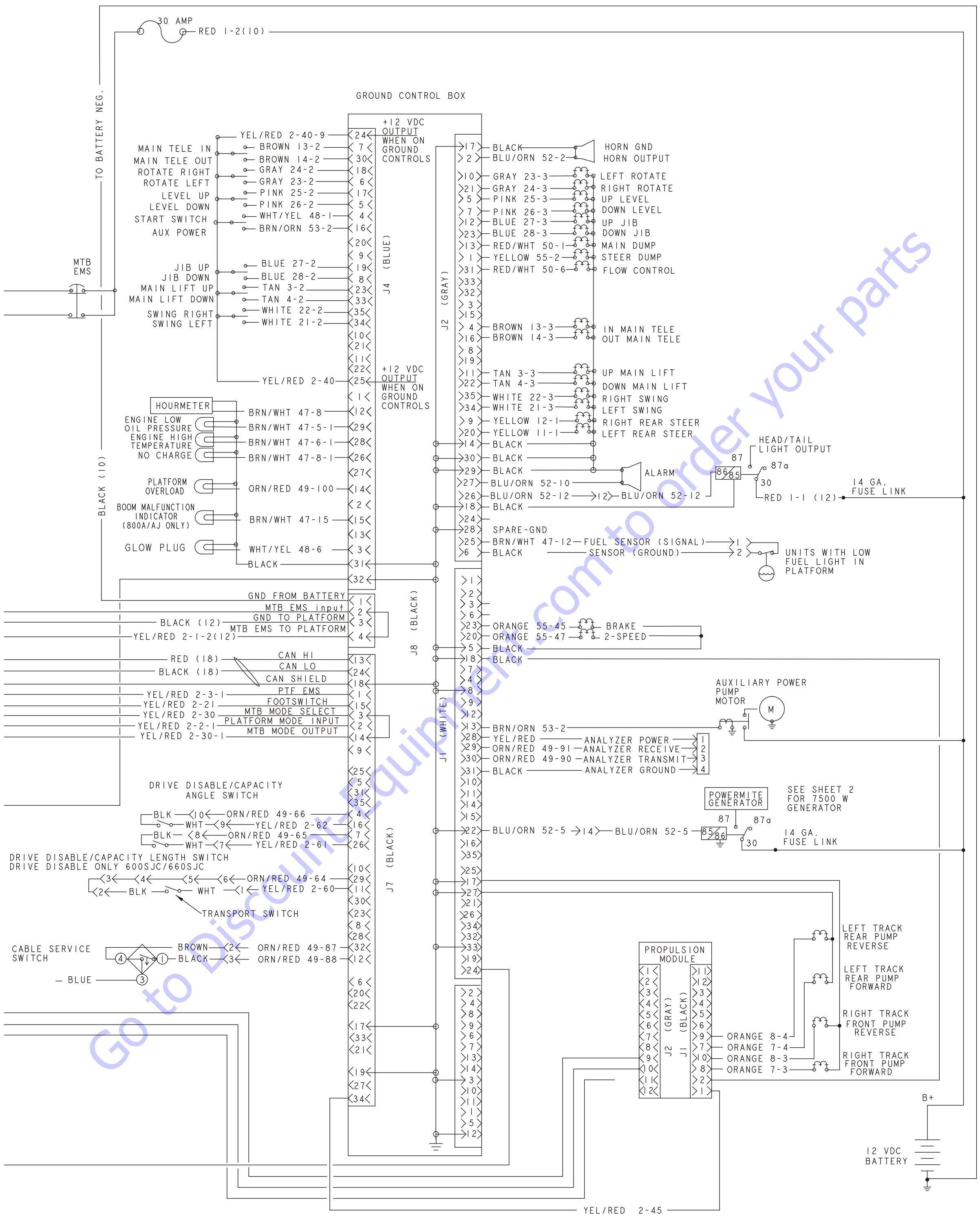


Figure 10-26. Electrical Schematic - Deutz EMR2/Gradall - Sheet 1 of 4



1870194-B

Figure 10-27. Electrical Schematic - Deutz EMR2/Gradall - Sheet 2 of 4

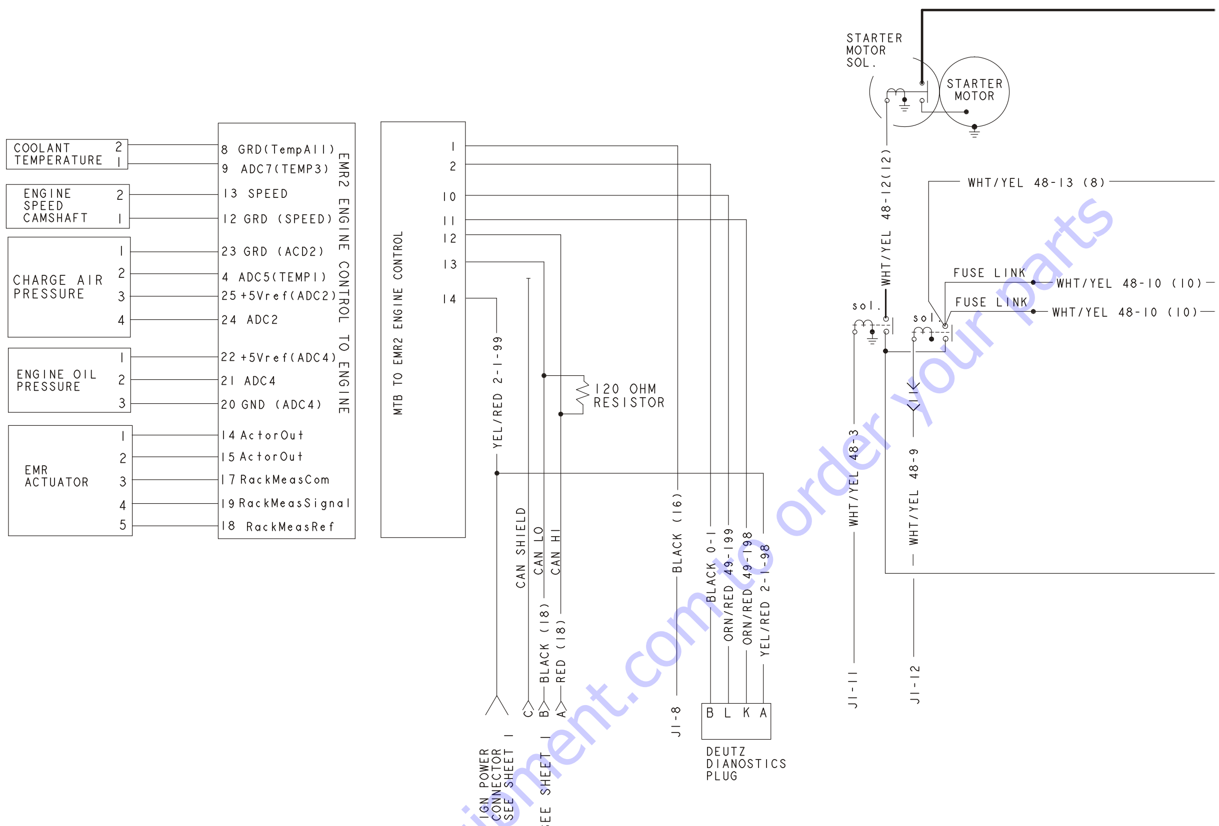
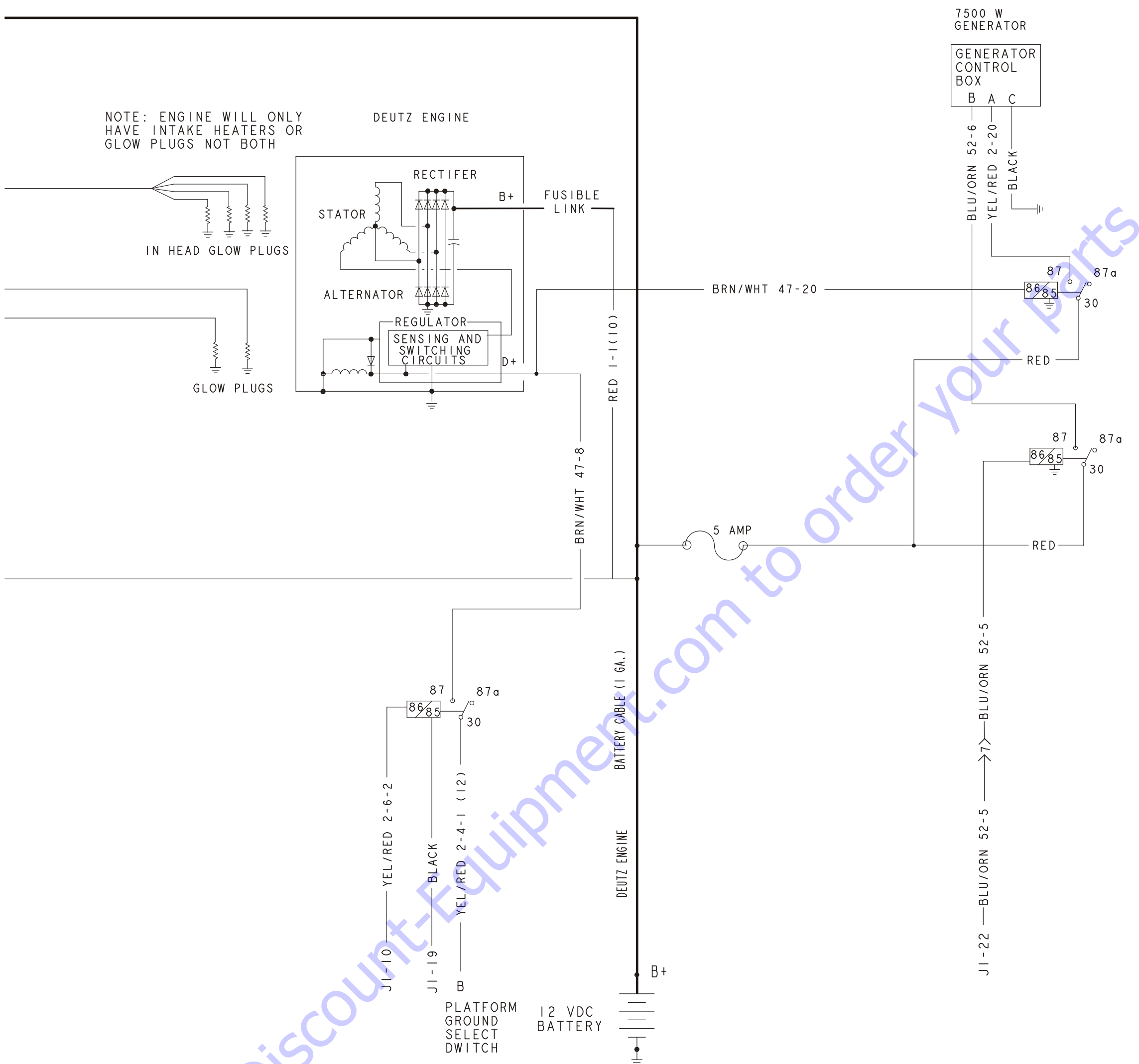


Figure 10-28. Electrical Schematic - Deutz EMR2/Gradall - Sheet 3 of 4



1870194-B

Figure 10-29. Electrical Schematic - Deutz EMR2/Gradall - Sheet 4 of 4

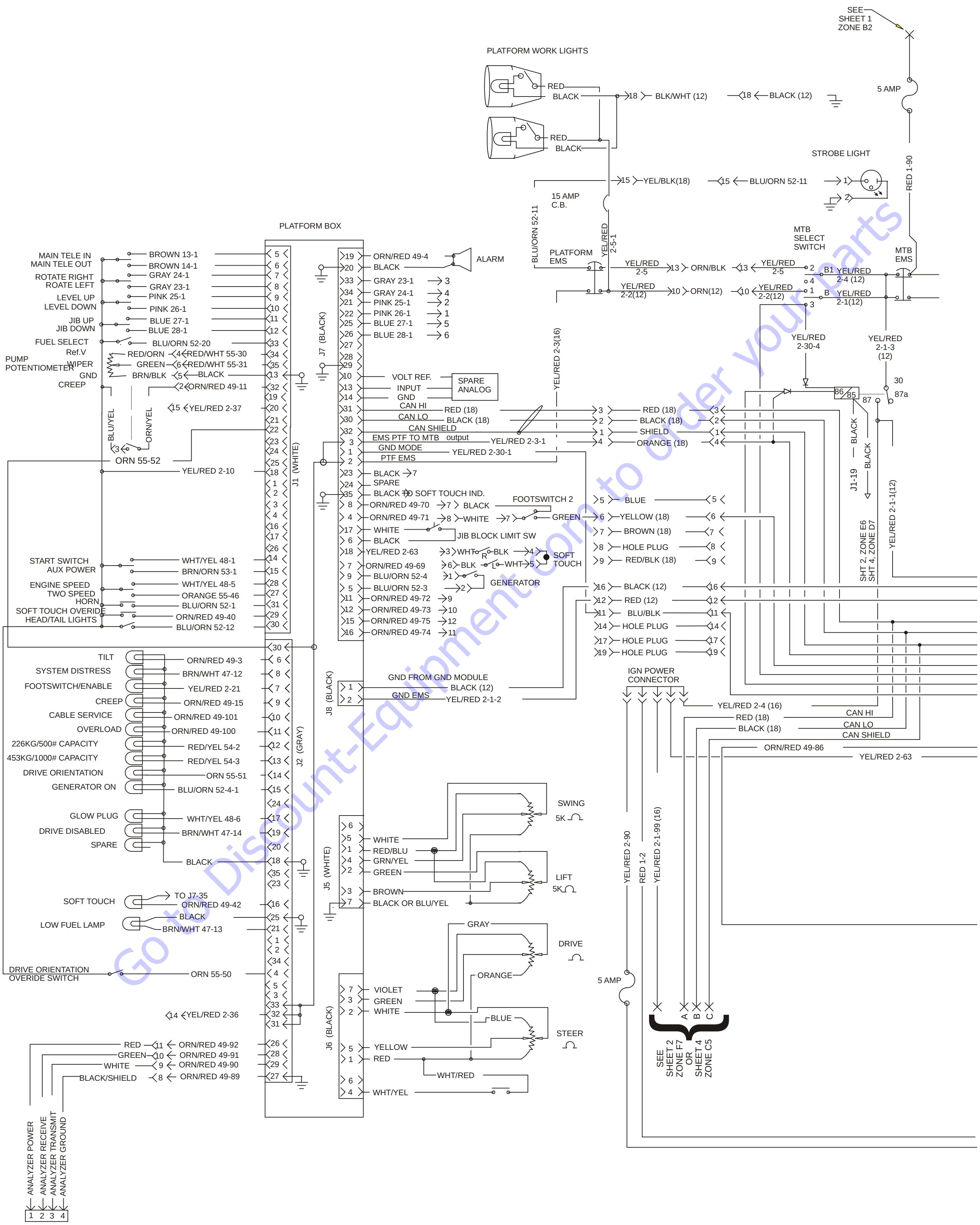


Figure 10-30. Electrical Schematic - Deutz/CAT - Sheet 1 of 7

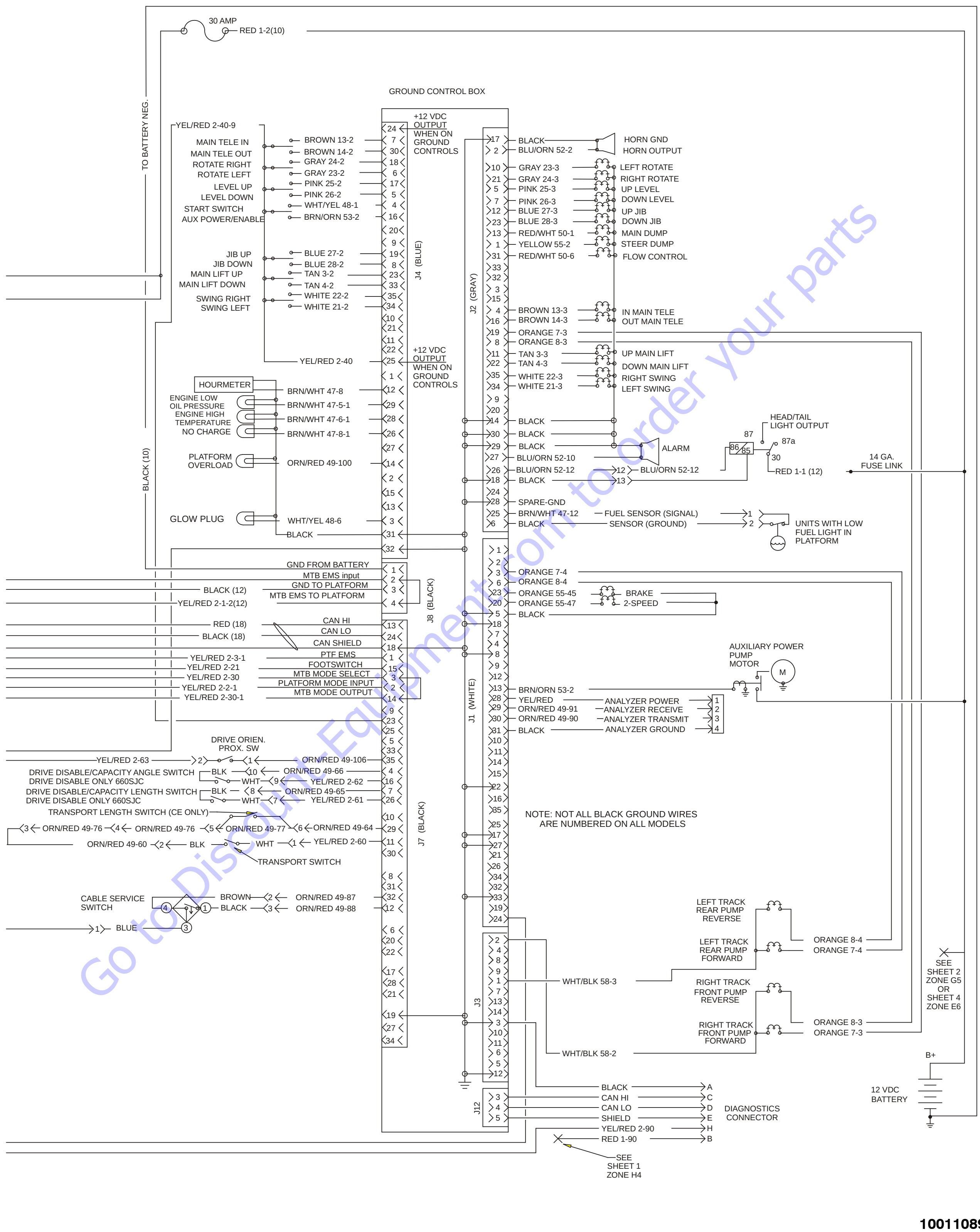


Figure 10-31. Electrical Schematic - Deutz/CAT - Sheet 2 of 7

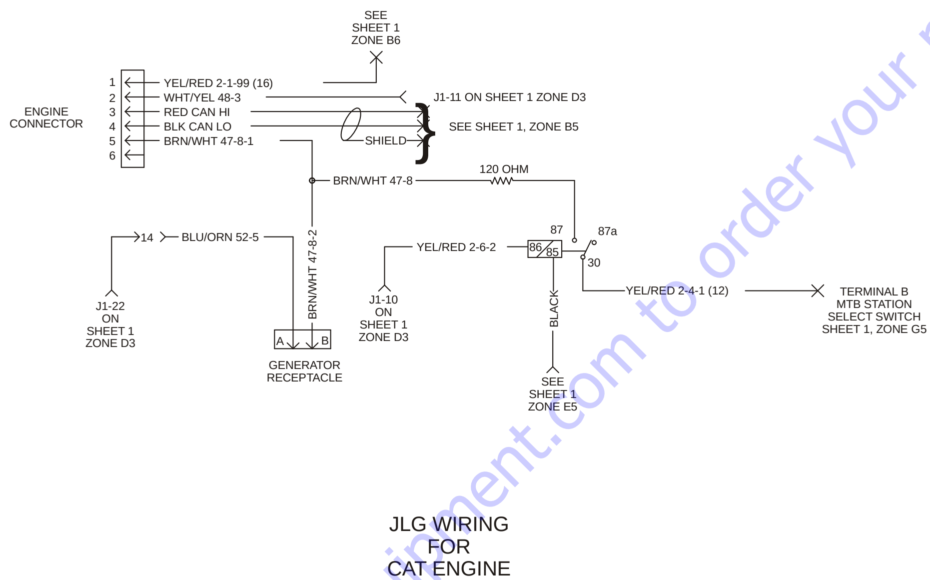


Figure 10-32. Electrical Schematic - Deutz/CAT - Sheet 3 of 7

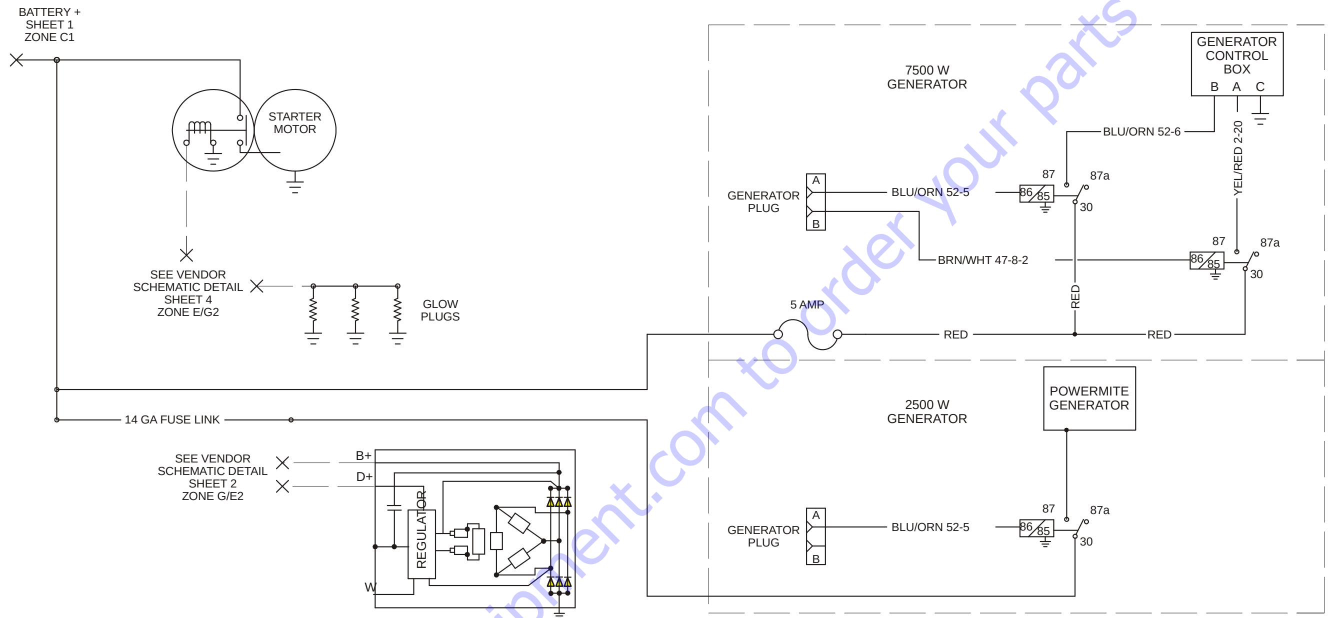


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Figure 10-33. Electrical Schematic - Deutz/CAT - Sheet 4 of 7

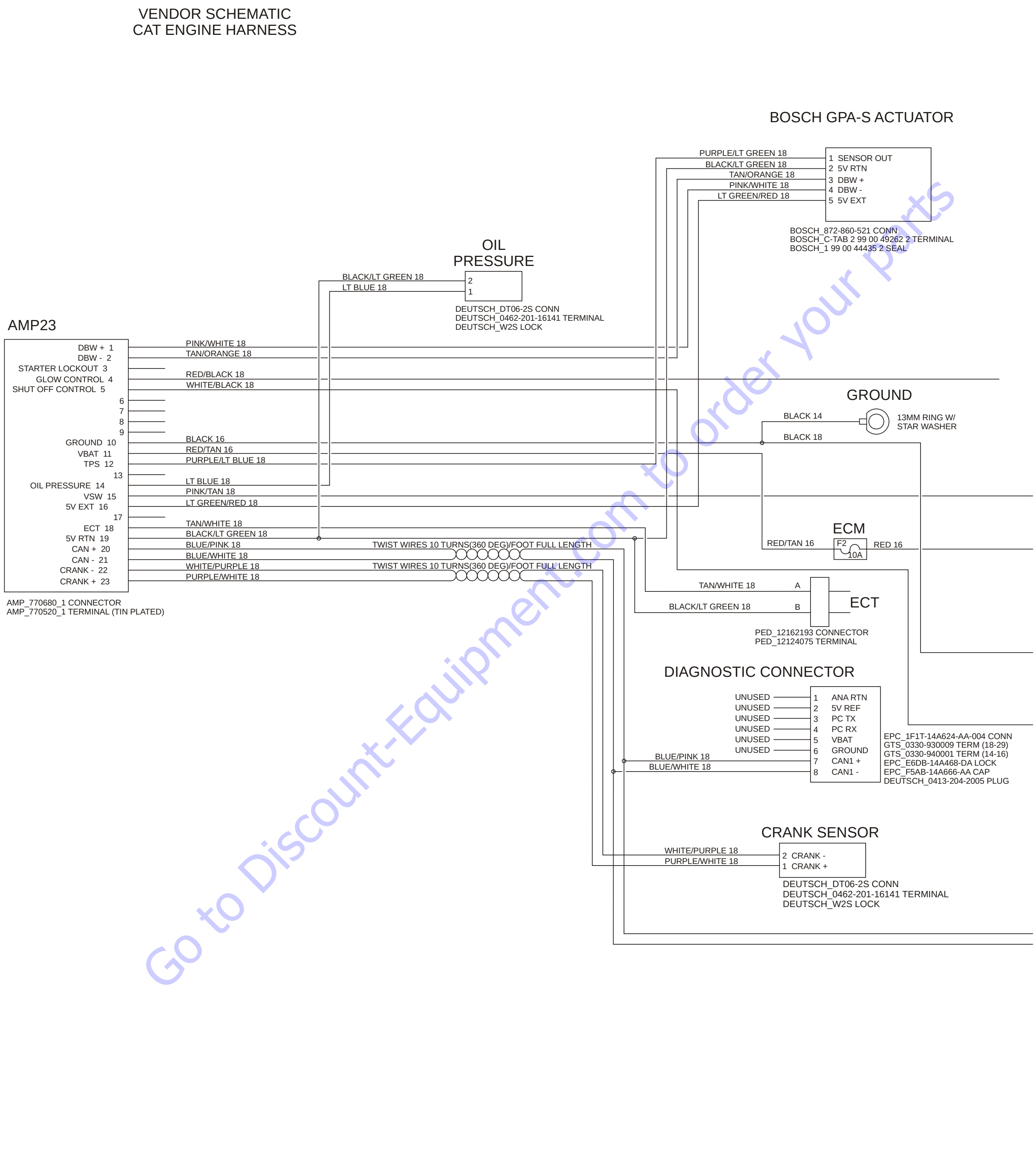

Figure 10-34. Electrical Schematic - Deutz/CAT - Sheet 5 of 7

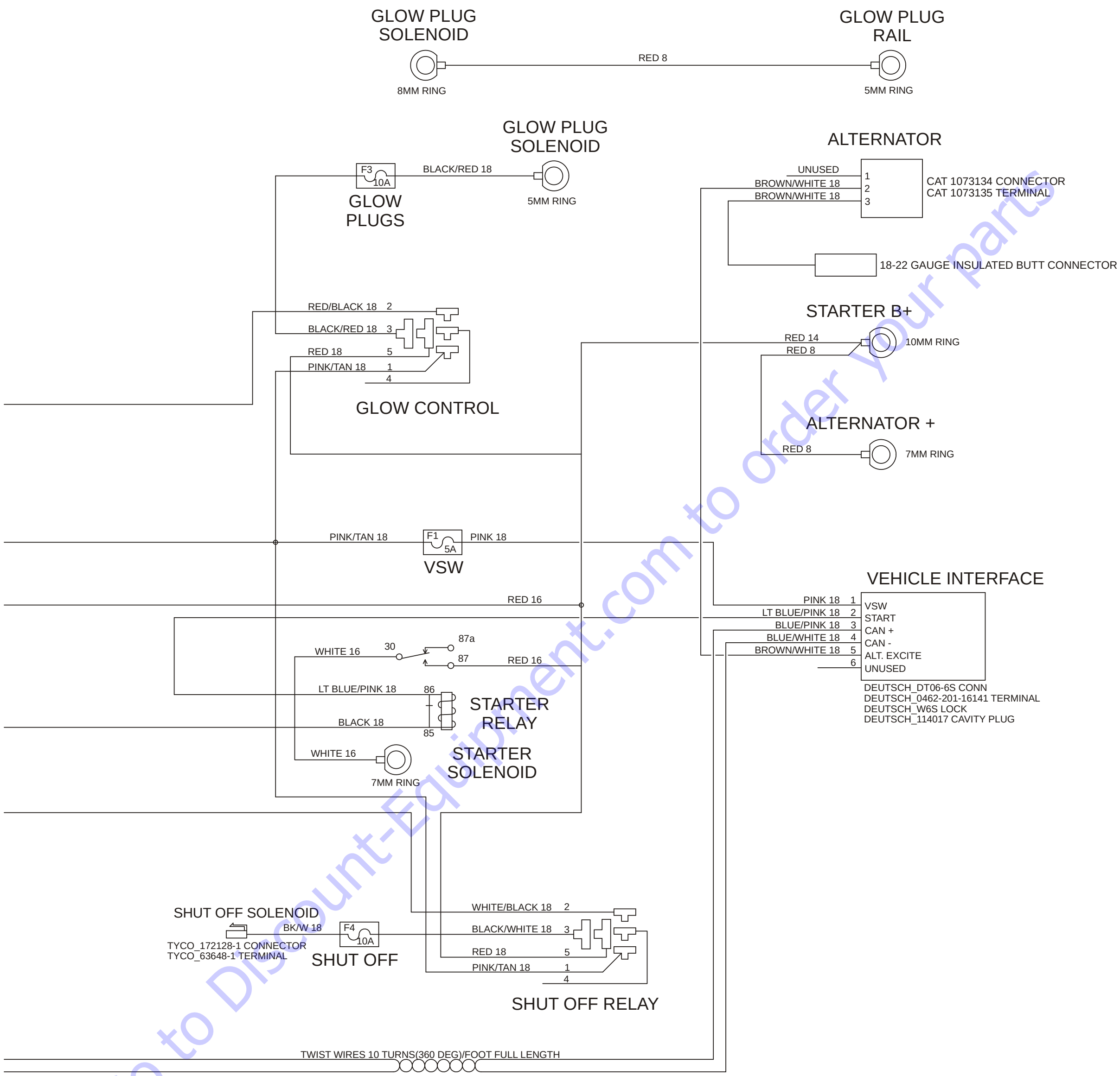

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Figure 10-35. Electrical Schematic - Deutz/CAT - Sheet 6 of 7

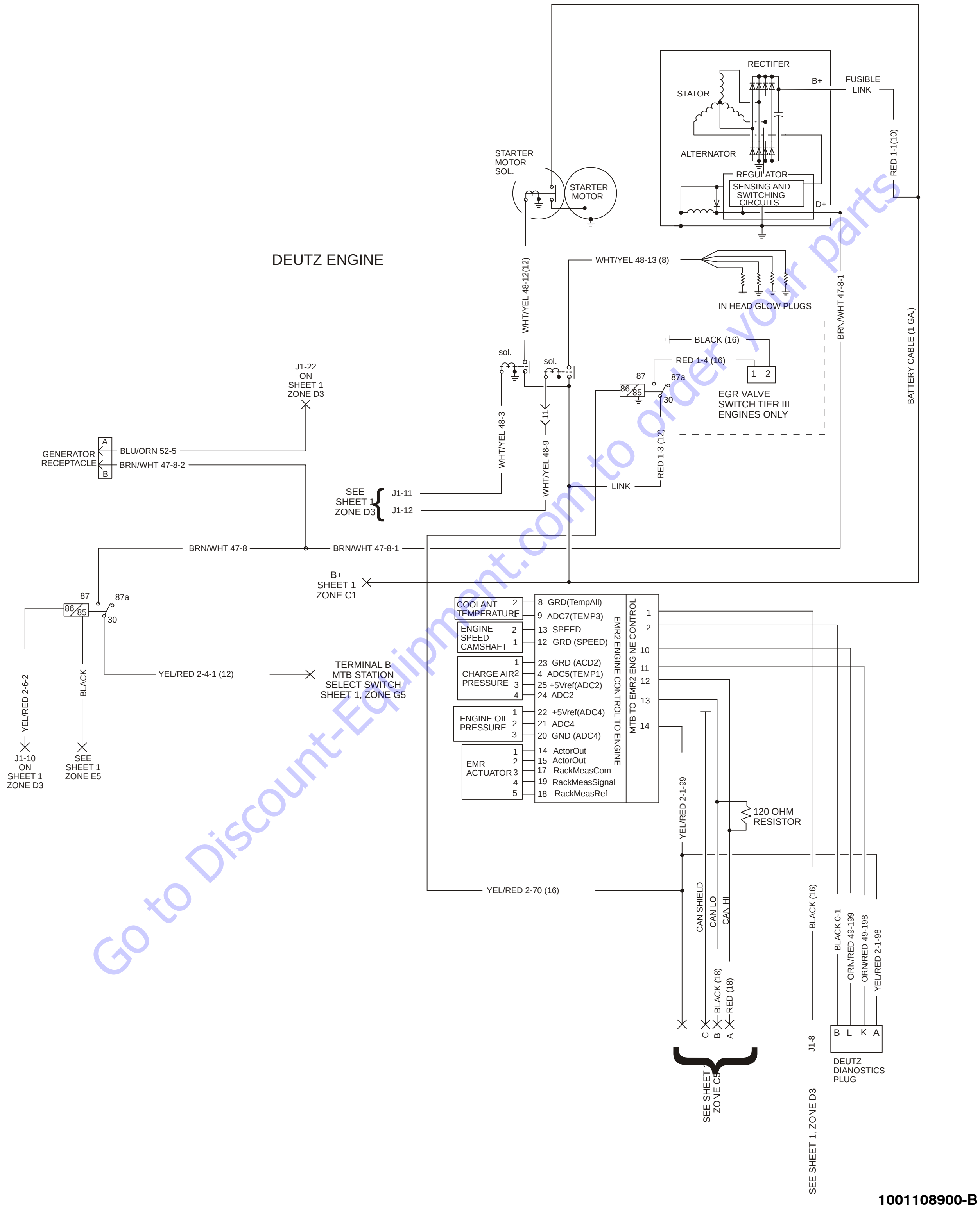

Figure 10-36. Electrical Schematic - Deutz/CAT - Sheet 7 of 7

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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