Service & Maintenance Manual

Model
450A, 450AJ

PVC 2201

31219918

January 10, 2022 - Rev A

ANSI CE UK CA EAC
AS/NZS MOL70 GB

An Oshkosh Corporation Company

INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

A GENERAL

This section contains the general safety precautions which must be observed during maintenance of the mobile elevating work 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 a mobile elevating work platform shall be made only with written permission from the manufacturer.

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

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

⚠ WARNING

Since the machine manufacturer has no direct control over the field inspection and maintenance, safety in this area responsibility of the owner/operator.

B HYDRAULIC SYSTEM SAFETY

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

Do not use your hand to check for leaks. Use a piece of cardboard or paper to search for leaks. Wear gloves to help protect hands from spraying fluid.

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.

- USE ONLY REPLACEMENT PARTS OR COMPONENTS THAT ARE APPROVED BY JLG. TO BE CONSIDERED APPROVED, REPLACEMENT PARTS OR COMPONENTS MUST BE 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 SERVICE MANUAL.
- 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.

REVISION LOG

DATE	REVISION	DESCRIPTION
January 10, 2022	A	Original Issue

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SECTION CONTENTS

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SECTION 1
SPECIFICATIONS

1.1 OPERATING SPECIFICATIONS

Capacity Unrestricted	550 lb (249.5 kg)
Maximum Operating Slope	5°
Maximum Travel Grade, stowed Position (Gradeability)	45%
Maximum Travel Grade, stowed Position (Side Slope)	5°
Drive Speed - Stowed	4.25 mph (6.8 km/h)
Gross Machine Weight - Approximate	13,250 lb (6010 kg)
Maximum Ground Bearing Pressure	65 psi (4.6 kg/cm^2)
Maximum Wind Speed	28 mph (12.5 m/s)
Max. Tire Load	7200 lb (3266 kg)
System Voltage	12V DC
Maximum Main Relief Hyd. Pressure	4060 psi (280 Bar)
Average Fuel Consumption	0.85 gph (3.2 lph)

1.2 DIMENSIONAL DATA

Turning Radius (Inside)	6 ft. 9 in. (2.06 m)
Turning Radius (Outside)	15 ft. 8 in. (4.78 m)
Machine Height (stowed)	89.3 in. (2269 mm)
Machine Length (stowed)	258.9 in. (6576 mm)
Up and Over Platform Height	24 ft. (7.3 m)
Horizontal Reach	25 ft. (7.62 m)
Machine Width	92.6 in. (2353 mm)
Wheel Base	93 in. (2362 mm)
Platform Height	45 ft. (13.72 m)
Ground Clearance	16.4 in. (417 mm)

1.3 CAPACITIES

Hydraulic System	38 gal. (143.8 L)
Hydraulic Oil Tank (to Full Level)	31.7 gal. (119.9 L)
Drive Hub	24 oz. (0.7 L)
Drive Brake	27 oz. (0.8 L)
Engine Coolant Deutz 2.9L Kubota	 2.9 gal. (11.3L) 2.25 gal. (8.5 L)

1.4 TIRES

Size	Type	Pressure	Weight
33/1550x16.5	Foam-Filled	N/A	395 lb (179 kg)
12 x 16.5	Foam-Filled	N/A	328 lb (149 kg)
315/55 D20	Foam-Filled	N/A	286 lb (130 kg)
	Solid	N/A	286 lb (130 kg)
33x12-20	Solid	N/A	285 lb (129 kg)
33x16LL500	Foam-Filled	N/A	390 lb (177.1 kg)

1.5 ENGINE DATA

Table 1. Deutz D2011L03

Fuel	Diesel
No. of Cylinders	3
Bore	3.7 in. (94 mm)
Stroke	4.4 in. (112 mm)
Displacement	142 cu. in. (2331 cm^3)
Oil Capacity crankcase cooler total capacity	 6.3 qts. (6 L) 3.7 qts. (3.5 L) 10 qts. (9.5 L)
Fuel Consumption	0.66 gal/hr (2.51 L/hr)
Low RPM	1200
Mid RPM Tower Lift, Upper Lift, Tele Swing, Basket Level, Basket	 1800

Table 1. Deutz D2011L03 (continued)

Rotate, Jib Lift	1500
High RPM	2800

Table 2. Deutz D2.9L4

Type	Diesel
Number of Cylinders	4
Bore	3.6 in. (92 mm)
Stroke	4.3 in. (110 mm)
Total Displacement	178 cu. in. (2925 cm^3)
Firing Order	1-3-4-2
Max Output Power	48.8 hp (36.4 kW)
Oil Capacity	2.4 gal. (8.9 L)
Engine Coolant Capacity	0.79 gal (3 L)
Coolant Capacity (System)	3.2 gal. (12.1 L)
Average Fuel Consumption	1.2 gph (4.1 Lph)
Min. Low Engine RPM	1200
Mid Engine RPM	1900
Max. High Engine RPM	2600
Max Output Torque	108 ft. lb (147 Nm)@1600 rpm
Alternator Rating	14 V, 95 Amp
Starter Rating	12 V, 3.2 kW
Glow Plug	12V, 110 Amp

Table 3. Deutz D2.9L4 Stage V

Type	Diesel
Number of Cylinders	4
Bore	3.6 in. (92 mm)
Stroke	4.3 in. (110 mm)
Total Displacement	178 cu. in. (2925 cm^3)
Firing Order	1-3-4-2
Max Output Power	48.8 hp (36.4 kW)
Oil Capacity	2.35 gal. (8.9 L)
Engine Coolant Capacity	0.92 gal. (3.5 L)
Coolant Capacity (System)	3.2 gal. (12.1 L)
Average Fuel Consumption	1.2 gph (4.1 Lph)
Min. Low Engine RPM	1000

Table 3. Deutz D2.9L4 Stage V (continued)

Mid Engine RPM	1900
Max. High Engine RPM	2600
Max Output Torque	110.6 ft. lb (150 Nm)@1600 rpm
Alternator Rating	14 V, 95 Amp
Starter Rating	12 V, 3.2 kW
Glow Plug	12V, 110 Amp

Table 4. Kubota WG 2503

Fuel	Gasoline or Gasoline/LP Gas
BHP Gasoline LP	 45.5 kW @ 2700 rpm 46 Kw @ 2700 rpm
Bore	3.46 in. (88 mm)
Stroke	4.03 in. (102.4 mm)
Displacement	153 cu. in (2.5 L)
Oil Capacity w/filter	2.5 gal. (9.5 L)
Max.High RPM	2700
Coolant Capacity (Engine only)	1.4 gal. (5.4 L)
Fuel Consumption - Gasoline In Drive @Idle	 2.35 gal/hr (8.92 L/hr) 0.48 gal/hr (1.83 L/hr)
Fuel Consumption - LP In Drive @Idle	 2.56 gal/hr (9.72 L/hr)/(5.64 Kg/hr) 0.62 gal/hr (2.36 L/hr)/(1.37 kg/hr)

1.6 ENGINE OIL SPECIFICATIONS

Table 5. Engine Diesel Fluid 15W-40 Specs

Inspection Data	Recommended SHELL		Optional MOBIL	
	ROTELLA T3 FLEET 15W-40 (US)	RIMULA R4 L 15W-40 (CE/UKCA)	DELVAC 1300 SUPER 15W-40 (US)	DELVAC MX ESP 15W-40 (CE/UKCA)
SAE Grade	15W-40			
Viscosity, cST at 104°F (40°C)	115		109	
Viscosity, cST at 212°F (100°C)	15.3		14	14.1
Total Base Number, mg KOH/g	10		9.4	9.8
Density at 59°F (15°C) kg/l	0.876		0.875	—
Ash, Sulfated, Mass%	Low Ash	1	0.9	0.98

Table 5. Engine Diesel Fluid 15W-40 Specs (continued)

Inspection Data	Recommended SHELL	Optional MOBIL	
API Classification	CK-4	CK-4	CJ-4
ACEA Classification	E9		
Fluid Requirements			
Deutz Specification	DQC 111-10 LA	DQC 11-10 LA	

1.7 HYDRAULIC OIL

Hydraulic System Operating Temperature Range	S.A.E. Viscosity Grade
+0° to + 180°F (-18° to +83°C)	10W
+0° to + 210° F (-18° to +99°C)	10W-20, 10W-30
+50° to + 210°F (+10° to +99°C)	20W-20

Note: Hydraulic oils require anti-wear qualities at least API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service.

Note: Machines may be equipped with Standard UTTO biodegradable and non-toxic hydraulic oil. This is a fully synthetic hydraulic oil that possesses the same anti-wear and rust protection characteristics as mineral oils, but will not adversely affect the ground water or the environment when spilled or leaked in small amounts.

Note: 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 Standard UTTO is desired refer contact JLG Industries for proper recommendations.

Table 6. Standard UTTO Hydraulic Fluid Specs

Inspection Data	Recommended SHELL SPIRAX S4 TXM	Optional MOBILFLUID 424
ISO Viscosity Grade	68	68
Specific Gravity	0.882	0.880
Pour Point	-43.6°F (-42°C)	-45.4°F (-43°C)
Flash Point	428°F (220°C)	442.4°F (228°C)
Base Oil Type	HV	HV
Viscosity		
Brookfield, at -20°C	-	4300 cP
Brookfield, at -5°C	-	-
Viscosity at 40° C	66.93 cSt	60.21 cSt
Viscosity at 100° C	10.53 cSt	9.26 cSt
Viscosity Index	146	134

Table 7. Premium Hydraulic Fluid (VG 32) Specs

Inspection Data	Recommended SHELL TELLUS S2 VX 32	Optional MOBIL DTE 10 EXCEL 32
ISO Viscosity Grade	32	32
Specific Gravity	0.854	0.847
Pour Point	-38.2°F (-39°C)	-65.2°F (-54°C)
Flash Point	419°F (215°C)	482°F (250°C)
Base Oil Type	HV	HV
Viscosity		
Brookfield, at -30°C	-	3360
Brookfield, at -20°C	-	1090
Brookfield, at -5°C	-	-
Viscosity at 40° C	33.01 cSt	32.76 cSt
Viscosity at 100° C	6.26 cSt	6.58 cSt
Viscosity Index	142	161

Table 8. Quintolubric Fire Resistant Hydraulic Fluid Specs

Inspection Data	Recommended QUINTOLUBRIC 888-46
ISO Viscosity Grade	46
Density@15°C, g/cm3	0.92
Pour Point	<-22°F (<-30°C)
Flash Point	572°F (300°C)
Fire Point	680°F (360°C)
Base Oil Type	POLYOL ESTER
	HEES
	HFDU
Auto Ignition Temperature	>842°F (>450°C)
Viscosity	
Brookfield, at 0°C	320 cSt
Brookfield, at 20°C	109 cSt
Viscosity at 40°C	47.5 cSt
Viscosity at 100°C	9.5 cSt
Viscosity Index	190

Table 9. Biodegradable Synthetic Hydraulic Fluid (VG 46) Specs

Inspection Data	Recommended SHELL NATURELLE HF-E46	Optional MOBIL EAL ENVIROSYN H46
ISO Viscosity Grade	46	46
Specific Gravity	0.921	0.874
Pour Point	-43.6°F (-42°C)	-49°F (-45°C)
Flash Point	611.6°F (322°C)	500°F (260°C)
Base Oil Type	POLYOL ESTER	FATTY ACID ESTER
	HEES	-
	HFDU	-
Auto Ignition Temperature	>752°F(>400°C)	-
Biodegradability (%28 Days)	76%	>60%
Viscosity		
Brookfield at -20°C	-	-
Brookfield at -5°C	-	-
Viscosity at 40° C	46.20 cSt	43.42 cSt
Viscosity at 100° C	9.41cSt	7.69 cSt
Viscosity Index	193	147

Table 10. Premium Hydraulic Fluid (All Weather) Spec

Inspection Data	Recommended SHELL TELLUS S4 VX 32		Optional MOBIL UNIVIS HVI 26	
	UNSHEARED	SHEARED	UNSHEARED	SHEARED
ISO Viscosity Grade	32		26	
Specific Gravity	0.866	-	0.89	-
Pour Point	-76°F (-60°C)		-76°F (-60°C)	
Flash Point	>212°F (>100°C)		>201.2°F (>94°C)	
Base Oil Type	HV		HV	
Viscosity				
Brookfield at -40°C	-	-	-	-
Brookfield at -30°C	-	-	-	-
Brookfield at -20°C	-	-	-	-
Brookfield at -5°C	-	-	-	-
Viscosity at 40° C	31.41 cSt	21.64 cSt	25.78 cSt	15.28 cSt
Relative Viscosity Loss*	31.1%		40.7%	
Viscosity at 100° C	9.17 cSt	6.1 cSt	8.74 cSt	5.02 cSt

Table 10. Premium Hydraulic Fluid (All Weather) Spec (continued)

Inspection Data	Recommended SHELL TELLUS S4 VX 32		Optional MOBIL UNIVIS HVI 26	
Relative Viscosity Loss*	33.5%		42.6%	
Viscosity Index	296	258	352	304
*Fluid is subjected to 20 hours in the CEC L-45-A-99 test to be mechanically degraded				

Table 11. Gear Fluid (80W-90) Specs

Inspection Data	Recommended SHELL SPIRAX S4 AX 80W-90	Optional MOBILUBE GX 80W-90
SAE Grade	80W-90	80W-90
Density@15°C, kg/l	0.887	0.89
Pour Point	-16.6°F (-27°C)	-27.4°F (-33°C)
Flash Point	424.4°F (218°C)	464°F (240°C)
Viscosity		
Viscosity at 40° C	139 cSt	135cSt
Viscosity at 100° C	14.8 cSt	14.5 cSt
Viscosity Index	110	104

1.8 MAJOR COMPONENT WEIGHT

⚠ WARNING

Do not replace items critical to stability with items of different weight or specification (for example: batteries, filled tires, platform) do not modify unit in any way to affect stability.

Components	LB	KG.
Counterweight	1875 ± 75	850.5 ± 34
Tire and Wheel - 20x9 Foam-Filled	220	99.8
Tire and Wheel - 18x7	230	104.3
Platform & Console - 30x60	242.5	110
Platform & Console - 30x48	216	98
Battery	66	30
Level Cylinder	41.2	18.7
Master Cylinder	48.5	22
Jib Cylinder	43.7	19.8
Telescope Cylinder	74.5	33.8
Tower Lift Cylinder	138.5	62.8

Components	LB	KG.
Upper Lift Cylinder	110	49.8
Upper Tower Boom	324.1	147
Lower Tower Boom	328.5	149

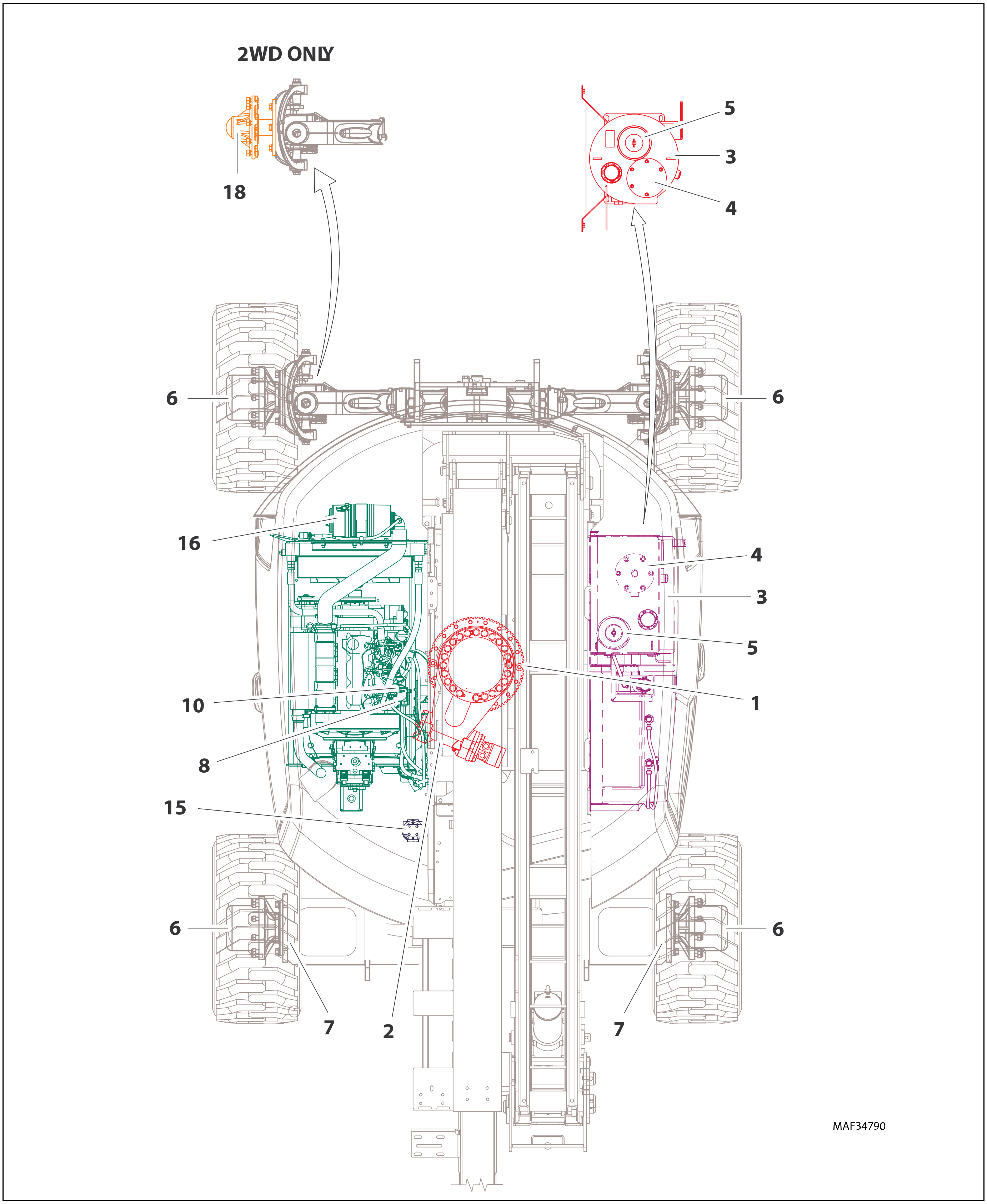


Figure 1. Maintenance and Lubrication Diagram - Deutz D2011L03 Engine

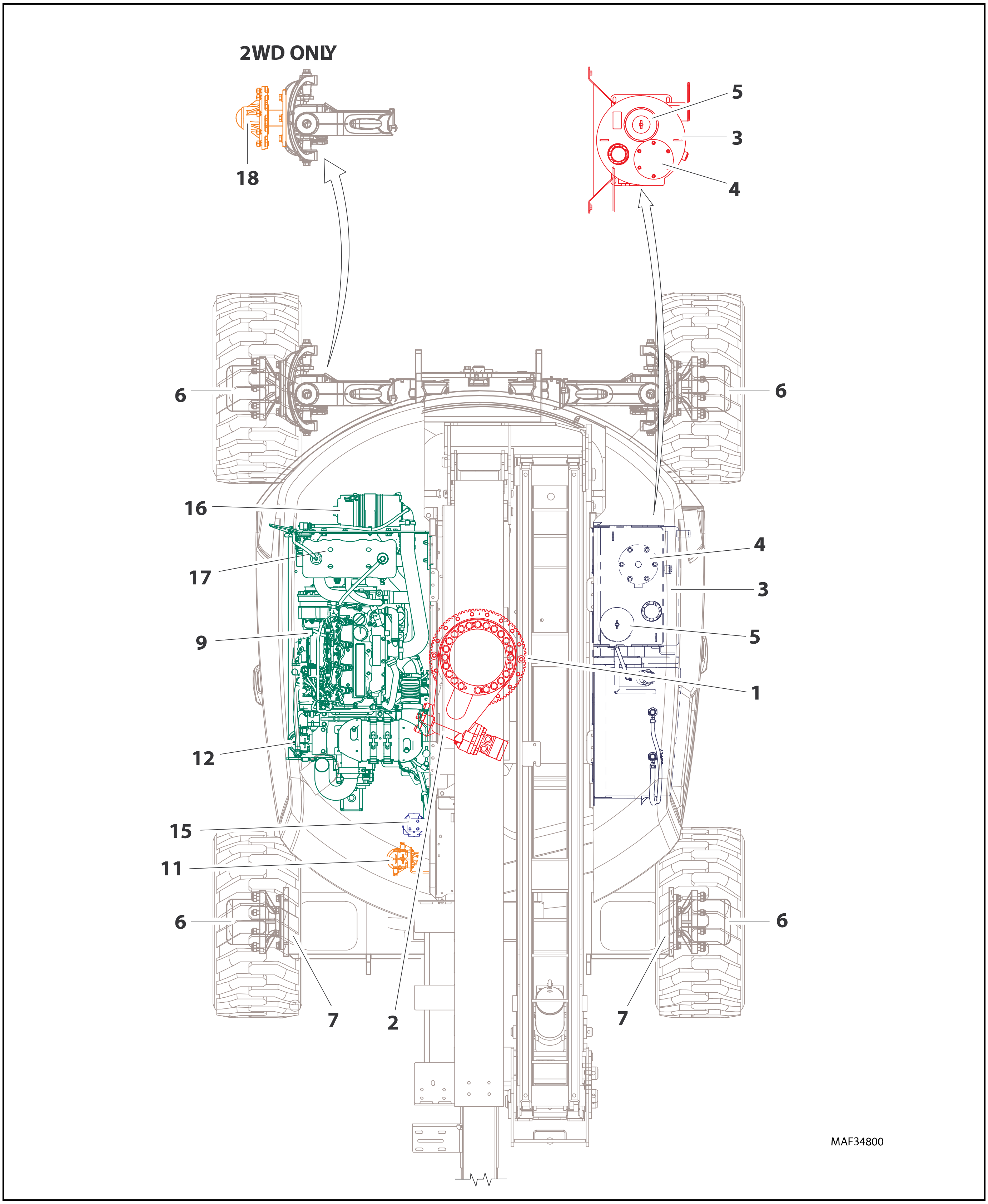


Figure 2. Maintenance and Lubrication Diagram - Deutz D2.9L4 Engine

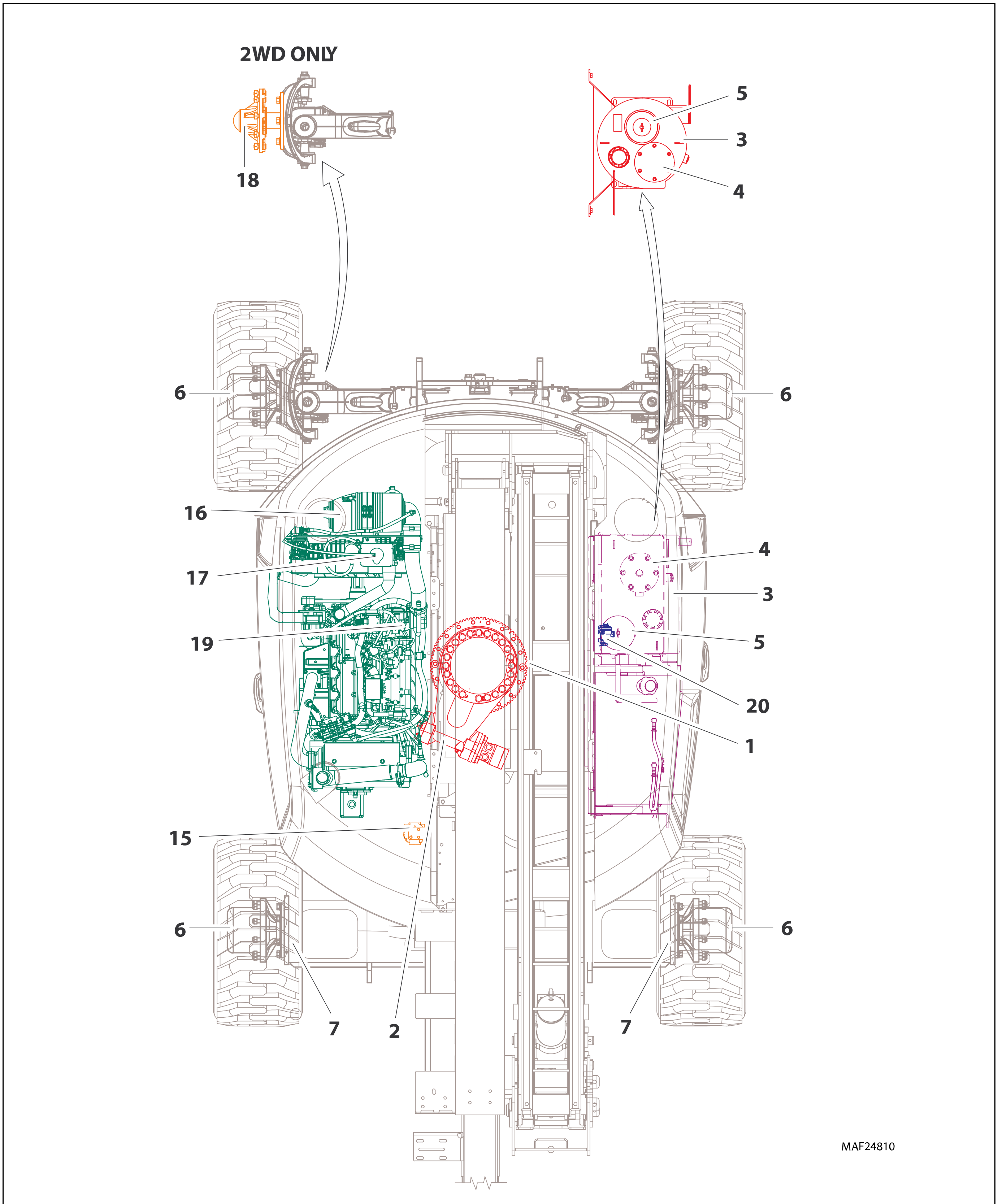


Figure 3. Maintenance and Lubrication Diagram - Kubota Engine

1.9 MAINTENANCE AND LUBRICATION

Note: The following numbers correspond to those in *Figure — Maintenance and Lubrication Diagram - Deutz D2011L03 Engine, page 20* ; *Figure — Maintenance and Lubrication Diagram - Deutz D2.9L4 Engine, page 21* and *Figure — Maintenance and Lubrication Diagram - Kubota Engine, page 22*.

Table 12. Lubrication Specifications.

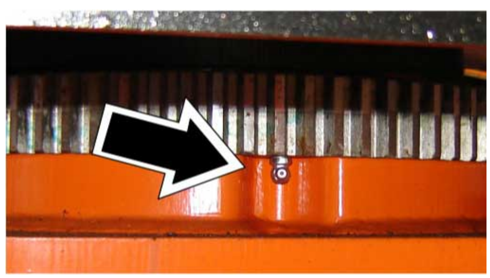
KEY	SPECIFICATIONS
BG*	Bearing Grease (JLG Part No. 3020029) Mobilith SHC 460.
HO	Hydraulic Oil. API service classification GL-4, e.g. Mobilfluid 424
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec MIL-L-2105
MPG	Multipurpose Grease having a minimum dripping point of 350°F (177°C). Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EO	Engine (crankcase). Gas (5W30)- API SN, -Arctic ACEA AI/BI, A5/B5 - API SM, SL, SJ, EC, CF, CD - ILSAC GF-4. Diesel (15W40, 5W30 Arctic) - API CJ-4.

*MPG may be substituted for these lubricants, if necessary, but service intervals will be reduced.

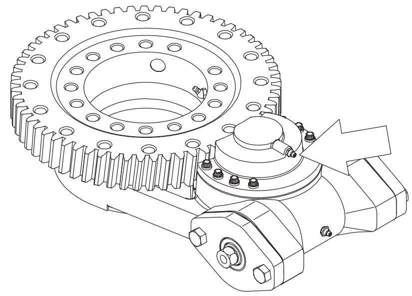
NOTICE

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.

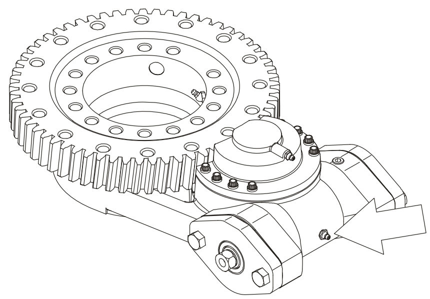
1. Swing Bearing
   Lube Point(s) - Fitting
   Capacity - A/R
   Lube - BG
   Interval - Every 3 months or 150 hrs of operation
   Comments - Apply grease and rotate in 90 degree intervals until bearing is completely lubricated



2. Swing Bearing/Worm Gear Teeth
   Lube Point(s) - Grease Fitting
   Capacity - A/R
   Lube - Lubriplate 930-AAA
   Interval - A/R



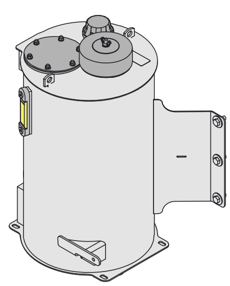
   Lube Point(s) - Grease Fitting
   Capacity - A/R
   Lube - Mobil SHC 007
   Interval - A/R



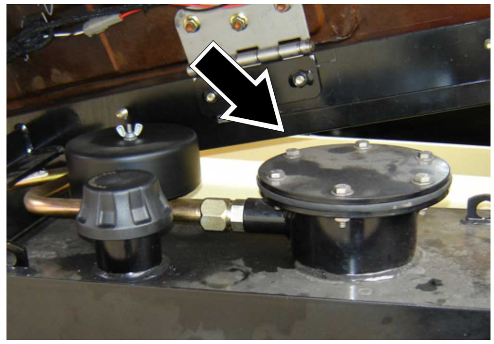
⚠ CAUTION

Do not overgrease bearings. Overgreasing bearings will result in damage to outer seal in housing.

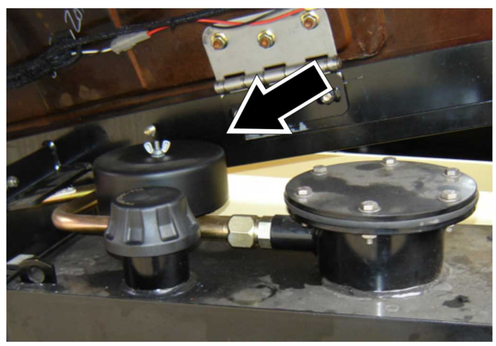
3. Hydraulic Tank
   Lube Point(s) - Fill Cap
   Total Capacity - 24.8 Gal. (93.9 L) to Full Level
   Lube - HO
   Interval - Check Level daily; Change every 2 years or 1200 hours of operation.
   Comments - On new machines, those recently overhauled, or after changing hydraulic oil, operate all systems a minimum of two complete cycles and recheck oil level in reservoir.



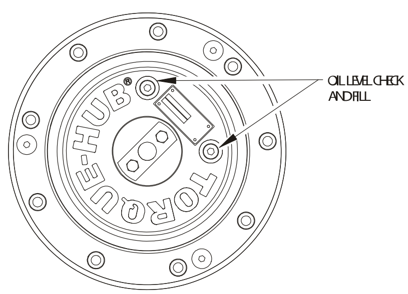
4. Hydraulic Return Filter
   Lube Point(s) - Replaceable Element
   Interval - Change after first 50 hours and every 6 months or 300 hours thereafter.



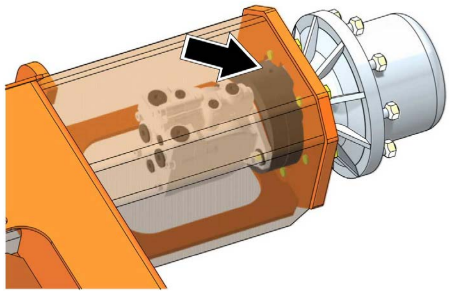
5. Hydraulic Tank Breather
   Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter.
   Comments - Remove wing nut and cover to replace. Under certain conditions, it may be necessary to replace on a more frequent basis.



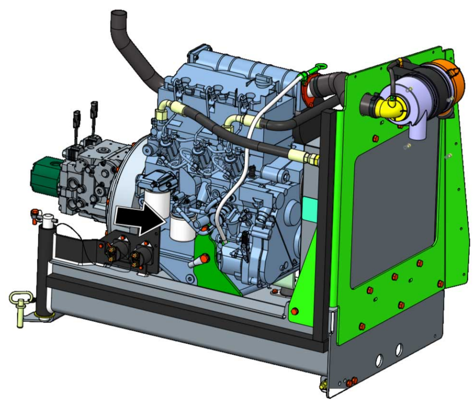
6. Wheel Drive Hub
   Lube Point(s) - Level/Fill Plug
   Capacity - 24 oz. (0.8 L)(1/2 Full)
   Lube - EPGL
   Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation



7. Drive Brake
   Lube Point(s) - Fill Plug
   Capacity - 2.7 oz. (89 mL)
   Lube - Premium Hydraulic Fluid
   Interval - Change as necessary

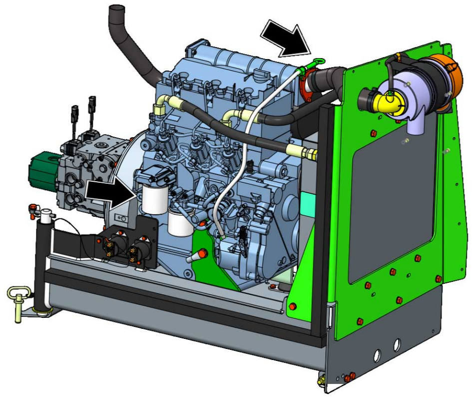


8. Oil Change with Filter - Deutz D2011L03
   Lube Point(s) - Fill Cap/Spin-on Element
   Capacity - 10 Quarts (9.5 L) w/Filter
   Lube - EO
   Interval - Check level daily; change every 500 hours or six months, whichever comes first. Adjust final oil level by mark on dipstick.



9. Oil Change w/Filter - Deutz D2.9L4
   Lube Point(s) - Fill Cap/Spin-on Element
   Capacity - 2.4 gal (8.9 L)
   Lube - EO
   Interval - Every Year or 600 hours of operation
   Comments - Check level daily/Change in accordance with engine manual

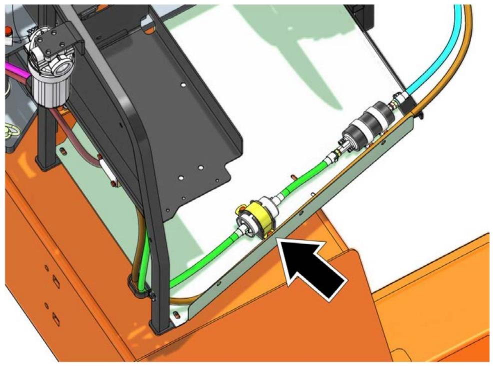
10. Fuel Filter/Water Separator - Deutz D2011L03
    Lube Point(s) - Replaceable Element
    Interval - Every year or 500 hours of operation



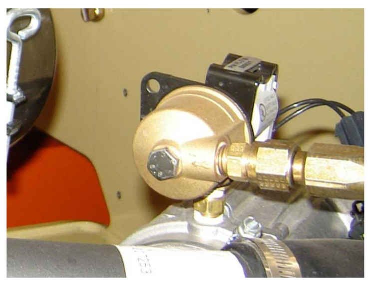
11. Fuel Pre-Filter - Deutz D2.9L4
    Lube Point(s) - Replaceable Element
    Interval - Drain water daily; Every year or 600 hours of operation

12. Fuel Filter - Deutz D2.9L4
    Lube Point(s) - Replaceable Element
    Interval - Every year or 600 hours of operation

13. Fuel Filter (Gasoline)
    Lube Point(s) - Replaceable Element
    Interval - Every 6 months or 300 hours of operation



14. Fuel Filter (Propane)
    Interval - 3 Months or 150 hours of operation
    Comments - Replace filter.

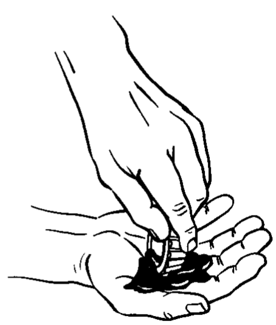


15. Charge Filter
    Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter.
    Comments - Remove the engine tray retaining bolt and pull out engine tray to gain access.

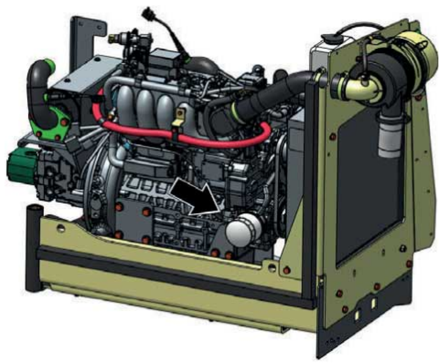
16. Air Filter
    Lube Point(s) - Replaceable Element
    Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator
    Comments - Check Dust Valve daily

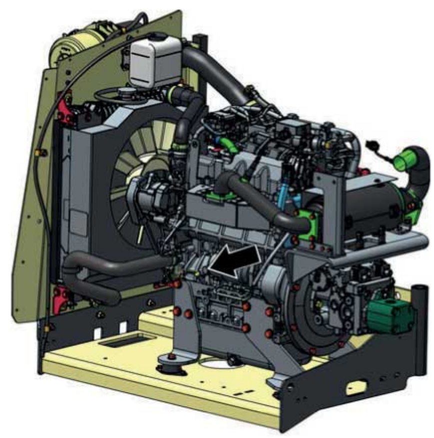
17. Engine Coolant
    Lube Point(s) - Fill Cap
    Capacity (Deutz 2.9L)- 2.9 gal. (11.3L)
    Capacity (Kubota)- 2.25 gal. (8.5L)
    Lube - Anti-Freeze
    Interval - Check level daily; change every 1000 hours or two years, whichever comes first.

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

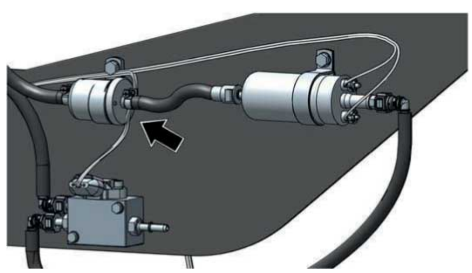


19. Oil Change w/Filter - Kubota
    Lube Point(s) - Fill Cap/Spin-on Element
    Capacity - 2.5 gal. (9.5 L) w/filter
    Lube - EO
    Interval - 3 Months or 150 hours of operation
    Comments - Check level daily/Change in accordance with engine manual

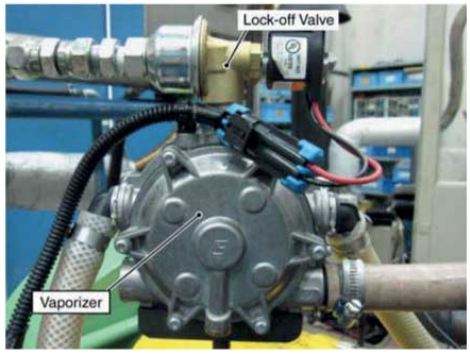




20. Fuel Filter - Kubota
    Lube Point(s) - Replaceable Component
    Interval - Every year or 600 hours of operation



21. Fuel Filter (Propane) - Kubota
Interval - Every year or 1000 hours of operation
Comments - Replace filter.



1.10 THREADLOCKING COMPOUND

JLG PN	Loctite®	ND Industries	Description
0100011	242™	Vibra-TITE™ 121	Medium Strength (Blue)
1001095650	243™	Vibra-TITE™ 122	Medium Strength (Blue)
0100019	271™	Vibra-TITE™140	High Strength (Red)
0100071	262™	Vibra-TITE™ 131	Medium - High Strength (Red)

Note: Loctite® 243™can be substituted in place of Loctite® 242™. Vibra-TITE™122 can be substituted in place of Vibra-TITE™ 121.

1.11 TORQUE CHARTS

1.11.1 SAE Fastener Torque Chart

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		

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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	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

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	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
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

5000059K

Note:

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

SAE Fastener Torque Chart (Continued)

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=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	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		

5000059K

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=0.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	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

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=0.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
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

5000059K

Note:
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

SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 5 BOLTS & GRADE 2 NUTS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	7	0.8				
	48	0.1120	0.00661	420	8	0.9				
6	32	0.1380	0.00909	580	14	1.5				
	40	0.1380	0.01015	610	14	1.6				
8	32	0.1640	0.01400	900	25	2.8				
	36	0.1640	0.01474	940	26	2.9				
10	24	0.1900	0.01750	1120	36	4.1				
	32	0.1900	0.02000	1285	42	4.7				
1/4	20	0.2500	0.0318	2020	86	9.7	80	9		
	28	0.2500	0.0364	2320	99	11.1	95	11		

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Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 5 BOLTS & GRADE 2 NUTS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	15	20	14	19	15	20
	24	0.3125	0.0580	3700	15	20	15	21	15	20
3/8	16	0.3750	0.0775	4940	25	35	25	34	25	34
	24	0.3750	0.0878	5600	30	40	28	38	25	34
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48
	20	0.4375	0.1187	7550	45	60	44	60	40	54
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75
	20	0.5000	0.1599	10700	75	100	71	97	65	88
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109
	18	0.5625	0.2030	12950	105	145	97	132	90	122
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156
	18	0.6250	0.2560	16300	145	195	136	185	125	170

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 5 BOLTS & GRADE 2 NUTS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272
	16	0.7500	0.3730	23800	255	345	238	324	225	306
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435
	14	0.8750	0.5090	32400	400	545	378	514	355	483
1	8	1.0000	0.6060	38600	545	740	515	700	480	653
	12	1.0000	0.6630	42200	600	815	563	765	530	721
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809
	12	1.1250	0.8560	47500	755	1025	713	969	670	911
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237

5000059K

Note:

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

SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		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	37	4				
10	24	0.1900	0.01750	1580	51	6				
	32	0.1900	0.02000	1800	58	7				
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		

5000059K

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		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

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
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

5000059K

Note:
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

SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SOCKET HEAD CAP SCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		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		

5000059K

Values for Magni Coating Fasteners (Ref 4150701)										
SOCKET HEAD CAP SCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		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	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

Values for Magni Coating Fasteners (Ref 4150701)										
SOCKET HEAD CAP SCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		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	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
3/4	10	0.7500	0.3340	30100	320	435	300	415	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

5000059K

Note:
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
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.

SAE Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*										
SOCKET HEAD CAP SCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		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		

5000059K

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*										
SOCKET HEAD CAP SCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		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	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

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*										
SOCKET HEAD CAP SCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		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	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
3/4	10	0.7500	0.3340	30100	320	435	300	415	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

5000059K

Note:

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
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.

1.11.2 Metric Fastener Torque Chart

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*							
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS							
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™)	Torque (Lube)	Torque (Loctite® 262™ or 271™ or Vibra-TITE™ 131)	Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 141)
		Sq mm	KN	[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

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*							
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS							
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™)	Torque (Lube)	Torque (Loctite® 262™ or 271™ or Vibra-TITE™ 131)	Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 141)
		Sq mm	KN	[N.m]		[N.m]	[N.m]
36	4	817	355.5	2560	1920	2300	2690
42	4.5	1120	487.0	4090	3070	3680	4290

Note:
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
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.

Metric Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS, CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M3 - M5*						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.20	Torque (Lube 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	23	19
8	1.25	36.60	22.8	37	33	27
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

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS, CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M3 - M5*						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.20	Torque (Lube 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]
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

Note:
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
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.

Metric Fastener Torque Chart (Continued)

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lube or Loctite® 242™or 271™ or Vibra-TITE™ 111 or 140) K=0.16	Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.1	1.1	1.0
3.5	0.6	6.78	2.95	1.8	1.7	1.5
4	0.7	8.78	3.82	2.6	2.4	2.3
5	0.8	14.20	6.18	5.3	4.9	4.6
6	1	20.10	8.74	9	8.4	7.9
7	1	28.90	12.6	15	14	13
8	1.25	36.60	15.9	22	20	19

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lube or Loctite® 242™or 271™ or Vibra-TITE™ 111 or 140) K=0.16	Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]
10	1.5	58.00	25.2	43	40	38
12	1.75	84.30	36.7	75	70	66
14	2	115	50.0	119	110	105
16	2	157	68.3	186	175	165
18	2.5	192	83.5	256	240	225
20	2.5	245	106.5	362	340	320
22	2.5	303	132.0	494	465	435
24	3	353	153.5	627	590	555
27	3	459	199.5	916	860	810
30	3.5	561	244.0	1245	1170	1100
33	3.5	694	302.0	1694	1595	1495

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lube or Loctite® 242™or 271™ or Vibra-TITE™ 111 or 140) K=0.16	Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]
36	4	817	355.5	2176	2050	1920
42	4.5	1120	487.0	3477	3275	3070

Note:
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
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.

Metric Fastener Torque Chart (Continued)

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS, CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE*						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lube 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	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	55
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

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS, CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE*						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lube 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]
20	2.5	245	152.5	520	490	460
22	2.5	303	189.0	705	665	625
24	3	353	222.0	905	850	800
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

Note:
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
4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

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SECTION 2
GENERAL

2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

2.1.1 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. With proper care, maintenance, and inspections performed per JLG's recommendations, and with any and all discrepancies corrected, this product will be fit for continued use.

2.1.2 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 mobile elevating work platform. The frequency of inspections and maintenance must be increased as environment, severity and frequency of usage requires.

2.1.3 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 Operation and Safety Manual for completion procedures for the Pre-Start Inspection. The Operation and Safety Manual must be read in its entirety and understood prior to performing the Pre-Start Inspection.

2.1.4 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 Preventive Maintenance Schedule for items requiring inspection during the performance of these inspections. Reference the appropriate areas of this manual for servicing and maintenance procedures.

2.1.5 Annual Machine Inspection

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

Reference the JLG Annual Machine Inspection Form and the Inspection and Preventive 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.

2.1.6 Preventive 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 Preventive 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 13. Inspection and Maintenance

Type	Frequency	Primary Responsibility	Service Qualification	Reference
Pre-Start Inspection (See Note)	Prior to use each day; or At each Operator change.	User or Operator	User or Operator	Operation 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 (See Note)	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 (See Note)	Annually, no later than 13 months from the date of the prior inspection.	Owner, Dealer, or User	Factory-Trained Service Technician	Service and Maintenance Manual and applicable JLG inspection form.
Preventive Maintenance	At intervals as specified in the Service and Maintenance Manual.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual

Note: Inspections forms are available from JLG. Use the Service and Maintenance Manual to perform inspections.

2.2 SERVICE AND GUIDELINES

2.2.1 General

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

2.2.2 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.

2.2.3 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.

2.2.4 Components Removal and Installation

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

2.2.5 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.

2.2.6 Pressure-Fit Parts

When assembling pressure-fit parts, use a molybdenum disulfide base compound or equivalent to lubricate the mating surface.

2.2.7 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.

2.2.8 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.

2.2.9 Bolt Usage and Torque Application

NOTICE

Self locking fasteners, such as nylon insert and thread deforming locknuts, are not intended to be reinstalled after removal.

1. Always use new replacement hardware when installing locking fasteners. 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. (Refer to *Section— Torque Chart, page 32*.
3. 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.

2.2.10 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.

2.2.11 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.

2.2.12 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.

2.2.13 Lubrication and Servicing

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

2.3 LUBRICATION AND INFORMATION

2.3.1 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 *Table — "Lubrication Specifications", page 23*. 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.

2.3.2 Hydraulic Oil

1. Refer to *Section — Hydraulic Oil, page 15* for recommendations for viscosity ranges.

2. JLG recommends standard utto fluid, 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°F (-26°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°F (-26°C).

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

2.3.3 Changing Hydraulic Oil

1. Filter elements must be changed after the first 50 hours of operation and every 300 hours (unless specified otherwise) thereafter. If it is necessary to change the oil, use only those oils meeting or exceeding the specifications appearing in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils.

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

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

2.3.4 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 *Table — "Lubrication Specifications", page 23* for an explanation of the lubricant key designations appearing in the Lubrication Chart.

2.4 CYLINDER DRIFT TEST

2.4.1 Theory

When a hydraulic cylinder is supporting a load, cylinder drift may occur as a result of any of the circumstances below:

- Normal leakage of load holding valves or malfunction of load holding valves. Refer to *"Cylinder Leakage Test", page 55* and *"Cylinder Drift", page 55* below for evaluation.
- Damaged or worn piston seals.
- Normal thermal expansion or contraction of the hydraulic oil within cylinders refer to *"Cylinder Thermal Drift", page 56* below.

The first two circumstances may result in cylinder movement due to oil leaking out of the cylinder externally or by leaking back to tank or due to oil leaking internally from one cylinder chamber to the other.

Thermal expansion or contraction of oil in hydraulic cylinders is a normal occurrence and does not result in oil leaking out of the cylinder or leaking internally from one cylinder chamber to the other. Thermal expansion or contraction is the tendency for materials to change size in response to a change in temperature.

2.4.2 Cylinder Leakage Test

Cylinder oil must be at stabilized ambient temperature before beginning this test.

Measure drift at cylinder rod with a calibrated dial indicator.

In an area free of obstructions, cylinder must have load applied and appropriately positioned to detect drift.

Cylinder leakage is acceptable if it passes this test.

Table 14. 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	0.004	0.10
9	228.6	0.003	0.08

Note: The information is based on 6 drops per minute cylinder leakage.

2.4.3 Cylinder Thermal Drift

The oil in all hydraulic cylinders will expand or contract due to thermal effects over time and may result in changes to the boom and/or platform position while the machine is stationary. These effects occur as the cylinder oil changes temperature, usually from a higher oil temperature as it cools and approaches the ambient air temperature. Results of these effects are related to several factors including cylinder length and change in temperature over the time the cylinder remains stationary.

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,

2.6.1 Do the Following When Welding on JLG Equipment

- Disconnect the battery.
- Disconnect the moment pin connection (where fitted)
- Ground only to structure being welded.

2.6.2 Do NOT Do the Following When Welding on JLG Equipment

- Ground on frame and weld on any other area than the chassis.
- Ground on turntable and weld on any other area than the turntable.
- Ground on the platform/support and weld on any other area than the platform/support.
- Ground on a specific boom section and weld on any other area than that specific boom section.

- Allow pins, wear pads, wire ropes, bearings, gearing, seals, valves, electrical wiring, or hoses to be between the grounding position and the welded area.

NOTICE

Failure to comply with the above requirements may result in component damage (i. e. Electronic modules, swing bearing, collector ring, boom wire ropes etc.

Note: Refer the Operation and Safety Manual for completion procedures for the Pre-Start Inspection.

Table 15. Inspection and Preventive Maintenance Schedule

AREA	Inspections	
	Pre-Delivery[1] or Frequent[2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
Boom Assembly		
Boom Weldments	1, 2	1, 2
Hose/Cable Carrier Installations	1, 2	1, 2
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
Platform Assembly		
Railing	2	2
Gate	1, 2, 3	1, 2, 3
Floor	2	2
Rotator	1, 2, 3, 4	1, 2, 3, 4
Lanyard Anchorage Point	1, 2, 6	1, 2, 6
Turntable Assembly		
Swing Bearing or Worm Gear	1[50], 2	1[50], 2
Oil Coupling	4	4
Swing Drive System	1, 4	1, 4
Turntable Lock	1, 2, 3	1, 2, 3
Hood, Hood Props, Hood Latches	3	3
Chassis Assembly		
Tires	1, 2	1, 2
Wheel Nuts/Bolts	1[50]	1[50]
Wheel Bearings	1, 2, 4, 5	1, 2, 4, 5

Table 15. Inspection and Preventive Maintenance Schedule (continued)

AREA	Inspections	
	Pre-Delivery[1] or Frequent[2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
Oscillating Axle/Lockout Cylinder Systems	1, 2, 4, 5	1, 2, 4, 5
Steer Components	1, 2	1, 2
Spindle Thrust Bearing/Washers	1, 2	1, 2
Drive Hubs	1, 4	1, 4
Functions/Controls		
Platform Controls Return to Neutral/Off when Released	1, 3, 6, 9	1, 3, 6, 9
Ground Controls Return to Neutral/Off when Released	1, 3, 6, 9	1, 3, 6, 9
Function Control Locks, Guards, or Detents	1, 3, 9	1, 3, 9
Footswitch (Shuts Off Function when Released)	1, 3, 9	1, 3, 9
Emergency Stop Switches (Ground & Platform) Arrest all Platform Movement	1, 3, 6	1, 3, 6
Function Limit or Cutout Switch Systems	1, 3, 9	1, 3, 9
Capacity Indicator	1, 3, 9	1, 3, 9
Drive Brakes	1, 3, 9	1, 3, 9
Swing Brakes	1, 3, 9	1, 3, 9
Auxiliary Power	1, 3, 9	1, 3, 9
Power System		
Engine Idle, Throttle, and RPM	1, 3, 7	1, 3, 7
Engine Fluids: Oil	4	4
Engine Fluids: Coolant	1, 4, 7	1, 4, 7
Air Filter	1, 4	1, 4
Fuel Filter(s)	1, 5	1, 5
Drain Oil Build Up in 2-Stage Vaporizer (LP Only)	1, 4	1, 4
Exhaust System	1, 4	1, 4
Batteries	1, 4	1, 4
Battery Fluid	4	4
Battery Charger	1, 3	1, 3
Intake System	1, 2	1, 2
Glow Plug (Diesel Only)	1, 2, 3	1, 2, 3
Serpentine Belt, Tensioner, Pulleys	1, 2, 3	1, 2, 3
Fuel Reservoir, Cap, and Breather	1, 2, 4	1, 2, 4

Table 15. Inspection and Preventive Maintenance Schedule (continued)

AREA	Inspections	
	Pre-Delivery[1] or Frequent[2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
Hydraulic/Electric System		
Hydraulic Pumps	1, 2, 4	1, 2, 4
Hydraulic Cylinders	1, 2, 4, 5	1, 2, 4, 5
Cylinder Attachment Pins and Pin Retainers	1, 2	1, 2
Hydraulic Hoses, Lines, and Fittings	1, 2, 4	1, 2, 4
Hydraulic Reservoir, Cap, and Breather	1, 2, 3, 4, 5	1, 2, 3, 4, 5
Hydraulic Filter(s)	1, 4, 5	1, 4, 5
Hydraulic Fluid	4, 5	4, 5
Electrical Connections	1, 2	1, 2
Instruments, Gauges, Switches, Lights, Horn	1, 3	1, 3
General		
All Decals/Placards Installed, Secure, Legible	9	9
Annual Machine Inspection Due	-	9
No Unauthorized Modifications or Additions	9	9
All Relevant Safety Publications Incorporated	9	9
General Structural Condition and Welds	2	2
All Fasteners, Pins, Shields, and Covers	1, 2	1, 2
Grease and Lubricate to Specifications	9	9
Function Test of All Systems	9	9
Paint and Appearance	5	5
Stamp Inspection Date on Frame	-	9
Notify JLG of Machine Ownership	-	9

Footnotes:
[1] Prior to each sale, lease, or delivery
[2] In service for 3 months; Out of service for 3 months or more; Purchased used
[3] Annually, no later than 13 months from the date of the prior inspection, Includes all daily and quarterly inspections, mandated by regulating body
[50] Indicates a 50 hour interval required to perform task after initial use of machine. This only occurs once in machine life

Performance Codes:
1 - Check for proper and secure: installation, adjustment, or torque
2 - Visual inspection for damage: (cracks, corrosion, abrasions, distortion, excessive wear, broken welds, gouges, chafing and threads showing)
3 - Proper operation
4 - Check for proper sealing, signs of leakage and fluid level
5 - Clean and free of debris
6 - Decals installed and legible
7 - Check for proper tolerances, routing, and lubrication
8 - Fully Charged
9 - Verify/Perform

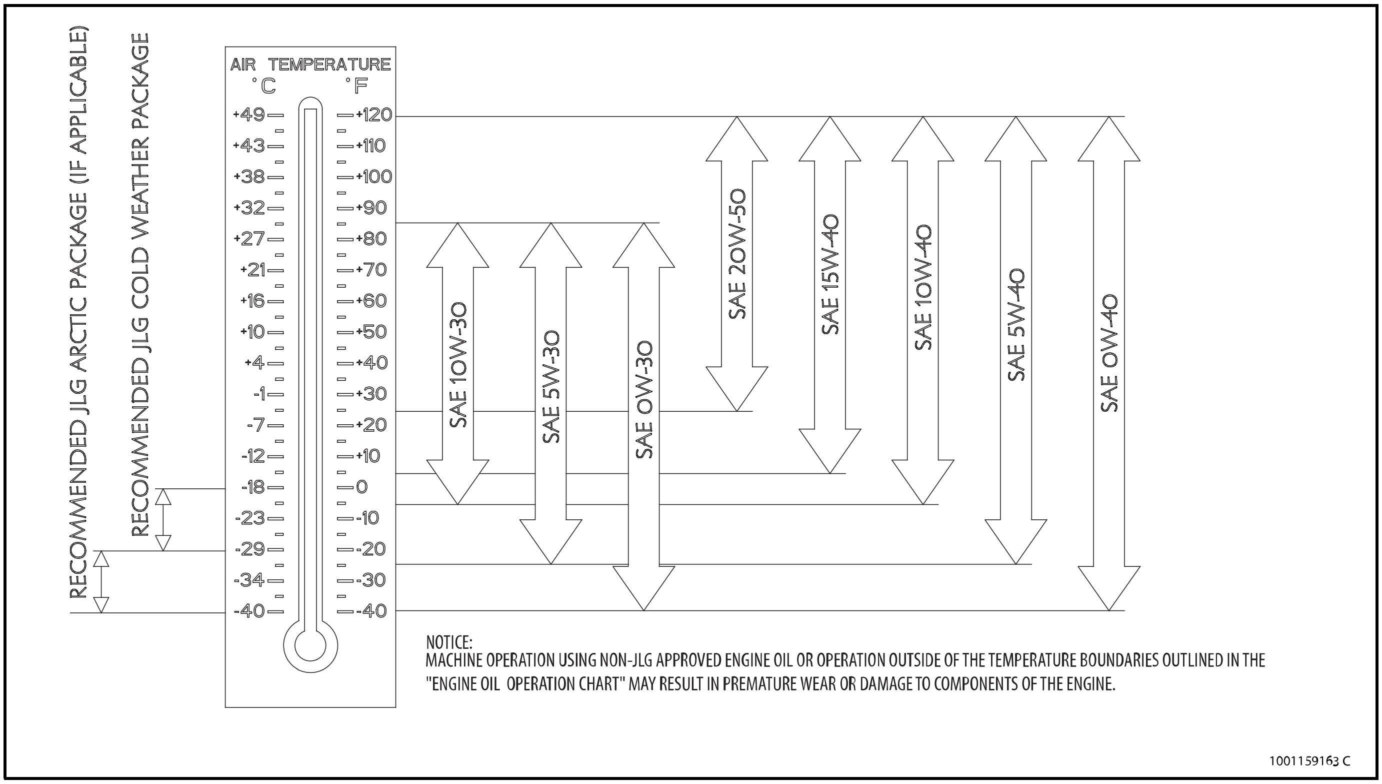
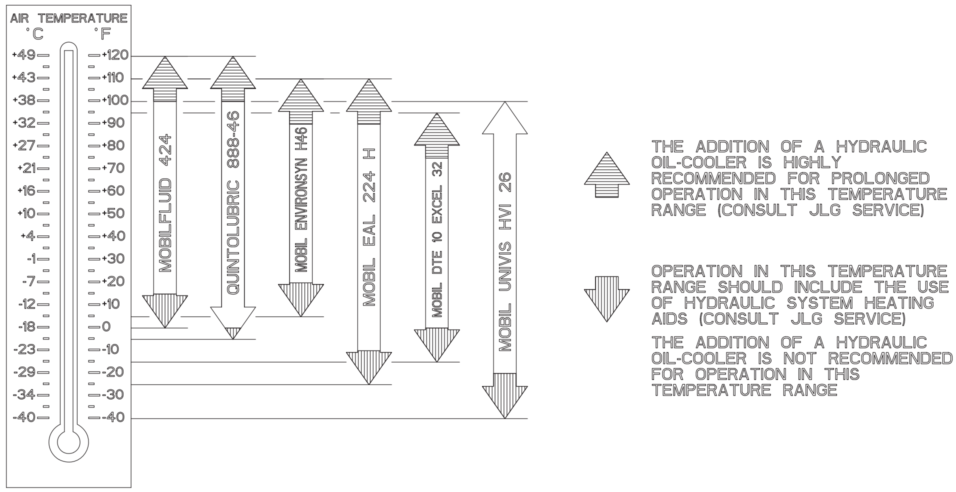


Figure 4. Engine Operating Temperature Specifications - Deutz 2.9L4



Fluid	Properties		Base				Classifications		
Description	Viscosity at 40° C (cSt, Typical)	Viscosity Index	Mineral Oils	Vegetable Oils	Synthetic	Synthetic Polyol Esters	Readily Biodegradable*	Virtually Non-toxic**	Fire Resistant***
Mobilfluid 424	55	145	X						
Mobil DTE 10 Excel 32	32	141	X						
Univis HVI 26	26	376	X						
Mobil EAL 224 H	47	212		X			X	X	
Mobil Envirosyn H 46	49	145			X		X	X	
Quintolubric 888-46	50	185				X	X	X	X

* Readily biodegradable classification indicates one of the following:
CO2 Conversion > 60% per EPA 560/6-82-003
CO2 Conversion > 80% per CEC-L-33-A-93

** Virtually Non-toxic classification indicates an LC50 > 5000 ppm per OECD 203

*** Fire Resistant classification indicates Factory Mutual Research Corp. (FMRC) Approval

NOTICE:
MACHINE OPERATION USING NON-JLG APPROVED HYDRAULIC FLUIDS OR OPERATION OUTSIDE OF THE TEMPERATURE BOUNDARIES OUTLINED IN THE "HYDRAULIC FLUID OPERATION CHART" MAY RESULT IN PREMATURE WEAR OR DAMAGE TO COMPONENTS OF THE HYDRAULIC SYSTEM.

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Figure 5. Hydraulic Oil Operating Temperature Specifications

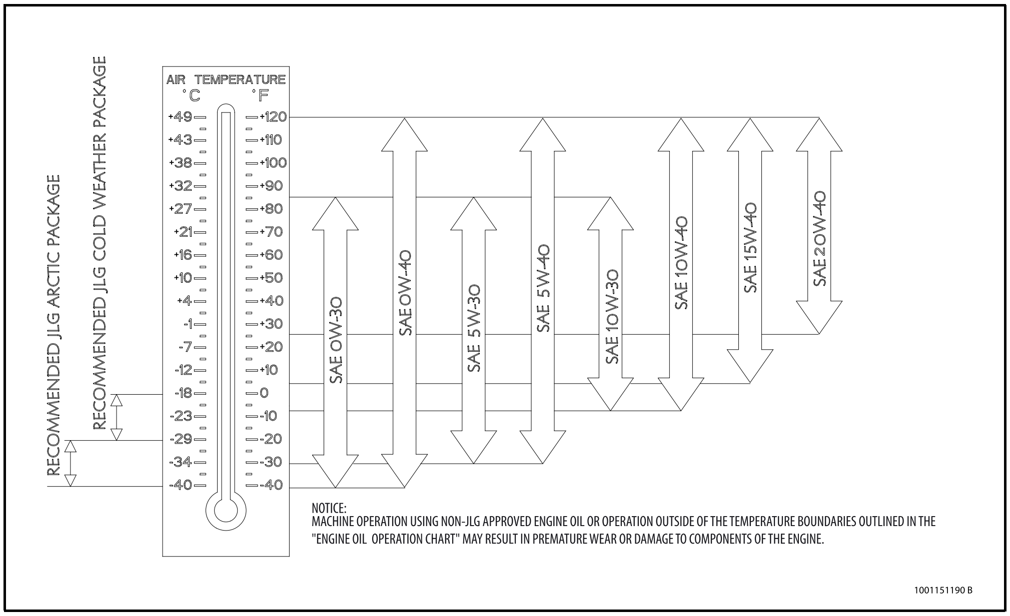


Figure 6. Engine Oil Operating Temperature Specifications - Deutz 2011L03

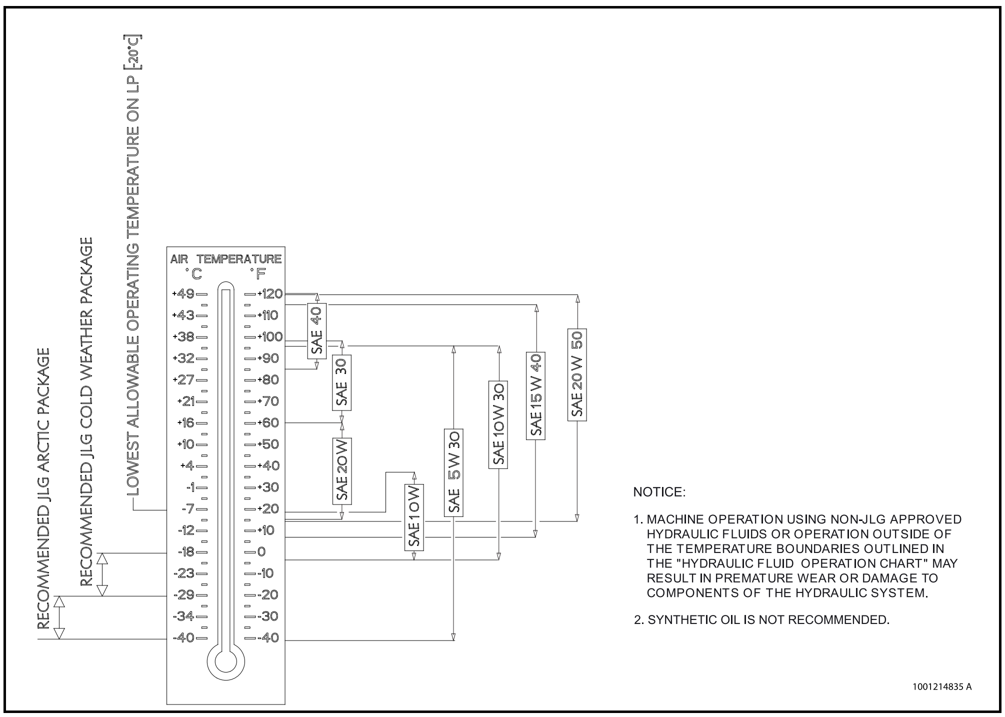


Figure 7. Engine Operating Temperature Specifications - Kubota

SECTION 3
CHASSIS & TURNTABLE

3.1 TIRES AND WHEELS

3.1.1 Tire Damage

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

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

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

3.1.2 Tire Replacement

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

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

Unless specifically approved by JLG Industries Inc. do not replace a foam filled or ballast filled tire assembly with a pneumatic tire. Due to size variations between tire brands, both tires on the same axle should be the same.

3.1.3 Wheel Replacement

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

3.1.4 Wheel Installation

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

⚠ WARNING

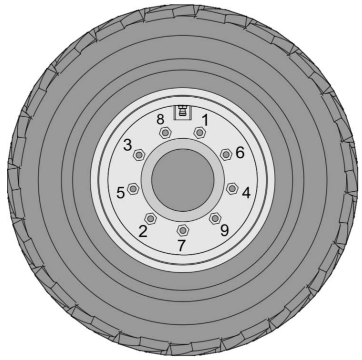
Wheel nuts must be installed and maintained at the proper torque to prevent loose wheels, broken studs, and possible dangerous separation of wheel from the axle. Be sure to use only the nuts matched to the cone angle of the wheel.

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

The proper procedure for attaching wheels is as follows:

1. Start all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.

2. Tighten nuts in the following sequence:



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

Table 16. Wheel Torque Chart

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
40 ft. lbs. (55 Nm)	95 ft. lbs. (130 Nm)	170 ft. lbs. (230 Nm)

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

3.2 OSCILLATING AXLE SYSTEM

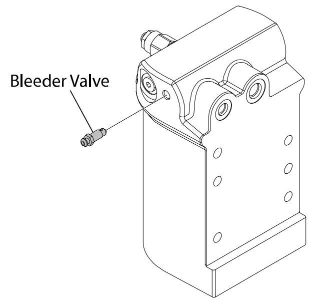
The oscillating front axle is attached to the frame by a pivot pin, which allows all four wheels to remain on the ground when traveling on rough terrain. There are two lockout cylinders connected to the frame. The lockout cylinders permit axle oscillation when the main boom is in Transport Position refer to “Transport Position Sensing System” , and when the boom is oriented between the rear tires, refer to *section — Drive Orientation System, page 69*.

The lockout cylinders will lock and hold the axle when the Main boom is above horizontal or swung beyond the rear tires. Pilot pressure is supplied through Drive Pump charge pressure. The cylinders unlock when pilot pressure is applied to the holding valves mounted on the cylinders and lock when pilot pressure is removed.

When the Main Boom is below horizontal and swung between the rear tires, the switches described above provide power to actuate the two control valves to supply charge pressure to the lock-out cylinder holding valves. This allows the cylinders to unlock allowing the axle to float. The first valve is normally closed and opens when actuated to allow flow to the lockout cylinder circuit. The second valve (located between the first valve and the lock-out cylinders) is normally open to tank. When actuated this valve closes to block the tank path and force the flow to the lock-out cylinders. If either of these valves is in its normal state, the axle will be locked. The Ground Control Module supplies power to and monitors the state of the boom elevation and oscillating axle switches. If the switch states are not in agreement, the Ground Control Module will remove power, causing the oscillating axle to lock in the fail safe position until power is cycled.

3.3 LOCKOUT CYLINDER BLEEDING

1. Start the engine.
2. Position the turntable to the normal stowed position.
3. Attach clear tubing to bleeder valve nipple.
4. Position a small bucket/bottle in front of the lockout cylinder bleeder valve and insert clear tubing.
5. Using a wrench, loosen the bleeder valve, turning counterclockwise slowly. Bleed air from the top of lockout cylinder. Capture hydraulic oil until a steady unbroken stream of hydraulic oil is viewed. Tighten/close the bleeder valve while stream of hydraulic oil is running.



3.4 CHASSIS TILT INDICATOR SYSTEM

The Chassis Tilt Indicator System measures the turntable angle with respect to level ground. The tilt sensor is mounted to the turntable base plate, has two settings; 5.0° and 8.0° degrees. The 5.0° angle is set by choosing the desired market selection for the machine. For location of tilt sensor refer *Figure — Tilt Sensor Location, page 505*

The 5.0° angle is used for the purpose of warning the operator of the inclined condition, illuminating the chassis tilt light in the platform display panel.

However, when the machine is out of transport position and the turntable tilts more than the 5.0° pre-set value, the boom functions can only operate in creep speed mode, and the drive function is disabled. The operator must return the machine into transport mode in order to continue to drive the machine.

When Chassis Tilt Indicator System used in conjunction with the Transport Position Sensing System (refer to *Section — Boom & Platform, page 283*, Transport Position Sensing System for more information on Transport Position Sensing System), the tilt sensor will cause an alarm to sound, and automatically put all functions in the creep speed mode.

The 8° angle is used exclusively for the purpose of automatically slowing drive speed when this angle is reached, and the boom is in Transport position. When the boom is in Transport Position (refer to *Section — Boom & Platform, page 283*, Transport Position Sensing System for more information on Transport Position Sensing System) and the chassis is at or above 8°, the drive system will automatically switch into Max Torque mode.

The control system responds to indicated angle readings 0.25 degree smaller than the required angles to account for calibration and sensor variation.

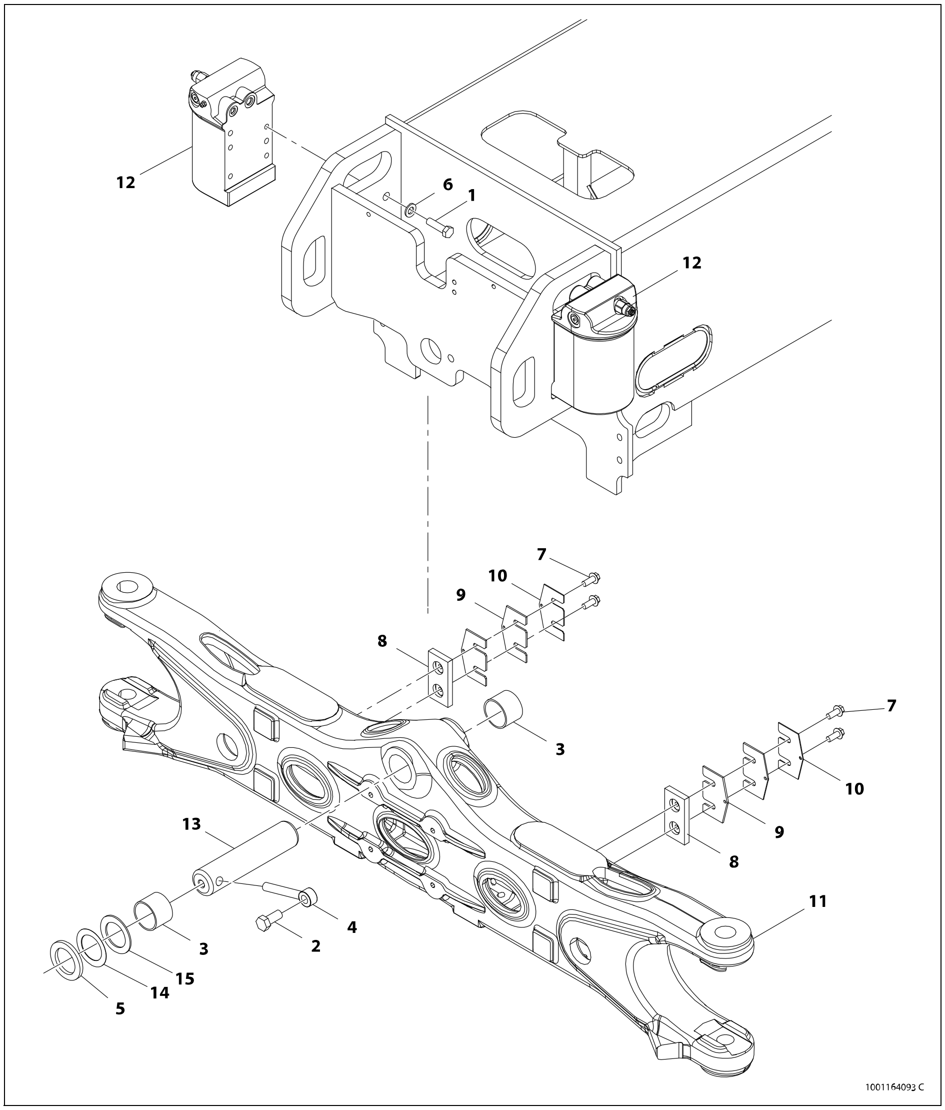


Figure 8. Axle Installation

1. Bolt	6. Washer	11. Axle
2. Bolt	7. Bolt	12. Axle Lockout Cylinder
3. Bearing	8. Wear Pad	13. Pin
4. Keeper Pin	9. Shim	14. Shim
5. Washer	10. Shim	15. Washer

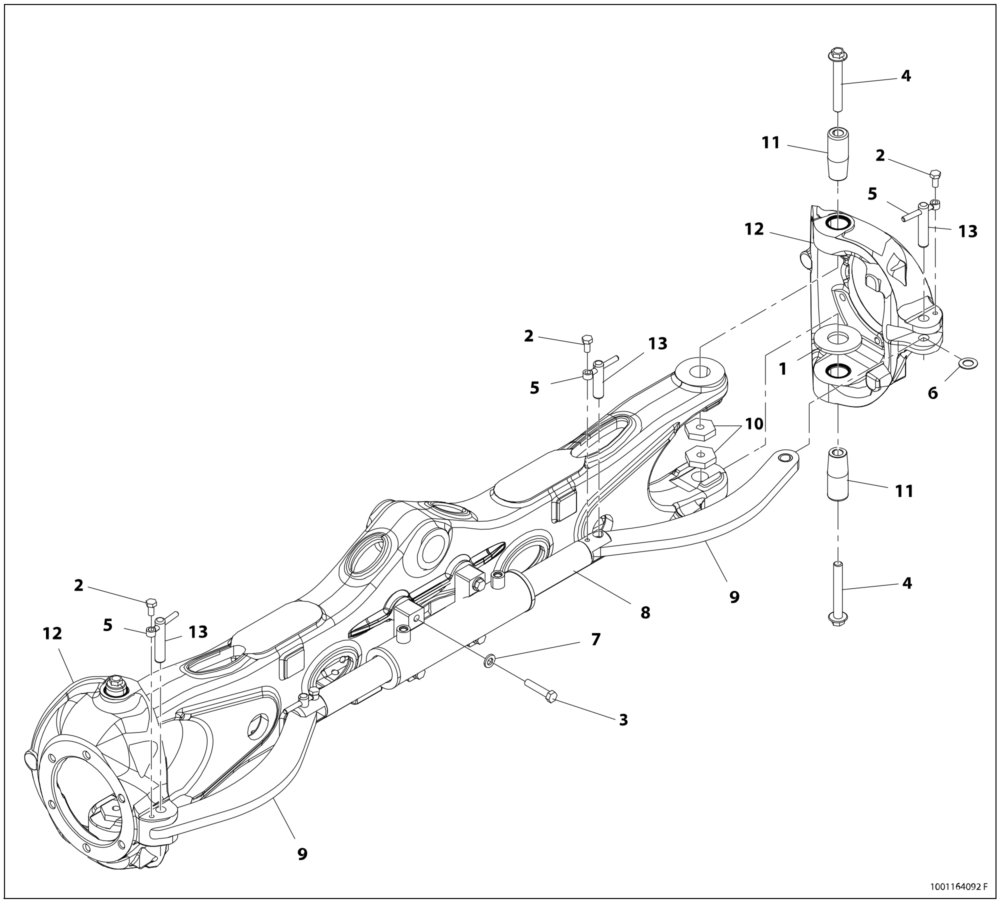


Figure 9. Steer Installation (Without Tow Package)

1. Thrust Bearing	6. Washer	11. Kingpin
2. Bolt	7. Washer	12. Spindle
3. Bolt	8. Steer Cylinder	13. Pin
4. Bolt	9. Link	
5. Keeper Pin	10. Nut	

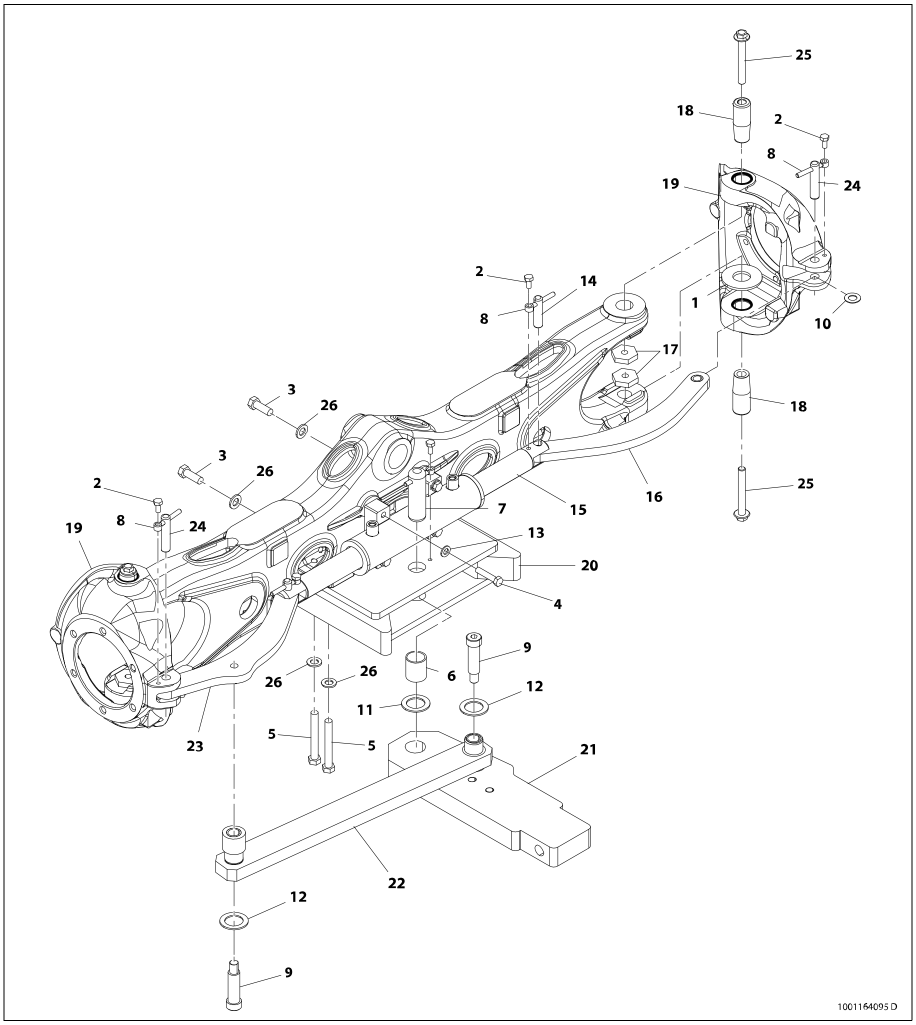


Figure 10. Steer Installation (With Tow Package)

1. Thrust Bearing	10. Washer	19. Spindle
2. Bolt	11. Washer	20. Bracket
3. Bolt	12. Washer	21. Pivot Plate
4. Bolt	13. Washer	22. Link
5. Bolt	14. Pin	23. Link
6. Bearing	15. Steer Cylinder	24. Pin
7. Pin	16. Link	25. Bolt
8. Keeper Pin	17. Nut	26. Washer
9. Bolt	18. Kingpin	

3.5 OSCILLATING AXLE LOCKOUT TEST

NOTICE

Lockout system test must be performed quarterly, any time a system component is replaced, or when improper system operation is suspected.

Note: Ensure boom is fully retracted, lowered, and centered between rear wheels prior to beginning lockout cylinder test.

1. Place a 6 in. (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control console, start engine.
3. Place the Drive control lever to the forward position and carefully drive machine up ascension ramp until left front wheel is on top of block.
4. Carefully activate Swing control lever and position boom over right side of machine or raise the main boom enough to get it out of the transport position.
5. Place Drive control lever to Reverse and drive machine off of block and ramp.
6. Have an assistant check to see that left front or right rear wheel remains elevated in position off of ground.
7. Carefully return boom to stowed position (centered between rear wheels if swung or fully lowered if raised). When boom reaches stowed position, lockout cylinders should release and allow wheel to rest on ground, it may be necessary to activate Drive to release cylinders.
8. Place the 6 in. (15.2 cm) high block with ascension ramp in front of right front wheel.
9. Place Drive control lever to Forward and carefully drive machine up ascension ramp until right front wheel is on top of block.
10. Repeat steps 4 through 7 to check the opposite side of the oscillating axle.
11. If lockout cylinders do not function properly, have qualified personnel correct the malfunction prior to any further operation.

3.6 COLD START SYSTEM (DIESEL)

The machine control system monitors the engine coolant and ambient temperature to make an assessment of cylinder preheating requirements. If the coolant temperature is below 50°C when control power is turned on, the glow plugs will be automatically fired for a duration that is based on the ambient temperature up to a maximum of 20 seconds. During this preheat period, the glow plug indicators will flash. The glow plugs will be turned off before the engine begins to crank.

3.7 DRIVE ORIENTATION SYSTEM

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

3.8 DRIVE SYSTEM

The four wheel drive system consists of one variable displacement closed loop pump, four variable displacement piston motors, gear reduction hubs, and a traction control manifold that includes three flow dividers/combiners.

The two wheel drive system consists of one variable displacement closed loop pump, two variable displacement piston motors, gear reduction hubs, and a traction control manifold that includes one flow dividers/combiner.

Drive speed is varied by a combination of drive pump displacement, engine speed, and motor displacement. Traction control is full-time and is present in all drive modes. There are three drive modes that can be selected at the platform console. The functionality of the drive system is dependent on the position of the boom. The following chart describes how the system works in each drive mode.

Table 17. Drive System Mode Chart

Boom Position	Drive Selection		Engine Speed when Drive is Actuated	Max. Speed MPH (kph)
In Transport	Max Speed		High-2600 RPM	4.25 (6.83)
	Mid-Engine		Mid-1800 RPM	3(4.8)
	Max Torque		High-2600 RPM	1.25(2.01)
Out of Transport	Max Speed		High-2600 RPM	0.5(0.8)
	Mid-Engine		Mid-1800 RPM	0.5(0.8)
	Max Torque		High-2600 RPM	0.5(0.8)

3.9 WHEEL DRIVE ASSEMBLY

3.9.1 Removal

Note: The drive motors can be removed through the axle flange as part of the wheel drive assembly or they can be removed separately through the bottom of the frame while leaving the drive hub bolted to the axle.

1. Use a jack to lift the frame enough so the tire and wheel assembly is off the ground. Place blocking strong enough to support the weight of the machine under the frame and remove the jack.

Note: The foam-filled tire & wheel assembly weighs approximately 395 lb (179 kg). The solid tire & wheel assembly weighs approximately 286 lb (130 kg).

2. Remove hardware securing wheel and remove tire and wheel assembly. Using suitable lifting device lift the tire and wheel assembly and place in a suitable area.
3. Tag and disconnect the hydraulic lines running to the drive motor. Cap or plug all openings to ensure no dirt enters the hydraulic system.

Note: The drive hub and drive motor assembly weighs approximately 149 lb (68 kg).

4. Use a supporting device capable of handling the weight of the drive hub and drive motor, and unbolt the drive hub from the frame. Remove the entire assembly from the machine.

5. Remove the capscrews and washers that secure the drive motor to the drive hub and remove the drive motor. Remove and discard the brake gasket between the drive motor and drive hub.

3.9.2 Installation

1. Install a new brake gasket between the drive motor and drive hub. Apply a coat of Medium Strength Threadlocking Compound on capscrews. Install the washers and capscrews to secure the drive hub and drive motor, and torque to 70 ft. lbs. (95 Nm).

2. Place the drive hub flange against the mounting flange on the axle and fasten it in place with the bolts and washers. Torque the bolts to 190 ft. lbs. (260 Nm).

3. Using adequate support, install wheel into wheel assembly and secure with bolts and washers. Refer to *Wheel Installation, page 71* for torque details.

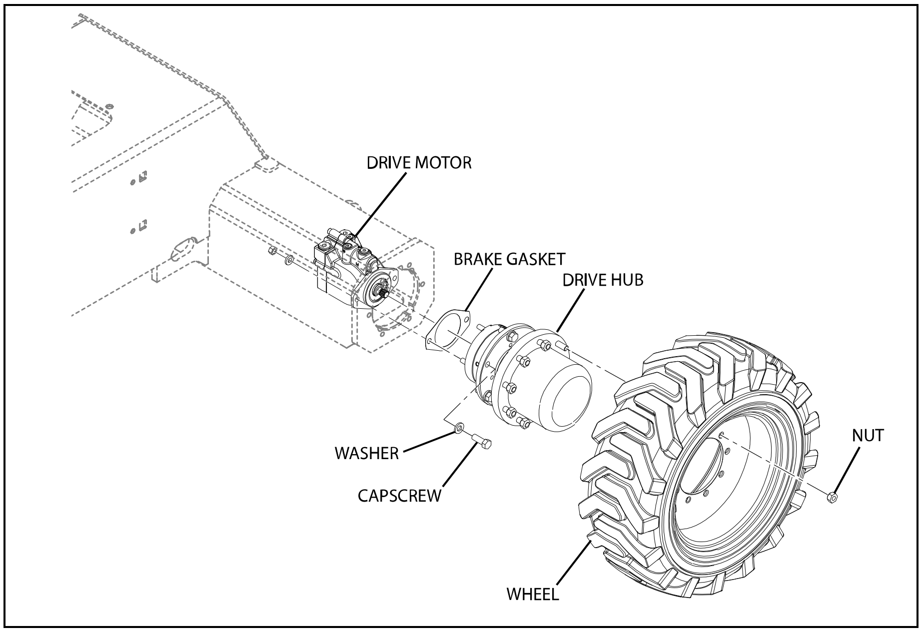


Figure 11. Wheel Drive Installation

3.10 TORQUE HUB

3.10.1 Roll and Leak Testing

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

ROLL TEST

The roll test determines if the unit's gears rotate freely and properly. You should be able to rotate gears by applying a constant force to the roll checker. If you feel moredrag in gears only at certain points, gears are not rolling freely. Examine them for improper installation or defects.

Some gear packages roll with more difficulty than others. Do not be concerned if gears seem to roll hard as long as they roll with consistency.

LEAK TEST

The purpose of a leak test is to make sure unit is air tight. You can tell if your unit has a leak if pressure gauge test reading starts to fall once you have pressurized the unit.

Leaks usually occur at the main seal or wherever O-rings or gaskets are located. You can usually detect location of a leak by brushing a soap and water solution around main seal and where O-rings or gaskets meet unit exterior, then checking for air bubbles. Replace part immediately if you detect a leak in a seal, O-ring, or gasket.

3.10.2 Tightening and Torquing Bolts

NOTICE

USE extreme care when using an air impact wrencH. do NOT tighten bolts beyond their torque specification. Never use an impact wrench to tighten shoulder bolts. tighten all shoulder bolts by hand.

1. Tighten (but do not torque) bolt ″A″ until snug.
2. Go to opposite side of bolt circle and tighten bolt ″B″ until equally snug.
3. Continue around bolt circle and tighten remaining bolts.
4. Apply specified torque to bolt ″A″.
5. Continue around bolt circle and apply equal torque to remaining bolts.

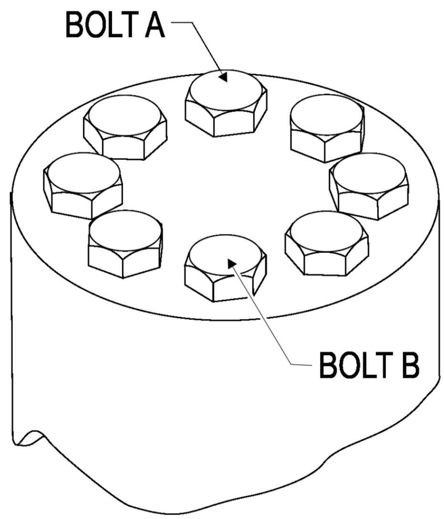


Figure 12. Bolt Tightening Sequence

3.10.3 Main Disassembly for “B” Drives

1. Turn hub (1G) on side, Remove coupling (14) from wide end of spindle (1A).
2. Mark location of shoulder bolt holes on outside of ring gear and hub for easy realignment when rebuilding. Remove four shoulder bolts (13) and 12 bolts (12) from cover (6).
3. Remove 16 flat washers (16) from cover (6).
4. Lift cover sub-assembly (6) off ring gear (4). Set cover on table with interior side facing up.

⚠ CAUTION

Sharp edges can cut and cause serious injury. Beware of sharp edges in counterbore when removing o-ring.

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

Note: If O-ring is not in cover counterbore, it is in ring gear counterbore. Remove it from hub and discard.

6. Remove thrust washer (11) from counterbore in top of carrier (3A).

7. Remove input gear (8) from middle of carrier sub-assembly (3).
8. Lift ring gear (4) off hub (1G).
9. Lift carrier sub-assembly (3) out of hub (1G).
10. Remove thrust spacer (9) from input shaft (7) in middle of spindle (1A).
11. Lift input shaft sub-assembly (7) out of middle of spindle (1A). Stand input shaft (7A) on splined end.

⚠ CAUTION

Uncontrolled objects can cause eye damage or serious injury. Always wear eye protection.

12. Using retaining ring pliers, remove retaining ring (7B) from groove on input shaft (7A).
13. Remove one spacer (7D), one spring (7C), and other spacer (7D) from input shaft (7A).
14. Remove thrust washer (11) from around spindle (1A).
15. Lift internal gear (2) out of hub (1G).
16. Remove O-ring (5) from counterbore in hub (1G). Discard O-ring.
17. Main disassembly for ”B” drives is complete.

3.10.4 Hub-Spindle Disassembly

Note: Start with large end of hub facing up and large end of spindle facing down.

⚠ CAUTION

Uncontrolled objects can cause eye damage or serious injury. Always wear eye protection.

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

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

4. If seal and bearing cone did not come out of small end of hub (1G) when you pressed spindle out of hub, remove seal (1B) and bearing cone (1D) from small end of hub (1G). Discard seal.
5. Bearing cone (1F) should be lying loose in wide end of hub (1G). Remove bearing cone (1F) from inside hub (1G).

Note: Do not strike counterbore with punch if using a punch and hammer when removing bearing cup.

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

Note: Do not strike counterbore with punch if using a punch and hammer when removing bearing cup.

7. Turn hub (1G) over and lift it out of flange-support. Remove bearing cup (1E) from counterbore in wide end of hub (1G).

8. Turn hub (1G) over onto its small end. Remove two pipe plugs (1J) from side of hub (1G).

Note: If your unit does not have studs, skip this step.

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

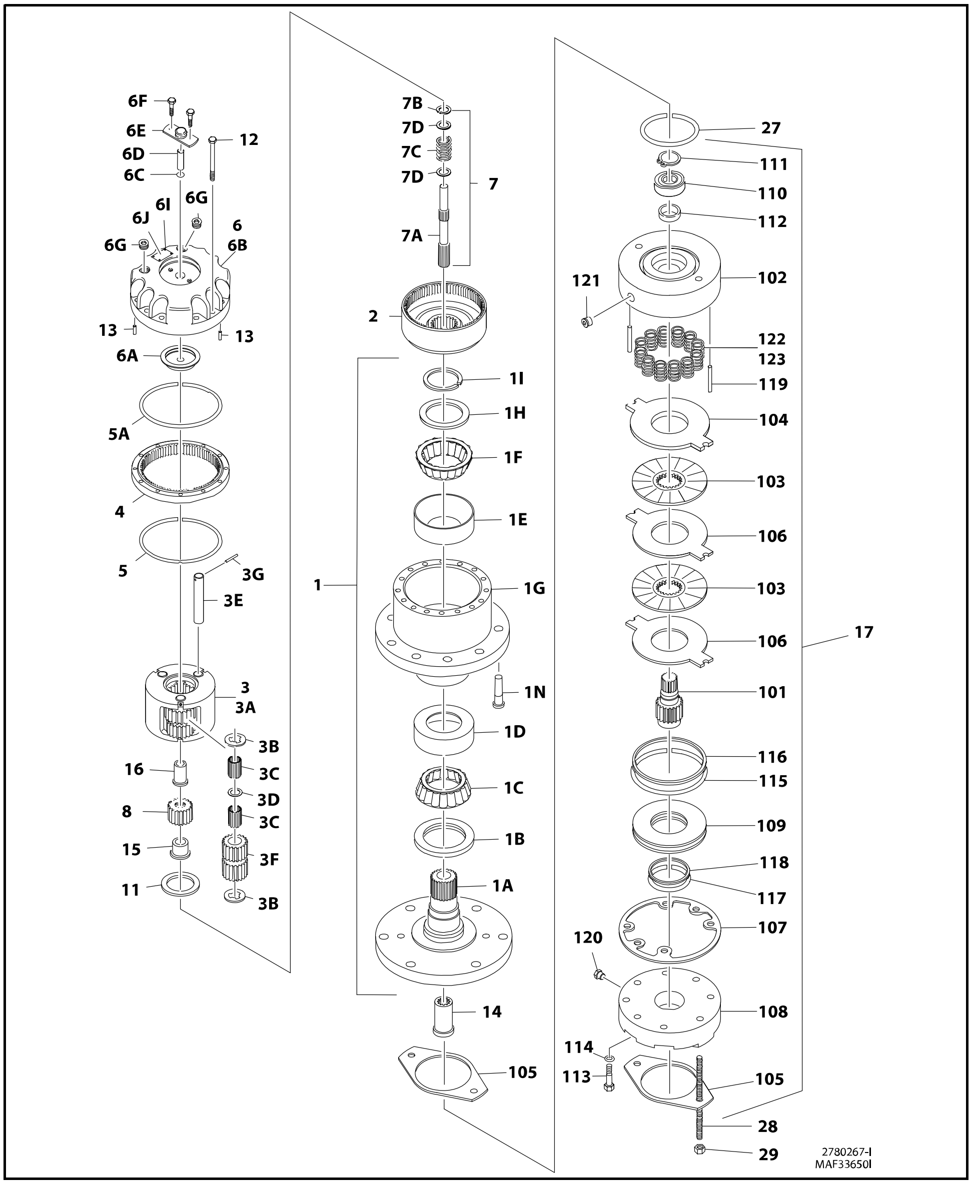


Figure 13. Drive Hub and Brake Assembly (Rear)

1 Spindle/Housing Assembly	3F Planet Gear	7C Spring	106 Outer Plate
1A Spindle	3G Roll Pin	7D Thrust Spacer	107 Gasket
1B Seal	4 Ring Gear	8 Sun Gear	108 Cylinder
1C Bearing Cone	5 O-Ring	11 Thrust Washer	109 Piston
1D Bearing Cup	5A O-Ring	12 Bolt	110 Ball Bearing
1E Bearing Cup	6 Cover Assembly	13 Dowel Pin	111 Retaining Ring
1F Bearing Cone	6A Thrust Spacer	14 Coupling	112 Shaft Seal
1G Housing/Ring Gear	6B Cover Plate	15 Input Spacer	113 Capscrew
1H Thrust Washer	6C O-Ring	16 Input Spacer	114 Lockwasher
1I Retaining Ring	6D Disconnect Rod	17 Brake Assembly	115 O-Ring
1N Wheel Stud	6E Disengage Cap	27 O-Ring	116 Backup Ring
2 Internal Gear	6F Bolt	28 Threaded Rod	117 O-Ring
3 Carrier Assembly	6G Pipe Plug	29 Nut, 1/2in-13NC	118 Backup Ring
3A Carrier	6I Rivet	101 Shaft	119 Dowel Pin
3B Retaining Ring	6J I.D. Plate	102 Housing	120 Plug
3C Needle Bearing	7 Input Shaft Assembly	103 Friction Plate	121 Plug
3D Thrust Washer	7A Shaft	104 Pressure Plate	122 Spring (Natural)
3E Planet Shaft	7B Retaining Ring	105 Gasket	123 Spring (Blue)

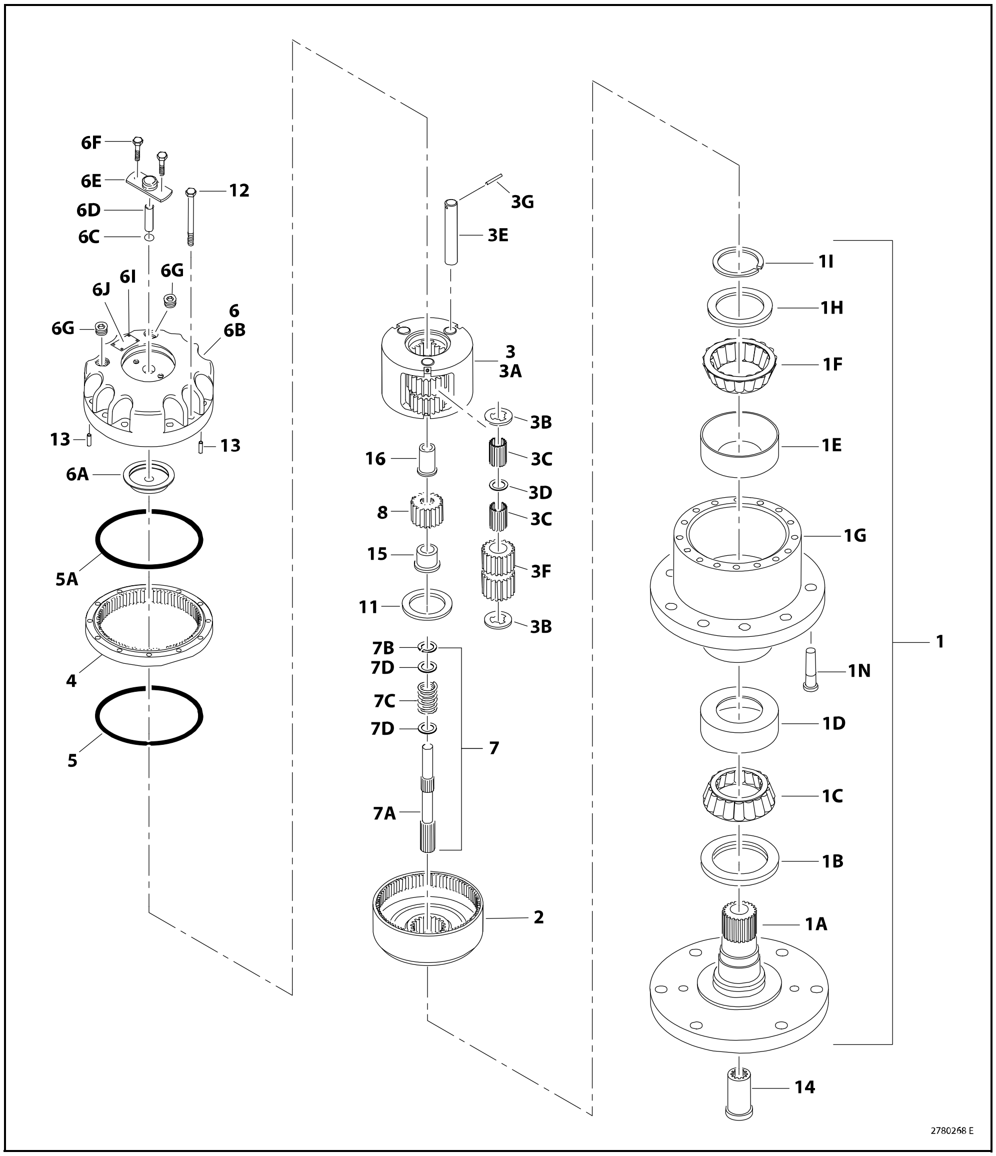


Figure 14. Drive Hub (4WD Front Only)

1 Spindle/Housing Assembly	3 Carrier Assembly	6 Cover Assembly	7A Shaft
1A Spindle	3A Carrier	6A Thrust Spacer	7B Retaining Ring
1B Seal	3B Retaining Ring	6B Cover Plate	7C Spring
1C Bearing Cone	3C Needle Bearing	6C O-Ring	7D Thrust Spacer
1D Bearing Cup	3D Thrust Washer	6D Disconnect Rod	8 Gear, Sun
1E Bearing Cup	3E Planet Shaft	6E Disengage Cap	11 Thrust Washer
1F Bearing Cone	3F Planet Gear	6F Bolt	12 Bolt
1G Housing/Ring Gear	3G Roll Pin	6G Plug, Pipe	13 Pin, Dowel
1H Thrust Washer	4 Ring Gear	6I Rivet	14 Coupling
1I Retaining Ring	5 O-Ring	6J I.D. Plate	15 Input Spacer
1N Wheel Stud	5A O-Ring	7 Input Shaft Assembly	16 Input Spacer
2 Internal Gear			

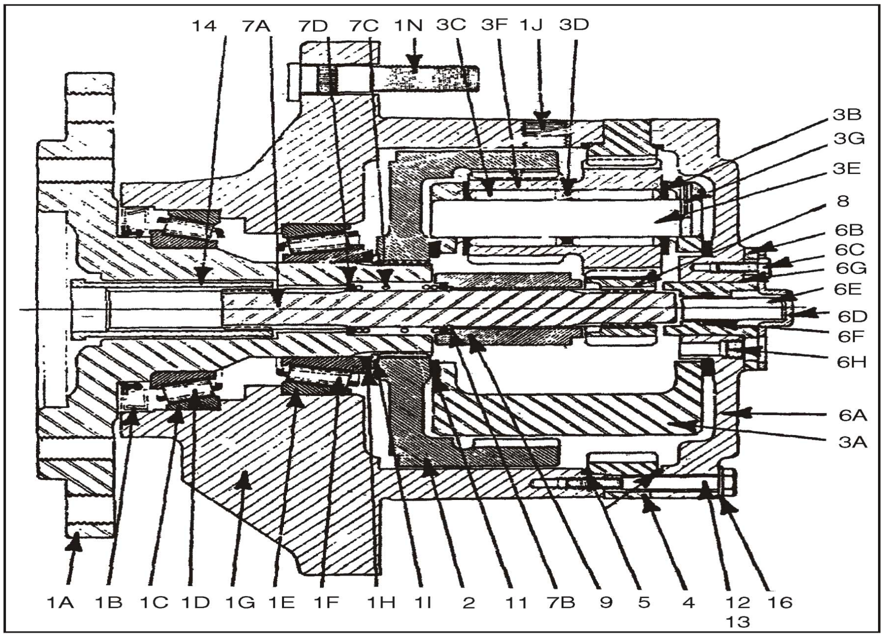


Figure 15. Drive Hub (Cross-Section)

1. Hub-Spindle Sub-Assembly	2. Internal Gear	A. Cover	C. Spring
A. Spindle	3. Carier Sub-Assembly	B. Cover Cap	D. Spacer
B. Seal	A. Carrier Housing	C. Bolt	8. Input Gear
C. Bearing Cup	B. Thrust Washer	D. Disconnect Cap	9. Thrust Spacer
D. Bearing Cone	C. Needle Roller	E. Disconnect Rod	11. Thrust Spacer
E. Bearing Cup	D. Spacer	F. O Ring	12. Bolt
F. Bearing Cone	E. Planet Shaft	G. O Ring	13. Shoulder Bolt
G. Hub	F. Cluster Gear	H. Pipe Plug	14. Coupling
H. Spacer	G. Roll Pin	I. ID Plate	16. Flat Washer
I. Retaining Ring	4. Ring Gear	7. Input Shaft Sub Assembly	
J. Pipe Plug	5. O Ring	A. Seal	
K. Stud	6. Cover Sub-Assembly	B. Retaining Ring	

3.10.5 Cover Disassembly

1. Remove two bolts (6C) holding disconnect cap (6D) to cover (6A).
2. Remove disconnect cap (6D) from on top of cover cap (6B) and cover (6A).
3. Remove two bolts (6C) holding cover cap (6B) to cover (6A).
4. Remove cover cap (6B) from cover (6A).
5. Remove disconnect rod (6E) from cover cap (6B).

6. Pry O-ring (6F) out of groove inside cover cap (6B). Discard O-ring.
7. Remove O-ring (6G) from flange of cover cap (6B). Discard O-ring.
8. Remove pipe plug (6H) from cover (6A).
9. Cover disassembly is complete.

3.10.6 Carrier Disassembly

Note: Discard old needle rollers and use new ones during reassembly.

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

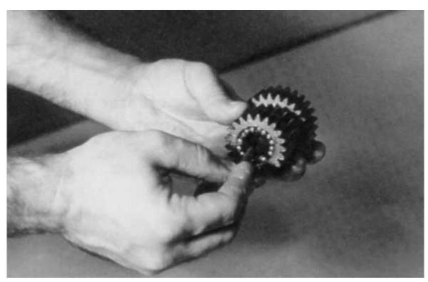
NOTICE

Drive roll pin all the way into planet shaft or carrier will be damaged when planet shaft is removed.

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

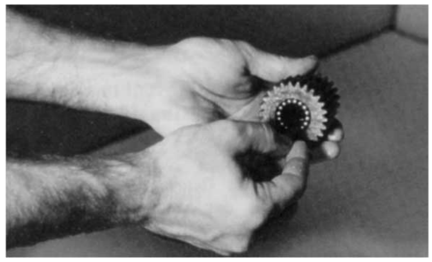
3.10.7 Assemble Carrier

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

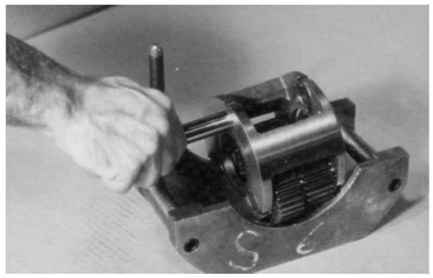


2. Place spacer (3D) inside cluster gear (3F) so it rests on top of needle rollers.

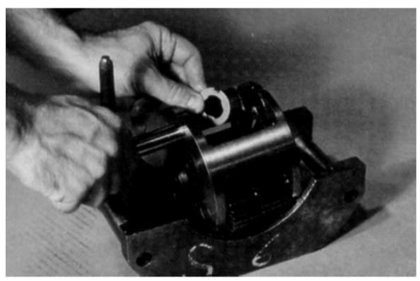
3. Line remaining half of cluster gear (3F) with 16 needle rollers (3C).



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

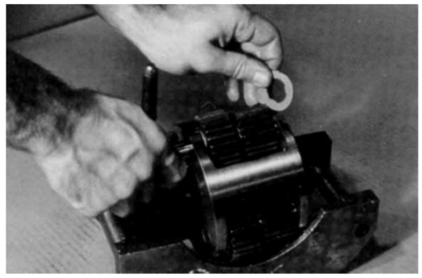


5. Place thrust washer (3B) on end of planet shaft (3E) inside carrier. Fit tang of thrust washer into slot on inside edge of planet shaft hole.

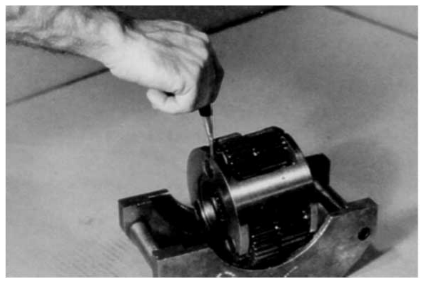


6. Following thrust washer, place cluster gear (3F), large end toward roll pin hole in carrier housing, on planet shaft (3E).

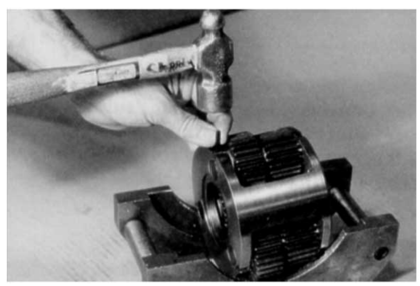
7. Following cluster gear, place one more thrust washer (3B) onto planet shaft (3E) through opposite planet shaft hole in carrier housing (3A).



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



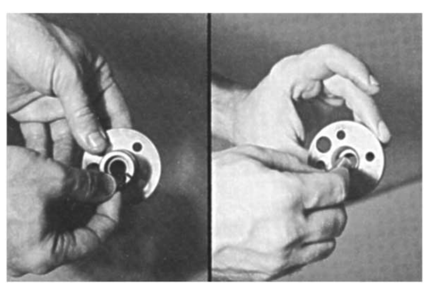
9. Drive roll pin (3G) into aligned roll pin holes in carrier housing (3A) and planet shaft (3E).



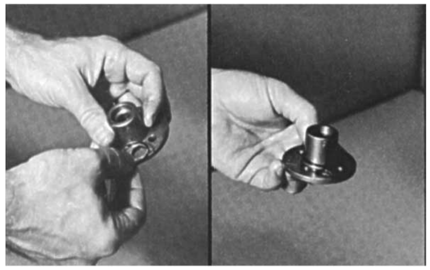
10. Repeat steps 1-9 to assemble and install two remaining cluster gears.
11. At this point carrier sub-assembly is complete.

3.10.8 Cover Sub-Assembly

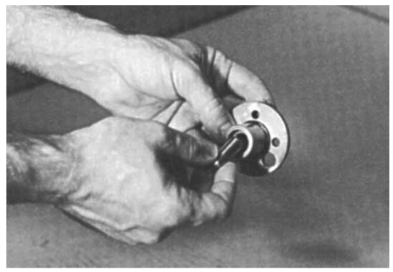
1. Using disconnect rod, push O-ring (6F) into groove inside cover cap (6B).



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



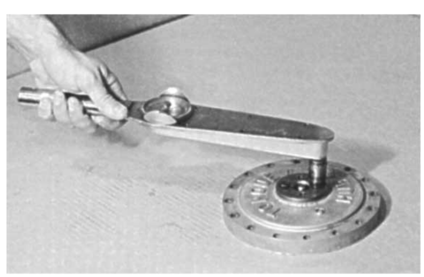
3. Insert disconnect rod (6E) into cover cap (6B).



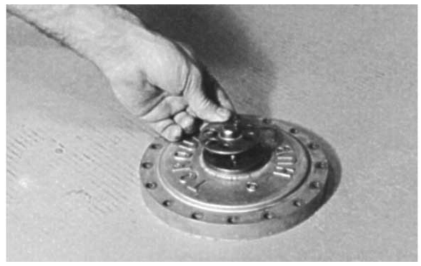
4. Set cover (6A) on table, exterior side up. Place cover cap (6B) on cover (6A). Align pipe plug hole in cover cap over pipe plug hole in cover.

5. Place two cover cap bolts (6C) in any two bolt holes 180° apart on cover cap (6B) and tighten bolts.

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

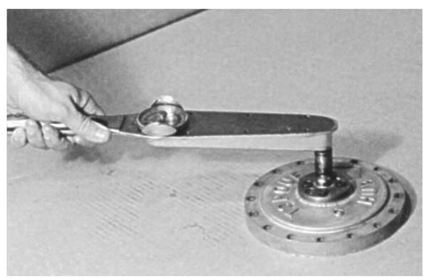


7. With large end down, place disconnect cap (6D) on cover cap (6B), aligning pipe plug hole in disconnect cap over pipe plug hole in cover cap.

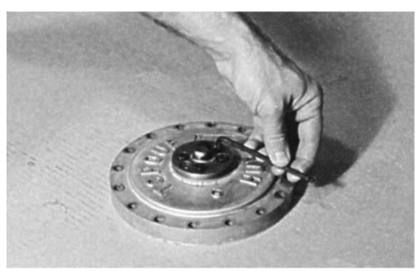


8. Place two remaining bolts (6C) in bolt holes in disconnect cap (6D) and tighten bolts.

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



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

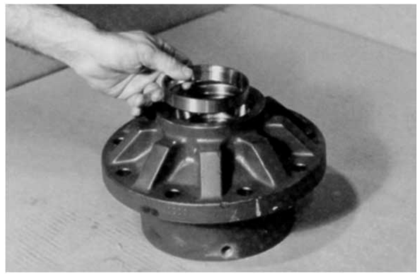


11. At this point cover sub-assembly is complete.

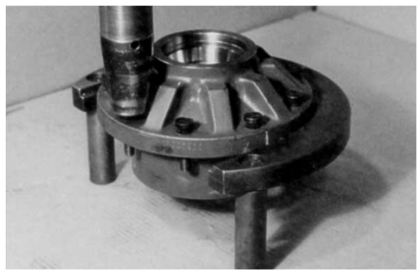
3.10.9 Hub-Spindle Sub-Assembly

Note: Make sure cup sits square with counterbore before pressing.

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

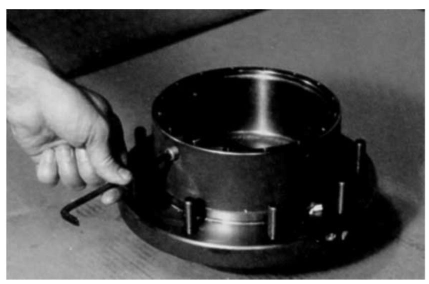


2. Press nine studs (1N) in stud holes in hub (1G).

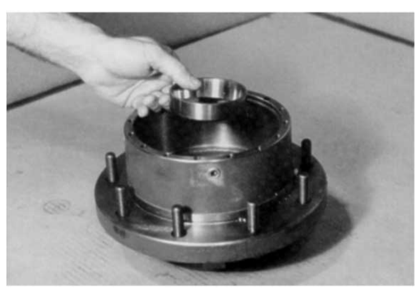


3. Apply a light coat of “Never-Seize” to two pipe plugs (1J) and tighten them in two pipe plug holes in side of hub (1G).

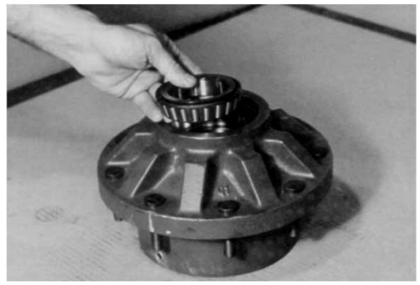
Note: Make sure cup sits square with counterbore before pressing.



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



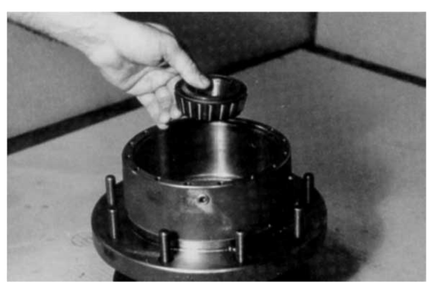
5. Set hub (1G) on large end. Place bearing cone (1D) into bearing cup (1C).



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

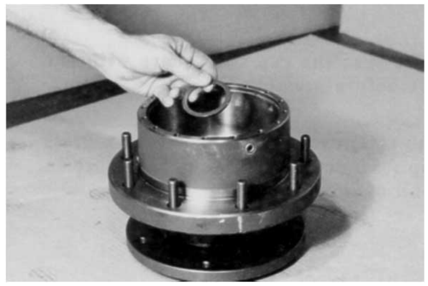
7. Oil spindle, then lower hub (1G) small end down, onto spindle (1A).

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



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

Note: Make sure retaining ring is securely seated in groove.



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

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

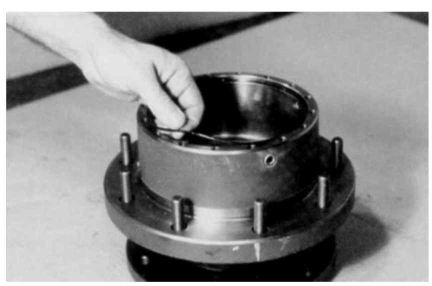
3.10.10 Main Assembly

CAUTION

Sharp edges can cut and cause serious injury. Beware of sharp edges in counterbore when removing o-ring.

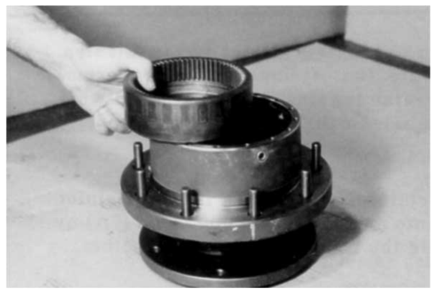
1. Grease O-ring (5) and place it into counterbore in hub (1G).

Note: O-ring may be stretched or pinched together to make it fit into counterbore.

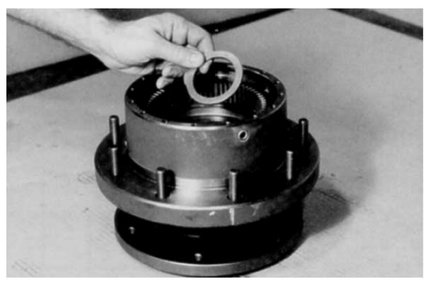


2. Oil exposed surfaces inside hub (1G).

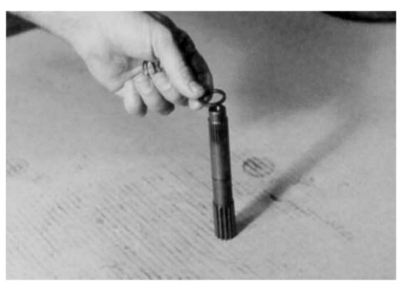
3. Place internal gear (2) in hub (1G) so its internal splines mesh with external splines of spindle (1A). Oil internal gear (2).



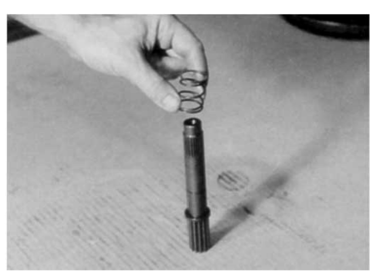
4. Place thrust washer (11) around spindle (1A) so it rests on bottom of internal gear (2).



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



6. Place spring (7C) on smooth end of input shaft (7A).

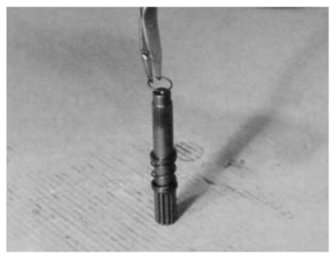


7. Place other spacer (7D) on smooth end of input shaft (7A).

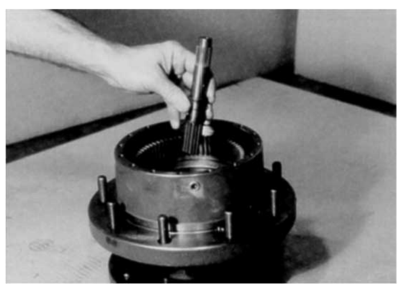
⚠ CAUTION

Uncontrolled objects can cause eye damage or serious injury. Always wear eye protection.

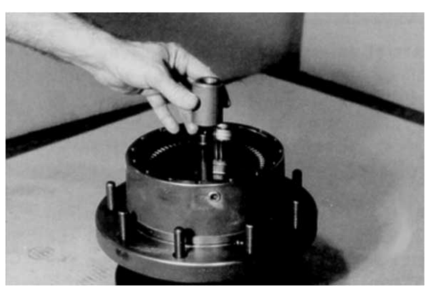
8. Using retaining ring pliers, insert retaining ring (7B) in groove on input shaft (7A) by compressing spring and spacers together.



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



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



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

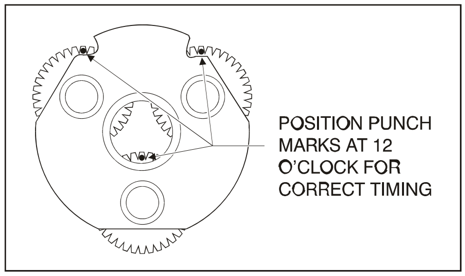
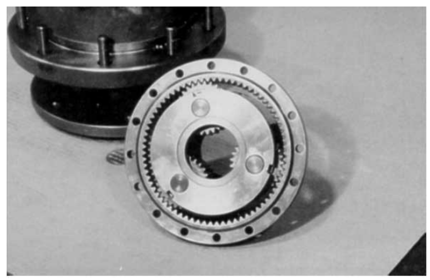


Figure 16. Cluster Gear Punch Marks

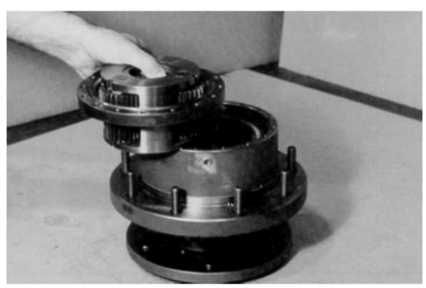
12. With “X” marked side facing up, place ring gear (4) around cluster gears (3F).

Note: This will hold punch marks in position while installing carrier into hub.

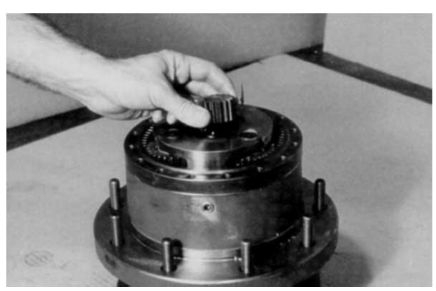


13. Place carrier sub assembly (3) and ring gear (4) together into mesh with internal gear (2), aligning “X” marked shoulder bolt hole in ring gear (4) over one of the shoulder bolt holes in hub. Mark location of shoulder bolt holes on outside of ring gear and hub.

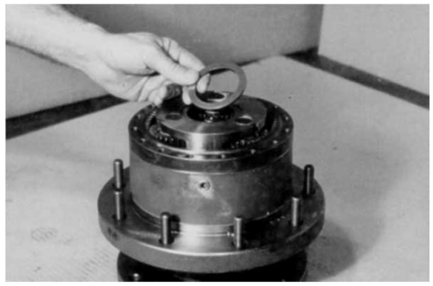
Note: You may lift ring gear off hub to align shoulder bolt holes. Ring gear and carrier are installed together only to keep punch marks on carrier in place.



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



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

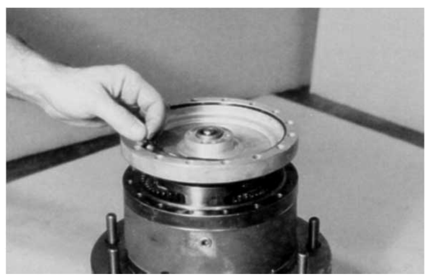


⚠ CAUTION

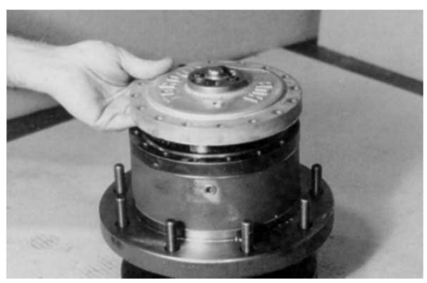
Sharp edges in counterbore can cut and cause injury when installing o-ring.

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

Note: O-ring may be stretched or pinched together to make it fit counterbore.



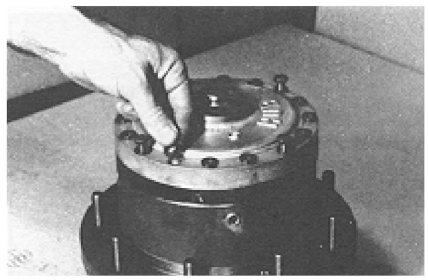
17. Place cover sub-assembly (6) on ring gear (4). Align pipe plug holes before disassembly.



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

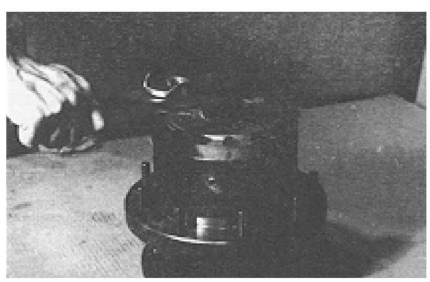
19. Place shoulder bolts (13) in four shoulder bolt holes in cover (6) and hand-tighten.

20. Place remaining 12 flat washers (16) on remaining bolt holes in cover (6).

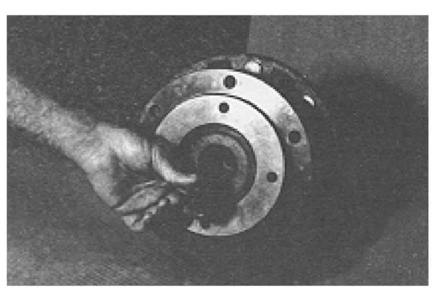


21. Place 12 bolts in remaining bolt holes in cover (6) and tighten.

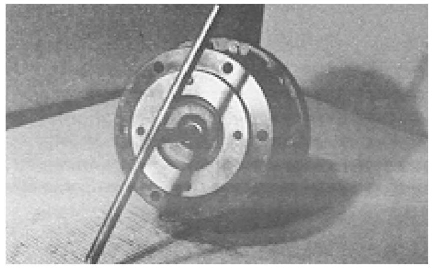
22. Torque shoulder bolts (13) 18 to 25 ft. lbs. (25 to 34 Nm). Torque bolts (12) 18 to 25 ft. lbs. (25 to 34 Nm).



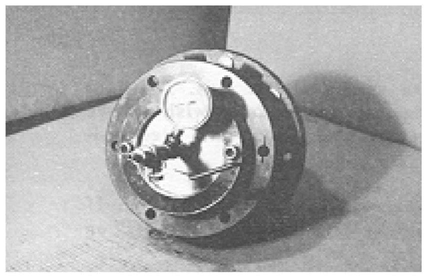
23. Turn hub (1G) on its side. Insert coupling (14) into end of spindle (1A).



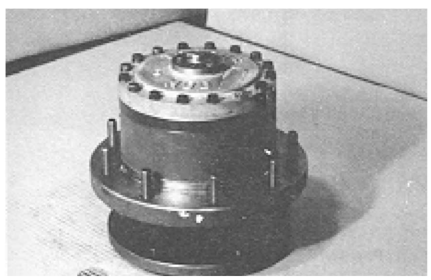
24. Roll test unit in clockwise and counterclockwise directions. Perform same number of turns in each direction as the ratio of the unit. The ratio is the last two digits of the model number on the unit's ID tag.



25. Leak test unit at a pressure of 5 psi (34.47 kPa) for 2 to 3 minutes.



26. At this point main assembly is complete.

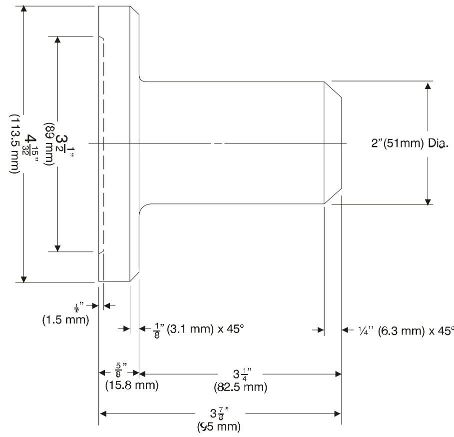


3.10.11 Tool List

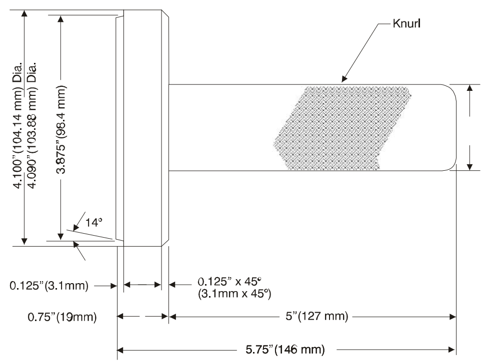
The following specialized tools are used to assemble this unit. Tool diagrams in this manual are intended for the customer who may wish to have a tool made. All tools are one piece and must be made from mild steel. All dimensions are in inches.

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

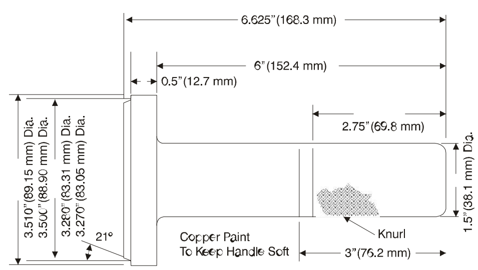
1. T-118126 SEAL PRESSING TOOL FOR SEAL (1B).



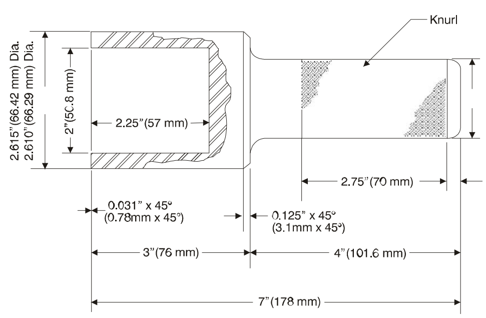
2. T-138903 ASSEMBLY PRESSING TOOL FOR CUP (1C).



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



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



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

3.11 RE-ALIGN TORQUE HUB INPUT COUPLING

This procedure applies to torque hubs with integral brakes:

3.11.1 Equipment Required

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

3.11.2 Procedure

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

3.12 DRIVE MOTOR

3.12.1 Description

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

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

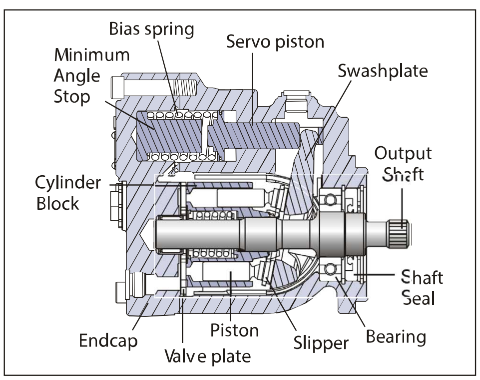


Figure 17. Drive Motor Cross Section

3.12.2 Shaft Seal Replacement

REMOVAL

1. Remove snap ring (1) and support washer (2).

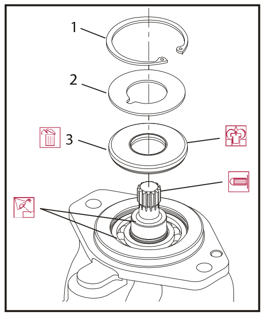


Figure 18. Removing Shaft Seal

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

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

2. Carefully pry out and discard shaft seal (3).

INSPECT COMPONENTS

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

INSTALLATION

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

3.12.3 Loop Flushing Valve

REMOVAL

1. Remove plug (1) and (2) with 11/16 in. internal hex wrench

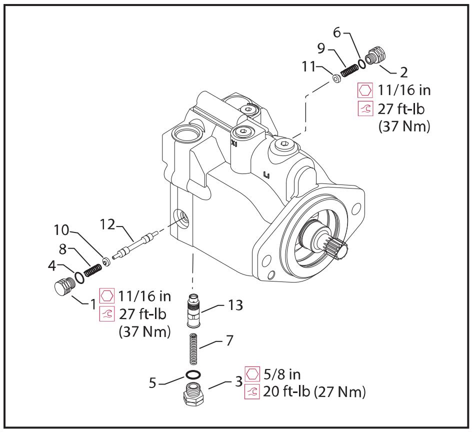


Figure 19. Loop Flushing Spool

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

2. Use 1/4 in. in hex wrench to remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Use pliers to remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).
8. Inspect new O-rings and sealing area for rust, wear, or contamination. Check springs and poppet for wear.

INSTALLATION

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

3.12.4 Troubleshooting

Table 18. Excessive Noise and/or Vibration

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

Table 19. System Operating Hot

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

Table 20. Won't Shift or Slow to Start

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

3.12.5 Disassembly

Note: Removal of endcap voids warranty.
During assembly, coat all moving parts with a film of clean hydraulic oil. This ensures parts are lubricated during start-up.
Replace all O-rings and gaskets. Lightly lubricate O-rings with clean petroleum jelly prior to assembly.

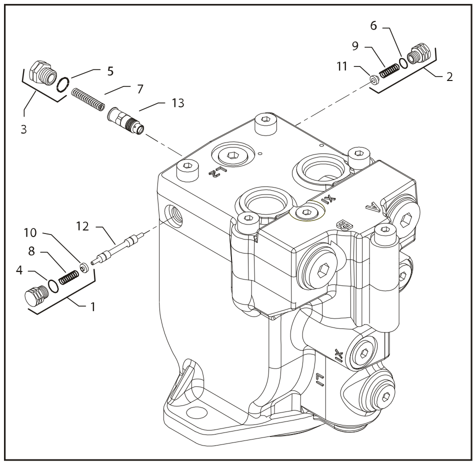


Figure 20. Loop Flushing Spool

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

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

7. Remove orifice poppet (13).

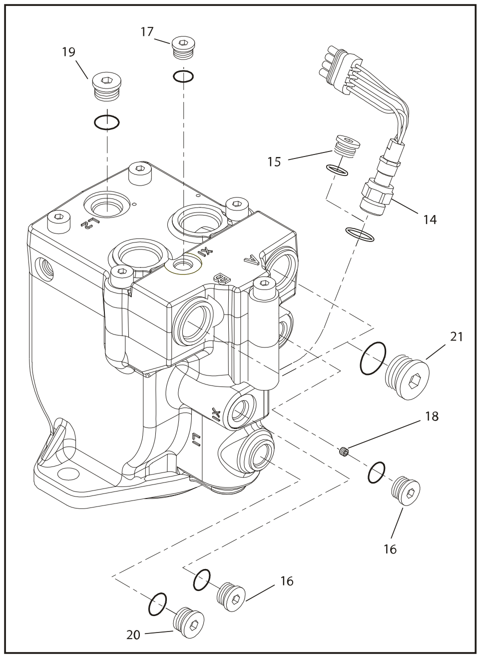


Figure 21. Plugs, Fittings, and Speed Sensor

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

8. Remove all fittings from unit. Discard O-rings.

9. Using an 11/16 in. hex wrench, loosen speed sensor lock nut (14) if equipped and remove speed sensor. Units without speed sensor have an O-ring plug (15) installed in that location; remove it with a1/4 in. internal hex wrench.

10. Using a 1/4 in. internal hex wrench, remove control line plugs (16, 17). Discard O-rings. Using a 3 mm hex wrench, remove cavity plug (18) (if equipped with two-line control), from X2 cavity.

11. Using a 5/16 in. internal hex wrench, remove drain plugs (19, 20). Discard O-rings.

12. If equipped with axial ports, use a 9/16 in. an internal hex wrench and remove work port plugs (21). Discard O-rings.

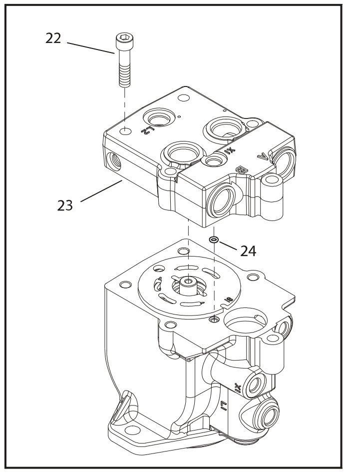


Figure 22. End Cap

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

13. Using an 8 mm internal hex wrench, remove endcap screws (22).

14. Remove endcap (23). Remove O-ring (24) from housing or endcap.

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

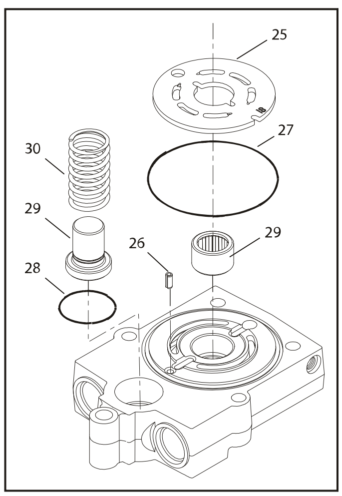


Figure 23. Valve Plate & Rear Shaft Bearing

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

NOTICE

Do not scratch valve plate surface.

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

Note: Each displacement has a unique valve plate. The last two digits of the part number are stamped on its surface.

16. Remove and discard O-rings (27, 28).

17. Remove rear shaft bearing (29) from endcap with a bearing puller.

NOTICE

Do not drive bearing past rear shaft journal. bearing may become trapped on shaft and damaged.

Note: Bearing may be difficult to remove with a puller. Try this as an alternative: Pack bearing cavity with heavy grease. After shaft is removed, insert it into bearing cavity and tap lightly with a soft mallet on the splined end. Grease will force out bearing.

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

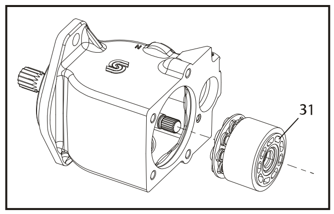


Figure 24. Cylinder Kit

31. Cylinder Kit Assembly

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

Note: Grooves on surface of cylinder kit identify its displacement:

Table 21. Displacement Identifiers

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

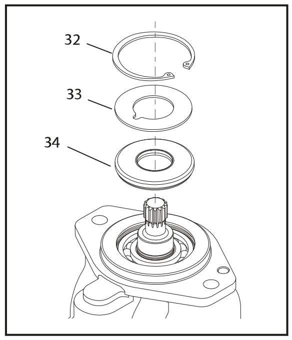


Figure 25. Shaft Seal

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

20. Turn housing over and remove snap ring (32), retaining shaft seal, and support washer. Remove support washer (33). Carefully pry out shaft seal (34). Discard seal.

Note: To avoid damaging shaft during seal removal. Install a large sheet metal screw in chuck of a slide hammer. Drive screw into seal surface. Use slide hammer to pull seal.

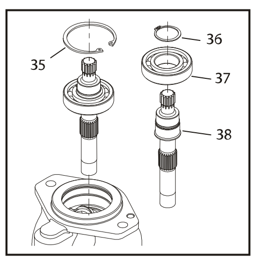


Figure 26. Shaft & Front Bearing

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

21. Remove inner snap ring (35) and shaft/bearing assembly.

22. Remove snap ring (36) retaining shaft front bearing. Pull bearing (37) off shaft (38).

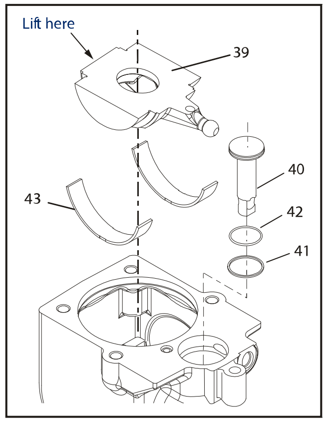


Figure 27. Swash Plate & Servo Piston

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

23. Turn housing over and remove swashplate (39) by lifting on end opposite servo lever.

24. Remove servo piston (40). Remove piston seal (41) and O-ring (42) from servo piston. Discard seal and O-ring.

25. Remove journal bearings (43) from housing. If bearings will be reused, note location and orientation of each bearing for reassembly.

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

Note: Pistons are not selectively fitted. Units with high hourly usage may develop wear patterns. Number pistons and bores for re-assembly if they will be reused.

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

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

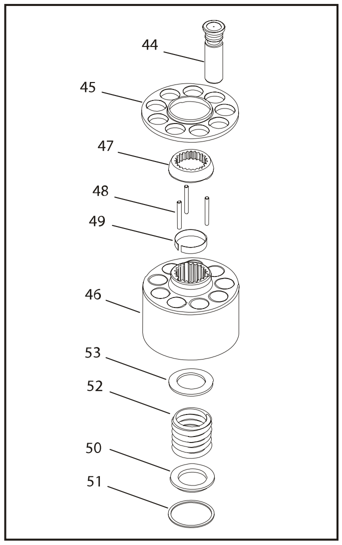


Figure 28. Cylinder Kit Disassembly

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

⚠ WARNING

Risk of personal injury: Compressing block spring requires force of about 80 to 90 lbf (350 to 400 N). Use a press sufficient to maintain this force with reasonable effort. Ensure spring is secure before attempting to remove spiral retaining ring. Release pressure slowly after retaining ring is removed.

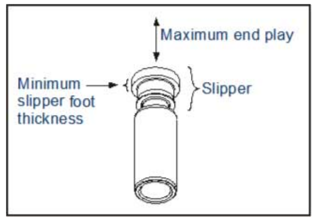
28. Turn block over. Using a press, apply pressure on block spring washer (50) to compress block spring enough to safely remove spiral retaining ring (51). Maintain pressure and unwind spiral retaining ring (51). Carefully release pressure and remove outer block spring washer (50), block spring (52),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

3.12.6 Inspection

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

PISTON

Inspect pistons for damage and discoloration. Discolored pistons may indicate excessive heat. Do not reuse.



SLIPPERS

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

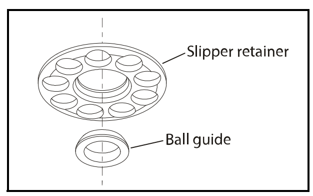
Minimum slipper foot thickness and maximum axial end-play are shown in *Table — Displacement Identifiers, page 102*.

Table 22. Slipper Foot Thickness & End Play

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

BALL GUIDE AND SLIPPER RETAINER

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

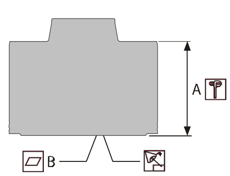


CYLINDER BLOCK

Measure cylinder block height. Replace blocks worn beyond minimum height specification. Inspect running surface of cylinder block. Replace or resurface worn or scratched blocks. Blocks may be resurfaced if resurfacing will not reduce block height below minimum specification shown in *Table — Cylinder Block Measurements, page 105*.

Table 23. Cylinder Block Measurements

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

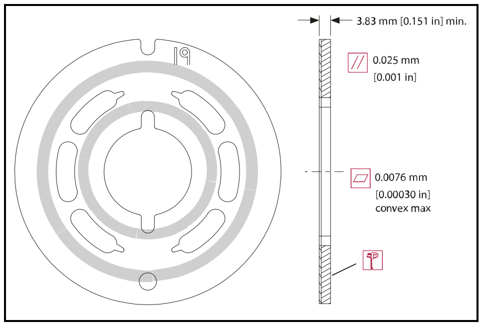


VALVE PLATE

Valve plate condition is critical to motor efficiency. Inspect valve plate surfaces for excessive wear, grooves, or scratches.

Replace or resurface grooved or scratched valve plates. Measure valve plate thickness and replace if worn beyond minimum specification.

Valve plate can be resurfaced if finished thickness is not below minimum specification shown in drawing.

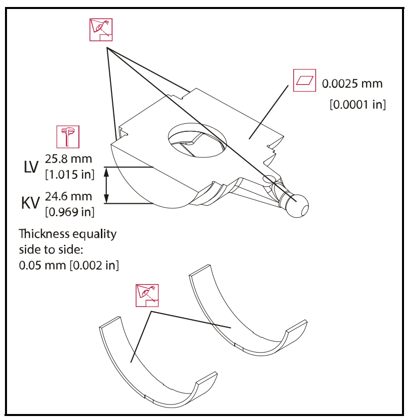


SWASHPLATE AND JOURNAL BEARINGS

Inspect running face, servo ball-joint, and swashplate journal surfaces for damage or excessive wear.

Some material transfer may appear on these surfaces and is acceptable providing surface condition meets specifications shown.

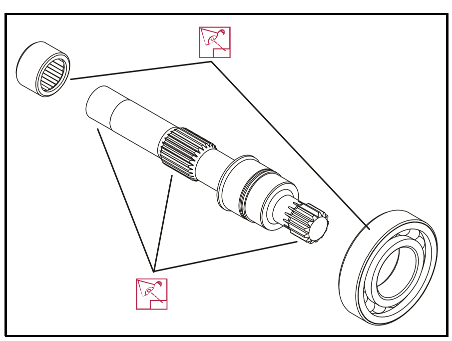
Measure swashplate thickness from journals to running face. Replace swashplate if damaged or worn beyond minimum specification.



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

SHAFT BEARINGS

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

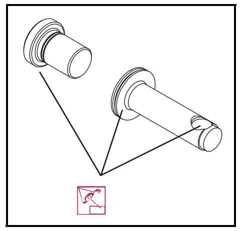


SHAFT

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

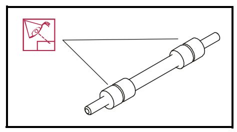
SERVO PISTON AND MINIMUM ANGLE STOP

Inspect minimum angle stop, servo piston head, and servo piston ball-socket for damage or excessive wear. Replace as needed.



LOOP FLUSHING SPOOL

Inspect loop flushing spool. Check for cracks or damage. Replace as needed.



3.12.7 Assembly

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

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

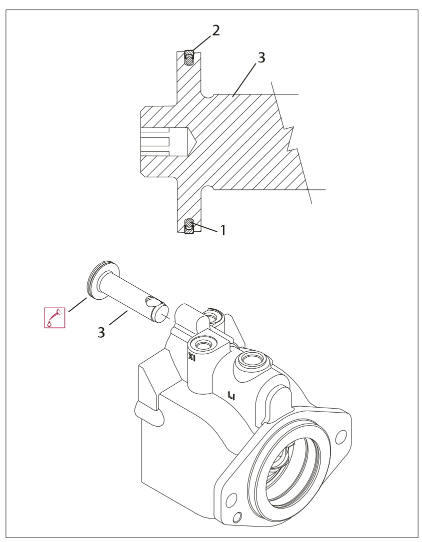


Figure 29. Servo Piston

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

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

⚠ WARNING

Compressed spring may fly out and cause serious injury. Compressing block spring requires about 80 to 90 LBF (350 to 400 N) of force. Use a press sufficient to maintain this force with reasonable effort. Ensure spring is secure before attempting to install spiral retaining ring. Release pressure slowly after retaining ring is installed.

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

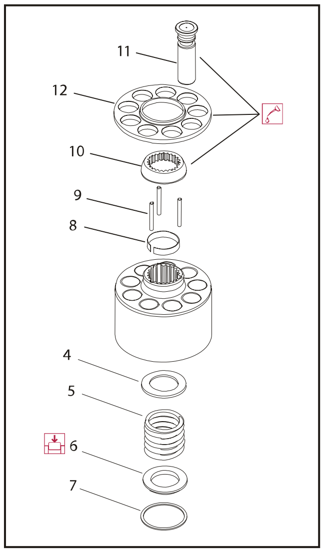


Figure 30. Cylinder Kit Assembly

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

4. Turn block over and install retaining ring (8), hold-down pins (9), and ball guide (10) to cylinder block.

NOTICE

If reusing pistons, install them in original block bores.

5. Install pistons (11) to slipper retainer (12). Install piston/retainer assembly in cylinder block. Ensure concave surface of retainer seats on the ball guide. Lubricate pistons, slippers, retainer, and ball guide before assembly. Set cylinder kit aside on a clean surface until needed.

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

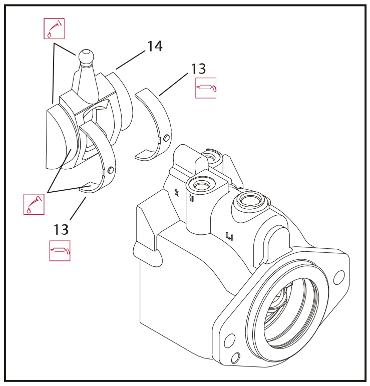


Figure 31. Swash Plate and Journal Bearing

13. Journal Bearings
14. Swash Plate

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

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

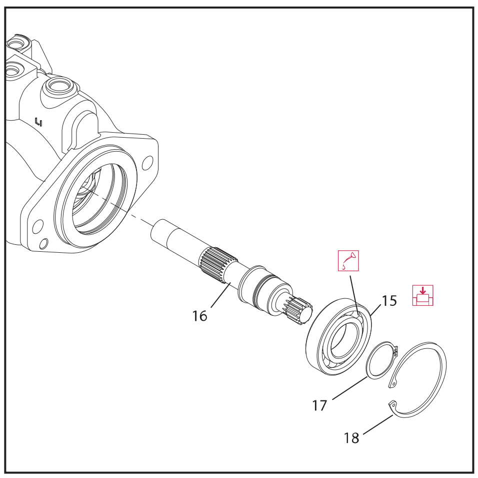


Figure 32. Shaft and Front Bearing

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

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

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

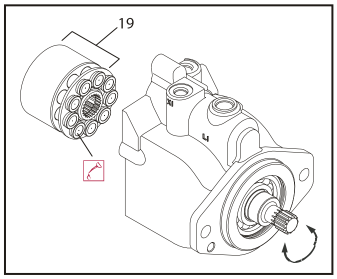


Figure 33. Cylinder Kit Installation

19. Cylinder Kit

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

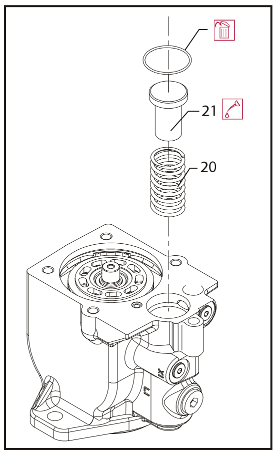


Figure 34. Servo Spring and Minimum Angle Stop

20. Servo Spring
21. Minimum Angle Stop

12. Press rear shaft bearing (22) into endcap. Install bearing with letters facing out. Press until bearing surface is 08 ±0.01 in (2 ±0.25 mm) above endcap surface.

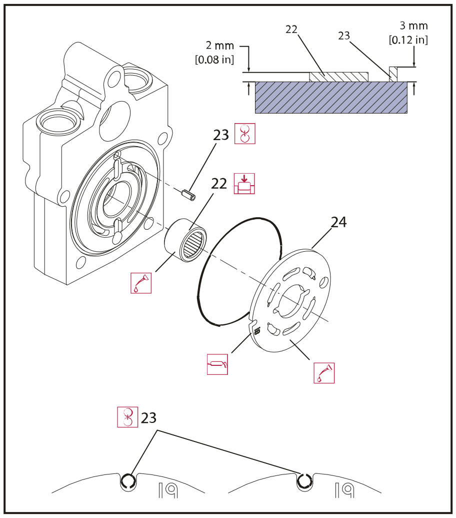


Figure 35. Valve Plate and Rear Bearing

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

13. Install timing pin (23) into bore in endcap. Install pin with groove facing toward or away from shaft. Press pin until end protrudes 0.12 ±0.01 in (3 ±0.25 mm) above endcap surface.

14. Install valve plate (24) on endcap. Install valve plate with yellow surface toward cylinder block. Align slot in valve plate with timing pin. Apply a liberal coat of assembly grease to endcap side of valve plate to keep it in place during installation.

15. Install endcap (25) on housing with endcap screws (26). Check endcap properly seats on housing without interference.

NOTICE

Improper assembly of internal components may prevent endcap from seating properly. Ensure O-rings seat properly when installing endcap.

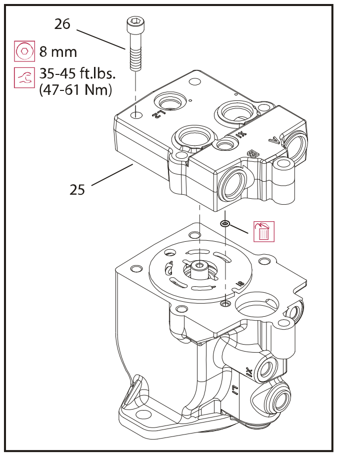


Figure 36. End Cap

25. End Cap
26. Screw

16. Using an 8 mm internal hex wrench, tighten endcap screws. Tighten screws in opposite corners slowly and evenly to compress servo spring and properly seat endcap. Torque endcap screws 35 to 45 ft. lbs. (47-61 Nm).

17. Before installing shaft seal, ensure shaft turns smoothly with less than 120 in. lbs. (13.5 Nm) of force. If shaft does not turn smoothly within specified force, disassemble and check unit.

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

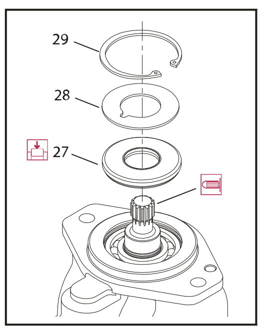


Figure 37. Shaft Seal

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

19. Install remaining plugs and fittings to housing. Refer to drawing below for wrench sizes and torque settings.

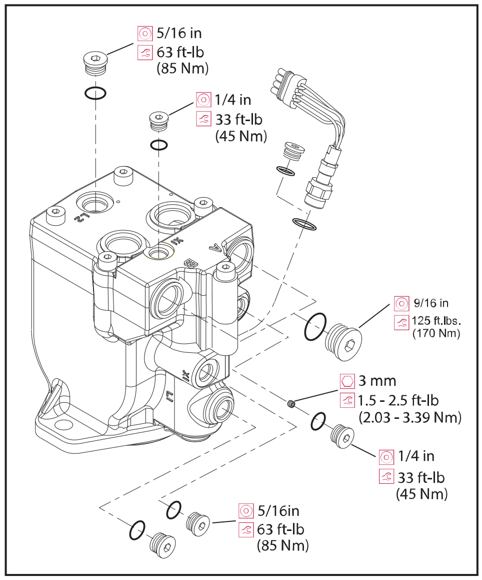


Figure 38. Plugs and Fittings Installation

20. Install orifice poppet (30).
21. Install shift spool (31).
22. Install spring retaining washers on springs (32 and 33).
23. Carefully install centering springs (34, 35, and 36).
24. Install new O-rings (37, 38, and 39).
25. Using a 5/8 in. wrench, torque plug (40) to 20 ft. lbs. (27 Nm).

26. Using a 11/16 in. wrench, torque plugs (41 and 42) to 27 ft. lbs. (37 Nm).

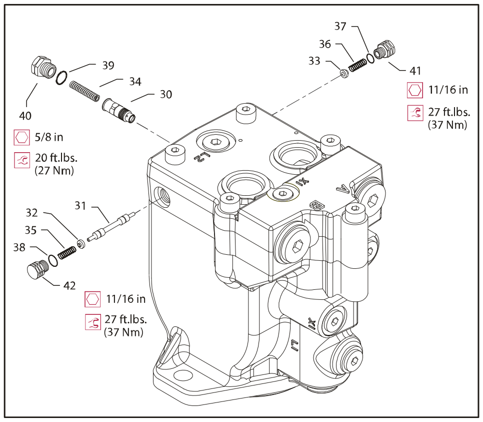


Figure 39. Loop Flushing Spool

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

3.12.8 Initial Start-Up Procedures

Follow this procedure when starting up a new motor or after reinstalling a motor.

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

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

3.13 DRIVE BRAKE

Refer to *Figure — Drive Brake, page 116*.

3.13.1 Disassembly

1. Supporting the brake on Face A, remove the socket head capscrews and washers (13 & 14) in equal increments to ensure the spring pressure within the break is reduced gradually and evenly. If a press is available, the cylinder housing (8) can be secured on Face B while removing the capscrews and washers (13 & 14).
2. Remove the cylinder housing (8) and piston (9) subassembly and disassemble if necessary, removing O-ring seals (15 & 17) and backing rings (16 & 18) as necessary.
3. Remove the gasket (7) from the housing.
4. Remove the friction plates (3&6) and pressure plate (4).
5. Remove the dowel pins (19).
6. Remove the springs (22 & 23). Note the color and arrangement of the springs so they can be assembled in the same order.
7. If it's necessary to replace the ball bearing (10) or shaft seal (12), and reverse the brake position so it is supported on Face C of the housing (2).
8. Remove the internal retaining ring (11).
9. Using a press or similar device, remove the brake shaft (1) from the housing (2) and lay it aside.
10. Reverse the position of the housing (2) and press out the ball bearing (10). if necessary, the shaft seal (12) can be removed.

3.13.2 Inspection

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

3.13.3 Assembly

1. Lightly lubricate the rotary shaft seal (12) and assemble it to the housing (2) taking care not to damage the seal lip.
2. Apply a ring of Medium Strength Threadlocking Compound or equivalent adhesive to the outside diameter of bearing (10) and assemble fully in the housing (2). Secure the bearing in place with the retaining ring (11). Remove any excess adhesive with a clean cloth. Press the shaft (1) through the bearing (10), ensuring the bearing inner ring is adequately supported.
3. Assemble the springs into position as recorded during Disassembly.
4. Lubricate the)-rings (15 & 17) with Molykote 55M or equivalent silicone grease and assemble them, with the backing rings (16 & 18) to the piston (9). To ensure correct brake operation, it is important that the backing rings are assembled opposite to the pressurized side of the piston (9).
5. Correctly orient the piston aligning spaces with the two dowel pin holes and install into the cylinder housing (8) taking care not to damage the seals. Carefully lay these parts aside.
6. Install the dowel pins (19) in the housing (2) followed by the pressure plate (4) and friction plates. For example, in inner plate (3) followed by an outer plate (6) in the correct sequence.
7. Position the gasket (7) in the correct location.

8. Align the two holes in the cylinder with the dowel pins (19) and assemble the piston and cylinder subassembly to the remainder of the brake. Secure in place with the capscrews and washers (13 & 14). Torque to 55 ft. lbs. (75 Nm).

Note: The use of a suitable press on cylinder end Face B will ease installation of the capscrews (13).

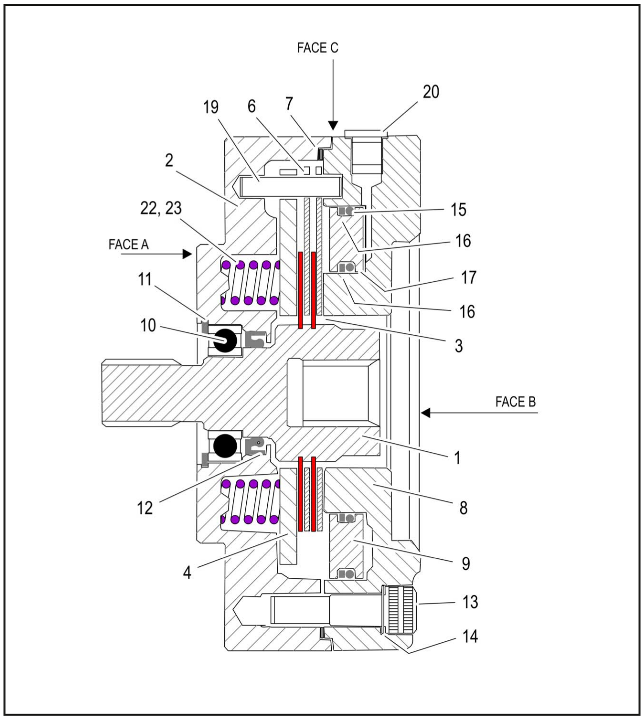


Figure 40. Drive Brake

1. Brake Shaft	9. Piston	17. O-ring
2. Housing	10. Ball Bearing	18. Backing Ring
3. Inner Friction Plate	11. Retaining Ring	19. Dowel Pin
4. Pressure Plate	12. Rotary Shaft Seal	20. Plug
5. Gasket (Not Shown)	13. Socket Head Capscrew	21. Not Used
6. Outer Plate	14. Washer	22. Spring
7. Gasket	15. O-ring	23. Spring
8. Cylinder	16. Backing Ring	

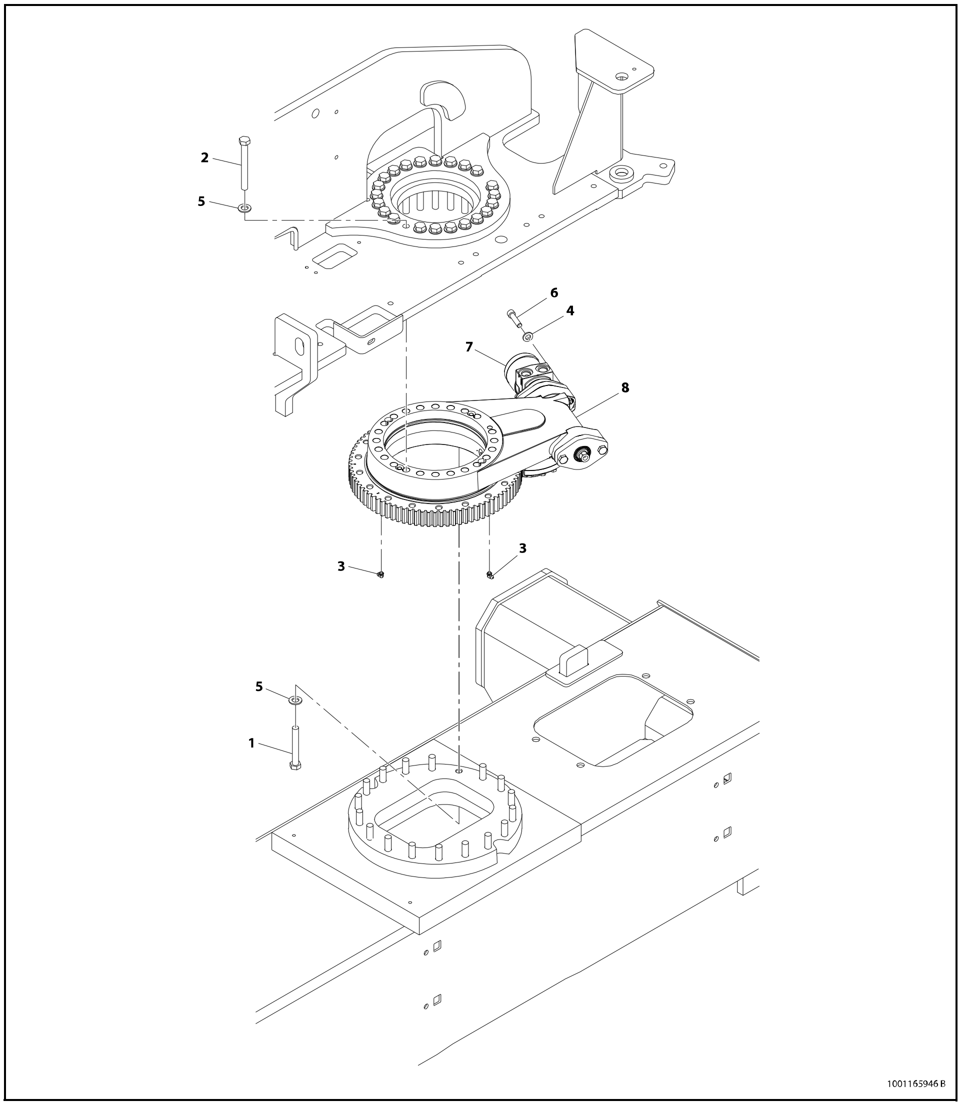


Figure 41. Swing System — US

1. Bolt	4. Washer	7. Swing Motor
2. Bolt	5. Washer	8. Turntable Bearing
3. Grease Fitting	6. Capscrew	

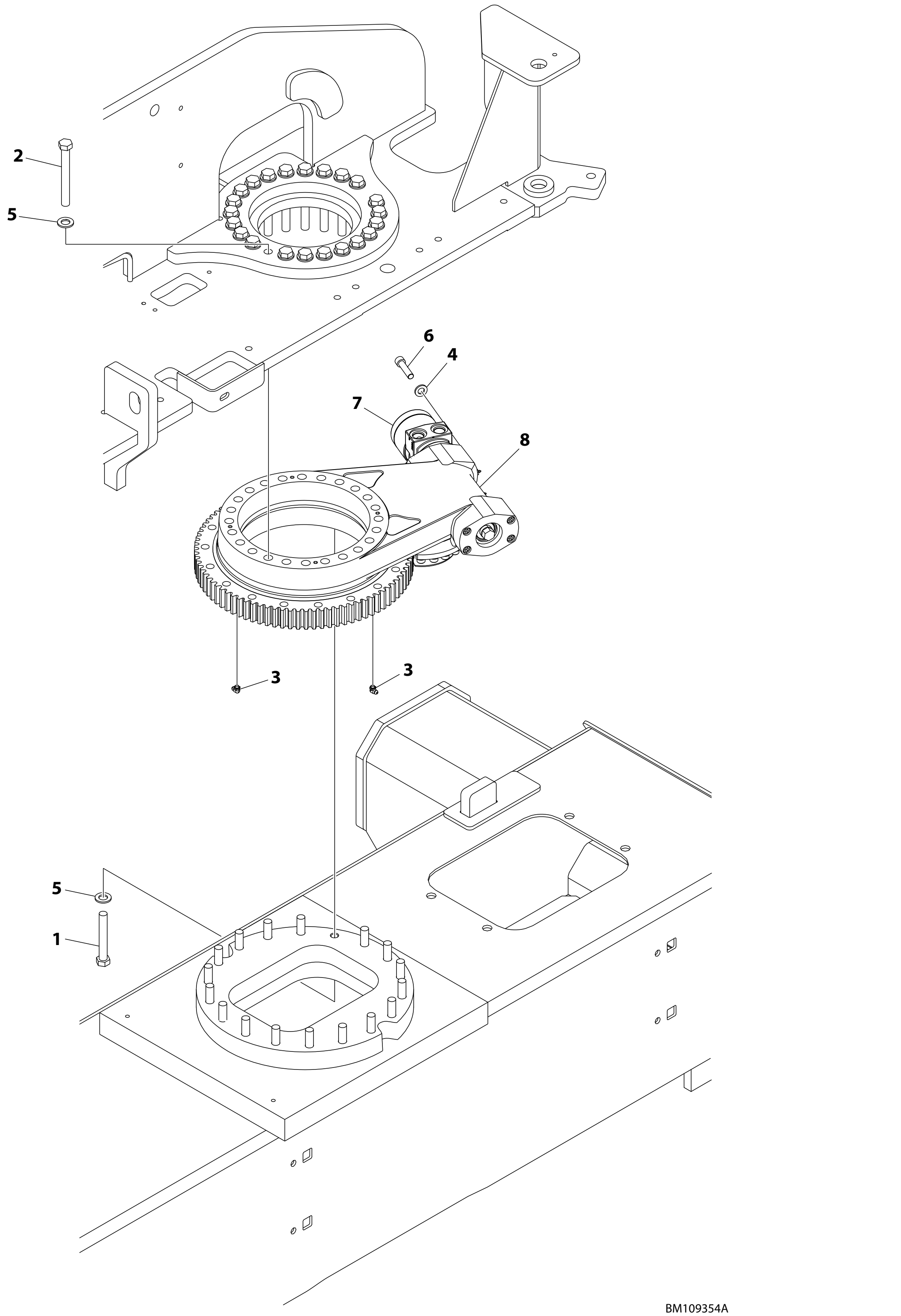


Figure 42. Swing System — TJN

1. Bolt	4. Washer	7. Swing Motor
2. Bolt	5. Washer	8. Turntable Bearing
3. Grease Fitting	6. Capscrew	

3.14 SWING BEARING

3.14.1 Removal

1. Attach an adequate support sling to the boom and draw all slack from sling. Prop or block the boom if feasible.
2. Tag and disconnect hydraulic lines running through center of turntable and frame. Use a suitable container to retain any residual hydraulic fluid. Cap lines and ports.
3. Remove the grease fittings attached to the frame and outer race of the swing bearing.
4. Attach suitable overhead lifting equipment to the base of turntable weldment.
5. Use a suitable tool to scribe a line on the inner race of the swing bearing and on the underside of the turntable. This will aid in aligning the bearing upon installation. Remove bolts, nuts and washers which attach the turntable to the bearing inner race. Discard nuts and bolts.
6. 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.
7. Carefully place the turntable on a suitably supported trestle. 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.
8. Remove the bolts and washers which attach the outer race of the bearing to the frame. Discard the bolts. Use suitable lifting equipment to remove the bearing and rotation box assembly from the frame; move to a clean, suitably supported work area.

3.14.2 Installation

1. Using an adequate lifting device, place the bearing assembly onto the frame. Align the 1/8 NPT holes in the bearing with the notches in the frame and install the grease fittings as shown in *Figure — Swing System, page 118*.
2. Coat the bearing bolts with High Strength Threadlocking Compound and secure the bearing assembly to the frame with the bolts. Following the torque sequence diagram in *Figure — Swing Bearing Torque Sequence, page 121*, tighten the bolts to torque of 206.5 ft. lbs. (280 Nm).
3. If any hydraulic hoses were disconnected to remove the swing bearing assembly, reconnect them as tagged during removal.

Note: The turntable assembly weighs approximately 7000 lb (3175 kg).

4. Using an adequate lifting device, lift the turntable assembly from the blocking it is resting on and lower it down onto the swing bearing assembly. Refer to the removal instructions for chain placement.
5. Install several bearing bolts snuggly to secure the turntable’s position on the swing bearing assembly, but do not torque them at this time and keep the lifting device in place to support the weight of the turntable.
6. Coat the bearing bolts with High Strength Threadlocking Compound and install the remaining bolts securing the turntable to the swing bearing. Tighten the bolts snugly but do not torque them at this time. Remove the bolts installed to secure the turntable’s position and apply threadlocker to them. Reinstall them in the same manner as the other bolts.
7. Following the torque sequence diagram in *Figure — Swing Bearing Torque Sequence, page 121*, tighten the bolts to torque of 206.5 ft. lbs. (280 Nm).
8. Remove the lifting equipment.
9. Route hydraulic lines through center of turntable and frame and connect as tagged prior to removal.
10. Using all applicable safety precautions, activate the hydraulic system and functionally check swing system for proper and safe operation.

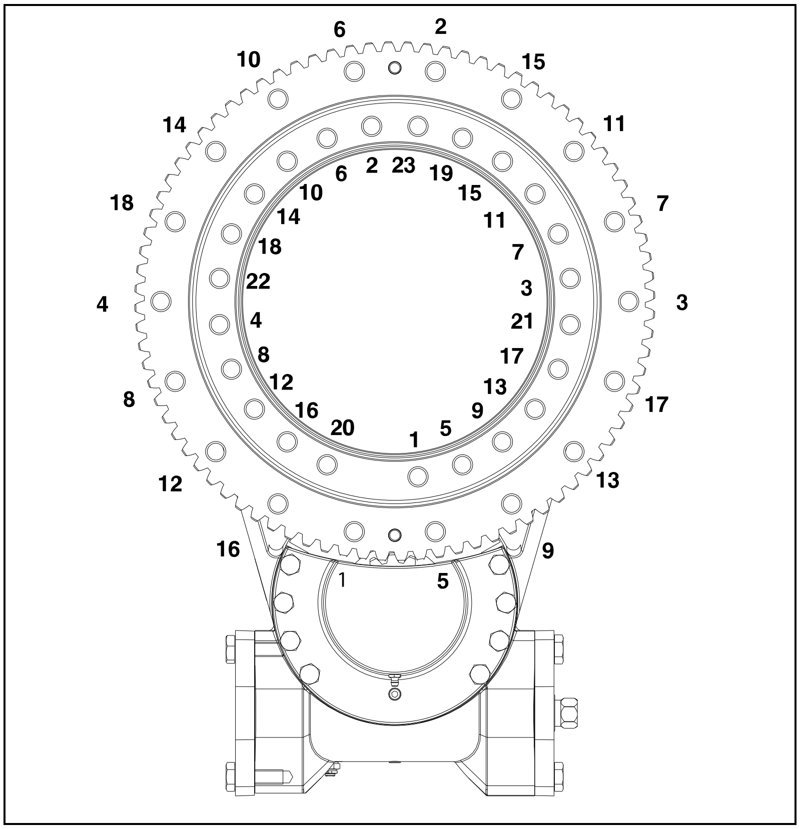


Figure 43. Swing Bearing Torque Sequence — US

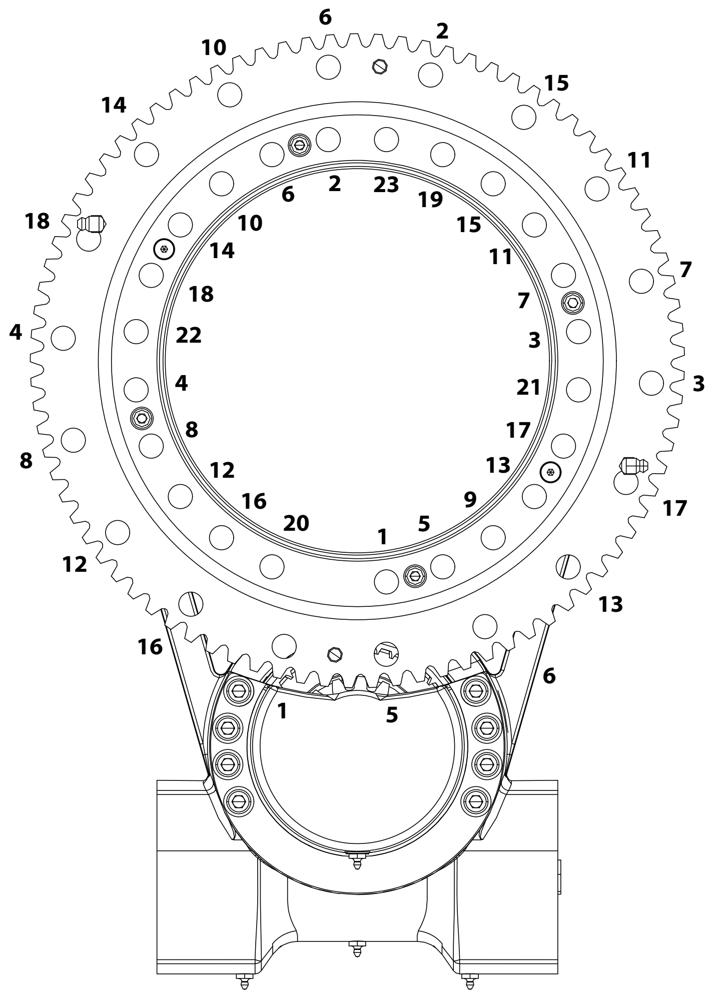


Figure 44. Swing Bearing Torque Sequence — TJN

3.14.3 Turntable Bearing Mounting Bolt Condition Check

Note: This check must be performed after 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 High Strength Threadlocking Compound. After replacing and retorquing the bolt recheck all existing bolts for looseness.

1. Check the bolts attaching the swing bearing to the frame as follows, Refer to *Figure — Swing Bearing Attaching Bolt Configuration, page 122*.

Note: These bolts engage the swing bearing from underneath.

   a. Position boom as Boom Fully Raised and Retracted. Refer to *Figure — Swing Bearing Tolerance Measurement Location and Boom Placement, page 125*, Position 2.

   b. Check the quadrant of bolts that are toward the turntable counterweight by inserting a 0.0015 in. (0.0381 mm) feeler gauge between the bolts and hardened washers. Refer to *Figure — Frame Side Bearing Bolt Feeler Gauge Check, page 122*.

   c. Ensure that the feeler gauge will not penetrate under the bolt head to the bolt shank.

   d. Rotate the turntable 90 degrees, and check the next quadrant of bolts.

   e. Continue rotating the turntable at 90 degree intervals until all bolts have been checked.

2. Check the bolts attaching the swing bearing to the turntable as follows, Refer to *Figure — Swing Bearing Attaching Bolt Configuration, page 122*.
   a. Position boom as Boom Fully Raised and Retracted. Refer to *Figure — Swing Bearing Tolerance Measurement Location and Boom Placement, page 125*, Position 2.
   b. Check the semi-circle of bolts that are toward the turntable counterweight by inserting a 0.0015 in. (0.0381 mm) feeler gauge between the bolts and hardened washers. Refer to *Figure — Turntable Side Bearing Bolt Feeler Gauge Check, page 123*.
   c. Ensure that the feeler gauge will not penetrate under the bolt head to the bolt shank.
   d. Reposition boom as shown in *Figure —Swing Bearing Tolerance Measurement Location and Boom Placement, page 125*, Position 1.
   e. Check the remaining semi-circle of bolts.

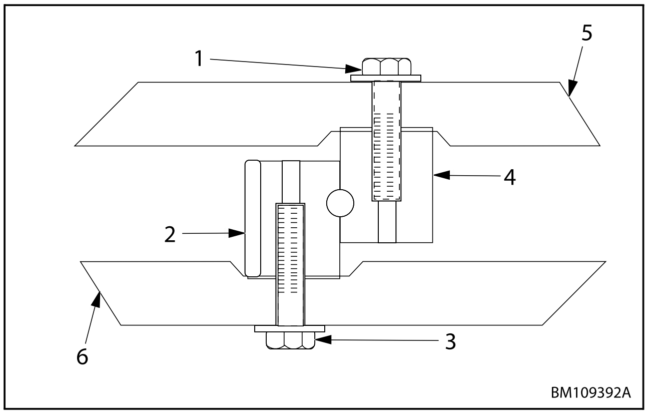


Figure 45. Swing Bearing Attaching Bolt Configuration

1. Turntable Side Bearing Bolt	4. Turntable Bearing Inner Race
2. Turntable Bearing Outer Race	5. Turntable
3. Frame Side Bearing Bolt	6. Frame

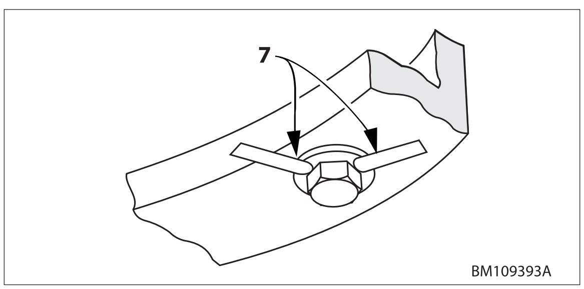


Figure 46. Frame Side Bearing Bolt Feeler Gauge Check

7. Feeler Gauge, 0.0015 In. (0.0381 mm)

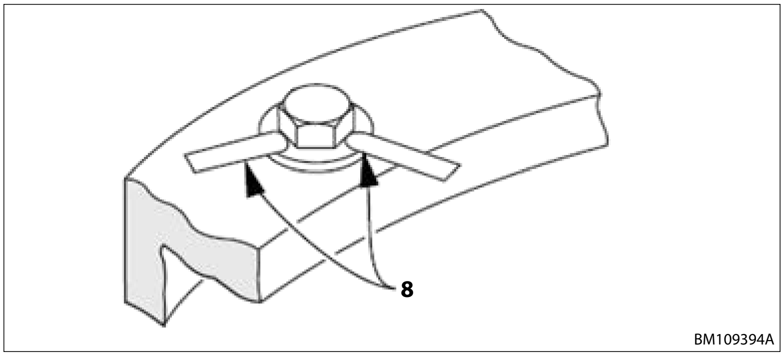


Figure 47. Turntable Side Bearing Bolt Feeler Gauge Check

8. Feeler Gauge, 0.0015 In. (0.0381 mm)

3.14.4 Wear Tolerance

NOTICE

The swing bearing is one of the most critical points on a mobile elevating work platform. It is here that the stresses of lifting are concentrated, at the center of rotation. Because of this, proper maintenance of the swing bearing is a must for safe operation.

1. Position machine as shown in *Figure — Swing Bearing Tolerance Measurement Location and Boom Placement, page 125*, Position 1.
2. Set up a dial indicator as follows:
   a. Dial indicator is to be located next to the swing bearing, in-line with the boom's centerline, opposite the turntable counterweight. Refer to *Figure — Dial Indicator Setup, page 124* and *Figure — Dial Indicator Pointer Location, page 124*.
   b. Position the magnetic base of the dial indicator on the frame.
   c. Position the indicator point to touch the underside of the turntable base plate 2.5 in. (64 mm) from root of gear tooth.
3. Zero the dial indicator.
4. Check dial indicator accuracy using a feeler gauge. Ensure dial indicator reading is same as thickness of feeler gauge.
5. Do not swing the turntable. Reposition boom as shown in *Figure —Swing Bearing Tolerance Measurement Location and Boom Placement, page 125*, Position 2
6. Verify that the dial indicator has not shifted, & then record the indicator value for bearing play.
7. Return the boom to Position 1. The dial indicator should return to zero. If dial indicator does not return to zero, take corrective action and repeat the test.
8. If the measurement is more than 0.079 in. (2.0 mm), replace the bearing. If the measurement is less, and any of the following conditions exist, the bearing should be removed, disassembled, and inspected:
   a. Metal particles in the grease.
   b. Increased drive power required.
   c. Noise.
   d. Rough rotation
9. If bearing inspection shows no defects, reassemble and return to service.

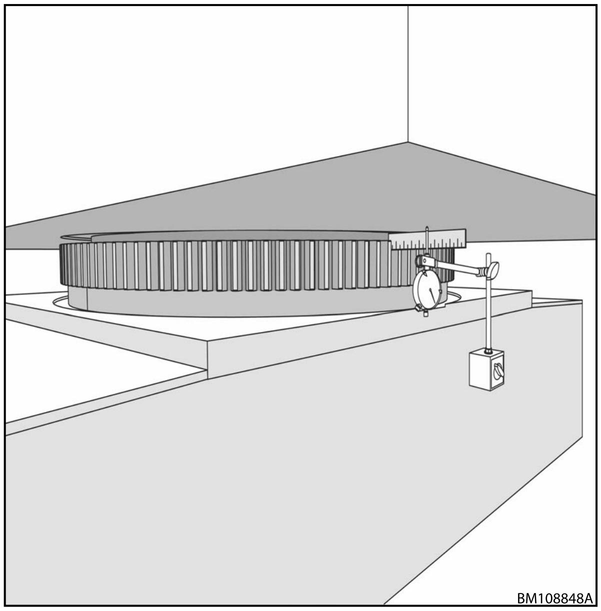


Figure 48. Dial Indicator Setup

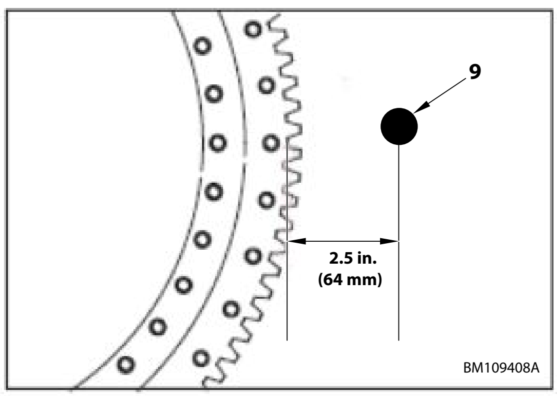


Figure 49. Dial Indicator Pointer Location

9. Dial Indicator Point

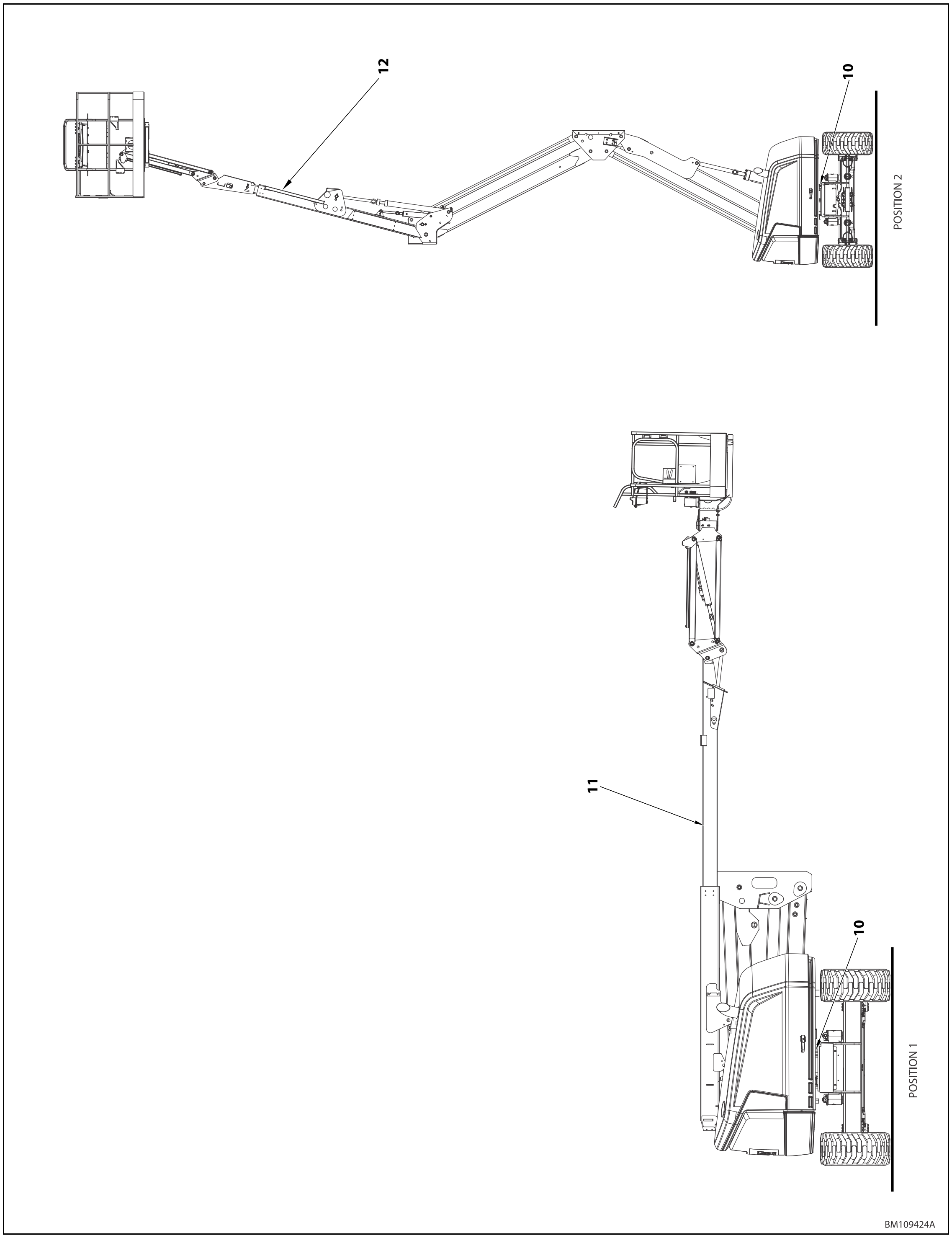


Figure 50. Swing Bearing Tolerance Measurement Location and Boom Placement

10. Dial Indicator Measuring Point	12. Boom Fully Raised and Retracted
11. Boom Horizontal and Fully Extended	

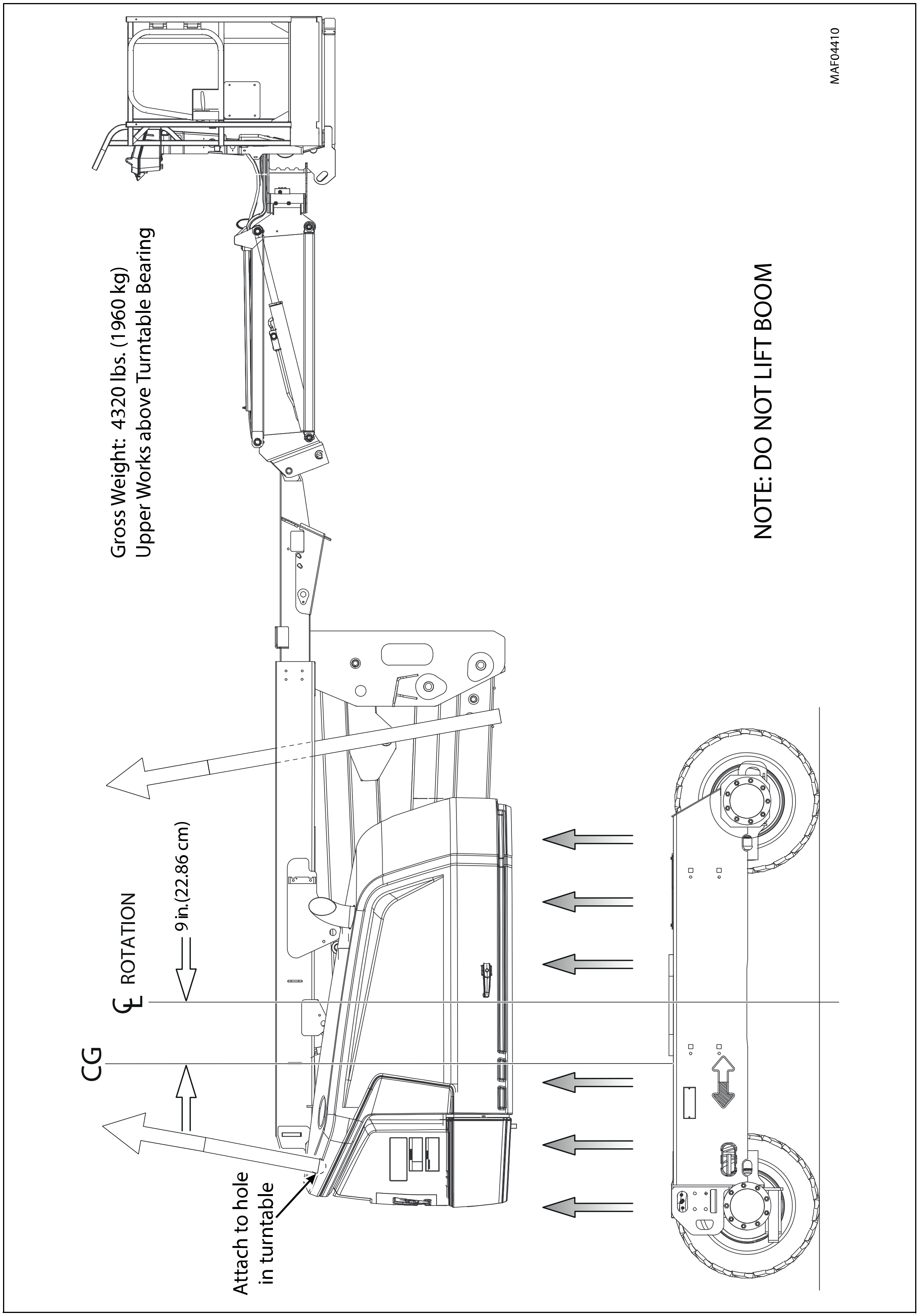


Figure 51. Swing Bearing Removal

3.15 SWING MOTOR

⚠ CAUTION

If the hydraulic system fluid becomes overheated (in excess of 200°F (93.3°C)), seals in the system can shrink, harden or crack, thus losing their sealing ability.

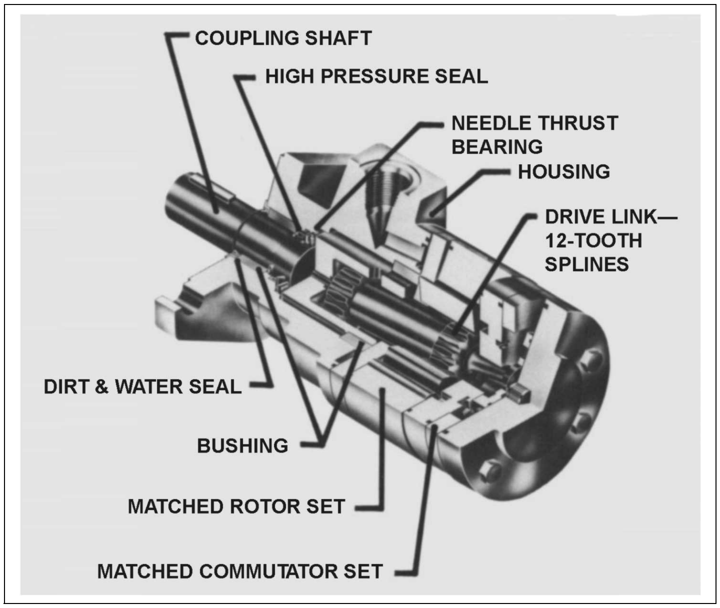


Figure 52. Swing Motor - Cutaway

Table 24. Swing Motor Troubleshooting

Trouble	Cause	Remedy
Oil Leakage	1. Hose fittings loose, worn or damaged.	Check & replace damaged fittings or "O" Rings. Torque to manufacturers specifications.
	2. Oil seal rings (4) deteriorated by excess heat.	Replace oil seal rings by disassembling unit.
	3. Special bolt (1, 1 A, 1B or 1C) loose or its sealing area	(a) Loosen then tighten single bolt to torque specification.
	deteriorated by corrosion.	(b) Replace bolt.
	4. Internal shaft seal (16) worn or damaged.	Replace seal. Disassembly of motor unit necessary.
	5. Worn coupling shaft (12) and internal seal (16).	Replace coupling shaft and seal by disassembling unit.
Significant loss of speed under load	1. Lack of sufficient oil supply	(a) Check for faulty relief valve and adjust or replace as required.
		(b) Check for and repair worn pump.
		(c) Check for and use correct oil for temperature of operation.
	2. High internal motor leakage	Replace worn rotor set by disassembling unit.
	3. Severely worn or damaged internal splines.	Replace rotor set, drive link and coupling shaft by disassembling unit.

Table 24. Swing Motor Troubleshooting (continued)

Trouble	Cause	Remedy
	4. Excessive heat.	Locate excessive heat source (usually a restriction) in the system and correct the condition.
Low mechanical efficiency or undue high	1. Line blockage	Locate blockage source and repair or replace.
pressure required to operate unit	2. Internal interference	Disassemble unit, identify and remedy cause and repair, replacing parts as necessary.
	3. Lack of pumping pressure	Check for and repair worn pump.
	4. Excessive binding or loading in system external to motor unit.	Locate source and eliminate cause.

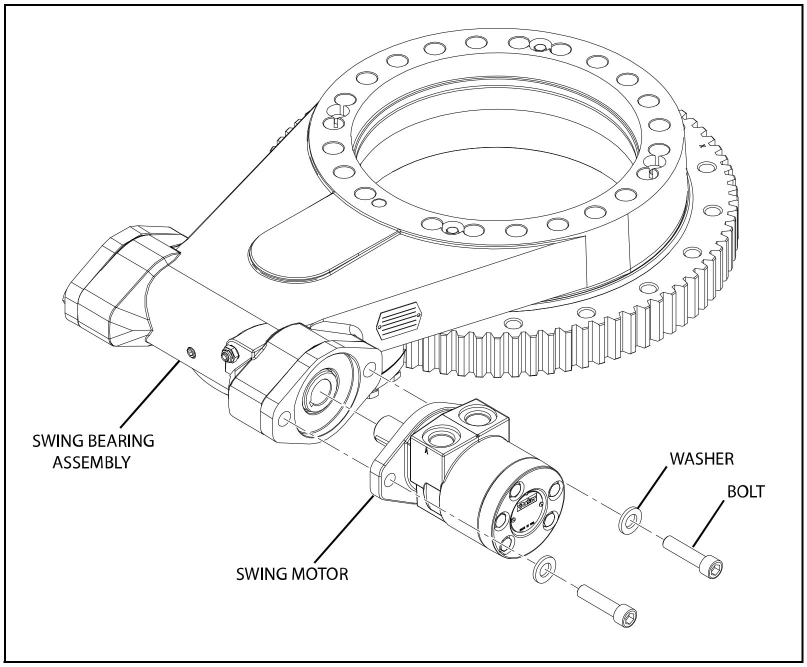


Figure 53. Swing Motor Removal and Installation — US

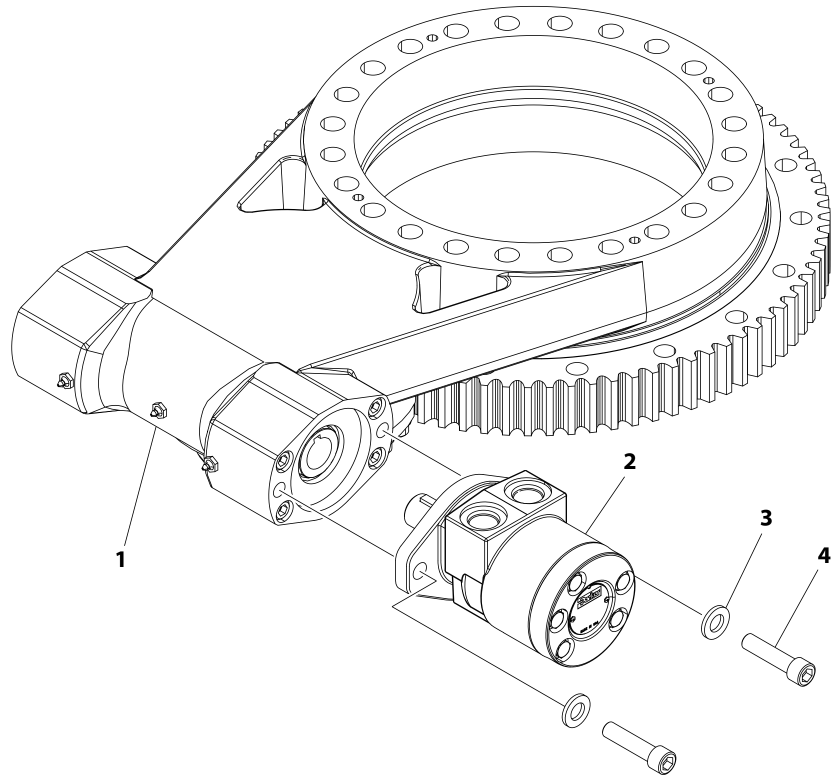


Figure 54. Swing Motor Removal and Installation — TJN

1. Swing Bearing Assembly	3. Washer
2. Swing Motor	4. Bolt

3.15.1 Removal

Refer to *Figure — Swing Motor Removal and Installation, page 129*.

1. Thoroughly clean the area around the swing motor to prevent any dirt from entering the system.
2. Tag and disconnect the hydraulic lines running to the swing motor. Cap or plug all openings.
3. Secure the worm gear shaft so it does not pull out any when removing the swing motor. Failure to do so could damage the worm gear seals.
4. Remove the bolts securing the swing motor to the swing drive assembly.
5. Carefully pull the swing motor from the swing drive.

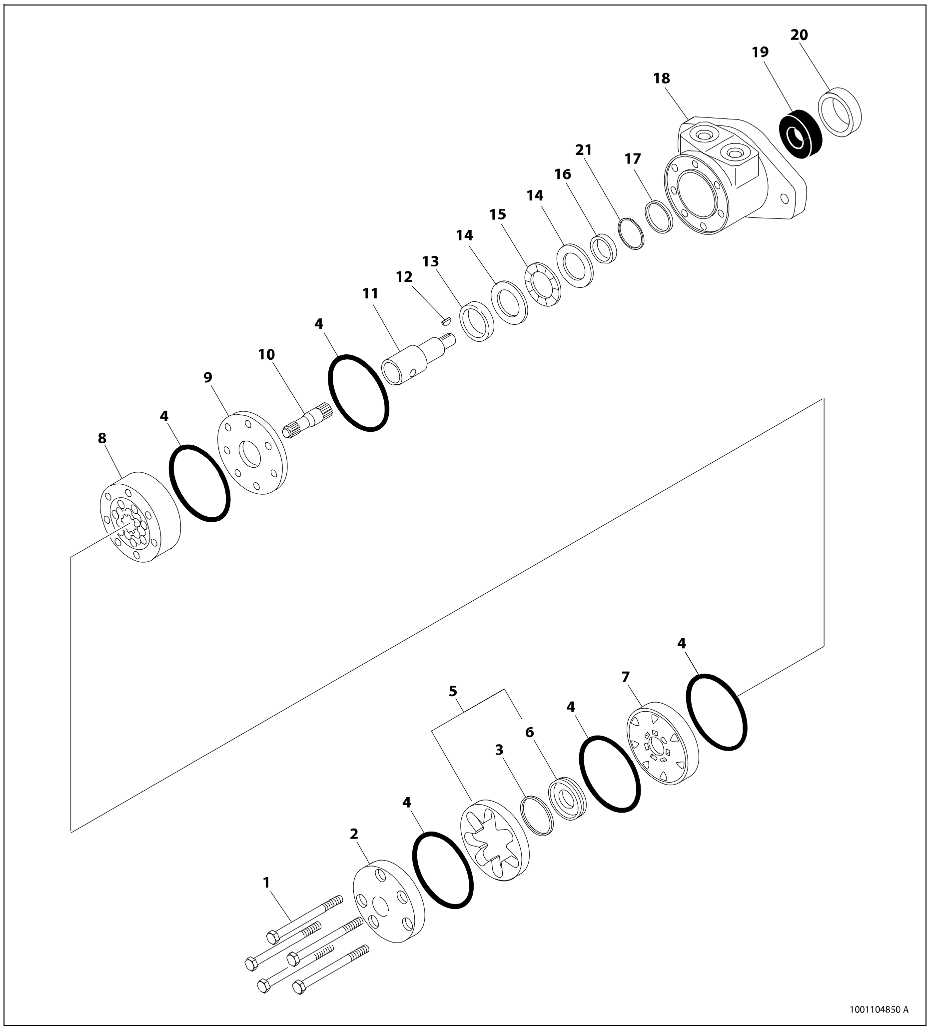


Figure 55. Swing Motor Assembly

1. Bolt	8. Rotor Set	15. Thrust Bearing
2. End Cover	9. Wear Plate	16. Inner Seal
3. Commutator Seal	10. Drive Link	17. Backup Washer
4. Seal Ring	11. Coupling Shaft	18. Housing
5. Commutator and Ring Assembly	12. Woodruff Key	19. Bearing
6. Ring	13. Bronze Bushing	20. Seal
7. Manifold	14. Thrust Washer	21. Backup Washer

3.15.2 Preparation Before Disassembly

- Before you disassemble the motor unit or any of its components read this entire section. It provides important information on parts and procedures you will need to know to service the motor.
- Thoroughly clean off all outside dirt, especially from around fittings and hose connections, before disconnecting and removing the motor. Remove rust or corrosion from coupling shaft.
- Remove coupling shaft connections and hose fittings and immediately plug port holes and fluid lines.
- Remove the motor from system, drain it of fluid and take it to a clean work surface.

- Clean and dry the motor before you start to disassemble the unit.
- As you disassemble the motor clean all parts, except seals, in clean petroleum-based solvent, and blow them dry.

WARNING

Petroleum-base solvents are flammable. Be extremely careful when using any solvent. Even a small explosion or fire could cause injury or death.

WARNING

Wear eye protection and be sure to comply with osha or other maximum air pressure requirements.

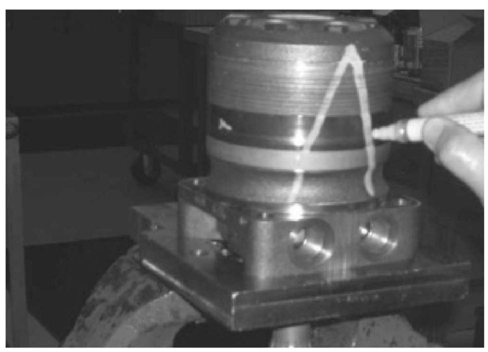
CAUTION

Never steam or high pressure wash hydraulic components. Do not force or abuse closely fitted parts.

- Keep parts separate to avoid nicks and burrs.
- Discard all seals and seal rings as they are removed from the motor. Replace all seals, seal rings and any damaged or worn parts with OEM approved service parts.

3.15.3 Disassembly and Inspection

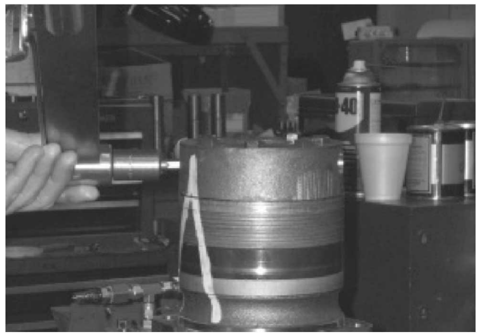
1. Place the motor in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-rings if applicable.

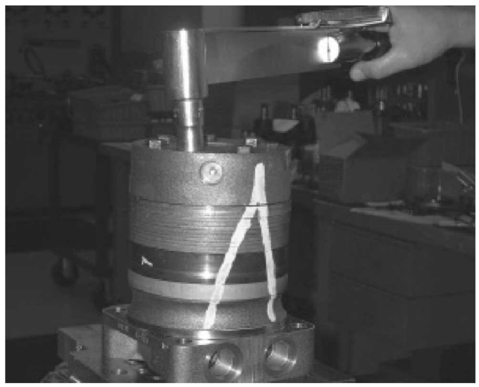


WARNING

If the motor is not firmly held in the vise, it could be dislodged during the service procedures, causing injury.

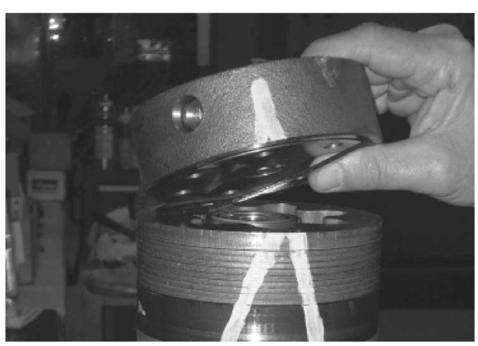
2. Scribe an alignment mark down and across the motor components from end cover (2) to housing (18) to facilitate reassembly orientation where required.



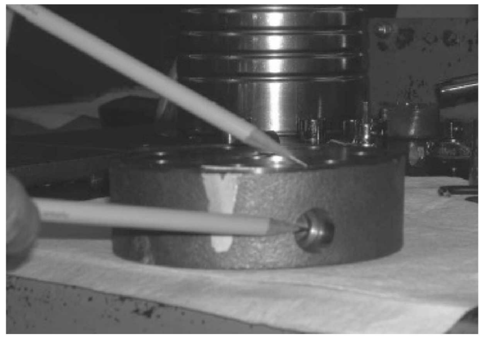


3. Remove the special ring head bolts (1) using an appropriate 1/2 or 9/16 in. size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.

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



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

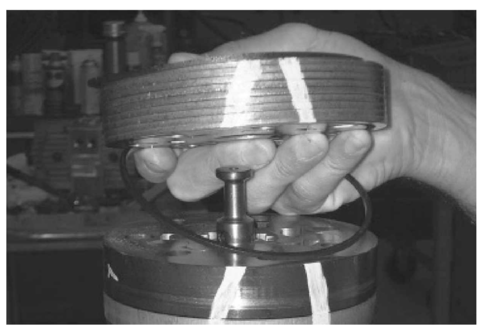


Note: A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.

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

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

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



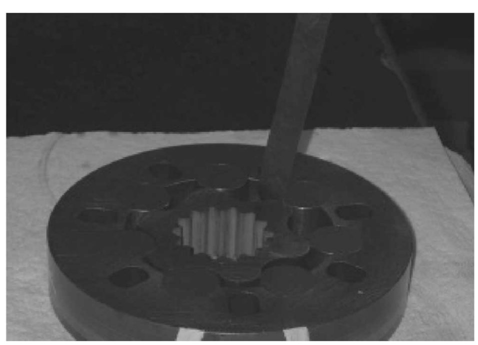
Note: The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides of the manifold to ensure that same surface is reassembled against the rotor set.

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

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

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

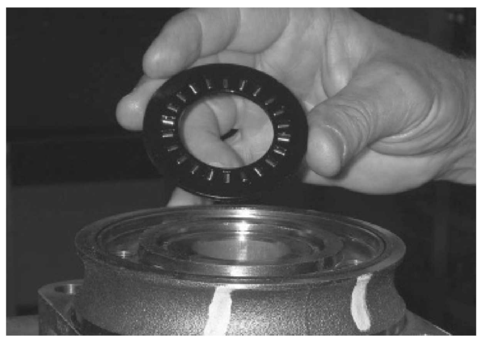
10. Place rotor set (8) and wear plate (9) on a flat surface and center rotor in stator such that two rotor lobes (180 degrees apart) and a roller vane centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gage at this common centerline. If there is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



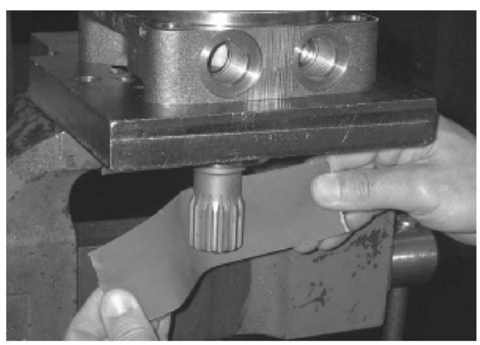
Note: If rotor set (8) has two stator halves and two sets of seven vanes as shown, check the rotor lobe to roller vane clearance at both ends of rotor.

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

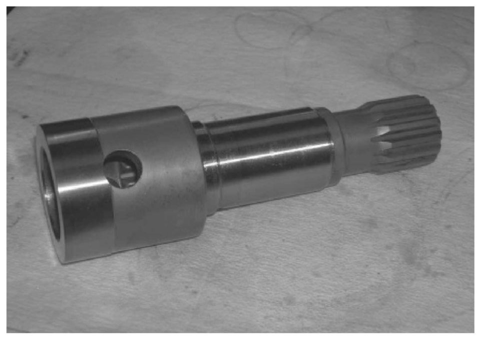
12. Remove thrust bearing (11) from top of coupling shaft (12). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.



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



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



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

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

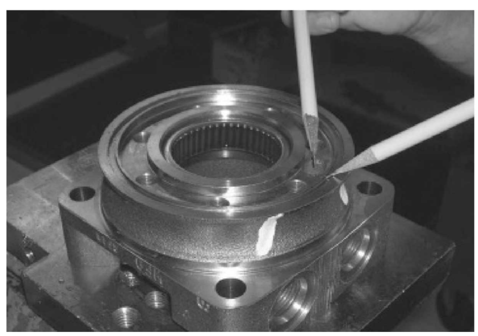
15. Remove and discard seal ring (4) from housing (18).

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

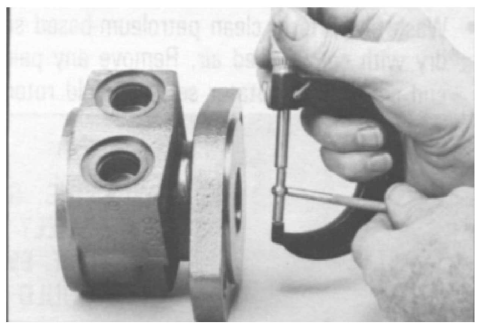
17. Remove seal (16) and backup ring (17) from housing (18) and backup washer (25). Discard both.

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

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



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



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

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

3.15.4 Assembly

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

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

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

⚠ WARNING

Since they are flammable, be extremely careful when using any solvent. Even a small explosion or fire could cause injury or death.

⚠ WARNING

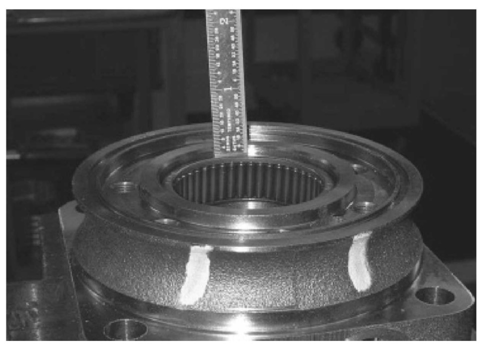
Wear eye protection and be sure to comply with osha or other maximum air pressure requirements.

1. If the housing (18) bearing components were removed for replacement, thoroughly coat and pack a new outer bearing/bushing (19) with clean corrosion resistant grease recommended in the material section. Press the new bearing/bushing into the counterbore at the mounting flange end of the housing, using the appropriate sized bearing mandrel as described which will control the bearing/ bushing depth.
   The housing requires the use of bearing mandrel to press bearing/ bushing (19) into the housing to a required depth of 0.151/ 0.161 in. (3.84/4.09 mm) from the end of the bearing counterbore.

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

⚠ CAUTION

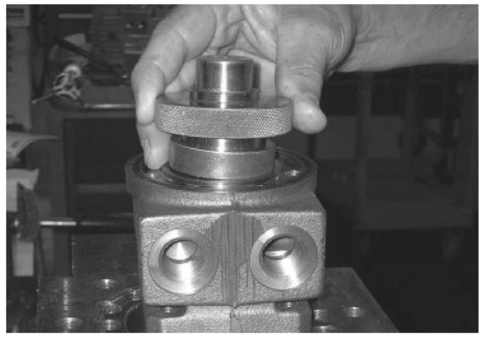
If a bearing mandrel is not available and alternate methods are used to press in bearing/bushing (13) and (19) the bearing/bushing depths specified must be achieved to insure adequate bearing support and correct relationship to adjacent components when assembled.



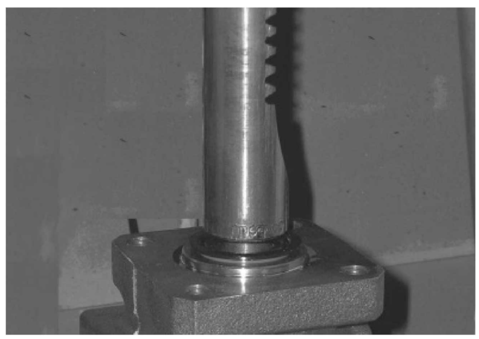
⚠ CAUTION

Because the bearing/bushings (13) and (19) have a press fit into the housing they must be discarded when removed. They must not be reused.

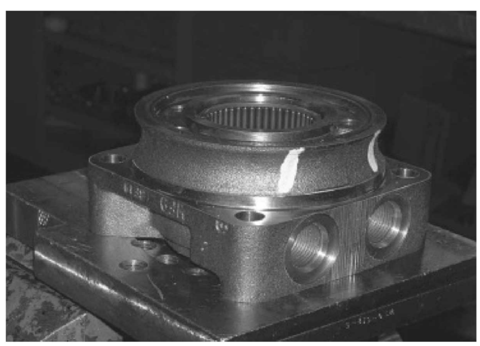
2. The inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to 03 in. (0.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/bushing (19).



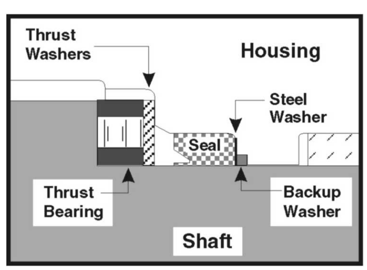
3. Press a new dirt and water seal (20) into the housing (18) outer bearing counterbore. The dirt and water seal (20) must be pressed in until its' flange is flush against the housing.



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



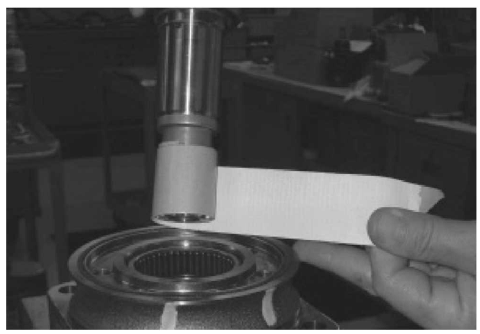
5. Assemble a new backup ring (17), new backup washer (25) and new seal (16) with the seal lip facing toward the inside of the motor, into their respective counterbores in housing (18).



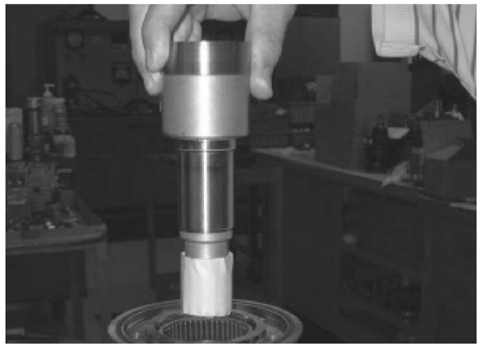
6. Assemble thrust washer (14) then thrust bearing (15) that was removed from the motor.

Note: The motor requires one thrust washer (14) with thrust bearing (15). The coupling shaft will be seated directly against the thrust bearing.

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



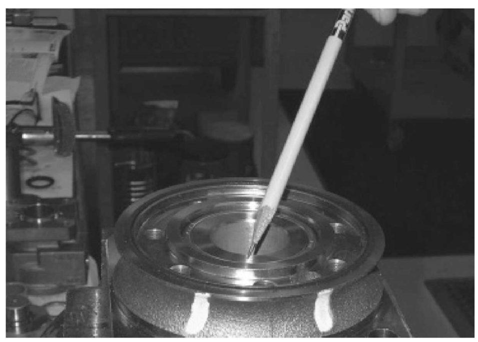
8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15).



⚠ CAUTION

The outer bearing (19) is not lubricated by the system's hydraulic fluid. Be sure it is thoroughly packed with the recommended grease.

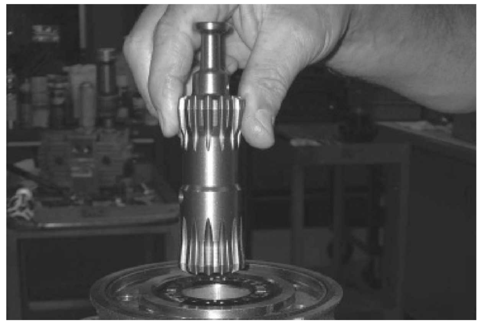
Note: The coupling shaft (12) will be flush or just below the housing wear surface when properly seated while the coupling shaft (12). The coupling shaft must rotate smoothly on the thrust bearing package.



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

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

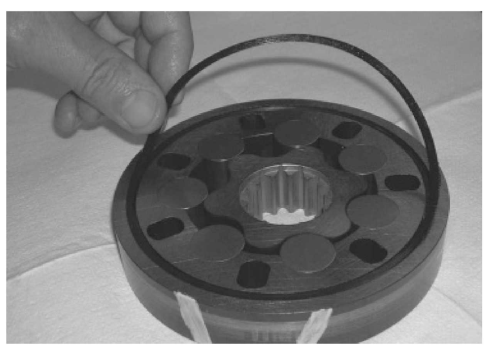
10. Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines.



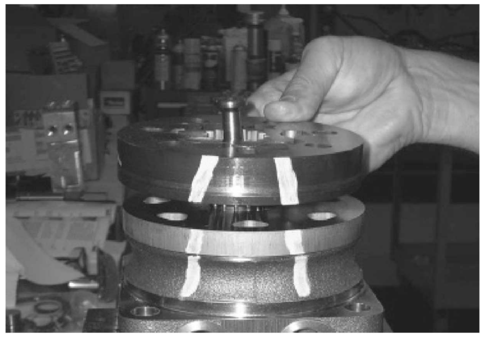
Note: Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.

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

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



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

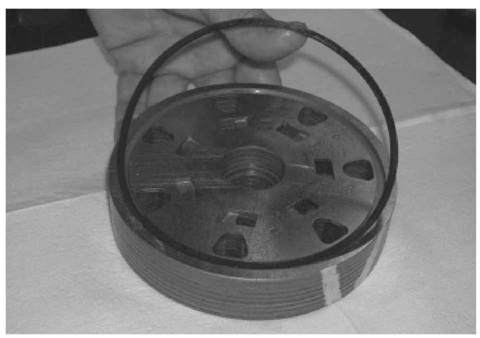


Note: It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.

Note: If necessary, go to the appropriate, “Rotor Set Component Assembly Procedure”.

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

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

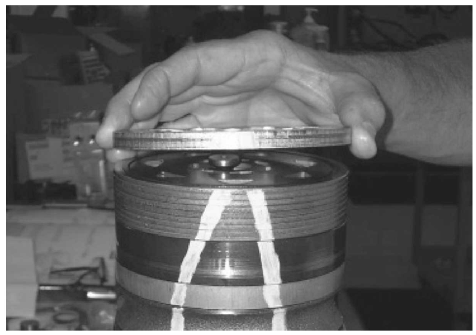


Note: The manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it’s series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression left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

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

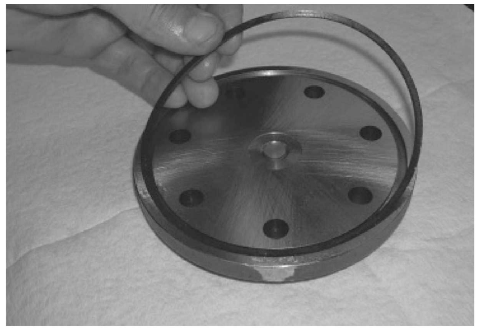
16. Apply grease to a new seal ring (4) and insert it in the seal ring groove exposed on the manifold.

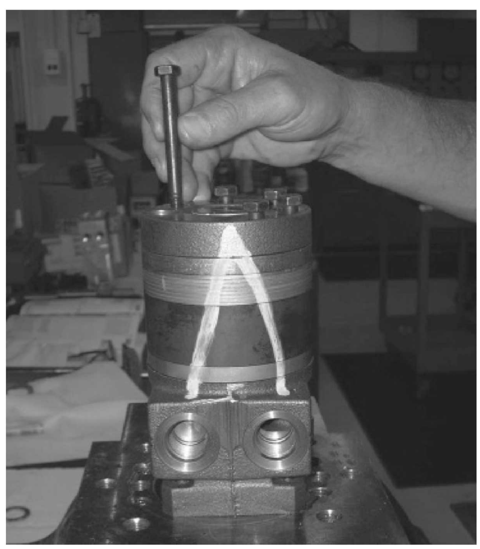
17. Assemble the commutator ring (6) over alignment studs onto the manifold.



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

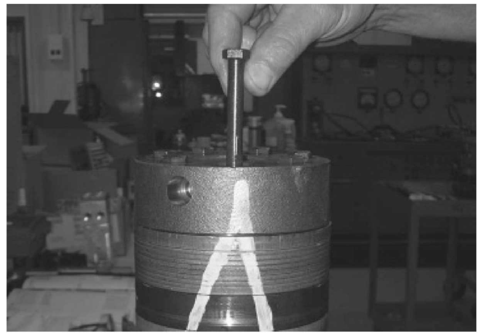
19. Assemble a new seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18). The correct 5 bolt end cover bolt hole relationship to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

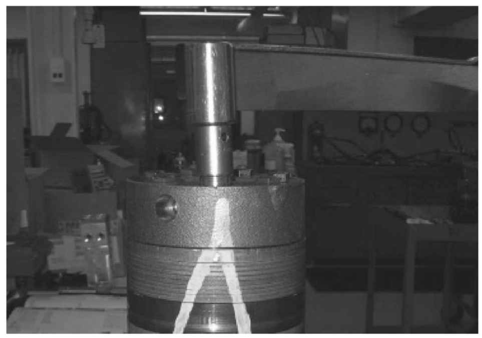


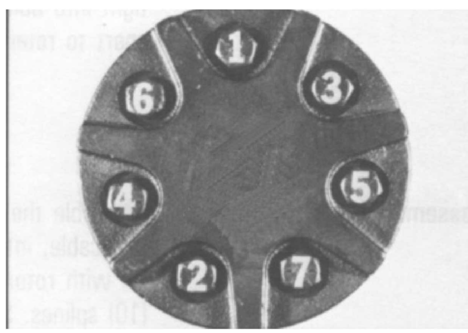


Note: If the end cover has a valve (24) or has five bolt holes, use the line you previously scribed on the cover to radially align the end cover into its original position.

20. Assemble the bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 25-30 ft. lbs. (34-41 Nm).







3.15.5 One Piece Stator Construction

A disassembled rotor stator and vanes that cannot be readily assembled by hand can be assembled by the following procedures.

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

2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

3. Assemble the rotor, counterbore down if applicable, into stator, and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.

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

⚠ CAUTION

Excessive force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets.

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

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

Go to assembly procedure #15, to continue assembly.

3.15.6 Two Piece Stator Construction

A disassembled rotor set (8) that cannot be readily assembled by hand and has a two piece stator can be assembled by the following procedures.

1. Place stator half onto wear plate (9) with seal ring (4) side down, after following motor assembly procedures 1 through 13. Be sure the seal ring is in place.
2. Align stator bolt holes with wear plate and housing bolts and turn two alignment studs finger tight into bolt holes approximately 180 degrees apart to retain stator half and wear plate stationary.
3. Assemble rotor, counterbore down if applicable, into stator half, and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.

Note: Use any marking you applied to rotor set components to reassemble the components in their original relationship to ensure ultimate wear life and performance.

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

⚠ CAUTION

Excessive force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets.

5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator half, creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.
6. Place second stator half on a flat surface with seal ring groove up. Apply a small amount of grease to a new seal ring (4) and assemble it into stator half ring groove.
7. Assemble the second stator half over the two alignment studs and rotor with seal ring side down onto the first stator half aligning any timing marks applied for this purpose.

⚠ CAUTION

If the stator half (8b) is a different height (thickness) than stator half (8d) the stator vanes (8c) or (8e)of the same length (height) as the stator half must be reassembled in their respective stator half for the rotor set to function properly.

8. Assemble six vanes, or as many vanes that will readily assemble into the stator vane pockets.
9. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes into stator, creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.

Go to assembly procedure #15, to continue assembly.

3.15.7 Final Checks

1. Pressurize the motor with 100 psi dry air or nitrogen and submerge in solvent to check for external leaks.
2. Check motor for rotation. Torque required to rotate coupling shaft should not be more than 50 ft. lbs. (68 Nm)
3. Pressure port with “A” cast under it on housing (18) is for clockwise coupling shaft rotation as viewed from the output end of coupling shaft. Pressure port with “B” cast under it is for counterclockwise coupling shaft rotation.
4. Use test stand if available, to check operation of the motor.

3.15.8 Installation

Refer to *Figure — Swing Motor Removal and Installation, page 129*.

1. Carefully insert the swing motor into the swing drive, making sure the swing motor shaft key is aligned correctly.
2. Secure the swing motor to the swing drive assembly with the retaining bolts. Apply High Strength Threadlocking Compound to the threads of the retaining bolts and torque to 73.75 ft. lbs. (100 Nm).
3. Connect the hydraulic lines running to the swing motor as tagged during removal.
4. Operate the swing function in both directions to ensure proper operation. Inspect the hose connections for any leakage.

3.16 GENERATOR

⚠ WARNING

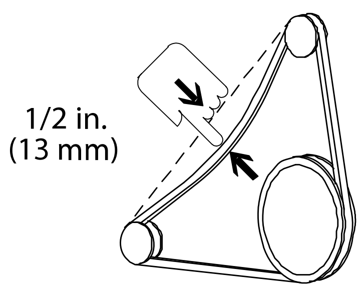
Stop engine before carry out schedule maintenance.

Note: Do often service, if operating in hostile environment.

3.16.1 Maintenance Schedule

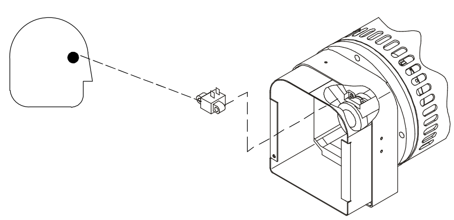
EVERY 250 HOURS

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

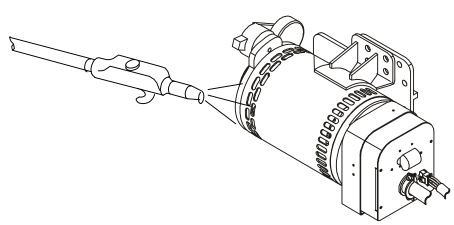


EVERY 500 HOURS

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.



3.16.2 Overload Protection

⚠ WARNING

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.

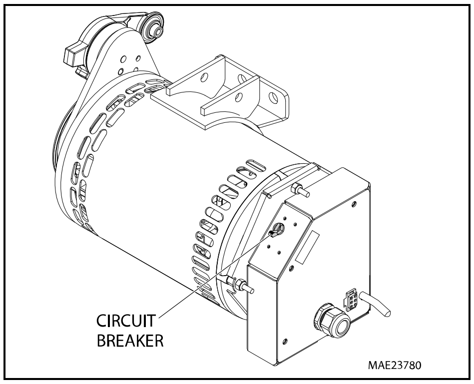


Figure 56. Generator Circuit Breaker Location (If Equipped with 2500W and 4000W)

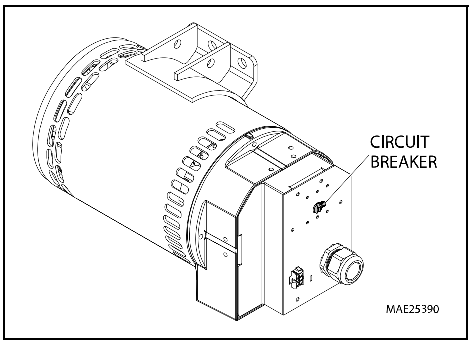


Figure 57. Generator Circuit Breaker Location (If Equipped with 7500W)

3.16.3 Inspecting Brushes, Replacing Brushes and Cleaning Slip Rings

Refer to *Figure — Inspecting Generator Brushes, Replacing Brushes and Cleaning Slip Rings, page 154*.

INSPECTING BRUSH POSITION

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

INSPECTING BRUSHES

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

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

CLEANING SLIP RINGS

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

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

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

Reinstall the belt, brush holder assembly and end panel.

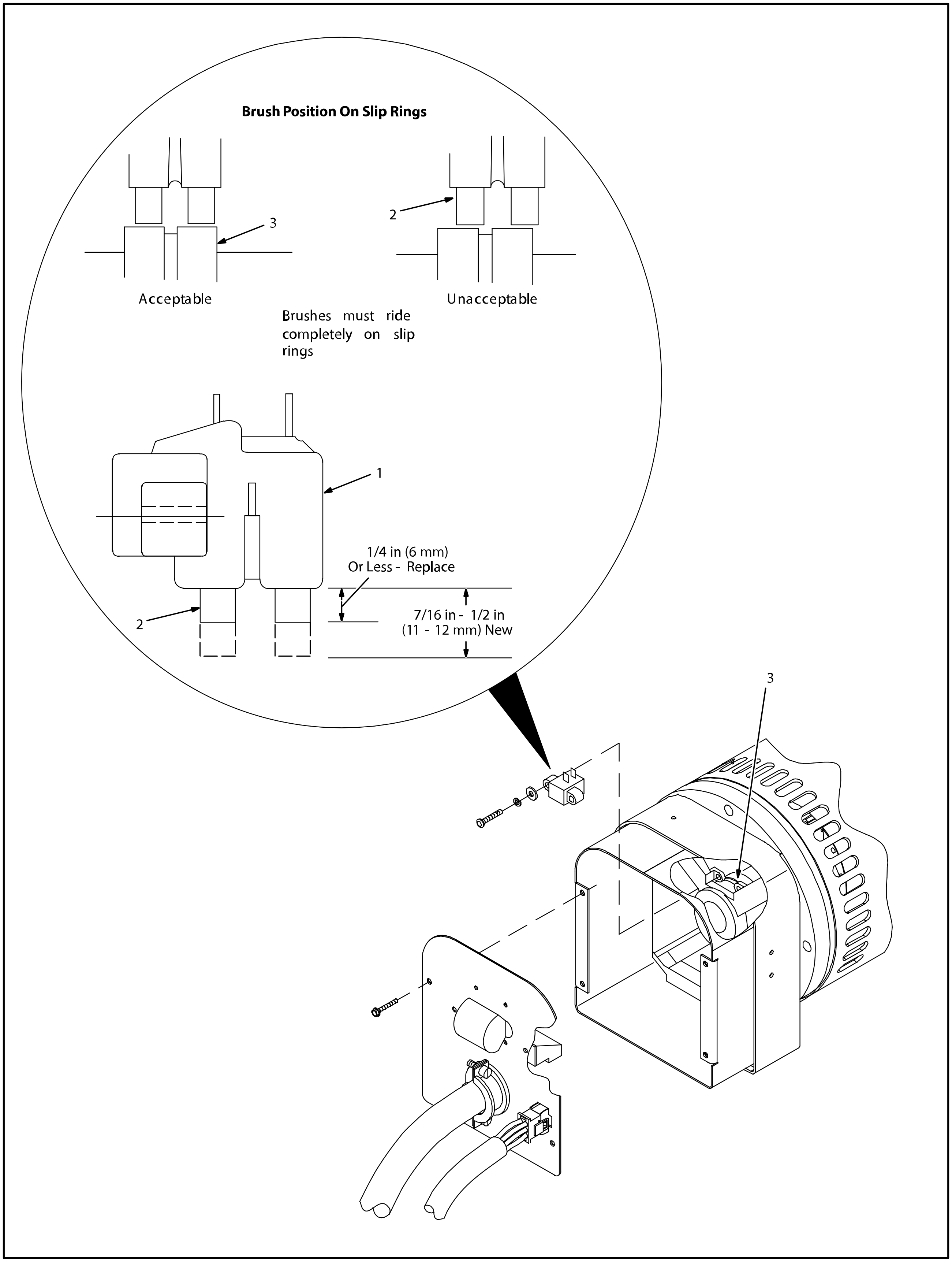


Figure 58. Inspecting Generator Brushes, Replacing Brushes and Cleaning Slip Rings

3.16.4 Troubleshooting

Table 25. Troubleshooting

Trouble	Remedy
No generator output at platform AC receptacles.	Be sure generator control switch is turned on at platform.
	Check and secure electrical connections at platform, generator, and control box.
	Be sure all equipment is turned off when starting unit.
	Reset circuit breaker CB1.
	Check plug PLG3 connection and/or connections at receptacles RC3 and RC5.
	Be sure + 12 volts DC input voltage is being supplied to control box.
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings (nominal reading is 26 ohms). Replace generator if rotor is open.
	Disconnect stator weld leads 1, 2, and 3 from circuit breaker CB1 , and check continuity between leads. Replace generator if necessary.
	Disconnect plug PLG4 and check continuity between exciter leads 5 and 6. Replace generator if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
Low generator output at platform AC receptacles.	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings nominal reading is 26 ohms). Replace generator if rotor is open.
	Disconnect stator weld leads 1, 2, and 3 from circuit breaker CB1, and check continuity between leads. Replace generator if necessary.
	Disconnect plug PLG4 and check continuity between exciter leads 5 and 6. Replace generator if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
High generator output at platform AC receptacles.	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
Erratic generator output at platform AC receptacles.	Check and secure electrical connections at platform, generator, and control box.
	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes n necessary.

Table 25. Troubleshooting (continued)

Trouble	Remedy
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings nominal reading is 26 ohms). Replace generator if rotor is open.
	Check power board PC1 and connections, and replace if necessary
	Check control board PC2 and connections, and replace if necessary

3.16.5 Generator Disassembly and Assembly

Refer to *Figure- Generator Troubleshooting Circuit Diagram - Sheet 1 of 2, page 158* and *Figure - Generator Troubleshooting Circuit Diagram - Sheet 2 of 2, page 159* to determine if trouble is in stator, rotor, control box, or combination of these components.

1. Rotor
2. Stator Assembly

⚠ CAUTION

Do not damage rotor or stator windings during disassembly and assembly procedure.

DISASSEMBLY

1. Mark and disconnect all electrical leads, secure using cable ties.
2. Remove brush holder assembly.
3. Disassemble generator parts shown in *Figure — Generator Disassembly and Assembly, page 157*.
4. Clean all parts with approved solvent and dry with compressed air, If applicable.
5. Inspect all part for damage. Replace if necessary.

ASSEMBLY

1. Assemble generator parts using torque values in table.
2. Reconnect all leads. Use cable ties to secure leads away from moving or hot parts.

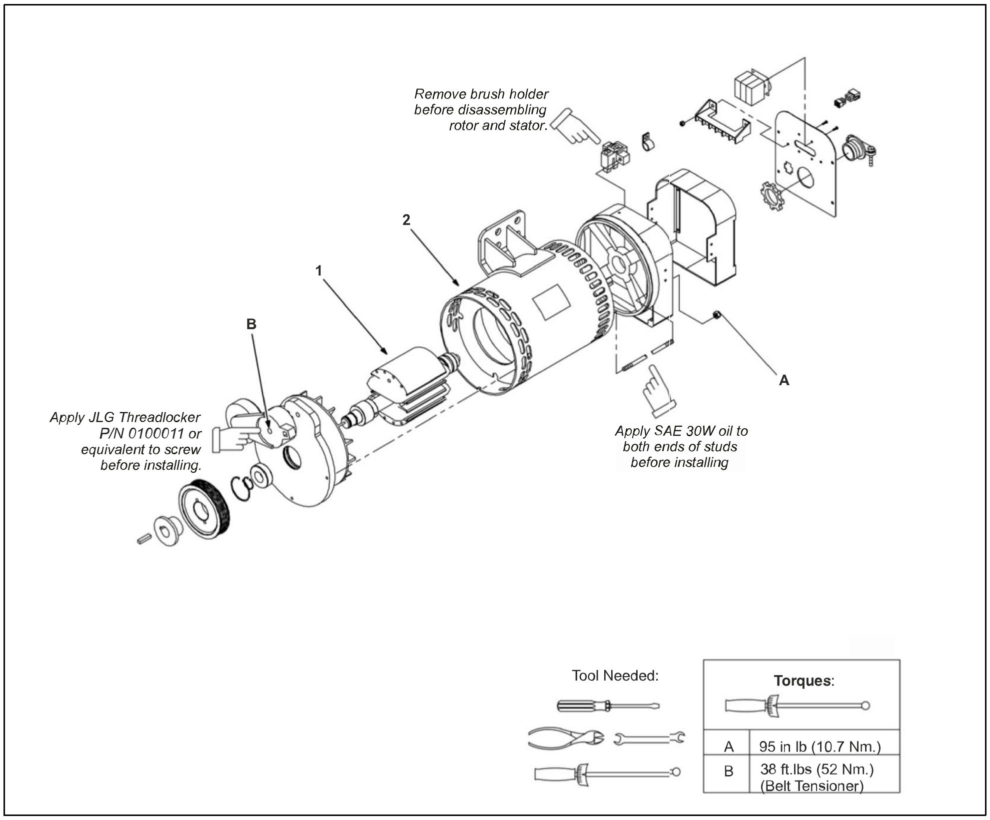


Figure 59. Generator Disassembly and Assembly

Resistance Values	
a) Tolerance – ±10% unless specified	
b) Condition – 70°F (21°C); cold machine (no warm-up)	
c) Wiring Diagram	
d) Stop generator before checking resistance	
R1	26 ohms
R2	1 ohm
R3 thru R5	Less than 1 ohm

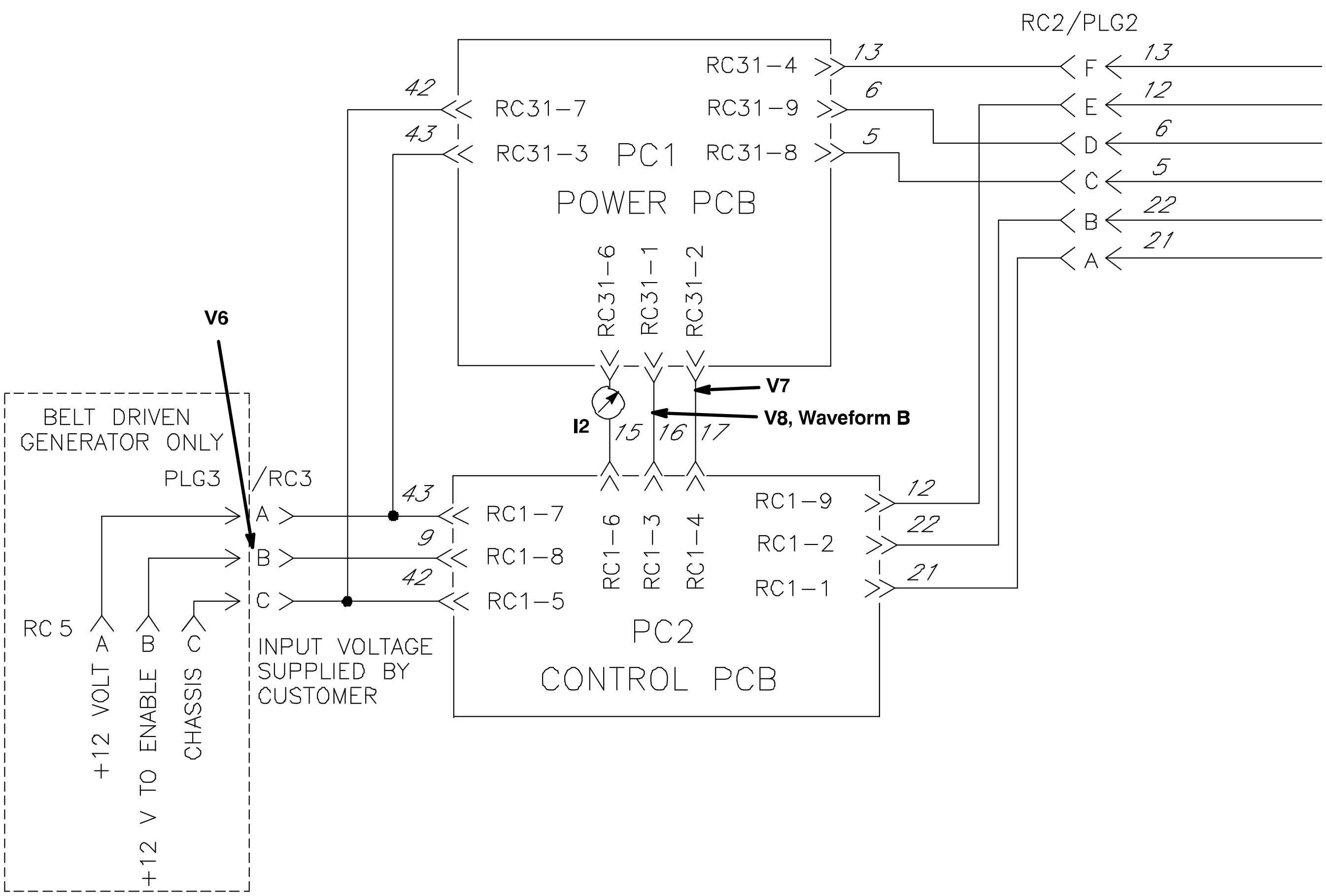
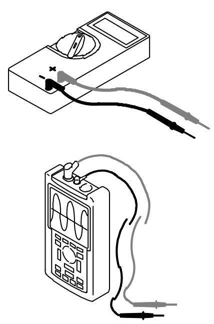


Figure 60. Generator Troubleshooting Circuit Diagram - Sheet 1 of 2

Test Equipment Needed:



Amperage Readings	
a) Tolerance – ±5% unless specified	
b) Condition – 70°F (21°C); cold machine (no warm-up); no load	
I1	1 amps DC (60 Hz) No greater than 3.5 amps DC under load
I2	1 amps DC (60 Hz) No greater than 3.5 amps DC under load

Voltage Readings	
a) Tolerance – ±10% unless specified	
b) Condition – 70°F (21°C); cold machine (no warm-up); no load	
c) Weld/power rpm unless specified	
d) Reference – single arrow: reference to circuit common (lead 42); double arrow: reference to points indicated	
e) Wiring Diagram	
V1	Rotor: +25 volts DC at no load ±20%; +75 volts DC at full load ±10%
V2	Exciter: 150 volts AC
V3	Voltage Feedback: 240 volts AC
V4	Output (Odd Leg): 245 volts AC
V5	Output: 120 volts AC
V6	Generator Enable: +12 volts DC when generator is enabled (On); 0 volts DC when not enabled (Off)
V7	Shutdown Signal: +12 volts DC when shutdown is latched; 0 volts DC when not latched
V8	PWM Signal: 0 to +15 volts DC

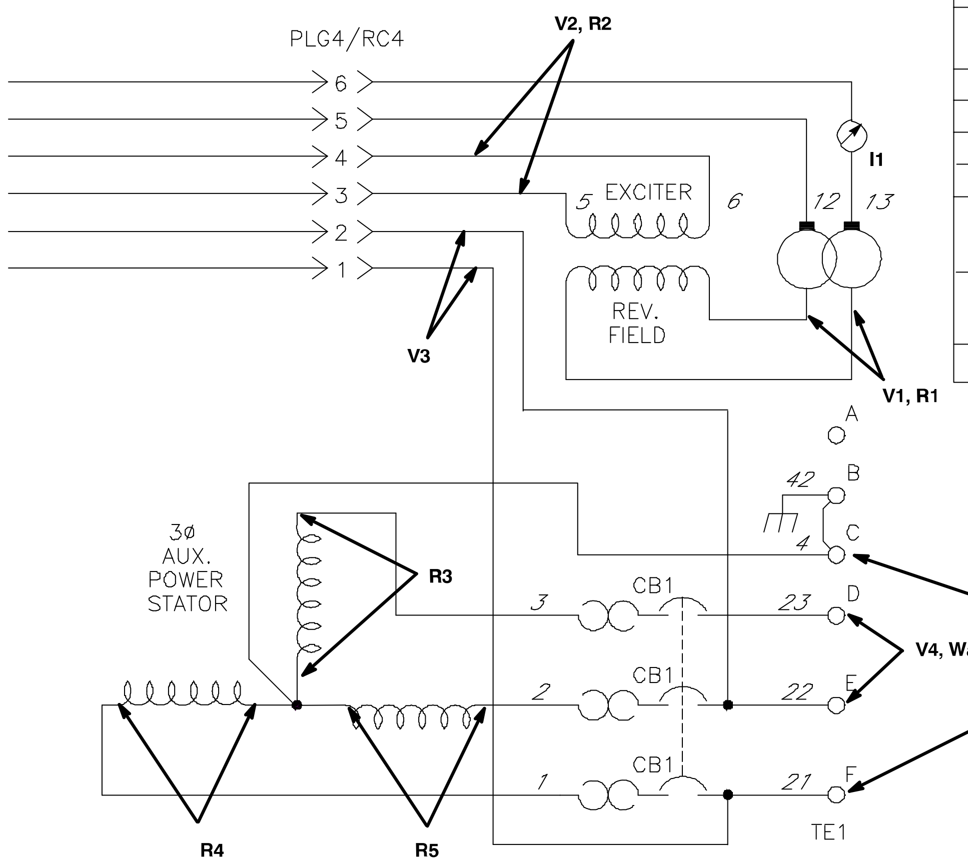


Figure 61. Generator Troubleshooting Circuit Diagram - Sheet 2 of 2

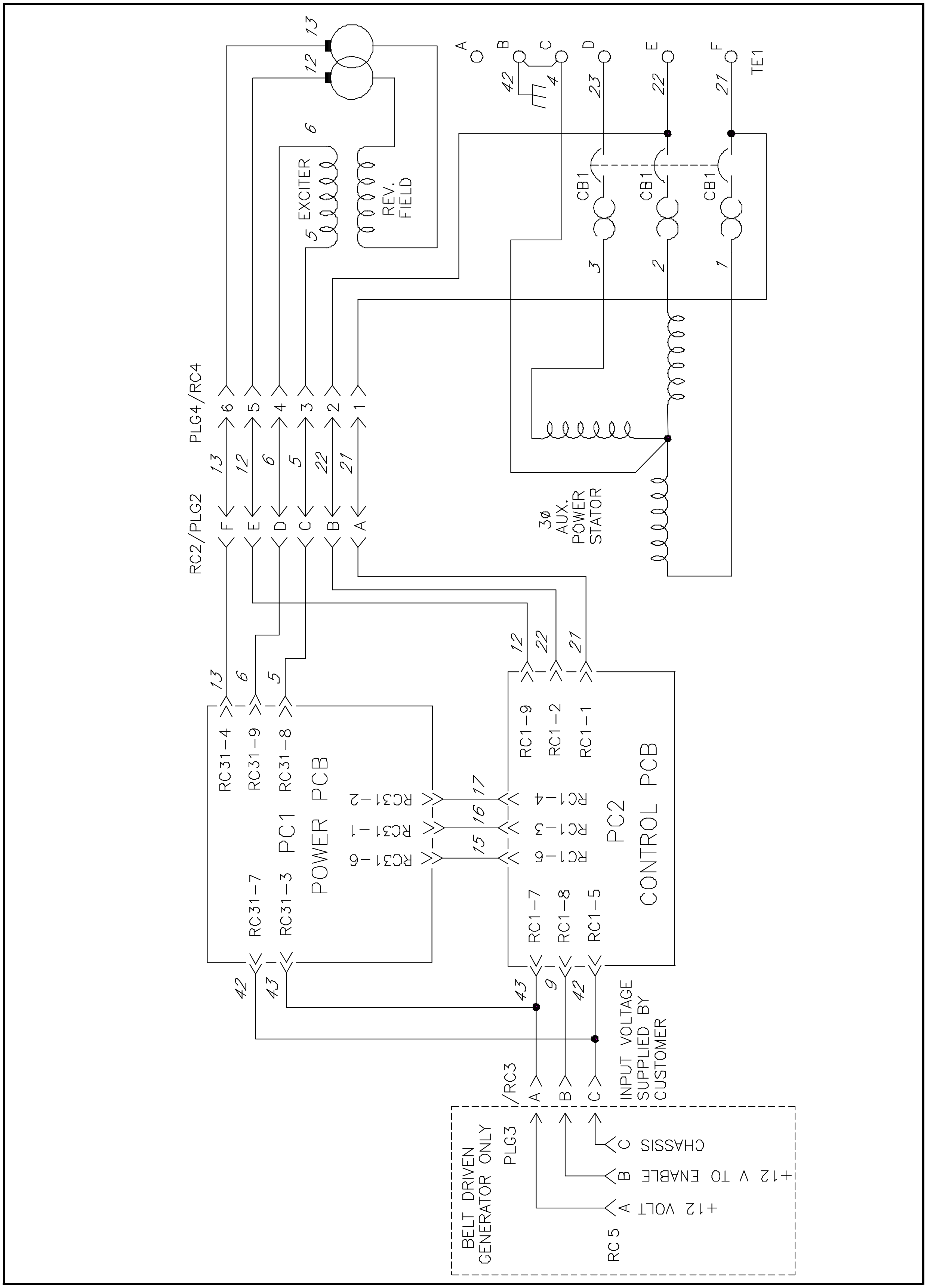


Figure 62. Generator Electrical Circuit Diagram

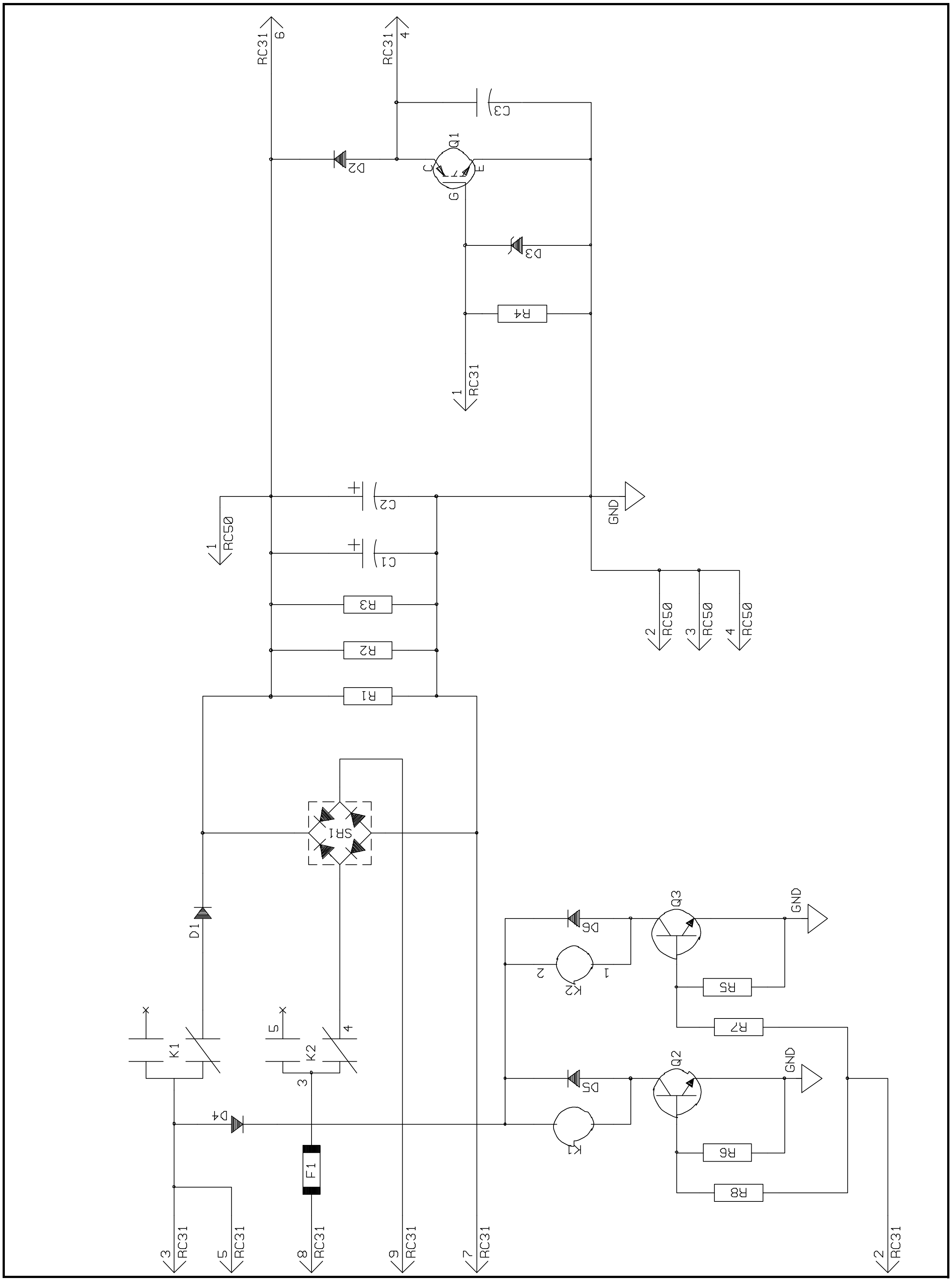
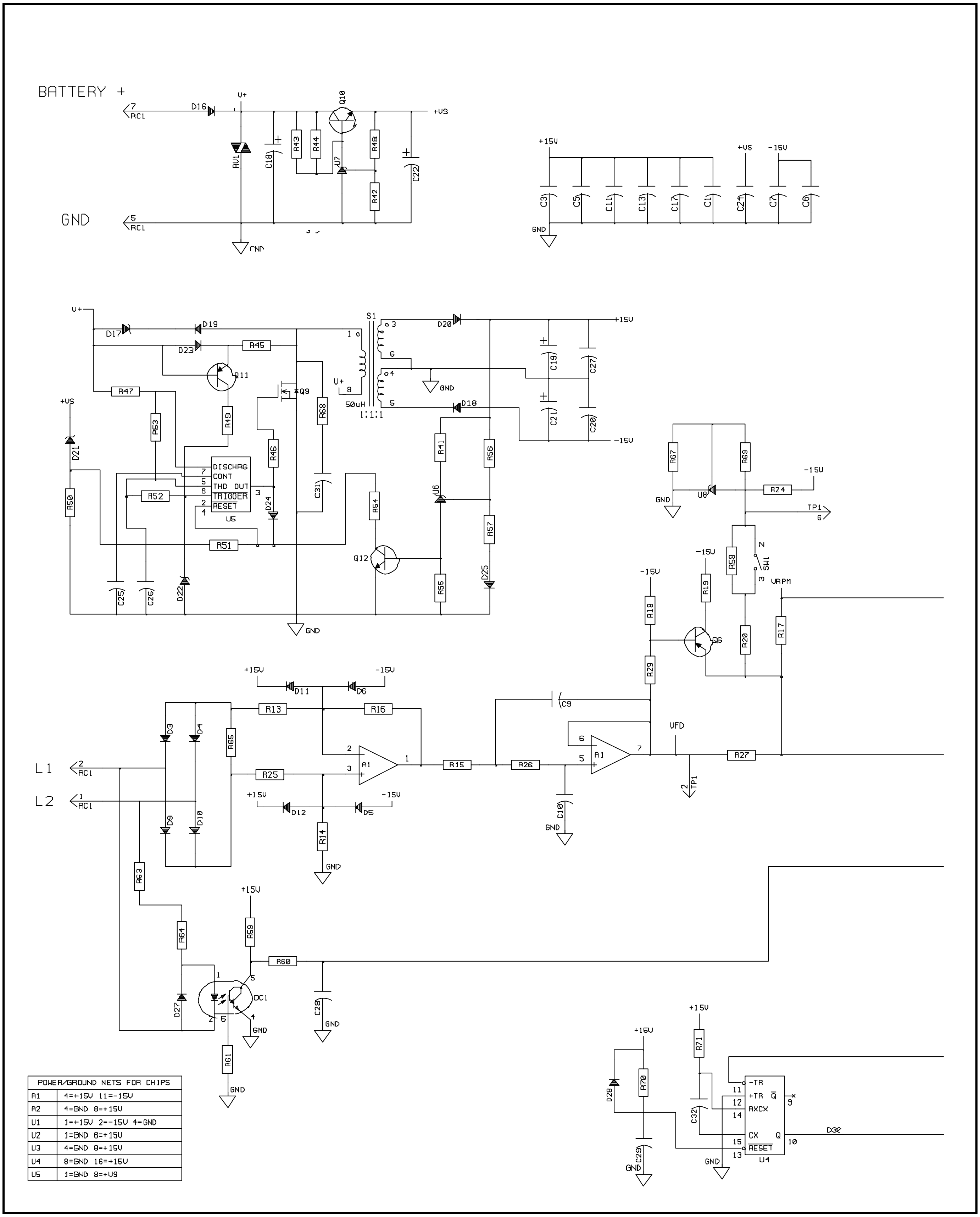


Figure 63. Power Board PC1 Electrical Circuit Diagram



POWER/GROUND NETS FOR CHIPS	
A1	4=+15V 11=-15V
A2	4=GND 8=+15V
U1	1=+15V 2=-15V 4=GND
U2	1=GND 6=+15V
U3	4=GND 8=+15V
U4	8=GND 16=+15V
U5	1=GND 8=+VS

Figure 64. Power Board PC2 Electrical Circuit Diagram - Sheet 1 of 2

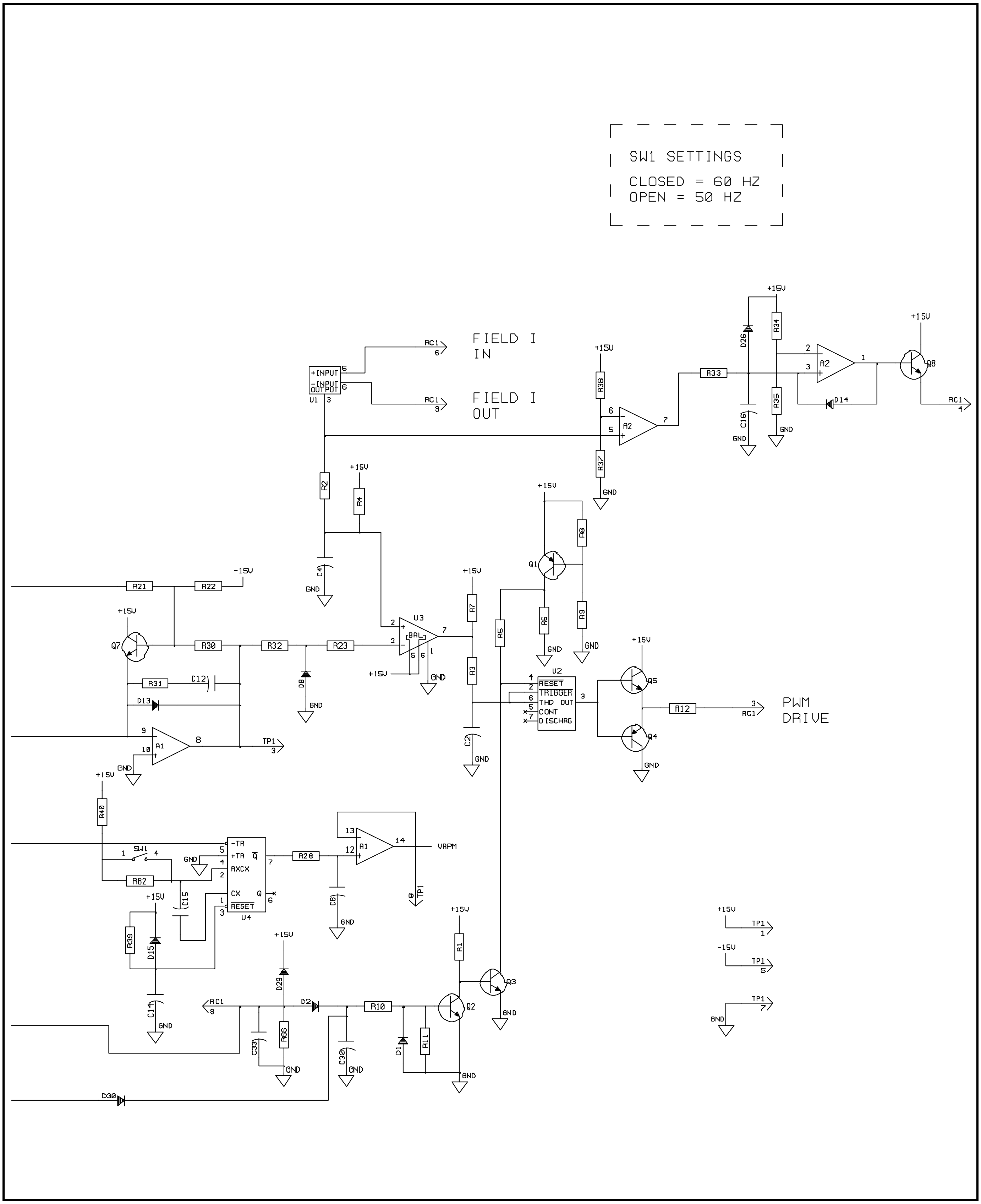


Figure 65. Power Board PC2 Electrical Circuit Diagram - Sheet 2 of 2

3.16.6 Lead Connection List for Generator

Note: Table shows physical lead connections and should be used with circuit diagram (table replaces wiring diagram).

Note: Apply small amount of dielectric grade, nonconductive electric grease to connectors where factory-applied grease had been present.

Table 26. Lead Connection List for Generator

Leads	Connections
1A	STATOR TO CB1
2A	STATOR TO CB1
3A	STATOR TO CB1
4A	STATOR TO TE1 (C)
5A	STATOR TO RC4 (3)
5B	PLG2 (C) TO PLG4 (3)
5C	RC2 (C) PLG31 (8)
6A	STATOR TO RC4 (4)
6B	PLG2 (D) TO PLG4 (4)
6C	RC2 (D) PLG31 (9)
9A	RC5 (B) TO PLG3 (B) (Customer Supplied)
9B	RC3 (B) PLG1 (8)
12A	PLG2 (E) TO PLG4 (5)
12B	RC2 (E) PLG1 (9)
12C	RC4 (5) TO BRUSH
13A	PLG2 (F) TO PLG4 (6)
13B	RC2 (F) PLG31 (4)
13C	RC4 (6) TO BRUSH
15A	PLG1 (6) TO PLG31 (6)
16A	PLG1 (3) TO PLG31 (1)
17A	PLG1 (4) TO PLG31 (2)
21A	CB1 TO TE1 (F)
21B	PLG2 (A) TO PLG4 (1)
21C	PLG1 (1) TO RC2 (A)
21D	RC4 (1) TO CB1
22A	CB1 TO TE1 (E)
22B	PLG2 (B) TO PLG4 (2)
22C	PLG1 (2) TO RC2 (B)
22D	RC4 (2) TO CB1
23A	CB1 TO TE1 (D)

Table 26. Lead Connection List for Generator (continued)

Leads	Connections
42A	RC5 (C) TO PLG3 (C) (Customer Supplied)
42B	RC3 (C) TO CONNECTION POINT 1
42C	PLG31 (7) TO CONNECTION POINT 1
42D	PLG1 (5) TO CONNECTION POINT 1
42F	END BELL SHROUD TO ENGINE MOUNT
42G	CHASSIS TO TE1 (B)
43A	RC5 (A) TO PLG3 (A) (Customer Supplied)
43B	RC3 (A) TO CONNECTION POINT 2
43C	PLG31 (3) TO CONNECTION POINT 2
43D	PLG1 (7) TO CONNECTION POINT 2

3.17 GENERATOR AND PULLEY

3.17.1 Generator Pulley (7500W) - Deutz D2011L03

REMOVAL

1. Remove the hardware securing the pulley belt tensioner assembly (1) to the generator (4) and remove pulley belt tensioner.
2. Remove hardware attaching tapered bushing (2) to the generator pulley (3) and remove tapered bushing and generator pulley from the generator shaft.

Note: The Generator approximately weighs 110 lb (50 kg).

3. Using suitable lifting equipment, adequately support engine assembly weight along entire length.
4. Remove the hardware securing generator (4) to the engine and remove generator from engine assembly.

INSTALLATION

1. Install generator (4) to the engine and secure with hardware. Torque hardwares to 71.54 ft.lbs. (97 Nm).
2. Install generator pulley (3) and tapered bushing (2) on the generator shaft and secure with hardware. Torque hardwares to 9 ft. lbs. (12 Nm).

Note: Ensure that generator pulley is aligned with engine pulley.

3. Install pulley belt and pulley belt tensioner assembly (1) to generator (4) and secure with hardware.

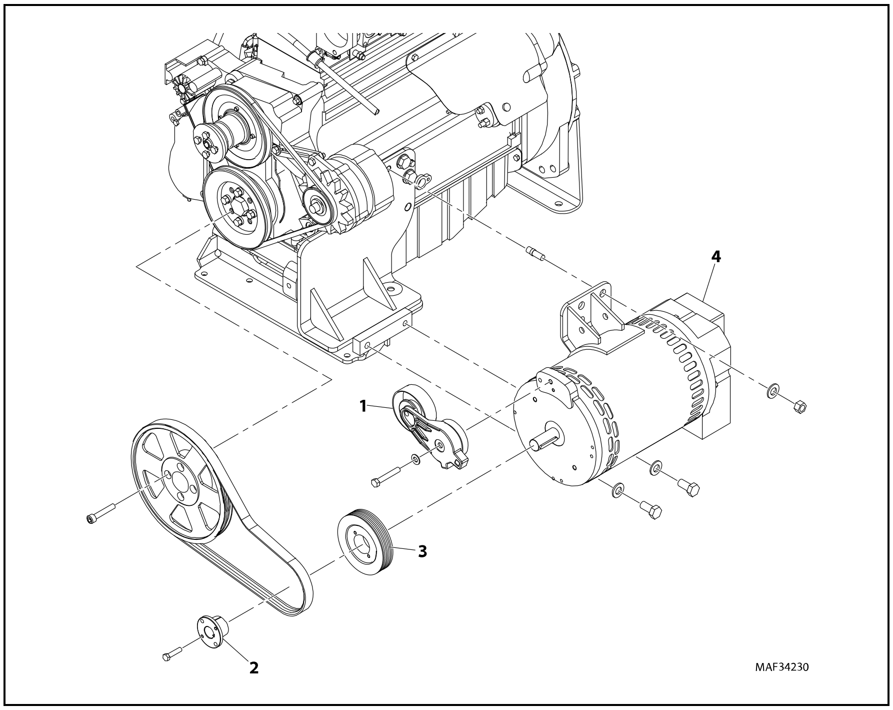


Figure 66. Generator Pulley (7500W) - Deutz D2011L03

3.17.2 Generator Pulley (4000W) - Deutz D2011L03

REMOVAL

1. Remove the hardware securing the pulley belt tensioner assembly (1) to the generator (4) and remove pulley belt tensioner.
2. Remove hardware attaching tapered bushing (2) to the generator pulley (3) and remove tapered bushing and generator pulley from the generator shaft.

Note: The Generator approximately weighs 95 lb (43.1 kg).

3. Using suitable lifting equipment, adequately support engine assembly weight along entire length.
4. Remove the hardware securing generator (4) to the engine and remove generator from engine assembly.

INSTALLATION

1. Install generator (4) to the engine and secure with hardware. Torque hardwares to 71.54 ft.lbs. (97 Nm).
2. Install generator pulley (3) and tapered bushing (2) on the generator shaft and secure with hardware. Torque hardwares to 9 ft. lbs. (12 Nm).

Note: Ensure that generator pulley is aligned with engine pulley.

3. Install pulley belt and pulley belt tensioner assembly (1) to generator and secure with hardware.

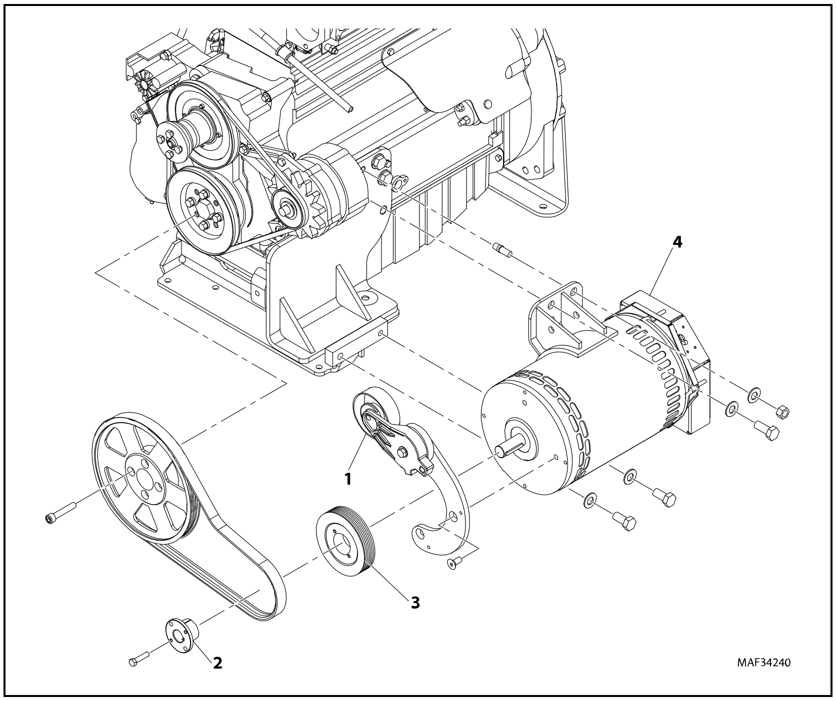


Figure 67. Generator Pulley (4000W) - Deutz D2011L03

3.17.3 Generator Pulley (2500W) - Deutz D2011L03

REMOVAL

1. Remove the hardware securing the pulley belt adjusting arm (1) to the generator (2) and remove bracket.
2. Remove hardware attaching engine pulley (3) to engine shaft and remove engine pulley.

Note: The Generator approximately weighs 32 lb (15 kg).

3. Using suitable lifting equipment, adequately support engine assembly weight along entire length.
4. Remove the hardware securing generator (2) to the engine and remove generator from engine assembly.

INSTALLATION

1. Install generator (2) to the engine and secure with hardware.
2. Install engine pulley (3) to the engine shaft and secure with hardware.

Note: Ensure that generator pulley is aligned with engine pulley.

3. Install pulley belt and pulley belt adjusting arm (1) to generator (2) and secure with hardware.

Note: Adjust the belt tension to 90 lb (400 N).

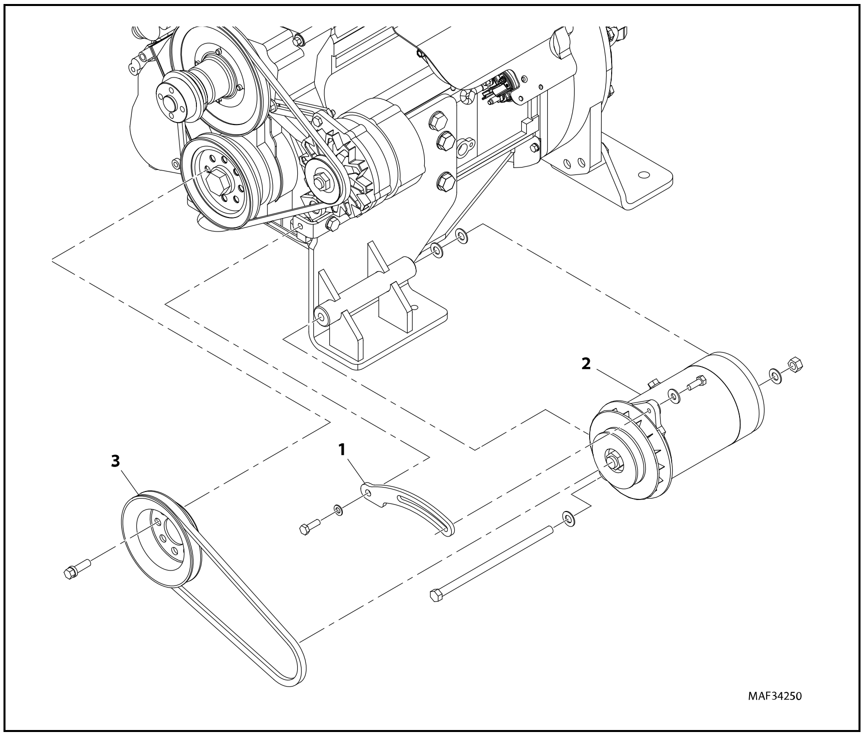


Figure 68. Generator Pulley (2500W) - Deutz D2011L03

3.17.4 Generator Pulley (2500W) - Kubota WG2503 and Deutz T4F

REMOVAL

1. Remove the hardware securing the pulley belt adjusting arm (1) to the generator (2) and remove pulley belt adjusting arm.
2. Remove hardware attaching engine pulley (3) to engine shaft and remove engine pulley.

Note: The Generator approximately weighs 36.5 lb (16 kg).

3. Using suitable lifting equipment, adequately support engine assembly weight along entire length.
4. Remove the hardware securing generator (2) to the engine and remove generator from engine assembly.

INSTALLATION

1. Install generator (2) to the engine and secure with hardware. Torque hardware to 71.5 ft. lbs. (97 Nm).
2. Install engine pulley (3) to the engine shaft and secure with hardware.

Note: Ensure that generator pulley is aligned with engine pulley.

3. Install pulley belt adjusting arm (1) to generator (2) and secure with hardware.

Note: Adjust the belt tension to 90 lb (400 N).

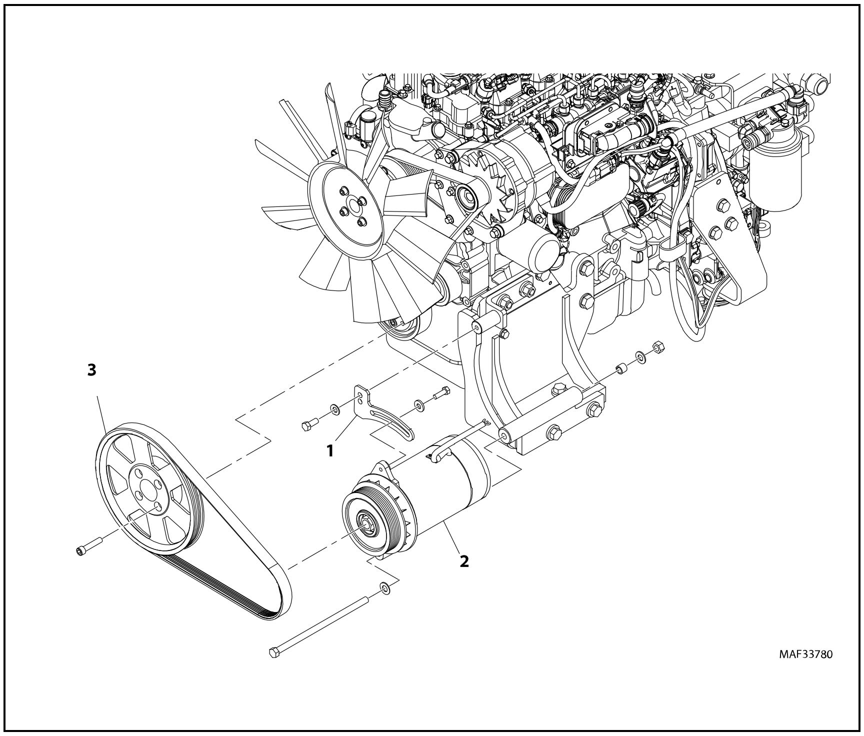


Figure 69. Generator Pulley (2500W) - Kubota WG2503 and Deutz T4F

3.17.5 Generator Pulley (7500W and 4000W) - Kubota, Deutz T4F and D2.9L4 Stage V

REMOVAL

1. Remove the hardware securing the pulley belt tensioner assembly (1) to the generator (4) and remove pulley belt tensioner.
2. Remove hardware attaching tapered bushing (2) to the generator pulley (3) and remove tapered bushing and generator pulley from the generator shaft.

Note: The Generator approximately weighs 110 lb (50 kg).

3. Using suitable lifting equipment, adequately support engine assembly weight along entire length.
4. Remove the hardware securing generator (4) to the engine and remove generator from engine assembly.

INSTALLATION

1. Install generator (4) to the engine and secure with hardware. Torque hardwares to 71.54 ft.lbs. (97 Nm).
2. Install generator pulley (3) and tapered bushing (2) on the generator shaft and secure with hardware. Torque hardwares to 9 ft. lbs. (12 Nm).

Note: Ensure that generator pulley is aligned with engine pulley.

3. Install pulley belt and pulley belt tensioner assembly (1) to generator (4) and secure with hardware.

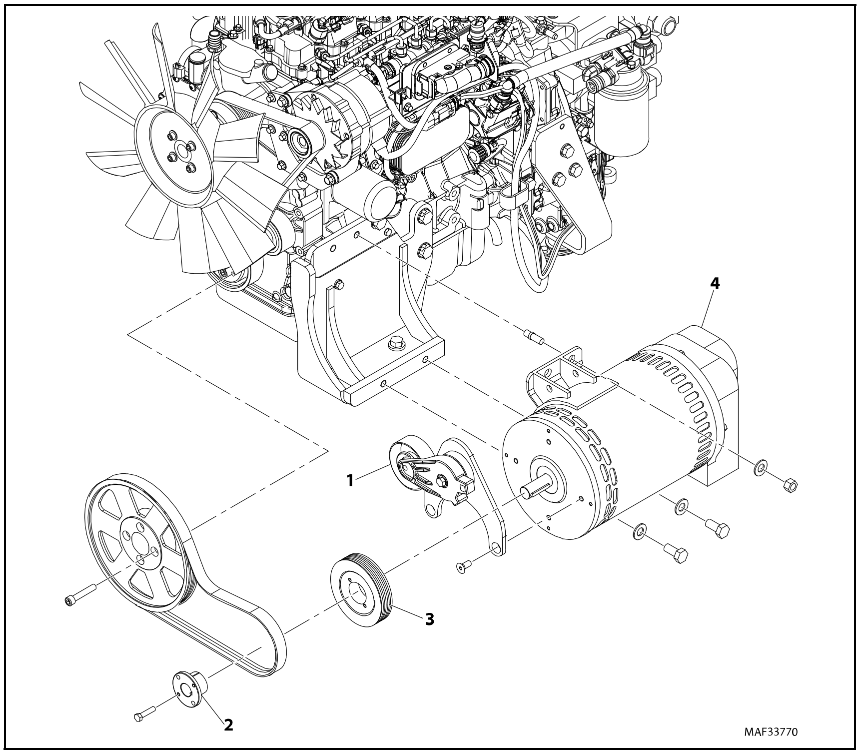


Figure 70. Generator Pulley (7500W and 4000W) - Kubota, Deutz T4F and D2.9L4 Stage V

3.18 DEUTZ ENGINE

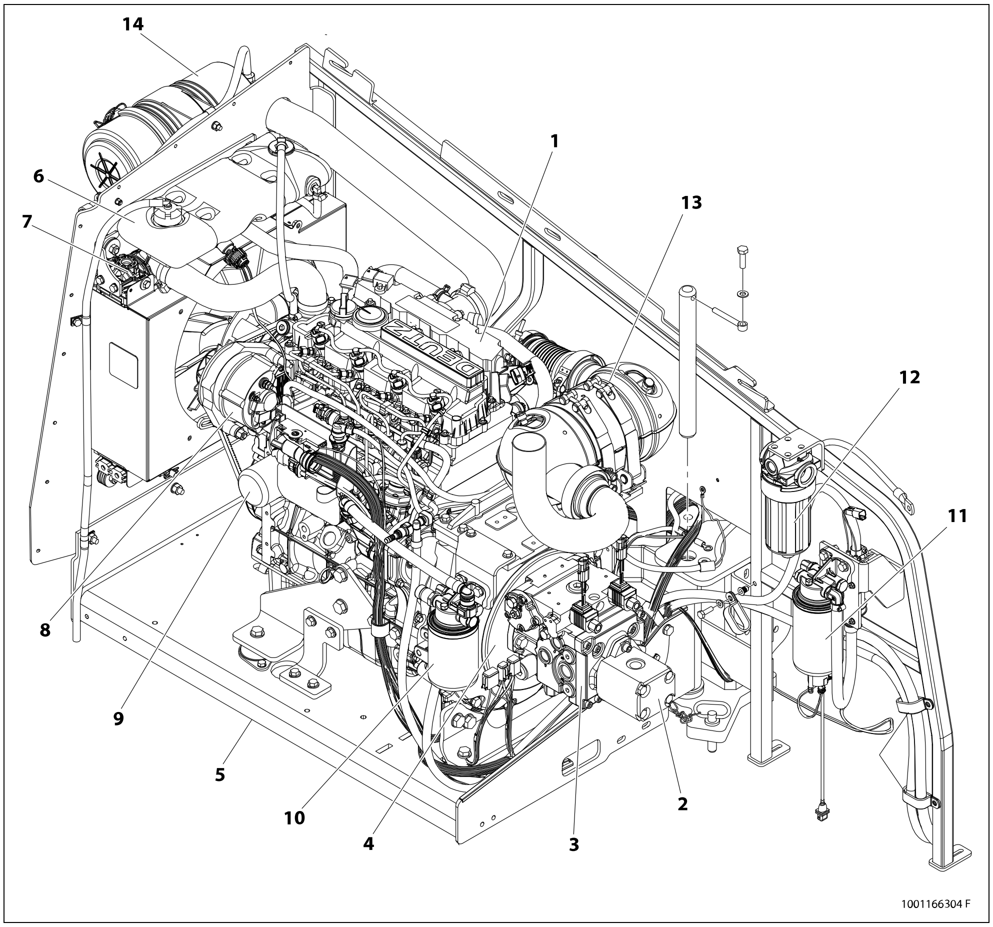


Figure 71. Deutz D2.9L4 Engine Components

1. Engine	6. Surge Tank	11. Fuel Pre-Filter
2. Gear Pump	7. Radiator	12. Hydraulic Filter
3. Piston Pump	8. Alternator	13. Exhaust System
4. Pump Coupling	9. Oil Filter	14. Air Cleaner
5. Engine Tray	10. Fuel Filter	

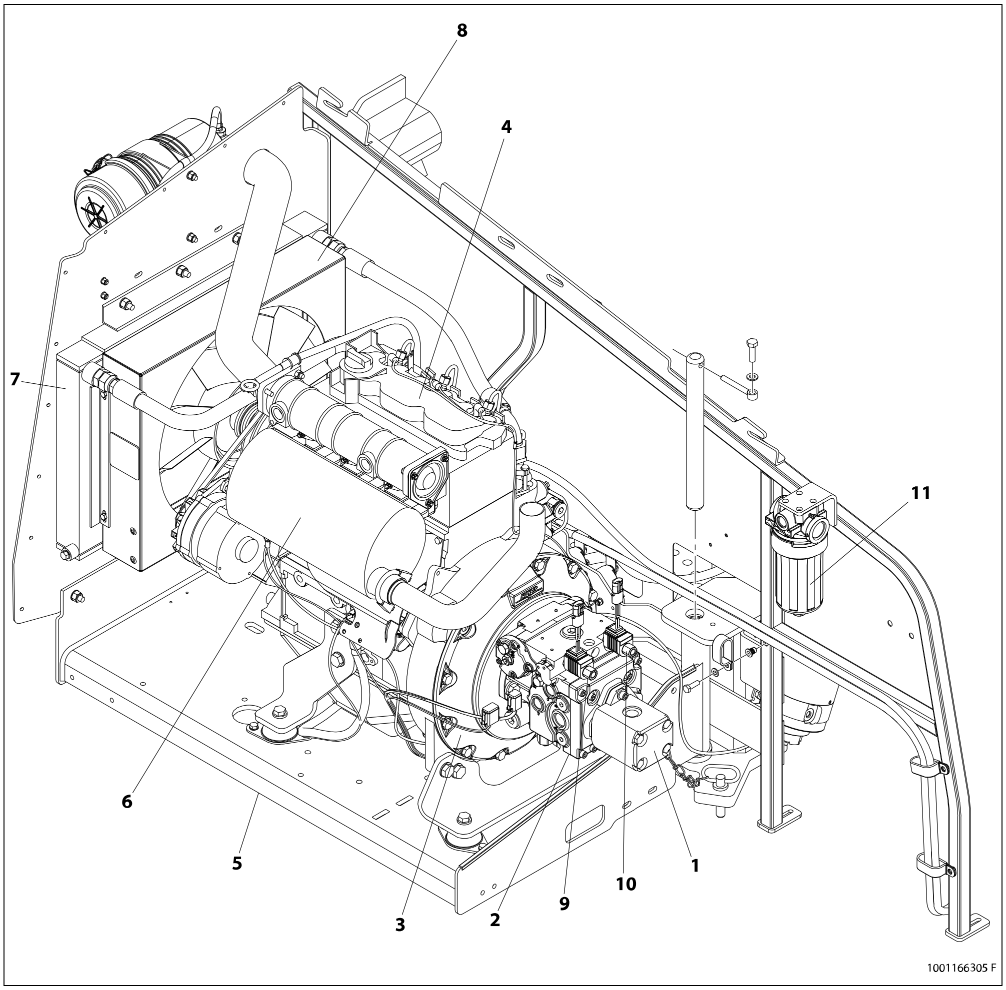


Figure 72. Deutz D2011L03 Engine Components - Sheet 1 of 3

1. Gear Pump	5. Engine Tray	9. Forward Solenoid
2. Piston Pump	6. Muffler	10. Reverse Solenoid
3. Pump Coupling Kit	7. Oil Cooler	11. Hydraulic Filter
4. Engine	8. Radiator	

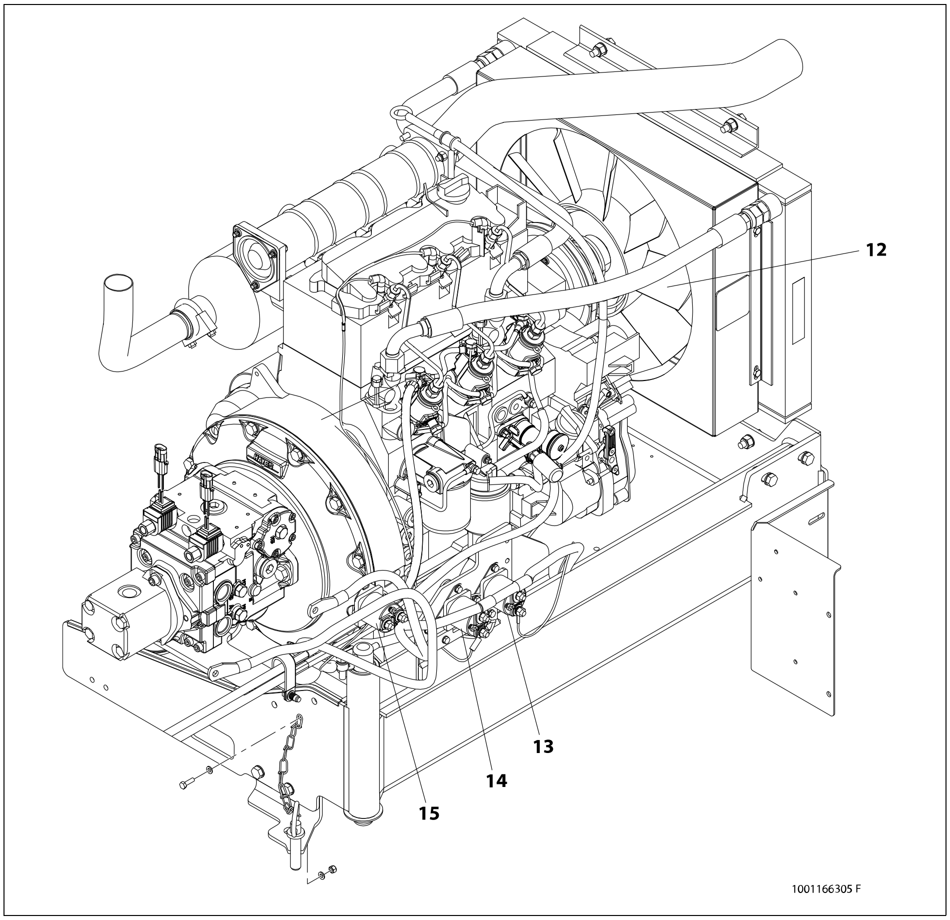


Figure 73. Deutz D2011L03 Engine Components - Sheet 2 of 3

12. Fan	14. Glow Plug Relay
13. Starter Relay	15. Auxiliary Pump Relay

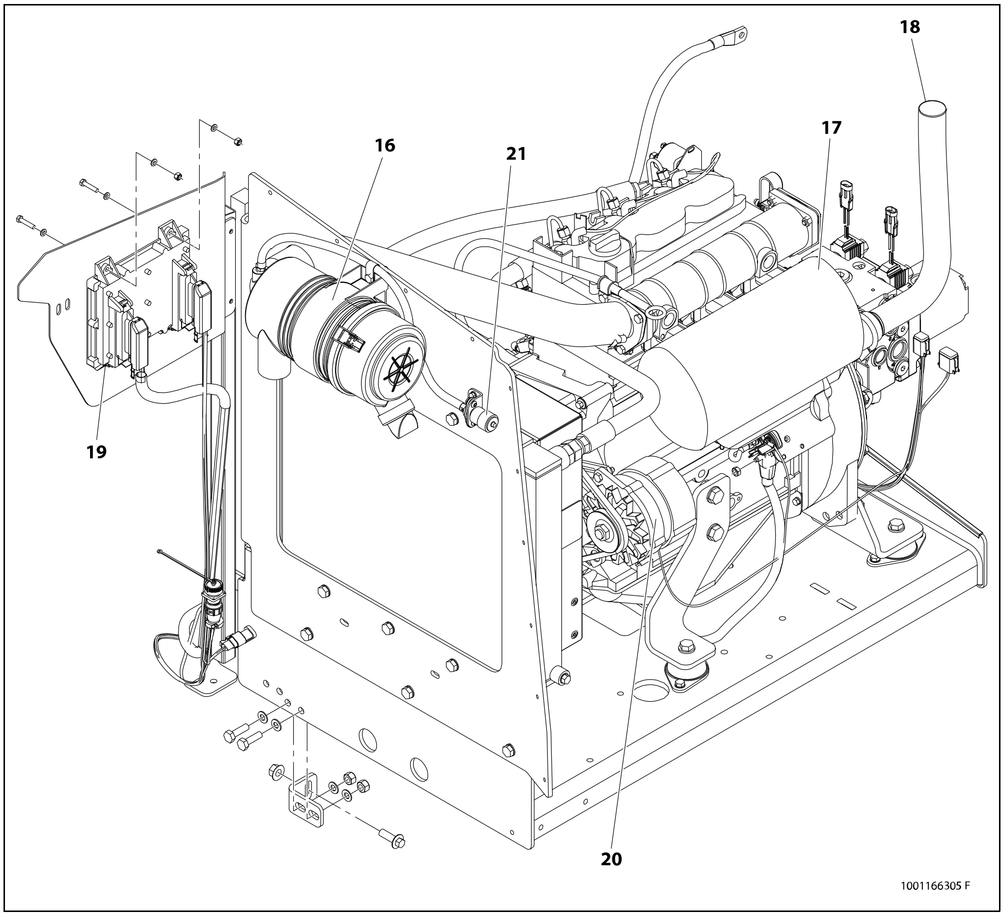


Figure 74. Deutz D2011L03 Engine Components - Sheet 3 of 3

16. Air Cleaner	18. Exhaust Pipe	20. Alternator
17. Muffler	19. ECM	21. Air Intake Restriction Indicator

3.19 KUBOTA ENGINE

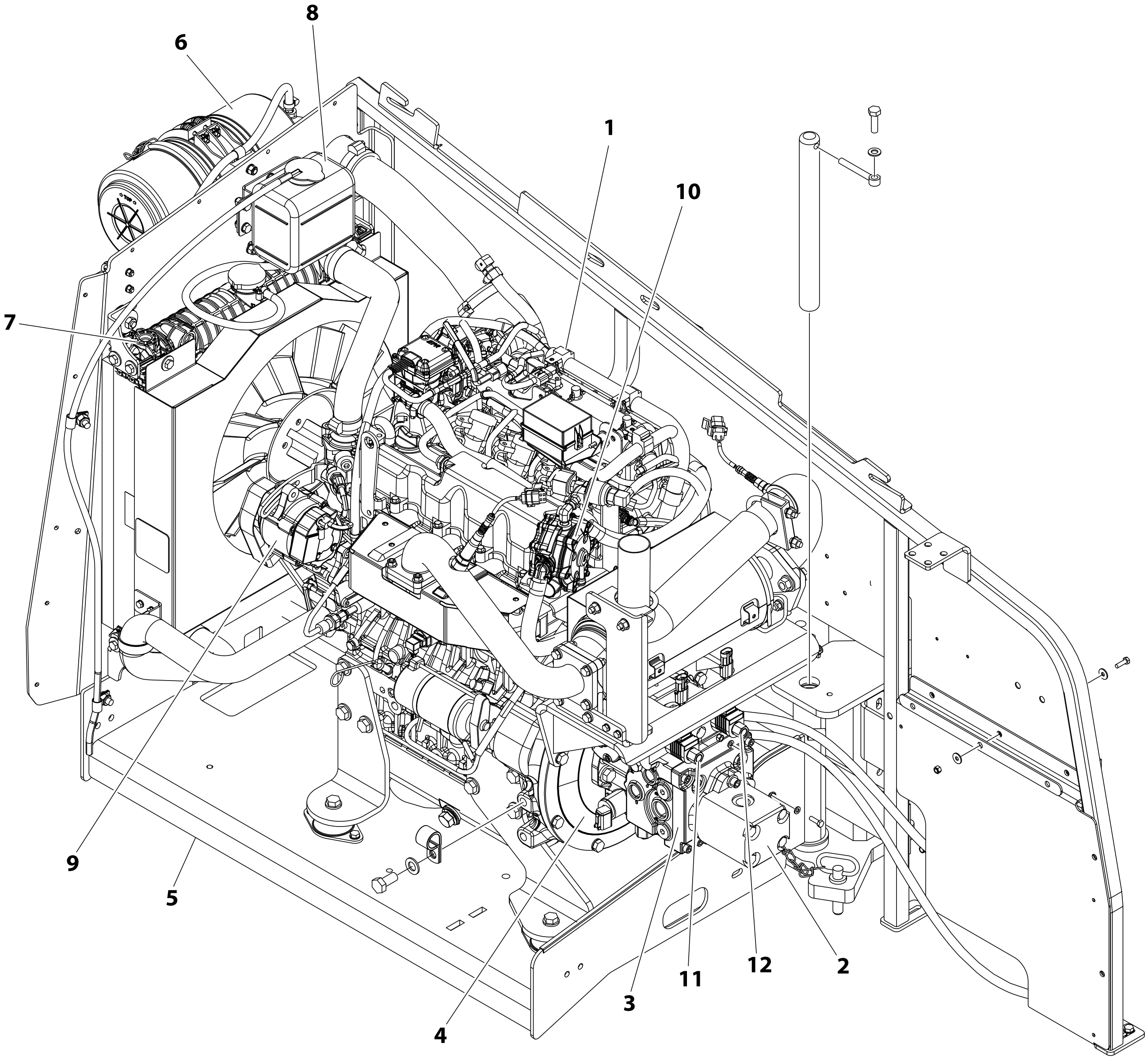


Figure 75. Kubota Engine Components - Sheet 1 of 2

1. Engine	5. Engine Tray	9. Alternator
2. Gear Pump	6. Air Cleaner	10. Regulator assembly
3. Piston Pump	7. Radiator	11. Forward Solenoid
4. Pump Coupling	8. Coolant Overflow Container	12. Reverse Solenoid

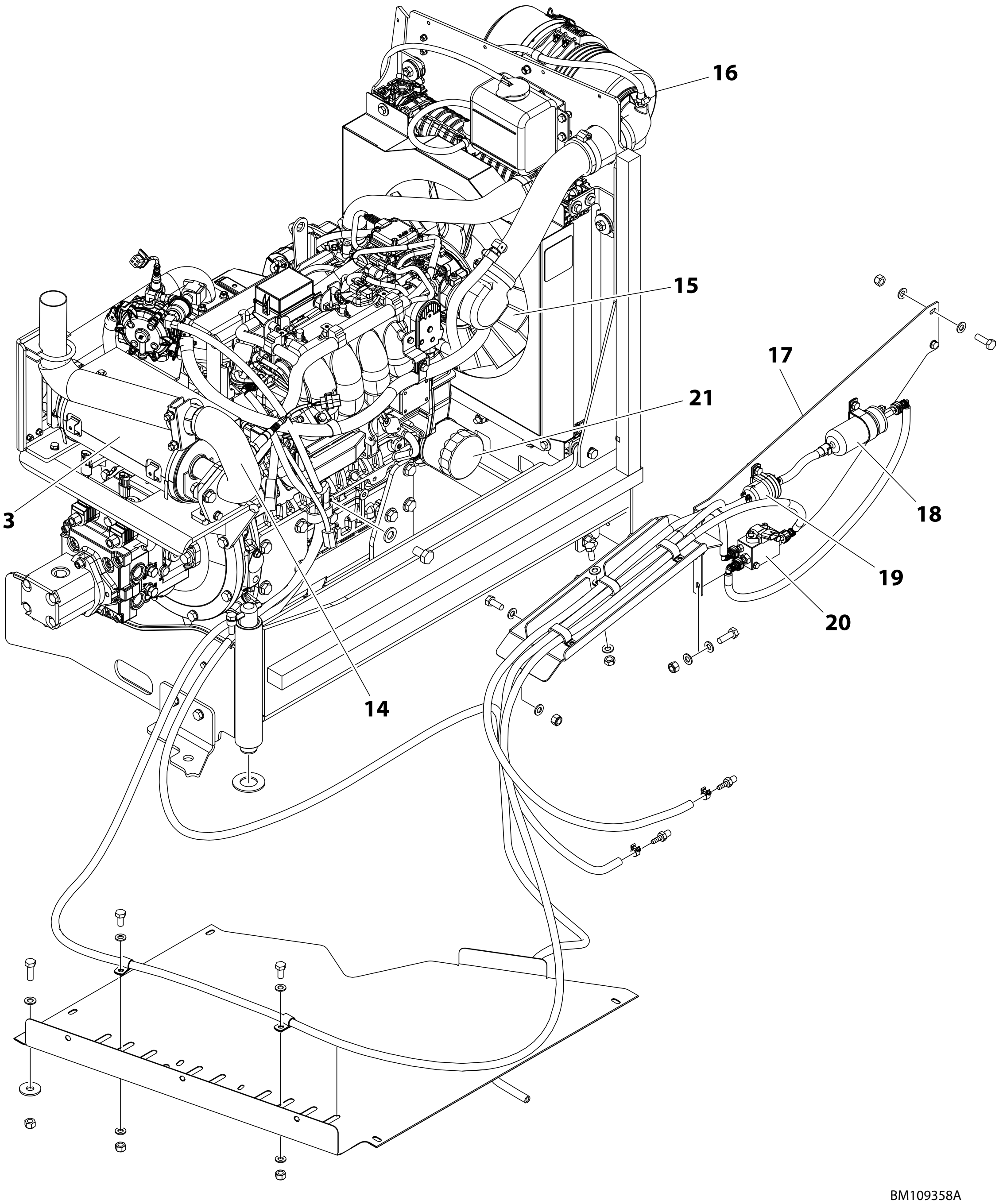


Figure 76. Kubota Engine Components - Sheet 2 of 2

13. Muffler	16. Air Cleaner	19. Fuel Filter
14. Exhaust Pipe	17. Fuel System Mount	20. Fuel Manifold
15. Fan	18. Fuel Pump	21. Oil Filter

3.20 DEUTZ ENGINE - D2.9L4

Note: Refer to engine manufacturer's manual for detailed operating and maintenance instructions. Limited engine maintenance items are presented here for convenience but detailed engine maintenance items and schedule are included in the engine manufacturer's manual.

3.20.1 Check Oil Level

1. Make sure machine and engine are level and switch engine OFF before checking oil level.
2. Remove oil dipstick and wipe with clean cloth.
3. Insert dipstick to the stop and remove again.
4. Check oil level. Top oil level as shown in figure below with an approved grade and type of oil outlined in engine manufacturer's operator's manual.
5. Replace dipstick until fully seated.

3.20.2 Replacing Engine Oil

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

⚠ CAUTION

Hot engine oil can cause burns. Avoid contact with hot oil when draining.

NOTICE

Collect used oil in a container suitable for disposal or recycling. Dispose of used engine oil in accordance with environmental regulations.

5. Open oil drain valve and drain oil.
6. Close oil drain valve.
7. Pour in new engine oil. Refer to *Section — Engine Data, page 12* for capacity and *Figure — Engine Oil Viscosity, page 177*.

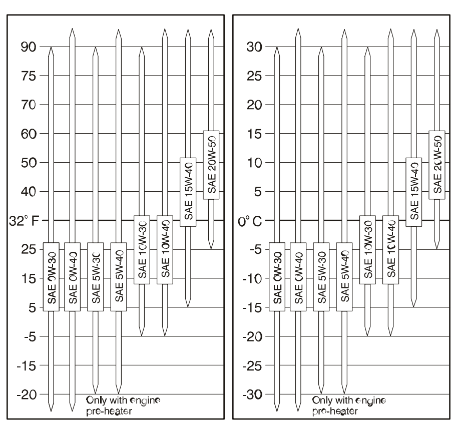
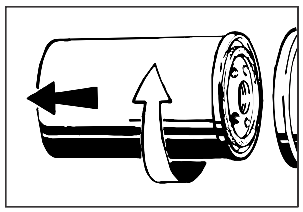


Figure 77. Engine Oil Viscosity

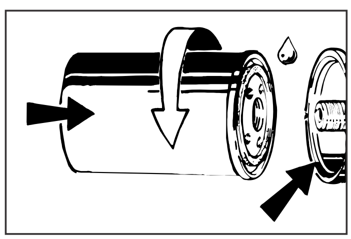
3.20.3 Replacing the Oil Filter

Figure 78. Location of the Oil Filter

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



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil.
6. Screw in new filter by hand until gasket is flush.
7. Hand-tighten filter another half-turn.



8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

3.20.4 Replacing the Fuel Filters

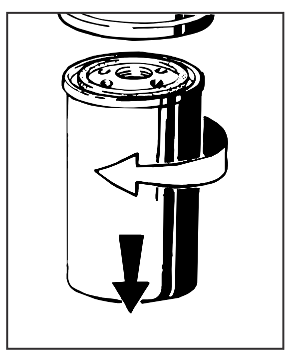
Figure 79. Location of the Fuel Filter

Figure 80. Location of the Fuel Pre-Filter

⚠ WARNING

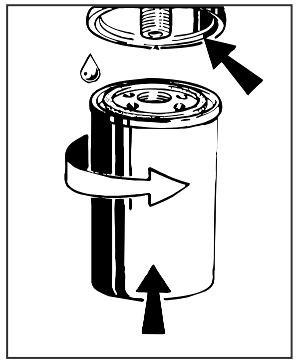
Fuel is flammable and can cause death or serious injury. Make sure no open flames or sparks are in the area when working on fuel system. do not smoke when working on the fuel systems.

1. Wipe area around filter to clean any dirt from area.
2. Fuel supply from the fuel tank may need to be blocked to prevent flow from the fuel tank.
3. Remove fuel filter cartridge.
4. Catch any escaping fuel.



5. Clean dirt from filter carrier sealing surface.
6. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.

7. Screw in new filter by hand until gasket is flush. Hand-tighten filter another 3/4 turn.



8. Check for leaks.

3.21 DEUTZ ENGINE - D2011L03

Note: Refer to engine manufacturer's manual for detailed operating and maintenance instructions. Limited engine maintenance items are presented here for convenience but detailed engine maintenance items and schedule are included in the engine manufacturer's manual.

3.21.1 Check Oil Level

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

5. Insert the dipstick to the stop and remove again. Check the oil level, and if necessary, top the oil level up to the MAX mark with an approved grade and type of oil as outlined in the engine manufacturer's operator's manual. Refer to *Figure — Deutz Engine Dipstick, page 181*.

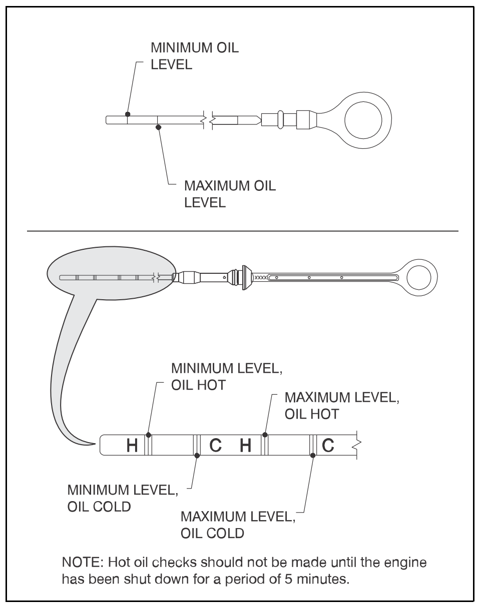


Figure 81. Deutz Engine Dipstick

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

3.21.2 Replacing Engine Oil

1. Allow the engine to warm up. The engine oil should reach approximately 176°F (80°C).

2. Make sure the machine and engine are level.

3. Switch off the engine.

4. Place an oil tray under the engine.

⚠ CAUTION

Hot engine oil can cause burns, avoid contact with hot oil when draining.

NOTICE

Collect used oil in a container suitable for disposal or recycling. Dispose of used engine oil in accordance with environmental regulations.

5. Open the oil drain valve.
6. Drain the oil.
7. Close the oil drain valve.
8. Pour in new engine oil. Refer to *Section — Engine Data, page 12* for capacity and refer to *Figure — Engine Oil Viscosity for the proper grade, page 182*.

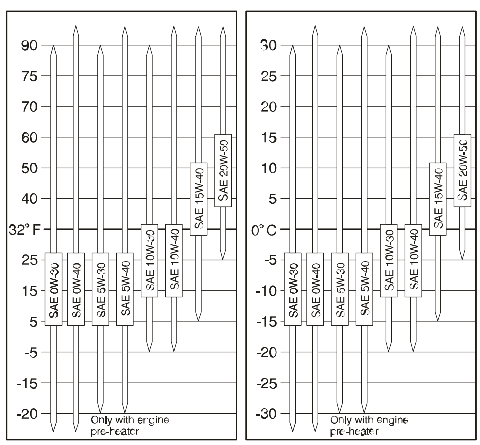
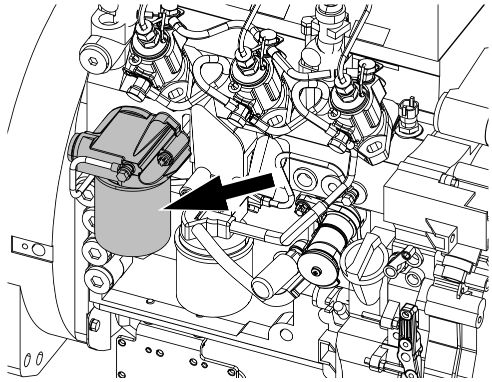
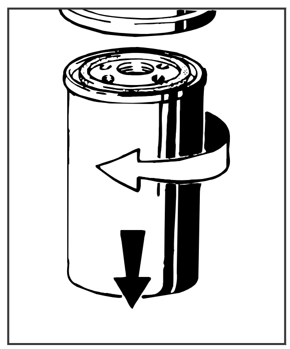


Figure 82. Engine Oil Viscosity

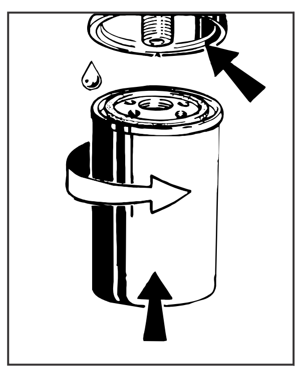
3.21.3 Replacing the Oil Filter



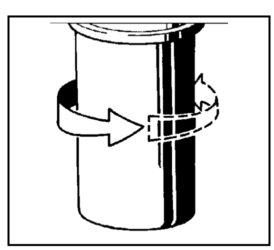
1. Wipe the area around the filter to clean any dirt from the area.
2. Using a suitable oil filter removal tool, loosen lube oil filter element and spin off.



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil.

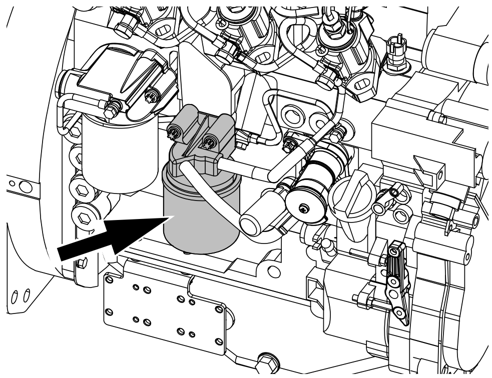


6. Manually screw in the new filter until the gasket is flush.



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

3.21.4 Replacing the Fuel Filter



⚠ WARNING

Fuel is flammable and can cause death or serious injury. Make sure no open flames or sparks are in the area when working on fuel system. Do not smoke when working on the fuel systems.

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

3.21.5 Deutz EMR 2

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

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

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

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

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

After the programming, that is carried out over the ISO9141 interface, the EMR2 possesses a motor-specific data set and this is then fixedly assigned to the engine. Included in this are the various application cases as well as the customer's wishes regarding a particular scope of function.

Each EMR2 module is matched by serial number to the engine. Modules cannot be swapped between engines.

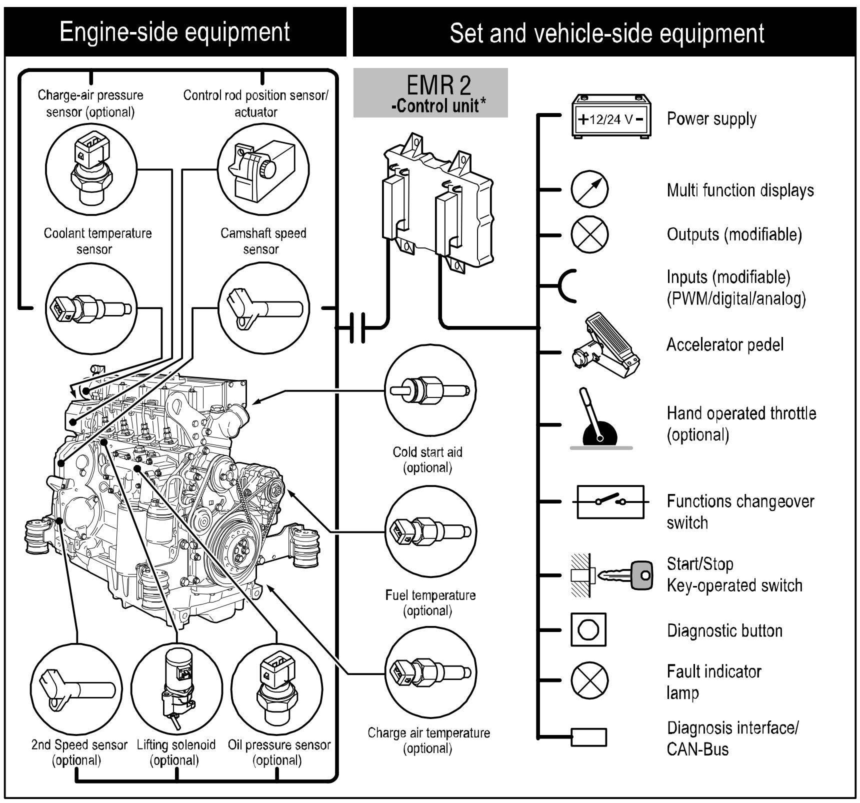


Figure 83. EMR 2 Engine Side Equipment

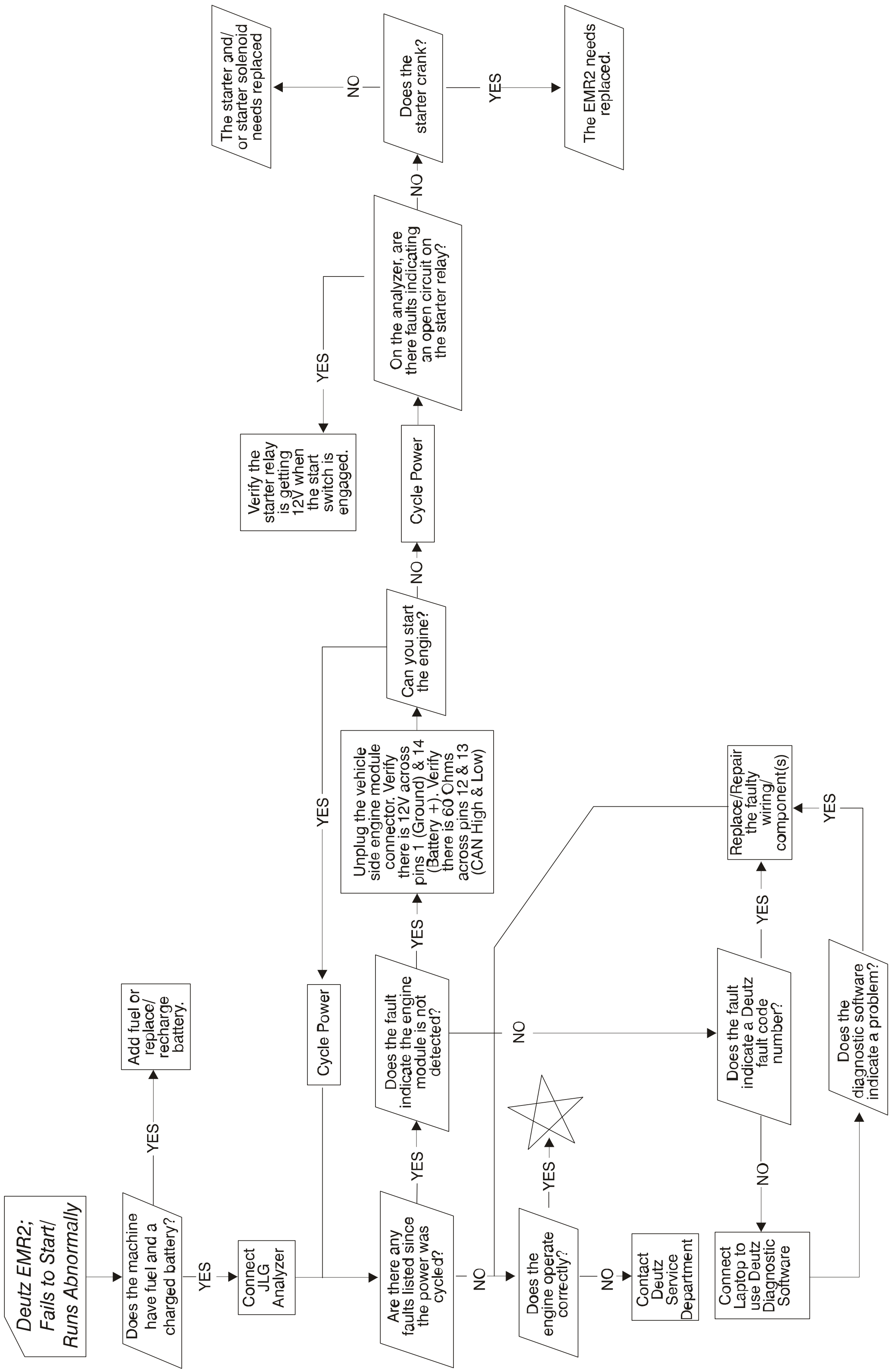


Figure 84. Deutz EMR 2 Troubleshooting Flow Chart

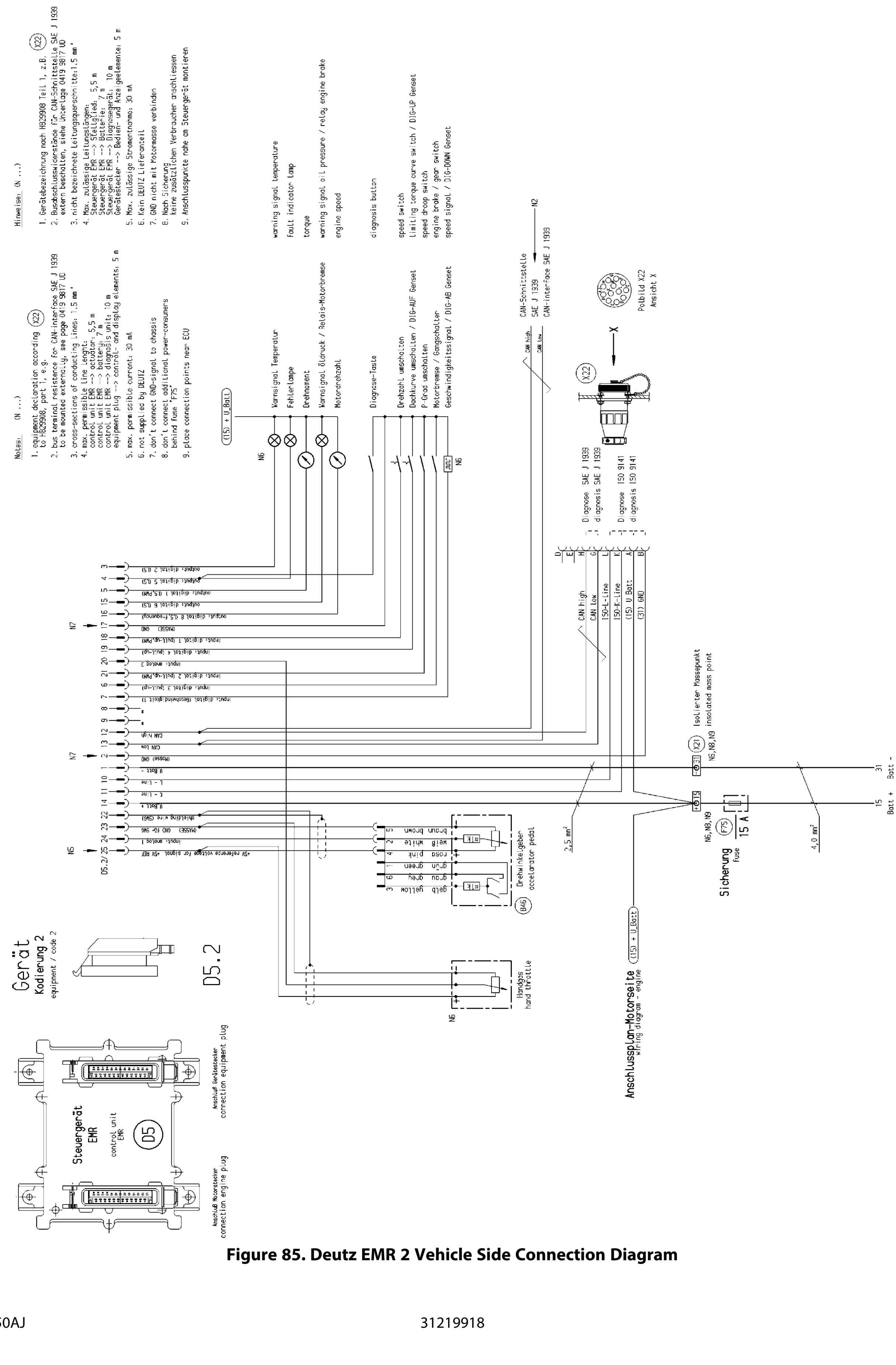


Figure 85. Deutz EMR 2 Vehicle Side Connection Diagram

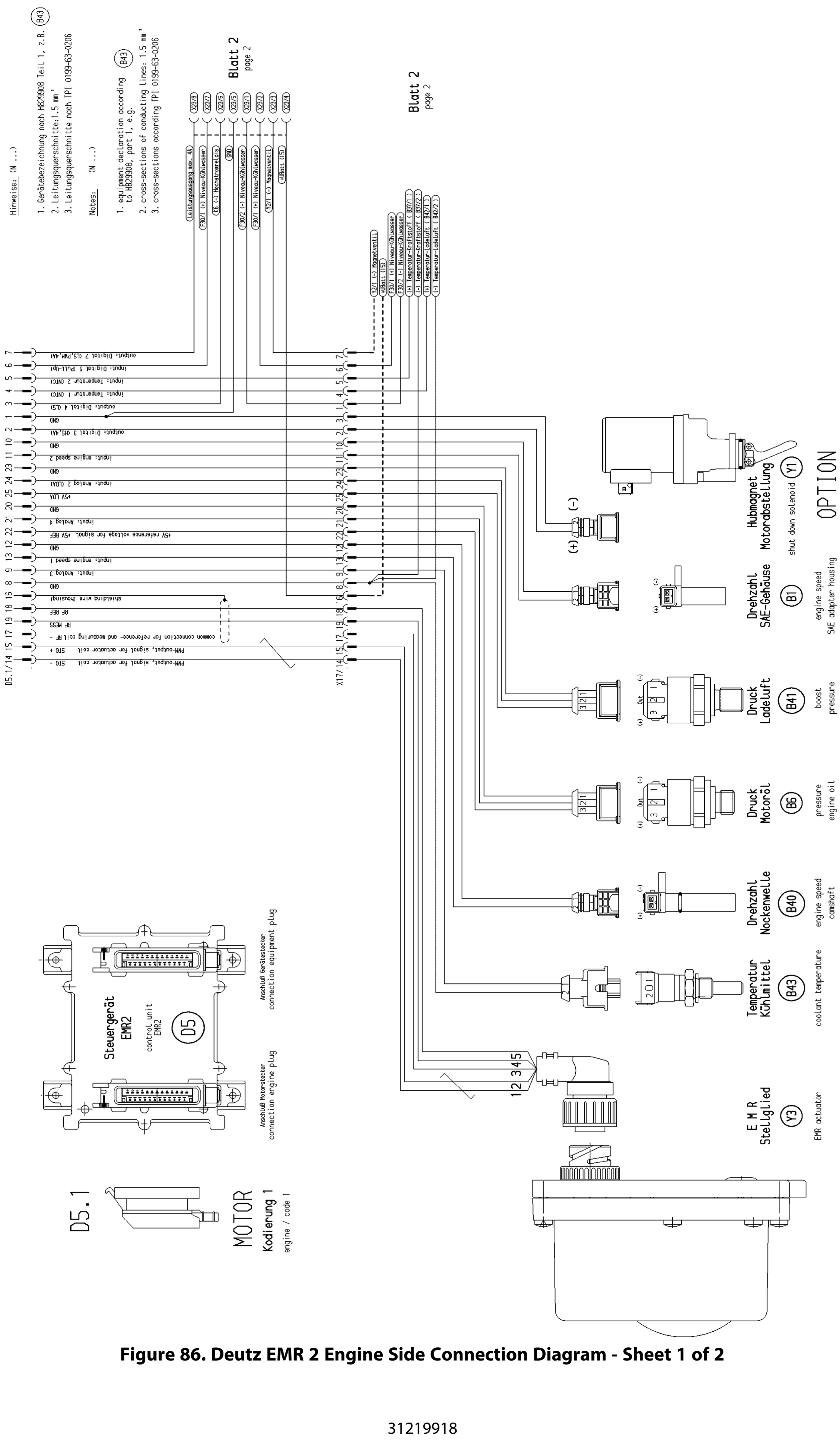


Figure 86. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

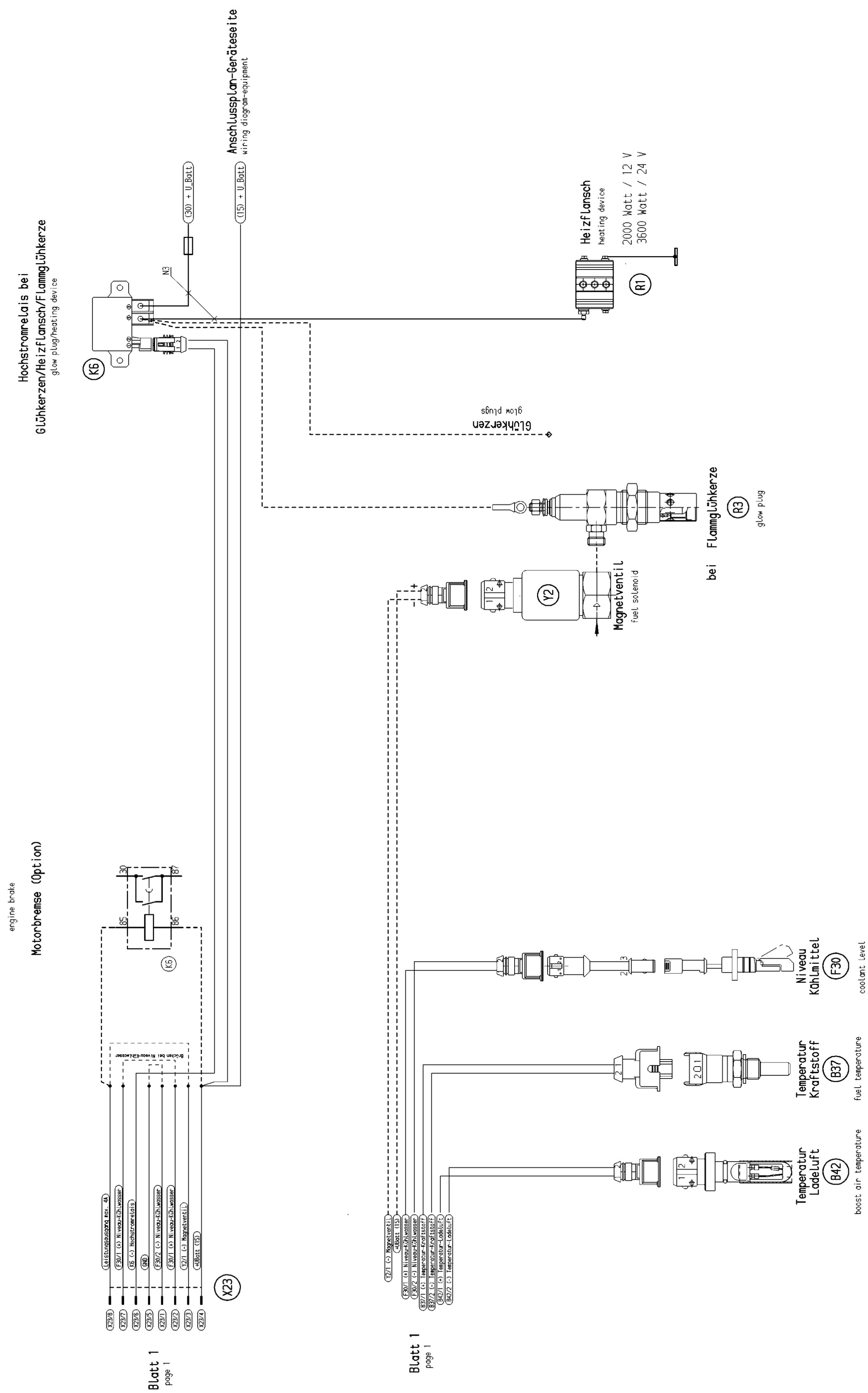
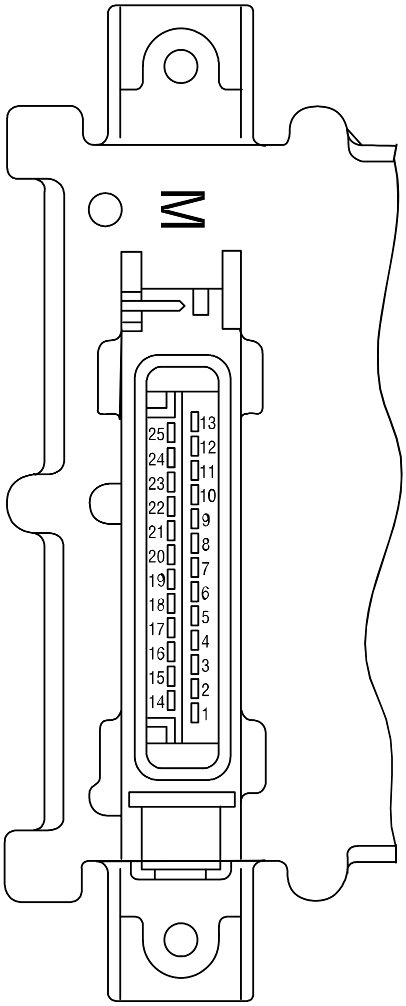


Figure 87. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2

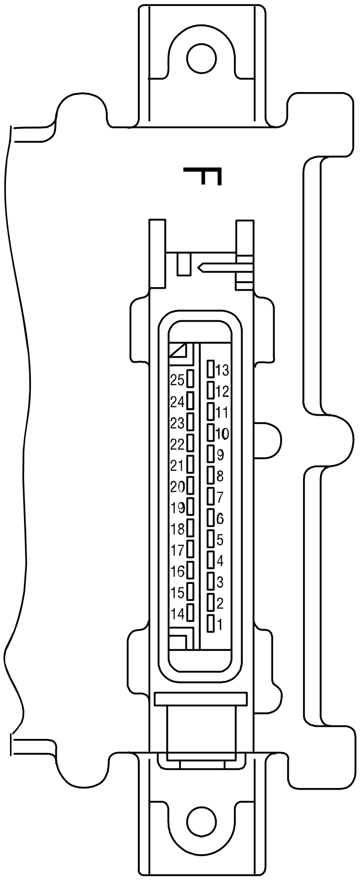


Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid 1)
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature 2)
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) DigIn 5	Coolant 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 88. 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 89. 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).	Check distance. Check cable connection. Check sensor and replace if required.
						Governor in emergency operation (with sensor 1) Emergency switch-off (if sensor 1 not available or failed).	
	03	Speed sensor	84	8	Tacho failed. Additional fault impulses. Cable connection interrupted.	Governor in emergency operation.	Check cable connection and Tacho. Replace if required.
	04	Excess speed switch-off	190	0	Speed was/is in excess of limit.e.	Engine stop.	Check parameter (21). Check speed settings.
					Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator (impulse on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.		
Sensors	07	Charge air pressure	102	2	Fault at corresponding sensor entry (e.g. short circuit or cable break).	With failure of the sensor, the associated monitoring function is de-activated.	Check sensor cable. Check sensor and replace if required. Check fault limits for sensor.
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2			
	10	Charge air temperature	105	2			
	11	Fuel temperature	174	2			

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

Figure 90. 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 91. 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 92. 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 93. 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 94. EMR2 Fault Codes - Sheet 5 of 5

Table 27. Deutz Trouble Codes (D2.9L4 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
155	0	0	-	
1464	0	0	-	
1466	0	0	-	
1467	0	0	-	
1469	0	0	-	
1470	0	0	-	
1471	0	0	-	
1472	0	0	-	
83	16	0	271	No detail informationen!
87	16	0	271	BusOff error CAN
978	29	2	126	Plausibility error between sensor and idle switch, Acceleration Pedal Detection. In case of Hand Throttle with Low Idle Switch, it is the plausibility check between hand throttle and idle switch.
932	29	3	126	Hand throttle idle validation switch; short circuit to battery.
937	29	4	126	Hand throttle; short circuit to ground.
1924	51	3	594	Intake Throttle Flap, H-Bridge, short circuit to battery (A02).
1925	51	3	594	Intake Throttle Flap, H-Bridge, short circuit to battery (A67).
1935	51	3	594	Intake Throttle Flap, H-Bridge, short circuit to battery oder broken wiring harness.
1926	51	4	594	Intake Throttle Flap, H-Bridge, short circuit to ground (A02).
1927	51	4	594	Intake Throttle Flap, H-Bridge, short circuit to ground (A67).
1936	51	4	594	Intake Throttle Flap, H-Bridge, short circuit to ground.
1921	51	5	594	Intake Throttle Flap, H-Bridge, wiring harness broken at connected actuator.
1922	51	6	594	Intake Throttle Flap, H-Bridge, current above maximum threshold.
1931	51	7	594	Intake Throttle Flap, H-Bridge, position of actuator not plausible (deviation from set point more than 7%).
935	91	3	226	Sensor error accelerator pedal. signal range check high.
940	91	4	226	Sensor error accelerator pedal. Signal is below the range.
976	91	11	226	Plausibility error between APP1 and APP2 or APP1 and idle switch.
474	94	1	216	Low fuel pressure; warning threshold exceeded.
475	94	1	216	Low fuel pressure; shut off threshold exceeded.
472	94	3	216	Sensor error low fuel pressure; signal range check high.
473	94	4	216	Sensor error low fuel pressure; signal range check low.
464	97	3	228	Sensor error water in fuel; signal range check high.
465	97	4	228	Sensor error water in fuel; signal range check low.
1157	97	12	228	Water in fuel level prefilter; maximum value exceeded.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
720	98	2	211	Plausibility Check. No detail informationen!
734	100	0	231	High oil pressure; warning threshold exceeded.
735	100	0	231	High oil pressure; shut off threshold exceeded.
736	100	1	231	Low oil pressure; warning threshold exceeded.
737	100	1	231	Low oil pressure; shut off threshold exceeded.
732	100	3	224	Sensor error oil pressure; signal range check high.
733	100	4	224	Sensor error oil pressure sensor; signal range check low.
774	102	1	223	Pressure downstream charge air cooler, pressure below lower physical threshold.
88	102	2	223	Charged air pressure above warning threshold.
89	102	2	223	Charged air pressure above shut off threshold.
772	102	2	223	Pressure downstream charge air cooler, plausibility error.
776	102	3	223	Pressure downstream charge air cooler, short circuit to battery or open load.
777	102	4	223	Pressure downstream charge air cooler, short circuit to ground.
996	105	0	233	Charged air cooler temperature. System reaction initiated. High charged air cooler temperature. Warning threshold exceeded.
997	105	0	233	Low charged air cooler temperature. Shut off threshold exceeded.
992	105	1	128	Charged Air cooler down stream temperature. Temperature below lower physical threshold.
994	105	3	128	Electrical error charged air temperature. Signal range check high.(SRC).
995	105	4	128	Electrical error charged air temperature. Signal range check low.
998	105	11	128	Diagnostic fault check for charged air cooler downstream temperature sensor. No detail informationen!
751	107	0	136	Sensor error airfilter differential pressure; short circuit to ground.
752	107	0	136	Air filter differential pressure; short circuit to ground.
750	107	3	136	Sensor error airfilter differential pressure; short circuit to battery.
412	108	3	292	Sensor error ambient air pressure; signal range check high.
413	108	4	292	Sensor error ambient air pressure; signal range check low.
411	108	11	292	DFC for CAN message.
92	110	0	225	Physical Range Check high for Coolant temperature.
98	110	0	232	High coolant temperature; warning threshold exceeded.
99	110	0	232	Coolant temperature; system reaction initiated.
93	110	1	225	Physical Range Check low for Coolant temperature.
90	110	2	225	defect fault check for Absolute plausibility test

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
				No detail informationen!
96	110	3	225	Sensor error coolant temperature; signal range check high.
97	110	4	225	Sensor error coolant temperature; signal range check low.
1	110	11	226	Air flow sensor load correction factor exceeding the maximum drift limit; plausibility error.
101	111	1	235	Coolant level too low.
8	132	1	226	The air mass flow AFS_dm is greater than or equal to AFS_PhysRng.Min_C. Physical Range Check low for air mass flow sensor No detail informationen!
874	157	0	147	Rail pressure raw value is intermittent No detail informationen!
875	157	1	147	rail pressure raw value is above maximum offset No detail informationen!
877	157	3	147	Sensor error rail pressure Sensor voltage above upper limit.
878	157	4	147	Sensor error rail pressure. Sensor voltage below lower limit.
1381	164	2	839	Rail pressure safety function is not executed correctly ().
1180	168	0	318	Physical range check high for battery voltage.
1181	168	1	318	Physical range check low for battery voltage.
47	168	2	318	High battery voltage; warning threshold exceeded.
48	168	2	318	High battery voltage; shot off threshold exceeded.
45	168	3	318	Sensor error battery voltage; signal range check high.
46	168	4	318	Sensor error battery voltage; signal range check low.
415	171	0	312	Environment temperature sensor, temperature above upper physical threshold.
416	171	1	312	Environment Temperature Physical Range Check low.
417	171	3	312	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check high.
418	171	4	312	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check low.
1425	172	0	226	air temperature within air filter box above maximum physical value.
1183	172	1	226	Air inlet filter sensor out of physical range check.
9	172	2	226	Air inlet filter temperature, plausibility error.
981	172	3	226	Air flow temperature sensor; short circuit to battery or open load.
982	172	4	226	Air flow temperature sensor; short circuit to ground.
483	174	11	227	DFC for fuel temperature plausibility check function No detail informationen!
745	175	0	144	High oil temperature; warning threshold exceeded.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
746	175	0	144	High oil temperature; shut off threshold exceeded.
1171	175	2	144	Customer oil temperature: signal unplausible.
743	175	3	144	Sensor error oil temperature; signal range check high.
744	175	4	144	Sensor error oil temperature; signal range check low.
388	190	0	214	Engine speed above warning threshold. Overspeed detection in component engine protection.
389	190	0	214	Engine speed above warning threshold (FOC-Level 1).
421	190	2	213	Offset angle between crank- and camshaft sensor is too large.
419	190	8	212	Sensor camshaft speed; disturbed signal.
422	190	8	212	Sensor crankshaft detection; out of range, signal disrupted; disturbed signal.
390	190	11	214	Engine speed above warning threshold (FOC-Level 2).
420	190	12	212	Sensor camshaft detection; out of range, signal disrupted; no signal.
423	190	12	212	Speed detection; out of range, signal disrupted Sensor crankshaft speed; no signal.
1222	190	14	212	Camshaft- and Crankshaft speed sensor signal not available on CAN.
391	190	14	214	Engine speed above warning threshold (Overrun Mode).
791	411	0	693	delta pressure across venturi in EGR line above physical high limit.
795	411	3	693	Sensor error differential pressure Venturiunit (EGR), signal range check low.
381	411	4	693	Physical range check low for EGR differential pressure.
796	411	4	693	Sensor error differential pressure Venturiunit (EGR), signal range check high.
793	411	11	693	Plausibility Check fault for deviation of desired and actual EGR-mass flow, where the latter is calculated out of EGR Delta Pressure Sensor.
1007	412	3	682	Electrical error EGR cooler downstream temperature. Signal range check high.
1008	412	4	682	electrical error EGR cooler downstream temperature. Signal range check low.
306	520	9	119	Timeout Error of CAN-Receive-Frame TSC1TR; control signal.
106	598	2	325	Plausibility check for Clutch No detail informationen!
971	624	3	513	SVS lamp; short circuit to battery.
972	624	4	513	SVS lamp; short circuit to ground.
969	624	5	513	SVS lamp; open load.
970	624	12	513	SVS lamp: powerstage over temperature.
376	630	12	281	Access error EEPROM memory (delete).

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
377	630	12	281	Access error EEPROM memory (read).
378	630	12	281	Access error EEPROM memory (write).
84	639	14	271	CAN-Bus 0 "BusOff-Status"
580	651	3	154	Injector 1 (in firing order); short circuit.
568	651	5	154	Injector 1 (in firing order); interruption of electric connection.
581	652	3	155	Injector 2 (in firing order); short circuit.
569	652	5	155	Injector 2 (in firing order); interruption of electric connection.
582	653	3	156	Injector 3 (in firing order); short circuit.
570	653	5	156	Injector 3 (in firing order); interruption of electric connection.
583	654	3	161	Injector 4 (in firing order); short circuit.
571	654	5	161	Injector 4 (in firing order); interruption of electric connection.
584	655	3	162	Injector 5 (in firing order); short circuit.
590	655	4	162	High side to low side short circuit in the injector 5 (in firing order).
572	655	5	162	Injector 5 (in firing order); interruption of electric connection.
585	656	3	163	Injector 6 (in firing order); short circuit.
591	656	4	163	High side to low side short circuit in the injector 6 (in firing order).
573	656	5	163	Injector 6 (in firing order); interruption of electric connection.
543	676	11	263	Cold start device relay error.
544	676	11	263	Cold start aid relay open load.
956	677	3	512	Starter relay high side. Short circuit to battery.
960	677	3	512	Starter relay low side short circuit to battery.
957	677	4	512	Starter relay high side short circuit to ground.
961	677	4	512	Starter relay low side short circuit to ground.
958	677	5	512	Starter relay low side no load error.
959	677	12	512	Starter relay powerstage over temperature.
549	729	3	263	Intake Air Heater Device; Short circuit to battery.
551	729	4	263	Air intake heater; Short circuit to ground error for powerstage on CJ945.
545	729	5	263	Cold start aid relay open load.
547	729	12	263	Cold start aid relay; over temperature error.
305	898	9	118	Timeout Error of CAN-Receive-Frame TSC1TE; Setpoint.
457	975	3	238	PWM-Signal Fan, short-circuit to plus.
458	975	4	238	PWM-Signal Fan, open load or short circuit to ground.
455	975	5	238	PWM-Signal Fan, Open load or short-circuit ground.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
946	1079	13	282	Failure of sensor supply voltage 1.
947	1080	13	282	Failure of sensor supply voltage 2.
121	1109	2	341	Engine shut off demand ignored.
1398	1136	0	681	Physical range check high for ECU temperature.
847	1176	0	139	Pressure sensor upstream turbine, Physical Range Check high.
848	1176	1	139	Pressure sensor upstream turbine, Physical Range Check low.
849	1176	3	141	Pressure sensor upstream turbine, signal range check (SRC) high.
850	1176	4	141	Pressure sensor upstream turbine, signal range check (SRC) low.
1193	1180	0	556	Physical range check high for exhaust gas temperature upstream turbine.
1194	1180	1	556	Physical range check low for exhaust gas temperature upstream turbine.
1067	1180	3	556	Sensor error exhaust gas temperature upstream turbine; signal range check high.
1068	1180	4	556	Sensor error exhaust gas temperature upstream turbine; signal range check low.
1799	1188	0	814	Turbocharger wastegate, temperature critical high.
1414	1188	2	814	Wastegate; status message from ECU missing.
1789	1188	2	814	Turbocharger wastegate, CAN Error.
1794	1188	3	814	Turbocharger wastegate, supply voltage above maximum threshold.
1795	1188	4	814	Turbocharger wastegate, supply voltage below minimum threshold.
1793	1188	6	814	Turbocharger wastegate, current above maximum threshold.
1415	1188	7	814	Wastegate actuator; blocked.
1788	1188	7	814	Turbocharger wastegate, mechanical blocking detected.
1797	1188	7	814	Turbocharger wastegate, broken spring detected.
1411	1188	11	814	Wastegate actuator; internal error.
1412	1188	11	814	Wastegate actuator; EOL calibration not performed correctly.
1417	1188	11	814	Wastegate actuator; over temperature (> 135°C).
1418	1188	11	814	Wastegate actuator; operating voltage error.
1791	1188	12	814	Turbocharger wastegate, internal electrical error.
1413	1188	13	814	Wastegate actuator calibration deviation too large, recalibration required.
1790	1188	13	814	Turbocharger wastegate, EOL calibration error.
1792	1188	13	814	Turbocharger wastegate, learning process aborted.
1796	1188	13	814	Turbocharger wastegate, learning process out of range.
85	1231	14	271	CAN-Bus 1 "BusOff-Status"
82	1235	14	271	CAN-Bus 2 = CAN_C reports Bus-error(for engines <8L and CV52 it is the engine-CAN@250kbaud) CAN Bus error passive; warning CAN C - engine CAN.
86	1235	14	271	CAN-Bus 2 = engine bus "BusOff-Status"

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
747	1237	2	145	Override switch; plausibility error.
604	1323	12	241	Too many recognized misfires in cylinder 1 (in firing order).
611	1346	0	241	Misfire detection monitoring No detail informationen!
542	1638	2	314	Hydraulic oil temperature check for Shut off condition No detail informationen!
460	1639	0	238	Sensor error fan speed; signal range check high or engine speed resp. fan speed too big.
461	1639	1	238	Sensor error fan speed; signal range check low or fan speed too low.
459	1639	12	238	Fan speed sensor; electrical error or signal disturbed or very low fan speed.
1593	1761	0	129	DEF tank, DEF level above upper physical threshold.
1594	1761	1	129	DEF tank, DEF level below lower physical threshold.
1869	1761	2	129	DEF tank level, plausibility error.
1074	1761	14	127	DEF tank level; warning threshold exceeded.
1654	1761	14	138	Urea Tank Signal to HMI for indicating the Urea Tank-Level (Urea tank volume ratio low threshold 1).
1655	1761	14	138	DEF tank, DEF level below first warning threshold.
1656	1761	14	138	DEF tank, DEF level below second warning threshold.
1880	1761	14	138	DEF tank, DEF level below third warning threshold.
654	2634	12	757	Early opening defect of main relay No detail informationen!
656	2634	12	757	DFC for stuck main relay error No detail informationen!
1524	2659	0	822	Exhaust Gas Recirculation AGS Sensor; Sensed exhaust mass value above maximum physical value.
1525	2659	1	822	Exhaust Gas Recirculation AGS Sensor; Sensed exhaust mass value below miniimum physical value.
1523	2659	2	822	Exhaust Gas Recirculation AGS Sensor; signal not plausible.
1527	2659	2	822	Exhaust Gas Recirculation AGS Sensor; Temperature of EGR mass not plausible.
1526	2659	12	822	Exhaust Gas Recirculation AGS Sensor; plausibility error, AGS sensor has not passed the burn off process.
1763	2791	0	415	EGR actuator, temperature critical high.
1753	2791	2	415	EGR actuator, CAN error.
1758	2791	3	415	EGR actuator supply voltage is above the maximum threshold.
1759	2791	4	415	EGR actuator supply voltage is below minimum threshold.
1757	2791	6	415	EGR actuator current is above maximum threshold.
1752	2791	7	415	EGR actuator, actuator blocked.
1761	2791	7	415	EGR actuator, broken spring detected.
384	2791	12	415	Actuator EGR Valve; powerstage over temperature.
1755	2791	12	415	EGR Actuator, internal electrical fault.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1754	2791	13	415	EGR actuator, EOL calibration error.
1756	2791	13	415	EGR actuator, learning process aborted.
1760	2791	13	415	EGR actuator, learning process out of range.
1762	2791	16	415	EGR actuator, temperature high.
1337	2797	4	565	Timeout of Short-Circuit Ground Diagnosis Cyl. Bank 0;_IVDiaShCirGndToutBnk_0.
1339	2797	4	565	Injector diagnostic; Short circuit to ground cylinder bank 0.
1338	2798	4	566	Timeout of Short-Circuit Ground Diagnosis Cyl. Bank 1;_IVDiaShCirGndToutBnk_1.
1340	2798	4	566	Injector diagnostic; Short circuit to ground cylinder bank 1.
1135	3031	0	669	DEF tank, DEF temperature in DEF tank is to high.
1136	3031	1	669	DEF tank, DEF temperature below lower physical threshold.
1870	3031	2	669	Urea tank temperature outside of plausible thresholds.
273	3219	2	649	DFC SAE J1939 error No detail informationen!
889	3224	1	185	DFC for plausibility error Max for NOx sensor upstream of SCR Cat.
127	3224	2	596	DLC Error of CAN-Receive-Frame AT1IG1 NOX Sensor (SCR-system upstream cat; DPF-system downstream cat); length of frame incorrect.
129	3224	2	596	DLC Error of CAN-Receive-Frame AT1IG1Vol NOX sensor.
128	3224	9	597	Timeout Error of CAN-Receive-Frame AT1IG1; NOX sensor upstream.
130	3224	9	597	Timeout Error of CAN-Receive-Frame AT1IG1Vol; NOX sensor.
659	3226	2	813	Nox feed back fault detection No detail informationen!
196	3227	2	638	DFC SAE J1939 error No detail informationen!
136	3234	2	114	DLC Error of CAN-Receive-Frame AT1O1 No detail informationen!
138	3234	2	114	DLC Error of CAN-Receive-Frame AT1O1Vol NOX.
137	3234	9	117	Timeout Error of CAN-Receive-Frame AT1OG1; NOX sensor (SCR-system down-stream cat; DPF-system downstream cat).
139	3234	9	117	Timeout Error of CAN-Receive-Frame AT1OG1Vol.
887	3234	11	184	DFC for plausibility error Min for NOx sensor downstream of SCR Cat.
905	3241	0	883	Sensor SCR catalyst upstream temperature too high; plausibility error.
1047	3248	4	685	Sensor error particle filter downstream temperature; signal range check low.
809	3251	0	692	Differential pressure DPF maximum value is exceeded.
810	3251	0	692	Differential pressure sensor across DPF exceeds warning high limit.
812	3251	1	692	Differential pressure DPF, pressure below lower shutoff threshold.
813	3251	1	692	Differential pressure DPF, pressure below lower warning threshold.
807	3253	2	692	Differential pressure DPF, plausibility error.
1380	3253	2	692	Sensor differential pressure (DPF); plausibility error.
814	3253	3	692	Electrical error differential pressure B58 (DPF). (signal range check high).

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
815	3253	4	692	Electrical error differential pressure (DPF). signal range check low.
1077	3361	3	677	DEF dosing valve; short circuit to battery on low side.
1078	3361	3	677	DEF dosing valve; short circuit to battery or open load on high side.
1079	3361	4	677	Urea dosing valve; short circuit to ground or open load on low side.
1080	3361	4	677	DEF dosing valve; short circuit on high side.
1075	3361	6	677	DEF dosing valve; power at the end of injection too high.
908	3361	7	886	DEF dosing valve blocked (SCR).
1898	3519	3	277	DEF quality sensor, internal temperature sensor short circuit to battery or open load
1899	3519	4	277	DEF quality sensor, internal temperature sensor short circuit to ground.
1895	3519	12	277	DEF tank temperature, temperature too high
1908	3519	13	277	Temperature at UQS invalid.
1904	3520	2	278	DEF quality seonsor, bad DEF quality detected or no DEF measuring possible.
1896	3520	3	278	DEF quality sensor, short circuit to battery or open load
1897	3520	4	278	DEF quality sensor, short circuit to ground
1907	3520	13	278	Urea quality at UQS invalid.
943	3532	3	127	Sensor error DEF tank level; signal range check high.
1911	3532	3	127	The DEF Level at UQS out of max. physical range.
945	3532	4	127	Sensor error DEF tank level; signal range check low.
1912	3532	4	127	Quality at UQS out of min. physical range.
1635	3699	0	818	Maximum standstill time reached; oil exchange request ignored.
1616	3699	2	818	Passive regeneration of DPF; plausibility error.DPF differential pressure sensor and a further sensor or actuator CRT system defective.
1617	3699	2	818	Passive regeneration of DPF; DOC error.Temperature sensor us. and ds. DOC simultaneously defect.
1455	3711	12	711	Temperature during stand-still main phase too low or too high.
1917	3936	14	286	Standstill request ignored too long.
1918	3936	14	286	Standstill time based escalation requests Inducement step 2.
2011	4171	2	668	Dynamic temperature check of temp before SCR.
1089	4243	11	783	SCR heater; Pressure line heater error and temperature condition to perform an afterrun (Group error diagnosis heater).SCR system heater diagnostic reports error; shut off SCR-system.
1122	4334	0	665	Supply module DEF, DEF pressure above upper physical threshold.
1124	4334	0	665	Urea pump pressure sensor; high signal not plausible.
1123	4334	1	665	Urea supply module pressure sensor; physical range check low (defect pressure sensor).

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1125	4334	1	665	Urea pump pressure sensor; low signal not plausible.
1866	4334	2	665	DEF supply module pressure, plausibility error.
1104	4341	3	675	SCR-heater DEF supplyline; short circuit to battery.
1105	4341	4	675	SCR-heater DEF supply line; short circuit to ground.
1086	4341	5	675	SCR heater relay DEF supplyline secondary side; open load.
1102	4341	5	675	SCR heater relay DEF supply line primary side; open load.
1096	4343	3	673	SCR heater DEF pressureline; short circuit to battery.
1097	4343	4	673	SCR heater DEF pressureline; short circuit to ground.
1083	4343	5	673	SCR heater relay DEF pressureline secondary side; open load.
1094	4343	5	673	SCR heater relay DEF pressureline primary side; open load.
893	4343	11	871	SCR Monitoring; Pressure stabilisation error, general pressure check error (SCR).
1095	4343	12	673	Over Temperature error No detail informationen!
1092	4345	3	674	SCR heater DEF returnline; short circuit to battery.
1093	4345	4	674	SCR heater DEF returnline; short circuit to ground.
1081	4345	5	674	SCR heater relay DEF returnline sekondary side; open load.
1090	4345	5	674	SCR heater relay DEF returnline primary side; open load.
892	4345	11	236	Sensor backflow line pressure (SCR); plausibility error.
1091	4345	12	674	Over Temperature error .No detail informationen!
1069	4360	0	668	Exhaust temperature upstream SCR-Cat, temperature above upper physical threshold.
1070	4360	1	668	Sensed exhaust temperature before SCR-Cat is < physical low limit.
1865	4360	2	668	Exhaust temperature sensor upstream SCR, plausibility error.
1071	4361	2	668	Signal error for CAN message .No detail informationen!
1072	4361	3	668	Sensor error DEF catalyst exhaust gas temperature upstream; signal range check high.
1073	4361	4	668	Sensor error DEF catalyst exhaust gas temperature upstream; signal range check low.
903	4365	0	881	DEF tank temperature too high.
1137	4365	2	669	Tank temperature signal error for CAN message.
1138	4365	3	669	Sensor error urea tank temperature: short circuit to battery.
1914	4365	3	669	DEF qualitysensor, tank temperatur; Short circuit to battery or open load.
1139	4365	4	669	Sensor error urea tank temperature; short circuit to ground.
1915	4365	4	669	DEF qualitysensor, tank temperatur; Short circuit to ground.
1112	4366	3	671	SCR Tank heating valve; short circuit to battery.
1113	4366	4	671	SCR Tank heating valve; short circuit to ground.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1088	4366	5	671	SCR Tank heating valve secundary side: open load.
1110	4366	5	671	SCR tank heating valve primary side; open load.
1082	4366	5	762	SCR main relay (secondary side): open load.
1084	4366	5	762	SCR main relay (secondary side); Shortcut to battery.
1085	4366	5	762	SCR main relay (secondary side), heat relay (secondary side), heating elementsor heating valve short to ground.
1111	4366	12	671	SCR-heater relay urea tank powerstage output; over temperature.
894	4374	13	872	Pressure stabilisation error dosing valve (SCR).
1120	4375	3	666	Urea pump motor; short circuit to battery.
1121	4375	4	666	Urea pump motor; short circuit to ground.
1118	4375	5	666	Urea pump motor; open load.
1131	4376	3	667	SCR reversal valve; short circuit to battery.
1132	4376	4	667	SCR reversing valve; short circuit to ground.
1493	4376	4	667	SCR reverting valve; short circuit to ground.
1129	4376	5	667	SCR reversal valve; open load.
1490	4376	5	667	SCR reverting valve; open load.
1130	4376	12	667	SCR reversing valve; over temperature.
1491	4376	12	667	SCR reverting valve; over temperature.
1039	4765	0	683	Temperature upstream DOC, temperature above upper shutoff threshold.
1040	4765	0	683	Temperature upstream DOC, temperature above upper warning threshold.
1029	4766	0	684	Temperature downstream DOC, temperature above upper shutoff threshold.
1030	4766	0	684	Temperature downstream DOC, temperature above upper warning threshold.
1036	4768	2	683	Temperature upstream DOC, plausibility error.
1881	4768	2	683	exhaust gas temperature sensors up- and downstream DOC are physically swapped
1044	4768	3	683	Electrical error exhaust gas temperature upstream (DOC); signal range check high.
1045	4768	4	683	Electrical error exhaust gas temperature upstream (DOC); signal range check low.
1026	4769	2	684	Temperature downstream DOC, plausibility error.
1402	4769	2	684	Sensor exhaust gas temperature OxiCat downstream (normal operation); plausibility error.
1403	4769	2	684	Sensor exhaust gas temperature OxiCat downstream (regeneration); plausibility error.
1034	4769	3	684	Sensor error exhaust gas temperature downstream (DOC); signal range check high.
1035	4769	4	684	Sensor error exhaust gas temperature downstream (DOC); signal range check low.
1423	5763	0	594	Warning threshold for an internal actuator error exceeded, < 4L EGR.actuator und >4L Air Intake Flap.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1424	5763	1	594	Shut off threshold for an internal actuator error exceeded, < 4L EGR.actuator und >4L Air Intake Flap.
1024	5763	3	594	Position sensor error of actuator EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8). Signal range check high.
1226	5763	3	594	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to battery.
1227	5763	3	594	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to battery.
1025	5763	4	594	Position sensor error actuator EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8). Signal range check low.
1228	5763	4	594	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to ground.
1229	5763	4	594	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to ground.
1232	5763	4	594	actuator AGR valve (2.9;3.6) throttle valve (4.1;6.1;7.8); Voltage below threshold.
1023	5763	5	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8);signal range check low.
1223	5763	5	594	Actuator EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); open load.
1014	5763	6	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8).Signal range check high.
1022	5763	6	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8);signal range check high.
1224	5763	6	594	Actuator EGR-Valve (2.9;3.6) or Throttle-Valve (6.1,7.8); over current.
1230	5763	6	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); Overload by short-circuit.
1016	5763	7	594	Actuator position for EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8)not plausible.
1231	5763	11	594	Power stage over temperature due to high current.
1015	520521	5	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8);signal range check low.
648	523008	1	424	Manipulation control was triggered.
649	523008	2	424	Timeout error in Manipulation control.
825	523009	9	253	The pressure relief valve (PRV) has reached the number of allowed activations.
833	523009	10	253	Open time of Pressure Relief Valve (PRV) for wear out monitoring had exceeded.
362	523090	2	329	Engine Brake Pre-Selection switch; Plausibility Error.
164	523211	9	331	Timeout Error of CAN-Receive-Frame EBC1.
171	523212	9	333	Timeout Error of CAN-Receive-Frame ComEngPrt; Engine Protection.
174	523213	12	334	Timeout Error of CAN-Transmit-Frame ERC1 No detail informationen!
198	523216	9	337	Timeout Error of CAN-Receive-Frame PrHtEnCmd; pre-heat command, engine command.
179	523240	9	527	Timeout CAN-message FunModCtl; Function Mode Control.
919	523330	14	131	Immobilizer status; fuel blocked.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
920	523330	14	131	DFC to block the fuel by Sia No detail informationen!
921	523330	14	131	DFC to indicate that TEN-code or UC-code received if ECU is learned.No detail informationen!
922	523330	14	131	DFC to indicate that no code is received via CAN. No detail informationen!
923	523330	14	131	DFC to indicate that wrong code is received. No detail informationen!
565	523350	4	151	Injector cylinder-bank 1; short circuit.
566	523352	4	152	Injector cylinder-bank 2; short circuit.
567	523354	12	153	Injector powerstage output defect.
826	523470	2	146	Pressure relief valve is forced to open, perform pressure increase.
827	523470	2	146	Pressure Relief Valve (PRV) forced to open. Performed by pressure increase.
876	523470	7	146	Maximum rail pressure exceeded (PRV).
831	523470	11	146	Pressure Relief Valve (PRV) error; Rail pressure out of tolerance range.
832	523470	11	146	Rail pressure out of tolerance range.The PRV can not be opened at this operating point with a pressure shock.
828	523470	12	146	Pressure Relief Valve (PRV) forced to open. Shutoff conditions.
829	523470	12	146	Pressure Relief Valve (PRV) forced to open. Warning conditions.
830	523470	14	146	Open Pressure Relief Valve (PRV).
980	523550	12	515	Terminal 50 was operated too long.
952	523580	2	555	Data set variant with the desired number not found Invalid variant dataset Identifier error.No detail informationen!
953	523580	11	555	An error has occurred in the switch over to the desired data set variant in the code word.
954	523580	11	555	The code word could not be read correctly from the EEPROM Variant dataset switching error.
948	523601	13	282	Failure of sensor supply voltage 3.
462	523602	0	238	High fan speed; warning threshold exceeded.
463	523602	0	238	High fan speed; shut off threshold exceeded.
126	523603	9	338	Timeout Error of CAN-Receive-Frame AMB; Ambient Temperature Sensor.
300	523605	9	118	Timeout Error of CAN-Receive-Frame TSC1AE; Traction Control.
301	523606	9	119	Timeout Error of CAN-Receive-Frame TSC1AR; Retarder.
644	523612	3	555	Reported Over Voltage of Supply.
646	523612	4	555	Reported Under Voltage of Supply.
387	523612	12	555	Internal software error ECU; injection cut off.
612	523612	12	555	Internal ECU monitoring detection reported error.
613	523612	12	555	ECU reported internal software error.Internal ECU monitoring detection reported error.
614	523612	12	555	ECU reported internal software error.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
615	523612	12	555	ECU reported internal software error.
616	523612	12	555	ECU reported internal software error.
617	523612	12	555	ECU reported internal software error.
618	523612	12	555	ECU reported internal software error.
619	523612	12	555	Injection system, electrical error injectors.
620	523612	12	555	ECU reported internal software error.
621	523612	12	555	ECU reported internal software error.
623	523612	12	555	ECU reported internal software error.
624	523612	12	555	ECU reported internal software error.
625	523612	12	555	ECU reported internal software error.
627	523612	12	555	ECU reported internal software error.
628	523612	12	555	ECU reported internal software error.
629	523612	12	555	Diagnostic fault check to report the accelerator pedal position error.
630	523612	12	555	Diagnostic fault check to report the engine speed error.
631	523612	12	555	Error in the plausibility of the injection energizing time.
632	523612	12	555	Error in the plausibility of the start of energising angles.
633	523612	12	555	Diagnostic fault check to report the error due to non plausibility in ZFC.
634	523612	12	555	Diagnosis fault check to report the demand for normal mode due to an error in the PoI2 quantity.
635	523612	12	555	Diagnosis fault check to report the error to demand for an ICO due to an error in the PoI2 shut-off.
636	523612	12	555	Diagnosis fault check to report the error to demand for an ICO due to an error in the PoI3 efficiency factor.
637	523612	12	555	Internal ECU monitoring detection reported error.
638	523612	12	555	Monitoring of Fuel Quantity Correction.
639	523612	12	555	Diagnostic fault check to report the plausibility error in rail pressure monitoring.
640	523612	12	555	Diagnostic fault check to report the error due to torque comparison.
641	523612	12	555	Diagnosis of curr path limitation forced by ECU monitoring level 2.
642	523612	12	555	Diagnosis of lead path limitation forced by ECU monitoring level 2.
643	523612	12	555	Diagnosis of set path limitation forced by ECU monitoring level 2.
714	523612	12	555	Diagnostic fault check to report WDA active due to errors in query/response communication.
715	523612	12	555	Diagnostic fault check to report ABE active due to undervoltage detection.
716	523612	12	555	Diagnostic fault check to report ABE active due to overvoltage detection.
717	523612	12	555	Diagnostic fault check to report WDA/ABE active due to unknown reason.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1170	523612	12	555	Internal software error ECU.
1857	523612	12	555	Engine starter, plausibility error of starter release condition.
973	523612	14	555	Softwarereset CPU SWReset_0.
974	523612	14	555	Softwarereset CPU SWReset_1.
975	523612	14	555	Softwarereset CPU SWReset_2.
856	523613	0	134	Rail pressure metering unit, Positive governor deviation.
857	523613	0	134	Rail pressure metering unit, Rail pressure disrupted. Maximum positive deviation of rail pressure exceeded.
858	523613	0	134	Rail pressure metering unit, Rail pressure disrupted. Maximum positive deviation of rail pressure in metering unit exceeded (RailMeUn1).
859	523613	0	134	Rail pressure metering unit, Rail pressure below the target range. (RailMeUn2)Rail system leakage detected.(RailMeUn10).
862	523613	0	134	Rail pressure metering unit, Maximum rail pressure exceeded.
865	523613	0	134	Setpoint of metering unit in overrun mode not plausible.
861	523613	1	134	Rail pressure metering unit, Minimum rail pressure exceeded (RailMeUn3).Negative deviation of rail pressure second stage (RailMeUn22).
864	523613	2	134	Rail pressure metering unit, Setpoint of metering unit in overrun mode not plausible.
594	523615	3	135	Metering unit (Fuel-System); short circuit to battery highside.
596	523615	3	135	Metering unit (Fuel-System); short circuit to battery low side.
598	523615	3	135	Metering unit, short circuit to battery.
595	523615	4	135	Metering unit (Fuel-System); short circuit to ground high side.
597	523615	4	135	Metering Unit (Fuel-System); short circuit to ground low side.
599	523615	4	135	Metering unit, short circuit to ground.
592	523615	5	135	Metering unit (Fuel-System); open load.
593	523615	12	135	Metering unit (Fuel-System); powerstage over temperature.
486	523618	3	133	Gearbox oil temperature; Short circuit to battery or broken harness.
487	523618	4	133	Gearbox oil temperature; Short circuit to ground.
488	523619	2	133	Physical range check high for exhaust gas temperature upstrem (SCR-CAT).
899	523632	0	877	Pressure overload of SCR-System.
900	523632	1	878	Pressure build-up error SCR-System.
1126	523632	2	665	Signal error for CAN message.No detail informationen!
1127	523632	3	665	Sensor error urea pump pressure; signal range check high.
1128	523632	4	665	Sensor error urea pump pressure; signal range check low.
1117	523632	11	666	Pump motor not available for actuation.
897	523632	16	875	Pump pressure SCR metering unit too high.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
898	523632	18	876	Pump pressure SCR metering unit too low.
881	523633	11	149	Lonterm adaption factor below threshold.
882	523633	11	149	Nox conversion rate insufficient (SCR-Cat defect, bad DEF quality).
883	523633	11	149	Nox conversion rate insufficient (SCR-Cat defect, bad DEF quality); temperature range 1.
122	523698	11	591	Shut off request from supervisory monitoring function.
780	523699	3	113	Boost pressure control; negative governor deviation below limit.
781	523699	4	113	learning valu too high No detail informationen!
167	523704	12	615	Timeout Error of CAN-Transmit-Frame EEC3.
178	523706	12	623	Timeout Error of CAN-Transmit-Frame FlEco No detail informationen!
125	523717	12	595	Timeout Error of CAN-Transmit-Frame AmbCon; Weather environments.
1100	523718	3	676	SCR main relay (primary side); short circuit to battery.
1488	523718	3	676	SCR mainrelay; short circuit to battery (only CV56B).
1101	523718	4	676	SCR main relay (primary side); short circuit to ground.
1489	523718	4	676	SCR mainrelay; short circuit to ground (only CV56B).
1098	523718	5	676	SCR main relay (primary side); open load.
1486	523718	5	676	SCR mainrelay; open load (only CV56B).
1099	523718	12	676	SCR main relay (primary side); powerstage over temperature.
1108	523719	3	672	SCR heater DEF supplymodule; short circuit to battery.
1109	523719	4	672	SCR heater DEF supplymodule; short circuit to ground.
1087	523719	5	672	SCR heater relay DEF supply modul secondary side; open load.
1106	523719	5	672	SCR heater relay DEF supplymodule primary side; open load.
1107	523719	12	672	Over Temperature error .No detail informationen!
914	523720	2	148	DEF supply module heater temperature; plausibility error (normal condition).
915	523720	2	148	Sensor DEF supply module heater temperature; plausibility error (cold start condition).
925	523720	8	148	DEF supply module heater temperature; duty cycle in failure range.
926	523720	8	148	DEF supply module heater temperature; duty cycle in invalid range.
916	523721	2	689	Sensor DEF supply module temperature; plausibility error (normal condition).
917	523721	2	689	Sensor DEF supply module temperature; plausibility error (cold start condition).
930	523721	8	689	DEF supply module temperature; duty cycle in failure range.
931	523721	8	689	Urea supply module temperature; duty cycle in invalid range.
927	523721	11	689	Urea supply module temperature measurement not available.
928	523722	8	691	DEF supply module PWM signal; period outside valid range.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
929	523722	8	691	Detect faulty PWM signal from Supply Modul.
172	523741	14	618	Engine shut off request through CAN No detail informationen!
692	523752	0	758	Plausibiliti error during Rich to Lean switch over No detail informationen!
693	523752	0	758	Monitoring of Nox signal readyness No detail informationen!
575	523756	14	155	special pattern for special cases No detail informationen!
576	523757	14	156	special pattern for special cases No detail informationen!
577	523758	14	161	special pattern for special cases No detail informationen!
578	523759	14	162	special pattern for special cases No detail informationen!
579	523760	14	163	special pattern for special cases No detail informationen!
281	523766	9	118	Timeout Error of CAN-Receive-Frame Active TSC1AE.
282	523767	9	118	Timeout Error of CAN-Receive-Frame Passive TSC1AE.
283	523768	9	119	Timeout Error of CAN-Receive-Frame Active TSC1AR.
284	523769	9	119	Timeout Error of CAN-Receive-Frame Passive TSC1AR.
291	523776	9	119	Timeout Error of CAN-Receive-Frame TSC1TE - active.
292	523777	9	119	Passive Timeout Error of CAN-Receive-Frame TSC1TE; Setpoint.
293	523778	9	118	Timeout Error of CAN-Receive-Frame TSC1TR.
294	523779	9	118	Passive Timeout Error of CAN-Receive-Frame TSC1TR.
1299	523788	0	655	Wastegate plauisibility error off CAN transmit message.
1300	523788	0	655	Timeout Error of CAN-Receive-Frame ComTrbChActr; Wastegate.
299	523788	12	655	Timeout Error of CAN-Transmit-Frame TrbCH; Status Wastegate.
202	523793	9	678	Timeout Error of CAN-Receive-Frame UAA10; AGS sensor service message.
203	523794	9	678	Timeout Error of CAN-Receive-Frame UAA11; AGS sensor data.
212	523803	9	678	Timeout error of CAN Receive Message RxEngPres; Status Burner Air Pump.
313	523858	12	679	Timeout Error of CAN-Transmit-Frame UAA11.
322	523867	12	679	Ansteuerung Brenner Luftpumpe;_Timeout Error of CAN-Transmit-Frame UAA1 on CAN A.
785	523889	3	113	over teperature of device driver of pressure control valve No detail informationen!
26	523891	14	263	When AirHt_ctDefSRCLoOn_mp is less than AirHt_ctMaxDef_C .DFC to SRC Low error when heater is On No detail informationen!
559	523895	13	158	Check of missing injector adjustment value programming (IMA) injector 1 (in firing order).
560	523896	13	158	check of missing injector adjustment value programming (IMA) injector 2 (in firing order).
561	523897	13	158	check of missing injector adjustment value programming (IMA) injector 3 (in firing order).
562	523898	13	158	check of missing injector adjustment value programming (IMA) injector 4 (in firing order).

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
563	523899	13	158	check of missing injector adjustment value programming (IMA) injector 5 (in firing order).
564	523900	13	158	check of missing injector adjustment value programming (IMA) injector 6 (in firing order).
836	523906	3	761	Electrical fuel pre - supply pump; short circuit to battery.
837	523906	4	761	Electrical fuel pre - supply pump. Short circuit to ground.
834	523906	5	761	Electrical fuel pre - supply pump; open load.
835	523906	12	761	Electrical fuel pre - supply pump. ECU powerstage over temperature.
1252	523910	0	695	Air Pump; operating voltage error.
1261	523910	6	695	Burner Control Air Pump; over current.Air pump electrically overloaded.
1249	523910	7	695	Air pump; CAN communication interrupted no purge function available.
1248	523910	9	695	Burner Control; Air Pump - CAN Lost.Air Pump; CAN communication lost.
1250	523910	12	695	Air Pump; internal error.
55	523910	14	695	Air pump doesn´t achieve air mass flow setpoint .Burner Control - burner air pump.
58	523911	0	723	Burner dosing valve (DV2); overcurrent at the end of the injection phase.
60	523911	3	723	Burner dosing valve (DV2); short circuit to battery.
62	523911	4	723	Burner dosing valve (DV2); short circuit to ground.
63	523911	11	723	Burner dosing valve (DV2); short circuit high side powerstage.
59	523911	12	723	Burner dosing valve (DV2); powerstage over temperature.
66	523912	0	722	Physical range check high for burner dosing valve (DV2) downstream pressure; shut off regeneration.
69	523912	1	722	Physical range check low for burner dosing valve (DV2) downstream pressure; shut off regeneration. When burner injector is actuated, the measured pressure does not rise above ca. 1250mbar abs (expected: ca. 2400mbar).
64	523912	2	722	Burner dosing valve (DV2) downstream pressure sensor; plausibility error.
72	523912	3	722	Sensor error burner dosing valve (DV2) downstream pressure sensor; signal range check high.
73	523912	4	722	@ engines < 4l:Throttle valve error, Open Load or Short cut to Battery, blocked valve or wrong control signal for valve.@ engines with Burner T4i:Pressure Sensor error after valve (DV2), lower limit reached.
74	523913	3	721	Sensor error glow plug control diagnostic line voltage; signal range check high.
75	523913	4	721	Sensor error glow plug control diagnostic line voltage; signal range check low.
78	523914	3	721	Glow plug control; short circuit to battery water pump control (PWM).
79	523914	4	721	Glow plug control; short circuit to ground.
76	523914	5	721	Glow plug control; open load water pump control (PWM).
77	523914	12	721	Glow plug control; powerstage over temperature.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
500	523915	0	165	HCI dosing valve (DV1); overcurrent at the end of the injection phase.
502	523915	3	159	HCI dosing valve (DV1); short circuit to battery.
503	523915	3	164	HCI dosing valve (DV1); short circuit to battery high side.
504	523915	4	159	HCI dosing valve (DV1); short circuit to ground.
1257	523915	7	853	HCI dosing valve (DV1); blocked open.
505	523915	11	164	HCI dosing valve (DV1); short circuit high side powerstage.
501	523915	12	166	HCI dosing valve (DV1); powerstage overtemperature.
508	523916	0	719	Physical range check high for HCI dosing valve (DV1) downstream pressure; shut off regeneration.
511	523916	1	719	Physical range check low for HCI dosing valve (DV1) downstream pressure; shut off regeneration.
506	523916	2	719	Sensor HCI dosing valve (DV1) downstream pressure; plausibility error.
514	523916	3	719	Sensor error HCI dosing valve (DV1) downstream pressure; signal range check high.
515	523916	4	719	Sensor error HCI dosing valve (DV1) downstream pressure; signal range check low.
524	523917	3	718	Sensor error DV1 & DV2 upstream pressure; signal range check high.
525	523917	4	718	Sensor error DV1 & DV2 upstream pressure; signal range check low.
534	523918	3	717	Sensor error DV1 & DV2 upstream temperature; signal range check high.
535	523918	4	717	Sensor error DV1 & DV2 upstream temperature; signal range check low.
755	523919	0	694	DPF burner air pump pressure sensor, pressure above upper shutoff threshold.
758	523919	1	694	DPF burner air pump pressure sensor, pressure below lower shutoff threshold.
753	523919	2	694	DPF burner air pump pressure sensor, plausibility error.
1378	523919	2	694	Sensor air pump air pressure; plausibility error.
761	523919	3	694	DPF burner air pump pressure sensor, short circuit to battery or open load.
762	523919	4	694	DPF burner air pump pressure sensor, short circuit to ground.
765	523920	0	716	Exhaust gaspressure upstream burner, pressure above upper shutoff threshold.
763	523920	2	716	Exhaust gaspressure upstream burner, plausibility error.
1379	523920	2	716	Sensor exhaust gas back pressure burner; plausibility error.
770	523920	3	716	Exhaust gaspressure upstream burner, short circuit to battery or open load.
771	523920	4	716	Exhaust gaspressure upstream burner, short circuit to ground.
986	523921	0	714	Burner temperature, temperature above upper shutoff threshold.
989	523921	1	714	Burner temperature, temperature below lower shutoff threshold.
1395	523921	2	714	Burner temperature sensor; Plausibility Check for burner temperature sensor. Sensor burner temperature; plausibility error.
942	523921	3	714	Sensor error burner temperature; signal range check high.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
944	523921	4	714	Sensor error burner temperature; signal range check low.
965	523922	3	715	Burner shut of valve; short circuit to battery.
1392	523922	4	715	Burner Shut Off Valve; short circuit to ground.
1389	523922	5	715	Burner Shut Off Valve; open load.
1262	523922	7	854	Burner Control; Shut-off Valve - Blocked closed. Burner Shut Off Valve; blocked closed.
1264	523922	7	855	Burner Shut Off Valve; blocked open.
1390	523922	12	715	Burner Shut Off Valve; powerstage over temperature.
36	523923	3	729	UB1; Short circuit to battery error of actuator relay 1.
41	523923	4	729	Short circuit to ground error No detail informationen!
37	523924	3	167	UB2; Short circuit to battery error of actuator relay 2.
42	523924	4	167	UB2; Short circuit to ground actuator relais 2.
38	523925	3	731	UB3: Short circuit to battery error of actuator relay 3.
43	523925	4	731	UB3; Short circuit to ground actuator relais 3.
44	523926	4	732	UB4; Short circuit to ground aktuator relais 4.
40	523927	3	733	UB5; Short circuit to battery error of actuator relay 5, SCR-Heater/Rev.Valve.
168	523935	12	763	Timeout Error of CAN-Transmit-Frame EEC3VOL1; Engine send messages.
169	523936	12	764	Timeout Error of CAN-Transmit-Frame EEC3VOL2; Engine send messages.
193	523937	9	765	Timeout DFC for NOxSensGlbReqTx. No detail informationen!
133	523938	9	766	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1IGCVol1.
134	523939	9	766	Broadcast Announce Message of the calibration message of the upstream catalytic NOx sensor has failed.
135	523940	9	766	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1IGCVol1
140	523941	9	767	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1OGCVol2.
141	523942	9	767	Calibration message 1 of the after catalyst NOx sensor has failed.
142	523943	9	767	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1OGCVol2.
1158	523946	0	772	Zero fuel calibration injector 1 (in firing order); maximum value exceeded.
1164	523946	1	772	Zero fuel calibration injector 1 (in firing order); minimum value exceeded.
1159	523947	0	772	Zero fuel calibration injector 2 (in firing order); maximum value exceeded.
1165	523947	1	772	Zero fuel calibration injector 2 (in firing order); minimum value exceeded.
1160	523948	0	772	Zero fuel calibration injector 3 (in firing order); maximum value exceeded.
1166	523948	1	772	Zero fuel calibration injector 3 (in firing order); minimum value exceeded.
1161	523949	0	772	Zero fuel calibration injector 4 (in firing order); maximum value exceeded.
1167	523949	1	772	Zero fuel calibration injector 4 (in firing order); minimum value exceeded.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1162	523950	0	772	Zero fuel calibration injector 5 (in firing order); maximum value exceeded.
1168	523950	1	772	Zero fuel calibration injector 5 (in firing order); minimum value exceeded.
1163	523951	0	772	Zero fuel calibration injector 6 (in firing order); maximum value exceeded.
28	523953	2	728	Healing takes place if the condition for error detection is not present.Air temperature monitoring plausibility check array No detail informationen!
30	523955	2	728	Healing takes place if the condition for error detection is not present.Air temperature monitoring plausibility check array No detail informationen!
1011	523960	0	771	Physical range check high for EGR cooler downstream temperature.
1458	523960	0	771	High exhaust gas temperature EGR cooler downstream; warning threshold exceeded.
1012	523960	1	771	Physical range check low for EGR cooler downstream temperature.
124	523969	11	774	Fault entry for override control mode. No detail informationen!
1173	523973	14	779	SCR Tamper detection; derating timer below limit 1.
1174	523974	14	779	SCR Tamper detection; derating timer below limit 2.
1175	523975	14	175	Urea quality; derating timer below limit 1.
1176	523976	14	175	Urea qulaity; derating timer below limit 2.
1177	523977	14	781	Urea tank level; derating timer below limit 1.
1178	523978	14	781	Urea tank level; derating timer below limit 2.
918	523981	11	243	SCR plausibility, OBD and diagnosis; Stuck in range check of DEF tank temperature sensor.DEF-tank without heating function (heating phase).
360	523982	0	737	Powerstage diagnosis disabled; high battery voltage.
361	523982	1	737	Powerstage diagnosis disabled; low battery voltage.
1239	523984	3	788	UB7; Short circuit to battery error of actuator relay 6.
1241	523986	4	176	Relais SCR-Heater, Short Circuit to Ground (High side Control side).
1242	523987	4	791	UB6; Short circuit to ground actuator relay 6.
153	523992	9	793	
1282	523993	9	794	
1324	523995	13	795	Check of missing injector adjustment value programming (IMA) injector 7 (in firing order).
1325	523996	13	796	check of missing injector adjustment value programming (IMA) injector 8 (in firing order).
1326	523997	4	797	Injector cylinder bank 1 slave; short circuit.
1327	523998	4	798	Injector cylinder bank 2 slave; short circuit.
1328	523999	12	799	Injector powerstage output Slave defect.
1333	524000	3	177	Injector 7 (in firing order); short circuit.
1329	524000	5	177	Injector 7 (in firing order); interruption of electric connection.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1334	524001	3	178	Injector 8 (in firing order); short circuit.
1330	524001	5	178	Injector 8 (in firing order); interruption of electric connection.
56	524013	7	856	Burner Control; burner Flame;Burner does not start after x trials (burner flame lost detection).Burner flame unintentional deleted.
1255	524013	7	857	Burner Control; Flame lost max.Burner operation is interrupted too often.
1254	524014	1	858	Air inlet EPV - pressure too low.Air pressure glow plug flush line; below limit.
1259	524016	2	859	Burner Control; HFM - Plausibilitätsfehler 1.Amount of air is not plausible to pump speed.
1258	524016	11	859	Burner Control; HFM - Electrical Fault.HFM sensor; electrical fault.
1219	524018	14	786	HMI engine derate service state.DPF wasn´t regenerated, power reduction phase 1 (manuell regeneration request).
1247	524019	11	862	Burner Control; Air Line - Blocked.Air Pump; air lines blocked.
57	524020	14	863	Burner Control: power reduction due to low lambda. Engine power; Not enough oxygen for regeneration.
1263	524021	11	864	Burner Control; Fuel line ShutOff downstream - broken.Burner fuel line pipe leak behind Shut Off Valve.
1220	524022	14	786	HMI engine derate stop state.DPF wasn´t regenerated, power reduction phase 2 (manuell regeneration request).
1302	524024	11	866	Deviation of the exhaust gas temperature setpoint to actual value downstream (DOC) too high.
1481	524025	5	845	DPF system; operating voltage error.
805	524025	14	845	Particulate filter regeneration. Regeneration after time X is not successful (The error occurs when the regeneration times (3x) over the max. has been aborted allowed recovery time).
1882	524025	14	845	The standstill-regeneration mode time exceeds the long-limit. Vehicle was too long or too often in standstill mode. Make oil change and reset counter.
1883	524025	14	845	The standstill-regeneration mode time exceeds the short-limit. Vehicle was too long or too often within a short time in standstill mode. Make oil change and reset counter.
1431	524028	2	815	CAN message PROEGRActr; plausibility error.
1432	524029	2	815	Timeout Error of CAN-Receive-Frame ComEGRActr - exhaust gas recirculation positioner.
1440	524030	7	815	EGR actuator; internal error.
1441	524031	13	815	EGR actuator, calibration error.
1442	524032	2	815	EGR actuator; status message "EGRCust" is missing.
1443	524033	7	815	EGR actuator; due to overload in Save Mode.
1438	524034	3	816	Disc separator; short circuit to battery.
1439	524034	4	816	Disc separator; short circuit to ground.
1436	524034	5	816	Disc Separator; open load.
1437	524034	12	816	Disc Separator; powerstage over temperature.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1341	524035	12	555	Injector diagnostics; time out error in the SPI communication.
1342	524036	12	555	Injector diagnostics Slave; time out error in the SPI communication.
1285	524038	9	824	Timeout error of CAN-Receive-Frame ComMS_Sys1TO (error memory Slave); Master-Slave internal CAN message.
1286	524039	9	825	Timeout error of CAN-Receive-Frame ComMS_Sys2TO (error memory Slave); Master-Slave internal CAN message.
1287	524040	9	826	Timeout error of CAN-Receive-Frame ComMS_Sys3TO (error memory Slave); Master-Slave internal CAN message.
1288	524041	9	827	Timeout error of CAN-Receive-Frame ComMS_Sys4TO (error memory Slave); Master-Slave internal CAN message.
1289	524042	9	828	Timeout error of CAN-Receive-Frame ComMS_Sys5TO (error memory Slave); Master-Slave internal CAN message.
1290	524043	9	829	Timeout error of CAN-Receive-Frame ComMS_Sys6TO (error memory Slave); Master-Slave internal CAN message.
1482	524044	9	188	CAN message ComMS_Sys7 not received from slave.
1291	524045	9	831	Master Slave, Error of message counter CAN receive message ComMSMoFOvR; ComMSMoFOvR1CNT.
1292	524046	9	832	Master-Slave CAN; Error Checksum of CAN-Receive Message.
1293	524047	9	833	Master-Slave CAN; Error of message length of CAN receive message ComMSMoFOvR;_ComMSMoFOvR1DLC.
1294	524048	9	834	Timeout error CAN message ComMSMoFOvR1TO error memory Slave.
1357	524052	11	836	Error memory Slave reports FID MSMonFC2 (collective error).
1368	524052	11	836	Error memory Slave reports FID MSMonFC3 (collective error).
1485	524052	11	836	Master ECU and Slave ECU data sets or software are not identical.
1505	524057	2	843	Fuel low pressure pump; error pressure build up.
806	524058	2	844	Particulate filter; regeneration not successful.
1558	524063	3	869	SCR heater main relay; short circuit to battery.
1559	524063	4	869	SCR heater main relay load side (K31) on heating valve (Y31),Short cut to ground.
1555	524063	5	869	SCR heater return line; open load.
1556	524063	5	869	SCR main relay not connected.
1557	524063	5	869	SCR heater pressure line; open load.
1560	524063	5	869	SCR relay for suction line not connected.
1561	524063	5	869	SCR heater supply module; open load.
1562	524063	5	869	SCR heater tank; open load.
1646	524063	12	869	DEF supply modul, time for defrosting too long.
1647	524063	12	869	DEF tank, time for defrosting too long.
1565	524065	0	892	Pressure sensor upstream SCR-CAT, pressure above upper physical threshold.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1566	524065	1	892	Pressure sensor upstream SCR-CAT, pressure below lower physical threshold.
1598	524065	2	892	Pressure sensor upstream SCR-CAT, plausibility error.
1569	524065	3	892	Pressure sensor upstream SCR-CAT; short circuit battery or open load.
1570	524065	4	892	Pressure sensor upstream SCR-CAT; short circuit ground.
1579	524066	3	893	SCR measurement heater output stage; short circuit battery or open load.
1581	524067	0	894	DEF supply module, heater temperature above upper physical threshold.
1585	524067	0	894	DEF supply module, temperature above upper physical threshold.
1582	524067	1	894	DEF supply module, heater temperature below lower physical threshold.
1586	524067	1	894	DEF supply module, temperature below lower physical threshold.
1867	524067	2	894	Supply module heater temperature, plausibility error.
1868	524067	2	894	Supply module temperature, plausibility error.
1484	524068	2	895	Master ECU and Slave ECU have been identified as the same types.
1345	524069	9	896	Timeout Error of CAN-Receive-Frame MSMon_FidFCCTO; Master-Slave CAN communication faulty.
1529	524070	2	897	(Upstream NOx-Sensor) Diagnostic Fault Check for invalid upstream NOx value (Sensor self diagnostic DFC set by Deutz-SW).NOx-Sensor before SCR-Cat: Invalid upstream NOx value.
1530	524071	2	898	(Downstream NOx-Sensor) Diagnostic Fault Check for invalid downstream lambda value (Sensor self diagnostic DFC set by Deutz-SW).
1531	524072	2	899	(Upstream NOx-Sensor) Diagnostic Fault Check for invalid upstream lambda value (Sensor self diagnostic DFC set by Deutz-SW).
1532	524073	2	245	(Downstream NOx-Sensor) Diagnostic Fault Check for invalid downstream NOx value (Sensor self diagnostic DFC set by Deutz-SW).
1860	524074	2	246	NOx-Sensor after SCR-Cat: Nox-Sensor dew point problem or plausibility problem.
1533	524074	9	246	NOx sensor downstream SCR-CAT, sensor internally open load.
1534	524075	11	247	NOx sensor downstream SCR-CAT, sensor internally short circuit.
1861	524076	2	248	NOx-Sensor before SCR-Cat: Nox-Sensor dew point problem or plausibility problem.
1535	524076	9	248	NOx sensor upstream SCR-CAT, sensor internally open line.
1536	524077	11	249	NOx sensor upstream SCR-CAT, sensor internally short circuit.
1537	524078	9	255	NOx sensor downstream SCR-CAT, lambda value above upper physical threshold.
1538	524079	9	256	NOx sensor downstream SCR-CAT, lambda value below lower physical threshold.
1539	524080	9	257	NOx sensor upstream SCR-CAT, lambda value above upper physical threshold.
1540	524081	9	258	NOx sensor upstream SCR-CAT, lambda value below lower physical threshold.
1541	524082	9	259	(Downstream NOx-Sensor) Diagnostic Fault Check for downstream NOx value over maximum limit (DFC set by Deutz-SW).
1542	524083	9	261	NOx-Sensor downstream SCR-CAT, NOx value below minimum value.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1543	524084	9	911	NOx-Sensor upstream SCR-CAT, NOx value above maximum value.
1544	524085	9	912	NOx sensor upstream SCR-CAT, NOx value below lower physical threshold.
1621	524087	3	884	Urea Error Lamp; short circuit battery.
1622	524087	4	884	Urea Error Lamp; short circuit ground.
1619	524087	5	884	Urea Error Lamp; open load.
1620	524087	12	884	Urea Error Lamp; temperature over limit.
1658	524096	14	196	Control of the SCR system; If the start stop counter (EPA-Counter) exceeds the threshold.SCRCtl_ctEngStrtStopThresh_C. This counter will increment only once in each driving cycle in case of an SCR error. If the counter reaches the threshold, the DFC will be set to inhibit the engine start.Engine will not be started, because of EPA-Counter.
1663	524097	9	921	Timeout error of CAN-Transmit-Frame DPFBrnAirPmpCtl.
1664	524098	9	922	Timeout error of CAN-Transmit-Frame ComDPFBrnPT.
1665	524099	9	923	Timeout error of CAN-Transmit-Frame ComDPFC1.
1666	524100	9	924	Timeout error of CAN-Transmit-Frame ComDPFHisDat.
1667	524101	9	925	Timeout error of CAN-Transmit-Frame ComDPFTstMon.
1674	524102	9	926	Timeout error of CAN-Receive-Frame ComRxDPFBrnAirPmpCtl.
1675	524103	9	927	Timeout error of CAN-Receive-Frame ComRxDPFBrnAirPmp.
1676	524104	9	928	Timeout error of CAN-Receive-Frame ComRxDPFCtl.
1668	524105	9	929	Timeout error of CAN-Transmit-Frame ComEGRMsFlw.
1677	524106	9	195	Timeout error of CAN-Receive-Frame ComRxEGRMsFlw1.
1678	524107	9	931	Timeout error of CAN-Receive-Frame ComRxEGRMsFlw2.
1669	524108	9	932	Timeout error of CAN-Transmit-Frame ComEGRTVActr.
1679	524109	9	933	Timeout error of CAN-Receive-Frame ComRxEGRTVActr.
1670	524110	9	934	Timeout error of CAN-Transmit-Frame ComETVActrTO.
1680	524111	9	935	Timeout error of CAN-Receive-Frame ComRxETVActr.
1671	524112	9	936	Timeout ComIntake Throttle Valve Actr.
1681	524113	9	937	Timeout error of CAN-Receive-Frame ComRxITVActr.
1659	524114	9	938	Timeout error of CAN-Transmit-Frame A1DOC.
1660	524115	9	939	Timeout error of CAN-Transmit-Frame AT1S.
1661	524116	9	194	Timeout error of CAN-Transmit-Frame SCR2.
1662	524117	9	941	Timeout error of CAN-Transmit-Frame SCR3.
1672	524118	9	942	Timeout error of CAN-Receive-Frame ComRxCM1.
1673	524119	9	943	Timeout error of CAN-Receive-Frame ComRxCustSCR3.
1682	524120	9	944	Timeout error of CAN-Receive-Frame ComRxSCRHtDiag.
1683	524121	9	945	Timeout error of CAN-Receive-Frame ComRxTrbChActr.
1684	524122	9	946	Timeout error of CAN-Receive-Frame ComRxUQSens.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1685	524123	9	947	Timeout error of CAN-Receive-Frame ComSCRHtCtl.
1686	524124	9	948	Timeout error of CAN-Receive-Frame ComTxAT1IMG.
1687	524125	9	949	Timeout error of CAN-Receive-Frame ComTxTrbChActr
1631	524132	0	955	Fuel low pressure upstream fuel low pressure pump, pressure above maximum warning threshold.
1632	524132	0	955	Fuel low pressure upstream fuel low pressure pump, pressure above maximum shut off threshold.
1633	524132	1	955	Fuel low pressure upstream fuel low pressure pump, pressure below minimum shut off threshold.
1634	524132	1	955	Fuel low pressure upstream fuel low pressure pump, pressure below minimum warning threshold.
1630	524132	2	955	Fuel low pressure upstream fuel low pressure pump not plausible.
1698	524133	2	956	HMI system; set if restore button blocked.
1699	524134	0	957	DPF, ash load exceeds the shutoff threshold.
1700	524134	0	957	DPF, ash load exceeds the warning threshold.
1701	524135	0	958	DPF, soot load exceeds the shutoff threshold.
1703	524135	0	958	DPF, soot load exceeds the warning threshold.
1702	524135	14	958	DPF, soot load exceeds the service request threshold.
1827	524141	7	192	DEF dosing valve, dosing valve blocked.
1858	524147	7	966	SCR-System, reverting valve blocked
1639	524147	13	966	SCR System,pressure build up not possible.
2013	524147	13	996	Set together with DFC_SCRCoBldUpLoPres.DFC_SCRCoBldUpLoPresRst is only used for inducement purposes.It ensures that legal inducement is working correctly.
1545	524149	2	968	Plausibility error between pressure downstream turbine (PTrbnDs) and ambient air pressure (EnvP).
1597	524149	2	968	Pressure downstream turbine, plausibility error.
1874	524152	2	971	Urea Quality Sensor; Timeout CAN message.
1875	524153	2	997	Urea tank level & urea tank temperature via CAN bus, timeout of CAN message.
1705	524156	9	972	Timeout error of CAN-Receive-Frame ComRxEBC2.
1859	524175	0	993	SCR-CAT, Nox emissions above maximum threshold.
1863	524177	7	995	SCR System, DEF suction line blocked.
1864	524178	7	996	SCR System, DEF pressure out of range.
1889	524189	9	269	Master / Slave Can disturbed.
1891	524190	14	272	Inducement level 1 activ.
1892	524191	14	273	Inducement level 2 activ.
1893	524193	8	275	The standstill-regeneration mode time exceeds the long limit threshold.Vehicle was too long or too often in standstill mode.Change oil and reset counter.

Table 27. Deutz Trouble Codes (D2.9L4 Engine) (continued)

KWP-Code	SPN	FMI	Blink code	Error Identification
1894	524194	8	276	The standstill-regeneration mode time exceeds the short-limit.Vehicle was too long or too often within a short time in standstill mode.Change oil and reset counter.
1900	524195	14	279	Standstill request due to crystalisation ignored too long.
1902	524196	2	283	Variant handling, Synchronisation error.
1901	524196	13	283	Variant handling, address error.
1943	524202	11	313	SCR error code in master ECU active.
1944	524203	11	313	DEF tank level failure is in master ECU active.
1945	524204	11	313	SCR afterrun failure is in master ECU active.
1946	524205	11	313	SCR Co2Off failure is in master ECU active.
1947	524206	11	313	SCR disable DEF dosing failure is in master ECU active.
1971	524230	11	315	Inducement HW Failure Slave.
1972	524231	11	315	Inducement SCR Tamp. Slave.
1973	524232	11	315	Inducement DEF Qualitity in Slave ECU.
1980	524239	11	315	SCR regeneration failure is in slave ECU active.
1989	524248	11	315	NOX sensor downstream error in slave ECU.
1990	524249	11	315	DEF dosing valve error in slave ECU.
1992	524251	11	315	DEF pressure problems in slave ECU.
1993	524252	11	315	Reverting valve error in slave ECU.
1994	524253	11	315	DEF back flow line heater error on slave ECU.
1995	524254	11	315	Error NOx-Tailpipe emissions exceeded on Slave ECU.
1996	524255	11	315	DEF suction line heater error on slave ECU.
1997	524256	11	315	DEF supply module heater error on slave ECU.
1998	524257	11	315	Error Exhaust pressure upstream SCR on Slave ECU.
1999	524258	11	315	Error Exhaust temperature upstream SCR on Slave ECU.
2000	524259	11	315	DEF pressure line heater error on slave ECU.
2001	524260	11	315	Error Urea pump temperature on Slave ECU.
2002	524261	11	315	Error DEF heater relais on Slave ECU.
2007	524266	14	287	Announcement triggers the Inducement Level 2.
2008	524267	14	845	Max. launch time for stand still exceeded (60min).

Table 28. DTC to SPN/FMI Cross Reference Chart

SPN Code	FMI Code	DTC	Description
51		2112	Unable to Reach Higher TPS
51	0	221	TPS 2 Signal Voltage Low
51	1	121	TPS 1 Lower Than TPS 2

Table 28. DTC to SPN/FMI Cross Reference Chart (continued)

SPN Code	FMI Code	DTC	Description
51	3	123	TPS 1 Signal Voltage High
51	4	122	TPS 1 Signal Voltage Low
51	7	2111	Unable to Reach Lower TPS
51	31	2135	TPS 1/2 Simultaneous Voltages
94	3	92	Fuel Pump High Voltage
100	1	524	Oil Pressure Low
105	0	127	IAT Higher Than Expected 2
105	3	113	IAT High Voltage
105	4	112	IAT Low Voltage
105	15	111	IAT Higher Than Expected 1
106	4	107	MAP Low Voltage
106	16	108	MAP High Pressure
108	0	2229	BP Pressure High
108	1	129	BP Low Pressure
110	0	217	ECT Higher Than Expected 2
110	3	118	ECT High Voltage
110	4	117	ECT Low Voltage
110	15	116	ECT Higher Than Expected 1
168	15	563	System Voltage High
168	17	562	System Voltage Low
174	3	183	Fuel Temp Gasoline High Voltage
174	4	182	Fuel Temp Gasoline Low Voltage
515	0	1112	Spark Rev Limit
515	15	219	Max Govern Speed Override
515	16	1111	Fuel Rev Limit
628	13	601	Flash Checksum Invalid
629	31	606	COP Failure
629	31	1612	RTI 1 loss
629	31	1613	RTI 2 Loss
629	31	1614	RTI 3 Loss
629	31	1615	A/D Loss
629	31	1616	Invalid Interrupt
630	12	604	RAM Failure
636	2	336	Crank Sync Noise

Table 28. DTC to SPN/FMI Cross Reference Chart (continued)

SPN Code	FMI Code	DTC	Description
636	4	337	Crank Loss
636	8	16	Crank Never Synced at Start
639	12	1626	CAN Tx Failure
639	12	1627	CAN Rx Failure
639	13	1628	CAN Address Conflict Failure
639	31	1629	Loss of TSC 1
651	5	261	Injector Driver 1 Open
651	6	262	Injector Driver 1 Shorted
652	5	264	Injector Driver 2 Open
652	6	265	Injector Driver 2 Shorted
653	5	267	Injector Driver 3 Open
653	6	268	Injector Driver 3 Shorted
654	5	270	Injector Driver 4 Open
654	6	271	Injector Driver 4 Shorted
723	2	341	Cam Sync Noise
723	4	342	Cam Sensor Loss
724	10	134	EGO 1 Open/Inactive
1079	3	643	External 5V Reference High
1079	4	642	External 5V Reference Low
1384	31	1625	Shutdown Request
1485	3	687	Power Relay Short to Power
1485	4	686	Power Relay Shorted
1485	5	685	Power Relay Open
5294	4	91	Fuel Pump Low Voltage
520200	0	171	Adaptive Learn High Gasoline
520200	1	172	Adaptive Learn Low Gasoline
520202	0	1161	Adaptive Learn High LPG
520202	1	1162	Adaptive Learn Low LPG
520204	0	1155	Closed Loop Multiplier High Gasoline
520204	1	1156	Closed Loop Multiplier Low Gasoline
520206	0	1151	Closed Loop Multiplier High LPG
520206	1	1152	Closed Loop Multiplier Low LPG
520208	10	154	EGO 2 Open/Inactive
520211	10	420	Gasoline Cat Monitor

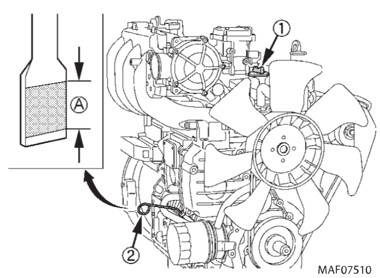
Table 28. DTC to SPN/FMI Cross Reference Chart (continued)

SPN Code	FMI Code	DTC	Description
520213	10	1165	LPG Cat Monitor
520240	3	188	Fuel Temp LPG High Voltage
520240	4	187	Fuel Temp LPG Low Voltage
520251	3	223	TPS 2 Signal High Voltage
520251	4	222	TPS 2 Signal Low Voltage
520260	0	1171	LPG Pressure Higher Than Expected
520260	1	1172	LPG Pressure Lower Than Expected
520260	3	1174	EPR Voltage Supply High
520260	4	1175	EPR Voltage Supply Low
520260	12	1176	EPR Internal Actuator Fault
520260	12	1177	EPR Internal Circuitry Fault
520260	12	1178	EPR Internal Comm Fault
520260	31	1173	EPR Comm Lost

3.22 KUBOTA ENGINE GENERAL MAINTENANCE

3.22.1 Checking Oil Level

1. Make sure machine and engine are level and stop engine before checking oil level.
2. Remove oil level gauge and wipe it clean.
3. Put oil level gauge and remove again.
4. Check oil level. Oil level should be within range as shown in below Figure.



1. Oil Filler Plug	2. Oil Level Gauge

3.22.2 Replacing Engine Oil

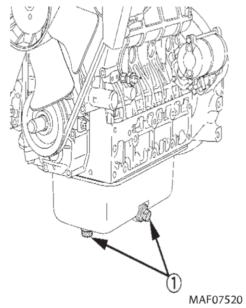
1. Make sure machine and engine are level.
2. Allow engine to warm up as it will be easier to drain oil when it is warm.
3. Stop engine.

4. Place oil tray under engine.

⚠ CAUTION

Hot engine oil can cause burns. Avoid contact with hot oil when draining.

5. Remove drain plug at the bottom of the engine and drain oil.
6. Replace the drain plug gasket and close the drain plug.



1. Oil Drain Plug

NOTICE

Collect used oil in a container suitable for disposal or recycling. Dispose of used engine oil in accordance with environmental regulations.

7. Add new engine oil up to the upper limit of the oil level gauge.
8. Refer to *Section — Engine Data, page 12* for capacity and refer to *Figure — Engine Oil Viscosity, page 227* for the proper grade.

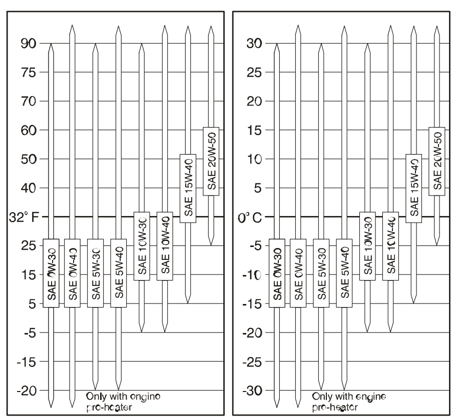


Figure 95. Engine Oil Viscosity

3.22.3 Replacing the Oil Filter

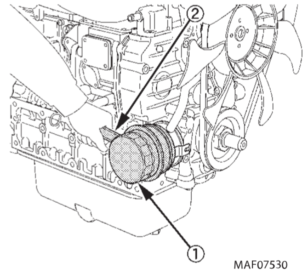
1. Stop the engine and allow it to cool down before replacing the filter.

⚠ CAUTION

Hot Engine oil can cause burns. avoid contact with hot oil when Replacing filter

2. Clean all debris, hydraulic fluid etc. around the filter area.

3. Use a filter wrench, remove the oil filter. Collect any escaping oil in a suitable container.

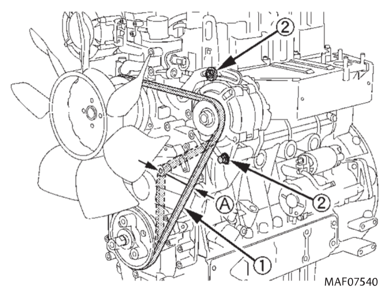


1. Oil Filter Cartridge
2. Wrench

4. Apply a light film of clean oil to the gasket of new oil filter cartridge.
5. Install oil filter cartridge and turn by hand until the gasket contacts the seal surface.
6. Check Oil level and pressure. Add oil if necessary.
7. Clean any oil sticking to the oil filter or machine completely.

3.22.4 Maintenance of the Drive Belt

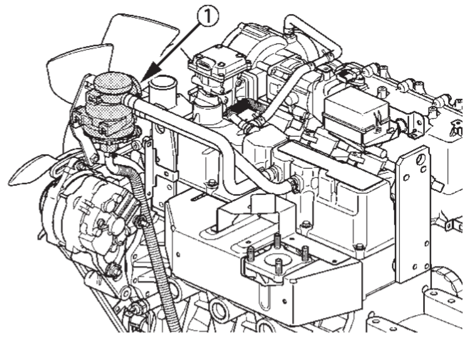
1. Make sure to stop the engine and remove key before checking the belt tension.
2. Check belt tension by applying thumb pressure to belt between the pulleys.
3. If belt tension is not correct, loosen the alternator mounting bolts, using a lever placed between alternator and engine block, pull the alternator out until the deflection of the belt falls within acceptable limits.
4. Replace the fan belt, if damaged.



1. Fan Belt
2. Bolt and Nut

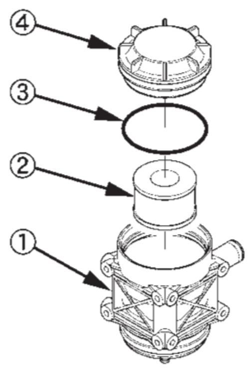
3.22.5 Replacing Oil Separator

1. Stop the engine and allow it to cool before replacing the oil separator.



1. Oil Separator

2. Remove the cover and take out oil separator element and gasket.
3. Clean any oil and grease in the area.
4. Install a new oil separator element and gasket into position.
5. Install the cover.



1. Body	3. Gasket
2. Oil Separator Element	4. Cover

Table 29. Engine Fault Codes - Kubota Engine

SPN Code	FMI Code	DTC	Description
29	3	2128	FPP2 voltage high
29	4	2127	FPP2 voltage low
51	0	221	TPS1 Higher Than TPS2
51	1	121	TPS1 Lower Than TPS2
51	3	123	TPS1 Signal Voltage High
51	4	122	TPS1 Signal Voltage Low
51	7	2111	Unable to Reach Lower TPS
51	7	2112	Unable to Reach Higher TPS

Table 29. Engine Fault Codes - Kubota Engine (continued)

SPN Code	FMI Code	DTC	Description
51	31	2135	TPS 1/2 Simultaneous Voltages
91	3	2122	FPP1 Voltage High
91	4	2123	FPP1 Voltage Low
91	16	2126	FPP1 Higher Than FPP2
91	18	2121	FPP1 Lower Than FPP2
91	31	1121	FPP Voltage Error
94	0	88	Fuel pressure high
94	1	87	Fuel pressure low
94	3	92	Fuel Pump High Voltage
94	4	91	Fuel Pump Low Voltage
100	1	524	Oil Pressure Low
105	0	127	IAT Higher Than Expected 2
105	3	113	IAT High Voltage
105	4	112	IAT Low Voltage
105	15	111	IAT Higher Than Expected 1
106	4	107	MAP Low Voltage
106	16	108	MAP high pressure
108	1	129	BP Low Pressure
110	0	217	ECT Higher Than Expected 2
110	3	118	ECT High Voltage
110	4	117	ECT Low Voltage
110	15	116	ECT Higher Than Expected 1
168	15	563	System Voltage High
168	17	562	System Voltage Low
174	3	183	Fuel Temp Gasoline High
174	4	182	Fuel Temp Gasoline Low
515	0	1112	Spark Rev Limit
515	15	219	Max Govern Speed Override
515	16	1111	Fuel Rev Limit
628	13	601	Flash Checksum Invalid
629	31	606	COP Failure
629	31	1612	RTI 1 loss
629	31	1613	RTI 2 loss
629	31	1614	RTI 3 Loss

Table 29. Engine Fault Codes - Kubota Engine (continued)

SPN Code	FMI Code	DTC	Description
629	31	1615	A/D Loss
629	31	1616	Invalid Interrupt
630	12	604	RAM Failure
632	31	359	Fuel run-out
636	2	336	Crank Sync Noise
636	4	337	Crank Loss
636	8	16	Crank Never Synced at Start
651	5	261	Injector Driver 1 Open
651	6	262	Injector Driver 1 Shorted
652	5	264	Injector Driver 2 Open
652	6	265	Injector Driver 2 Shorted
653	5	267	Injector Driver 3 Open
653	6	268	Injector Driver 3 Shorted
654	5	270	Injector Driver 4 Open
654	6	271	Injector Driver 4 Shorted
723	2	341	Cam Sync Noise
723	4	342	Cam Sensor Loss
731	2	326	Excessive Knock 1
731	4	327	Knock 1 Sensor Open
1079	3	643	External 5V Reference 1 High
1079	4	642	External 5V Reference 1 Low
1079	31	1611	External 5V Reference Shorted
1080	3	653	External 5V Reference 2 High
1080	4	652	External 5V Reference 2 Low
1268	5	2300	Spark Coil 1 Primary Shorted
1268	6	2301	Spark Coil 1 Primary Short to Power
1269	5	2303	Spark Coil 2 Primary Shorted
1269	6	2304	Spark Coil 2 Primary Short to Power
1270	5	2306	Spark Coil 3 Primary Shorted
1270	6	2307	Spark Coil 3 Primary Short to Power
1271	5	2309	Spark Coil 4 Primary Shorted
1271	6	2310	Spark Coil 4 Primary Short to Power
1347	6	629	Fuel Pump Relay Shorted
1348	3	629	Fuel Pump Relay Shorted

Table 29. Engine Fault Codes - Kubota Engine (continued)

SPN Code	FMI Code	DTC	Description
1348	4	628	Fuel Pump Relay Shorted
1348	5	627	Fuel Pump Relay Open
1485	3	687	Power Relay Short to Power
1485	4	686	Power Relay Shorted
1485	5	685	Power Relay Open
1634	13	1673	Calibration Configuration Error
3050	11	420	Gasoline Cat Monitor
3050	11	1165	LPG Cat Monitor
3050	11	1166	NG Cat Monitor
3147	5	628	Fuel Pump Relay Shorted
3217	5	134	EGO 1 Open/Inactive
3227	5	154	EGO 2 Open/Inactive
3468	1	187	Fuel Temp LPG Low
3673	3	223	TPS2 Signal Voltage High
3673	4	222	TPS2 Signal Voltage Low
4236	0	1151	Closed Loop Multiplier High LPG
4236	0	1153	Closed Loop Multiplier High NG
4236	0	1155	Closed Loop Multiplier High Gasoline
4236	1	1152	Closed Loop Multiplier Low LPG
4236	1	1154	Closed Loop Multiplier Low NG
4236	1	1156	Closed Loop Multiplier Low Gasoline
4237	0	171	Adaptive Learn High Gasoline
4237	0	1161	Adaptive Learn High LPG
4237	0	1163	Adaptive Learn High NG
4237	1	172	Adaptive Learn Low Gasoline
4237	1	1162	Adaptive Learn Low LPG
4237	1	1164	Adaptive Learn Low NG
520260	0	1171	EPR Pressure Higher than Expected
520260	1	1172	EPR Pressure Lower than Expected
520260	3	1174	EPR Voltage Supply High
520260	4	1175	EPR Voltage Supply Low
520260	12	1176	EPR Internal Actuator Fault
520260	12	1177	EPR Internal Circuitry Fault
520260	31	1173	EPR Comm Lost

3.23 DEUTZ ENGINE D2.9L4 (STAGE V)

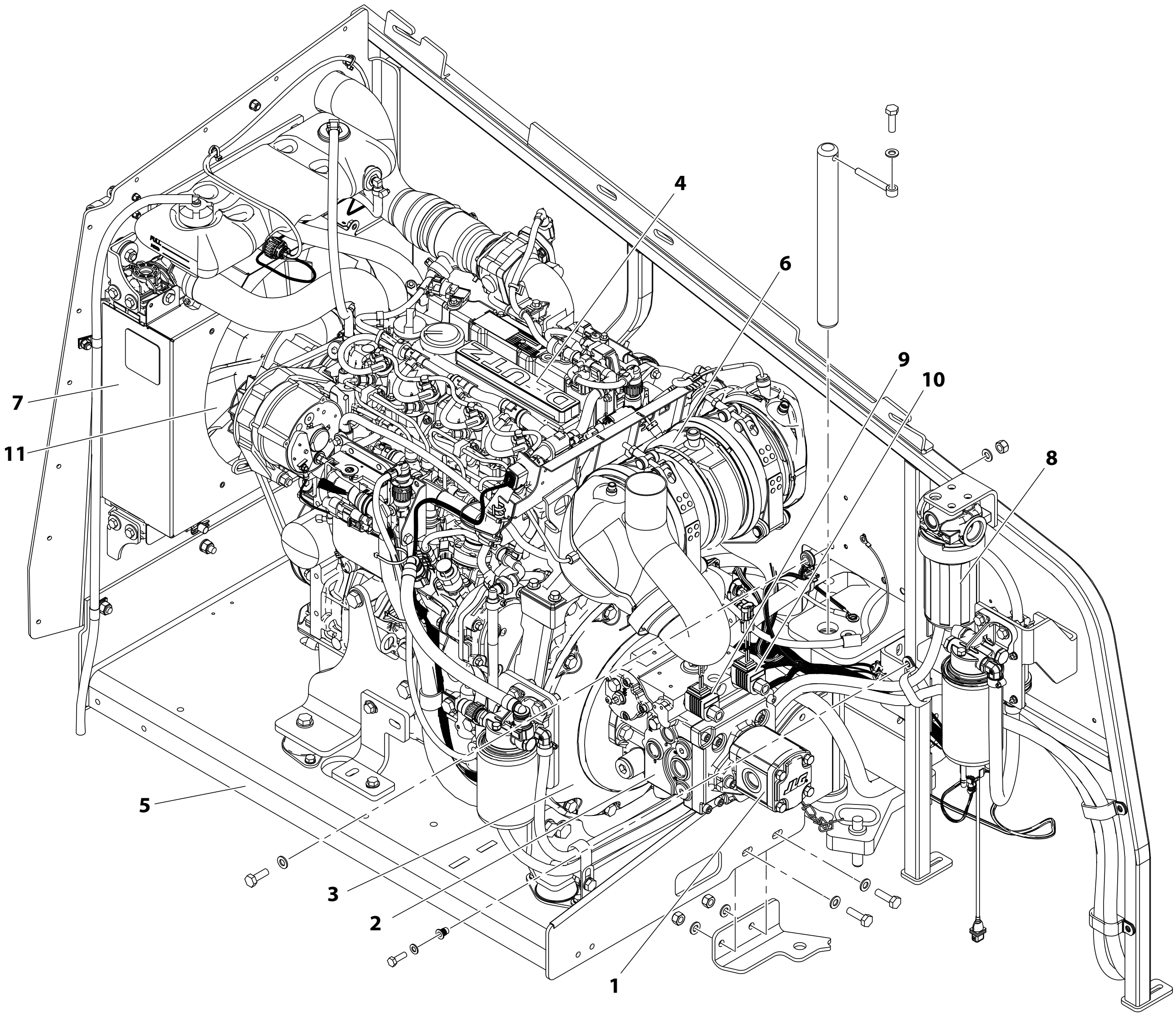


Figure 96. Deutz Engine D2.9L4 (Stage V) - Sheet 1 of 2

1. Gear Pump	5. Engine Tray	9. Forward Solenoid
2. Piston Pump	6. Muffler	10. Reverse Solenoid
3. Pump Coupling Kit	7. Radiator	11. Fan
4. Engine	8. Hydraulic Filter	

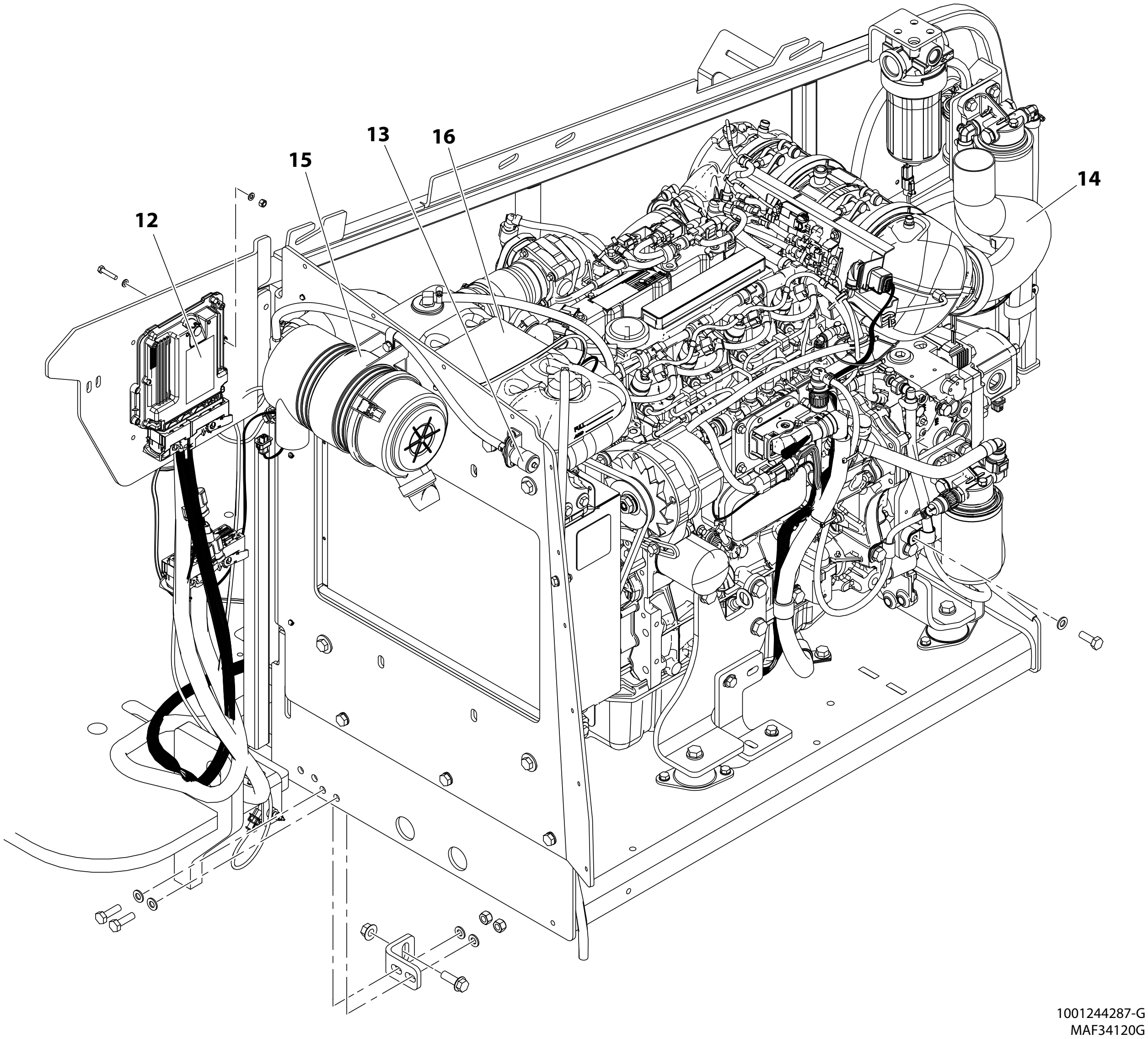


Figure 97. Deutz Engine D2.9L4 (Stage V) - Sheet 2 of 2

12. ECM	14. Exhaust Pipe	16. Surge Tank
13. Air Intake Restriction Indicator	15. Air Cleaner	

3.23.1 General Maintenance

Note: Refer to engine manufacturer's manual for detailed operating and maintenance instructions. Limited engine maintenance items are presented here for convenience but detailed engine maintenance items and schedule are included in the engine manufacturer's manual.

3.23.2 Check Oil Level

1. Make sure machine and engine are level and switch engine OFF before checking oil level.
2. Remove oil dipstick and wipe with clean cloth.
3. Insert dipstick to the stop and remove again.

4. Check oil level. Top oil level as shown in figure below with an approved grade and type of oil outlined in engine manufacturer's operator's manual.

5. Replace dipstick until fully seated.

3.23.3 Replacing Engine Oil

1. Allow engine to warm up. Engine oil should reach approximately 176°F (80°C).

2. Make sure machine and engine are level.

3. Switch off engine.

4. Place oil tray under engine.

⚠ CAUTION

Hot engine oil can cause burns. Avoid contact with hot oil when draining.

NOTICE

Collect used oil in a container suitable for disposal or recycling. Dispose of used engine oil in accordance with environmental regulations.

5. Open oil drain valve and drain oil.

6. Close oil drain valve.

7. Pour in new engine oil. Refer to *Section — Engine Data, page 12* for capacity and *Figure — Engine Oil Viscosity, page 235*.

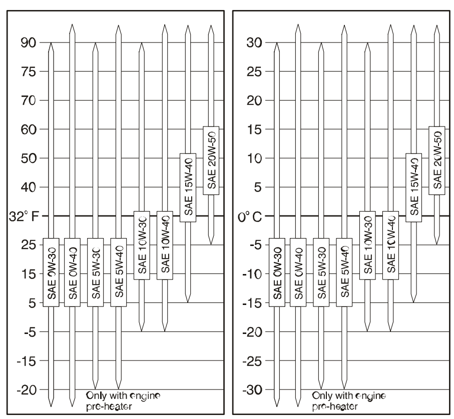
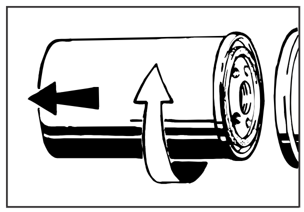


Figure 98. Engine Oil Viscosity

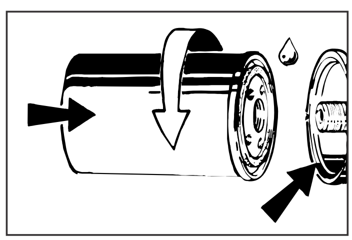
3.23.4 Replacing the Oil Filter

Figure 99. Location of the Oil Filter

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



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil.
6. Screw in new filter by hand until gasket is flush.
7. Hand-tighten filter another half-turn.



8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

3.23.5 Replacing the Fuel Filters

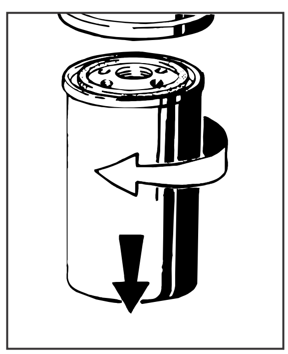
Figure 100. Location of the Fuel Filter

Figure 101. Location of the Fuel Pre-Filter

⚠ WARNING

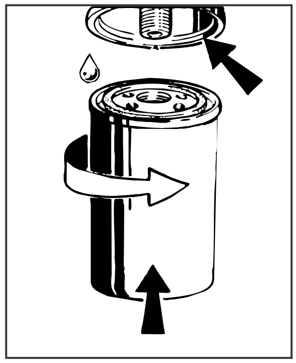
Fuel is flammable and can cause death or serious injury. Make sure no open flames or sparks are in the area when working on fuel system. do not smoke when working on the fuel systems.

1. Wipe area around filter to clean any dirt from area.
2. Fuel supply from the fuel tank may need to be blocked to prevent flow from the fuel tank.
3. Remove fuel filter cartridge.
4. Catch any escaping fuel.



5. Clean dirt from filter carrier sealing surface.
6. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.

7. Screw in new filter by hand until gasket is flush. Hand-tighten filter another 3/4 turn.



8. Check for leaks.

3.23.6 Deutz EMR5

The EMR5 consists of the sensors, the control unit and the common rail injection system. 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 EMR5 controls the injection pump and thus doses the fuel quantity in accordance with the performance requirements.

The EMR5 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 EMR5 is switched in a de-energized fashion over the ignition switch.

After the programming, that is carried out over the interface, the EMR5 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 EMR5 module is matched by serial number to the engine. Modules cannot be swapped between engines.

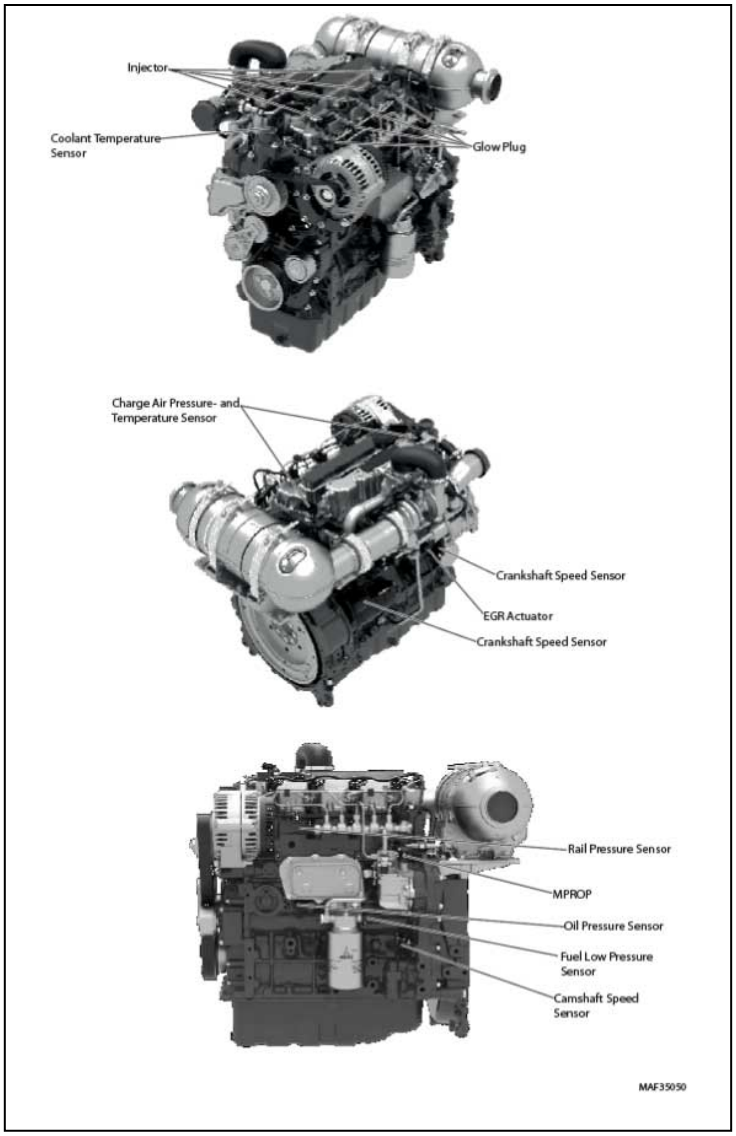


Figure 102. EMR5 Engine Side Equipment

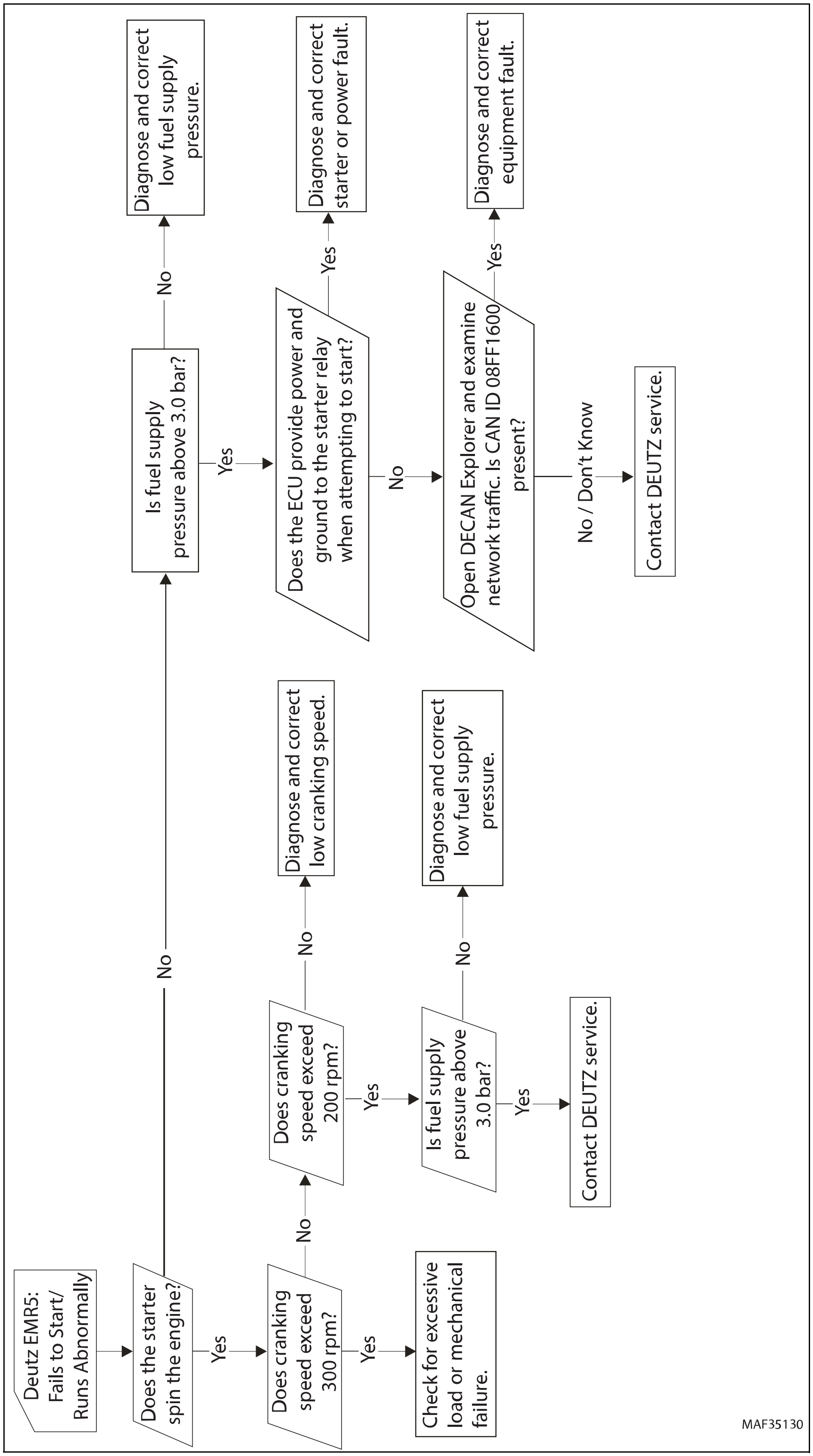
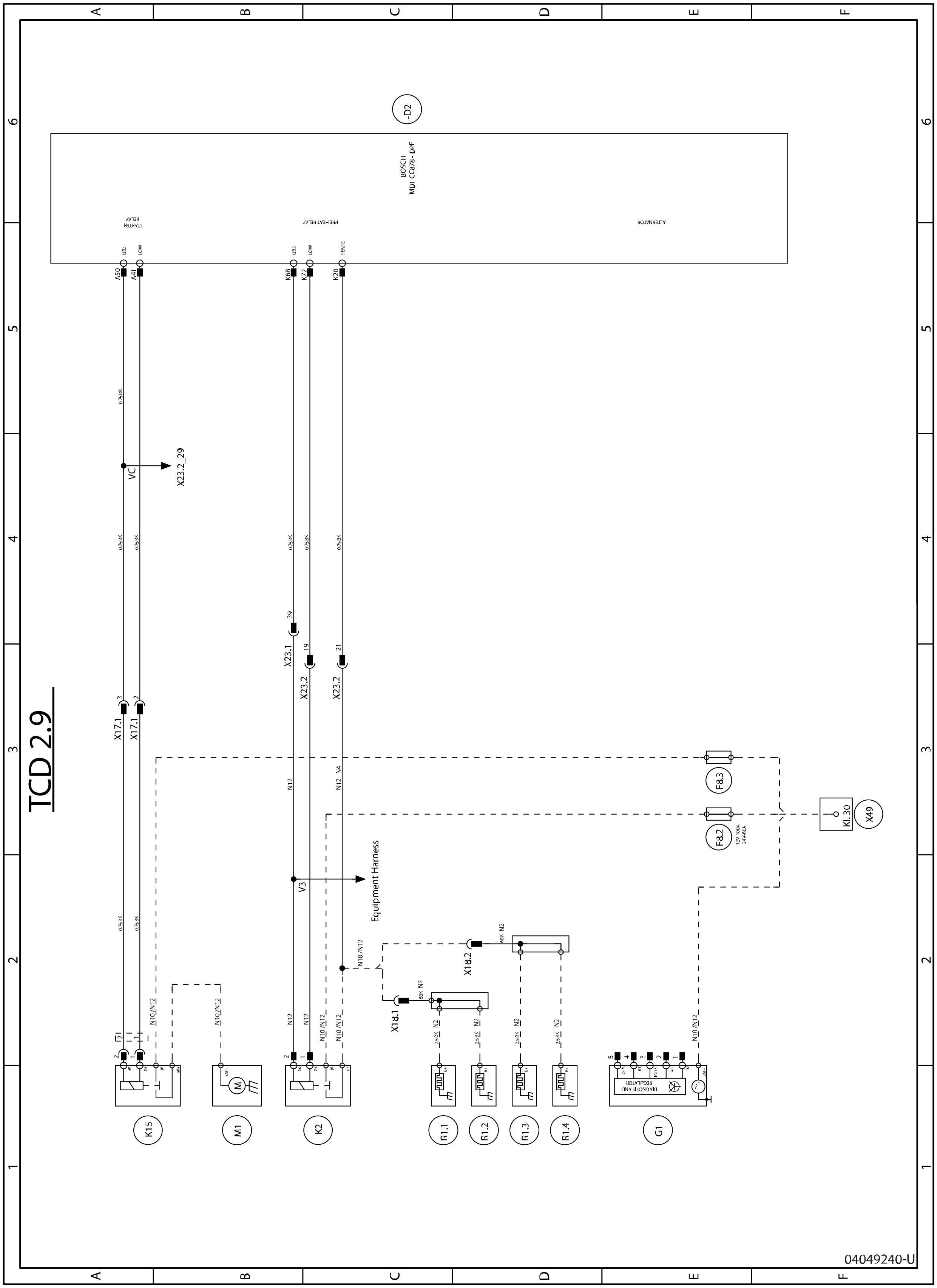
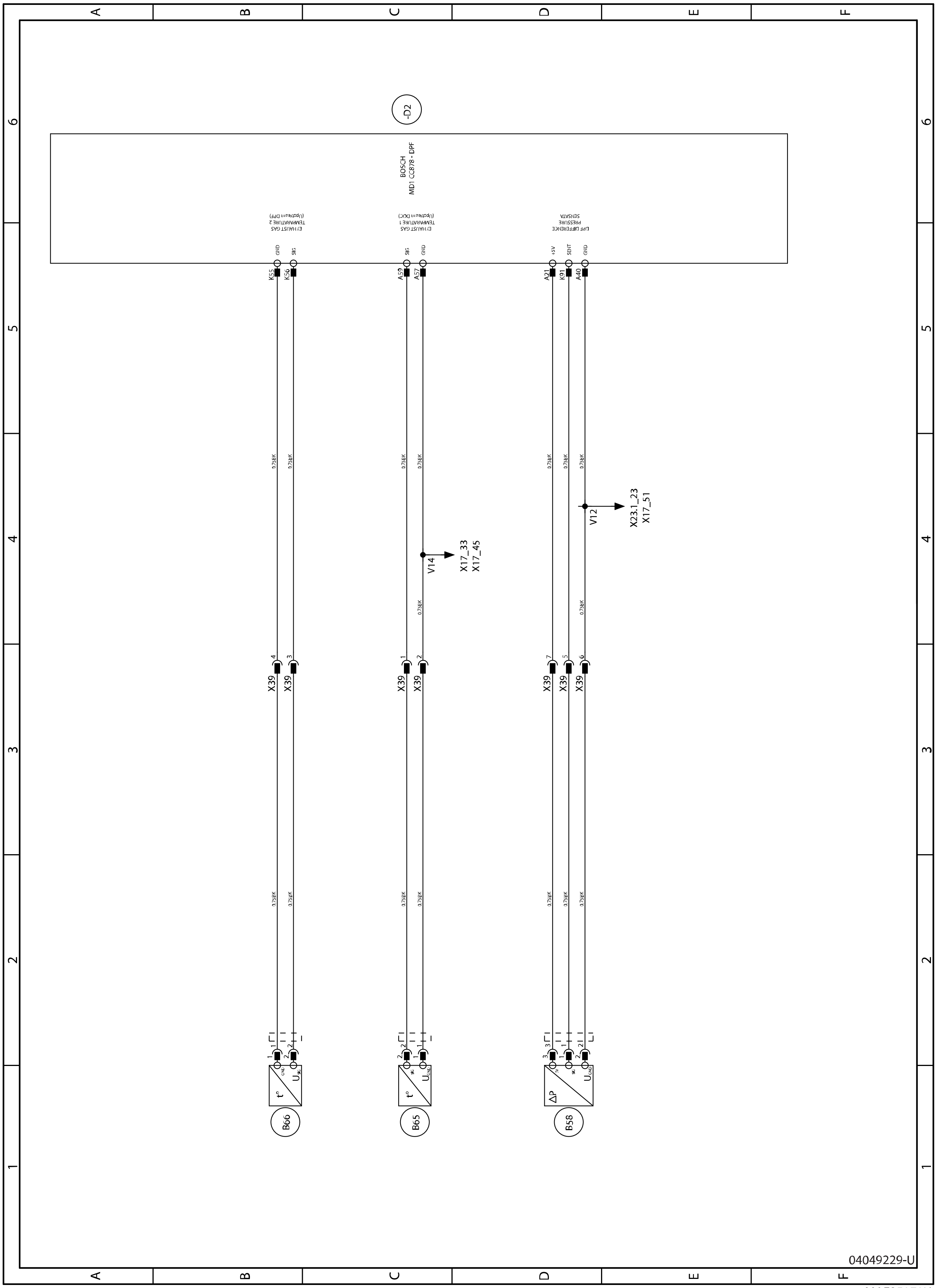


Figure 103. Deutz EMR5 Troubleshooting Flow Chart



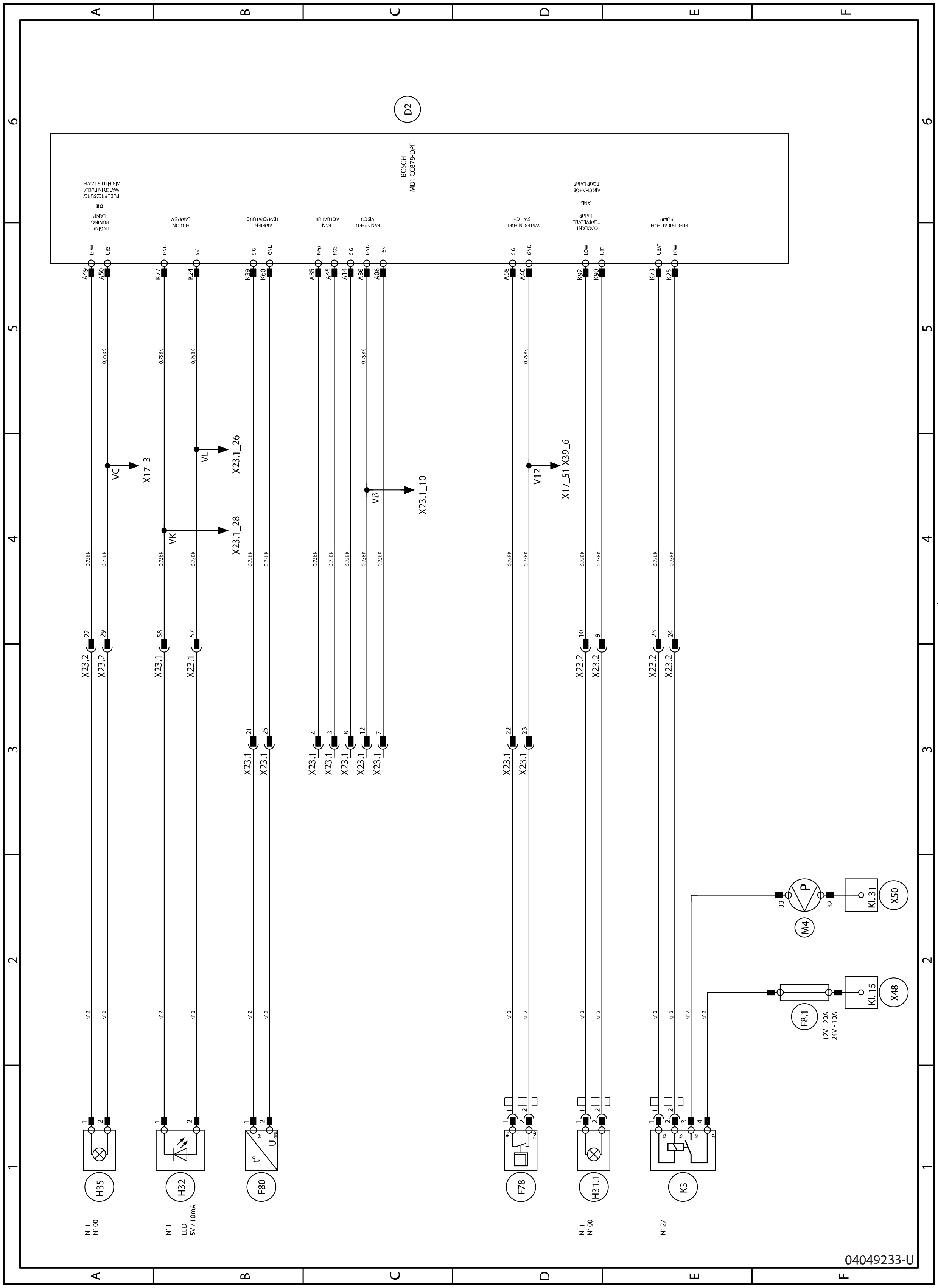
MAF35060U

Figure 104. Deutz EMR5 Power Harness



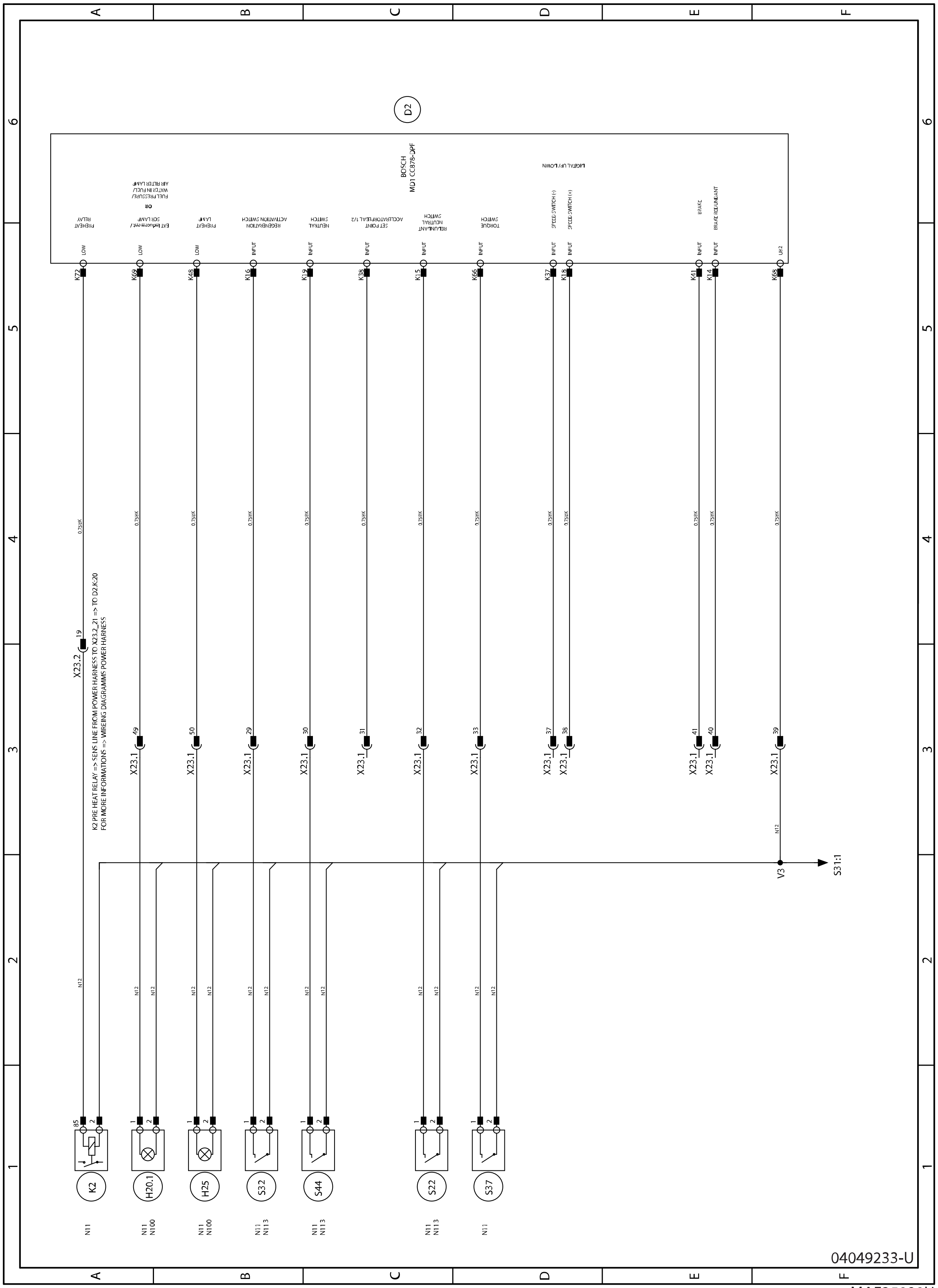
MAF35070U

Figure 105. Deutz EMR5 Exhaust After Treatment Harness



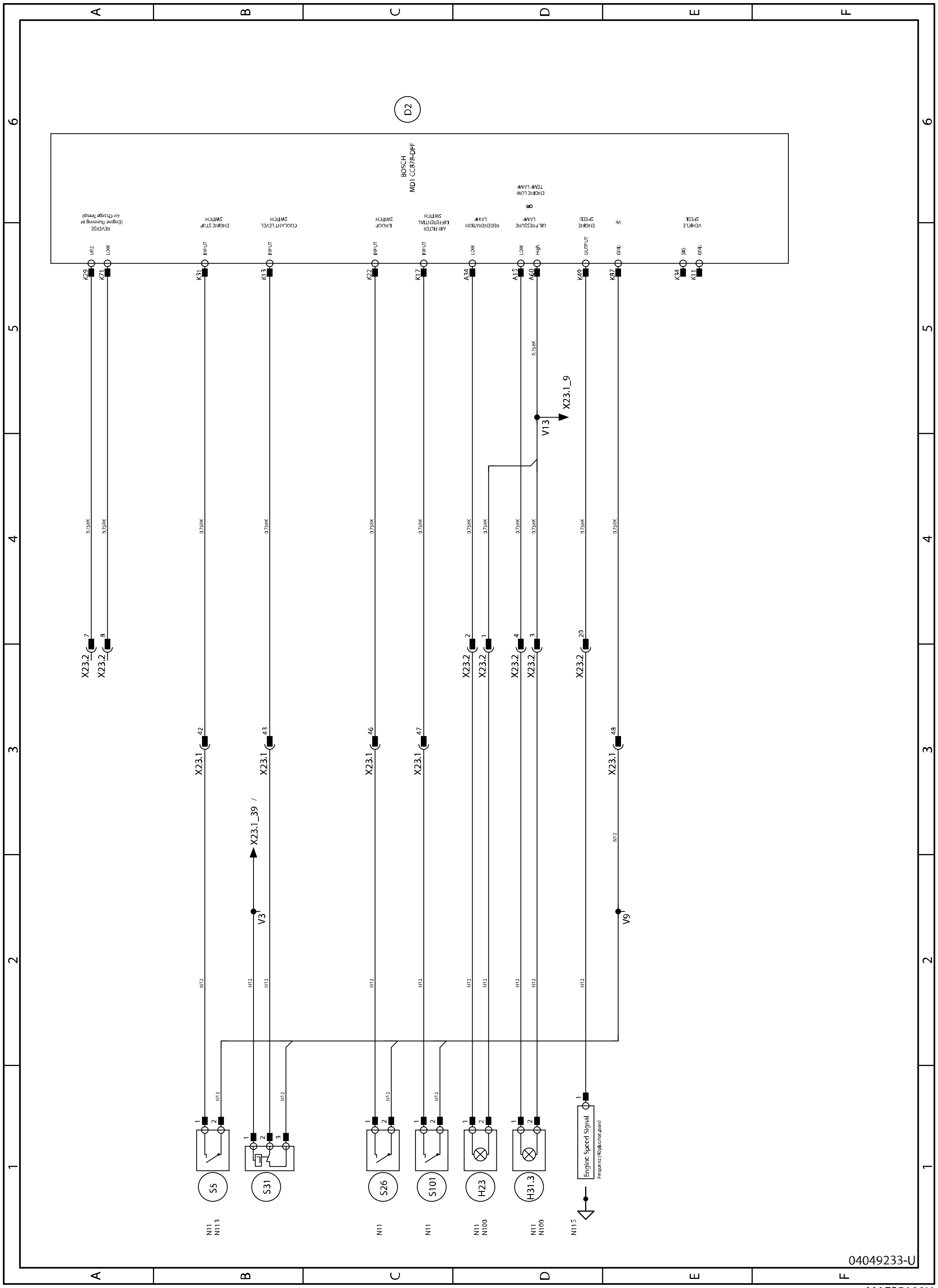
MAF35080U

Figure 106. Deutz EMR5 Equipment Harness - Sheet 1 of 5



MAF35090U

Figure 107. Deutz EMR5 Equipment Harness - Sheet 2 of 5



MAF35100U

Figure 108. Deutz EMR5 Equipment Harness - Sheet 3 of 5

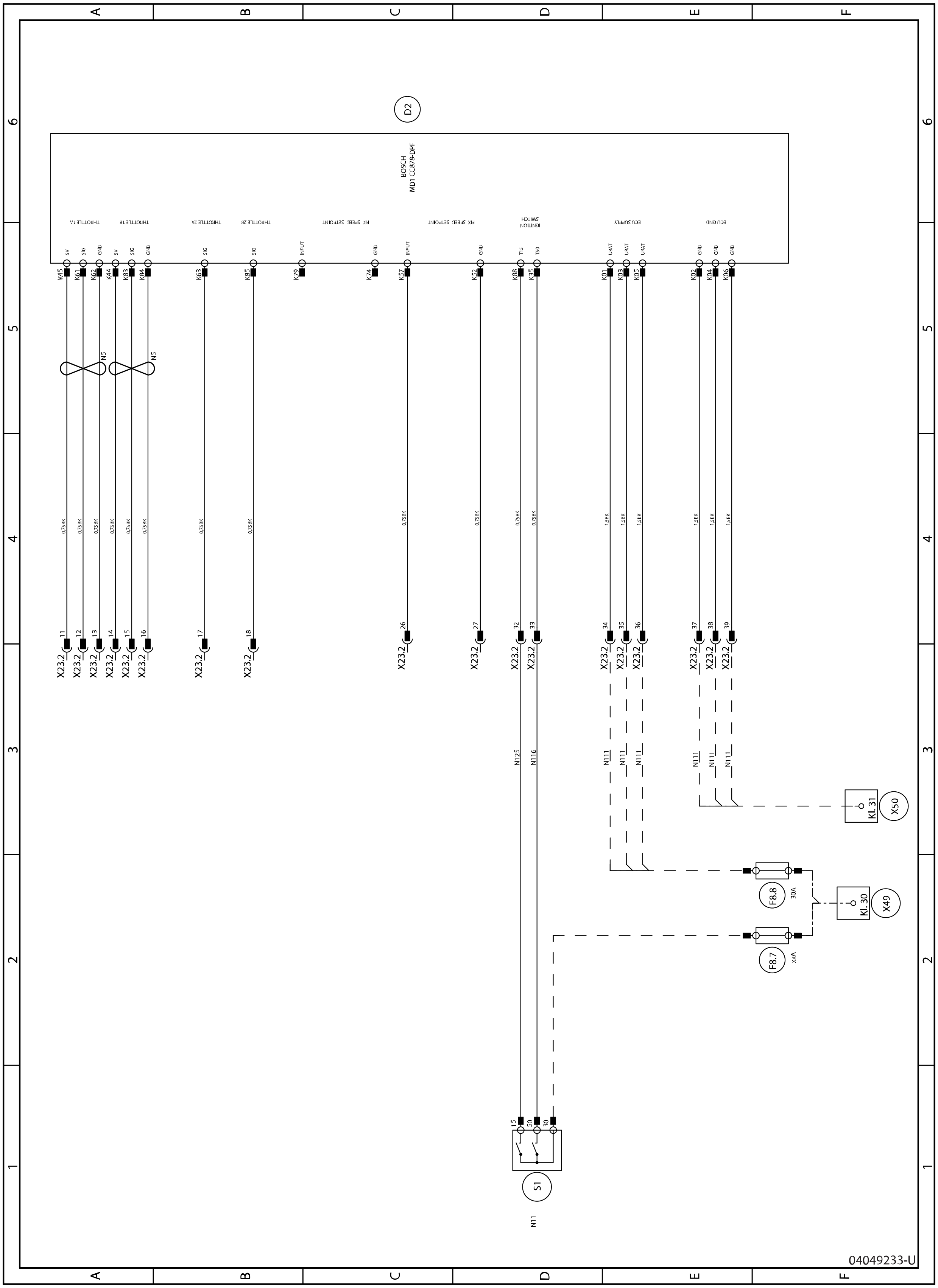


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Figure 109. Deutz EMR5 Equipment Harness - Sheet 4 of 5

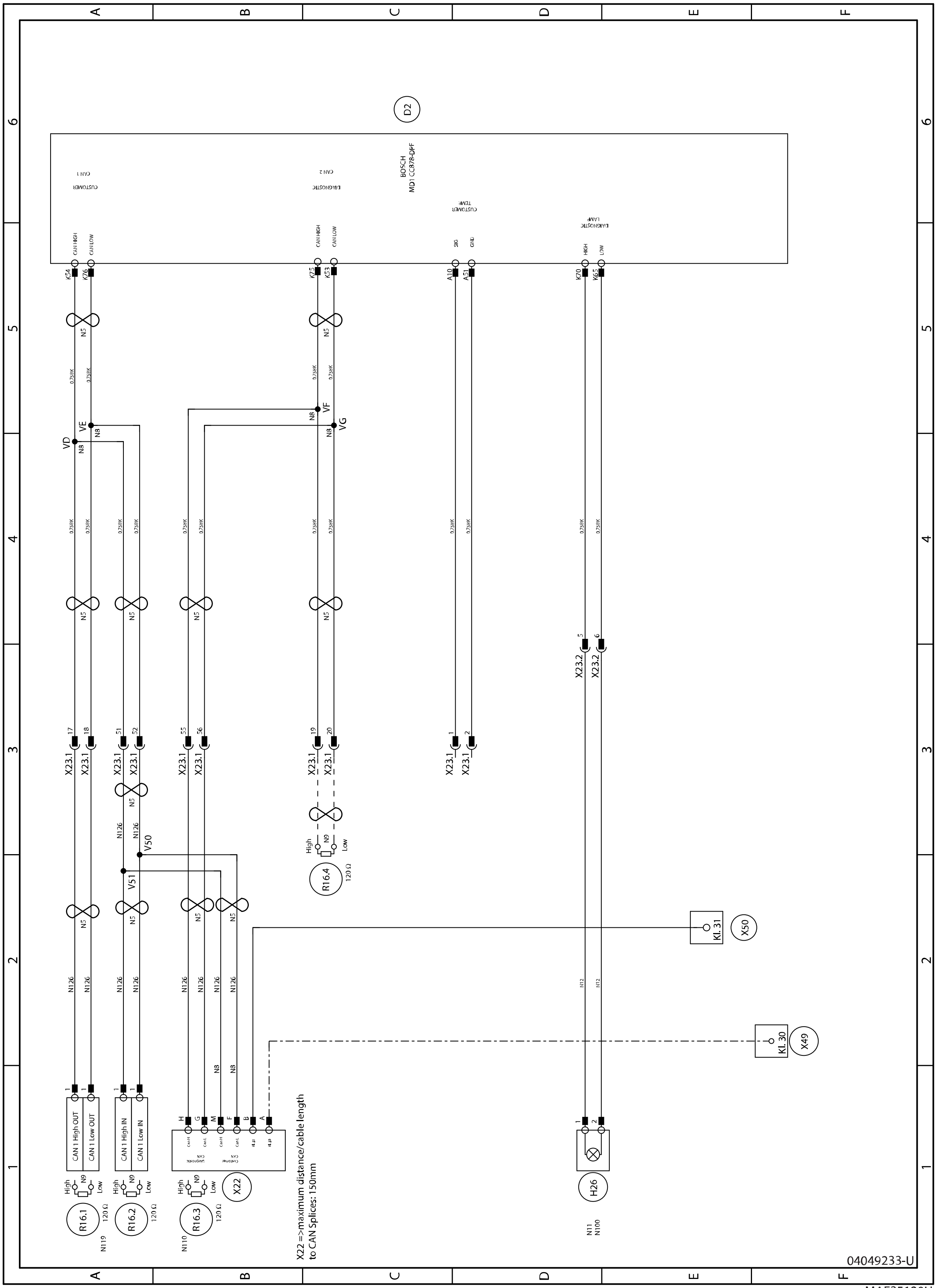

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Figure 110. Deutz EMR5 Equipment Harness - Sheet 5 of 5

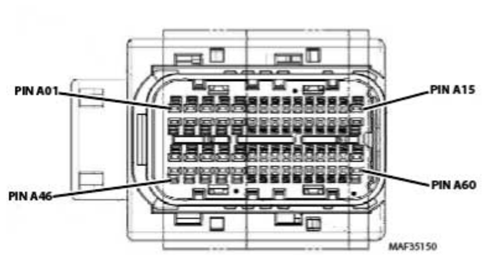


Figure 111. EMR5 Engine Plug Pin Identification

Pin No.	Description
A01	INJS3
A02	INJS4
A03	INJS5
A04	Fuel metering unit (BAT+)
A05	Fuel metering unit (low side)
A06	
A07	Rail fuel pressure supply
A08	Fan speed visco supply
A09	Boost pressure and temperature supply
A10	Customer Temperature
A11	Exhaust pressure P3
A12	EGR position sensor signal
A13	Air inlet temperature
A14	Fan speed visco
A15	Oil warning lamp
A16	INJS0
A17	INJS1
A18	INJS2
A19	EGR control pos
A20	EGR control neg
A21	DPF differential pressure sensor supply
A22	EGR feedback supply
A23	Oil level sensor (Hella)
A24	Oil pressure supply
A25	Rail fuel pressure ground
A26	Rail pressure sensor signal
A27	Boost temperature
A28	Coolant temperature

Pin No.	Description
A29	Exhaust pressure P3 ground
A30	Differential pressure sensor
A30	Differential pressure sensor (see analog input)
A31	INJS3
A32	INJS4
A33	INJS0
A34	Regeneration indication lamp
A35	Fan actuator
A36	Air inlet temperature ground
A37	Cam shaft speed sensor positive
A38	Crankshaft sensor shield
A39	Crank shaft speed sensor positive
A40	EGR feedback ground
A41	Starter low side
A42	Boost pressure and temperature ground
A43	Boost pressure sensor signal
A44	Oil pressure sensor input signal
A45	Switched Battery UB2
A46	INJS5
A47	INJS1
A48	INJS2
A49	After run active
A50	Switched Battery UB3
A51	Customer Temperature ground
A52	Cam shaft speed sensor negative
A53	Camshaft speed sensor shield
A54	Crank shaft speed sensor negative
A55	Reserve Ground
A56	Reserve Ground
A57	Oil pressure ground
A58	Water in fuel switch
A59	Exhaust gas temperature 1
A60	Switched Battery UB2

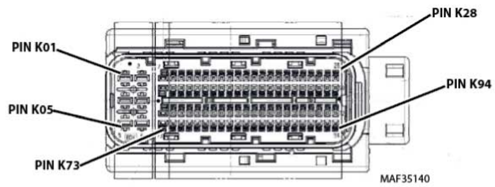


Figure 112. EMR5 Vehicle Plug Pin Identification

Pin No.	Description
K01	BATTERY PLUS
K02	BATTERY MINUS
K03	BATTERY PLUS
K04	BATTERY MINUS
K05	BATTERY PLUS
K06	BATTERY MINUS
K07	EGR temperature behind venturi ground
K08	ITV-H-bridge pos
K08	Intake air throttle pos
K09	Intake air throttle neg
K09	ITV-H-bridge neg
K10	Electrical connected with K9
K11	Vehicle speed sensor ground
K12	Speed switch on/off
K13	Coolant level
K14	Redundant brake switch
K15	Clutch switch
K16	Regeneration activation switch
K17	Air filter differential
K18	Speed switch (+)
K19	Gearbox neutral switch
K20	Preheat sense
K21	Low fuel pressure ground
K22	Controller parameter choise
K23	Delta P venturi supply
K24	Reserve pressure input supply
K25	Fuel pump relay
K26	Intake air throttle (PWM) low side switch
K27	Reserve
K28	Disk seperator
K29	Switched Battery UB2

Pin No.	Description
K30	Reserve
K31	Engine stop switch
K32	Speed switch (hold/resume)
K33	EGR Temperature behind venturi
K34	Vehicle speed sensor
K35	Terminal 50
K36	Reserve analog temperatur input
K37	Speed switch (-)
K38	Parking brake switch
K39	Ambient temperature
K40	Engine brake switch
K41	Brake main switch
K42	Override switch
K43	Low fuel pressure supply
K44	App2 supply
K45	App1 supply
K46	Air intake throttle feedback supply
K47	Exhaust flap
K48	Preheat lamp
K49	Engine speed output
K50	Reserve 2
K51	Switched Battery UB6
K52	Multiple state switch 2 ground
K53	CAN2 low
K54	CAN1 high
K55	Exhaust gas temperature 2 ground
K56	Exhaust gas temperature 2
K57	Multiple state switch 2
K58	Low fuel pressure
K59	LIN bus
K61	Throttle 1a
K62	APP1 ground
K63	Throttle 2a
K65	Diagnostic lamp ground
K66	Diagnostic switch

Pin No.	Description
K67	Intake air throttle (PWM) status
K68	Switched Battery UB2
K69	OBD lamp
K70	Diagnostic lamp
K71	Engine running lamp
K72	Prehead relay
K73	Switched Battery UB3
K74	Torque / droop Line ground
K75	CAN2 high
K76	CAN1 low
K77	Reserve pressure input ground
K78	Reserve analog pressure input
K79	Torque / droop Line
K80	Feedback intake air throttle
K81	Delta p venturi
K83	Throttle 1b
K84	APP2 ground
K85	Throttle 2b
K86	Controller mode
K87	Digital ground
K88	Terminal 15
K89	Switched Battery UB3
K90	Switched Battery UB3
K91	Sent1
K92	Warning temperature lamp
K93	Reserve 3
K94	Reserve 1

Table 30. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
1000	0	98	2	Engine Oil Level - Data Erratic, Intermittent or Incorrect
1001	0	98	31	Engine Oil Level - Condition Exists
1002	0	98	31	Engine Oil Level - Condition Exists
1003	0	98	2	Engine Oil Level - Data Erratic, Intermittent or Incorrect
1004	0	98	31	Engine Oil Level - Condition Exists
1005	0	98	14	Engine Oil Level - Special Instructions

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
1021	0	100	3	Engine Oil Pressure 1 -Voltage Above Normal or Shorted To High Source
1022	0	100	4	Engine Oil Pressure 1 -Voltage Above Normal or Shorted To High Source
1025	0	100	1	Engine Oil Pressure 1 - Data Below Normal Operational Range (Most Severe Level)
1026	0	100	1	Engine Oil Pressure 1 - Data Below Normal Operational Range (Most Severe Level)
1043	0	107	0	Engine Air Filter 1 Differential Pressure - Data Above Normal Operational Range (Most Severe Level)
1071	0	411	2	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Erratic, Intermittent or Incorrect
1072	0	411	0	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Above Normal Operational Range (Most Severe Level)
1073	0	411	1	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Below Normal Operational Range (Most Severe Level)
1074	0	411	2	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Erratic, Intermittent or Incorrect
1075	0	411	2	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Erratic, Intermittent or Incorrect
1077	0	411	3	Engine Exhaust Gas Recirculation 1 Differential Pressure - Voltage Above Normal or Shorted To High Source
1078	0	411	4	Engine Exhaust Gas Recirculation 1 Differential Pressure - Voltage Below Normal or Shorted To Low Source
1079	0	108	0	Barometric Pressure - Data Above Normal Operational Range (Most Severe Level)
080	0	108	1	Barometric Pressure - Data Below Normal Operational Range (Most Severe Level)
1081	0	108	15	Barometric Pressure - Data Above Normal Operational Range (Least Severe Level)
1082	0	108	17	Barometric Pressure - Data Above Normal Operational Range (Least Severe Level)
1083	0	108	2	Barometric Pressure - Data Erratic, Intermittent or Incorrect

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
1084	0	3720	0	Aftertreatment 1 Diesel Particulate Filter Ash Load Percent - Data Above Normal Operational Range (Most Severe Level)
1086	0	3734	0	Aftertreatment 1 Diesel Particulate Filter Trip Active Regeneration Time - Data Above Normal Operational Range (Most Severe Level)
1087	0	4781	14	Aftertreatment 1 Diesel Particulate Filter Soot Mass - Special Instructions
1088	0	4781	0	Aftertreatment 1 Diesel Particulate Filter Soot Mass - Data Above Normal Operational Range (Most Severe Level)
1089	0	4781	16	Aftertreatment 1 Diesel Particulate Filter Soot Mass - Data Above Normal Operational Range (Moderately Sever Level)
1090	0	10156	0	DPF Active Regeneration Time Remaining - Data Above Normal Operational Range (Most Severe Level)
1091	0	3735	16	Aftertreatment 1 Diesel Particulate Filter Trip Disabled Time - Data Above Normal Operational Range (Moderately Sever Level)
1092	0	3735	0	Aftertreatment 1 Diesel Particulate Filter Trip Disabled Time - Data Above Normal Operational Range (Most Severe Level)
1093	0	4766	1	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Data Below Normal Operational Range (Most Severe Level)
1102	0	171	2	Ambient Air Temperature - Data Erratic, Intermittent or Incorrect
1113	0	102	0	Engine Intake Manifold 1 Pressure - Data Above Normal Operational Range (Most Severe Level)
1114	0	102	1	Engine Intake Manifold 1 Pressure - Data Below Normal Operational Range (Most Severe Level)
1115	0	102	3	Engine Intake Manifold 1 Pressure - Voltage Above Normal or Shorted To High Source
1116	0	102	4	Engine Intake Manifold 1 Pressure - Voltage Below Normal or Shorted To Low Source
1118	0	102	1	Engine Intake Manifold 1 Pressure - Data Below Normal Operational Range (Most Severe Level)
1121	0	102	2	Engine Intake Manifold 1 Pressure - Data Erratic, Intermittent or Incorrect
1122	0	102	0	Engine Intake Manifold 1 Pressure - Data Above Normal Operational Range (Most Severe Level)

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
1123	0	102	1	Engine Intake Manifold 1 Pressure - Data Below Normal Operational Range (Most Severe Level)
1124	0	1209	2	Engine Exhaust Pressure 1 - Data Erratic, Intermittent or Incorrect
1125	0	1209	15	Engine Exhaust Pressure 1 - Data Above Normal Operational Range (Least Severe Level)
1126	0	1176	1	Engine Turbocharger 1 Compressor Intake Pressure - Data Below Normal Operational Range (Most Severe Level)
1127	0	1209	2	Engine Exhaust Pressure 1 - Data Erratic, Intermittent or Incorrect
1130	0	1209	3	Engine Exhaust Pressure 1 - Voltage Above Normal or Shorted To High Source
1131	0	1209	4	Engine Exhaust Pressure 1 - Voltage Below Normal or Shorted To Low Source
1134	0	3251	3	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Voltage Above Normal or Shorted To High Source
1135	0	3251	4	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Voltage Below Normal or Shorted To Low Source
1136	0	3251	14	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Special Instructions
1137	0	3251	14	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Special Instructions
1138	0	3251	14	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Special Instructions
1139	0	3251	14	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Special Instructions
1149	0	3251	2	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Erratic, Intermittent or Incorrect
1150	0	3251	0	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Above Normal Operational Range (Most Severe Level)
1151	0	3251	16	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Above Normal Operational Range (Moderately Sever Level)
1152	0	3251	1	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Below Normal Operational Range (Most Severe Level)

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
1153	0	3251	18	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Below Normal Operational Range (Moderately Severe Level)
1161	0	5571	16	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Moderately Sever Level)
1162	0	5571	2	High Pressure Common Rail Fuel Pressure Relief Valve - Data Erratic, Intermittent or Incorrect
1163	0	5571	2	High Pressure Common Rail Fuel Pressure Relief Valve - Data Erratic, Intermittent or Incorrect
1164	0	5571	16	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Moderately Sever Level)
1165	0	5571	15	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Least Severe Level)
1166	0	5571	0	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Most Severe Level)
1167	0	5571	2	High Pressure Common Rail Fuel Pressure Relief Valve - Data Erratic, Intermittent or Incorrect
1168	0	5571	2	High Pressure Common Rail Fuel Pressure Relief Valve - Data Erratic, Intermittent or Incorrect
1169	0	5571	13	High Pressure Common Rail Fuel Pressure Relief Valve - Out of Calibration
1170	0	5571	16	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Moderately Sever Level)
1171	0	94	1	Engine Fuel Delivery Pressure - Data Below Normal Operational Range (Most Severe Level)
1172	0	1347	5	Engine Fuel Pump Pressurizing Assembly 1 - Current Below Normal or Open Circuit
1174	0	1347	3	Engine Fuel Pump Pressurizing Assembly 1 - Voltage Above Normal or Shorted To High Source
1175	0	1347	4	Engine Fuel Pump Pressurizing Assembly 1 - Voltage Below Normal or Shorted To Low Source
119	0	1231	14	CAN Bus 2 / Engine/Diagnose CAN - Special Instructions
1190	0	7103	13	Engine Fuel Metering Rail Pump - Out of Calibration

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
1191	0	7103	13	Engine Fuel Metering Rail Pump - Out of Calibration
1194	0	7103	13	Engine Fuel Metering Rail Pump - Out of Calibration
1195	0	7103	1	Engine Fuel Metering Rail Pump - Data Below Normal Operational Range (Most Severe Level)
1197	0	7103	0	Engine Fuel Metering Rail Pump - Data Above Normal Operational Range (Most Severe Level)
1198	0	7103	2	Engine Fuel Metering Rail Pump - Data Erratic, Intermittent or Incorrect
120	0	639	14	CAN 1 / Customer CAN (J1939) - Special Instructions
1200	0	5357	14	Engine Fuel Injection Quantity Error for Multiple Cylinders - Special Instructions
1202	0	157	0	Engine Fuel 1 Injector Metering Rail 1 Pressure - Data Above Normal Operational Range (Most Severe Level)
1208	0	157	3	Engine Fuel 1 Injector Metering Rail 1 Pressure - Voltage Above Normal or Shorted To High Source
1209	0	157	4	Engine Fuel 1 Injector Metering Rail 1 Pressure - Voltage Below Normal or Shorted To Low Source
121	0	520252	2	CAN-Receive-Message EAT Control Checksum - Data Erratic, Intermittent or Incorrect
1212	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1213	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1215	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1216	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1218	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1219	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
122	0	4207	2	TSC1 Message Checksum- Data Erratic, Intermittent or Incorrect - Bad Intelligent Device or Component
123	0	4207	2	TSC1 Message Checksum - Data Erratic, Intermittent or Incorrect
1233	0	5826	15	Emission Control System Operator Inducement Severity (NCD Inducement) - Data Above Normal Operational Range (Least Severe Level)
1235	0	5826	0	Emission Control System Operator Inducement Severity (NCD Inducement) - Data Above Normal Operational Range (Most Severe Level)
1236	0	5826	14	Emission Control System Operator Inducement Severity (NCD Inducement) - Special Instructions
124	0	4207	2	TSC1 Message Checksum - Data Erratic, Intermittent or Incorrect
125	0	4207	2	TSC1 Message Checksum - Data Erratic, Intermittent or Incorrect
1274	0	91	3	Accelerator Pedal Position 1 - Voltage Above Normal or Shorted To High Source
1275	0	2623	3	Accelerator Pedal 1 Channel 2 - Voltage Above Normal or Shorted To High Source
1276	0	29	3	Accelerator Pedal 2 Position - Voltage Above Normal or Shorted To High Source
1277	0	2625	3	Accelerator Pedal 2 Channel 2 - Voltage Above Normal or Shorted To High Source
1280	0	91	4	Accelerator Pedal Position 1 - Voltage Below Normal or Shorted To Low Source
1281	0	2623	4	Accelerator Pedal 1 Channel 2 - Voltage Below Normal or Shorted To Low Source
1282	0	29	4	Accelerator Pedal 2 Position - Voltage Below Normal or Shorted To Low Source
1283	0	2625	4	Accelerator Pedal 2 Channel 2 - Voltage Below Normal or Shorted To Low Source
1289	0	3509	14	Sensor supply voltage 1 from ECU - Special Instructions
1290	0	3509	0	Sensor supply voltage 1 from ECU - Data Above Normal Operational Range (Most Severe Level)

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
1291	0	3509	6	Sensor supply voltage 1 from ECU - Current Above Normal or Grounded Circuit
1292	0	3509	1	Sensor supply voltage 1 from ECU - Data Below Normal Operational Range (Most Severe Level)
1293	0	3510	14	Sensor supply voltage 2 from ECU - Special Instructions
1294	0	3510	0	Sensor supply voltage 2 from ECU - Data Above Normal Operational Range (Most Severe Level)
1295	0	3510	6	Sensor supply voltage 2 from ECU - Current Above Normal or Grounded Circuit
1296	0	3510	1	Sensor supply voltage 2 from ECU - Data Below Normal Operational Range (Most Severe Level)
1306	0	677	3	Engine Starter Motor Relay - Voltage Above Normal or Shorted To High Source
1307	0	677	4	Engine Starter Motor Relay - Voltage Below Normal or Shorted To Low Source
1308	0	677	5	Engine Starter Motor Relay - Current Below Normal or Open Circuit
1310	0	677	3	Engine Starter Motor Relay - Voltage Above Normal or Shorted To High Source
1311	0	677	4	Engine Starter Motor Relay - Voltage Below Normal or Shorted To Low Source
1323	0	91	11	Accelerator Pedal Position 1 - Root Cause Not Known
1326	0	29	11	Accelerator Pedal 2 Position - Root Cause Not Known
1346	0	1041	14	Start Signal Indicator - Special Instructions
1354	0	105	0	Engine Intake Manifold 1 Temperature - Data Above Normal Operational Range (Most Severe Level)
1355	0	105	0	Engine Intake Manifold 1 Temperature - Data Above Normal Operational Range (Most Severe Level)
1357	0	1136	0	- Data Above Normal Operational Range (Most Severe Level) - Data Above Normal Operational Range (Most Severe Level)
1358	0	1136	1	Engine ECU Temperature - Data Below Normal Operational Range (Most Severe Level)
1359	0	1136	15	Engine ECU Temperature - Data Above Normal Operational Range (Least Severe Level)
1360	0	1136	17	Engine ECU Temperature - Data Above Normal Operational Range (Least Severe Level)

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
1361	0	1136	2	Engine ECU Temperature - Data Erratic, Intermittent or Incorrect
1362	0	412	15	Engine Exhaust Gas Recirculation 1 Temperature - Data Above Normal Operational Range (Least Severe Level)
1363	0	412	17	Engine Exhaust Gas Recirculation 1 Temperature - Data Above Normal Operational Range (Least Severe Level)
1364	0	412	3	Engine Exhaust Gas Recirculation 1 Temperature - Voltage Above Normal or Shorted To High Source
1365	0	412	4	Engine Exhaust Gas Recirculation 1 Temperature - Voltage Below Normal or Shorted To Low Source
1372	0	51	5	Engine Throttle Valve 1 Position 1 - Current Below Normal or Open Circuit
1375	0	51	3	Engine Throttle Valve 1 Position 1 - Voltage Above Normal or Shorted To High Source
1376	0	51	3	Engine Throttle Valve 1 Position 1 - Voltage Above Normal or Shorted To High Source
1377	0	51	4	Engine Throttle Valve 1 Position 1 - Voltage Below Normal or Shorted To Low Source
1378	0	51	4	Engine Throttle Valve 1 Position 1 - Voltage Below Normal or Shorted To Low Source
1379	0	51	6	Engine Throttle Valve 1 Position 1 - Current Above Normal or Grounded Circuit
1382	0	51	7	Engine Throttle Valve 1 Position 1 - Mechanical System not Responding or Out of Adjustment
1383	0	51	7	Engine Throttle Valve 1 Position 1 - Mechanical System not Responding or Out of Adjustment
1391	0	51	3	Engine Throttle Valve 1 Position 1 - Voltage Above Normal or Shorted To High Source
1392	0	51	4	Engine Throttle Valve 1 Position 1 - Voltage Below Normal or Shorted To Low Source
1397	0	105	0	Engine Intake Manifold 1 Temperature - Data Above Normal Operational Range (Most Severe Level)
1398	0	105	1	Engine Intake Manifold 1 Temperature - Data Below Normal Operational Range (Most Severe Level)

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
1399	0	4766	2	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Data Erratic, Intermittent or Incorrect
1400	0	4766	2	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Data Erratic, Intermittent or Incorrect
1401	0	4766	15	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Data Above Normal Operational Range (Least Severe Level)
1402	0	4766	3	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Voltage Above Normal or Shorted To High Source
1403	0	4766	4	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Voltage Below Normal or Shorted To Low Source
1404	0	4765	2	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Data Erratic, Intermittent or Incorrect
1405	0	4765	15	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Data Above Normal Operational Range (Least Severe Level)
1406	0	4765	3	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Voltage Above Normal or Shorted To High Source
1407	0	4765	4	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Voltage Below Normal or Shorted To Low Source
1408	0	4765	2	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Data Erratic, Intermittent or Incorrect
142	0	520256	9	CAN-Receive-Message EAT Control - Abnormal Update Rate / Timeout
144	0	523211	9	CAN-Receive-Message EBC1 - Abnormal Update Rate / Timeout
154	0	523212	9	CAN-Receive-Message Engine Protection - Abnormal Update Rate / Timeout
1540	0	520254	8	Time in Standstill Mode - Abnormal Frequency or Pulse Width or Period
1541	0	520255	2	Hoses Connected to dp DPF SENT Sensor Inverted - Data Erratic, Intermittent or Incorrect
155	0	523741	14	Engine Shutdown Request via CAN - Special Instructions
1587	0	97	0	Water In Fuel Indicator 1 - Data Above Normal Operational Range (Most Severe Level)

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
188	0	523240	9	CAN-Receive-Message Function Mode Control - Abnormal Update Rate / Timeout
219	0	520253	2	CAN-Receive-Message EAT Control Message Counter - Data Erratic, Intermittent or Incorrect
220	0	4206	2	TSC1 Message Counter - Data Erratic, Intermittent or Incorrect
221	0	4206	2	TSC1 Message Counter - Data Erratic, Intermittent or Incorrect
222	0	4206	2	TSC1 Message Counter - Data Erratic, Intermittent or Incorrect
223	0	4206	2	TSC1 Message Counter - Data Erratic, Intermittent or Incorrect
349	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
350	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
351	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
352	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
353	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
354	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
355	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
356	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
361	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
363	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
365	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
367	0	3349	0	TSC1 Receive Timeout-Error

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
				- Data Above Normal Operational Range (Most Severe Level)
38	0	1485	3	ECM Main Relay - Voltage Above Normal or Shorted To High Source
39	0	1485	3	ECM Main Relay - Voltage Above Normal or Shorted To High Source
40	0	1485	3	ECM Main Relay - Voltage Above Normal or Shorted To High Source
41	0	1485	4	ECM Main Relay - Voltage Below Normal or Shorted To Low Source
42	0	1485	4	ECM Main Relay - Voltage Below Normal or Shorted To Low Source
43	0	1485	4	ECM Main Relay - Voltage Below Normal or Shorted To Low Source
48	0	168	0	Battery voltage - Data Above Normal Operational Range (Most Severe Level)
49	0	168	1	Battery voltage - Data Below Normal Operational Range (Most Severe Level)
50	0	168	3	Battery voltage - Voltage Above Normal or Shorted To High Source
51	0	168	4	Battery voltage - Voltage Below Normal or Shorted To Low Source
516	0	523982	0	Powerstage Diagnosis disabled, Battery Potential - Data Above Normal Operational Range (Most Severe Level)
517	0	523982	1	Powerstage Diagnosis disabled, Battery Potential - Data Below Normal Operational Range (Most Severe Level)
52	0	168	0	Battery voltage - Data Above Normal Operational Range (Most Severe Level)
567	0	27	5	Engine Exhaust Gas Recirculation 1 Valve Position - Current Below Normal or Open Circuit
570	0	27	3	Engine Exhaust Gas Recirculation 1 Valve Position - Voltage Above Normal or Shorted To High Source
571	0	27	3	Engine Exhaust Gas Recirculation 1 Valve Position - Voltage Above Normal or Shorted To High Source

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
572	0	27	4	Engine Exhaust Gas Recirculation 1 Valve Position - Voltage Below Normal or Shorted To Low Source
573	0	27	4	Engine Exhaust Gas Recirculation 1 Valve Position - Voltage Below Normal or Shorted To Low Source
574	0	27	6	Engine Exhaust Gas Recirculation 1 Valve Position - Current Above Normal or Grounded Circuit
577	0	27	7	Engine Exhaust Gas Recirculation 1 Valve Position - Mechanical System not Responding or Out of Adjustment
578	0	27	7	Engine Exhaust Gas Recirculation 1 Valve Position - Mechanical System not Responding or Out of Adjustment
582	0	5763	3	Engine Exhaust Gas Recirculation 1 Actuator 1 - Voltage Above Normal or Shorted To High Source
583	0	5763	4	Engine Exhaust Gas Recirculation 1 Actuator 1 - Voltage Below Normal or Shorted To Low Source
586	0	3055	14	Engine Fuel System Monitor (ECU Internal Error) - Special Instructions
587	0	190	0	Engine Speed - Data Above Normal Operational Range (Most Severe Level)
588	0	190	0	Engine Speed - Data Above Normal Operational Range (Most Severe Level)
589	0	190	0	Engine Speed - Data Above Normal Operational Range (Most Severe Level)
590	0	190	0	Engine Speed - Data Above Normal Operational Range (Most Severe Level)
610	0	171	15	Ambient Air Temperature - Data Above Normal Operational Range (Least Severe Level)
613	0	171	3	Ambient Air Temperature - Voltage Above Normal or Shorted To High Source
614	0	171	4	Ambient Air Temperature - Voltage Below Normal or Shorted To Low Source
615	0	723	8	Camshaft Speed Sensor - Abnormal Frequency or Pulse Width or Period
616	0	723	14	Camshaft Speed Sensor - Special Instructions
617	0	723	13	Camshaft Speed Sensor - Out of Calibration
618	0	4201	8	Crankshaft Speed Sensor - Abnormal Frequency or Pulse Width or Period

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
619	0	4201	14	Crankshaft Speed Sensor - Special Instructions
68	0	1669	14	CAN Bus ID-5 - Special Instructions
70	0	110	2	Engine Coolant Temperature - Data Erratic, Intermittent or Incorrect
709	0	97	3	Water In Fuel Indicator 1 - Voltage Above Normal or Shorted To High Source
710	0	97	4	Water In Fuel Indicator 1 - Voltage Below Normal or Shorted To Low Source
721	0	94	15	Engine Fuel Delivery Pressure - Data Above Normal Operational Range (Least Severe Level)
723	0	94	3	Engine Fuel Delivery Pressure - Voltage Above Normal or Shorted To High Source
724	0	94	4	Engine Fuel Delivery Pressure - Voltage Below Normal or Shorted To Low Source
725	0	94	1	Engine Fuel Delivery Pressure - Data Below Normal Operational Range (Most Severe Level)
726	0	94	1	Engine Fuel Delivery Pressure - Data Below Normal Operational Range (Most Severe Level)
75	0	110	3	Engine Coolant Temperature - Voltage Above Normal or Shorted To High Source
76	0	110	4	Engine Coolant Temperature - Voltage Below Normal or Shorted To Low Source
77	0	110	0	Engine Coolant Temperature - Data Above Normal Operational Range (Most Severe Level)
78	0	110	0	Engine Coolant Temperature - Data Above Normal Operational Range (Most Severe Level)
797	0	676	12	Engine Cold Start Aid Relay - Bad Intelligent Device or Component
798	0	676	5	Engine Cold Start Aid Relay - Current Below Normal or Open Circuit
799	0	676	5	Engine Cold Start Aid Relay - Current Below Normal or Open Circuit

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
80	0	411	2	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Erratic, Intermittent or Incorrect
803	0	676	3	Engine Cold Start Aid Relay - Voltage Above Normal or Shorted To High Source
805	0	676	4	Engine Cold Start Aid Relay - Voltage Below Normal or Shorted To Low Source
807	0	2797	14	Engine Fuel 1 Injector Group 1 - Special Instructions
815	0	2797	4	Engine Fuel 1 Injector Group 1 - Voltage Below Normal or Shorted To Low Source
816	0	5358	5	Engine Cylinder 1 Fuel Injection Quantity - Current Below Normal or Open Circuit
817	0	5359	5	Engine Cylinder 2 Fuel Injection Quantity - Current Below Normal or Open Circuit
818	0	5360	5	Engine Cylinder 3 Fuel Injection Quantity - Current Below Normal or Open Circuit
819	0	5361	5	Engine Cylinder 4 Fuel Injection Quantity - Current Below Normal or Open Circuit
820	0	5362	5	Engine Cylinder 5 Fuel Injection Quantity - Current Below Normal or Open Circuit
821	0	5363	5	Engine Cylinder 6 Fuel Injection Quantity - Current Below Normal or Open Circuit
822	0	2797	6	Engine Fuel 1 Injector Group 1 - Current Above Normal or Grounded Circuit
823	0	2798	6	Engine Fuel 1 Injector Group 2 - Current Above Normal or Grounded Circuit
824	0	5358	6	Engine Cylinder 1 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
825	0	5359	6	Engine Cylinder 2 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
826	0	5360	6	Engine Cylinder 3 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
827	0	5361	6	Engine Cylinder 4 Fuel Injection Quantity - Current Above Normal or Grounded Circuit

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
828	0	5362	6	Engine Cylinder 5 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
829	0	5363	6	Engine Cylinder 6 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
83	0	111	1	Engine Coolant Level 1 - Data Below Normal Operational Range (Most Severe Level)
830	0	5358	6	Engine Cylinder 1 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
831	0	5359	6	Engine Cylinder 2 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
832	0	5360	6	Engine Cylinder 3 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
833	0	5361	6	Engine Cylinder 4 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
834	0	5362	6	Engine Cylinder 5 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
835	0	5363	6	Engine Cylinder 6 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
836	0	105	3	Engine Intake Manifold 1 Temperature - Voltage Above Normal or Shorted To High Source
837	0	105	4	Engine Intake Manifold 1 Temperature - Voltage Below Normal or Shorted To Low Source
838	0	2797	14	Engine Fuel 1 Injector Group 1 - Special Instructions
839	0	2798	14	Engine Fuel 1 Injector Group 2 - Special Instructions
840	0	4257	14	Engine Fuel 1 Injector Group 3 - Special Instructions
841	0	4258	14	Engine Fuel 1 Injector Group 4 - Special Instructions
853	0	0	0	Not defined - Data Above Normal Operational Range (Most Severe Level)
854	0	7103	5	Engine Fuel Metering Rail Pump - Current Below Normal or Open Circuit

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
855	0	7103	3	Engine Fuel Metering Rail Pump - Voltage Above Normal or Shorted To High Source
856	0	7103	3	Engine Fuel Metering Rail Pump - Voltage Above Normal or Shorted To High Source
857	0	7103	4	Engine Fuel Metering Rail Pump - Voltage Below Normal or Shorted To Low Source
858	0	7103	4	Engine Fuel Metering Rail Pump - Voltage Below Normal or Shorted To Low Source
859	0	7103	6	Engine Fuel Metering Rail Pump - Current Above Normal or Grounded Circuit
868	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
869	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
870	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
871	0	91	14	Accelerator Pedal Position 1 - Special Instructions
875	0	190	2	Engine Speed - Data Erratic, Intermittent or Incorrect
876	0	5357	2	Engine Fuel Injection Quantity Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
877	0	5441	2	Engine Fuel Injection Timing Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
878	0	5357	2	Engine Fuel Injection Quantity Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
879	0	523612	12	Internal Recovery - Bad Intelligent Device or Component
88	0	598	10	Clutch Switch - Abnormal Rate of Change
880	0	523612	12	Internal Recovery - Bad Intelligent Device or Component
881	0	523612	12	Internal Recovery - Bad Intelligent Device or Component
882	0	5357	2	Engine Fuel Injection Quantity Error for Multiple Cylinders

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
				- Data Erratic, Intermittent or Incorrect
883	0	5357	2	Engine Fuel Injection Quantity Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
884	0	5442	2	Engine Fuel Injection Pressure Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
885	0	29	2	Accelerator Pedal 2 Position - Data Erratic, Intermittent or Incorrect
886	0	677	2	Engine Starter Motor Relay - Data Erratic, Intermittent or Incorrect
887	0	513	2	Actual Engine Percent Torque - Data Erratic, Intermittent or Incorrect
888	0	513	2	Actual Engine Percent Torque - Data Erratic, Intermittent or Incorrect
889	0	520250	2	Function Monitoring: Error During Subsequent Selectable Monitoring - Data Erratic, Intermittent or Incorrect
890	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
891	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
893	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
894	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
895	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
896	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
897	0	629	12	Engine Control Unit (Controller 1)- Bad Intelligent Device or Component
898	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
899	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
900	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
901	0	629	12	Engine Control Unit (Controller 1)

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
				- Bad Intelligent Device or Component
902	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
903	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
904	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
905	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
906	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
907	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
908	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
909	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
91	0	1109	2	Engine Protection System Approaching Shutdown - Data Erratic, Intermittent or Incorrect
910	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
911	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
912	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
913	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
914	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
915	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
916	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
917	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
918	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
919	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
92	0	1109	14	Engine Protection System Approaching Shutdown - Special Instructions
920	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
921	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
922	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
923	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
924	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
925	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
926	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
927	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
928	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
929	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
930	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
931	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
932	0	629	12	Engine Control Unit (Controller 1)

Table 30. EMR5 Trouble Codes (continued)

DTC-Code	FTB	SPN	FMI	Error Identification
				- Bad Intelligent Device or Component
933	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
935	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
936	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
937	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
938	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
939	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
940	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
941	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
942	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
943	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
944	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
945	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
996	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
997	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
998	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
999	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component

3.24 HRC ENGINE EMISSION CHARACTERISTICS

The Deutz D2.9L engine uses multiple & different technologies in order to maintain engine emissions compliance in Highly Regulated Countries (HRC).

All HRC regions, except for CE, utilize an engine with Exhaust Gas Recirculation (EGR), & Diesel Oxidation Catalyst (DOC). These systems are passive, requiring no operator input or regular maintenance. This engine meets ANSI Tier 4F.

The CE market utilizes a similar engine, also incorporating EGR & DOC, but also includes a Diesel Particulate Filter (DPF). This engine meets CE Stage V. The DPF system requires monitoring & periodic maintenance. Failure to follow the DPF maintenance will cause the engine to de-rate & eventually shut down, if not addressed.

The DPF traps two kinds of contaminants: Soot & Ash. Soot can be burned off with heat. Ash is a byproduct of the burnt soot, & builds up over time, eventually necessitating filter replacement after thousands of hours of engine run-time.

3.24.1 Terminology for Removing Soot

Automatic Background Regeneration

During normal operation, if the DPF has accumulated a little too much soot, the system automatically engages a routine to increase the exhaust temperatures to burn out the soot. It operates in the background. It does not affect operation of the machine. Long periods of idle and/or low ambient temperatures may reduce the effectiveness of this type of regen.

Standstill Regeneration

This is supposed to be activated by the operator when the Automatic Background Regen fails to reduce the soot sufficiently. The machine must be made stationary and no functions may be operated. The system elevates the exhaust temperatures much higher to clean the DPF. Regen takes estimated 35 minutes every 500 hours (will vary). If the operator refuses to initiate a standstill regen when indicated, the engine will automatically be limited to lower power and/or idle lock.

The engine’s control unit also monitors the time elapsed since the last Standstill Regen. Even if soot loading doesn’t rise high enough to request a regen, the clock will eventually request the regen.

3.25 DIESEL PARTICULATE FILTER (IF EQUIPPED)

Diesel Particulate Filter (DPF) is an emissions control system used in diesel engines and requires operator interaction to make sure proper operation of the system.

For peak operation, the DPF system must be cleaned using one of two methods, Standstill Cleaning and Maintenance Standstill Cleaning. Standstill Cleaning is any cleaning requested by the engine outside of the regular maintenance window (for example, if the system detects excessive soot in the DPF canister). Maintenance Standstill Cleaning is cleaning requested by the engine on the regular maintenance interval.

Note: The system will reset the maintenance interval back to zero hours after Standstill or Maintenance Standstill Cleaning events are performed.

Table 31. DPF Operational Indicators

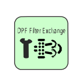
Indicator / Switch	Meaning / Use	Platform Control LED Module	Ground Control LED Module	Ground Control LCD
Regen Required	The DPF TThe DPF Time?Since?Last?Regen Clock, or Soot Loading, is calling for a		-	
HEST	The engine is producing High			-
Ash Overload	The DPF Ash Loading has reached levels that require	-	-	

Table 31. DPF Operational Indicators (continued)

Indicator / Switch	Meaning / Use	Platform Control LED Module	Ground Control LED Module	Ground Control LCD
Engine Distress	The Engine's monitoring systems have detected an issue requiring service. Fault Codes will be displayed on the LCD.			Fault Codes
Emission System Malfunction	The Emission Controls' monitoring systems have detected an issue requiring service. Fault Codes will be displayed on the LCD.		-	Fault Codes
Standstill Regen Initiation Switch	Actuated by the Operator to initiate a	-	 Switch	-

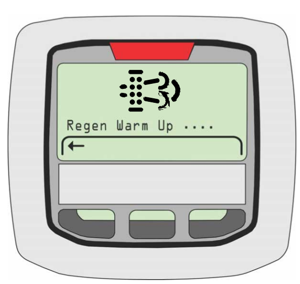
3.25.1 Standstill Cleaning

The following conditions must be met to perform Standstill Cleaning.

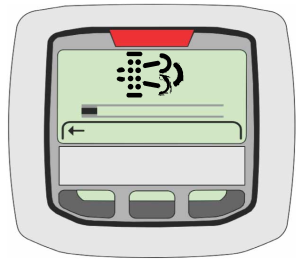
- Machine must be stationary
- Boom in the stowed position
- No personnel in platform
- Engine must be idling
- Coolant temperature must be above 104° F (40° C)
- Machine in Ground Station mode

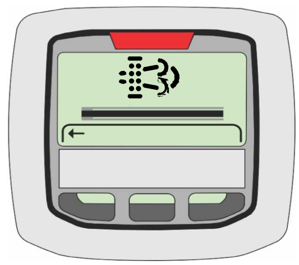
1. The Diesel Particulate Filter (DPF) Indicator on the Platform Control Panel will flash when standstill cleaning is required.

2. Move the machine to an suitable area free of flammables and personnel that could be exposed to hot exhaust.
3. Launch the cleaning process by pressing the DPF button on the Ground Console for 3 seconds. The Indicator Gauge will display the following screen.

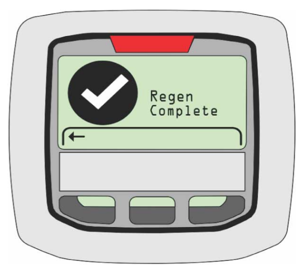


4. The Main Cleaning process will begin and last for approximately 30 to 60 minutes. The following screen will show that the process has begun and includes a status bar that indicates the progress of the cleaning process.





5. After the cleaning process is complete, the engine will run for approximately 5 minutes to allow the Engine and Exhaust After Treatment (EAT) to cool down. The Indicator Gauge will display the “Regen Complete” screen as shown and the Emissions Temperature indicator will no longer be illuminated.



3.25.2 Maintenance Standstill Cleaning Initiation Methods

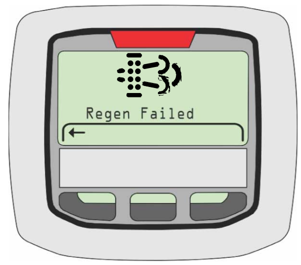
Maintenance Standstill Cleaning can be started by one of two methods, by using the Analyzer or the DPF button on the Ground Console. All the same conditions as outlined under Standstill Cleaning must be met.

3.25.3 Canceling Maintenance Standstill

Maintenance Standstill Cleaning will be stopped immediately if:

- The Platform/Ground Select switch is switched from Ground to Platform mode
- Any function switch is enabled to perform a boom function
- The Engine is powered down

If Maintenance Standstill Cleaning is interrupted, it must be reinitiated and the Indicator Gauge will display the “Regen Failed” screen as shown.

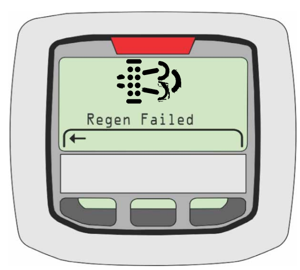


3.25.4 Unsuccessful Cleaning Event

If there is an unsuccessful cleaning event, the DPF icon will show on the display gauge. Possible causes of an Unsuccessful Cleaning Event are:

- Engine is not warmed up
- DEF tank is frozen
- Machine functions operated during cleaning event in progress
- Other engine faults are active

The Gauge will display “Regen Failed” screen as shown. If the cleaning event has failed, the process must be repeated.



3.25.5 DPF Filter Replacement due to Ash Load

The DPF collects non-burnable particulates which cannot be removed by the Standstill Cleaning process. Build up of the ash load requires filter maintenance and/or exchange. DPF filter maintenance or exchange requirement is indicated by the DPF Exchange icon shown on the display gauge.

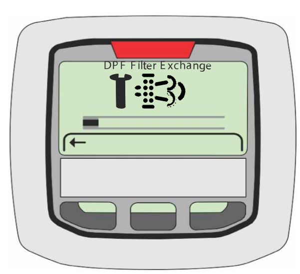


Table 32. Maintenance Standstill Cleaning

Standstill Cleaning Levels		Machine Hours Since Last Cleaning	DPF Regeneration Initiation Methods	Engine Error Indicator	DPF Indicator	Emissions Temperature Indicator*	Derate	Comments
0	Normal Operation	0-500	Serdia Tool(Level 2)+(Switch in JLG machine or JLG Analyzer)	-	-		None	Between 500 and 650 hours, cleaning cycle can be initiated with a JLG analyzer or Switch in machine.(Deutz ECM will generate DPF cleaning required lamp at 500 hours. JLG will mask this lamp until 650 hours.)
		500-650	Switch in JLG Machine OR JLG Analyzer					
1	Standstill Required	650-750	Switch in JLG Machine OR JLG Analyzer	-			None	Exhaust gas temperature will be around 600°C during standstill DPF regeneration.
2	Warning Level	750-775	Switch in JLG Machine OR JLG Analyzer	Continuous 			Derating Step 1 (25% Powerderate)	Machine placed in Creep and DTC active
3	Shut Off Level	>775	Must have Serdia Level 3 access+(switch in JLG machine or JLG analyzer)	Blinking 			Derating Step 2 (Idle Lock)	Idle Lock. Boom Functions Locked Out and trapped in Transport.
4	Filter Exchange	DPF Regeneration NOT POSSIBLE		Blinking 			Derating Step 2 (Idle Lock)	Idle Lock. Boom Functions Locked Out and trapped in Transport.
*Emissions Temperature indicator continuously ON during Standstill Cleaning								

Table 33. Standstill Cleaning: DPF Filled with Soot

Standstill Escalation Steps		Soot Load	Time in Heat Mode (Hours)	DPF Regeneration Initiation Methods	Check Engine Lamp	DPF Cleaning Lamp	HEST Lamp (Possible), Continuously on during standstill cleaning	Derate	Comments
0	Normal Operation	<62%	-	-	-	-		None	
1	Heat Mode 1	62% to 78%	50						If soot load reaches 56% in 50 hours of Heat Mode 1, System will automatically take it to normal operation.

Table 33. Standstill Cleaning: DPF Filled with Soot (continued)

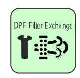
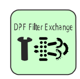
Standstill Escalation Steps		Soot Load	Time in Heat Mode (Hours)	DPF Regeneration Initiation Methods	Check Engine Lamp	DPF Cleaning Lamp	HEST Lamp (Possible), Continuously on during standstill cleaning	Derate	Comments
2	Heat Mode 2	78% to 100%	250						If soot load reaches 56% in 250 hours of Heat Mode 2, System will automatically take it to normal operation.
3	Standstill Required	100% to 109%	100	Switch in JLG Machine or JLG Analyzer	-	0.5 Hz		None	Will remain in Standstill mode for 100 hours or until the soot load reaches 109%
4	Warning Level	109% to 125%	25	Switch in JLG Machine or JLG Analyzer	Continuous	0.5 Hz		Derating Step 1(25% Powerderate)	Will remain in Warning level (Derate) for 25 hours or until the soot load reaches 125%. Machine placed in Creep and DTC active
5	Shut Off Level	125 % to 161%		Must have Serdia Level 3 access + (switch in JLG machine or JLG analyzer)	Blinking	3 Hz		Derating Step 2(Idle Lock)	Idle Lock. Boom Functions Locked Out and Trapped in Transport.
6	Filter Exchange	>161%		DPF Regeneration NOT POSSIBLE. DPF Filter exchange required	Blinking	3 Hz		Derating Step 2(Idle Lock)	Idle Lock. Boom Functions Locked Out and Trapped in Transport.
*Emissions Temperature indicator continuously ON during Standstill Cleaning									

3.25.6 Ash Load

- During the lifetime of the EAT system the DPF collects also particulates that cannot be removed by regeneration process. All non-burnable particles stored in the filter are here summarized as ash load. This ash load leads to shortened regeneration intervals and finally a filter maintenance or exchange is required.
- When 100'% of the rated ash load is reached, a filter exchange is required. The maintenance request is indicated by the ash lamp (solid on) and/or by the respective CAN-message.
- In case of continuously ignored maintenance requests the available filter volume is reduced and the need for standstill regenerations becomes more probable.
- Therefore, at higher ash loads an error paths is set and engine protection functionalities are activated. At this state the ash lamp is flashing with 1 Hz.

- After exchanging the filter, the soot and ash load stored in the ECU must be reset with the Service Tool (SERDIA).

Table 34. Ash Load DPF Filter Replacement

Ash Load	AT1S Byte 2 [%]	DPF Test Monitor Byte 3.3-4	Ash Lamp	DM1 Byte1.3-6	Warning Lamp	Symbol	System reaction EU and EPA
Normal Operation	<100%	00	Off	xx0000xx	-	-	No Derating
Filter Exchange Required	≥100%	01		xx0000xx	-	-	No Derating
Warning Level	≥105%	10	Blinking 	xx0000xx	-	-	No Derating
Warning Level	≥110%	11	Blinking 	xx0000xx	On	Continuous 	Derating Step 1 Active.

3.26 COUNTERWEIGHT

If the counterweight has been removed, ensure the retaining bolts are torqued to the proper value as shown in *Figure — Counterweight - 450A, page 280* and *Figure — Counterweight - 450AJ, page 281*.

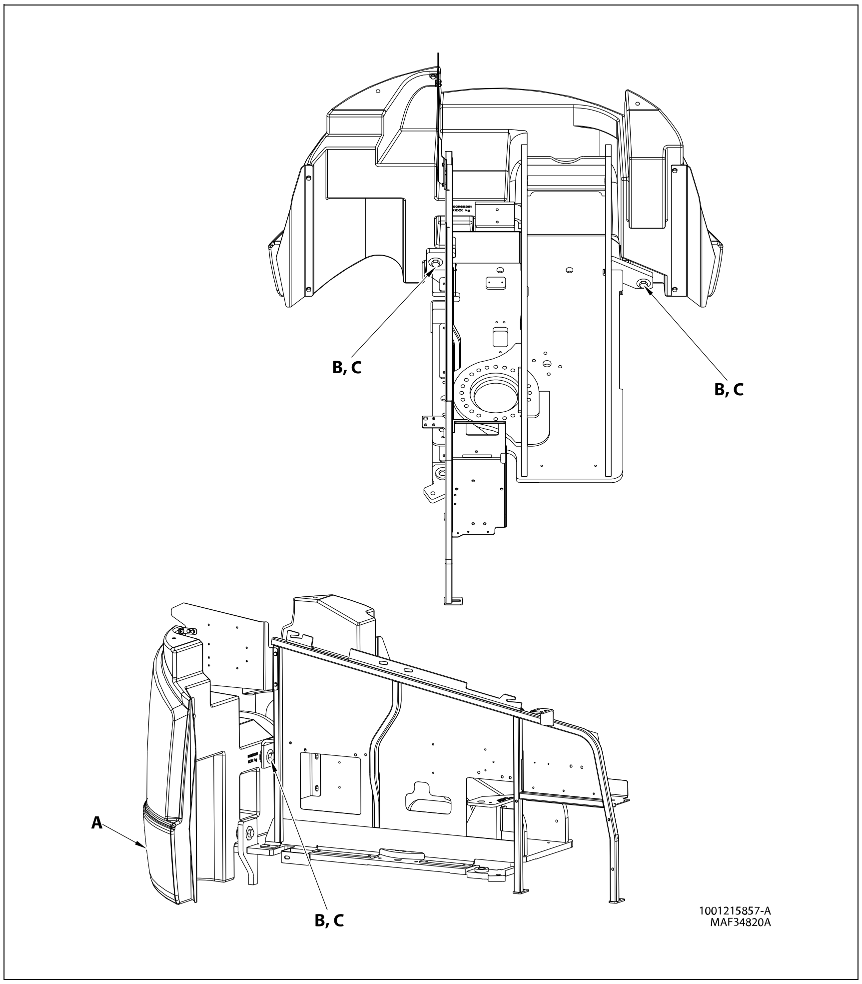


Figure 113. Counterweight - 450A

A. Counterweight Casting
B. Apply High Strength Threadlocking Compound to Bolt Threads and to Threads in Counterweight.
C. Torque to 345.9 ft. lbs. (469 Nm). Typical Three Places.

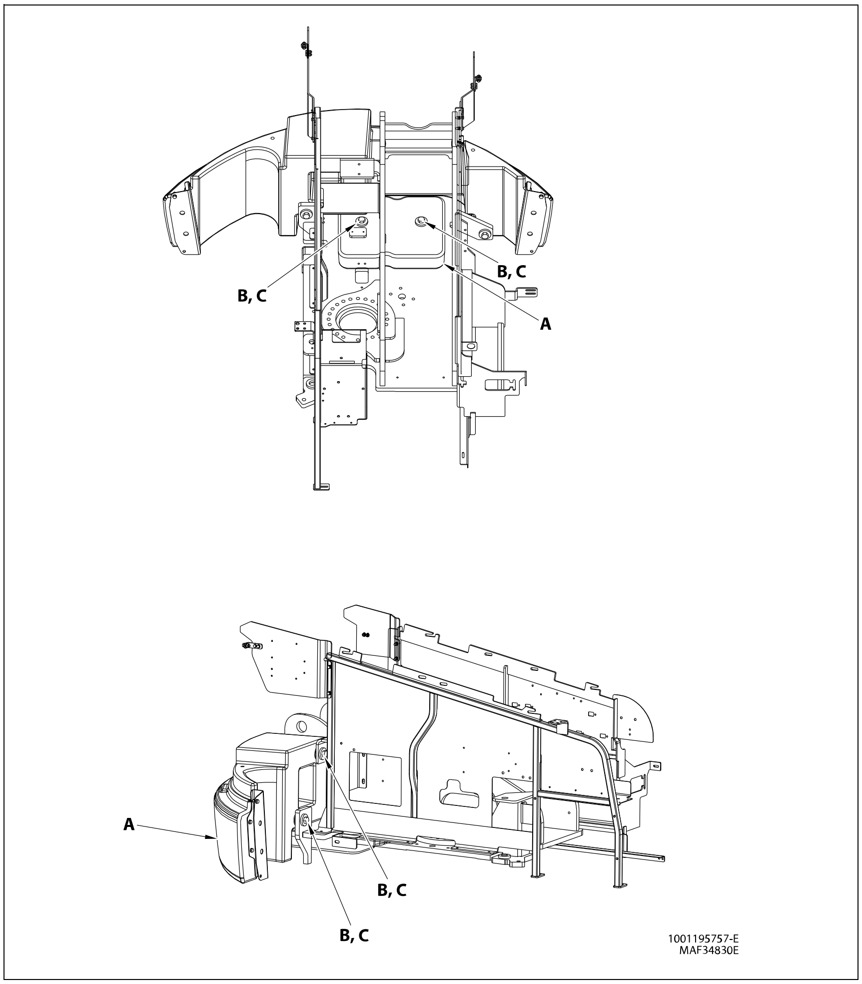


Figure 114. Counterweight - 450AJ

A. Counterweight Casting
B. Apply High Strength Threadlocking Compound to Bolt Threads and to Threads in Counterweight.
C. Torque to 345.9 ft. lbs. (469 Nm). Typical Three Places.

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SECTION 4
BOOM & PLATFORM

4.1 BOOM SYSTEMS

4.1.1 Platform Control Enable System

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

4.1.2 Transport Position Sensing System

The transport position sensing system uses a rotary angle sensor with internal redundancy (mounted on the upper upright at the lift cylinder pivot bushing) and the tower boom angle switch (mounted on the lower upright at the upper link pivot bushing) to sense when the boom is in the position associated with high speed travel. The rotary angle sensors have inverse signals with a spring return to a safe state. The tower boomswitch is normally closed and positively open in the safe state. Above transport angle is recognized when the main boom travels from the stowed position to 4° to 6° above horizontal (it resets at less than 3° above horizontal) or when the upper tower boom is sensed to be more than 6° to 10° above horizontal (it resets at 1° to 5° above horizontal). The main boom may be telescoped to any position, and the articulating jib (if equipped) may be in any position. This system is used to control the following systems:

- Above Elevation - Drive Speed Cutback System
- Drive/Steer – Boom Function Interlock System (CE/UKCA Only)
- Tower boom soft stop.
- Main Boom soft stop (top and bottom).

4.1.3 Platform Load Sensing System (LSS)

The Platform Load Sensing System (LSS) consists of 1 load cell and 2 linkages mounted to the platform rotator and platform support. The load cell includes a sealed circuit and is connected directly to a CAN-based platform control panel within the platform box. This system measures the weight in the platform. When the capacity is exceeded, or when there is a fault in the system, the platform overload indicator will flash, the platform alarm will sound at the standard JLG duty cycle of 5 sec on / 2 sec off and all platform controls (except emergency descent) will be disabled.

4.1.4 Beyond Transport Position - Drive Speed Cutback System

When boom is positioned beyond the Transport Position as described in the Transport Position Sensing System, the drive pump command is automatically restricted to a value that results in a drive speed of approximately 0.5 mph. See Drive System for more detail on the drive speeds, and see the Chassis Tilt Indicator System for interaction with the tilt sensor.

4.1.5 Drive/Steer –Boom Function Interlock System

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

4.1.6 Jib Lift End of Stroke Dampening (if equipped)

The jib lift cylinder is constructed in a way that causes the jib lift cylinder oil flow to be restricted by an orifice while lowering the jib near the end of stroke at minimum elevation. This flow restriction reduces the speed of this function just before bottoming out the cylinder.

4.1.7 Main Boom Lift End of Stroke Dampening

When the lift cylinder is activated to lower or raise the main boom, the UGM monitors the main boom angle through an angle sensor. When the boom is approaching maximum angle and is within 5° of end of stroke, the UGM will slow down the travelling speed of the cylinder to provide end of stroke dampening by controlling hydraulic valve flow rate of the lift cylinder. The damping rate can be adjusted by personal settings through JLG hand analyzer.

4.1.8 Emergency Decent System

The emergency descent system allows the boom and jib (if equipped) to be lowered in the event of primary power (engine power) loss. This system uses a secondary set of electrically powered solenoid valves and the force of gravity to lower the booms. The following functions are included in this system and will operate normally if the engine is not running and the “auxiliary power” switch has been activated: Main Lift Up/Down, Tower Lift Up/Down, Jib Up/Down (if equipped), Telescope In/Out, Swing Left/Right.

4.2 PLATFORM

4.2.1 Platform/Support Removal

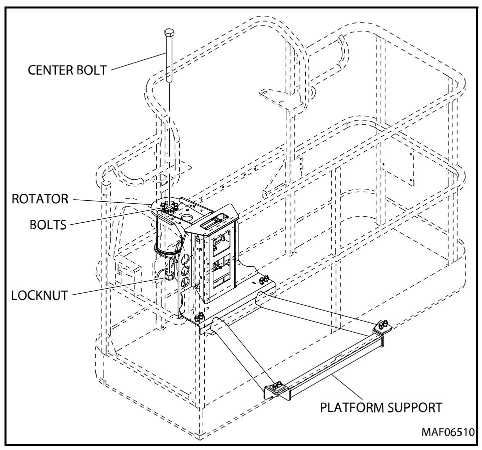
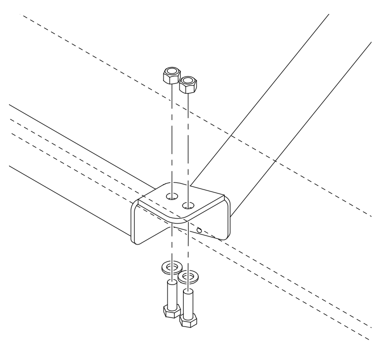


Figure 115. Location of Components Platform Support

1. Disconnect electrical cable from control console.

Note: The platform weighs approximately 176 lb (80 kg).

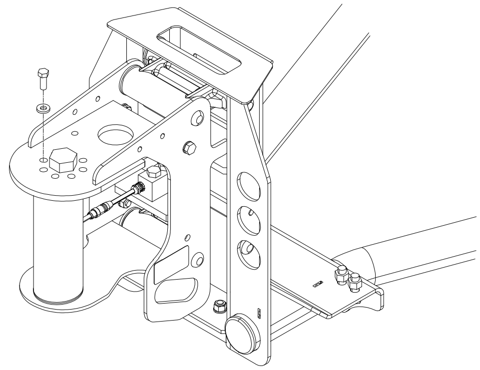
2. Remove the bolts securing the platform to the platform support, then remove the platform.



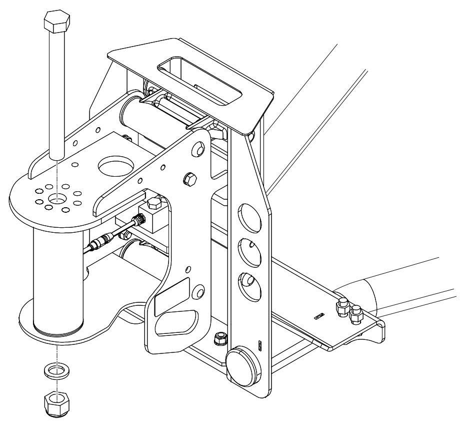
Note: The platform support weighs approximately 125 lb (56.8 kg).

3. Using a suitable device, support the platform support.

4. Remove the bolts and locknuts securing the support to the rotator.



5. Using a suitable brass drift and hammer, remove the center bolt and locknut.

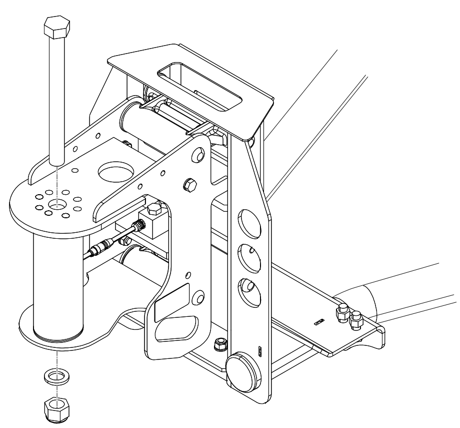


6. Remove the platform support from rotator.

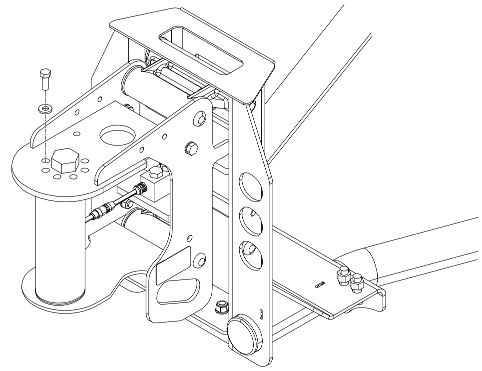
4.2.2 Platform/Support Installation

Note: The platform support weighs approximately 125 lb (56.8 kg).

1. Using a suitable device, support the platform support and position it on the rotator.
2. Install the rotator center bolt and locknut.



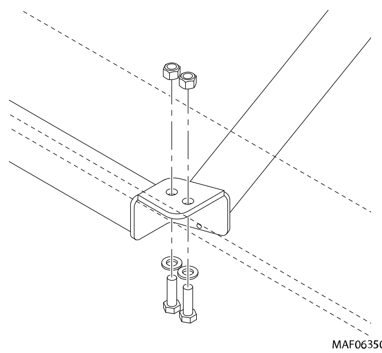
3. Apply medium strength threadlocking compound to the eight bolts securing the support to the rotator and install the bolts.



4. Torque the nut on the rotator center bolt and the retaining bolts.

Note: The platform weighs approximately 176 lb (80 kg).

5. Using a suitable lifting device, position the platform on the platform support and install the bolts securing the platform to the platform support.



6. Connect the electrical cable to the platform control console.

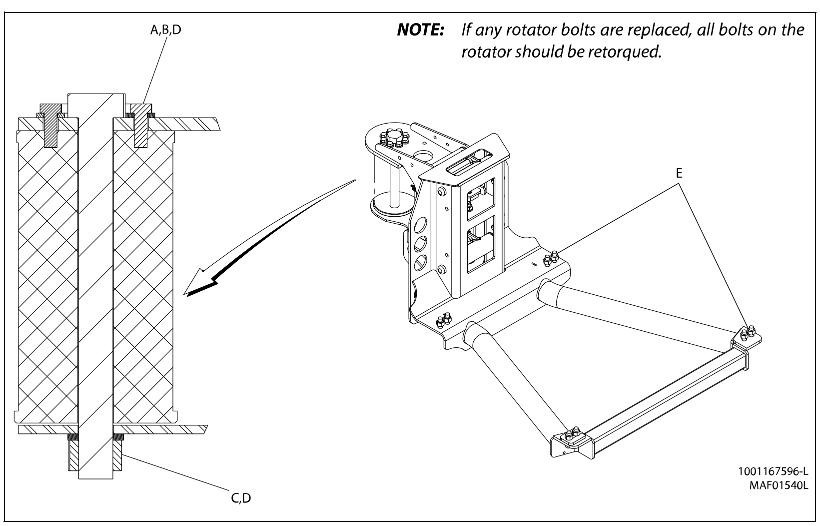


Figure 116. Platform Support Torque Values (with 1 Cell LSS)

A. Torque to 40 ft. lbs. (55 Nm)	D. Check torque every 150 hours of operation
B. Medium Strength Threadlocking Compound	E. Torque to 71.5 ft. lbs. (97 Nm)
C. Torque to 586 ft. lbs. (795 Nm)	

4.3 ROTATOR

4.3.1 Removal

1. Remove the Platform and Platform Support. Refer to *Section — Platform, page 284*.
2. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap or plug all openings of hydraulic lines and ports.

Note: The rotator approximately weighs 50 lb (23 kg).

Note: The jib lift cylinder approximately weighs 45 lb (21 kg).

3. Supporting the rotator and jib lift cylinder, remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1.
4. Remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 and remove the rotator.

4.3.2 Installation

Note: The rotator approximately weighs 50 lb (23 kg).

Note: The jib lift cylinder approximately weighs 45 lb (21 kg).

1. Supporting the rotator and jib lift cylinder, align rotator with jib lift cylinder and jib. Using a soft head mallet, install pin #1 to the jib assembly. Install hardware securing pin #1.
2. Using a soft head mallet install pin #2 to jib assembly and install the rotator. Install hardware securing pin #2.
3. Install the platform and platform support. Refer *Section — Platform, page 284*.
4. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the rotator as tagged during removal.

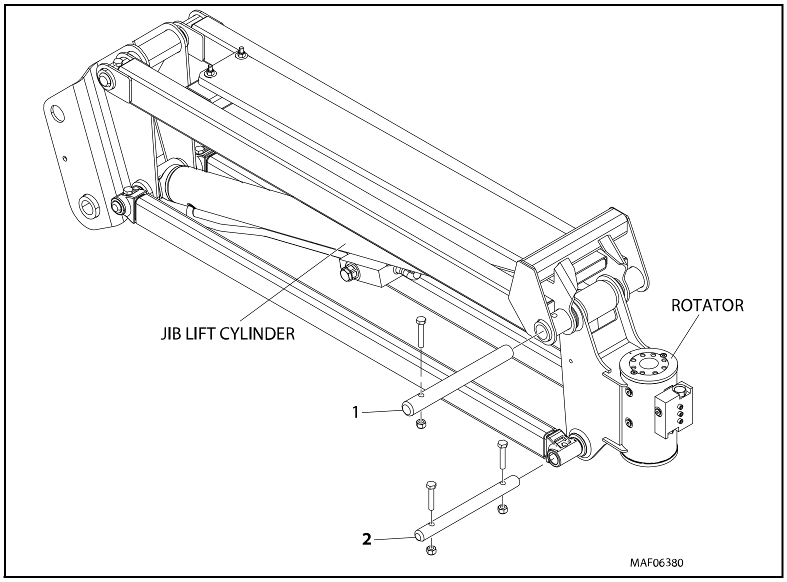


Figure 117. Rotator Removal/Installation

4.4 JIB

4.4.1 Removal

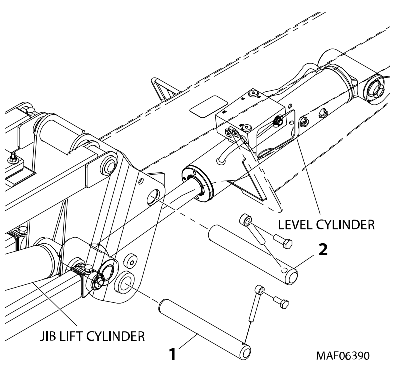
1. Remove the platform and platform support. Refer to *Section — Platform, page 284*.

Note: The jib assembly approximately weighs 220 lb (100 kg).

2. Using a suitable lifting device, adequately support jib assembly weight along entire length.
3. Tag and disconnect hydraulic lines from level cylinder and jib lift cylinder. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings of hydraulic lines and ports.

Note: The level cylinder approximately weighs 42 lb (19 kg).

4. Attach an adequate supporting device to the Level cylinder to support its weight.
5. Remove mounting hardware from level cylinder pin #1. Using a suitable brass drift and hammer, remove the pin #1.
6. Remove mounting hardware from jib pivot pin #2. Using a suitable brass drift and hammer, remove the pivot pin from jib assembly.
7. Remove the jib assembly from the boom.

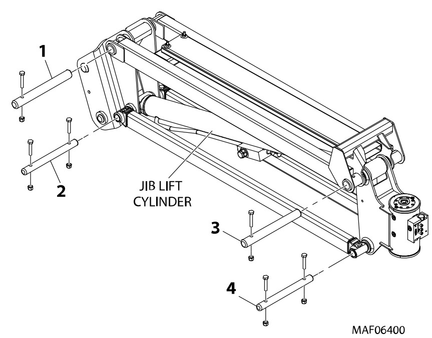


4.4.2 Disassembly

1. Remove mounting hardware from jib pivot pin #1 and #2. Using a suitable brass drift and hammer, remove the pin #1 and #2 from jib pivot.
2. Remove the jib pivot from jib assembly.

Note: The jib lift cylinder approximately weighs 45 lb (21 kg).

3. Attach an adequate supporting device to the lift cylinder assembly to support its weight.
4. Remove mounting hardware from pin #3. Using a suitable brass drift and hammer, remove the pin #3.
5. Carefully remove the lift cylinder from jib assembly.
6. Remove mounting hardware from pin #4. Using a suitable brass drift and hammer, remove the pin #4.
7. Remove rotator from jib assembly.



4.4.3 Inspection

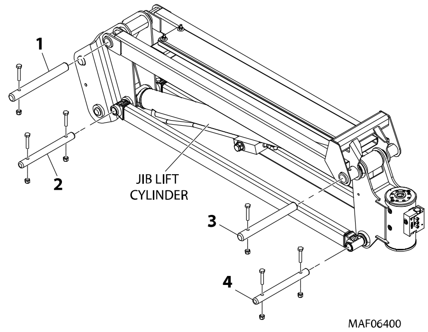
Note: When inspecting pins and bearings Refer to *Section — Pins and Composite Bearing Repair Guidelines, page 56*.

1. Inspect pivot pins for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
2. Inspect pivot attach points for scoring, tapering and ovality, or other damage. Replace pins as necessary.
3. Inspect inner diameter of 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.
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of jib assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

4.4.4 Assembly

1. Supporting the rotator and jib lift cylinder, align the jib lift cylinder rod end and rotator with the jib assembly. Using a soft head mallet, install pin #3. Install hardware securing pin #3.
2. Using a soft head mallet install pin #4 to jib assembly and rotator. Install hardware securing pin #4.
3. Align the jib lift cylinder barrel end and jib pivot to the jib assembly. Using a soft head mallet, install pin #2 and secure with mounting hardware.

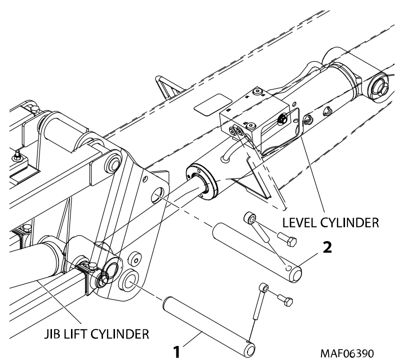
4. Align jib pivot with jib assembly. Using a soft head mallet, install pin #1 into jib assembly and secure with mounting hardware.



4.4.5 Installation

Note: The jib assembly approximately weighs 220 lb (100 kg).

1. Attach an adequate lifting device to the jib assembly and position it in front of the fly boom.
2. Lift the jib assembly into position on the boom fly section and install the pin #2 using a soft head mallet. Secure the pin #2 in place with the bolt and keeper pin.
3. Align level cylinder with fly boom and jib pivot and install pin #1 using a soft head mallet. Secure the pin #1 in place with the bolt and keeper pin.



4. Install the platform and platform support. Refer *Section — Platform, page 284*.
5. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the level cylinder and jib lift cylinder as tagged during removal.

4.5 PLATFORM LEVEL CYLINDER

4.5.1 Removal

1. Tag and disconnect hydraulic lines from platform level cylinder. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings of hydraulic lines and ports.
2. Place blocking or a soft material under the platform level cylinder barrel to protect the rod from being scratched.

Note: The jib assembly approximately weighs 220 lb (100 kg).

3. Using a suitable lifting device, adequately support jib assembly.
4.

5. Remove mounting hardware from platform level cylinder pin #2. Using a suitable brass drift and hammer, remove the cylinder pin #2 from jib pivot.

Note: The platform level cylinder approximately weighs 42 lb (19 kg).

6. Carefully remove the platform level cylinder assembly from fly boom.

4.5.2 Installation

Note: The jib assembly approximately weighs 220 lb (100 kg).

1. Using a suitable lifting device, adequately support jib assembly.

Note: The platform level cylinder approximately weighs 42 lb (19 kg).

2. Support the platform level cylinder. Using a soft head mallet, install pin #1 to the level cylinder. Install hardware securing pin #1 and torque to 40.5 ft. lbs. (55 Nm).
3. Using soft head mallet install pin #2 to jib pivot and install the level cylinder. Install hardware securing pin #2 and torque to 40.5 ft. lbs. (55 Nm).
4. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the platform level cylinder as tagged during removal.

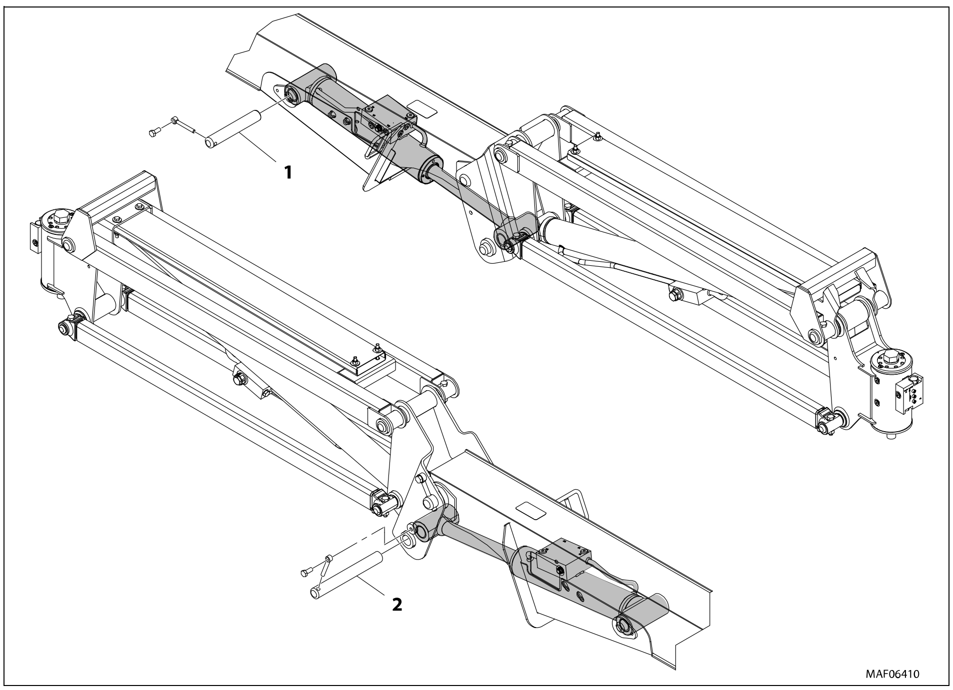


Figure 118. Platform Level Cylinder Removal and Installation

4.6 MAIN BOOM POWERTRACK

4.6.1 Removal

1. Disconnect wiring harness connectors located in turntable.
2. Tag and disconnect hydraulic lines from connectors at boom assembly. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings hydraulic lines and ports.

3. Remove hydraulic lines and electrical cables from Powertrack.

Note: The powertrack weighs approximately 12.6 lb (5.7 kg).

4. Using suitable lifting device, adequately support Powertrack weight along entire length.
5. Remove hardware #1 securing the powertrack on the tube carrier.
6. Remove bolt #2 securing the powertrack on the base boom section. Remove the powertrack assembly.

4.6.2 Installation

1. Using suitable lifting device, adequately support the powertrack weight along entire length.

Note: The powertrack weighs approximately 12.6 lb (5.7 kg).

2. With powertrack supported and using all applicable safety precautions, install hardware #2 securing rail to the base boom.
3. Install hardware #1 to tube carrier.
4. Remove cap or plugs from openings of hydraulic lines and ports. Remove tag and reconnect all hydraulic lines and electrical cable from powertrack.
5. Remove cap or plugs from openings of hydraulic lines and ports. Remove tag and reconnect hydraulic lines from connectors at boom assembly.

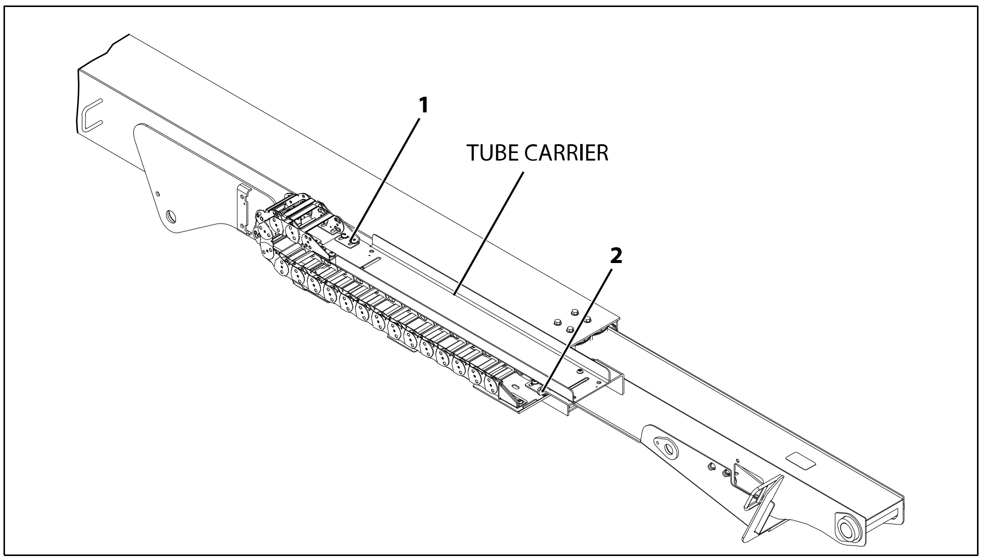


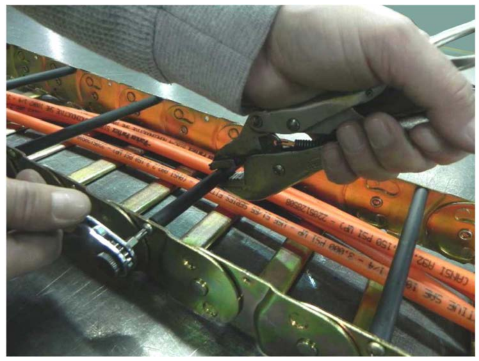
Figure 119. Location of Components - Powertrack

4.7 POWERTRACK MAINTENANCE

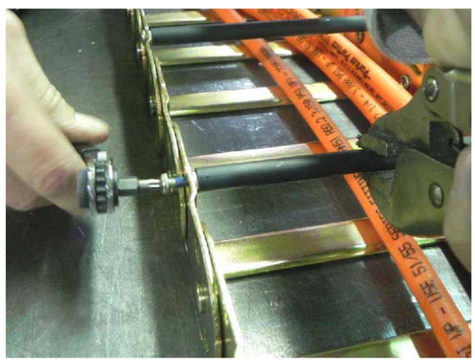
4.7.1 Remove Link

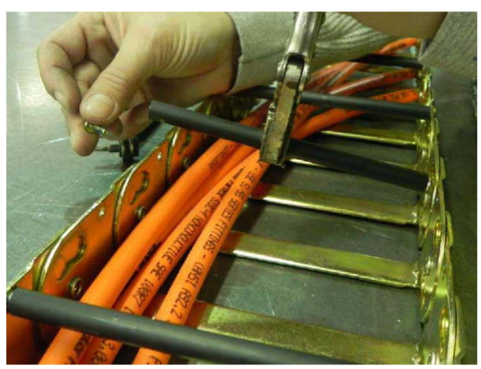
Note: Hoses shown in powertrack are for example only. Actual hose and cable arrangements are different.

1. Clamp bar and poly roller tightly so they do not spin when removing screw. With a small 1/4 in. ratchet and a T-20 torx bit, remove 8-32 x 0.500 screw from one side.



2. Repeat step 1 and remove screw from other side of track. Remove bar/poly roller from powertrack.

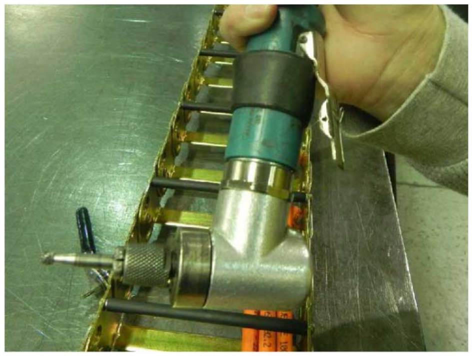




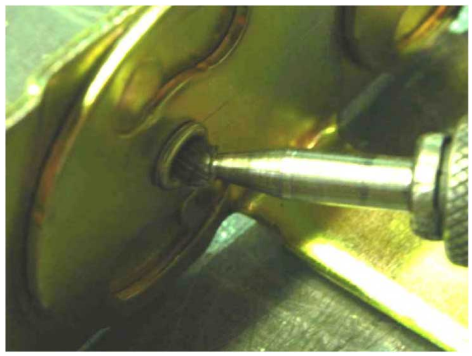
NOTICE

Reposition cables/hoses and keep covered during grinding to prevent damage.

3. To remove a link, rivets holding links together must be removed. Use a right-angle pneumatic die grinder with a 1/4 in. ball double cut bur attachment.

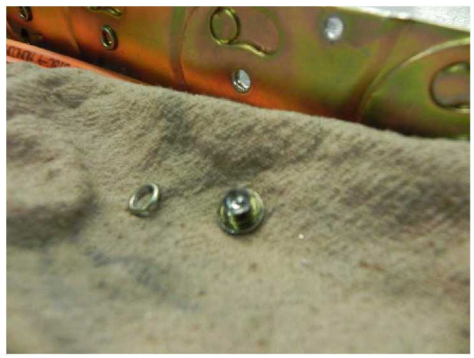


4. Insert tool into rolled over end of rivet. Grind out middle of rivet until rolled over part of rivet falls off. Repeat for all rivets to be removed.

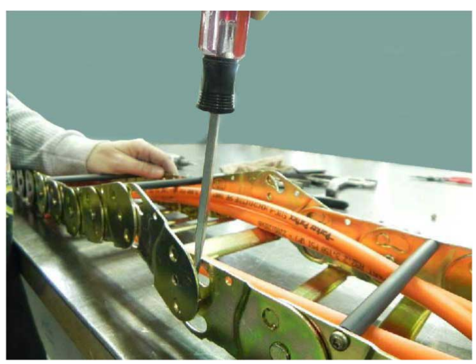


5. After grinding it may be necessary to use a center punch with a hammer to remove rivet.

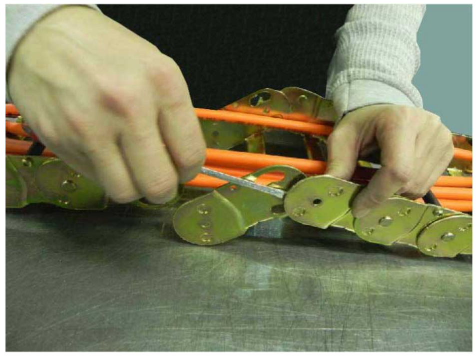
Note: It may be necessary to loosen fixed end brackets from machine to move track section enough to disconnect links.



6. Insert flat head screwdriver between links. Twist and pull links apart

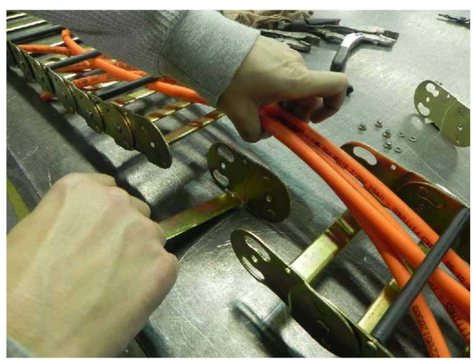


7. Remove link from other section of powertrack using screwdriver.

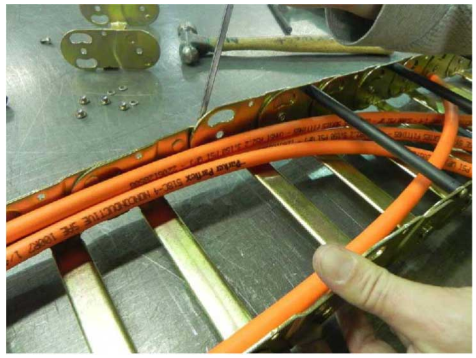


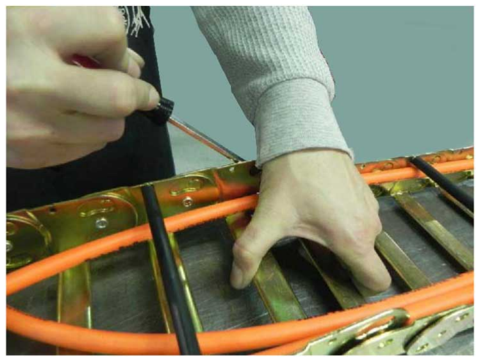
4.7.2 Install New Link

1. Squeeze cut-out end of new link into half-shear (female) end of track section

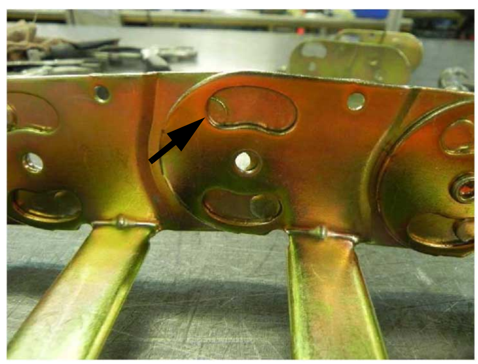


2. Spread half-shear (female) end of new link and slide cut-out end of track section into it. Use a screwdriver if necessary.



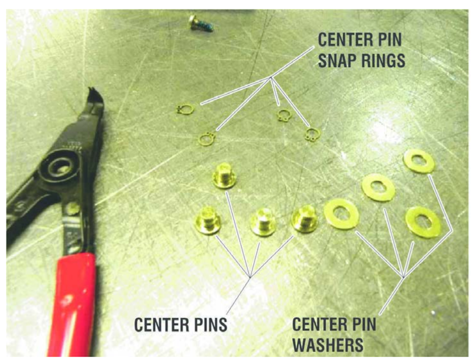


3. After new link is installed round half-shears do not fit properly in cut-outs.



4. Pull moving end over track so new connection is positioned in curve of powertrack. Round half-shears will rotate into cut-outs.

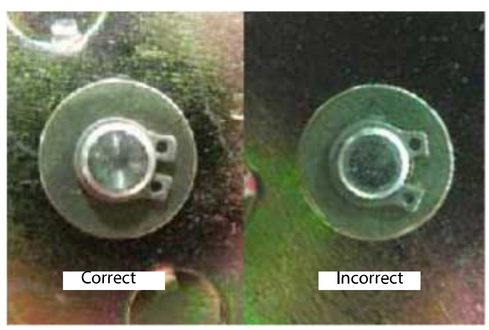
5. Parts shown below connect new link to powertrack.



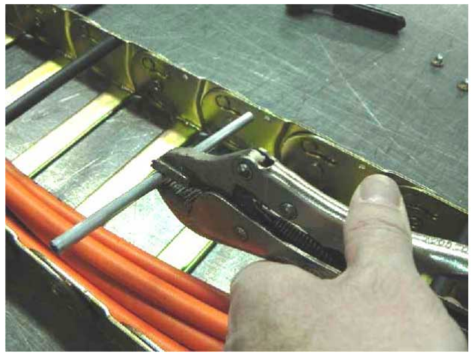
6. Push pin through center hole then slide washer on pin.

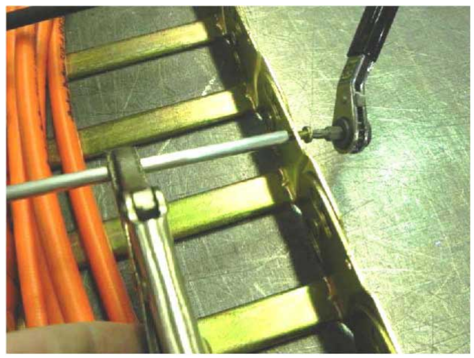
7. Install snap ring in groove on pin. Repeat pin installation steps for all center holes with rivets removed.

Note: Make sure snap rings are seated in pin groove and closed properly.

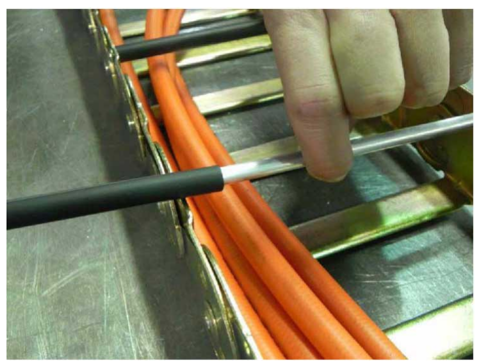


8. Install new 8-32 x 0.500 self-threading torx head screw in end of new aluminum round bar. Torque to 18-20 in. lbs. (2-2.25 Nm).

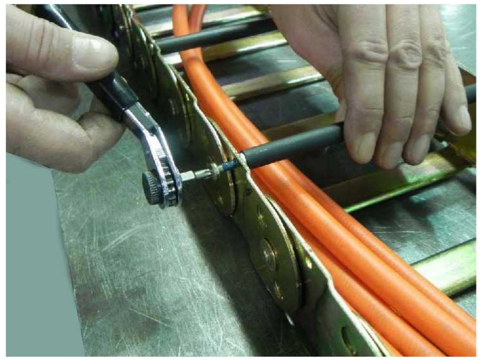




9. Pull up on other end of round bar and slide new poly roller on bar.

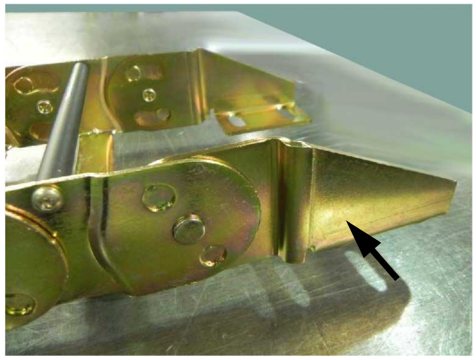


10. Install new 8-32 x 0.500 self threading screw on other side. Torque to 18-20 in. lbs. (2-2.25 Nm).



Note: When tightening screws make sure screw head is seated against link with no space in between link and underside of screw head.

4.7.3 Replace Fixed End Brackets



NOTICE

Reposition cables/hoses and keep covered during grinding to prevent damage.

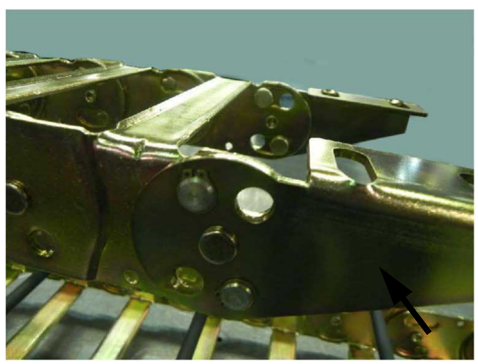
1. Remove rivets as shown in link removal instructions on *Refer — Removal Link, page 292*.

2. Parts used: Bracket Center Pin and Center Pin Snap Ring.

3. Take new bracket and install bracket center pin and snap ring. Repeat on other bracket if replacing it.

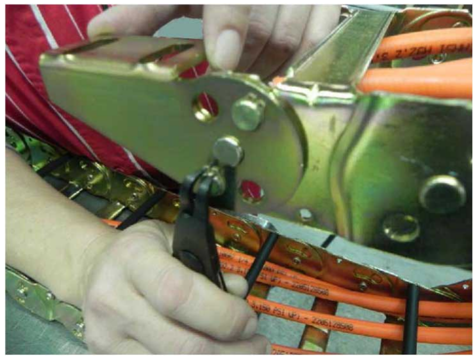
Note: When installing snap rings make sure they are seated in pin groove and closed properly.

4.7.4 Replace Moving End Brackets

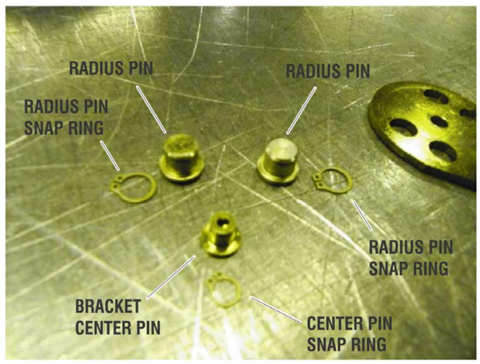


NOTICE
Reposition cables/hoses and keep covered during grinding to prevent damage.

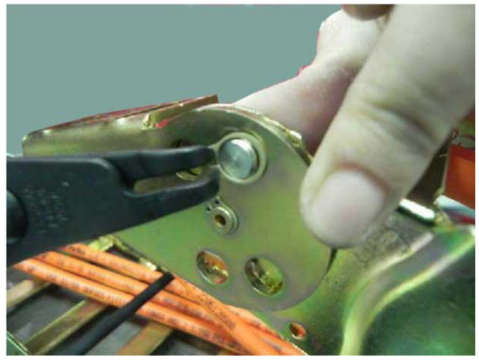
1. Remove existing pins and center rivet. Remove rivet as shown in link removal instructions on page 10. Repeat on other bracket if replacing it.



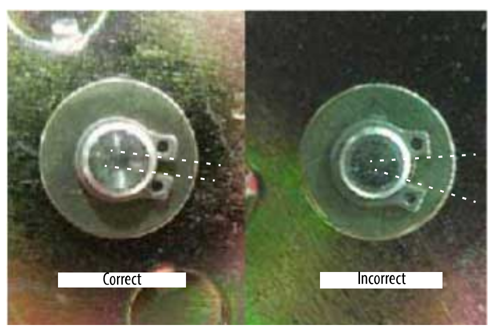
2. Install center pin with snap ring in new bracket.



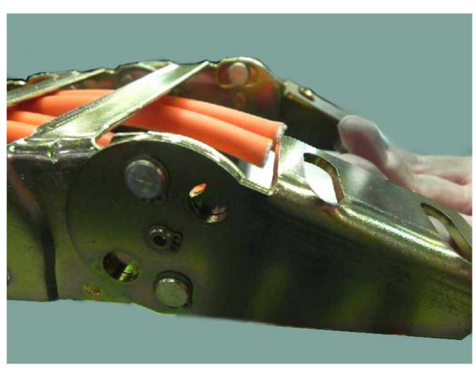
3. Install radius pins and snap rings in original locations. Repeat with other moving end if replacing it.



Note: When installing snap rings make sure they are seated in pin groove and closed properly.



4. Make sure both brackets rotate correctly.



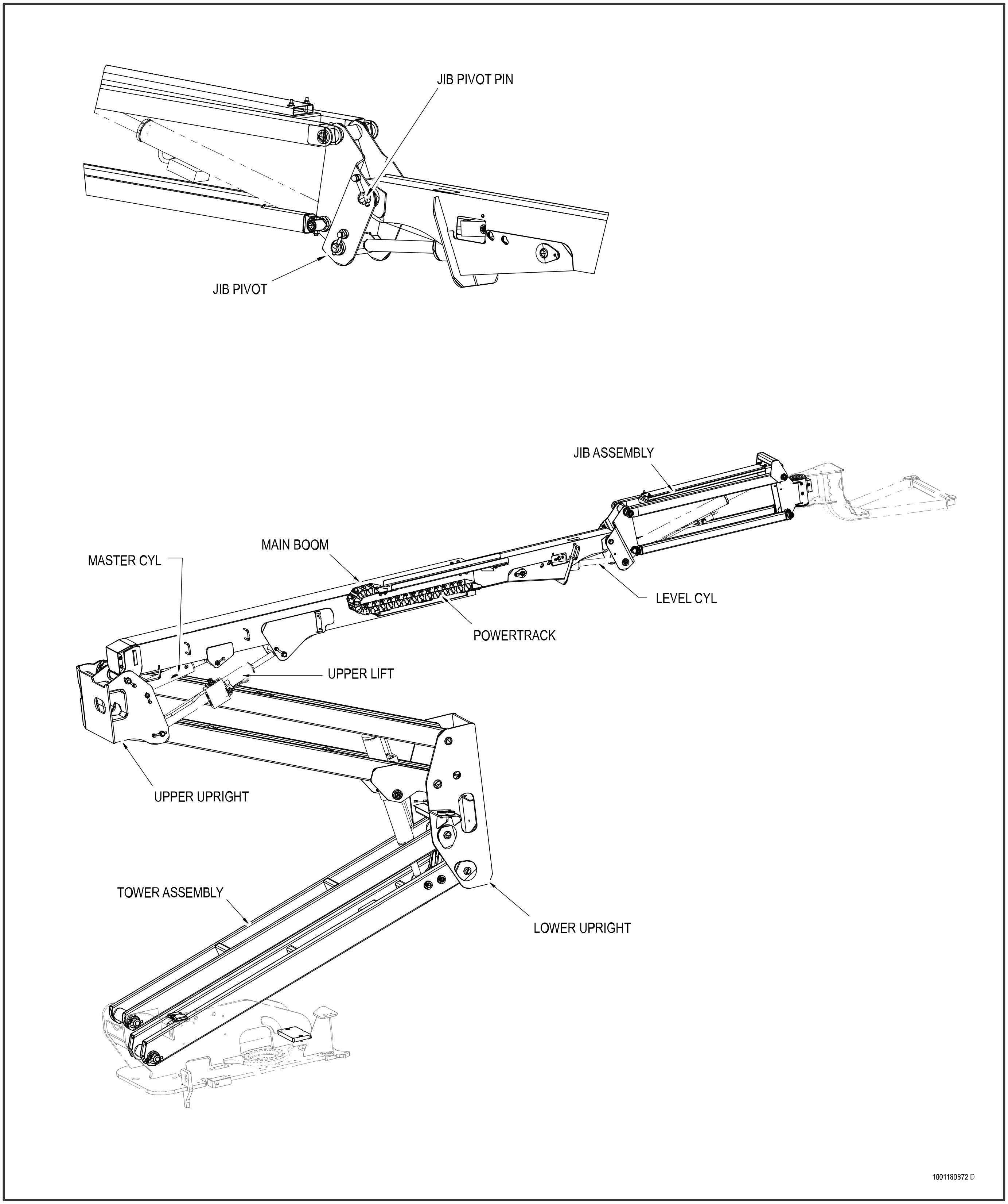


Figure 120. Boom Assembly

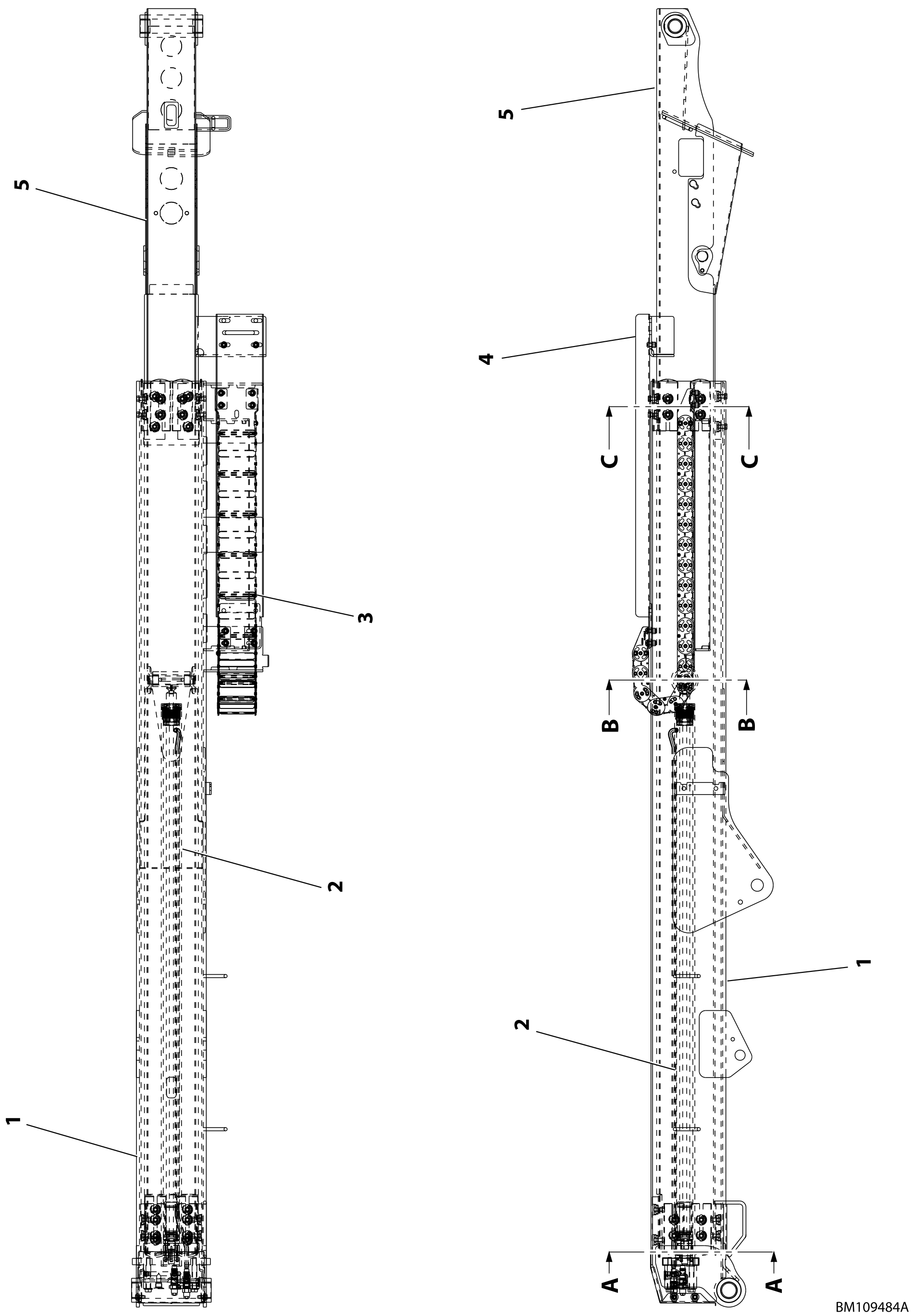


Figure 121. Main Boom Assembly - Sheet 1 of 2

1. Base Boom	4. Hose Carrier
2. Telecscope Cylinder	5. Fly Boom
3. Powertrack	

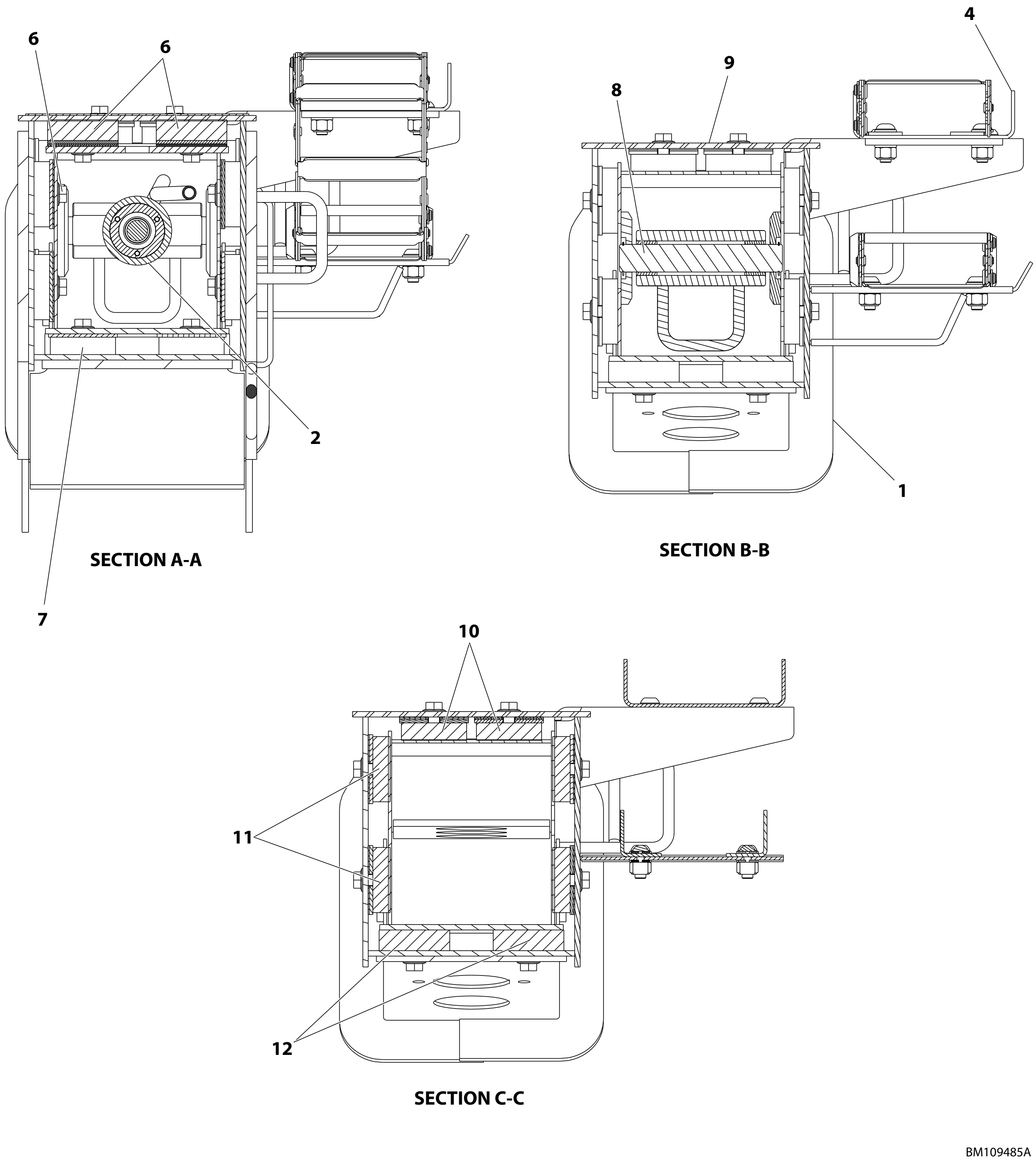


Figure 122. Main Boom Assembly - Sheet 2 of 2

6. Rear Side Wear Pads & Shims	10. Front Top Wear Pads & Shims
7. Rear Lower Wear Pads & Shims	11. Front Side Wear Pads & Shims
8. Telescope Cylinder Pin	12. Front Lower Wear Pads & Shims
9. Fly Section	

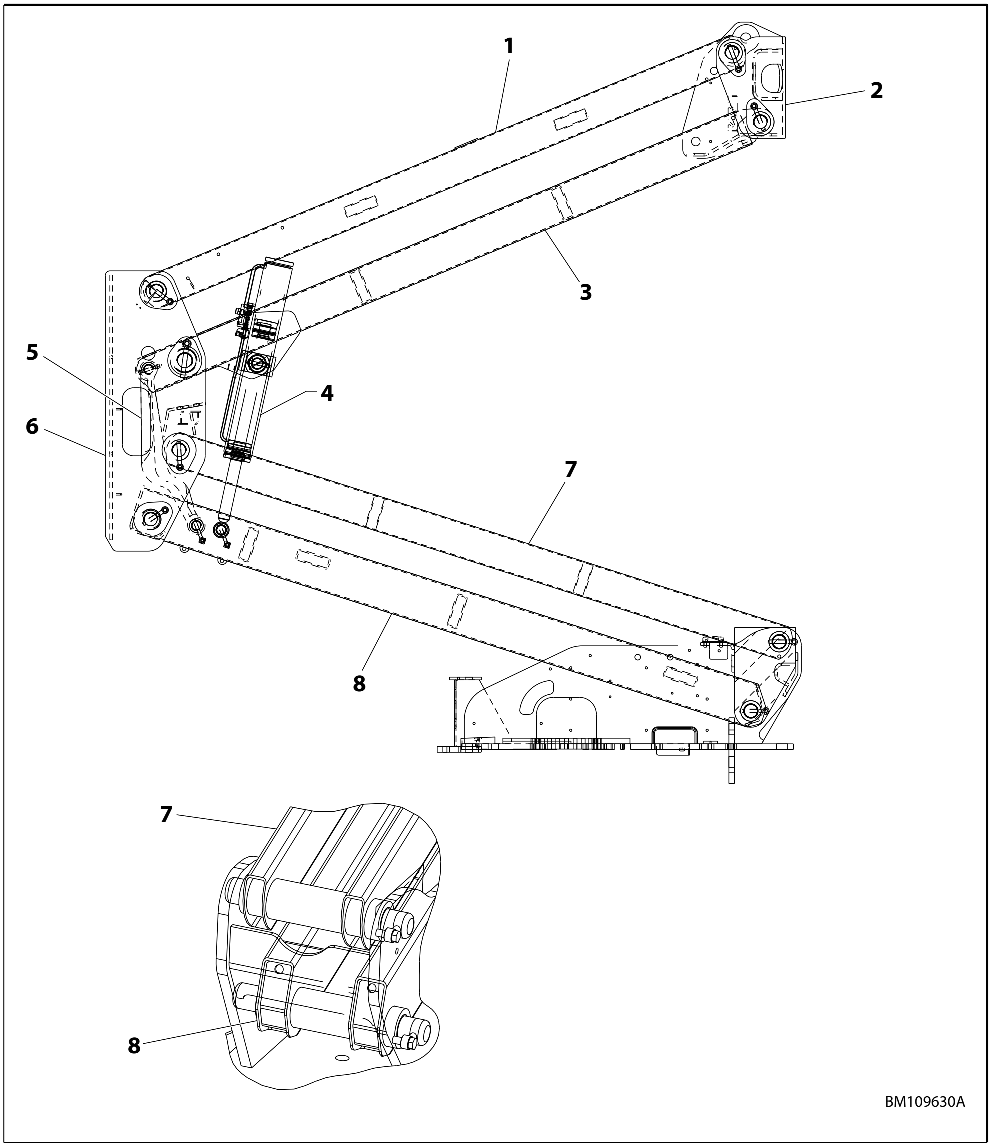


Figure 123. Upper Boom Assembly

1. Upper Link Boom	4. Tower Lift Cylinder	7. Lower Link Boom
2. Upper Upright	5. Timing Link	8. Lower Tower Boom
3. Upper Tower Boom	6. Lower Upright	

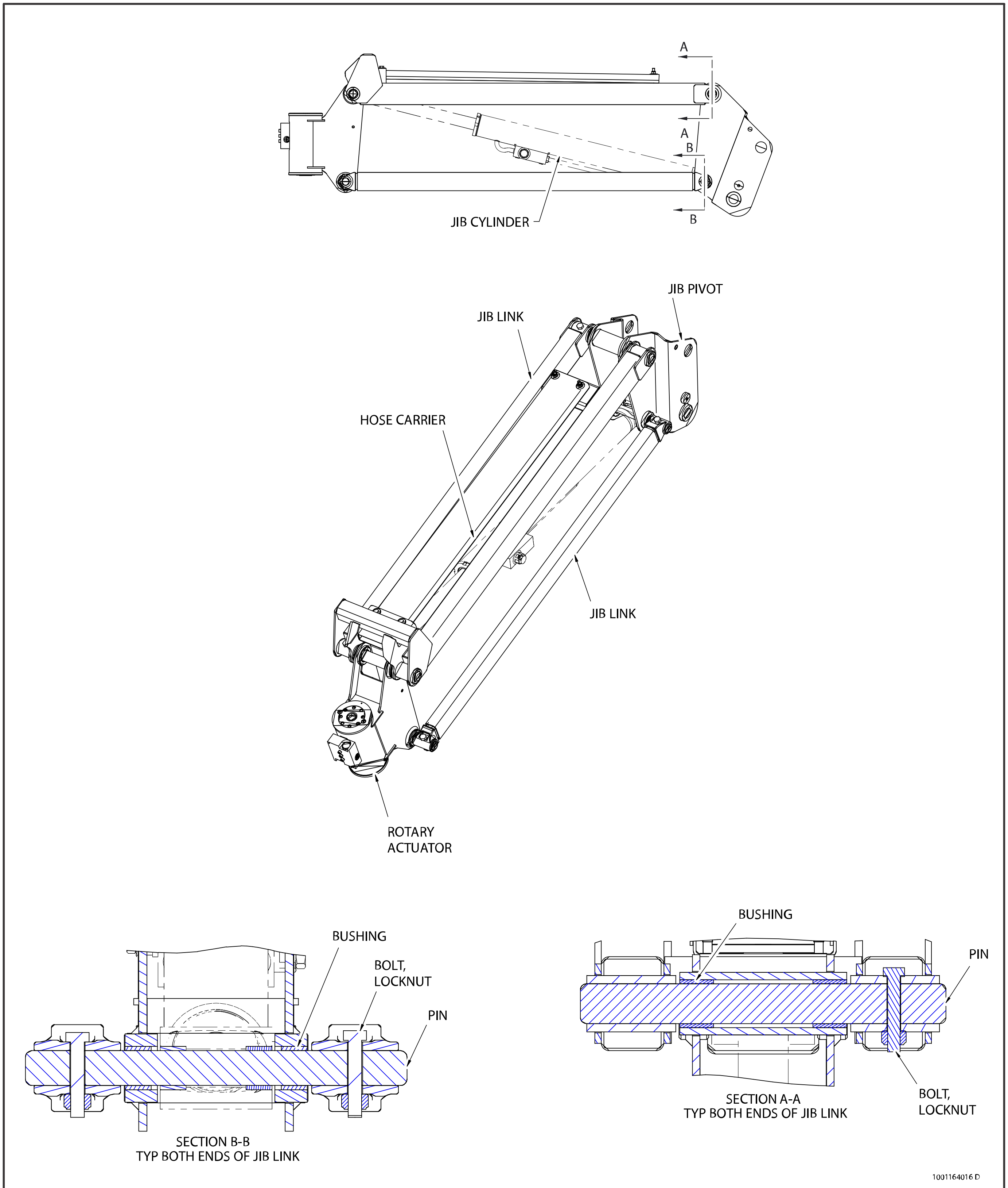


Figure 124. Jib Assembly

4.8 BOOM CLEANLINESS GUIDELINES

The following are guidelines for internal boom cleanliness for machines that are used in excessively dirty environments.

1. JLG recommends the use of the JLG Hostile Environment Package if available to keep the internal portions of a boom cleaner and to help prevent dirt and debris from entering the boom. This package reduces the amount of contamination which can enter the boom but does not eliminate the need for more frequent inspections and maintenance when used in these types of environments.
2. JLG recommends that you follow all guidelines for servicing your equipment in accordance with the instructions outlined in the JLG Service & Maintenance Manual for your machine. Periodic maintenance and inspection is vital to the proper operation of the machine. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.
3. Debris and foreign matter inside of the boom can cause premature failure of components and should be removed. Methods to remove debris should always be done using all applicable safety precautions outlined in the JLG Service & Maintenance Manuals.
4. The first attempt to remove debris from inside the boom must be to utilize pressurized air to blow the debris toward the nearest exiting point from the boom. Make sure that all debris is removed before operating the machine.
5. If pressurized air cannot dislodge the debris, then water with mild solvents applied via a pressure washer can be used. Again the method is to wash the debris toward the nearest exiting point from the boom. Make sure that all debris is removed, that no “puddling” of water has occurred, and that the boom internal components are dry prior to operating the machine. Make sure you comply with all federal and local laws for disposing of the wash water and debris.
6. If neither pressurized air nor washing of the boom dislodges and removes the debris, then disassemble the boom in accordance to the instructions outlined in the JLG Service & Maintenance Manual to remove the debris.

4.9 BOOM SHIMMING PROCEDURE

Note: When installing wear pads, the wear pad bolt lengths may need to be adjusted as shim thicknesses are adjusted. Bolt lengths should be flush or up to one thread below the surface of the insert.

1. Measure and take note of the inside width and inside height of the base boom opening for reference later in this procedure.
2. Install the side wear pads on the fly boom and shim as required to match the corresponding dimension recorded in Step 1 within +0/-1.2 mm. Shims should be divided as evenly as possible between the sides of the boom. The number of shims installed at position #1 must match with position #2, and position #3 must match position #4 as shown below. Take note to how many shims are installed in each position.

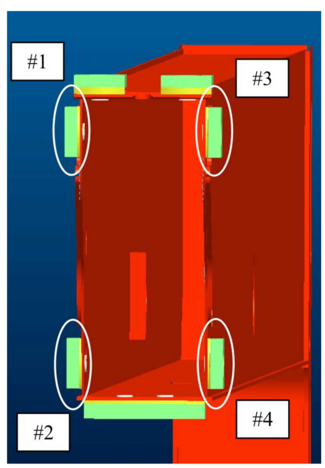


Figure 125. Fly Boom Wear Pads

3. Install the top wear pads and shims on the fly boom.
4. Install the bottom wear pads on the fly boom and shim as required to obtain the total base boom dimension within +0/-1.2 mm of the corresponding dimension from Step 1.
5. Slide the fly boom into the base boom, leaving 1 to 2 meters exposed.

6. Install the bottom wear pads and shims into the end of the base boom.

7. Install the side pads and shims into the base boom. Distribute shims to each side to match the distribution noted in Step 2. Positions #5/6 must match positions #1/2. Positions #7/8 must match positions #3/4 (Refer to *Figure — Fly Boom Wear Pads, page 311* and *Figure — Base Boom Wear Pads, page 312*. Verify that no more shims will fit on either side.

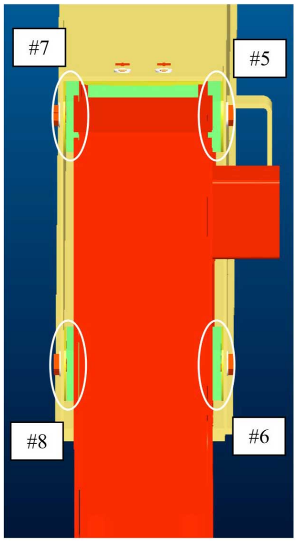


Figure 126. Base Boom Wear Pads

Note: Do not use a wedge to install more shims than will fit with the use of a pry bar. This may result in the boom being shimmed too tight. The use of pry bars should only be used to finish installing a shim that can be installed by hand more than half of its length.

8. Install the top wear pads and shims into the base boom leaving a gap of 0 mm to 1.2 mm between the top of the fly boom and the inside of the base boom.

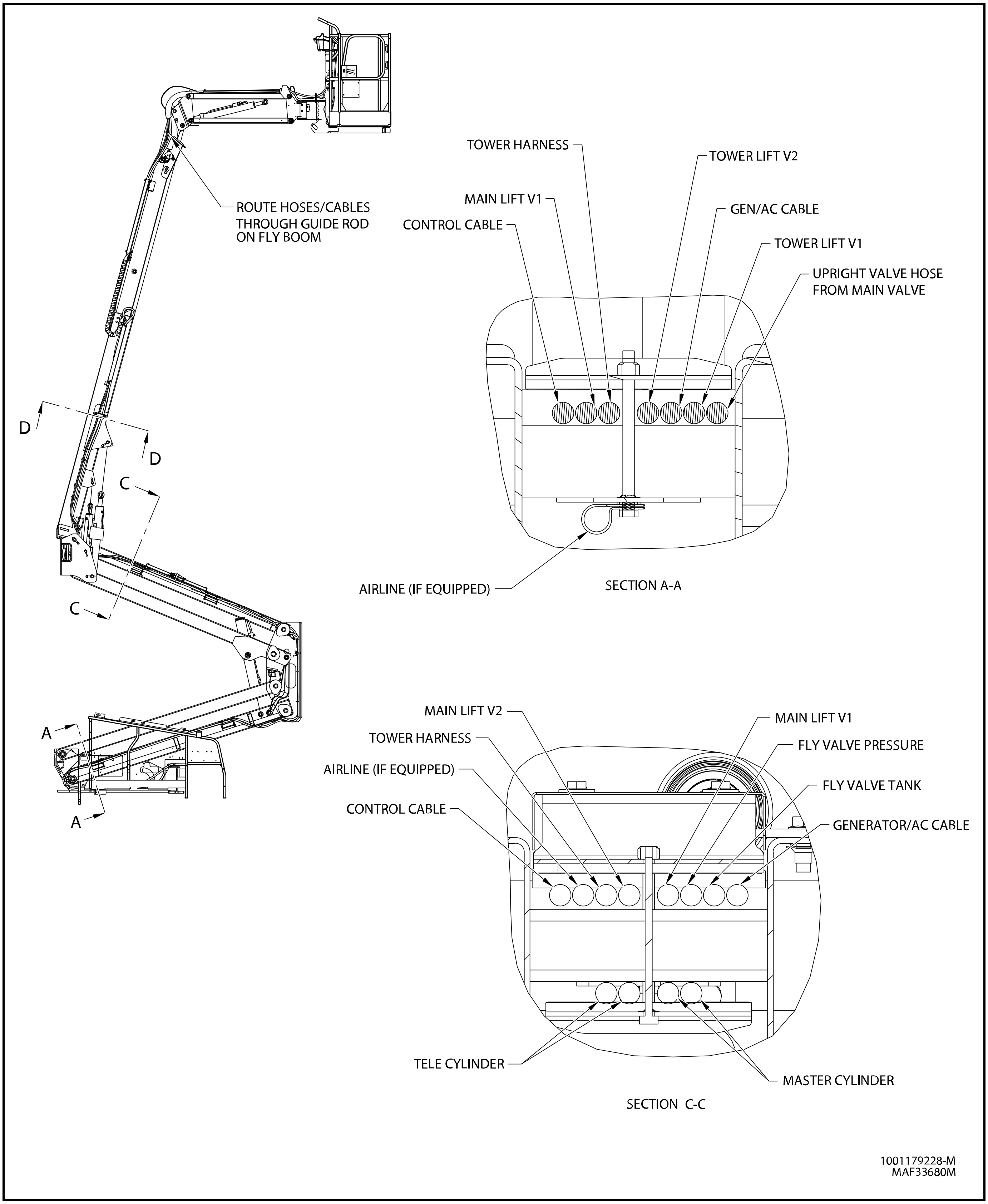


Figure 127. Cables and Clamps Installation - Sheet 1 of 8

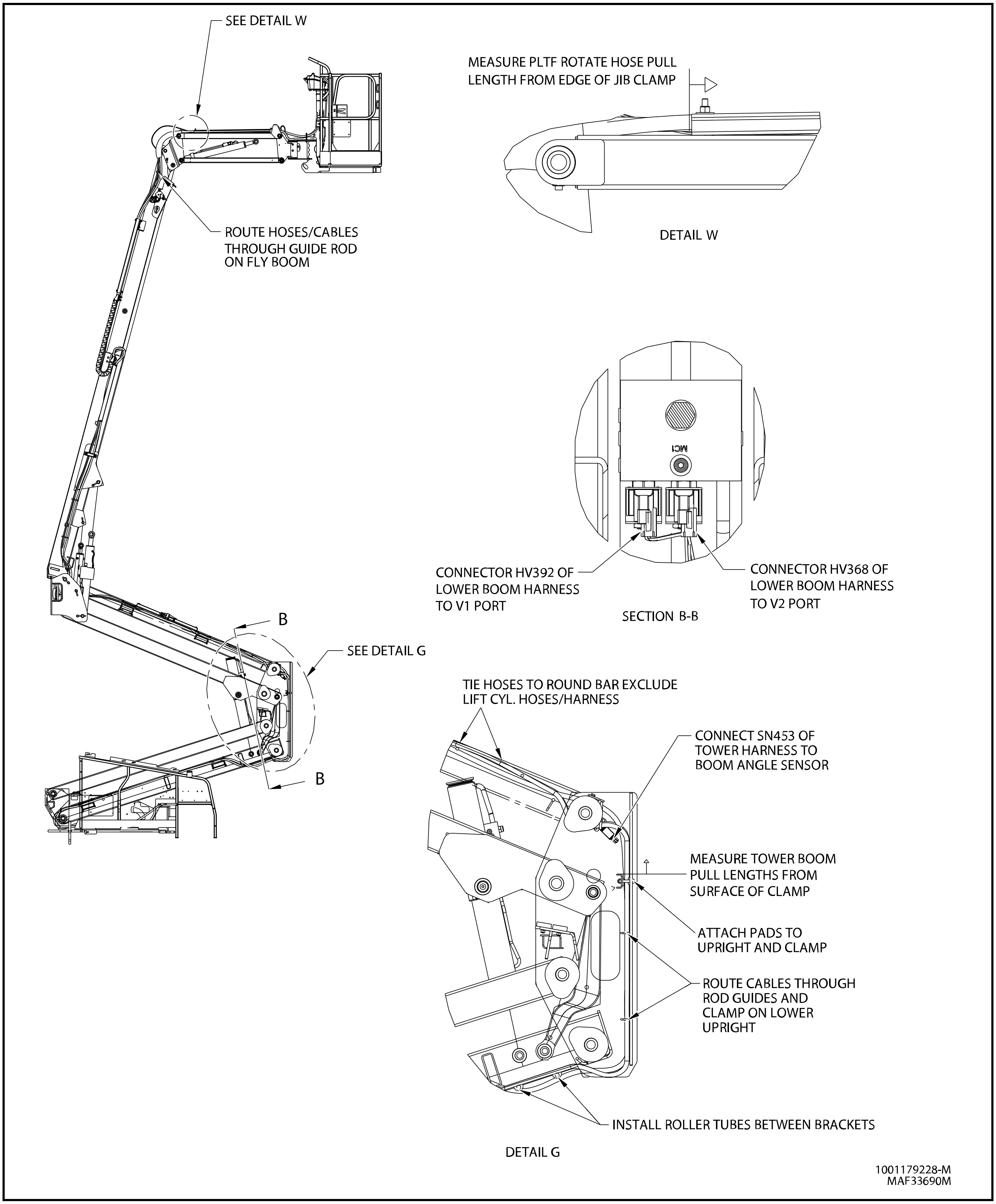


Figure 128. Cables and Clamps Installation - Sheet 2 of 8

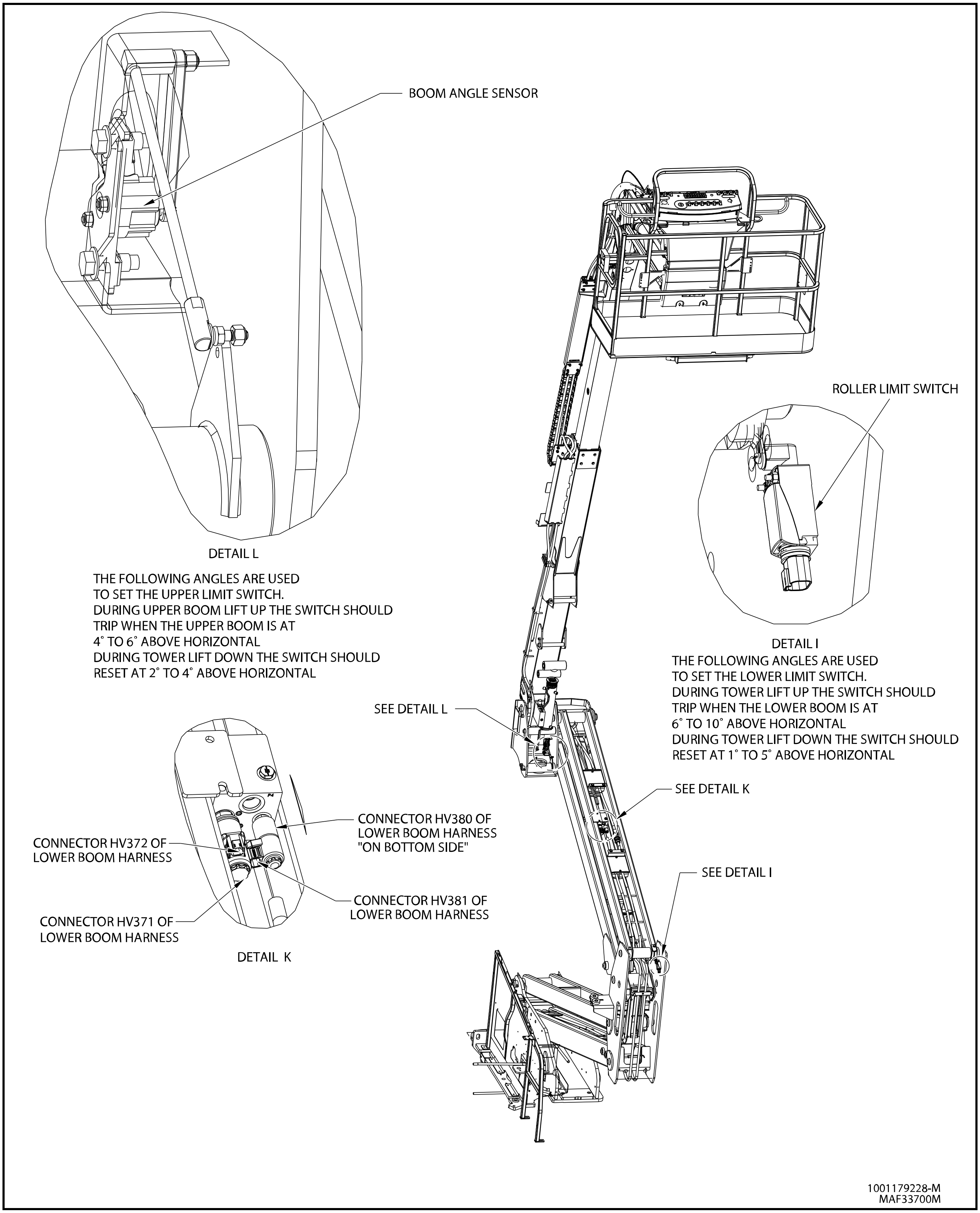


Figure 129. Cables and Clamps Installation - Sheet 3 of 8

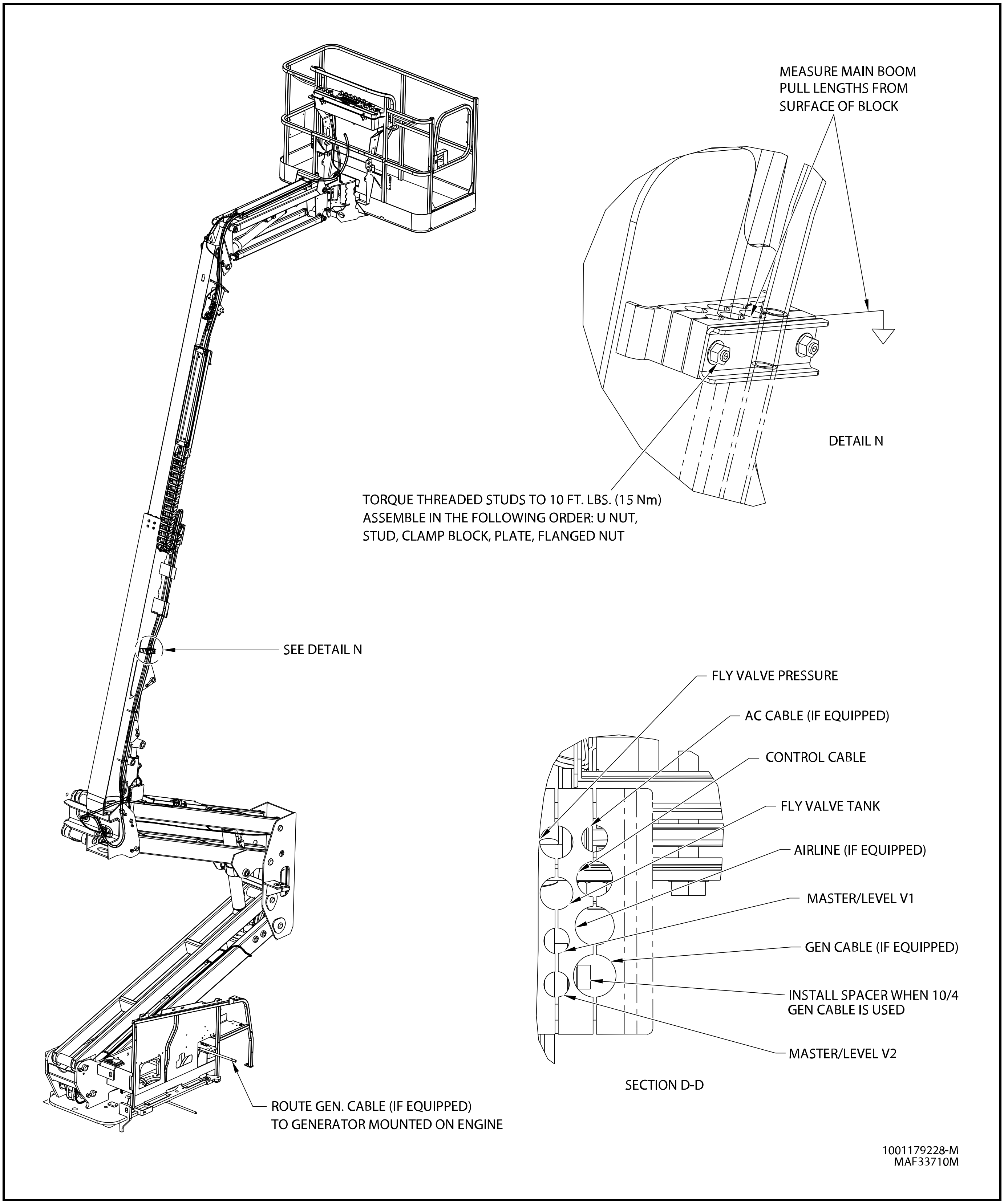


Figure 130. Cables and Clamps Installation - Sheet 4 of 8

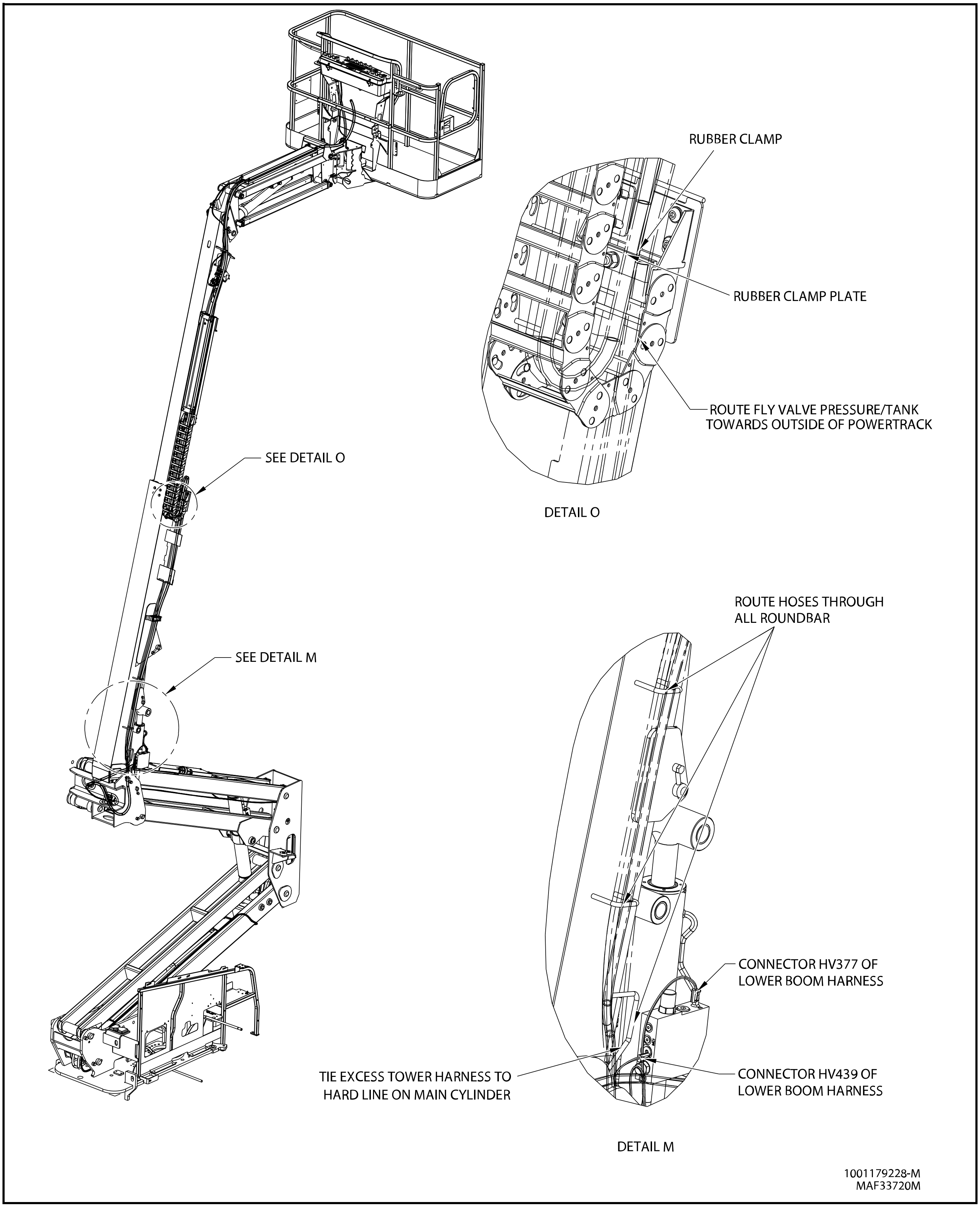


Figure 131. Cables and Clamps Installation - Sheet 5 of 8

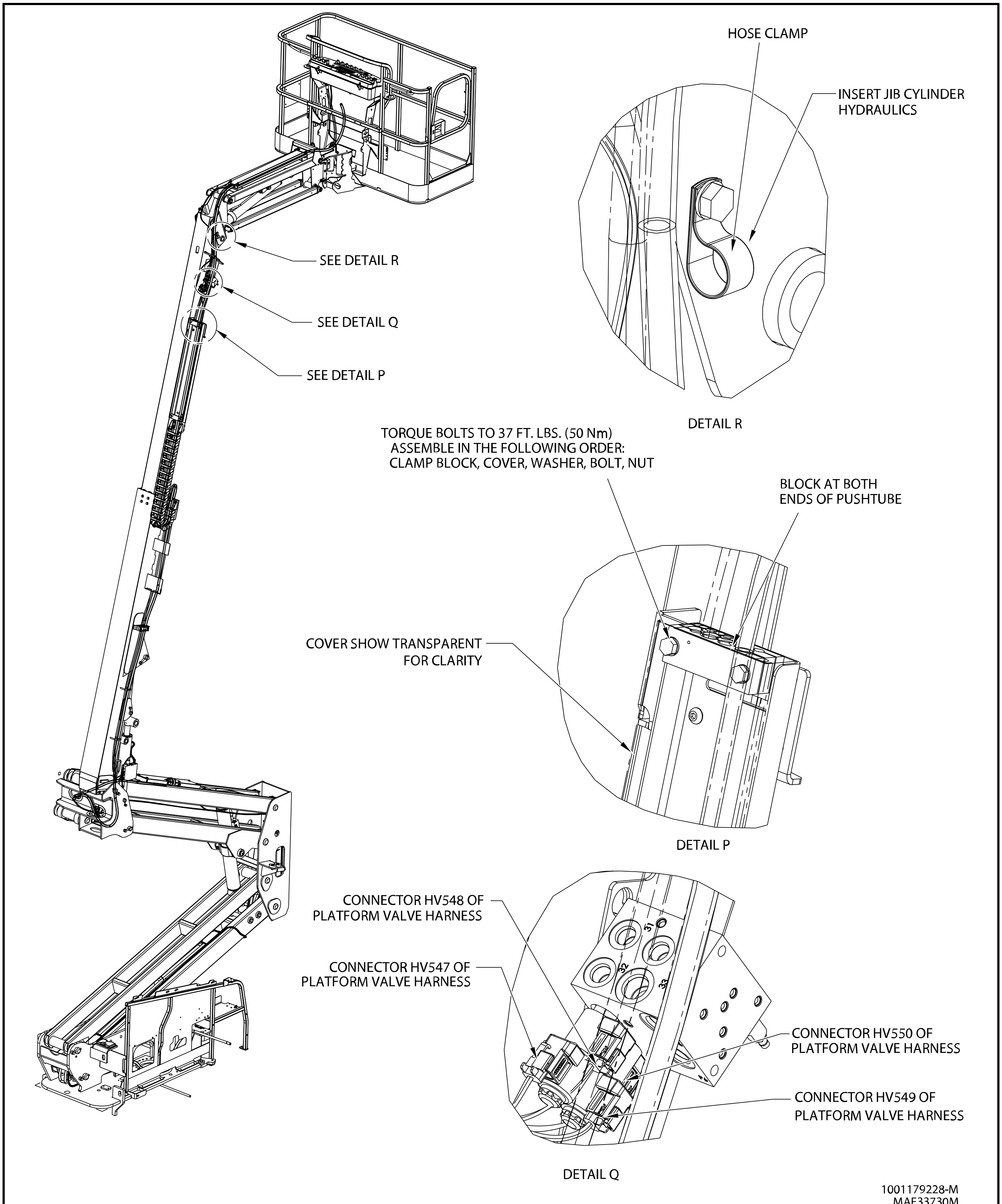


Figure 132. Cables and Clamps Installation - Sheet 6 of 8

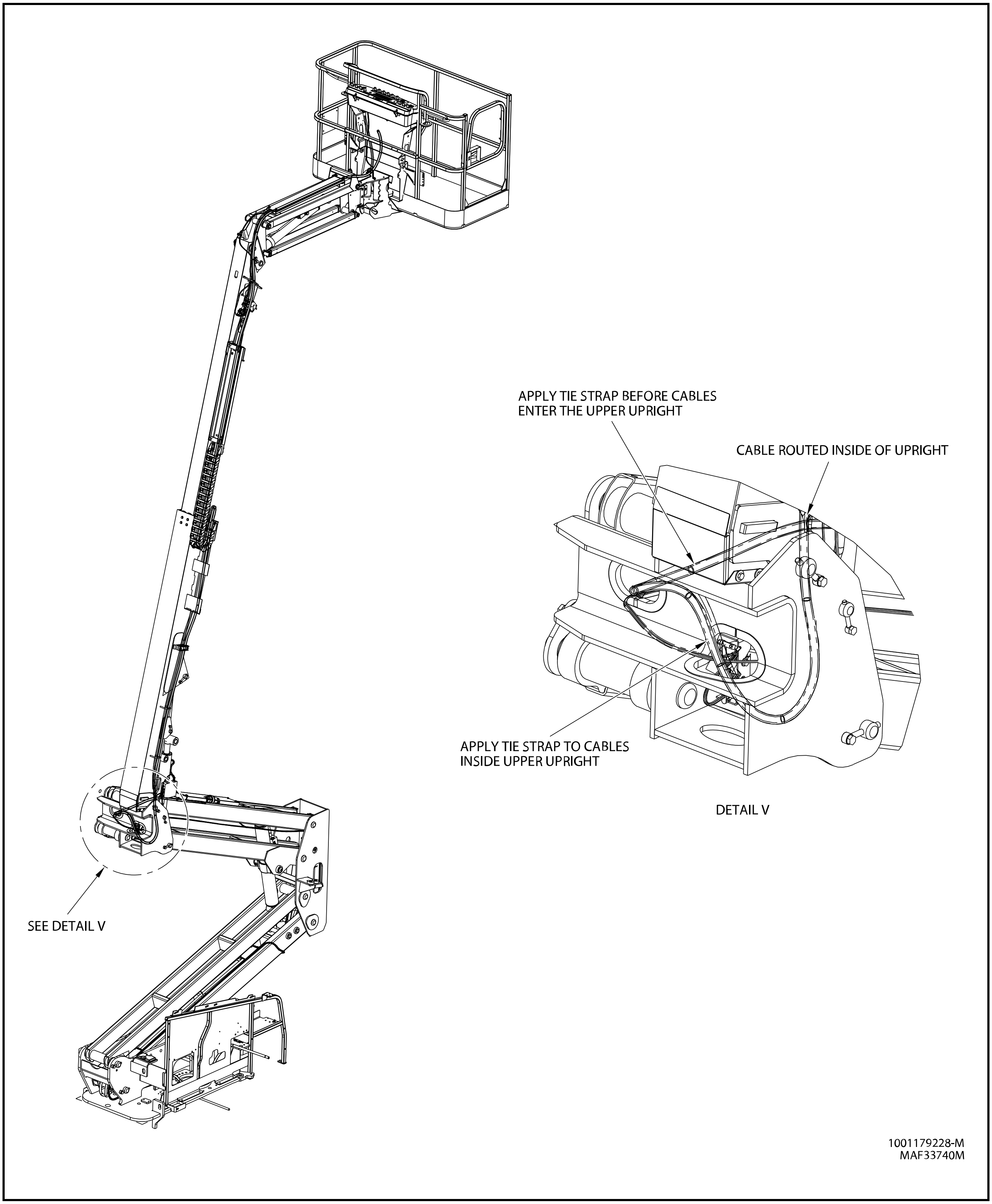


Figure 133. Cables and Clamps Installation - Sheet 7 of 8

HOSE & CABLE PULL LENGTHS (TOWER)	
DESCRIPTION	DIMENSION FROM TOP OF CLAMP INSIDE LOWER UPRIGHT (± 25)
AIR LINE	1829
CONTROL CABLE	2197
MAIN LIFT V1	4369
TOWER HARNESS	5213
TOWER LIFT V2	521
GENERATOR/AC CABLE	1626
TOWER LIFT V1	546
UPRIGHT VALVE HOSE FROM MAIN VALVE	1880

HOSE & CABLE PULL LENGTHS 450AJ (MAIN)	
DESCRIPTION	DIMENSION FROM BACK SURFACE OF CLAMP BLOCK ON BASE BOOM (MIN)
CONTROL CABLE	3543
AIRLINE	3658
MASTER/LEVEL V1	2489
MASTER/LEVEL V2	2337
FLY VALVE PRESSURE	3632
FLY VALVE TANK	3683
GENERATOR/AC CABLE	4242
DIMENSION FROM FRONT OF JIB CLAMP. SEE SHT. 1 (DETAIL W) FOR INSTRUCTIONS	
PLATFORM ROTATE	1550

19 PIN BOOM PLUG/ RECEPTACLE LOADING		
SOCKET NUMBER	WIRE COLOR	WIRE SIZE
1	HOLE PLUG SHIELD (ARCTIC)	18 GA.
2	GREEN/J1939 BLACK (ARCTIC)	18 GA.
3	YELLOW/J1939 RED (ARCTIC)	18 GA.
4	ORANGE	18 GA.
5	BLUE	18 GA.
6	YELLOW	18 GA.
7	BROWN	18 GA.
8	HOLE PLUG	N/A
9	RED/BLACK	18 GA.
10	ORANGE 12GA	12 GA.
11	BLUE/BLACK	18 GA.
12	RED 12GA	12 GA.
13	ORANGE/BLACK	18 GA.
14	HOLE PLUG	N/A
15	YELLOW/BLACK	18 GA.
16	BLACK 12GA	12 GA.
17	HOLE PLUG	N/A
18	BLACK/WHITE 12GA	12 GA.
19	HOLE PLUG	N/A

RELATED INSTALLS	
INSTALL #	DESCRIPTION
1001179364	450AJ 7500W
1001179737	450AJ ARCTIC
1001179738	450AJ (4000W 50Hz)
1001179771	450AJ 7500W ARCTIC
1001179776	450AJ (4000W 60Hz)
1001179778	520AJ (4000W 50Hz)
1001179781	520AJ 7500W

GEN CABLE CONNECTOR ROUTING	
Z	BLACK #1
Y	BLACK #2
X	BROWN
WH	BLUE
GRD	GREEN/YELLOW

1001179228-M
MAF33750M

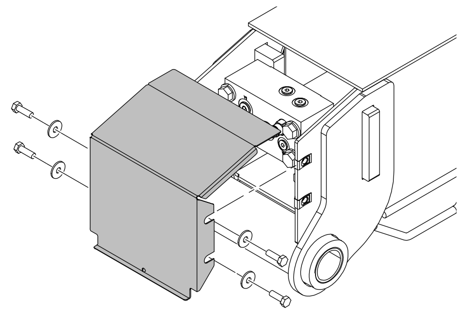
Figure 134. Cables and Clamps Installation - Sheet 8 of 8

4.10 BOOM ASSEMBLY

4.10.1 Upper Boom Removal

Note: Prior to removing the upper boom, extend fly boom section out far enough to access telescope cylinder retainer pin, if upper boom needs to be dissembled.

1. Remove the platform assembly and jib. Refer to *Section — Platform, page 284* and *Section — Jib, page 288*.
2. Remove the hardware securing boom end cover to the upper boom. Remove the boom end cover.



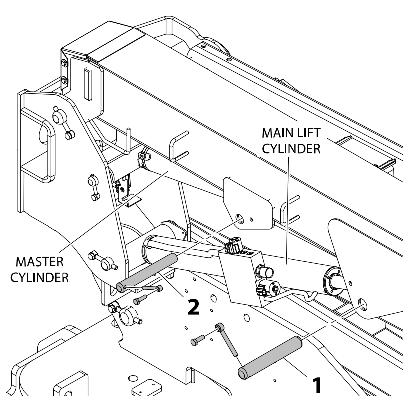
Note: The upper boom assembly weighs approximately 850 lb (385 kg).

3. Using a suitable lifting device, adequately support upper boom assembly weight along entire length.
4. Tag and disconnect hydraulic lines from telescope cylinder, main lift cylinder and master cylinder. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings of hydraulic lines and ports.

Note: The main lift cylinder weighs approximately 135 lb (61 kg).

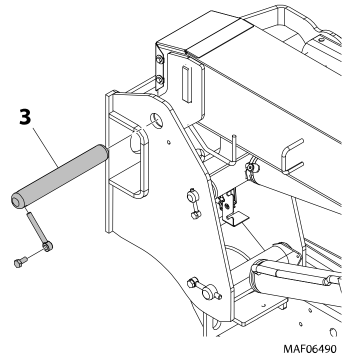
Note: The master cylinder weighs approximately 50 lb (22 kg).

5. Attach an adequate supporting device to the main lift cylinder and master cylinder to support their weight.
6. Remove bolt and keeper pin from main lift cylinder pin #1. Using a suitable brass drift and hammer, remove the cylinder pin #1 securing main lift cylinder to upper boom.
7. Remove bolt and keeper pin from master cylinder pin #2. Using a suitable brass drift and hammer, remove the cylinder pin #2 securing master cylinder to upper boom.



8. Remove Engine side hood to gain access to keeper pins on upper upright, if necessary.

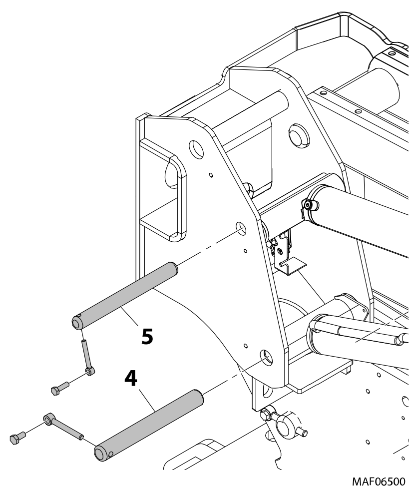
9. Remove bolt and keeper pin #3 securing the upper boom to the upper upright. Using a suitable brass drift and hammer, remove the pin #3 from upper boom.



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

11. If necessary remove bolt and keeper pin from main lift cylinder pin #4. Using a suitable brass drift and hammer, remove the cylinder pin #4 from upper upright. Carefully remove the main lift cylinder.

12. If necessary remove bolt and keeper pin #5 from master cylinder pin. Using a suitable brass drift and hammer, remove the cylinder pin #5 from upper upright. Carefully remove the master cylinder.



4.10.2 Mid Boom Removal

1. Using a suitable lifting equipment, adequately support mid boom assembly weight.

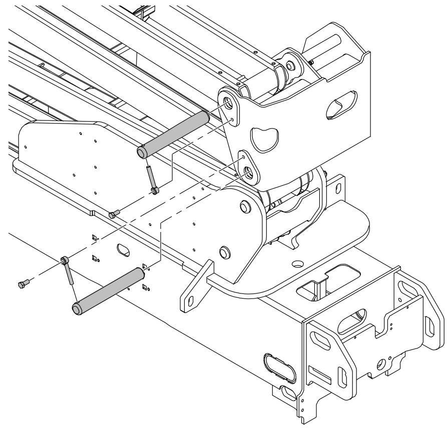
2. Tag and disconnect hydraulic lines from tower lift cylinder. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings of hydraulic lines and ports.

3. Remove Hydraulic tank side hood to gain access to keeper pins on upper upright, if necessary.

Note: The upper upright weighs approximately 210 lb (95 kg).

4. Attach an adequate supporting device to the upper upright to support its weight.

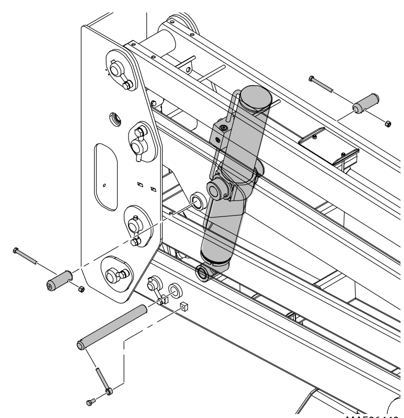
5. Remove mounting hardware from pins. Using a suitable brass drift and hammer, remove the pins from upper upright.



6. Using all applicable safety precautions, carefully lift upper upright and lower to ground or suitably supported work surface.

Note: The tower lift cylinder weighs approximately 140 lb (65 kg).

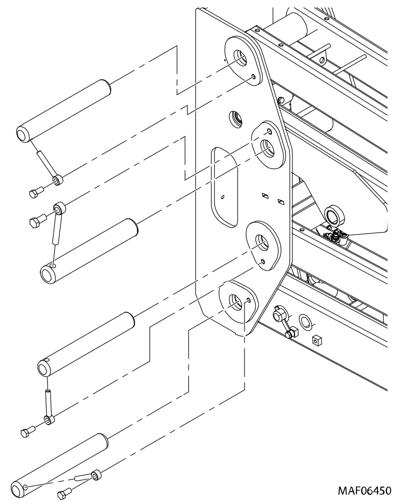
7. Using a suitable lifting equipment, adequately support tower lift cylinder to supper its weight.
8. Remove mounting hardware from pins securing tower lift cylinder to the mid boom. Using a suitable brass drift and hammer, remove the pin from tower lift cylinder securing to mid boom.
9. If necessary remove bolt and keeper pin from tower lift cylinder pin. Using a suitable brass drift and hammer, remove the cylinder pin from lower boom. Carefully remove the tower lift cylinder.



Note: The lower upright weighs approximately 295 lb(135 kg).

10. Attach an adequate supporting device to the lower upright to support its weight.

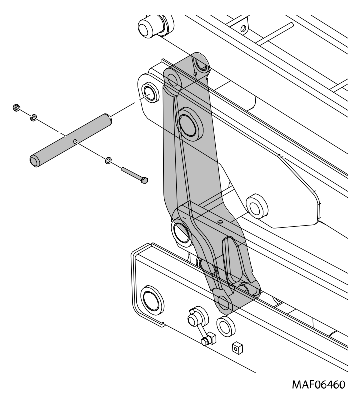
11. Remove mounting hardware from pins. Using a suitable brass drift and hammer, remove the pins from lower upright.



12. Using all applicable safety precautions, carefully lift lower upright and lower to ground or suitably supported work surface.

Note: The timing link weighs approximately 110 lb (50 kg).

13. Attach an adequate supporting device to the timing link to support its weight.
14. Remove mounting hardware from pin. Using a suitable brass drift and hammer, remove the pin from timing link.

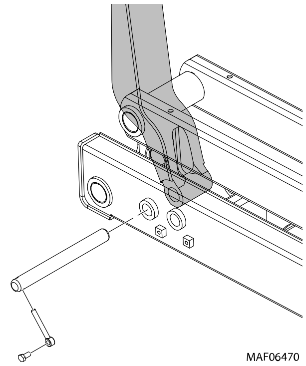


15. Using all applicable safety precautions, carefully lift mid boom assembly and lower to ground or suitably supported work surface.

4.10.3 Lower Boom Removal

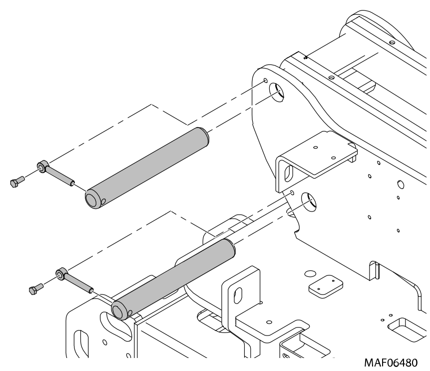
1. Using a suitable lifting device, adequately support lower boom assembly weight.

2. Remove mounting hardware from pin. Using a suitable brass drift and hammer, remove the pin from timing link.



Note: The timing link weighs approximately 110 lb (50 kg).

3. Using all applicable safety precautions, carefully lift lower timing link to ground or suitably supported work surface.
4. Remove front hood and counterweight to gain access to keeper pins on turntable, if necessary.
5. Remove mounting hardware from pins. Using a suitable brass drift and hammer, remove the pins from lower boom securing to turntable.

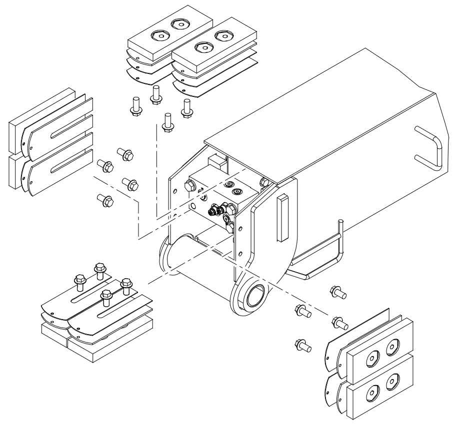


6. Using all applicable safety precautions, carefully lift lower boom assembly and lower to ground or suitably supported work surface.

4.10.4 Upper Boom Disassembly

1. Loosen jam nuts on aft end of fly boom wear pad adjustment and loosen adjustments.

2. Loosen the wear pad retaining bolts at the rear of fly boom section and remove the shims and wear pads noting the location and number of shims to aid in reassembly.

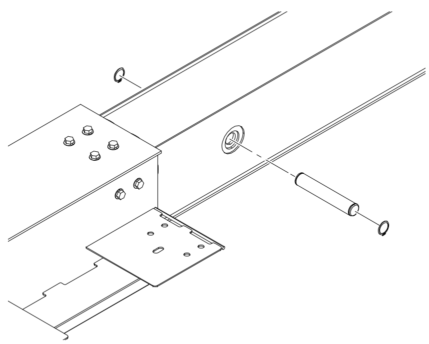


3. If necessary, using a portable power source, attach hose to telescope cylinder port block. Using all applicable safety precautions, activate hydraulic system and extend cylinder to gain access to cylinder rod retaining pin. Shut down the portable power source.

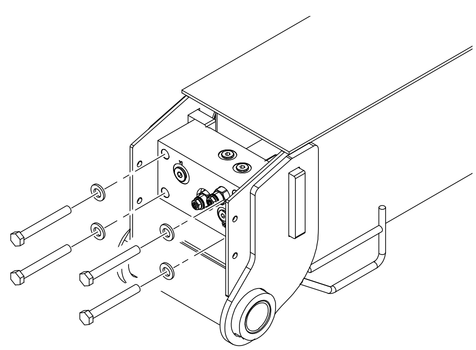
4. Carefully disconnect hydraulic hose from retract port of cylinder. There will be initial weeping of hydraulic fluid which can be caught in a suitable container. After initial discharge, there should be no further leakage from the retract port. Cap or plug all openings.

Note: When removing the retaining pin from the rod end of the telescope cylinder, make sure the cylinder is properly supported.

5. Remove the retaining ring and pin securing the telescope cylinder rod end to the fly boom section.

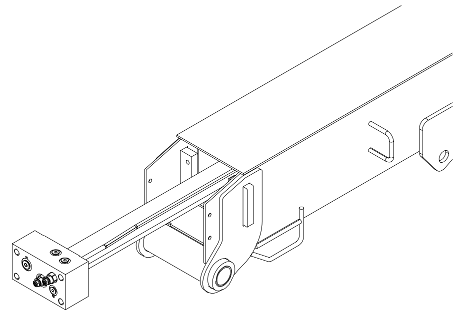


6. Remove the bolts and washers securing telescope cylinder to the rear of the base boom section.

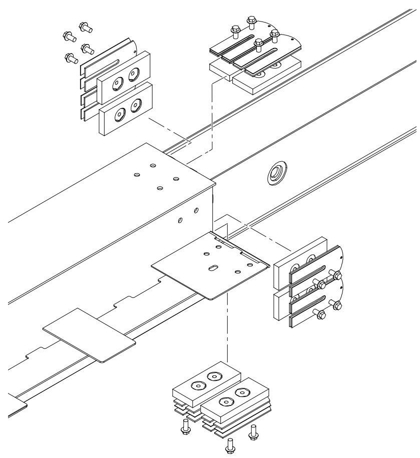


Note: The telescope cylinder weighs approximately 120 lb (55 kg).

7. Using a suitable lifting device, remove telescope cylinder from the rear of the boom sections.



8. Remove hardware securing the front wear pads on base boom section, remove wear pads and shims, noting the location and number of shims to aid in reassembly.



Note: The fly boom section weighs approximately 200 lb (90 kg).

9. Using a suitable lifting device, remove fly boom from boom section.

4.10.5 Inspection

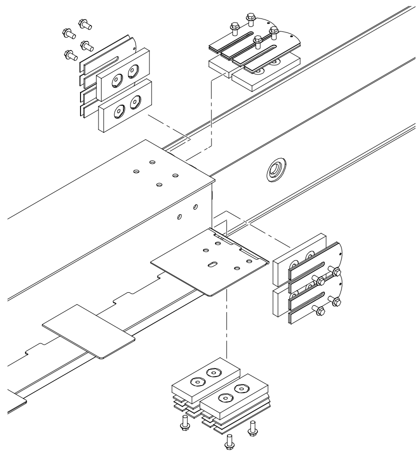
1. Inspect all boom pivot pins for wear, scoring or other damage, and for tapering or ovality. Replace pins as necessary.
2. Inspect lift cylinder pins for wear, scoring or other damage, and for tapering or ovality. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
3.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

4.10.6 Upper Boom Assembly

1. Using Medium Strength Threadlocking Compound or equivalent, install the bottom wear pads and shims as noted during disassembly on the rear of the fly section. Torque the retaining bolts to 40 ft. lbs. (55 Nm). Install the rest of the wear pads on the rear of the fly section but do not install the shims or torque them at this time.

2. Using an adequate lifting device, slide the fly boom section into the base boom section. Install the remaining shims on the rear of the fly section as noted during disassembly and torque the retaining bolts to 40 ft. lbs. (55 Nm). Pull the fly section out of the base section enough to install the pin that secures the telescope cylinder rod to the fly boom section.

3. Using Medium Strength Threadlocking Compound or equivalent, install the front wear pads and shims as noted during disassembly on the base boom section. Torque the retaining bolts to 40 ft. lbs. (55 Nm).

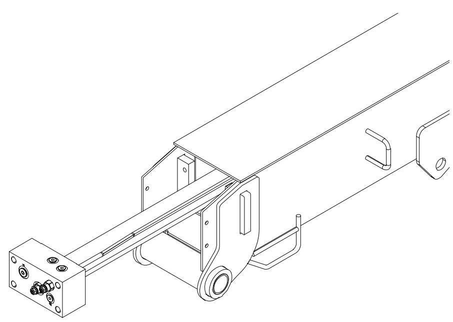


NOTICE

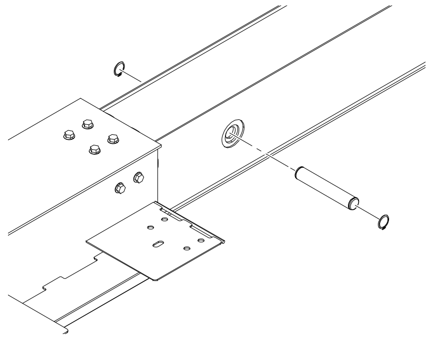
When inserting telescope cylinder into boom, care must be taken not to damage power track assembly.

Note: The telescope cylinder weighs approximately 120 lb (55 kg).

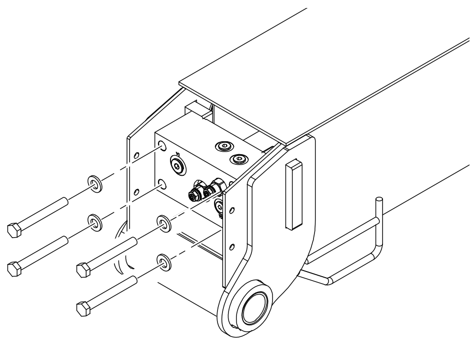
4. Using an adequate lifting device, install the telescope cylinder into the boom assembly. It will aid assembly if the cylinder is extended to enable connection to the fly boom section.



5. Align the telescope cylinder rod end with the corresponding hole in the fly boom section. If necessary, attach a portable power supply to the cylinder to extend or retract the cylinder for alignment. Install the retaining pin and secure it in place with the retaining ring.



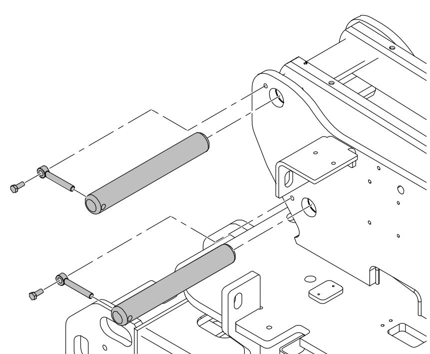
6. Using Medium Strength Threadlocking Compound or equivalent, secure the rear of the telescope cylinder to the base boom section with the attaching bolts and washers. Torque the bolts 85 ft. lbs. (115 Nm).



7. Retract boom section fully. Using shims, adjust wear pads at aft end of boom section to zero clearance. Adjust pads alternately side to side, so fly boom section is centered in base boom section.

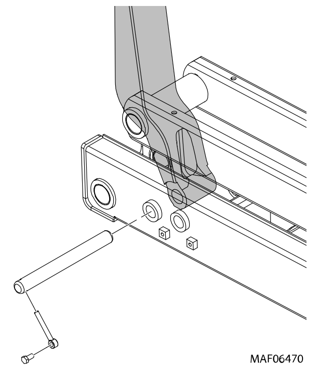
4.10.7 Lower Boom Installation

1. Remove front hood and counterweight to gain access to keeper pins on turntable, if necessary.
2. Using all applicable safety precautions, carefully lift lower boom assembly to align the pivot holes in the lower boom with those of the turntable.
3. Using a soft head mallet, install pins into turntable and secure with mounting hardware.



Note: The timing link weighs approximately 110 lb (50 kg).

4. Using all applicable safety precautions, carefully lift and align timing link with lower boom assembly. Using a soft head mallet, install pins into timing link and secure with mounting hardware.

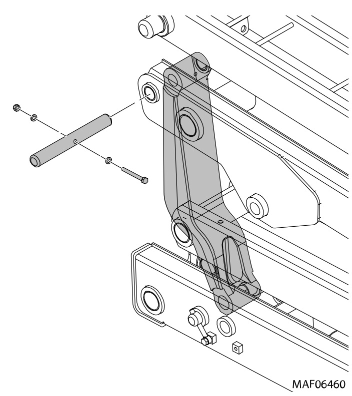


4.10.8 Mid Boom Installation

1. Attach an adequate supporting device to the Mid Boom to support its weight.

Note: The timing link weighs approximately 110 lb (50 kg).

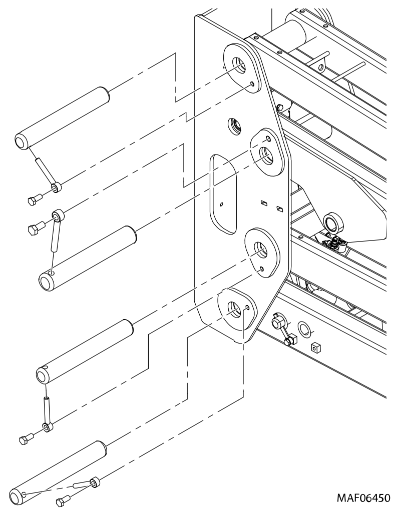
2. Using all applicable safety precautions, carefully lift timing link and mid boom to align the pivot hole in the timing link with holes of the Mid boom.
3. Using a soft head mallet, install pin into lower boom and secure with mounting hardware.



Note: The lower upright weighs approximately 295 lb (135 kg).

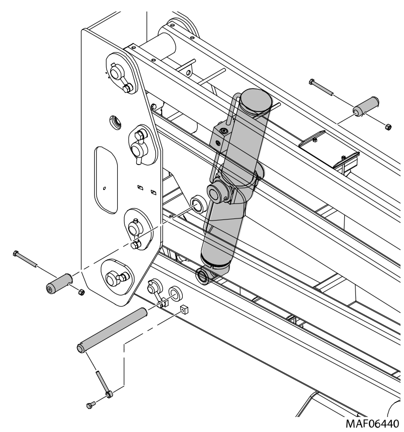
4. Attach an adequate supporting device to the lower upright to support its weight.

5. Using all applicable safety precautions, carefully lift and align lower upright with lower boom and mid boom. Using a soft head mallet, install pins into lower upright and secure with mounting hardware.



Note: The tower lift cylinder weighs approximately 140 lb (65 kg).

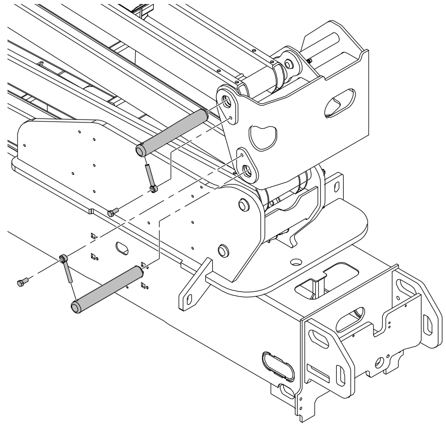
6. Using a suitable lifting equipment, adequately support tower lift cylinder to supper its weight.
7. Using all applicable safety precautions, carefully lift and align tower lift cylinder assembly with lower boom and mid boom. Using a soft head mallet, install pins into tower lift cylinder and secure with mounting hardware.



Note: The upper upright weighs approximately 210 lb (95 kg).

8. Attach an adequate supporting device to the upper upright to support its weight.

9. Using all applicable safety precautions, carefully lift and align upper upright with mid boom. Using a soft head mallet, install pins into lower upright and secure with mounting hardware.



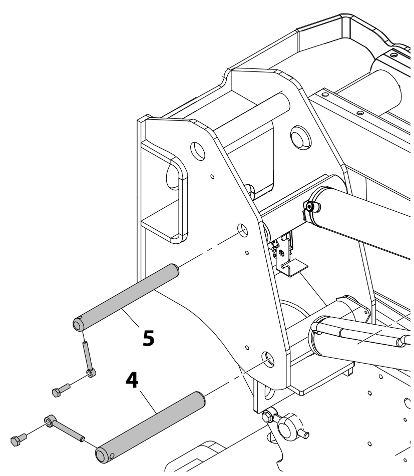
10. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the tower lift cylinder as tagged during removal.

4.10.9 Upper Boom Installation

Note: The main lift cylinder weighs approximately 135 lb (61 kg).

Note: The master cylinder weighs approximately 50 lb (22 kg).

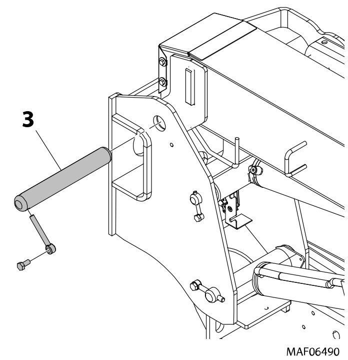
1. Using a suitable lifting device, align the master cylinder with the upper upright. Using a soft head mallet install pin #5 in the upper upright. Install the hardware for pin #5.
2. Using a suitable lifting device, align the main lift cylinder with the upper upright. Using a soft head mallet install pin #4 in the upper upright. Install the hardware for pin #4



Note: The upper boom assembly weighs approximately 850 lb (385 kg).

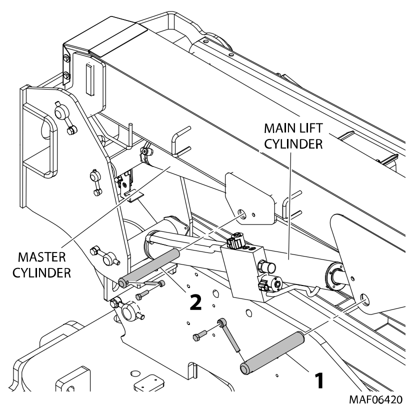
3. Attach an adequate lifting device to support the entire length of the upper boom.

4. Using all applicable safety precautions, carefully lift and align upper boom with upper upright. Using a soft head mallet, install pin3 into upper upright and secure with mounting hardware.



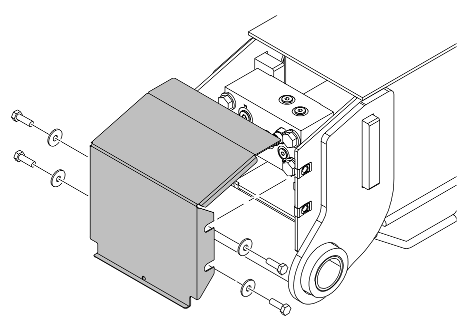
5. Using all applicable safety precautions, carefully lift and align master cylinder with upper boom. Using a soft head mallet, install pin #2 into master cylinder and secure with mounting hardware.

6. Using all applicable safety precautions, carefully lift and align main lift cylinder with upper boom. Using a soft head mallet, install pin #1 into main lift cylinder and secure with mounting hardware.



7. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the master cylinder, main lift cylinder and telescope cylinder as tagged during removal.

8. Install boom end cover on the upper boom.



9. Install the jib and platform assembly. Refer to *Section — Jib, page 288* and *Section — Platform, page 284*.

10. Start machine and check all hydraulic functions for proper operation. Check for any hydraulic oil leaks

4.11 ROTATOR ASSEMBLY

4.11.1 Theory of Operation

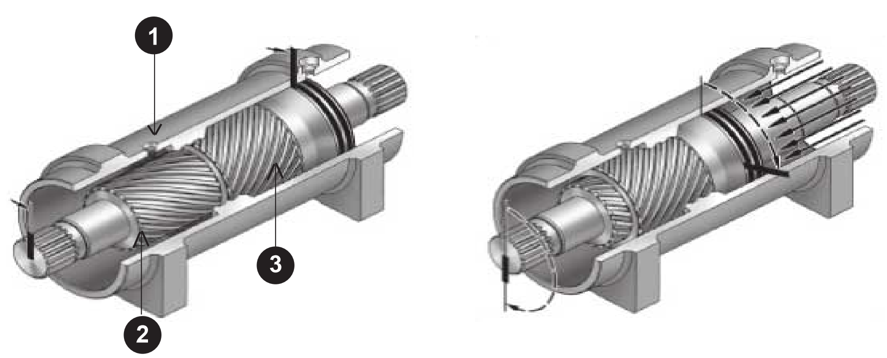
The rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert axial piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear ring (1) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (2), and the annular piston sleeve (3). Helical spline teeth machined on the shaft engage matching splines on the inside 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 housing, preventing piston movement and locking the shaft in position.

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

The actuators are equipped with factory installed counterbalance valves, which performs four major functions.

- Protects the actuator in the event of overload.
- Enables the actuator to hold position without drifting when external loads are applied.
- Reduces hydraulic backlash by pressuring the hydraulic fluid.

Provides a constant controlled rate of rotation in over-center load conditions.



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

Applying fluid pressure will displace the piston 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. Applying pressure to the opposite port will return the piston and shaft

4.11.2 Required Tools

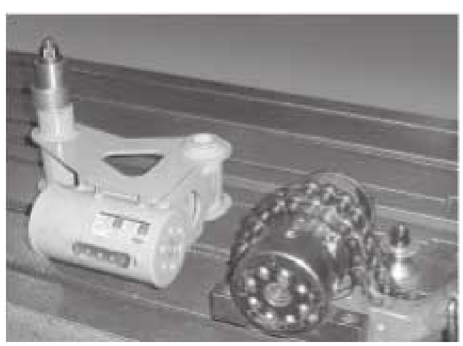
Upon assembly and disassembly of the actuator there are basic tools required. The tools and their intended functions are as follows:

1. PIPE VISE
2. HEX WRENCH - Removal and replacement of port plugs and setscrews.
3. ASSORTED SCREWS
4. SAFETY GLASSES
5. END CAP REMOVAL TOOLS (provided with Helac seal kit).
6. DRILL
7. FLASHLIGHT - Helps to locate and examine timing marks, component failure and overall condition.
8. RUBBER MALLET - Removal and installation of shaft and piston sleeve assembly.
9. PLASTIC MANDREL
10. PRY BAR - Removal of end cap and manual rotation of shaft.
11. FELT MARKER - Highlights the timing marks and outline troubled areas.
12. T-HANDLE SCREW EXTRACTOR
13. HEX WRENCH SET - Removal and replacement of port plugs and setscrews (106 &110).
14. SEAL TOOLS - Removal and installation of seals and wear guides.
15. PUNCH
16. DOWEL PINS - Removal and installation of end cap.

4.11.3 Before Disassembly

Inspect the actuator for corrosion prior to disassembly. Severe corrosion can make it difficult to remove the lock pins (109) and unthread the end cap (04). If corrosion is evident, soak the lock pins and end cap with penetrating oil for several hours before disassembly.

Disassembly is considerably easier if the actuator is firmly secured to the work bench. A pipe vise or mounting fixture work well.



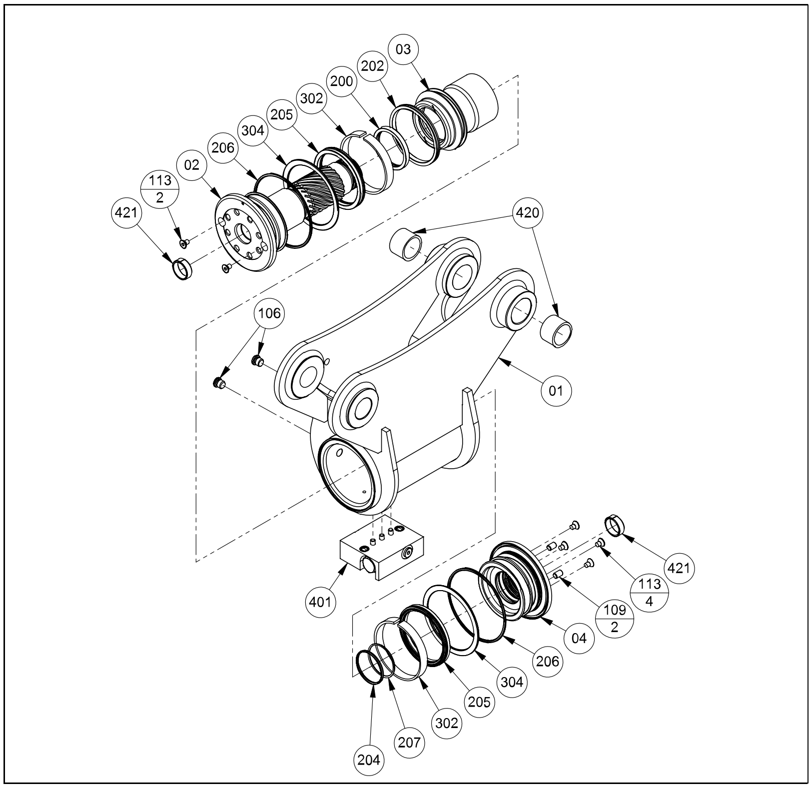


Figure 135. Rotator - Exploded View

PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	106. Port Plug	202. T-Seal	304. Thrust Washer	401. Counterbalance Valve
3. Piston Sleeve	109. Lock Pin	204. O-ring		403. Motion Control Valve
4. End Cap	113. Capscrew	205. Cup Seal		420. Bushing
		206. Exclusion Seal		421 Bushing
		207. Backup Ring		

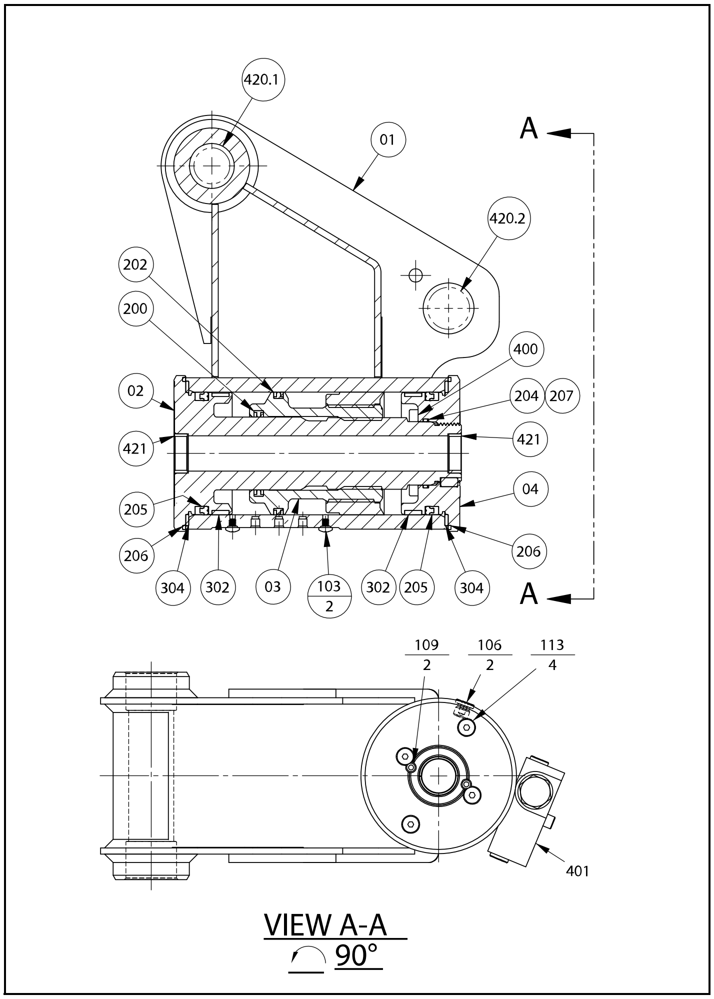


Figure 136. Rotator - Assembly Drawing

PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	106. Port Plug	202. T-Seal	304. Thrust Washer	401. Counterbalance Valve
3. Piston Sleeve	109. Lock Pin	204. O-ring		403. Motion Control Valve
4. End Cap	113. Capscrew	205. Cup Seal		420.1 Bushing
		206. Exclusion Seal		420.2 Bushing
		207. Backup Ring		421 Bushing

4.11.4 Disassembly

⚠ CAUTION

Secure product to slotted table or vise.

⚠ CAUTION

Contents under pressure. Wear approved eye protection. Use caution when removing port plugs and fittings.

NOTICE

Make sure work area is clean.

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

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

3. Remove the lock pins using an ”Easy Out” (a size #2 is shown). If the pin will not come out with the ”Easy Out”, use 5/16 in. drill bit to a depth of 1/2 in. (12.7 mm) to drill out the entire pin.

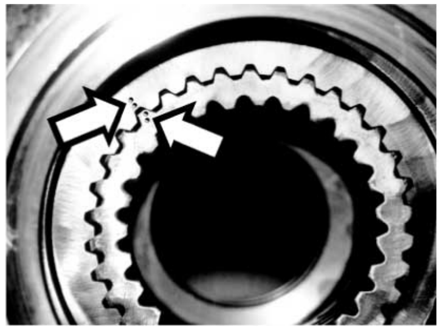
4. Install the end cap (4) removal tools provided with the Helac seal kit

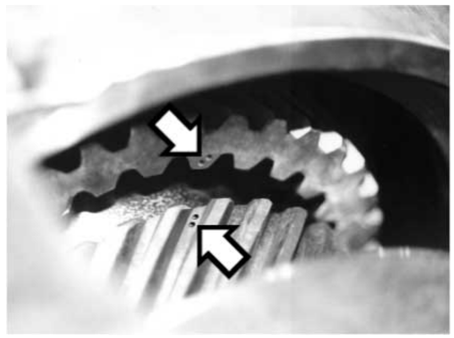
5. Using a metal bar, or similar tool, unscrew the end cap (4) by turning it counterclockwise.

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

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

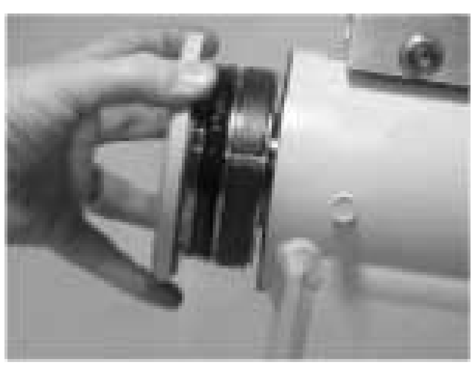
8. Every actuator has timing marks for proper engagement.





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

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



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

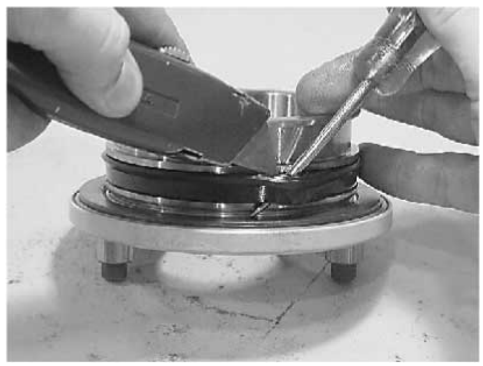
12. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is not damaged.

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

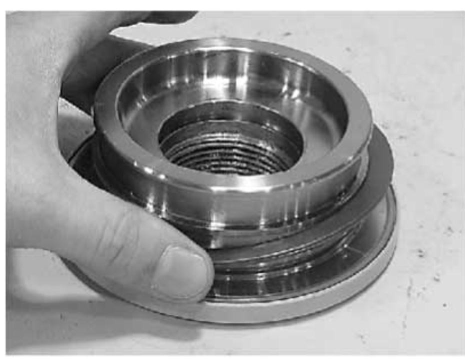
14. Remove the O-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.

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

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



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



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

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

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

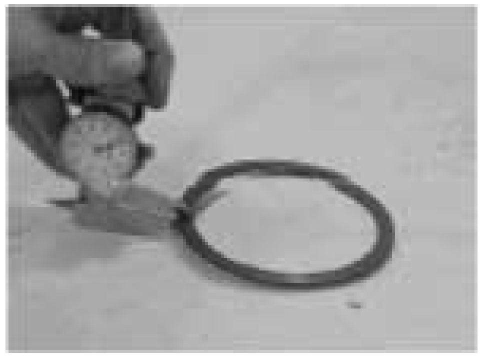
4.11.5 Inspection

NOTICE

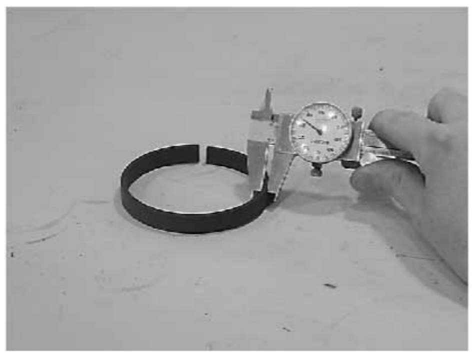
Small or minor surface scratches can be carefully polished.

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

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



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

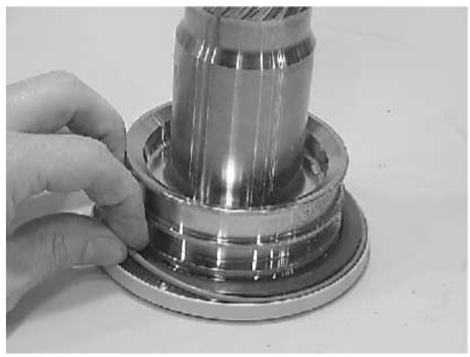


4.11.6 Assembly

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

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

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



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

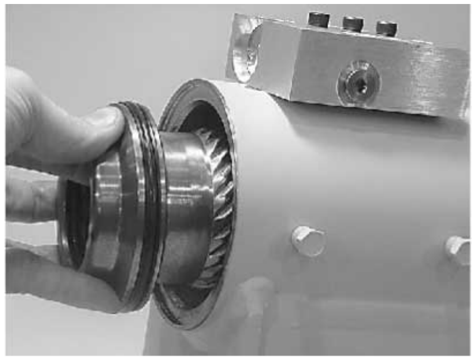
5. Install the wear guide (302) on the end cap (4) and shaft (2).

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

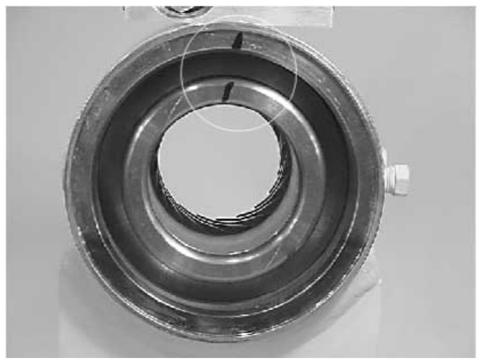
7. Install the inner T-seal (200) into the piston (3) using a circular motion.
Install the outer T-seal (202) by stretching it around the groove in a circular motion.
Each T-seal has 2 backup rings (see drawing for orientation).

8. 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).

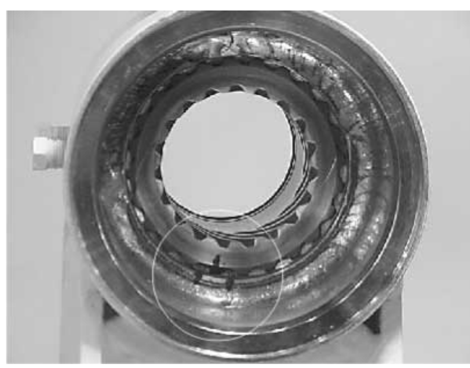
9. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) is touching inside the housing bore.



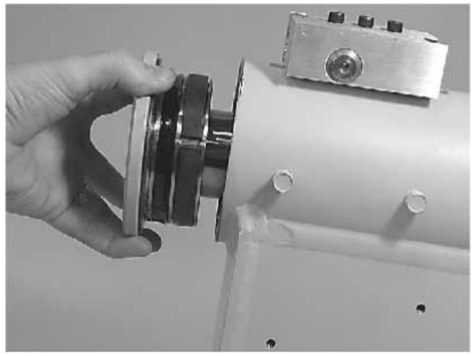
10. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.



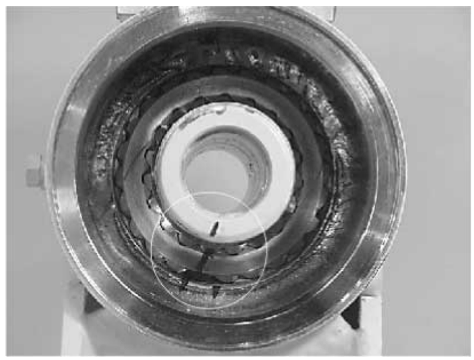
11. Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.



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



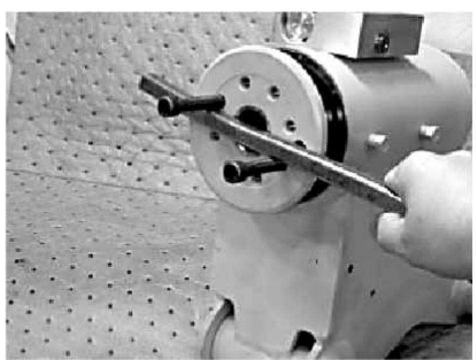
13. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.



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

NOTICE

As the shaft is rotated, be careful not to disengage the piston and house gearing.

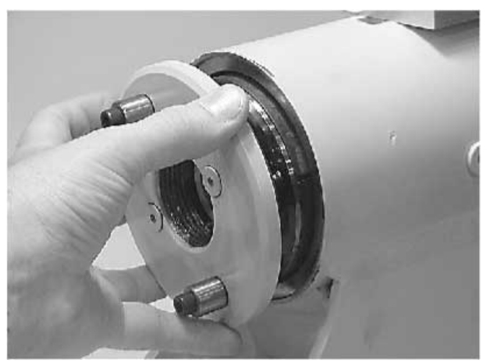


15. Install the stop tube onto the shaft end, if equipped. Stop tube is an available option to limit the rotation of an actuator.

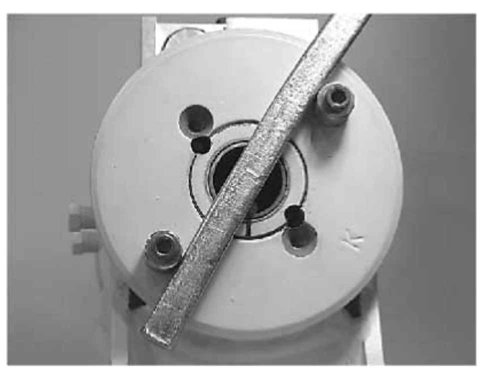
16. Coat the threads on the end of the shaft with anti-seize grease to prevent galling.

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

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

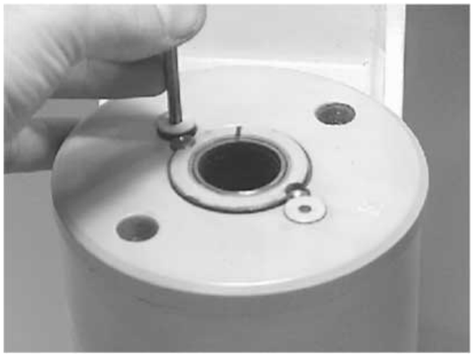


19. Tighten the end cap (4). In most cases the original holes for the lock pins will line up.



20. 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.

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



4.11.7 Installing Counterbalance Valve

Refer to *Figure — Rotator Counterbalance Valve, page 351*.

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

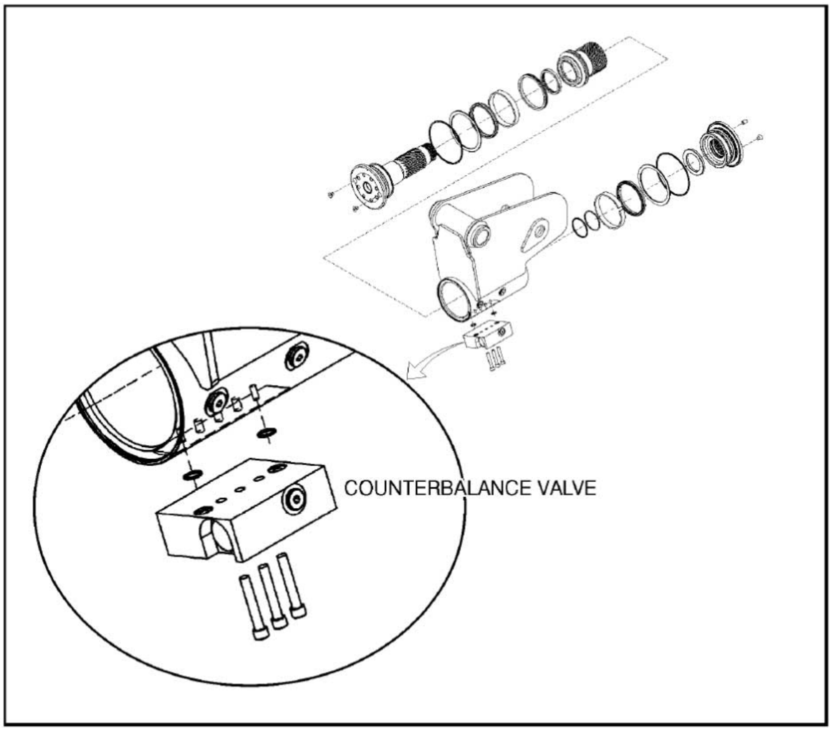


Figure 137. Rotator Counterbalance Valve

4.11.8 Greasing Thrust Washers

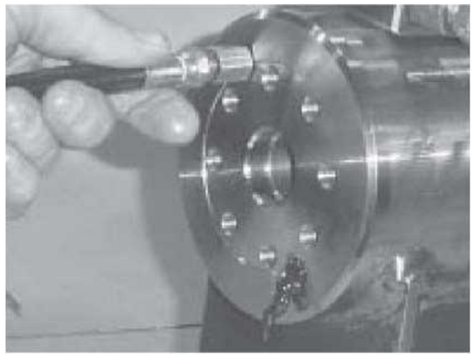
1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.

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

NOTICE

If a hydraulic test bench is not available, the actuator can be rotated by hand, open the pressure ports and use a pry bar with capscrews inserted into the shaft flange to turn the shaft in the desired direction.

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



4.11.9 Testing the Actuator

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

TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

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

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

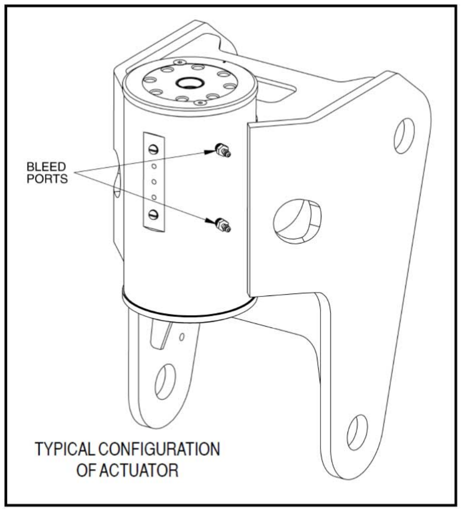
4.11.10 Installation and Bleeding

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

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

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

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



2. With an operator in the platform, open both bleed nipples 1/4 turn. Hydraulically rotate the platform to the end of rotation (either clockwise or counterclockwise), and maintain hydraulic pressure. Oil with small air bubbles will be seen flowing through the tubes. Allow a 1/2 gallon of fluid to be purged from the actuator.

3. Keep the fittings open and rotate the platform in the opposite direction to the end position. Maintain hydraulic pressure until an additional 1/4 gallon of fluid is pumped into the container.

4. Repeat steps 2 & 3. After the last 1/2 gallon is purged, close both bleed nipples before rotating away from the end position.

4.12 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.

4.12.1 Troubleshooting

Table 35. Troubleshooting

Problem	Cause	Solution
Shaft rotates slowly or not at all	a. Insufficient torque output	a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.
	b. Low rate of fluid flow	b. Inspect ports for obstructions and hydraulic lines for restrictions and leaks.
	c. Control or counterbalance valve has internal leak	c. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.
	d. Piston and/or shaft seal leak	d. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test.
	e. Corrosion build-up on the thrust surfaces	e. Re-build the actuator. Remove all rust then polish. Replacement parts may be needed.

Table 35. Troubleshooting (continued)

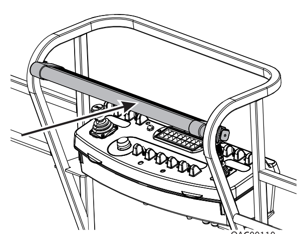
Problem	Cause	Solution
	f. Swollen seals and composite bearings caused by incompatible hydraulic fluid	f. Re-build the actuator. Use fluid that is compatible with seals and bearings.
2. Operation is erratic or not responsive	a. Air in actuator	a. Purge air from actuator. See bleeding procedures.
3. Shaft will not fully rotate	a. Twisted or chipped gear teeth	a. Check for gear binding. Actuator may not be able to be re-built and may need to be replaced. Damage could be a result of overload or shock.
	b. Port fittings are obstructing the piston	b. Check thread length of port fittings. Fittings should during stroke not reach inside the housing bore.
4. Selected position cannot be maintained	a. Control or counterbalance valve has internal leak	a. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.
	b. Piston and/or shaft seal leak	b. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test.
	c. Air in actuator	c. Purge air from actuator. See bleeding procedures.

4.13 SKYGUARD

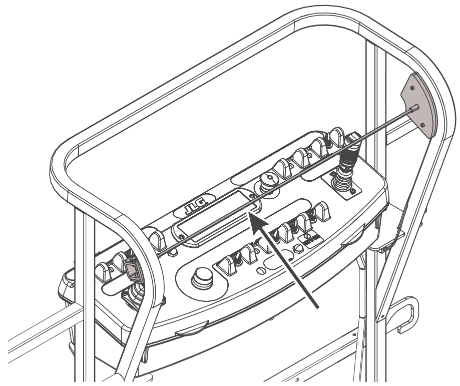
4.13.1 Operation

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

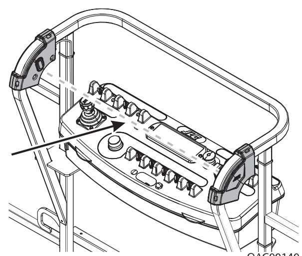
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



SkyGuard



SkyGuard SkyLine™



SkyGuard SkyEye™

⚠ WARNING

The machine operator is required to perform a daily function test to ensure proper operation of the skyguard system.

4.13.2 Function Test

SkyGuard Only

Perform this function test if SkyGuard only is selected in machine setup (Refer to *Table — Machine Configuration Programming Information, page 524*).

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

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

In Ground Mode:

Operation is allowed regardless of SkyGuard activation.

Soft touch only

If **Soft Touch only** is selected in machine setup (refer to *Table — Machine Configuration Programming Information, page 524*), machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch.

SkyGuard not selected in machine setup

If the SkyGuard system is installed on the machine, but no option is selected in the machine setup (refer to *Table — Machine Configuration Programming Information, page 524*), SkyGuard sensor status will be ignored. No function cutout or reversal will be implemented.

4.13.3 Diagnostics & Troubleshooting

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

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

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

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

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

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

Fault Codes

Refer to *Table — Machine Configuration Programming Information, page 524* for more fault code information

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

Table 36. SkyGuard Function Table

Drive Forward	Drive Reverse	Steer	Swing	Tower Lift Up	Tower Lift Down	Boom Lift Up	Boom Lift Down	Boom Tele Out	Boom Tele In	Jib Lift	Basket Level	Basket Rotate
R * / C * *	R	C	R	R	C	R	R	R	C	C	C	C
R = Indicates Reversal is Activated												
C = Indicates Cutout is Activated												
* DOS Enabled												
* * DOS Not Enabled, machine is driving straight without steering, and any other hydraulic function is active												

4.14 BOLT-ON EXTERNAL FALL ARREST

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

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

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

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

⚠ WARNING

Do not operate any machine functions while outside of platform. Be careful when entering/exiting the platform at elevation.

⚠ WARNING

If the bolt-on external fall arrest system is used to arrest a fall or is otherwise damaged, the entire system must be replaced and the platform fully inspected before returning to service. Refer to the service manual for removal and installation procedures.

The bolt-on external fall arrest system requires an annual inspection and certification. The annual inspection and certification must be performed by a qualified person other than the user.

4.14.1 Inspection Before Use

The Bolt-On External Fall Arrest system must be inspected before each use of the Mobile Elevating Work Platform. Replace components if there are any signs of wear or damage.

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

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

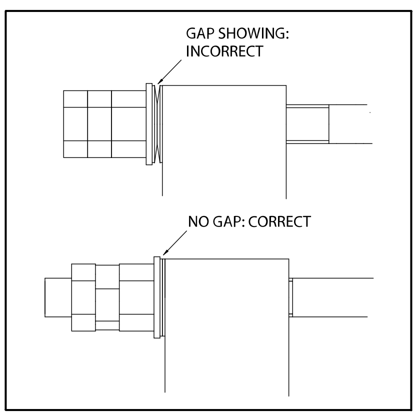
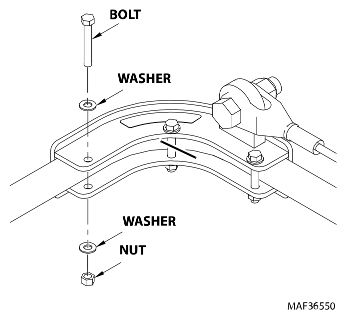


Figure 138. Bolt-On External Fall Arrest Cable Tension

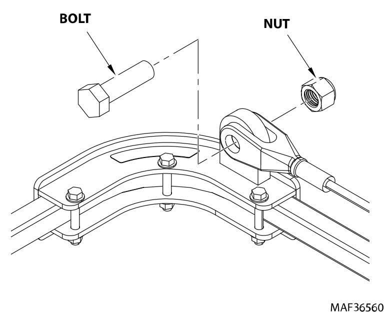
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are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

4.14.2 Installation

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

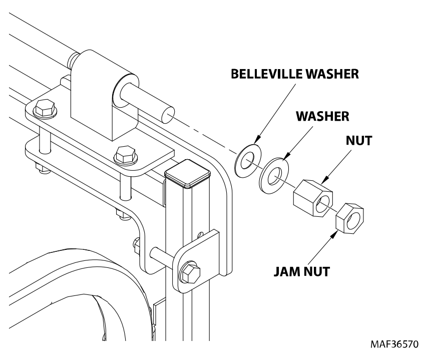


2. Attach the fall arrest cable to the right hand bracket Using the attaching bolt and nut. Orient the bolt as shown below. Do not tighten the nut so cable can still rotate.

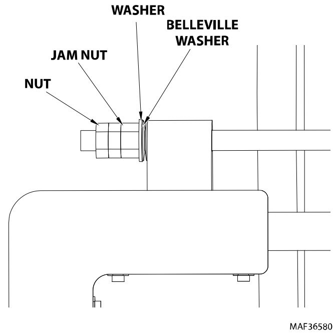


3. Install the Attachment Ring onto the cable.

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



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



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

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

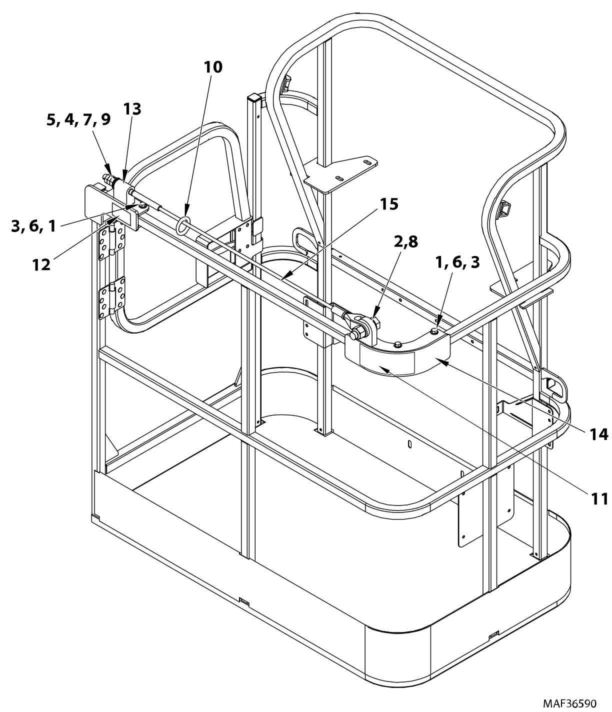


Figure 139. Bolt-On External Fall Arrest System

1. Hex Bolt	6. Washer	11. Decal
2. Hex Bolt	7. Washer	12. SN Plate
3. Lock Nut	8. Nut	13. RH Bracket
4. Nut	9. Belleville Washer	14. LH Bracket
5. Jam Nut	10. Fall Arrest Ring	15. Rope

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SECTION 5
BASIC HYDRAULICS INFORMATION & SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

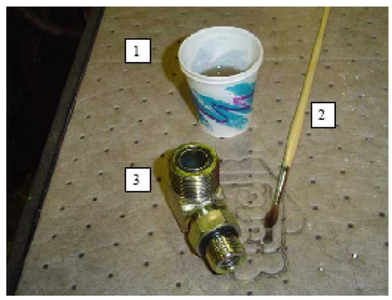
When assembling connectors in the hydraulic that use O-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

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

5.1.1 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.

5.1.2 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.

5.1.3 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.

5.1.4 Brush-on Method

This method requires a sealed bottle brush.

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

5.2 HYDRAULIC CONNECTION ASSEMBLY AND TORQUE SPECIFICATION

5.2.1 Tapered Thread Types

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

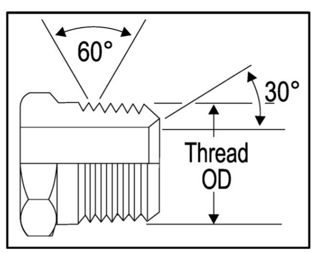


Figure 140. NPTF thread

BSPT = British standard pipe tapered per ISO7-1

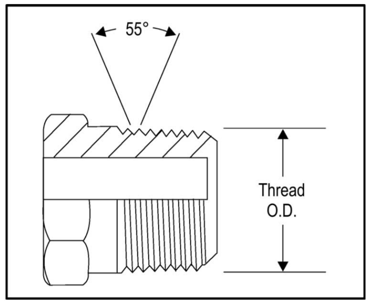


Figure 141. BSPT thread

5.2.2 Straight Thread Types, Tube and Hose Connections

JIC = 37° flare per SAE J514

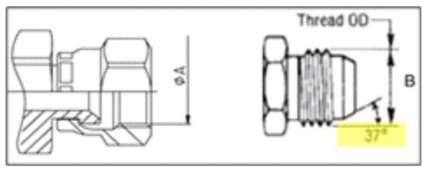


Figure 142. JIC Thread

SAE = 45° flare per SAE J512

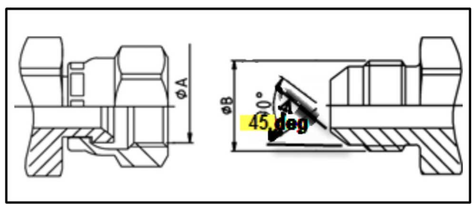


Figure 143. SAE Thread

ORFS = O-ring face seal per SAE J1453

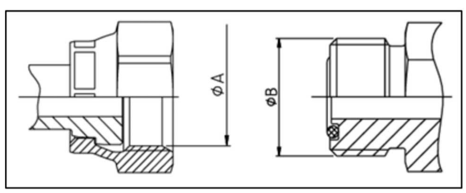


Figure 144. ORFS Thread

MBTL = metric flareless bite type fitting, pressure rating L

(medium) per ISO 8434, DIN 2353

MBTS = metric flareless bite type fitting, pressure rating S

(high) per ISO 8434, DIN 2353

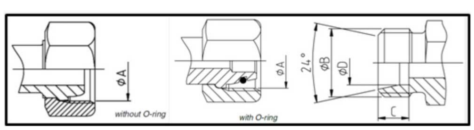


Figure 145. MTBL-MBTS Thread

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

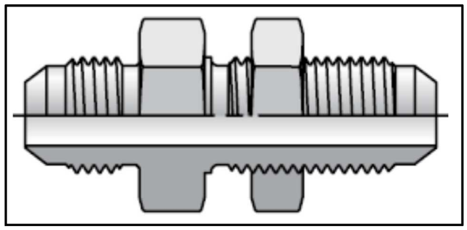
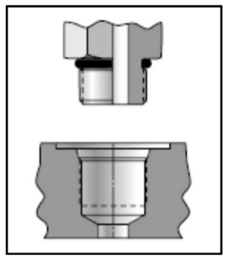


Figure 146. Bulkhead Thread

5.2.3 Straight Thread Types, Port Connections

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

MPP = metric pipe parallel o-ring boss per SAE J2244, ISO 6149, DIN3852



MFF = metric flat face port per ISO 9974-1

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

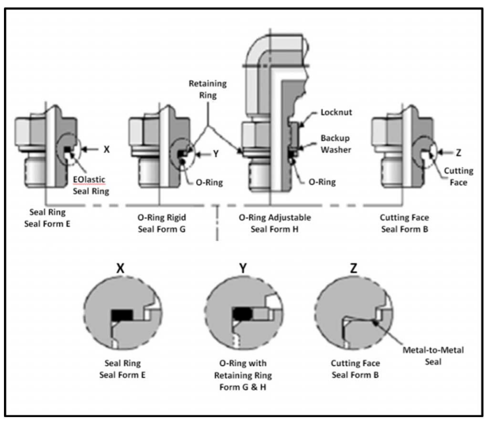


Figure 147. MFF-BSPP Thread

5.2.4 Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

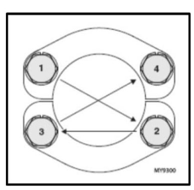


Figure 148. ORB-MPP Thread

5.2.5 Tightening Methods

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

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

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

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

5.2.6 Assembly And Torque Specifications

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

GENERAL TUBE TYPE FITTING ASSEMBLY INSTRUCTIONS

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

5. To achieve the specified torque, the torque wrench is to be held perpendicular to the axis of rotation.

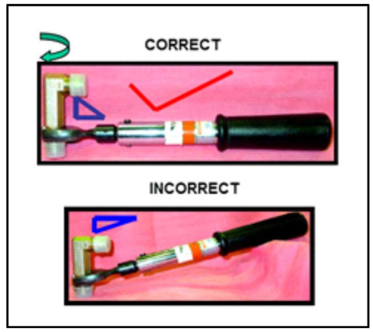


Figure 149. Torque Wrench Angle

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

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

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

⚠ CAUTION

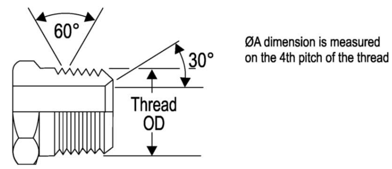
Over tightening may cause deformation of the pipe fitting and damage to the joining fitting, flange or component may occur. Never back off (loosen) pipe threaded connectors to achieve alignment. Meet the minimum required turns and use the last turn for alignment.

5. Rotate male fitting the number of turns per *Table — NPTF Pipe Thread, page 368*, NPTF Pipe Thread. Refer to *FFWR and TFFT Methods, page 418* for TFFT procedure requirements.

Note: TFFT values provided in *Table — NPTF Pipe Thread, page 368* are applicable for the following material configurations:

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

Table 37. NPTF Pipe Thread



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

* ØA thread dimension for reference only.

** Refer to subsection for TFFT procedure requirements.

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

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

⚠ CAUTION

Over tightening may cause deformation of the pipe fitting and damage to the joining fitting, flange or component may occur.

Never back off (loosen) pipe threaded connectors to achieve alignment. Meet the minimum required turns and use the last turn for alignment.

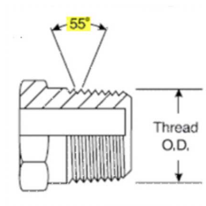
5. Rotate male fitting the number of turns per *Table — BSPT Pipe Thread, page 369*. Refer to *FFWR and TFFT Methods, page 418* for TFFT procedure requirements.

Note: TFFT values provided in *Table — BSPT Pipe Thread, page 369* are applicable for the following material configurations:

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

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

Table 38. BSPT Pipe Thread



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

* ØA thread dimension for reference only.

** Refer to Appendix B for TFFT procedure requirements.

5.2.9 Assembly Instructions for 37° (JIC) Flare Fittings

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

⚠ CAUTION

Do not force a misaligned or short hose/tube into alignment. It puts undesirable strain onto the joint eventually leading to leakage.

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

⚠ CAUTION

The torque method should not be used on lubricated or oily fittings. No lubrication or sealant is required. The lubrication would cause increased clamping force and cause fitting damage.

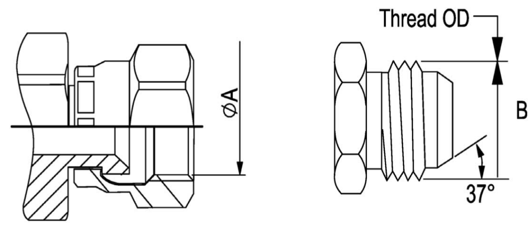
3. Torque assembly to value listed in *Table – 37° Flare (JIC) Thread - Steel, page 370* or *Table – 37° Flare (JIC)Thread - Aluminum/Brass, page 371* while using the Double Wrench Method per Double Wrench Method. Refer to *FFWR and TFFT Methods* for procedure requirements if using the FFWR method.

Note: Torque values provided in *Table – 37° Flare (JIC) Thread - Steel, page 370* and *Table – 37° Flare (JIC)Thread - Aluminum/Brass, page 371* are segregated based on the material configuration of the connection.

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

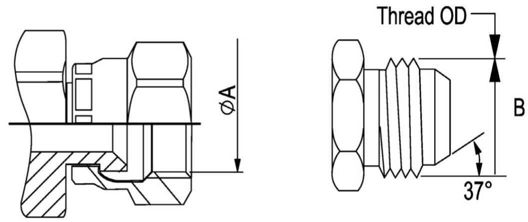
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 39. 37° Flare (JIC) Thread - Steel



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

Table 40. 37° Flare (JIC)Thread - Aluminum/Brass



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

* ØA and ØB thread dimensions for reference only.

** Refer to *FFWR and TFFT Methods, page 418* for FFWR procedure requirements.

5.2.10 Assembly Instructions for 45° SAE Flare Fittings

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

⚠ CAUTION

Do not force a misaligned or short hose/tube into alignment. It puts undesirable strain onto the joint eventually leading to leakage.

2. Align tube to fitting.

3. Tighten fitting by hand until hand tight.

⚠ CAUTION

The torque method should not be used on lubricated or oily fittings. No lubrication or sealant is required. The lubrication would cause increased clamping force and cause fitting damage.

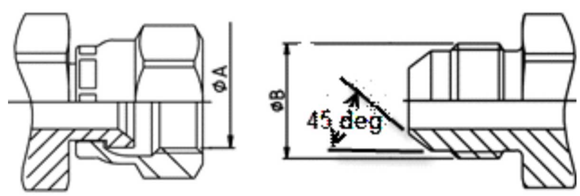
Torque fitting to value listed in *Table – 45° Flare (SAE) - Steel, page 372* and *Table – 45° Flare (SAE) - Aluminum/Brass, page 373* while using the Double Wrench Method outlined in this section. Refer to *FFWR and TFFT Methods* for procedure requirements if using the TFFT method.

Note: Torque values provided in *Table – 45° Flare (SAE) - Steel, page 372* and *Table – 45° Flare (SAE) - Aluminum/Brass, page 373* are segregated based on the material configuration of the connection.

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

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

Table 41. 45° Flare (SAE) - Steel

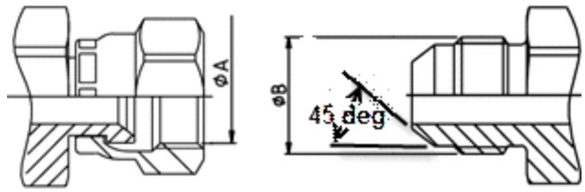


TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UNLUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	13	14	14	18	19	19
	6	5/8-18	0.56	14.30	0.63	15.90	22	23	24	30	31	33
	8	3/4-16	0.69	17.50	0.75	19.10	42	44	46	57	60	62
	10	7/8-14	0.81	20.60	0.87	22.20	60	63	66	81	85	89
	12	1 1/16-14	0.98	25.00	1.06	27.00	84	88	92	114	119	125

* ØA and ØB thread dimensions for reference only.

** Refer to *FFWR and TFFT Methods, page 418* procedure requirements.

Table 42. 45° Flare (SAE) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	8	9	9	11	12	12
	6	5/8-18	0.56	14.30	0.63	15.90	14	15	15	19	20	20
	8	3/4-16	0.69	17.50	0.75	19.10	27	29	30	37	39	41
	10	7/8-14	0.81	20.60	0.87	22.20	39	41	43	53	56	58
	12	1 1/16-14	0.98	25.00	1.06	27.00	55	58	61	75	79	83
* ØA and ØB thread dimensions for reference only.												
** Refer to *FFWR and TFFT Methods, page 418* procedure requirements.												

5.2.11 Assembly Instructions for O-ring Face Seal (ORFS) Fittings

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

⚠ CAUTION

Care to be taken when lubricating O-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

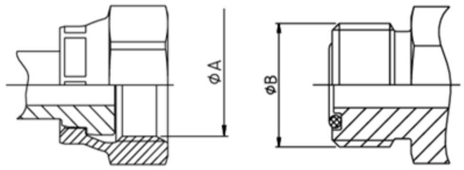
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Place the tube assembly against the fitting body so that the flat face comes in contact with the O-ring. Hand thread the nut onto the fitting body.
5. Torque nut to value listed in *Table — O-ring Face Seal (ORFS) - Steel, page 374* or *Table — O-ring Face Seal (ORFS) - Aluminum/ Brass, page 375* while using the Double Wrench Method. Refer to *FFWR and TFFT Methods* for procedure requirements if using the FFWR method.

Note: Torque values provided in *Table — O-ring Face Seal (ORFS) - Steel, page 374* and *Table — O-ring Face Seal (ORFS) - Aluminum/ Brass, page 375* are segregated based on the material configuration of the connection.

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

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

Table 43. O-ring Face Seal (ORFS) - Steel

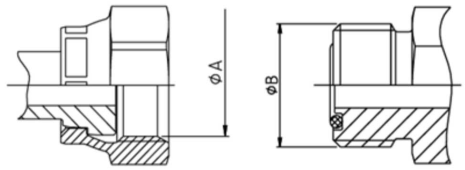


TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size (UNF)	ØA* (in)	ØA* (mm)	ØB* (in)	ØB* (mm)	[Ft-Lb] Min	[Ft-Lb] Nom	[Ft-Lb] Max	[N-m] Min	[N-m] Nom	[N-m] Max	Tube Nuts	Swivel & Hose Ends
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UNLUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	18	19	20	25	26	27	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	30	32	33	40	43	45	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	40	42	44	55	57	60	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	60	63	66	81	85	89	1/4 to 1/2	1/2 to 3/4
	12	1 3/16-12	1.11	28.20	1.19	30.10	85	90	94	115	122	127	1/4 to 1/2	1/2 to 3/4
	16	1 7/16-12	1.34	34.15	1.44	36.50	110	116	121	149	157	164	1/4 to 1/2	1/2 to 3/4
	20	111/16-12	1.59	40.50	1.69	42.90	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	230	242	253	312	328	343	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	375	394	413	508	534	560	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** Refer to *FFWR and TFFT Methods, page 418* procedure requirements.

Table 44. O-ring Face Seal (ORFS) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	No-m	Max		
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	26	28	29	35	38	39	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	39	41	43	53	56	58	1/4 to 1/2	1/2 to 3/4
	12	1 3/16-12	1.11	28.20	1.19	30.10	55	58	61	75	79	83	1/4 to 1/2	1/2 to 3/4
	16	1 7/16-12	1.34	34.15	1.44	36.50	72	76	79	98	103	107	1/4 to 1/2	1/2 to 3/4
	20	111/16-12	1.59	40.50	1.69	42.90	98	103	108	133	140	146	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** Refer to *FFWR and TFFT Methods, page 418* procedure requirements.

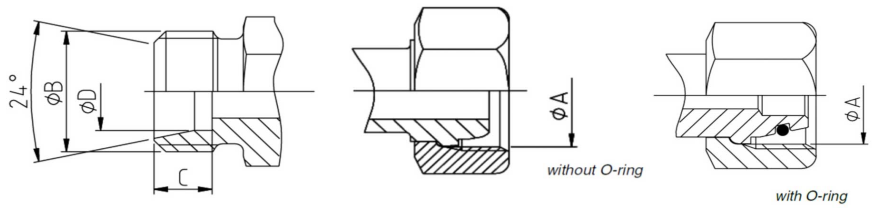
5.2.12 Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

⚠ CAUTION

A non-square tube end can cause improperly seated fittings and leakage.

1. Inspect the components to ensure free of contamination, external damage, rust, splits, dirt, foreign matter, or burrs. Ensure tube end is visibly square. If necessary replace fitting or tube.
2. Lubricate thread and cone of fitting body or hardened pre-assembly tool, as well as the progressive ring and nut threads.
3. Slip nut and progressive ring over tube, assuring that they are in the proper orientation.
4. Push the tube end into the coupling body.
5. Slide collet into position and tighten until finger tight. Mark nut and tube in the finger-tight position. Tighten nut to the number of flats listed in *Table — DIN 24° Cone (MBTL & MBTS), page 376* while using the Double Wrench Method. The tube must not turn with the nut.

Table 45. DIN 24° Cone (MBTL & MBTS)



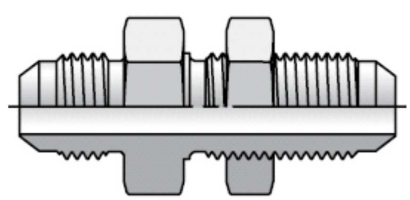
TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)						
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque						Flats from Resistance (F.F.W.R)**
								[Ft-Lb]			[N-m]			
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12 x 1.5	10.50	12.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the Service Manual						1.5 to 1.75
		8	M14 x 1.5	12.50	14.00	7.00	8.20							1.5 to 1.75
		10	M16 x 1.5	14.50	16.00	7.00	10.20							1.5 to 1.75
		12	M18 x 1.5	16.50	18.00	7.00	12.20							1.5 to 1.75
		15	M22 x 1.5	20.50	22.00	7.00	15.20							1.5 to 1.75
		18	M26 x 1.5	24.50	26.00	7.50	18.20							1.5 to 1.75
		22	M30 x 2	27.90	30.00	7.50	22.20							1.5 to 1.75
		28	M36 x 2	33.90	36.00	7.50	28.20							1.5 to 1.75
		35	M45 x 2	42.90	45.00	10.50	35.30							1.5 to 1.75
		42	M52 x 2	49.90	52.00	11.00	42.30							1.5 to 1.75

TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)						
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque						Flats from Resistance (F.F.W.R)**
								[Ft-Lb]			[N-m]			
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	Min	Nom	M-ax	Min	Nom	Ma-x	
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14 x 1.5	12.50	14.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the Service manual						1.5 to 1.75
		8	M16 x 1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
		10	M18 x 1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
		12	M20 x 1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
		14	M22 x 1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
		16	M24 x 1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
		20	M30 x 2	27.90	30.00	10.50	20.20							1.5 to 1.75
		25	M36 x 2	33.90	36.00	12.00	25.20							1.5 to 1.75
		30	M42 x 2	39.90	42.00	13.50	30.20							1.5 to 1.75
		38	M52 x 2	49.90	52.00	16.00	38.30							1.5 to 1.75
* ØA, ØB, C, & ØD thread dimensions for reference only.														
** Refer to Appendix B for FFWR procedure requirements.														

5.2.13 Assembly Instructions for Bulkhead (BH) Fittings

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

Table 46. Bulkhead Fittings (BH) - INCH



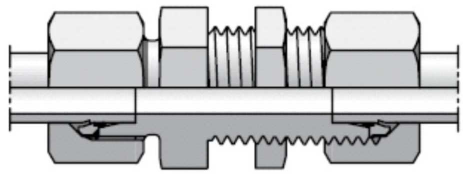
TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors
MATERIAL	TYPE	Dash Size	Thread Size	Torque

Table 46. Bulkhead Fittings (BH) - INCH (continued)

				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	O-RING FACE SEAL (ORFS) BULKHEAD FITTING	4	9/16-18	15	16	17	20	22	23
		6	11/16-16	25	27	28	34	37	38
		8	13/16-16	55	58	61	75	79	83
		10	1-14	85	90	94	115	122	127
		12	1 3/16-12	135	142	149	183	193	202
		14	1 5/16-12	170	179	187	230	243	254
		16	1 7/16-12	200	210	220	271	285	298
		20	1 11/16-12	245	258	270	332	350	366
		24	2-12	270	284	297	366	385	403

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

Table 47. Bulkhead Fittings (BH) - METRIC



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTL) BULKHEAD FITTING	6	M12 x 1.5	14	15	16	19	20	22
		8	M14 x 1.5	17	18	19	23	24	26
		10	M16 x 1.5	22	23	24	30	31	33
		12	M18 x 1.5	35	37	39	47	50	53
		15	M22 x 1.5	44	47	50	60	64	68
		18	M26 x 1.5	70	75	80	95	102	108
		22	M30 x 2	115	120	125	156	163	169
		28	M36 x 2	150	157	164	203	213	222
		35	M45 x 2	155	162	169	210	220	229
		42	M52 x 2	220	230	240	298	312	325

TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTS) BULKHEAD FITTING	6	M14 x 1.5	17	15	16	23	20	22
		8	M16 x 1.5	22	18	19	30	24	26
		10	M18 x 1.5	35	23	24	47	31	33
		12	M20 x 1.5	40	35	37	54	47	50
		14	M22 x 1.5	44	47	50	60	64	68
		16	M24 x 1.5	70	75	80	95	102	108
		20	M30 x 2	115	120	125	156	163	169
		25	M36 x 2	150	157	164	203	213	222
		30	M42 x 2	155	162	169	210	220	229
		38	M52 x 2	220	230	240	298	312	325

5.2.14 Assembly Instructions for O-ring Boss (ORB) Fittings

1. Inspect components to ensure that male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.

2. Ensure proper O-ring is installed. If O-ring is missing install per .

⚠ CAUTION

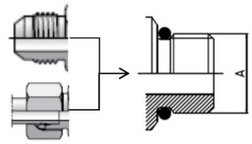
Care to be taken when lubricating O-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to *Adjustable Stud End Assembly for proper assembly, page 419*.
6. Torque the fitting or nut to value listed in *Table — O-ring Boss (ORB) - Table 1 of 6, page 382* through *Table — O-ring Boss (ORB) - Table 6 of 6, page 392* while using the Double Wrench Method.
   a. The table headings identify the straight thread O-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread O-ring port.
   b. Torque values provided in Table 5-12 through Table 5-17 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

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

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

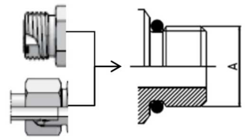
Table 48. O-ring Boss (ORB) - Table 1 of 6



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

TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UNLUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363
* ØA Thread OD dimension for reference only.										
**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.										

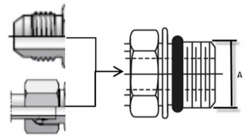
Table 49. O-ring Boss (ORB) - Table 2 of 6



TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	–	–	–	–	–	–
	3	3/8-24	0.37	9.52	–	–	–	–	–	–
	4	7/16-20	0.44	11.11	26	27	28	35	37	38
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UNLUBRICATED THREADS	2	5/16-24	0.31	7.93	–	–	–	–	–	–
	3	3/8-24	0.37	9.52	–	–	–	–	–	–
	4	7/16-20	0.44	11.11	17	18	18	23	24	24
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363
* ØA Thread OD dimension for reference only.										
**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.										

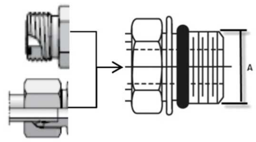
Table 50. O-ring Boss (ORB) - Table 3 of 6



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

TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UNLUBRICATED THREADS	2	5/16-24	0.31	7.93	(39)	(41)	(43)	4	5	5
	3	3/8-24	0.37	9.52	(65)	(69)	(72)	7	8	8
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	15	19	20	20
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363
* ØA Thread OD dimension for reference only.										
**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.										

Table 51. O-ring Boss (ORB) - Table 4 of 6



TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	–	–	–	–	–	–
	3	3/8-24	0.37	9.52	–	–	–	–	–	–
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UNLUBRICATED THREADS	2	5/16-24	0.31	7.93	–	–	–	–	–	–
	3	3/8-24	0.37	9.52	–	–	–	–	–	–
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363
* ØA Thread OD dimension for reference only.										
**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.										

Table 52. O-ring Boss (ORB) - Table 5 of 6

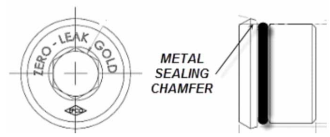
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	16	19	20	22
	6	9/16-18	0.56	14.28	34	36	38	46	49	52
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UNLUBRICATED THREADS	2	5/16-24	0.31	7.93	(20)	(21)	(21)	2	2	2
	3	3/8-24	0.37	9.52	(36)	(38)	(40)	4	4	5
	4	7/16-20	0.44	11.11	6	7	7	8	9	9
	5	1/2-20	0.50	12.70	9	10	10	12	14	14
	6	9/16-18	0.56	14.28	22	24	25	30	33	34
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

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

Table 53. O-ring Boss (ORB) - Table 6 of 6



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

TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque**					
					[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UNLUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
	32	2 1/2-12	2.50	63.50						
* ØA Thread OD dimension for reference only.										
**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.										

5.2.15 Assembly Instructions for Adjustable Port End Metric (MFF) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. Refer to *O-ring Installation (Replacement), page 420* for instructions.

⚠ CAUTION

Care to be taken when lubricating O-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

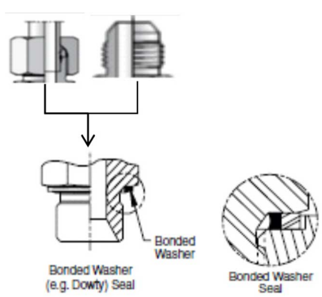
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to for proper assembly. Refer to *Adjustable Stud End Assembly for proper assembly, page 419*.

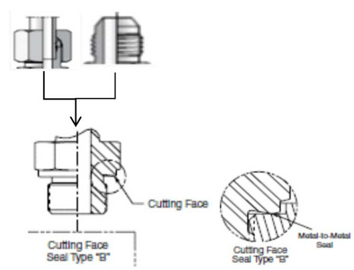
6. Torque the fitting or nut to value listed in *Table — Metric Flat Face Port (MFF) - L Series - Table 1 of 3, page 394*; *Table — Metric Flat Face Port (MFF) - L Series - Table 2 of 3, page 395*; *Table — Metric Flat Face Port (MFF) - L Series - Table 3 of 3, page 396*; *Table — Metric Flat Face Port (MFF) - S Series - Table 1 of 3, page 397*; *Table — Metric Flat Face Port (MFF) - S Series - Table 2 of 3, page 398* or *Table — Metric Flat Face Port (MFF) - S Series - Table 3 of 3, page 400* while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in *Table — Metric Flat Face Port (MFF) - L Series - Table 1 of 3, page 394*; *Table — Metric Flat Face Port (MFF) - L Series - Table 2 of 3, page 395*; *Table — Metric Flat Face Port (MFF) - L Series - Table 3 of 3, page 396*; *Table — Metric Flat Face Port (MFF) - S Series - Table 1 of 3, page 397*; *Table — Metric Flat Face Port (MFF) - S Series - Table 2 of 3, page 398* and *Table — Metric Flat Face Port (MFF) - S Series - Table 3 of 3, page 400* are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

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

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

Table 54. Metric Flat Face Port (MFF) - L Series - Table 1 of 3

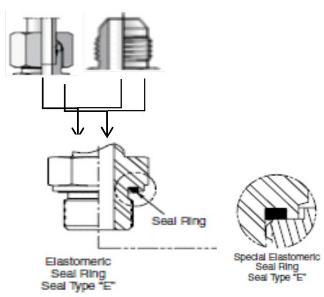


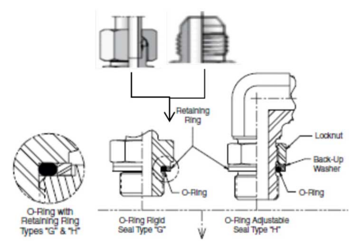


TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	7	8	8	9	11	11	13	14	14	18	19	19
	M12x1.5	8	15	16	17	20	22	23	22	23	24	30	31	33
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	33	35	36	45	47	49	48	51	53	65	69	72
	M18x1.5	15	41	43	45	55	58	61	59	62	65	80	84	88
	M22x1.5	18	48	51	53	65	69	72	103	108	113	140	146	153
	M27x2	22	66	70	73	90	95	99	140	147	154	190	199	209
	M33x2	28	111	117	122	150	159	165	251	264	276	340	358	374
	M42x2	35	177	186	195	240	252	264	369	388	406	500	526	550
	M48x2	42	214	225	235	290	305	319	465	489	512	630	663	694

MATERIAL	Thread M Size (metric)	Connecting Tube O.D. (mm)	FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end — Torque [Ft-Lb] Min	Nom	Max	[N-m] Min	Nom	Max	FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end — Torque [Ft-Lb] Min	Nom	Max	[N-m] Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	4	5	5	5	7	7	8	9	9	11	12	12
	M12x1.5	8	10	11	11	14	15	15	14	15	16	19	20	22
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	21	22	23	28	30	31	31	33	34	42	45	46
	M18x1.5	15	27	28	29	37	38	39	38	40	42	52	54	57
	M22x1.5	18	31	33	34	42	45	46	67	70	73	91	95	99
	M27x2	22	43	45	47	58	61	64	91	96	100	123	130	136
	M33x2	28	72	76	79	98	103	107	163	171	179	221	232	243
	M42x2	35	115	121	127	156	164	172	240	252	264	325	342	358
	M48x2	42	139	146	153	188	198	207	302	318	332	409	431	450

Table 55. Metric Flat Face Port (MFF) - L Series - Table 2 of 3

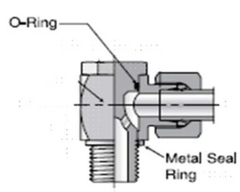


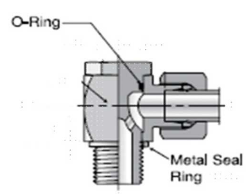


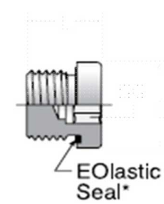
MATERIAL	Thread M Size (metric)	Connecting Tube O.D. (mm)	FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end — Torque [Ft-Lb] Min	Nom	Max	[N-m] Min	Nom	Max	FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end — Torque [Ft-Lb] Min	Nom	Max	[N-m] Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	15	18	19	20
	M12x1.5	8	18	19	20	25	26	27	18	19	20	25	26	28
	M14x1.5	10	33	35	36	45	47	49	30	31	32	40	42	44
	M16x1.5	12	41	43	45	55	58	61	41	43	45	55	58	61
	M18x1.5	15	52	55	57	70	75	77	52	54	57	70	74	77
	M22x1.5	18	92	97	101	125	132	137	66	70	73	90	95	99
	M27x2	22	133	140	146	180	190	198	133	139	146	180	189	198
	M33x2	28	229	241	252	310	327	342	229	240	252	310	326	341
	M42x2	35	332	349	365	450	473	495	332	348	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12
	M12x1.5	8	12	13	13	16	18	18	12	13	13	16	18	18
	M14x1.5	10	21	22	23	28	30	31	19	20	21	26	27	29
	M16x1.5	12	27	28	29	37	38	39	26	28	29	36	38	39
	M18x1.5	15	34	36	37	46	49	50	34	35	37	46	48	50
	M22x1.5	18	60	63	66	81	85	89	43	45	47	59	61	64
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 56. Metric Flat Face Port (MFF) - L Series - Table 3 of 3



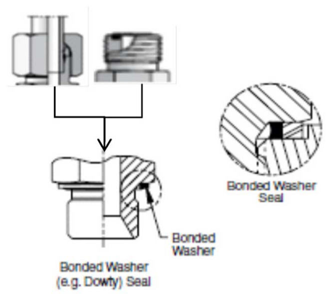


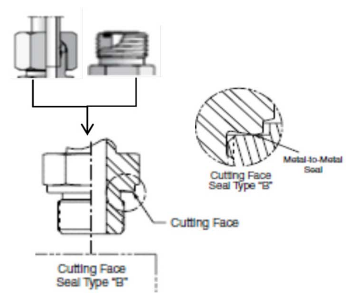


TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end						HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	14	18	19	19	9	10	10	12	14	14
	M12x1.5	8	26	28	29	35	38	39	33	35	36	45	47	49	18	19	20	25	26	27
	M14x1.5	10	37	39	41	50	53	56	41	43	45	55	58	61	26	28	29	35	38	39
	M16x1.5	12	44	46	48	60	62	65	59	62	65	80	84	88	41	43	45	55	58	61
	M18x1.5	15	59	62	65	80	84	88	74	78	81	100	106	110	48	51	53	65	69	72
	M22x1.5	18	89	94	98	120	127	133	103	108	113	140	146	153	66	70	73	90	95	99
	M27x2	22	96	101	106	130	137	144	236	248	260	320	336	353	100	105	110	135	142	149
	M33x2	28	–	–	–	–	–	–	266	280	293	360	380	397	166	175	183	225	237	248
	M42x2	35	–	–	–	–	–	–	398	418	438	540	567	594	266	280	293	360	380	397
	M48x2	42	–	–	–	–	–	–	516	542	568	700	735	770	266	280	293	360	380	397

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end						HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	M12x1.5	8	17	18	19	23	24	26	21	22	23	28	30	31	12	13	13	16	18	18
	M14x1.5	10	24	26	27	33	35	37	27	28	29	37	38	39	17	18	19	23	24	26
	M16x1.5	12	29	30	31	39	41	42	38	40	42	52	54	57	27	28	29	37	38	39
	M18x1.5	15	38	40	42	52	54	57	48	51	53	65	69	72	31	33	34	42	45	46
	M22x1.5	18	58	61	64	79	83	87	67	70	73	91	95	99	43	45	47	58	61	64
	M27x2	22	62	66	69	84	89	94	153	161	169	207	218	229	65	69	72	88	94	98
	M33x2	28	–	–	–	–	–	–	173	182	190	235	247	258	108	114	119	146	155	161
	M42x2	35	–	–	–	–	–	–	259	272	285	351	369	386	173	182	190	235	247	258
	M48x2	42	–	–	–	–	–	–	335	352	369	454	477	500	173	182	190	235	247	258

Table 57. Metric Flat Face Port (MFF) - S Series - Table 1 of 3





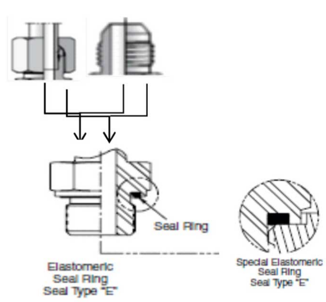
TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	15	16	17	20	22	23	26	28	29	35	38	39
	M14x1.5	8	26	28	29	35	38	39	41	43	45	55	58	61
	M16x1.5	10	33	35	36	45	47	49	52	55	57	70	75	77
	M18x1.5	12	41	43	45	55	58	61	81	85	89	110	115	121
	M20x1.5	14	41	43	45	55	58	61	111	117	122	150	159	165
	M22x1.5	16	48	51	53	65	69	72	125	132	138	170	179	187
	M27x2	20	66	70	73	89	95	99	199	209	219	270	283	297

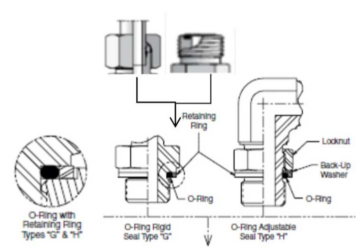
Table 57. Metric Flat Face Port (MFF) - S Series - Table 1 of 3 (continued)

	M33x2	25	111	117	122	150	159	165	302	317	332	410	430	450
	M42x2	30	177	186	195	240	252	264	398	418	438	540	567	594
	M48x2	38	214	225	235	290	305	319	516	542	568	700	735	770

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	10	11	11	14	15	15	17	18	19	23	24	26
	M14x1.5	8	17	18	19	23	24	26	27	28	29	37	38	39
	M16x1.5	10	21	22	23	28	30	31	34	36	37	46	49	50
	M18x1.5	12	27	28	29	37	38	39	53	56	58	72	76	79
	M20x1.5	14	27	28	29	37	38	39	72	76	79	98	103	107
	M22x1.5	16	31	33	34	42	45	46	81	86	90	110	117	122
	M27x2	20	43	45	47	58	61	64	129	136	142	175	184	193
	M33x2	25	72	76	79	98	103	107	196	206	216	266	279	293
	M42x2	30	115	121	127	156	164	172	259	272	285	351	369	386
	M48x2	38	139	146	153	188	198	207	335	352	369	454	477	500

Table 58. Metric Flat Face Port (MFF) - S Series - Table 2 of 3





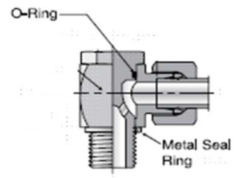
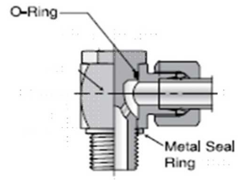
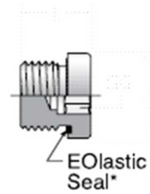
TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-	M10x1	6	26	28	29	35	38	39	26	28	29	35	38	39
	M12x1.5	8	33	35	36	45	47	49	41	43	45	55	58	61
	M14x1.5	10	52	55	57	70	75	77	52	55	57	70	75	77
	M16x1.5	12	66	70	73	90	95	99	66	70	73	90	95	99
	M18x1.5	15	92	97	101	125	132	137	92	97	101	125	132	137

Table 58. Metric Flat Face Port (MFF) - S Series - Table 2 of 3 (continued)

LUBRICATED THREADS	M22x1.5	18	100	105	110	135	142	149	100	105	110	135	142	149
	M27x2	22	133	140	146	180	190	198	133	140	146	180	190	198
	M33x2	28	229	241	252	310	327	342	229	241	252	310	327	342
	M42x2	35	332	349	365	450	473	495	332	349	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594

TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	17	18	19	23	24	26
	M12x1.5	8	21	23	23	29	31	32	27	28	29	37	38	39
	M14x1.5	10	34	36	37	46	49	50	34	36	37	46	49	50
	M16x1.5	12	43	45	47	58	61	64	43	45	47	58	61	64
	M18x1.5	15	60	63	66	81	85	89	60	63	66	81	85	89
	M22x1.5	18	65	69	72	88	94	98	65	69	72	88	94	98
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 59. Metric Flat Face Port (MFF) - S Series - Table 3 of 3

																				
TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						FORM E (EOLASTIC SEALING RING) HOL-LOW HEX PLUGS					
MATERI-AL	Thread M Size	Connect-ing Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(met-ric)	(mm)	Min	No-m	Ma-x	Mi-yn	No-m	Ma-x	Min	No-m	Ma-x	Min	No-m	Ma-x	Min	No-m	Ma-x	Min	No-m	Ma-x
STEEL FIT-TINGS WITH STEEL MATING COMPO-NENTS; UN-LU-BRICAT-ED THREA-DS	M10x1	6	26	28	29	35	38	39	33	35	36	45	47	49	–	–	–	–	–	–
	M12x1.5	8	37	39	41	50	53	56	41	43	45	55	58	61	–	–	–	–	–	–
	M14x1.5	10	44	46	48	60	62	65	59	62	65	80	84	88	–	–	–	–	–	–
	M16x1.5	12	59	62	65	80	84	88	74	78	81	100	106	110	–	–	–	–	–	–
	M18x1.5	15	81	85	89	110	115	121	92	97	101	125	132	137	59	62	65	80	84	88
	M22x1.5	18	89	94	98	120	127	133	100	105	110	135	142	149	–	–	–	–	–	–
	M27x2	22	100	105	110	135	142	149	236	248	260	320	336	353	–	–	–	–	–	–
	M33x2	28	–	–	–	–	–	–	266	280	293	360	380	397	–	–	–	–	–	–
	M42x2	35	–	–	–	–	–	–	398	418	438	540	567	594	–	–	–	–	–	–
	M48x2	42	–	–	–	–	–	–	516	542	568	700	735	770	–	–	–	–	–	–

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						FORM E (EOLASTIC SEALING RING) HOL-LOW HEX PLUGS					
MATERI-AL	Thread M Size	Connect-ing Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	No-m	Ma-x	Min	No-m	Ma-x	Min	No-m	Ma-x	Min	No-m	Ma-x	Min	No-m	Ma-x	Min	No-m	Ma-x
ALUMI-NUM/ BRASS FIT-TINGS OR ALU-MINUM/ BRASS MATING COMPO-NENTS; UN-LU-BRICAT-ED THREA-DS	M10x1	6	17	18	19	23	24	26	21	22	23	28	30	31	–	–	–	–	–	–
	M12x1.5	8	24	26	27	33	35	37	27	28	29	37	38	39	–	–	–	–	–	–
	M14x1.5	10	29	30	31	39	41	42	38	40	42	52	54	57	–	–	–	–	–	–
	M16x1.5	12	38	40	42	52	54	57	48	51	53	65	69	72	–	–	–	–	–	–
	M18x1.5	15	53	56	58	72	76	79	60	63	66	81	85	89	38	40	42	52	54	57
	M22x1.5	18	58	61	64	79	83	87	65	69	72	88	94	98	–	–	–	–	–	–
	M27x2	22	65	69	72	88	94	98	153	161	169	207	218	229	–	–	–	–	–	–
	M33x2	28	–	–	–	–	–	–	173	182	190	235	247	258	–	–	–	–	–	–
	M42x2	35	–	–	–	–	–	–	259	272	285	351	369	386	–	–	–	–	–	–
	M48x2	42	–	–	–	–	–	–	335	352	369	454	477	500	–	–	–	–	–	–

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

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter or burrs.

2. If O-ring is not pre-installed, install proper size, taking care not to damage it. Refer to *O-ring Installation (Replacement), page 420* for instructions.

⚠ CAUTION

Care to be taken when lubricating O-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

3. Pre-lubricate the O-ring with Hydraulic Oil.

4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.

5. For Adjustable fittings, refer to *Adjustable Stud End Assembly for proper assembly, page 419*.

6. Torque the fitting or nut to value listed in *Table — Metric Pipe Parallel O-Ring Boss (MPP), page 402* while using the Double Wrench Method.

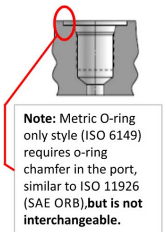
    a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.

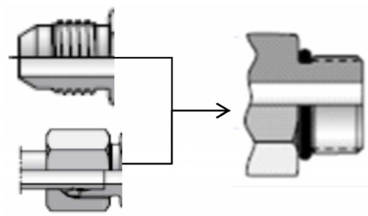
    b. Torque values provided in Table 5-24 are segregated based on the material configuration of the connection. 'ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS' indicate either the following material configurations:

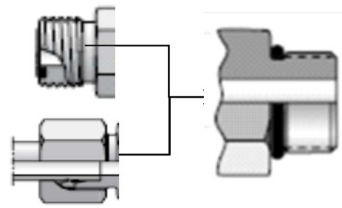
    STEEL fittings with ALUMINUM or BRASS mating components
    ALUMINUM or BRASS fittings with STEEL mating components
    ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

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

Table 60. Metric Pipe Parallel O-Ring Boss (MPP)

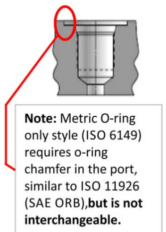


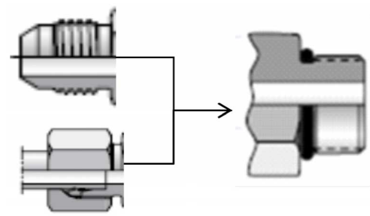


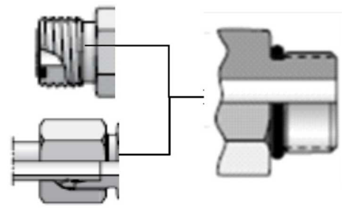


TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M8 x 1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10 x 1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12 x 1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14 x 1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16 x 1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18 x 1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20 x 1.5	–	–	–	–	–	–	–	59	62	65	80	84	88
	M22 x 1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27 x 2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30 x 2	–	95	100	105	130	136	142	175	184	193	237	249	262
	M33 x 2	25	120	126	132	160	171	179	230	242	253	310	328	343
	M38 x 2	–	135	142	149	183	193	202	235	247	259	319	335	351
	M42 x 2	30	155	163	171	210	221	232	245	258	270	330	350	366
	M48 x 2	38	190	200	209	260	271	283	310	326	341	420	442	462
	M60 x 2	50	230	242	253	315	328	343	370	389	407	500	527	552

Table 61. Metric Pipe Parallel O-Ring Boss (MPP)







TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING	M8 x 1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10 x 1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12 x 1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14 x 1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16 x 1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18 x 1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20 x 1.5	–	–	–	–	–	–	–	30	40	42	41	54	57
	M22 x 1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27 x 2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30 x 2	–	62	65	68	84	88	92	114	120	125	155	163	169
	M33 x 2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38 x 2	–	88	93	97	119	126	132	153	161	168	207	218	228
	M42 x 2	30	101	106	111	137	144	150	159	168	176	216	228	239
	M48 x 2	38	124	130	136	168	176	184	202	212	222	274	287	301
	M60 x 2	50	150	157	164	203	213	222	241	253	265	327	343	359

5.2.17 Assembly instructions for Adjustable Port End (BSPP) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. Refer to *O-ring Installation (Replacement), page 420* for instructions.

⚠ CAUTION

Care to be taken when lubricating O-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to *Adjustable Stud End Assembly for proper assembly, page 419*.

6. Torque the fitting or nut to value listed in *Table — British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3, page 405*; *Table — British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3, page 407*; *Table — British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3, page 408*; *Table — British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3, page 409*; *Table — British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3, page 412* or *Table — British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3, page 413* while using the Double Wrench Method.

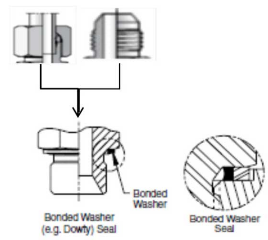
   a. The table headings identify the BSPP port and the type on the other side of the fitting. The torque will be applied to the BSPP port.

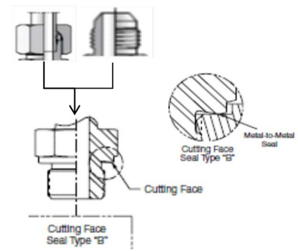
   b. Torque values provided in *Table — British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3, page 405*; *Table — British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3, page 407*; *Table — British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3, page 408*; *Table — British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3, page 409*; *Table — British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3, page 412* and *Table — British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3, page 413* are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

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

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

Table 62. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3





TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B** (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UNLUBRICATED THREADS	G 1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G 1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G 1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G 3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G 1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G 1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694

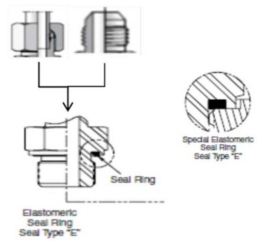
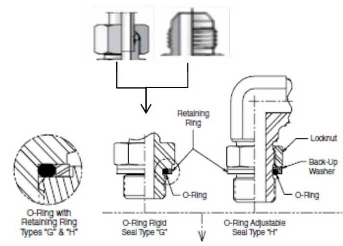
TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B** (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UNLUBRICATED THREADS	G 1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G 1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G 1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G 3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G 1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G 1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	42	139	146	153	188	198	207	302	318	333	409	431	451

* Typical for JLG Straight Male Stud Fittings

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

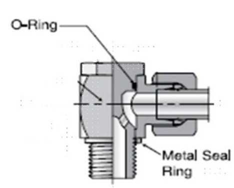
*** Typical for JLG Adjustable Fittings

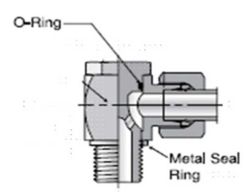
Table 63. British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3

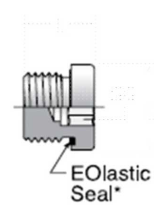
														
TYPE/FITTING IDENTIFICATION			**FORM E* (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end**						**FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end**					
MATERIAL	**BSPP Thread G Size**	**Connect-ing Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UNLUBRICATED THREADS	G 1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	52	55	57	70	75	77	52	55	57	70	75	77
	G 1/2A	15	66	70	73	90	95	99	66	70	73	90	95	99
	G 1/2A	18	66	70	73	90	95	99	66	70	73	90	95	99
	G 3/4A	22	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	28	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	35	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	42	398	418	438	540	567	594	398	418	438	540	567	594

TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	34	36	37	46	49	50	34	36	37	46	49	50
	G 1/2A	15	43	45	47	58	61	64	43	45	47	58	61	64
	G 1/2A	18	43	45	47	58	61	64	43	45	47	58	61	64
	G 3/4A	22	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	28	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	35	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	42	259	272	285	351	369	386	259	272	285	351	369	386
* Typical for JLG Straight Male Stud Fittings														
** Non typical for JLG Straight Male Stud Fittings, reference only.														
*** Typical for JLG Adjustable Fittings														

Table 64. British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3







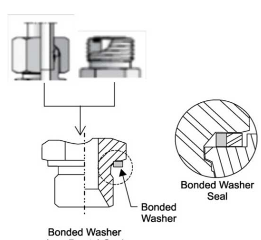
TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end						HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G 1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65
	G 1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G 1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G 3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153

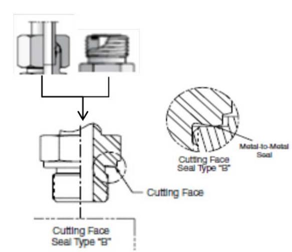
Table 64. British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3 (continued)

	G 1A	28	–	–	–	–	–	–	236	248	260	320	336	353	148	156	163	200	212	221
	G 1-1/4A	35	–	–	–	–	–	–	398	418	438	540	567	594	295	31-3.5	332	400	425	450
	G 1-1/2A	42	–	–	–	–	–	–	516	542	568	700	735	770	332	349	365	450	473	495

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end						HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	G 1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G 1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42
	G 1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G 1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G 3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99
	G 1A	28	–	–	–	–	–	–	153	161	169	207	218	229	96	101	106	130	137	144
	G 1-1/4A	35	–	–	–	–	–	–	259	272	285	351	369	386	216	227	237	293	308	321
	G 1-1/2A	42	–	–	–	–	–	–	335	352	369	454	477	500	216	227	237	293	308	321
* Typical for JLG Straight Male Stud Fittings																				
** Non typical for JLG Straight Male Stud Fittings, reference only.																				
*** Typical for JLG Adjustable Fittings																				

Table 65. British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3





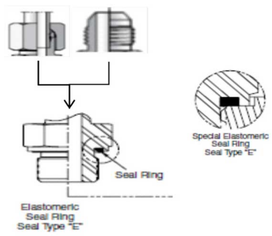
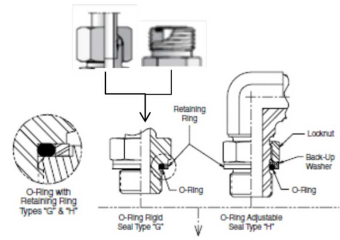
TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING	G 1/4A	6	26	28	29	35	38	39	41	43	45	55	58	61
	G 1/4A	8	26	28	29	35	38	39	41	43	45	55	58	61

Table 65. British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3 (continued)

COMPONENTS; UNLUBRICATED THREADS	G 3/8A	10	33	35	36	45	47	49	66	70	73	90	95	99
	G 3/8A	12	33	35	36	45	47	49	66	70	73	90	95	99
	G 1/2A	14	48	51	53	65	69	72	111	117	122	150	159	165
	G 1/2A	16	48	51	53	65	69	72	96	101	106	130	137	144
	G 3/4A	20	66	70	73	90	95	99	199	209	219	270	283	297
	G 1A	25	111	117	122	150	159	165	251	264	276	340	358	374
	G 1-1/4A	30	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	38	214	225	235	290	305	319	516	542	568	700	735	770

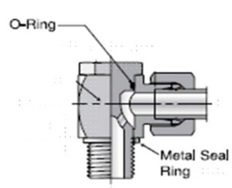
TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	17	18	19	23	24	26	27	28	29	37	38	39
	G 1/4A	8	17	18	19	23	24	26	27	28	29	37	38	39
	G 3/8A	10	21	22	23	28	30	31	43	45	47	58	61	64
	G 3/8A	12	21	22	23	28	30	31	43	45	47	58	61	64
	G 1/2A	14	31	33	34	42	45	46	72	76	79	98	103	107
	G 1/2A	16	31	33	34	42	45	46	62	66	69	84	89	94
	G 3/4A	20	43	45	47	58	61	64	129	136	142	175	184	193
	G 1A	25	72	76	79	98	103	107	163	171	179	221	232	243
	G 1-1/4A	30	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	38	139	146	153	188	198	207	335	352	369	454	477	500
* Typical for JLG Straight Male Stud Fittings														
** Non typical for JLG Straight Male Stud Fittings, reference only.														
*** Typical for JLG Adjustable Fittings														

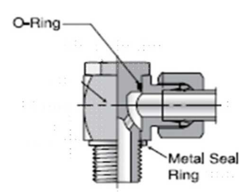
Table 66. British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3

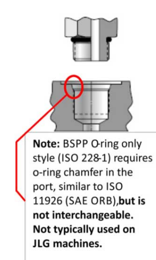
														
TYPE/FITTING IDENTIFICATION			**FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end**						**FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end**					
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	41	43	45	55	58	61	26	28	29	35	38	39
	G 1/4A	8	41	43	45	55	58	61	26	28	29	35	38	39
	G 3/8A	10	59	62	65	80	84	88	52	55	57	70	75	77
	G 3/8A	12	59	62	65	80	84	88	52	55	57	70	75	77
	G 1/2A	14	85	90	94	115	122	127	66	70	73	90	95	99
	G 1/2A	16	85	90	94	115	122	127	66	70	73	90	95	99
	G 3/4A	20	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	25	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	30	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	38	398	418	438	540	567	594	398	418	438	540	567	594

TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	27	28	29	37	38	39	17	18	19	23	24	26
	G 1/4A	8	27	28	29	37	38	39	17	18	19	23	24	26
	G 3/8A	10	38	40	42	52	54	57	34	36	37	46	49	50
	G 3/8A	12	38	40	42	52	54	57	34	36	37	46	49	50
	G 1/2A	14	55	58	61	75	79	83	43	45	47	58	61	64
	G 1/2A	16	55	58	61	75	79	83	43	45	47	58	61	64
	G 3/4A	20	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	25	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	30	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	38	259	272	285	351	369	386	259	272	285	351	369	386
* Typical for JLG Straight Male Stud Fittings														
** Non typical for JLG Straight Male Stud Fittings, reference only.														
*** Typical for JLG Adjustable Fittings														

Table 67. British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3







TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						JIS/BSPP O-RING ONLY					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	30	32	33	40	43	45	33	35	36	45	47	49	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G 3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G 1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G 1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						

Table 67. British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3 (continued)

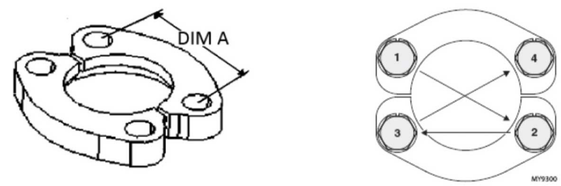
	G 3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254	
	G 1A	25	–	–	–	–	–	–	236	248	260	320	336	353	
	G 1-1/4A	30	–	–	–	–	–	–	398	418	438	540	567	594	
	G 1-1/2A	38	–	–	–	–	–	–	516	542	568	700	735	770	

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						JIS/BSPP O-RING ONLY					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UNLUBRICATED THREADS	G 1/4A	6	20	21	21	27	28	28	22	22	23	30	30	31	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G 3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G 1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G 1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G 3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G 1A	25	–	–	–	–	–	–	153	161	169	207	218	229						
	G 1-1/4A	30	–	–	–	–	–	–	259	272	285	351	369	386						
	G 1-1/2A	38	–	–	–	–	–	–	335	352	368	454	477	499						
* Typical for JLG Straight Male Stud Fittings																				
** Non typical for JLG Straight Male Stud Fittings, reference only.																				
*** Typical for JLG Adjustable Fittings																				

5.2.18 Assembly Instructions for Flange Connections: (FL61 and FL62)

1. Make sure sealing surfaces are free of rust, splits, scratches, dirt, foreign matter or burrs.
2. Install O-ring as per *O-ring Installation (Replacement), page 420*.
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Position flange and clamp halves.
5. Place lock washers on bolt and bolt through clamp halves.
6. Tighten all bolts by hand.
7. Torque bolts in diagonal sequence in two or more increments to the torque listed on *Table — Flange Code (FL61 & FL62) - Inch Fasteners, page 415* and *Table — Flange Code (FL61 & FL62) - Metric Fasteners, page 417*.

Table 68. Flange Code (FL61 & FL62) - Inch Fasteners

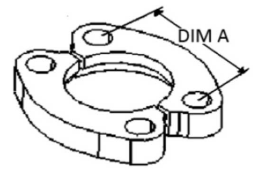


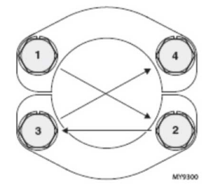
TYPE/FITTING IDENTIFICATION							STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)													
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws							
							[Ft-Lb]			[N-m]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

TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)																		
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(m-m)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLAN-GE (FL62)	8	0.50	13	1.59	40.39	5/16-18	–	–	–	–	–	–	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	3/8-16	–	–	–	–	–	–	44	46	49	60	63	66
	16	1.00	25	2.25	57.15	7/16-14	–	–	–	–	–	–	68	71	75	92	97	101
	20	1.25	32	2.62	66.55	1/2-13	–	–	–	–	–	–	111	116	122	150	158	165
	20	1.25	32	2.62	66.55	–	–	–	–	–	–	–	–	–	–	–	–	–
	24	1.50	38	3.12	79.25	5/8-11	–	–	–	–	–	–	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	3/4-10	–	–	–	–	–	–	332	348	365	450	473	495

* A dimension for reference only.

Table 69. Flange Code (FL61 & FL62) - Metric Fasteners





TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)												
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(m-m)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLAN-GE (FL61)	8	0.50	13	1.50	38.10	M8 x 1.25	18	19	19	24	25	26	18	19	19	24	25	26
	12	0.75	19	1.88	47.75	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	16	1.00	25	2.06	52.32	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	20	1.25	32	2.31	58.67	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	24	1.50	38	2.75	69.85	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	32	2.00	51	3.06	77.72	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	40	2.50	64	3.50	88.90	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	48	3.00	76	4.19	106.-43	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231
	56	3.50	89	4.75	120.-65	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231
	64	4.00	102	5.13	130.-30	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231
	80	5.00	127	6.00	152.-40	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231

TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)												
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	M8 x 1.25	–	–	–	–	–	–	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	M10 x 1.5	–	–	–	–	–	–	52	54	57	70	74	77
	16	1.00	25	2.25	57.15	M12 x 1.75	–	–	–	–	–	–	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M12 x 1.75	–	–	–	–	–	–	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M14 x 2	–	–	–	–	–	–	133	139	146	180	189	198
	24	1.50	38	3.12	79.25	M16 x 2	–	–	–	–	–	–	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	M20 x 2.5	–	–	–	–	–	–	406	426	446	550	578	605
* A dimension for reference only.																		

5.2.19 Double Wrench Method

To prevent undesired hose or connector rotation, two wrenches must be used; one torque wrench and one backup wrench. If two wrenches are not used, inadvertent component rotation may occur which absorbs torque and causes improper joint load and leads to leaks. For hose connections, the 'layline' printed on the hose is a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted. Refer to *Figure — Double Wrench Method, page 418*. for double wrench method requirements.

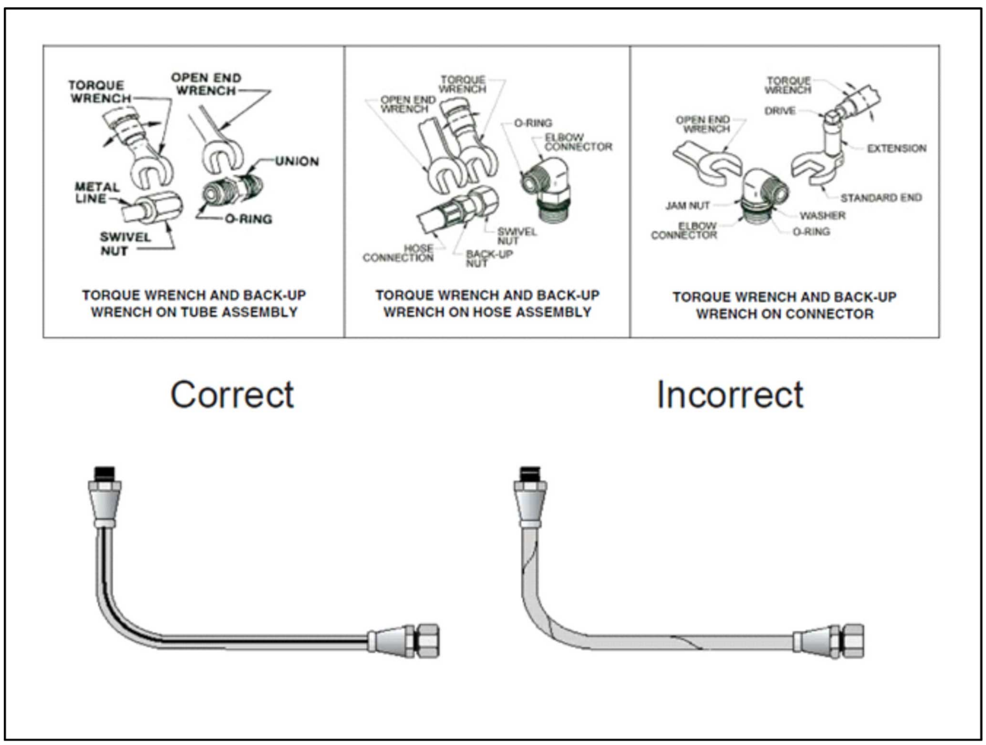


Figure 150. Double Wrench Method

5.2.20 FFWR and TFFT Methods

FFWR (FLATS FROM WRENCH RESISTANCE METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.

2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter. Refer to Figure B.1.

3. Use the double wrench method per Appendix A, turn the swivel nut to tighten as shown in *Figure — Double Wrench Method, page 418*. The nut is to be rotated clockwise the number of hex flats as defined by the applicable Table in Section 5.0.

4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened. Refer to *Figure — FFWR Method, page 419*.

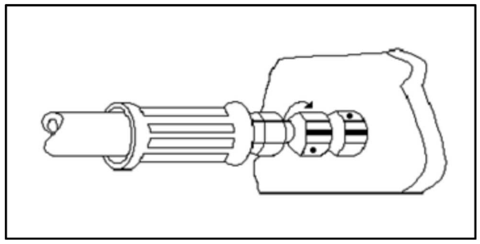


Figure 151. FFWR Method

TFFT (TURNS FROM FINGER TIGHT METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.

2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.

3. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of turns as defined by the applicable Table in Section 5.0.

4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

5.2.21 Adjustable Stud End Assembly

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

1. Lubricate the O-ring with a light coat of hydraulic oil.

2. Position #1 – The O-ring should be located in the groove adjacent to the face of the backup washer. The washer and O-ring should be positioned at the extreme top end of the groove as shown.

3. Position #2 – Position the locknut to just touch the backup washer as shown. The locknut in this position will eliminate potential backup washer damage during the next step.

4. Position #3 – Install the connector into the straight thread box port until the metal backup washer contacts the face of the port as shown.

5. Position #4 – Adjust the connector to the proper position by turning out (counterclockwise) up to a maximum of one turn as shown to provide proper alignment with the mating connector, tube assembly, or hose assembly.

6. Position #5 – Using two wrenches, use the backup wrench to hold the connector in the desired position and then use the torque wrench to tighten the locknut to the appropriate torque.

7. Visually inspect, where possible, the joint to ensure the O-ring is not pinched or bulging out from under the washer and that the backup washer is properly seated flat against the face of the port.

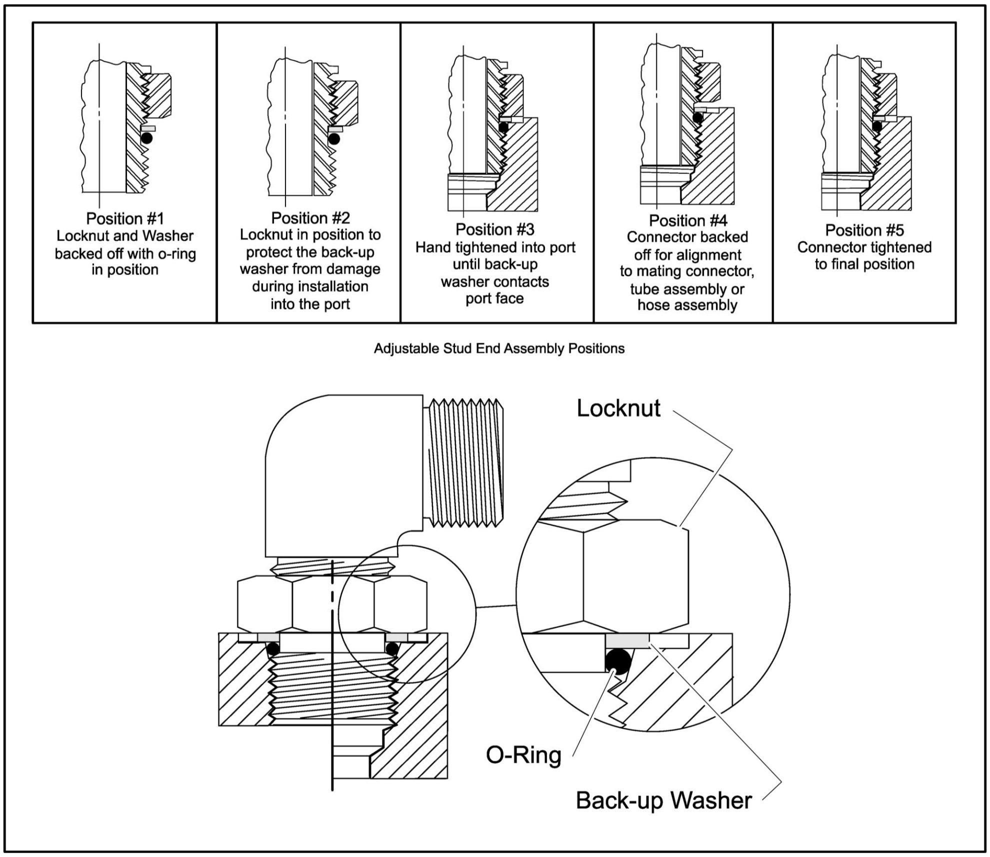


Figure 152. Adjustable Stud End Assembly

5.2.22 O-ring Installation (Replacement)

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

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

5.3 HYDRAULIC CYLINDERS

5.3.1 Axle Lockout Cylinder

DISASSEMBLY

NOTICE

Disassembly of the cylinder should be performed on a clean work surface in a dirt free work area.

⚠ WARNING

Rod can fall out of barrel and cause injury or damage to the equipment. Be careful when removing axle cylinder. Opening bleed valve can cause rod to fall out of barrel.

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

CLEANING AND INSPECTION

1. Inspect bore and rod for scoring, pitting, or excessive wear.
2. Remove minor surface blemishes with wet sandpaper.
3. Pitting requires replacement of barrel and rod.

ASSEMBLY

Note: Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. Refer to your JLG Parts Manual.

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

NOTICE

When installing new seals, ensure seals are installed properly. Improper seal installation could result in cylinder leakage and improper cylinder operation.

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

NOTICE

Extreme care should be taken when installing the rod. Avoid pulling the rod off-center, which could cause damage to the rod and cylinder barrel surfaces.

3. Insert and push the rod into top of barrel bore, rotate to install the rod into barrel bore.
4. Install plugs and counterbalance valve. Torque the plugs to 22-24 ft. lbs. (30-33 Nm) and counterbalance valve to 22 ft. lbs. (30 Nm).
5. Bleed system.

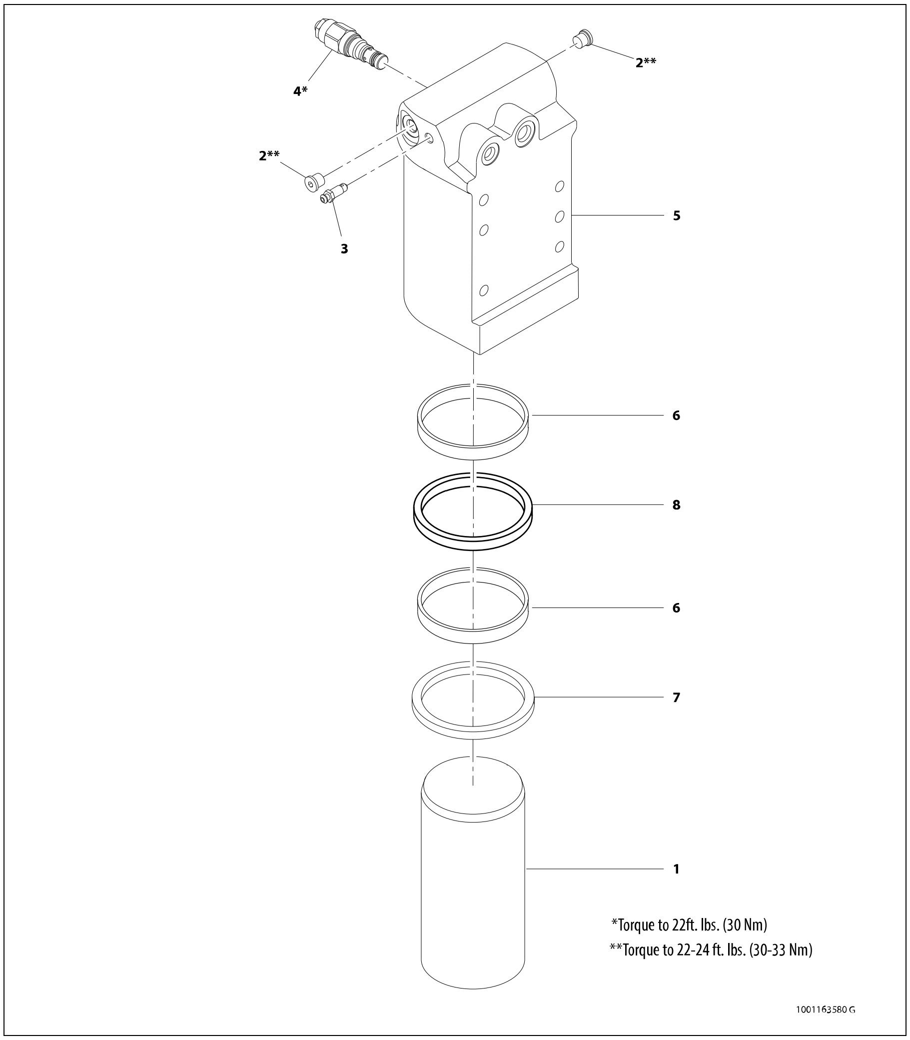


Figure 153. Axle Lockout Cylinder

1. Rod	4. Counterbalance valve	7. Rod Seal
2. Plug	5. Barrel	8. Wiper seal
3. Bleeder Valve	6. Wear Ring	

5.3.2 Platform Level Cylinder

DISASSEMBLY

NOTICE

Disassembly of the cylinder should be performed on a clean work surface in a dirt free work area.

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

⚠ WARNING

Do not fully extend cylinder to the end of stroke. Retract cylinder slightly to avoid trapping pressure.

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

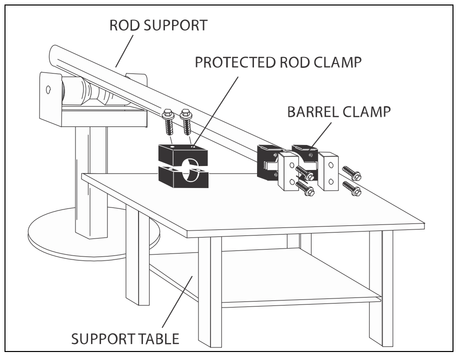


Figure 154. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using a pin-face spanner wrench, unscrew the cylinder head from the barrel.

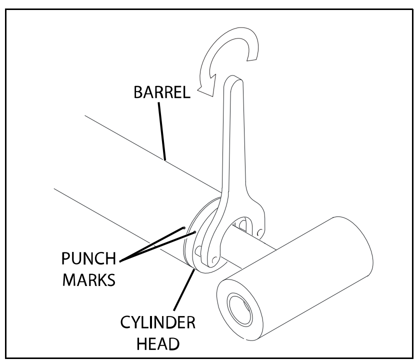


Figure 155. Cylinder Head Removal

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.

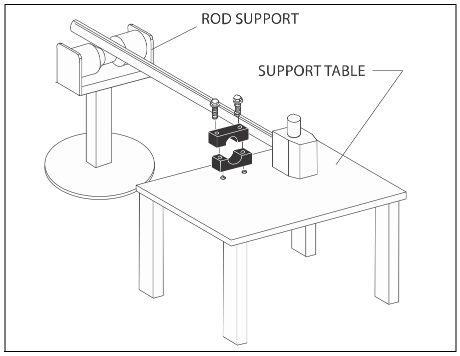


Figure 156. Cylinder Rod Support

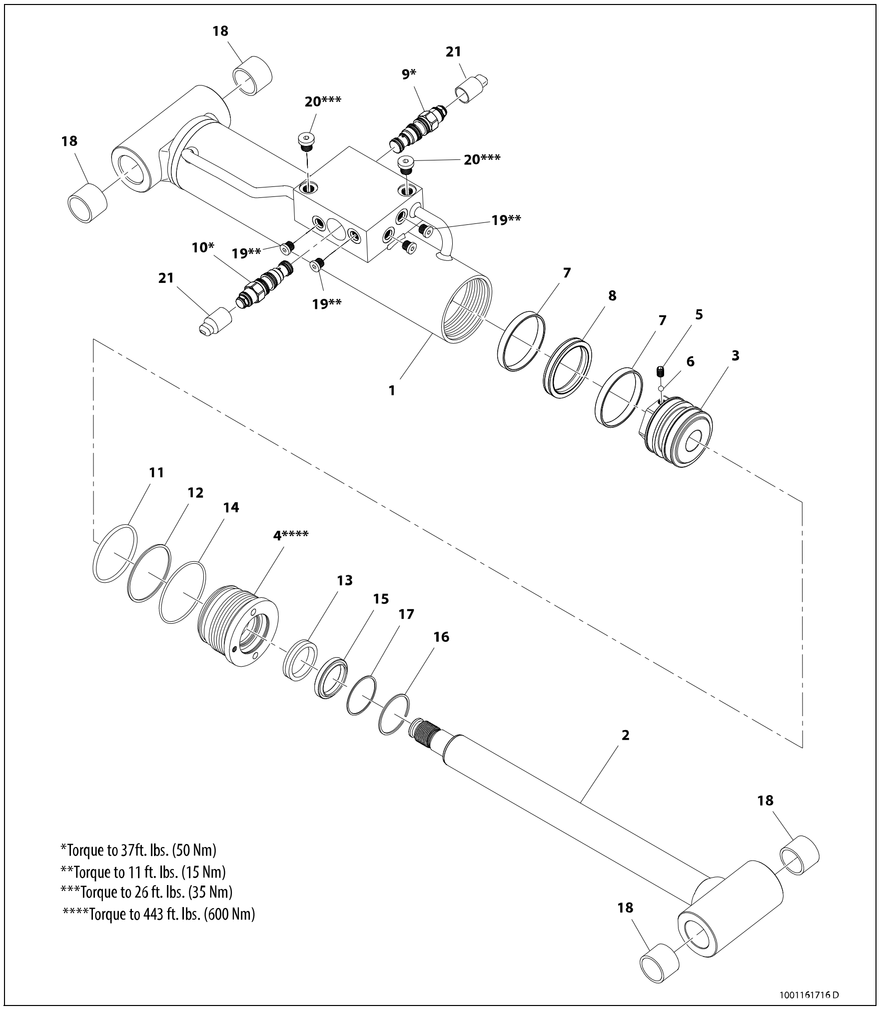


Figure 157. Platform Level Cylinder

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

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 setscrew and ball which attaches the piston to the rod.
10. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
11. Remove and discard the piston bearing rings and piston seal.
12. Remove the rod from the holding fixture. Remove the cylinder head. Discard the O-rings, seal, rod seal, retaining ring and wiper seal.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Briteor 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, tapering, ovality or other damage. Replace if 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, tapering, ovality or other damage. Replace if 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 inner side of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

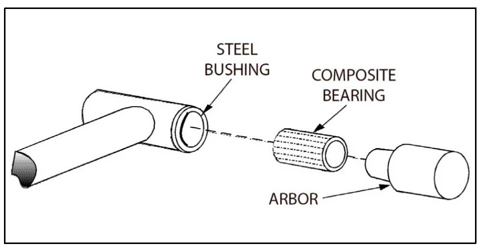


Figure 158. Composite Bearing Installation

14. Inspect port block fittings and holding valve. Replace if necessary.
15. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair if necessary.
16. Inspect piston rings for cracks or other damage. Replace if necessary.

ASSEMBLY

Note: Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. Refer to your JLG Parts Manual.

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

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

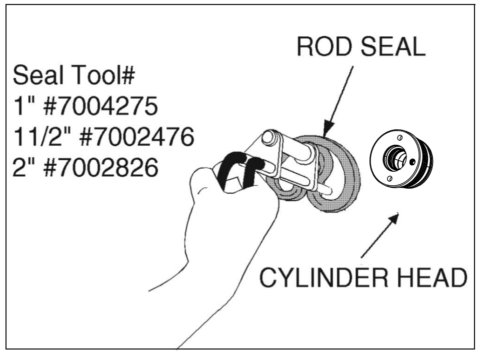


Figure 159. Rod Seal Installation

NOTICE

When installing new seals, ensure seals are installed properly. Improper seal installation could result in cylinder leakage and improper cylinder operation.

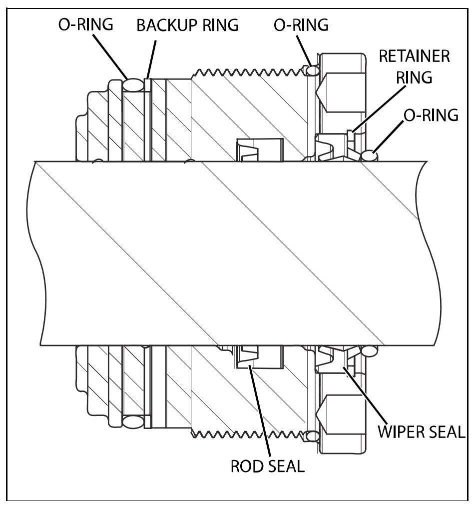


Figure 160. Cylinder Head Seal Installation

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head groove. Install a new retaining ring and O-ring into the applicable inside diameter of the cylinder head groove.

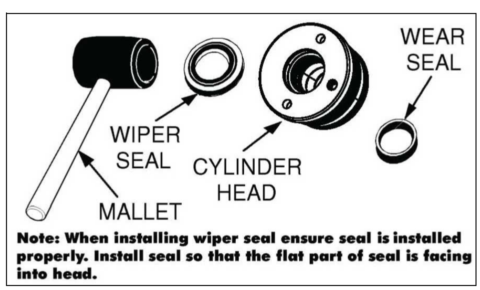


Figure 161. Wiper Seal Installation

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

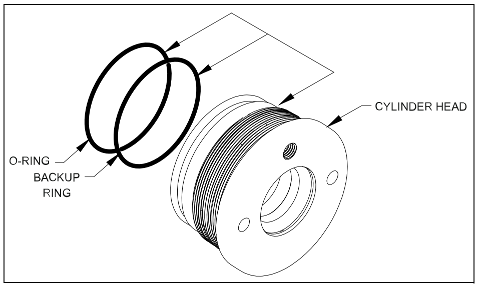


Figure 162. Installation of Head Seal Kit

4. Carefully install the cylinder head on the rod, ensuring that the wiper seal, retaining ring and rod seals are not damaged or dislodged. Push the head along the rod to the rod end.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Carefully thread the piston on the cylinder rod hand tight. Secure using ball and setscrew.
7. Remove the cylinder rod from the holding fixture. Place new seal and bearing rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

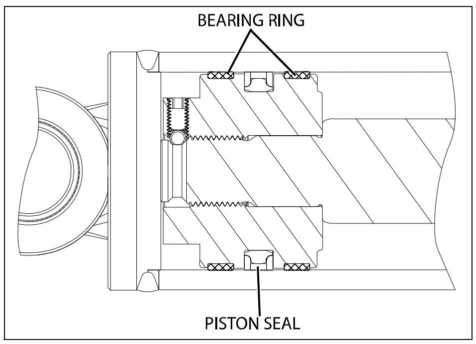


Figure 163. Piston Seal Kit Installation

8. 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.

9. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading bearing rings and seals are not damaged or dislodged.
10. Continue pushing the rod into the barrel until the cylinder head can be inserted into the barrel cylinder.
11. Screw the cylinder head into the barrel using a pin-face spanner wrench and torque cylinder head to 443 ft. lbs. (600 Nm).
12. 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.
13. Install the counterbalance valves in the rod port block. Torque to 37 ft. lbs. (50 Nm).
14. Install the new O-rings and plugs into the cylinder port block and torque plugs as shown in *Figure — Platform Level Cylinder, page 425*.

5.3.3 Jib Lift Cylinder

DISASSEMBLY

NOTICE

Disassembly of the cylinder should be performed on a clean work surface in a dirt free work area.

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

⚠ WARNING

Do not fully extend cylinder to the end of stroke. Retract cylinder slightly to avoid trapping pressure.

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

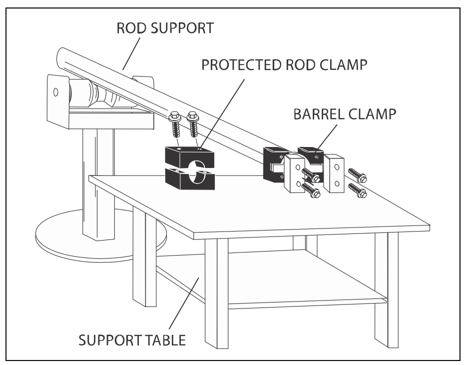


Figure 164. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using a spanner wrench, unscrew the cylinder head from the barrel. (It is easier to do this with rod pulled out 5 cm from the cylinder head).

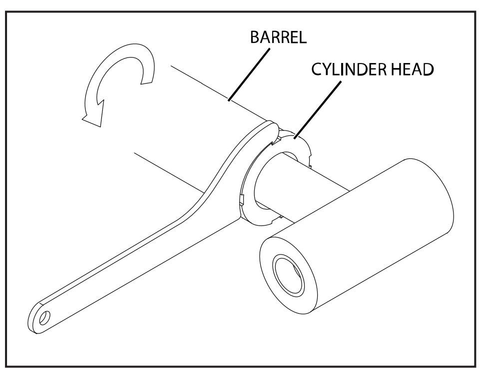


Figure 165. Cylinder Head Removal

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.

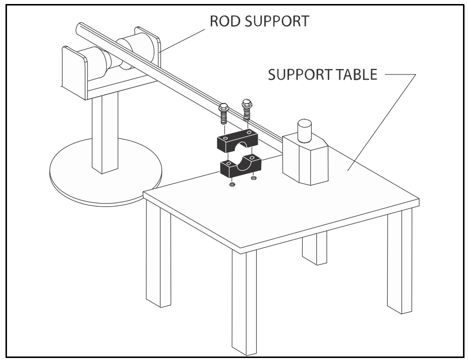


Figure 166. Cylinder Barrel Support

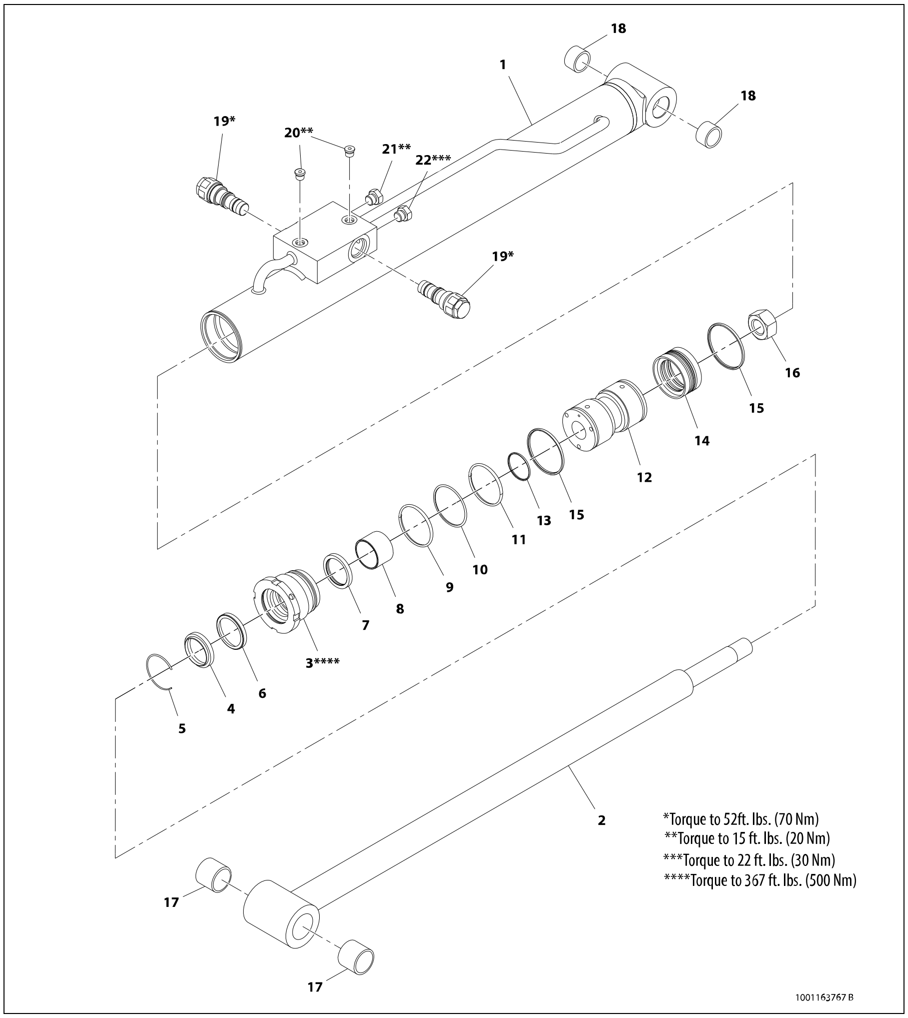


Figure 167. Jib Lift Cylinder

1. Barrel	9. O-ring	17. Bushing
2. Rod	10. Backup Ring	18. Bushing
3. Head	11. O-ring	19. Counterbalance Valve
4. Wiper Seal	12. Piston	20. Plug
5. Retaining Ring	13. O-ring	21. Plug
6. Rod Seal	14. Piston Seal	22. Plug
7. Backup Ring	15. Piston Ring	
8. Bearing	16. Nut	

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove locknut from the piston rod.
10. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
11. Remove and discard the piston ring and piston seals.
12. Remove the rod from the holding fixture. Remove the cylinder head. Discard the O-rings, backup rings, rod seal, retainer ring, bearing and wiper seal.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect 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 seal and O-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring, tapering, ovality or other damage. Replace if necessary.
9. Inspect threaded portion of head for damage. Dress threads as necessary.
10. Inspect seal and O-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
11. Inspect cylinder head outside diameter for scoring, tapering or ovality other damage. Replace if necessary.
12. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

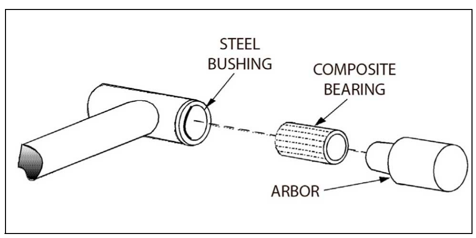


Figure 168. Composite Bearing Installation

13. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
14. Inspect piston rings for cracks or other damage. Replace if necessary.

ASSEMBLY

Note: Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. Refer to the respective JLG Parts Manual.

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

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

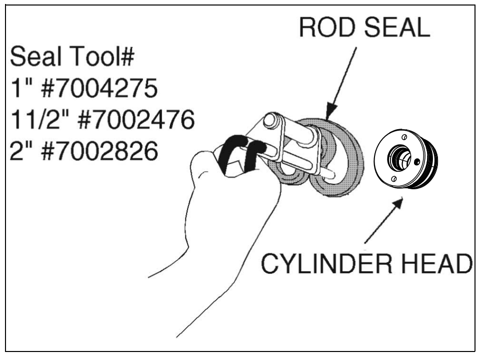


Figure 169. Rod Seal Installation

NOTICE

When installing new seals, ensure seals are installed properly. Improper seal installation could result in cylinder leakage and improper cylinder operation.

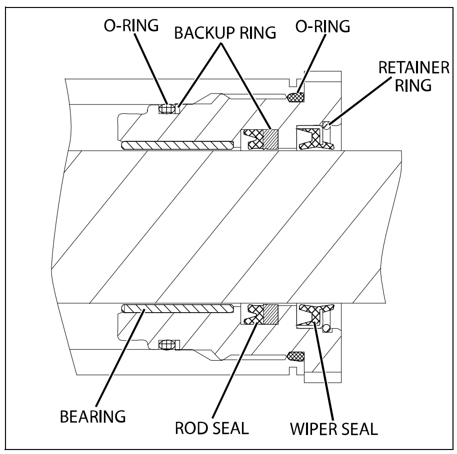
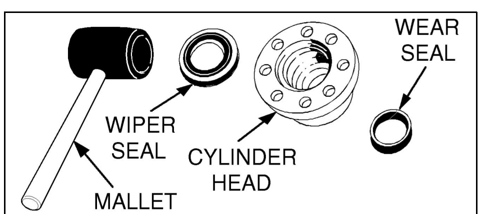


Figure 170. Cylinder Head Seal Installation

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head groove. Install a new retaining ring, backup ring and dry bearing into the applicable inside diameter of the cylinder head groove.



Note: When installing wiper seal ensure seal is installed properly. Install seal so that the flat part of seal is facing into head.

Figure 171. Wiper Seal Installation

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

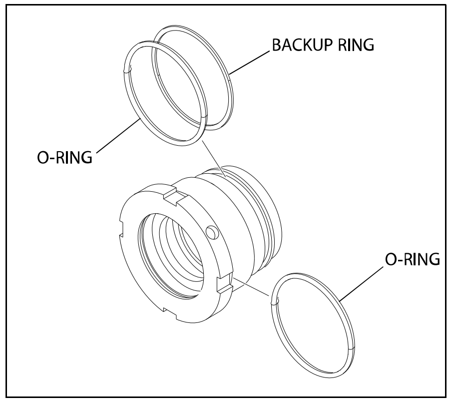


Figure 172. Installation of Head Seal Kit

4. Carefully install the cylinder head on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Place a new O-ring in the applicable inner piston diameter
7. Carefully thread the piston on the cylinder rod and hand tight.
8. Install locknut onto the piston rod.
9. Remove the cylinder rod from the holding fixture.
10. Place new piston rings and piston seal in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

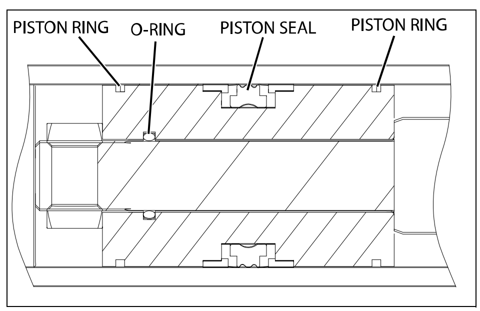


Figure 173. Installation of Piston Seal Kit

11. 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.

12. With barrel clamped secured and adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading piston rings and piston seal are not damaged or dislodged.
13. Continue pushing the rod into the barrel until the cylinder head can be inserted into the barrel cylinder.
14. Screw the cylinder head into the barrel using a spanner wrench and torque cylinder head to 369 ft. lbs. (500 Nm).
15. 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.

16. Install the counterbalance valves in the rod port block. Torque to 52 ft. lbs. (70 Nm).
17. Install the new O-rings and plugs into the cylinder port block and torque plug as shown in *Figure — Jib Lift Cylinder, page 432*.

5.3.4 Main Lift Cylinder

Note: Service Information Not Available At Time of Publishing.

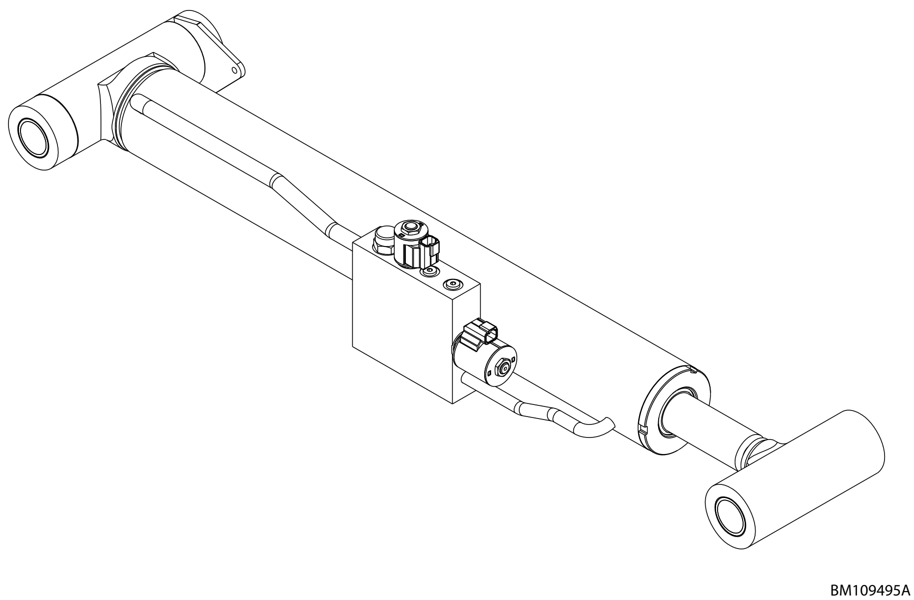


Figure 174. Main Lift Cylinder

5.3.5 Tower Boom Lift Cylinder

Note: Service Information Not Available At Time of Publishing.

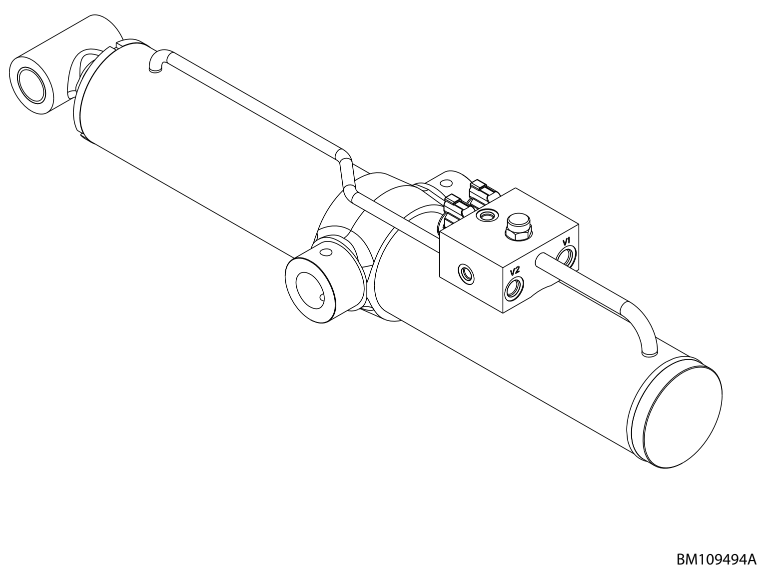


Figure 175. Tower Boom Lift Cylinder

5.3.6 Master Cylinder

DISASSEMBLY

NOTICE

Disassembly of the cylinder should be performed on a clean work surface in a dirt free work area.

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

⚠ WARNING

Do not fully extend cylinder to the end of stroke. Retract cylinder slightly to avoid trapping pressure.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.

3. Remove the plugs from the cylinder ports.

4. Place the cylinder barrel into a suitable holding fixture.

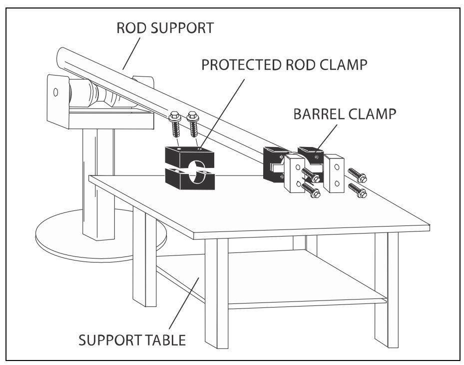


Figure 176. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using a pin-face spanner wrench, unscrew the cylinder head from the barrel.

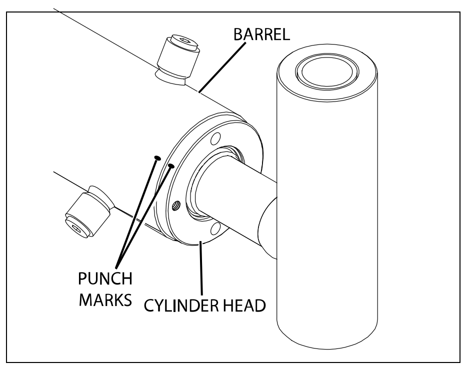


Figure 177. Cylinder Head Removal

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.

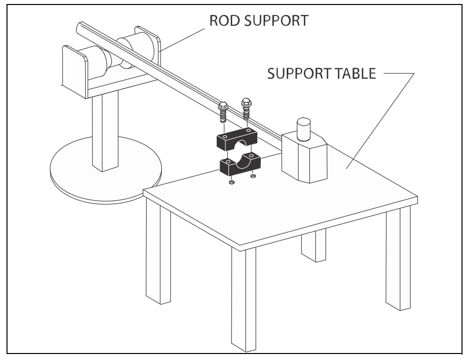


Figure 178. Cylinder Barrel Support

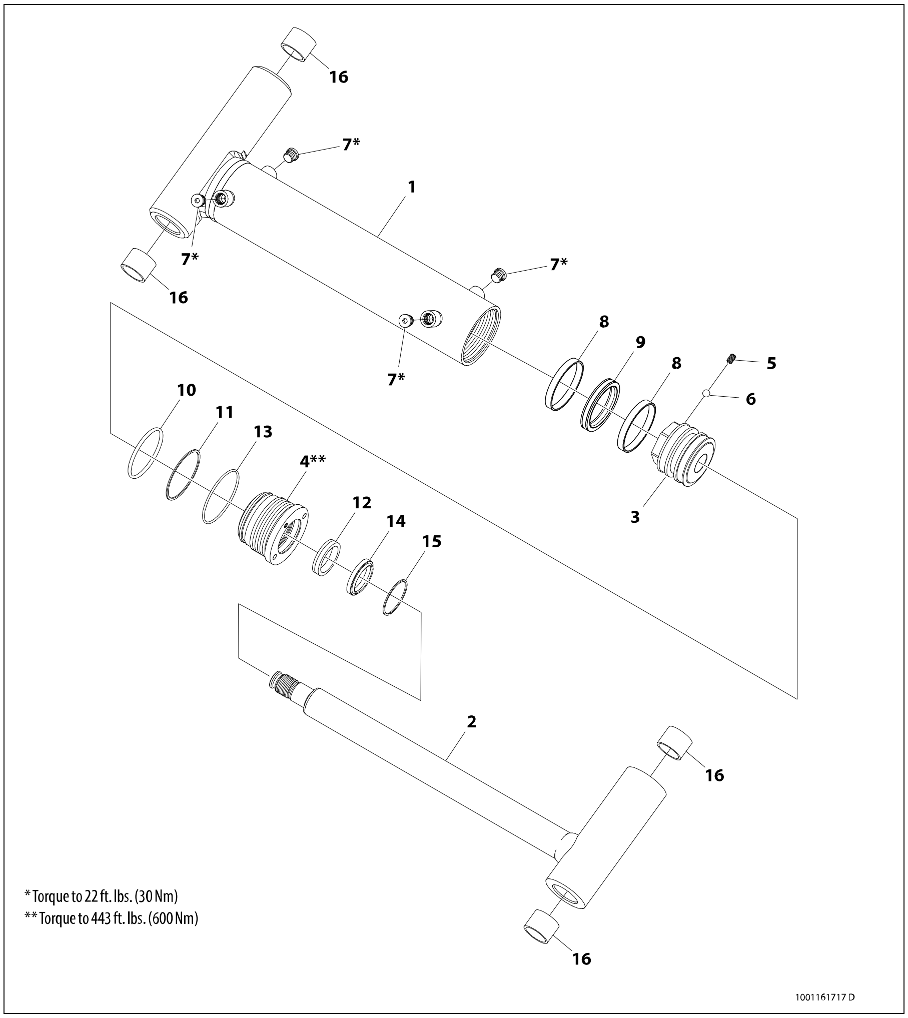


Figure 179. Master Cylinder

1. Barrel	5. Setscrew	9. Seal	13. O-ring
2. Rod	6. Ball	10. O-ring	14. Wiper Seal
3. Piston	7. Plug	11. Backup Ring	15. Retainer Ring
4. Head	8. Piston Ring	12. Rod Seal	16. Bushing

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 setscrew and which attaches the piston to the rod.
10. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
11. Remove and discard the piston rings and seal.
12. Remove the rod from the holding fixture. Remove the cylinder head. Discard the O-rings, backup rings, rod seal, retaining ring, and wiper seal.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.

3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect 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, tapering, ovality or other damage. Replace if 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, tapering or ovality other damage. Replace if necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

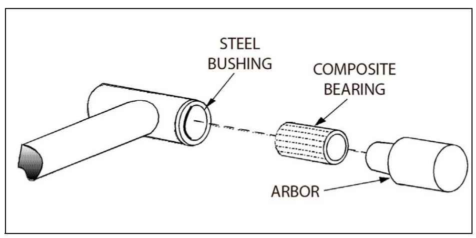


Figure 180. Composite Bearing Installation

14. Inspect port block fittings and valves. Replace if necessary.
15. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
16. Inspect piston rings for cracks or other damage. Replace if necessary.

ASSEMBLY

Note: Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. Refer to the respective JLG Parts Manual.

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

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

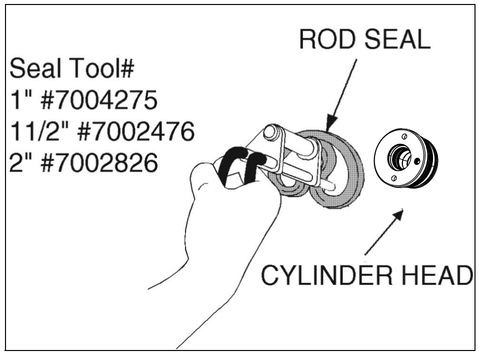


Figure 181. Rod Seal Installation

NOTICE

When installing new seals, ensure seals are installed properly. Improper seal installation could result in cylinder leakage and improper cylinder operation.

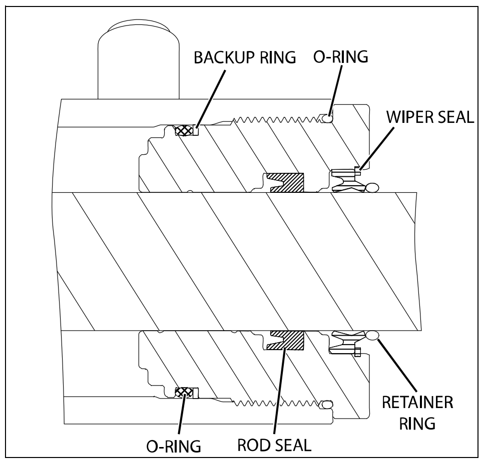
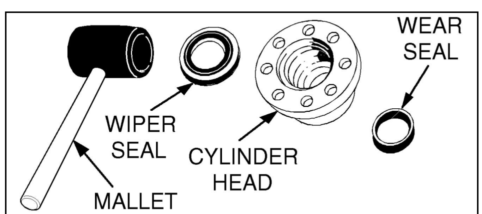


Figure 182. Cylinder Head Seal Installation

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head groove. Install a new retainer ring into the applicable inside diameter of the cylinder head groove.



Note: When installing wiper seal ensure seal is installed properly. Install seal so that the flat part of seal is facing into head.

Figure 183. Wiper Seal Installation

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

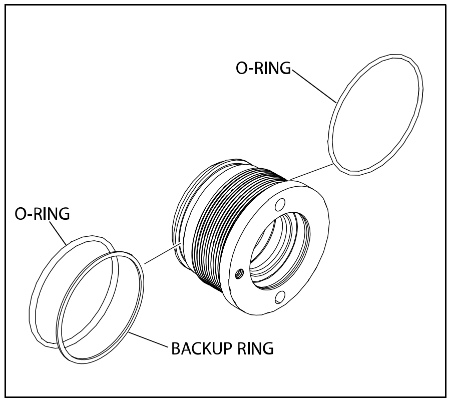


Figure 184. Installation of Head Seal Kit

4. Carefully install the cylinder head on the rod, ensuring that the wiper seal, retaining ring and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Carefully thread the piston on the cylinder rod, hand tight, ensuring that the O-ring and backup rings are not damaged or dislodged.
7. Install the setscrew and ball on the piston and attach the piston on the rod.
8. Remove the cylinder rod from the holding fixture.
9. Place new seal and piston ring in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

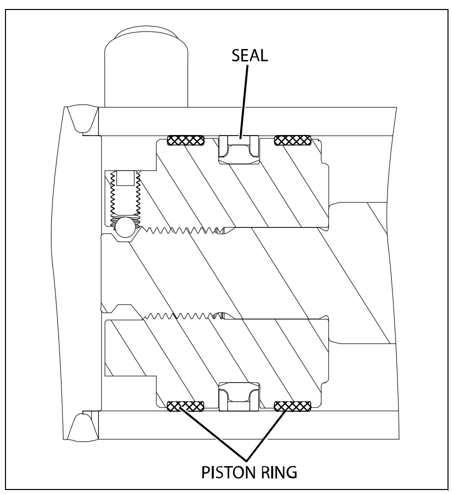


Figure 185. Installation of Piston Seal Kit

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

NOTICE

Extreme care should be taken when installing the cylinder rod, head and piston. Avoid pulling the rod off-center, which could cause damage to the piston and cylinder barrel surfaces.

11. With barrel clamped secured and adequately support ng the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading piston rings and piston seal are not damaged or dislodged.

12. Continue pushing the rod into the barrel until the cylinder head can be inserted into the barrel cylinder.
13. Screw the cylinder head into the barrel using a pin-face spanner wrench and torque cylinder head to 443 ft. lbs. (600 Nm).
14. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any plugs.
15. Install the plugs in the cylinder ports and torque to 22 ft. lbs. (30 Nm).

5.3.7 Steer Cylinder

DISASSEMBLY

NOTICE

Disassembly of the cylinder should be performed on a clean work surface in a dirt free work area.

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

⚠ WARNING

Do not fully extend cylinder to the end of stroke. Retract cylinder slightly to avoid trapping pressure.

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

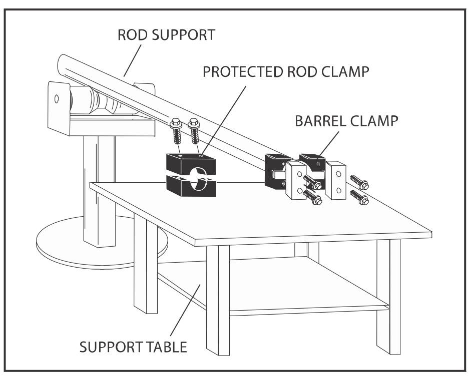


Figure 186. Cylinder Barrel Support

5. Using a hook spanner, loosen the cylinder head on both ends of the rod. Remove the cylinder head from the barrel and the rod.

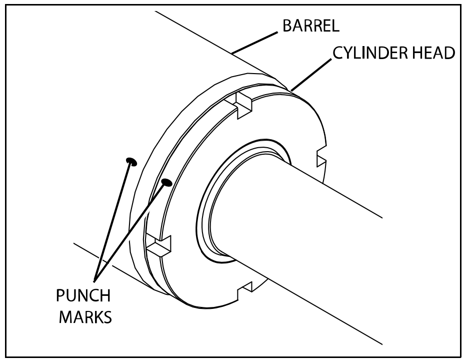


Figure 187. Cylinder Head Removal

6. Remove and discard the wiper seal, rod seal, backup ring, bearing, and O-ring from both the cylinder head.

7. 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.

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

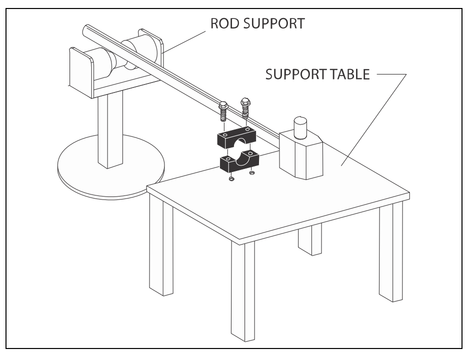


Figure 188. Cylinder Barrel Support

9. Remove and discard the piston seal form the rod.

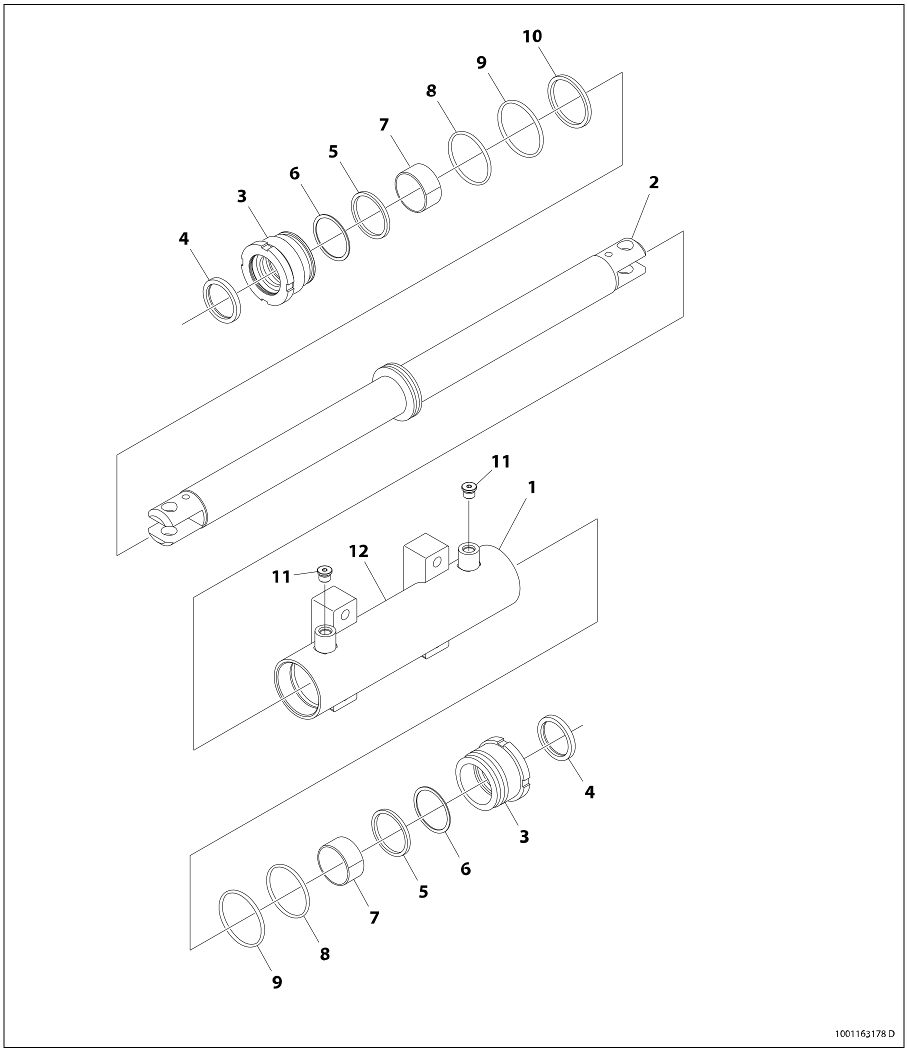


Figure 189. Steer Cylinder

1. Barrel	5. Rod Seal	9. O-ring
2. Rod	6. Backup Ring	10. Piston Seal
3. Head	7. Bearing	11. Plug
4. Wiper Seal	8. O-ring	

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 inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
4. Inspect threaded portion of barrel for damage. Dress threads as necessary.
5. Inspect cylinder head inside diameter for scoring, tapering, ovality or other damage. Replace if necessary.
6. Inspect threaded portion of head for damage. Dress threads as necessary.

7. Inspect seal and O-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head outside diameter for scoring, tapering or ovality other damage. Replace if necessary.
9. Inspect port block fittings and valves. Replace if necessary.
10. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.

ASSEMBLY

Note: Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. Refer to the respective JLG Parts Manual.

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

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

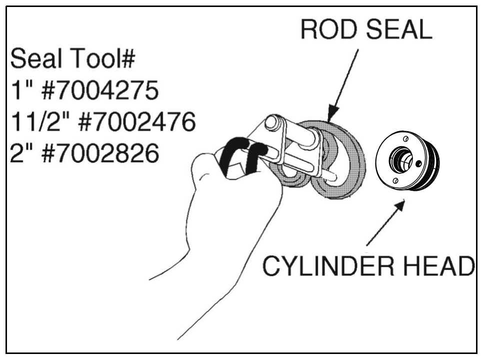


Figure 190. Rod Seal Installation

NOTICE

When installing new seals, ensure seals are installed properly. Improper seal installation could result in cylinder leakage and improper cylinder operation.

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head groove. Install a new bearing and backup ring into the applicable inside diameter of the cylinder head groove.

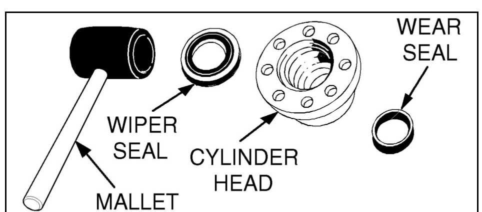


Figure 191. Wiper Seal Installation

3. Place new O-rings in the applicable outside diameter groove of the cylinder head.
4. Place new piston seal in the applicable groove of the rod.
5. With barrel clamped secured and adequately supporting the rod, insert the rod into the barrel cylinder.
6. Carefully install the cylinder head on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the barrel, as applicable.
7. Install new plugs into the cylinder port block.

5.3.8 Telescope Cylinder

Note: Service Information Not Available At Time of Publishing.

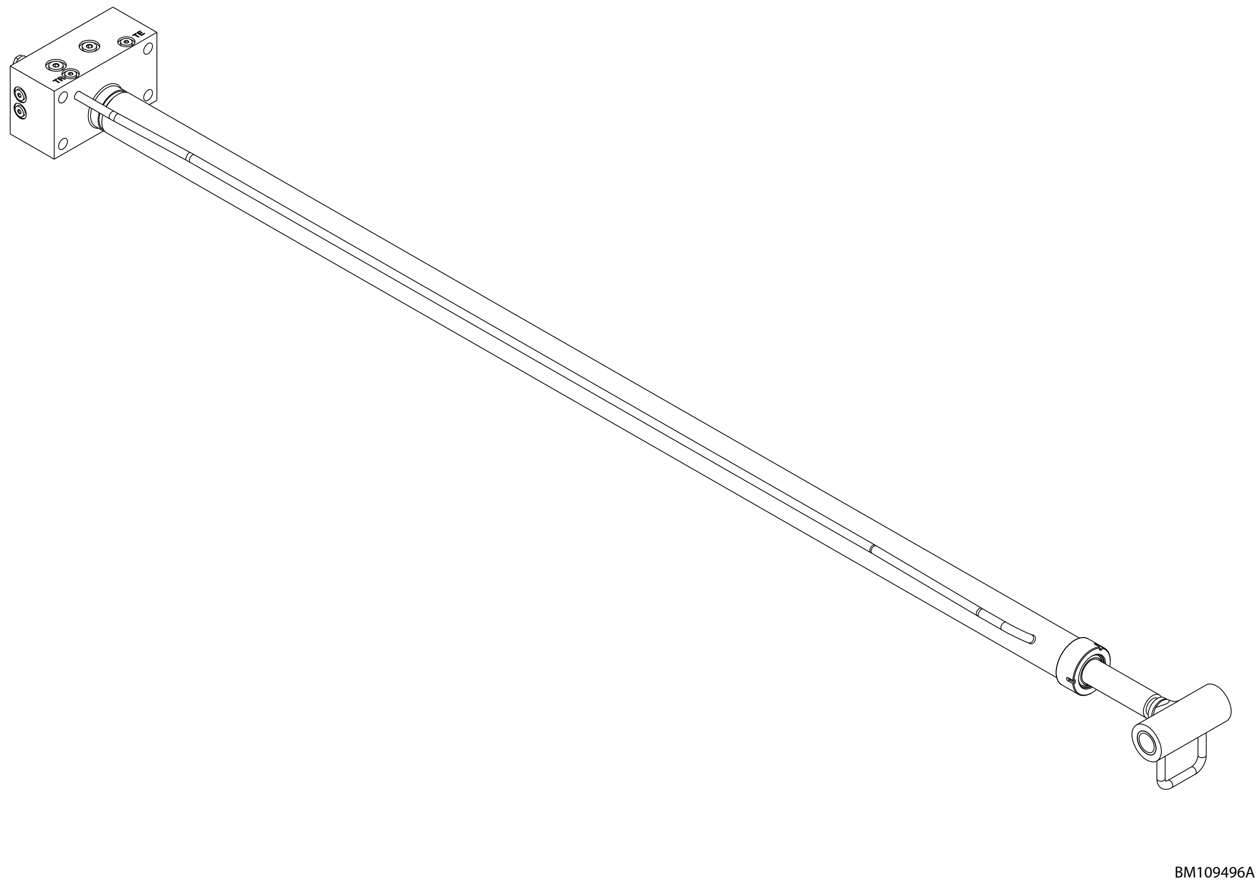


Figure 192. Telescope Cylinder

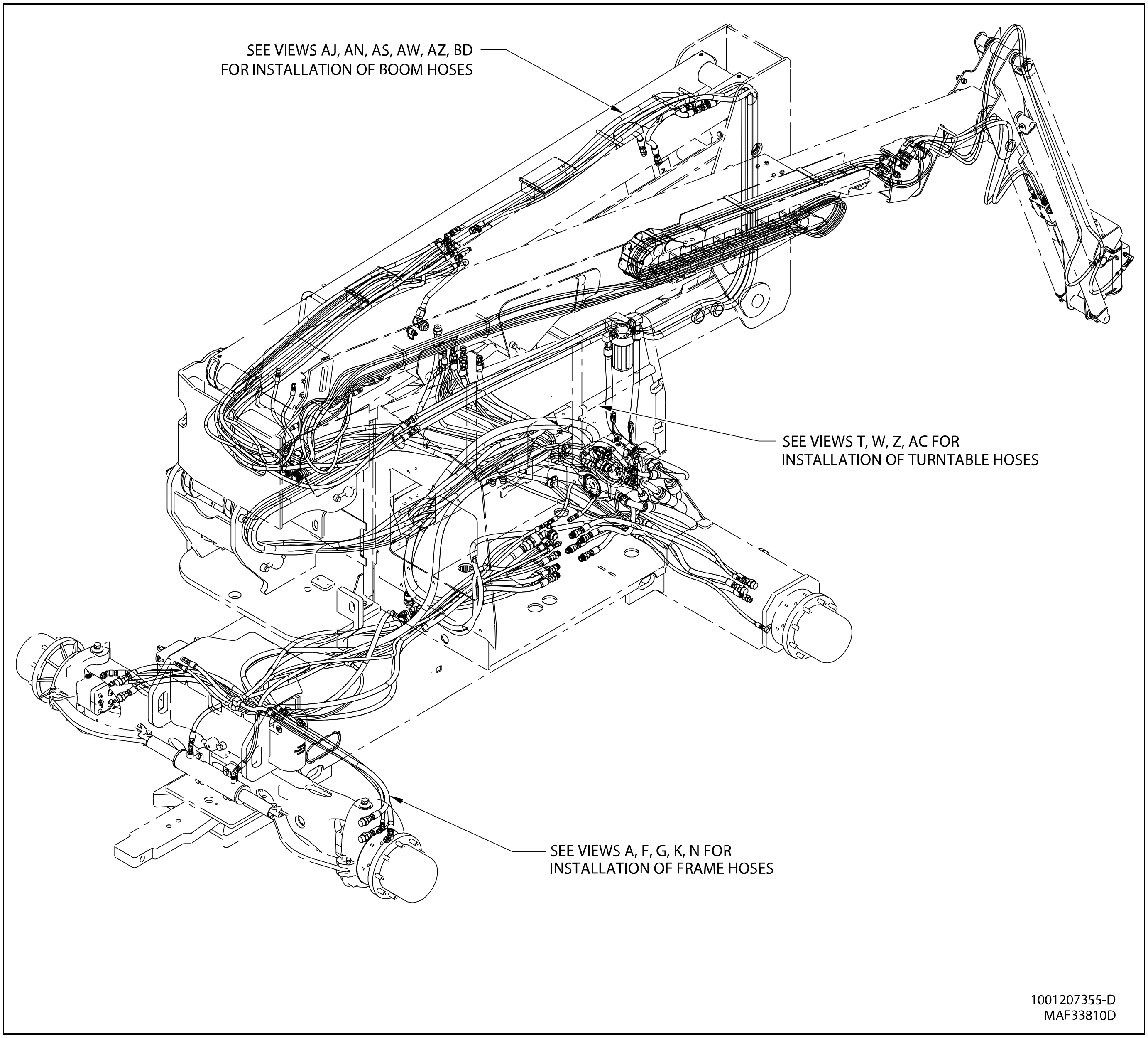


Figure 193. Hydraulics Installation - Sheet 1 of 28

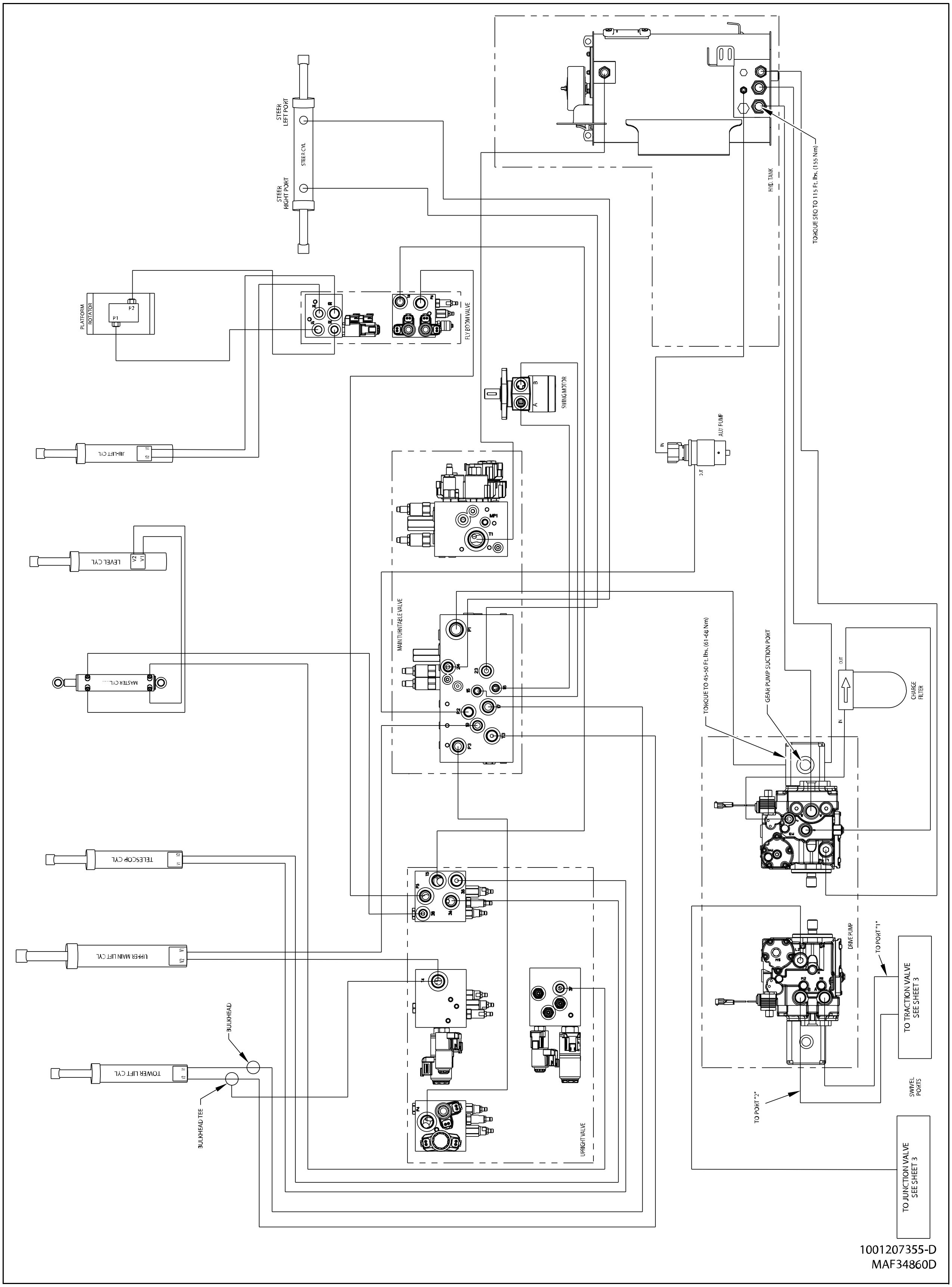


Figure 194. Hydraulics Installation - Sheet 2 of 28

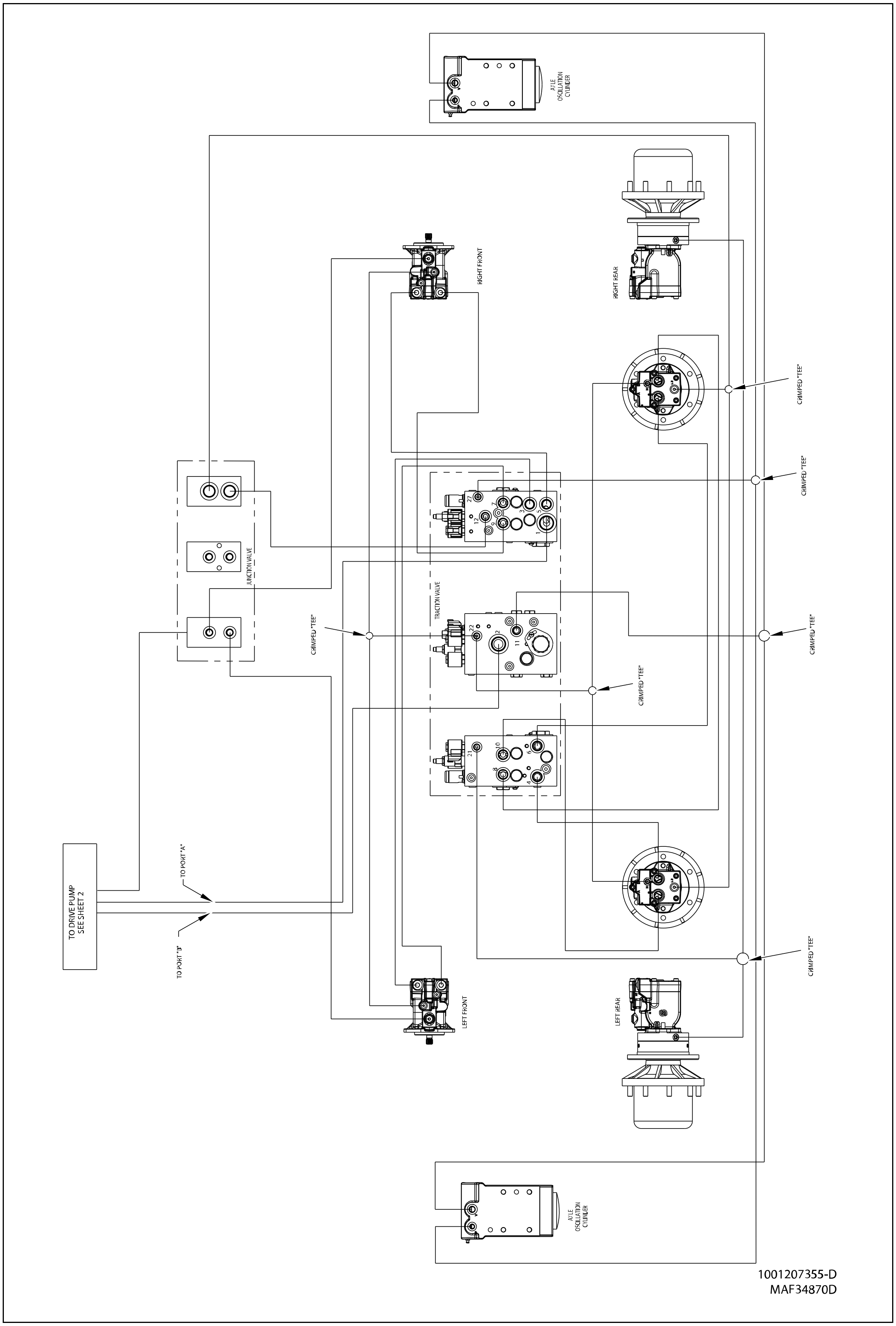


Figure 195. Hydraulics Installation - Sheet 3 of 28

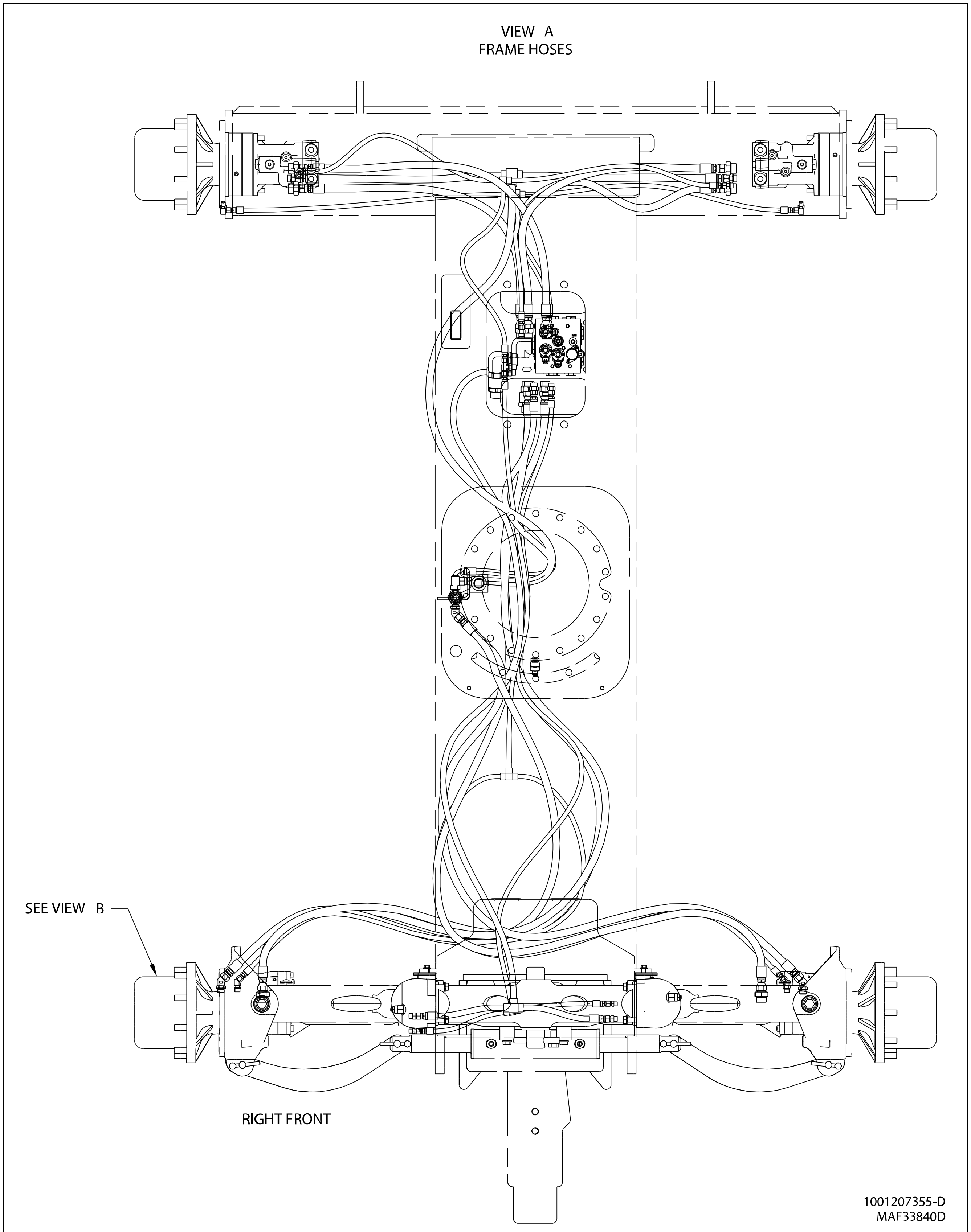


Figure 196. Hydraulics Installation - Sheet 4 of 28

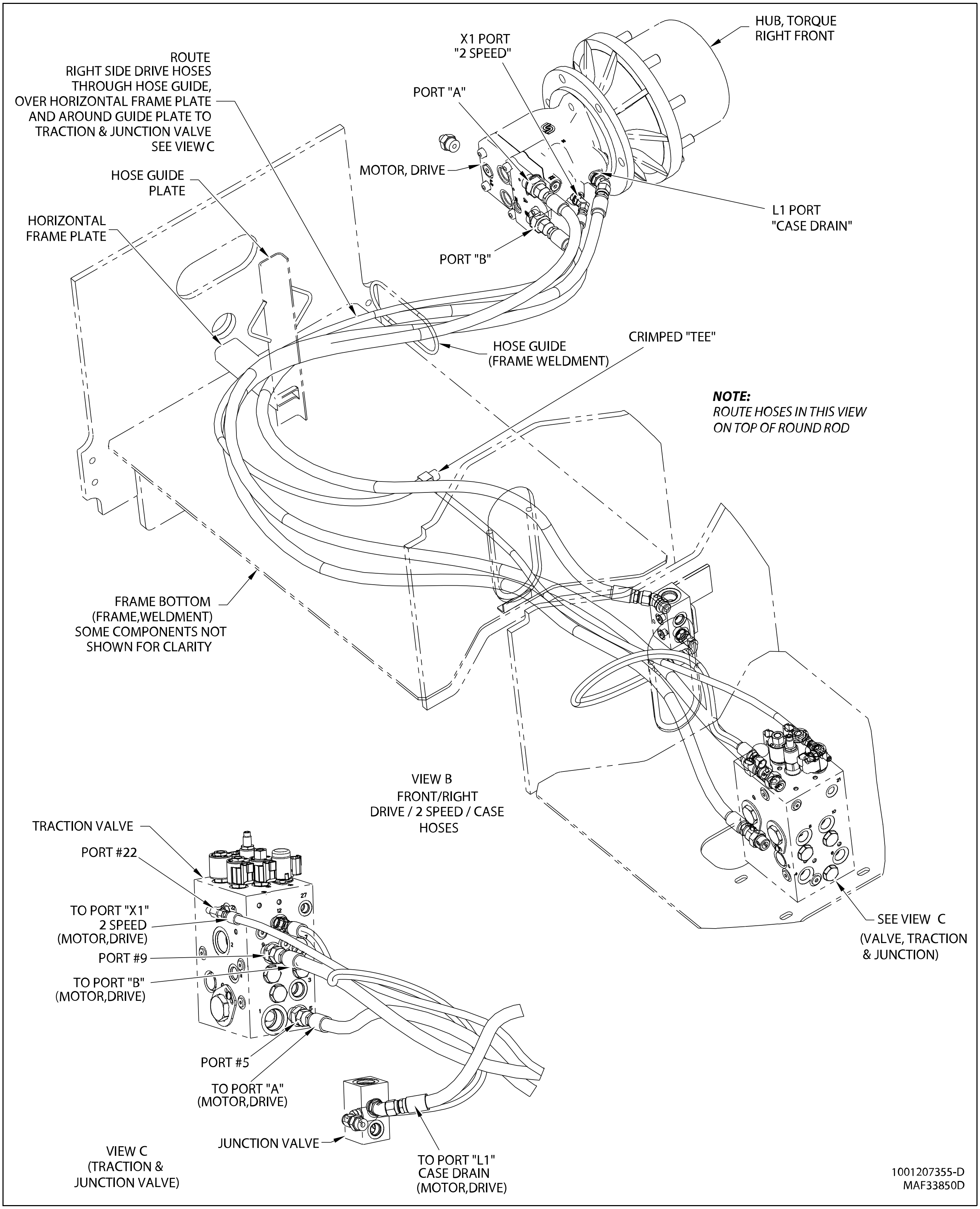


Figure 197. Hydraulics Installation - Sheet 5 of 28

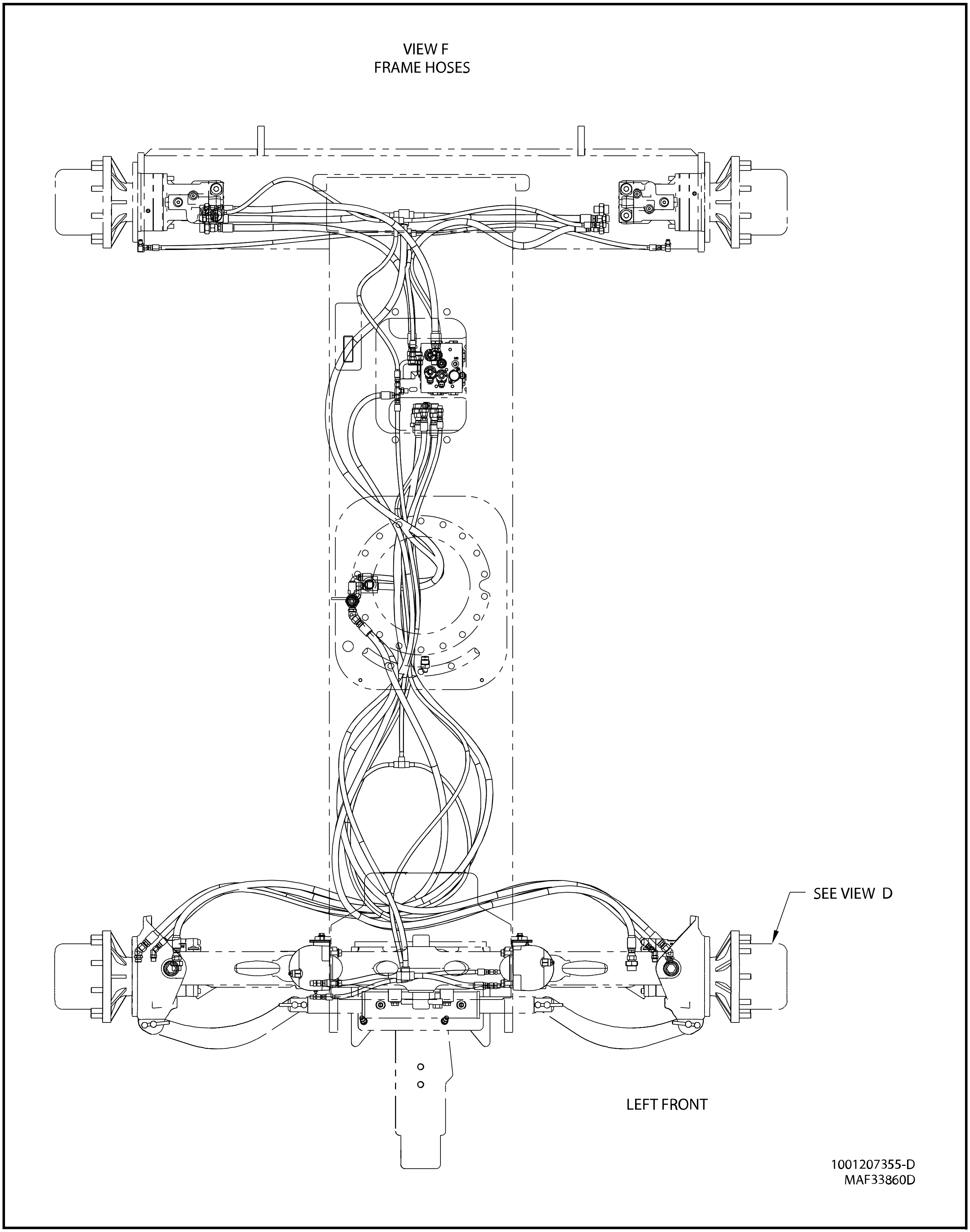


Figure 198. Hydraulics Installation - Sheet 6 of 28

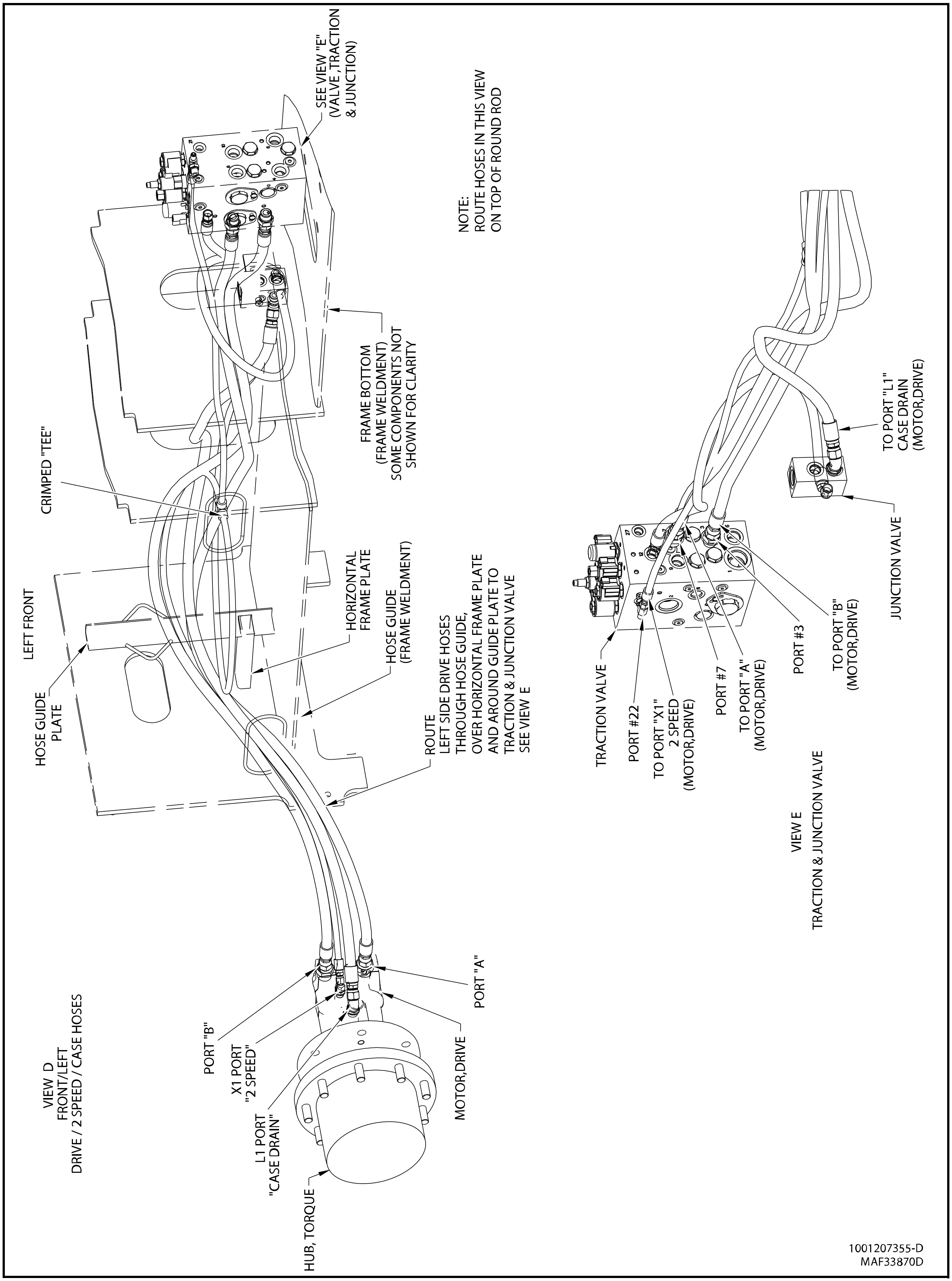


Figure 199. Hydraulics Installation - Sheet 7 of 28

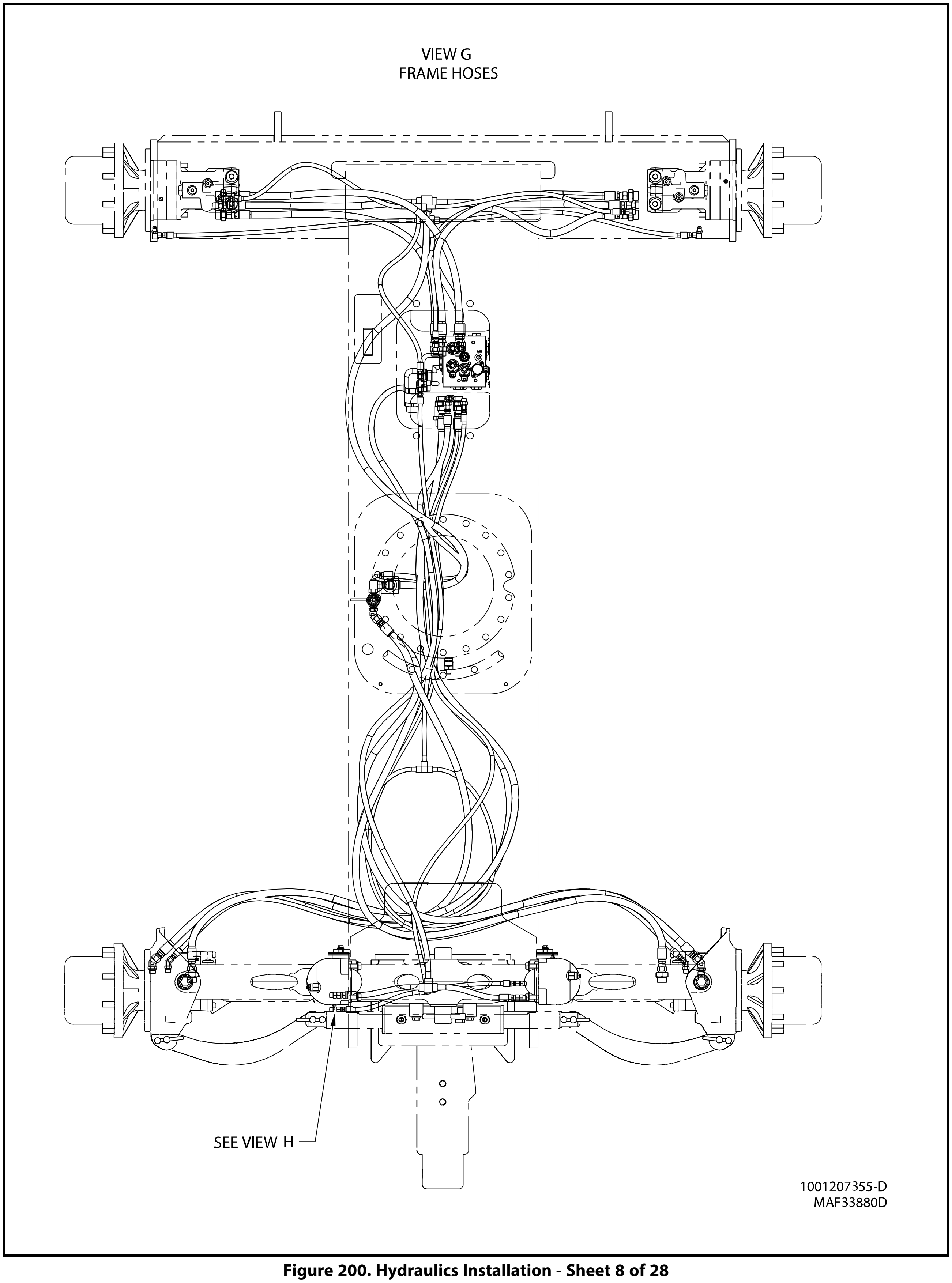


Figure 200. Hydraulics Installation - Sheet 8 of 28

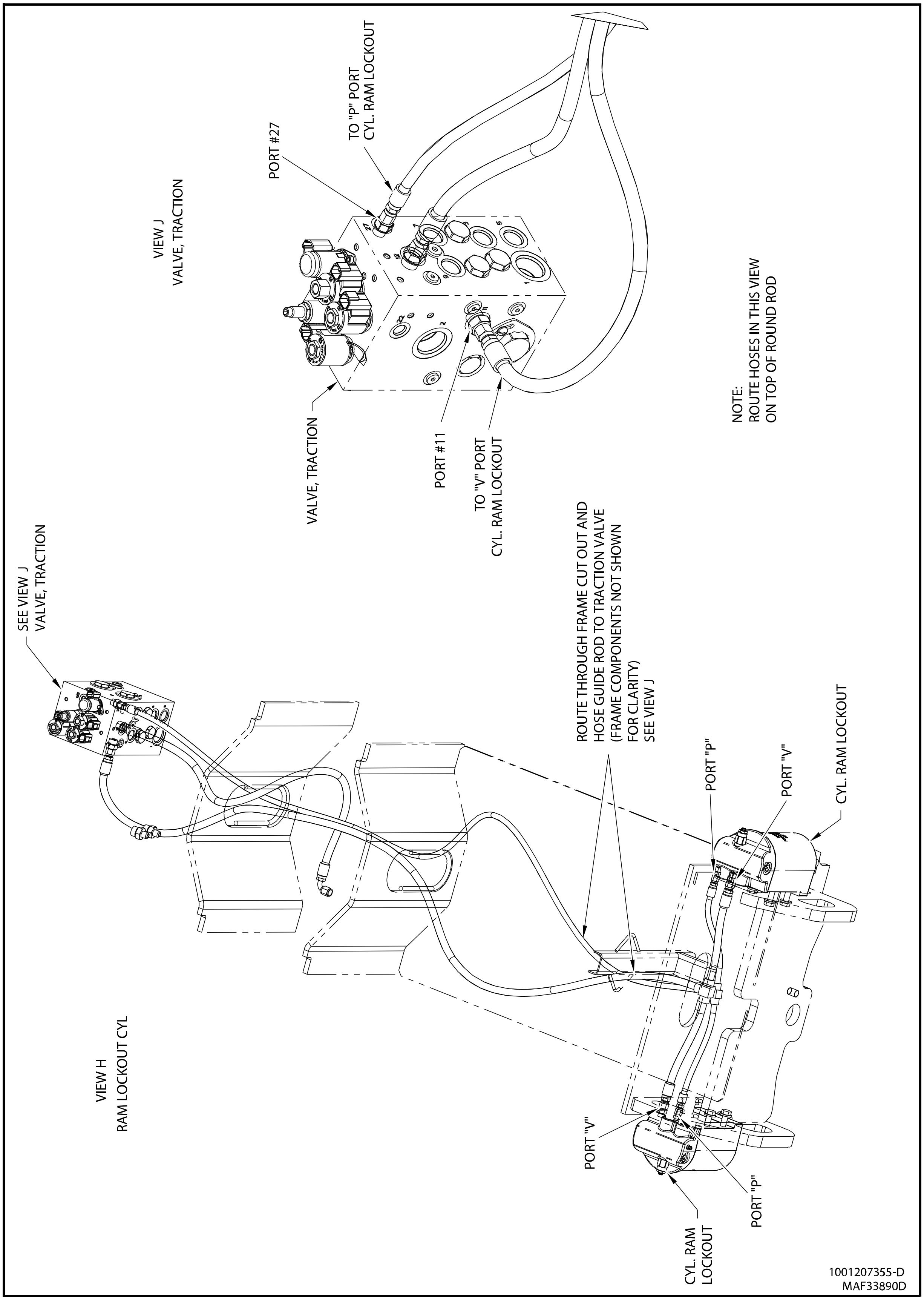


Figure 201. Hydraulics Installation - Sheet 9 of 28

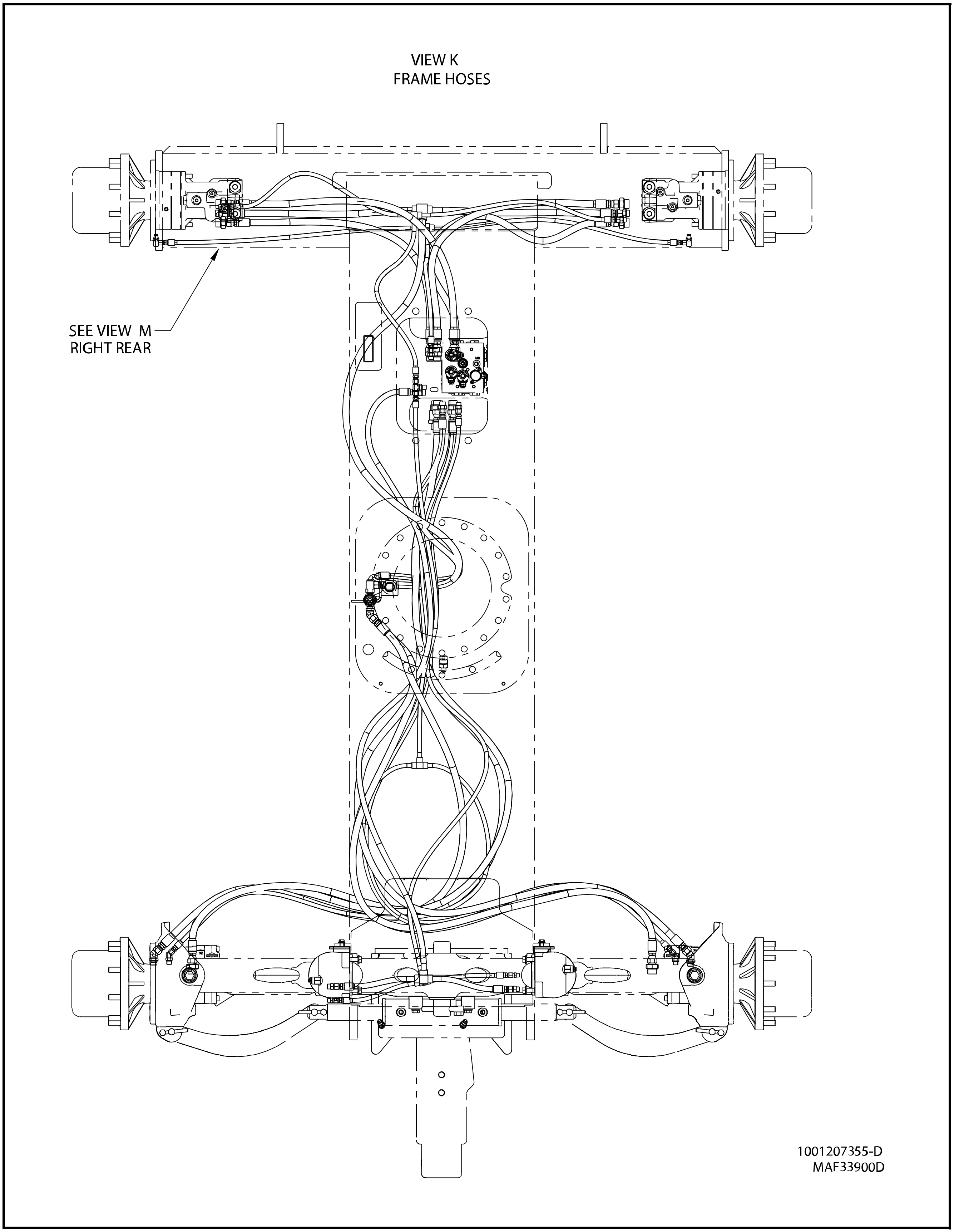


Figure 202. Hydraulics Installation - Sheet 10 of 28

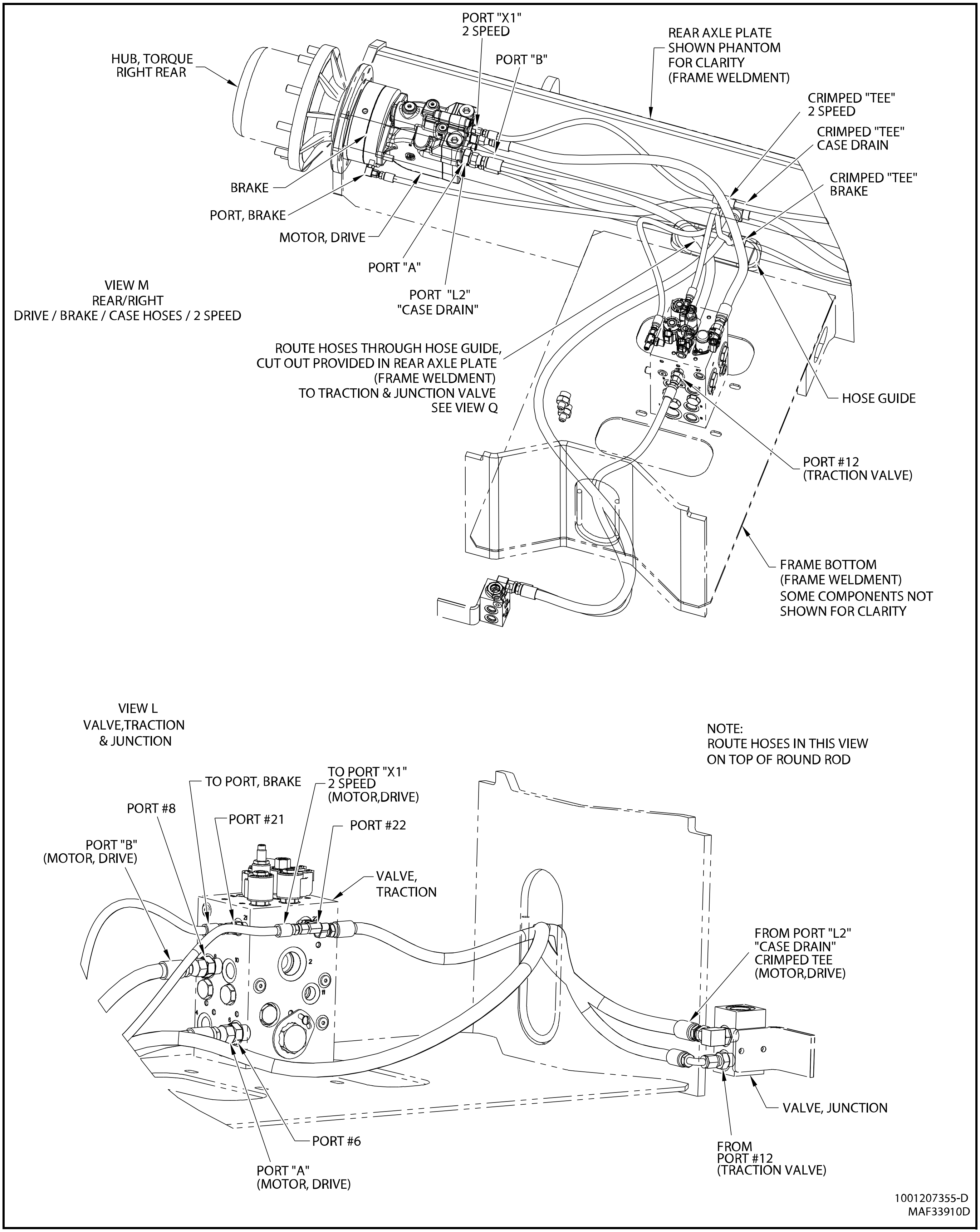


Figure 203. Hydraulics Installation - Sheet 11 of 28

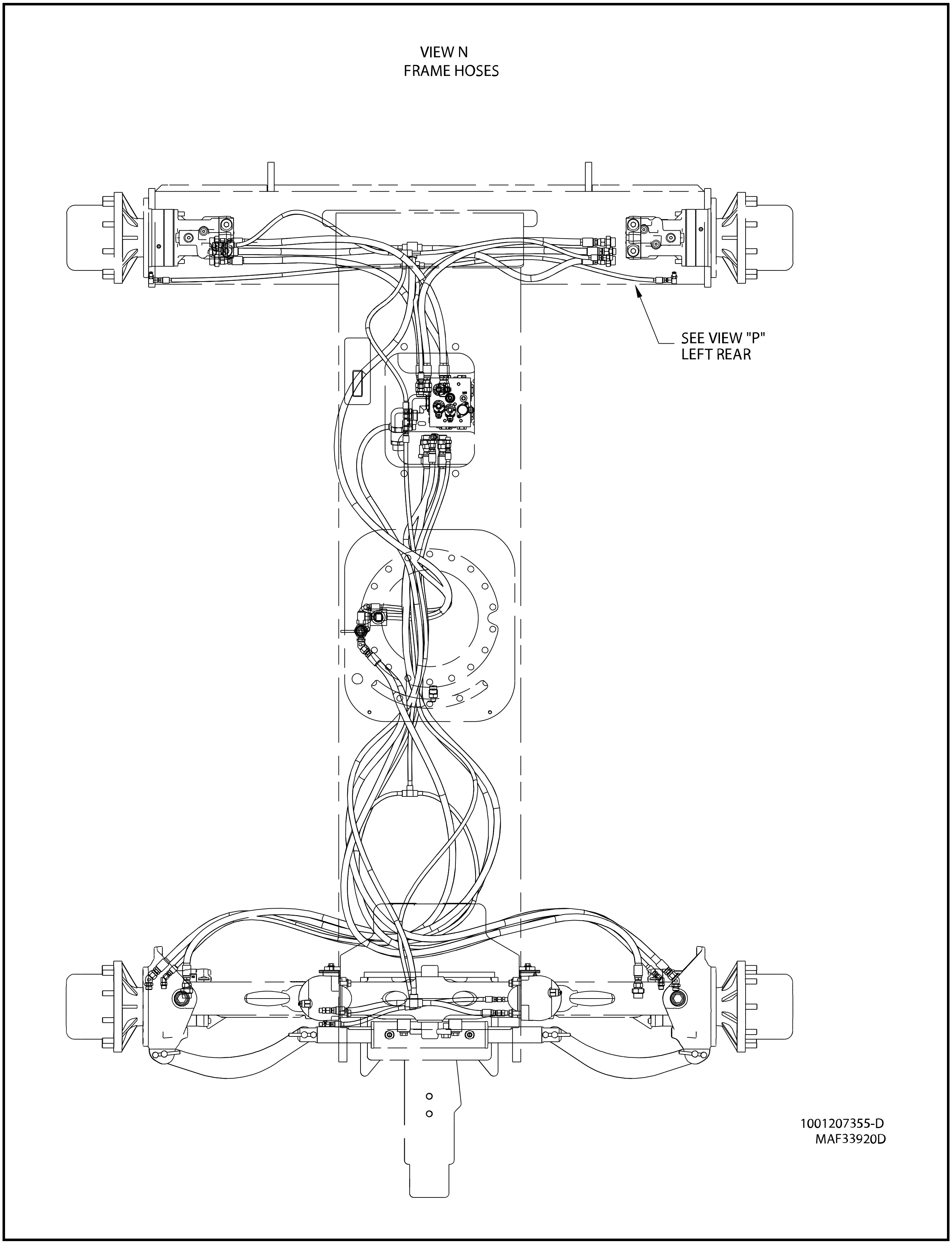


Figure 204. Hydraulics Installation - Sheet 12 of 28

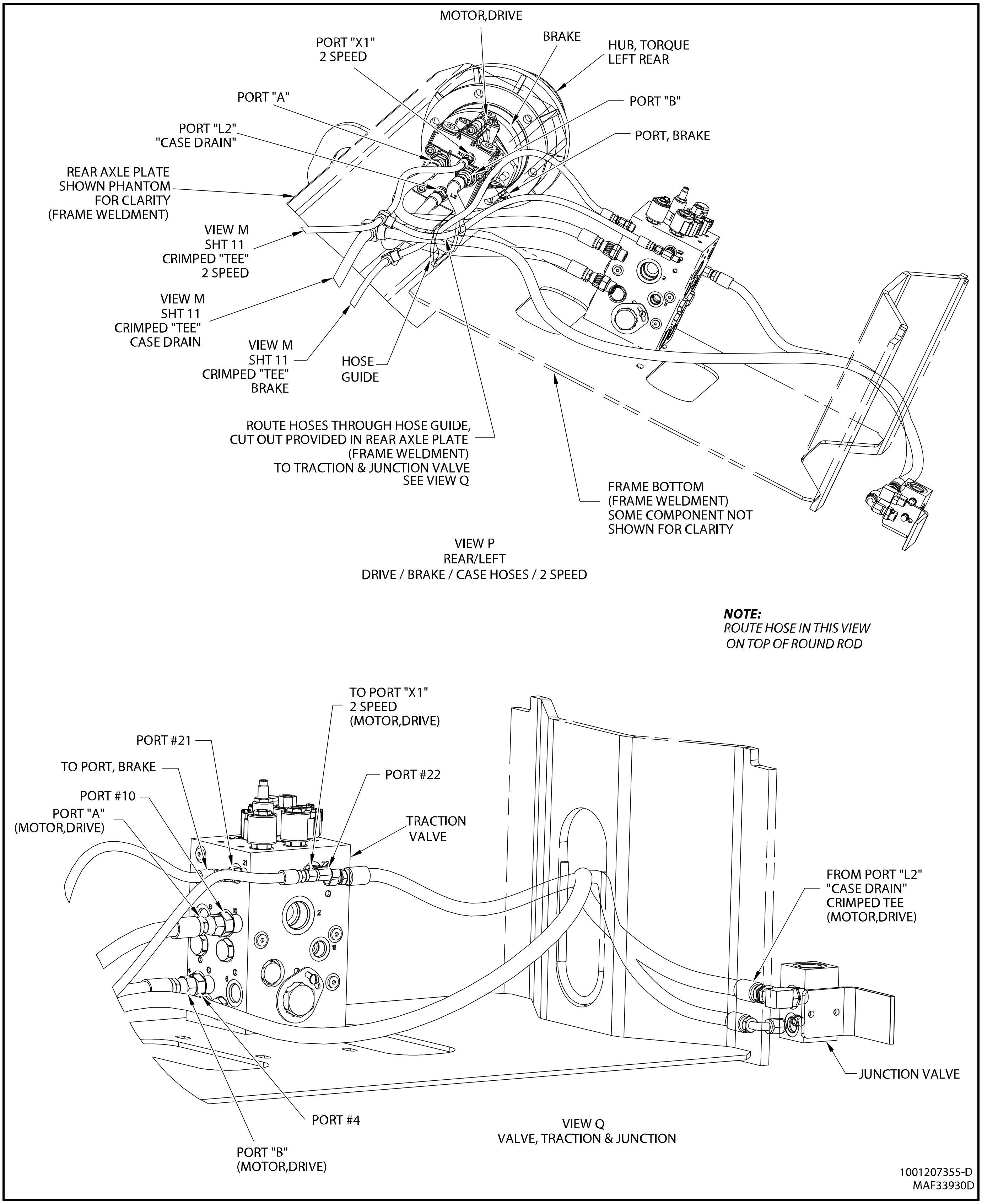


Figure 205. Hydraulics Installation - Sheet 13 of 28

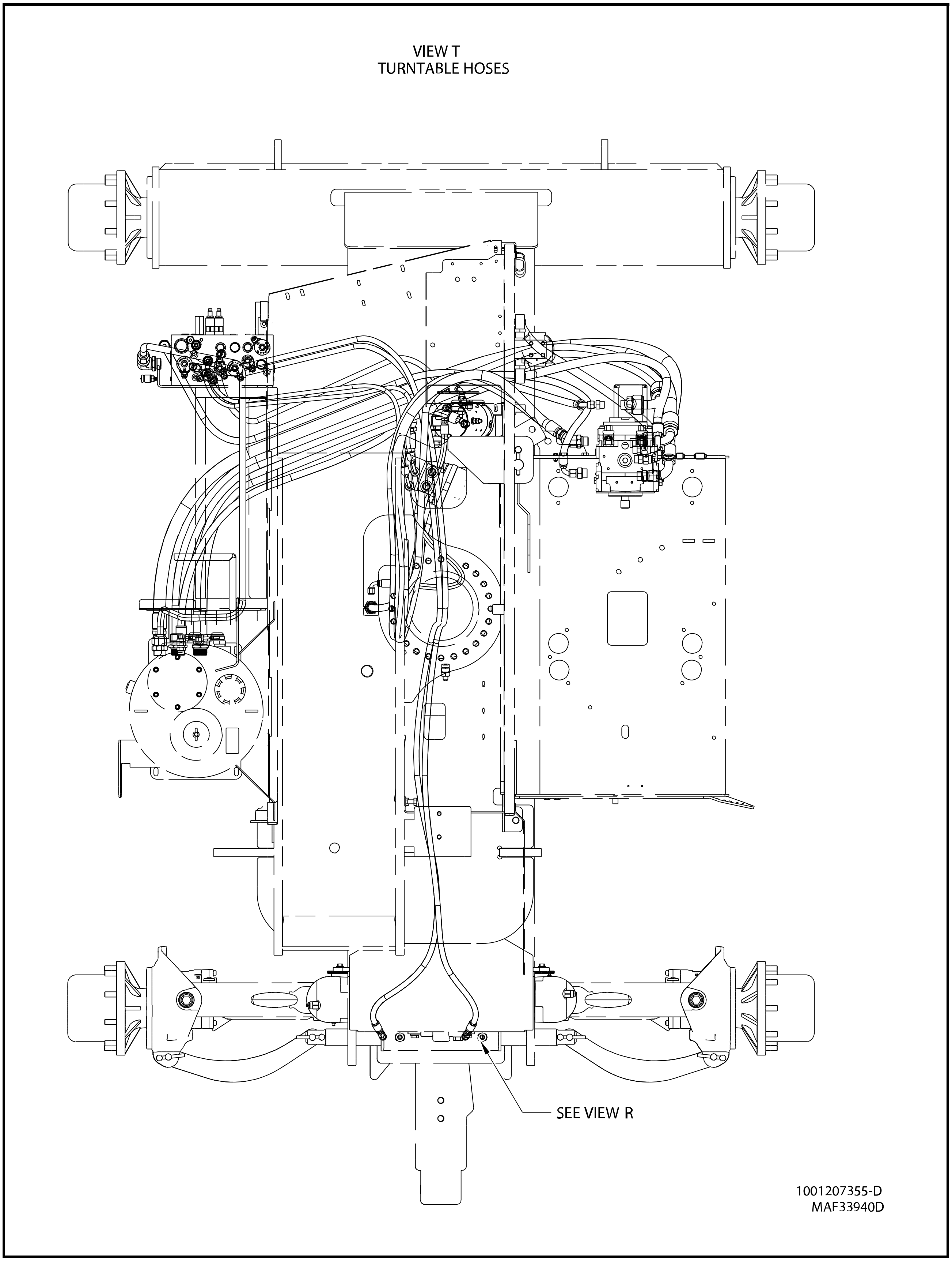


Figure 206. Hydraulics Installation - Sheet 14 of 28

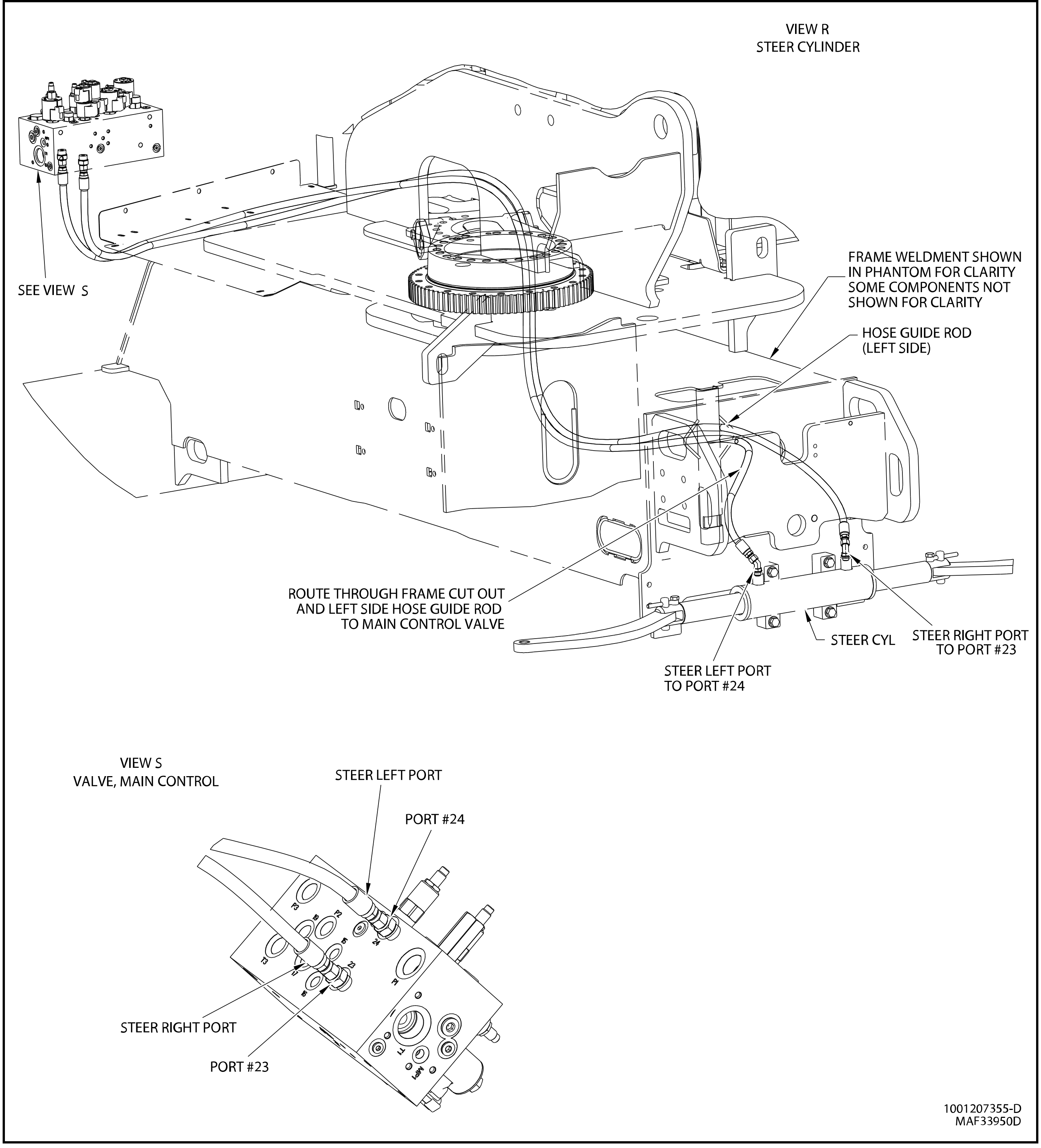


Figure 207. Hydraulics Installation - Sheet 15 of 28

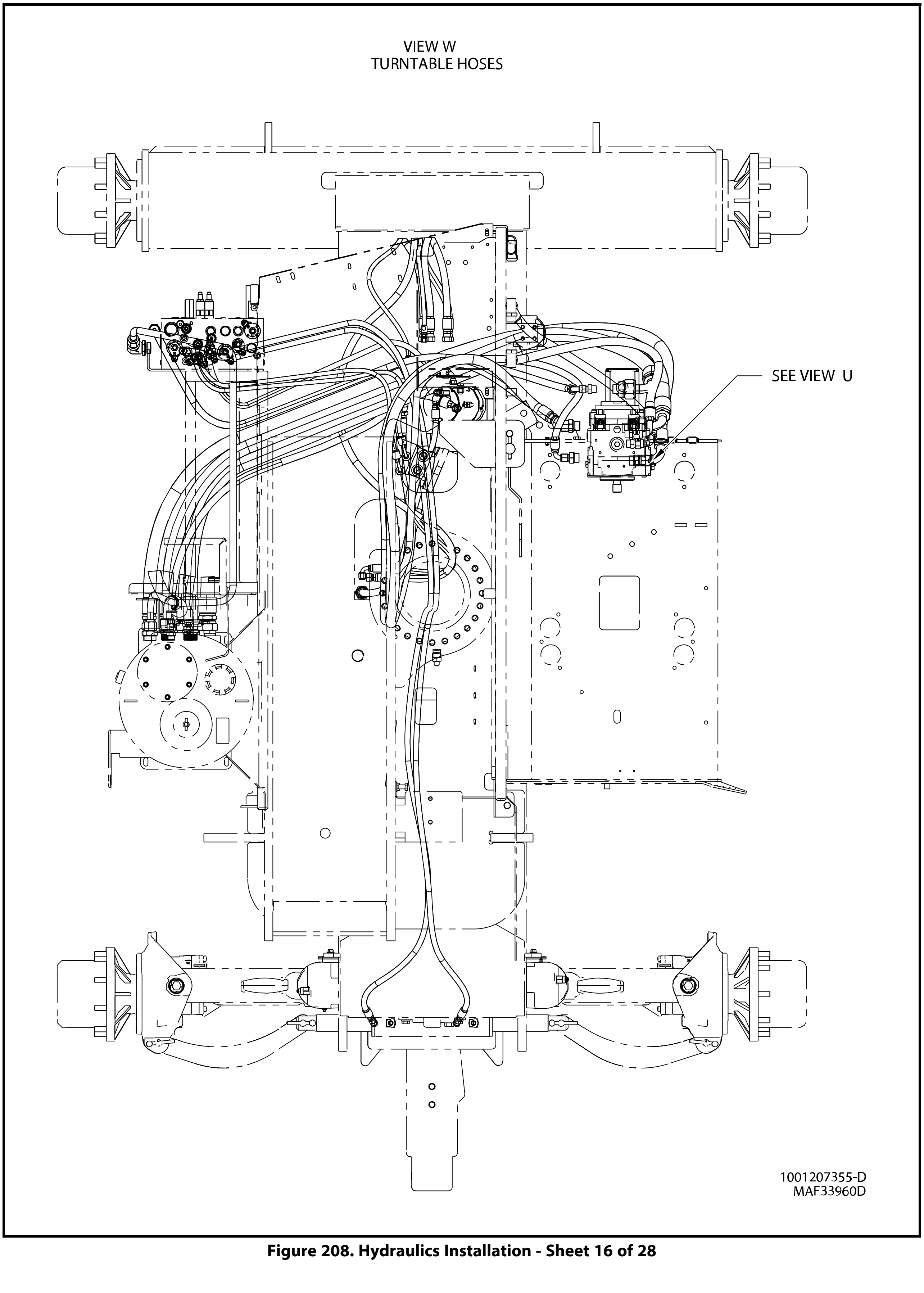


Figure 208. Hydraulics Installation - Sheet 16 of 28

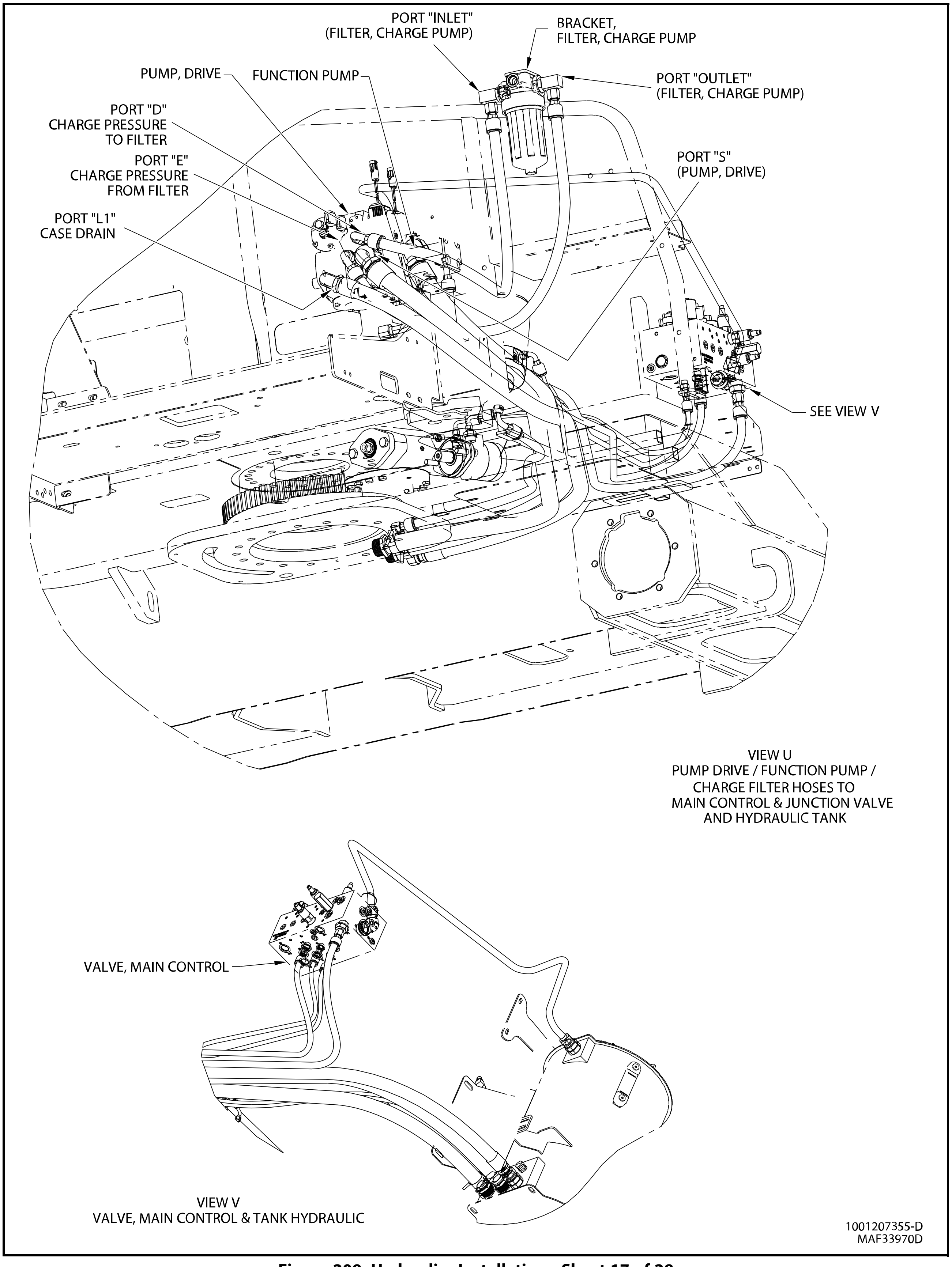


Figure 209. Hydraulics Installation - Sheet 17 of 28

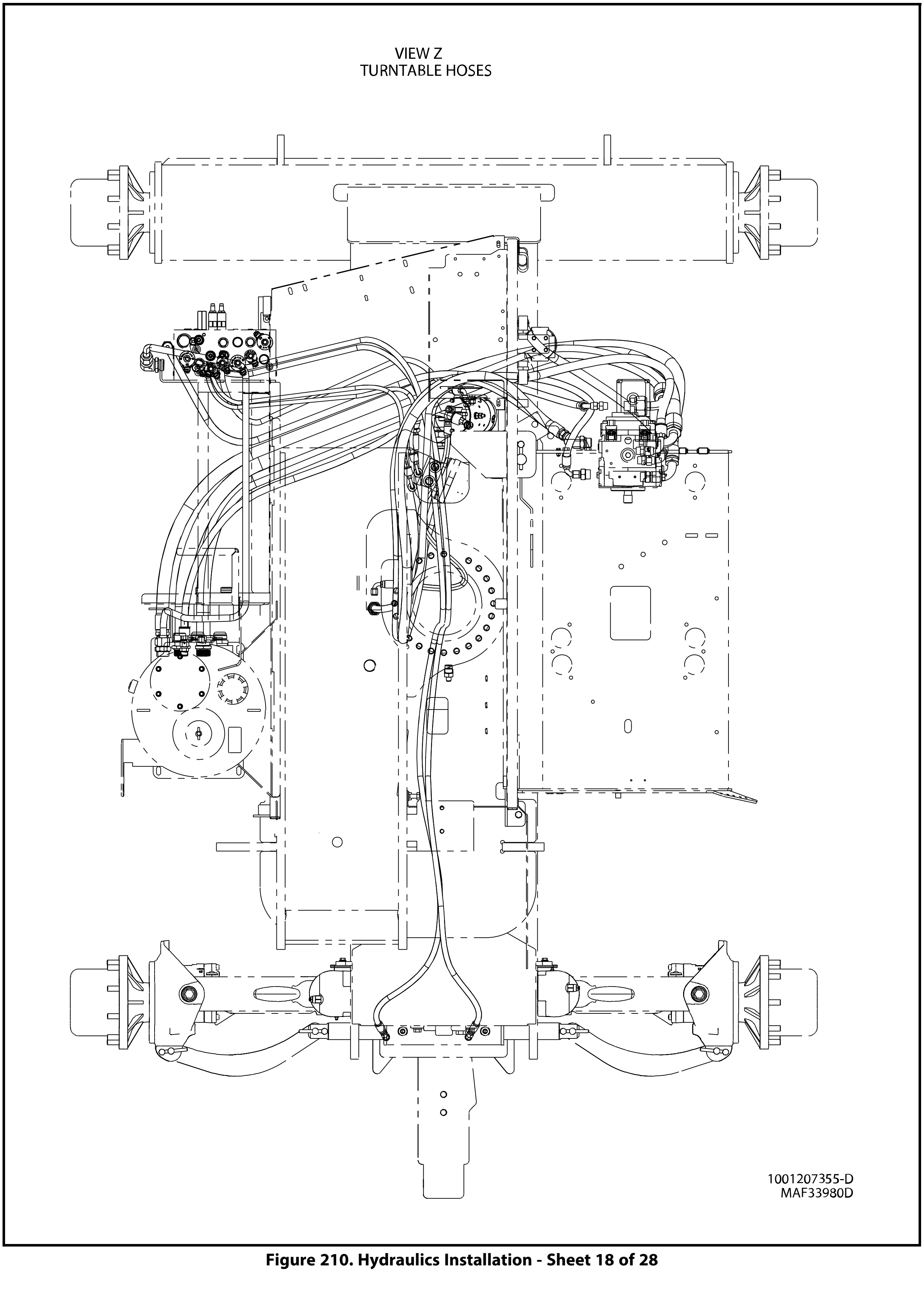


Figure 210. Hydraulics Installation - Sheet 18 of 28

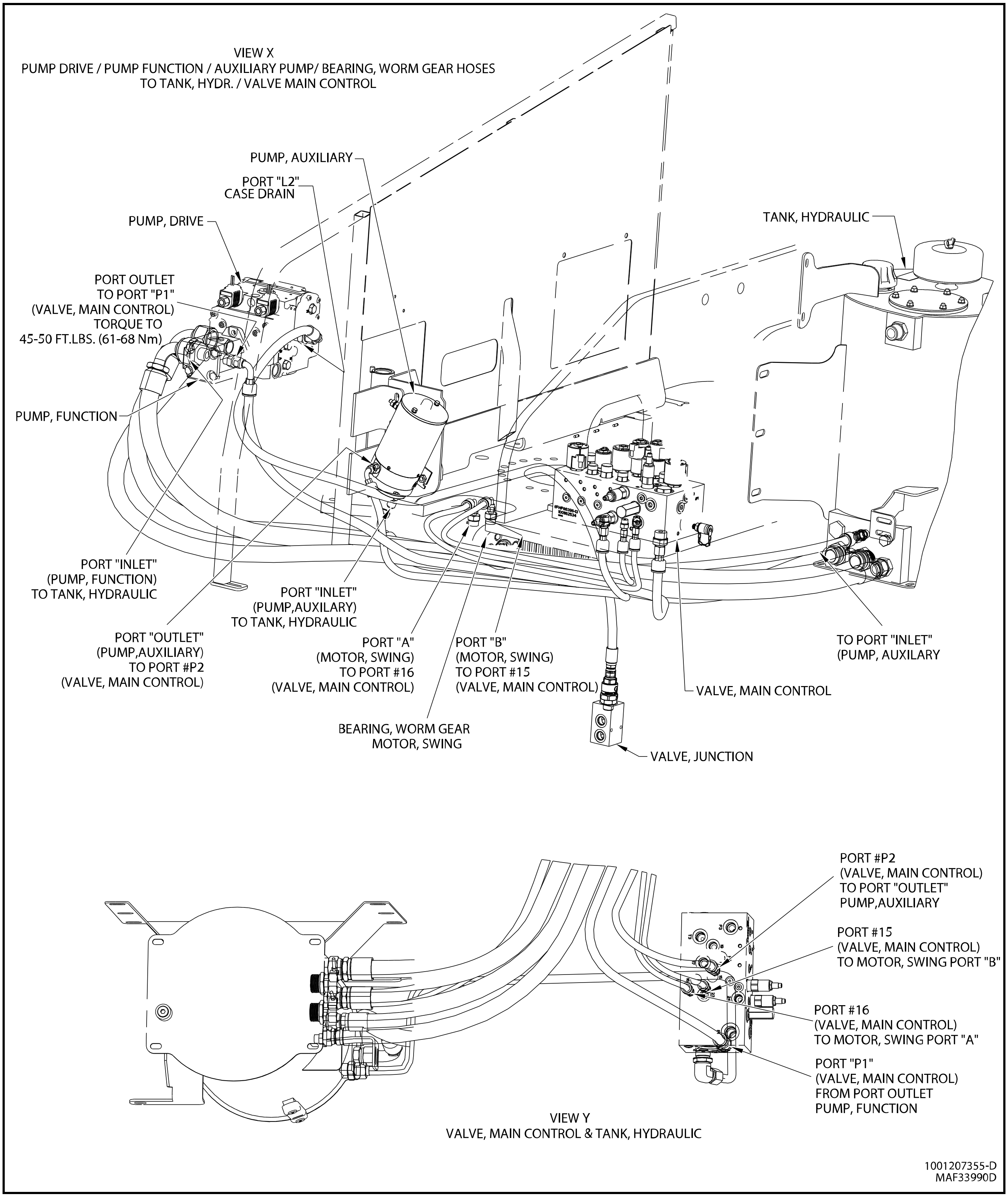


Figure 211. Hydraulics Installation - Sheet 19 of 28

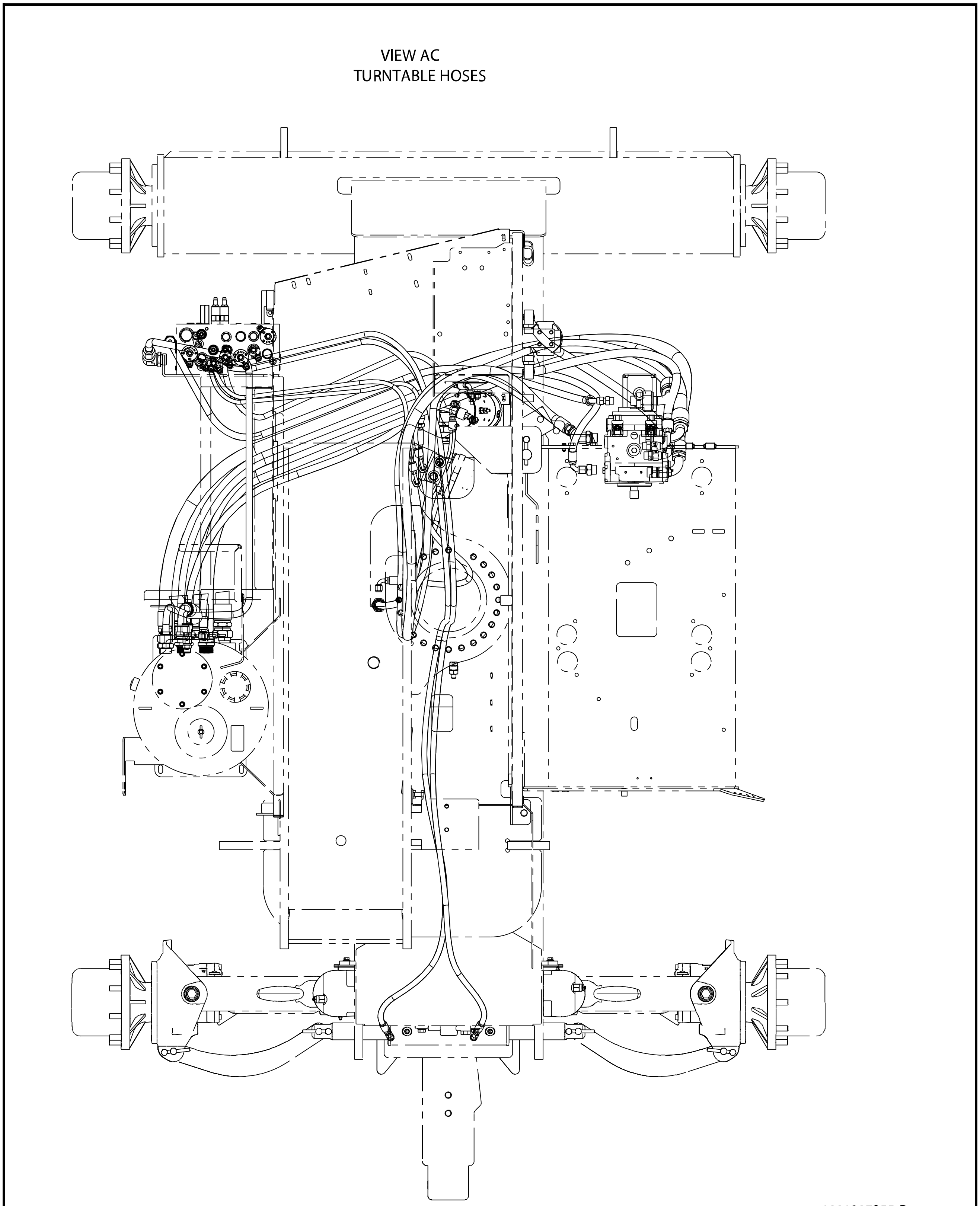


Figure 212. Hydraulics Installation - Sheet 20 of 28

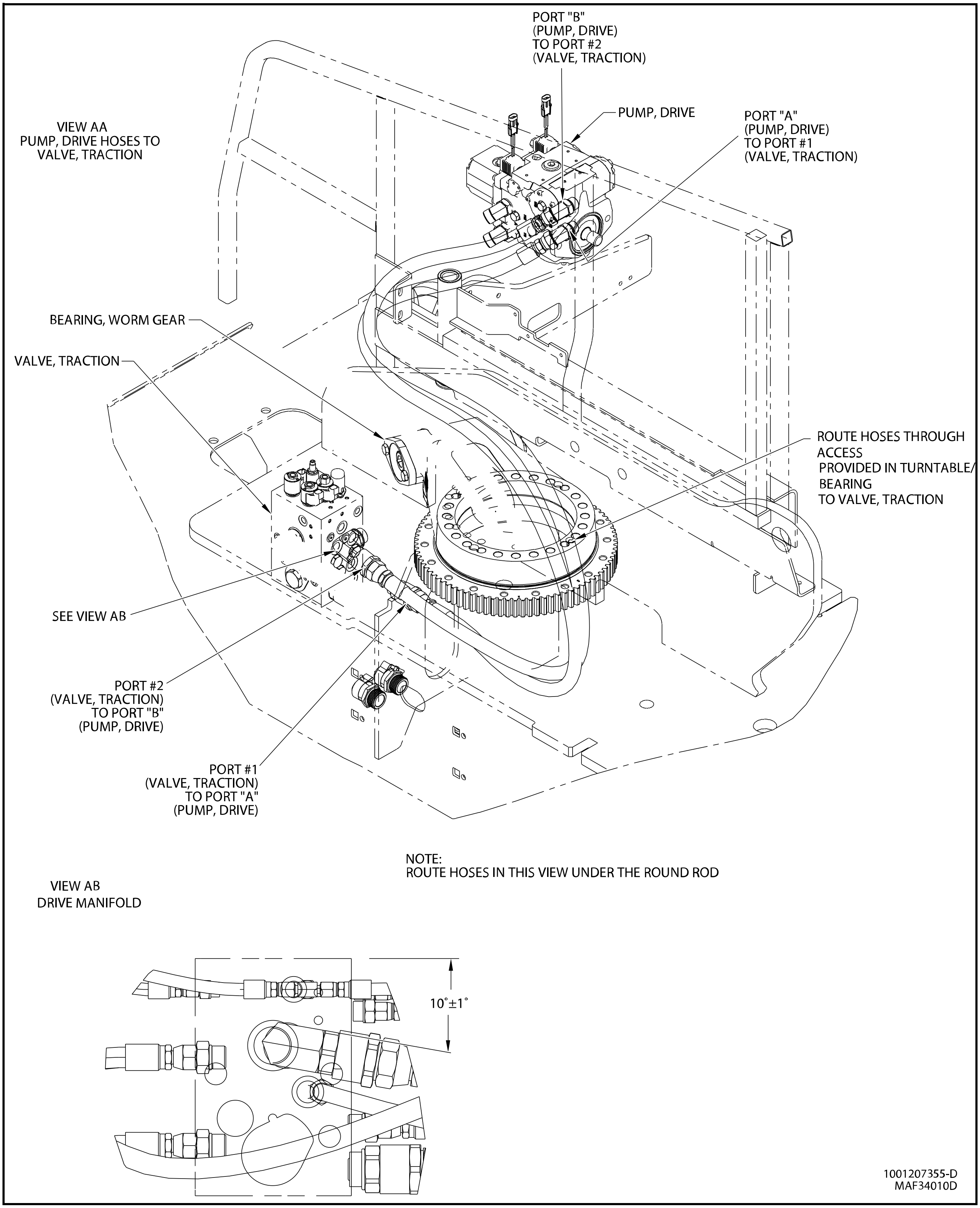


Figure 213. Hydraulics Installation - Sheet 21 of 28

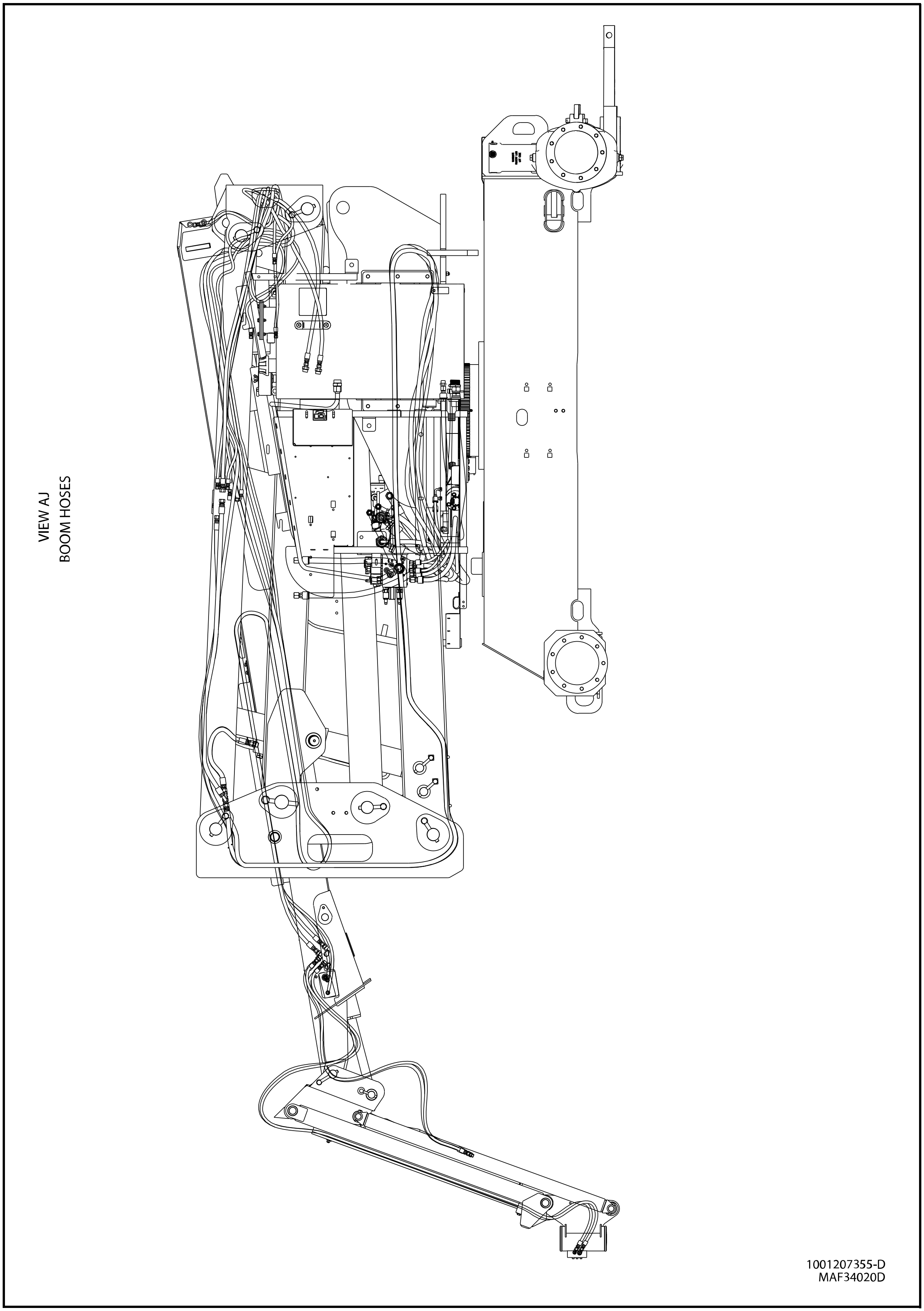


Figure 214. Hydraulics Installation - Sheet 22 of 28

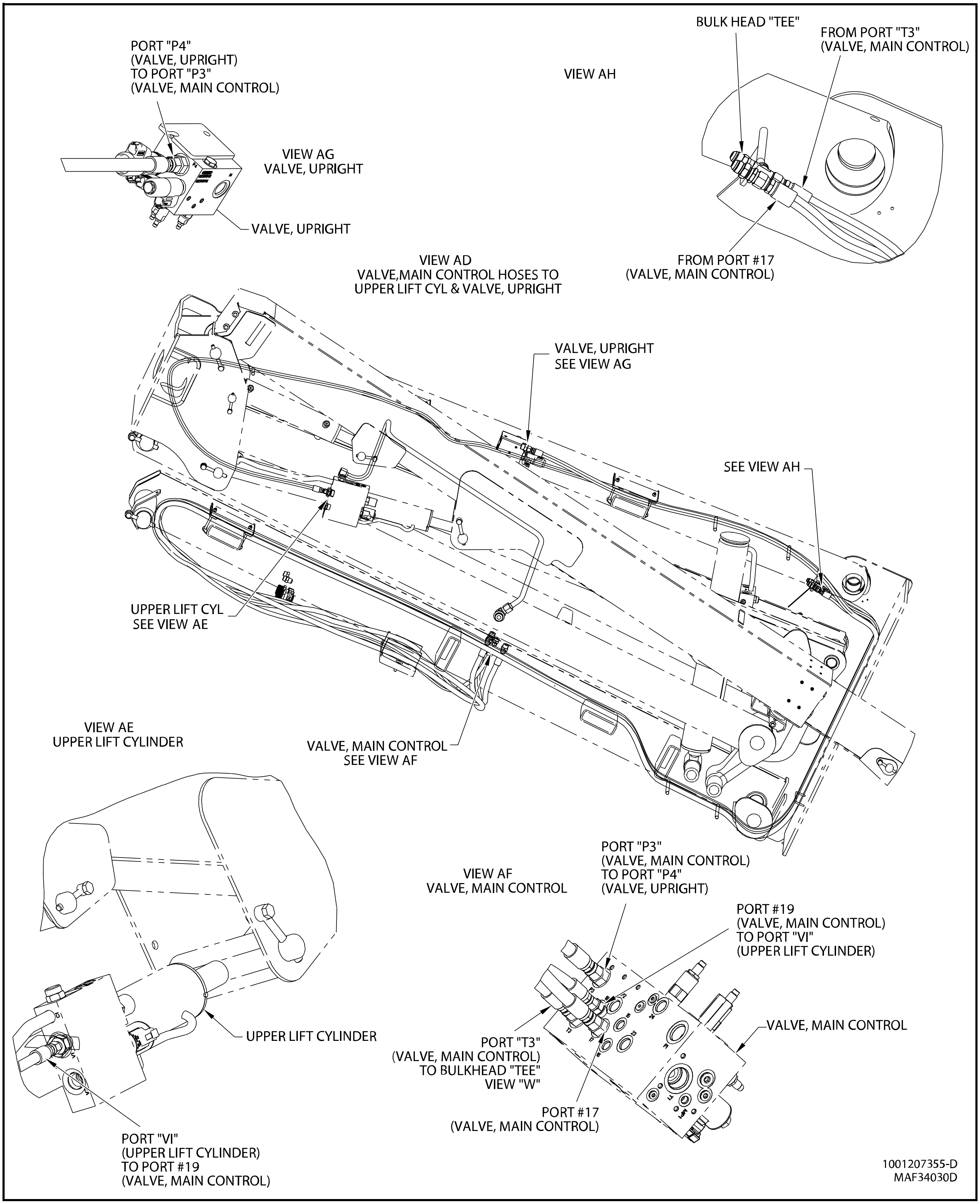


Figure 215. Hydraulics Installation - Sheet 23 of 28

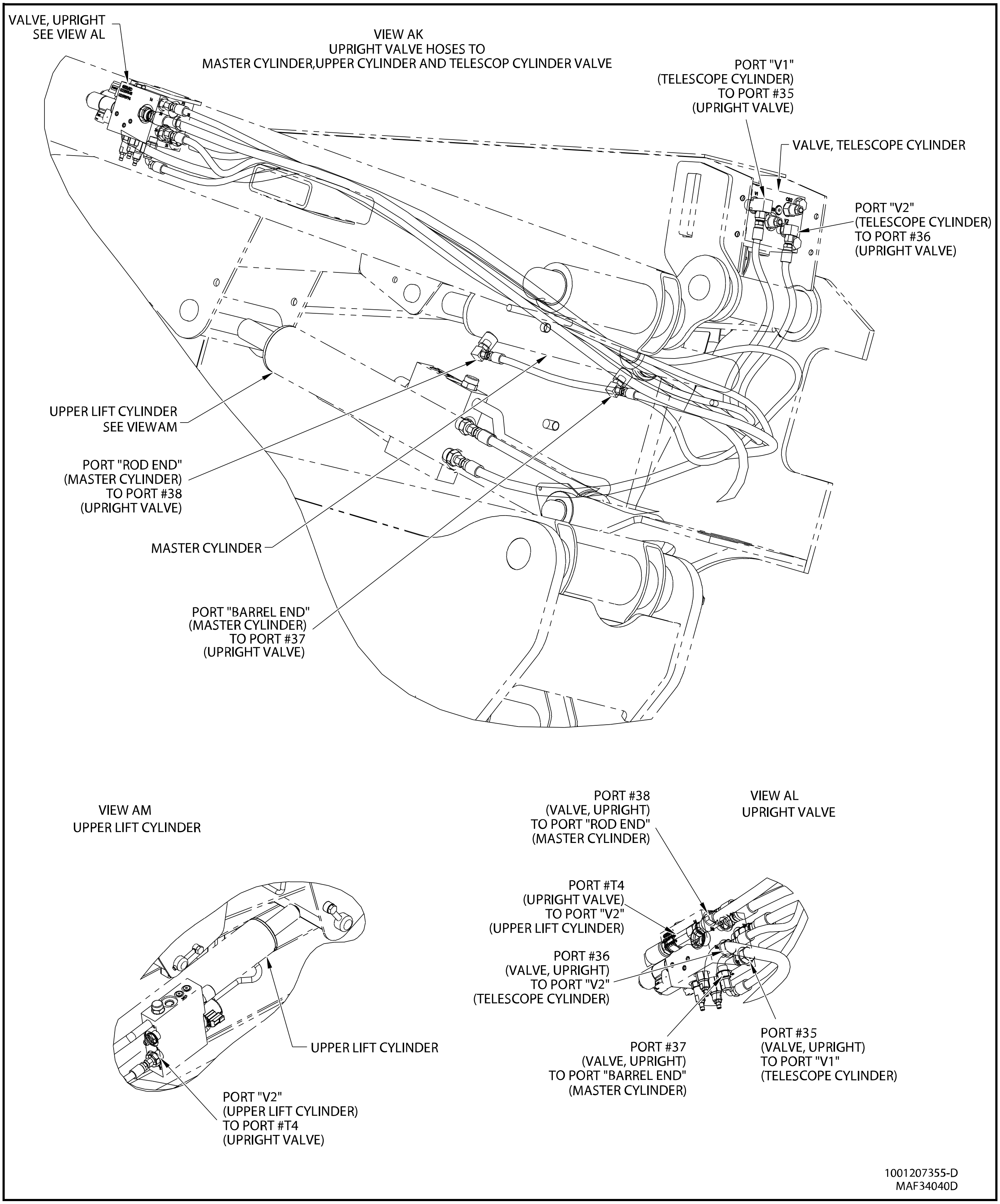


Figure 216. Hydraulics Installation - Sheet 24 of 28

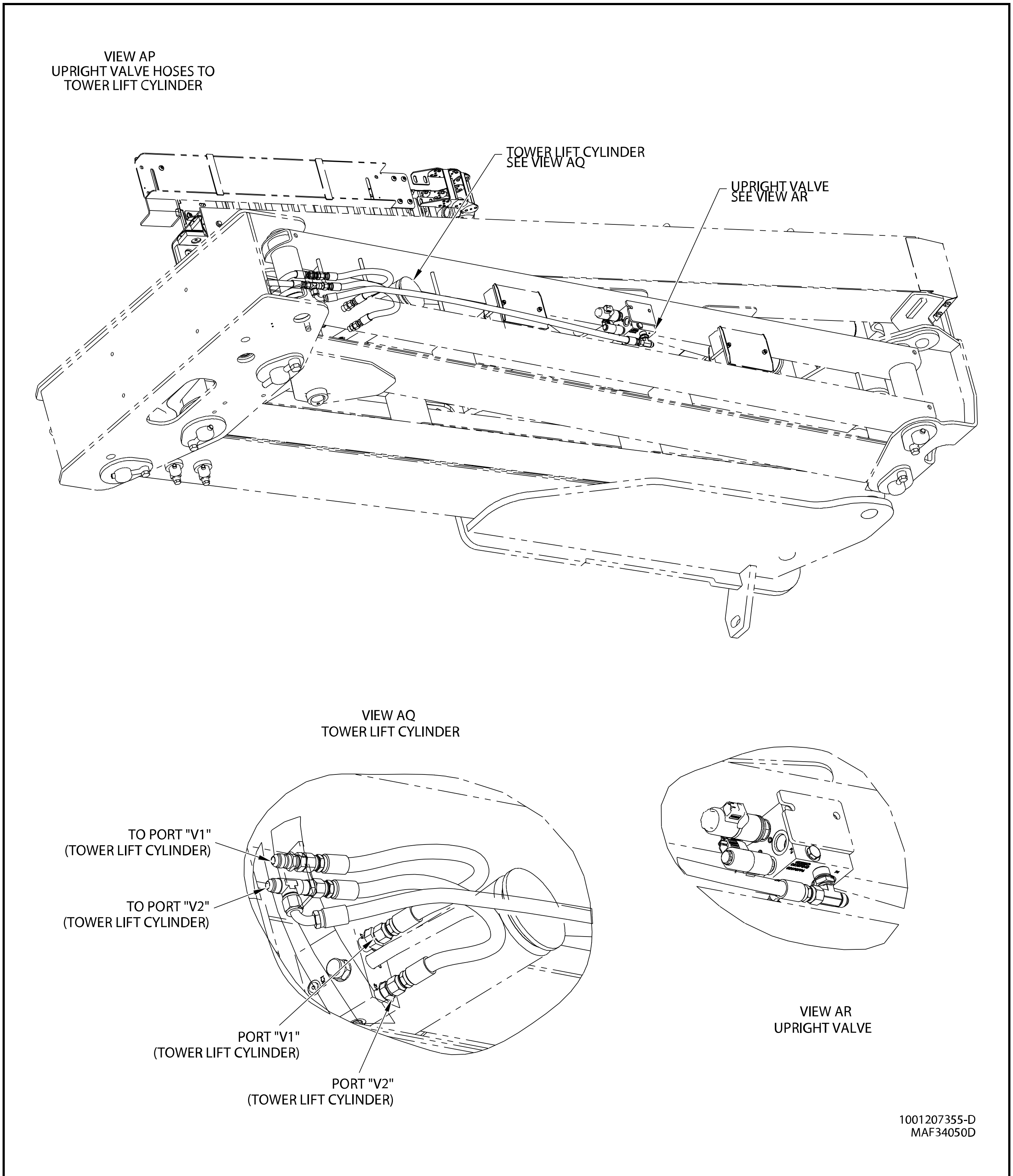


Figure 217. Hydraulics Installation - Sheet 25 of 28

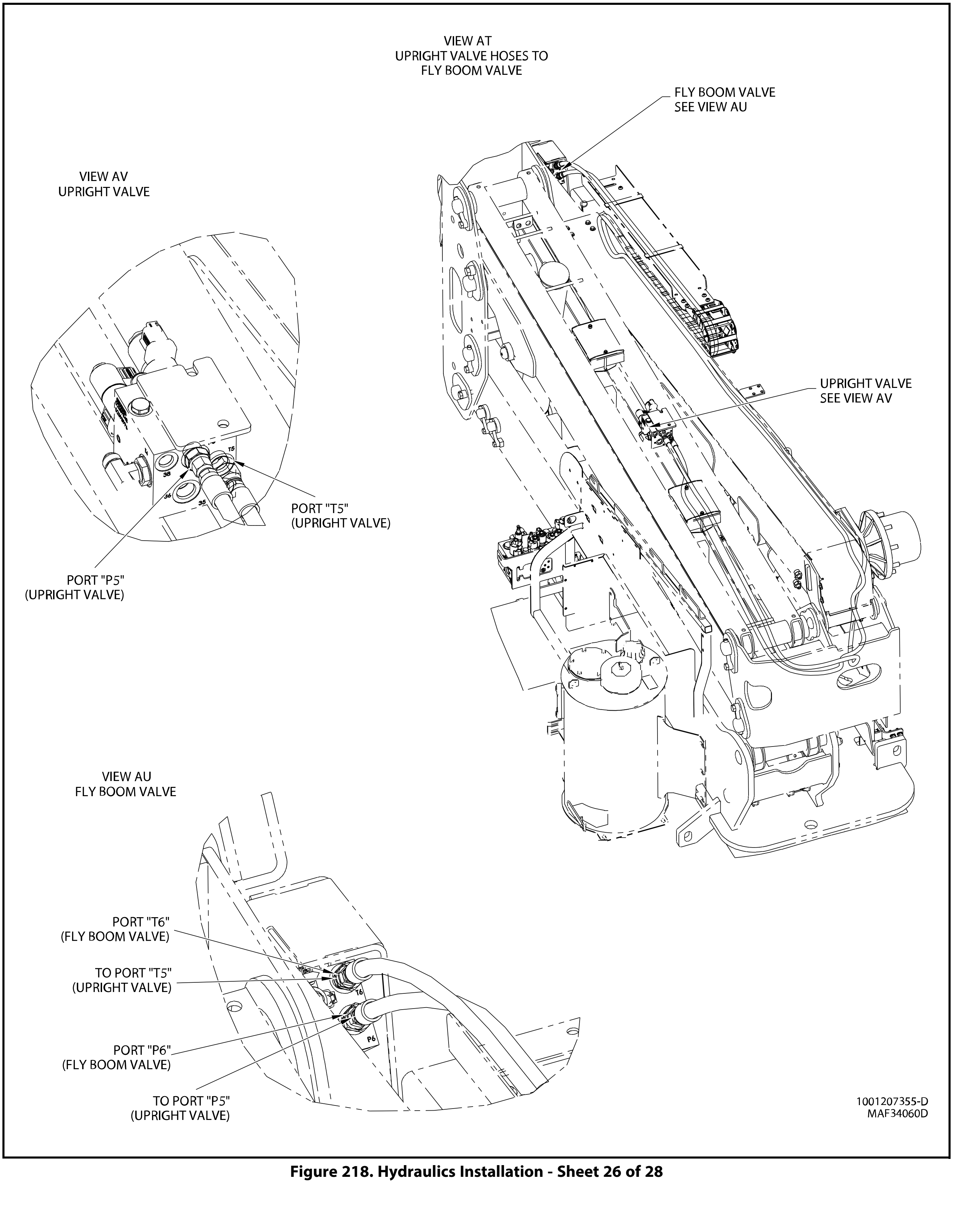


Figure 218. Hydraulics Installation - Sheet 26 of 28

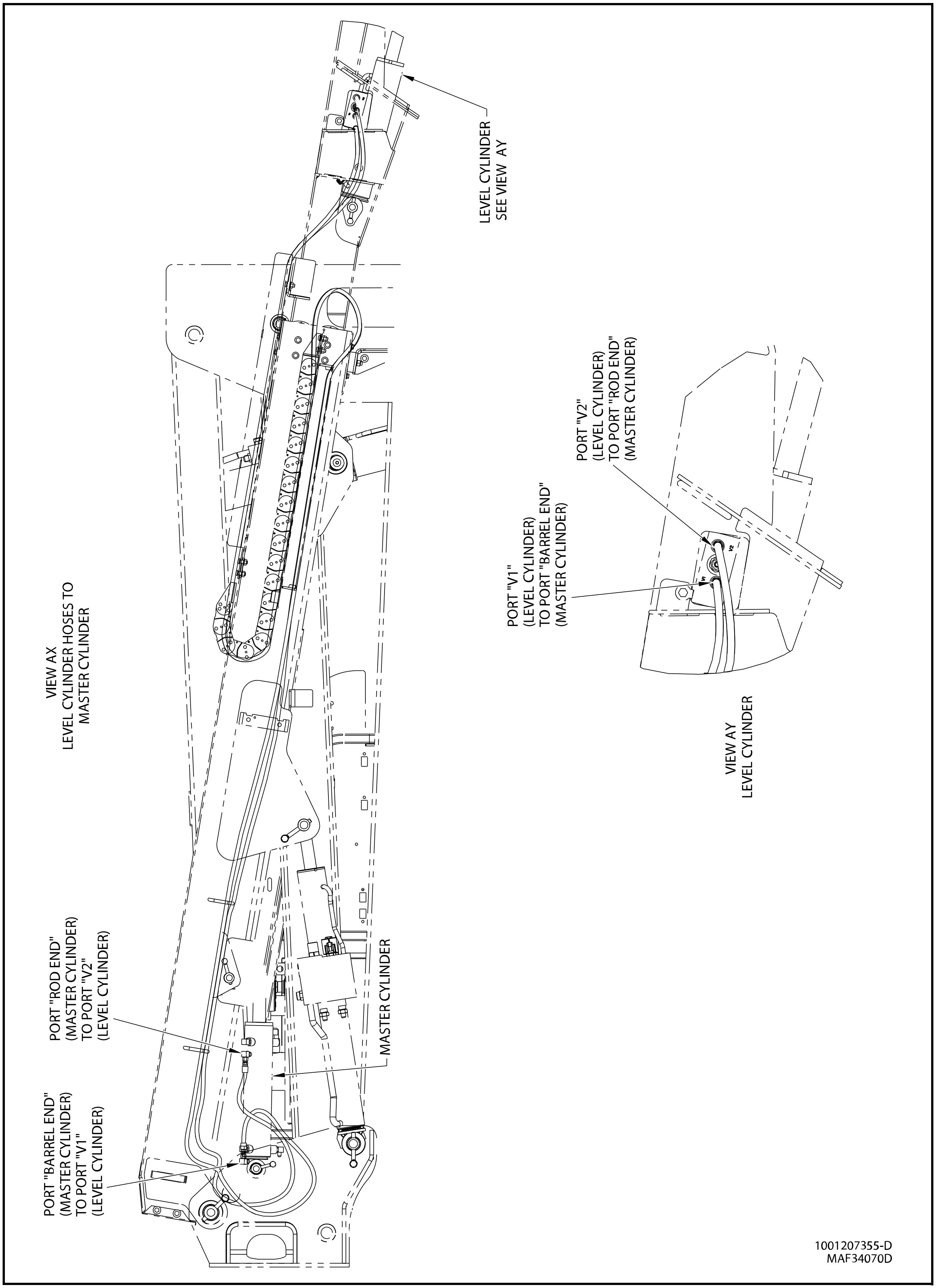


Figure 219. Hydraulics Installation - Sheet 27 of 28

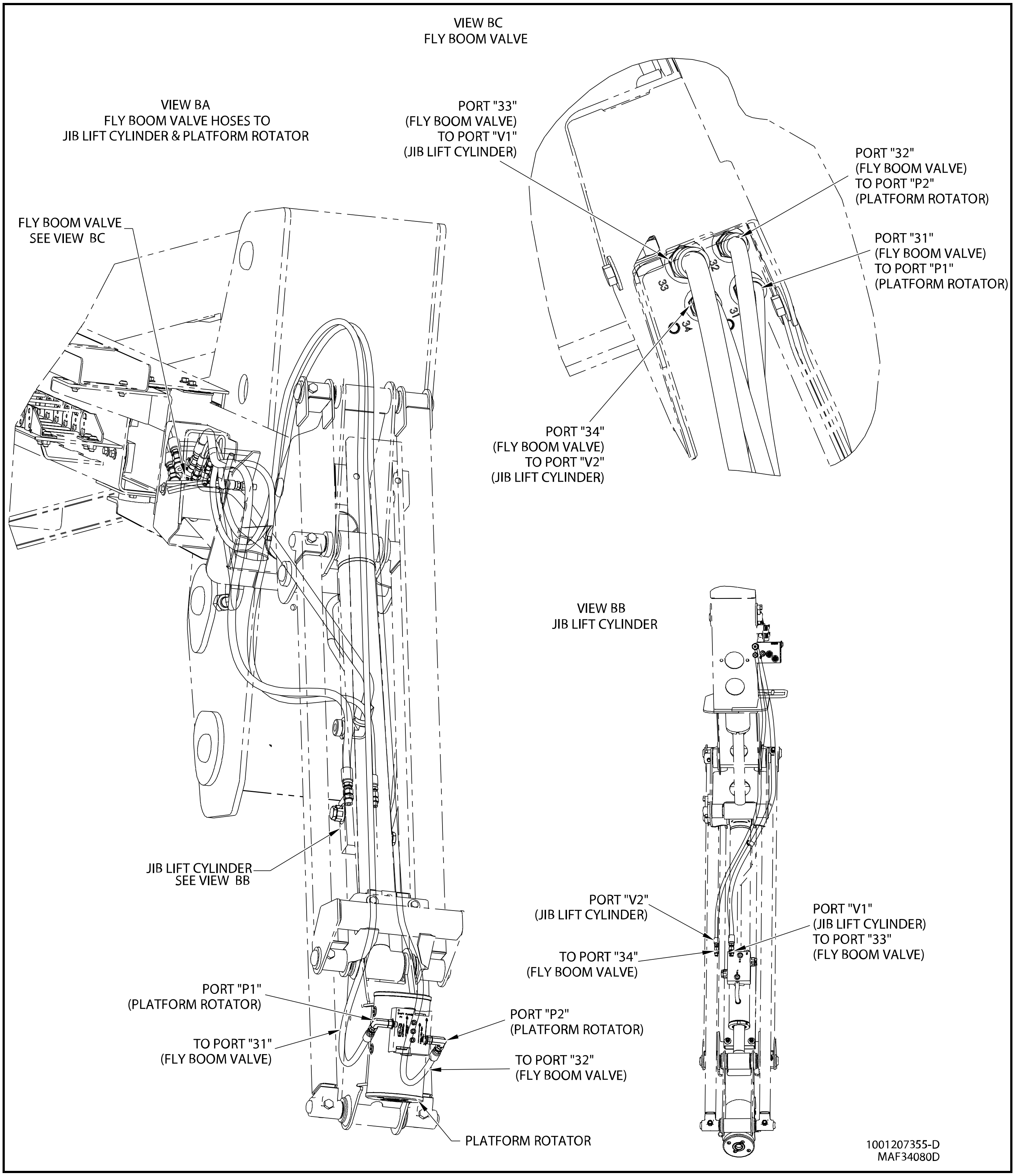


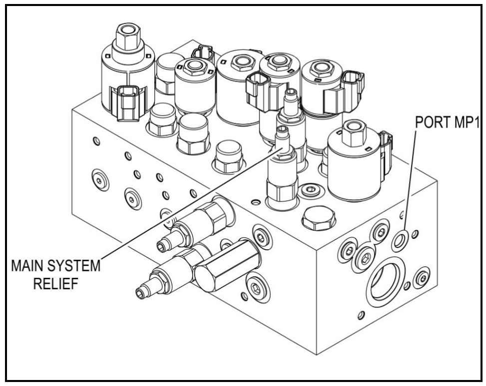
Figure 220. Hydraulics Installation - Sheet 28 of 28

5.4 PRESSURE SETTING PROCEDURE

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

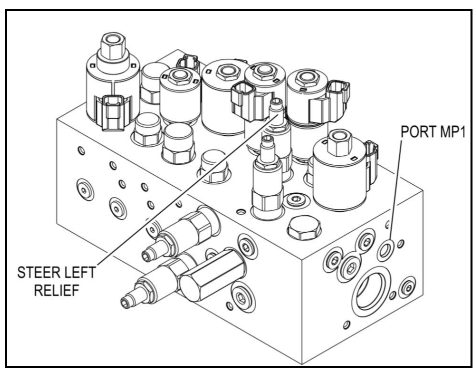
To ensure all pressures are set correctly, the following procedures must be followed.

5.4.1 Main System Relief



1. Install a pressure gauge at port MP1 of the Main Control Valve capable of reading pressures up to 4000 psi (275 Bar).
2. Activate telescope in function continuously at end of stroke. Pressure that is observed should be 3000 ± 75 psi (207 ± 6 Bar).
3. If necessary, loosen jam nut and adjust the Main System Relief valve clockwise to increase and counterclockwise to decrease.

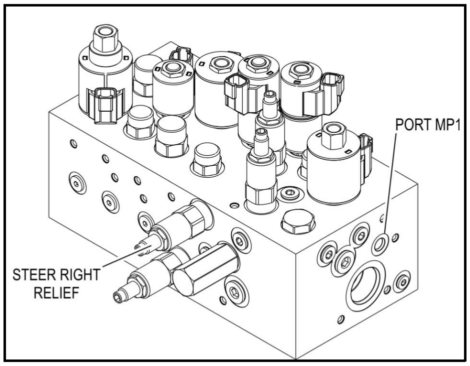
5.4.2 Steer Left Relief



1. Install a pressure gauge at port MP1 of the Main Control Valve capable of reading pressures up to 4000 psi (275 Bar).
2. Activate Steer Left function continuously at end of stroke. Pressure that is observed should be 2750 ± 75 psi (190 ± 6 Bar).
3. If necessary, loosen jam nut and adjust the Steer Left Relief valve clockwise to increase and counterclockwise to decrease.

Note: Steer left pressure at port 24 is 2500 psi (173 Bar); a gauge may be placed there for troubleshooting.

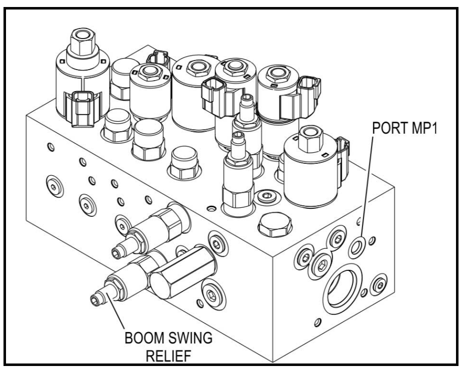
5.4.3 Steer Right Relief



1. Install a pressure gauge at port MP1 of the Main Control Valve capable of reading pressures up to 4000 psi (275 Bar).
2. Activate Steer Right function continuously at end of stroke. Pressure that is observed should be 2750 ± 75 psi (190 ± 6 Bar).
3. If necessary, loosen jam nut and adjust the Steer Right Relief valve clockwise to increase and counterclockwise to decrease.

Note: Steer Right pressure at port 23 is 2500 psi (173 Bar); a gauge may be placed there for troubleshooting.

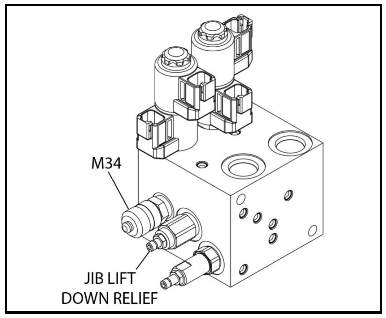
5.4.4 Swing Relief



1. Install a pressure gauge at port MP1 of the Main Control Valve capable of reading pressures up to 3000 psi (207 Bar).
2. Activate Boom Swing Right or Left function continuously against the stop or lock. Pressure that is observed should be 1800 ± 50 psi (125 ± 4 Bar).
3. If necessary, loosen jam nut and adjust the Boom Swing Relief valve clockwise to increase and counterclockwise to decrease.

Note: Boom Swing Right pressure at port 15 and Boom Swing Left pressure at port 16 is 1700 psi (117 Bar); a gauge may be placed there for troubleshooting.

5.4.5 Jib Lift Down Relief

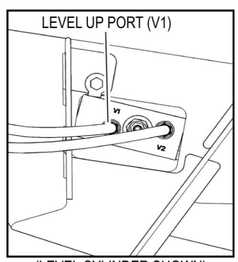


1. Install a pressure gauge at port M34 of the Jib Control Valve capable of reading pressures up to 3000 psi (207 Bar).
2. Activate Jib Lift Down function continuously at end of stroke.
3. Pressure that is observed should be 1500 ± 50 psi (104 ± 4 Bar).
4. If necessary, loosen jam nut and adjust the Jib Lift Down Relief valve clockwise to increase and counterclockwise to decrease.

5.4.6 Platform Level Up Relief

The Platform Level Up relief is preset and does not normally need checked or adjusted. If necessary, the following procedure may be utilized for troubleshooting purposes:

1. With the tower boom fully lowered, lift the main boom up several degrees from the fully lowered position. Ensure that there is still access to the level cylinder.
2. Remove the hose from the Level Up port of the Level Cylinder (V1 Port) - Install a pressure gauge capable of reading pressures up to 4000 psi (275 Bar) onto this hose and cap or plug the port in the Level Cylinder.



(LEVEL CYLINDER SHOWN)

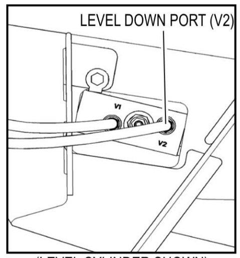
3. Fully extend the main boom telescope cylinder using Auxiliary Mode.
4. Activate Main Boom Lift Down function using Auxiliary Mode continuously until fully lowered.
5. Pressure that is observed should be 3400 ± 85 psi (234 ± 6 Bar).
6. If necessary, loosen jam nut and adjust the Platform Level Up Relief valve clockwise to increase and counterclockwise to decrease.
7. Remove the gauge and reinstall the hose.

5.4.7 Platform Level Down Relief

The Platform Level Down relief is preset and does not normally need checked or adjusted. If necessary, the following procedure may be utilized for troubleshooting purposes:

1. With the tower boom fully lowered, lift the main boom down until fully lowered.

2. Remove the hose from the Level Down port of the Level Cylinder (V2 Port) - Install a pressure gauge capable of reading pressures up to 3000 psi (207 Bar) onto this hose and cap or plug the port in the Level Cylinder.



(LEVEL CYLINDER SHOWN)

3. Activate Platform Level Down function continuously.

4. Pressure that is observed should be 2000 ± 50 psi (138 ± 4 Bar). If necessary, loosen jam nut and adjust the Platform Level Down Relief valve clockwise to increase and counterclockwise to decrease.

5. Remove the gauge and reinstall the hose.

5.5 DRIVE PUMP PRE-FILL PROCEDURE

The case of the hydraulic drive pump, MUST be pre-filled before starting the engine. Failure to do so can cause premature failure of the pump.

1. Fill the hydraulic reservoir.

2. Determine if the hydraulic oil tank sight level gauge is higher than other hydraulic components.

   a. Determine if the hydraulic oil tank sight level gauge is higher than the hydraulic drive pump assembly.

   b. Determine if the hydraulic oil tank sight level gauge is higher than all hydraulic hose loops or routings between the hydraulic tank and the drive pump assembly.

   c. If sight level gauge is the highest hydraulic oil level point, proceed to step 3.

   d. If sight level gauge is NOT the highest hydraulic oil level point, low pressure air may need to be applied to the hydraulic oil tank (fill cap via air regulator) in conjunction with step 4 to get hydraulic oil to move over the air locks created by these high spots.

3. If the machine is be equipped with a hydraulic oil cooler option:

   a. Determine if there is a hydraulic ‘tee’ fitting installed at the hydraulic drive pump that has a ‘cap’ fitting attached to it. (this will generally be at or near the top of the hydraulic drive pump body). This ‘cap’ fitting is to be used to manually fill the hydraulic drive pump case.

   b. Remove ‘cap’ fitting.

   c. Fill hydraulic drive pump case with hydraulic oil.

   d. Reattach and torque ‘cap’ fitting.

   e. Prefilling of the hydraulic drive pump w/oil cooler option is complete (Step #4 can be omitted at this point.)

4. If machine is NOT equipped with a hydraulic oil cooler option,

   a. Locate a case access port on the hydraulic drive pump. Preferably one located at or near the top or upper sides of the pump.

   b. Using the proper wrench, remove the O-ring plug to allow air to escape from the hydraulic drive pump case.

   c. Hydraulic oil will flow by gravity from the hydraulic tank to the drive pump.

   d. When hydraulic oil starts to flow out this port, the pump is full.

   e. Re-install the O-ring plug and torque.

5. Pre-filling of the hydraulic drive pump is complete.

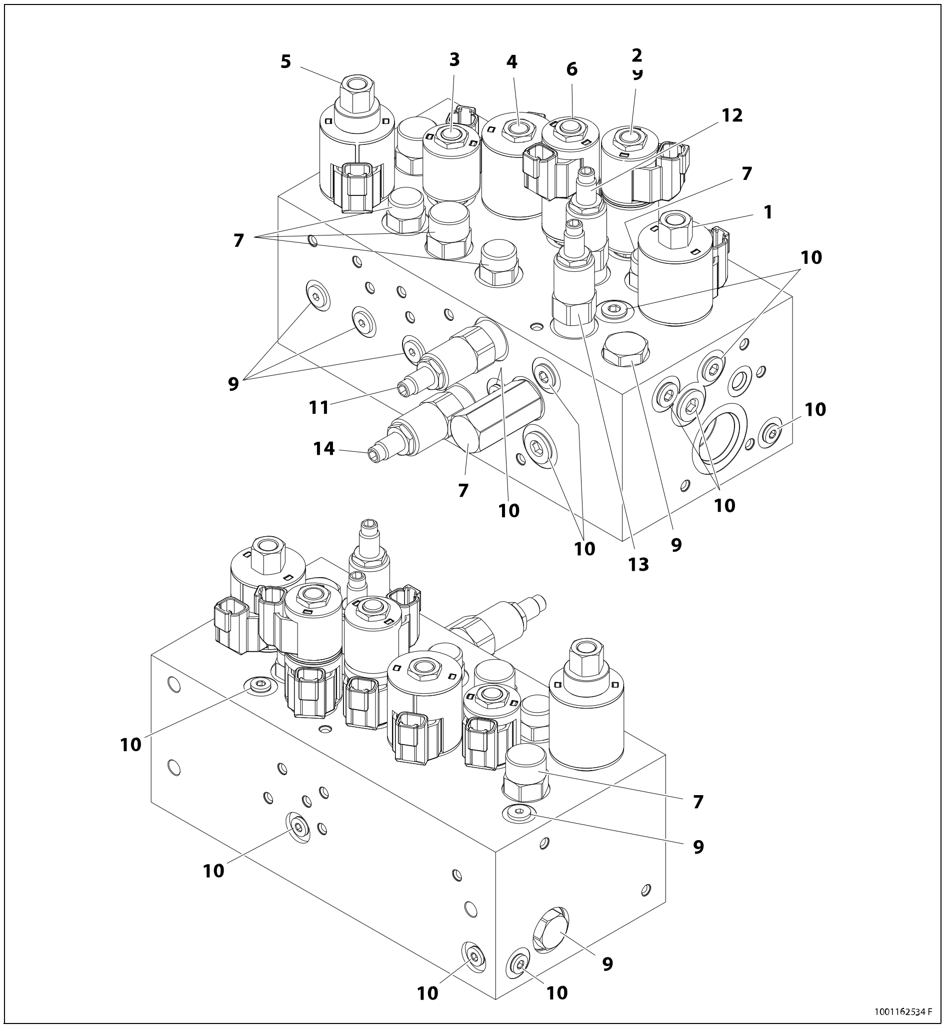


Figure 221. Main Control Valve Identification

1. Main Dump Valve	6. Swing Valve	11. Steer Right Relief
2. Steer Valve	7. Cartridge Valve	12. Steer Left Relief
3. Main Lift Up Valve	8. Relief Valve	13. Main System Relief
4. Tower Lift Up Valve	9. Check Valve	14. Boom Swing Relief
5. Flow Control Valve	10. Plug	

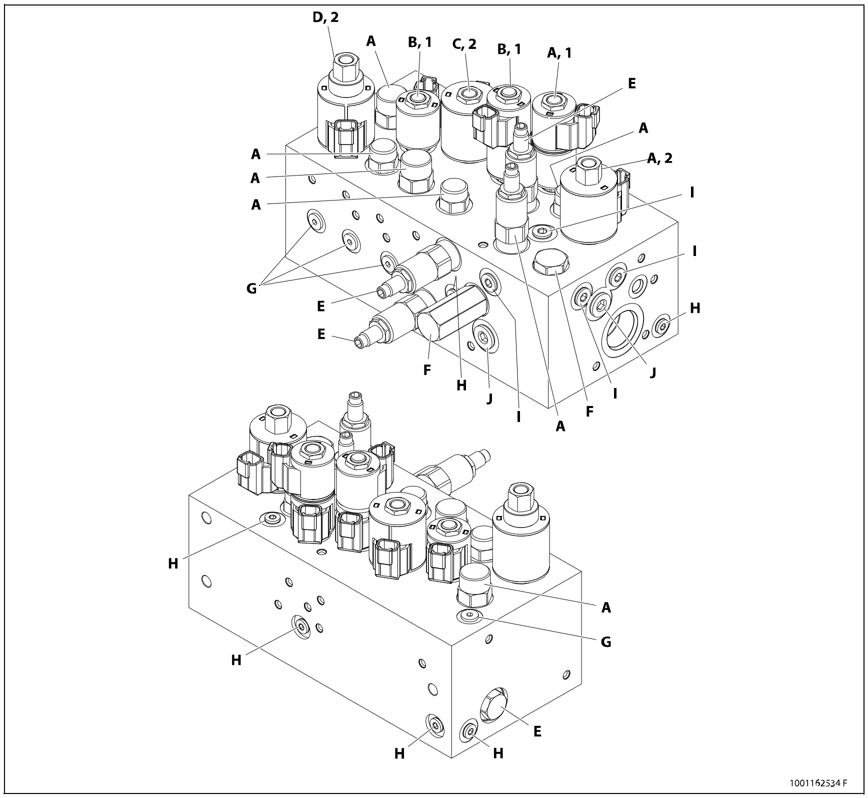


Figure 222. Main Control Valve Torque Values

Table 70. Cartridge Torque Values

	Ft. lbs.	Nm
A	38	51
B	40	54
C	48	65
D	50	67
E	28	38
F	43	58
G	13	18
H	8	11
I	12	16
J	30	41

Table 71. Coil Torque Values

	Ft. lbs.	Nm
1	4.5	6
2	6	8

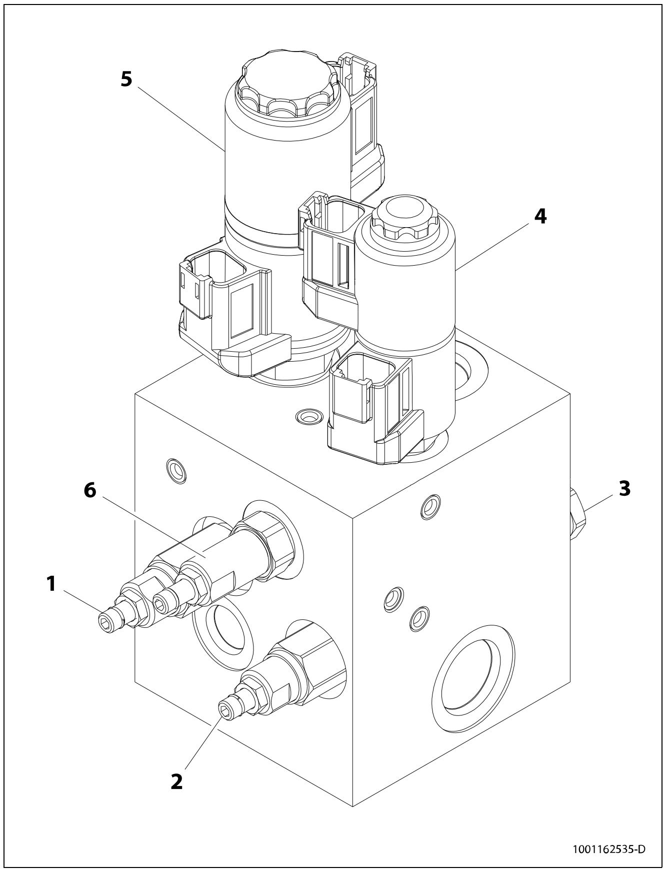


Figure 223. Upright Valve Identification

1. Cartridge Valve	4. Cartridge Valve Without Coil
2. Platform Level Down Relief	5. Cartridge Valve Without Coil
3. Relief Valve	6. Platform Level Down Relief

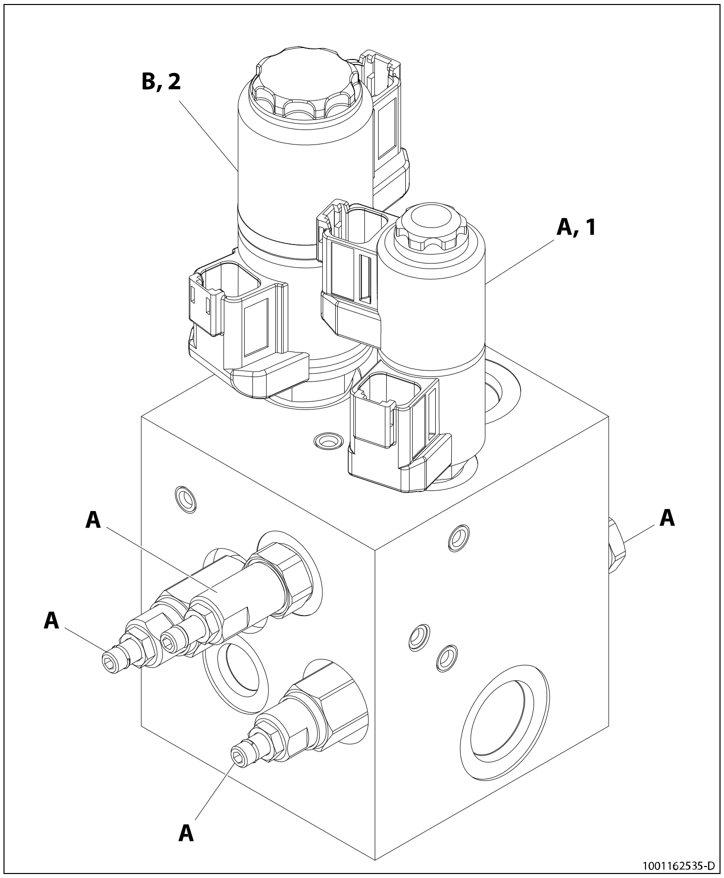


Figure 224. Upright Valve Torque Values

Table 72. Cartridge Torque Values

	Ft. lbs.	Nm
A	13.5	18
B	31	42

Table 73. Coil Torque Values

	Ft. lbs.	Nm
1	1.5	2
2	4	5

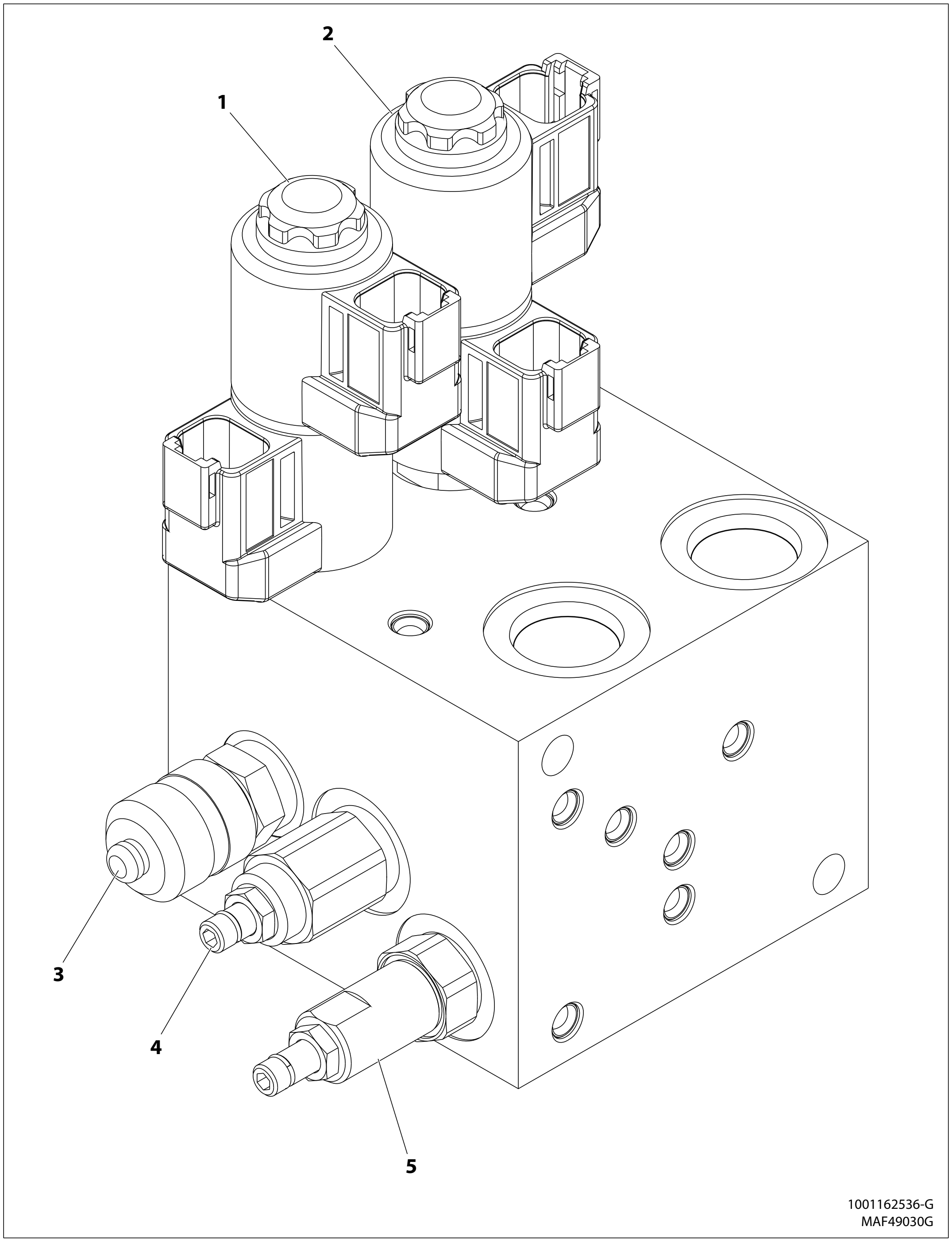


Figure 225. Fly Boom Valve Identification

1. Jib Lift	4. Jib Down Relief Valve
2. Platform Rotate	5. Cartridge Valve
3. Test Fittings	

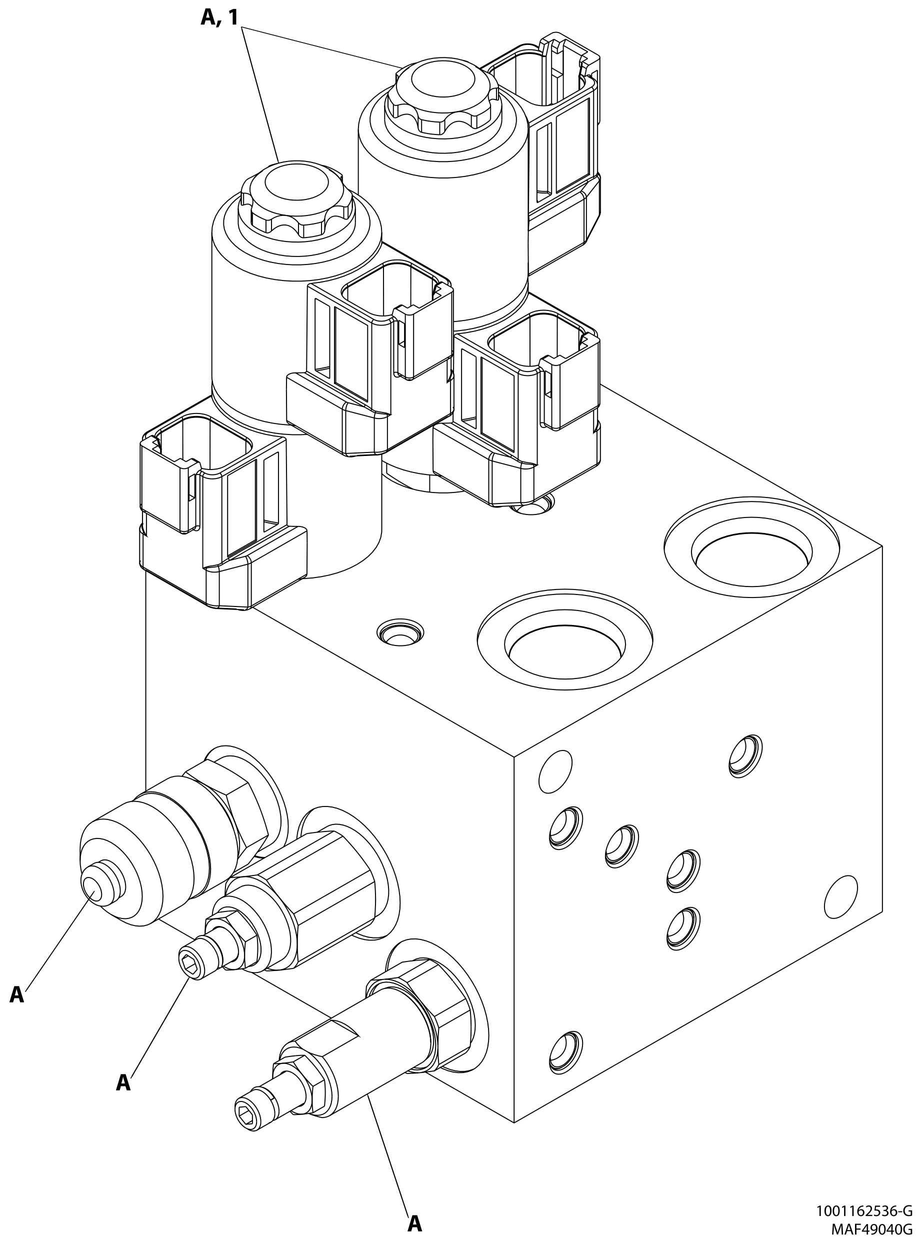


Figure 226. Fly Boom Valve Torque Values

Table 74. Cartridge Torque Values

	Ft. lbs.	Nm
A	13.5	18

Table 75. Coil Torque Values

	Ft. lbs.	Nm
1	1.5	2

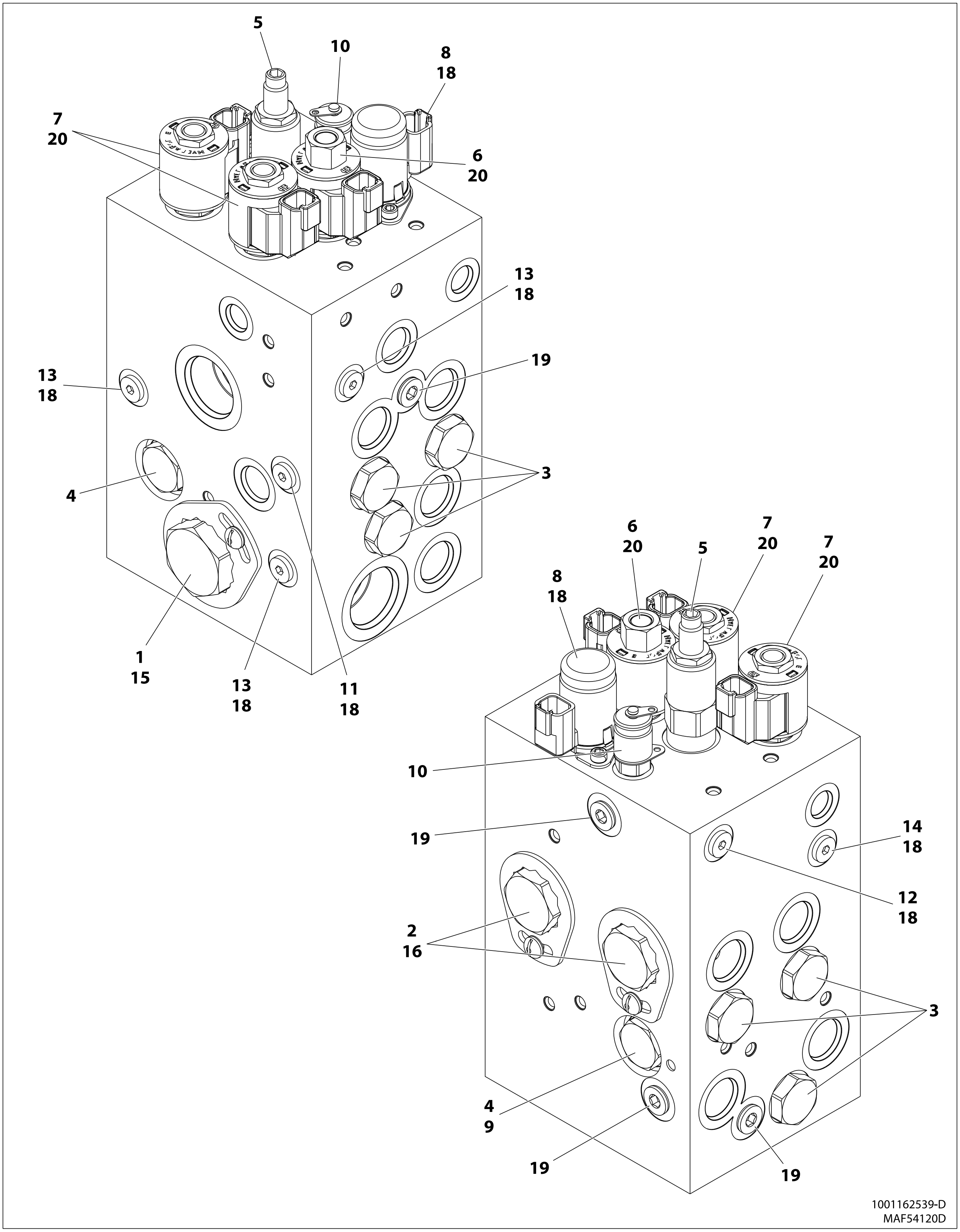
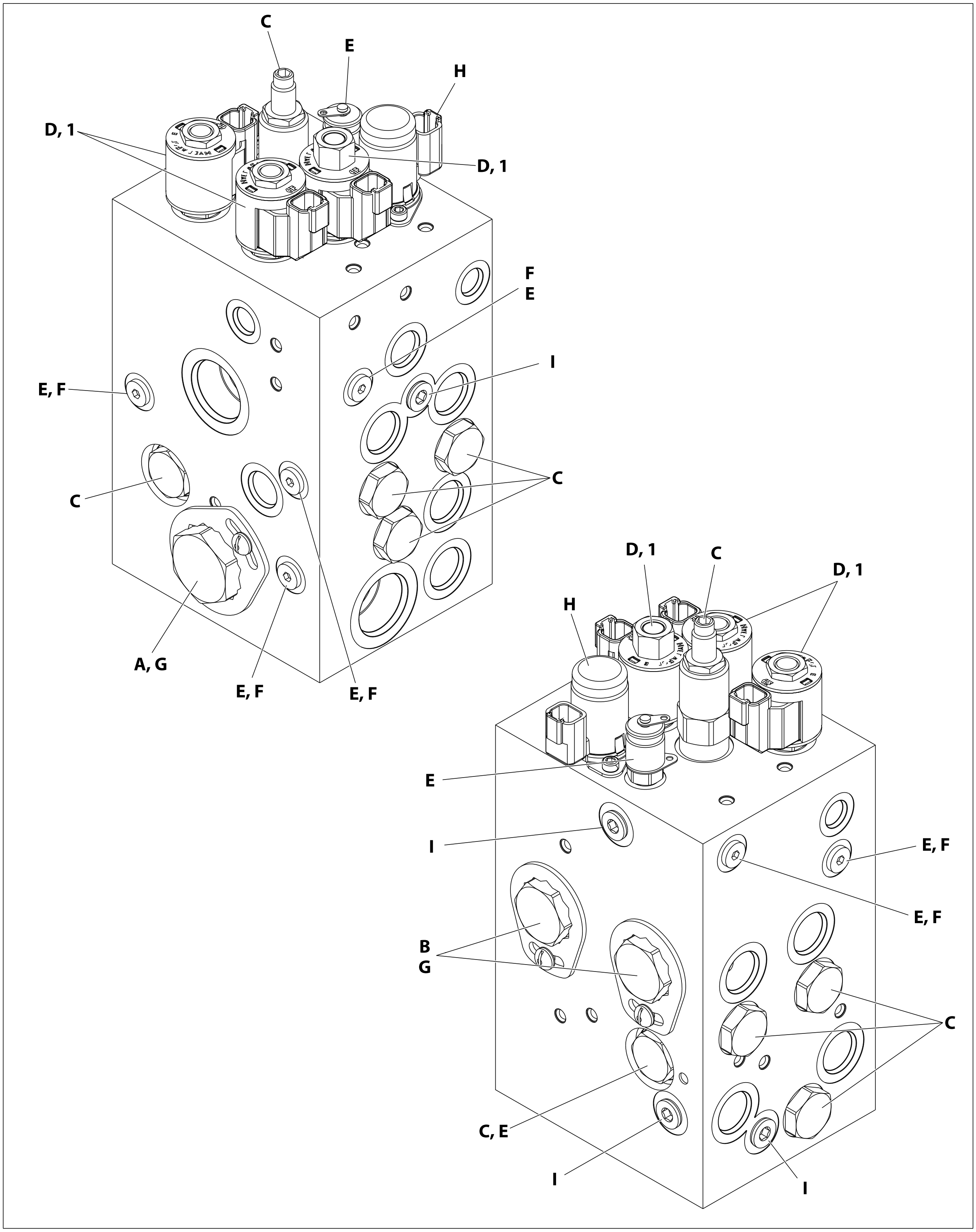


Figure 227. Traction Valve Identification

1. Cartridge, Flow Divider	11. Plug
2. Cartridge, Flow Divider	12. Plug
3. Cartridge, Check Valve	13. Plug
4. Cartridge, Check Valve	14. Plug
5. Cartridge, Relief Valve	15. Locking Kit
6. Cartridge, Solenoid Less Coil	16. Locking Kit
7. Cartridge, Solenoid Less Coil	17. Screw
8. Cartridge, Solenoid Less Coil	18. Plug Port 4
9. Piston, Pilot	19. Plug Port 6
10. Fitting	20. Coil



1001162539-D
MAF54130D

Figure 228. Traction Valve Torque Values

Table 76. Cartridge Torque Values

	Ft. lbs.	Nm
A	100	135
B	75	101
C	43	58
D	40	54
E	7	9
F	4	5.5
G	5	6.5
H	2.5	3.5
I	12	16

Table 77. Coil Torque Values

	Ft. lbs.	Nm
J	4.5	6

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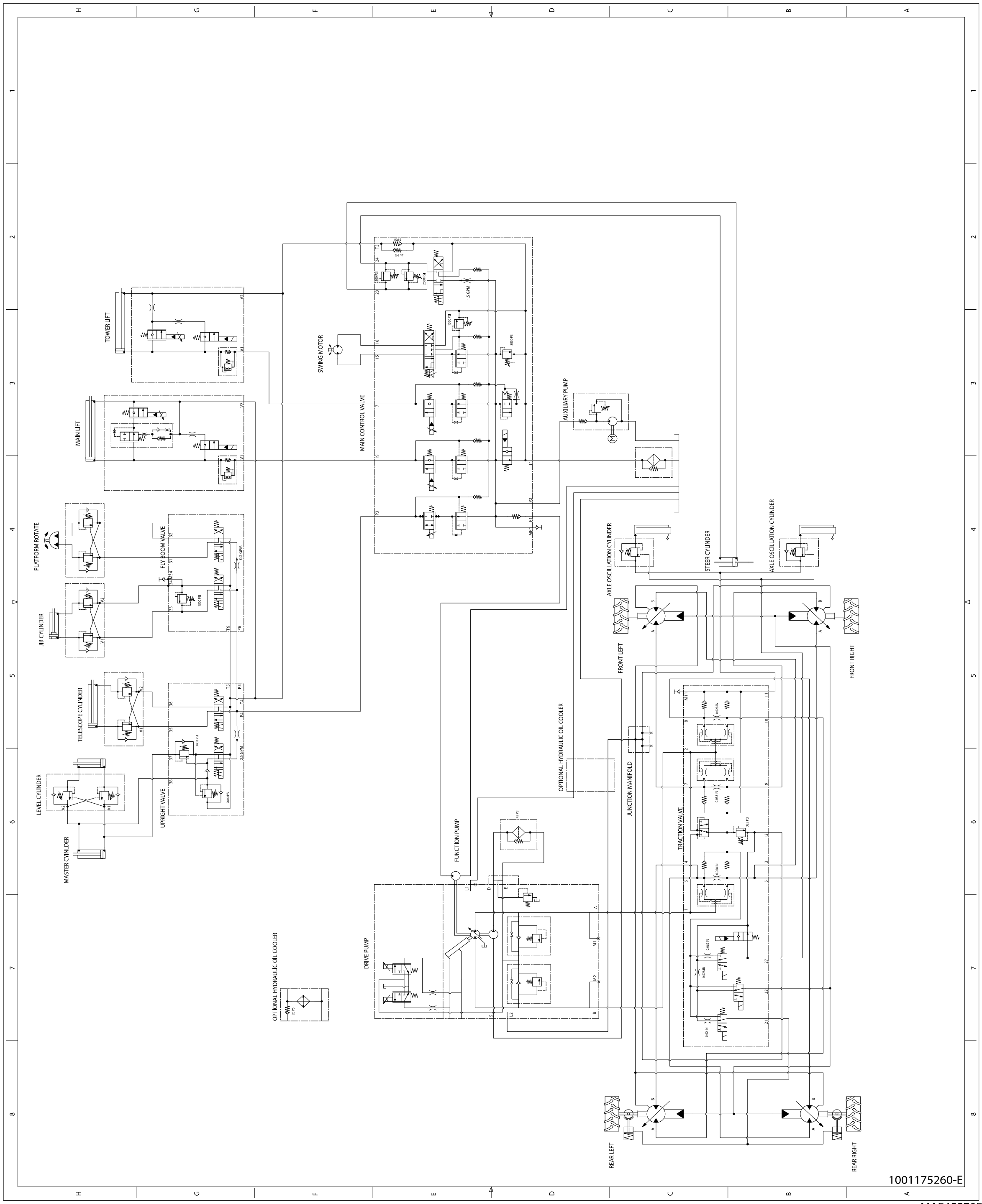
5.6 HYDRAULIC SCHEMATICS



MAF45570E

Figure 229. Hydraulic Schematics - Sheet 1 of 2

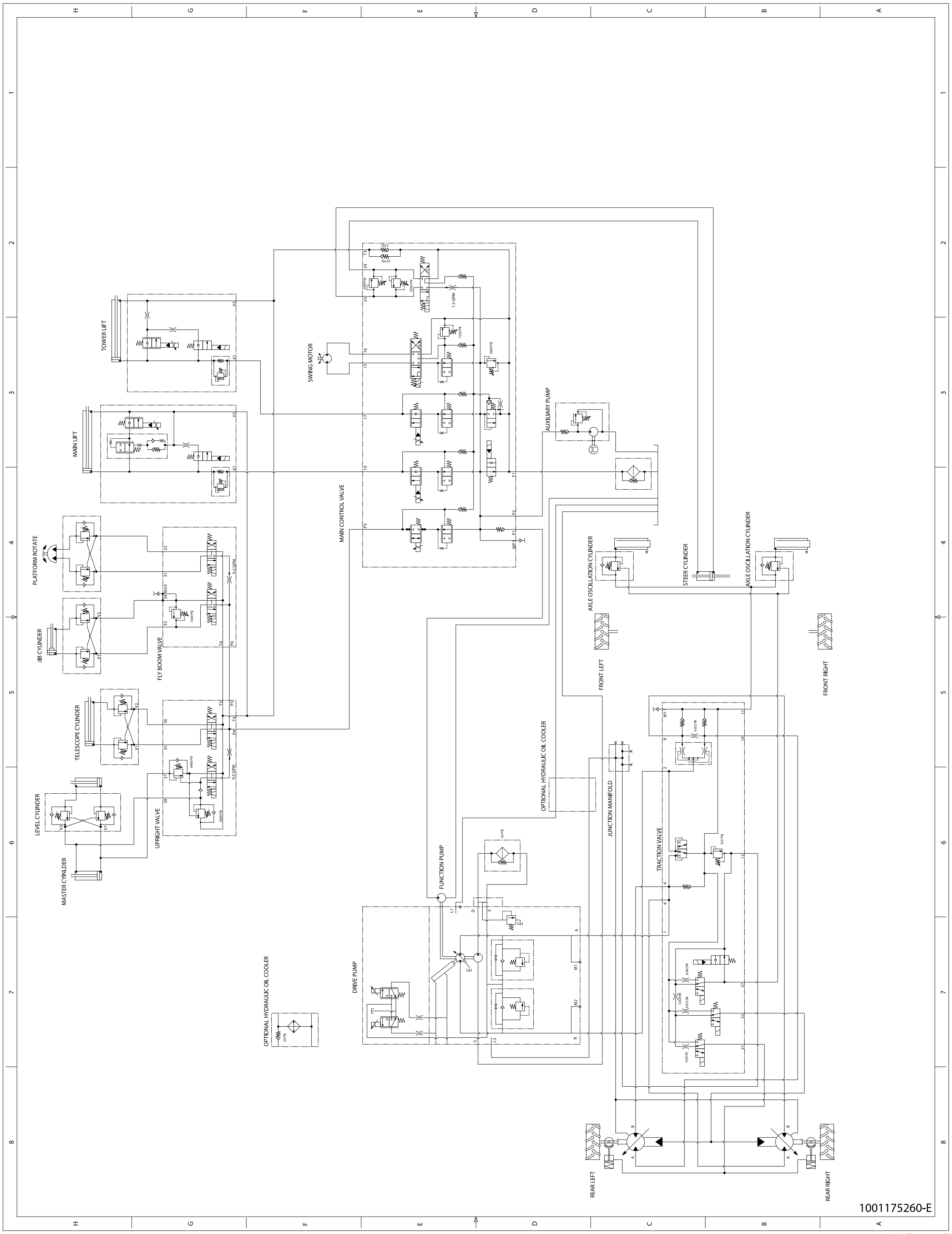


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Figure 230. Hydraulic Schematics - Sheet 2 of 2

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SECTION 6
JLG CONTROL SYSTEM

6.1 JLG CONTROL SYSTEM ANALYZER KIT INSTRUCTIONS

6.1.1 Introduction

NOTICE

When installing a new power module controller on the machine, it will be necessary to program the controller for the proper machine configuration, including options.

NOTICE

It is a good practice to avoid pressure-washing electrical/electronic components. Should pressure-washing be utilized to wash areas containing electrical/electronic components, JLG industries, inc. recommends a maximum pressure of 750 psi (52 bar) at a minimum distance of 12 inches (30.5 cm) away from these components. If electrical/electronic components are sprayed, spraying must not be direct and be for brief time periods to avoid heavy saturation.

The JLG designed Control System is a 12 volt based control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

The main lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer Kit, JLG part no. 1001249695) which will display two lines of information at a time, by scrolling through the program.

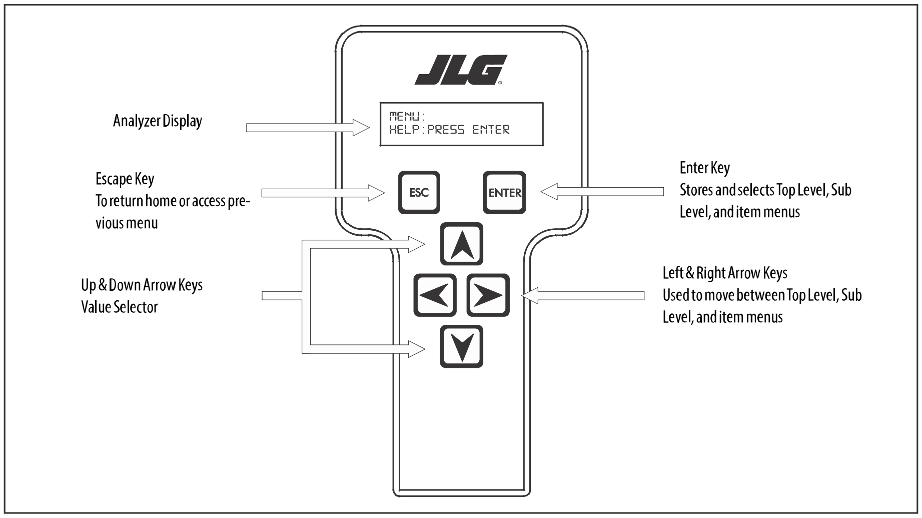


Figure 231. Hand Held Analyzer

6.1.2 To Connect the JLG Control System Analyzer

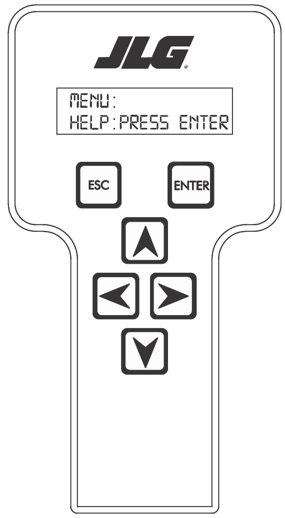
1. Connect the four pin end of the cable supplied with the analyzer, to the motor controller module located in the platform box or at the power module and connect the remaining end of the cable to the analyzer.

Note: The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.

2. Power up the Control System by turning the lower key to the platform or ground position and pulling both emergency stop buttons on.

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

The top level menus are as follows:

HELP

DIAGNOSTICS

ACTIVATE TEST

ACCESS LEVEL

PERSONALITIES

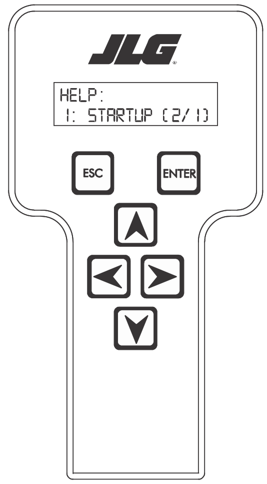
MACHINE SETUP

LEVEL VEHICLE (level 1 only)

CALIBRATIONS (view only)

If you press **ENTER**, 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: STARTUP (2/1)

At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESCAPE** two times. **STARTUP (2/1)** indicates a power up.

When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE

BOOM

SYSTEM

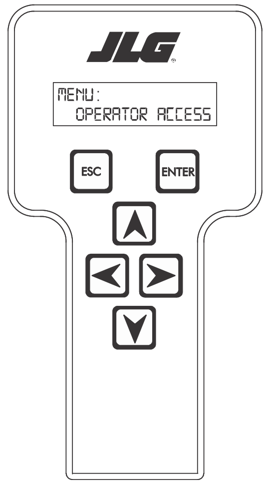
DATALOG

VERSIONS

Pressing **ENTER** with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases, such as **DRIVE**, , the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected menu item by pressing the **ESCAPE** key.

6.1.4 Changing the Access Level of the Hand Held Analyzer

When the analyzer is first connected, you will be in Operator Access which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change the access level, the correct password must be entered. To enter the password, scroll to the **ACCESS LEVEL** menu. For example:



ACCESS LEVEL:

CODE 00000

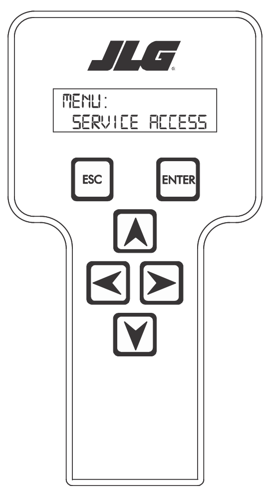
Press **ENTER** to select the **ACCESS LEVEL** menu.

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

Then using the **RIGHT** arrow key, position the cursor to the right one space to enter the second digit of the password.

Use the **UP** or **DOWN** arrow key to enter the second digit of the password which is 33271.

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:



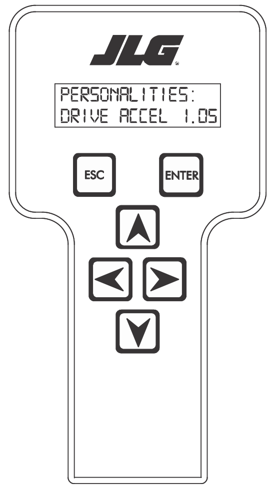
MENU:

SERVICE ACCESS

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

6.1.5 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:



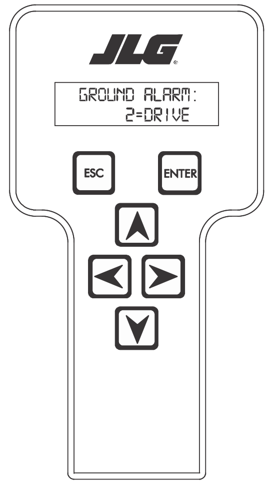
DRIVE:

ACCEL 1.5s

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at access level 1.

6.1.6 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 = DRIVE

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when driving. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

Note: Refer to Personality Ranges/Defaults for the recommended factory settings.

Note: Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

ELEVATION CUTBACK

⚠ WARNING

Changing this setting may adversely affect the performance of your machine.

NOTICE

Its is a good practice to avoid pressure-washing electrical/electronic components. Should pressure-washing be utilized to wash areas containing electrical/electronic components, JLG industries inc. Recommends a maximum pressure of 750 psi (52 bar) at a minimum distance of 12 inches (30.5cm) away from these components. If electrical/electronic components are sprayed, spraying must not be direct and be for brief time periods to avoid heavy saturation

6.1.7 Tilt Sensor Calibration

Refer to *Figure — Tilt Sensor Location, page 505*.

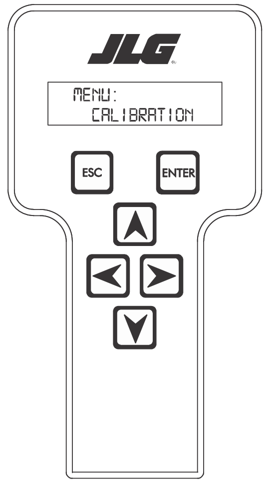
⚠ WARNING

Do not calibrate the tilt sensor except on a level surface.

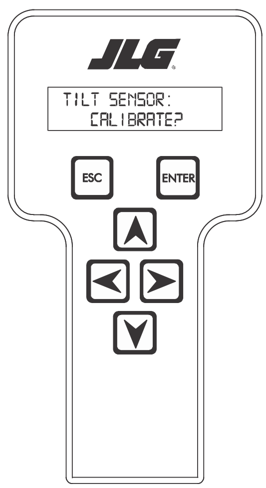
1. Place the machine on a firm, level surface.

2. Using the analyzer, go to Service Access level. Refer to *Changing the Access Level of the Hand Held Analyze, page 498*r in this section.

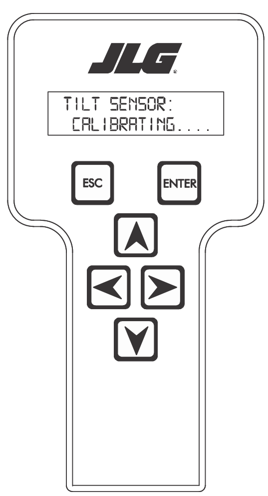
3. Using the arrow keys, navigate to Calibrations Menu as shown below and press **ENTER**



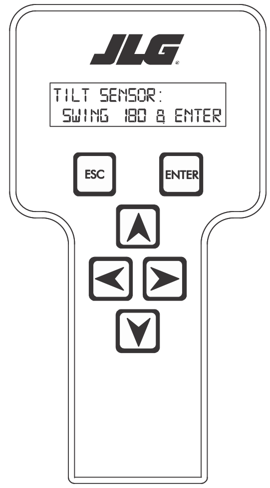
4. Using the arrow keys, navigate to the Tilt Sensor calibration as shown below and press **ENTER**



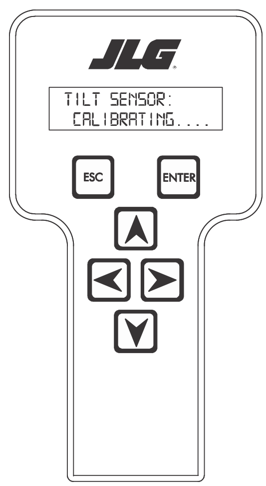
the screen will then read:



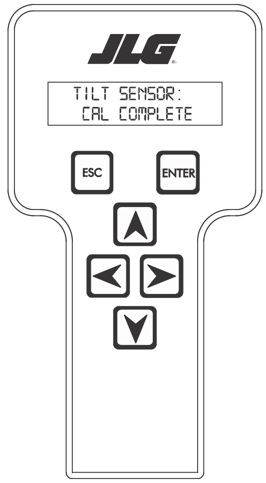
5. When the sensor is calibrated in that position, the screen will read:



6. Swing the machine 180 degrees, making sure the boom is centered and in the transport position, and **ENTER** ENTER The screen will read:



7. When the calibration is complete the screen will read as shown below. Return the machine to the travel position.



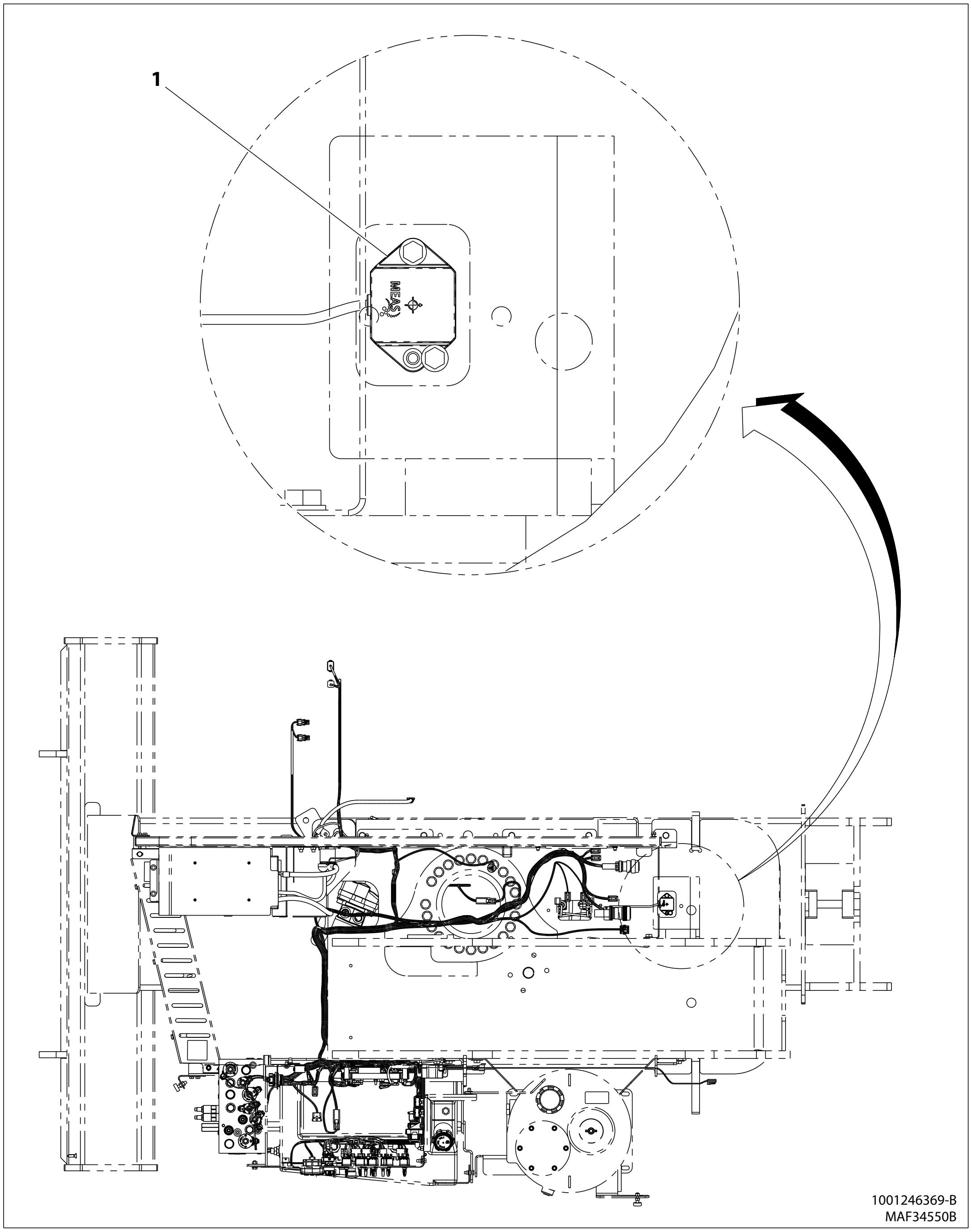


Figure 232. Tilt Sensor Location

1. Tilt Sensor

6.1.8 Ground Control Console Display Gauge

(Refer to *Figure — Ground Control Console Display Gauge, page 507*)

The Display Gauge shows engine hours, fuel level (if applicable), and Diagnostic Trouble Codes (DTCs) from both the JLG Control System and the engine control system. During machine start up, with no active DTCs in the control system, the splash screen will show for 3 seconds and then switch to main screen. If there is an active DTC while powering up the machine, the splash screen will show for 3 seconds, and then launch the Diagnostics Screen. The indicator lamp will light when there is an active DTC in the Fault Log.

Figure 233. Splash Screen

The Diagnostic Screen will show active and inactive faults from the JLG Control System on the screen. An asterisk (*) will be displayed to show active faults.

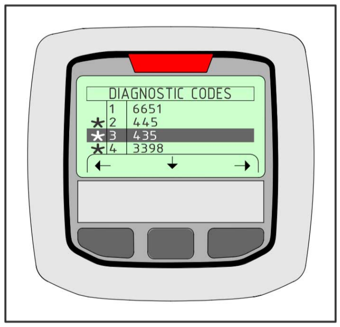


Figure 234. Diagnostic Screen

The Engine Diagnostics Screen will show SPN (Suspect Parameter Number), FMI (Failure Mode Identifier), and Occurrence count information. Engine SPN text is not scrollable. If there is more than one engine trouble code, the operator must exit from the Engine DTC Screen to see other SPN and FMI information.

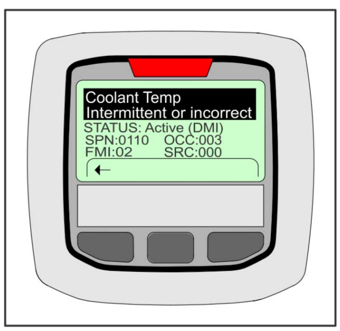


Figure 235. Engine Diagnostic Screen

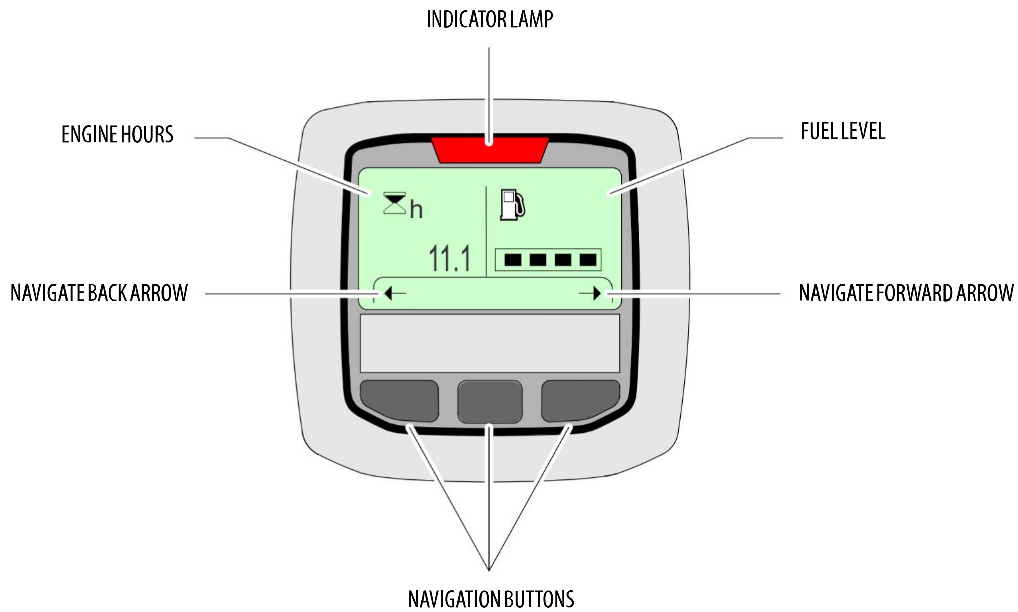


Figure 236. Ground Control Console Display Gauge

Table 78. Analyzer Abbreviations

ABBREVIATION	MEANING
ACCEL	ACCELERATE
ACT	ACTIVE
A/D	ANALOG DIGITAL CONVERTER COUNT
AMB.	AMBIENT
ANG	ANGLE
AUX	AUXILIARY
BCS	BOOM CONTROL SYSTEM
BM	BOOM LENGTH ANGLE MODULE
BLAM	BOOM LENGTH ANGLE MODULE
BR	BROKEN
BSK	BASKET
CAL	CALIBRATION
CL	CLOSED
CM	CHASSIS MODULE
CNTL	CONTROL
CNTRL	CONTROL
C/O	CUT OUT
CONT(S)	CONTRACTOR(S)

Table 78. Analyzer Abbreviations (continued)

ABBREVIATION	MEANING
COOR	COORDINATED
CRK PT	CRACK POINT
CRP	CREEP
CUT	CUTOUT
CYL	CYLINDER
DECEL	DECELERATE
D	DOWN
DN	DOWN
DWN	DOWN
DEG.	DEGREE
DOS	DRIVE ORIENTATION SYSTEM
DRV	DRIVE
E	ERROR
E&T	ELEVATED & TILTED
ELEV	ELEVATION
ENG	ENGINE
EXT	EXTEND
F	FRONT
FL	FLOW
FNT	FRONT
FOR	FORWARD
FWD	FORWARD
FSW	FOOT SWITCH
FUNC	FUNCTION
G	GROUND
GND	GROUND
GRN	GREEN
GM	GROUND MODULE
H	HOURS
HW	HARDWARE
HWFS	HARDWARE FAILSAFE
I	IN or CURRENT
JOY	JOYSTICK
L	LEFT
LB	POUND
LEN	LENGTH
LIM	LIMIT

Table 78. Analyzer Abbreviations (continued)

ABBREVIATION	MEANING
LT	LEFT
LVL	LEVEL
M	MINUTES
MIN	MINIMUM
MAX	MAXIMUM
M	MAIN
MN	MAIN
NO	NORMALLY OPEN or NO
NC	NORMALLY CLOSED
O	OUT
O/C	OPEN CIRCUIT
OP	OPEN
O/R	OVERRIDE or OUTRIGGER
O//R	OVERRIDE
OSC	OSCILLATING
OVRD	OVERRIDE
P	PLATFORM
P	PRESSURE
PCV	PROPORTIONAL CONTROL VALVE
PLAT	PLATFORM
PLT	PLATFORM
PM	PLATFORM MODULE
POT	POTENTIOMETER
PRES	PRESSURE
PRS	PRESSURE
PT	POINT
R	REAR or RIGHT
REV	REVERSE or REVISION
RET	RETRACT
ROT.	ROTATE
RT	RIGHT
S/C	SHORT CIRCUIT
SEL	SELECTOR
SN	SERIAL NUMBER
SPD	SPEED
STOW	STOWED
STOWD	STOWED

Table 78. Analyzer Abbreviations (continued)

ABBREVIATION	MEANING
SW	SWITCH or SOFTWARE
TELE	TELESCOPE
TEMP	TEMPERATURE
TORQ.	TORQUE
TRN	TRANSPORT
T/T	TURNTABLE
T	TOWER
TURNTBL	TURNTABLE
TWR	TOWER
U	UPPER or UP
V	VOLT
VER	VERSION
VLV	VALVE
WIT	WITNESS
YEL	YELLOW

Figure 237. Analyzer Connecting Points

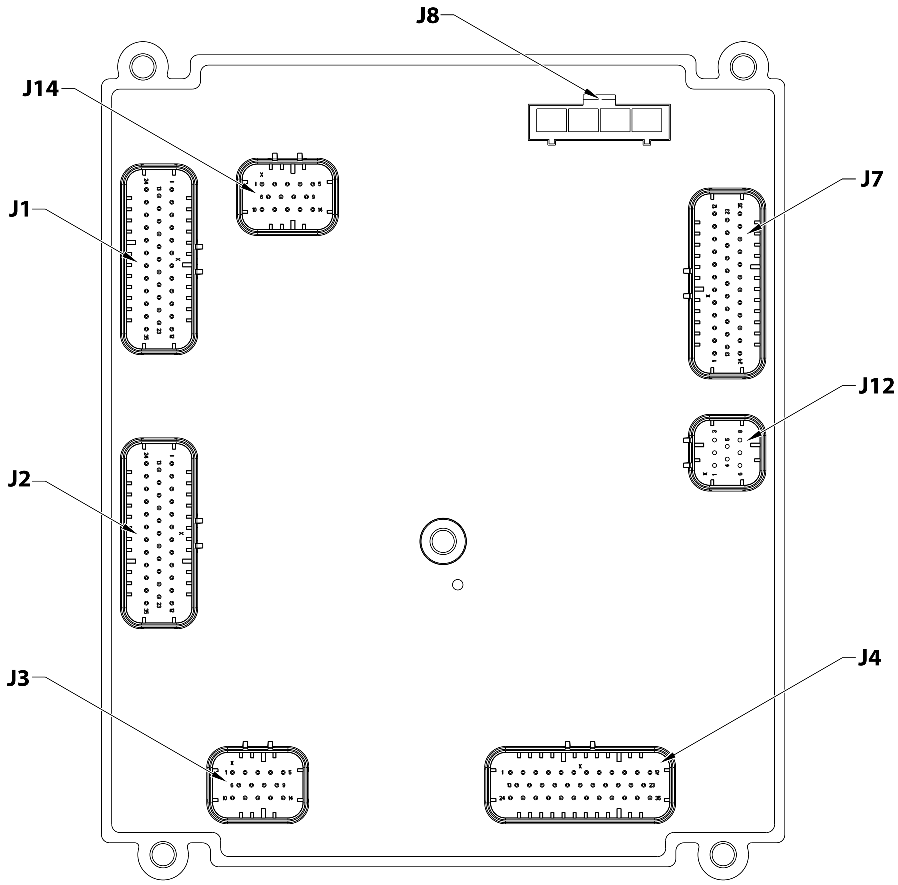


Figure 238. Ground Control Module

Connector	Pin	Function	Type	
J1 (Natural)	1	UNUSED (FUEL RACK ACTUATOR)	DIGITAL	OUTPUT
	2	OSCILLATING AXLE VALVE #2	DIGITAL	OUTPUT
	3	DRIVE FORWARD / LEFT TRACK FORWARD VALVE	DIGITAL	OUTPUT
	4	UNUSED	GROUND	INPUT
	5	UNUSED	GROUND	INPUT
	6	DRIVE REVERSE / LEFT TRACK REVERSE VALVE	DIGITAL	OUTPUT
	7	OSCILLATING AXLE VALVE #1	DIGITAL	OUTPUT
	8	UNUSED	GROUND	INPUT
	9	MSSO SWITCH GROUND	GROUND	INPUT
	10	ECU POWER	DIGITAL	OUTPUT
	11	ENGINE START	DIGITAL	OUTPUT
	12	ENGINE GLOW PLUGS	DIGITAL	OUTPUT
	13	APU ENABLE RELAY	DIGITAL	OUTPUT
	14	UNUSED (ENGINE COOLANT TEMPERATURE SENSOR)	ANALOG	INPUT
	15	UNUSED (ENGINE OIL PRESSURE SENSOR)	ANALOG	INPUT
	16	UNUSED (ENGINE SPEED SENSOR)	FREQUENCY	INPUT
	17	UNUSED (ENGINE SPEED SENSOR GROUND)	GROUND	INPUT
	18	UNUSED (ENGINE GROUND)	GROUND	INPUT
	19	UNUSED (ENGINE GROUND)	GROUND	INPUT
	20	2 SPEED VALVE	DIGITAL	OUTPUT
	21	UNUSED (TOWER ELEVATION SWITCH #2)	DIGITAL	INPUT
	22	GENERATOR ENABLE RELAY	DIGITAL	OUTPUT
	23	BRAKE VALVE	DIGITAL	OUTPUT
	24	UNUSED	N/C	N/C
	25	UNUSED (RS-485 HIGH)	SERIAL	I/O
	26	UNUSED (RS-485 LOW)	SERIAL	I/O
	27	BRAKE / 2 SPEED VALVE GROUND	GROUND	INPUT
	28	ANALYZER POWER	VOLTAGE	OUTPUT
	29	ANALYZER RS-232 RX	SERIAL	INPUT
	30	ANALYZER RS-232 TX	SERIAL	OUTPUT
	31	ANALYZER GROUND	GROUND	INPUT
	32	ALTERNATOR EXCITATION	DIGITAL	OUTPUT
	33	UNUSED (RS-485 GROUND)	GROUND	INPUT
	34	TELESCOPE RETRACTED SWITCH #2	DIGITAL	INPUT
	35	CAPACITY LENGTH SWITCH #2	DIGITAL	INPUT

Connector	Pin	Function	Type	
J8 (Black)	1	MODULE GROUND	GROUND	OUTPUT

Connector	Pin	Function	Type	
	2	MODULE POWER	VBAT	INPUT
	3	GROUND TO PLATFORM MODULE	GROUND	INPUT
	4	POWER TO PLATFORM MODULE	VBAT	OUTPUT

Connector	Pin	Function	Type	
J2 (Gray)	1	STEER DUMP VALVE	DIGITAL	OUTPUT
	2	GROUND ALARM	DIGITAL	OUTPUT
	3	PLATFORM DUMP VALVE #1	DIGITAL	OUTPUT
	4	BYPASS DUMP VALVE	DIGITAL	OUTPUT
	5	PLATFORM LEVEL UP VALVE	DIGITAL	OUTPUT
	6	FUEL SENSOR GROUND	GROUND	INPUT
	7	PLATFORM LEVEL DOWN VALVE	DIGITAL	OUTPUT
	8	FRONT STEER RIGHT/RIGHT TRACK REVERSE VALVE	DIGITAL	OUTPUT
	9	MAIN TELESCOPE IN VALVE	DIGITAL	OUTPUT
	10	UNUSED (PLATFORM ROTATE LEFT VALVE)	DIGITAL	OUTPUT
	11	MAIN LIFT UP VALVE	DIGITAL	OUTPUT
	12	UNUSED (JIB LIFT UP VALVE)	DIGITAL	OUTPUT
	13	MAIN DUMP VALVE	DIGITAL	OUTPUT
	14	UNUSED (MAIN TELESCOPE VALVES GROUND)	GROUND	INPUT
	15	UNUSED (TOWER TELESCOPE OUT VALVE)	DIGITAL	OUTPUT
	16	USED (MAIN TELESCOPE OUT VALVE)	DIGITAL	OUTPUT
	17	UNUSED (PLATFORM ROTATE / JIB LIFT VALVE GROUND)	GROUND	INPUT
	18	STEER DUMP VALVE GROUND	GROUND	INPUT
	19	FRONT LEFT STEER VALVE / RIGHT TRACK FORWARD VALVE	DIGITAL	OUTPUT
	20	MAIN TELESCOPE OUT VALVE	DIGITAL	OUTPUT
	21	AUX MAIN LIFT DOWN VALVE	DIGITAL	OUTPUT
	22	MAIN LIFT DOWN VALVE	DIGITAL	OUTPUT
	23	PLATFORM DUMP VALVE #2	DIGITAL	OUTPUT
	24	CONFIGURATION #2	DIGITAL	INPUT
	25	FUEL SENSOR	ANALOG	INPUT
	26	HEAD / TAIL LIGHT ENABLE RELAY	DIGITAL	OUTPUT
	27	GROUND ALARM / HORN	DIGITAL	OUTPUT
	28	STEER VALVES GROUND	GROUND	INPUT
	29	GROUND ALARM / HORN GROUND	GROUND	INPUT
	30	MAIN/TELESCOPE IN/ BYPASS DUMP VALVE GROUND	GROUND	INPUT
	31	TELESCOPE IN DUMP VALVE	DIGITAL	OUTPUT
	32	REAR STEER RIGHT VALVE	DIGITAL	OUTPUT
	33	REAR STEER LEFT VALVE	DIGITAL	OUTPUT

Connector	Pin	Function	Type	
	34	SWING LEFT VALVE	DIGITAL	OUTPUT
	35	SWING RIGHT VALVE	DIGITAL	OUTPUT

Connector	Pin	Function	Type	
J12 (Black)	1	UNUSED	FREQUENCY	INPUT
	2	UNUSED	FREQUENCY	INPUT
	3	CAN2 HIGH	SERIAL	I/O
	4	CAN2 LOW	SERIAL	I/O
	5	UNUSED (CAN2 SHIELD)	GROUND	INPUT
	6	CAN2 TERMINATOR	TERM	I/O
	7	CAN2 TERMINATOR	TERM	I/O
	8	MSSO SWITCH	DIGITAL	INPUT

Connector	Pin	Function	Type	
J3 (Black)	1	DRIVE/ LEFT TRACK DRIVE VALVES CURRENT FEEDBACK	GROUND	INPUT
	2	AUX DOWN / RIGHT TRACK DRIVE VALVES CURRENT FEEDBACK	GROUND	INPUT
	3	WIRE ROPE SERVICE SWITCH GROUND	GROUND	INPUT
	4	SWING VALVES CURRENT FEEDBACK	GROUND	INPUT
	5	AUX DOWN VALVES CURRENT FEEDBACK	GROUND	INPUT
	6	TELESCOPE FLOW CONTROL VALVES CURRENT FEEDBACK	GROUND	INPUT
	7	GROUND ALARM POWER	VBAT	OUTPUT
	8	WIRE ROPE SERVICE SWITCH	DIGITAL	INPUT
	9	CRIBBING ENABLE SWITCH	DIGITAL	INPUT
	10	UNUSED	DIGITAL	INPUT
	11	CONFIGURATION #1	DIGITAL	INPUT
	12	UNUSED	VOLTAGE	OUTPUT
	13	UNUSED	ANALOG	INPUT
	14	MAIN LIFT VALVES CURRENT FEEDBACK	GROUND	INPUT

Connector	Pin	Function	Type	
J4 (Blue)	1	CRIBBING ENGAGED INDICATOR	DIGITAL	OUTPUT
	2	SYSTEM DISTRESS INDICATOR	DIGITAL	OUTPUT
	3	GLOW PLUG INDICATOR	DIGITAL	OUTPUT
	4	ENGINE START SWITCH	DIGITAL	INPUT
	5	PLATFORM LEVEL DOWN SWITCH	DIGITAL	INPUT
	6	PLATFORM ROTATE LEFT SWITCH	DIGITAL	INPUT
	7	MAIN TELESCOPE IN SWITCH	DIGITAL	INPUT
	8	JIB LIFT DOWN SWITCH	DIGITAL	INPUT
	9	UNUSED (JIB LEFT SWITCH)	DIGITAL	INPUT

Connector	Pin	Function	Type	
	10	UNUSED (TOWER LIFT UP SWITCH)	DIGITAL	INPUT
	11	UNUSED (TOWER TELESCOPE IN SWITCH)	DIGITAL	INPUT
	12	UNUSED (HOUR METER)	DIGITAL	OUTPUT
	13	LOW FUEL INDICATOR	DIGITAL	OUTPUT
	14	PLATFORM OVERLOADED INDICATOR	DIGITAL	OUTPUT
	15	UNUSED (UMS INDICATOR)	DIGITAL	OUTPUT
	16	AUXILIARY POWER / FUNCTION ENABLE	DIGITAL	INPUT
	17	PLATFORM LEVEL UP SWITCH	DIGITAL	INPUT
	18	PLATFORM ROTATE RIGHT SWITCH	DIGITAL	INPUT
	19	JIB LIFT UP SWITCH	DIGITAL	INPUT
	20	UNUSED (JIB RIGHT SWITCH)	DIGITAL	INPUT
	21	UNUSED (TOWER LIFT DOWN SWITCH)	DIGITAL	INPUT
	22	UNUSED (TOWER TELESCOPE OUT SWITCH)	DIGITAL	INPUT
	23	MAIN LIFT UP SWITCH	DIGITAL	INPUT
	24	UNUSED	VBAT	OUTPUT
	25	SWITCHES POWER	VBAT	OUTPUT
	26	BATTERY LOW / NOT CHARGING INDICATOR	DIGITAL	OUTPUT
	27	UNUSED	DIGITAL	OUTPUT
	28	UNUSED	DIGITAL	OUTPUT
	29	CHECK ENGINE INDICATOR	DIGITAL	OUTPUT
	30	MAIN TELESCOPE OUT SWITCH	DIGITAL	INPUT
	31	INDICATORS GROUND	GROUND	INPUT
	32	INDICATORS GROUND	GROUND	INPUT
	33	MAIN LIFT DOWN SWITCH	DIGITAL	INPUT
	34	SWING LEFT SWITCH	DIGITAL	INPUT
	35	SWING RIGHT SWITCH	DIGITAL	INPUT

Connector	Pin	Function	Type	
J7 (Black)	1	PLATFORM EMS	DIGITAL	INPUT
	2	PLATFORM MODE	DIGITAL	INPUT
	3	GROUND MODE	DIGITAL	INPUT
	4	BOOM ANGLE SENSOR #1	ANALOG	INPUT
	5	UNUSED (ENGINE SPEED SENSOR)	VOLTAGE	OUTPUT
	6	CAN1 TERMINATOR	TERM	I/O
	7	BOOM ANGLE SENSOR #2	ANALOG	INPUT
	8	UNUSED	ANALOG	INPUT
	9	BOOM ANGLE SENSOR GROUND	GROUND	INPUT
	10	TILT SENSOR GROUND	GROUND	INPUT

Connector	Pin	Function	Type	
	11	UNUSED (TOWER ELEVATION SWITCH #1)	DIGITAL	INPUT
	12	UNUSED (OSCILLATING AXLE SWING SWITCH #1)	DIGITAL	INPUT
	13	CAN1 HIGH	SERIAL	I/O
	14	GROUND MODE POWER TO PLATFORM	DIGITAL	INPUT
	15	FOOTSWITCH	DIGITAL	INPUT
	16	BOOM ANGLE SENSOR POWER	VOLTAGE	OUTPUT
	17	CAN1 TERMINATOR	TERM	I/O
	18	UNUSED (CAN1 SHIELD)	GROUND	INPUT
	19	IGNITION RELAY GROUND	GROUND	INPUT
	20	UNUSED (OSCILLATING AXLE SWING SWITCH #2)	ANALOG	INPUT
	21	TELESCOPE RETRACTED SWITCH #1	DIGITAL	INPUT
	22	UNUSED	DIGITAL	INPUT
	23	CAPACITY LENGTH SWITCH #1	DIGITAL	INPUT
	24	CAN1 LOW	SERIAL	I/O
	25	GROUND DISPLAY GROUND	GROUND	INPUT
	26	UNUSED	VOLTAGE	OUTPUT
	27	UNUSED	VOLTAGE	OUTPUT
	28	TELESCOPE RETRACTED SWITCH GROUND	GROUND	INPUT
	29	GROUND DISPLAY POWER	VBAT	OUTPUT
	30	UNUSED	VBAT	OUTPUT
	31	WIRE ROPE SERVICE SWITCH POWER	VBAT	OUTPUT
	32	TRANSPORT SWITCHES POWER	VBAT	OUTPUT
	33	TELESCOPE RETRACTED SWITCH POWER	VBAT	OUTPUT
	34	TILT SENSOR POWER	VBAT	OUTPUT
	35	DOS SWITCH	DIGITAL	INPUT

Connector	Pin	Function	Type	
J14 (Gray)	1	CAN HIGH CH3	SERIAL	I / O
	2	CAN LOW CH3	SERIAL	I / O
	3	CAN CH3 TERMINATOR	TERM	I / O
	4	CAN CH3 TERMINATOR	TERM	I / O
	5	GROUND	GROUND	INPUT
	6	GROUND	GROUND	INPUT
	7	LS DIGITAL INPUT 7	DIGITAL	INPUT
	8	HS DIGITAL INPUT 29	DIGITAL	INPUT
	9	ME DIGITAL OUTPUT 19	DIGITAL	OUTPUT
	10	ME DIGITAL OUTPUT 20	DIGITAL	OUTPUT
	11	CURRENT LIMITED VBAT (200 mA)	VBAT	OUTPUT

Connector	Pin	Function	Type	
	12	GROUND	GROUND	INPUT
	13	CAN HIGH CH1	SERIAL	I / O
	14	CAN LOW CH1	SERIAL	I / O

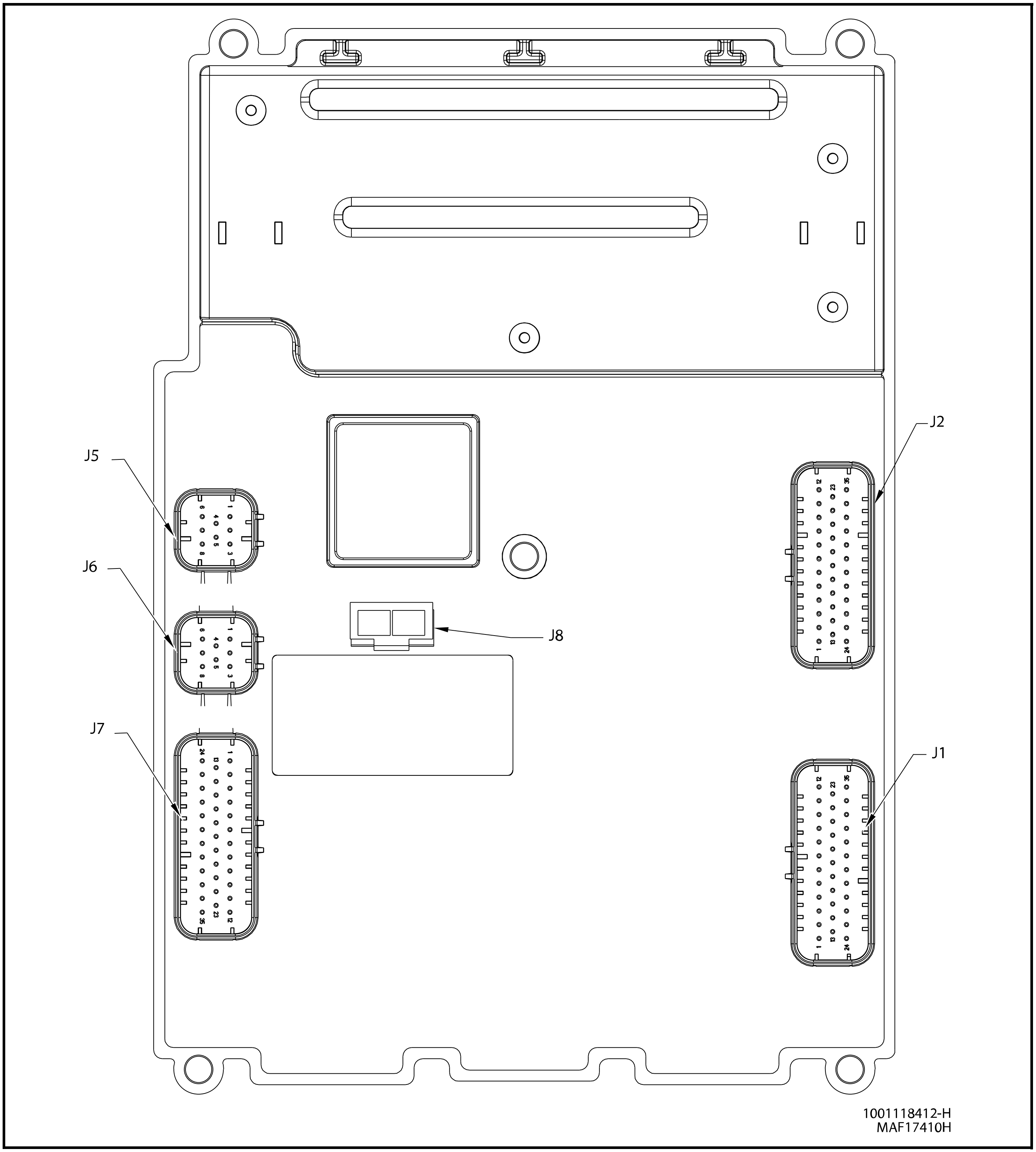


Figure 239. Platform Control Module

Connector	Pin	Assignment	Function
J1 NATURAL	1	TOWER LIFT UP SWITCH	DIGITAL INPUT
	2	TOWER LIFT DOWN SWITCH	DIGITAL INPUT
	3	UNUSED(TOWER TELESCOPE IN SWITCH)	DIGITAL INPUT
	4	UNUSED(TOWER TELESCOPE OUT SWITCH)	DIGITAL INPUT
	5	MAIN TELESCOPE IN SWITCH	DIGITAL INPUT
	6	MAIN TELESCOPE OUT SWITCH	DIGITAL INPUT
	7	PLATFORM ROTATE RIGHT SWITCH	DIGITAL INPUT
	8	PLATFORM ROTATE LEFT SWITCH	DIGITAL INPUT
	9	PLATFORM LEVEL UP SWITCH	DIGITAL INPUT
	10	PLATFORM LEVEL DOWN SWITCH	DIGITAL INPUT
	11	JIB LIFT UP SWITCH	DIGITAL INPUT
	12	JIB LIFT DOWN SWITCH	DIGITAL INPUT
	13	SPEED PUMP POTENTIOMETER GROUND	GROUND
	14	ENGINE START SWITCH	DIGITAL INPUT
	15	AUXILIARY POWER SWITCH	DIGITAL INPUT
	16	UNUSED(CRAB STEER SELECT SWITCH)	DIGITAL INPUT
	17	UNUSED(COORDINATED STEER SELECT SWITCH)	DIGITAL INPUT
	18	SWITCH POWER	BATTERY VOLTAGE
	19	UNUSED	DIGITAL INPUT
	20	SOFTTOUCH SWITCH	DIGITAL INPUT
	21	UNUSED (CAPACITY SELECT SWITCH)	DIGITAL INPUT
	22	UNUSED	DIGITAL INPUT
	23	SKYGUARD INPUT#2 SWITCH	DIGITAL INPUT
	24	UNUSED	DIGITAL INPUT
	25	UNUSED	DIGITAL INPUT
	26	UNUSED	DIGITAL INPUT
	27	MAX SPEED SWITCH	DIGITAL INPUT
	28	MAX TORQUE SWITCH	DIGITAL INPUT
	29	SOFTTOUCH/SKYGUARD OVERRIDE BUTTON	DIGITAL INPUT
	30	HEAD/TAILLIGHT SWITCH	DIGITAL INPUT
	31	HORN BUTTON	DIGITAL INPUT
	32	CREEP SWITCH	DIGITAL INPUT
	33	FUEL SELECT SWITCH	DIGITAL INPUT
	34	SPEED PUMP POTENTIOMETER POWER	+7 REFERENCE VOLTAGE
	35	SPEED PUMP POTENTIOMETER SIGNAL	DIGITAL INPUT

Connector	Pin	Assignment	Function
J2 GRAY	1	UNUSED(JIB RIGHT SWITCH)	DIGITAL INPUT
	2	UNUSED(JIB LEFT SWITCH)	DIGITAL INPUT
	3	UNUSED(POWER)	HS DIGITAL INPUT
	4	DOS OVERRIDE SWITCH	HS DIGITAL INPUT
	5	UNUSED	LAMP OUTPUT
	6	CHASSIS TILTED INDICATOR	LAMP OUTPUT
	7	FUNCTION ENABLE INDICATOR	LAMP OUTPUT
	8	VEHICLE SYSTEM DISTRESS INDICATOR	LAMP OUTPUT
	9	CREEP SPEED INDICATOR	LAMP OUTPUT
	10	UNUSED(BROKEN CABLE INDICATOR)	LAMP OUTPUT
	11	PLATFORM OVERLOADED INDICATOR	LAMP OUTPUT
	12	500/600 LB CAPACITY INDICATOR	LAMP OUTPUT
	13	1000 LB CAPACITY INDICATOR	LAMP OUTPUT
	14	DOS INDICATOR	LAMP OUTPUT
	15	GENERATOR ON INDICATOR	LAMP OUTPUT
	16	SOFTTOUCH/SKYGUARD INDICATOR	LAMP OUTPUT
	17	GLOW PLUG ENGAGED INDICATOR	LAMP OUTPUT
	18	INDICATOR GROUND	GROUND
	19	UNUSED(LOW BATTERY INDICATOR)	LAMP OUTPUT
	20	UNUSED	LAMP OUTPUT
	21	LOW FUEL INDICATOR	LAMP OUTPUT
	22	1/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	23	3/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	24	1/2 FUEL LEVEL INDICATOR	LAMP OUTPUT
	25	INDICATOR GROUND	GROUND
	26	ANALYZER POWER	ANALYZER POWER
	27	ANALYZER GROUND	ANALYZER GROUND
	28	ANALYZER RX	ANALYZER RX
	29	ANALYZER TX	ANALYZER TX
	30	UNUSED (POWER)	BATTERY VOLTAGE
	31	SOFTTOUCH POWER	BATTERY VOLTAGE
	32	LSS POWER	BATTERY VOLTAGE
	33	OPTION POWER	BATTERY VOLTAGE
	34	UNUSED(POWER)	BATTERY VOLTAGE
	35	FULL FUEL LEVEL INDICATOR	LAMP OUTPUT

Connector	Pin	Assignment	Function
J8	1	MODULE GROUND	GROUND

Connector	Pin	Assignment	Function
	2	MODULE POWER	BATTERY VOLTAGE

Connector	Pin	Assignment	Function
J5 NATURAL	1	LIFT/SWING JOYSTICK POWER	SUPPLY VOLTAGE
	2	LIFT CENTER TAP	INPUT
	3	LIFT SIGNAL	INPUT
	4	SWING SIGNAL	INPUT
	5	SWING CENTER TAP	INPUT
	6	UNUSED	INPUT
	7	LIFT/ SWING JOYSTICK GROUND	GROUND
	8	UNUSED(GROUND)	GROUND

Connector	Pin	Assignment	Function
J6 BLACK	1	DRIVE / STEER JOYSTICK POWER	SUPPLY VOLTAGE
	2	DRIVE CENTE RTAP	INPUT
	3	DRIVE SIGNAL	INPUT
	4	STEER SIGNAL	INPUT
	5	STEER LEFT	INPUT
	6	STEER RIGHT	INPUT
	7	DRIVE/ STEER JOYSTICK GROUND	GROUND
	8	UNUSED(GROUND)	GROUND

Connector	Pin	Assignment	Function
J7 BLACK	1	GROUND MODE	GROUND MODE
	2	PLATFORM EMS	PLATFORM EMS
	3	PLATFORM EMSTO GROUND MODULE	PLATFORM MODE
	4	FOOT SWITCH POWER	BATTERY VOLTAGE
	5	GENERATOR SWITCH POWER	BATTERY VOLTAGE
	6	UNUSED (JIB BLOCK LIMIT SWITCH POWER)	BATTERY VOLTAGE
	7	SKYGUARD POWER	BATTERY VOLTAGE
	8	FOOT SWITCH DISENGAGE	DIGITAL INPUT
	9	GENERATOR SWITCH	DIGITAL INPUT
	10	UNUSED(+7 VOLTS)	+7 REFERENCE VOLTAGE
	11	UNUSED	ANALOG INPUT
	12	UNUSED	ANALOG INPUT
	13	UNUSED	ANALOG INPUT
	14	UNUSED(GROUND)	GROUND
	15	UNUSED(+7 VOLTS)	+7 REFERENCE VOLTAGE

Connector	Pin	Assignment	Function
	16	LSS GROUND	GROUND
	17	UNUSED(JIB BLOCK LIMIT SWITCH)	HS DIGITAL INPUT
	18	SKYGUARD INPUT #1 SWITCH	HS DIGITAL INPUT
	19	PLATFORM ALARM	LAMP OUTPUT
	20	PLATFORM ALARM GROUND	GROUND
	21	UNUSED (PLATFORM LEVEL UP VALVE)	ME DIGITAL OUTPUT
	22	UNUSED(PLATFORM LEVEL DOWN VALVE)	ME DIGITAL OUTPUT
	23	VALVES GROUND	GROUND
	24	SKYGUARD GROUND	GROUND
	25	JIB UP VALVE	ME DIGITAL OUTPUT
	26	JIB DOWN VALVE	ME DIGITAL OUTPUT
	27	UNUSED (JIB RIGHT VALVE)	ME DIGITAL OUTPUT
	28	UNUSED (JIB LEFT VALVE)	ME DIGITAL OUTPUT
	29	OPTION GROUND	GROUND
	30	CAN LOW	CAN LOW
	31	CAN HIGH	CAN HIGH
	32	CAN SHIELD	CAN SHIELD
	33	PLATFORM ROTATE LEFT VALVE	ME DIGITAL OUTPUT
	34	PLATFORM ROTATE RIGHT VALVE	ME DIGITAL OUTPUT
	35	UNUSED(GROUND)	GROUND

Table 79. Machine Configuration Programming Information (Software Version P2.22)

Configuration Label/Digit	Number	Description	Default Number
Note: 1. The machine configuration must be completed before any personality settings can be changed. Changing personality settings first and then changing the model number of the machine configuration will cause personality settings to return to default. 2. Select Market as CE for UKCA specification machine on Analyzer.			
MODEL NUMBER:	0	????: Visible only on a Non-Configured UGM	
1	**1**	**400S: For 400S / 400S HC3 / 460SJ / 460SJ HC3**	**1**
	2	400SC: For 400SC / 460SJC	
	3	450AJ: For 450A / 450AJ / 520AJ/ 520AJ HC3	
MARKET:	**1**	**ANSI USA**	**1**
2*	2	ANSI EXPORT	
	3	CSA	
	4	CE	
	5	AUSTRALIA	
	6	MOL70	
	7	GB	
	8	EAC	
* Certain model selection will limit market option.			
ENGINE:	1	KUBOTA D1105	
3*	2	GM DUAL FUEL: GM/PSI 0.97 Dual Fuel (Tier 3)	
	3	KUBOTA DUAL FUEL	
	4	FORD DUAL FUEL	
	5	**DEUTZ EMR2: (Tier 4i)**	**5**
	6	DEUTZ EMR4: (Tier 4f)	
	7	DZD29 E5 X-36: (Deutz D26 Stage V 36kW)	
	8	DZTD22 E5 X-36: (Deutz TD22 Stage V 36kW)	
	9	DZTD29 E5 X-50: (Deutz TD26 Stage V 50kW)	
* Certain model selections will limit engine options. * Certain market selection will limit engine options.			
STARTER LOCKOUT:	**1**	**DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.**	**1**
4*	2	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	
*Only visible for Diesel Engine Selection			

Table 79. Machine Configuration Programming Information (Software Version P2.22) (continued)

Configuration Label/Digit	Number	Description	Default Number
ENGINE SHUTDOWN:	1	DISABLED: No engine shutdown.	
5	**2**	**ENABLED: Shutdown engine for high coolant temperature fault or low oil pressure fault.**	**2**
FUEL CUTOUT:	1	ONE RESTART: One restart with limited run time when near Empty.	
6*	2	ENGINE STOP: No starting permitted when near Empty.	
	3	NONE	
	4	**RESTART: Restarts allowed with limited run time when near Empty.**	**4**
*Only visible for Diesel Engine Selection			
JIB:	**1**	**NO: No jib installed.**	**1**
7*	2	YES: Jib installed, which has up and down movements only.	
* Certain model selections will limit visibility			
CAPACITY:	1	SINGLE: Single Capacity system installed.	
8*	**2**	**DUAL: Dual Capacity system installed.**	**2**
	3	TRIPLE: Triple Capacity system installed.	
* Certain model selections will limit visibility.			
* Certain model selections will limit capacity options.			
*Certain market selections will limit capacity options.			
TILT:	1	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.	
9*	2	4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep.	
	3	3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep.	
	4	5 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also disallows tower lift up, drive, telescope out and lift up.	
	5	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, drive, telescope out and lift up.	
	6	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, drive, telescope out and lift up.	

Table 79. Machine Configuration Programming Information (Software Version P2.22) (continued)

Configuration Label/Digit	Number	Description	Default Number
	7	**5 DEG + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.**	**7**
	8	4 DEG + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
	9	3 DEG + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
*Certain market selections will limit tilt options or alter default setting.			
4 WHEEL STEER:	**1**	**NO: 4 Wheel Steer not installed.**	**1**
10*	2	YES: 4 Wheel Steer installed.	
*Certain model selections will limit visibility.			
SOFT TOUCH:	**1**	**NO: No Soft Touch system installed.**	**1**
11*	2	YES: Soft Touch system installed.	
*Certain model selections will limit visibility.			
SKYGUARD:	1	NO: No SkyGuard system installed.	
12	**2**	**BAR/SKYLINE: SkyGuard system installed.**	**2**
	3	SKYEYE: SkyGuard system installed	
GEN SET/WELDER:	**1**	**NO: No generator installed.**	**1**
13	2	BELT DRIVE: Belt driven setup.	
GEN SET CUTOUT:	**1**	**MOTION ENABLED: Motion enabled when generator is ON.**	**1**
14*	2	MOTION CUTOUT: Motion cutout in platform mode only.	
* Only visible if gen set / welder selection is not NO.			
H & T LIGHTS:	**1**	**NO: No head and tail lights installed.**	**1**
15	2	YES: Head and tail lights installed.	
LOAD SYSTEM:	1	NO: No load sensor installed.	
16*	2	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	

Table 79. Machine Configuration Programming Information (Software Version P2.22) (continued)

Configuration Label/Digit	Number	Description	Default Number
	3	**CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).**	**3**
	4	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
* Certain market selections will limit load system options or alter default setting.			
FUNCTION CUTOUT:	**1**	**NO: No drive cutout.**	**1**
17*	2	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	3	DRIVE CUTOUT: Drive & steer cutout above elevation.	
	4	DRIVE CUT E/T: Drive & steer cutout above elevation or telescoped.	
* Certain market selections will limit function cutout options or alter default setting.			
GROUND ALARM:	1	NO: No ground alarm installed.	
18	2	DRIVE: Travel alarm sounds when the drive function is active.	
	3	DESCENT: Descent alarm sounds when lift down is active.	
	4	**MOTION: Motion alarm sounds when any function is active.**	**4**
DRIVE TYPE:	**1**	**4WD: 4 wheel drive.**	**1**
19*	2	2WD: 2 wheel drive.	
* Certain model selections will limit visibility.			
DISPLAY UNITS:	1	METRIC: Celsius, Kilograms, KiloPascal.	
20*	**2**	**IMPERIAL: Fahrenheit, Pounds, Pounds/in^2**	**2**
* Certain market selections will alter default setting.			
CLEARSKY:	**1**	**NO: ClearSky (telematics) options is disabled.**	**1**
21	2	YES: ClearSky (telematics) option is enabled.	
CRIBBING OPTION:	**1**	**NO: Cribbing Option is disabled.**	**1**
22*	2	YES: Cribbing Option is enabled.	
* Certain model selections will limit visibility.			
ALERT BEACON:	**1**	**OFF FOR CREEP**	**1**
23	2	IN CREEP 20FPM	
TEMP CUTOUT:	**1**	**NO: No Low Temp Cutout system installed.**	**1**

Table 79. Machine Configuration Programming Information (Software Version P2.22) (continued)

Configuration Label/Digit	Number	Description	Default Number
24*	2	YES: Low Temp Cutout system installed.	
* Only visible under certain market selection.			
PLAT LVL OVR CUT:	**1**	**NO: Platform Level functions above elevation.**	**1**
25	2	YES: Platform Level does not function above elevation.	
ALARM / HORN:	1	SEPARATE: Ambient alarm installed.	
26	**2**	**COMBINED: Single Horn / Alarm installed.**	**2**
WATER IN FUEL SENSOR:	**1**	**NO: Water in Fuel Sensor is not installed**	**1**
27*	2	YES: Water in Fuel Sensor is installed	
*Only visible if engine selection is Deutz EMR4.			
LIFT CYL WITH	1	NONE: No additional Lift Down Valves installed.	
28*	**2**	**AUX VALVE: Lift Down Aux Valve is installed.**	**2**
	3	ENABLE VALVE: Lift Down Enable Valve is installed.	
* Certain model selections will limit visibility.			
GROUND DISPLAY	1	NO: No Ground Display installed.	
29*	2	MDI: MDI display installed.	
	3	**MONO LCD DISP: Kongsburg Ground Display installed.**	**3**
* Certain model selections will limit visibility.			

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Note: Select Market as CE for UKCA specification machine on Analyzer.

Table 80. Machine Configuration Programming Settings - 450A (Software Version P2.22)

450A	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB	EAC
Model Number	3	3	3	3	3	3	3	3
Market	1	2	3	4	5	6	7	8
Engine	X	X	X	X	X	X	X	X
	2	2	2	X	X	2	X	X
	3	3	3	X	X	3	X	X
	X	X	X	X	X	X	X	X
	5	5	5	5	5	5	5	5
	6	6	6	6	6	6	6	6
	X	X	X	7	X	X	X	X
	X	X	X	X	X	X	X	X

Table 80. Machine Configuration Programming Settings - 450A (Software Version P2.22) (continued)

450A	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB	EAC
	X	X	X	X	X	X	X	X
Starter Lockout	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Engine Shutdown	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Fuel Cutout	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
	X	X	X	X	X	X	X	X
	4	4	4	4	4	4	4	4
Jib	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Capacity	1	1	1	1	1	1	1	1
	X	X	X	X	X	X	X	X
	3	3	3	3	3	3	3	3
Tilt	X	X	X	X	X	1	X	X
	X	X	X	X	X	2	X	X
	X	X	X	X	X	3	X	X
	4	4	4	4	4	4	4	4
	5	5	5	5	5	5	5	5
	6	6	6	6	6	6	6	6
	7	7	7	7	7	7	7	7
	8	8	8	8	8	8	8	8
	9	9	9	9	9	9	9	9
4 Wheel Steer	1	1	1	1	1	1	1	1
	X	X	X	X	X	X	X	X
Soft Touch	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
SkyGuard	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
	3	3	3	3	3	3	3	3
Gen Set / Welder	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Gen Set Cutout	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Head & Taillights	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Load System	X	X	X	X	X	X	X	X
	X	X	X	X	X	X	X	X

Table 80. Machine Configuration Programming Settings - 450A (Software Version P2.22) (continued)

450A	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB	EAC
	3	**3**	**3**	X	**3**	**3**	**3**	X
	4	4	4	**4**	X	4	4	**4**
Function Cutout	**1**	**1**	**1**	X	**1**	**1**	**1**	X
	X	2	2	**2**	2	2	2	**2**
	3	3	3	X	3	3	3	X
	X	X	X	X	X	X	X	X
Ground Alarm	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
	3	3	3	3	3	3	3	3
	4	**4**	**4**	**4**	**4**	**4**	**4**	**4**
Drive Type	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2	2
Display Units	1	1	**1**	**1**	**1**	**1**	**1**	**1**
	2	**2**	2	2	2	2	2	2
Clearsky	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2	2
Cribbing Option	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	X	X	2	X	X
Alert Beacon	**1**	**1**	**1**	**1**	1	**1**	**1**	**1**
	2	2	2	2	**2**	2	2	2
Temp Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	X	2	X	2	X	X	2	2
Plat Lvl Ovr Cut	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2	2
Alarm/Horn	1	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**	**2**
Water In Fuel Sensor	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2	2
Lift Cyl With	X	X	X	X	X	X	X	X
	2	**2**	**2**	**2**	**2**	**2**	**2**	**2**
	X	X	X	X	X	X	X	X
Ground Display	1	1	1	X	1	1	1	1
	X	X	X	X	X	X	X	X
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**
BOLD BLUE indicates the default setting. Plain text indicates another available selection. **RED** indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.								

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Note: Select Market as CE for UKCA specification machine on Analyzer.

Table 81. Machine Configuration Programming Settings - 450AJ (Software Version P2.22)

450AJ	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB	EAC
Model Number	3	3	3	3	3	3	3	3
Market	1	2	3	4	5	6	7	8
Engine	X	X	X	X	X	X	X	X
	2	2	2	X	X	2	X	X
	3	3	3	X	X	3	X	X
	X	X	X	X	X	X	X	X
	5	5	5	5	5	5	5	5
	6	6	6	6	6	6	6	6
	X	X	X	7	X	X	X	X
	X	X	X	X	X	X	X	X
	X	X	X	X	X	X	X	X
Starter Lockout	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Engine Shutdown	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Fuel Cutout	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
	X	X	X	X	X	X	X	X
	4	4	4	4	4	4	4	4
Jib	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Capacity	1	1	1	1	1	1	1	1
	X	X	X	X	X	X	X	X
	3	3	3	3	3	3	3	3
Tilt	X	X	X	X	X	1	X	X
	X	X	X	X	X	2	X	X
	X	X	X	X	X	3	X	X
	4	4	4	4	4	4	4	4
	5	5	5	5	5	5	5	5
	6	6	6	6	6	6	6	6
	7	7	7	7	7	7	7	7
	8	8	8	8	8	8	8	8
	9	9	9	9	9	9	9	9
4 Wheel Steer	1	1	1	1	1	1	1	1
	X	X	X	X	X	X	X	X
Soft Touch	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2

Table 81. Machine Configuration Programming Settings - 450AJ (Software Version P2.22) (continued)

450AJ	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB	EAC
SkyGuard	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
	3	3	3	3	3	3	3	3
Gen Set / Welder	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Gen Set Cutout	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Head & Taillights	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Load System	X	X	X	X	X	X	X	X
	X	X	X	X	X	X	X	X
	3	3	3	X	3	3	3	X
	4	4	4	4	X	4	4	4
Function Cutout	1	1	1	X	1	1	1	X
	X	2	2	2	2	2	2	2
	3	3	3	X	3	3	3	X
	X	X	X	X	X	X	X	X
Ground Alarm	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
	3	3	3	3	3	3	3	3
	4	4	4	4	4	4	4	4
Drive Type	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Display Units	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Clearsky	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Cribbing Option	1	1	1	1	1	1	1	1
	2	2	2	X	X	2	X	X
Alert Beacon	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Temp Cutout	1	1	1	1	1	1	1	1
	X	2	X	2	X	X	2	2
Plat Lvl Ovr Cut	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Alarm/Horn	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2
Water In Fuel Sensor	1	1	1	1	1	1	1	1

Table 81. Machine Configuration Programming Settings - 450AJ (Software Version P2.22) (continued)

450AJ	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB	EAC
	2	2	2	2	2	2	2	2
Lift Cyl With	X	X	X	X	X	X	X	X
	2	**2**	**2**	**2**	**2**	**2**	**2**	**2**
	X	X	X	X	X	X	X	X
Ground Display	1	1	1	X	1	1	1	1
	X	X	X	X	X	X	X	X
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**
BOLD TEXT indicates the default setting. Plain text indicates another available selection. **RED** indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.								

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Note: Select Market as CE for UKCA specification machine on Analyzer.

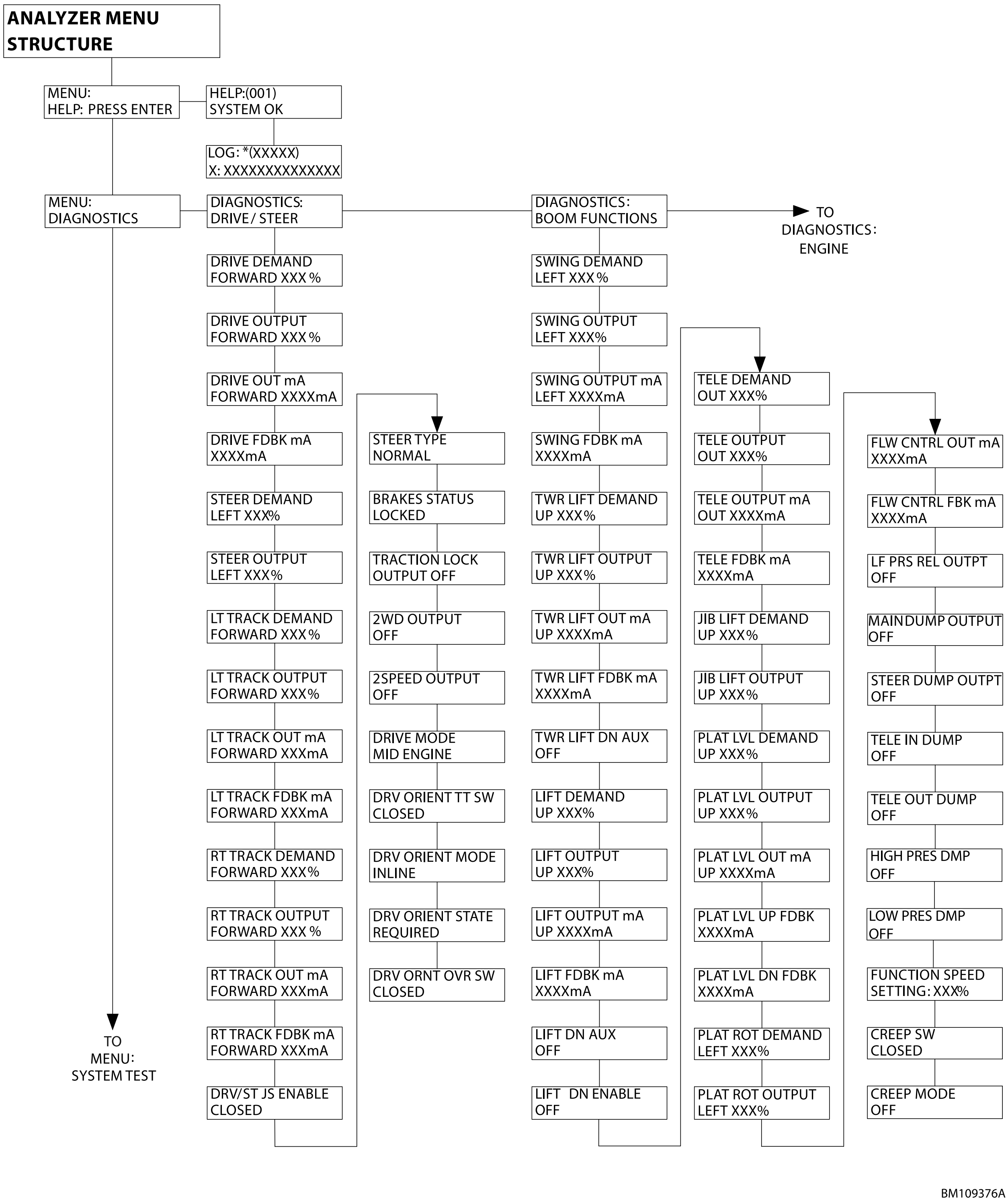


Figure 240. Analyzer Flow Chart (Software Version P2.22) - Sheet 1 of 17

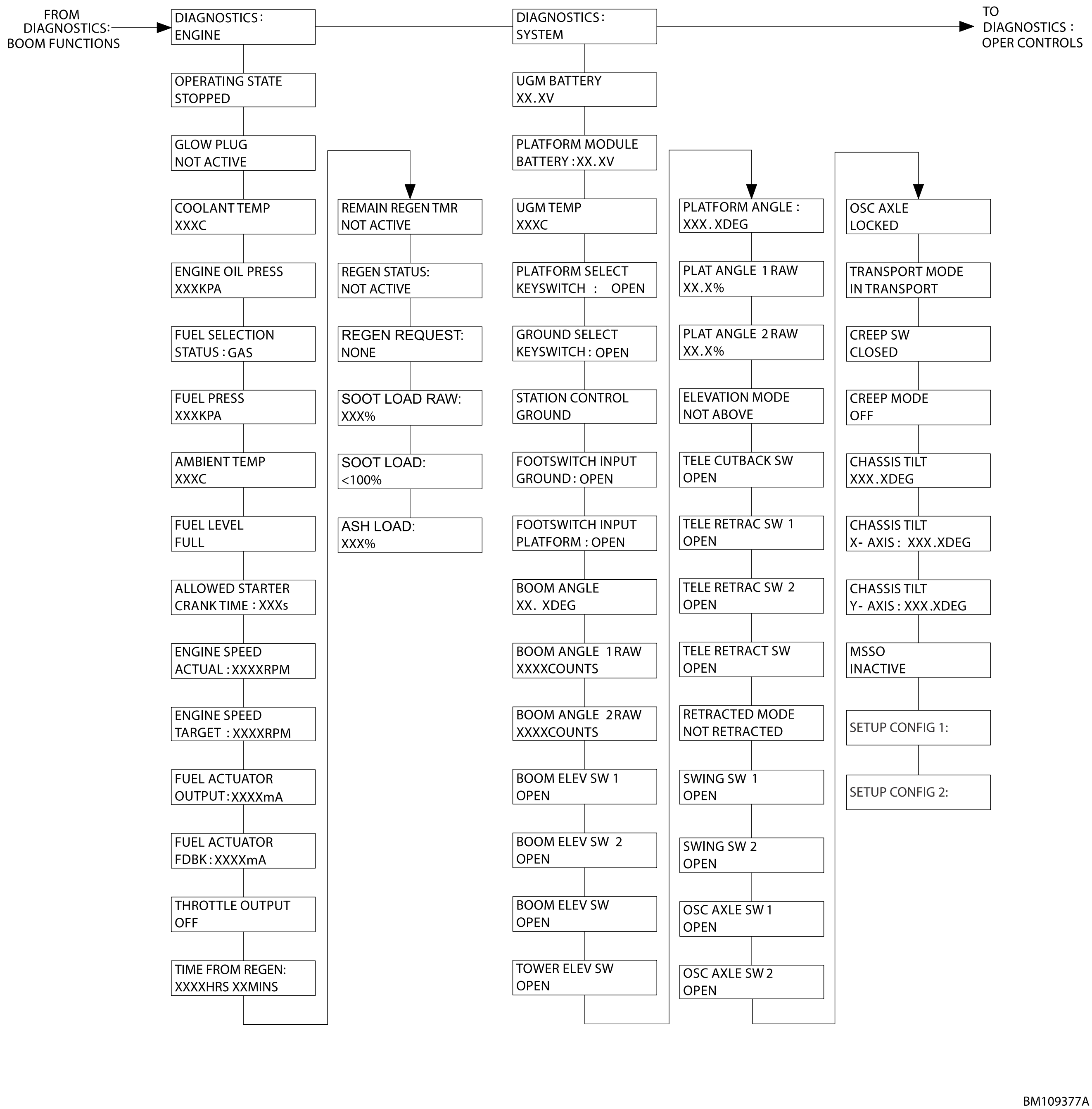


Figure 241. Analyzer Flow Chart (Software Version P2.22) - Sheet 2 of 17

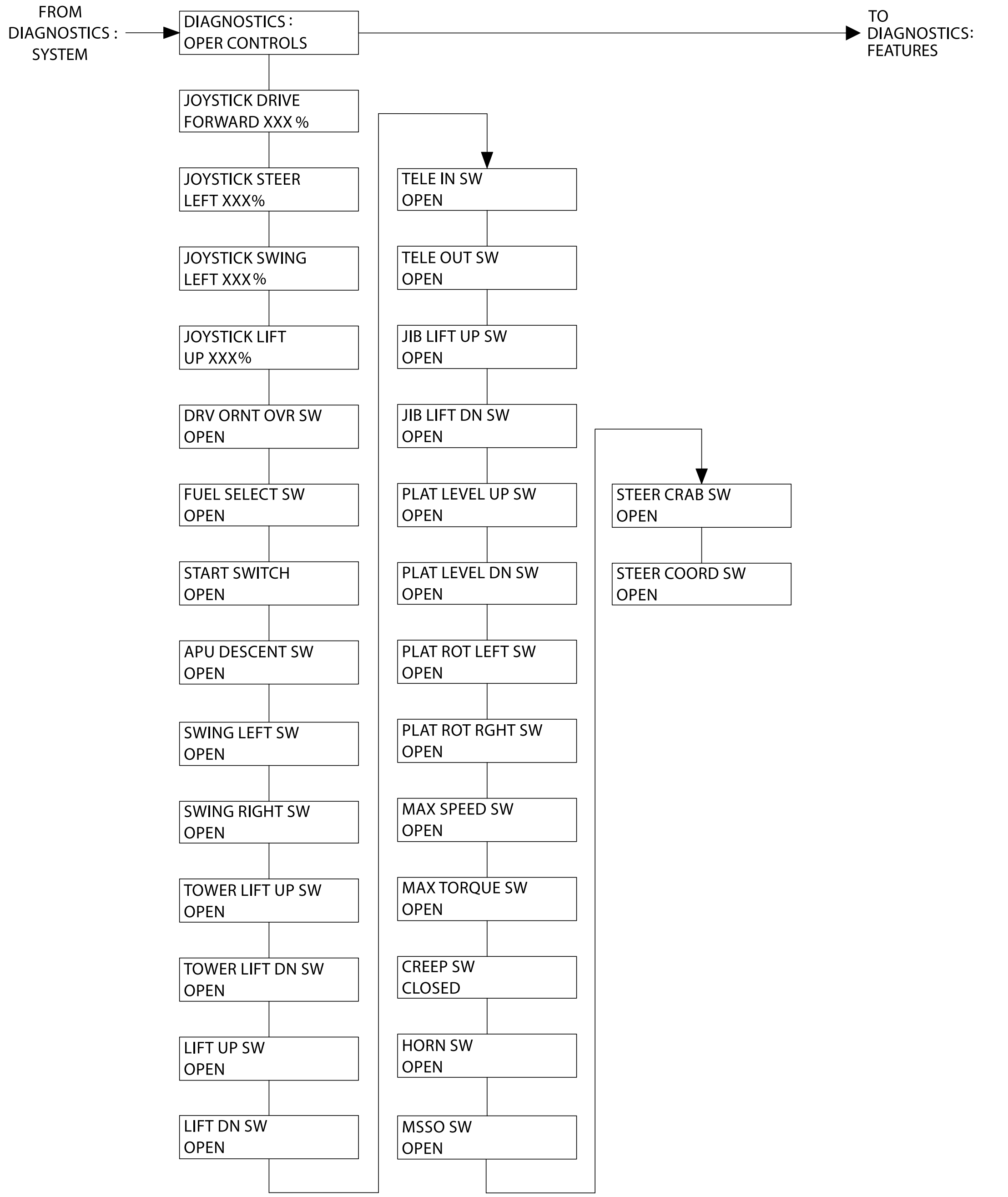


Figure 242. Analyzer Flow Chart (Software Version P2.22) - Sheet 3 of 17

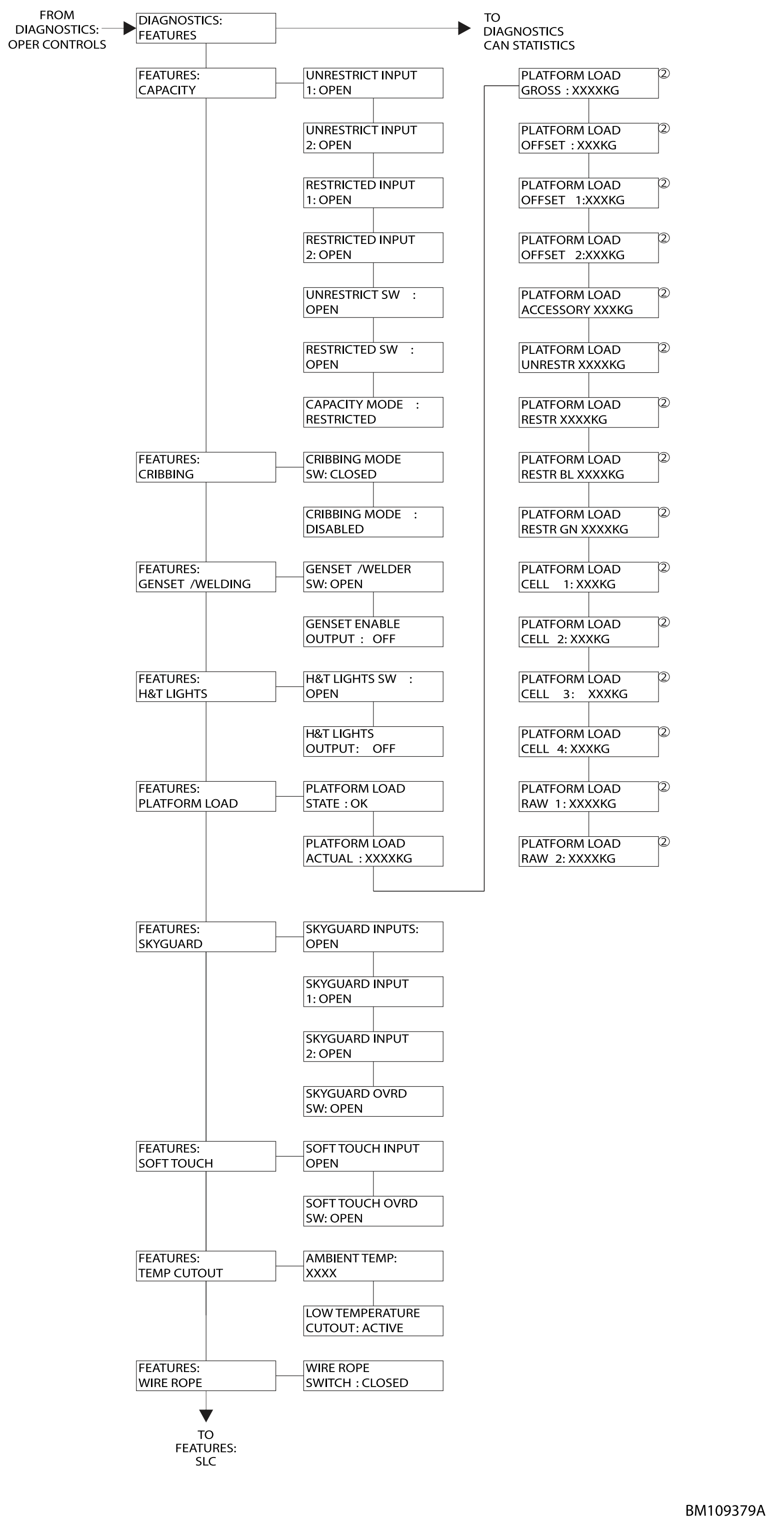


Figure 243. Analyzer Flow Chart (Software Version P2.22) - Sheet 4 of 17

Figure 244. Analyzer Flow Chart (Software Version P2.22) - Sheet 5 of 17

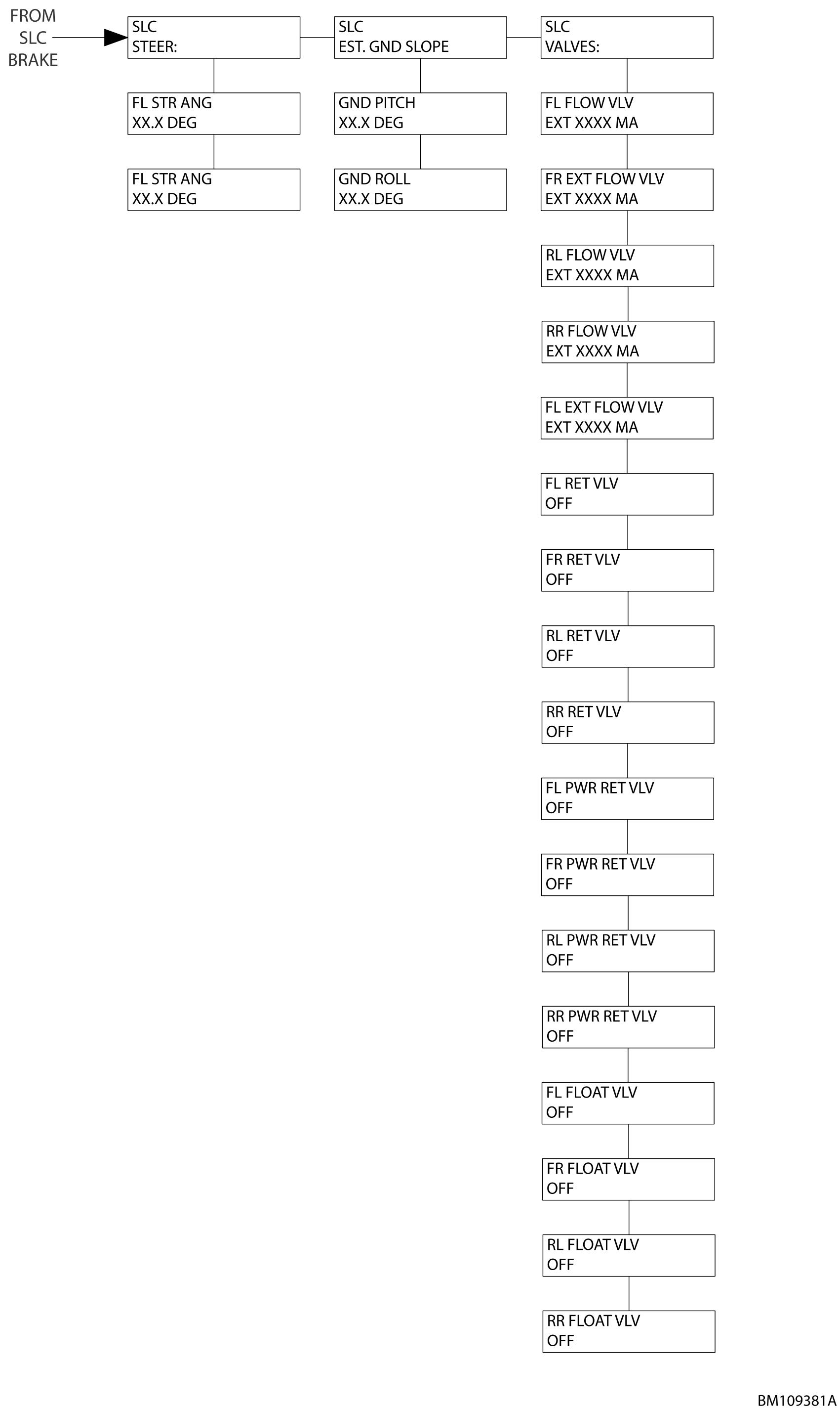


Figure 245. Analyzer Flow Chart (Software Version P2.22) - Sheet 6 of 17

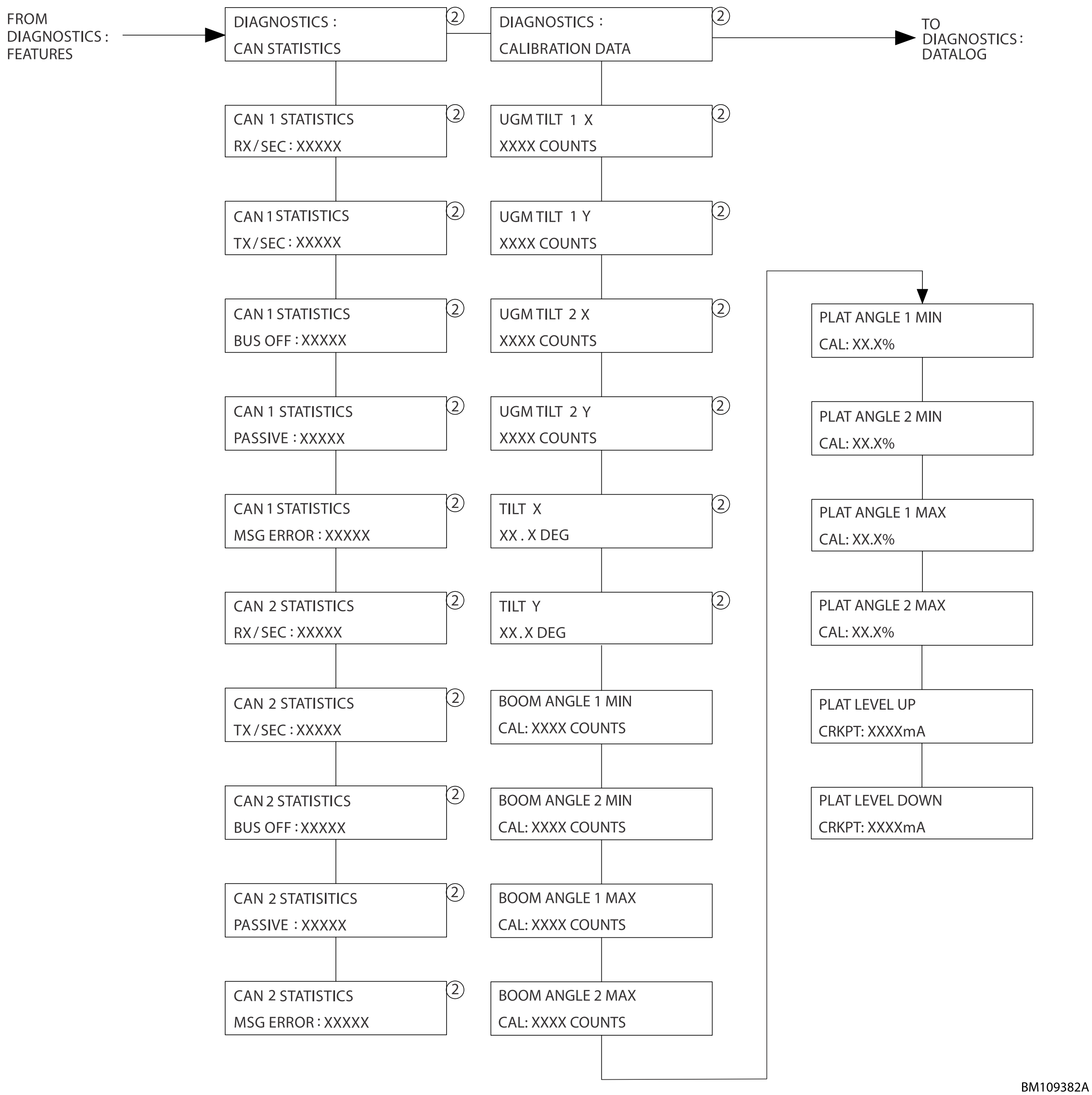


Figure 246. Analyzer Flow Chart (Software Version P2.22) - Sheet 7 of 17

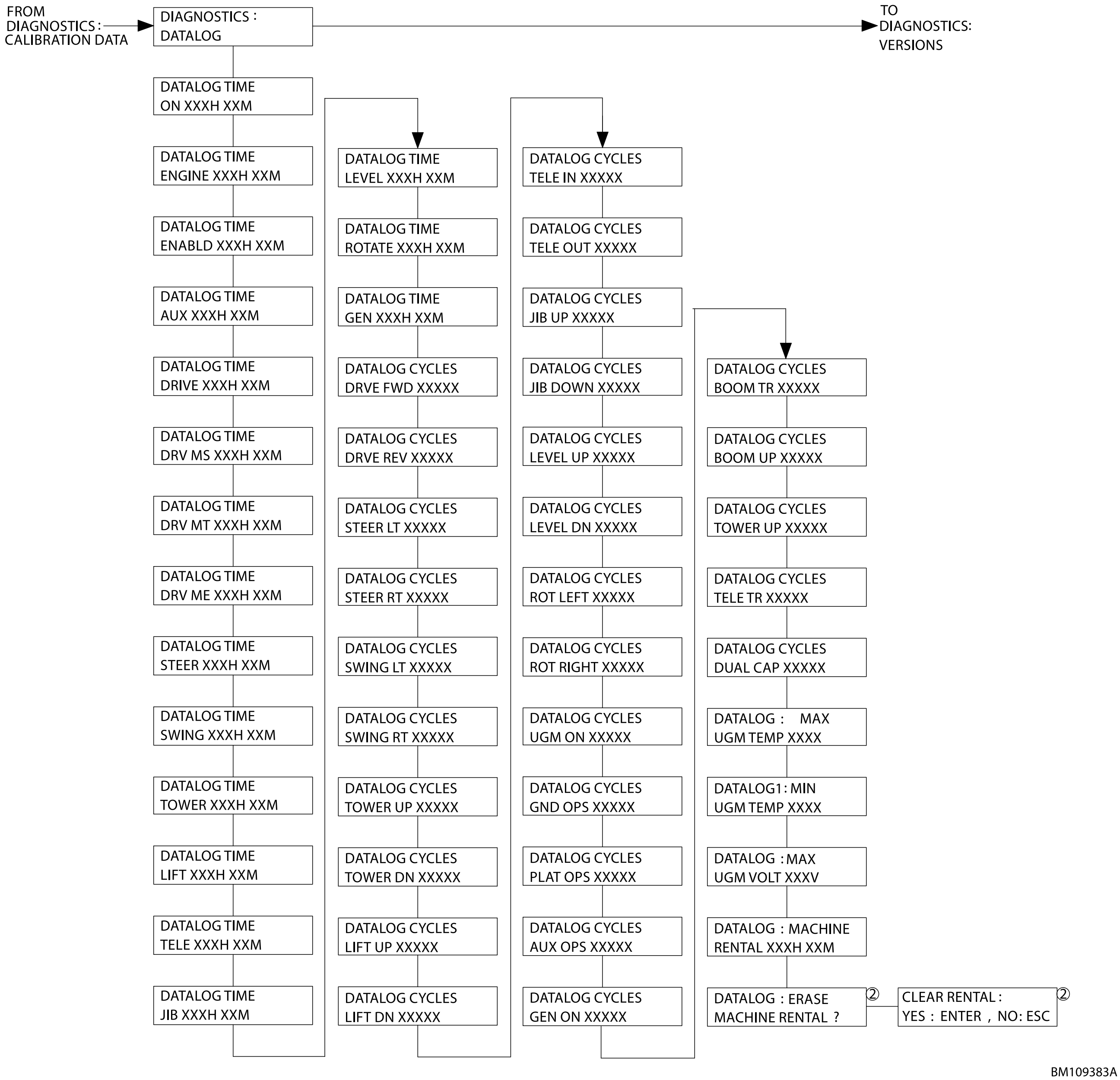


Figure 247. Analyzer Flow Chart (Software Version P2.22) - Sheet 8 of 17

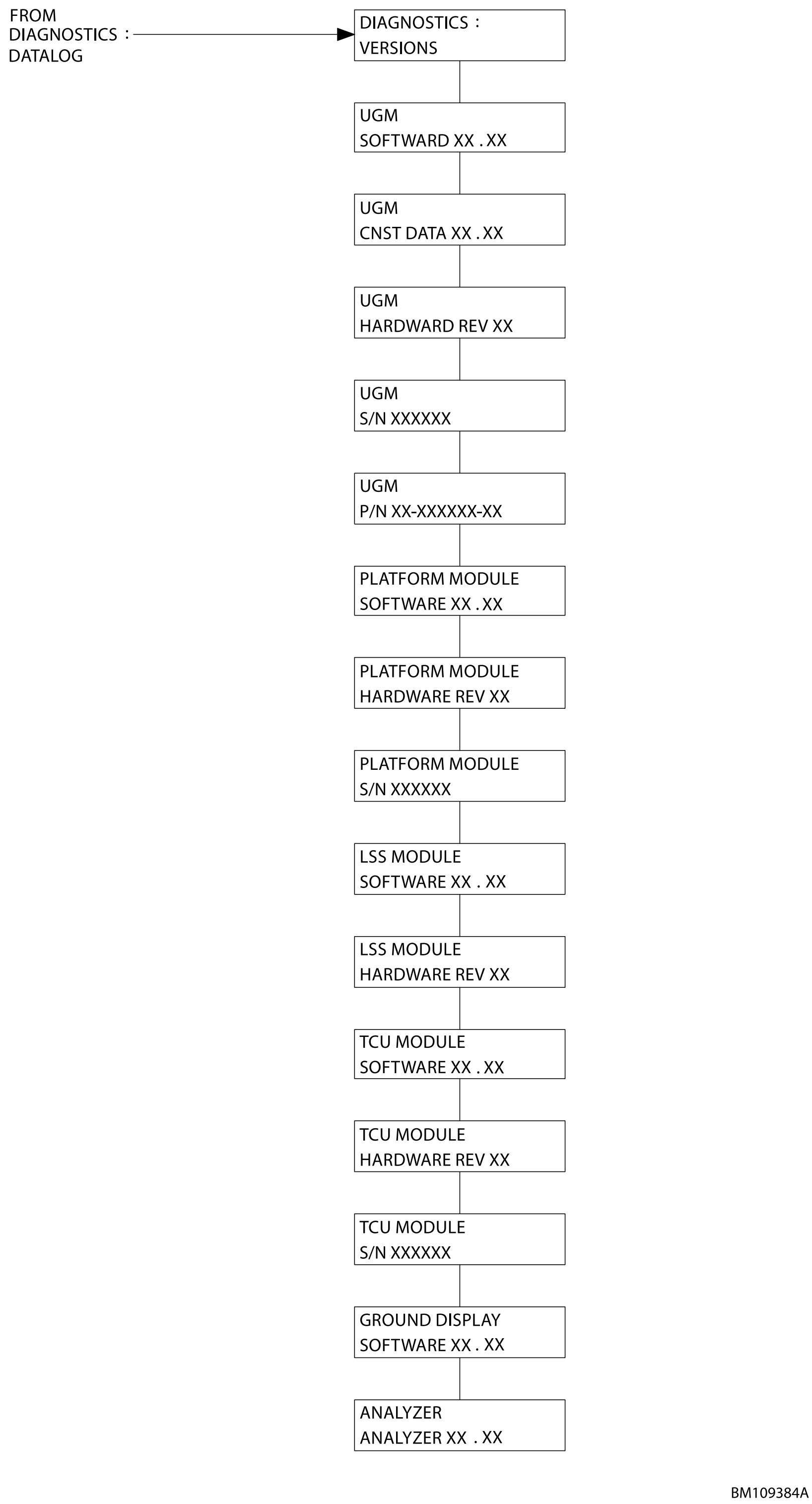


Figure 248. Analyzer Flow Chart (Software Version P2.22) - Sheet 9 of 17

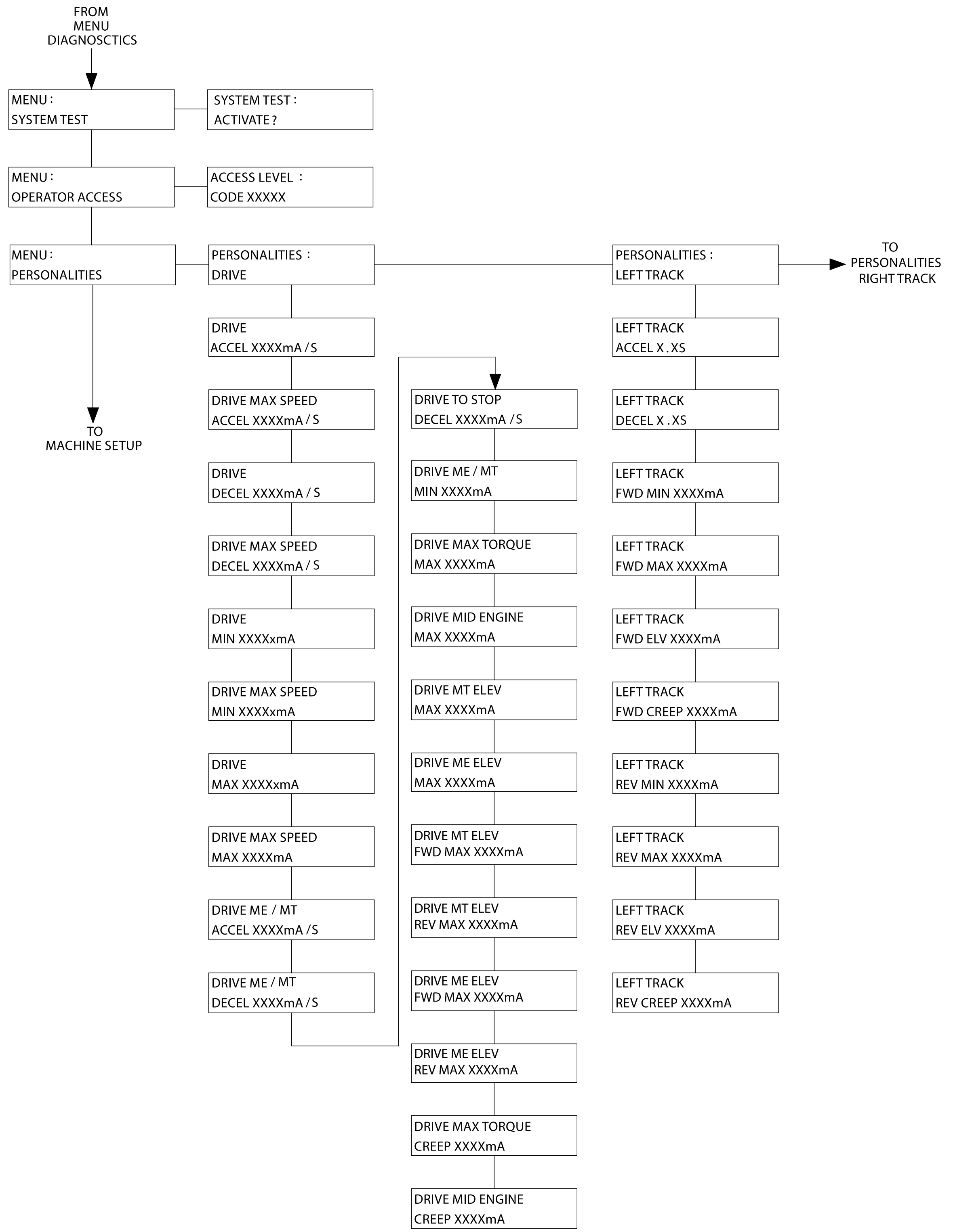


Figure 249. Analyzer Flow Chart (Software Version P2.22) - Sheet 10 of 17

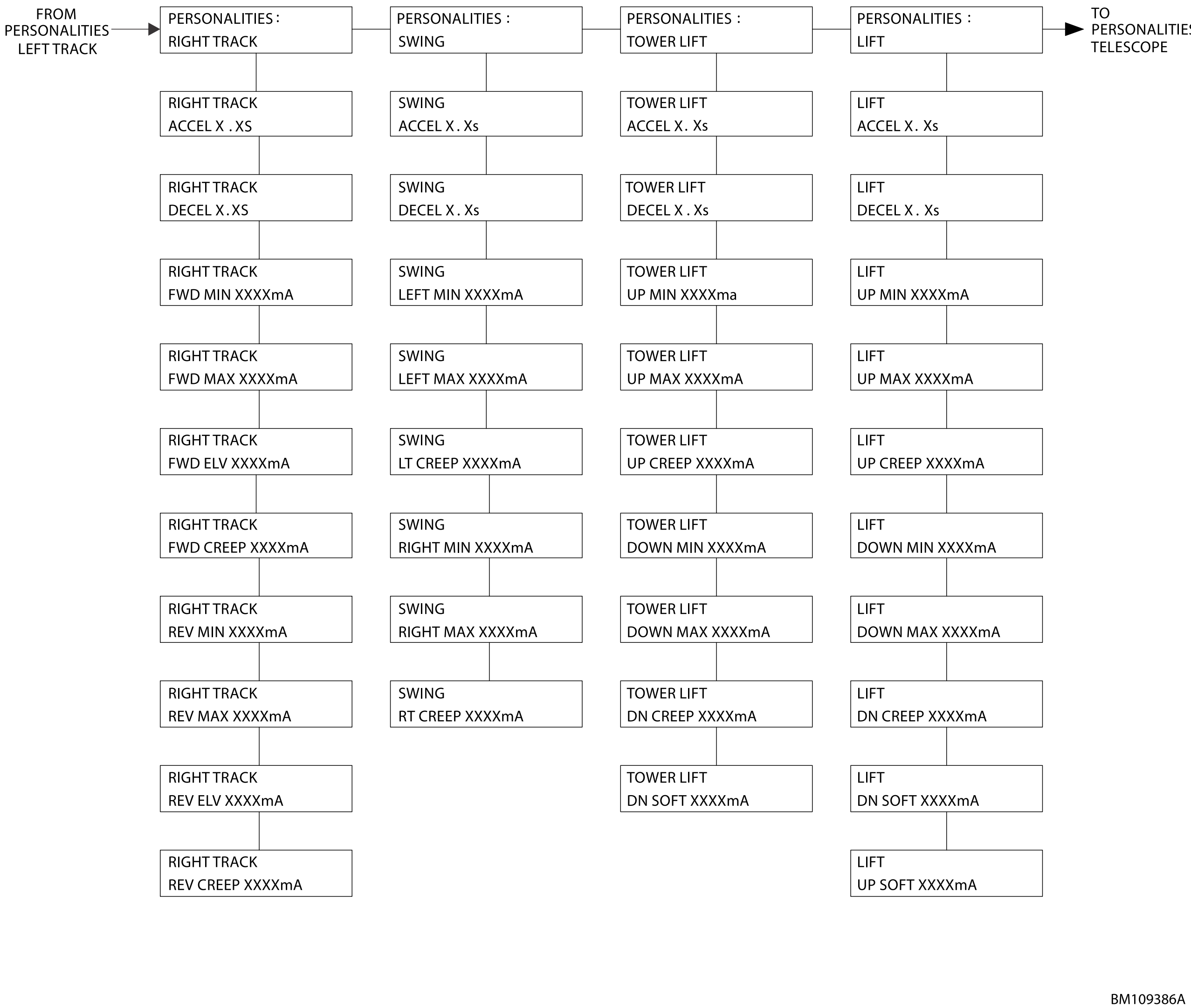


Figure 250. Analyzer Flow Chart (Software Version P2.22) - Sheet 11 of 17

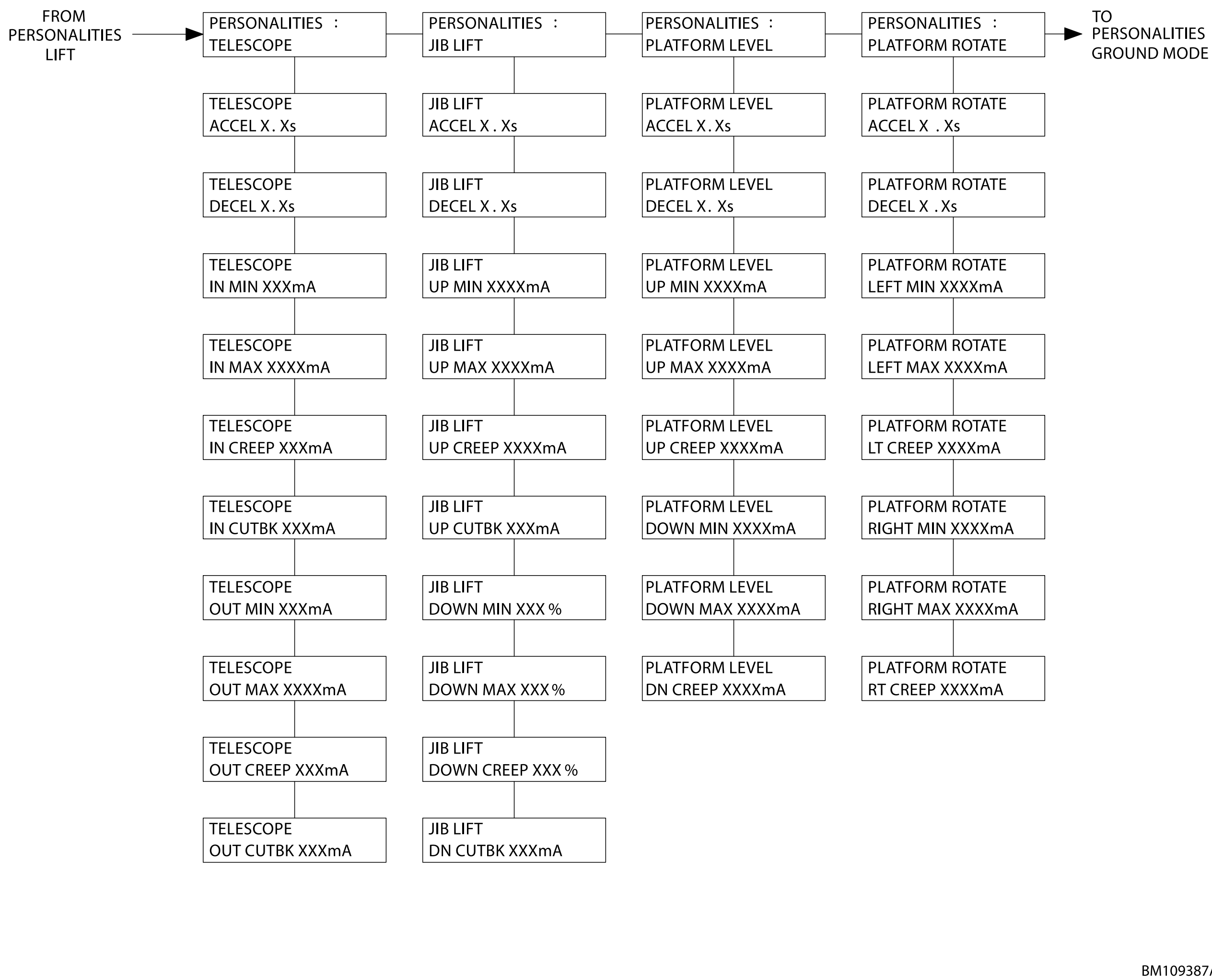


Figure 251. Analyzer Flow Chart (Software Version P2.22) - Sheet 12 of 17

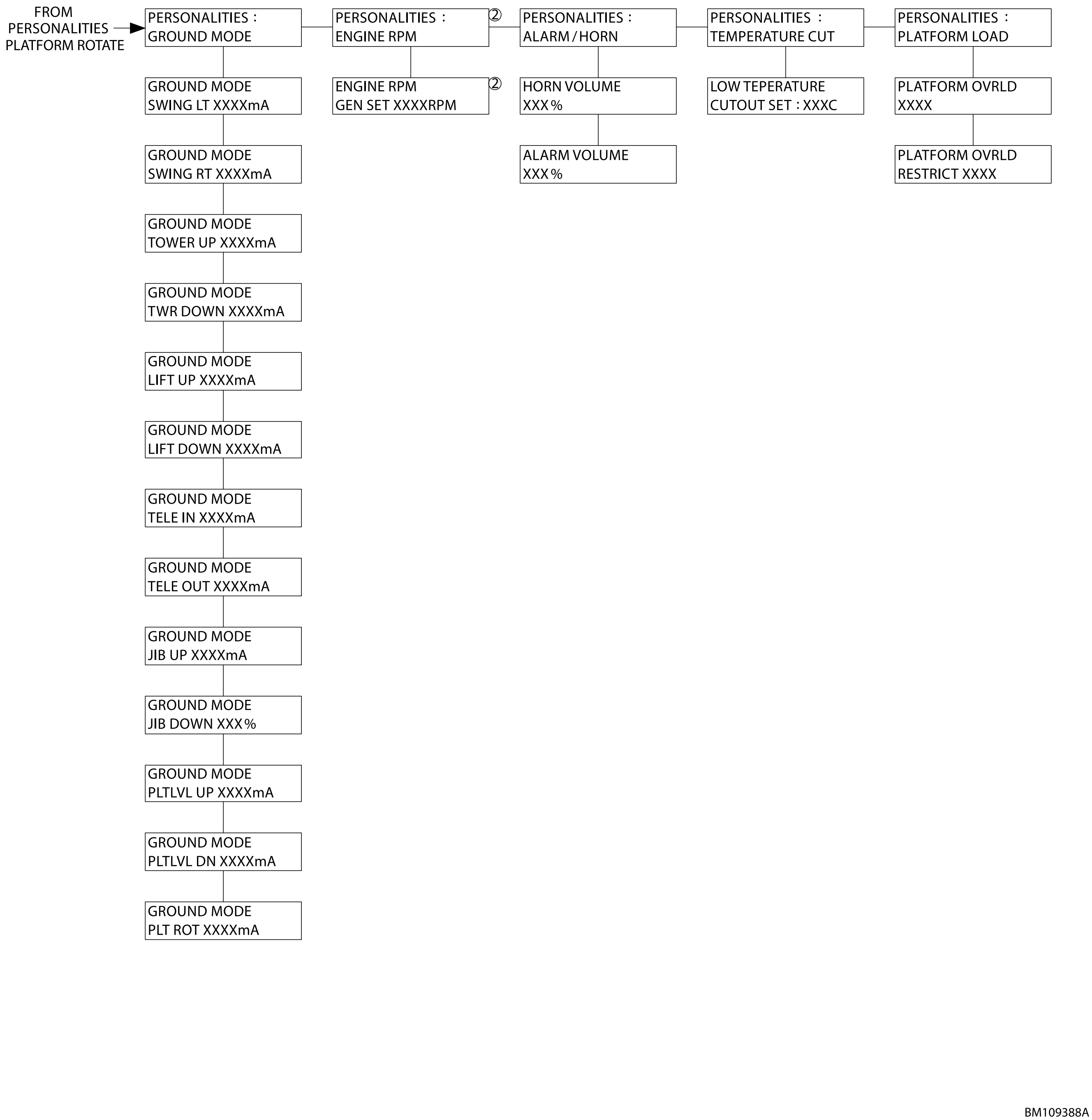


Figure 252. Analyzer Flow Chart (Software Version P2.22) - Sheet 13 of 17

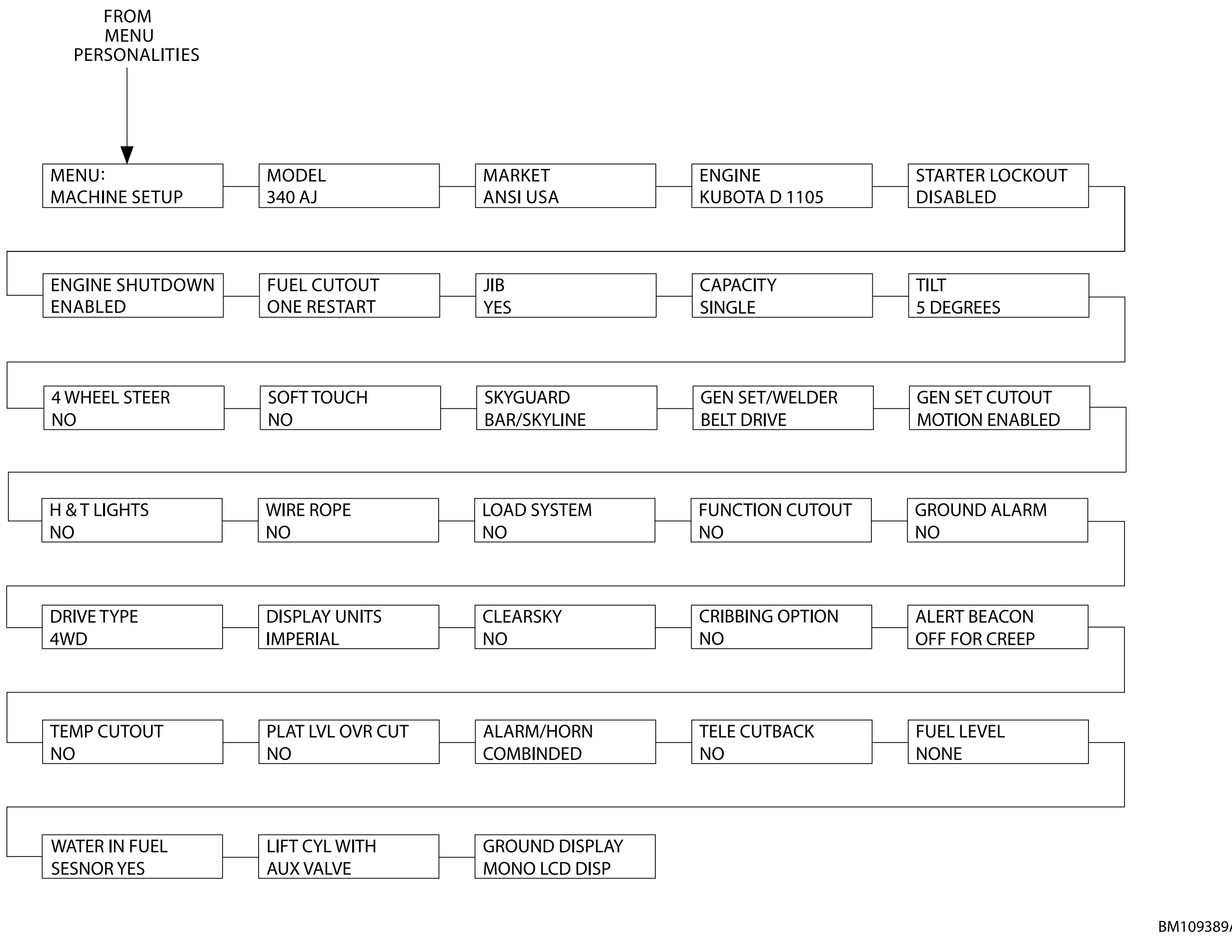


Figure 253. Analyzer Flow Chart (Software Version P2.22) - Sheet 14 of 17

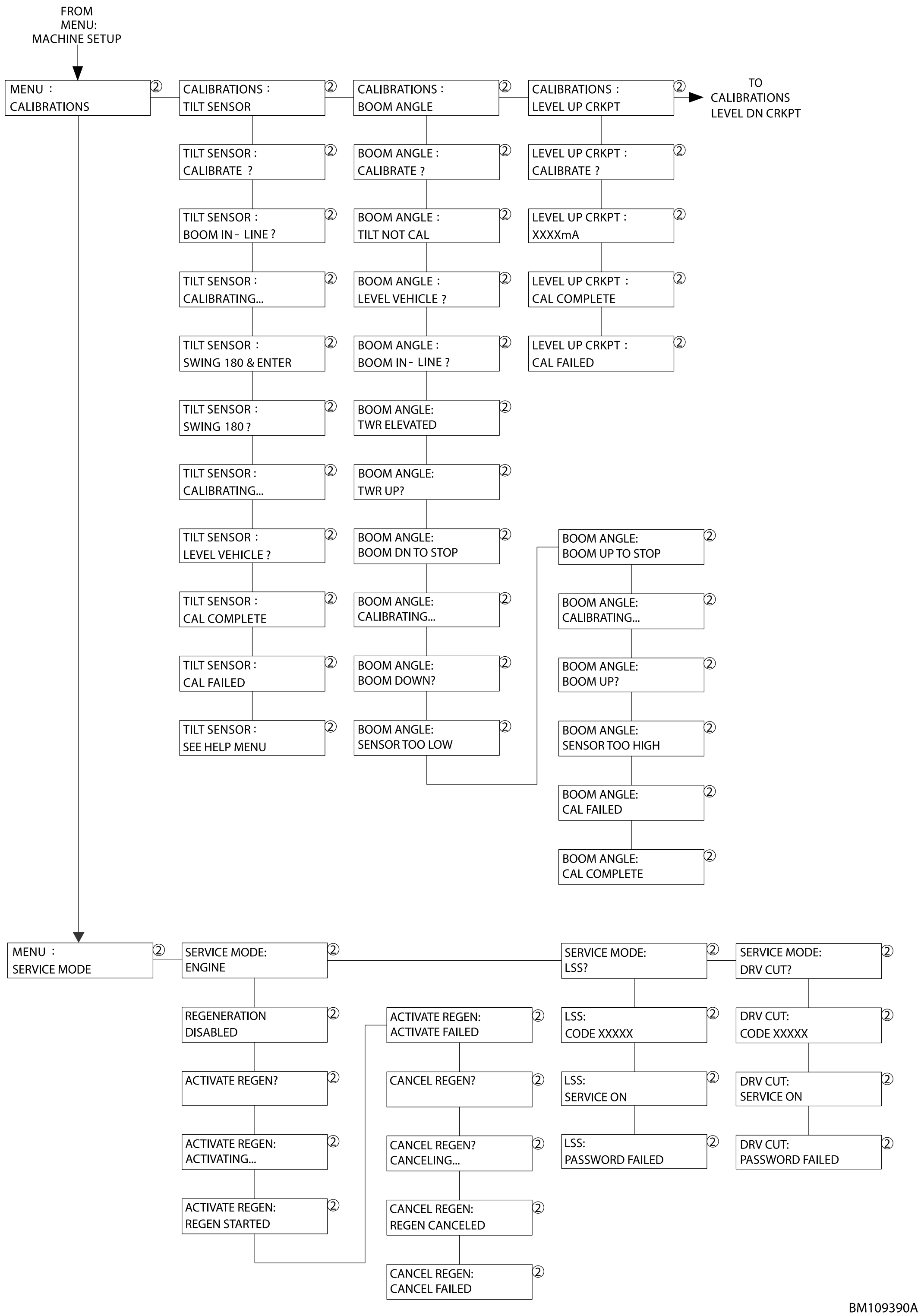


Figure 254. Analyzer Flow Chart (Software Version P2.22) - Sheet 15 of 17

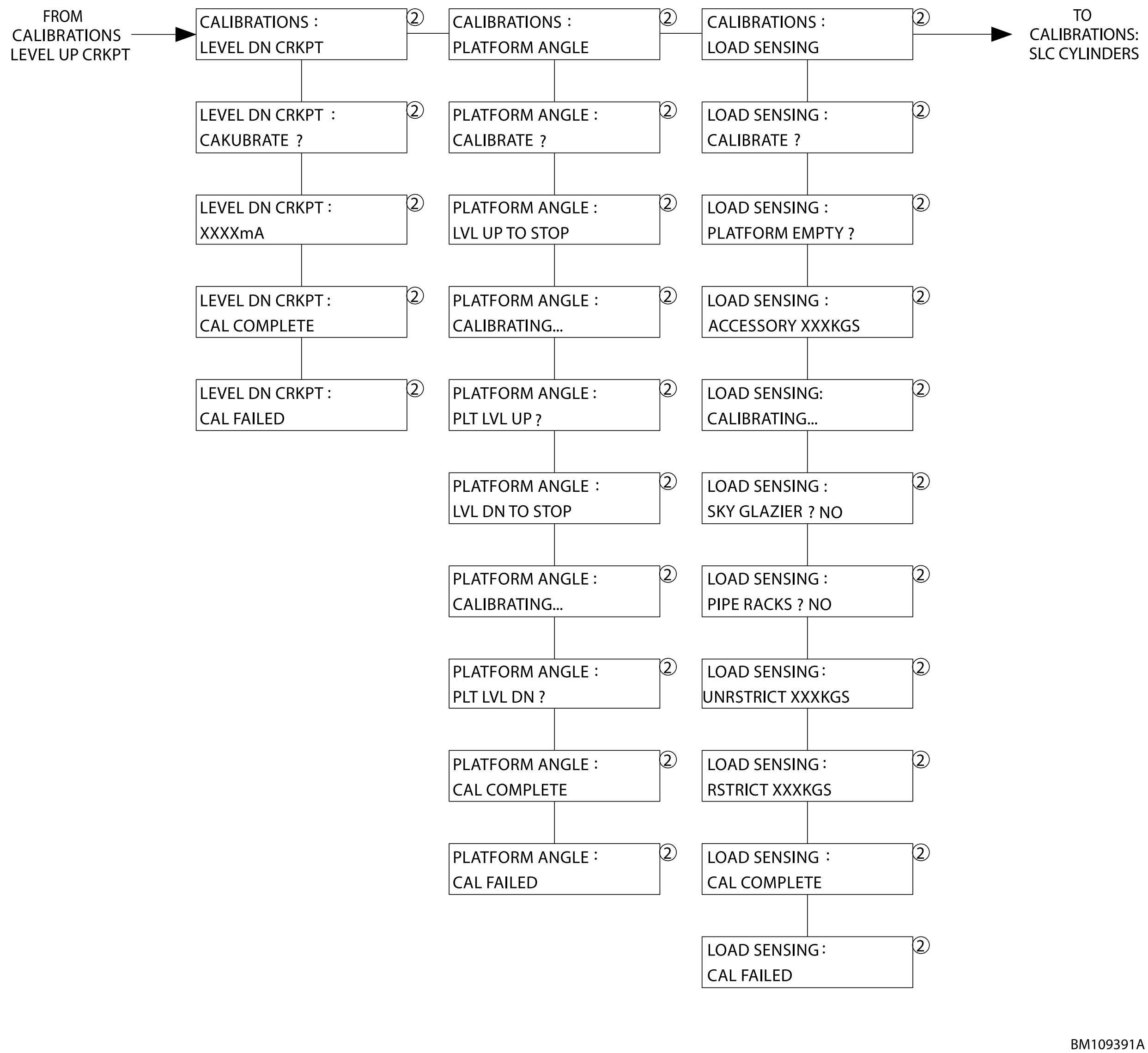


Figure 255. Analyzer Flow Chart (Software Version P2.22) - Sheet 16 of 17

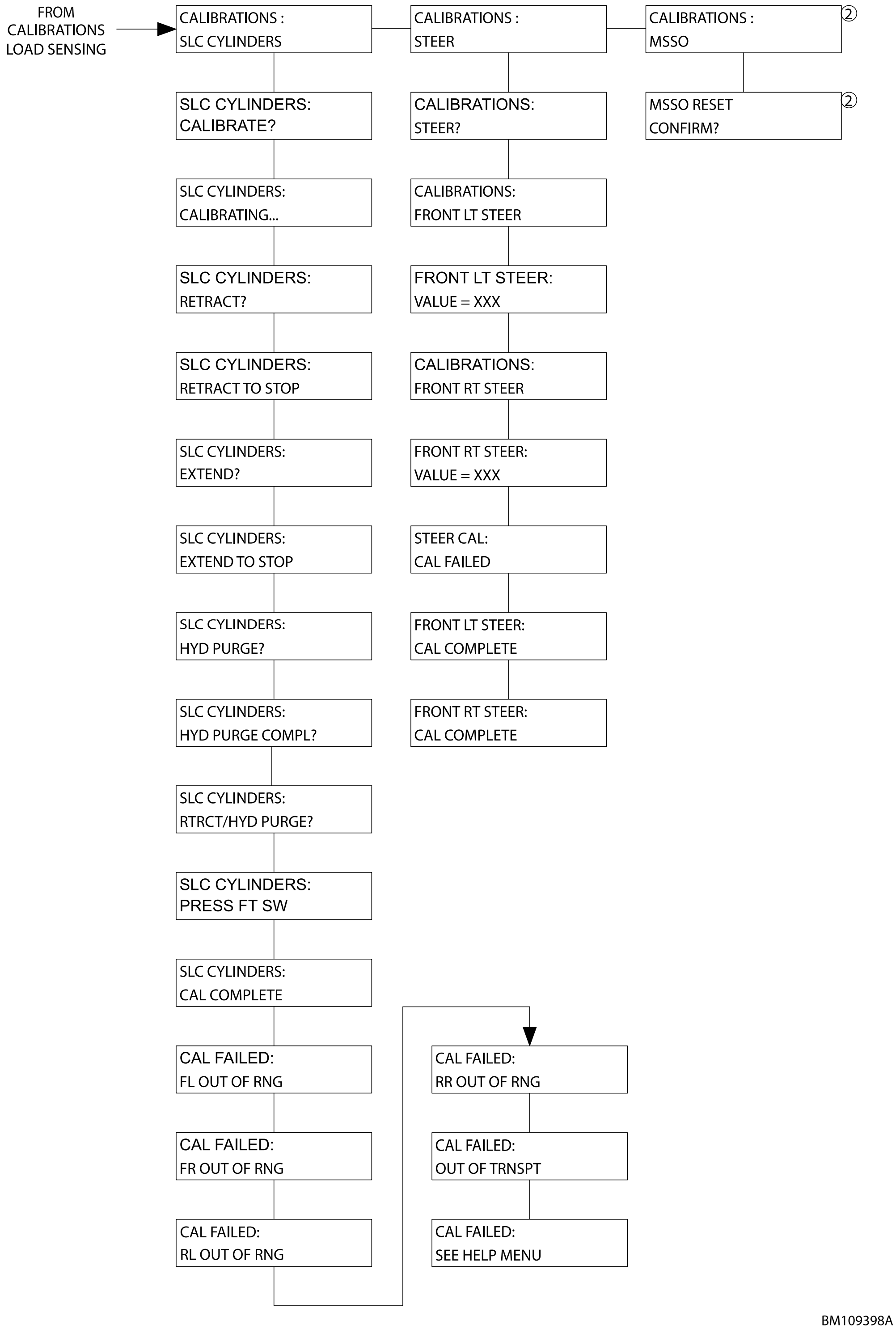
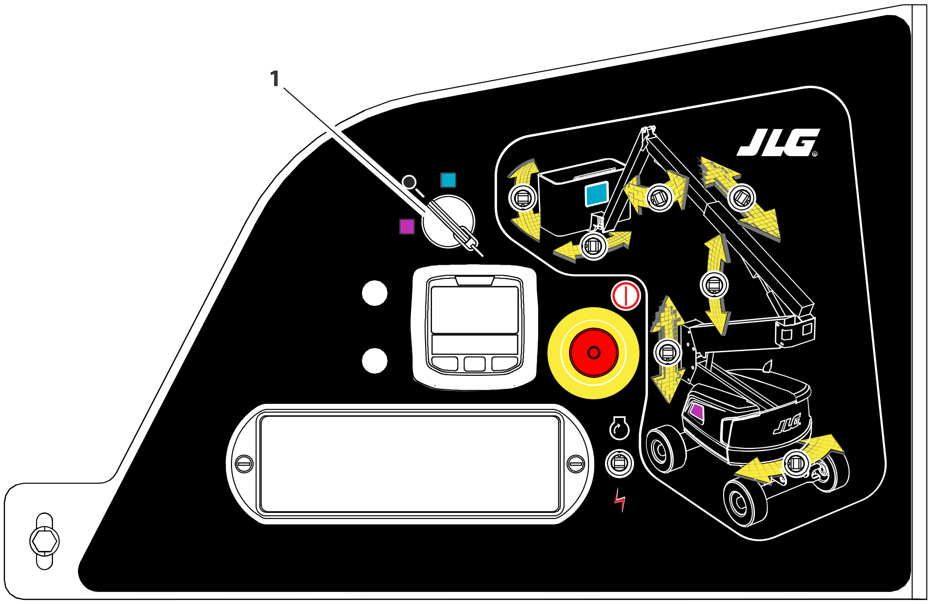


Figure 256. Analyzer Flow Chart (Software Version P2.22) - Sheet 17 of 17

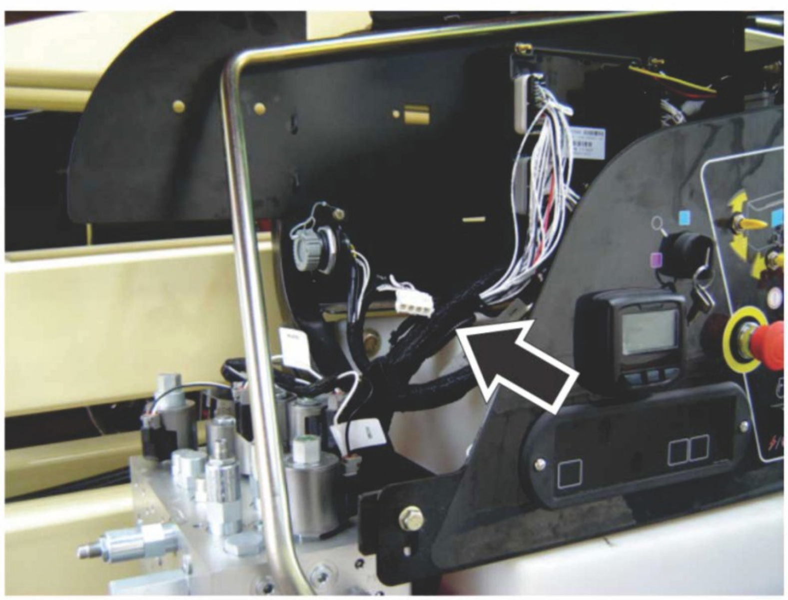
6.2 CALIBRATING BOOM ANGLE

1. Position the Platform/Ground select switch (1) to the Ground position.



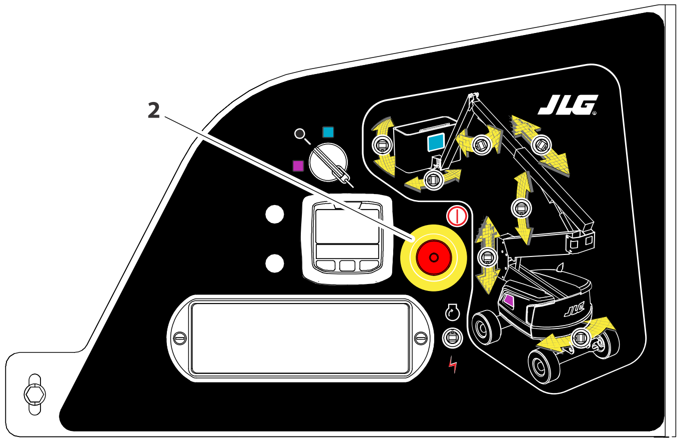
BM102076A

2. Plug the analyzer into the connector inside the Ground control box.



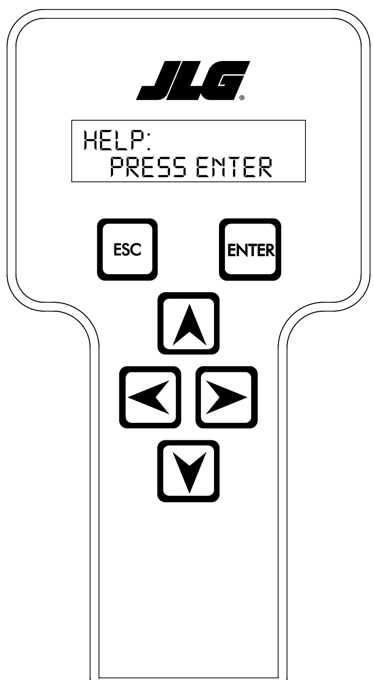
BM102075A

3. Pull out the Emergency Stop switch (2) and Start the engine.



BM102077A

4. The analyzer screen should read:



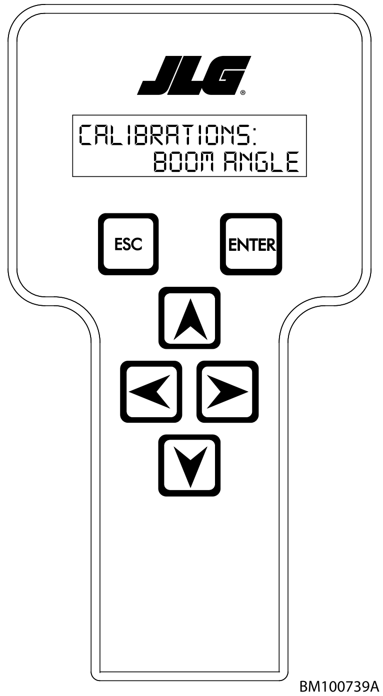
BM100738A

5. Use the arrow button to reach ACCESS LEVEL. Hit Enter.

6. Enter the Access Code, 33271.

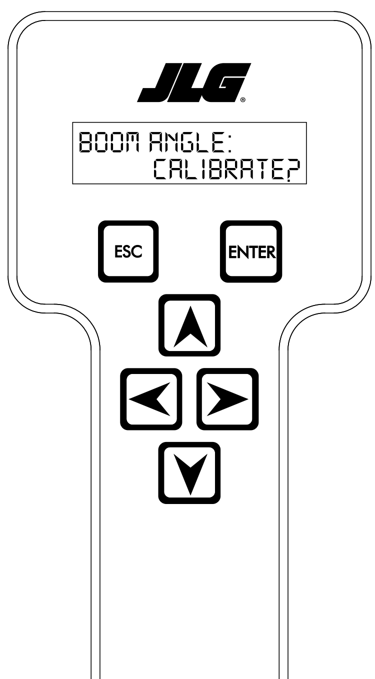
7. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.

8. Use arrow keys to reach BOOM ANGLE. The Screen will read:



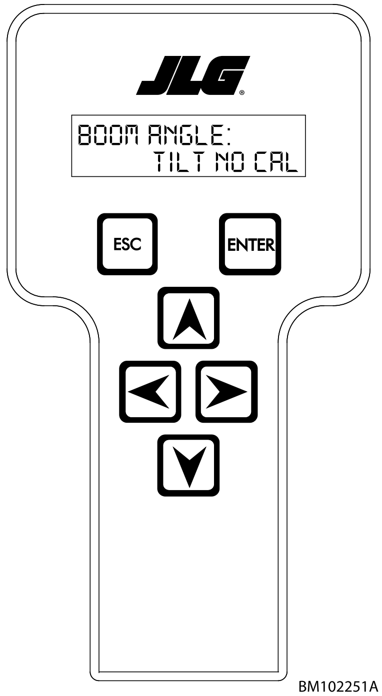
BM100739A

9. Hit Enter. The screen will read:



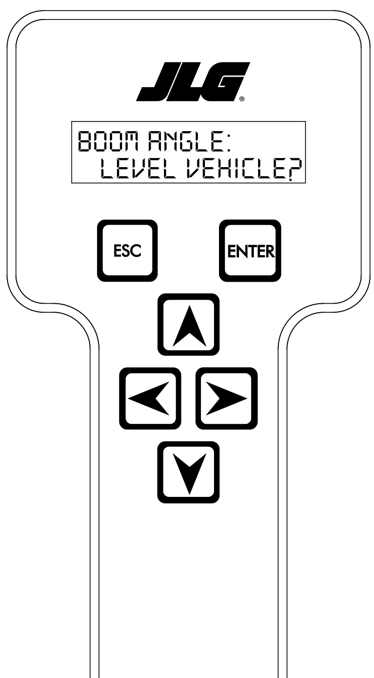
BM100740A

10. UGM will confirm the tilt sensor calibration. The screen will read:



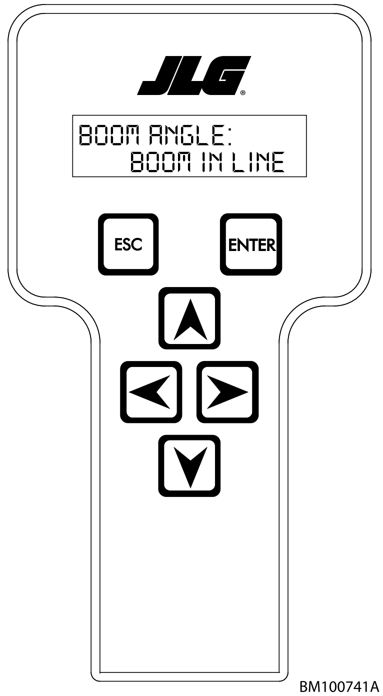
BM102251A

11. Hit Enter. The screen will read.



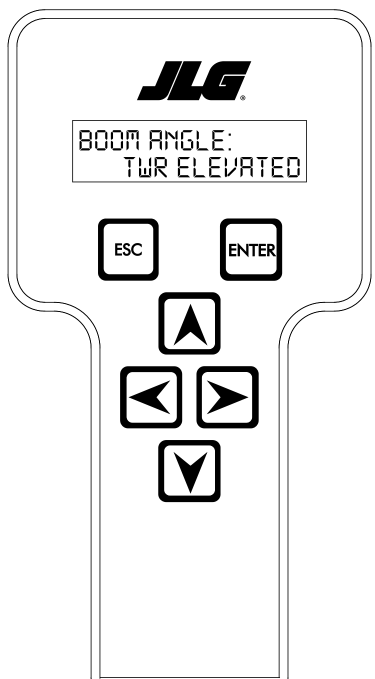
BM102252A

12. UGM will confirm the Boom In-Line position. The screen will read:



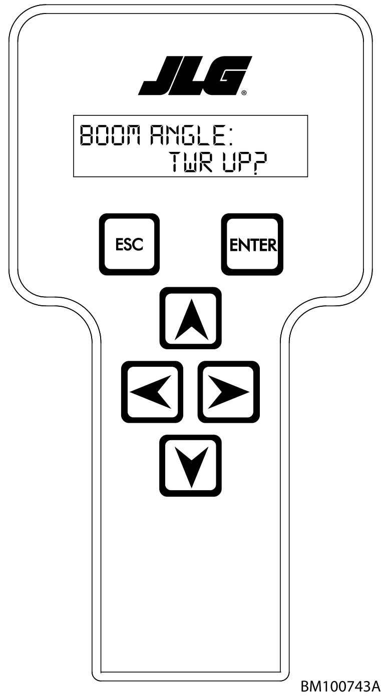
BM100741A

13. UGM will confirm the tower elevated position. The screen will read:



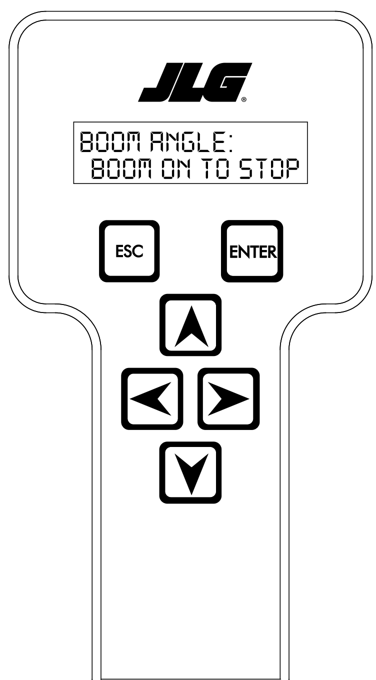
BM100742A

14. Hit Enter. The Screen will read:



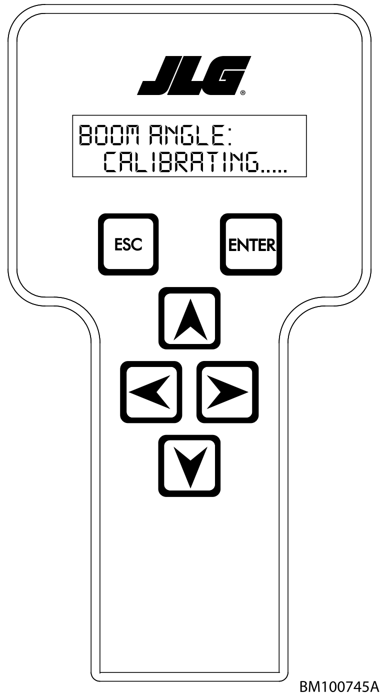
BM100743A

15. Hit Enter. The Screen will read:



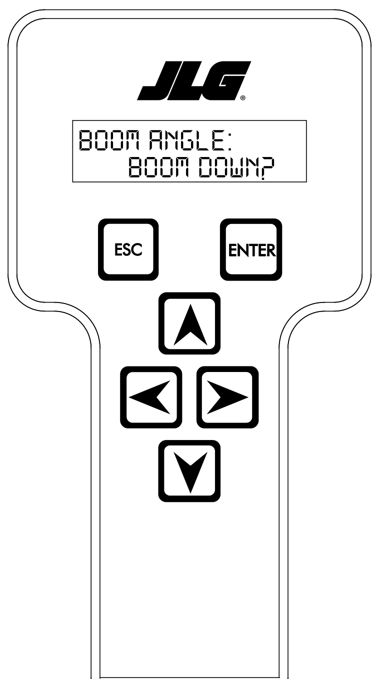
BM100744A

16. When the sensor is calibrated at lower position of the boom. The screen will read:



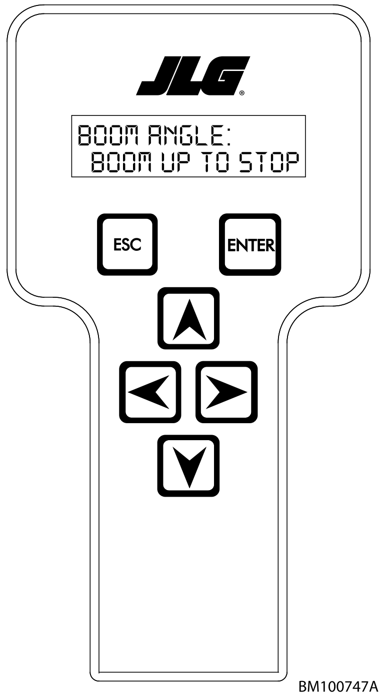
BM100745A

17. UGM will confirm the position of the boom. Press Enter. The screen will read:



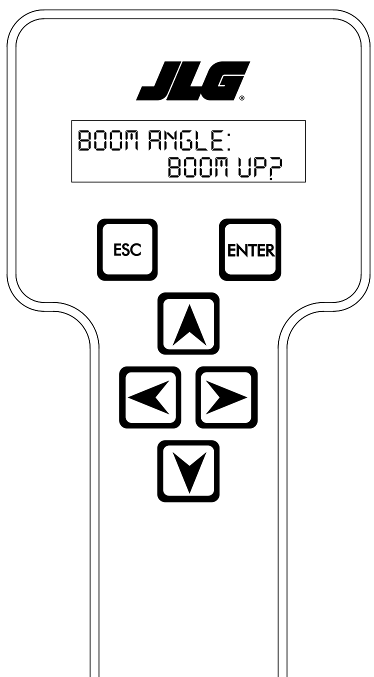
BM100746A

18. If the calibrating values are under acceptable limits, Raise the boom and press Enter. The screen will read:



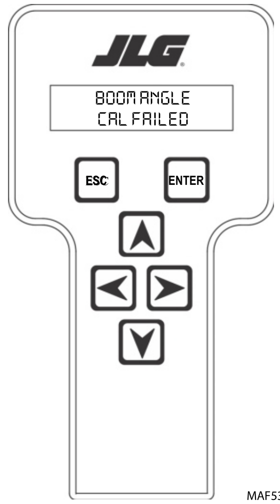
BM100747A

19. UGM will confirm the position of the boom. Press Enter. The screen will read:



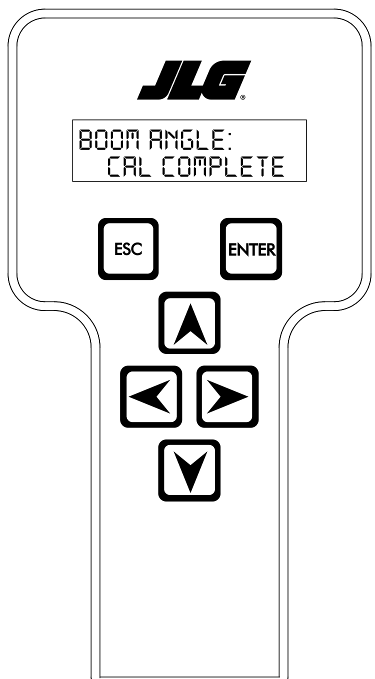
BM100748A

20. Hit Enter. The Screen will read:



MAF53610

21. After few seconds. The screen will read:



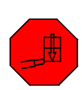
BM100750A

22. Hit ESC twice to go back to CALIBRATIONS.

6.3 LSS SYSTEM

The JLG-designed Load Sensing System (LSS) measures platform load via a sensor mounted in the platform support structure. If the actual platform load exceeds the selected Rated Load, the following will occur:

1. The Overload Visual Warning Indicator will flash at the selected control position (platform or ground).



2. The Platform and Ground Alarms will sound 5 seconds On, and 2 seconds Off.
3. All normal movement will be prevented from the platform control position (optional - ground control functions may be prevented).
4. Further movement is permitted by:
   a. Removing the excess platform load until actual platform load is less than Rated Load.
   b. Operation of the overriding emergency system (Auxiliary Power Unit).
   c. By an authorized person at the ground control position (optional - ground control functions may be prevented).
5. The Load Sensing System MUST be calibrated when one or more of the following conditions occur:
   a. LSS Sensor removal or replacement
   b. Addition or removal of certain platform mounted accessories. (Refer to Calibration)
   c. Platform is removed, replaced, repaired or shows evidence of impact.

NOTICE

The load sensing system requires periodic function verification not to exceed 6 months from previous verification. Refer to testing & evaluation.

All calibration procedures are menu driven through the use of a JLG Analyzer.

6.3.1 Diagnostic Menu

The Diagnostic Menu is another troubleshooting tool for the Load Sensing System. Sensor and status information is presented in real-time for the technician. Several sub-menus exist to organize the data.

To access the Diagnostic Menu, use the LEFT and RIGHT Arrow keys to select DIAGNOSTICS from the Top Level Menu. Press the ENTER key to view the menu.

Press the LEFT and RIGHT Arrow keys to view the displays and select the various sub-menus. To access a sub-menu, press the ENTER key. Once in a sub-menu, press the LEFT and RIGHT Arrow keys to view the various displays (just like a Top Level menu). To exit a sub-menu, press the ESC key.

Table — Diagnostic Menu Descriptions, page 560 details the structure of the Diagnostic Menu, and describes the meaning of each piece of information presented.

Table 82. Diagnostic Menu Descriptions

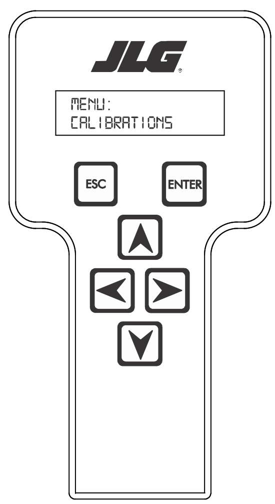
Diagnostics Menu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
PLATFORM LOAD	STATE:	OK / OVERLOAD	LSS Status.
PLATFORM LOAD	ACTUAL:	XXX.X KG	Calibrated weight of the platform. ??? if Platform Load is Unhealthy**.
PLATFORM LOAD (service*)	GROSS:	XXX.X KG	Gross weight of the platform. ??? if both Cells are Unhealthy**.
PLATFORM LOAD (service*)	OFFSET 1:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	OFFSET 2:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	ACCESSORY	XXX.X KG	Stored accessory weight. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	UNRESTRICT	XXX.X KG	UGM will set Unrestricted Rated Load as defined by Machine Configuration.

Table 82. Diagnostic Menu Descriptions (continued)

Diagnostics Menu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
PLATFORM LOAD (service*)	RESTRICT	XXX.X KG	UGM will set Restricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RAW 1:	XXX.X KG	Gross value from Cell 1. ??? if Unhealthy**.
PLATFORM LOAD (service*)	RAW 2:	XXX.X KG	Gross value from Cell 2. ??? if Unhealthy**.
* Indicates only visible in service view mode ** Typically indicates a DTC is active			

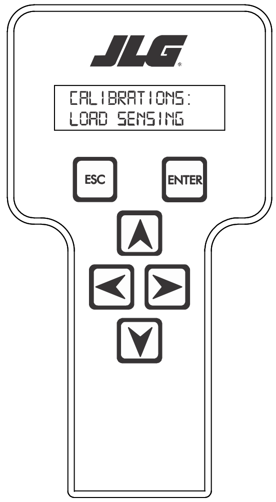
6.3.2 Calibration Procedure

1. Remove everything from the platform, except permanently fixed JLG Accessories, to allow the Load Sensing System to record its' weight during calibration. This includes all tools, debris, and customer-installed devices.
2. Plug the JLG Analyzer into the Machine at the Ground Station and enter Service Access Password 33271.
3. The platform should be approximately level for calibration. Level the platform from ground control (if necessary) to within +/- 5°.
4. To access the Calibration Menu, use the LEFT and RIGHT Arrow keys to select CALIBRATION from the Top Level Menu. The screen will read:

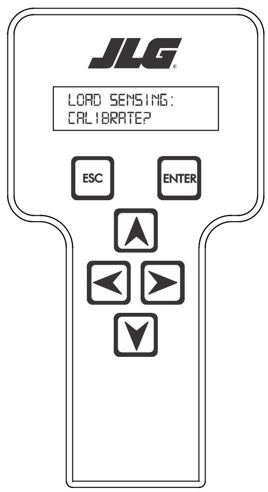


Note: The Calibration Menu is not available in OPERATOR ACCESS.

5. Press the ENTER key to view the menu. Upon entry to the Calibration Menu, the JLG Control System will link to the Analyzer and the screen will read:



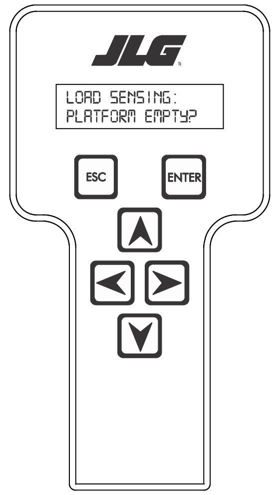
6. Press Enter . The Screen will read:



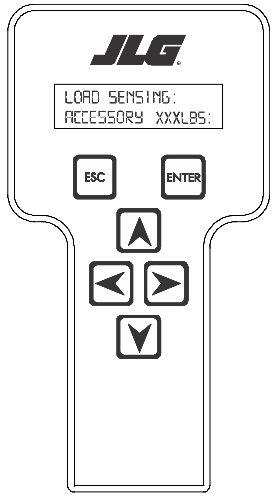
Note: Calibration will auto fail if LSS DTC's are active (443, 444, 4479, 4480, 663, 821, 822, 823, 824, 8218, 8222 -> 8238, 991, 992, 993, 994 or 99285).

Pressing the ESC key after starting calibration and before calibration is complete will display the CAL FAILED message. This will not disturb the prior calibration information.

7. Press ENTER [ENTER]. The analyzer screen will read:



8. If the platform is empty, press ENTER. The screen will read:



Note: Accessory weight will reset to 0 lb each time the machine is re-calibrated and will need to be re-entered.

Note: The Accessory weight will be temporarily stored in the Control System until calibration has been completed successfully.

Refer to *Table — Accessory Weights, page 565*. Use the up and down analyzer keys to enter the accessory weight(s) (in lb). When all the accessory weights are entered, press ENTER. The screen will read:

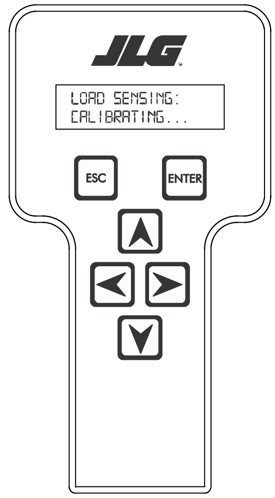
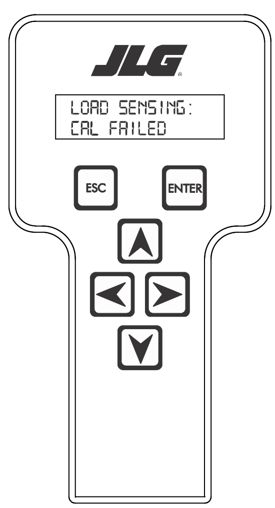


Table 83. Accessory Weights

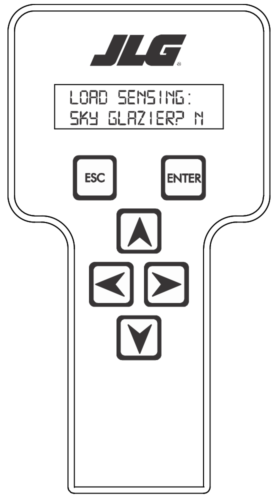
Accessory	Weight
SkyWelder (stick welder)	70 lb (32 kg)
SkyWelder Prep	Prep only = 15 lb (7 kg) Full install = 70 lb (32 kg)
SkyCutter (plasma cutter)	70 lb (32 kg)
SkCutter / SkyWelder Combo	140 lb (64 kg)
Fire Extinguisher	45 lb (20 kg)
Overhead SoftTouch	80 lb (36 kg)
Work Surface	20 lb (9 kg)

Note: Not all Accessories are available on every JLG model. Some Accessory combinations are prohibited due to excessive weight and/or load restriction. If any installed JLG Accessories are labeled with weight decals but are not listed in the table above, include their weight when entering the ACC WEIGHT value.

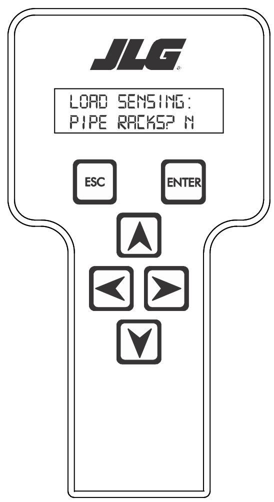
9. The control system will calculate the load cell readings and ensure it is greater than 130 lb (59 kg), but less than 575 lb (261 kg). If the platform weight is not within the allowed range, the calibration attempt will be unsuccessful and the Analyzer will show the following:



10. Press ENTER ENTER. The control system will ask for installed accessories. The screen will show the following:



11. Use the analyzer keys to select N for no or Y for yes. Press ENTER ENTER. The screen will read:



12. Use the analyzer keys to select N for no or Y for yes. Press ENTER. The control system will default to an estimate of unrestricted capacity, which can be adjusted if necessary. Refer to *Table — SkyGlazier Capacity Reductions, page 567* and *Table — Pipe Rack Capacity Reductions, page 567*.
The screen will read:

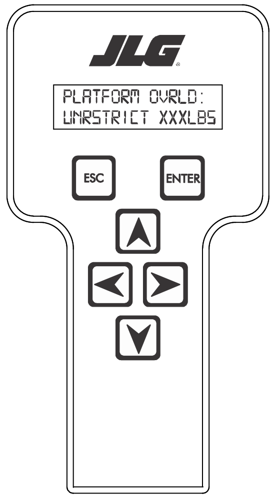


Table 84. SkyGlazier Capacity Reductions

Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	400 lb (181 kg)	n/a
600 lb (272 kg)	400 lb (181 kg)	n/a
750 lb (340 kg)	n/a	590 lb (268 kg)
1000 lb (454 kg)	n/a	750 lb (340 kg)

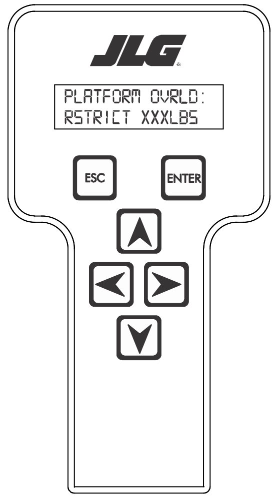
Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.

Table 85. Pipe Rack Capacity Reductions

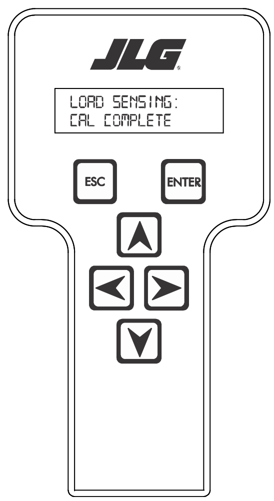
Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	450 lb (204 kg)	n/a
600 lb (272 kg)	500 lb (227 kg)	n/a
750 lb (340 kg)	n/a	650 lb (295 kg)
1000 lb (454 kg)	n/a	900 lb (408 kg)

Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.

13. Press ENTER. The following screen will be displayed for restricted capacity, which can be adjusted if necessary. Refer to Refer to *Table — SkyGlazier Capacity Reductions, page 567* and *Table — Pipe Rack Capacity Reductions, page 567*.



14. Press ENTER. If calibration is successful, the screen will read:



6.3.3 Testing & Evaluation

Refer to Troubleshooting if the Load Sensing System fails to meet these guidelines.

1. Connect the JLG Analyzer.

2. Level the Platform. The platform should be approximately level for analysis, or the guidelines below will not be applicable. Level the platform from Ground Control (if necessary) to within ±5 degrees.

3. Observe the Empty Platform Weight. Proceed to the DIAGNOSTICS, PLTLOAD sub-menu and observe the measured platform load. All tools, debris, and customer-installed devices shall be removed during evaluation. Ideally, the PLTLOAD should be zero but can vary ±15 lb (± 7 kg). Further, the reading should be stable and should not vary by more than ±2 lb (±1 kg) (unless there is heavy influence from wind or vibration).

4. Use the Technician's Weight to Evaluate. The technician should enter the platform and record the PLTLOAD reading while standing in the center of the platform.

5. Confirm Control System Warnings and Interlocks. Using the keyswitch, select Platform Mode and power-up. Start the vehicle's engine and ensure that all controls are functional and the Load Sensing System's Overload Visual and Audible Warnings are not active. Simulate an Overload by unplugging the Shear Beam Load Cell. The Overload Visual Warning should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, and 2 seconds Off. With the engine running, all control should be prevented. Cycle the Platform EMS to stop the engine and then power-up again. The Overload Visual and Audible Warning should continue. Confirm that controls are responsive when using the Auxiliary Power Unit for emergency movement. Reconnect the Load Cell. The Overload Visual and Audible Warnings should cease and normal control function should return. Switch the vehicle's keyswitch to Ground Mode and repeat the above procedure. The Overload Visual Warning at the Ground Controls should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, 2 seconds Off. However, the controls should remain functional when using the engine and the Auxiliary Power Unit (if the Control System's MACHINE SETUP, LOAD is set to "2=CUTOUT PLT". If set to "3=CUTOUT ALL", then Ground Controls will be prevented when using the engine as in the platform).

6. Confirm Control System Capacity Indication (optional for vehicles with Dual Capacity Ratings). For vehicles equipped with a Capacity Select switch on the Platform Console Box, it is necessary to examine an additional interface between the Load Sensing System and the Control System. Using the keyswitch, select Platform Mode and power-up. If necessary, put the boom in the transport position (completely stowed) and center the Jib Plus (if equipped). Place the Capacity Select switch in the unrestricted position and ensure that the proper indicator illuminates on the Platform Console Box. Plug the JLG Analyzer into the Analyzer connection and proceed to the DIAGNOSTICS, SYSTEM submenu. Ensure that the CAPACITY displays indicate OFF. Place the Capacity Select switch in the unrestricted position (if so equipped) and ensure that the proper indicator illuminates on the Platform Console Box (but does not flash). For vehicles with unrestricted capacity, ensure that the unrestricted CAPACITY display indicates ON but the restricted CAPACITY indicates OFF. For vehicles with restricted capacity, ensure that the unrestricted CAPACITY display indicates OFF but the restricted CAPACITY indicates ON.

7. Confirm Load Sensing System Performance with Calibrated Weights. Operate the vehicle from Ground Control and place the boom in the transport position (fully stowed) for safety. Plug the JLG Analyzer into the control system connection and proceed to the DIAGNOSTICS, PLTLOAD display. Place 500lb (230kg) in the platform and ensure that PLTLOAD is with ±5% of the actual weight. For Dual Capacity vehicles, do the same for the alternate capacity (unrestricted or restricted).

6.3.4 Troubleshooting

The following tables are furnished to provide possible resolutions for common difficulties. Difficulties are classified as General, Calibration, Measurement Performance, and Host System Functionality.

Table 86. LSS Troubleshooting Chart

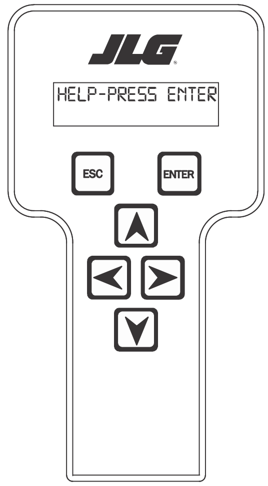
Difficulty	Possible Resolution
Empty Platform Weight (DIAGNOSTICS, PLATFORM LOAD) is not within ±15 lb (±7 kg) of zero. or Platform Load readings (DIAGNOTICS, PLTLOAD) are unstable by more than ±2 lb (±1 kg) (without the influence of vibration or wind). or There are large variations in Platform Load (DIAGNOSTICS, PLTLOAD) based on the location of the load. Tolerance to variations is 20 lb for an evaluation using the technician's weight, and +5% of Rated Load when using calibrated weights.	The LSS System is unable to properly measure the platform weight. 1. The Load Cell is not properly plugged into the LSS Harness. It is possible poor electrical contact is made. 2. Wiring leading to the Load Cell is damaged. Carefully inspect sensor wiring where it passes through cable clamps for signs of damage. Inspect wiring where damage to the channel is apparent. 3. The Load Cell was not assembled properly during installation. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable. It is often helpful to apply slight downward pressure above the sensor and observe that its output increases (increasing force measurement; decreasing means the sensor is mounted upside-down). 4. The Load Cell is contaminated by debris or moisture. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable and stable (not changing by more than ±2 lb (±1 kg) (without the influence of vibration or wind). Lack of measurement stability is a key indication of contamination. Unplug the connector and inspect for dirt or moisture. Look carefully into the female connector on the sensor's cordset for evidence of contamination. Debris should be brushed away with a soft bristle brush (do not introduce any cleaners as they will leave conductive residue). Moisture should be allowed to evaporate or accelerated with a heat-gun (use low heat and be carefully to not melt connector materials). Moisture intrusion into the molded portion of the connector (capillary action into the wire bundle) or the Shear Beam Load Cell itself will require replacement of the sensor. 5. The Load Cell has been mechanically damaged. If the Load Cell is physically deformed or has damage to the cover it should be replaced immediately. It is also possible to have invisible mechanical damage resulting from an extreme overload (>6000 lb [>2722 kg]).
The Visual and Audible Overload Warnings fail to sound when platform is loaded beyond Rated Load, or when simulated by unplugging the Load Cell. Controls remain functional at Platform and Ground Control positions.	The Control System is failing to regard the overload signal from the LSS System, or the signal is shorted. 1. The Load Sensing System must be enabled within the Control System. Plug the JLG Analyzer into the Control System, enter the Access Level 1 password (33271), and examine the MACHINE SETUP, LOAD sub-menu. The selection "2=CUTOUT PLT" should be displayed (platform controls prevented during overload, ground controls remain operational). In country- or customer-specific circumstance, the selection "3=CUTOUT ALL" is used (platform and ground controls prevented during overload).
The Ground Audible Warning fails to sound, but the Platform Audible Warning sounds properly.	The Ground Alarm is missing or improperly installed. Verify that the device is mounted. Verify wiring from the Main Terminal Box and Ground Module.
Controls remain functional at the Ground Control position during an overload, or when simulated by unplugging the Load Cell. The Controls at the Platform Control position are prevented when using the engine, but not when using the Auxiliary Power Unit.	The JLG Control System is configured to prevent platform controls only in the event of overload. Alternately, the Host Control System can be configured to prevent ground and platform controls for country- or customer-specific circumstances. Using the JLG Analyzer, enter the Access Level 1 password (33271). Proceed to the MACHINE SETUP, LOAD sub-menu. Set this parameter to "2=CUTOUT PLT" to prevent platform controls in the event of overload. Set this parameter to "3=CUTOUT ALL" to prevent platform and ground controls in the event of overload.

6.4 RESETTING THE MSSO SYSTEM

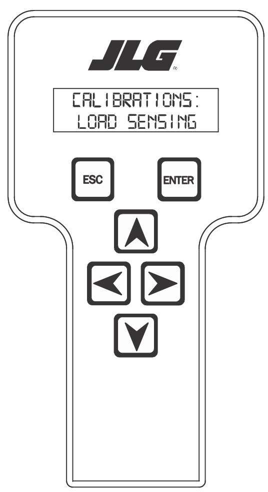
1. Use the following procedure to reset the MSSO system.
2. Position the Platform/Ground select switch to the desired position.
3. Plug the analyzer into the connector coming from the ground control module or from the platform console.

Note: If performing the procedure from the platform console, the Emergency Stop switch on the ground console must also be pulled out.

4. Pull out the Emergency Stop switch.
5. The analyzer screen should read:

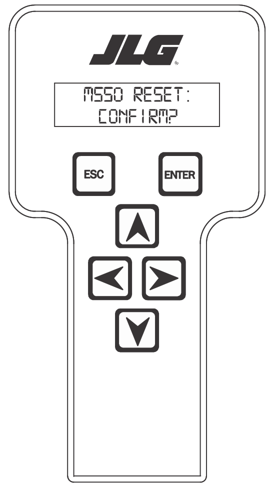


6. Use the arrow button to reach OPERATOR ACCESS. Press Enter ENTER.
7. Enter the Access Code, 33271.
8. Use the right Arrow key to reach MENU: CALIBRATIONS. Press Enter ENTER.
9. Use the arrow keys to reach the LOAD SENSING menu. The screen should read:



10. Press ENTER ENTER.
11. Use the Down arrow to reach MSSO RESET.

12. Press Enter . The screen will read:



13. Press Enter . The JLG Control System will reset an active 873 DTC and the MSSO System will be reset. Press Escape to return to the CALIBRATIONS menu.

6.5 FUNCTION SPEED CONTROL SYSTEM

Engine Speed is increased above idle when the machine is enabled from ground and platform. An additional engine speed increase occurs when additional hydraulic flow is needed functions are activated. Drive Speeds occur at fixed engine RPM and will not increase if boom functions are also active.

The platform controls for the platform rotate, platform level, jib lift, telescope, and tower lift functions are controlled through a common variable speed control knob. This knob provides a common control signal allowing a smooth ramp up, controlled maximum output speed, and ramp down. Each function has its own personality settings allowing the characteristics of each function to be modified using the standard analyzer. Not all functions will respond the same to the changes in the function speed knob position.

6.6 FUEL RESERVE / CUT-OUT SYSTEM

The Fuel Shutoff System senses the low fuel level and automatically shuts the engine down before the fuel tank is emptied. When the fuel level gets below . 1.2 gallons, the fault light will flash at the platform controls and the control system will report fault 0/0 “FUEL LEVEL LOW – ENGINE SHUTDOWN” on analyzer.

The control system has analyzer personality setting that controls the machines response to this fault.

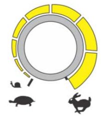
- With the “RESTART” setting, the operator can start the engine and run for 2 minutes. After 2 minutes, the engine will shut off, and a power cycle will allow the engine to run for 2 more minutes
- With the “ENGINE STOP” setting, the machine will remain in this fault mode until the fuel level is returned to a level above ≈ 1.2 gallons.
- With the “ONE RESTART” setting, the operator can start the engine and run for 2 minutes. After 2 minutes, the engine will shut off for a second time and the machine will return to the “Engine Shutdown” fault mode.
- The machine will then stay in this mode until the fuel level is returned to a level above 1.2 gallons.

6.7 MACHINE MODEL ADJUSTMENT

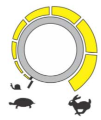
6.7.1 Adjustment Notes

1. Personality settings can be adjusted anywhere within the adjustment range in order to achieve optimum machine performance.
2. Stop watch should be started with the function movement, not with actuation of the joystick or switch.

3. Drive speeds should be set to the values below regardless of the tire size.
4. All speed tests are run from the platform, these speeds do not reflect the ground control operation.
5. The Function Speed Control knob must be at full speed (turned clockwise completely) unless noted.



6. Some flow control functions may not work with the Function Speed Control knob clicked into the creep position.

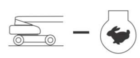


7. Functional speeds may vary due to cold thick hydraulic oil. Test should be run with the oil temperature above 38°C (100°F)

6.7.2 Machine Orientation When Performing Test

DRIVE (BELOW ELEVATION)

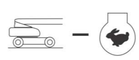
1. Test should be done on a smooth, level surface. The Drive Select Switch should be in the "Max Speed" position.



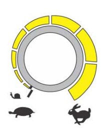
2. Start approximately 7.6 m (25 ft) from starting point so the unit is at a maximum speed when starting the test.
3. Results should be recorded for a 61 m (200 ft) course.
4. Drive forward, "High Speed", record time
5. Drive Reverse, "High Speed", record time

DRIVE (ABOVE ELEVATION)

1. Test should be done on a smooth, level surface. The Drive Select Switch should be in the "Max Speed" position.



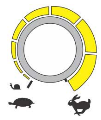
2. The boom should be > 10° above horizontal to ensure the drive is operating in Max Torque mode.
3. Results should be recorded for a 15.2 m (50 ft) course.
4. Drive forward, record time
5. Drive Reverse, record time
6. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode.



7. Creep light on Panel must be energized.

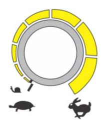
8. Verify that machine will Drive Forward and Reverse.

9. Return Knob to fully clockwise.



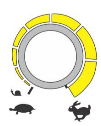
SWING

1. Boom at full elevation, Telescope retracted. Swing Right until over rear axle or end stop (if equipped).
2. Swing Left 360° or end stop (if equipped), record time.
3. Swing Right 360° or end stop (if equipped), record time.
4. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode.



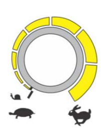
5. Creep light on Panel must be energized.

6. Verify that machine will swing left and right.
7. Return Function Speed Knob to fully clockwise.



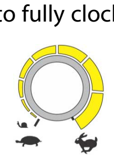
TOWER LIFT

1. Tower Lift in stowed position, Telescope Retracted.
2. Tower Lift Up, record time.
3. Tower Lift Down, record time.
4. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode.



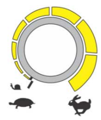
5. Creep light on Panel must be energized.

6. Verify that machine will Tower Up and Down. Return Knob to fully clockwise.



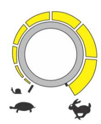
MAIN LIFT

1. Main Lift in stowed position, Telescope Retracted.
2. Main Lift Up, record time.
3. Main Lift Down, record time.
4. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode.



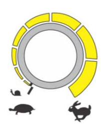
5. Creep light on Panel must be energized.

6. Verify that machine will Lift Up and Down.
7. Return Knob to fully clockwise.



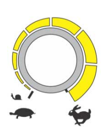
TELESCOPE

1. Main Lift at full elevation, Telescope Retracted.
2. Telescope Out, record time.
3. Telescope In, record time.
4. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode.



5. Creep light on Panel must be energized.

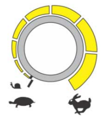
6. Verify that machine will Telescope In and Out.
7. Return Knob to fully clockwise.



JIB LIFT

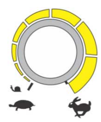
1. Platform level and centered with the boom. Jib Lift Down until stop.
2. Jib Lift Up, record time.

3. Jib Lift Down, record time.
4. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode.



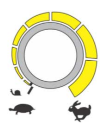
5. Creep light on Panel must be energized.

6. Verify that machine will Jib Lift Up and Down.
7. Return Knob to fully clockwise.



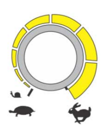
PLATFORM ROTATE

1. Platform level, Rotate Platform Right until stop
2. Platform Left, record time.
3. Platform Right, record time.
4. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode.



5. Creep light on Panel must be energized.

6. Verify that machine will Platform Rotate Left and Right.
7. Return Knob to fully clockwise.



Note: When the platform speed control knob is turned fully counterclockwise. The platform rotate may not work, this is acceptable.

Table 87. Machine Model Adjustment Speeds

FUNCTION		ADJUSTMENT RANGES	450A/AJ MODEL DEFAULTS		MODEL TIME RANGES (IN SECONDS)	
					450A	450AJ
DRIVE			4WD	2WD		
	Accel	25 – 2000mA/s	300 mA/s			
	Decel	25 – 2000mA/s	800 mA/s			
	Min	250 – 1000mA	725mA			
	Max	250 – 1400mA	1175mA		30 – 34	
Drive to Stop	Decel	25 – 2000mA/s	400 mA/s			
MT: Elevated	Max	250 – 1200mA	890 mA	795 mA	68 – 85	85 – 133
ME: Elevated	Max	250 – 1200mA	990 mA	835 mA	68 – 85	85 – 133
Max Torque	Creep	250 – 1200mA	890 mA	795mA		
Mid Engine	Creep	250 – 1200mA	990 mA	835 mA		
ME = Mid Engine, MT = Max Torque						
SWING						
	Accel	0 – 3s	2.2 s			
	Decel	0 – 2s	1.2 s			
LEFT	Min	250 – 1400mA	570 mA			
	Max	250 – 1400mA	900 mA		70 – 90	
	Creep	250 – 1400mA	650 mA			
RIGHT	Min	250 – 1400mA	570 mA			
	Max	250 – 1400mA	950 mA		70 – 90	
	Creep	250 – 1400mA	650 mA			
TOWER LIFT						
	Accel	0 – 3s	1.5 s			
	Decel	0 – 2s	0.6 s			
UP	Min	250 – 1400mA	380 mA			
	Max	250 – 1400mA	990 mA		15 – 18	
	Creep	250 – 1400mA	600 mA			
DOWN	Min	250 – 1400mA	380 mA			
	Max	250 – 1400mA	950 mA		15 – 18	
	Creep	250 – 1400mA	500 mA			
	Soft Down	250 – 1400mA	450 mA			
LIFT						
	Accel	0 – 3s	1.5 s			
	Decel	0 – 2s	0.8 s			
UP	Min	250 – 1400mA	420 mA			
	Max	250 – 1400mA	900 mA		23 – 28	

Table 87. Machine Model Adjustment Speeds (continued)

FUNCTION		ADJUSTMENT RANGES	450A/AJ MODEL DEFAULTS	MODEL TIME RANGES (IN SECONDS)	
				450A	450AJ
	Creep	250 – 1400mA	650 mA		
DOWN	Min	250 – 1300mA	380 mA		
	Max	250 – 1400mA	690 mA	23 – 28	
	Creep	250 – 1400mA	500 mA		
	Soft Down	250 – 1400mA	450 mA		
TELESCOPE					
	Accel	0 – 3s	1 s		
	Decel	0 – 2s	0.8 s		
IN	Min	250 – 1400mA	350 mA		
	Max	250 – 1400mA	775 mA	20 – 24	
	Creep	250 – 1400mA	550 mA		
OUT	Min	250 – 1400mA	360 mA		
	Max	250 – 1400mA	1100 mA	20 – 24	
	Creep	250 – 1400mA	625 mA		
JIB LIFT					
	Accel	0 – 3s	1.2 s		
	Decel	0 – 2s	0.5 s		
UP	Min	250 – 1400mA	350 mA		
	Max	250 – 1400mA	690 mA	N/A	18 – 22
	Creep	250 – 1400mA	500 mA		
DOWN	Min	250 – 1400mA	350 mA		
	Max	250 – 1400mA	600 mA	N/A	18 – 22
	Creep	250 – 1400mA	450 mA		
PLATFORM LEVEL					
	Accel	0 – 3s	0 s		
	Decel	0 – 2s	0 s		
UP	Min	250 – 1400mA	400 mA		
	Max	250 – 1400mA	600 mA		
	Creep	250 – 1400mA	600 mA		
DOWN	Min	250 – 1400mA	400 mA		
	Max	250 – 1400mA	600 mA		
	Creep	250 – 1400mA	600 mA		
PLATFORM ROTATE					
	Accel	0 – 3s	0 s		
	Decel	0 – 2s	0 s		

Table 87. Machine Model Adjustment Speeds (continued)

FUNCTION		ADJUSTMENT RANGES	450A/AJ MODEL DEFAULTS	MODEL TIME RANGES (IN SECONDS)	
				450A	450AJ
LEFT	Min	250 – 1400mA	400 mA		
	Max	250 – 1400mA	600 mA	20 – 32	
	Creep	250 – 1400mA	600 mA		
RIGHT	Min	250 – 1400mA	400 mA		
	Max	250 – 1400mA	600 mA	20 – 32	
	Creep	250 – 1400mA	600 mA		
GROUND MODE					
SWING	Left	250 – 1400mA	865 mA		
	Right	250 – 1400mA	920 mA		
TOWER LIFT	Up	250 – 1400mA	985 mA		
	Down	250 – 1400mA	945 mA		
LIFT	Up	250 – 1400mA	895 mA		
	Down	250 – 1400mA	685 mA		
TELESCOPE	In	250 – 1400mA	770 mA		
	Out	250 – 1400mA	1095 mA		
JIB	Up	250 – 1400mA	685 mA		
	Down	250 – 1400mA	695 mA		
PLATFORM	Up / Down	250 – 1400mA	595 mA		
PLATFORM	Left / Right	250 – 1400mA	595 mA		

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Table 88. Diagnostic Trouble Code Chart

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
Note: "Controls Initialized" means all controls have been released / returned to neutral, and the machine enable (footswitch) has been released.				
EVERYTHING OK	001[1]	Machine is in Platform Mode; The UGM determines no problems exist	No response required for this DTC	
GROUND MODE OK	002[1]	Machine is in Ground Mode; The UGM determines no problems exist	No response required for this DTC	
RUNNING AT CUTBACK – OUT OF TRANSPORT POSITION	0010[1]	Machine is in the Out of Transport position	Response described in Drive Modes section	Machine is not in the Out of Transport position
FSW OPEN	0011[1]	Machine is in Platform Mode; Any of the following Platform inputs become active after power up, but before Machine Enabled: Drive joystick is not in the neutral position Steer;	The UGM shall not Enable the Machine	Controls initialized

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
		Lift and/or Swing joystick is not in the neutral position; Tower Lift (340AJ, 450AJ); Telescope; Platform Level; Platform Rotate; Jib Lift (if MACHINE SETUP > JIB = YES)		
RUNNING AT CREEP - CREEP SWITCH OPEN	0012[1]	Machine is in Platform Mode; Platform Creep switch input = HIGH ; DTC 0013 is not active	The UGM shall limit the machine to Creep speed	Platform Creep switch input = Low
RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	0013[1]	Machine is in Platform Mode; The Boom is Above Elevation; Machine chassis is considered Tilted	The UGM shall limit the machine to Creep speed; If MACHINE SETUP > TILT = (angle) + CUT, response described in Tilted Output Cutouts section	Not all of the trigger conditions are met
FUEL LEVEL LOW – ENGINE SHUTDOWN	0031	Engine Shutdown has occurred due to Fuel Level = EMPTY condition.	Response described in Fuel Shutdown section	Power Cycled
APU ACTIVE	0035	Auxiliary Power/Emergency Descent Mode is active	Response described in Auxiliary Power/Emergency Descent Mode section	Auxiliary Power/Emergency Descent Mode is not active
FUNCTION PREVENTED - FUNCTION SELECTED BEFORE GROUND ENABLE	0036	Machine is in Ground Mode; Any of the following Ground inputs become active after power up, but before Machine Enabled: Lift; Swing; Tower Lift (340AJ, 450AJ); Telescope; Platform Level; Platform Rotate; Jib Lift (if MACHINE SETUP > JIB = YES)	The UGM shall not Enable the Machine	Controls initialized
SKYGUARD ACTIVE – FUNCTIONS CUTOUT	0039	MACHINE SETUP > SKYGUARD = YES; Machine is in Platform Mode; SkyGuard Enabled	Response described in SkyGuard section	Not all of the trigger conditions are met
Power Cycle	211			
KEYSWITCH FAULTY	212	UGM Ground Mode input J7-3 input = High; UGM Platform Mode input J7-2 input = High	The UGM shall assume a station selection of Ground	(J7-3 input = LOW) or (J7-2 input = LOW)
FSW FAULTY	213	The ground footswitch input and platform footswitch input have been both HIGH or both LOW for greater than or equal to 1 second	The UGM shall not Enable the Machine	Power Cycled
FUNCTION PROBLEM - HORN PERMANENTLY SELECTED	221	Machine is in Platform Mode; The Horn switch input = High at Startup	The UGM shall prohibit Horn; Ground and Platform Alarm are still permitted	The Horn switch input = Low
FUNCTION PROBLEM - STEER LEFT PERMANENTLY SELECTED	224	Machine is in Platform Mode; The Steer Left switch input = High at Startup	The UGM shall prohibit Steer Left and Right; The UGM shall limit Drive to Creep	The Steer Left switch input = Low;

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
				Steer Left and Right and full Drive speed permitted after controls are initialized
FUNCTION PROBLEM - STEER RIGHT PERMANENTLY SELECTED	225	Machine is in Platform Mode; The Steer Right switch input = High at Startup	The UGM shall prohibit Steer Left and Right; The UGM shall limit Drive to Creep	The Steer Right switch input = Low; Steer Left and Right and full Drive speed permitted after controls are initialized
STEER SWITCHES FAULTY	227	The Steer Left switch input = High; The Steer Right switch input = High; (detectable in Platform or Ground mode)	The UGM shall prohibit Steer; The UGM shall limit Drive to Creep	The Steer Left switch input = Low; The Steer Right switch input = Low; Steer and full Drive speed permitted after controls are initialized
FSW INTERLOCK TRIPPED	2211	Machine is in Platform Mode; The Footswitch is active for more than seven seconds with no Drive, Steer, or Boom commands	The UGM shall disable Machine Enable	The footswitch is released
DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	2212	Machine is in Platform Mode; The UGM detects one of the following conditions: Drive joystick is not in the neutral position at Startup; Drive joystick is not in the neutral position when Footswitch becomes active or while DTC 2213, 2221 or 2223 is active	If triggered by the Drive joystick not being in the neutral position at Startup, the UGM shall prohibit Drive and Steer. If triggered by the Drive joystick not being in the neutral position when Footswitch becomes active or while DTC 2213, 2221 or 2223 is active, the UGM shall not Enable the Machine	If triggered by the Drive joystick not being in the neutral position at Startup, then (Drive joystick is returned to its neutral position) and (Drive and Steer permitted after controls initialized) If triggered by the Drive joystick not being in the neutral position when Footswitch becomes active or while DTC 2213, 2221 or 2223, then controls initialized
STEER LOCKED - SELECTED BEFORE FOOTSWITCH	2213	Machine is in Platform Mode; A Steer input is active when Footswitch becomes active or while DTC 2212, 2221 or 2223 is active	The UGM shall not Enable the Machine	Controls initialized
D/S JOY. OUT OF RANGE HIGH	2216	The PM detects that the Drive or Steer joystick signal voltage > 8.1V and reports the fault to the UGM.	The UGM shall prohibit Drive; Brake release and Steer still permitted	The PM no longer reports the fault
D/S JOY. CENTER TAP BAD	2217	The PM detects that the Drive or Steer center tap voltage is not between 3.31 volts and 3.75 volts and reports the fault to the UGM	The UGM shall prohibit Drive; Brake release and Steer still permitted	The PM detects that the drive/ steer center tap voltage is between 3.31 and 3.75 volts and no longer reports the fault to the UGM
L/S JOY. OUT OF RANGE HIGH	2219	The PM detects that the Lift or Swing joystick signal voltage > 8.1V and reports the fault to the UGM.	If the Machine is in Platform Mode, the UGM shall prohibit Lift and Swing	The PM detects that the Lift and Swing joystick signal voltage is < 8.1V and no longer reports the fault to the UGM
L/S JOY. CENTER TAP BAD	2220	The PM detects that the Lift or Swing center tap voltage is not between 3.31 volts and 3.75 volts and reports the fault to the UGM	If the Machine is in Platform Mode, the UGM shall prohibit Lift and Swing	The PM detects that the lift/ swing center tap voltage is between 3.31 and 3.75 volts and no longer reports the fault to the UGM

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	2221	Machine is in Platform Mode; The UGM detects one of the following conditions: Lift and/or Swing joystick is not in the neutral position at Startup; Lift and/or Swing joystick is not in the neutral position when Footswitch becomes active or while DTC 2212, 2213 or 2223 is active	If triggered by the Lift and/or Swing joystick not being in the neutral position at Startup, the UGM shall prohibit Lift and Swing. If triggered by Lift and/or Swing joystick is not in the neutral position when Footswitch becomes active or while DTC 2212, 2213 or 2223 is active, the UGM shall not Enable the Machine	If triggered by the Lift and/or Swing joystick not being in the neutral position at Startup, then (Lift and/or Swing joystick is returned to its neutral position) and (Lift and Swing permitted after controls initialized) If triggered by the Lift and/or Swing joystick is not in the neutral position when Footswitch becomes active or while DTC 2212, 2213 or 2223 is active, then controls initialized
WAITING FOR FSW TO BE OPEN	2222	Machine is in Platform Mode; Footswitch is active at Start Up	The UGM shall not Enable the Machine	Controls initialized
FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE	2223	Machine is in Platform Mode; Any of the following Platform inputs are active when Footswitch becomes active or while DTC 2212, 2213 or 2221 is active: Tower Lift; Telescope; Platform Level; Platform Rotate; Jib Lift (if MACHINE SETUP > JIB = YES)	The UGM shall not Enable the Machine	Controls initialized
FOOTSWITCH SELECTED BEFORE START	2224	Machine is in Platform Mode; The engine is stopped; Startup time has expired; The Footswitch is active before the Platform Engine Start switch input = High	The UGM shall prohibit Engine Start	The Platform Engine Start switch input = Low;
FUNCTION PROBLEM - PLATFORM ROTATE LEFT PERMANENTLY SELECTED	2247	Machine is in Platform Mode; The Platform Rotate Left switch input = High at Startup	The UGM shall prohibit Platform Rotate Left and Right	The Platform Rotate Left switch input = Low; Platform Rotate Left and Right permitted after controls are initialized
FUNCTION PROBLEM - PLATFORM ROTATE RIGHT PERMANENTLY SELECTED	2248	Machine is in Platform Mode; The Platform Rotate Right switch input = High at Startup	The UGM shall prohibit Platform Rotate Left and Right	The Platform Rotate Right switch input = Low; Platform Rotate Left and Right permitted after controls are initialized
FUNCTION PROBLEM - JIB LIFT UP PERMANENTLY SELECTED	2249	Machine is in Platform Mode; MACHINE SETUP > JIB = YES; The Jib Lift Up switch input = High at Startup	The UGM shall prohibit Jib Lift Up and Down	The Jib Lift Up switch input = Low; Jib Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM - JIB LIFT DOWN PERMANENTLY SELECTED	2250	Machine is in Platform Mode; MACHINE SETUP > JIB = YES; The Jib Lift Down switch input = High at Startup	The UGM shall prohibit Jib Lift Up and Down	The Jib Lift Down switch input = Low; Jib Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM - TELESCOPE IN PERMANENTLY SELECTED	2251	Machine is in Platform Mode; The Telescope In switch input = High at Startup	The UGM shall prohibit Telescope In and Out	The Telescope In switch input = Low; Telescope permitted after controls are initialized

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
FUNCTION PROBLEM - TELESCOPE OUT PERMANENTLY SELECTED	2252	Machine is in Platform Mode; The Telescope Out switch input = High at Startup	The UGM shall prohibit Telescope In and Out	The Telescope Out switch input = Low; Telescope permitted after controls are initialized
FUNCTION PROBLEM - TOWER LIFT UP PERMANENTLY SELECTED	2257	Machine is in Platform Mode; The Tower Lift Up switch input = High at Startup	The UGM shall prohibit Tower Lift Up and Down	The Tower Lift In switch input = Low; Tower Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM - TOWER LIFT DOWN PERMANENTLY SELECTED	2258	Machine is in Platform Mode; The Tower Lift Down switch input = High at Startup	The UGM shall prohibit Tower Lift Up and Down	The Tower Lift Down switch input = Low; Tower Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM - PLATFORM LEVEL UP PERMANENTLY SELECTED	2262	Machine is in Platform Mode; The Platform Level Up switch input = High at Startup	The UGM shall prohibit Platform Level Up and Down	The Platform Level Up switch input = Low; Platform Level Up and Down permitted after controls are initialized
FUNCTION PROBLEM - PLATFORM LEVEL DOWN PERMANENTLY SELECTED	2263	Machine is in Platform Mode; The Platform Level Down switch input = High at Startup	The UGM shall prohibit Platform Level Up and Down	The Platform Level Down switch input = Low; Platform Level Up and Down permitted after controls are initialized
FUNCTION PROBLEM - DOS OVERRIDE PERMANENTLY SELECTED	2264	Machine is in Platform Mode; The DOS Override switch input = High at Startup	No response required for this DTC	The DOS Override switch input = Low
FUNCTION PROBLEM - SOFT TOUCH / SKYGUARD OVERRIDE PERMANENTLY SELECTED	2286	[(MACHINE SETUP > SKYGUARD = YES) or (MACHINE SETUP > SOFT TOUCH = YES)]; Machine is in Platform Mode; The Soft Touch / SkyGuard Override switch input = High at Startup	No response required for this DTC	The Soft Touch / SkyGuard Override switch input = Low
FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	234	The UGM detects one of the following conditions (continuous monitoring): The machine is in Ground Mode and both direction inputs of the following boom controls are engaged at the same time: Engine Start/Aux, Telescope, Platform Level, Platform Rotate, Jib Lift, Tower Lift, Lift, or Swing. The machine is in Platform Mode and both direction inputs of the following boom controls are engaged at the same time: Engine Start/Aux, Telescope, Platform Level, Platform Rotate, Jib Lift (MACHINE SETUP > JIB = YES), Tower Lift (340AJ, 450AJ); or for Drive Mode – Max Speed/ Max Torque	Disable whichever boom functions whose boom control inputs are triggering the fault. If Engine Start/ Aux at fault, disable Engine Start but permit Auxiliary Power/Emergency Descent.	None of the boom controls that trigger this fault have both of their direction inputs engaged at the same time
FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER	235	The UGM detects one of the following conditions:	The UGM not enable Auxiliary Power/ Emergency Descent mode	The applicable APU/Auxiliary Descent switch is disengaged or all applicable control inputs

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
		The machine is in Ground Mode and the engine is stopped and the ground APU/ Function Enable switch becomes engaged while a Ground control input is already engaged. The machine is in Platform Mode and the engine is stopped and the platform APU/ Auxiliary Descent switch becomes engaged while a Platform control input is already engaged.		become disengaged or the engine state becomes ENGINE RUNNING
FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH	236	The UGM detects one of the following conditions: The machine is in Ground Mode and the engine is stopped and any configured boom control is already engaged and the ground start switch changes from not engaged to engaged The machine is in Platform Mode and the engine is stopped and any drive/steer or configured boom control is already engaged and the footswitch is not engaged and the platform start switch changes from not engaged to engaged	The UGM shall prohibit Engine Start	The selected station's start switch is no longer engaged
START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH	237	The start switch for the selected station is engaged during the UGM startup sequence	The UGM shall prohibit Engine Start	The selected station's start switch is no longer engaged
FUNCTION PROBLEM - GROUND ENABLE PERMANENTLY SELECTED	2310	Machine is in Ground Mode; The Ground Enable switch input = High at Startup	The UGM shall prohibit Engine Start; The UGM shall not Enable the Machine	Controls initialized
BOOM ANGLE SENSOR – NOT CALIBRATED	2343	The Boom Angle Sensor has not been calibrated	The UGM shall assume the Boom is Above Elevation; The UGM shall report a faulted boom angle of 90 degrees	Boom angle sensor calibrated
BOOM ANGLE SENSOR - OUT OF RANGE HIGH	2344	The UGM detects that Boom Angle Sensor #1 or Boom Angle Sensor #2 signal voltage > 4.5V.	The UGM shall assume the Boom is Above Elevation; The UGM shall report a faulted boom angle of 90 degrees	Power Cycled
BOOM ANGLE SENSOR - OUT OF RANGE LOW	2345	The UGM detects that Boom Angle Sensor #1 or Boom Angle Sensor #2 signal voltage < 0.5V.	The UGM shall assume the Boom is Above Elevation; The UGM shall report a faulted boom angle of 90 degrees	Power Cycled
BOOM ANGLE SENSOR – NOT RESPONDING	2346	The UGM detects the following conditions: The UGM detects < 1 deg change of Boom Angle Main Lift Up or Main Lift Down output value ≥ Creep output value Main Lift Up or Main Lift Down has been active longer than 5 seconds.	The UGM shall assume the Boom is Above Elevation; The UGM shall report a faulted boom angle of 90 degrees	Power Cycled
FUNCTION PROBLEM - JIB LIFT UP PERMANENTLY SELECTED	2370	Machine is in Ground Mode; MACHINE SETUP > JIB = YES;	The UGM shall prohibit Jib Lift Up and Down	The Jib Lift Up switch input = Low;

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
		The Jib Lift Up switch input = High at Startup		Jib Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM - JIB LIFT DOWN PERMANENTLY SELECTED	2371	Machine is in Ground Mode; MACHINE SETUP > JIB = YES; The Jib Lift Down switch input = High at Startup	The UGM shall prohibit Jib Lift Up and Down	The Jib Lift Down switch input = Low; Jib Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM - SWING LEFT PERMANENTLY SELECTED	2372	Machine is in Ground Mode; The Swing Left switch input = High at Startup	The UGM shall prohibit Swing Left and Right	The Swing Left switch input = Low; Swing Left and Right permitted after controls are initialized
FUNCTION PROBLEM - SWING RIGHT PERMANENTLY SELECTED	2373	Machine is in Ground Mode; The Swing Right switch input = High at Startup	The UGM shall prohibit Swing Left and Right	The Swing Left switch input = Low; Swing Left and Right permitted after controls are initialized
BOOM ANGLE SENSOR DISAGREEMENT	2396	The UGM detects that Boom Angle Sensor #1 and Boom Angle Sensor #2 readings disagree ≥ 2.5 deg for longer than 5 seconds; Do not report if DTC 2343 is active	The UGM shall assume the Boom is Above Elevation and will report a faulted boom angle of 90 degrees	Power Cycled
FUNCTION PROBLEM – TOWER LIFT UP PERMANENTLY SELECTED	23105	Machine is in Ground Mode; The Tower Lift Up switch input = High at Startup	The UGM shall prohibit Tower Lift Up and Down	The Tower Lift Up switch input = Low; Tower Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM – TOWER LIFT DOWN PERMANENTLY SELECTED	23106	Machine is in Ground Mode; The Tower Lift Down switch input = High at Startup	The UGM shall prohibit Tower Lift Up and Down	The Tower Lift Down switch input = Low; Tower Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM - LIFT UP PERMANENTLY SELECTED	23107	Machine is in Ground Mode; The Lift Up switch input = High at Startup	The UGM shall prohibit Lift Up and Down	The Lift Up switch input = Low; Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM - LIFT DOWN PERMANENTLY SELECTED	23108	Machine is in Ground Mode; The Lift Down switch input = High at Startup	The UGM shall prohibit Lift Up and Down	The Lift Down switch input = Low; Lift Up and Down permitted after controls are initialized
FUNCTION PROBLEM - TELESCOPE IN PERMANENTLY SELECTED	23109	Machine is in Ground Mode; The Telescope In switch input = High at Startup	The UGM shall prohibit Telescope In and Out	The Telescope In switch input = Low; Telescope In and Out permitted after controls are initialized
FUNCTION PROBLEM - TELESCOPE OUT PERMANENTLY SELECTED	23110	Machine is in Ground Mode; The Telescope Out switch input = High at Startup	The UGM shall prohibit Telescope In and Out	The Telescope Out switch input = Low; Telescope In and Out permitted after controls are initialized
FUNCTION PROBLEM - PLATFORM LEVEL UP PERMANENTLY SELECTED	23111	Machine is in Ground Mode; The Platform Level Up switch input = High at Startup	The UGM shall prohibit Platform Level Up and Down	The Platform Level Up switch input = Low; Platform Level Up and Down permitted after controls are initialized

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
FUNCTION PROBLEM - PLATFORM LEVEL DOWN PERMANENTLY SELECTED	23112	Machine is in Ground Mode; The Platform Level Down switch input = High at Startup	The UGM shall prohibit Platform Level Up and Down	The Platform Level Down switch input = Low; Platform Level Up and Down permitted after controls are initialized
FUNCTION PROBLEM - PLATFORM ROTATE LEFT PERMANENTLY SELECTED	23113	Machine is in Ground Mode; The Platform Rotate Left switch input = High at Startup	The UGM shall prohibit Platform Rotate Left and Right	The Platform Rotate Left switch input = Low; Platform Rotate Left and Right permitted after controls are initialized
FUNCTION PROBLEM - PLATFORM ROTATE RIGHT PERMANENTLY SELECTED	23114	Machine is in Ground Mode; The Platform Rotate Right switch input = High at Startup	The UGM shall prohibit Platform Rotate Left and Right	The Platform Rotate Right switch input = Low; Platform Rotate Left and Right permitted after controls are initialized
TELESCOPE RETRACT SWITCHES - DISAGREEMENT	23154	The UGM detects the following conditions: Telescope Retracted Switch #1 and Telescope Retracted Switch #2 readings disagree for longer than 5 seconds; Telescope In or Telescope Out output value ≥ Creep output value	The UGM shall assume the Boom is Not Retracted	Power Cycled
SWING SWITCHES - DISAGREEMENT	23155	The UGM detects the following conditions: Swing Switch #1 and Swing Switch #2 readings disagree for longer than 5 seconds; Swing Left or Swing Right value ≥ Creep output value	The UGM shall assume the Boom is Swung	Power Cycled
FUNCTION PROBLEM – MSSO PERMANENTLY SELECTED	23163	The MSSO switch input = Low at Startup	No response required for this DTC	Power Cycled
BOOM ANGLE SENSOR - SINGLE POINT CALIBRATION PERFORMED	23170	Single point Boom Angle calibration is successfully completed	No response required for this DTC	Fault shall be retentive through Power Cycled; Can be reset if CALIBRATIONS > BOOM ANGLE is successfully completed
BOOM ANGLE SENSOR - ANGLE OUT OF RANGE LOW	23240	The UGM detects a Boom Angle < (Boom Angle Min - 1.5 deg); Do not report if Boom Angle == Unhealthy		Fault shall be retentive through Power Cycled; Can be reset by performing a Boom Angle Sensor Calibration
AMBIENT TEMPERATURE SENSOR – OUT OF RANGE LOW	241	MACHINE SETUP > TEMP CUTOUT = YES; Ambient Temperature sensor reading ≤ -50C	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation; The UGM shall limit Swing, Tower Lift (340AJ. 450AJ), Tele, Lift, Platform	Ambient Temperature sensor reading > -50C; Full Speed permitted after controls are initialized

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
			Rotate, Platform Level, and Jib Lift (if MACHINE SETUP > JIB = YES) to Creep speed If the Machine is in Ground Mode; No response required for this DTC	
AMBIENT TEMPERATURE SENSOR – OUT OF RANGE HIGH	242	MACHINE SETUP > TEMP CUTOUT = YES; Ambient Temperature sensor reading ≥ 85C	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation; The UGM shall limit Swing, Tower Lift (340AJ. 450AJ), Tele, Lift, Platform Rotate, Platform Level, and Jib Lift (if MACHINE SETUP > JIB = YES) to Creep speed If the Machine is in Ground Mode; No response required for this DTC	Ambient Temperature sensor reading < 85C; Full Speed permitted after controls are initialized
DRIVE & LIFT PREVENTED - BRAKES ELECTRICALLY RELEASED FOR TOWING	258			
MODEL CHANGED – HYDRAULICS SUSPENDED – CYCLE EMS	259	The MACHINE SETUP > MODEL NUMBER is changed using the analyzer	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start)	Power Cycled
GENERATOR MOTION CUTOUT ACTIVE	2513	MACHINE SETUP > GEN SET = BELT DRIVE; MACHINE SETUP > GEN SET CUTOUT = MOTION CUTOUT; The platform Generator Switch is engaged Footswitch State = Depressed The machine is in Platform mode	The UGM shall not Enable the Machine	Not all of the trigger conditions are met
BOOM PREVENTED – DRIVE SELECTED	2514	MACHINE SETUP > FUNCTION CUTOUT = BOOM CUTOUT; Drive or Steer is already engaged; The boom is Above Elevation The operator is attempting to activate one of the boom functions DTC 2514 supercedes DTC 2518 if drive/ steer and boom functions are both active when machine transitions from Below Elevation to Above Elevation.	The UGM shall prohibit all boom functions	Not all of the trigger conditions are met
DRIVE PREVENTED – ABOVE ELEVATION	2516	MACHINE SETUP > FUNCTION CUTOUT = DRIVE CUTOUT The boom is Above Elevation The operator is attempting to activate Drive or Steer	The UGM shall prohibit Drive and Steer	Not all of the trigger conditions are met
DRIVE PREVENTED – TILTED & ABOVE ELEVATION	2517	MACHINE SETUP > FUNCTION CUTOUT = DRIVE CUT E&T The boom is Above Elevation	The UGM shall prohibit Drive and Steer	Not all of the trigger conditions are met

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
		The chassis is considered Tilted The operator is attempting to activate Drive or Steer		
DRIVE PREVENTED – BOOM SELECTED	2518	MACHINE SETUP > FUNCTION CUTOUT = BOOM CUTOUT The boom is Above Elevation Any boom function is already active The operator attempts to activate Drive or Steer	The UGM shall prohibit Drive and Steer	Not all of the trigger conditions are met
SYSTEM TEST MODE ACTIVE	2548			
DRIVE & BOOM PREVENTED - SOFT TOUCH ACTIVE	2549	MACHINE SETUP > SOFT TOUCH = YES; Machine is in Platform Mode; Soft Touch State = Enabled	Response detailed in Soft Touch section	Not all of the trigger conditions are met
SKYGUARD SWITCH – DISAGREEMENT	2563	MACHINE SETUP > SKYGUARD = YES; Machine is in Platform Mode; [(SkyGuard input #1 Platform Module J7-18) ≠ (SkyGuard input #2 Platform Module J1-23)] > 160ms	Response detailed in SkyGuard section	[{SkyGuard inputs (Platform Module J7-18 = High) and (Platform Module J1-23 = High)} and (Footswitch State = Not Depressed)]
DRIVE PREVENTED - LEFT BRAKE NOT RELEASING	2564			
PLATFORM LEVEL PREVENTED – ABOVE ELEVATION	2576	Platform Level Override Cutout = Enabled; The Platform Level Up or Down switch input = High; Footswitch is active	The UGM shall suspend Platform Level Up and Down commandos; The UGM shall prohibit Platform Level Up and Down	Controls initialized
BRAKE – SHORT TO BATTERY	331	The UGM detects a short to battery at this output	The UGM shall prohibit Drive and Brake outputs.	Power Cycled
BRAKE – OPEN CIRCUIT	332	The UGM detects an open circuit at this output	No response required for this DTC	Power Cycled
LIFT UP VALVE – OPEN CIRCUIT	334	The UGM detects an open circuit at this output	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized	The UGM no longer detects open circuit; Full speed Lift Up and Down permitted after controls are initialized
LIFT DOWN VALVE – OPEN CIRCUIT	336	The UGM detects an open circuit at this output	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall prohibit Lift Up; The UGM shall limit Lift Down to Creep speed after controls initialized	The UGM no longer detects open circuit; Full speed Lift Up and Lift Down permitted after controls are initialized
GROUND ALARM – SHORT TO BATTERY	3311	The UGM detects a short to battery at this output	No response required for this DTC	Power Cycled
MAIN DUMP VALVE – SHORT TO GROUND	3358	The UGM detects a short to ground at this output	The UGM shall prohibit Main Dump	Power Cycled
MAIN DUMP VALVE – OPEN CIRCUIT	3359	The UGM detects an open circuit at this output	The UGM shall suspend Swing (340AJ, 400S, 450AJ), Tower Lift Up	The UGM no longer detects open circuit;

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
			(340AJ, 450AJ), Lift Up, Telescope (400S, 450AJ, 18RS, 24RS), Jib Lift (400S, 450AJ); Platform Rotate (400S, 450AJ) and Platform Level (400S, 450AJ); The UGM shall limit Tower Lift Up (340AJ, 450AJ), Telescope (400S, 450AJ, 18RS, 24RS), Lift Up, Platform Rotate (400S, 450AJ), Platform Level (400S, 450AJ), and Jib Lift (400S, 450AJ) to Creep speed after controls initialized	Full speed Swing (340AJ, 400S, 450AJ), Tower Lift Up (340AJ, 450AJ), Lift Up, Telescope (400S, 450AJ, 18RS, 24RS) Jib Lift (400S, 450AJ), Platform Rotate (400S, 450AJ) and Platform Level (400S, 450AJ)permitted after controls are initialized
MAIN DUMP VALVE – SHORT TO BATTERY	3360	The UGM detects a short to battery at this output	The UGM shall prohibit Main Dump, Steer (400S, 450AJ), Swing (340AJ, 400S, 450AJ), Tower Lift Up (340AJ, 450AJ), Lift Up, Telescope (400S, 450AJ, 18RS, 24RS), Jib Lift (400S, 450AJ), Platform Level (400S, 450AJ) and Platform Rotate (400S, 450AJ)	Power Cycled
BRAKE – SHORT TO GROUND	3361	The UGM detects a short to ground at this output	Disable UGM Drive/Steer and Brake outputs	Power Cycled
START SOLENOID – SHORT TO GROUND	3362	UGM detects a short to ground at this output	Engine Start attempt shall not be permitted.	Power Cycled
START SOLENOID – OPEN CIRCUIT	3363	UGM detects an open circuit at this output; if MACHINE SETUP > ENGINE = DUAL FUEL ECU, only evaluate until first Start is attempted for each power cycle due to possibility of ECU opening ground solenoid return path to disable Start and causing erroneous diagnostics.	No response required for this DTC	Power Cycled
START SOLENOID – SHORT TO BATTERY	3364	UGM detects a short to battery at this output	Disable UGM Engine Start by deenergizing Fuel Actuator (Kubota) or sending Engine Shutdown command (CAN-based ECUs)	Power Cycled
GROUND ALARM -SHORT TO GROUND	3371			
GROUND ALARM -OPEN CIRCUIT	3372			
GEN SET/WELDER – SHORT TO GROUND	3373	MACHINE SETUP > GEN SET = BELT DRIVE and the UGM detects a short to ground at this output	Disable UGM Generator output. Do not Enable generator functionality or set Engine to Generator RPM.	Power Cycled
GEN SET/WELDER – OPEN CIRCUIT	3374	MACHINE SETUP > GEN SET = BELT DRIVE and the UGM detect an open circuit at this output	No response required for this DTC	Power Cycled
GEN SET/WELDER – SHORT TO BATTERY	3375	MACHINE SETUP > GEN SET = BELT DRIVE and the UGM detects a short to battery at this output	Disable UGM Generator output, but UGM shall consider Generator always excited (enabled) and restrict engine to Generator RPM. If MACHINE SETUP > GENSET CUTOUT = MOTION	Power Cycled

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
			CUTOUT, disregard cutout and permit motion.	
HEAD TAIL LIGHT – SHORT TO GROUND	3376	MACHINE SETUP > H & T LIGHTS =YES and the UGM detects a short to ground at this output	Disable UGM H&T Light relay output	Power Cycled
HEAD TAIL LIGHT – OPEN CIRCUIT	3377	MACHINE SETUP > H & T LIGHTS =YES and the UGM detects an open circuit at this output	No response required for this DTC	Power Cycled
HEAD TAIL LIGHT – SHORT TO BATTERY	3378	MACHINE SETUP > H & T LIGHTS =YES and the UGM detects a short to battery at this output	Disable UGM H&T Light relay output	Power Cycled
PLATFORM LEVEL UP VALVE – SHORT TO GROUND	3382	The UGM detects a short to ground at this output	The UGM shall prohibit Platform Level Up; (340AJ, 400S, 450AJ) The UGM shall limit Platform Level Down to Creep speed	Power Cycled
PLATFORM LEVEL UP VALVE – OPEN CIRCUIT	3383	The UGM detects an open circuit at this output	The UGM shall suspend Platform Level Up and Down; (340AJ, 400S, 450AJ) The UGM shall limit Platform Level Up and Down to Creep speed after controls initialized; (18RS, 24RS) Platform Level Up and Down permitted after controls are initialized	The UGM no longer detects open circuit; (340AJ, 400S, 450AJ) Full speed Platform Level Up and Down permitted after controls are initialized
PLATFORM LEVEL UP VALVE – SHORT TO BATTERY	3384	The UGM detects a short to battery at this output	The UGM shall prohibit Platform Level Up, Level Down, and Flow Control	Power Cycled
PLATFORM LEVEL DOWN VALVE – SHORT TO GROUND	3388	The UGM detects a short to ground at this output	The UGM shall prohibit Platform Level Up and Down	Power Cycled
PLATFORM LEVEL DOWN VALVE – OPEN CIRCUIT	3389	The UGM detects an open circuit at this output	The UGM shall suspend Platform Level Up and Down; The UGM shall prohibit Platform Level Up; (340AJ, 400S, 450AJ) The UGM shall limit Platform Level Down to Creep speed after controls initialized; (18RS, 24RS) Platform Level Down permitted after controls are initialized	The UGM no longer detects open circuit; (340AJ, 400S, 450AJ) Full speed Platform Level Up and Platform Level Down permitted after controls are initialized
PLATFORM LEVEL DOWN VALVE – SHORT TO BATTERY	3390	The UGM detects a short to battery at this output	The UGM shall prohibit Platform Level Up, Level Down, and Flow Control	Power Cycled
PLATFORM ROTATE LEFT VALVE – OPEN CIRCUIT	3395	The UGM detects an open circuit at this output	The UGM shall suspend Platform Rotate Left and Right; (340AJ, 400S, 450AJ) The UGM shall limit Platform Rotate Left and Right to Creep speed after controls initialized; (18RS, 24RS) Platform Rotate Left and Right permitted after controls are initialized	The UGM no longer detects open circuit; (340AJ, 400S, 450AJ) Full speed Platform Rotate Left and Right permitted after controls are initialized

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
TOWER LIFT UP VALVE – SHORT TO GROUND	33106	The UGM detects a short to ground at this output	The UGM shall prohibit Tower Lift Up; The UGM shall limit Tower Lift Down Creep speed	Power Cycled
TOWER LIFT UP VALVE – OPEN CIRCUIT	33107	The UGM detects an open circuit at this output	The UGM shall suspend Tower Lift Up and Down command and revert to Open Loop Current control for Tower Lift; The UGM shall limit Tower Lift Up and Down to Creep speed after controls initialized	The UGM no longer detects open circuit; Full speed Tower Lift Up and Down permitted after controls are initialized
TOWER LIFT DOWN VALVE – SHORT TO GROUND	33109	The UGM detects a short to ground at this output	The UGM shall prohibit Tower Lift Up and Down	Power Cycled
TOWER LIFT DOWN VALVE – OPEN CIRCUIT	33110	The UGM detects an open circuit at this output	The UGM shall suspend Tower Lift Up and Down command and revert to Open Loop Current control for Tower Lift; The UGM shall prohibit Tower Lift Up; The UGM shall limit Tower Lift Down to Creep speed after controls initialized	The UGM no longer detects open circuit; Tower Lift Up permitted after controls are initialized; Full speed Tower Lift Down permitted after controls are initialized
SWING RIGHT VALVE – SHORT TO GROUND	33118	The UGM detects a short to ground at this output	The UGM shall prohibit Swing Left and Right	Power Cycled
SWING RIGHT VALVE – OPEN CIRCUIT	33119	The UGM detects an open circuit at this output	The UGM shall suspend Swing Left and Right command and revert to Open Loop Current control for Swing; The UGM shall limit Swing Left and Right to Creep speed after controls initialized	The UGM no longer detects open circuit; Full speed Swing Left and Right permitted after controls are initialized
TELESCOPE IN VALVE – SHORT TO BATTERY	33120	The UGM detects a short to battery at this output	The UGM shall prohibit Telescope In, Out and Flow Control	Power Cycled
SWING LEFT VALVE – SHORT TO GROUND	33122	The UGM detects a short to ground at this output	The UGM shall prohibit Swing Left and Right	Power Cycled
TELESCOPE OUT VALVE – SHORT TO BATTERY	33123	The UGM detects a short to battery at this output	The UGM shall prohibit Telescope In, Out and Flow Control	Power Cycled
LIFT VALVES – SHORT TO BATTERY	33182	The UGM detects a short to battery at either the Lift Up or Lift Down valve	The UGM shall prohibit Lift Up and Down; The UGM shall open the Lift Current Feedback low side FET	Power Cycled
TELESCOPE OUT VALVE – OPEN CIRCUIT	33186	The UGM detects an open circuit at this output	(340AJ, 400S, 450AJ) The UGM shall suspend Telescope In and Out (18RS, 24RS) The UGM shall suspend Telescope In and Out command and revert to Open Loop Current control for Telescope The UGM shall limit Telescope In and Out to Creep speed after controls initialized	The UGM no longer detects open circuit; Full speed Telescope In and Out permitted after controls are initialized

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
TELESCOPE OUT VALVE – SHORT TO GROUND	33188	The UGM detects a short to ground at this output	The UGM shall prohibit Telescope Out; Tele In speed limited to Creep	Power Cycled
TELESCOPE IN VALVE – OPEN CIRCUIT	33189	The UGM detects an open circuit at this output	(340AJ, 400S, 450AJ) The UGM shall suspend Telescope In and Out (18RS, 24RS) The UGM shall suspend Telescope In and Out command and revert to Open Loop Current control for Telescope The UGM shall prohibit Telescope Out; The UGM shall limit Telescope In to Creep speed after controls initialized	The UGM no longer detects open circuit; Telescope Out permitted after controls are initialized; Full speed Telescope In permitted after controls are initialized
TELESCOPE IN VALVE – SHORT TO GROUND	33190	The UGM detects a short to ground at this output	The UGM shall prohibit Telescope In and Out	Power Cycled
HORN - SHORT TO BATTERY	33208			
APU PUMP RELAY - OPEN CIRCUIT	33276	The UGM detects an open circuit at this output	No response required for this DTC	Power Cycled
APU PUMP RELAY - SHORT TO BATTERY	33277	The UGM detects a short to battery at this output	Disable UGM APU Pump relay output	Power Cycled
APU PUMP RELAY - SHORT TO GROUND	33278	The UGM detects a short to ground at this output	Disable UGM APU Pump relay output	Power Cycled
GLOWPLUG – OPEN CIRCUIT	33279	MACHINE SETUP > ENGINE ≠ DUAL FUEL ECM MACHINE SETUP > ENGINE ≠ DEUTZ EMR4 MACHINE SETUP > GLOW PLUG ≠ NO The UGM detects an open circuit at this output	No response required for this DTC	Power Cycled
GLOWPLUG – SHORT TO BATTERY	33280	MACHINE SETUP > ENGINE ≠ DUAL FUEL ECM MACHINE SETUP > ENGINE ≠ DEUTZ EMR4 MACHINE SETUP > GLOW PLUG ≠ NO The UGM detects a short to battery at this output	Disable UGM Glow Plug relay output	Power Cycled
GLOWPLUG – SHORT TO GROUND	33281	MACHINE SETUP > ENGINE ≠ DUAL FUEL ECM MACHINE SETUP > ENGINE ≠ DEUTZ EMR4 MACHINE SETUP > GLOW PLUG ≠ NO The UGM detects a short to ground at this output	Disable UGM Glow Plug relay output	Power Cycled
LIFT – CURRENT FEEDBACK READING TOO LOW	33287	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized	Power Cycled

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
SWING LEFT VALVE – OPEN CIRCUIT	33295	The UGM detects an open circuit at this output	The UGM shall suspend Swing Left and Right command and revert to Open Loop Current control for Swing; The UGM shall limit Swing Left and Right to Creep speed after controls initialized	The UGM no longer detects open circuit; Full speed Swing Left and Right permitted after controls are initialized
DRIVE FORWARD VALVE – OPEN CIRCUIT	33317	The UGM detects an open circuit at this output	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized	The UGM no longer detects open circuit; Full speed Drive Forward and Reverse permitted after controls are initialized
DRIVE VALVES – SHORT TO BATTERY	33318	The UGM detects a short to battery at either the Drive Forward or Drive Reverse valve.	The UGM shall prohibit Drive Forward and Reverse; The UGM shall open the Drive Current Feedback low side FET	Power Cycled
DRIVE FORWARD VALVE – SHORT TO GROUND	33319	The UGM detects a short to ground at this output	The UGM shall prohibit Drive Forward and Reverse	Power Cycled
DRIVE REVERSE VALVE – OPEN CIRCUIT	33320	The UGM detects an open circuit at this output	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized	The UGM no longer detects open circuit; Full speed Drive Forward and Reverse permitted after controls are initialized
DRIVE REVERSE VALVE – SHORT TO GROUND	33322	The UGM detects a short to ground at this output	The UGM shall prohibit Drive Forward and Reverse	Power Cycled
DRIVE – CURRENT FEEDBACK READING TOO LOW	33331	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized	Power Cycled
LIFT UP VALVE – SHORT TO GROUND	33406	The UGM detects a short to ground at this output	The UGM shall prohibit Lift Up; The UGM shall limit Lift Down Creep speed	Power Cycled
LIFT DOWN VALVE – SHORT TO GROUND	33407	The UGM detects a short to ground at this output	The UGM shall prohibit Lift Up and Down	Power Cycled
DRIVE – LOSS OF CURRENT FEEDBACK	33410	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized	Power Cycled
SWING VALVES – SHORT TO BATTERY	33412	The UGM detects a short to battery at either the Swing Right or Swing Left valve	The UGM shall prohibit Swing Left and Right; The UGM shall open the Swing Current Feedback low side FET	Power Cycled

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
TOWER LIFT – CURRENT FEEDBACK READING TOO LOW	33413	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Tower Lift Up and Down command and revert to Open Loop Current control for Tower Lift; The UGM shall limit Tower Lift Up and Down to Creep speed after controls initialized	Power Cycled
SWING – CURRENT FEEDBACK READING TOO LOW	33414	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Swing Left and Right command and revert to Open Loop Current control for Swing; The UGM shall limit Swing Left and Right to Creep speed after controls initialized	Power Cycled
FLOW CONTROL VALVE – CURRENT FEEDBACK READING TOO LOW	33415	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control; The UGM shall limit Telescope, Jib Lift Up; Jib Lift Down (400S, 450AJ), Platform Rotate and Platform Level to Creep speed after controls initialized	Power Cycled
TOWER LIFT – CURRENT FEEDBACK READING LOST	33416	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Tower Lift Up and Down command and revert to Open Loop Current control for Tower Lift; The UGM shall limit Tower Lift Up and Down to Creep speed after controls initialized	Power Cycled
LIFT – CURRENT FEEDBACK READING LOST	33417	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized	Power Cycled
SWING – CURRENT FEEDBACK READING LOST	33418	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Swing Left and Right command and revert to Open Loop Current control for Swing; The UGM shall limit Swing Left and Right to Creep speed after controls initialized	Power Cycled
FLOW CONTROL VALVE – CURRENT FEEDBACK READING LOST	33419	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control; The UGM shall limit Telescope In and Out, Jib Lift Up and Down (400S, 450AJ), Platform Rotate Right and Left and Platform Level Up and Down to Creep speed after controls initialized	Power Cycled

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
TOWER LIFT VALVES – SHORT TO BATTERY	33425	The UGM detects a short to battery at either the Tower Lift Up or Tower Lift Down valve.	The UGM shall prohibit Tower Lift Up and Down; The UGM shall open the Tower Lift Current Feedback low side FET	Power Cycled
AUXILIARY LIFT DOWN VALVE - SHORT TO GROUND	33537	The UGM detects a short to ground at this output	The UGM shall prohibit Aux Lift Down	Power Cycled
AUXILIARY LIFT DOWN VALVE - OPEN CIRCUIT	33538	The UGM detects an open circuit at this output	The UGM shall suspend Aux Lift Down; Aux Lift Down permitted after controls are initialized	The UGM no longer detects open circuit
AUXILIARY TOWER LIFT DOWN VALVE - SHORT TO GROUND	33540	The UGM detects a short to ground at this output	The UGM shall prohibit Aux Tower Lift Down	Power Cycled
AUXILIARY TOWER LIFT DOWN VALVE - OPEN CIRCUIT	33541	The UGM detects an open circuit at this output	The UGM shall suspend Aux Tower Lift Down; Aux Tower Lift Down permitted after controls are initialized	The UGM no longer detects open circuit
OSCILLATING AXLE #1 VALVE - SHORT TO GROUND	33543	The UGM detects a short to ground at this output	UGM shall disable Oscillating Axle #1 valve and Oscillating Axle #2 valve outputs; The UGM shall Lock the Oscillating Axle	Power Cycled
OSCILLATING AXLE #1 VALVE - OPEN CIRCUIT	33544	The UGM detects an open circuit at this output	UGM shall disable Oscillating Axle #1 valve and Oscillating Axle #2 valve outputs; The UGM shall Lock the Oscillating Axle	Power Cycled
OSCILLATING AXLE #1 VALVE - SHORT TO BATTERY	33545	The UGM detects a short to battery at this output	UGM shall disable Oscillating Axle #1 valve and Oscillating Axle #2 valve outputs; The UGM shall Lock the Oscillating Axle	Power Cycled
OSCILLATING AXLE #2 VALVE - SHORT TO GROUND	33546	The UGM detects a short to ground at this output	UGM shall disable Oscillating Axle #1 valve and Oscillating Axle #2 valve outputs; The UGM shall Lock the Oscillating Axle	Power Cycled
OSCILLATING AXLE #2 VALVE - OPEN CIRCUIT	33547	The UGM detects an open circuit at this output	UGM shall disable Oscillating Axle #1 valve and Oscillating Axle #2 valve outputs; The UGM shall Lock the Oscillating Axle	Power Cycled
OSCILLATING AXLE #2 VALVE - SHORT TO BATTERY	33548	The UGM detects a short to battery at this output	UGM shall disable Oscillating Axle #1 valve and Oscillating Axle #2 valve outputs; The UGM shall Lock the Oscillating Axle	Power Cycled
AUXILIARY VALVES - SHORT TO BATTERY	33567	The UGM detects a short to battery at either the Aux Lift Down or Aux Tower Lift Down valve	The UGM shall prohibit Aux Lift Down and Aux Tower Lift Down;	Power Cycled

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
			The UGM shall open the Auxiliary low side FET	
AUXILIARY - CURRENT FEEDBACK READING LOST	33568	Measured feedback current < 225mA while output is active for a period of 100ms.	The UGM shall suspend Aux Lift Down and Aux Tower Down (450AJ); Aux Lift Down and Aux Tower Down (450AJ) permitted after controls are initialized	Power Cycled
ECM PULL DOWN RESISTOR - OPEN CIRCUIT	33575	MACHINE SETUP > ENGINE = DEUTZ EMR4; Pull down resister not detected	The UGM shall send the Engine Shutdown command	Power Cycled
PLATFORM ROTATE LEFT VALVE – OPEN CIRCUIT	349	The PM detects an open circuit at this output and reports it to the UGM	The UGM shall suspend commands to PM for Platform Rotate Right and Left; The UGM shall limit Platform Rotate Right and Left to Creep speed after controls are initialized	The PM no longer detects open circuit; Full speed Platform Rotate Right and Left permitted after controls are initialized
PLATFORM ROTATE LEFT VALVE – SHORT TO BATTERY	3410	The PM detects a short to battery at this output and reports it to the UGM	The UGM shall disable commands to PM for Platform Rotate Right and Left; The UGM shall prohibit Flow Control	Power Cycled
PLATFORM ROTATE LEFT VALVE – SHORT TO GROUND	3411	The PM detects a short to ground at this output and reports it to the UGM	The UGM shall disable commands to PM for Platform Rotate Right and Left	Power Cycled
PLATFORM ROTATE RIGHT VALVE – OPEN CIRCUIT	3412	The PM detects an open circuit at this output and reports it to the UGM	The UGM shall suspend commands to PM for Platform Rotate Right and Left; The UGM shall limit Platform Rotate Right and Left to Creep speed after controls are initialized	The PM no longer detects open circuit; Full speed Platform Rotate Right and Left permitted after controls are initialized
PLATFORM ROTATE RIGHT VALVE – SHORT TO BATTERY	3413	The PM detects a short to battery at this output and reports it to the UGM	The UGM shall disable commands to PM for Platform Rotate Right and Left; The UGM shall prohibit Flow Control	Power Cycled
PLATFORM ROTATE RIGHT VALVE – SHORT TO GROUND	3414	The PM detects a short to ground at this output and reports it to the UGM	The UGM shall disable commands to PM for Platform Rotate Right and Left	Power Cycled
JIB LIFT UP VALVE – OPEN CIRCUIT	3415	MACHINE SETUP > JIB = YES The PM detects an open circuit at this output and reports it to the UGM	The UGM shall suspend commands to PM for Jib Lift Up and Down; The UGM shall limit Jib Lift Up and Down to Creep speed	The PM no longer detects open circuit; Full speed Jib Lift Up and Down permitted after controls are initialized
JIB LIFT UP VALVE – SHORT TO BATTERY	3416	MACHINE SETUP > JIB = YES The PM detects a short to battery at this output and reports it to the UGM	The UGM shall disable commands to PM for Jib Lift Up and Down; The UGM shall prohibit Flow Control	Power Cycled
JIB LIFT UP VALVE – SHORT TO GROUND	3417	MACHINE SETUP > JIB = YES The PM detects a short to ground at this output and reports it to the UGM	The UGM shall disable commands to PM for Jib Lift Up; The UGM limits Jib Lift Down to Creep speed	Power Cycled

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
JIB LIFT DOWN VALVE – OPEN CIRCUIT	3418	MACHINE SETUP > JIB = YES The PM detects an open circuit at this output and reports it to the UGM	The UGM shall suspend commands to PM for Jib Lift Up and Down; The UGM shall prohibit Jib Lift Up; The UGM shall limit Jib Lift Down to Creep speed	The PM no longer detects open circuit; Jib Lift Up permitted after controls are initialized Full speed Jib Lift Down permitted after controls are initialized
JIB LIFT DOWN VALVE – SHORT TO BATTERY	3419	MACHINE SETUP > JIB = YES The PM detects a short to battery at this output and reports it to the UGM	The UGM shall disable commands to PM for Jib Lift Up and Down; (450AJ) The UGM shall prohibit Flow Control	Power Cycled
JIB LIFT DOWN VALVE – SHORT TO GROUND	3420	MACHINE SETUP > JIB = YES The PM detects a short to ground at this output and reports it to the UGM; detection occurs for PWM output approximately ≤ 15% or for STG condition.	The UGM shall disable commands to PM for Jib Lift Up and Down	Power Cycled
ENGINE TROUBLE CODE	437	An engine with a CAN engine controller is configured in MACHINE SETUP The engine controller reports a J1939 fault	Report and log in Help If [(MACHINE SETUP > DEUTZ EMR2) or (MACHINE SETUP > DEUTZ EMR4) and SPN:FMI = 535:7], prohibit engine cranking	Power Cycled
HIGH ENGINE TEMP	438	An engine with a CAN engine controller is not configured in MACHINE SETUP: The Engine State = ENGINE RUNNING > 10 seconds The coolant temperature is greater than or equal to the configured engines max allowed temperature. The maximum allowed temperature > 110ºC. An engine with a CAN engine controller is configured in MACHINE SETUP: ECM transmits a J1939 DM1 message for an engine coolant high temperature critical fault (SPN:FMI 110:0) on CAN2 or uses the J1939 Transport Protocol every one second to send this information if multiple engine faults exist.	MACHINE SETUP > ENGINE SHUTDOWN = ENABLED then shutdown the engine Activate High Engine Temperature indicator J4-28	Power Cycled
NO ALTERNATOR OUTPUT	4310	The Engine State = ENGINE RUNNING > 10 seconds and UGM system voltage < 11.5 volts for 10 seconds	Activate the No Charge indicator J4-26 per System Indicators	UGM system voltage > 11.7 volts
LOW OIL PRESSURE	4311	An engine with a CAN engine controller is not configured in MACHINE SETUP The Engine State = ENGINE RUNNING > 10 seconds The engine oil pressure is LOW (debounce 3s). An engine with a CAN engine controller is configured in MACHINE SETUP ECM transmits a J1939 DM1 message for an engine oil low pressure critical fault (SPN:FMI 100:1) on CAN2 or uses the J1939 Transport Protocol every one second	MACHINE SETUP > ENGINE SHUTDOWN = ENABLED then shutdown the engine Activate the Low Oil Pressure indicator J4-29	Power Cycled

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
		to send this information if multiple engine faults exist.		
ENGINE COOLANT – LOW LEVEL	4334	MACHINE SETUP > ENGINE = DEUTZ EMR4; ECM transmits a J1939 DM1 message for an engine coolant low level fault (SPN:FMI 111:1) on CAN2 or uses the J1939 Transport Protocol every one second to send this information if multiple engine faults exist.	MACHINE SETUP > ENGINE SHUTDOWN = ENABLED then shutdown the engine; Activate High Engine Temperature indicator J4-28	Power Cycled
WATER IN FUEL	4375			
BATTERY VOLTAGE TOO LOW – SYSTEM SHUTDOWN	441	The UGM detects that its supply voltage is less than 9 volts Engine State ≠ ENGINE CRANKING Auxiliary Power/Emergency Descent Mode is not active	Disable all UGM valve outputs except those used during APU/Emergency Descent [Tower Lift Down, Lift Down, Swing (400S, 450AJ, 24RS), Jib Lift Up/Down (MACHINE SETUP > JIB= YES)]. If MACHINE SETUP > H&T LIGHTS = YES or > ENGINE ≠ DUAL FUEL ECM turn off lights	Voltage is greater than 9.25 volts
BATTERY VOLTAGE TOO HIGH – SYSTEM SHUTDOWN	442	The UGM detects that its supply voltage > 16.0 volts	Disable all UGM and Platform outputs until voltage < 15.75 volts and do not permit Machine Enable	Power Cycled
LSS BATTERY VOLTAGE TOO HIGH	443	MACHINE SETUP > LOAD SYSTEM ≠ NO The UGM detects that the LSS reports supply voltage > 16.0V	UGM to set Platform Load State = Overloaded	Not all of the trigger conditions are met
LSS BATTERY VOLTAGE TOO LOW	444	MACHINE SETUP > LOAD SYSTEM ≠ NO The UGM detects that the LSS reports supply voltage < 9.0V	UGM to set Platform Load State = Overloaded	Not all of the trigger conditions are met
BATTERY VOLTAGE LOW	445	The UGM detects that its supply voltage < 11 volts for 5 seconds. Engine State ≠ ENGINE CRANKING Auxiliary Power/Emergency Descent Mode is not active Glow Plugs are not energized	No response required for this DTC	Voltage is greater than 11.25 volts
LSS BATTERY VOLTAGE - INITIALIZATION ERROR	4479			
LSS BATTERY VOLTAGE - NOT CALIBRATED	4480			
CANBUS FAILURE – PLATFORM MODULE	662	UGM does not receive any CAN messages from the PM in 250ms	The UGM shall suspend motion; If MACHINE SETUP > GENERATOR, the UGM shall disable to turn off generator relay output and assume generator off state. If MACHINE SETUP > ENGINE = DUAL FUEL and > H & T LIGHTS = YES, state of switch prior to loss of CAN Bus 1 shall be retained until CAN Bus 1 is restored or power cycled.	CAN messages are received from the PM

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
			Reactivation of Footswitch is required after CAN Bus 1 is restored to obtain Machine Enable. (340AJ, 450AJ) If the Machine is in Ground Mode, the UGM shall disable commands to PM for Jib Lift Up and Down, Platform Rotate Right and Left;	
CANBUS FAILURE – LOAD SENSING SYSTEM MODULE	663	MACHINE SETUP > LOAD SYSTEM ≠ NO UGM does not receive any CAN messages from the LSS module in 1000ms	UGM to set Platform Load State = Overloaded	Not all of the trigger conditions are met
CANBUS FAILURE – ENGINE CONTROLLER	666	An engine with a CAN engine controller is configured in MACHINE SETUP No CAN messages are received from the engine controller for more than 250ms	UGM shall set Target engine RPM = Mid-Engine if Engine State ≠ ENGINE STOPPED, and assume Engine Controller reporting mid-Engine; otherwise, Engine State = ENGINE STOPPED. If engine state = ENGINE STOPPED at time of CAN loss, UGM shall permit one start attempt. If engine state ≠ ENGINE STOPPED at time of CAN loss, UGM shall decel all functions. If MACHINE SETUP > GENERATOR ≠ NO, Generator Relay output to be turned off until re-enabled by operator after CAN is re-established.	CAN messages are received from the engine controller; UGM shall require re-activation of Footswitch (Platform Mode) or Ground Enable (Ground Mode) to enable functions and resume operation.
CANBUS FAILURE – EXCESSIVE CANBUS ERRORS	6613	More than 22 error frames per second for 4 seconds or more than 500 Buss Off conditions since last power cycle.	No response required for this DTC	Power Cycled
CANBUS FAILURE – TCU MODULE	6622	MACHINE SETUP > CLEARSKY = YES No CAN2 messages are received from the TCU module for more than 30 seconds	No response required for this DTC	Not all of the trigger conditions are met
CANBUS FAILURE – CHASSIS TILT SENSOR	6635	UGM does not receive any CAN messages from the Chassis Tile Sensor in 250ms	The UGM shall consider the machine Tilted; UGM reports a combined chassis tilt angle of 90 degrees; UGM shall report individual axis readings as ??	CAN messages are received from the Chassis tilt Sensor and controls are initialized
CANBUS FAILURE - GROUND DISPLAY	6651	UGM does not receive any CAN messages from the Ground Display in 250ms	No response required for this DTC	CAN messages are received from the Ground Display
CANBUS FAILURE – TEMPERATURE SENSOR	6657	MACHINE SETUP > TEMP CUTOUT = YES; UGM does not receive any CAN messages from the Ambient Temperature sensor in 250ms	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation; The UGM shall limit Swing, Tower Lift (340AJ. 450AJ), Tele, Lift, Platform	CAN messages are received from the Ambient Temperature sensor

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
			Rotate, Platform Level, and Jib Lift (if MACHINE SETUP > JIB = YES) to Creep speed If the Machine is in Ground Mode; No response required for this DTC	
REMOTE CONTRACT MANAGEMENT OVERRIDE – ALL FUNCTIONS IN CREEP	681	MACHINE SETUP > CLEARSKY = YES Value set by ClearSky TCU	Response detailed in Remote Contract Management section.	Cleared by ClearSky TCU
CHASSIS TILT SENSOR NOT CALIBRATED	813	The UGM detects one of the follow conditions: The tilt sensor has not been calibrated; For 400S, 450AJ, the Tilt Sensor source Address is 0xC0; For 400S, 450AJ, the Tilt Sensor Serial number does not match	The UGM shall consider the machine Tilted UGM reports a combined chassis tilt angle of 90 degrees; UGM shall report individual axis readings	Tilt sensor calibrated
CHASSIS TILT SENSOR OUT OF RANGE	814	Fault CHASSIS TILT SENSOR NOT CALIBRATED (813) is not present and Tilt sensor measurement > 19º for 4 seconds. Not to be reported during Tilt Sensor calibration.	No additional action required beyond Tilted requirements specified elsewhere; UGM reports a combined chassis tilt angle of 90 degrees; UGM shall report individual axis readings	Not all of the trigger conditions are met.
CHASSIS TILT SENSOR DISAGREEMENT	815			
TILT SENSOR STAGNANT	818	The UGM detects the following conditions: The X axis or Y axis filtered readings change by < ±0.1º in 5 second; Drive Forward or Drive Reverse output value is ≥ Creep output value; Do not report if DTC 823 is active	The UGM shall consider the machine Tilted; UGM reports a combined chassis tilt angle of 90 degrees; The UGM reports individual axis readings	Power Cycled
CHASSIS TILT SENSOR - SINGLE POINT CALIBRATION PERFORMED	8112			
LSS CELL #1 ERROR	821	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; The UGM detects that LSS is reporting error with Cell #1	UGM to set Platform Load State = Overloaded	Not all of the trigger conditions are met
LSS CELL #2 ERROR	822	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; The UGM detects that LSS is reporting error with Cell #2	UGM to set Platform Load State = Overloaded	Not all of the trigger conditions are met
LSS CELL #3 ERROR	823	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; The UGM detects that LSS is reporting error with Cell #3	UGM to set Platform Load State = Overloaded	Not all of the trigger conditions are met
LSS CELL #4 ERROR	824	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; The UGM detects that LSS is reporting error with Cell #4.	UGM to set Platform Load State = Overloaded	Not all of the trigger conditions are met

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
LSS HAS NOT BEEN CALIBRATED	825	MACHINE SETUP > LOAD SYSTEM ≠ NO If Load System is the 4-Cell LSS; The load sensor has not been calibrated, or DTC 992 (LSS EEPROM ERROR) is active, or DTC 9977 (LSS CORRUPT EEPROM) is active If Load System is the 1-Cell LSS; The LSS serial number does not match	UGM to set Platform Load State = Overloaded	Not all of the trigger conditions are met
RUNNING AT CREEP – PLATFORM OVERLOADED	826	Machine Setup > LOAD SYSTEM = WARN ONLY The platform is Overloaded Ground mode is active with Auxiliary Power/Emergency Descent mode not active or Platform mode is active	Refer to *Table — Wiring Harness Connector Labels, page 625* for machine response.	Not all of the trigger conditions are met
DRIVE & BOOM PREVENTED – PLATFORM OVERLOADED	827	The Platform is Overloaded and Machine Setup > LOAD SYSTEM = CUTOUT PLATFORM, Platform Mode is active, and conditions of Table 7-1 apply. -or- The Platform is Overloaded and Machine Setup > LOAD SYSTEM = CUTOUT ALL and conditions of Table 7-1 apply.	Refer to *Table — Wiring Harness Connector Labels, page 625* for machine response.	Not all of the trigger conditions are met
LIFT UP & TELE OUT PREVENTED – PLATFORM OVERLOADED	828	MACHINE SETUP > LOAD SYSTEM = SPECIAL 1 Platform Mode is active The platform is Overloaded	Refer to *Table — Wiring Harness Connector Labels, page 625* for machine response.	Not all of the trigger conditions are met
FUNCTIONS CUTOUT - PLATFORM OVERLOADED	829			
LSS READING UNDER WEIGHT	8211	MACHINE SETUP > LOAD SYSTEM ≠ NO; The load sensor has been calibrated and Gross Platform Weight < (0.5 * Empty Platform Weight); Do not report if DTC 0030 is active	UGM to set Platform Load State = Overloaded	Not all of the trigger conditions are met
LSS SENSOR DISAGREEMENT	8218	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 1-Cell LSS; The UGM detects that Platform Gross 1 calculation and Platform Gross 2 calculation disagree by > 10% for longer than 5 seconds; Do not report of DTC 825 is active	UGM to set Platform Load State = Overloaded	Power Cycled
LSS STRAIN GAUGE 1 - STAGNANT	8222			
LSS STRAIN GAUGE 1 - STAGNANT	8223			
LSS STRAIN GAUGE 1 - OUT OF RANGE LOW	8224			
LSS STRAIN GAUGE 2 - OUT OF RANGE LOW	8225			

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
LSS STRAIN GAUGE 1 - OUT OF RANGE HIGH	8226			
LSS STRAIN GAUGE 2 - OUT OF RANGE HIGH	8227			
LSS STRAIN GAUGE 1 - INITIALIZATION ERROR	8228			
LSS STRAIN GAUGE 2 - INITIALIZATION ERROR	8229			
LSS STRAIN GAUGE 1 - NOT CALIBRATED	8230			
LSS STRAIN GAUGE 2 - NOT CALIBRATED	8231			
LSS STRAIN GAUGE 1 - SENSOR DEFECT	8232			
LSS STRAIN GAUGE 2 - SENSOR DEFECT	8233			
LSS STRAIN GAUGE 1 - NOT INSTALLED	8234			
LSS STRAIN GAUGE 2 - NOT INSTALLED	8235			
LSS NOT DETECTING CHANGE	8236			
LSS STRAIN GAUGE 1 - A/D DEFECT	8237			
LSS STRAIN GAUGE 2 - A/D DEFECT	8238			
FRONT LEFT STEER VALVE – OPEN CIRCUIT	8639	The UGM detects an open circuit at this output	Steer Left and Right speed limited to Creep (340AJ, 400S, 450AJ); No response required for this DTC (18RS, 24RS)	Power Cycled
FRONT LEFT STEER VALVE – SHORT TO BATTERY	8640	The UGM detects a short to battery at this output	Disable UGM Drive Forward/Reverse and Steer Left/Right outputs	Power Cycled
FRONT LEFT STEER VALVE – SHORT TO GROUND	8641	The UGM detects a short to ground at this output	Disable UGM Steer Left and Right outputs	Power Cycled
FRONT RIGHT STEER VALVE – OPEN CIRCUIT	8642	The UGM detects an open circuit at this output	Steer Left and Right speed limited to Creep(340AJ, 400S, 450AJ); No response required for this DTC (18RS, 24RS)	Power Cycled
FRONT RIGHT STEER VALVE – SHORT TO BATTERY	8643	The UGM detects a short to battery at this output	Disable UGM Drive Forward/Reverse and Steer Left/Right outputs	Power Cycled
FRONT RIGHT STEER VALVE – SHORT TO GROUND	8644	The UGM detects a short to ground at this output	Disable UGM Steer Left and Right outputs	Power Cycled
MACHINE SAFETY SYSTEM OVERRIDE OCCURRED	873	MSSO = Active	Response described in MSSO Influence on Machine Operation section	Fault shall be retentive through Power Cycled;

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
				Can be reset only with an Analyzer via the CALIBRATIONS > MSSO > MSSO RESET menu
LSS WATCHDOG RESET	991	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; UGM detects LSS report of an anomaly exists that has caused a WatchDog Timer reset.	UGM to set Platform Load State = Overloaded	Power Cycled
LSS EEPROM ERROR	992	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; UGM detects LSS report of an anomaly that exists in the LSS EEPROM	UGM to set Platform Load State = Overloaded	Power Cycled
LSS INTERNAL ERROR – PIN EXCITATION	993	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; UGM detects LSS report of improper excitation voltage	UGM to set Platform Load State = Overloaded	Power Cycled
LSS INTERNAL ERROR – DRDY MISSING FROM A/D	994	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; UGM detects LSS report of an anomaly that exists in the LSS A/D converter operations.	UGM to set Platform Load State = Overloaded	Power Cycled
EEPROM FAILURE - CHECK ALL SETTINGS	998	The UGM has detected an anomaly in EEPROM	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start); reset the section of EEPROM where the failure occurred to defaults.	Power Cycled
FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	9910	The UGM software version type is ‘P’ or ‘B’ The UGM has received valid version information from the PM The PM software version type is ‘P’ or ‘B’ The UGM software major version number does not match the major version number of the platform software	Activate the platform alarm continuously Creep mode is active If Platform Mode is active, disable all Drive, Steer, and Boom functions and do not permit Machine Enable	Not all of the trigger conditions are met
FUNCTION LOCKED OUT - LSS MODULE SOFTWARE VERSION IMPROPER	9911	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; The UGM determines that the LSS software version is not compatible with existing code.	UGM to set Platform Load State = Overloaded	Power Cycled
CHASSIS TILT SENSOR NOT GAIN CALIBRATED	9915	The tilt sensor gain calibration values recorded to flash memory during Phoenix International’s manufacturing test are not present	The UGM reports a faulted chassis tilt angle of 90 degrees	Valid values are present
PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	9920	The PM detects that its reference voltage is out of range and reports the fault to the UGM	If in Platform mode, Lift/Swing and Drive shall be place in Creep. All other functions shall operate normally.	Power Cycled
GROUND MODULE FAILURE:HIGH SIDE DRIVER CUTOUT FAULTY	9921	The engine is not running The engine is not cranking The UGM footswitch input J7-15 is LOW The machine is in Platform Mode	Disable all Drive/Steer and Boom functions except Tower Lift Down (340AJ, 450AJ), Lift Down, and Jib Lift Down (340AJ).	Power Cycled

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
		The Main Dump output J2-13 is detected as HIGH via the analog feedback 300ms after it is attempted to be activated during the one time startup test of the UGM hardware shutoff circuitry		
PLATFORM MODULE FAILURE: HWFS CODE 1	9922	The PM detects that its V(low) FET has failed and reports this fault to the UGM	No response required for this DTC	Power Cycled
FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED	9924	The machine is powered up and no model has been selected yet in the MACHINE SETUP menu	Display ??? or NO MODEL at Analyzer MACHINE SETUP menu MACHINE SETUP->MODEL NUMBER Do not report any other faults Disable all machine and engine functions (i.e., command engine shutdown and do not permit start)	Power Cycled
GROUND MODULE CONSTANT DATA UPDATE REQUIRED	9927	The UGM detects one of the following conditions when software type is 'P' or 'B': The Version Verification Word #1 or the Version Verification Word #2 values located in the constant data sector of flash memory (found on constant data spreadsheet tab pstConstant DataVersion) do not match the values located in the code area of flash memory The Version Major value located in the constant data sector of flash memory (found on constant data spreadsheet tab pst ConstantDataVersion) does not match the value located in the code area of flash memory	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start)	A different application code or constant data version is programmed so that the values match Power Cycled
CURRENT FEEDBACK GAINS OUT OF RANGE	9944	One or more of the current feedback gains that are calculated and written to flash memory during the PIC manufacturing test process are detected as being out of range	A gain of 1 is used for the factory gain(s) that was out of range; all functions shall be placed in Creep mode.	Power Cycled
CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	9945	The current feedback gains checksum that is calculated and written to flash memory during the PIC manufacturing test process is detected as being incorrect	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).	Power Cycled
MACHINE CONFIGURATION OUT OF RANGE – CHECK ALL SETTINGS	9949	UGM has detected an anomaly in EEPROM with regard to the Machine Setup configuration.	UGM to prompt operator to correct issue via Analyzer and disable all machine and engine functions (i.e., command engine shutdown and do not permit start).until EEPROM data in corrupted area is changed.	Power Cycled and EEPROM data in associated area is changed
LSS CORRUPT EEPROM	9977	MACHINE SETUP > LOAD SYSTEM ≠ NO; Load System is the 4-Cell LSS; and one of the following conditions: UGM determines LSS-stored values for Unloaded weight in Indirect 0x100≠ 0x108 or	UGM to set Platform Load State = Overloaded	Power Cycled

Table 88. Diagnostic Trouble Code Chart (continued)

Help Message	DTC	Fault Condition/Trigger (For configurable items, fault applies only if configured. All listed conditions to be met unless stated otherwise)	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault
		UGM determines LSS-stored values for Accessory weight in Indirect 0x102≠ 0x10A UGM determines LSS-stored checksum1 (0x10F) ≠ checksum 2 (0x107)		
FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER	9979	Ground software has been installed on a UGM with a ST10F274 processor (Hardware Rev < 6), which does not have guaranteed flash storage in the sector where Constant Data is written.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start)	Power Cycled
GROUND MODULE VLOW FET FAILURE	9986	VLow FET determined to be failed because all Digital Inputs are high; UGM unable to read high-sensing inputs.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).	Power Cycled
LSS - FACTORY CALIBRATION ERROR	99285			

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SECTION 7
BASIC ELECTRICAL INFORMATION & SCHEMATICS

7.1 GENERAL

This section contains basic electrical information and schematics to be used for locating and correcting most of the operating problems which may develop. 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.

Note: Some of the procedures/connectors shown in this section may not be applicable to all models.

7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

7.2.1 Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

7.2.2 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.

7.2.3 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.

7.2.4 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.

7.2.5 Scale

M = Mega = 1,000,000 * (Displayed Number)

k = kilo = 1,000 * (Displayed Number)

m = milli = (Displayed Number) / 1,000

μ = micro = (Displayed Number) / 1,000,000

Example: 1.2 kW= 1200 W

Example: 50 mA = 0.05 A

7.2.6 Voltage Measurement

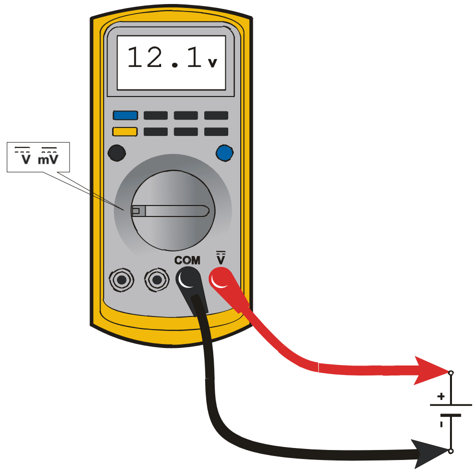


Figure 257. Voltage Measurement (DC)

- If meter is not auto ranging, set it to the correct range (Refer to multimeter's operation manual).
- Use firm contact with meter leads.

7.2.7 Resistance Measurement

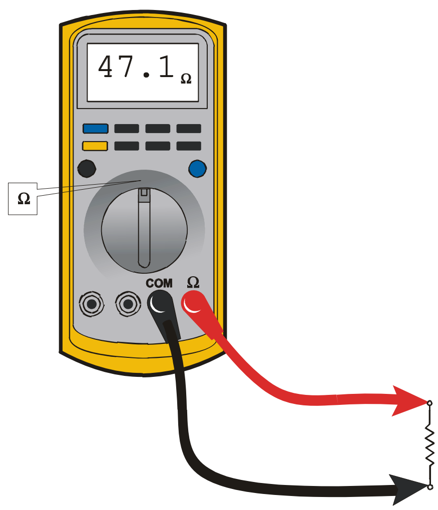


Figure 258. Resistance Measurement

- 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 (Refer to multimeter's operation manual).
- Use firm contact with meter leads.

7.2.8 Continuity Measurement

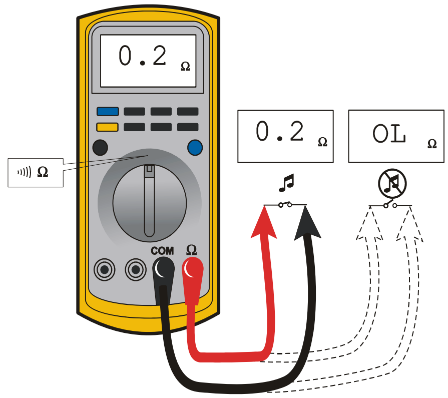


Figure 259. Continuity Measurement

- 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.

7.2.9 Current Measurement

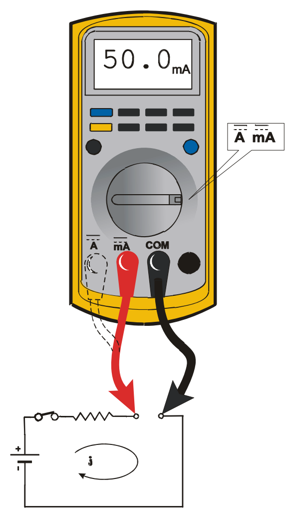


Figure 260. Current Measurement (DC)

- 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 (Refer to multi meter’s operation manual).
- Use firm contact with meter leads.

7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

Note: This section is not applicable for battery terminals.

NOTICE

JLG 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).

7.4 DIELECTRIC GREASE APPLICATION

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

7.4.1 Installation

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

- Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
- Apply dielectric grease to plug/male connector housing which typically contains sockets contact/female terminals.

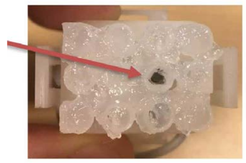
- Leave a layer of dielectric grease on the mating face of the connector, completely covering each connector terminal hole. Refer the pictures shown below.

Assemble the connector system immediately to prevent moisture ingress or dust contamination.

The following connector systems are specifically addressed because of their widespread use at JLG. However, this guidance may be applied to similar devices.

7.4.2 AMP Mate-N-Lok

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



Improper

Proper

7.4.3 AMP Faston

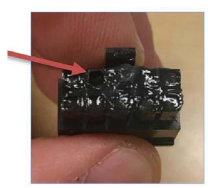
This connector system is typically used on operator switches at JLG. Follow the general guidance for installation.

Improper

Proper

7.4.4 AMP Micro-Fit

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



Improper

Proper

7.4.5 AMP Mini Fit Jr.

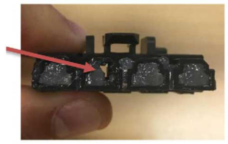
This connector system is typically used on control modules at JLG. Follow the general guidance for installation.

Improper

Proper

7.4.6 Mini Fit Sr.

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



Improper

Proper

7.4.7 DIN Connectors

This connector is typically used on hydraulic valves. Follow the installation instructions.

Improper

Proper

7.4.8 Exceptions

Some waterproof connector applications do benefit from dielectric grease, and some non waterproof connectors do not benefit from dielectric grease.

In the exceptions below, we have found dielectric grease is not needed for some applications, and in some cases can interfere with the intended connection. Dielectric grease shall be used as an exception in other applications.

ENCLOSURES

Application of dielectric grease is not required in properly sealed enclosures. To meet criteria, the enclosure must be rated to at least IP56 (dust protected; protected from powerful jets of water).

CARLING SWITCH CONNECTORS

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

7.5 AMP CONNECTOR

7.5.1 Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on the inside of the connector after the mating of the housing to the header. This is easily achieved by using a syringe to fill the header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling the housing to the header, it is possible that the housing will become air locked, thus preventing the housing latch from engaging.
2. Pierce one of the unused wire seals to allow the trapped air inside the housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

7.5.2 Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (Refer to *Figure — Connector Assembly Figure 1, page 613*). Proceed as follows:

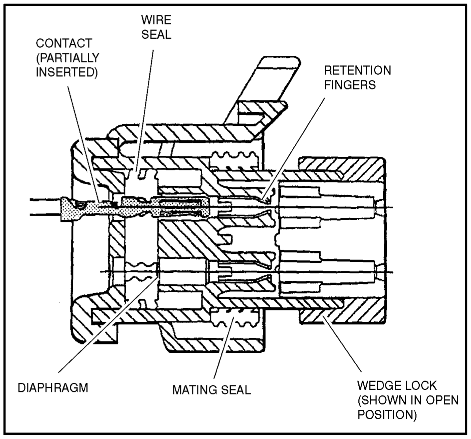


Figure 261. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (Refer to *Figure — Connector Assembly Figure 2, page 614*).

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 (Refer to *Figure — Connector Assembly Figure 2, page 614*).

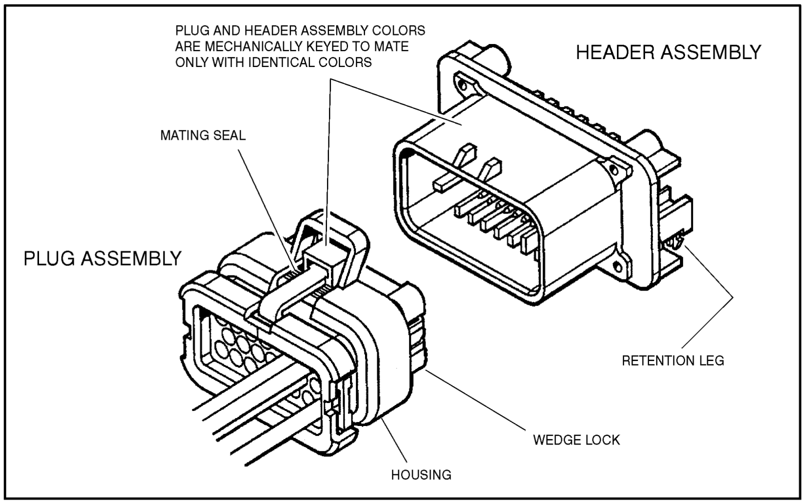


Figure 262. AMP Connector

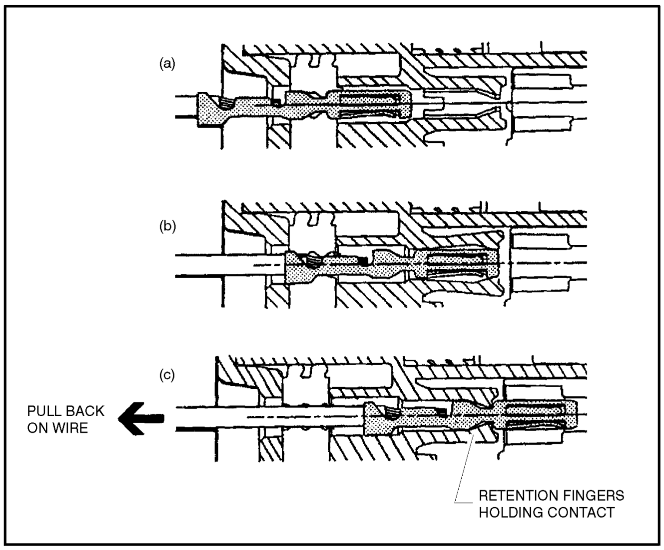


Figure 263. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (Refer to *Figure — Connector Assembly Figure 3, page 615*).

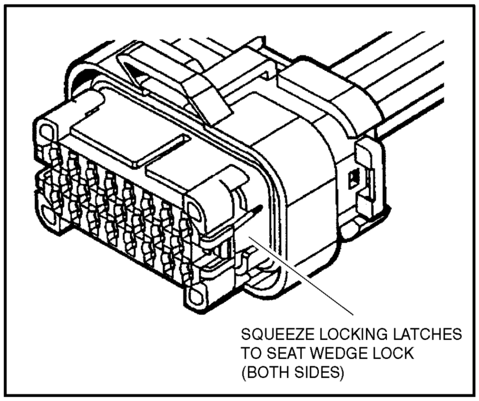


Figure 264. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (Refer to *Figure — Connector Assembly Figure 4, page 615*).

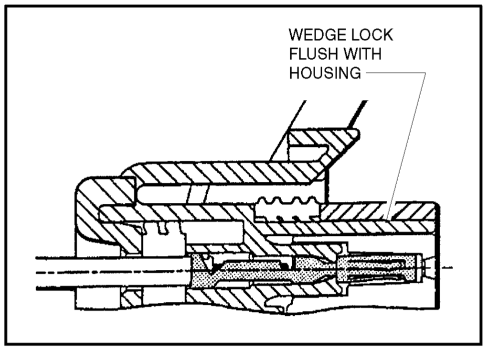


Figure 265. Connector Assembly Figure 4

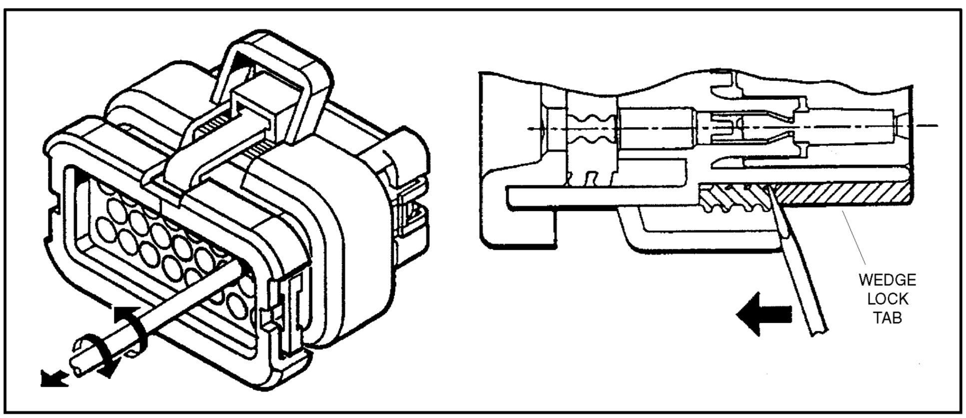


Figure 266. Connector Disassembly

7.5.3 Disassembly

1. Insert a 4.8 mm (3/16 in.) 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.

7.5.4 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.

7.5.5 Service - Voltage Reading

NOTICE

Do not pierce wire insulation to take voltage readings.

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

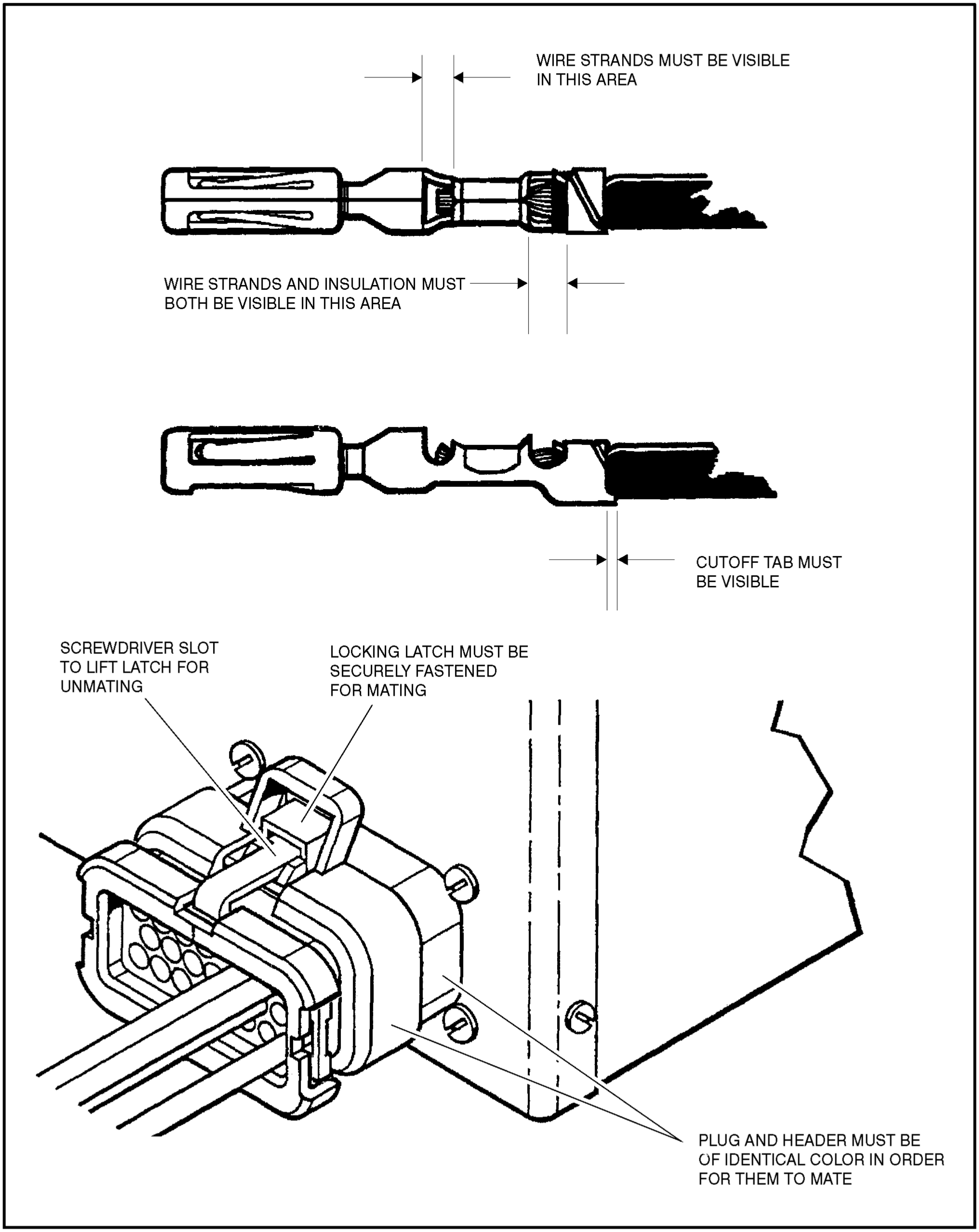


Figure 267. Connector Installation

7.6 DEUTSCH CONNECTORS

7.6.1 DT/DTP Series Assembly

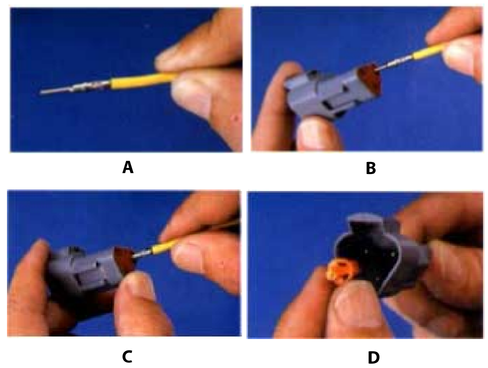


Figure 268. DT/DTP Contact Installation

1. Grasp crimped contact about 25 mm behind the contact barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that it is properly locked in place.
4. Once all contacts are in place, insert wedgelock with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. They may go in either way.

Note: The receptacle is shown - use the same procedure for plug.

7.6.2 DT/DTP Series Disassembly

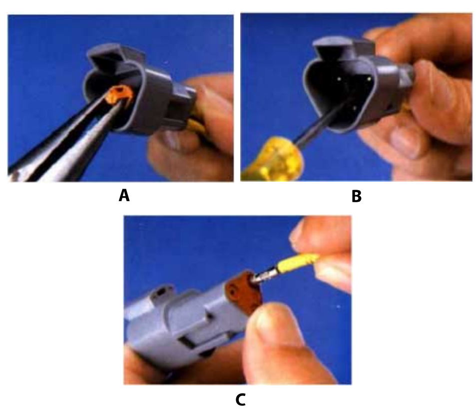


Figure 269. DT/DTP Contact Removal

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.

7.6.3 HD30/HDP20 Series Assembly

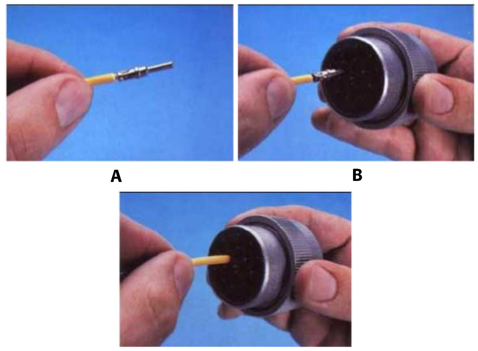


Figure 270. HD/HDP Contact Installation

1. Grasp contact about 25 mm 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.

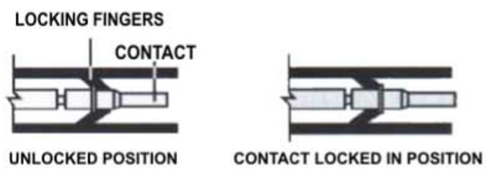


Figure 271. HD/HDP Locking Contacts Into Position

Note: For unused wire cavities, insert sealing plugs for full environmental sealing.

7.6.4 HD30/HDP20 Series Disassembly

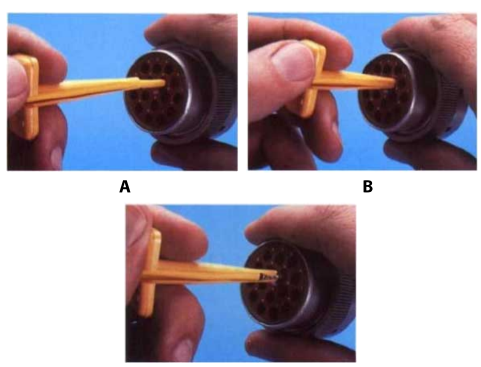


Figure 272. HD/HDP Contact Removal

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.

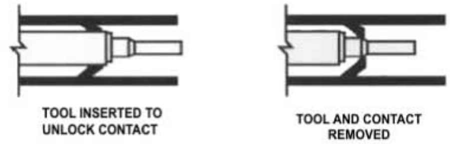


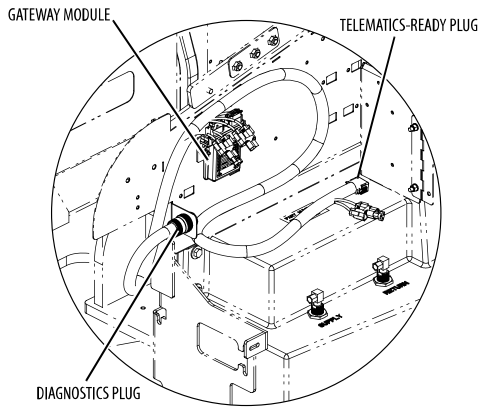
Figure 273. HD/HDP Unlocking Contacts

Note: Do Not twist or insert tool at an angle.

7.7 TELEMATICS GATEWAY

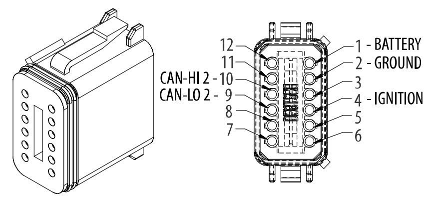
Personnel using machines equipped with an optional telematics gateway will be able to view the following data through their telematics device:

JLG LABEL	DESCRIPTION	UNIT
Engine Speed	Actual engine speed.	RPM
DEF Tank Level (If Equipped)	Indicates the level of DEF (diesel exhaust fluid) within the DEF tank if the machine is equipped with DEF tank. • 0% = Empty • 100% = Full	Percentage (%)
JLG Machine Faults: Active / Not-Active	• 00 - No Machine Faults • 01 - Active Machine Fault • 10 - Error • 11 - Not available	Bit
Total Idle Fuel Used	Total amount of fuel used during vehicle operation during idle conditions.	Liters
Total Idle Hours	Total time of engine operation during idle conditions.	Seconds
Total Engine Hours	Total time of engine operation.	Seconds
Total Fuel Used	Total amount of fuel used during vehicle operation.	Liters
Fuel Rate	Amount of fuel consumed by engine per unit of time.	Liters/Hour
Fuel Level	Ratio of fuel volume to the total volume of the fuel storage container. When a low fuel limit switch is present, the fuel level will indicate "full" until the switch opens, which will then indicate 10% fuel remaining. When Fuel Level 2 (SPN 38) is not used, Fuel Level 1 represents the total fuel in all fuel storage containers. When Fuel Level 2 is used, Fuel Level 1 represents the fuel level in the primary or left side fuel storage container.	Percentage (%)
DM1 Engine Faults	Shows actual engine fault codes.	N/A



7.7.1 Telematics-Ready (TCU) Plug

The telematics-ready (TCU) plug is a standard 12-pin Deutsch connector. Pin-out locations are shown below:



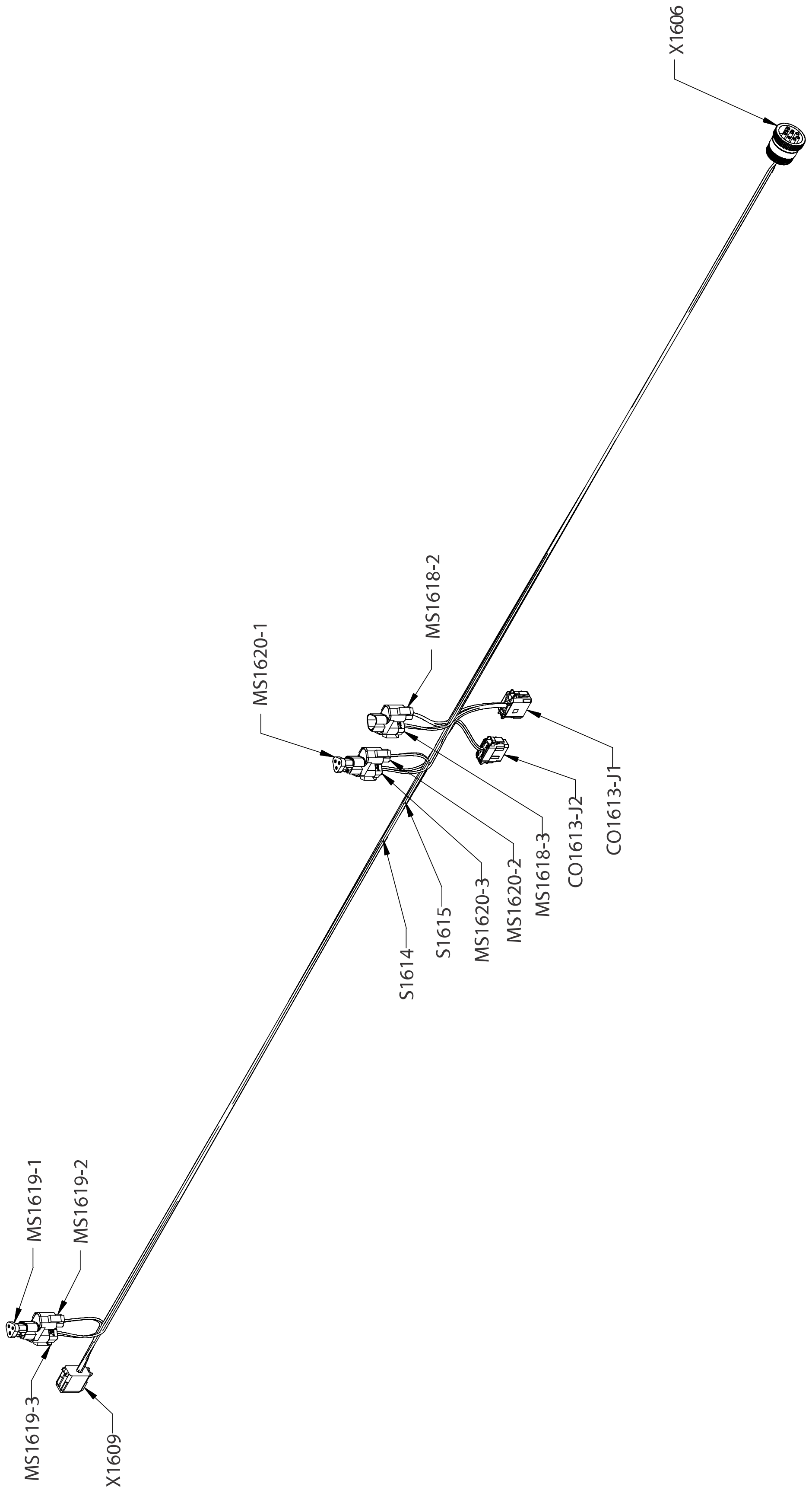


Figure 274. Telematics Gateway Harness - Sheet 1 of 3

X1609 (TCU)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-0 BAT	16 AWG	GXL	X1606 (B)
2	BLK	0-0 GND	16 AWG	GXL	S1615 (1)
4	ORN	2-0 IGN	16 AWG	GXL	S1614 (1)
9	GRN	CANL2	18 AWG	GXL	MS1619-2 (B)
10	YEL	CANH2	18 AWG	GXL	MS1619-2 (A)

MS1619-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	X1609 (10)
B	GRN	CANL2	18 AWG	GXL	X1609 (9)

MS1619-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1620-2 (A)
B	GRN	CANL2	18 AWG	GXL	MS1620-2 (B)

CO1613-J1 (GATEWAY 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CAN1	18 AWG	GXL	MS1618-2 (B)
10	YEL	CANH1	18 AWG	GXL	MS1618-2 (A)
11	BLK	0-2 GND	16 AWG	GXL	S1615 (2)
12	ORN	2-2 IGN	16 AWG	GXL	S1614 (2)

CO1613-J2 (GATEWAY 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CANL2	18 AWG	GXL	MS1620-3 (B)
10	YEL	CANH2	18 AWG	GXL	MS1620-3 (A)

MS1620-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1619-3 (A)
B	GRN	CANL2	18 AWG	GXL	MS1619-3 (B)

MS1620-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	CO1613-J2 (10)
B	GRN	CANL2	18 AWG	GXL	CO1613-J2 (9)

S1614					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORN	2-0 IGN	16 AWG	GXL	X1609 (4)
2	ORN	2-1 IGN	16 AWG	GXL	X1606 (H)
2	ORN	2-2 IGN	16 AWG	GXL	CO1613-J1 (12)

S1615					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-0 GND	16 AWG	GXL	X1609 (2)
2	BLK	0-1 GND	16 AWG	GXL	X1606 (A)
2	BLK	0-2 GND	16 AWG	GXL	CO1613-J1 (11)

MS1618-2 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	CO1613-J1 (10)
B	GRN	CANL1	18 AWG	GXL	CO1613-J1 (9)

MS1618-3 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	X1606 (C)
B	GRN	CANL1	18 AWG	GXL	X1606 (D)

X1606 (DIAG)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	0-1 GND	16 AWG	GXL	S1615 (2)
B	RED	1-0 BAT	16 AWG	GXL	X1609 (1)
C	YEL	CANH1	18 AWG	GXL	MS1618-3 (A)
D	GRN	CANL1	18 AWG	GXL	MS1618-3 (B)
H	ORN	2-1 IGN	16 AWG	GXL	S1614 (2)

Figure 275. Telematics Gateway Harness - Sheet 2 of 3

					FROM		TO	
WIRE NO.	COLOR	WIRE GAUGE	LENGTH (mm)	JACKET	REFERENCE	PIN	REFERENCE	PIN
CAN L2	GRN	18 AWG	1151	GXL	MS1619-3	B	MS1620-2	B
CAN L2	GRN	18 AWG	151	GXL	X1609	9	MS1619-2	B
CAN L1	GRN	18 AWG	157	GXL	MS1618-2	B	CO1613-J1	9
CAN L2	GRN	18 AWG	225	GXL	MS1620-3	B	CO1613-J2	9
CAN L1	GRN	18 AWG	1076	GXL	MS1618-3	B	X1606	D
CAN H2	YEL	18 AWG	155	GXL	X1609	10	MS1619-2	A
CAN H2	YEL	18 AWG	233	GXL	MS1620-3	A	CO1613-J2	10
CAN H1	YEL	18 AWG	157	GXL	MS1618-2	A	CO1613-J1	10
CAN H2	YEL	18 AWG	1150	GXL	MS1619-3	A	MS1620-2	A
CAN H1	YEL	18 AWG	1079	GXL	MS1618-3	A	X1606	C
0-0 GND	BLK	16 AWG	1006	GXL	X1609	2	S1615	1
0-1 GND	BLK	16 AWG	1145	GXL	X1606	A	S1615	2
0-2 GND	BLK	16 AWG	223	GXL	CO1613-J1	11	S1615	2
1-0 BAT	RED	16 AWG	2150	GXL	X1609	1	X1606	B
2-0 IGN	ORN	16 AWG	939	GXL	X1609	4	S1614	1
2-1 IGN	ORN	16 AWG	1212	GXL	S1614	2	X1606	H
2-2 IGN	ORN	16 AWG	287	GXL	CO1613-J1	12	S1614	2

Figure 276. Telematics Gateway Harness - Sheet 3 of 3

7.8 WIRING HARNESS CONNECTOR LABELS

7.8.1 Connector Labels

Connectors between harnesses are identified by the prefix "X" and a sequentially assigned number. An optional suffix (letters & numbers) may be added when multiple terminations occur at one device or when there are optional connections.

Examples:

X25 connects to X25 in another harness.

X65A, X65B connect to different portions of one device

X163 connects to X163A in ANSI and X163B in CE/UKCA machines

7.8.2 Component Labels

Every component on the vehicle has a unique identification. A standard prefix letter is assigned according to the table below, followed by a unique sequential number. An optional suffix (letters & numbers) may be added when multiple terminations occur at one device.

Terminals that are not loaded into connectors are considered independent components and labeled in the same fashion.

Table 89. Wiring Harness Connector Labels

Component	Category	Label
Audible	Alarms	AH
	Horns	
Battery	Batteries	BT
	Battery Terminals	
Control Module	Ground	CO
	LSS	
	Platform	
Engine	Alternator	EC
	Cold Start	
	Controller	
	Coolant Temp	
	Fuel Pump	
	Fuel Solenoid	
	Glow Plugs	
	Oil Pressure	
	Starter	
Fuse & CB Fuse FC	Fuse	FC
	Fusible Link	FC
	Circuit Breaker	CB
Gauge & Display	Board	GD
	Cluster	
	Hour meter	
	LMI	
	Speedometer	
Inline	Resistor	R
	Diode	D
Joystick & Steering	Electronic	JS
	Hydraulic	
Lights	Dome	LB
	Headlights	
	Simple	
	Taillights	
Membrane Panel		MP
Miscellaneous	Radio	MS
	Speakers	
	Splice Blocks	

Table 89. Wiring Harness Connector Labels (continued)

Component	Category	Label
	T-Connectors	
Other Switches	Disconnect	SW
	EMS	
	Foot	
	HVAC	WH
	Key	SW
	Park brake	
	Pump pot	
	Push	
	Shifter	
	Turn signal	
Relay	5 Pin	RL
	4 Pin	
	Contactor	
	Power module	
Rocker Switch		SW
Sensor	Angle	SN
	Fuel	
	Length	
	Limit	
	Load	
	Pressure	
	Proximity	
	Speed	
	Temperature	
Terminals	Pins	T
	Sockets	
	Male Blades	
	Female Blades	
	Rings	
	Forks	
Toggle Switch	DPDT	SW
	DPST	
	SPDT	
	SPST	
	Special	

Table 89. Wiring Harness Connector Labels (continued)

<table>
<tr><th>Component</th><th>Category</th><th>Label</th></tr>
<tr><td rowspan="2">Valves</td><td>Simple</td><td rowspan="2">HV</td></tr>
<tr><td>Suppression</td></tr>
<tr><td colspan="3">Examples:
T67 is a ring terminal connected during installation.
C01-J3 is the J3 connector for a UGM control module.
EC9 is a glow plug supplied with the engine</td></tr>
</table>

7.9 ELECTRICAL INSTALLATION

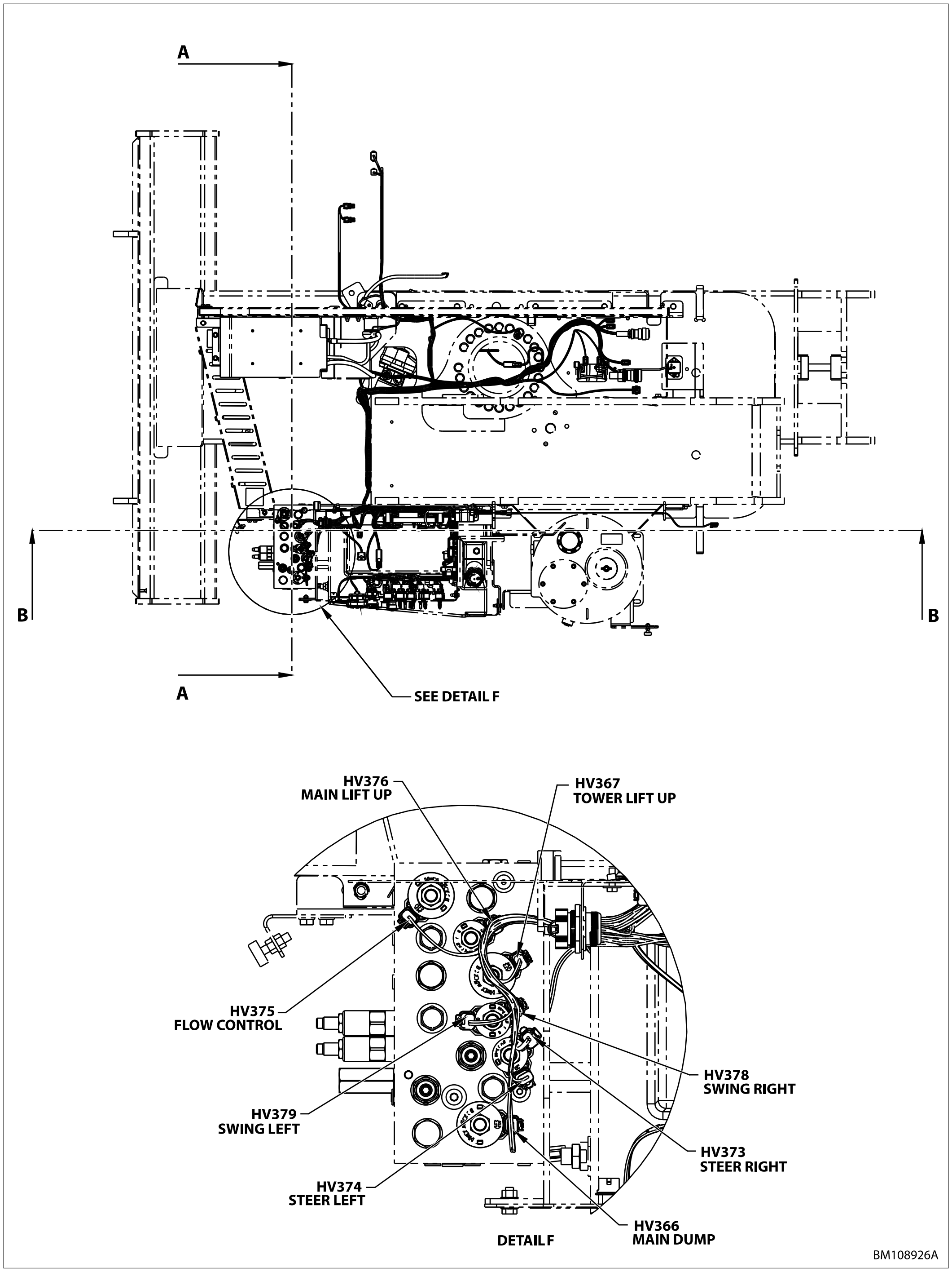


Figure 277. Electrical Installation - Sheet 1 of 10

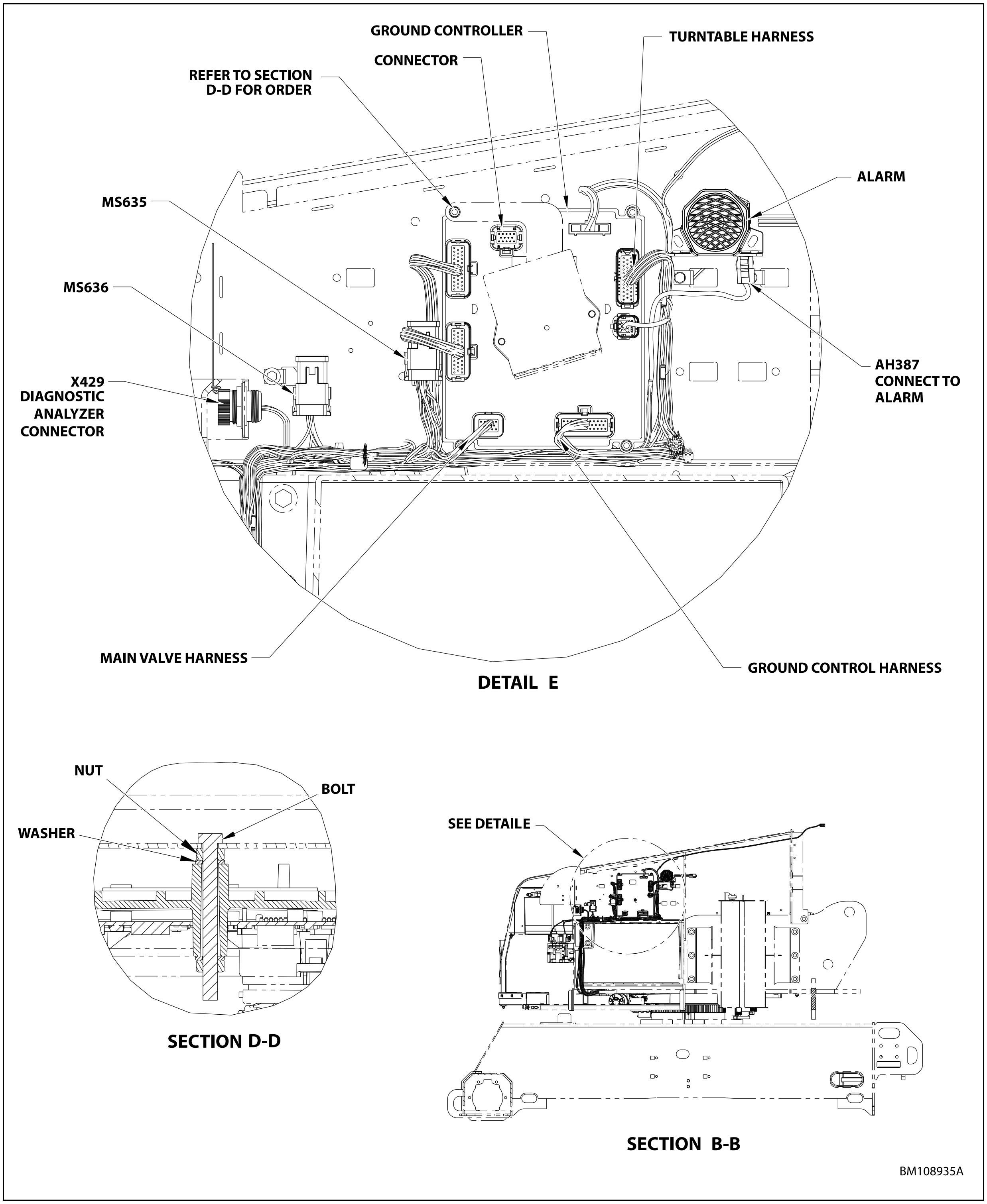


Figure 278. Electrical Installation - Sheet 2 of 10

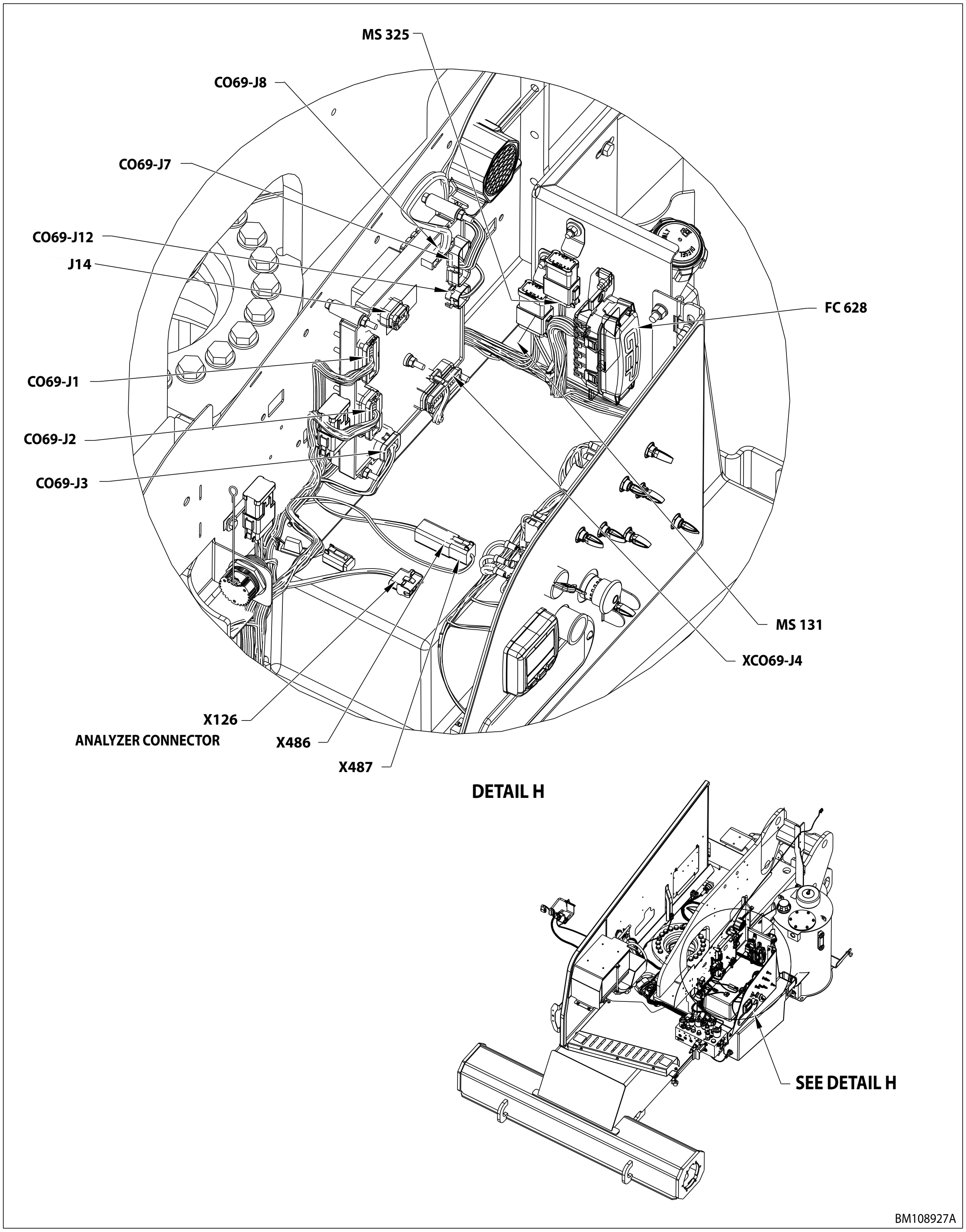


Figure 279. Electrical Installation - Sheet 3 of 10

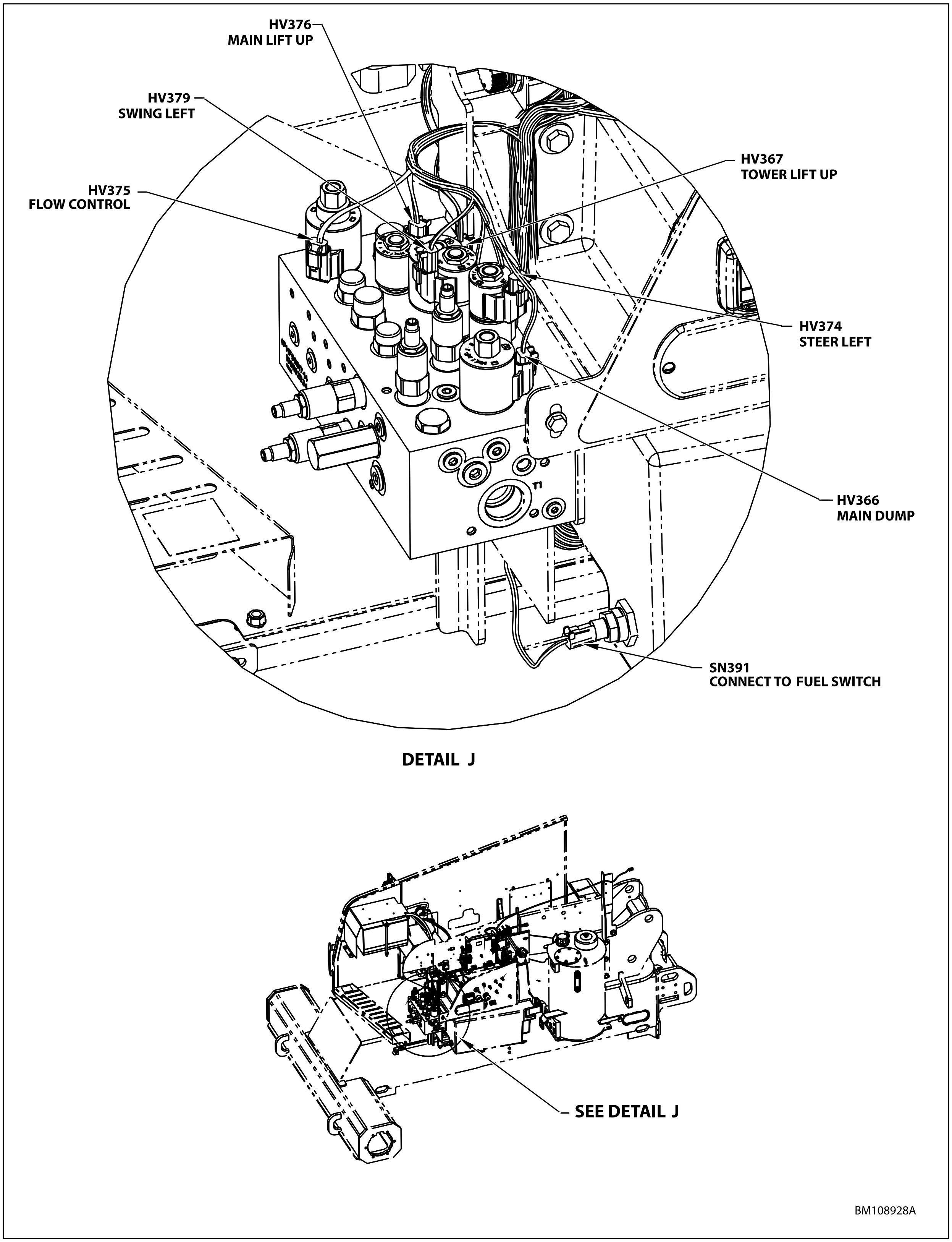


Figure 280. Electrical Installation - Sheet 4 of 10

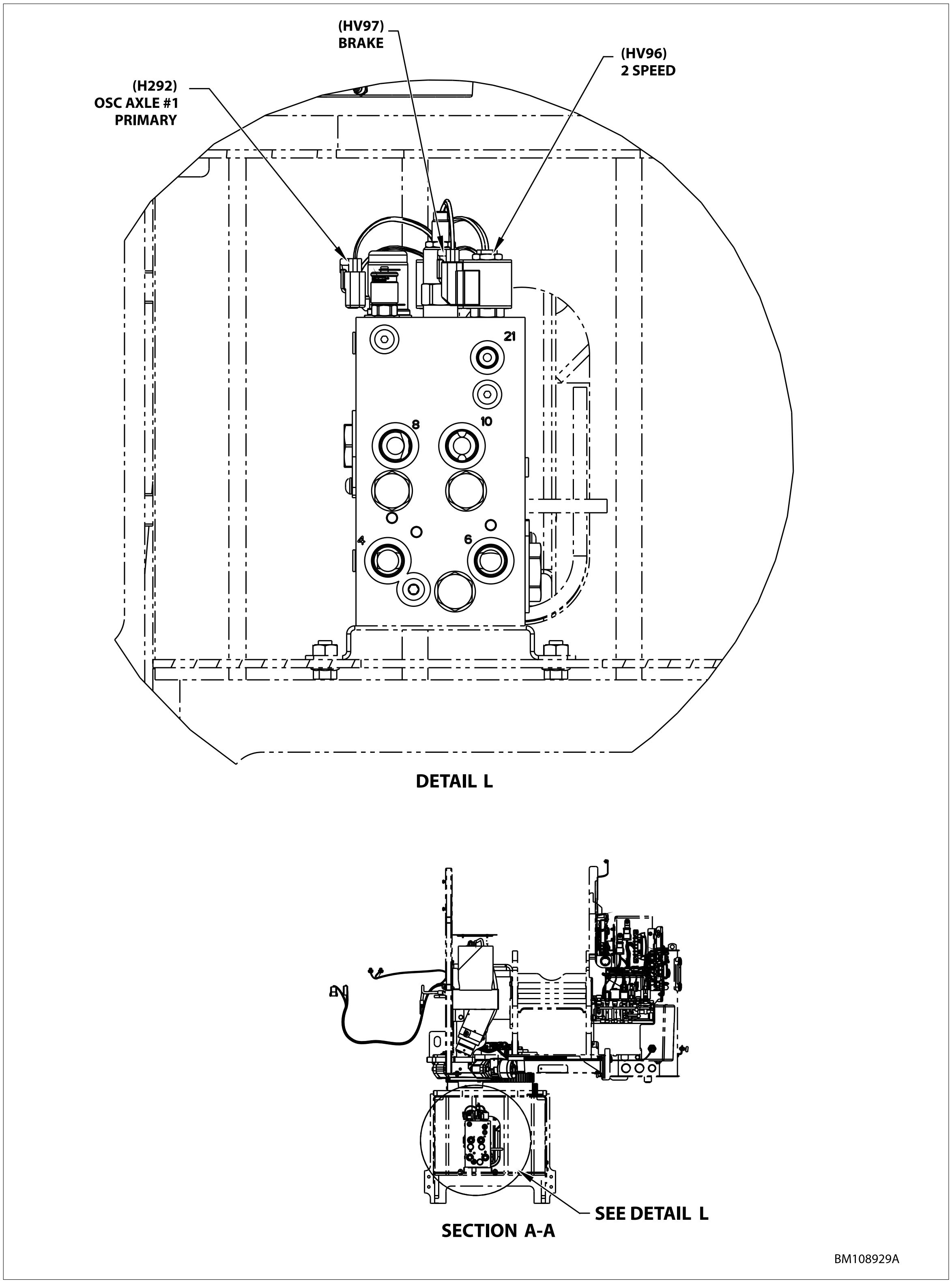


Figure 281. Electrical Installation - Sheet 5 of 10

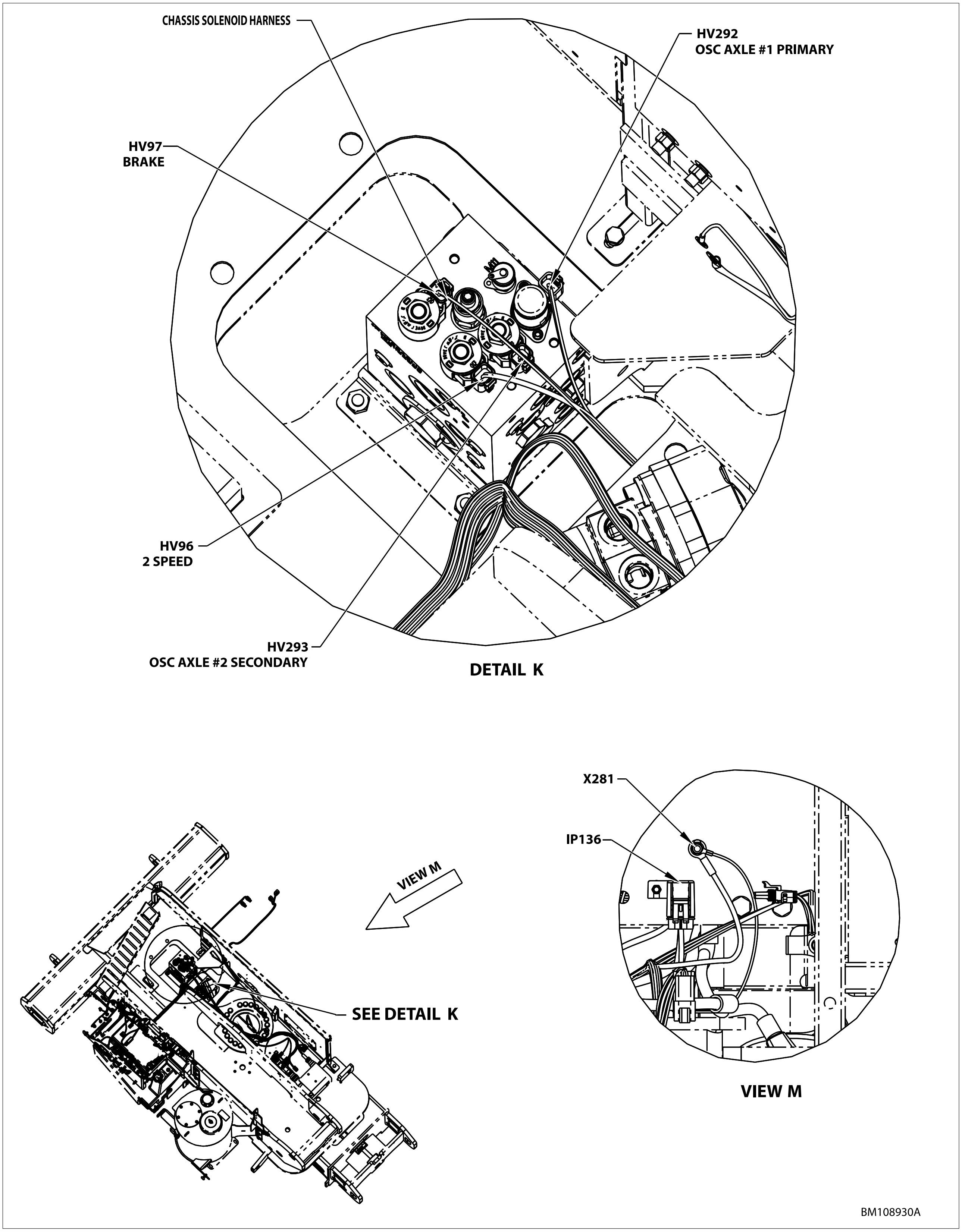


Figure 282. Electrical Installation - Sheet 6 of 10

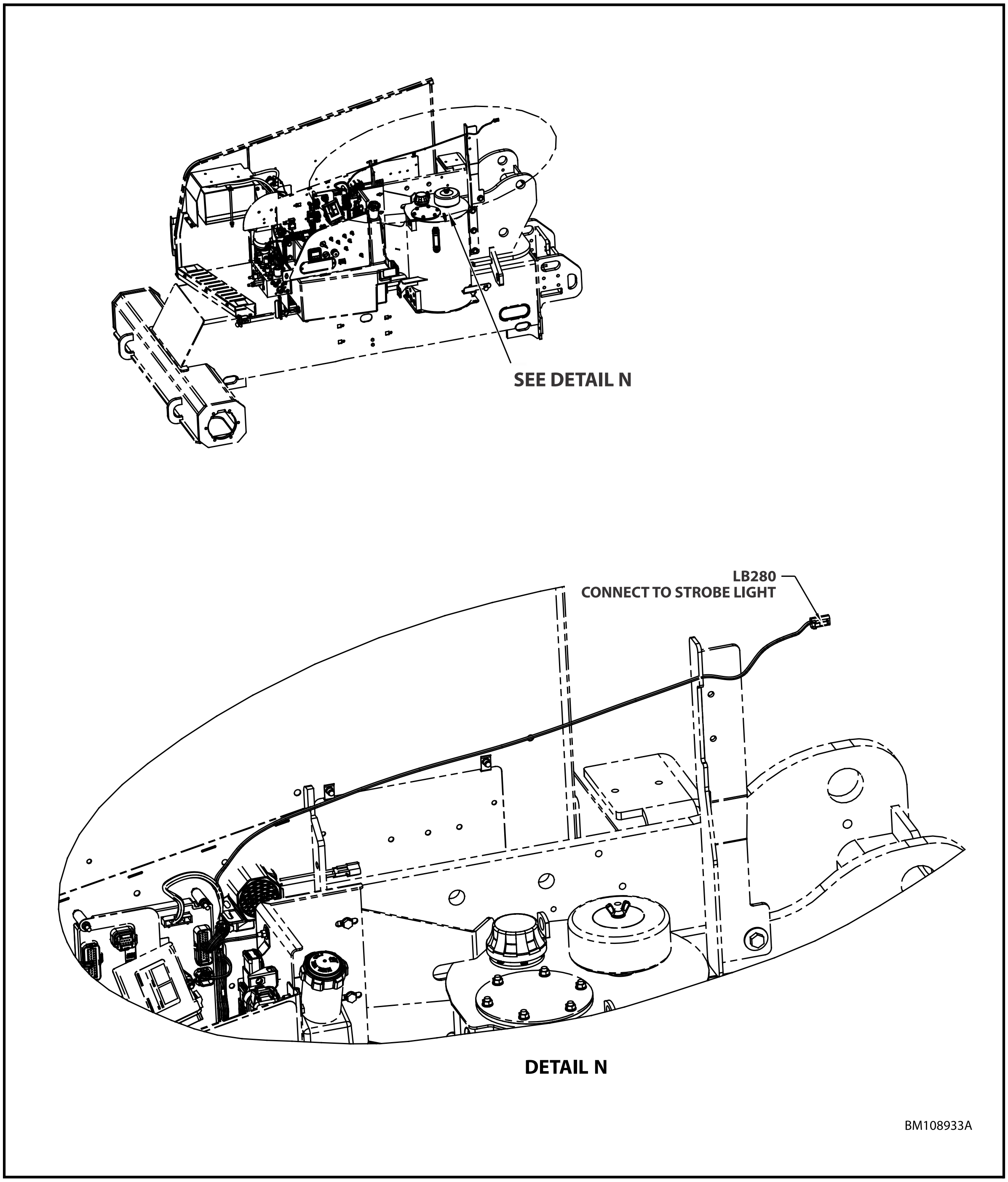


Figure 283. Electrical Installation - Sheet 7 of 10

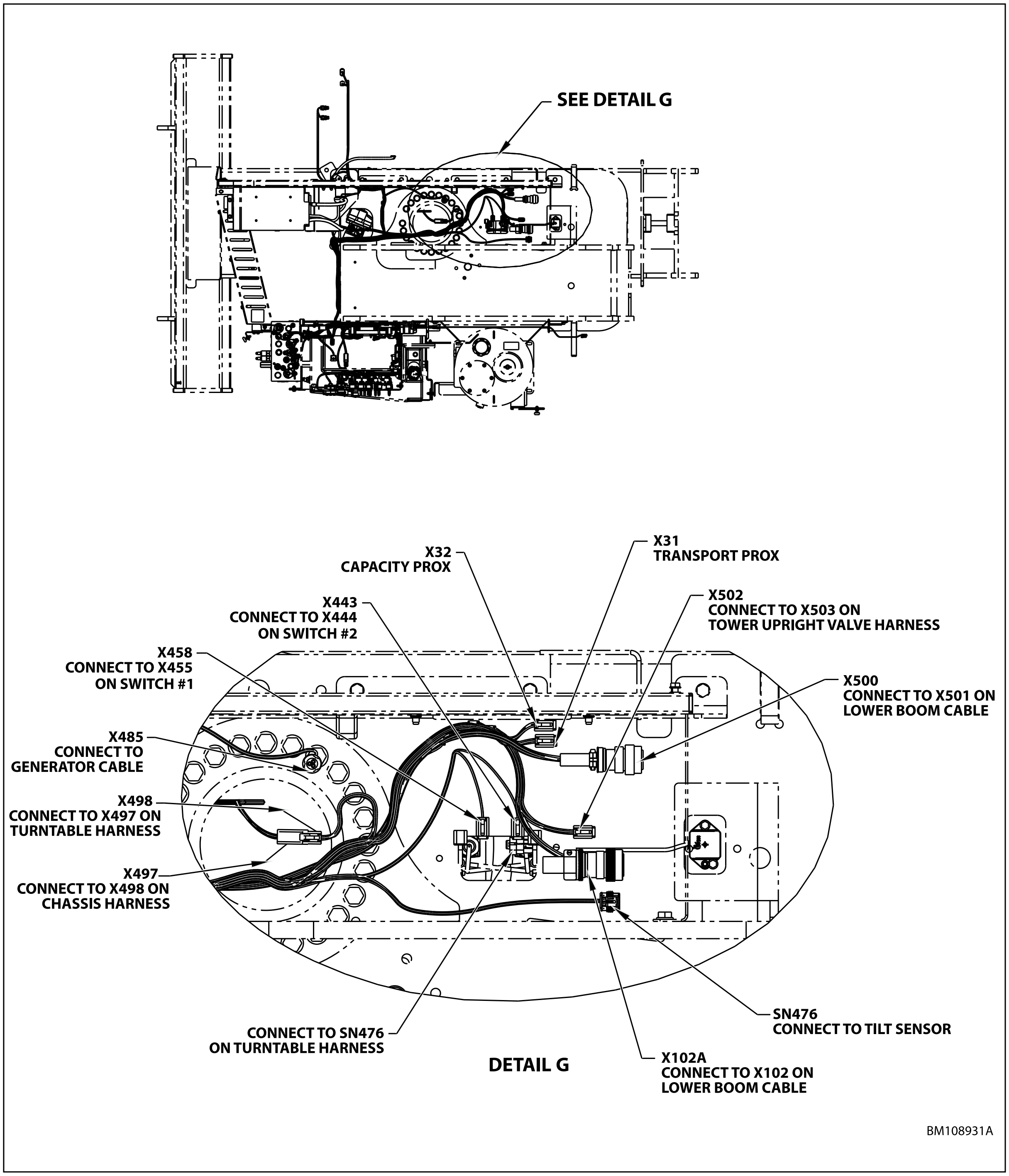
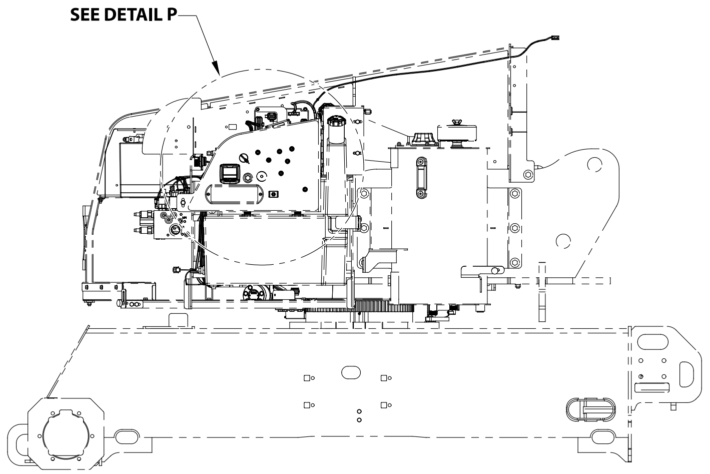


Figure 284. Electrical Installation - Sheet 8 of 10



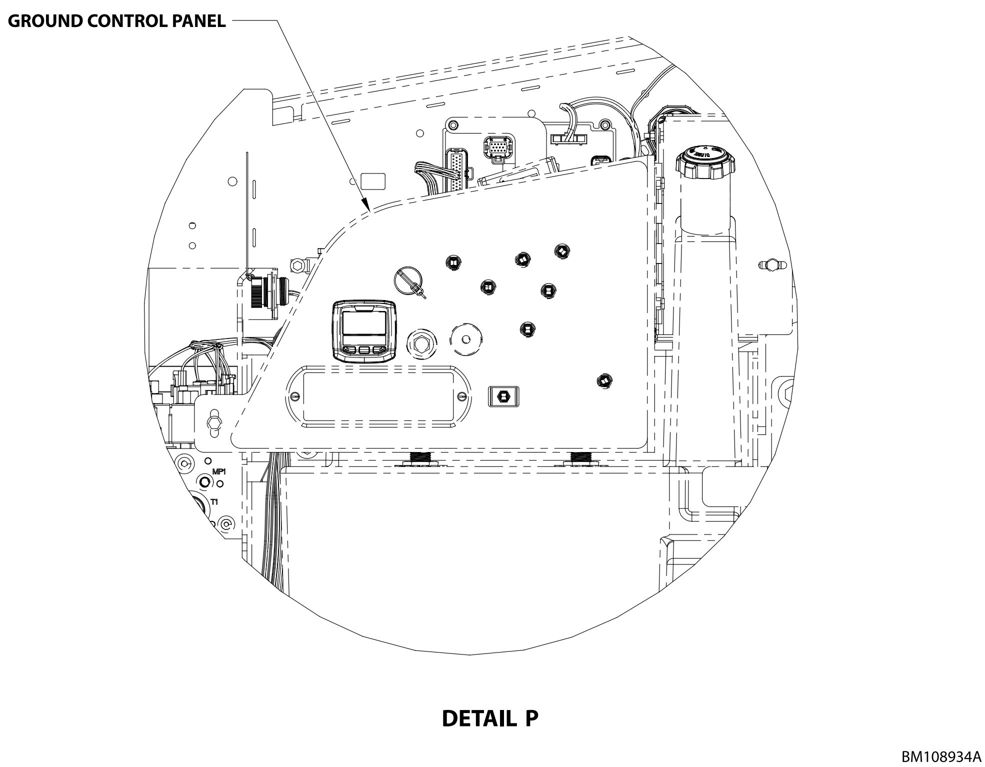


Figure 285. Electrical Installation - Sheet 9 of 10

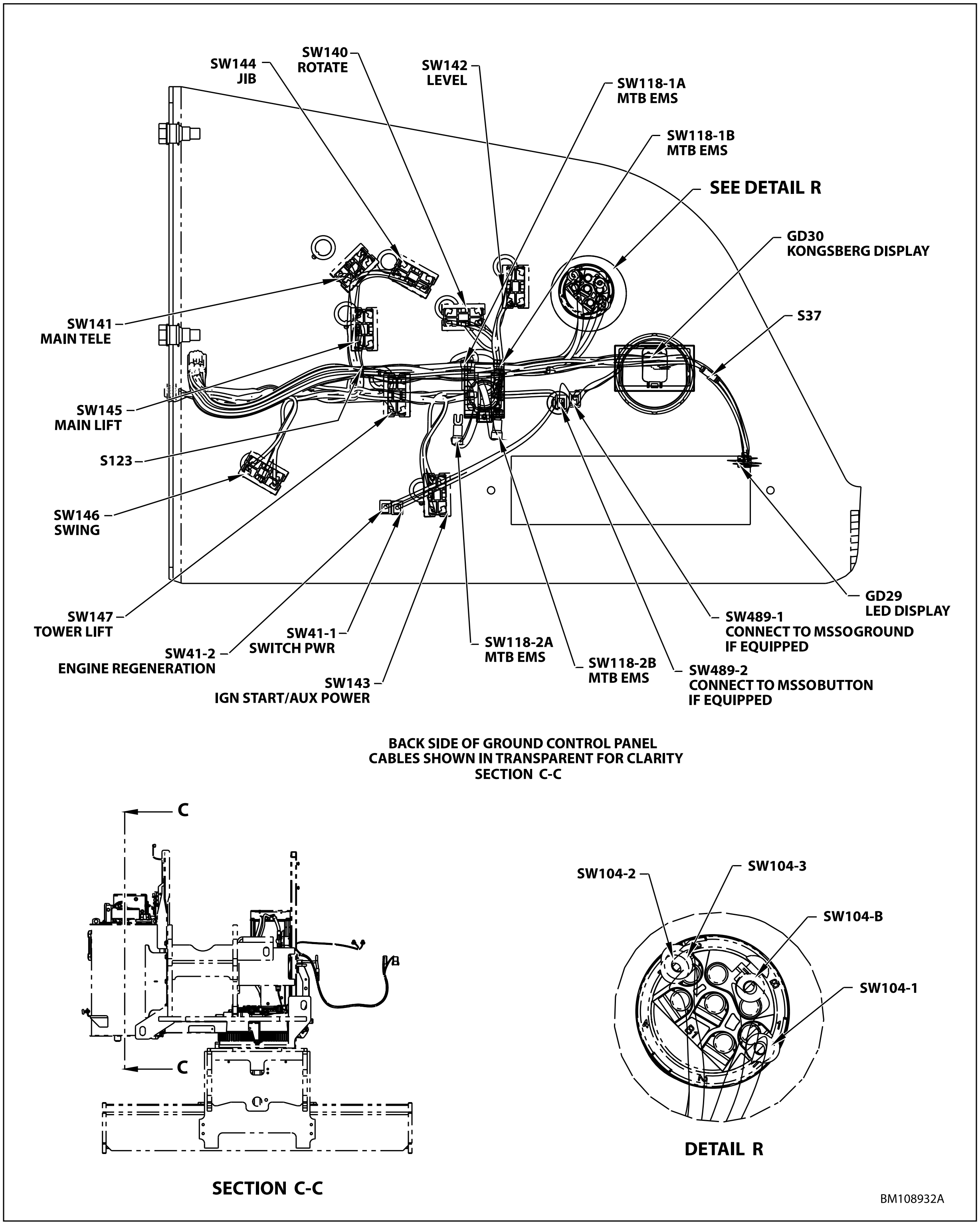


Figure 286. Electrical Installation - Sheet 10 of 10

7.10 WIRING HARNESS

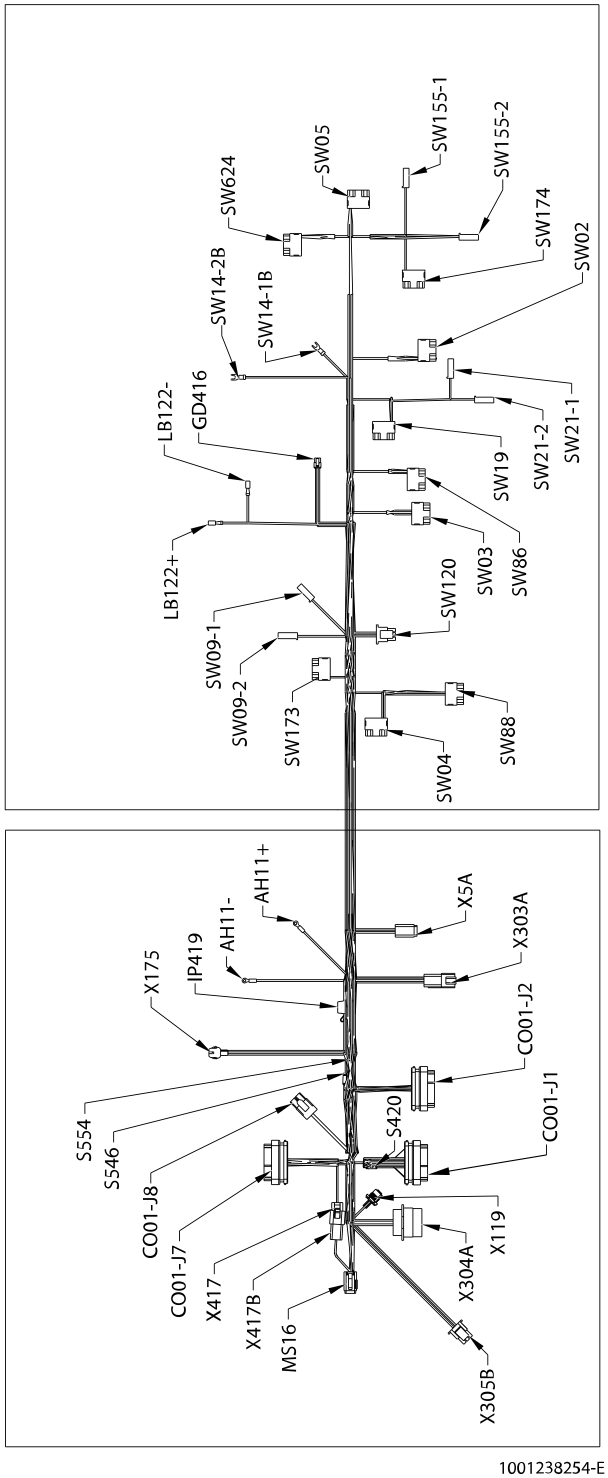
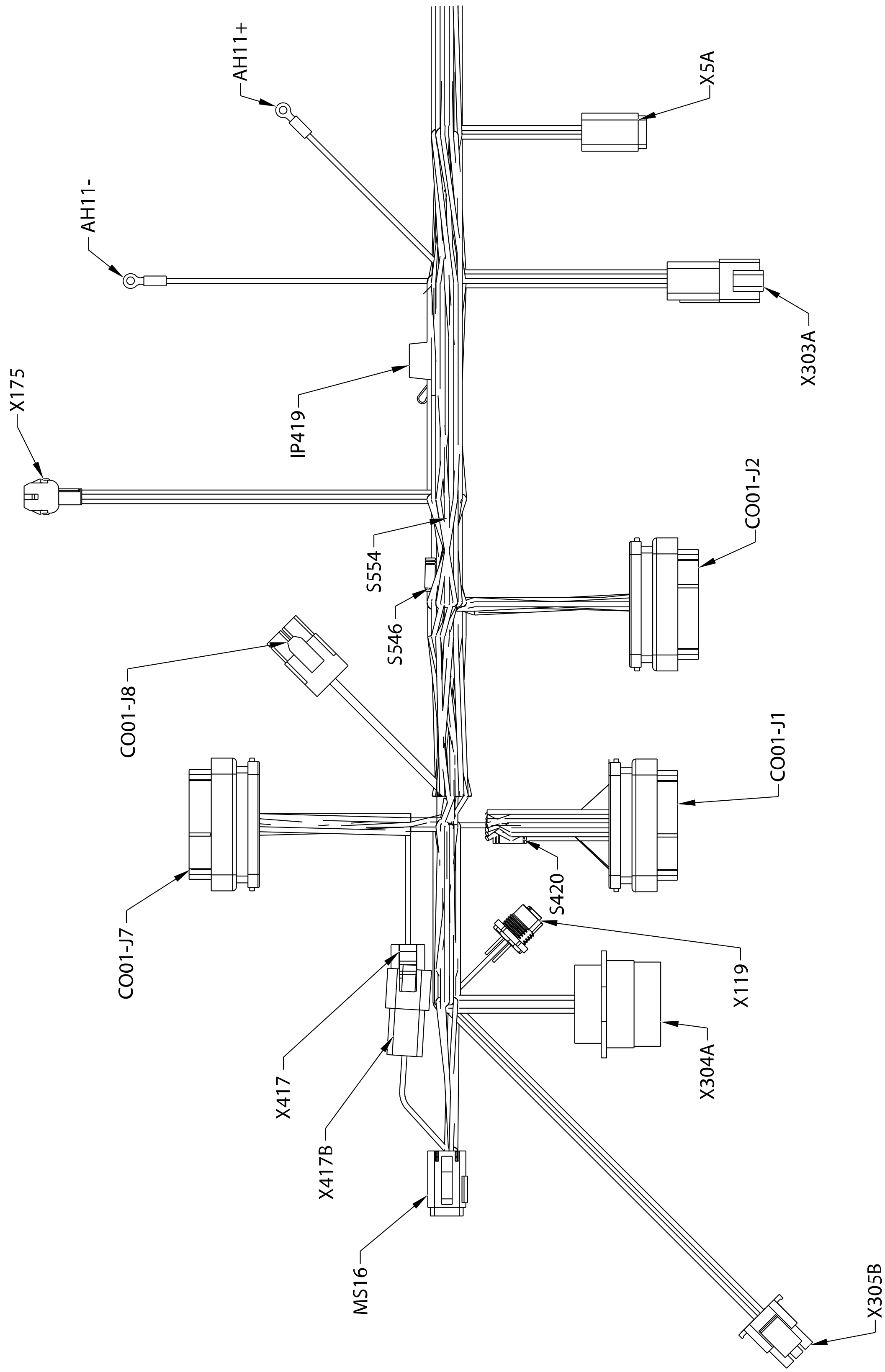


Figure 287. Platform Control Box Harness - Sheet 1 of 4



1001238254-E
MAF13410E

Figure 288. Platform Control Box Harness - Sheet 2 of 4

X304A					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	GRN	CAN-ONE LOW	18 AWG	GXL	X417 (B)
3	YEL	CAN-ONE HIGH	18 AWG	GXL	X417 (A)
4	WHT	9-0 PLAT MODE/GND ENABLE	18 AWG	GXL	C001-J7 (3)
5					
6					
7					
8					
9	YEL	4-0	18 AWG	GXL	SW14-1B (1B)
10					
11	WHT	1-37 GND MODE/PLAT ENABLE	18 AWG	GXL	C001-J7 (1)
12	YEL	2-7	12 AWG	GXL	C001-J8 (2)
13					
14					
15					
16	BLK	0-7	12 AWG	GXL	C001-J8 (1)
17					
18					
19					

X417 CAN TAP					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN-ONE HIGH	18 AWG	GXL	X304A (3)
B	GRN	CAN-ONE LOW	18 AWG	GXL	X304A (2)
C					

X305B					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	508-1 GENERATOR SWINPUT	18 AWG	GXL	C001-J7 (9)
2	YEL	10-4 GENERATOR SW +	18 AWG	GXL	C001-J7 (5)
3					
4	WHT	7-2 FOOT SW N.C.	18 AWG	GXL	C001-J7 (8)
5	YEL	10-3 FOOT SW +	18 AWG	GXL	C001-J7 (4)
6					
7					
8					
9	YEL	10-8 SOFT TOUCH +	18 AWG	GXL	C001-J2 (31)
10					

X305B					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
11					
12	WHT	504-1-2 SOFT TOUCH	18 AWG	GXL	S420 (2)
13					
14	WHT	1-551	18 AWG	GXL	X305B (15)
15	WHT	1-551	18 AWG	GXL	X305B (14)

MS16 CAN BUSS					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CAN-ONE HIGH	18 AWG	GXL	X417B (A)
2	BLK	CAN-ONE HIGH	20 AWG	CABLE	X119 (4)
3	YEL	CAN-ONE HIGH	18 AWG	GXL	X303A (8)
4	GRN	CAN-ONE LOW	18 AWG	GXL	X417B (B)
5	GRY	CAN-ONE LOW	20 AWG	CABLE	X119 (5)
6	GRN	CAN-ONE LOW	18 AWG	GXL	X303A (9)
7	GRN	CAN-ONE LOW	18 AWG	GXL	C001-J7 (30)
8	GRN	CAN-ONE LOW	20 AWG	TXL	GD416 (4)
9					
10	YEL	CAN-ONE HIGH	18 AWG	GXL	C001-J7 (31)
11	YEL	CAN-ONE HIGH	20 AWG	TXL	GD416 (1)
12					

X417B CAN TAP					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN-ONE HIGH	18 AWG	GXL	MS16 (1)
B	GRN	CAN-ONE LOW	18 AWG	GXL	MS16 (4)
C					

C001-J7					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	1-37 GND MODE/PLATENABLE	18 AWG	GXL	X304A (11)
2	YEL	5-0	18 AWG	GXL	SW14-2B(2B)
3	WHT	9-0 PLAT MODE/GNDENABLE	18 AWG	GXL	X304A (4)
4	YEL	10-3 FOOT SW +	18 AWG	GXL	X305B (5)
5	YEL	10-4 GENERATOR SW +	18 AWG	GXL	X305B (2)
6					
7	YEL	10-10 SKYG/STCH +	18 AWG	GXL	IP419 (1)
8	WHT	7-2 FOOT SW N.C.	18 AWG	GXL	X305B (4)

C001-J7					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
9	WHT	508-1 GENERATOR SWINPUT	18 AWG	GXL	X305B (1)
10					
11					
12					
13					
14					
15					
16	BLU	12-4-2L SS -	20 AWG	CABLE	X119 (3)
17					
18	WHT	503-1 SKYG INPUT 1	18 AWG	GXL	X5A (4)
19	WHT	94-2 PLAT ALARM	18 AWG	GXL	AH11+ (1)
20	WHT	12-1 PLAT ALARM -	18 AWG	GXL	AH11- (1)
21					
22					
23	BLK	12-3 P LAT VLV -	18 AWG	GXL	X303A (5)
24	BLK	12-10 SKY GUARD -	18 AWG	GXL	X5A (2)
25	WHT	82-3 JIB UP	18 AWG	GXL	X303A (3)
26	WHT	83-3 JIB DOWN	18 AWG	GXL	X303A (4)
27					
28					
29	BLK	12-2 OPTION -	18 AWG	GXL	S554 (1)
30	GRN	CAN-ONE LOW	18 AWG	GXL	MS16 (7)
31	YEL	CAN-ONE HIGH	18 AWG	GXL	MS16 (10)
32					
33	WHT	86-3 ROTATE LEFT	18 AWG	GXL	X303A (1)
34	WHT	87-3 ROTATE RIGHT	18 AWG	GXL	X303A (2)
35					

C001-J8					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-7	12 AWG	GXL	X304A (16)
2	YEL	2-7	12 AWG	GXL	X304A (12)

X175 ANALYZER					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	10-7 ANALYZER +	18 AWG	GXL	C001-J2 (26)
2	WHT	13-3 RECEIVE	18 AWG	GXL	C001-J2 (28)

X175 ANALYZER					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
3	WHT	13-4 TRANSMIT	18 AWG	GXL	C001-J2 (29)
4	BLK	12-6 ANALYZER -	18 AWG	GXL	C001-J2 (27)

IP 419 3A					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	10-10 SKYG/STCH +	18 AWG	GXL	C001-J7 (7)
2	YEL	10-10-1 SKY GUARD +	18 AWG	GXL	X5A (1)
2	YEL	10-10-2 SOFT TOUCH +	18 AWG	GXL	X5A (3)

AH11-ALARM					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	12-1 PLAT ALARM -	18 AWG	GXL	C001-J7 (20)

AH11+ ALARM					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	94-2 PLAT ALARM	18 AWG	GXL	C001-J7 (19)

X5A SKYGUARD					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	10-10-1 SKY GUARD +	18 AWG	GXL	IP419 (2)
2	BLK	12-10 SKY GUARD -	18 AWG	GXL	C001-J7 (24)
3	YEL	10-10-2 SOFT TOUCH +	18 AWG	GXL	IP419 (2)
4	WHT	503-1 SKYG INPUT1	18 AWG	GXL	C001-J7 (18)
5	WHT	503-2S KYG INPUT2	18 AWG	GXL	C001-J1 (23)
6	WHT	504-1-1 SOFT TOUCH	18 AWG	GXL	S420 (2)

X303A					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	86-3 ROTATE LEFT	18 AWG	GXL	C001-J7 (33)
2	WHT	87-3 ROTATE RIGHT	18 AWG	GXL	C001-J7 (34)
3	WHT	82-3 JIB UP	18 AWG	GXL	C001-J7 (25)
4	WHT	83-3 JIB DOWN	18 AWG	GXL	C001-J7 (26)
5	BLK	12-3 PLAT VLV -	18 AWG	GXL	C001-J7 (23)
6	BLK	12-2-1 OPTION -	18 AWG	GXL	S554 (2)
7	YEL	10-6-1 OPTION +	18 AWG	GXL	S546 (2)
8	YEL	CAN-ONE HIGH	18 AWG	GXL	MS16 (3)
9	GRN	CAN-ONE LOW	18 AWG	GXL	MS16 (6)
10					

X303A					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
11	YEL	10-6-2 OPTION +	18 AWG	GXL	S546 (2)
12	BLK	12-2-2 OPTION -	18 AWG	GXL	S554 (2)

C001-J2					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3					
4	WHT	51-2 DRV ORENTIONSW	18 AWG	GXL	SW174 (1)
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16	WHT	504-2 SOFT TCH/SKYG LT	18 AWG	GXL	LB122+ (1)
17					
18	BLK	12-8 DISPLAY -	20 AWG	TXL	GD416 (6)
19					
20					
21					
22					
23					
24					
25	BLK	12-7 SKYG LT -	18 AWG	GXL	LB122- (1)
26	YEL	10-7 ANALYZER +	18 AWG	GXL	X175 (1)
27	BLK	12-6 ANALYZER -	18 AWG	GXL	X175 (4)
28	WHT	13-3 RECEIVE	18 AWG	GXL	X175 (2)
29	WHT	13-4 TRANSMIT	18 AWG	GXL	X175 (3)
30					
31	YEL	10-8 SOFT TOUCH +	18 AWG	GXL	X305B (9)
32	WHT	10-2-2 LSS +	20 AWG	CABLE	X119 (2)

C001-J2					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
33	YEL	10-6 OPTION +	18 AWG	GXL	S546 (1)
34	YEL	10-9 DISPLAY +	20 AWG	TXL	GD416 (3)
35					

C001-J1					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	72-2 TOWER UP	18 AWG	GXL	SW86 (3)
2	WHT	73-2 TOWER DOWN	18 AWG	GXL	SW86 (1)
3					
4					
5	WHT	78-2 TELE IN	18 AWG	GXL	SW02 (3)
6	WHT	79-2 TELE OUT	18 AWG	GXL	SW02 (1)
7	WHT	87-2 ROTATE RIGHT	18 AWG	GXL	SW03 (3)
8	WHT	86-2 ROTATE LEFT	18 AWG	GXL	SW03 (1)
9	WHT	88-2 LEVEL UP	18 AWG	GXL	SW04 (3)
10	WHT	89-2 LEVEL DOWN	18 AWG	GXL	SW04 (1)
11	WHT	82-2 JIB UP	18 AWG	GXL	SW19 (3)
12	WHT	83-2 JIB DOWN	18 AWG	GXL	SW19 (1)
13	WHT	12-0 FUNCTION SPD -	18 AWG	GXL	SW120 (5)
14	WHT	100-2 START SWITCH	18 AWG	GXL	SW05 (3)
15	WHT	93-2 AUX POWER	18 AWG	GXL	SW05 (1)
16					
17					
18	YEL	10-0 PLAT CNTRL +	18 AWG	GXL	SW88 (2)
19	WHT	54-5 ZONE 3	18 AWG	GXL	SW624 (1)
20	WHT	504-1 SOFT TOUCH	18 AWG	GXL	S420 (1)
21	WHT	54-2 ZONE 1	18 AWG	GXL	SW624 (3)
22					
23	WHT	503-2 SKYG INPUT 2	18 AWG	GXL	X5A (5)
24					
25					
26					
27	WHT	24-2 TWO SPEED	18 AWG	GXL	SW88 (3)
28	WHT	25-1 MAX TORQUE	18 AWG	GXL	SW88 (1)
29	WHT	504-0 SOFT/SKYGOVERIDE	18 AWG	GXL	SW21-1 (1)
30	WHT	500-3 HEAD LIGHTS	18 AWG	GXL	SW155-1 (1)

C001-J1					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
31	WHT	30-0 HORN	18 AWG	GXL	SW09-1 (1)
32	WHT	29-0 CREEP SW	18 AWG	GXL	SW120 (2)
33	WHT	107-0 FUEL SELECT	18 AWG	GXL	SW173 (3)
34	WHT	11-0 FUNCTION SPD7V+	18 AWG	GXL	SW120 (4)
35	WHT	69-0 FUNCTION SPDINPUT	18 AWG	GXL	SW120 (6)

S420					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	504-1 SOFT TOUCH	18 AWG	GXL	C001-J1 (20)
2	WHT	504-1-1 SOFT TOUCH	18 AWG	GXL	X5A (6)
2	WHT	504-1-2 SOFT TOUCH	18 AWG	GXL	X305B (12)

X119 SINGLE CELL LSS					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BRN	—	20 AWG	CABLE	CAP - NOTUSED
2	WHT	10-2-2 LSS +	20 AWG	CABLE	C001-J2 (32)
3	BLU	12-4-2 LSS -	20 AWG	CABLE	C001-J7 (16)
4	BLK	CAN-ONE HIGH	20 AWG	CABLE	MS16 (2)
5	GRY	CAN-ONE LOW	20 AWG	CABLE	MS16 (5)

S554					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	12-2 OPTION -	18 AWG	GXL	C001-J7 (29)
2	BLK	12-2-1 OPTION -	18 AWG	GXL	X303A (6)
2	BLK	12-2-2 OPTION -	18 AWG	GXL	X303A (12)

S546					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	10-6 OPTION +	18 AWG	GXL	C001-J2 (33)
2	YEL	10-6-1 OPTION +	18 AWG	GXL	X303A (7)
2	YEL	10-6-2 OPTION +	18 AWG	GXL	X303A (11)

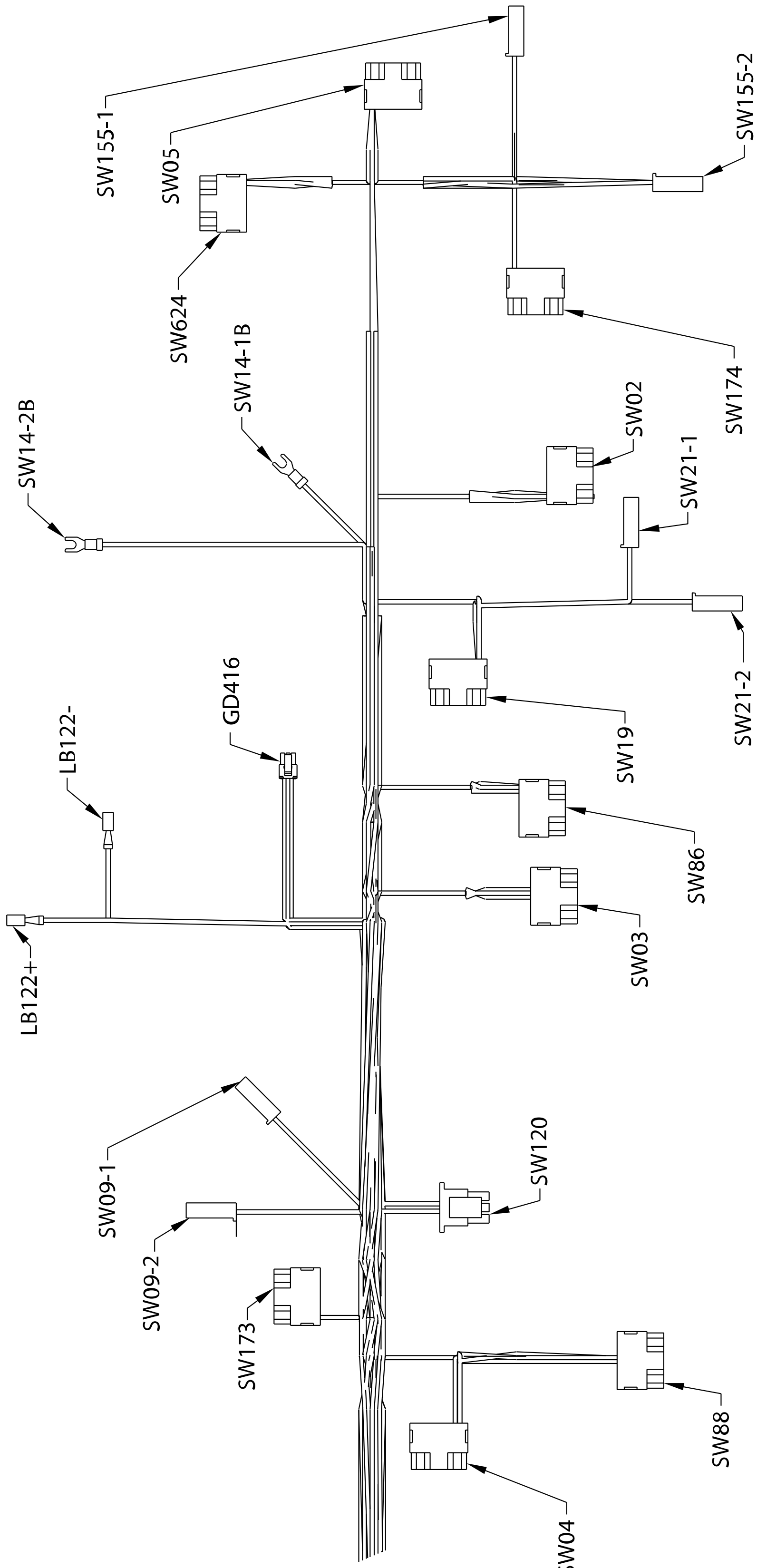


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Figure 289. Platform Control Box Harness - Sheet 3 of 4

SW 09-2 HORN					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	10-0-12 PLAT CNTRL+	18 AWG	GXL	SW120 (3)
1	YEL	10-0-13 PLAT CNTRL+	18 AWG	GXL	SW21-2 (1)

SW 09-1 HORN					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	30-0 HORN	18 AWG	GXL	C001-J1 (31)

LB 122+ SKYGUARD WARNING					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	504-2 SOFT TCH/SKYGLT	18 AWG	GXL	C001 - J2(16)

LB 122- SKYGUARD WARNING					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	12-7 SKYG LT-	18 AWG	GXL	C001-J2 (25)

GD 416 LED DISPLAY					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CAN-ONE HIGH	20 AWG	TXL	MS16 (11)
2					
3	YEL	10-9 DISPLAY+	20 AWG	TXL	C001-J2 (34)
4	GRN	CAN-ONE LOW	20 AWG	TXL	MS16 (8)
5					
6	BLK	12-8 DISPLAY-	20 AWG	TXL	C001-J2 (18)

SW 14-2B E STOP					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
2B	YEL	5-0	18 AWG	GXL	C001-J7 (2)

SW14-1B E STOP					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1B	YEL	4-0	18 AWG	GXL	X304A (9)

SW 624 PLATFORM CAPACITY					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	54-5 ZONE 3	18 AWG	GXL	C001-J1 (19)
2	YEL	10-0-9 PLAT CNTRL+	18 AWG	GXL	SW05 (2)
2	YEL	10-0-10 PLATCNTRL+	18 AWG	GXL	SW174 (2)
3	WHT	54-2 ZONE 1	18 AWG	GXL	C001-J1 (21)
4					

SW 624 PLATFORM CAPACITY					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
5					
6					

SW05 START/AUX					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	93-2 AUX POWER	18 AWG	GXL	C001-J1 (15)
2	YEL	10-0-8 PLATCNTRL+	18 AWG	GXL	SW155-2 (1)
2	YEL	10-0-9 PLATCNTRL+	18 AWG	GXL	SW624 (2)
3	WHT	100-2 STARTSWITCH	18 AWG	GXL	C001-J1 (14)
4					
5					
6					

SW155-1 HEAD AND TAIL LIGHTS					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	500-3 HEAD LIGHTS	18 AWG	GXL	C001-J1 (30)

SW155-2 HEAD AND TAIL LIGHTS					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	10-0-7 PLAT CNTRL +	18 AWG	GXL	SW02 (2)
1	YEL	10-0-8 PLAT CNTRL +	18 AWG	GXL	SW05 (2)

SW174 DRIVE ORIENTATION OVERRIDE					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	51-2 DRVORENTION SW	18 AWG	GXL	C001-J2 (4)
2	YEL	10-0-10 PLATCNTRL +	18 AWG	GXL	SW624 (2)
2	YEL	10-0-11 PLATCNTRL +	18 AWG	GXL	SW120 (3)
3					
4					
5					
6					

SW02 MAIN TELE					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	79-2 TELE OUT	18 AWG	GXL	C001-J1 (6)
2	YEL	10-0-6 PLATCNTRL +	18 AWG	GXL	SW19 (2)
2	YEL	10-0-7 PLATCNTRL +	18 AWG	GXL	SW155-2 (1)
3	WHT	78-2 TELE IN	18 AWG	GXL	C001-J1 (5)
4					

SW02 MAIN TELE					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
5					
6					

SW21-1 SOFT TCH/SKY GUARD					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	504-0 SOFT/SKYGOVRIDE	18 AWG	GXL	C001-J1 (29)

SW21-2 SOFT TCH/SKY GUARD					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	10-0-13 PLAT CNTRL +	18 AWG	GXL	SW09-2 (1)

SW19 JIB LIFT					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	83-2 JIB DOWN	18 AWG	GXL	C001-J1 (12)
2	YEL	10-0-5 PLAT CNTRL +	18 AWG	GXL	SW86 (2)
2	YEL	10-0-6 PLAT CNTRL +	18 AWG	GXL	SW02 (2)
3	WHT	82-2 JIB UP	18 AWG	GXL	C001-J1 (11)
4					
5					
6					

SW86 TOWER LIFT					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	73-2 TOWER DOWN	18 AWG	GXL	C001-J1 (2)
2	YEL	10-0-4 PLAT CNTRL +	18 AWG	GXL	SW03 (2)
2	YEL	10-0-5 PLAT CNTRL +	18 AWG	GXL	SW19 (2)
3	WHT	72-2 TOWER UP	18 AWG	GXL	C001-J1 (1)
4					
5					
6					

SW03 PLATFORM ROTATE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	86-2 ROTATE LEFT	18 AWG	GXL	C001-J1 (8)
2	YEL	10-0-3 PLAT CNTRL +	18 AWG	GXL	SW173 (2)
2	YEL	10-0-4 PLAT CNTRL +	18 AWG	GXL	SW86 (2)
3	WHT	87-2 ROTATE RIGHT	18 AWG	GXL	C001-J1 (7)
4					

SW03 PLATFORM ROTATE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
5					
6					

SW120 PUMP POT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	29-0 CREEP SW	18 AWG	GXL	C001-J1 (32)
2	YEL	10-0-11 PLAT CNTRL +	18 AWG	GXL	SW174 (2)
3	YEL	10-0-12 PLAT CNTRL +	18 AWG	GXL	SW09-2 (1)
4	WHT	11-0 FUNCTION SPD 7V +	18 AWG	GXL	C001-J1 (34)
5	WHT	12-0 FUNCTION SPD -	18 AWG	GXL	C001-J1 (13)
6	WHT	69-0 FUNCTION SPD INPUT	18 AWG	GXL	C001-J1 (35)

SW 173 FUEL SELECT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	YEL	10-0-2 PLAT CNTRL+	18 AWG	GXL	SW04 (2)
2	YEL	10-0-3 PLAT CNTRL+	18 AWG	GXL	SW03 (2)
3	WHT	107-0 FUEL SELECT	18 AWG	GXL	C001-J1 (33)
4					
5					
6					

SW88 ENGINE SPEED					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	25-1 MAX TORQUE	18 AWG	GXL	C001-J1 (28)
2	YEL	10-0 PLAT CNTRL +	18 AWG	GXL	C001-J1 (18)
2	YEL	10-0-1 PLAT CNTRL +	18 AWG	GXL	SW04 (2)
3	WHT	24-2 TWO SPEED	18 AWG	GXL	C001-J1 (27)
4					
5					
6					

SW04 LEVEL					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	89-2 LEVEL DOWN	18 AWG	GXL	C001-J1 (10)
2	YEL	10-0-1 PLAT CNTRL +	18 AWG	GXL	SW88 (2)
2	YEL	10-0-2 PLAT CNTRL +	18 AWG	GXL	SW173 (2)
3	WHT	88-2 LEVEL UP	18 AWG	GXL	C001-J1 (9)

SW04 LEVEL					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
4					
5					
6					

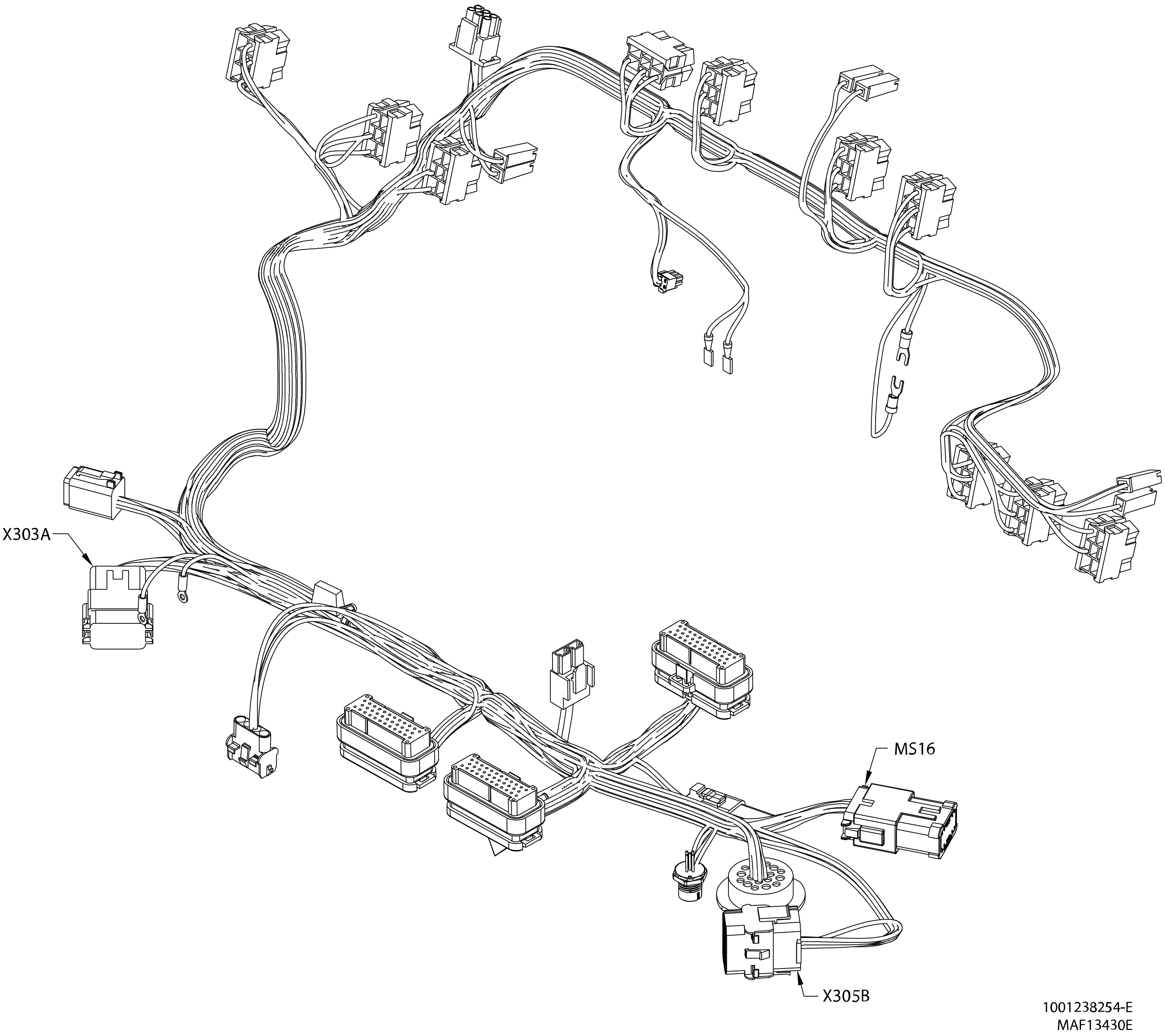


Figure 290. Platform Control Box Harness - Sheet 4 of 4

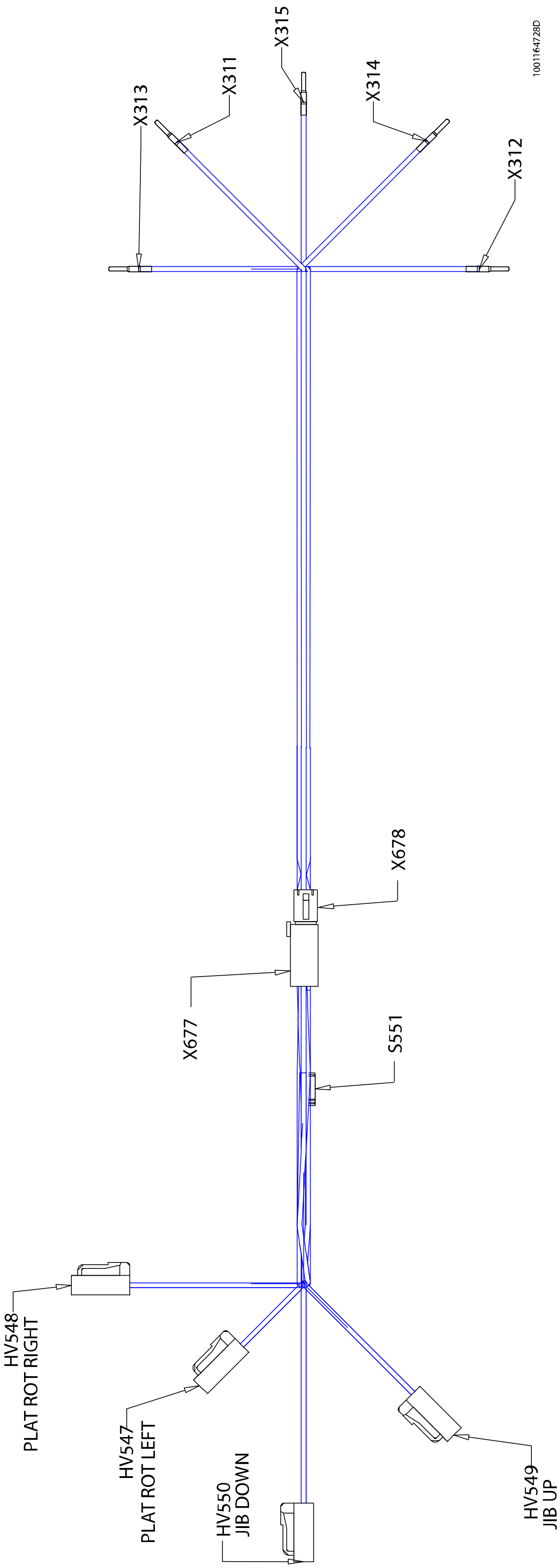


Figure 291. Platform Valve Harness - Sheet 1 of 2

AH387
ALARM

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	4-30 ALRM	18 AWG	GXL	CO69-J3 (7)
B	WHT	4-29 ALRM	18 AWG	GXL	CO69-J2 (27)
C	BLK	000-40-11 ALRM GND	18 AWG	GXL	S656 (1)

X486

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-44 CF	18 AWG	GXL	CO69-J3 (1)
2	WHT	4-102 HEAD & TAIL LIGHTS	18 AWG	GXL	CO69-J2 (26)
3	WHT	4-105 CRIBBING	18 AWG	GXL	CO69-J3 (9)
4	WHT	4-89 NO FULL EXTENDED	18 AWG	GXL	CO69-J3 (10)
5					
6					

CO69-J3

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-44 CF	18 AWG	GXL	X486 (1)
2	BLK	000-40-49 AUX TWR LIFT DOWN	18 AWG	GXL	S438 (2)
3					
4	BLK	000-40-38 CF	18 AWG	GXL	S389 (2)
5	BLK	000-40-42 CF	18 AWG	GXL	S390 (2)
6	BLK	000-40-33 CF	18 AWG	GXL	HV375 (2)
7	WHT	4-30 ALRM	18 AWG	GXL	AH387 (A)
8					
9	WHT	4-105 CRIBBING	18 AWG	GXL	X486 (3)
10	WHT	4-89 NO FULL EXTENDED	18 AWG	GXL	X486 (4)
11					
12					
13					
14	BLK	000-40-35 CF	18 AWG	GXL	S388 (2)

HV379
SWING LEFT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-27 SWING LEFT	18 AWG	GXL	CO69-J2 (34)
2	BLK	000-40-39 CF	18 AWG	GXL	S389 (1)

HV367
TOWER LIFT UP

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-15 TOWER LIFT UP	18 AWG	GXL	CO69-J2 (20)
2	BLK	000-40-26	18 AWG	GXL	S390 (1)

HV376
MAIN LIFT UP

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-24 MAIN LIFT UP	18 AWG	GXL	CO69-J2 (11)
2	BLK	000-40-34 CF	18 AWG	GXL	S388 (1)

HV375
FLOW CONTROL

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-23 FLOW CONTROL	18 AWG	GXL	CO69-J2 (31)
2	BLK	000-40-33 CF	18 AWG	GXL	CO69-J3 (6)

CO69-J2

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	77-1 WHT NOISE	18 AWG	GXL	AH388 (1)
3					
4	WHT	4-19 MAIN TELE IN	18 AWG	GXL	X500 (E)
5	WHT	4-8 LEVEL UP	18 AWG	GXL	X500 (C)
6	BLK	000-40-45	18 AWG	GXL	SN391 (1)
7	WHT	4-11 LEVEL DOWN	18 AWG	GXL	X500 (B)
8	WHT	4-21 STEER RIGHT	18 AWG	GXL	HV373 (1)
9	WHT	4-16 TOWER LIFT DOWN	18 AWG	GXL	X500 (N)
10					
11	WHT	4-24 MAIN LIFT UP	18 AWG	GXL	HV376 (1)
12					
13	WHT	4-14 MAIN DUMP	18 AWG	GXL	HV366 (1)
14	BLK	000-40-7	18 AWG	GXL	X500 (A)
15					
16	WHT	4-20 MAIN TELE OUT	18 AWG	GXL	X500 (D)
17					
18					
19	WHT	4-22 STEER LEFT	18 AWG	GXL	HV374 (1)
20	WHT	4-15 TOWER LIFT UP	18 AWG	GXL	HV367 (1)
21	WHT	4-103 MAIN LIFT DOWN AUX	18 AWG	GXL	X500 (G)
22	WHT	4-104 MAIN LIFT DOWN	18 AWG	GXL	X500 (J)
23	BLK	4-93 AUX TOWER LIFT DOWN	18 AWG	GXL	X500 (L)
24	BLK	0 CONFIG	18 AWG	GXL	S27 (2)
25	WHT	4-75 FUEL SWITCH	18 AWG	GXL	SN391 (2)
26	WHT	4-102 HEAD & TAIL LIGHTS	18 AWG	GXL	X486 (2)
27	WHT	4-29 ALRM	18 AWG	GXL	AH387 (B)
28	BLK	000-40-53 GND	18 AWG	GXL	S415 (2)
29	BLK	000-40-10 ALRM GND	18 AWG	GXL	S27 (2)
30	BLK	000-40-25	18 AWG	GXL	HV366 (2)
31	WHT	4-23 FLOW CONTROL	18 AWG	GXL	HV375 (1)
32					
33					
34	WHT	4-27 SWING LEFT	18 AWG	GXL	HV379 (1)
35	WHT	4-26 SWING RIGHT	18 AWG	GXL	HV378 (1)

HV374
STEER LEFT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-22 STEER LEFT	18 AWG	GXL	CO69-J2 (19)
2	BLK	000-40-32	18 AWG	GXL	S415 (1)

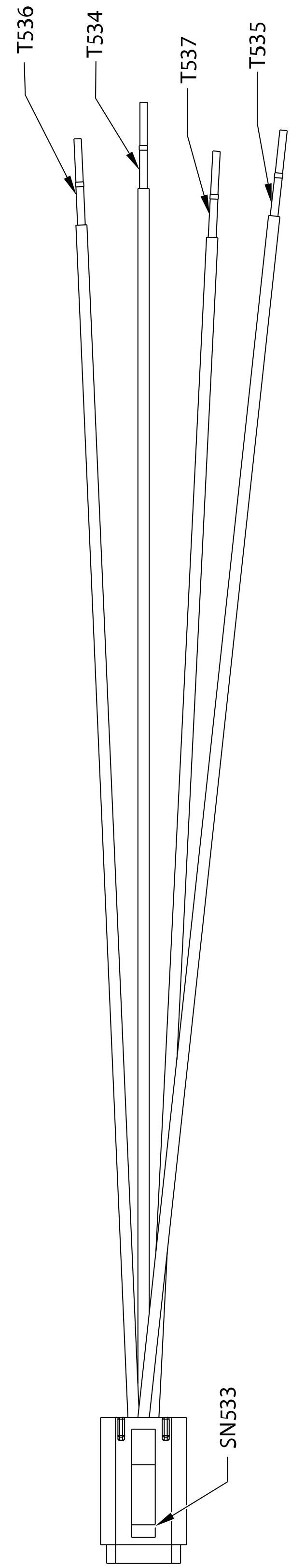
HV373
STEER RIGHT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-21 STEER RIGHT	18 AWG	GXL	CO69-J2 (8)
2	BLK	000-40-32	18 AWG	GXL	S415 (1)

HV378
SWING RIGHT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-26 SWING RIGHT	18 AWG	GXL	CO69-J2 (35)
2	BLK	000-40-37 CF	18 AWG	GXL	S389 (1)

Figure 292. Platform Valve Harness - Sheet 2 of 2



1001183398-B
MAF14050B

Figure 293. Low Temp Cutout Option Harness

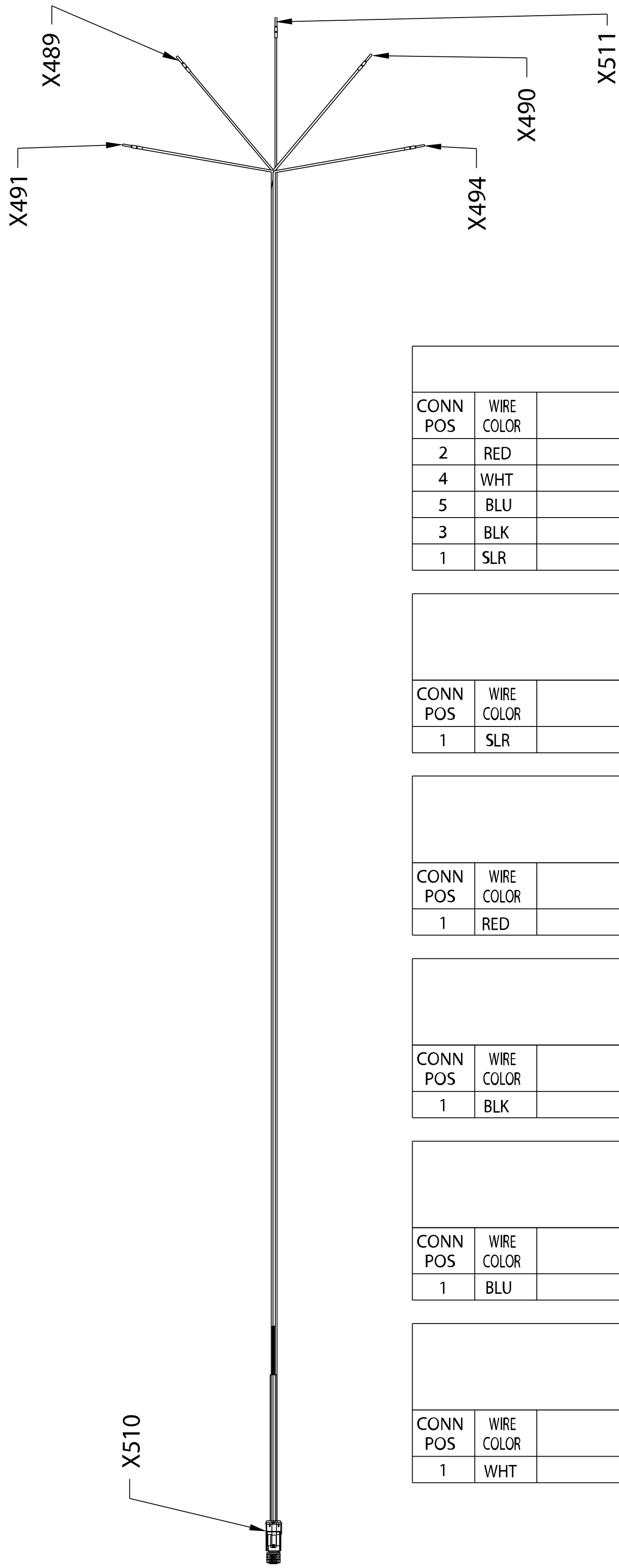
T537					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	81-5	GRN	18 AWG	GXL	SN533 (3)

T535					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	1-43	WHT	18 AWG	GXL	SN533 (2)

SN533					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	3-26	WHT	18 AWG	GXL	T534 (1)
2	1-43	WHT	18 AWG	GXL	T535 (1)
3	81-5	GRN	18 AWG	GXL	T537 (1)
4	80-5	YEL	18 AWG	GXL	T536 (1)

T536					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	80-5	YEL	18 AWG	GXL	SN533 (4)

T534					
CONNPOS	WIRECOLOR	WIRE LABEL	GAUGE	JACKET	TO
1	3-26	WHT	18 AWG	GXL	SN533 (1)



X510					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
2	RED	POWER	22 AWG	GXL	X489 (1)
4	WHT	CAN_HI	24 AWG	GXL	X490 (1)
5	BLU	CAN_LO	24 AWG	GXL	X491 (1)
3	BLK	V-	22 AWG	GXL	X494 (1)
1	SLR	SHLD	22 AWG	SHLD	X511 (1)

X511 CAN SHIELD					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	SLR	SHLD	22AWG	SHLD	X510 (1)

X489 LSS POWER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	POWER	22 AWG	GXL	X510 (2)

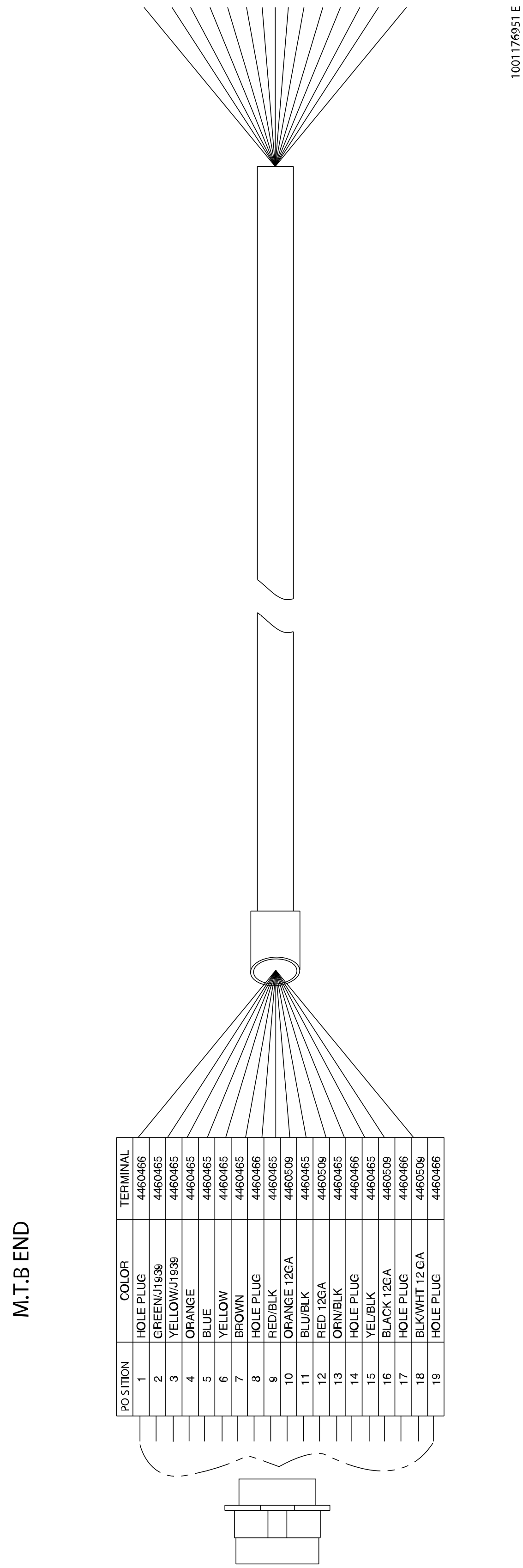
X494 LSS GROUND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	V-	22 AWG	GXL	X510 (3)

X491 LSS CAN LO					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLU	CAN_LO	24 AWG	GXL	X510 (5)

X490 LSS CAN HI					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	CAN_HI	24 AWG	GXL	X510 (4)

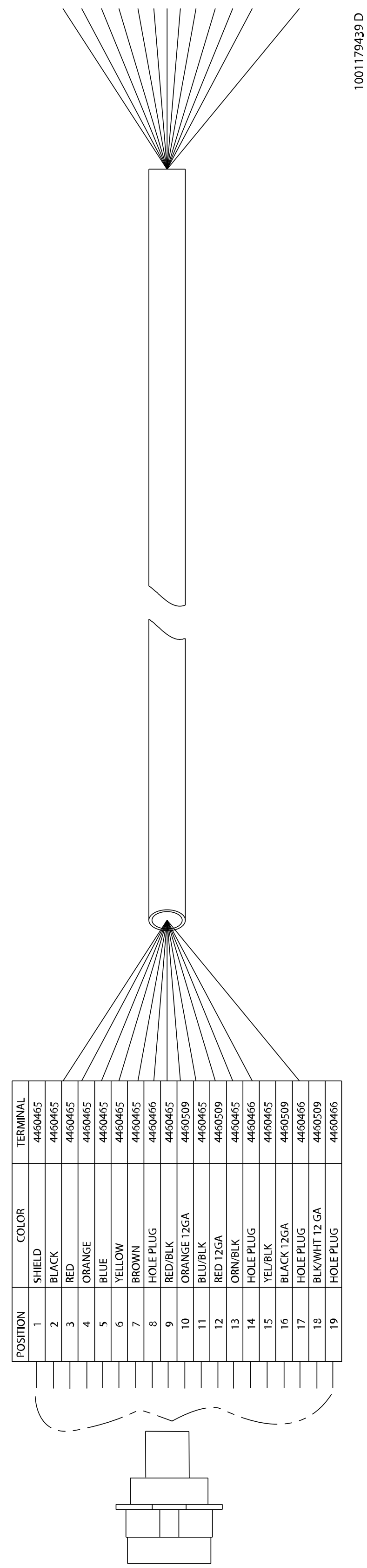
1001175244-D
MAF34540D

Figure 294. LSS Harness



POSITION	COLOR	TERMINAL
1	HOLE PLUG	4460466
2	GREEN/J1939	4460465
3	YELLOW/J1939	4460465
4	ORANGE	4460465
5	BLUE	4460465
6	YELLOW	4460465
7	BROWN	4460465
8	HOLE PLUG	4460466
9	RED/BLK	4460465
10	ORANGE 12GA	4460509
11	BLU/BLK	4460465
12	RED 12GA	4460509
13	ORN/BLK	4460465
14	HOLE PLUG	4460466
15	YEL/BLK	4460465
16	BLACK 12GA	4460509
17	HOLE PLUG	4460466
18	BLK/WHT 12 GA	4460509
19	HOLE PLUG	4460466

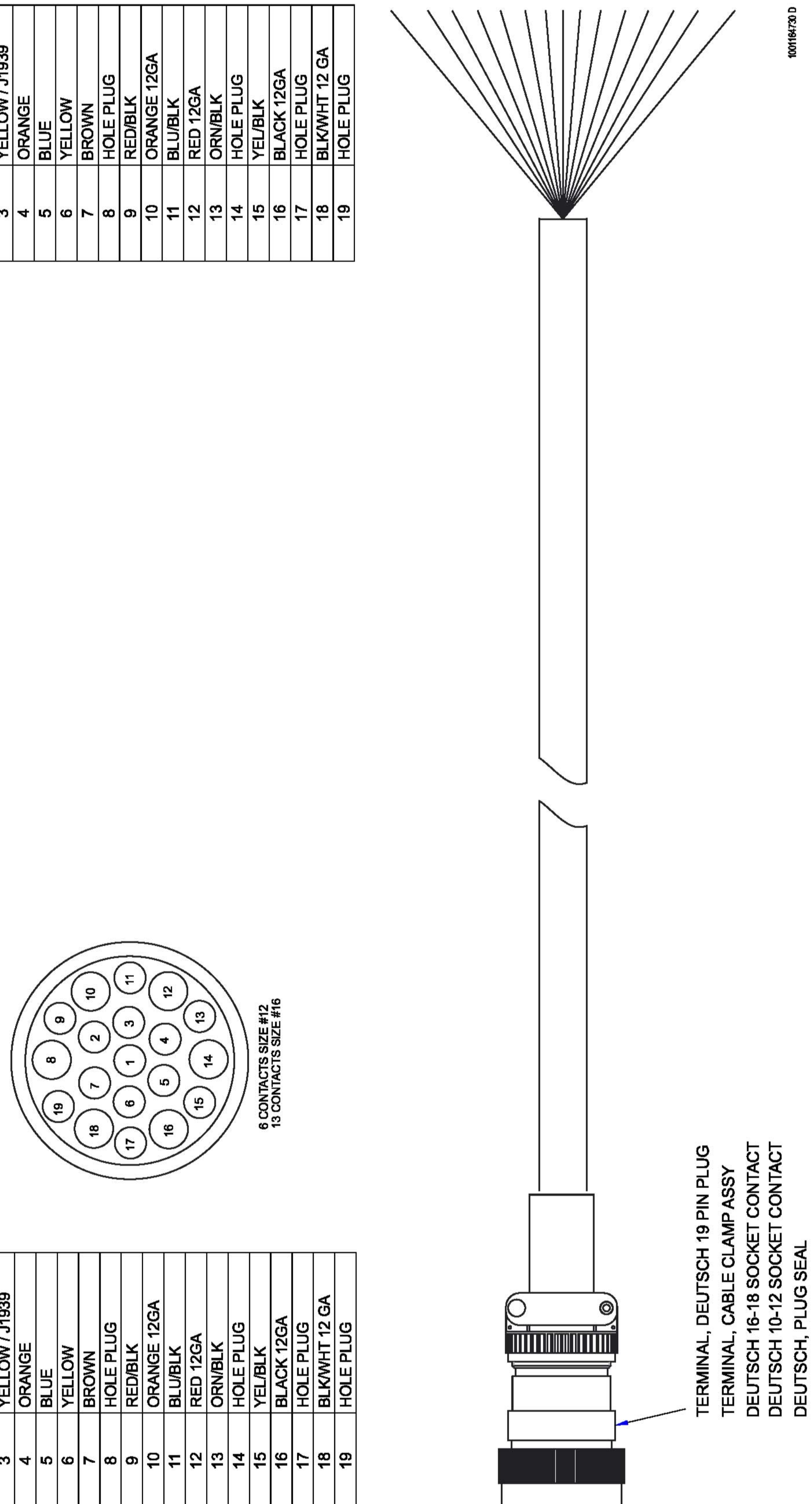
Figure 295. Boom Lower Harness - Standard



POSITION	COLOR	TERMINAL
1	SHIELD	4460465
2	BLACK	4460465
3	RED	4460465
4	ORANGE	4460465
5	BLUE	4460465
6	YELLOW	4460465
7	BROWN	4460465
8	HOLE PLUG	4460466
9	RED/BLK	4460465
10	ORANGE 12GA	4460509
11	BLU/BLK	4460465
12	RED 12GA	4460509
13	ORN/BLK	4460465
14	HOLE PLUG	4460466
15	YEL/BLK	4460465
16	BLACK 12GA	4460509
17	HOLE PLUG	4460466
18	BLK/WHT 12 GA	4460509
19	HOLE PLUG	4460466

Figure 296. Boom Lower Harness - Arctic

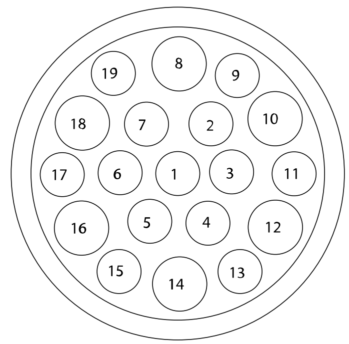
POSITION	COLOR
1	HOLE PLUG
2	GREEN / J1939
3	YELLOW / J1939
4	ORANGE
5	BLUE
6	YELLOW
7	BROWN
8	HOLE PLUG
9	RED/BLK
10	ORANGE 12GA
11	BLU/BLK
12	RED 12GA
13	ORN/BLK
14	HOLE PLUG
15	YEL/BLK
16	BLACK 12GA
17	HOLE PLUG
18	BLK/WHT 12 GA
19	HOLE PLUG



POSITION	COLOR
1	HOLE PLUG
2	GREEN / J1939
3	YELLOW / J1939
4	ORANGE
5	BLUE
6	YELLOW
7	BROWN
8	HOLE PLUG
9	RED/BLK
10	ORANGE 12GA
11	BLU/BLK
12	RED 12GA
13	ORN/BLK
14	HOLE PLUG
15	YEL/BLK
16	BLACK 12GA
17	HOLE PLUG
18	BLK/WHT 12 GA
19	HOLE PLUG

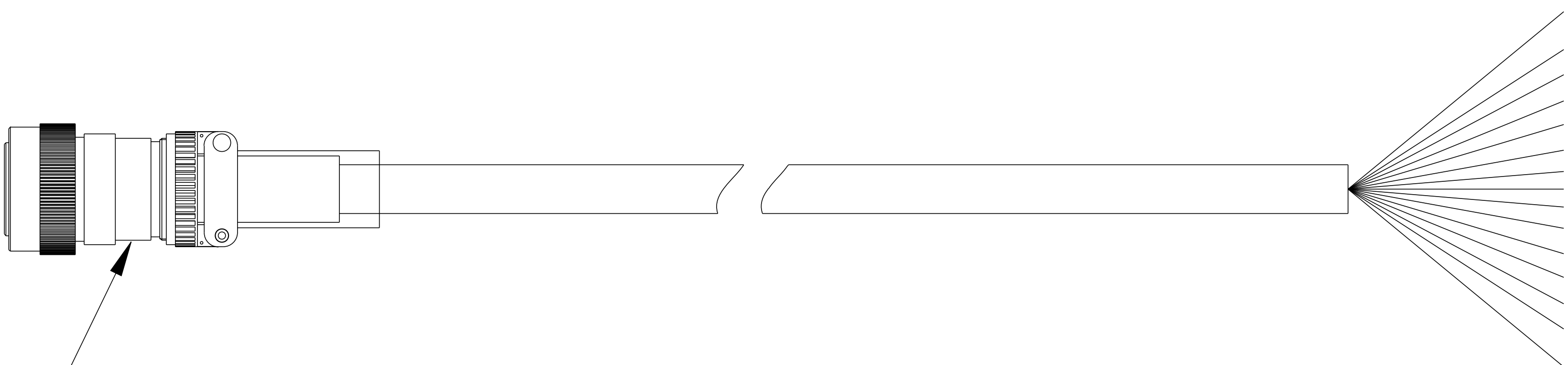
Figure 297. Boom Upper Harness - Standard

POSITION	COLOR	TERMINAL
1	SHIELD	4460465
2	BLACK	4460465
3	RED	4460465
4	ORANGE	4460465
5	BLUE	4460465
6	YELLOW	4460465
7	BROWN	4460465
8	HOLE PLUG	4460466
9	RED/BLK	4460465
10	ORANGE 12GA	4460509
11	BLU/BLK	4460465
12	RED 12GA	4460509
13	ORN/BLK	4460465
14	HOLE PLUG	4460466
15	YEL/BLK	4460465
16	BLACK 12GA	4460509
17	HOLE PLUG	4460466
18	BLK/WHT 12 GA	4460509
19	HOLE PLUG	4460466



6 CONTACTS SIZE #12
13 CONTACTS SIZE #16

COLOR	TERMINAL
SHIELD	4460465
BLACK	4460465
RED	4460465
ORANGE	4460465
BLUE	4460465
YELLOW	4460465
BROWN	4460465
RED/BLK	4460465
ORANGE 12GA	4460509
BLU/BLK	4460465
RED 12GA	4460509
ORN/BLK	4460465
YEL/BLK	4460465
BLACK 12GA	4460509
BLK/WHT 12 GA	4460509



1001174748 C

Figure 298. Boom Upper Harness - Arctic

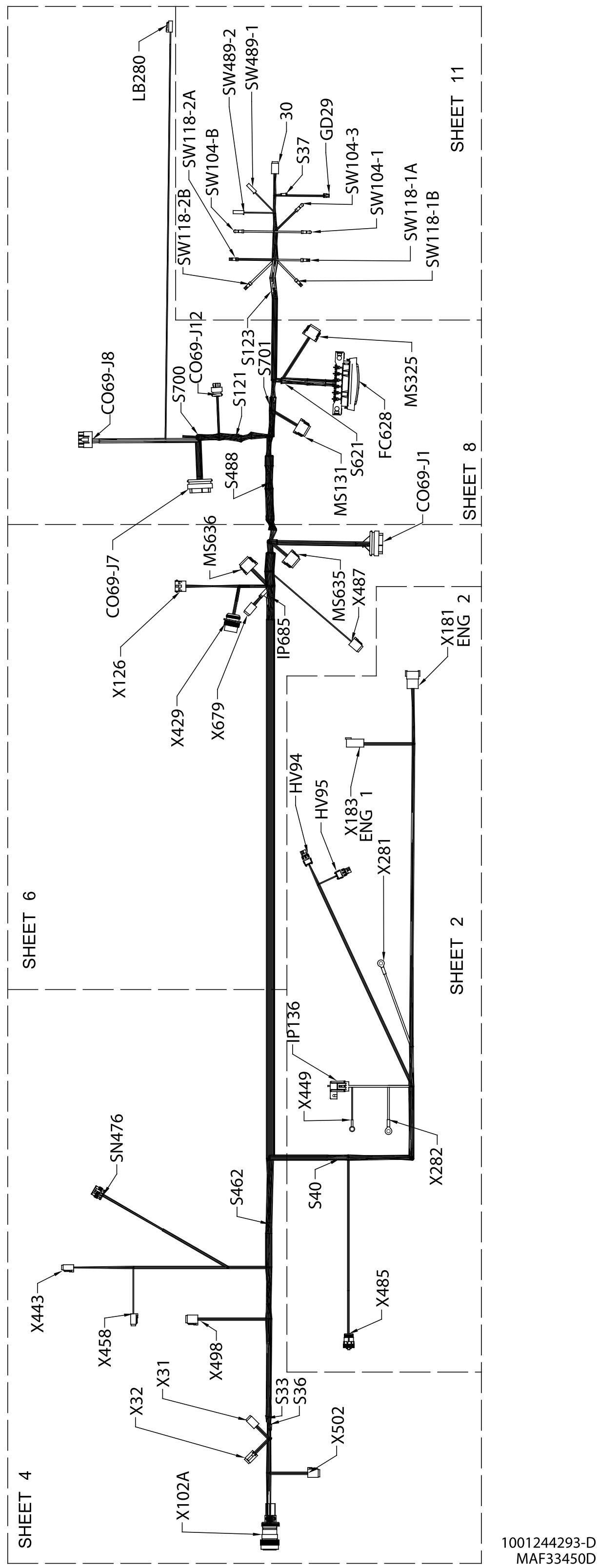


Figure 299. Turntable Harness - Sheet 1 of 13

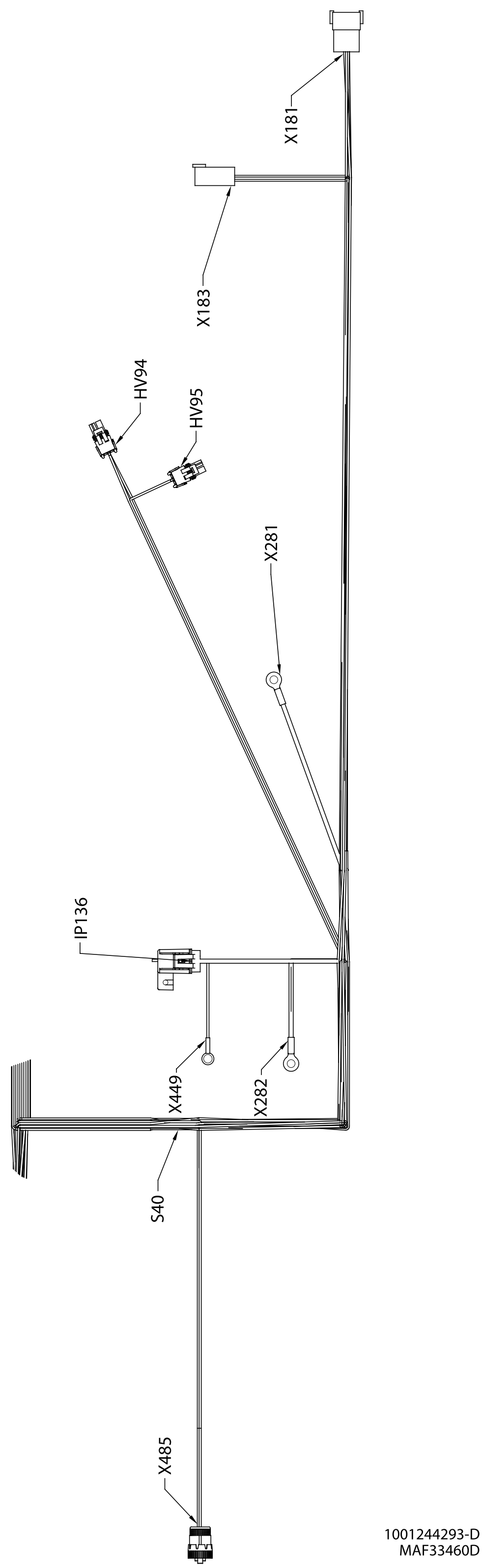


Figure 300. Turntable Harness - Sheet 2 of 13

S40

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-40CF	18 AWG	GXL	HV95 (2)
1	BLK	000-40-41CF	18 AWG	GXL	HV94 (2)
2	BLK	000-40-43GND	18 AWG	GXL	X487 (1)

IP136
30A

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	4-79 12AWG	12 AWG	GXL	S123 (2)
2	RED	4-49 12AWG	12 AWG	GXL	X282 (1)

X485
GENERATOR

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4-82 IGN	18 AWG	GXL	FC628 (41)
2	WHT	4-76GEN ON	18 AWG	GXL	CO69-J1 (22)
3	BLK	000-40-109	18 AWG	GXL	MS635 (5)

X449
AUX PUMP

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-78 AUX PUMP	16 AWG	GXL	CO69-J1 (13)

X282
B+ AUX PUMP RELAY

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	4-49 12AWG	12 AWG	GXL	IP136 (2)

HV94
DRIVE REVERSE

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-4 DRIVE REVERSE	18 AWG	GXL	CO69-J1 (6)
2	BLK	000-40-41CF	18 AWG	GXL	S40 (1)

HV95
DRIVE FORWARD

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-3 DRIVE FORWARD	18 AWG	GXL	CO69-J1 (3)
2	BLK	000-40-40CF	18 AWG	GXL	S40 (1)

X281
GND

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-8(10)	10 AWG	GXL	CO69-J8 (1)

X183
ENG 1

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4-84 IGN	18 AWG	GXL	MS636 (4)
2	WHT	4-67 SATRT	16 AWG	GXL	CO69-J1 (11)
3	YEL	CAN 2 HI	20 AWG	J1939 CABLE	MS325 (8)
4	GRN	CAN 2 LO	20 AWG	J1939 CABLE	MS325 (11)
5	RED	4-76 ALT EXCITE	16 AWG	GXL	CO69-J1 (32)
6					

X181
ENG 2

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-94 EMR4 IGNITION	18 AWG	GXL	CO69-J1 (10)
2	BLK	000-40-557GROUND	18 AWG	GXL	MS635 (6)
3					
4	WHT	4-80 GLOW PLUG	16 AWG	GXL	CO69-J1 (12)
5					
6					
7	YEL	4-63 WIF PWR	18 AWG	GXL	CO69-J7 (30)
8	WHT	4-99 WIF	18 AWG	GXL	CO69-J7 (22)

Figure 301. Turntable Harness - Sheet 3 of 13

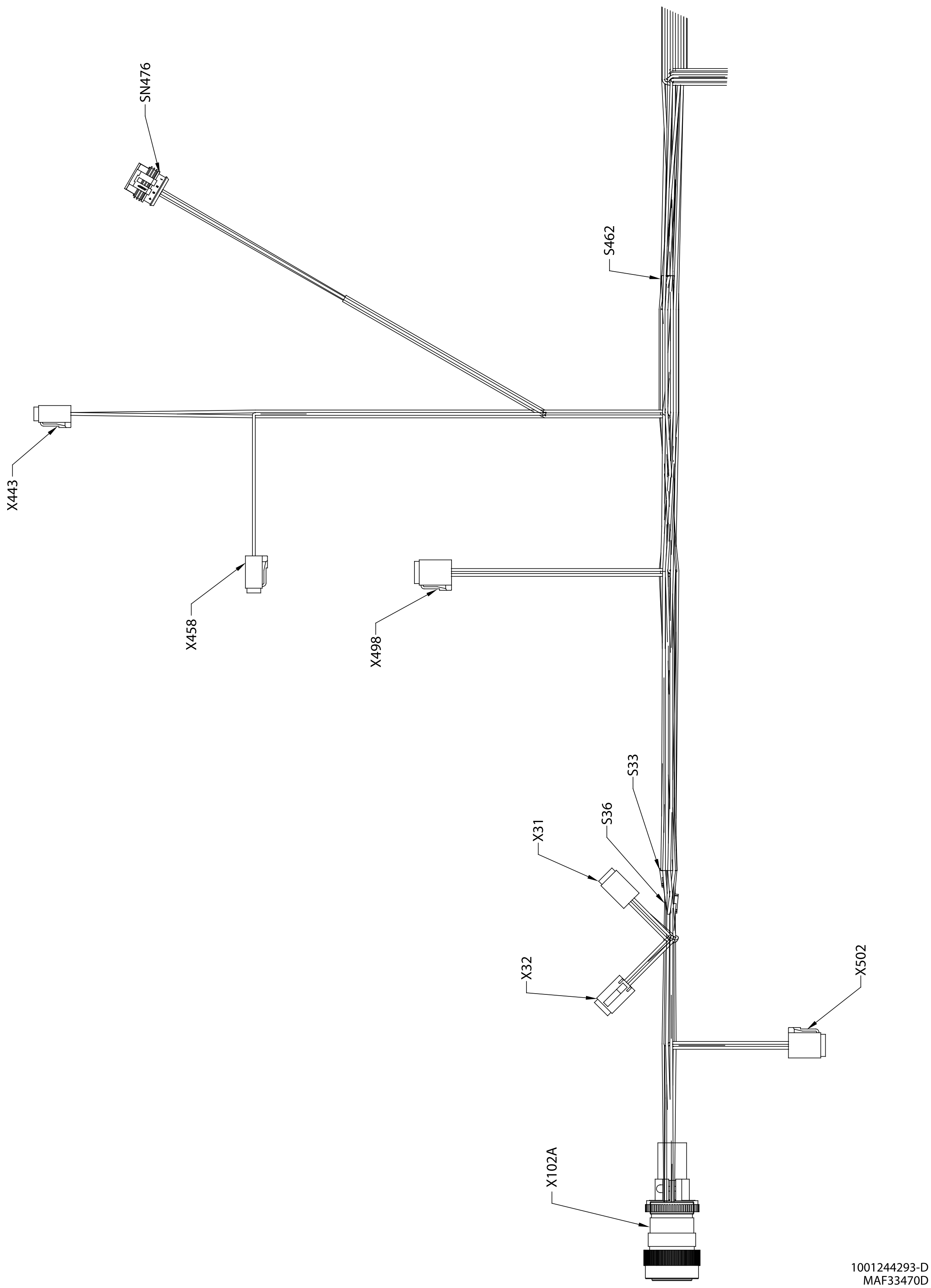


Figure 302. Turntable Harness - Sheet 4 of 13

X102A MAIN BOOM					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	GRN	CAN 1 LO	20 AWG	J1939 CABLE	MS131 (4)
3	YEL	CAN 1 HI	20 AWG	J1939 CABLE	MS131 (1)
4	WHT	4-43 PLTF EMS	18 AWG	GXL	S121 (2)
5					
6	WHT	4-52 FOOT SW	18 AWG	GXL	CO69-J7 (15)
7					
8					
9	RED	4-552	16 AWG	GXL	FC628 (34)
10					
11	WHT	4-53 GROUND MODE	18 AWG	GXL	CO69-J7 (14)
12	RED	4-71	12 AWG	GXL	FC628 (33)
13					
14					
15					
16	BLK	000-40-12 PLATF GND	12 AWG	GXL	CO69-J8 (3)
17					
18					
19					

X502					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-114 BOOM ANG SEN PWR	18 AWG	GXL	CO69-J7 (16)
2	WHT	4-115 BOOM ANG SEN #2	18 AWG	GXL	CO69-J7 (7)
3	BLK	000-40-80 GND	18 AWG	GXL	CO69-J7 (9)
4	WHT	4-117 BOOM ANG SEN #1	18 AWG	GXL	CO69-J7 (4)
5	WHT	4-107	18 AWG	GXL	S462 (2)
6	WHT	4-108 TOWER EL SW	18 AWG	GXL	CO69-J7 (11)

X498					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-498 OSC VLVs GND	18 AWG	GXL	MS635 (2)
2	WHT	4-400 OSC AXLE #2 SEC	18 AWG	GXL	CO69-J1 (2)
3	WHT	4-401 OSC AXLE #1 PRIMARY	18 AWG	GXL	CO69-J1 (7)
4	BLK	000-40-499 GND	18 AWG	GXL	CO69-J1 (5)
5	WHT	4-402 BRAKE	18 AWG	GXL	CO69-J1 (23)
6	WHT	4-403 TWO SPEED	18 AWG	GXL	CO69-J1 (20)

X458 SWING 1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	4-109	18 AWG	GXL	S462 (2)
3	WHT	4-110 OSC AXL SWING SW#1	18 AWG	GXL	CO69-J7 (12)
4					

S33					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4-83 PROX PWR	18 AWG	GXL	CO69-J7 (33)
2	YEL	4-83-2 PROX PWR	18 AWG	GXL	X31 (1)
2	YEL	4-83-3 PROX PWR	18 AWG	GXL	X31 (4)

SN476 CAN TILT SENSOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-130 TILT VCC	18 AWG	GXL	CO69-J7 (34)
2	WHT	4-129 TILT GND	18 AWG	GXL	CO69-J7 (10)
3	YEL	CAN 1 HI	20 AWG	J1939 CABLE	MS131 (3)
4	GRN	CAN 1 LO	20 AWG	J1939 CABLE	MS131 (6)

S462					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-106 TRANS EL SW	18 AWG	GXL	CO69-J7 (32)
1	WHT	4-111	18 AWG	GXL	X443 (1)
2	WHT	4-107	18 AWG	GXL	X502 (5)
2	WHT	4-109	18 AWG	GXL	X458 (2)

X32 CAPACITY PROX					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4-92 PROX PWR	18 AWG	GXL	MS636 (8)
2	BLK	4-93 PROX GND	18 AWG	GXL	MS635 (9)
3	WHT	4-87 NO MID	18 AWG	GXL	CO69-J7 (23)
4	WHT	4-89-2 NO EXTENDED	18 AWG	GXL	X487 (4)
5	WHT	4-90 NC EXTENED	18 AWG	GXL	CO69-J1 (21)
6	WHT	4-88 NC MID	18 AWG	GXL	CO69-J1 (35)
7					
8					

X31 TRANSPORT PROX					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4-83-2 PROX PWR	18 AWG	GXL	S33 (2)
2	BLK	4-91-2 PROX GND	18 AWG	GXL	S36 (2)
3	WHT	4-85 NO TRANSPORT	18 AWG	GXL	CO69-J7 (21)
4	YEL	4-83-3 PROX PWR	18 AWG	GXL	S33 (2)
5	BLK	4-91-3 PROX GND	18 AWG	GXL	S36 (2)
6	WHT	4-86 NC TRANSPORT	18 AWG	GXL	CO69-J1 (34)

S36					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	4-91 PROX GND	18 AWG	GXL	CO69-J7 (28)
2	BLK	4-91-2 PROX GND	18 AWG	GXL	X31 (2)
2	BLK	4-91-3 PROX GND	18 AWG	GXL	X31 (5)

X443 SWING 2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-111	18 AWG	GXL	S462 (1)
2					
3					
4	WHT	4-112 OSC AXL SWING SW#2	18 AWG	GXL	CO69-J7 (20)

Figure 303. Turntable Harness - Sheet 5 of 13

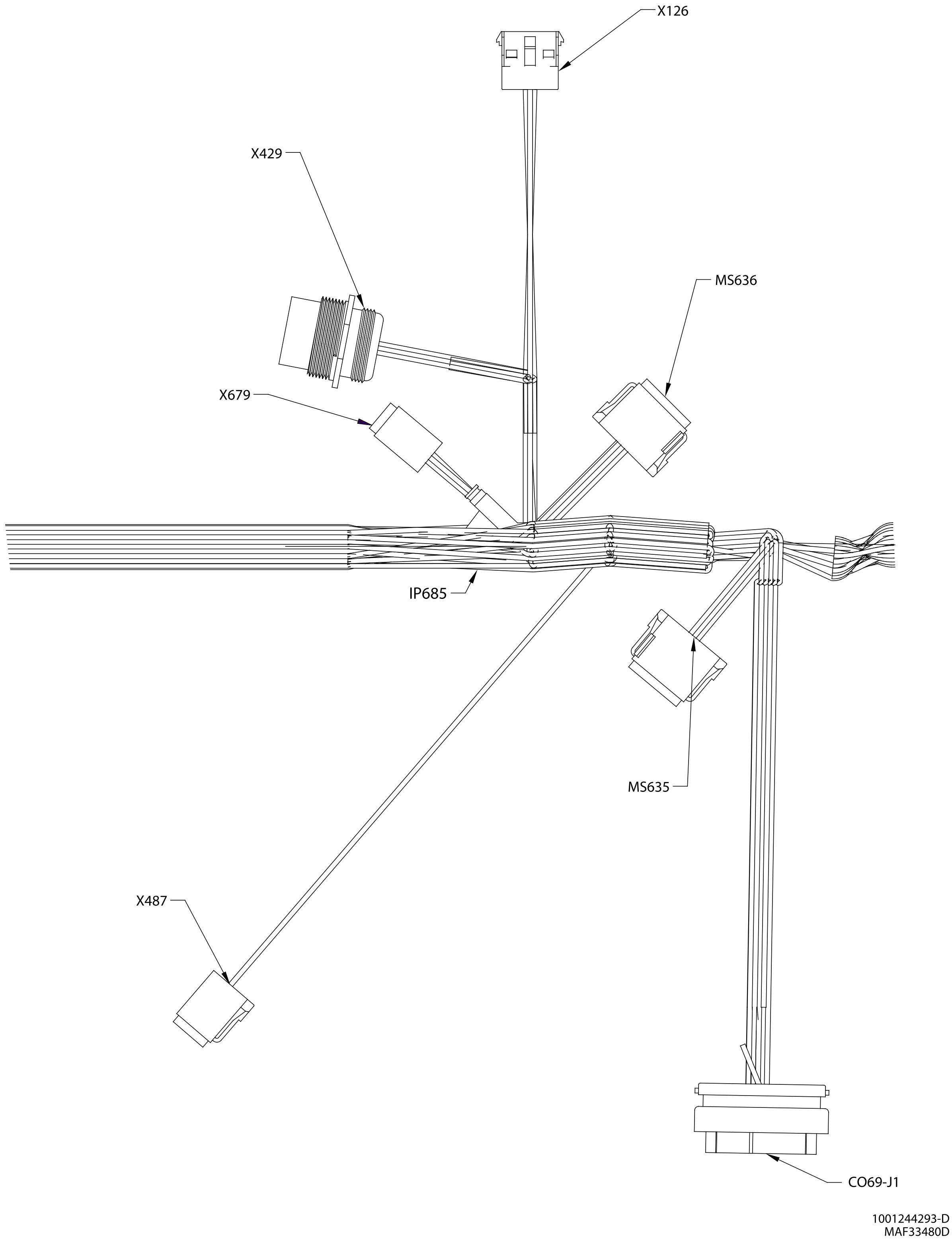


Figure 304. Turntable Harness - Sheet 6 of 13

CO69-J1
NATURAL

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	4-400OSC AXLE #2 SEC	18 AWG	GXL	X498 (2)
3	WHT	4-3DRIVE FORWARD	18 AWG	GXL	HV95 (1)
4					
5	BLK	000-40-499 GND	18 AWG	GXL	X498 (4)
6	WHT	4-4DRIVE REVERSE	18 AWG	GXL	HV94 (1)
7	WHT	4-401OSC AXLE #1 PRIMARY	18 AWG	GXL	X498 (3)
8					
9	BLK	4-164GND	18 AWG	GXL	SW489-2 (1)
10	WHT	4-94EMR4 IGNITION	18 AWG	GXL	X181 (1)
11	WHT	4-67SATRT	16 AWG	GXL	X183 (2)
12	WHT	4-80 GLOW PLUG	16 AWG	GXL	X181 (4)
13	WHT	4-78 AUX PUMP	16 AWG	GXL	X449 (1)
14					
15					
16					
17					
18					
19					
20	WHT	4-403TWO SPEED	18 AWG	GXL	X498 (6)
21	WHT	4-90NC EXTENED	18 AWG	GXL	X32 (5)
22	WHT	4-74GEN ON	18 AWG	GXL	X485 (2)
23	WHT	4-402BRAKE	18 AWG	GXL	X498 (5)
24					
25					
26					
27					
28	WHT	4-5POWER	18 AWG	GXL	X126 (1)
29	WHT	4-6 RECEIVE	18 AWG	GXL	X126 (2)
30	WHT	4-7 TRANSMIT	18 AWG	GXL	X126 (3)
31	BLK	000-40-4GND	18 AWG	GXL	X126 (4)
32	RED	4-76 ALT EXCITE	16 AWG	GXL	X183 (5)
33					
34	WHT	4-86NC TRANSPORT	18 AWG	GXL	X31 (6)
35	WHT	4-88NC MID	18 AWG	GXL	X32 (6)

X487

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-43GND	18 AWG	GXL	S40 (2)
2					
3					
4	WHT	4-89-2NO EXTENDED	18 AWG	GXL	X32 (4)
5					
6					

X679
TELEMATICS

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-65-2	18 AWG	GXL	S701 (2)
2	BLK	000-40-558GROUND	18 AWG	GXL	MS635 (7)
3	RED	4-97-2PWR	18 AWG	GXL	S700 (2)
4	RED	4-51-1	18 AWG	GXL	IP685 (2)

MS635
NEG BUSS

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-64BATT GND	18 AWG	GXL	CO69-J8 (1)
2	BLK	000-40-498OSC VLVs GND	18 AWG	GXL	X498 (1)
3	BLK	000-40-18STROBE GND	18 AWG	GXL	LB280 (2)
4	BLK	000-40-1NEG	18 AWG	GXL	X429 (A)
5	BLK	000-40-109	18 AWG	GXL	X485 (3)
6	BLK	000-40-557GROUND	18 AWG	GXL	X181 (2)
7	BLK	000-40-558GROUND	18 AWG	GXL	X679 (2)
8	BLK	4-98DISPLAY GND	20 AWG	TXL	GD29 (6)
9	BLK	4-93 PROX GND	18 AWG	GXL	X32 (2)
10					
11					
12					

MS636
IGN BUSS

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4-36 IGN	12 AWG	GXL	CO69-J8 (4)
2	YEL	4-72 IGN	18 AWG	GXL	FC628 (40)
3	YEL	4-54 IGN	18 AWG	GXL	LB280 (1)
4	YEL	4-84 IGN	18 AWG	GXL	X183 (1)
5	YEL	4-81 IGN	18 AWG	GXL	FC628 (45)
6					
7	YEL	4-95DISPLAY PWR	18 AWG	GXL	S37 (1)
8	YEL	4-92 PROX PWR	18 AWG	GXL	X32 (1)
9					
10					
11					
12					

X429
DIAGNOSTIC CONNECTOR

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	000-40-1NEG	18 AWG	GXL	MS635 (4)
B	WHT	4-65-1	18 AWG	GXL	S701 (2)
C	YEL	CAN 2 HI	20 AWG	J1939 CABLE	MS325 (6)
D	GRN	CAN 2 LO	20 AWG	J1939 CABLE	MS325 (3)
E					
F					
G					
H	WHT	4-66 IGN	18 AWG	GXL	FC628 (36)
J					

X126
ANALYZER

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-5 POWER	18 AWG	GXL	CO69-J1 (28)
2	WHT	4-6 RECEIVE	18 AWG	GXL	CO69-J1 (29)
3	WHT	4-7 TRANSMIT	18 AWG	GXL	CO69-J1 (30)
4	BLK	000-40-4GND	18 AWG	GXL	CO69-J1 (31)

IP685
UTC 5A

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	4-51-1	18 AWG	GXL	SW104-3 (1)
2	RED	4-51-1	18 AWG	GXL	X679 (4)

Figure 305. Turntable Harness - Sheet 7 of 13

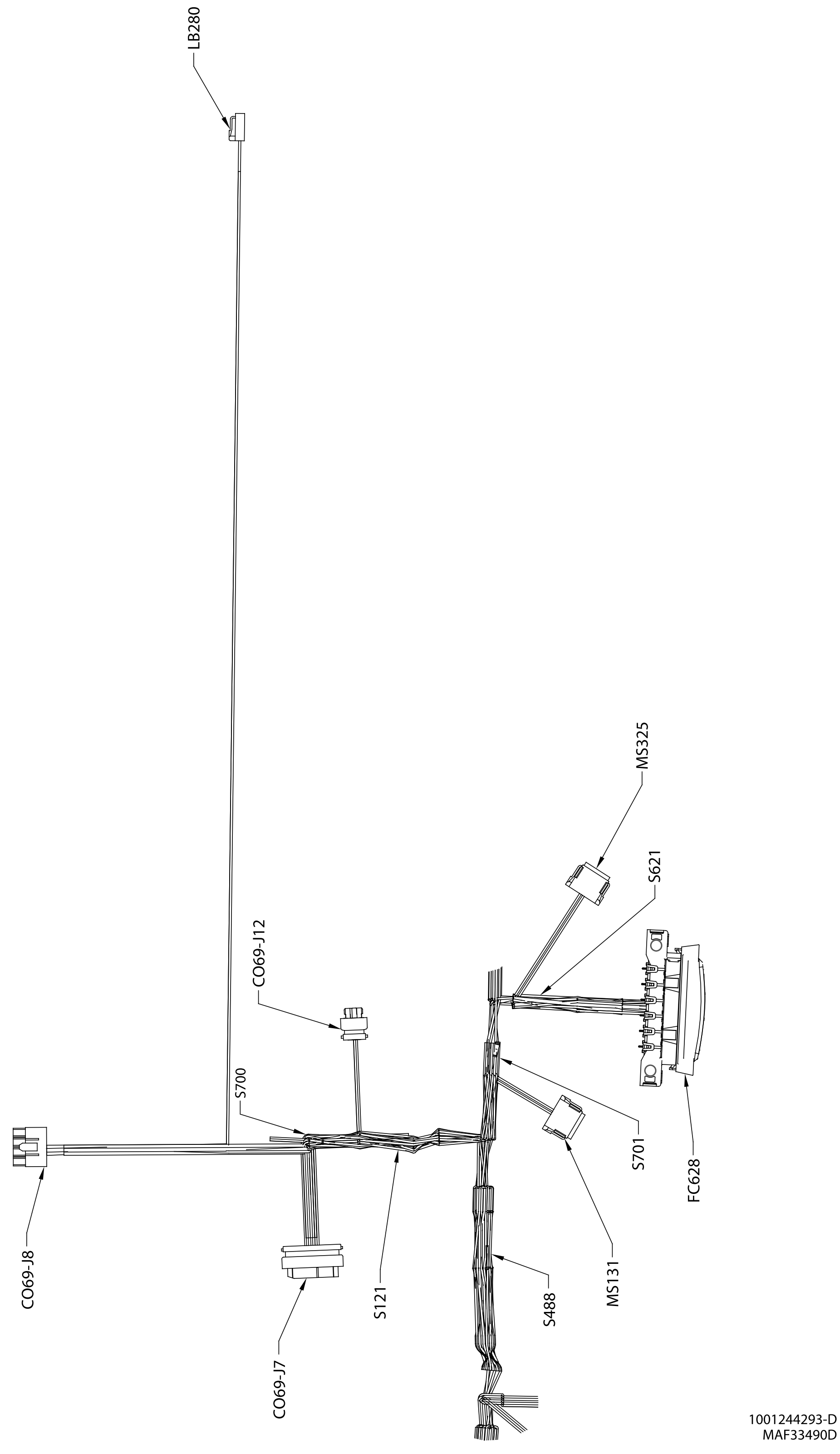


Figure 306. Turntable Harness - Sheet 8 of 13

C069-J12					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3	YEL	CAN 2 HI	20 AWG	J1939 CABLE	MS325 (7)
4	GRN	CAN 2 LO	20 AWG	J1939 CABLE	MS325 (10)
5					
6	WHT	4-96 JUMP	18 AWG	GXL	C069-J12 (7)
7	WHT	4-96 JUMP	18 AWG	GXL	C069-J12 (6)
8	WHT	4-165 MSS0	18 AWG	GXL	SW489-1 (1)

S488					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-38	18 AWG	GXL	FC628 (26)
1	RED	4-39	18 AWG	GXL	FC628 (25)
2	WHT	4-38	18 AWG	GXL	FC628 (1)

S621					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	4-550 -	12 AWG	GXL	FC628 (37)
1	RED	4-551	12 AWG	GXL	FC628 (32)
2	RED	4-166	12 AWG	GXL	FC628 (2)
2	RED	4-553	18 AWG	GXL	FC628 (47)

S700					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	4-97-1 PWR	18 AWG	GXL	GD30 (2)
2	RED	4-97 PWR	18 AWG	GXL	C069-J7 (29)
2	RED	4-97-2 PWR	18 AWG	GXL	X679 (3)

MS131					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CAN 1 HI	20 AWG	J1939 CABLE	X102A (3)
2	YEL	CAN 1 HI	20 AWG	J1939 CABLE	C069-J7 (13)
3	YEL	CAN 1 HI	20 AWG	J1939 CABLE	SN476 (3)
4	GRN	CAN 1 LO	20 AWG	J1939 CABLE	X102A (2)
5	GRN	CAN 1 LO	20 AWG	J1939 CABLE	C069-J7 (24)
6	GRN	CAN 1 LO	20 AWG	J1939 CABLE	SN476 (4)
7	GRN	CAN1 LO	20 AWG	TXL	GD29 (4)
8					
9					
10	YEL	CAN1 HI	20 AWG	TXL	GD29 (1)
11					
12					

S121					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-41	18 AWG	GXL	FC628 (30)
1	WHT	4-42 PLTF EMS	18 AWG	GXL	C069-J7 (1)
2	WHT	4-132 PLT MODE	18 AWG	GXL	C069-J7 (2)
2	WHT	4-43 PLTF EMS	18 AWG	GXL	X102A (4)

C069-J7 BLACK					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-42 PLTF EMS	18 AWG	GXL	S121 (1)
2	WHT	4-132 PLT MODE	18 AWG	GXL	S121 (2)
3	RED	4-122 MOD SEL	18 AWG	GXL	FC628 (46)
4	WHT	4-117BOOM ANG SEN #1	18 AWG	GXL	X502 (4)
5					
6	WHT	4-131 JUMP	18 AWG	GXL	C069-J7 (17)
7	WHT	4-115BOOM ANG SEN #2	18 AWG	GXL	X502 (2)
8					
9	BLK	000-40-80 GND	18 AWG	GXL	X502 (3)
10	WHT	4-129 TILT GND	18 AWG	GXL	SN476 (2)
11	WHT	4-108 TOWER EL SW	18 AWG	GXL	X502 (6)
12	WHT	4-110OSC AXL SWING SW#1	18 AWG	GXL	X458 (3)
13	YEL	CAN 1 HI	20 AWG	J1939 CABLE	MS131 (2)
14	WHT	4-53 GROUND MODE	18 AWG	GXL	X102A (11)
15	WHT	4-52 FOOT SW	18 AWG	GXL	X102A (6)
16	WHT	4-114BOOM ANG SEN PWR	18 AWG	GXL	X502 (1)
17	WHT	4-131 JUMP	18 AWG	GXL	C069-J7 (6)
18					
19	BLK	000-40-13 GND	18 AWG	GXL	FC628 (10)
20	WHT	4-112OSC AXL SWING SW#2	18 AWG	GXL	X443 (4)
21	WHT	4-85NO TRANSPORT	18 AWG	GXL	X31 (3)
22	WHT	4-99 WIF	18 AWG	GXL	X181 (8)
23	WHT	4-87 NO MID	18 AWG	GXL	X32 (3)
24	GRN	CAN 1 LO	20 AWG	J1939 CABLE	MS131 (5)
25	BLK	000-40-51 GND	18 AWG	GXL	GD30 (1)
26					
27					
28	BLK	4-91 PROX GND	18 AWG	GXL	S36 (1)
29	RED	4-97 PWR	18 AWG	GXL	S700 (2)
30	YEL	4-63 WIF PWR	18 AWG	GXL	X181 (7)
31					
32	WHT	4-106 TRANS EL SW	18 AWG	GXL	S462 (1)
33	YEL	4-83 PROX PWR	18 AWG	GXL	S33 (1)
34	WHT	4-130 TILT VCC	18 AWG	GXL	SN476 (1)
35					

MS325					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3	GRN	CAN 2 LO	20 AWG	J1939 CABLE	X429 (D)
4					
5					
6	YEL	CAN 2 HI	20 AWG	J1939 CABLE	X429 (C)
7	YEL	CAN 2 HI	20 AWG	J1939 CABLE	C069-J12 (3)
8	YEL	CAN 2 HI	20 AWG	J1939 CABLE	X183 (3)
9	YEL	CAN 2 HI	20 AWG	J1939 CABLE	GD30 (3)
10	GRN	CAN 2 LO	20 AWG	J1939 CABLE	C069-J12 (4)
11	GRN	CAN 2 LO	20 AWG	J1939 CABLE	X183 (4)
12	GRN	CAN 2 LO	20 AWG	J1939 CABLE	GD30 (4)

Figure 307. Turntable Harness - Sheet 9 of 13

FC628					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-38	18 AWG	GXL	S488 (2)
2	RED	4-166	12 AWG	GXL	S621 (2)
3					
4					
5					
6					
7					
8					
9	RED	4-37 EMS	12 AWG	GXL	SW118-1A (1A)
10	BLK	000-40-13 GND	18 AWG	GXL	CO69-J7 (19)
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25	RED	4-39	18 AWG	GXL	S488 (1)
26	WHT	4-38	18 AWG	GXL	S488 (1)
27					
28	RED	4-35 IGN	12 AWG	GXL	CO69-J8 (2)
29	RED	4-40	12 AWG	GXL	SW104-1 (1)
30	WHT	4-41	18 AWG	GXL	S121 (1)
31					
32	RED	4-551	12 AWG	GXL	S621 (1)
33	RED	4-71	12 AWG	GXL	X102A (12)
34	RED	4-552	16 AWG	GXL	X102A (9)
35	WHT	4-65	18 AWG	GXL	S701 (1)
36	WHT	4-66 IGN	18 AWG	GXL	X429 (H)
37	RED	4-550	12 AWG	GXL	S621 (1)
38	RED	4-51	12 AWG	GXL	SW104-3 (1)
39	WHT	4-50	18 AWG	GXL	SW118-2A (2A)
40	YEL	4-72 IGN	18 AWG	GXL	MS636 (2)
41	YEL	4-82 IGN	18 AWG	GXL	X485 (1)
42	RED	4-122 MOD SEL	12 AWG	GXL	SW104-1 (1)
43					
44					
45	YEL	4-81IGN	18 AWG	GXL	MS636 (5)
46	RED	4-122 MOD SEL	18 AWG	GXL	CO69-J7 (3)
47	RED	4-553	18 AWG	GXL	S621 (2)
48					

S701					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-65	18 AWG	GXL	FC628 (35)
2	WHT	4-65-1	18 AWG	GXL	X429 (B)
2	WHT	4-65-2	18 AWG	GXL	X679 (1)

LB280					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4-54 IGN	18 AWG	GXL	MS636 (3)
2	BLK	000-40-1[illegible] STROBE GND	18 AWG	GXL	MS635 (3)

CO69-J8					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-64 BATT GND	18 AWG	GXL	MS635 (1)
1	BLK	000-40-8 (10)	10 AWG	GXL	X281 (1)
2	RED	4-35 IGN	12 AWG	GXL	FC628 (28)
3	BLK	000-40-12 PLATF GND	12 AWG	GXL	X102A (16)
4	YEL	4-36 IGN	12 AWG	GXL	MS636 (1)

Figure 308. Turntable Harness - Sheet 10 of 13

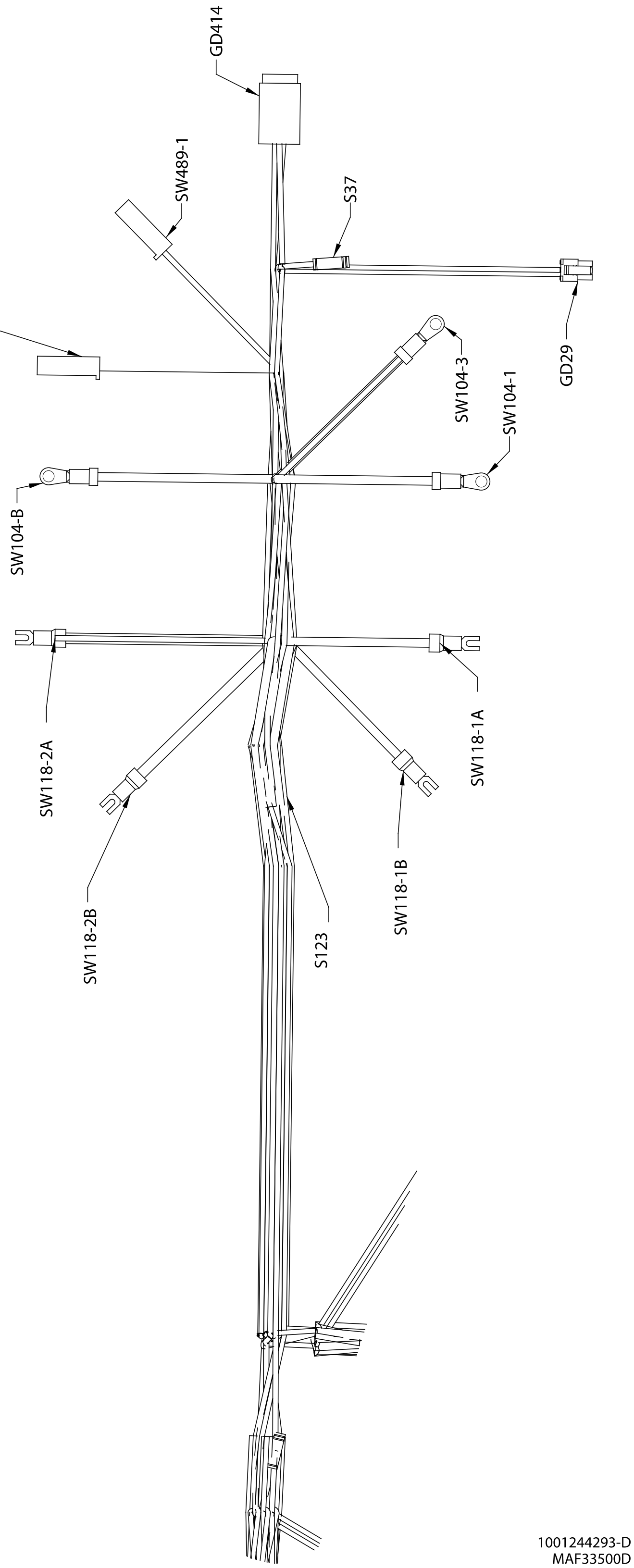


Figure 309. Turntable Harness - Sheet 11 of 13

S123					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	4-121 12AWG	12 AWG	GXL	SW118-2A (2A)
1	RED	4-47 12AWG	12 AWG	GXL	SW118-2B (2B)
2	RED	4-79 12AWG	12 AWG	GXL	IP136 (1)

SW118-2B MTB EMS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
2B	RED	4-4712AWG	12 AWG	GXL	S123 (1)

SW118-2A MTB EMS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
2A	RED	4-121 12AWG	12 AWG	GXL	S123 (1)
2A	WHT	4-50	18 AWG	GXL	FC628 (39)

SW118-1B MTB EMS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1B	RED	4-45	12 AWG	GXL	SW104-B (1)

SW118-1A MTB EMS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1A	RED	4-37 EMS	12 AWG	GXL	FC628 (9)

SW104-3 KEY SWITCH					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	4-51	12 AWG	GXL	FC628 (38)
1	RED	4-51-1	18 AWG	GXL	IP685 (1)

SW104-1 KEY SWITCH					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	4-122 MOD SEL	12 AWG	GXL	FC628 (42)
1	RED	4-40	12 AWG	GXL	FC628 (29)

SW489-2 MSSO					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	4-164 GND	18 AWG	GXL	CO69-J1 (9)

SW104-B KEY SWITCH					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	4-45	12 AWG	GXL	SW118-1B (1B)

SW489-1 MSSO					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-165MSSO	18 AWG	GXL	CO69-J12 (8)

GD30 KONGSBERG DISPLAY					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-51GND	18 AWG	GXL	CO69-J7 (25)
2	RED	4-97-1PWR	18 AWG	GXL	S700 (1)
3	YEL	CAN 2 HI	20 AWG	J1939 CABLE	MS325 (9)
4	GRN	CAN 2 LO	20 AWG	J1939 CABLE	MS325 (12)
5					
6					

GD29 LED DISPLAY					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CAN1 HI	20 AWG	TXL	MS131 (10)
2	YEL	4-95-2DISPLAY PWR	20 AWG	TXL	S37 (2)
3	YEL	4-95-3DISPLAY PWR	20 AWG	TXL	S37 (2)
4	GRN	CAN1 LO	20 AWG	TXL	MS131 (7)
5					
6	BLK	4-98 DISPLAY GND	20 AWG	TXL	MS635 (8)

S37					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4-95DISPLAY PWR	18 AWG	GXL	MS636 (7)
2	YEL	4-95-2DISPLAY PWR	20 AWG	TXL	GD29 (2)
2	YEL	4-95-3DISPLAY PWR	20 AWG	TXL	GD29 (3)

Figure 310. Turntable Harness - Sheet 12 of 13

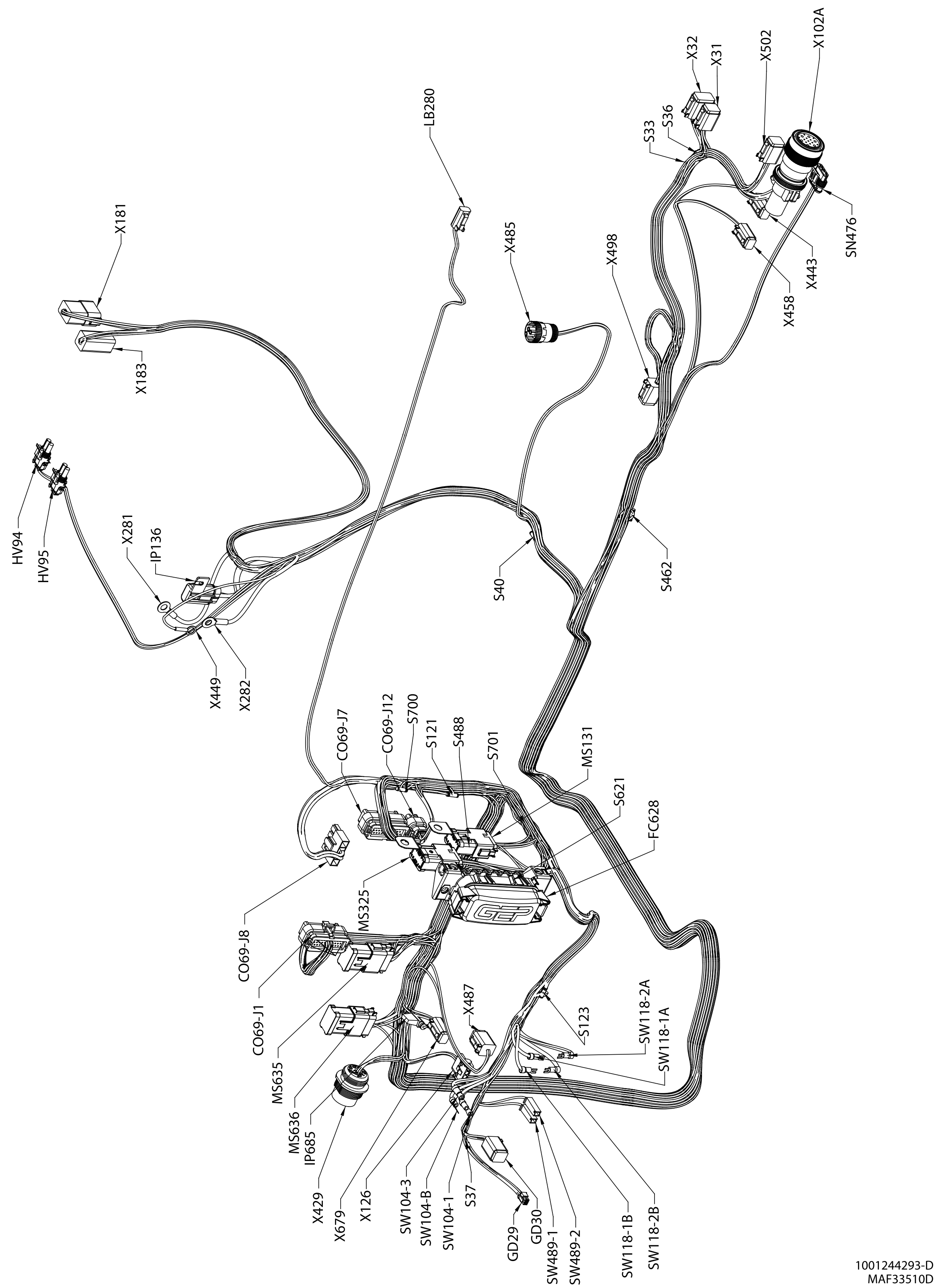


Figure 311. Turntable Harness - Sheet 13 of 13

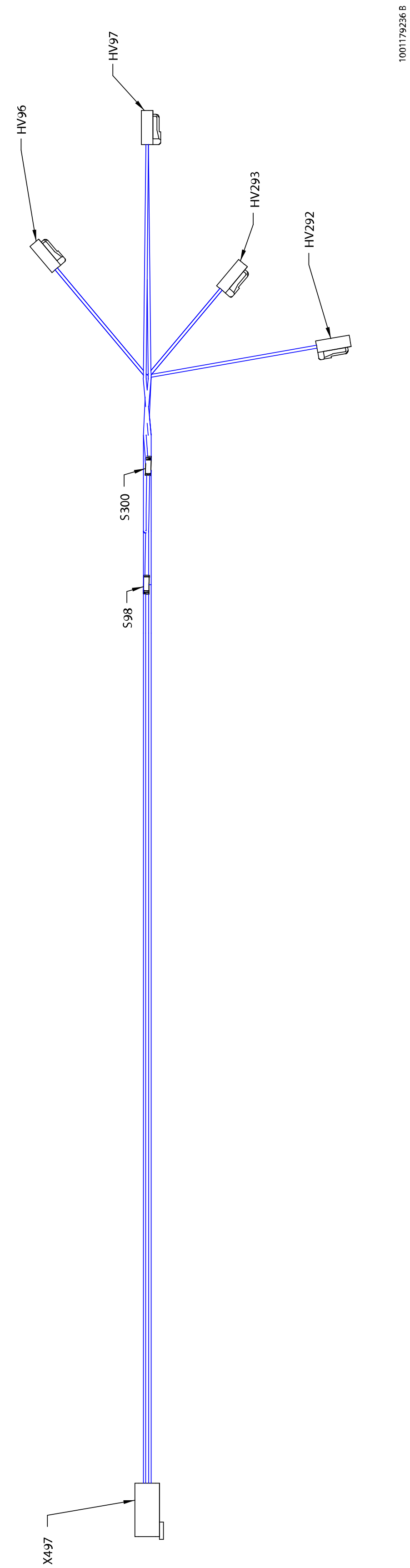


Figure 312. Chassis Solenoid Harness - Sheet 1 of 3

X497					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-47 OSC VLV GND	18 AWG	GXL	S300 (1)
2	WHT	4-101 OSC AXLE #2 SECONDARY	18 AWG	GXL	HV293 (1)
3	WHT	4-100 OSC AXLE #1 PRIMARY	18 AWG	GXL	HV292 (1)
4	BLK	000-40-3 GND	18 AWG	GXL	S98 (2)
5	WHT	4-1 BRAKE	18 AWG	GXL	HV97 (1)
6	WHT	4-2 TWO SPEED	18 AWG	GXL	HV96 (1)

S98					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-1 GND	18 AWG	GXL	HV97 (2)
1	BLK	000-40-2	18 AWG	GXL	HV96 (2)
2	BLK	000-40-3 GND	18 AWG	GXL	X497 (4)

S300					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-47 OSC VLV GND	18 AWG	GXL	X497 (1)
2	BLK	000-40-75	18 AWG	GXL	HV292 (2)
2	BLK	000-40-76	18 AWG	GXL	HV293 (2)

HV97					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-1 BRAKE	18 AWG	GXL	X497 (5)
2	BLK	000-40-1 GND	18 AWG	GXL	S98 (1)

HV 293					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-101 OSC AXLE #2 SECONDARY	18 AWG	GXL	X497 (2)
2	BLK	000-40-76	18 AWG	GXL	S300 (2)

HV 96					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-2 TWO SPEED	18 AWG	GXL	X497 (6)
2	BLK	000-40-2	18 AWG	GXL	S98 (1)

HV 292					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-100 OSC AXLE #1 PRIMARY	18 AWG	GXL	X497 (3)
2	BLK	000-40-75	18 AWG	GXL	S300 (2)

Figure 313. Chassis Solenoid Harness - Sheet 2 of 3

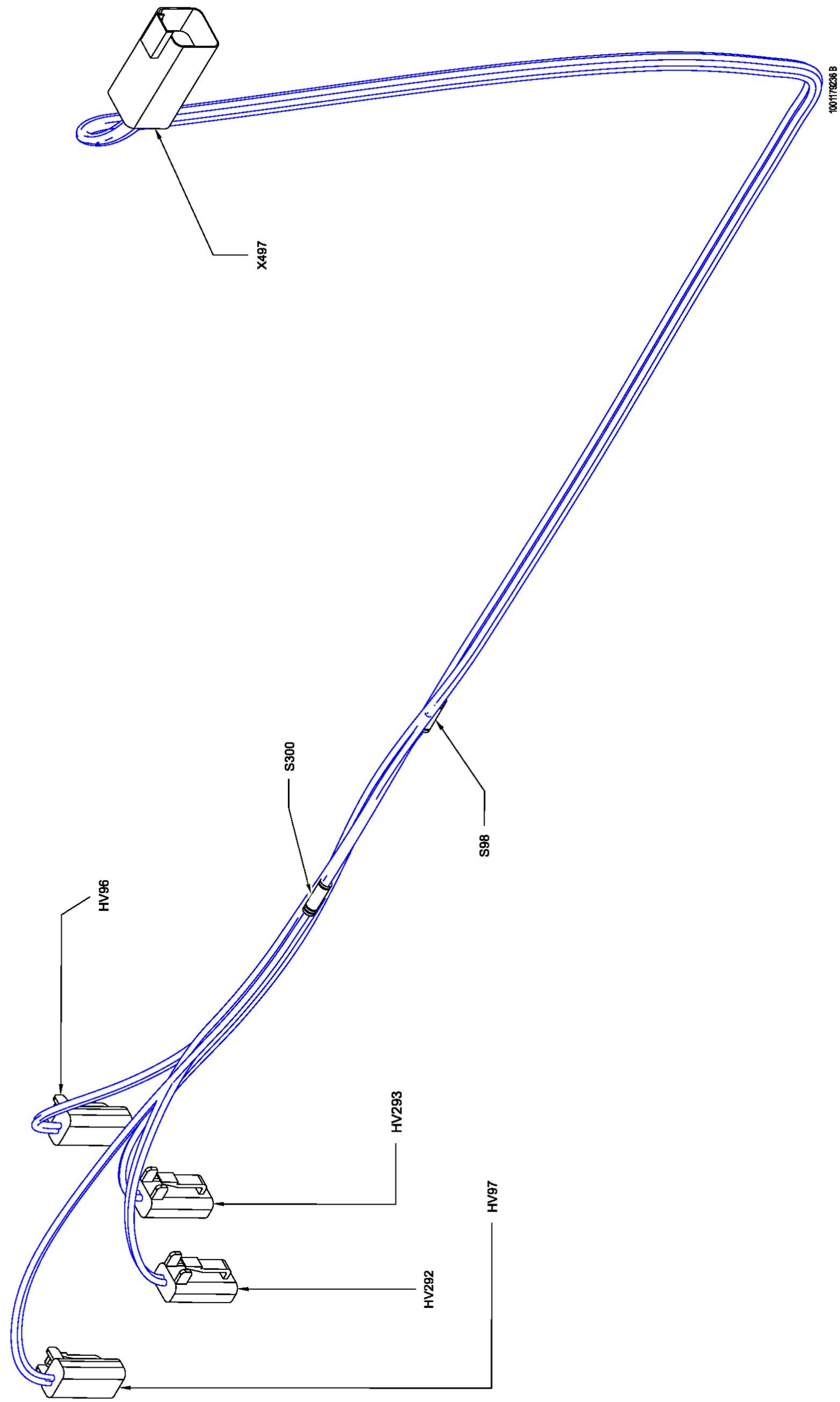


Figure 314. Chassis Solenoid Harness - Sheet 3 of 3

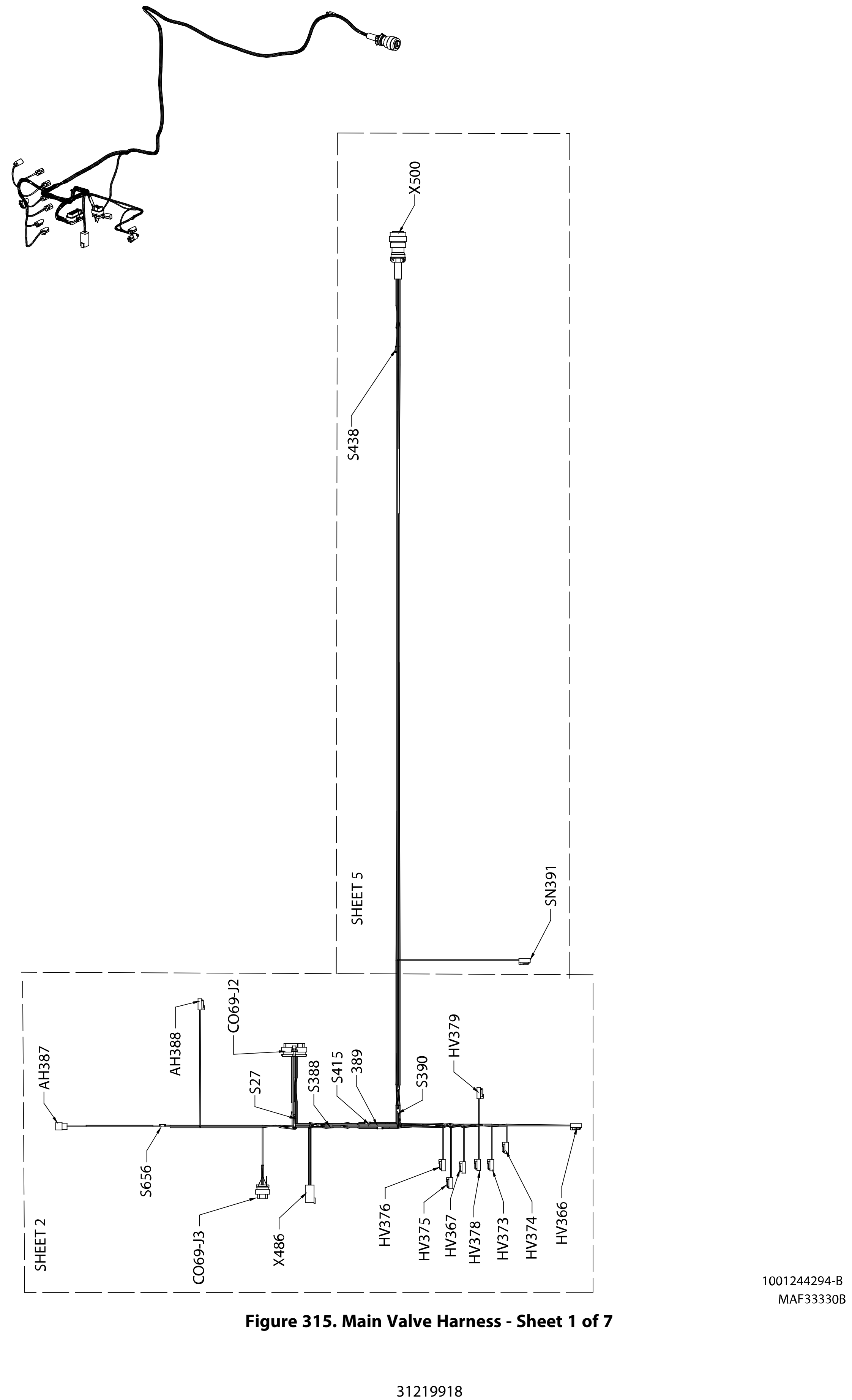


Figure 315. Main Valve Harness - Sheet 1 of 7

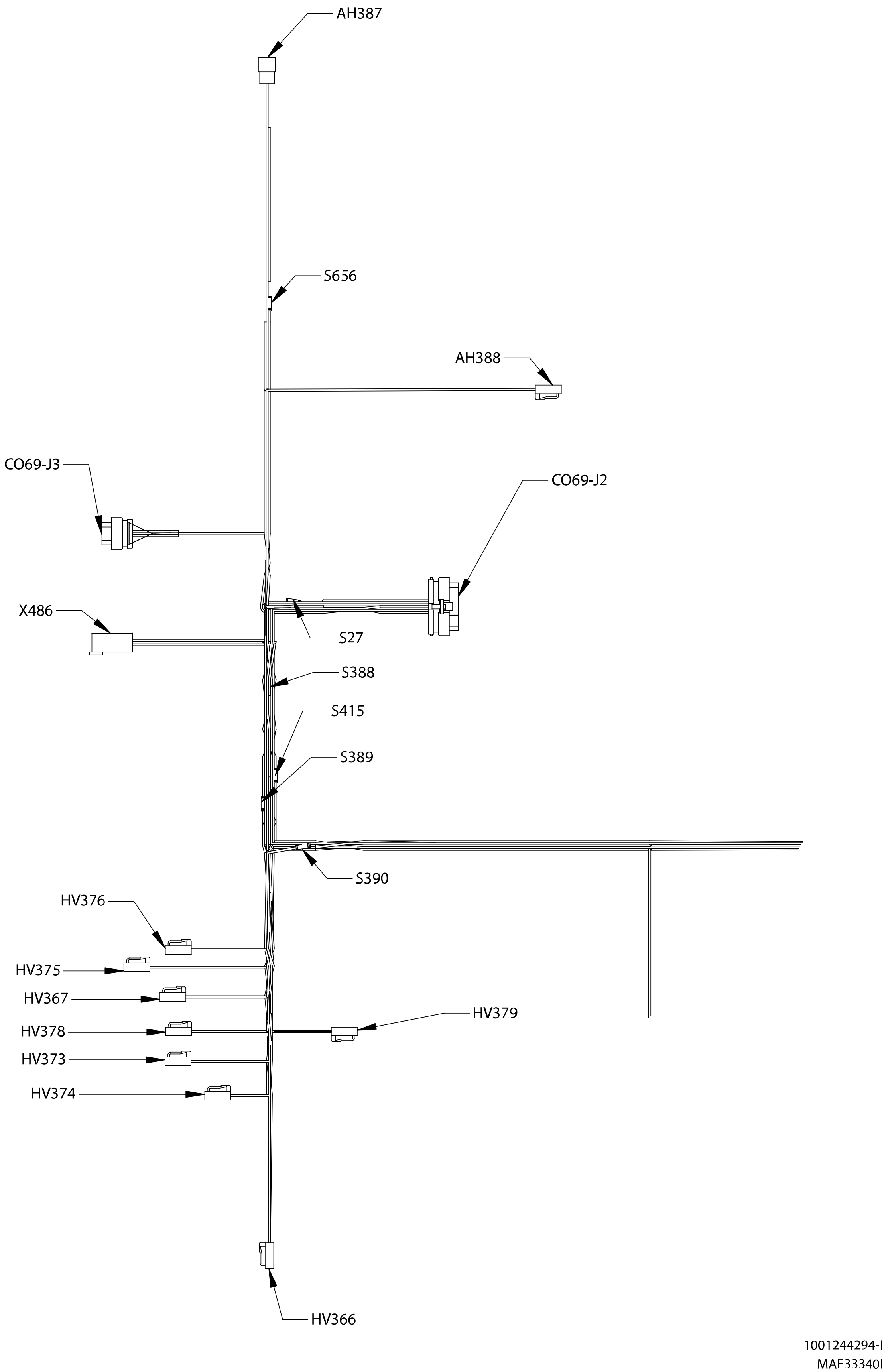


Figure 316. Main Valve Harness - Sheet 2 of 7

AH387
ALARM

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	4-30 ALRM	18 AWG	GXL	CO69-J3 (7)
B	WHT	4-29 ALRM	18 AWG	GXL	CO69-J2 (27)
C	BLK	000-40-11 ALRM GND	18 AWG	GXL	S656 (1)

X486

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-44 CF	18 AWG	GXL	CO69-J3 (1)
2	WHT	4-102 HEAD & TAIL LIGHTS	18 AWG	GXL	CO69-J2 (26)
3	WHT	4-105 CRIBBING	18 AWG	GXL	CO69-J3 (9)
4	WHT	4-89 NO FULL EXTENDED	18 AWG	GXL	CO69-J3 (10)
5					
6					

CO69-J3

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-44 CF	18 AWG	GXL	X486 (1)
2	BLK	000-40-49 AUX TWR LIFT DOWN	18 AWG	GXL	S438 (2)
3					
4	BLK	000-40-38 CF	18 AWG	GXL	S389 (2)
5	BLK	000-40-42 CF	18 AWG	GXL	S390 (2)
6	BLK	000-40-33 CF	18 AWG	GXL	HV375 (2)
7	WHT	4-30 ALRM	18 AWG	GXL	AH387 (A)
8					
9	WHT	4-105 CRIBBING	18 AWG	GXL	X486 (3)
10	WHT	4-89 NO FULL EXTENDED	18 AWG	GXL	X486 (4)
11					
12					
13					
14	BLK	000-40-35 CF	18 AWG	GXL	S388 (2)

HV379
SWING LEFT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-27 SWING LEFT	18 AWG	GXL	CO69-J2 (34)
2	BLK	000-40-39 CF	18 AWG	GXL	S389 (1)

HV367
TOWER LIFT UP

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-15 TOWER LIFT UP	18 AWG	GXL	CO69-J2 (20)
2	BLK	000-40-26	18 AWG	GXL	S390 (1)

HV376
MAIN LIFT UP

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-24 MAIN LIFT UP	18 AWG	GXL	CO69-J2 (11)
2	BLK	000-40-34 CF	18 AWG	GXL	S388 (1)

HV375
FLOW CONTROL

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-23 FLOW CONTROL	18 AWG	GXL	CO69-J2 (31)
2	BLK	000-40-33 CF	18 AWG	GXL	CO69-J3 (6)

CO69-J2

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	77-1 WHT NOISE	18 AWG	GXL	AH388 (1)
3					
4	WHT	4-19 MAIN TELE IN	18 AWG	GXL	X500 (E)
5	WHT	4-8 LEVEL UP	18 AWG	GXL	X500 (C)
6	BLK	000-40-45	18 AWG	GXL	SN391 (1)
7	WHT	4-11 LEVEL DOWN	18 AWG	GXL	X500 (B)
8	WHT	4-21 STEER RIGHT	18 AWG	GXL	HV373 (1)
9	WHT	4-16 TOWER LIFT DOWN	18 AWG	GXL	X500 (N)
10					
11	WHT	4-24 MAIN LIFT UP	18 AWG	GXL	HV376 (1)
12					
13	WHT	4-14 MAIN DUMP	18 AWG	GXL	HV366 (1)
14	BLK	000-40-7	18 AWG	GXL	X500 (A)
15					
16	WHT	4-20 MAIN TELE OUT	18 AWG	GXL	X500 (D)
17					
18					
19	WHT	4-22 STEER LEFT	18 AWG	GXL	HV374 (1)
20	WHT	4-15 TOWER LIFT UP	18 AWG	GXL	HV367 (1)
21	WHT	4-103 MAIN LIFT DOWN AUX	18 AWG	GXL	X500 (G)
22	WHT	4-104 MAIN LIFT DOWN	18 AWG	GXL	X500 (J)
23	BLK	4-93 AUX TOWER LIFT DOWN	18 AWG	GXL	X500 (L)
24	BLK	0 CONFIG	18 AWG	GXL	S27 (2)
25	WHT	4-75 FUEL SWITCH	18 AWG	GXL	SN391 (2)
26	WHT	4-102 HEAD & TAIL LIGHTS	18 AWG	GXL	X486 (2)
27	WHT	4-29 ALRM	18 AWG	GXL	AH387 (B)
28	BLK	000-40-53 GND	18 AWG	GXL	S415 (2)
29	BLK	000-40-10 ALRM GND	18 AWG	GXL	S27 (2)
30	BLK	000-40-25	18 AWG	GXL	HV366 (2)
31	WHT	4-23 FLOW CONTROL	18 AWG	GXL	HV375 (1)
32					
33					
34	WHT	4-27 SWING LEFT	18 AWG	GXL	HV379 (1)
35	WHT	4-26 SWING RIGHT	18 AWG	GXL	HV378 (1)

HV374
STEER LEFT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-22 STEER LEFT	18 AWG	GXL	CO69-J2 (19)
2	BLK	000-40-32	18 AWG	GXL	S415 (1)

HV373
STEER RIGHT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-21 STEER RIGHT	18 AWG	GXL	CO69-J2 (8)
2	BLK	000-40-32	18 AWG	GXL	S415 (1)

HV378
SWING RIGHT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-26 SWING RIGHT	18 AWG	GXL	CO69-J2 (35)
2	BLK	000-40-37 CF	18 AWG	GXL	S389 (1)

Figure 317. Main Valve Harness - Sheet 3 of 7

AH388 WHITE NOISE ALARM					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	77-1 WHT NOISE	18 AWG	GXL	CO69-J2 (2)
2	BLK	000-40-12 ALARM GND	18 AWG	GXL	S656 (1)

S390					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-42 CF	18 AWG	GXL	CO69-J3 (5)
2	BLK	000-40-26	18 AWG	GXL	HV367 (2)
2	BLK	000-40-27	18 AWG	GXL	X500 (14)

S388					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-34 CF	18 AWG	GXL	HV376 (2)
2	BLK	000-40-35	18 AWG	GXL	CO69-J3 (14)
2	BLK	000-40-63	18 AWG	GXL	X500 (10)

S415					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
2	BLK	000-40-53	18 AWG	GXL	CO69-J2 (28)
S415415:1	BLK	000-40-32	18 AWG	GXL	HV373 (2)
S415415:1	BLK	000-40-32	18 AWG	GXL	HV374 (2)

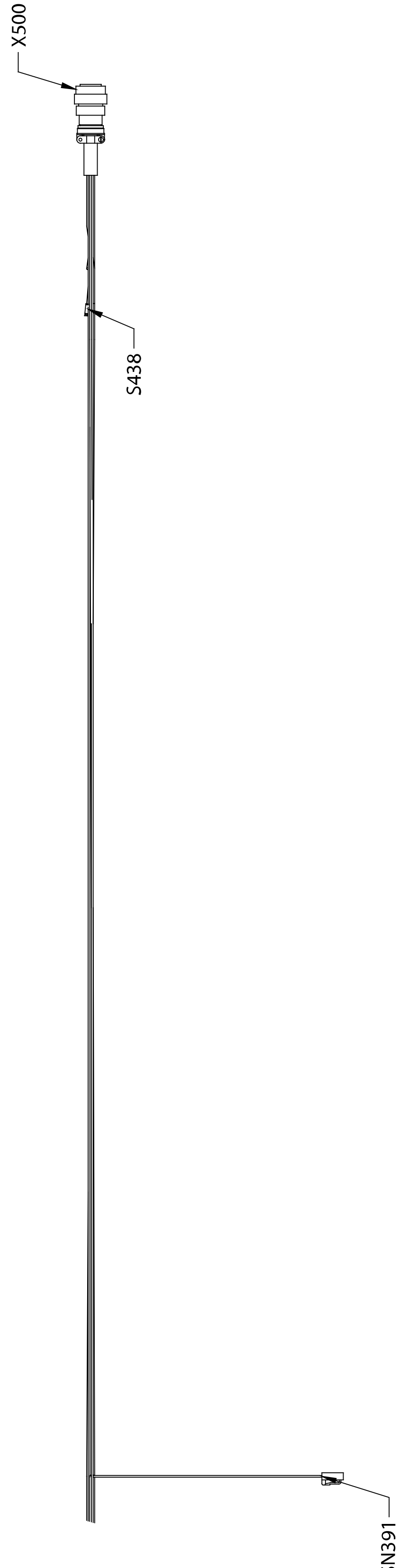
HV366 MAIN DUMP					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-14 MAIN DUMP	18 AWG	GXL	CO69-J2 (13)
2	BLK	000-40-25	18 AWG	GXL	CO69-J2 (30)

S656					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-11 ALRM GND	18 AWG	GXL	AH387 (C)
1	BLK	000-40-12 ALARM GND	18 AWG	GXL	AH388 (2)
2	BLK	000-40-10 ALRM GND	18 AWG	GXL	S27 (1)

S27					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-10 ALRM GND	18 AWG	GXL	S656 (2)
2	BLK	0 CONFIG	18 AWG	GXL	CO69-J2 (24)
2	BLK	000-40-10 ALRM GND	18 AWG	GXL	CO69-J2 (29)

S389					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-38 CF	18 AWG	GXL	CO69-J3 (4)
1	BLK	000-40-39 CF	18 AWG	GXL	HV379 (2)
2	BLK	000-40-37 CF	18 AWG	GXL	HV378 (2)

Figure 318. Main Valve Harness - Sheet 4 of 7



1001244294-B
MAF33350B

Figure 319. Main Valve Harness - Sheet 5 of 7

X500					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	000-40-7	18 AWG	GXL	CO69-J2 (14)
B	WHT	4-11 LEVEL DOWN	18 AWG	GXL	CO69-J2 (7)
C	WHT	4-8 LEVEL UP	18 AWG	GXL	CO69-J2 (5)
D	WHT	4-20 MAIN TELE OUT	18 AWG	GXL	CO69-J2 (16)
E	WHT	4-19 MAIN TELE IN	18 AWG	GXL	CO69-J2 (4)
F					
G	WHT	4-103 MAIN LIFT DOWN AUX	18 AWG	GXL	CO69-J2 (21)
H	BLK	000-40-62	18 AWG	GXL	S438 (1)
J	WHT	4-104 MAIN LIFT DOWN	18 AWG	GXL	CO69-J2 (22)
K	BLK	000-40-63	18 AWG	GXL	S388 (2)
L	BLK	4-93 AUX TOWER LIFT DOWN	18 AWG	GXL	CO69-J2 (23)
M	BLK	000-40-61	18 AWG	GXL	S438 (1)
N	WHT	4-16 TOWER LIFT DOWN	18 AWG	GXL	CO69-J2 (9)
P	BLK	000-40-27	18 AWG	GXL	S390 (1)

SN391 FUEL SWITCH					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-45	18 AWG	GXL	CO69-J2 (6)
2	WHT	4-75 FUEL SWITCH	18 AWG	GXL	CO69-J2 (25)

S438					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-61	18 AWG	GXL	X500 (M)
1	BLK	000-40-62	18 AWG	GXL	X500 (H)
2	BLK	000-40-49 AUX TWR LIFT DOWN	18 AWG	GXL	CO69-J3 (2)

Figure 320. Main Valve Harness - Sheet 6 of 7

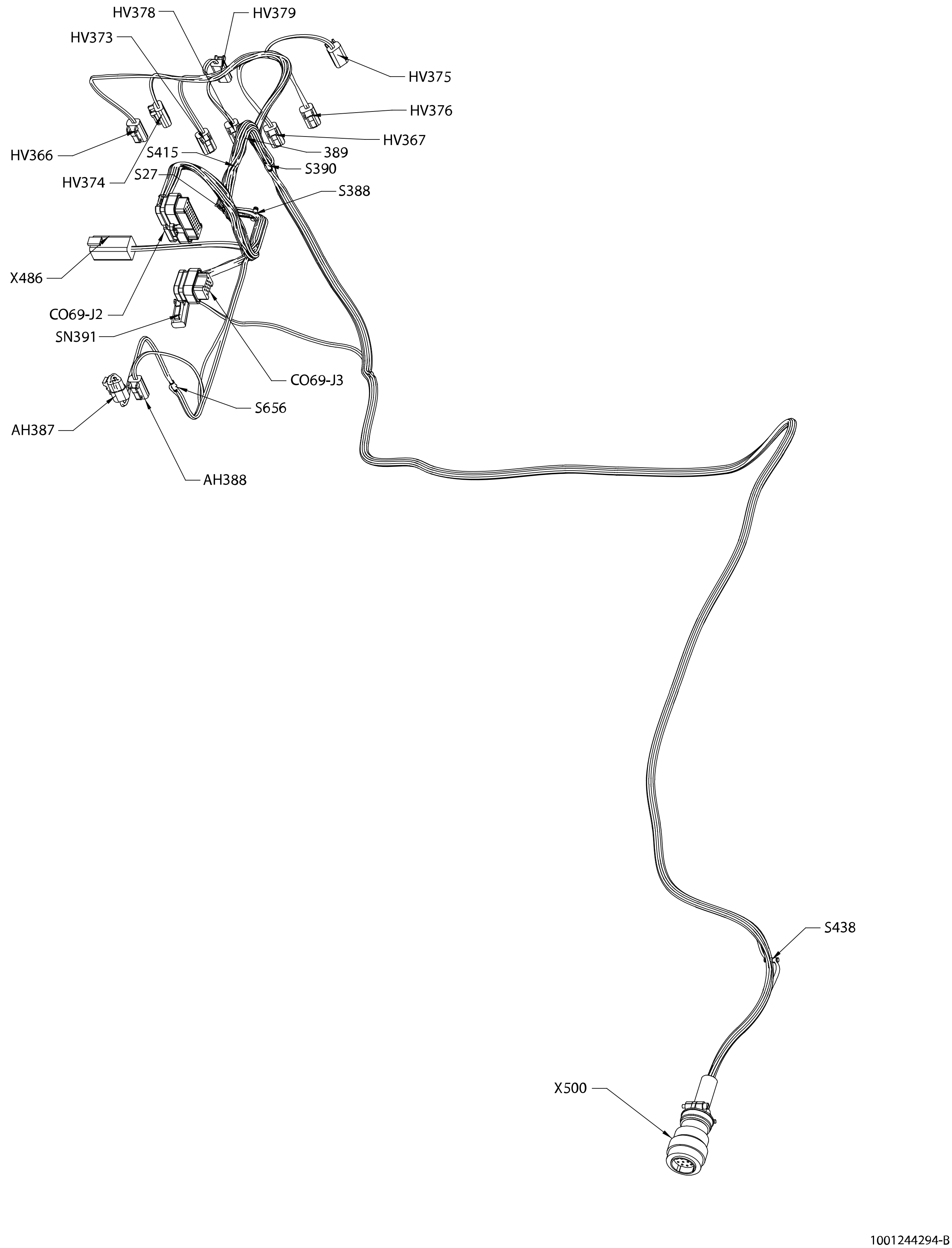


Figure 321. Main Valve Harness - Sheet 7 of 7

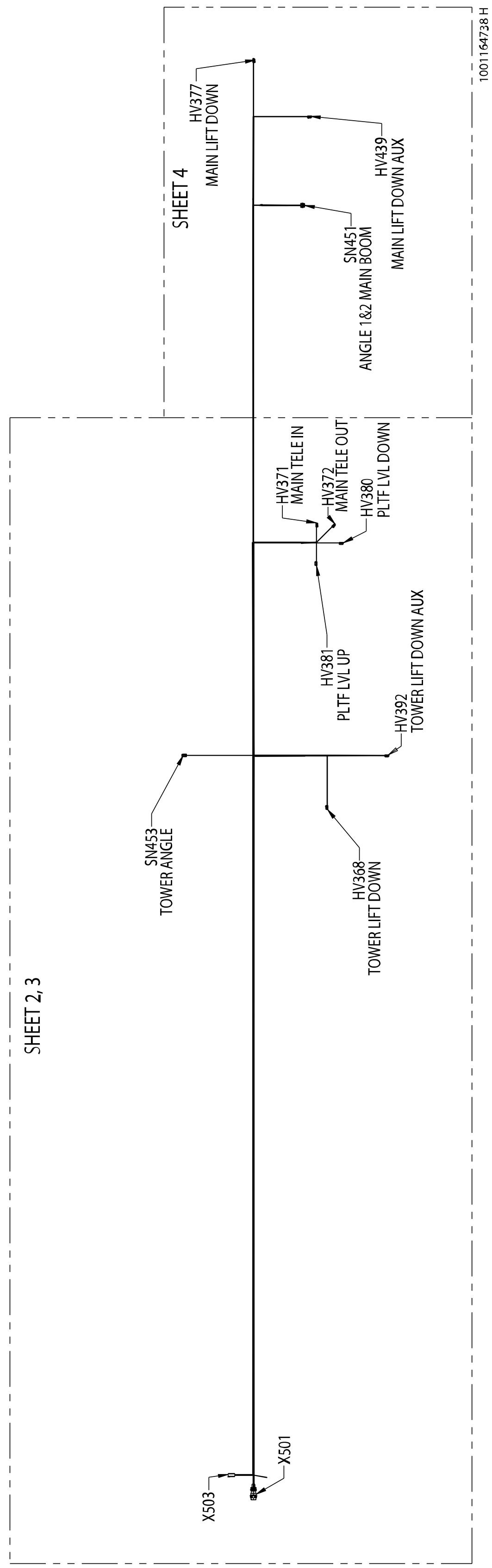


Figure 322. Tower Upright Valve Harness - Sheet 1 of 4

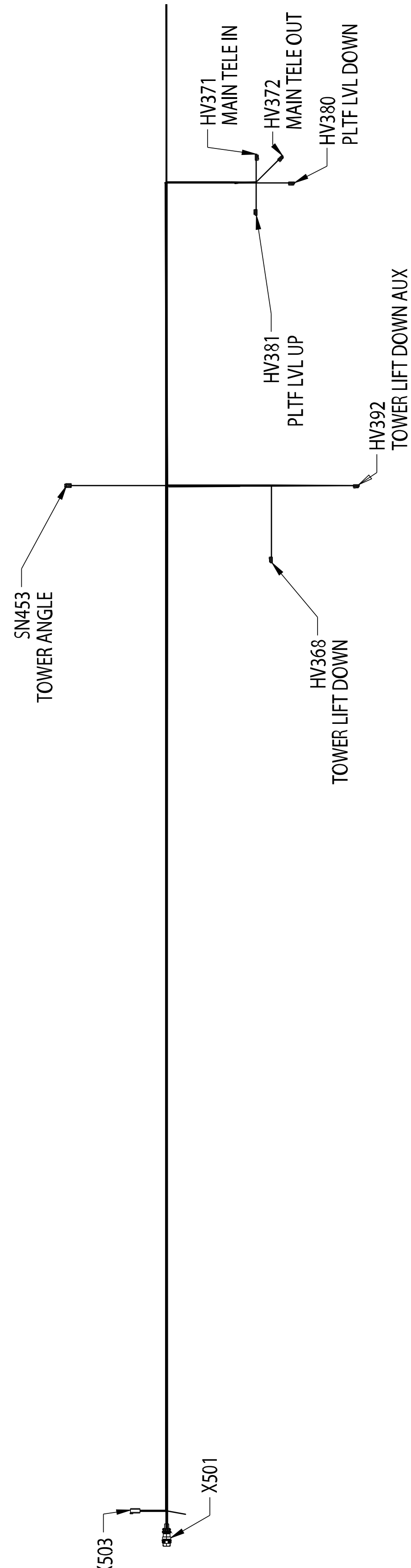


Figure 323. Tower Upright Valve Harness - Sheet 2 of 4

X501					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BRNBLK	CABLE 4	18 AWG	TFFN	S465 (2)
B	YEL/BLK	CABLE 4	18 AWG	TFFN	HV380 (1)
C	ORN/BLK	CABLE 4	18 AWG	TFFN	HV381 (1)
D	BLU/BLK	CABLE 4	18 AWG	TFFN	HV372 (1)
E	BLK/RED	CABLE 4	18 AWG	TFFN	HV371 (1)
F					
G	ORG	CABLE 3	16 AWG	CABLE	HV439 (1)
H	BLU	CABLE 3	16 AWG	CABLE	HV439 (2)
J	RED	CABLE 3	16 AWG	CABLE	HV377 (1)
K	BLK	CABLE 3	16 AWG	CABLE	HV377 (2)
L	BLU	CABLE 2	16 AWG	CABLE	HV392 (1)
M	ORG	CABLE 2	16 AWG	CABLE	HV392 (2)
N	RED	CABLE 2	16 AWG	CABLE	HV368 (1)
P	BLK	CABLE 2	16 AWG	CABLE	HV368 (2)

X503					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK/RED	CABLE 5	18 AWG	TFFN	S471 (1)
2	BLU/BLK	CABLE 5	18 AWG	TFFN	SN451 (C)
3	ORN/BLK	CABLE 5	18 AWG	TFFN	S472 (1)
4	BRN/BLK	CABLE 5	18 AWG	TFFN	SN451 (D)
5	WHT	CABLE 1	18 AWG	CABLE	SN453 (2)
6	BLK	CABLE 1	18 AWG	CABLE	SN453 (3)

HV392 - TOWER LIFT DOWN AUX					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLU	CABLE 2	16 AWG	CABLE	X501 (L)
2	ORG	CABLE 2	16 AWG	CABLE	X501 (M)

Table 90.

HV371 MAIN TELE IN					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK/RED	CABLE 4	18 AWG	TFFN	X501 (E)
2	BLK	000-50-52	18 AWG	GXL	S465 (2)

Table 91.

HV381 PLTF LVL UP					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORN/BLK	CABLE 4	18 AWG	TFFN	X501 (C)
2	BLK	000-50-54	18 AWG	GXL	S465 (1)

HV380 PLTF LVL DOWN					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL/BLK	CABLE 4	18 AWG	TFFN	X501 (B)
2	BLK	000-50-49	18 AWG	GXL	S465 (1)

HV372 MAIN TELE OUT					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLU/BLK	CABLE 4	18 AWG	TFFN	X501 (D)
2	BLK	000-50-53	18 AWG	GXL	S465 (1)

SN453 - TOWER ANGLE					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	CABLE 1	18 AWG	CABLE	X503 (5)
3	BLK	CABLE 1	18 AWG	CABLE	X503 (6)
4	S				

HV368 TOWER LIFT DOWN					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	CABLE 2	16 AWG	CABLE	X501 (N)
2	BLK	CABLE 2	16 AWG	CABLE	X501 (P)

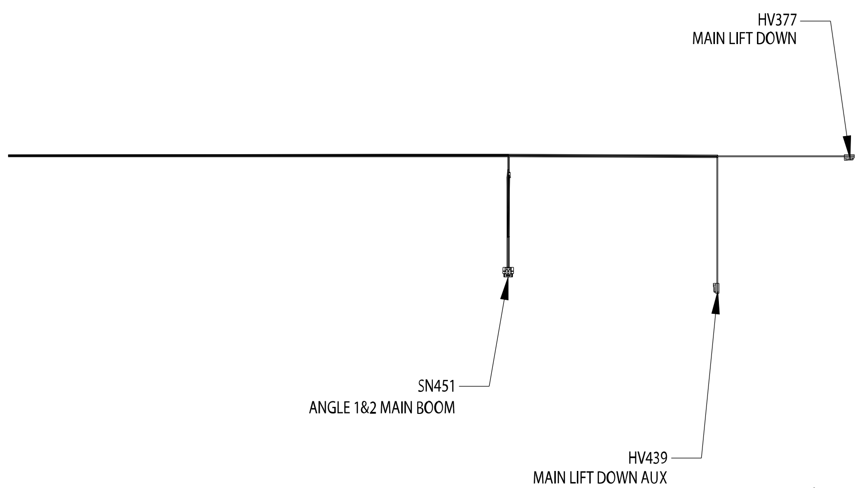


Figure 324. Tower Upright Valve Harness - Sheet 3 of 4

SN451 ANGLE 1&2 MAIN BOOM					
CONNPOS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
A	ORN/BLK	CABLE 5	18 AWG	TFFN	S472 (2)
B	YEL/BLK	CABLE 5	18 AWG	TFFN	S471 (2)
C	BLU/BLK	CABLE 5	18 AWG	TFFN	X503 (2)
D	BRN/BLK	CABLE 5	18 AWG	TFFN	X503 (4)
E	BLU/RED	CABLE 5	18 AWG	TFFN	S472 (2)
F	BLK/RED	CABLE 5	18 AWG	TFFN	S471 (2)

HV439 MAIN LIFT DOWN AUX					
CONNPOS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	ORG	CABLE 3	16 AWG	CABLE	X501 (G)
2	BLU	CABLE 3	16 AWG	CABLE	X501 (H)

HV377 MAIN LIFT DOWN					
CONNPOS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	RED	CABLE 3	16 AWG	CABLE	X501 (J)
2	BLK	CABLE 3	16 AWG	CABLE	X501 (K)

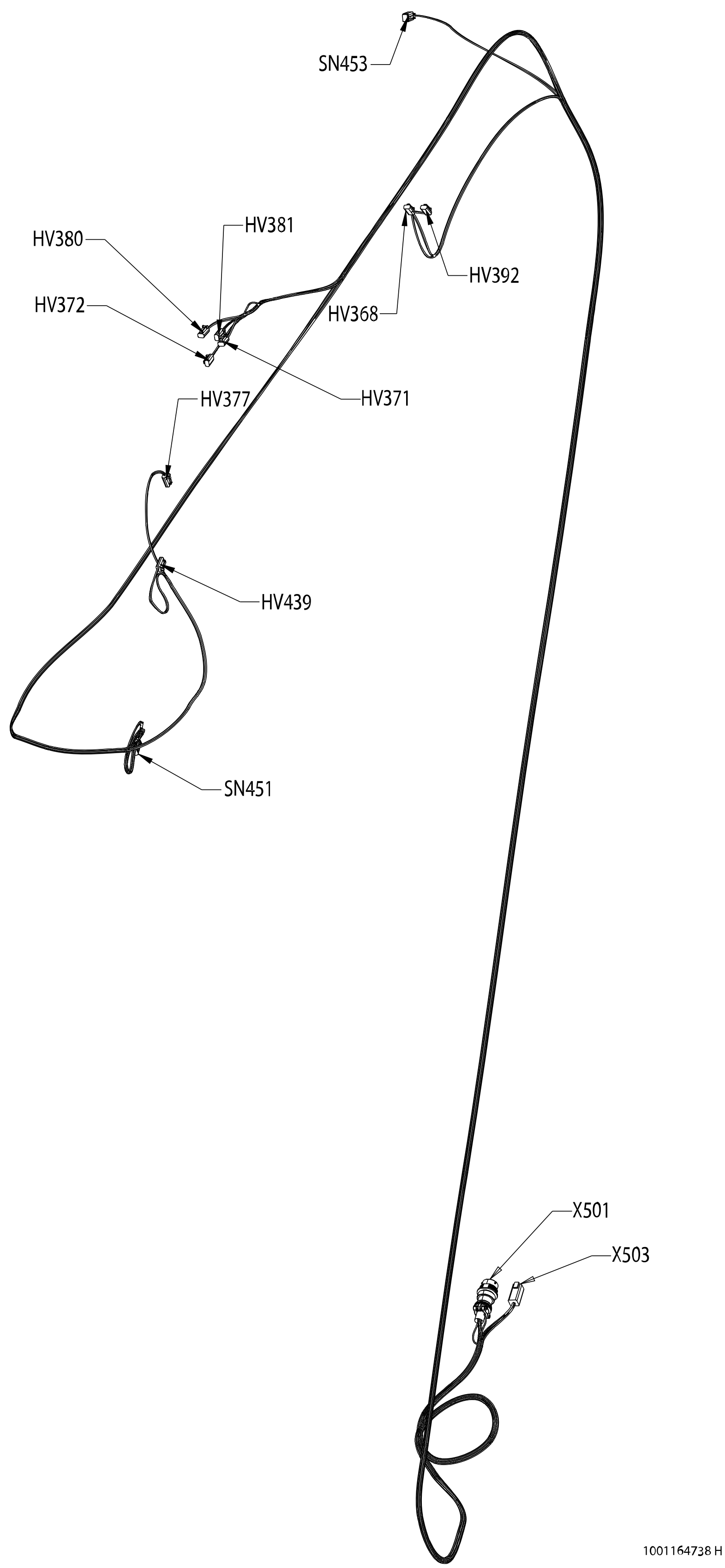


Figure 325. Tower Upright Valve Harness - Sheet 4 of 4

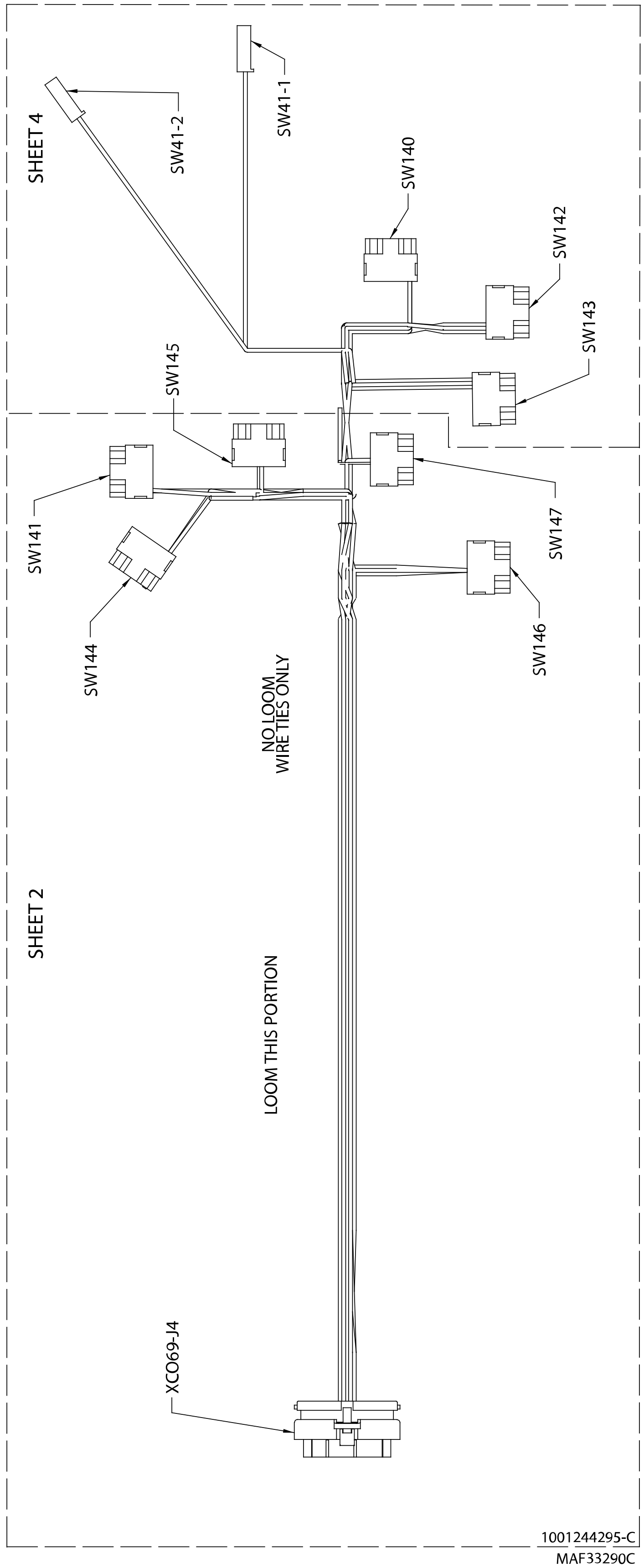


Figure 326. Ground Control Panel Harness - Sheet 1 of 6

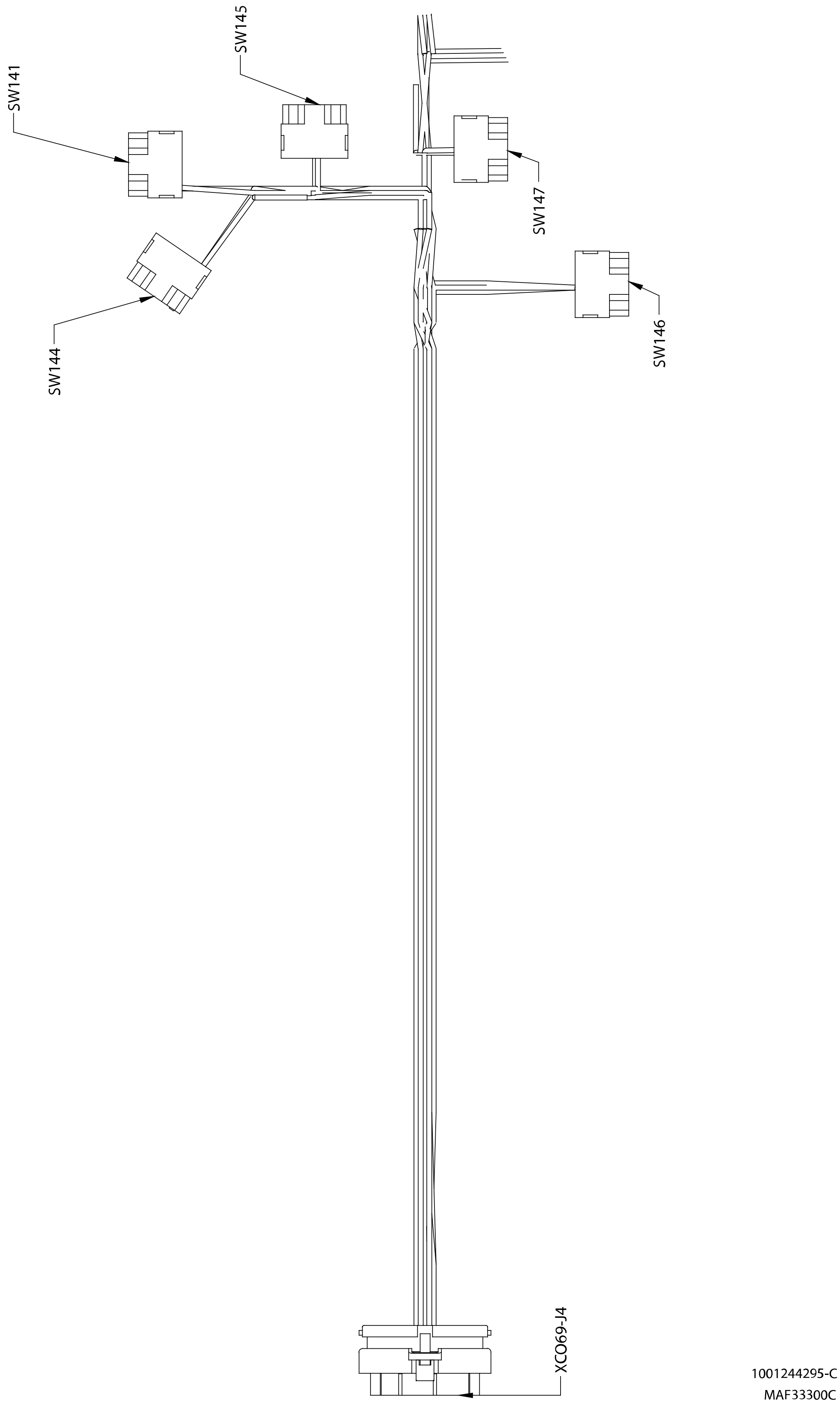


Figure 327. Ground Control Panel Harness - Sheet 2 of 6

XCO69-J4 BLUE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3					
4	WHT	5-9 IGNITION START	18 AWG	GXL	SW143 (3)
5	WHT	5-6 LEVEL DOWN	18 AWG	GXL	SW142 (1)
6	WHT	5-4 ROTATE LEFT	18 AWG	GXL	SW140 (1)
7	WHT	5-1 TELE IN	18 AWG	GXL	SW141 (1)
8	WHT	5-11 JIB DOWN	18 AWG	GXL	SW144 (3)
9	WHT	5-18 ENGINE REGEN	18 AWG	GXL	SW41-2 (1)
10	WHT	5-16 TOWER LIFT UP	18 AWG	GXL	SW147 (3)
11					
12					
13					
14					
15					
16	WHT	5-8 AUX POWER	18 AWG	GXL	SW143 (1)
17	WHT	5-5 LEVEL UP	18 AWG	GXL	SW142 (3)
18	WHT	5-3 ROTATE RIGHT	18 AWG	GXL	SW140 (3)
19	WHT	5-10 JIB UP	18 AWG	GXL	SW144 (1)
20					
21	WHT	5-17 TOWER LIFT DOWN	18 AWG	GXL	SW147 (1)
22					
23	WHT	5-12 MAIN LIFT UP	18 AWG	GXL	SW145 (3)
24					
25	WHT	5-26 SWITCH POWER	18 AWG	GXL	SW141 (2)
26					
27					
28					
29					
30	WHT	5-2 TELE OUT	18 AWG	GXL	SW141 (3)
31					
32					
33	WHT	5-13 MAIN LIFT DOWN	18 AWG	GXL	SW145 (1)
34	WHT	5-15 SWING LEFT	18 AWG	GXL	SW146 (1)
35	WHT	5-14 SWING RIGHT	18 AWG	GXL	SW146 (3)

SW141 MAIN TELE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-1 TELE IN	18 AWG	GXL	XCO69-J4 (7)
2	WHT	5-26 SWITCH POWER	18 AWG	GXL	XCO69-J4 (25)
2	WHT	5-27	18 AWG	GXL	SW140 (2)
3	WHT	5-2 TELE OUT	18 AWG	GXL	XCO69-J4 (30)
4					
5					
6					

SW147 TOWER LIFT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-16 TOWER LIFT UP	18 AWG	GXL	XCO69-J4 (10)
2	WHT	5-33	18 AWG	GXL	SW146 (2)
2	WHT	5-34 PWR	18 AWG	GXL	SW41-1 (1)
3	WHT	5-17 TOWER LIFT DOWN	18 AWG	GXL	XCO69-J4 (21)
4					
5					
6					

SW145 MAIN LIFT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-13 MAIN LIFT DOWN	18 AWG	GXL	XCO69-J4 (33)
2	WHT	5-31	18 AWG	GXL	SW144 (2)
2	WHT	5-32	18 AWG	GXL	SW146 (2)
3	WHT	5-12 MAIN LIFT UP	18 AWG	GXL	XCO69-J4 (23)
4					
5					
6					

SW146 SWING					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-15 SWING LEFT	18 AWG	GXL	XCO69-J4 (34)
2	WHT	5-32	18 AWG	GXL	SW145 (2)
2	WHT	5-33	18 AWG	GXL	SW147 (2)
3	WHT	5-14 SWING RIGHT	18 AWG	GXL	XCO69-J4 (35)
4					
5					
6					

SW144 JIB					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-10 JIB UP	18 AWG	GXL	XCO69-J4 (19)
2	WHT	5-30	18 AWG	GXL	SW143 (2)
2	WHT	5-31	18 AWG	GXL	SW145 (2)
3	WHT	5-11 JIB DOWN	18 AWG	GXL	XCO69-J4 (8)
4					
5					
6					

Figure 328. Ground Control Panel Harness - Sheet 3 of 6

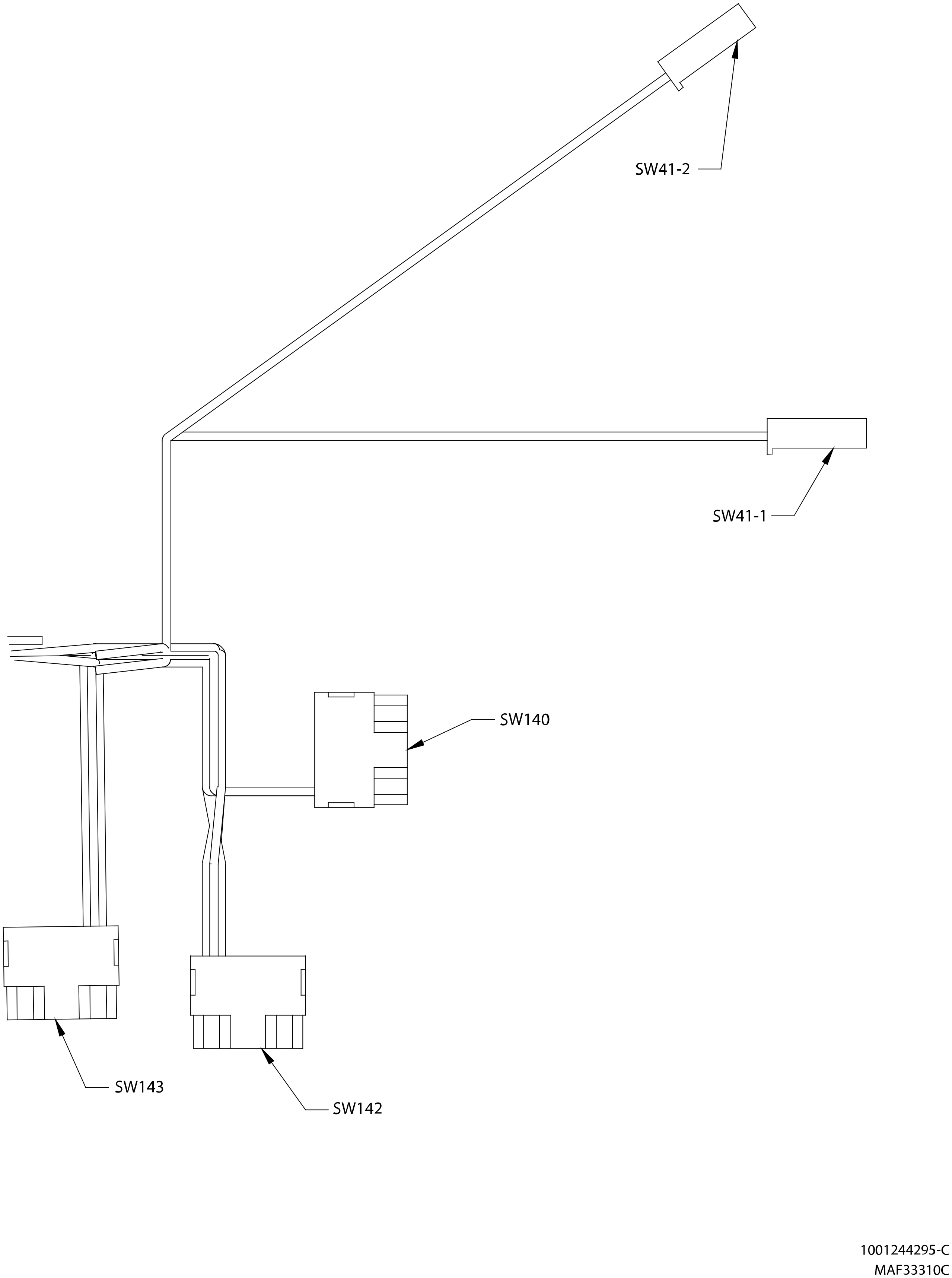


Figure 329. Ground Control Panel Harness - Sheet 4 of 6

SW143 IGN START/ AUX POWER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-8 AUX POWER	18 AWG	GXL	XCO69-J4 (16)
2	WHT	5-29	18 AWG	GXL	SW142 (2)
2	WHT	5-30	18 AWG	GXL	SW144 (2)
3	WHT	5-9 IGNITION START	18 AWG	GXL	XCO69-J4 (4)
4					
5					
6					

SW140 PLATFORM ROTATE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-4 ROTATE LEFT	18 AWG	GXL	XCO69-J4 (6)
2	WHT	5-27	18 AWG	GXL	SW141 (2)
2	WHT	5-28	18 AWG	GXL	SW142 (2)
3	WHT	5-3 ROTATE RIGHT	18 AWG	GXL	XCO69-J4 (18)
4					
5					
6					

SW142 PLATFORM LEVEL					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-6 LEVEL DOWN	18 AWG	GXL	XCO69-J4 (5)
2	WHT	5-28	18 AWG	GXL	SW140 (2)
2	WHT	5-29	18 AWG	GXL	SW143 (2)
3	WHT	5-5 LEVEL UP	18 AWG	GXL	XCO69-J4 (17)
4					
5					
6					

SW41-2 ENGINE REGENERATION					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-18 ENGINE REGEN	18 AWG	GXL	XCO69-J4 (9)

SW41-1 SWITCH PWR ENGINE REGENERATION					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-34 PWR	18 AWG	GXL	SW147 (2)

Figure 330. Ground Control Panel Harness - Sheet 5 of 6

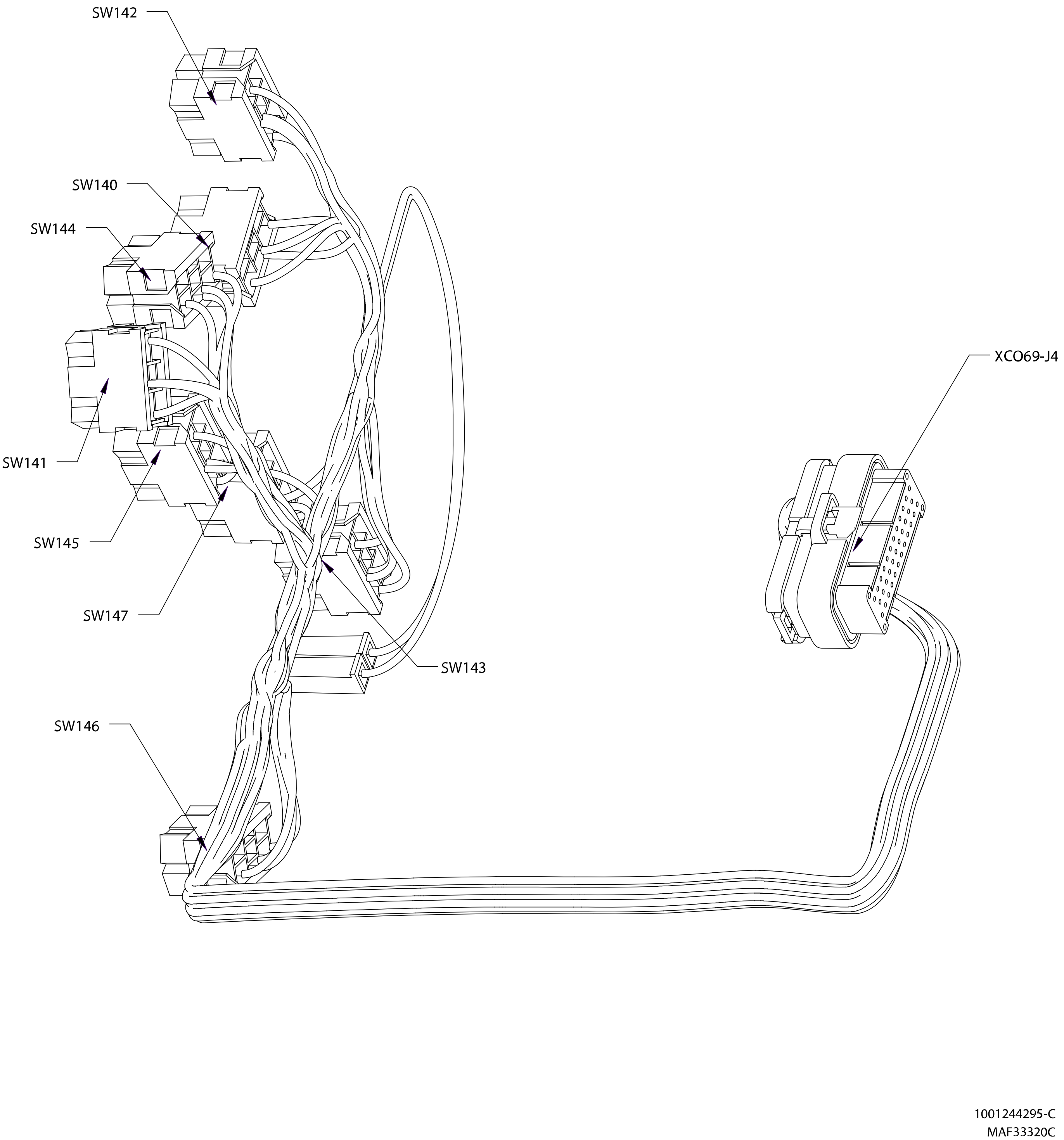


Figure 331. Ground Control Panel Harness - Sheet 6 of 6

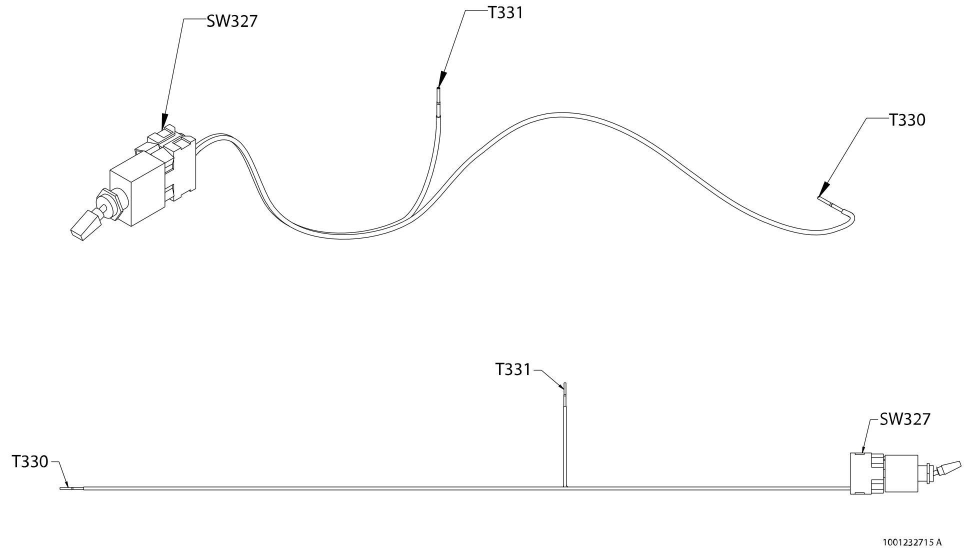


Figure 332. Cribbing Enable Harness

T330					
CONNPOS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	WHT	4-105 CRIBBING	18 AWG	GXL	SW327 (3)

T331					
CONNPOS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	YEL	4-31 IGN	18 AWG	GXL	SW327 (2)

SW327					
CONNPOS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1					
2	YEL	4-31 IGN	18 AWG	GXL	T331 (1)
3	WHT	4-105 CRIBBING	18 AWG	GXL	T330 (1)
4					
5					
6					

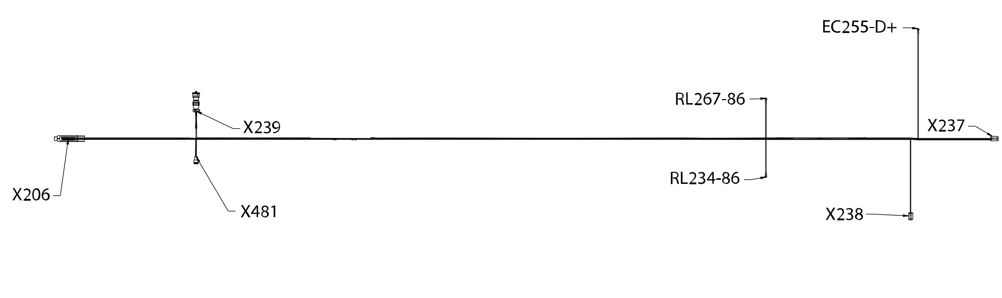


Figure 333. Deutz T4I Engine Harness - Sheet 1 of 2

X238					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	BLK	000-6-1 GROUND	16 AWG	TFFN	X206 (1)
3					

X481					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	RED	CABLE	18 AWG	CABLE	S484 (1)
B	BLK	CABLE	18 AWG	CABLE	S483 (2)
C	SHIELD	6-50	18 AWG	SHLD	X237 (6)
X237					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	6-16	18 AWG	GXL	S240 (1)
2	WHT	6-25	14 AWG	GXL	RL267-86 (1)
3	RED	CABLE CAN HI	18 AWG	CABLE	S484 (1)
4	BLK	CABLE CAN LO	18 AWG	CABLE	S483 (1)
5	RED	6-51 16AWG	16 AWG	GXL	EC255-D+ (1)***

X206					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-6-1 GROUND	16 AWG	TFFN	X238 (2)
2	BLK	000-6-3	18 AWG	GXL	X239 (B)
3					
4					
5					
6					
7					
8					
9					
10	WHT	6-23	18 AWG	GXL	X239 (L)
11	WHT	6-23	18 AWG	GXL	X239 (K)
12	RED	CABLE	18 AWG	CABLE	S484 (2)
13	BLK	CABLE CAN LO	18 AWG	CABLE	S483 (2)
14	WHT	6-15 DIAGNOSTIC	18 AWG	GXL	S240 (2)
15					
16					
17					
18					

X206					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
19					
20					
21					
22					
23					
24					
25					

X239					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	6-17 DIAGNOSTIC	18 AWG	GXL	S240 (2)
B	BLK	000-6-3	18 AWG	GXL	X206 (2)
K	WHT	6-23	18 AWG	GXL	X206 (11)
L	WHT	6-23	18 AWG	GXL	X206 (10)

RL234-86					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	6-18 GLOW	18 AWG	GXL	X238 (4)

EC255-D+					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	6-51 16AWG	16 AWG	GXL	X237 (5)

RL267-86					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	6-25	14 AWG	GXL	X237 (2)

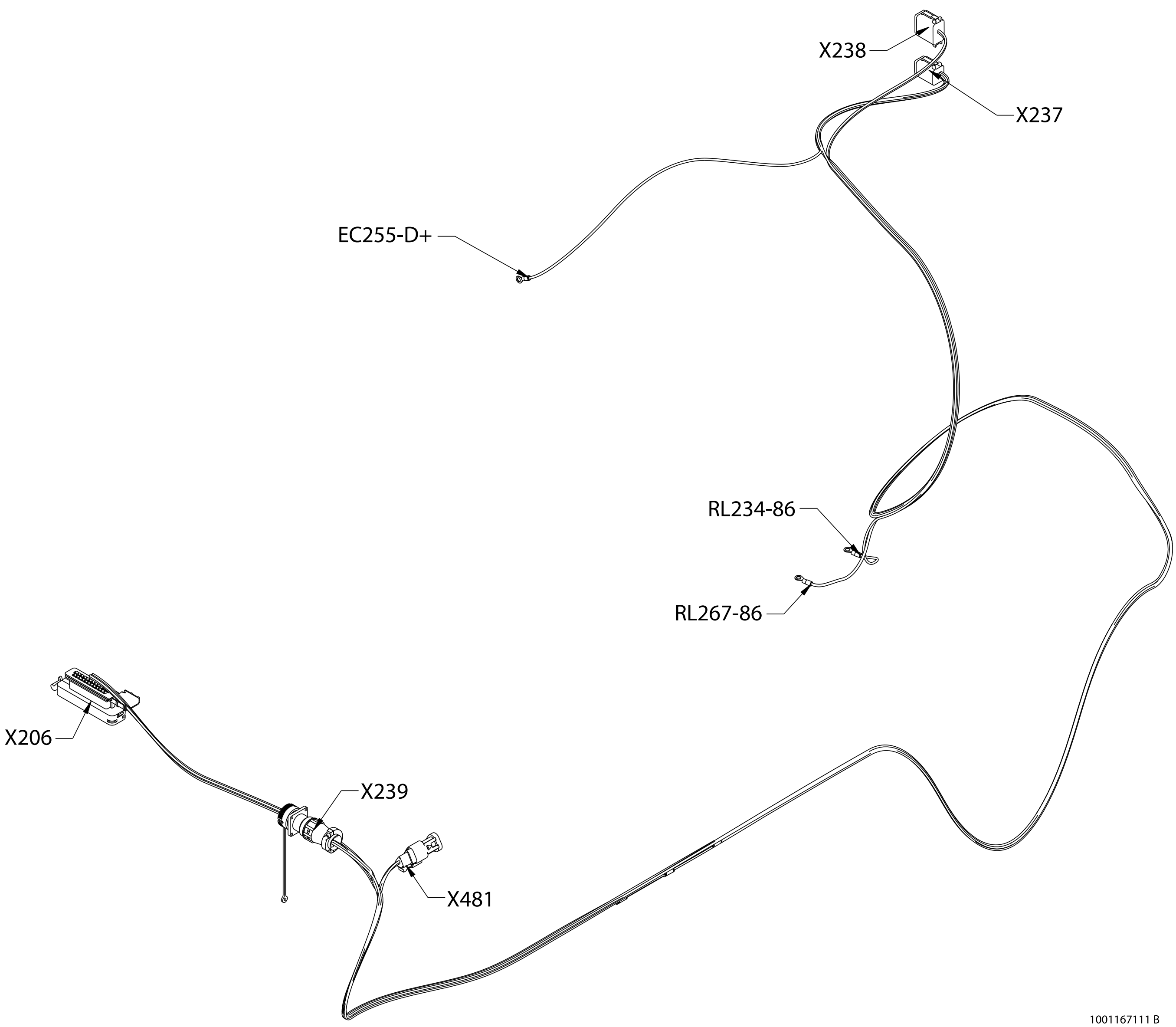


Figure 334. Deutz T4I Engine Harness - Sheet 2 of 2

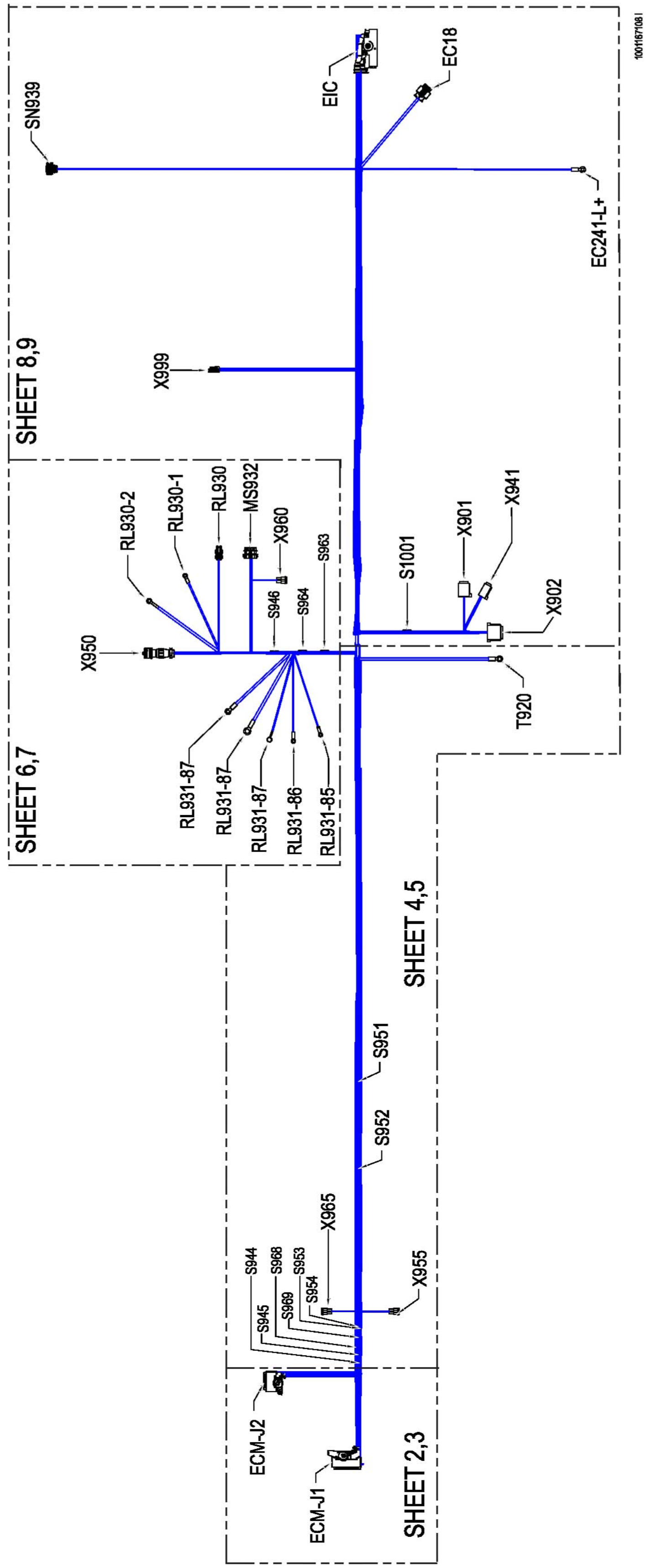


Figure 335. Deutz 2.9L4 Harness - Sheet 1 of 12

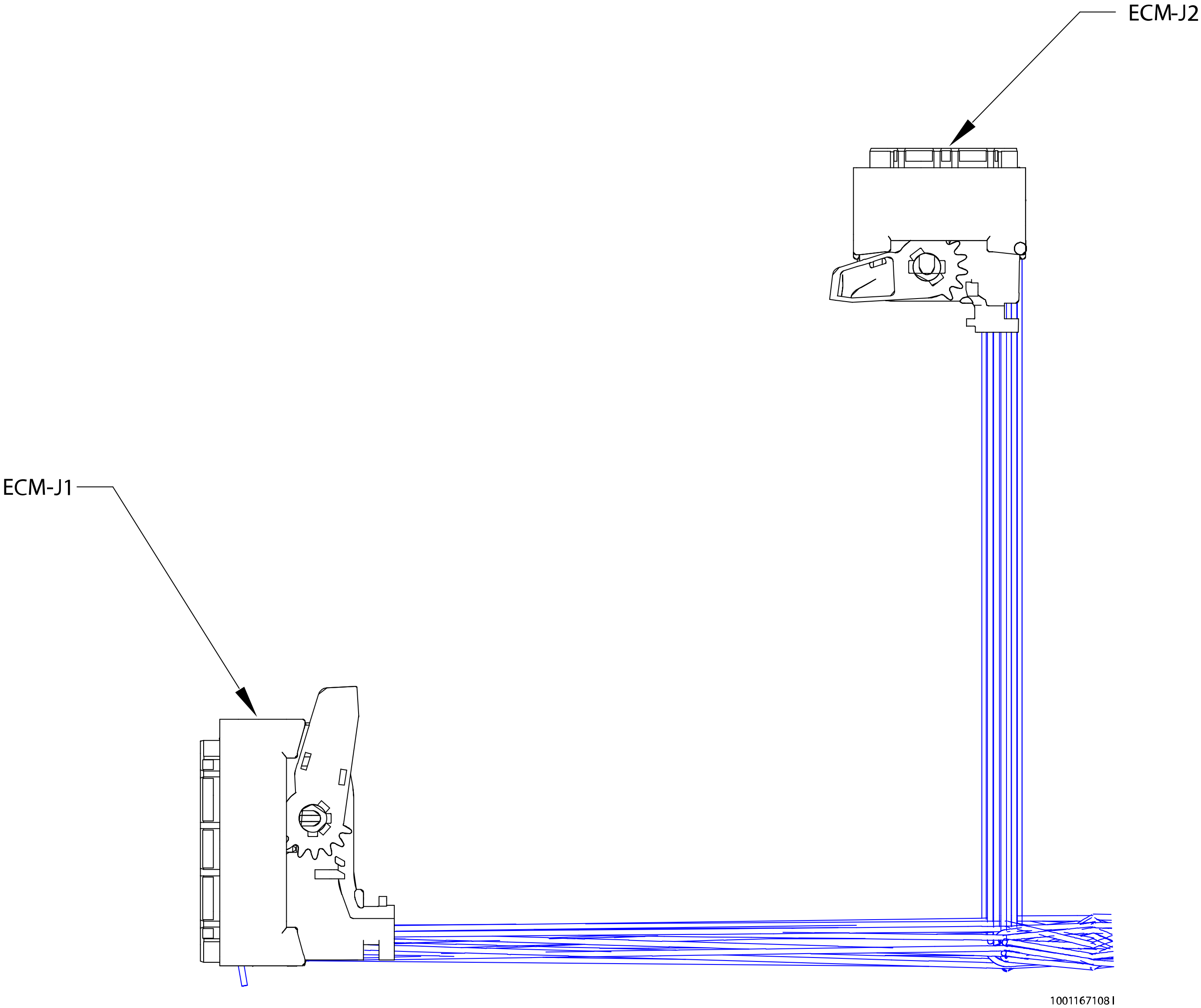


Figure 336. Deutz 2.9L4 Harness - Sheet 2 of 12

ECM-J1

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	148-1 ECM PWR	2.5 mm^2	FLRYW	S944 (2)
2	BLK	148-2 ECM GND	2.5 mm^2	FLRYW	S945 (2)
3	RED	148-3 ECM PWR	2.5 mm^2	FLRYW	S944 (2)
4	BLK	148-4 ECM GND	2.5 mm^2	FLRYW	S945 (2)
5	RED	148-5 ECM PWR	2.5 mm^2	FLRYW	S944 (2)
6	BLK	148-6 ECM GND	2.5 mm^2	FLRYW	S945 (2)
7					
8					
9					
10					
11					
12					
13	BLK	148-13 COOLANT LEVEL SIG	0.75 mm^2	FLRYW	SN939 (3)
14					
15	BLK	148-15-68 CLUTCH SWITCH	0.75 mm^2	FLRYW	ECM-J1 (68)
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26	BLK	148-26 FUEL PUMP RELAY CONTROL GND	0.75 mm^2	FLRYW	RL930 (2)
27					
28	BLK	148-28 START RTN	0.75 mm^2	FLRYW	EIC (2)
29	BLK	148-29 COOLANT LEVEL PWR	0.75 mm^2	FLRYW	SN939 (1)
30					
31					
32					
33					
34					
35	BLK	148-35-2 START	0.75 mm^2	FLRYW	S1001 (1)
36					
37					
38	BLK	148-38 THROTTLE FLAP 4	0.75 mm^2	FLRYW	EIC (52)
39					
40					
41					
42					
43					
44	BLK	148-44 EHXAUST GAS RECIRCULATION	0.75 mm^2	FLRYW	EIC (50)
45					
46					
47					
48					
49					
50					
51					
52					
53	GRN	CAN 2LO DIAG CAN LOW	18 AWG	J1939 CABLE	S968 (1)
54	YEL	CAN 1HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	S953 (1)
55					
56	BLK	148-56 AIR INLET TEMP	0.75 mm^2	FLRYW	EIC (34)
57	BLK	148-57 WATER IN FUEL SW RTN	0.75 mm^2	FLRYW	X941 (2)
58					
59					
60					
61	BLK	148-61 FUEL LOW PRESSURE	0.75 mm^2	FLRYW	EIC (17)
62					
63					
64	BLK	148-64 WATER IN FUEL SW	0.75 mm^2	FLRYW	X941 (1)
65					
66					
67					
68	BLK	148-15-68 CLUTCH SWITCH	0.75 mm^2	FLRYW	ECM-J1 (15)
69					
70					
71					
72	BLK	148-72 THROTTLE FLAP 3	0.75 mm^2	FLRYW	EIC (49)
73	BLK	148-73 START SIG	0.75 mm^2	FLRYW	EIC (3)
74					
75	YEL	CAN 2HI DIAG CAN HIGH	18 AWG	J1939 CABLE	S969 (1)
76	GRN	CAN 1LO CUSTOMER CAN LOW	18 AWG	J1939 CABLE	S954 (1)
77					
78					
79					
80					
81					
82	BLK	148-82 EHXAUST GAS RECIRCULATION	0.75 mm^2	FLRYW	EIC (51)
83					
84					
85	BLK	148-85 EHXAUST GAS RECIRCULATION	0.75 mm^2	FLRYW	EIC (46)
86					
87	BLK	148-87 COOLANT LEVEL GND	0.75 mm^2	FLRYW	SN939 (2)
88	BLK	148-88 IGNITION	0.75 mm^2	FLRYW	S946 (2)
89					
90					
91					
92					
93					
94					
NC	SHLD	CAN 1SHLD CUSTOMER CAN SHIELD	18 AWG	J1939 CABLE	X901 (6)

ECM -J2

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	BLK	248-2 INJECTOR 3	1.5 mm^2	FLRYW	EIC (61)
3	BLK	248-3 INJECTOR 2	1.5 mm^2	FLRYW	EIC (41)
4	BLK	248-4 MPROP ACTUATOR	1.5 mm^2	FLRYW	EIC (19)
5	BLK	248-5 MPROP ACTUATOR	1.5 mm^2	FLRYW	EIC (20)
6					
7	BLK	248-7 RAIL PRESSURE FUEL	0.75 mm^2	FLRYW	EIC (32)
8					
9					
10					
11					
12					
13					
14					
15					
16	BLK	248-16 INJECTOR 1	1.5 mm^2	FLRYW	EIC (35)
17					
18	BLK	248-18 INJECTOR 4	1.5 mm^2	FLRYW	EIC (37)
19	BLK	248-19 EHXAUST GAS RECIRCULATION	1.5 mm^2	FLRYW	EIC (47)
20	BLK	248-20 EHXAUST GAS RECIRCULATION	1.5 mm^2	FLRYW	EIC (48)
21					
22					
23	BLK	248-23 GLOW SENSE	0.75 mm^2	FLRYW	MS932 (E)
24	BLK	248-24 BOOST PRESSURE TEMP	0.75 mm^2	FLRYW	EIC (22)
25	BLK	248-25 RAIL PRESSURE FUEL	0.75 mm^2	FLRYW	EIC (31)
26	BLK	248-26 RAIL PRESSURE FUEL	0.75 mm^2	FLRYW	EIC (25)
27	BLK	248-27 BOOST PRESSURE TEMP	0.75 mm^2	FLRYW	EIC (29)
28	BLK	248-28 COOLING TEMPERATURE	0.75 mm^2	FLRYW	EIC (24)
29	BLK	248-29 OIL PRESSURE	0.75 mm^2	FLRYW	EIC (27)
30					
31					
32	BLK	248-32 INJECTOR 3	1.5 mm^2	FLRYW	EIC (38)
33	BLK	248-33 INJECTOR 1	1.5 mm^2	FLRYW	EIC (62)
34					
35	BLK	248-35 GLOW RELAY CONTROL GND	0.75 mm^2	FLRYW	RL931-85 (1)
36					
37	BLK	248-37 ENGINE SPEED CAMSHAFT	18 AWG	CABLE	EIC (14)
38	SHLD	248-38 ENGINE SPEED CRANKSHAFT	18 AWG	CABLE	EIC (1)
39	BLK	248-39 ENGINE SPEED CRANKSHAFT	18 AWG	CABLE	EIC (15)
40	BLK	248-40 AIR INLET TEMP	0.75 mm^2	FLRYW	EIC (28)
41					
42					
43	BLK	248-43 OIL PRESSURE	0.75 mm^2	FLRYW	EIC (23)
44	BLK	248-44 OIL PRESSURE	0.75 mm^2	FLRYW	EIC (26)
45					
46	BLK	248-46 INJECTOR 2	1.5 mm^2	FLRYW	EIC (40)
47					
48	BLK	248-48 INJECTOR 4	1.5 mm^2	FLRYW	EIC (42)
49					
50					
51					
52	WHT	248-52 ENGINE SPEED CAMSHAFT	18 AWG	CABLE	EIC (13)
53	SHLD	248-53 ENGINE SPEED CAMSHAFT	18 AWG	CABLE	EIC (9)
54	WHT	248-54 ENGINE SPEED CRANKSHAFT	18 AWG	CABLE	EIC (21)
55					
56					
57					
58					
59					
60					

Figure 337. Deutz 2.9L4 Harness - Sheet 3 of 12

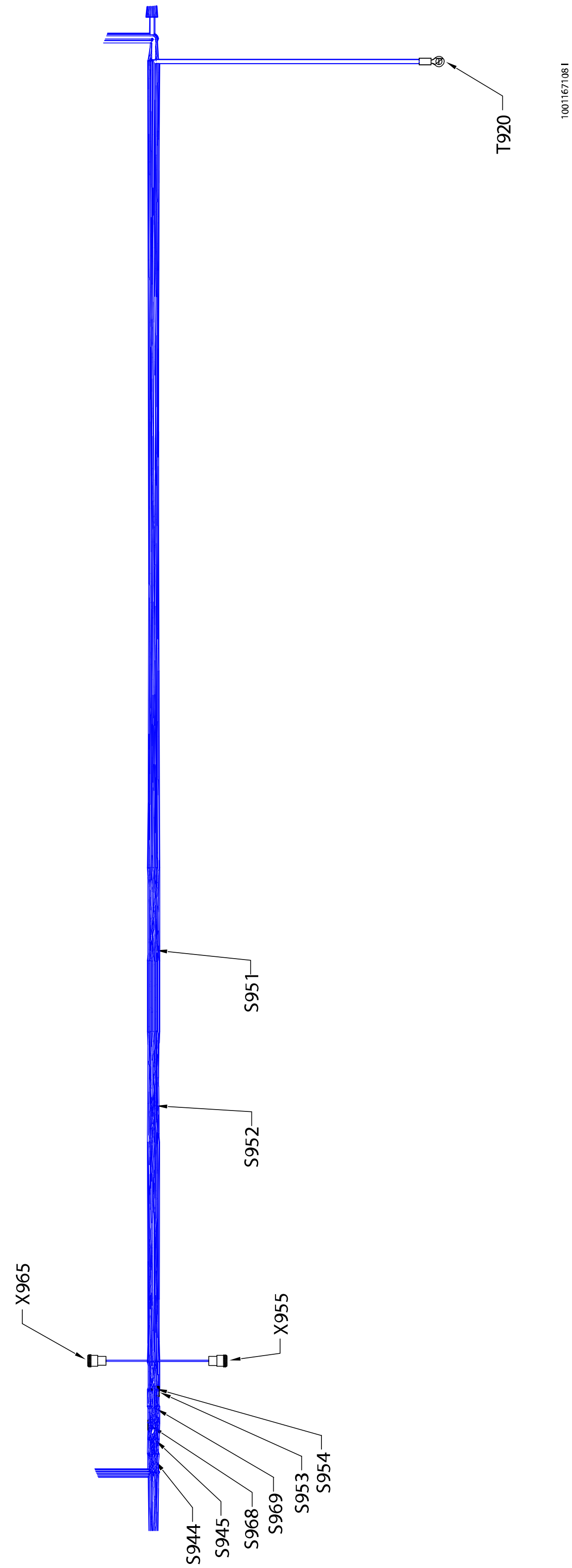


Figure 338. Deutz 2.9L4 Harness - Sheet 4 of 12

S951

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CAN 1 HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	S953 (2)
2	YEL	CAN 1 HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	X901 (3)
2	YEL	CAN 1 HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	X950 (M)

S952

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	GRN	CAN 1 LO CUSTOMER CAN LOW	18 AWG	J1939 CABLE	S954 (2)
2	GRN	CAN 1 LO CUSTOMER CAN LO	18 AWG	J1939 CABLE	X901 (4)
2	GRN	CAN 1 LO CUSTOMER CAN LO	18 AWG	J1939 CABLE	X950 (F)

S968

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	GRN	CAN 2 LO DIAG CAN LOW	18 AWG	J1939 CABLE	ECM-J1 (53)
2	GRN	CAN 2 LO DIAG CAN LOW	18 AWG	J1939 CABLE	S963 (1)
2	GRN	CAN 2 LO DIAG CAN LOW	18 AWG	J1939 CABLE	X965 (B)

S969

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CAN 2 HI DIAG CAN HIGH	18 AWG	J1939 CABLE	ECM-J1 (75)
2	YEL	CAN 2 HI DIAG CAN HIGH	18 AWG	J1939 CABLE	S964 (1)
2	YEL	CAN 2 HI DIAG CAN HIGH	18 AWG	J1939 CABLE	X965 (A)

S953

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CAN 1 HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	ECM-J1 (54)
2	YEL	CAN 1 HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	S951 (1)
2	YEL	CAN 1 HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	X955 (A)

S954

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	GRN	CAN 1 LO CUSTOMER CAN LOW	18 AWG	J1939 CABLE	ECM-J1 (76)
2	GRN	CAN 1 LO CUSTOMER CAN LOW	18 AWG	J1939 CABLE	S952 (1)
2	GRN	CAN 1 LO CUSTOMER CAN LOW	18 AWG	J1939 CABLE	X955 (B)

X955

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN 1 HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	S953 (2)
B	GRN	CAN 1 LO CUSTOMER CAN LOW	18 AWG	J1939 CABLE	S954 (2)
C					

X965

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN 2 HI DIAG CAN HIGH	18 AWG	J1939 CABLE	S969 (2)
B	GRN	CAN 2 LO DIAG CAN LOW	18 AWG	J1939 CABLE	S968 (2)
C					

T920

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-148-246 ECM GND	8 AWG	GXL	S945 (1)
1	BLK	000-48-1 ENG GND	14 AWG	GXL	X941 (4)
1	BLK	000-48-2 ENG GND	18 AWG	GXL	X950 (B)
1	BLK	000-48-3 GND	18 AWG	GXL	X999 (2)

S944

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-148-135 ECM PWR	8 AWG	GXL	RL930-2 (1)
2	RED	148-1 ECM PWR	2.5 mm^2	FLRYW	ECM-J1 (1)
2	RED	148-3 ECM PWR	2.5 mm^2	FLRYW	ECM-J1 (3)
2	RED	148-5 ECM PWR	2.5 mm^2	FLRYW	ECM-J1 (5)

S945

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-148-246 ECM GND	8 AWG	GXL	T920 (1)
2	BLK	148-2 ECM GND	2.5 mm^2	FLRYW	ECM-J1 (2)
2	BLK	148-4 ECM GND	2.5 mm^2	FLRYW	ECM-J1 (4)
2	BLK	148-6 ECM GND	2.5 mm^2	FLRYW	ECM-J1 (6)

Figure 339. Deutz 2.9L4 Harness - Sheet 5 of 12

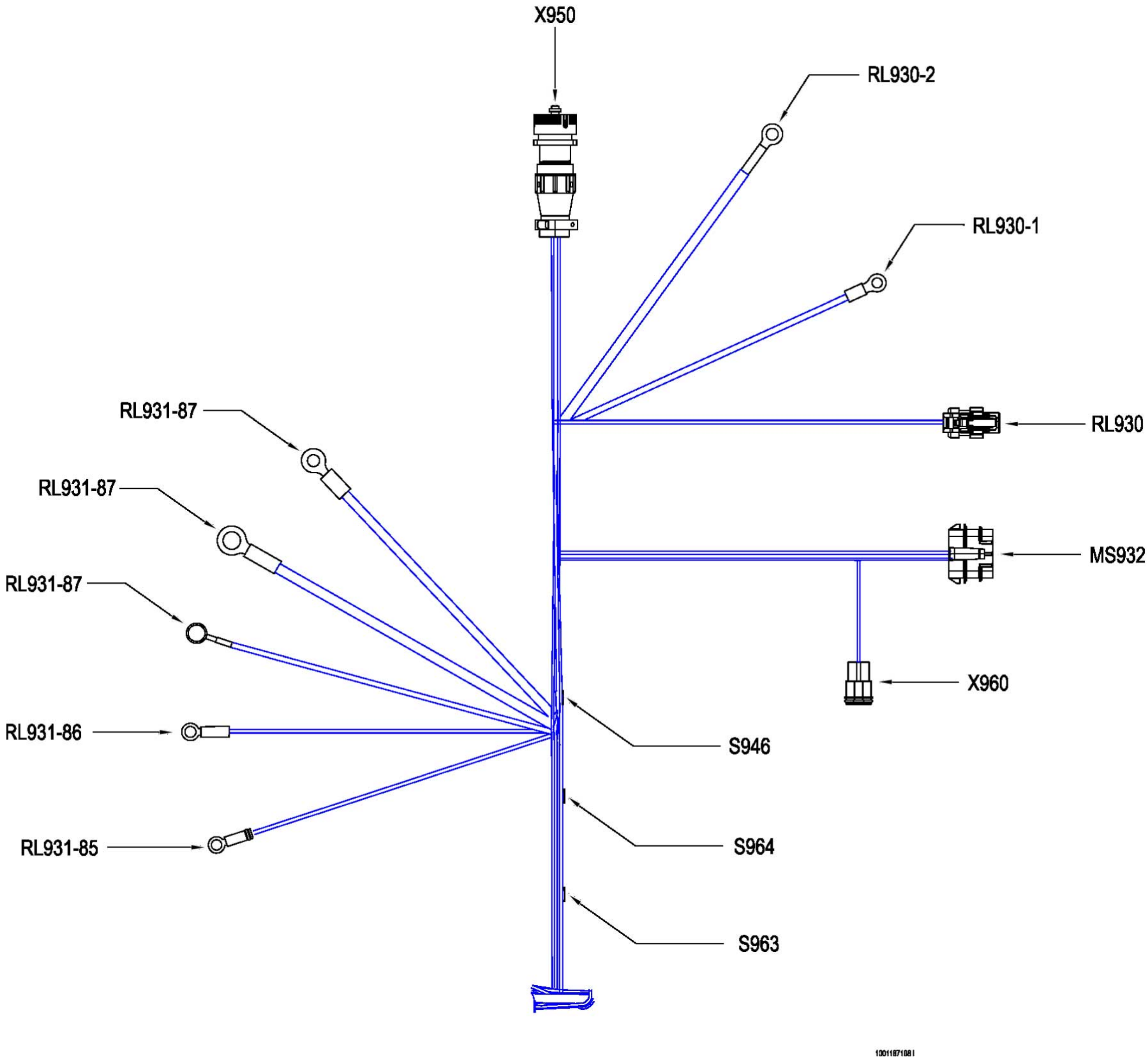


Figure 340. Deutz 2.9L4 Harness - Sheet 6 of 12

X950

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	2-48-2 IGNITION	18 AWG	GXL	S946 (1)
B	BLK	000-48-2 ENG GND	18 AWG	GXL	T920 (1)
C					
D					
E					
F	GRN	CAN 1LO CUSTOMER CAN LO	18 AWG	J1939 CABLE	S952 (2)
G	GRN	CAN 2LO DIAG CAN LOW	18 AWG	J1939 CABLE	S963 (2)
H	YEL	CAN 2HI DIAG CAN HIGH	18 AWG	J1939 CABLE	S964 (2)
J					
K					
L					
M	YEL	CAN 1HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	S951 (2)

S946

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-48-1 IGNITION	16 AWG	GXL	MS932 (H)
1	YEL	2-48-2 IGNITION	18 AWG	GXL	X950 (A)
2	YEL	2-48-3 IGNITION	18 AWG	GXL	RL931-86 (1)
2	YEL	2-48-4 IGNITION	18 AWG	GXL	RL930 (1)
2	BLK	148-88 IGNITION	0.75 mm^2	FLRYW	ECM-J1 (88)

MS932

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A					
B					
C					
D					
E	BLK	248-23 GLOW SENSE	0.75 mm^2	FLRYW	ECM-J2 (23)
F	ORG	248-23-1 GLOW SENSE	18 AWG	GXL	RL931-87 (1)
G	YEL	2-1-99 IGNITION	18 AWG	GXL	X902 (1)
H	YEL	2-48-1 IGNITION	16 AWG	GXL	S946 (1)

S964

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CAN 2HI DIAG CAN HIGH	18 AWG	J1939 CABLE	S969 (2)
2	YEL	CAN 2HI DIAG CAN HIGH	18 AWG	J1939 CABLE	X950 (H)
2	YEL	CAN 2HI DIAG CAN HIGH	18 AWG	J1939 CABLE	X960 (A)

S963

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	GRN	CAN 2LO DIAG CAN LOW	18 AWG	J1939 CABLE	S968 (2)
2	GRN	CAN 2LO DIAG CAN LOW	18 AWG	J1939 CABLE	X950 (G)
2	GRN	CAN 2LO DIAG CAN LOW	18 AWG	J1939 CABLE	X960 (B)

RL 930

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-48-4	18 AWG	GXL	S946 (2)
2	BLK	148-26	0.75 mm^2	FLRYW	ECM-J1 (26)

RL 930-2

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-148-135 ECM PWR	8 AWG	GXL	S944 (1)

RL 930-1

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-96 FUEL PUMP	14 AWG	GXL	X941 (3)

RL 931-85

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	248-35 GLOW RELAY CONTROL GND	0.75 mm^2	FLRYW	ECM-J2 (35)

RL 931-87

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	248-23-1 GLOW SENSE	18 AWG	GXL	MS932 (F)

RL 931-87

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	48-13 GLOW	8 AWG	GXL	EC 18 (1)

RL 931-87

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	48-14 GLOW	8 AWG	GXL	EC 18 (2)

RL 931-86

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-48-3 IGNITION	18 AWG	GXL	S946 (2)

X960

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN 2HI DIAG CAN HIGH	18 AWG	J1939 CABLE	S964 (2)
B	GRN	CAN 2LO DIAG CAN LOW	18 AWG	J1939 CABLE	S963 (2)
C					

Figure 341. Deutz 2.9L4 Harness - Sheet 7 of 12

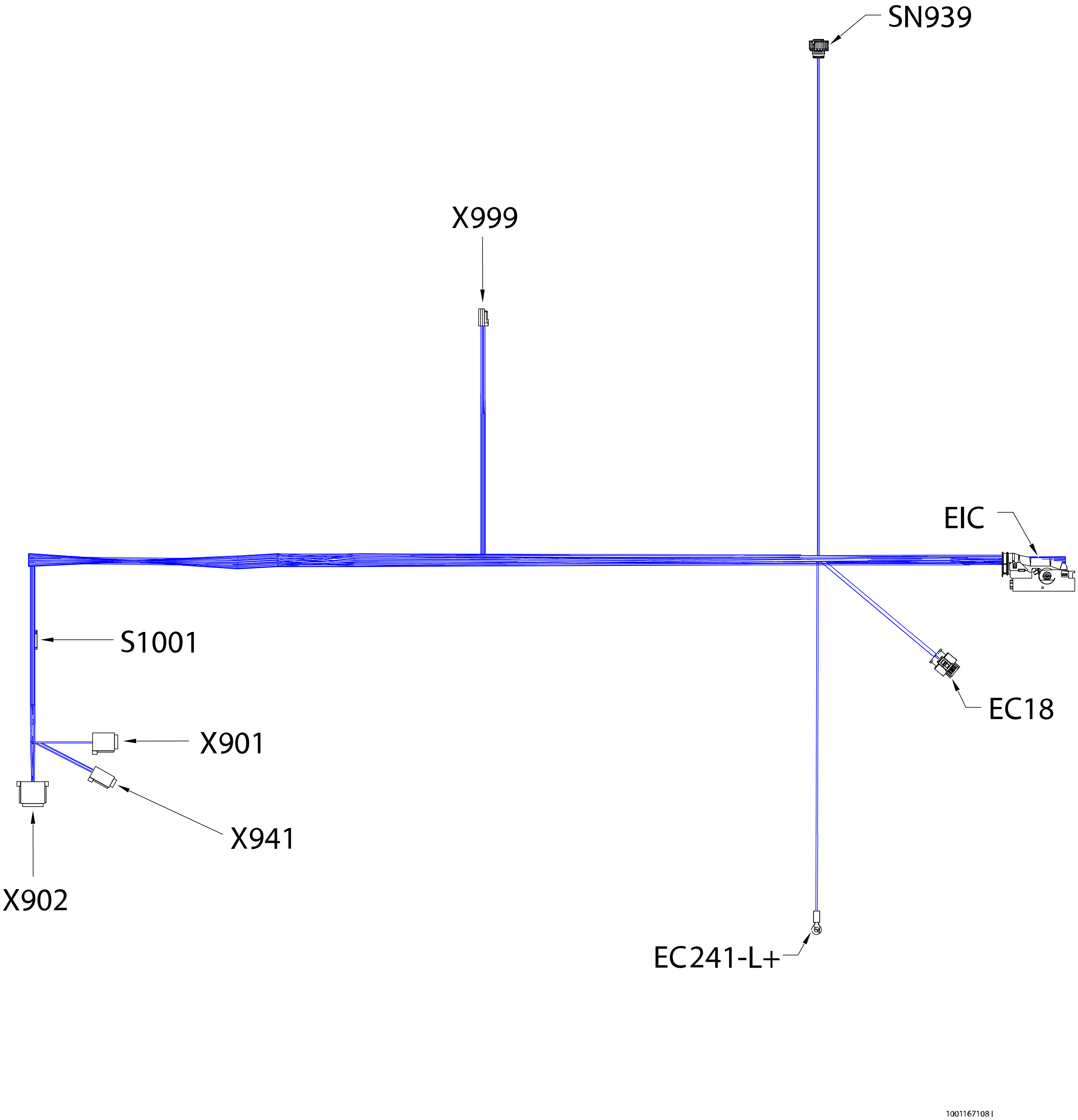


Figure 342. Deutz 2.9L4 Harness - Sheet 8 of 12

EIC

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	SHLD	248-38	18 AWG	CABLE	ECM-J2 (38)
2	BLK	148-28	0.75 mm^2	FLRYW	ECM-J1 (28)
3	BLK	148-73	0.75 mm^2	FLRYW	ECM-J1 (73)
4					
5					
6					
7					
8					
9	SHLD	248-53	18 AWG	CABLE	ECM-J2 (53)
10					
11					
12					
13	WHT	248-52	18 AWG	CABLE	ECM-J2 (52)
14	BLK	248-37	18 AWG	CABLE	ECM-J2 (37)
15	BLK	248-39	18 AWG	CABLE	ECM-J2 (39)
16					
17	BLK	148-61	0.75 mm^2	FLRYW	ECM-J1 (61)
18					
19	BLK	248-4	1.5 mm^2	FLRYW	ECM-J2 (4)
20	BLK	248-5	1.5 mm^2	FLRYW	ECM-J2 (5)
21	WHT	248-54	18 AWG	CABLE	ECM-J2 (54)
22	BLK	248-24	0.75 mm^2	FLRYW	ECM-J2 (24)
23	BLK	248-43	0.75 mm^2	FLRYW	ECM-J2 (43)
24	BLK	248-28	0.75 mm^2	FLRYW	ECM-J2 (28)
25	BLK	248-26	0.75 mm^2	FLRYW	ECM-J2 (26)
26	BLK	248-44	0.75 mm^2	FLRYW	ECM-J2 (44)
27	BLK	248-29	0.75 mm^2	FLRYW	ECM-J2 (29)
28	BLK	248-40	0.75 mm^2	FLRYW	ECM-J2 (40)
29	BLK	248-27	0.75 mm^2	FLRYW	ECM-J2 (27)
30					
31	BLK	248-25	0.75 mm^2	FLRYW	ECM-J2 (25)
32	BLK	248-7	0.75 mm^2	FLRYW	ECM-J2 (7)
33					
34	BLK	148-56	0.75 mm^2	FLRYW	ECM-J1 (56)
35	BLK	248-16	1.5 mm^2	FLRYW	ECM-J2 (16)
36					
37	BLK	248-18	1.5 mm^2	FLRYW	ECM-J2 (18)
38	BLK	248-32	1.5 mm^2	FLRYW	ECM-J2 (32)
39					
40	BLK	248-46	1.5 mm^2	FLRYW	ECM-J2 (46)
41	BLK	248-3	1.5 mm^2	FLRYW	ECM-J2 (3)
42	BLK	248-48	1.5 mm^2	FLRYW	ECM-J2 (48)
43					
44					
45					
46	BLK	148-85	0.75 mm^2	FLRYW	ECM-J1 (85)
47	BLK	248-19	1.5 mm^2	FLRYW	ECM-J2 (19)
48	BLK	248-20	1.5 mm^2	FLRYW	ECM-J2 (20)
49	BLK	148-72	0.75 mm^2	FLRYW	ECM-J1 (72)
50	BLK	148-44	0.75 mm^2	FLRYW	ECM-J1 (44)
51	BLK	148-82	0.75 mm^2	FLRYW	ECM-J1 (82)
52	BLK	148-38	0.75 mm^2	FLRYW	ECM-J1 (38)
53					
54					
55					
56					
57					
58					
59					
60					
61	BLK	248-2	1.5 mm^2	FLRYW	ECM-J2 (2)
62	BLK	248-33	1.5 mm^2	FLRYW	ECM-J2 (33)

X999

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-35-3 -	18 AWG	GXL	S1001 (1)
2	BLK	000-48-3 GND	18 AWG	GXL	T920 (1)

S1001

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-35-2 START	0.75 mm^2	FLRYW	ECM-J1 (35)
1	BLK	148-35-3 -	18 AWG	GXL	X999 (1)
2	BLK	148-35-1 START	18 AWG	GXL	X901 (2)

X941

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-64 WATER IN FUEL SW	0.75 mm^2	FLRYW	ECM-J1 (64)
2	BLK	148-57 WATER IN FUEL SW RTN	0.75 mm^2	FLRYW	ECM-J1 (57)
3	WHT	48-96 FUEL PUMP	14 AWG	GXL	RL930-1 (1)
4	BLK	000-48-1 ENG GND	14 AWG	GXL	T920 (1)

X902

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-1-99 IGNITION	18 AWG	GXL	MS932 (G)

X901

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	BLK	148-35-1 START	18 AWG	GXL	S1001 (2)
3	YEL	CAN 1 HI CUSTOMER CAN HIGH	18 AWG	J1939 CABLE	S951 (2)
4	GRN	CAN 1 LO CUSTOMER CAN LO	18 AWG	J1939 CABLE	S952 (2)
5	RED	47-8 ALT EXCITE	16 AWG	GXL	EC241-L+ (1)
6	SHLD	CAN 1 SHLD CUSTOMER CAN SHIELD	18 AWG	J1939 CABLE	ECM -JNC( )

EC 241-L+

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	47-8 ALT EXCITE	16 AWG	GXL	X901 (5)

EC 18

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	48-13 GLOW	8 AWG	GXL	RL931-87 (1)
2	RED	48-14 GLOW	8 AWG	GXL	RL931-87 (1)

SN 939

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-29 COOLANT LEVEL PWR	0.75 mm^2	FLRYW	ECM-J1 (29)
2	BLK	148-87 COOLANT LEVEL GND	0.75 mm^2	FLRYW	ECM-J1 (87)
3	BLK	148-13 COOLANT LEVEL SIG	0.75 mm^2	FLRYW	ECM-J1 (13)
4					

Figure 343. Deutz 2.9L4 Harness - Sheet 9 of 12

WIRE NO	COLOR	WIRE GAUGE	JACKET	LENGTH (mm)	FROM		TO	
					REFERENCE	PIN	REFERENCE	PIN
000-148-246 ECM GND	BLK	8	GXL	85	T920	1	S945	1
000-48-1 ENG GND	BLK	14	GXL	17	T920	1	X941	4
000-48-2 ENG GND	BLK	18	GXL	22	T920	1	X950	B
000-48-3 GND	BLK	18	GXL	40	T920	1	X999	2
1-148-135 ECM PWR	RED	8	GXL	96	RL930-2	1	S944	1
2-1-99 IGNITION	YEL	18	GXL	26	MS932	G	X902	1
2-48-1 IGNITION	YEL	16	GXL	11	MS932	H	S946	1
2-48-2 IGNITION	YEL	18	GXL	8	X950	A	S946	1
2-48-3 IGNITION	YEL	18	GXL	10	RL931-86	1	S946	2
2-48-4 IGNITION	YEL	18	GXL	13	RL930	1	S946	2
47-8 ALT EXCITE	RED	16	GXL	74	EC241-L+	1	X901	5
48-14 GLOW	RED	8	GXL	65	RL931-87	1	EC18	2
48-96 FUEL PUMP	WHT	14	GXL	25	RL930-1	1	X941	3
148-13 COOLANT LEVEL SIG	BLK	0.75	FLRYW	165	ECM-J1	13	SN939	3
148-15-68 CLUTCH SWITCH	BLK	0.75	FLRYW	1	ECM-J1	15	ECM-J1	68
148-1 ECM PWR	RED	2.5	FLRYW	11	S944	2	ECM-J1	1
148-26 FUEL PUMP RELAY CONTROL GND	BLK	0.75	FLRYW	109	RL930	2	ECM-J1	26
148-28 START RTN	BLK	0.75	FLRYW	149	ECM-J1	28	EIC	2
148-29 COOLANT LEVEL PWR	BLK	0.75	FLRYW	166	ECM-J1	29	SN939	1
148-2 ECM GND	BLK	2.5	FLRYW	12	S945	2	ECM-J1	2
148-35-1 START	BLK	18	GXL	5	X901	2	S1001	2
148-35-2 START	BLK	0.75	FLRYW	93	ECM-J1	35	S1001	1
148-35-3 -	BLK	18	GXL	33	S1001	1	X999	1
148-38 THROTTLE FLAP 4	BLK	0.75	FLRYW	148	EIC	52	ECM-J1	38
148-3 ECM PWR	RED	2.5	FLRYW	11	ECM-J1	3	S944	2
148-44 EHXAUST GAS RECIRCULATION	BLK	0.75	FLRYW	149	EIC	50	ECM-J1	44
148-4 ECM GND	BLK	2.5	FLRYW	12	ECM-J1	4	S945	2
148-56 AIR INLET TEMP	BLK	0.75	FLRYW	148	EIC	34	ECM-J1	56
148-57 WATER IN FUEL SW RTN	BLK	0.75	FLRYW	98	X941	2	ECM-J1	57
148-5 ECM PWR	RED	2.5	FLRYW	11	S944	2	ECM-J1	5
148-61 FUEL LOW PRESSURE	BLK	0.75	FLRYW	149	EIC	17	ECM-J1	61
148-64 WATER IN FUEL SW	BLK	0.75	FLRYW	97	X941	1	ECM-J1	64
148-6 ECM GND	BLK	2.5	FLRYW	12	S945	2	ECM-J1	6
148-72 THROTTLE FLAP 3	BLK	0.75	FLRYW	148	EIC	49	ECM-J1	72
148-73 START SIG	BLK	0.75	FLRYW	147	ECM-J1	73	EIC	3
148-82 EHXAUST GAS RECIRCULATION	BLK	0.75	FLRYW	150	EIC	51	ECM-J1	82
148-85 EHXAUST GAS RECIRCULATION	BLK	0.75	FLRYW	148	EIC	46	ECM-J1	85
148-87 COOLANT LEVEL GND	BLK	0.75	FLRYW	169	ECM-J1	87	SN939	2
148-88 IGNITION	BLK	0.75	FLRYW	97	ECM-J1	88	S946	2
248-16 INJECTOR 1	BLK	1.5	FLRYW	147	ECM-J2	16	EIC	35
248-18 INJECTOR 4	BLK	1.5	FLRYW	147	ECM-J2	18	EIC	37
248-19 EHXAUST GAS RECIRCULATION	BLK	1.5	FLRYW	146	ECM-J2	19	EIC	47
248-20 EHXAUST GAS RECIRCULATION	BLK	1.5	FLRYW	147	ECM-J2	20	EIC	48
248-23-1 GLOW SENSE	ORG	18	GXL	19	MS932	F	RL931-87	1
248-23 GLOW SENSE	BLK	0.75	FLRYW	109	MS932	E	ECM-J2	23
248-24 BOOST PRESSURE TEMP	BLK	0.75	FLRYW	148	ECM-J2	24	EIC	22
248-25 RAIL PRESSURE FUEL	BLK	0.75	FLRYW	148	ECM-J2	25	EIC	31
248-26 RAIL PRESSURE FUEL	BLK	0.75	FLRYW	148	ECM-J2	26	EIC	25

Figure 344. Deutz 2.9L4 Harness - Sheet 10 of 12

WIRE NO	COLOR	WIRE GAUGE	JACKET	LENGTH (mm)	FROM		TO	
					REFERENCE	PIN	REFERENCE	PIN
248-27 BOOST PRESSURE TEMP	BLK	0.75	FLRYW	148	ECM-J2	27	EIC	29
248-28 COOLING TEMPERATURE	BLK	0.75	FLRYW	149	ECM-J2	28	EIC	24
248-29 OIL PRESSURE	BLK	0.75	FLRYW	146	ECM-J2	29	EIC	27
248-2 INJECTOR 3	BLK	1.5	FLRYW	147	ECM-J2	2	EIC	61
248-32 INJECTOR 3	BLK	1.5	FLRYW	148	ECM-J2	32	EIC	38
248-33 INJECTOR 1	BLK	1.5	FLRYW	148	ECM-J2	33	EIC	62
248-35 GLOW RELAY CONTROL GND	BLK	0.75	FLRYW	106	RL931-85	1	ECM-J2	35
248-37 ENGINE SPEED CAMSHAFT	BLK	18	CABLE	148	ECM-J2	37	EIC	14
248-38 ENGINE SPEED CRANKSHAFT	SHLD	18	CABLE	146	EIC	1	ECM-J2	38
248-39 ENGINE SPEED CRANKSHAFT	BLK	18	CABLE	146	ECM-J2	39	EIC	15
248-3 INJECTOR 2	BLK	1.5	FLRYW	147	ECM-J2	3	EIC	41
248-40 AIR INLET TEMP	BLK	0.75	FLRYW	147	ECM-J2	40	EIC	28
248-43 OIL PRESSURE	BLK	0.75	FLRYW	146	ECM-J2	43	EIC	23
248-44 OIL PRESSURE	BLK	0.75	FLRYW	149	ECM-J2	44	EIC	26
248-46 INJECTOR 2	BLK	1.5	FLRYW	147	ECM-J2	46	EIC	40
248-48 INJECTOR 4	BLK	1.5	FLRYW	147	ECM-J2	48	EIC	42
248-4 MPROP ACTUATOR	BLK	1.5	FLRYW	146	ECM-J2	4	EIC	19
248-52 ENGINE SPEED CAMSHAFT	WHT	18	CABLE	147	ECM-J2	52	EIC	13
248-53 ENGINE SPEED CAMSHAFT	SHLD	18	CABLE	149	ECM-J2	53	EIC	9
248-54 ENGINE SPEED CRANKSHAFT	WHT	18	CABLE	147	ECM-J2	54	EIC	21
248-5 MPROP ACTUATOR	BLK	1.5	FLRYW	147	ECM-J2	5	EIC	20
248-7 RAIL PRESSURE FUEL	BLK	0.75	FLRYW	147	ECM-J2	7	EIC	32
48-13 GLOW	RED	8	GXL	67	RL931-87	1	EC18	1
CAN 1 HI CUSTOMER CAN HIGH	YEL	18	J1939 CABLE	59	X950	M	S951	2
CAN 1 HI CUSTOMER CAN HIGH	YEL	18	J1939 CABLE	29	S953	2	S951	1
CAN 1 HI CUSTOMER CAN HIGH	YEL	18	J1939 CABLE	55	X901	3	S951	2
CAN 1 HI CUSTOMER CAN HIGH	YEL	18	J1939 CABLE	15	ECM-J1	54	S953	1
CAN 1 HI CUSTOMER CAN HIGH	YEL	18	J1939 CABLE	6	S953	2	X955	A
CAN 1 LO CUSTOMER CAN LO	GRN	18	J1939 CABLE	64	X901	4	S952	2
CAN 1 LO CUSTOMER CAN LOW	GRN	18	J1939 CABLE	18	S954	2	S952	1
CAN 1 LO CUSTOMER CAN LO	GRN	18	J1939 CABLE	69	X950	F	S952	2
CAN 1 LO CUSTOMER CAN LOW	GRN	18	J1939 CABLE	16	ECM-J1	76	S954	1
CAN 1 LO CUSTOMER CAN LOW	GRN	18	J1939 CABLE	6	S954	2	X955	B
CAN 1 SHLD CUSTOMER CAN SHIELD	SHLD	18	J1939 CABLE	99	X901	6	ECM-J1	NC
CAN 2 HI DIAG CAN HIGH	YEL	18	J1939 CABLE	12	S964	2	X960	A
CAN 2 HI DIAG CAN HIGH	YEL	18	J1939 CABLE	10	X950	H	S964	2
CAN 2 HI DIAG CAN HIGH	YEL	18	J1939 CABLE	14	ECM-J1	75	S969	1
CAN 2 HI DIAG CAN HIGH	YEL	18	J1939 CABLE	79	S964	1	S969	2
CAN 2 HI DIAG CAN HIGH	YEL	18	J1939 CABLE	7	S969	2	X965	A
CAN 2 LO DIAG CAN LOW	GRN	18	J1939 CABLE	14	S963	2	X960	B
CAN 2 LO DIAG CAN LOW	GRN	18	J1939 CABLE	12	X950	G	S963	2
CAN 2 LO DIAG CAN LOW	GRN	18	J1939 CABLE	13	ECM-J1	53	S968	1
CAN 2 LO DIAG CAN LOW	GRN	18	J1939 CABLE	80	S963	1	S968	2
CAN 2 LO DIAG CAN LOW	GRN	18	J1939 CABLE	8	S968	2	X965	B

Figure 345. Deutz 2.9L4 Harness - Sheet 11 of 12

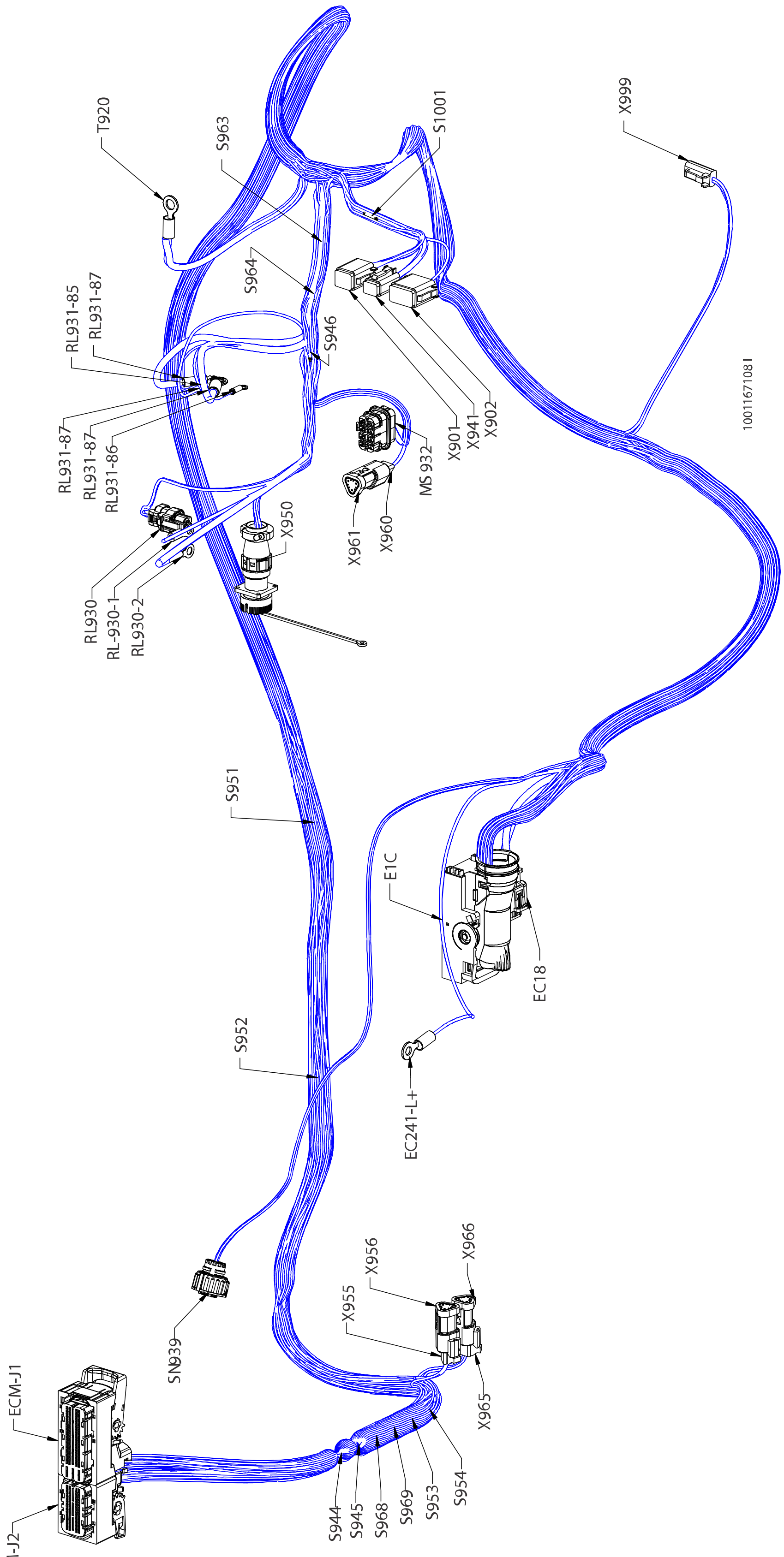


Figure 346. Deutz 2.9L4 Harness - Sheet 12 of 12

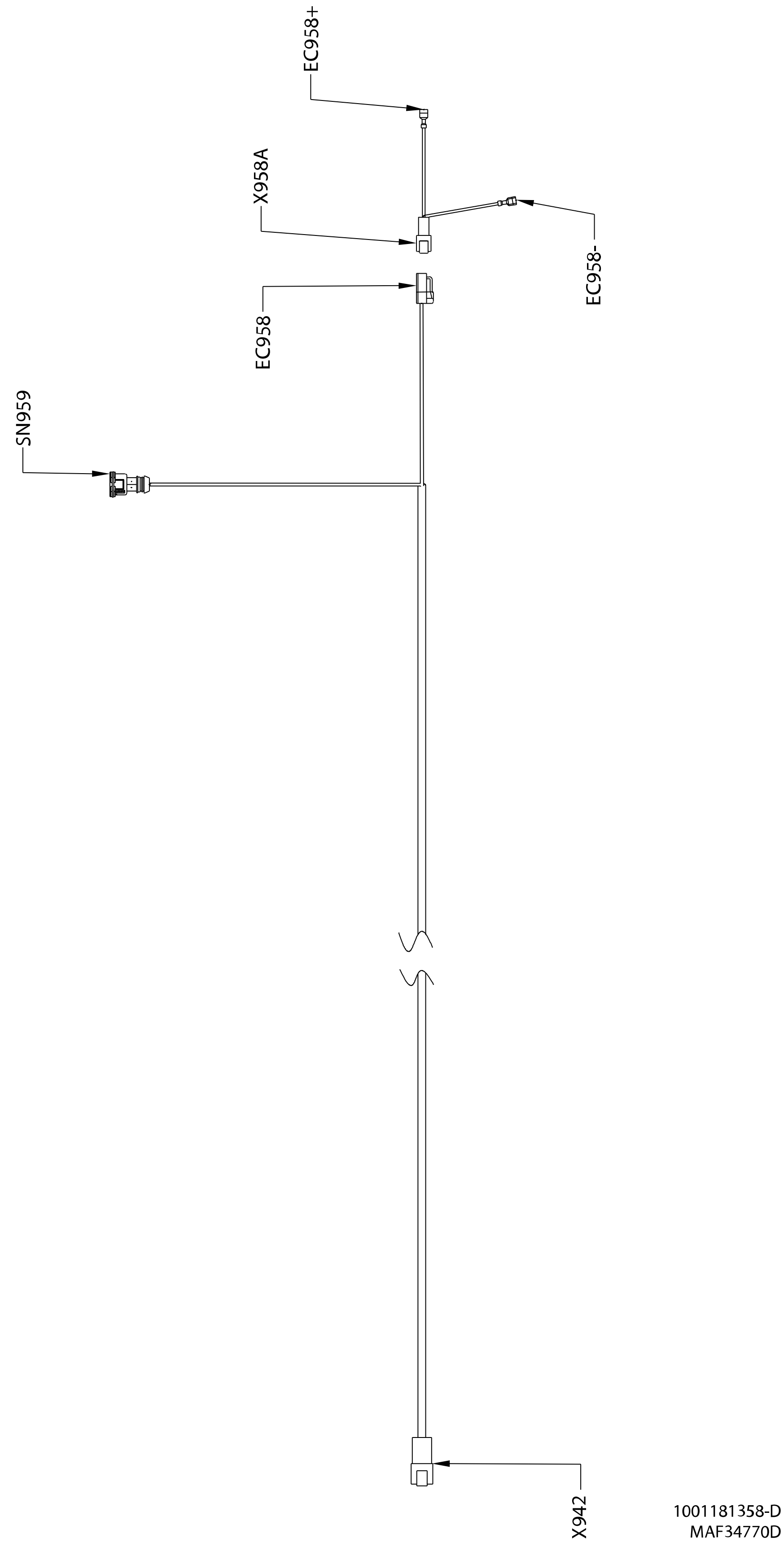


Figure 347. Deutz Fuel Harness - Sheet 1 of 2

X942					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-64 WATER IN FUEL SW	16 AWG	GXL	SN959 (1)
2	BLK	148-57 WATER IN FUEL SW RTN	16 AWG	GXL	SN959 (2)
3	WHT	48-96 FUEL PUMP	14 AWG	GXL	EC958 (1)
4	BLK	000-48-1 ENG GND	14 AWG	GXL	EC958 (2)

SN959					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-64 WATER IN FUEL SW	16 AWG	GXL	X942 (1)
2	BLK	148-57 WATER IN FUEL SW RTN	16 AWG	GXL	X942 (2)

EC958					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-96 FUEL PUMP	14AWG	GXL	X942 (3)
2	BLK	000-48-1 ENG GND	14AWG	GXL	X942 (4)

X958A					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-96 FUEL PUMP	14 AWG	GXL	EC958+ (1)
2	BLK	000-48-1 ENG GND	14 AWG	GXL	EC958- (1)

EC958-					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-48-1 ENG GND	14 AWG	GXL	X958A (2)

EC958+					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-96 FUEL PUMP	14 AWG	GXL	X958A (1)

Figure 348. Deutz Fuel Harness - Sheet 2 of 2

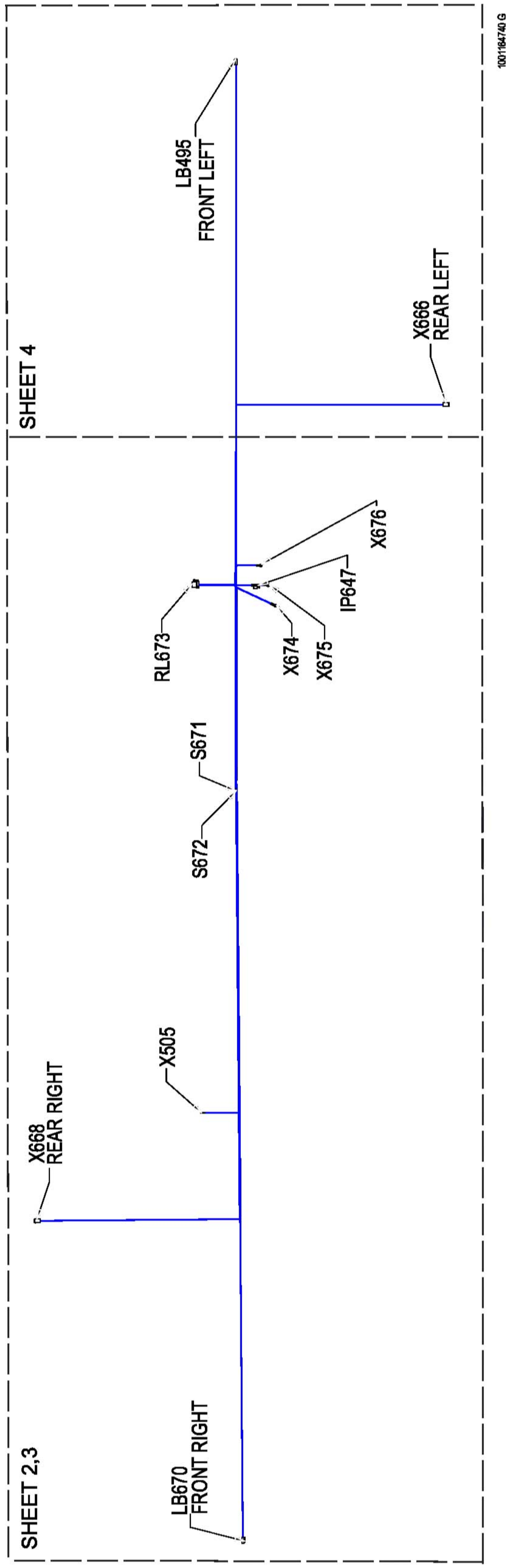


Figure 349. Chassis Head and Tail Lights Harness - Sheet 1 of 5

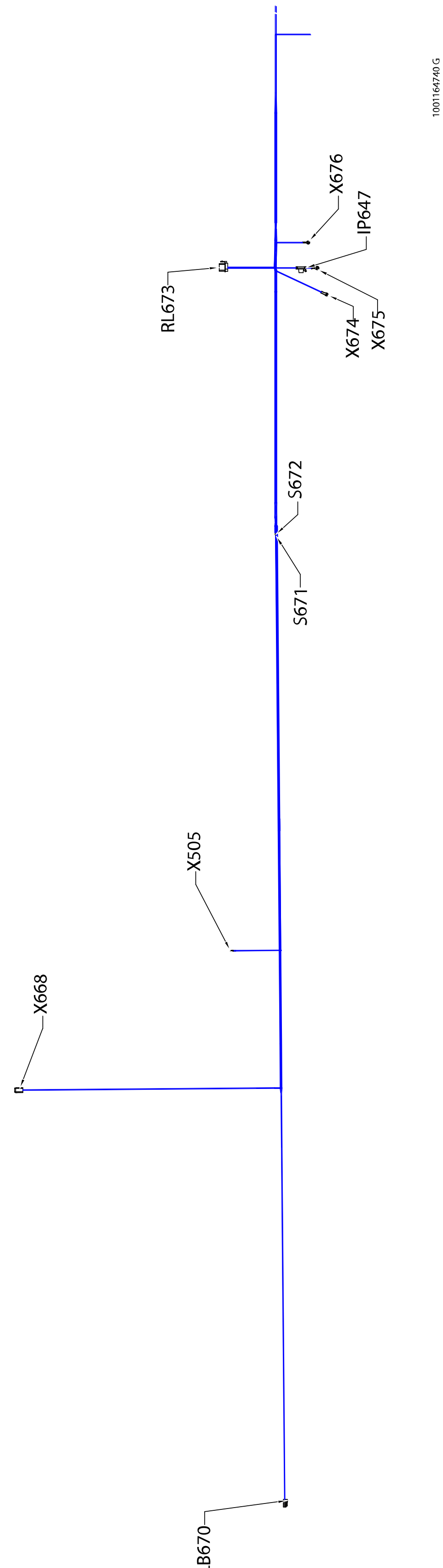


Figure 350. Chassis Head and Tail Lights Harness - Sheet 2 of 5

S671

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	6-11 12V+	16 AWG	GXL	LB495 (2)
1	WHT	6-29 12V+	16 AWG	GXL	LB670 (2)
2	WHT	6-13 12V+	16 AWG	GXL	X666 (3)
2	WHT	6-30 12V+	16 AWG	GXL	X668 (3)
2	WHT	6-8 12V+	14 AWG	GXL	RL673 (4)

RL673

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-146 PWR	16 AWG	GXL	IP647 (2)
2	BLK	000-40-109 GND	16 AWG	GXL	X676 (1)
3					
4	WHT	6-8 12V+	14 AWG	GXL	S671 (2)
5	WHT	4-145	18 AWG	GXL	X505 (1)

X674
CONNECT TO CASE GROUND ON AUX PUMP RELAY

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	4-122	14 AWG	GXL	S672 (2)

X675
CONNECT TO B+ OF AUX PUMP RELAY

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	FUSE HOLDER LEAD	16 AWG	GXL	IP647 (1)

CONNECT TO X434 PIN 2

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-145	18 AWG	GXL	RL673 (5)

X668
REAR RIGHT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	BLK	000-60-30 GND	16 AWG	GXL	S672 (2)
3	WHT	6-30 12V+	16 AWG	GXL	S671 (2)
4					

LB
FRONT RIGHT

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-60-29 GND	16 AWG	GXL	S672 (1)
2	WHT	6-29 12V+	16 AWG	GXL	S671 (1)

POS		WIRE			TO
1	BLK	000-60-11 GND	16 AWG	GXL	LB495 (1)
1	BLK	000-60-29 GND	16 AWG	GXL	LB670 (1)
2	BLK	000-60-12 GND	16 AWG	GXL	X666 (2)
2	BLK	000-60-30 GND	16 AWG	GXL	X668 (2)
2	BLK	4-122	14 AWG	GXL	X674 (1)

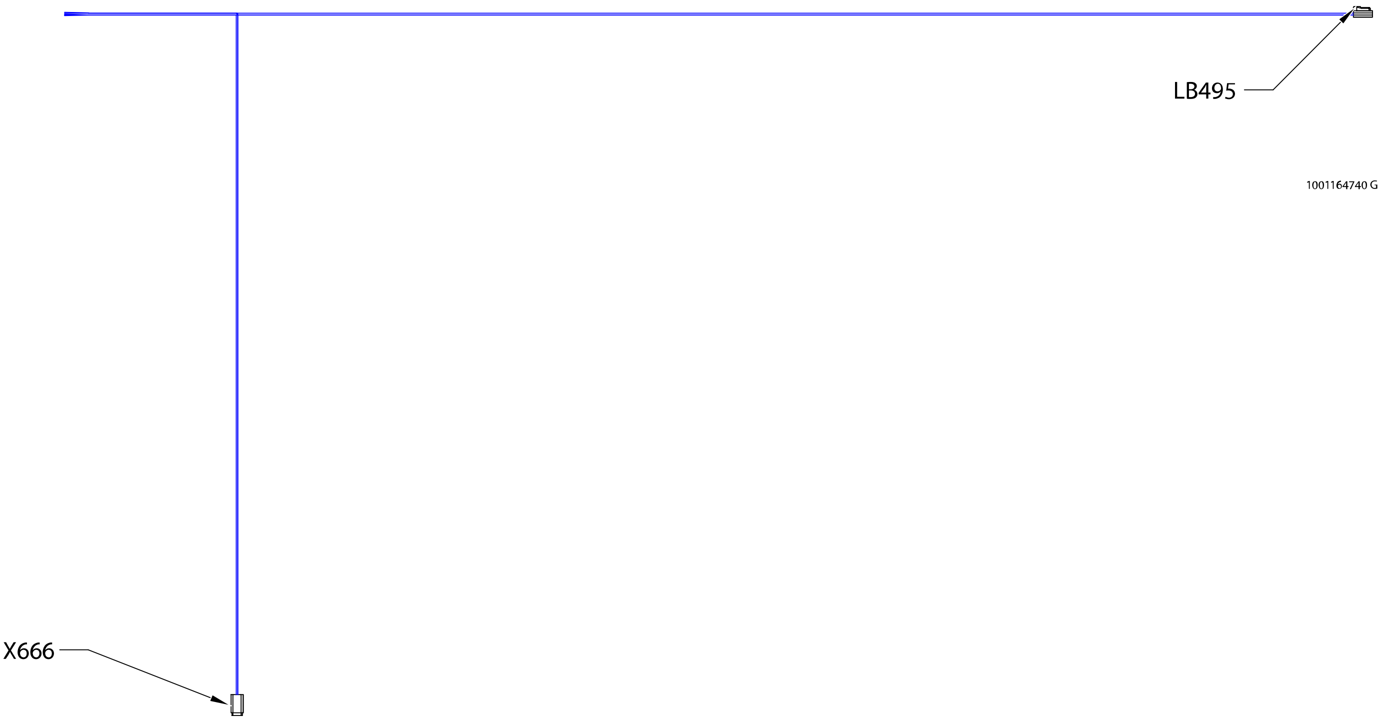
CONNECT TO CASE GROUND ON AUX PUMP RELAY

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-40-109 GND	16 AWG	GXL	RL673 (2)

CONNECTOR MUST INCLUDE 7.5A MINI FUSE

CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	FUSE HOLDER LEAD	16 AWG	GXL	X675 (1)
2	WHT	4-146 PWR	16 AWG	GXL	RL673 (1)

Figure 351. Chassis Head and Tail Lights Harness - Sheet 3 of 5



LB495					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-60-11 GND	16 AWG	GXL	S672 (1)
2	WHT	6-11 12V+	16 AWG	GXL	S671 (1)

X666					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	BLK	000-60-12 GND	16 AWG	GXL	S672 (2)
3	WHT	6-13 12V+	16 AWG	GXL	S671 (2)
4					

Figure 352. Chassis Head and Tail Lights Harness - Sheet 4 of 5

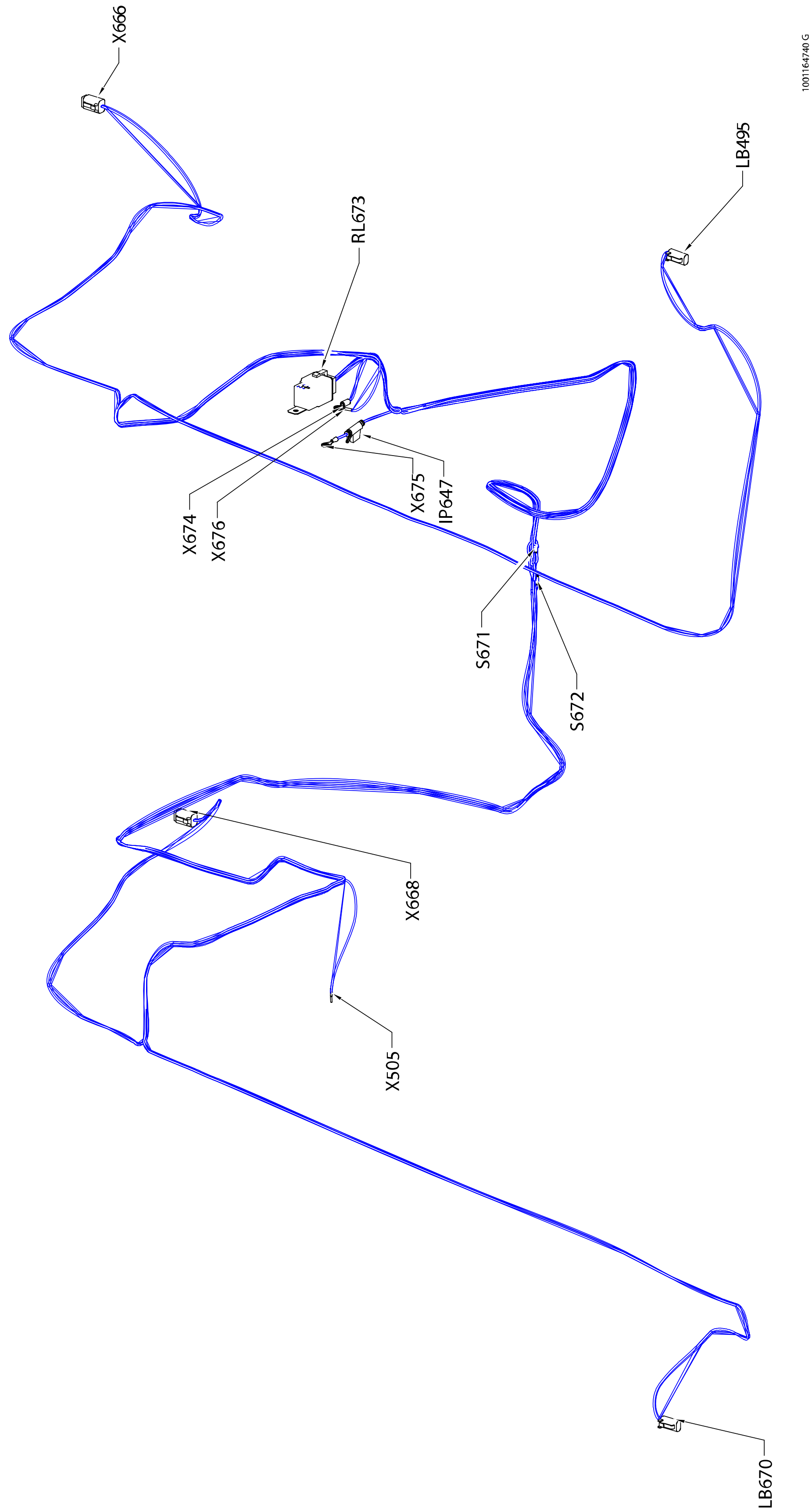


Figure 353. Chassis Head and Tail Lights Harness - Sheet 5 of 5

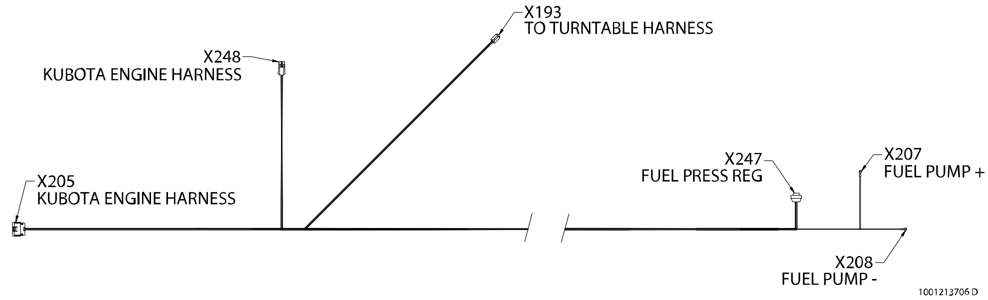


Figure 354. Kubota Engine Harness

X205KUBOTA ENGINE HARNESS					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	6-14 IGNITION	18 AWG	TXL	X193 (1)
B					
C	BLK	000-60-11 FUEL PUMP NEGATIVE	16 AWG	TXL	X208 (1)
D	WHT	6-54 FUEL PUMP POSITIVE	16 AWG	TXL	X207 (1)
E					
F	WHT	6-12 ENGINE START	18 AWG	TXL	X193 (2)
G					
H					
J					
K					
L					
M					
N	RED	CAN HI	18 AWG	CABLE	X193 (3)
P	BLK	CAN LO	18 AWG	CABLE	X193 (4)
R					
S					

X193 TO TURNTABLE HARNESS					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	6-14 IGNITION	18 AWG	TXL	X205 (A)
2	WHT	6-12 ENGINE START	18 AWG	TXL	X205 (F)
3	RED	CAN HI	18 AWG	CABLE	X205 (N)
4	BLK	CAN LO	18 AWG	CABLE	X205 (P)
5					
6					

X247 FUEL PRESS REG					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	6-19	18 AWG	TXL	X248 (1)
2	WHT	6-20	18 AWG	TXL	X248 (2)

X247 FUEL PRESS REG					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
3	RED	6-21	18 AWG	TXL	X248 (3)
4	GRN	6-22	18 AWG	TXL	X248 (4)

X208 FUEL PUMP -					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK0	00-60-11 FUEL PUMPNEGATIVE	16 AWG	TXL	X205 (C)

X207 FUEL PUMP +					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	6-54 FUEL PUMP POSITIVE	16 AWG	TXL	X205 (D)

X248 KUBOTA ENGINE HARNESS					
CONNPOS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	6-19	18 AWG	TXL	X247 (1)
2	WHT	6-20	18 AWG	TXL	X247 (2)
3	RED	6-21	18 AWG	TXL	X247 (3)
4	GRN	6-22	18 AWG	TXL	X247 (4)

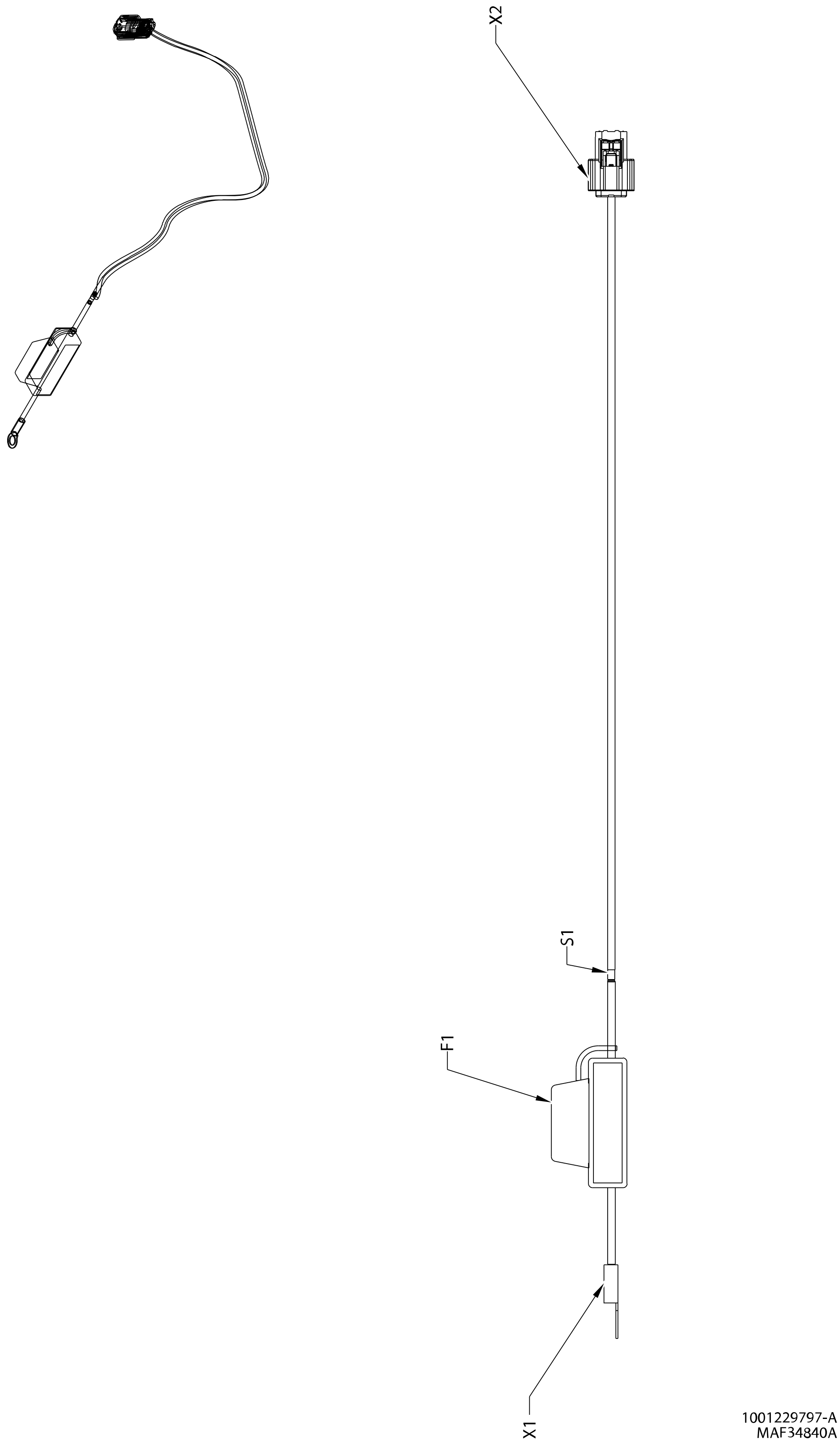


Figure 355. Kubota D/F PWR Harness - Sheet 1 of 2

X1 BATT POS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-1	6 AWG	GXL	F1 (1)

X2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-2	10 AWG	GXL	S1 (2)
2	RED	1-3	10 AWG	GXL	S1 (2)

F1 40A					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-1	6 AWG	GXL	X1 (1)
2	RED	1-1	6 AWG	GXL	S1 (1)

S1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-1	6 AWG	GXL	F1 (1)
2	RED	1-2	10 AWG	GXL	X2 (1)
2	RED	1-3	10 AWG	GXL	X2 (2)

Figure 356. Kubota D/F PWR Harness - Sheet 2 of 2

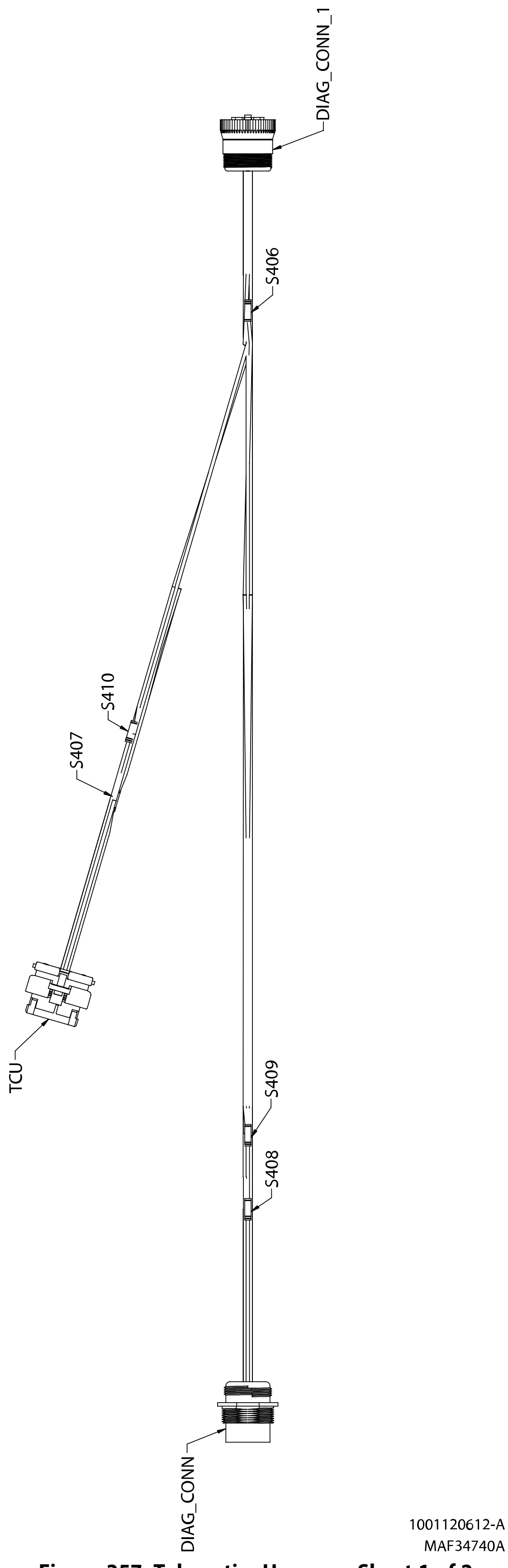


Figure 357. Telematics Harness - Sheet 1 of 2

S406					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-100-1 GND	16 AWG	GXL	TCU (16)
1	BLK	0-100-2 GND	16 AWG	GXL	DIAG_CONN (A)
2	BLK	0-100-3 GND	16 AWG	GXL	DIAG_CONN_1 (A)

S407					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-100-2 B+	16 AWG	GXL	DIAG_CONN (B)
1	RED	1-100-3 B+	16 AWG	GXL	DIAG_CONN_1 (B)
2	RED	1-100-1 B+	16 AWG	GXL	TCU (23)

S408					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4-100-1 CAN HI	18 AWG	GXL	TCU (7)
1	YEL	4-100-3 CAN HI	18 AWG	GXL	DIAG_CONN_1 (C)
2	YEL	4-100-2 CAN HI	18 AWG	GXL	DIAG_CONN (C)

S409					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	GRN	3-100-1 CAN LO	18 AWG	GXL	TCU (22)
1	GRN	3-100-3 CAN LO	18 AWG	GXL	DIAG_CONN_1 (D)
2	GRN	3-100-2 CAN LO	18 AWG	GXL	DIAG_CONN (D)

S410					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL/RED	2-100-2 IGN	18 AWG	GXL	DIAG_CONN (H)
2	YEL/RED	2-100-1 IGN	18 AWG	GXL	TCU (15)
2	YEL/RED	2-100-3 IGN	18 AWG	GXL	DIAG_CONN_1 (H)

DIAG_CONN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	0-100-2 GND	16 AWG	GXL	S406 (1)
B	RED	1-100-2 B+	16 AWG	GXL	S407 (1)
C	YEL	4-100-2 CAN HI	18 AWG	GXL	S408 (2)
D	GRN	3-100-2 CAN LO	18 AWG	GXL	S409 (2)
E	BLK	5-100-1 SHLD	18 AWG	GXL	DIAG_CONN_1 (E)
F					
G					
H	YEL/RED	2-100-2 IGN	18 AWG	GXL	S410 (1)
J					

TCU					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3					
4					
5					
6					
7	YEL	4-100-1 CAN HI	18 AWG	GXL	S408 (1)
8					
9					
10					
11					
12					
13					
14					
15	YEL/RED	2-100-1 IGN	18 AWG	GXL	S410 (2)
16	BLK	0-100-1 GND	16 AWG	GXL	S406 (1)
17					
18					
19					
20					
21					
22	GRN	3-100-1 CAN LO	18 AWG	GXL	S409 (1)
23	RED	1-100-1 B+	16 AWG	GXL	S407 (2)

DIAG_CONN_1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	0-100-3 GND	16 AWG	GXL	S406 (2)
B	RED	1-100-3 B+	16 AWG	GXL	S407 (1)
C	YEL	4-100-3 CAN HI	18 AWG	GXL	S408 (1)
D	GRN	3-100-3 CAN LO	18 AWG	GXL	S409 (1)
E	BLK	5-100-1 SHLD	18 AWG	GXL	DIAG_CONN (E)
F					
G					
H	YEL/RED	2-100-3 IGN	18 AWG	GXL	S410 (2)
J					

Figure 358. Telematics Harness - Sheet 2 of 2

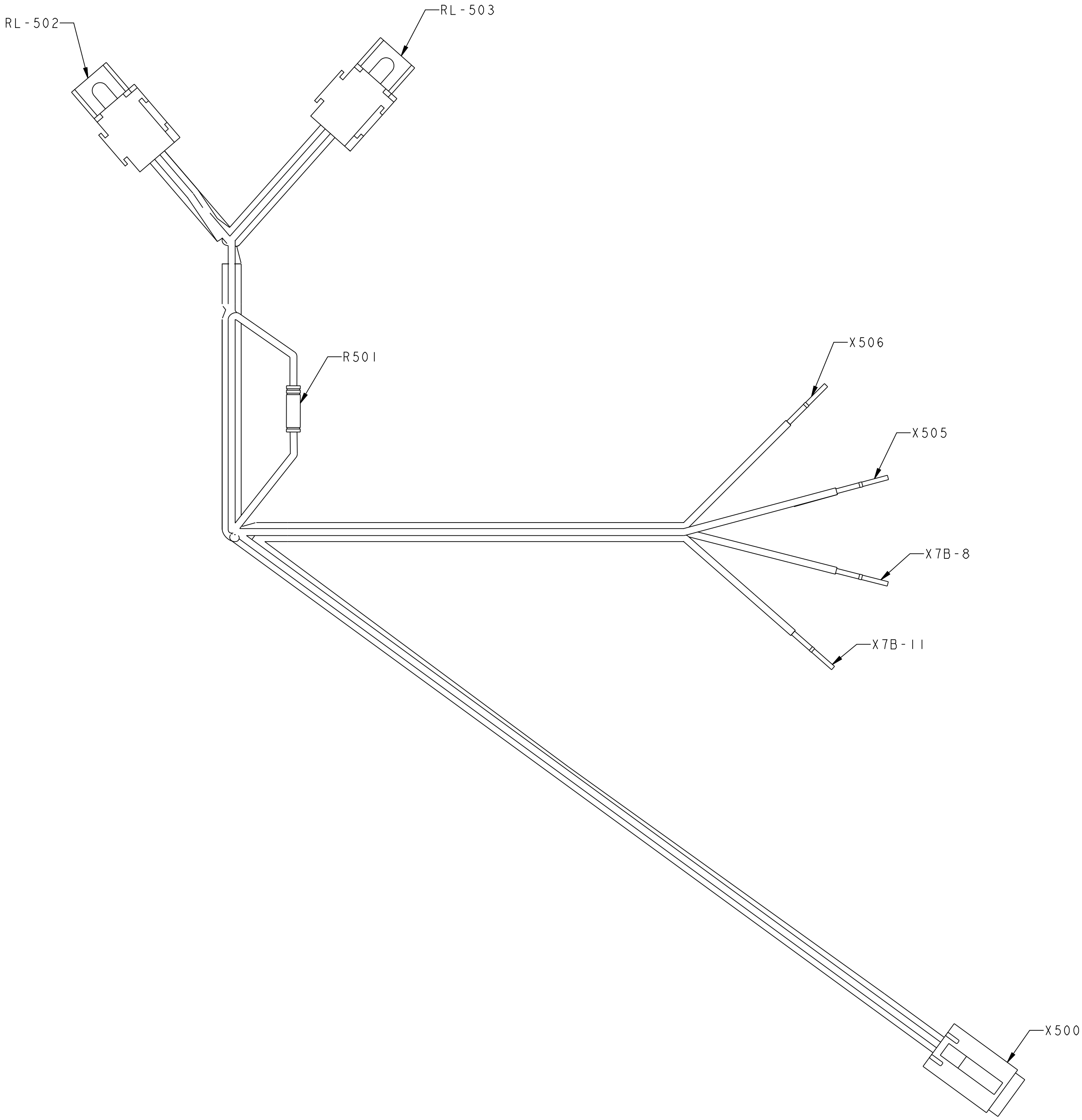


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Figure 359. Skyguard Harness - Sheet 1 of 2

RL-503 - SNSR RELAY 1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
30	WHT	P9	18 AWG	GXL	X505 (1)
30	WHT	P9-1	18 AWG	GXL	RL-502 (30)
85	WHT	P5-1	18 AWG	GXL	RL-502 (85)
86	WHT	P4-1	18 AWG	GXL	RL-502 (86)
87	WHT	P1	18 AWG	GXL	X506 (1)
87a					

R501					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P2	18 AWG	GXL	X505 (1)
2	WHT	P10	18 AWG	GXL	X500 (1)

RL-502 - SNSR RELAY 2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
30	WHT	P9-1	18 AWG	GXL	RL-503 (30)
85	WHT	P5	18 AWG	GXL	X500 (4)
85	WHT	P5-1	18 AWG	GXL	RL-503 (85)
86	WHT	P4	18 AWG	GXL	X500 (3)
86	WHT	P4-1	18 AWG	GXL	RL-503 (86)
87	WHT	P3	18 AWG	GXL	X7B-11 (1)
87a					

X506					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P1	18 AWG	GXL	RL-503 (87)

X505					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P2	18 AWG	GXL	R501 (1)
1	WHT	P9	18 AWG	GXL	RL-503 (30)

X7B-8					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P6	18 AWG	GXL	X500 (2)

X7B-11					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P3	18 AWG	GXL	RL-502 (87)

X500 - PLTFM SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P10	18 AWG	GXL	R501 (2)
2	WHT	P6	18 AWG	GXL	X7B-8 (1)
3	WHT	P4	18 AWG	GXL	RL-502 (86)
4	WHT	P5	18 AWG	GXL	RL-502 (85)

Figure 360. Skyguard Harness - Sheet 2 of 2

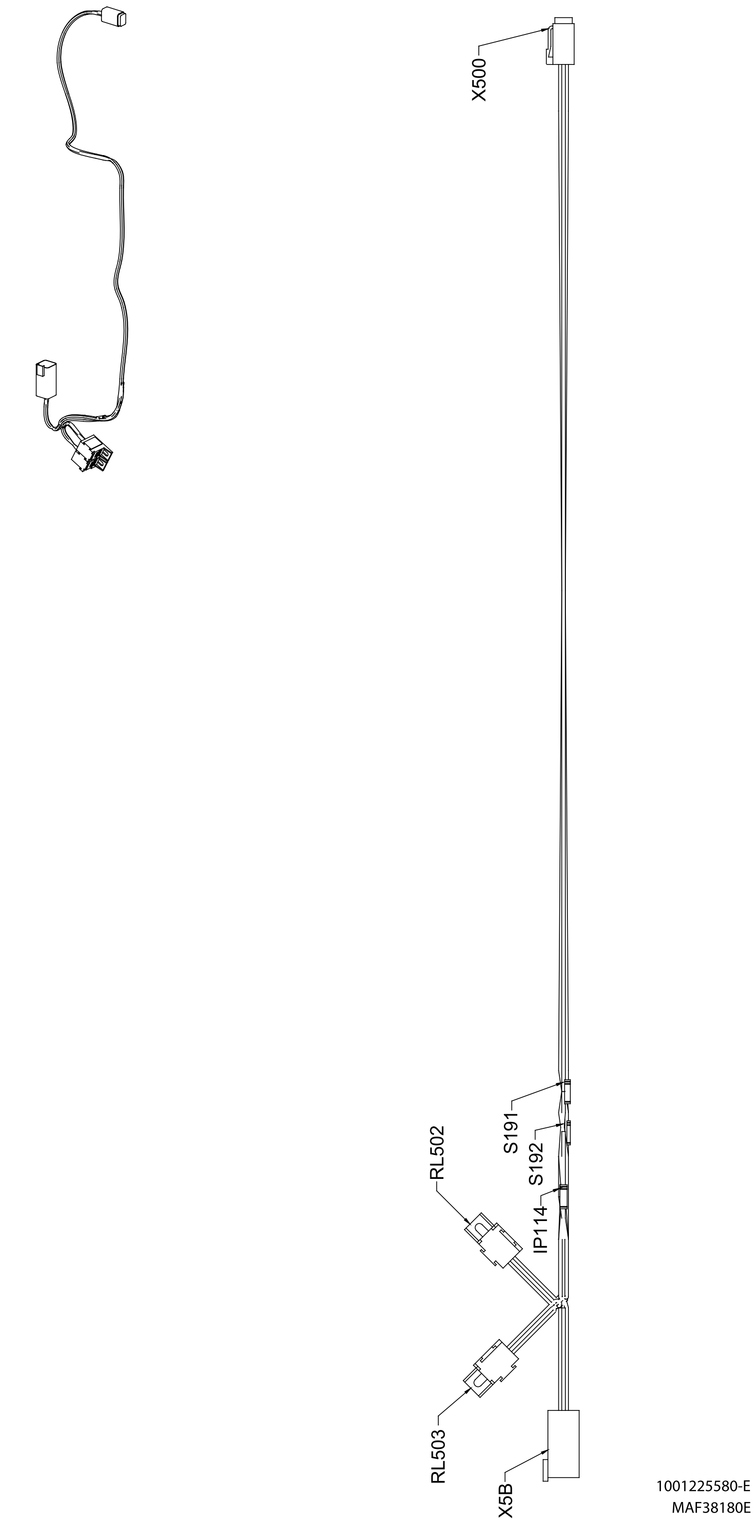


Figure 361. Gen 2 Platform Interface - Sheet 1 of 2

X5B - INTERFACE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P2	18 AWG	GXL	IP114 (1)
2	WHT	P6	18 AWG	GXL	X500 (2)
3					
4	WHT	P1	18 AWG	GXL	RL503 (87)
5	WHT	P3	18 AWG	GXL	RL502 (87)
6					

RL503 - SKYGUARD RELAY #1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
30	WHT	P9-1	18 AWG	GXL	IP114 (1)
85	WHT	P5-1	18 AWG	GXL	S191 (1)
86	WHT	P4-1	18 AWG	GXL	S192 (1)
87	WHT	P1	18 AWG	GXL	X5B (4)
87A					

RL502 - SKYGUARD RELAY #2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
30	WHT	P9-2	18 AWG	GXL	IP114 (1)
85	WHT	P5-2	18 AWG	GXL	S191 (1)
86	WHT	P4-2	18 AWG	GXL	S192 (1)
87	WHT	P3	18 AWG	GXL	X5B (5)
87A					

S191					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P5-1	18 AWG	GXL	RL503 (85)
1	WHT	P5-2	18 AWG	GXL	RL502 (85)
2	WHT	P5	18 AWG	GXL	X500 (4)

S192					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P4-1	18 AWG	GXL	RL503 (86)
1	WHT	P4-2	18 AWG	GXL	RL503 (86)
2	WHT	P4	18 AWG	GXL	X500 (3)

X500 - PLAT SENSOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	P10	18 AWG	GXL	IP114 (2)
2	WHT	P6	18 AWG	GXL	X5B (2)

X500 - PLAT SENSOR					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
3	WHT	P4	18 AWG	GXL	S192 (2)
4	WHT	P5	18 AWG	GXL	S191 (2)

IP114					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	WHT	P2	18 AWG	GXL	X5B (1)
1	WHT	P9-1	18 AWG	GXL	RL503 (30)
1	WHT	P9-2	18 AWG	GXL	RL502 (30)
2	WHT	P10	18 AWG	GXL	X500 (1)

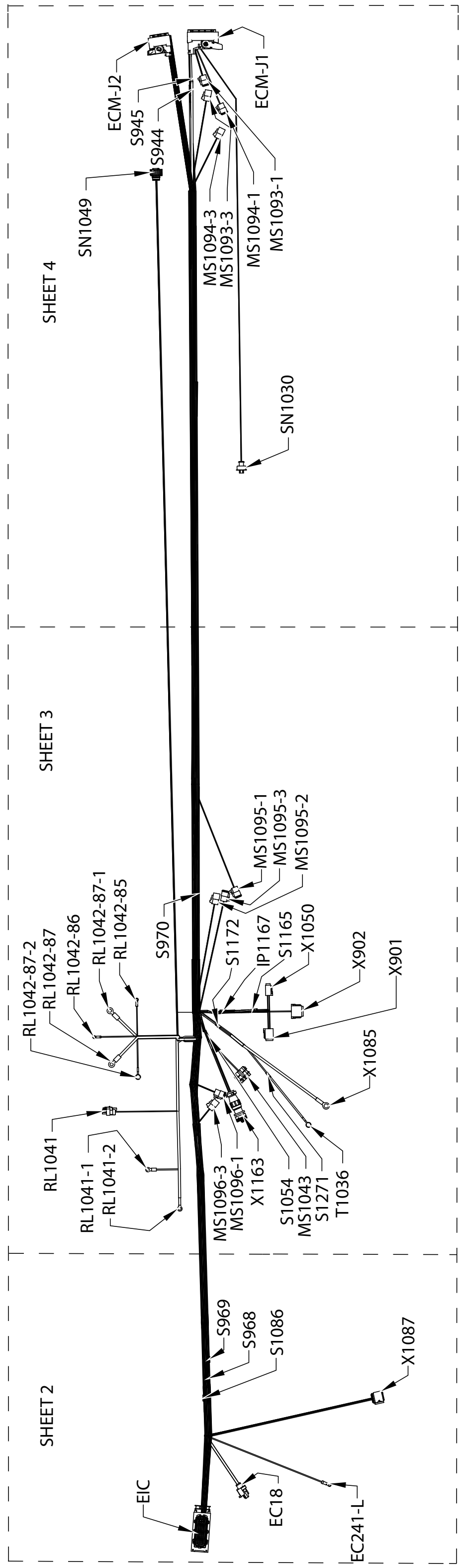


Figure 362. Deutz D2.9L4 (Stage V) Engine Harness - Sheet 1 of 4

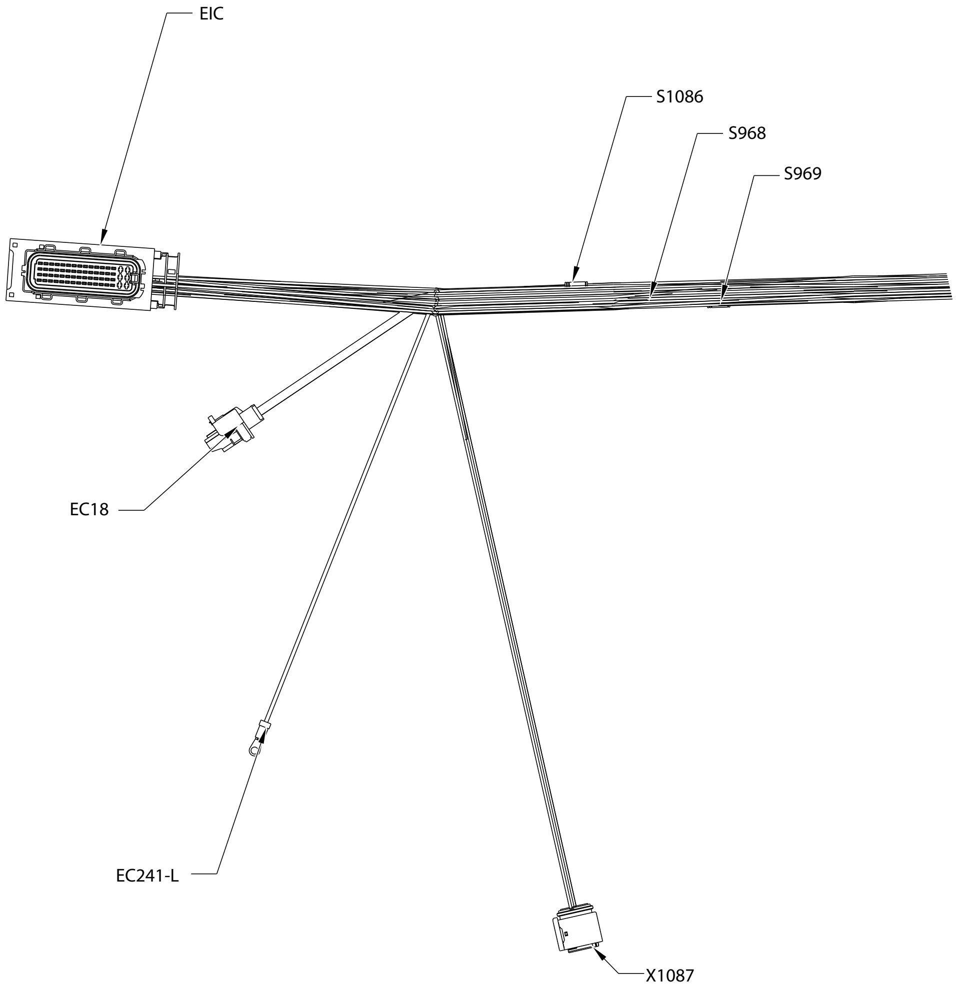


Figure 363. Deutz D2.9L4 (Stage V) Engine Harness - Sheet 2 of 4

EIC					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	SHLD	248-38	18 AWG	CABLE	ECM-J2 (38)
2	BLK	148-30	0.75 mm^2	FLRYW	ECM-J2 (41)
3	BLK	148-51	0.75 mm^2	FLRYW	ECM-J2 (50)
4	BLK	148-23	0.75 mm^2	FLRYW	ECM-J1 (23)
5	BLK	148-82	0.75 mm^2	FLRYW	ECM-J1 (82)
6	BLK	148-81	0.75 mm^2	FLRYW	ECM-J1 (81)
7	BLK	148-33	0.75 mm^2	FLRYW	ECM-J1 (33)
8	BLK	148-7	0.75 mm^2	FLRYW	ECM-J1 (7)
9	SHLD	248-53	18 AWG	CABLE	ECM-J2 (53)
10					
11					

EIC					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
12					
13	BLK	248-52	18 AWG	CABLE	ECM-J2 (52)
14	RED	248-37	18 AWG	CABLE	ECM-J2 (37)
15	RED	248-39	18 AWG	CABLE	ECM-J2 (39)
16					
17	BLK	148-58	0.75 mm^2	CABLE	ECM-J1 (58)
18	BLK	148-43	0.75 mm^2	CABLE	ECM-J1 (43)
19	BLK	248-5	1.5 mm^2	CABLE	ECM-J2 (5)
20	BLK	248-4	1.5 mm^2	CABLE	ECM-J2 (4)
21	BLK	248-54	18 AWG	CABLE	ECM-J2 (54)
22	BLK	248-9	0.75 mm^2	FLRYW	ECM-J2 (9)
23	BLK	248-43	0.75 mm^2	FLRYW	ECM-J2 (43)
24	BLK	248-28	0.75 mm^2	FLRYW	ECM-J2 (28)
25	BLK	248-26	0.75 mm^2	FLRYW	ECM-J2 (26)
26	BLK	248-44	0.75 mm^2	FLRYW	ECM-J2 (44)
27	BLK	248-29	0.75 mm^2	FLRYW	ECM-J2 (29)
28	BLK	248-42	0.75 mm^2	FLRYW	ECM-J2 (42)
29	BLK	248-27	0.75 mm^2	FLRYW	ECM-J2 (27)
30	BLK	248-24-2	0.75 mm^2	FLRYW	S1086 (2)
31	BLK	248-25	0.75 mm^2	FLRYW	ECM-J2 (25)
32	BLK	248-7	0.75 mm^2	FLRYW	ECM-J2 (7)
33	BLK	248-57-33	0.75 mm^2	FLRYW	S968 (2)
34	BLK	148-21	0.75 mm^2	FLRYW	ECM-J2 (21)
35	BLK	248-16	1.5 mm^2	FLRYW	ECM-J2 (16)
36	BLK	248-33	1.5 mm^2	FLRYW	ECM-J2 (33)
37	BLK	248-18	1.5 mm^2	FLRYW	ECM-J2 (18)
38	BLK	248-32	1.5 mm^2	FLRYW	ECM-J2 (32)
39	BLK	248-2	1.5 mm^2	FLRYW	ECM-J2 (2)
40	BLK	248-46	1.5 mm^2	FLRYW	ECM-J2 (46)
41	BLK	248-3	1.5 mm^2	FLRYW	ECM-J2 (3)
42	BLK	248-48	1.5 mm^2	FLRYW	ECM-J2 (48)
43	BLK	248-24-1	0.75 mm^2	FLRYW	S1086 (2)
44	BLK	248-11	0.75 mm^2	FLRYW	ECM-J2 (11)
45	BLK	248-57-45	0.75 mm^2	FLRYW	S968 (2)
46	BLK	248-12	0.75 mm^2	FLRYW	ECM-J2 (12)

EIC					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
47	BLK	248-19	1.5 mm^2	FLRYW	ECM-J2 (19)
48	BLK	248-20	1.5 mm^2	FLRYW	ECM-J2 (20)
49	BLK	148-80	0.75 mm^2	FLRYW	ECM-J1 (80)
50	BLK	248-22	0.75 mm^2	FLRYW	ECM-J2 (22)
51	BLK	248-40-51	0.75 mm^2	FLRYW	S969 (2)
52	BLK	148-64	0.75 mm^2	FLRYW	ECM-J1 (64)
53	BLK	148-46	0.75 mm^2	FLRYW	ECM-J1 (46)
54					
55					
56					
57					
58					
59	BLK	148-8	0.75 mm^2	FLRYW	ECM-J1 (8)
60	BLK	148-9	0.75 mm^2	FLRYW	ECM-J1 (9)
61					
62					

EC18					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	48-13	8 AWG	GXL	RL1042-87 (1)
2	RED	48-14	8 AWG	GXL	RL1042-87-1 (1)

EC241-L					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	47-8	16 AWG	GXL	X901 (1)

X1087					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	248-59	0.75 mm^2	FLRYW	ECM-J2 (59)
2	BLK	248-57-2	0.75 mm^2	FLRYW	S968 (2)
3	BLK	148-56	0.75 mm^2	FLRYW	ECM-J1 (56)
4	BLK	148-55	0.75 mm^2	FLRYW	ECM-J1 (55)
5	BLK	248-21	0.75 mm^2	FLRYW	ECM-J1 (91)
6	BLK	248-40-7	0.75 mm^2	FLRYW	S969 (2)
7	BLK	248-30	0.75 mm^2	FLRYW	ECM-J2 (21)
8					

S1086					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	248-24	0.75 mm^2	FLRYW	ECM-J2 (24)
2	BLK	248-24-1	0.75 mm^2	FLRYW	EIC (43)
2	BLK	248-24-2	0.75 mm^2	FLRYW	EIC (30)

S968					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	248-57	0.75 mm^2	FLRYW	ECM-J2 (57)
2	BLK	248-57-2	0.75 mm^2	FLRYW	X1087 (2)
2	BLK	248-57-33	0.75 mm^2	FLRYW	EIC (33)
2	BLK	248-57-45	0.75 mm^2	FLRYW	EIC (45)

S969					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	248-40	0.75 mm^2	FLRYW	ECM-J2 (40)
2	BLK	248-40-7	0.75 mm^2	FLRYW	X1087 (6)
2	BLK	248-40-51	0.75 mm^2	FLRYW	EIC (51)

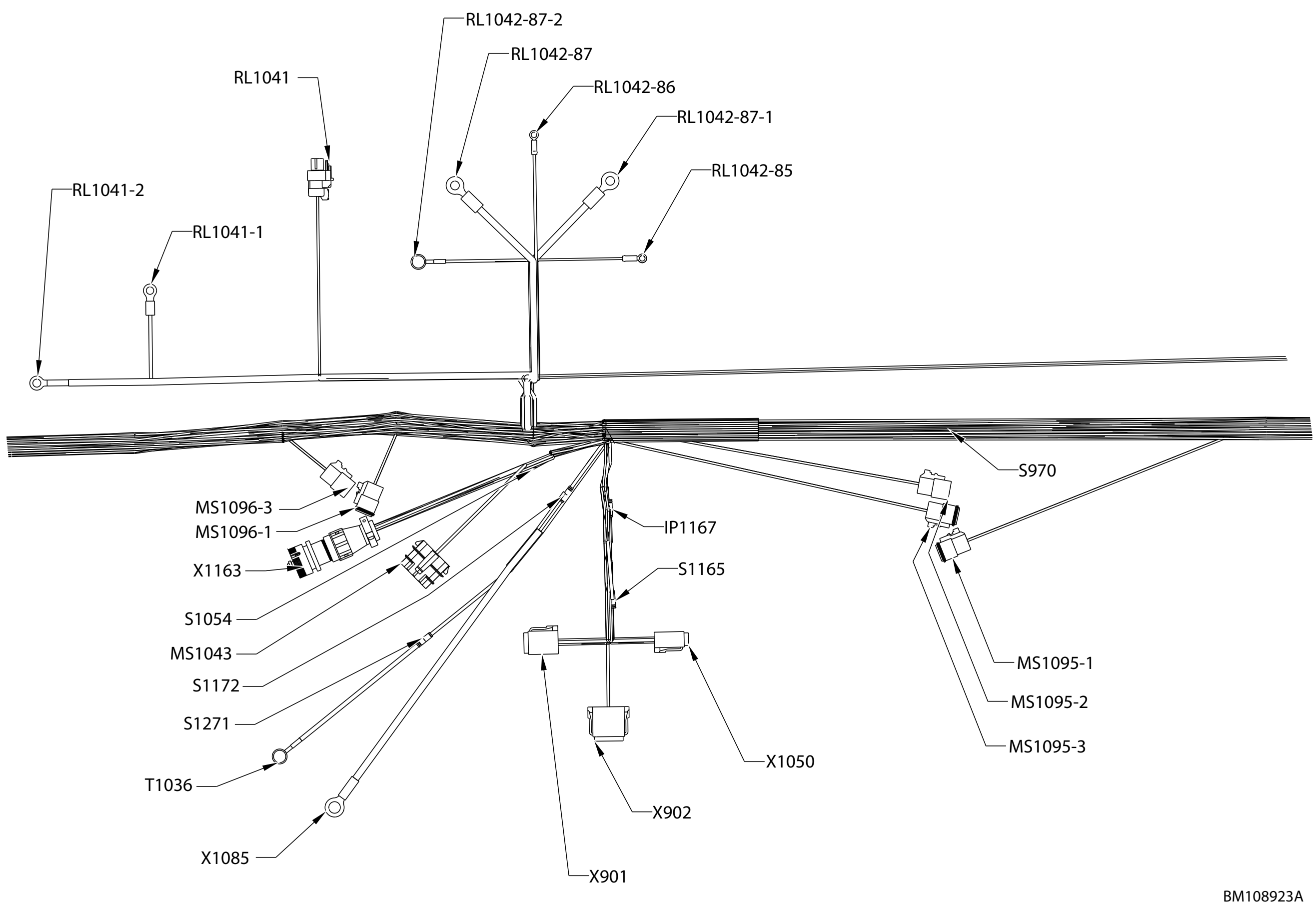


Figure 364. Deutz D2.9L4 (Stage V) Engine Harness - Sheet 3 of 4

RL1042-87-1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	48-14	8 AWG	GXL	EC18 (2)

RL1042-87					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	48-13	8 AWG	GXL	EC18 (1)

RL1041					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	148-73	18 AWG	TXL	ECM-J1 (73)
2	BLK	148-25	0.75 mm^2	FLRYW	ECM-J1 (25)

RL1041-2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	148-135	8 AWG	GXL	S944 (2)

RL1041-1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-96	14 AWG	GXL	X1050 (3)

MS1095-1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN_1_HI	18 AWG	J1939 CABLE	MS1094-3 (A)
B	GRN	CAN_1_LO	18 AWG	J1939 CABLE	MS1094-3 (B)
C					

MS1095-2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN_1_HI	18 AWG	J1939 CABLE	X901 (3)
B	GRN	CAN_1_LO	18 AWG	J1939 CABLE	X901 (4)
C					

MS1095-3					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN_1_HI	18 AWG	J1939 CABLE	X1163 (M)
B	GRN	CAN_1_LO	18 AWG	J1939 CABLE	X1163 (F)
C					

MS1096-1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN_2_HI	18 AWG	J1939 CABLE	MS1093-3 (A)
B	GRN	CAN_2_LO	18 AWG	J1939 CABLE	MS1093-3 (B)
C					

MS1096-3					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN_2_HI	18 AWG	J1939 CABLE	X1163 (H)
B	GRN	CAN_2_LO	18 AWG	J1939 CABLE	X1163 (G)
C					

X1085					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-246	8 AWG	GXL	S945 (2)

T1036					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-48-5	12 AWG	GXL	S1271 (2)

X1050					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	248-58	0.75 mm^2	FLRYW	ECM-J2 (58)
2	BLK	148-87-2	0.75 mm^2	FLRYW	S970 (1)
3	WHT	48-96	14 AWG	GXL	RL1041-1 (1)
4	BLK	000-48-1	14 AWG	GXL	S1271 (1)

RL1042-87-2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	148-20-1	18 AWG	GXL	MS1043 (F)

S1271					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-48-1	14 AWG	GXL	X1050 (4)
1	BLK	000-48-2	18 AWG	GXL	X1163 (B)
1	BLK	000-48-4	18 AWG	GXL	S1172 (1)
2	BLK	000-48-5	12 AWG	GXL	T1036 (1)

X901					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	48-3	18 AWG	GXL	S1165 (2)

X901					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
3	YEL	CAN_1_HI	18 AWG	J1939 CABLE	MS1095-2 (A)
4	GRN	CAN_1_LO	18 AWG	J1939 CABLE	MS1095-2 (B)
5	RED	47-8	16 AWG	GXL	EC241-L (1)
6					

X902					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-1-99	18 AWG	GXL	MS1043 (G)
2					
3					
4					
5					
6					
7					
8					

S1054					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-48-1	16 AWG	GXL	MS1043 (H)
1	YEL	2-48-2	18 AWG	GXL	X1163 (A)
2	YEL	2-48-3	18 AWG	GXL	RL1042-86 (1)
2	YEL	2-48-4	0.75 mm^2	FLRYW	ECM-J1 (88)
2	YEL	2-48-5	0.75 mm^2	FLRYW	ECM-J1 (19)

RL1042-85					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-72	0.75 mm^2	FLRYW	ECM-J1 (72)

X1163					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	2-48-2	18 AWG	GXL	S1054 (1)
B	BLK	000-48-2	18 AWG	GXL	S1271 (1)
C					
D					
E					
F	GRN	CAN_1_LO	18 AWG	J1939 CABLE	MS1095-3 (B)
G	GRN	CAN_2_LO	18 AWG	J1939 CABLE	MS1096-3 (B)
H	YEL	CAN_2_HI	18 AWG	J1939 CABLE	MS1096-3 (A)

X1163					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
J					
K					
L					
M	YEL	CAN_1_HI	18 AWG	J1939 CABLE	MS1095-3 (A)

RL1042-86					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-48-3	18 AWG	GXL	S1054 (2)

MS1043					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A					
B					
C					
D					
E	BLK	148-20	0.75 mm^2	FLRYW	ECM-J1 (20)
F	ORG	148-20-1	18 AWG	GXL	RL1042-87-2 (1)
G	YEL	2-1-99	18 AWG	GXL	X902 (1)
H	YEL	2-48-1	18 AWG	GXL	S1054 (1)

S1172					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	000-48-4	18 AWG	GXL	S1271 (1)
2	BLK	FUSE	14 AWG	GXL	IP1167 (2)

IP1167					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	FUSE	14 AWG	GXL	S1165 (1)
2	BLK	FUSE	14 AWG	GXL	S1172 (2)

S1165					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-3-2	0.75 mm^2	FLRYW	ECM-J1 (35)
1	BLK	FUSE	14 AWG	GXL	IP1167 (1)
2	WHT	48-3	18 AWG	GXL	X901 (2)

S970					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	148-87	0.75 mm^2	FLRYW	ECM-J1 (87)
1	BLK	148-87-2	0.75 mm^2	FLRYW	X1050 (2)
2	BLK	148-87-1	0.75 mm^2	FLRYW	SN1049 (2)

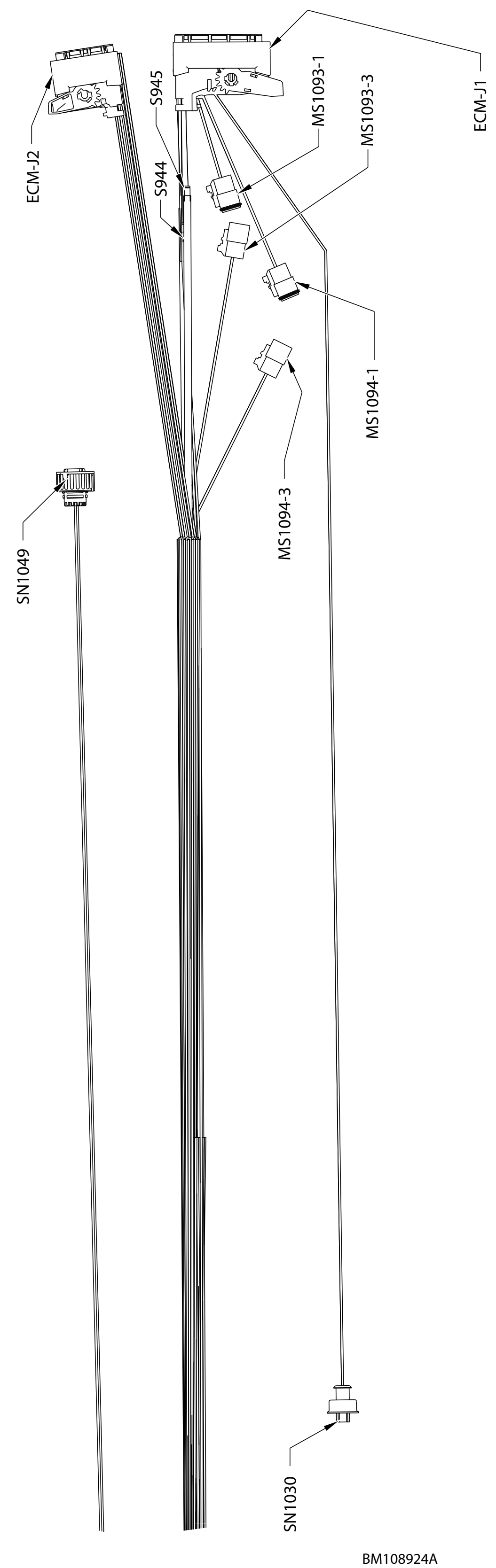


Figure 365. Deutz D2.9L4 (Stage V) Engine Harness - Sheet 4 of 4

ECM-J1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	148-1	2.5 mm^2	FLRYW	S944 (1)
2	BLK	148-2	2.5 mm^2	FLRYW	S945 (1)
3	RED	148-3	2.5 mm^2	FLRYW	S944 (1)
4	BLK	148-4	2.5 mm^2	FLRYW	S945 (1)
5	RED	148-5	2.5 mm^2	FLRYW	S944 (1)
6	BLK	148-6	2.5 mm^2	FLRYW	S945 (1)
7	BLK	148-7	0.75 mm^2	FLRYW	EIC (8)
8	BLK	148-8	0.75 mm^2	FLRYW	EIC (59)
9	BLK	148-9	0.75 mm^2	FLRYW	EIC (60)
10					
11					
12					
13	BLK	148-13	0.75 mm^2	FLRYW	SN1049 (3)
14					
15					
16					
17					
18					
19	YEL	2-48-5	0.75 mm^2	FLRYW	S1054 (2)
20	BLK	148-20	0.75 mm^2	FLRYW	MS1043 (E)
21	BLK	148-21	0.75 mm^2	FLRYW	EIC (34)
22					
23	BLK	148-23	0.75 mm^2	FLRYW	EIC (4)
24					
25	BLK	148-25	0.75 mm^2	FLRYW	RL1041 (2)
26					
27					
28					
29	WHT	148-89	0.75 mm^2	FLRYW	SN1049 (1)
30					
31					
32					
33	BLK	148-33	0.75 mm^2	FLRYW	EIC (7)
34					
35	WHT	48-3-2	0.75 mm^2	FLRYW	S1165 (1)
36					

ECM-J1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
37					
38					
39	BLK	148-39	0.75 mm^2	FLRYW	SN1030 (1)
40					
41					
42					
43	BLK	148-43	0.75 mm^2	FLRYW	EIC (18)
44					
45					
46	BLK	148-46	0.75 mm^2	FLRYW	EIC (53)
47					
48					
49					
50					
51					
52					
53	GRN	CAN_2_LO	20 AWG	TXL	MS1093-1 (B)
54	YEL	CAN_1_HI	20 AWG	TXL	MS1094-1 (A)
55	BLK	148-55	0.75 mm^2	FLRYW	X1087 (4)
56	BLK	148-56	0.75 mm^2	FLRYW	X1087 (3)
57					
58	BLK	148-58	0.75 mm^2	FLRYW	EIC (17)
59					
60	BLK	148-60	0.75 mm^2	FLRYW	SN1030 (2)
61					
62					
63					
64	BLK	148-64	0.75 mm^2	FLRYW	EIC (52)
65					
66					
67					
68					
69					
70					
71					
72	BLK	148-72	0.75 mm^2	FLRYW	RL1042-85 (1)
73	YEL	148-73	18 AWG	TXL	RL1041 (1)

ECM-J1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
74					
75	YEL	CAN_2_HI	20 AWG	TXL	MS1093-1 (A)
76	GRN	CAN_1_LO	20 AWG	TXL	MS1094-1 (B)
77					
78					
79					
80	BLK	148-80	0.75 mm^2	FLRYW	EIC (49)
81	BLK	148-81	0.75 mm^2	FLRYW	EIC (6)
82	BLK	148-82	0.75 mm^2	FLRYW	EIC (5)
83					
84					
85					
86					
87	BLK	148-87	0.75 mm^2	FLRYW	S970 (1)
88	YEL	2-48-4	0.75 mm^2	FLRYW	S1054 (2)
89					
90					
91	BLK	248-21	0.75 mm^2	FLRYW	X1087 (5)
92					
93					
94					

ECM-J2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	BLK	248-2	1.5 mm^2	FLRYW	EIC (39)
3	BLK	248-3	1.5 mm^2	FLRYW	EIC (41)
4	BLK	248-4	1.5 mm^2	FLRYW	EIC (20)
5	BLK	248-5	1.5 mm^2	FLRYW	EIC (19)
6					
7	BLK	248-7	0.75 mm^2	FLRYW	EIC (32)
8					
9	BLK	248-9	0.75 mm^2	FLRYW	EIC (22)
10					
11	BLK	248-11	0.75 mm^2	FLRYW	EIC (44)
12	BLK	248-12	0.75 mm^2	FLRYW	EIC (46)
13					

ECM-J2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
14					
15					
16	BLK	248-16	1.5 mm^2	FLRYW	EIC (35)
17					
18	BLK	248-18	1.5 mm^2	FLRYW	EIC (37)
19	BLK	248-19	1.5 mm^2	FLRYW	EIC (47)
20	BLK	248-20	1.5 mm^2	FLRYW	EIC (48)
21	BLK	248-30	0.75 mm^2	FLRYW	X1087 (7)
22	BLK	248-22	0.75 mm^2	FLRYW	EIC (50)
23					
24	BLK	248-24	0.75 mm^2	FLRYW	S1086 (1)
25	BLK	248-25	0.75 mm^2	FLRYW	EIC (31)
26	BLK	248-26	0.75 mm^2	FLRYW	EIC (25)
27	BLK	248-27	0.75 mm^2	FLRYW	EIC (29)
28	BLK	248-28	0.75 mm^2	FLRYW	EIC (24)
29	BLK	248-29	0.75 mm^2	FLRYW	EIC (27)
30					
31					
32	BLK	248-32	1.5 mm^2	FLRYW	EIC (38)
33	BLK	248-33	1.5 mm^2	FLRYW	EIC (36)
34					
35					
36					
37	RED	248-37	18 AWG	CABLE	EIC (14)
38	SHLD	248-38	18 AWG	CABLE	EIC (1)
39	RED	248-39	18 AWG	CABLE	EIC (15)
40	BLK	248-40	0.75 mm^2	FLRYW	S969 (1)
41	BLK	148-30	0.75 mm^2	FLRYW	EIC (2)
42	BLK	248-42	0.75 mm^2	FLRYW	EIC (28)
43	BLK	248-43	0.75 mm^2	FLRYW	EIC (23)
44	BLK	248-44	0.75 mm^2	FLRYW	EIC (26)
45					
46	BLK	248-46	1.5 mm^2	FLRYW	EIC (40)
47					
48	BLK	248-48	1.5 mm^2	FLRYW	EIC (42)
49					

ECM-J2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
50	BLK	148-51	0.75 mm^2	FLRYW	EIC (3)
51					
52	BLK	248-52	18 AWG	CABLE	EIC (13)
53	SHLD	248-53	18 AWG	CABLE	EIC (9)
54	BLK	248-54	18 AWG	CABLE	EIC (21)
55					
56					
57	BLK	248-57	0.75 mm^2	FLRYW	S968 (1)
58	BLK	248-58	0.75 mm^2	FLRYW	X1050 (1)
59	BLK	248-59	0.75 mm^2	FLRYW	X1087 (1)
60					

S944					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	148-1	2.5 mm^2	FLRYW	ECM-J1 (1)
1	RED	148-3	2.5 mm^2	FLRYW	ECM-J1 (3)
1	RED	148-5	2.5 mm^2	FLRYW	ECM-J1 (5)
2	RED	148-135	8 AWG	GXL	RL1041-2 (1)

SN1030					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-39	0.75 mm^2	FLRYW	ECM-J1 (39)
2	BLK	148-60	0.75 mm^2	FLRYW	ECM-J1 (60)

MS1093-3					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN_2_HI	18 AWG	J1939 CABLE	MS1096-1 (A)
B	GRN	CAN_2_LO	18 AWG	J1939 CABLE	MS1096-1 (B)
C					

MS1093-1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN_2_HI	20 AWG	TXL	ECM-J1 (75)
B	GRN	CAN_2_LO	20 AWG	TXL	ECM-J1 (53)
C					

MS1094-3					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN_1_HI	18 AWG	J1939 CABLE	MS1095-1 (A)
B	GRN	CAN_1_LO	18 AWG	J1939 CABLE	MS1095-1 (B)
C					

S945					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	148-2	2.5 mm^2	FLRYW	ECM-J1 (2)
1	BLK	148-4	2.5 mm^2	FLRYW	ECM-J1 (4)
1	BLK	148-6	2.5 mm^2	FLRYW	ECM-J1 (6)
2	BLK	148-246	8 AWG	GXL	X1085 (1)

MS1094-1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CAN_1_HI	20 AWG	TXL	ECM-J1 (54)
B	GRN	CAN_1_LO	20 AWG	TXL	ECM-J1 (76)
C					

SN1049					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	148-89	0.75 mm^2	FLRYW	ECM-J1 (29)
2	BLK	148-87-1	0.75 mm^2	FLRYW	S970 (2)
3	BLK	148-13	0.75 mm^2	FLRYW	ECM-J1 (13)
4					

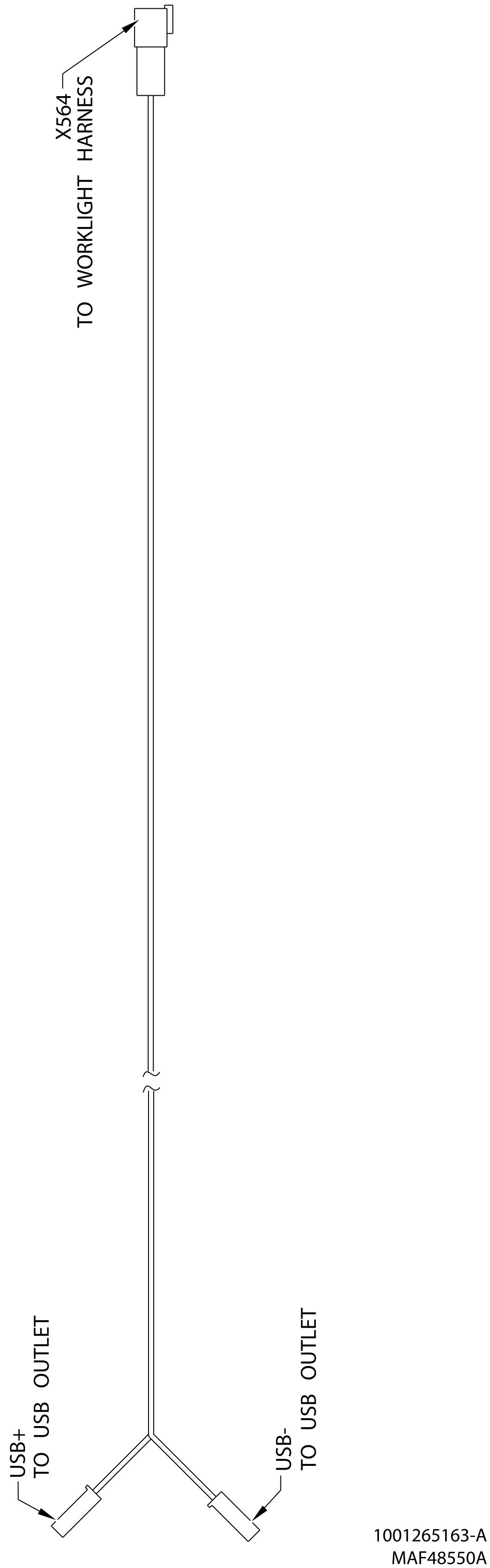


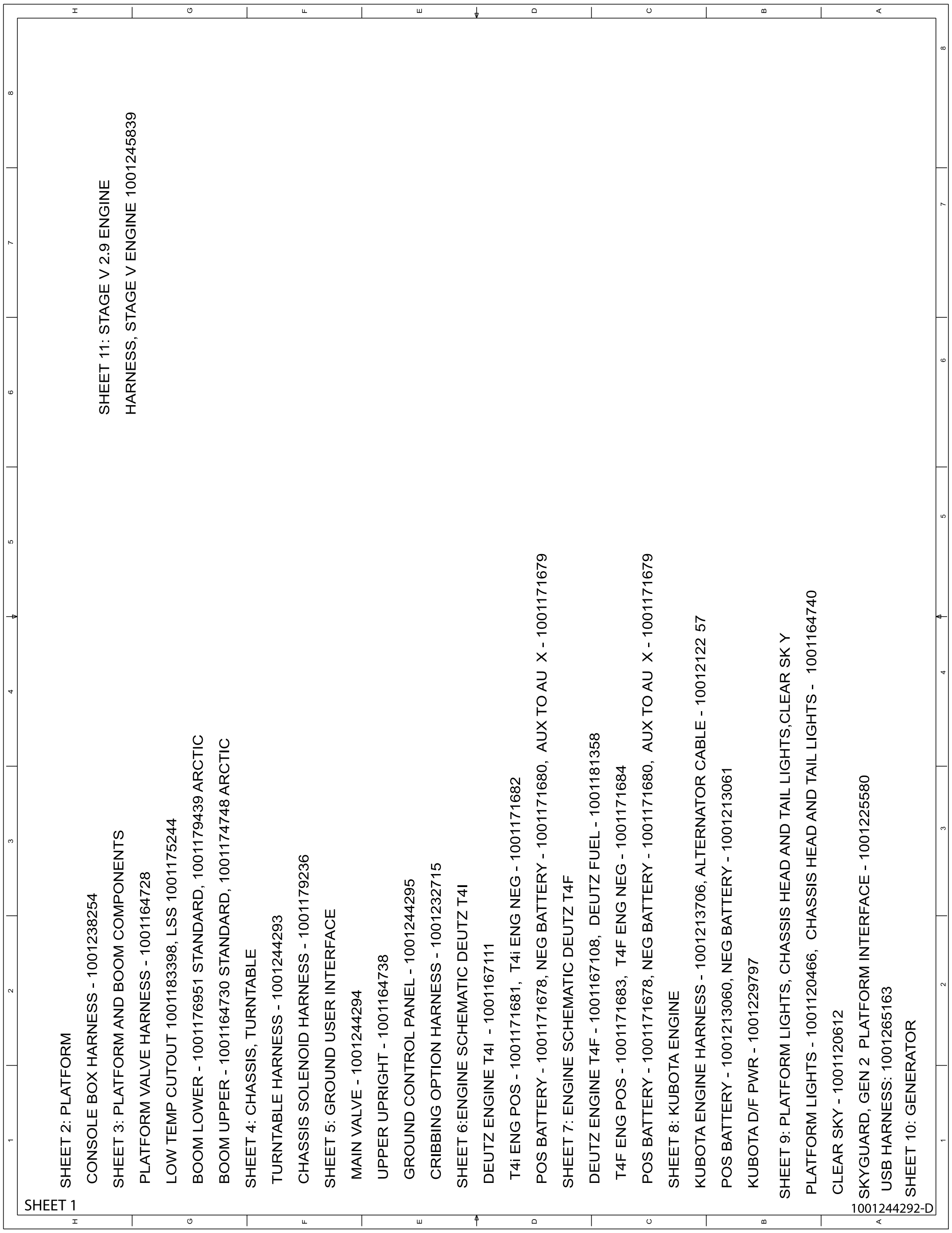
Figure 366. USB Harness

USB+ - TO USB OUTLET					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	B+	16 AWG	GXL	X564 (2)

USB- - TO USB OUTLET					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	B-	16 AWG	GXL	X564 (1)

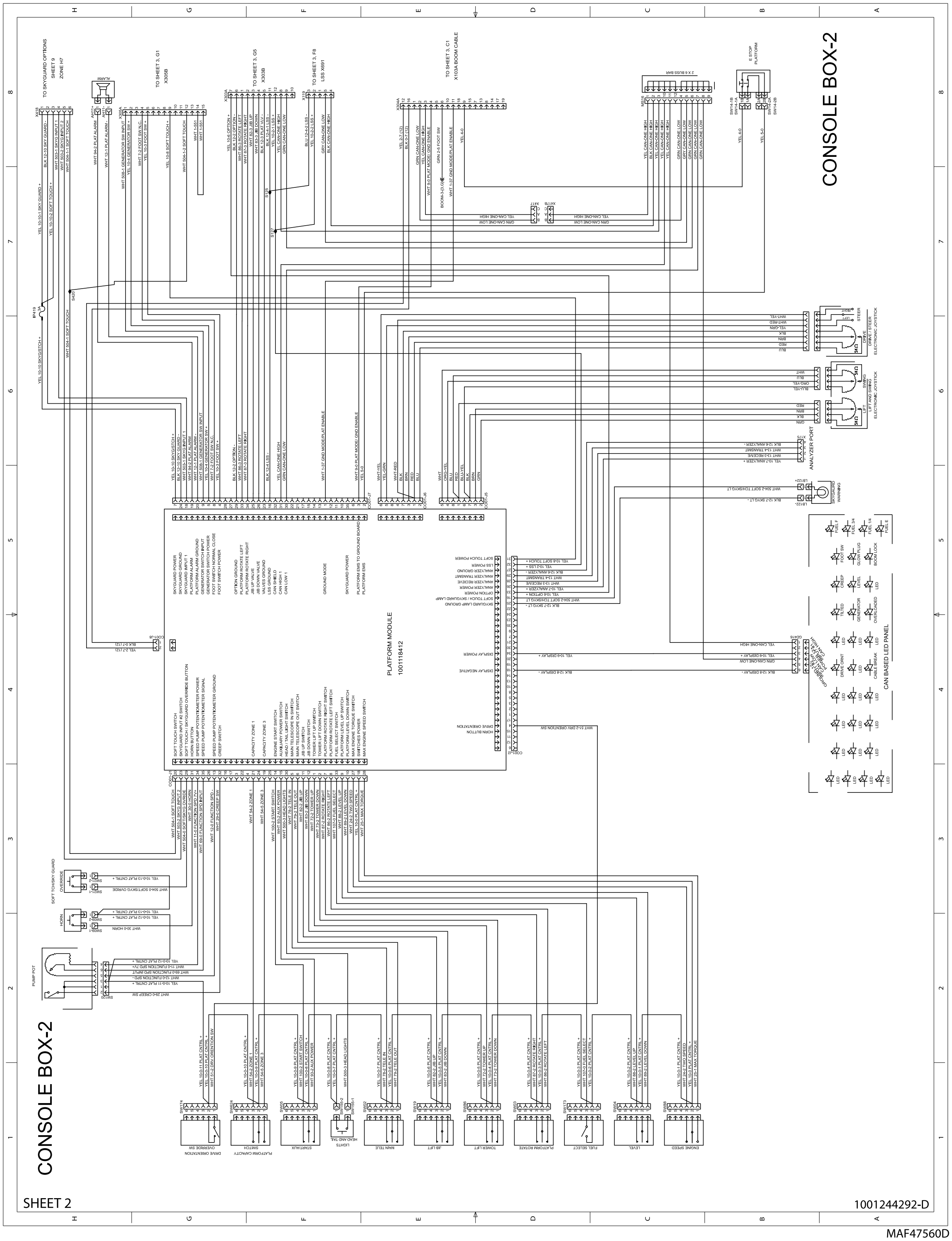
X564 - TO WORKLIGHT HARNESS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	B-	16 AWG	GXL	USB- (1)
2	RED	B+	16 AWG	GXL	USB+ (1)
3					
4					

7.11 ELECTRICAL SCHEMATICS



MAF50170D

Figure 367. Electrical Schematic - Sheet 1 of 11



MAF47560D

Figure 368. Electrical Schematic - Sheet 2 of 11

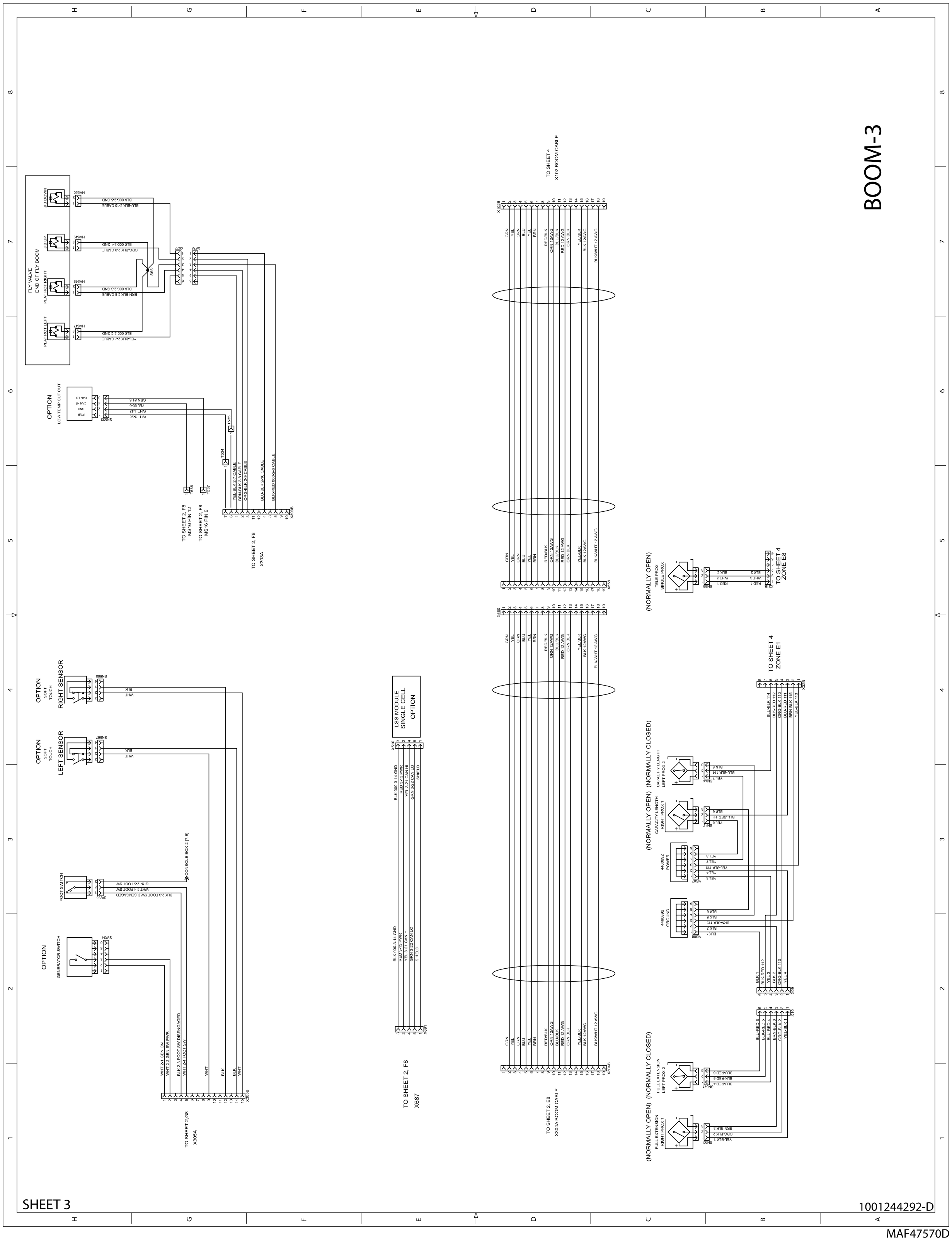
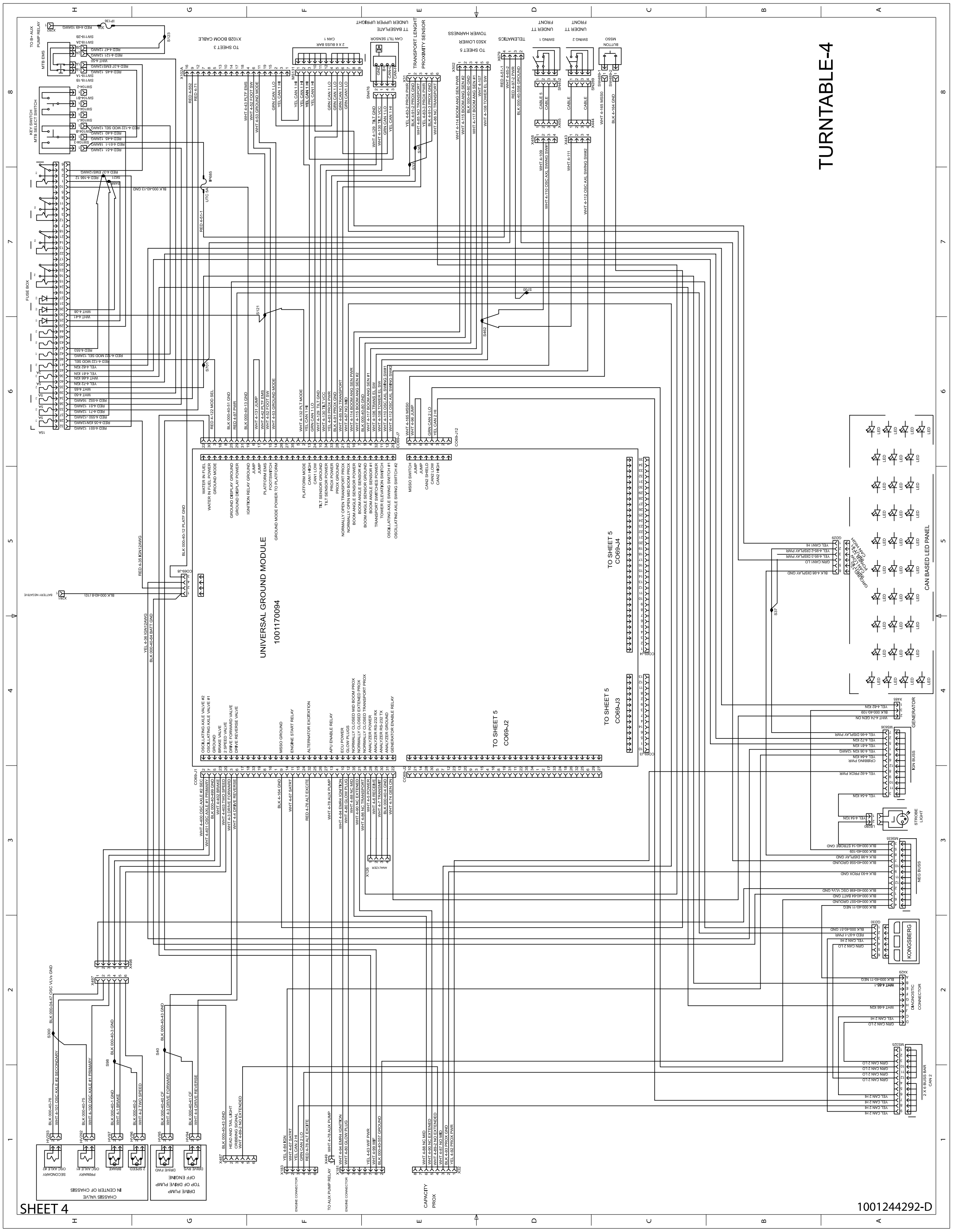
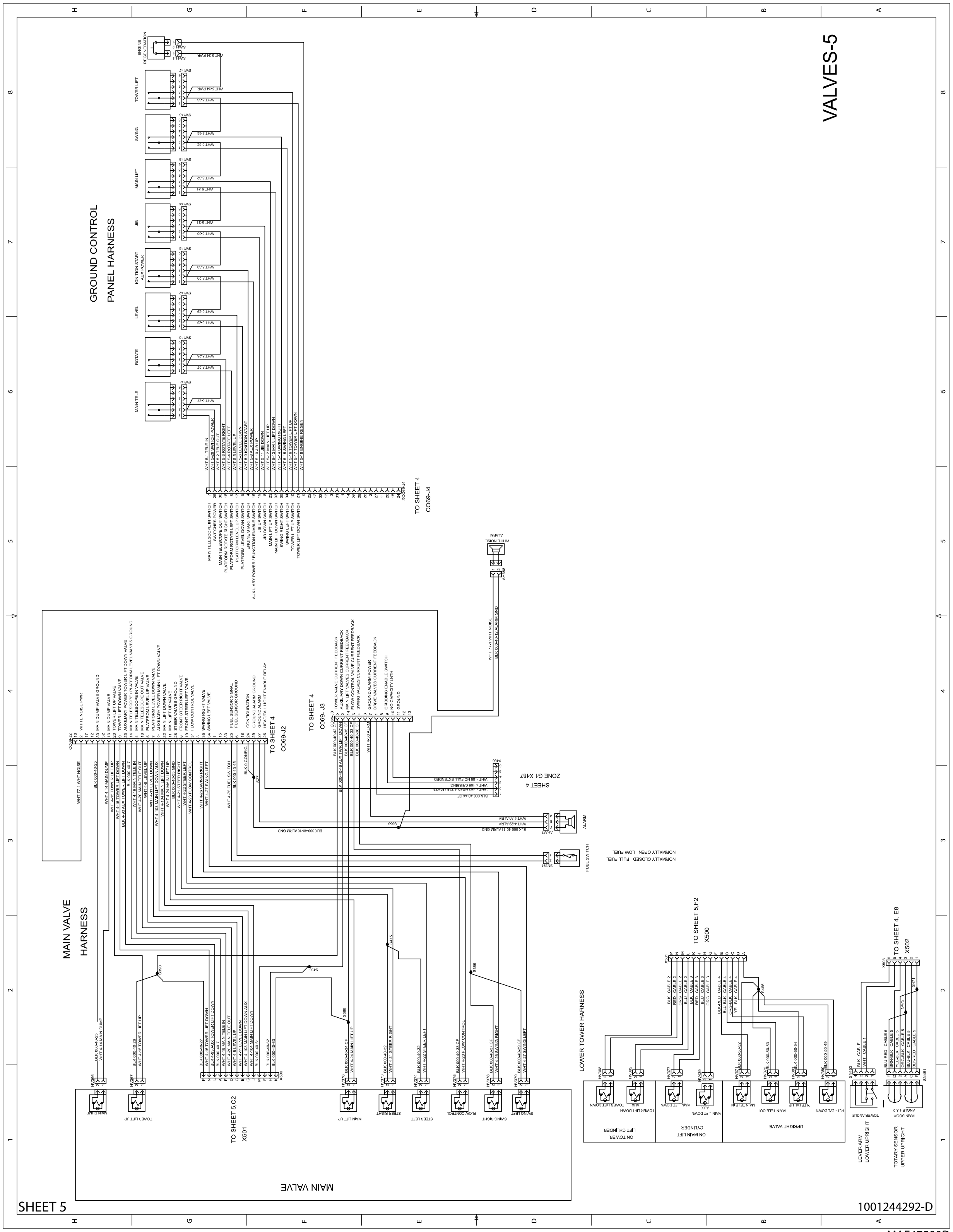


Figure 369. Electrical Schematic - Sheet 3 of 11



MAF47580D

Figure 370. Electrical Schematic - Sheet 4 of 11



MAF47590D

Figure 371. Electrical Schematic - Sheet 5 of 11

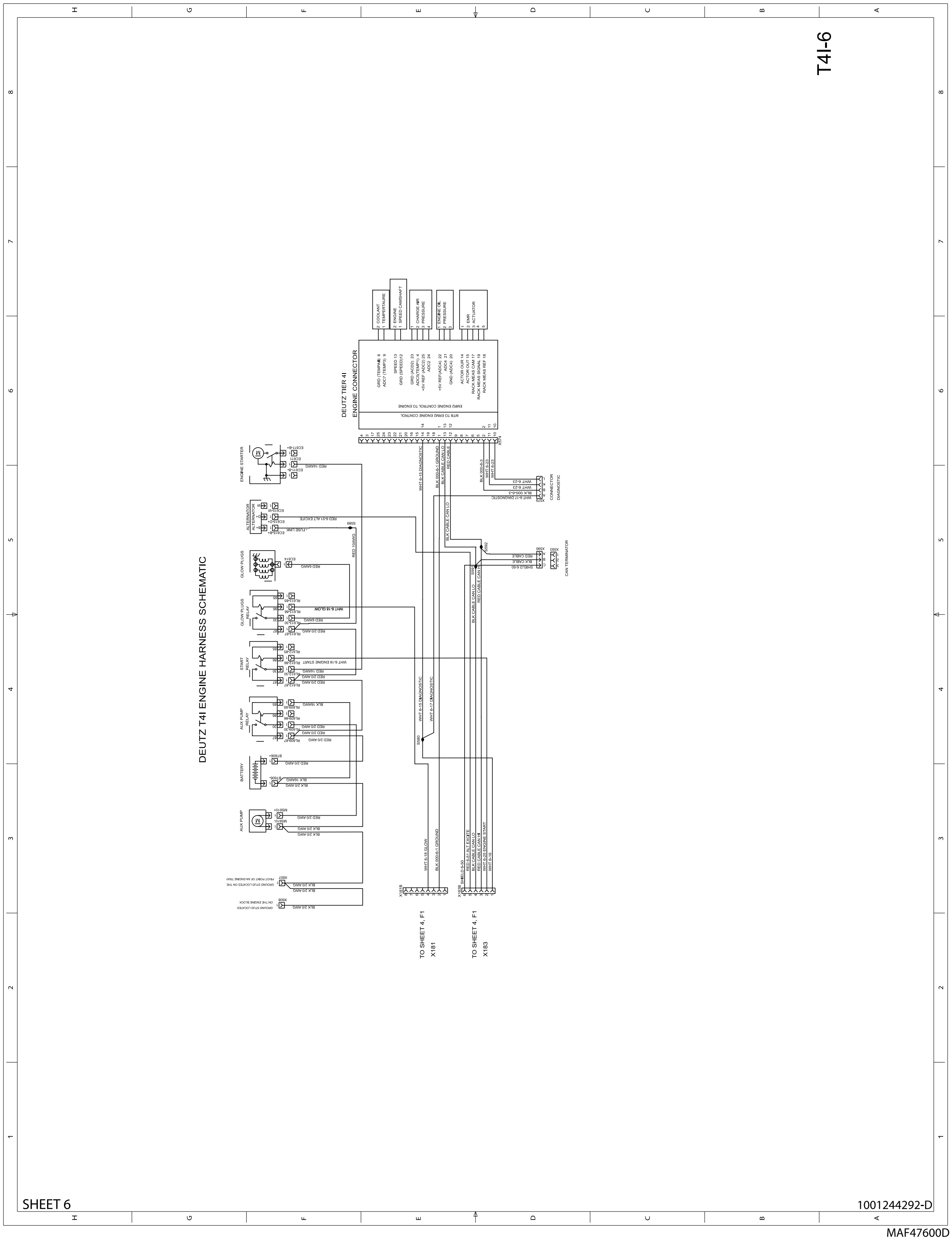
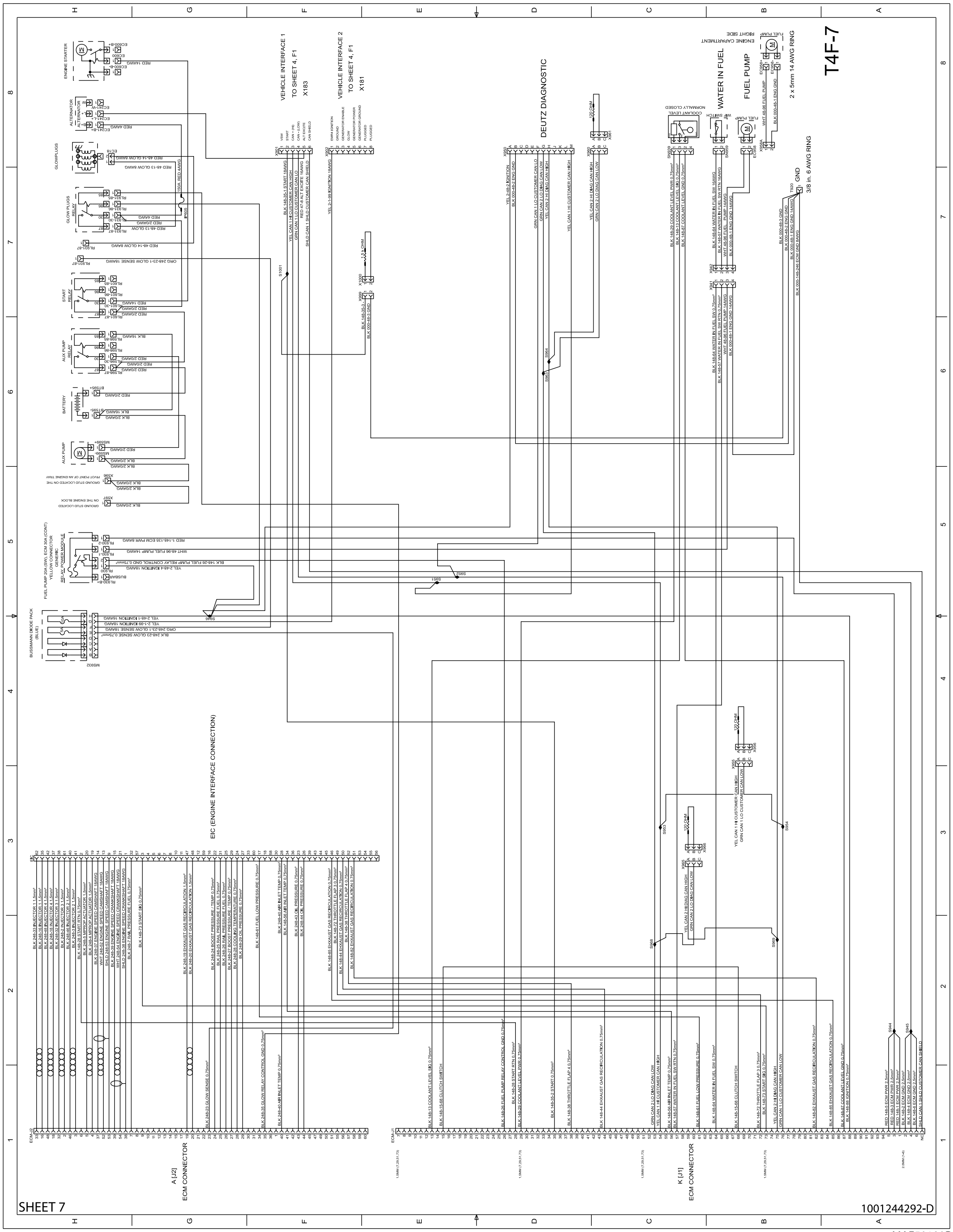


Figure 372. Electrical Schematic - Sheet 6 of 11



MAF50180D

Figure 373. Electrical Schematic - Sheet 7 of 11

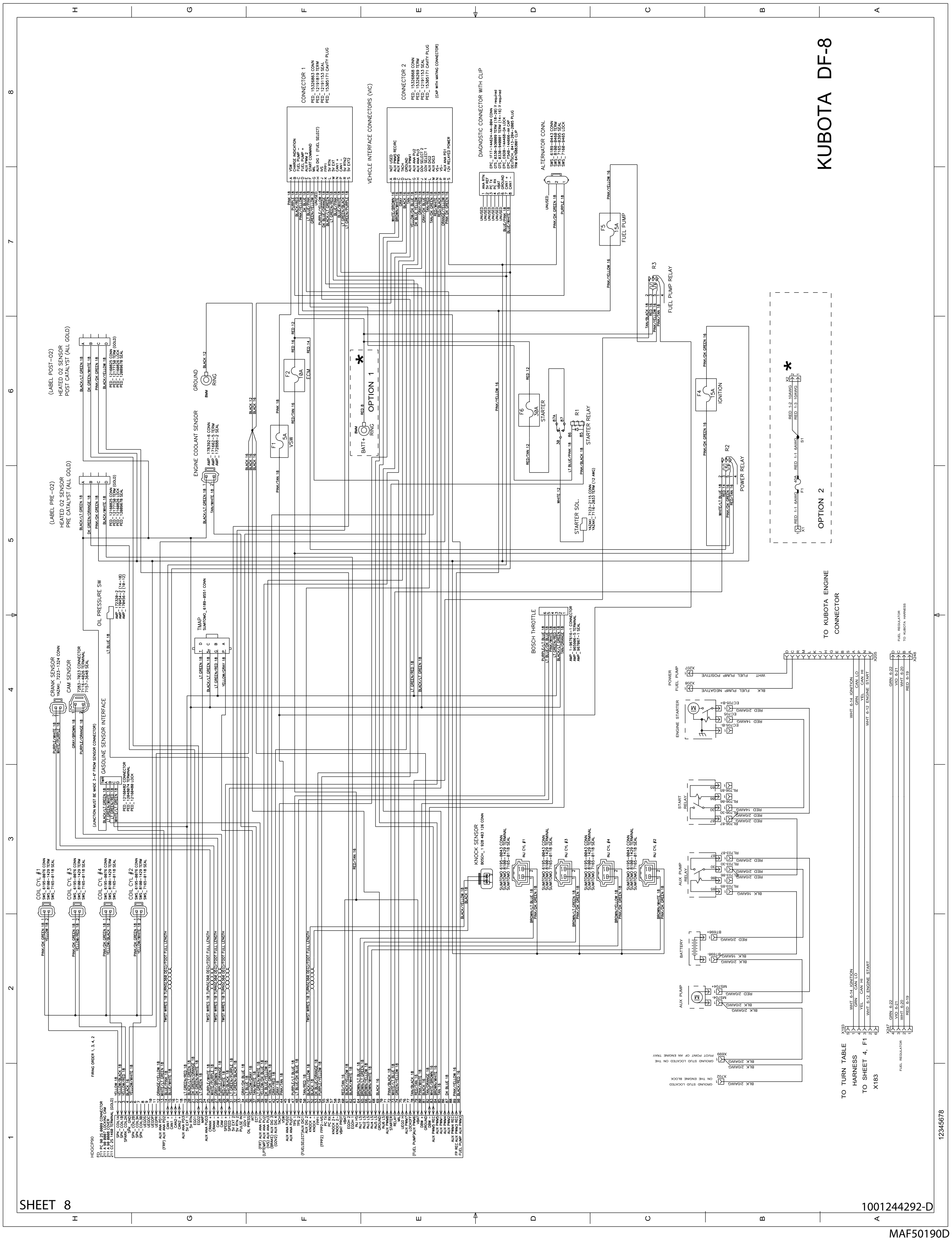
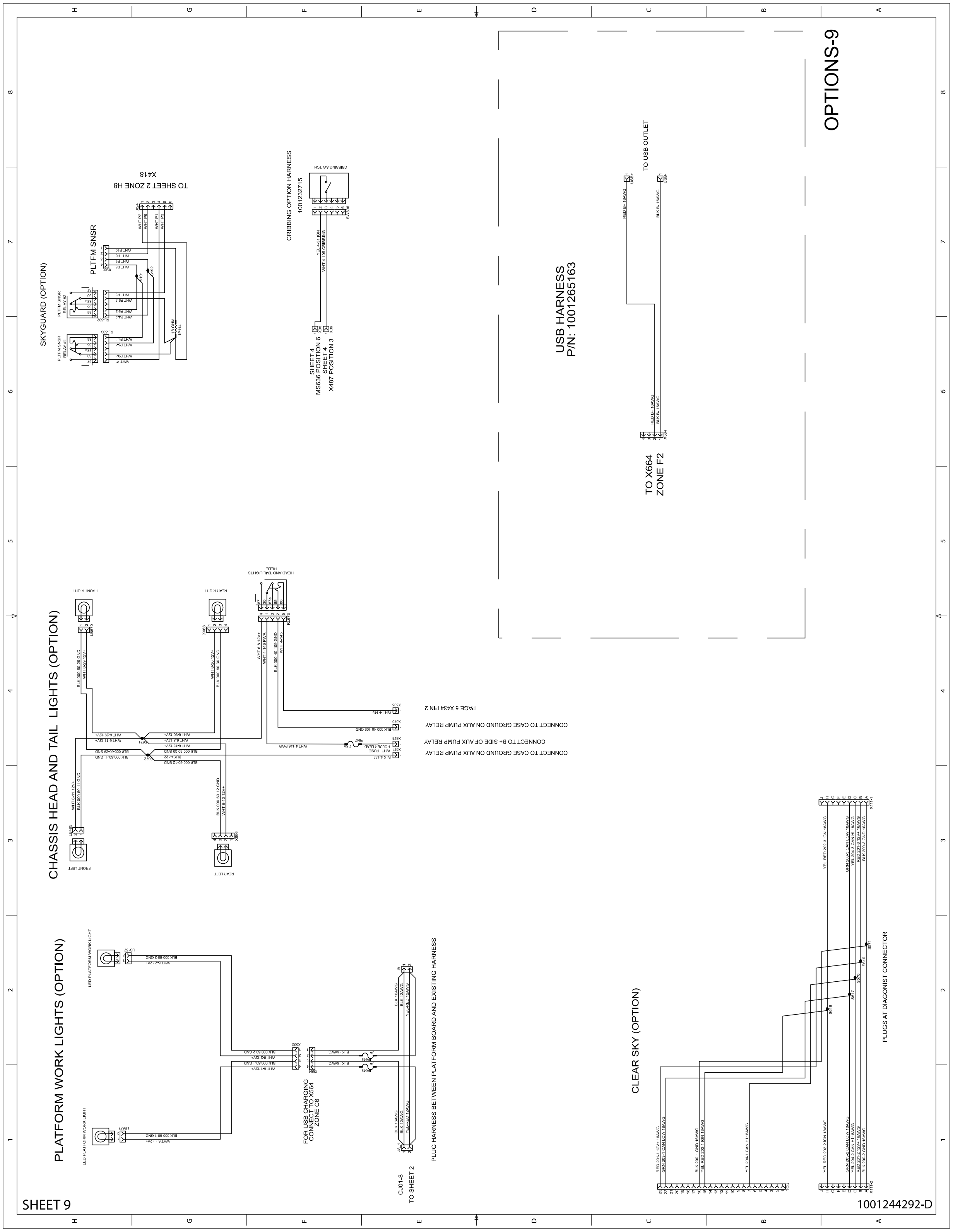
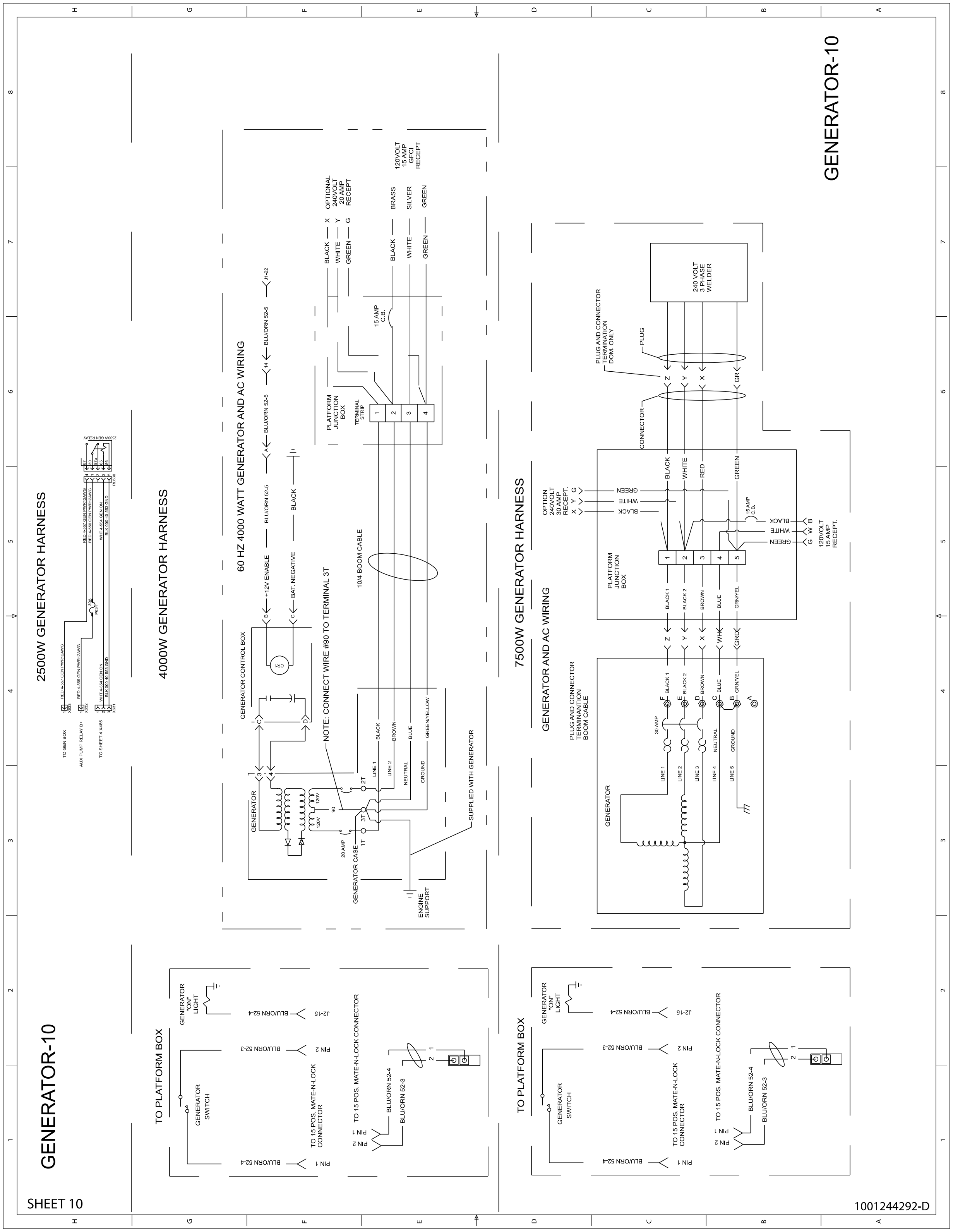


Figure 374. Electrical Schematic - Sheet 8 of 11



MAF47610D

Figure 375. Electrical Schematic - Sheet 9 of 11



MAF47620D

Figure 376. Electrical Schematic - Sheet 10 of 11

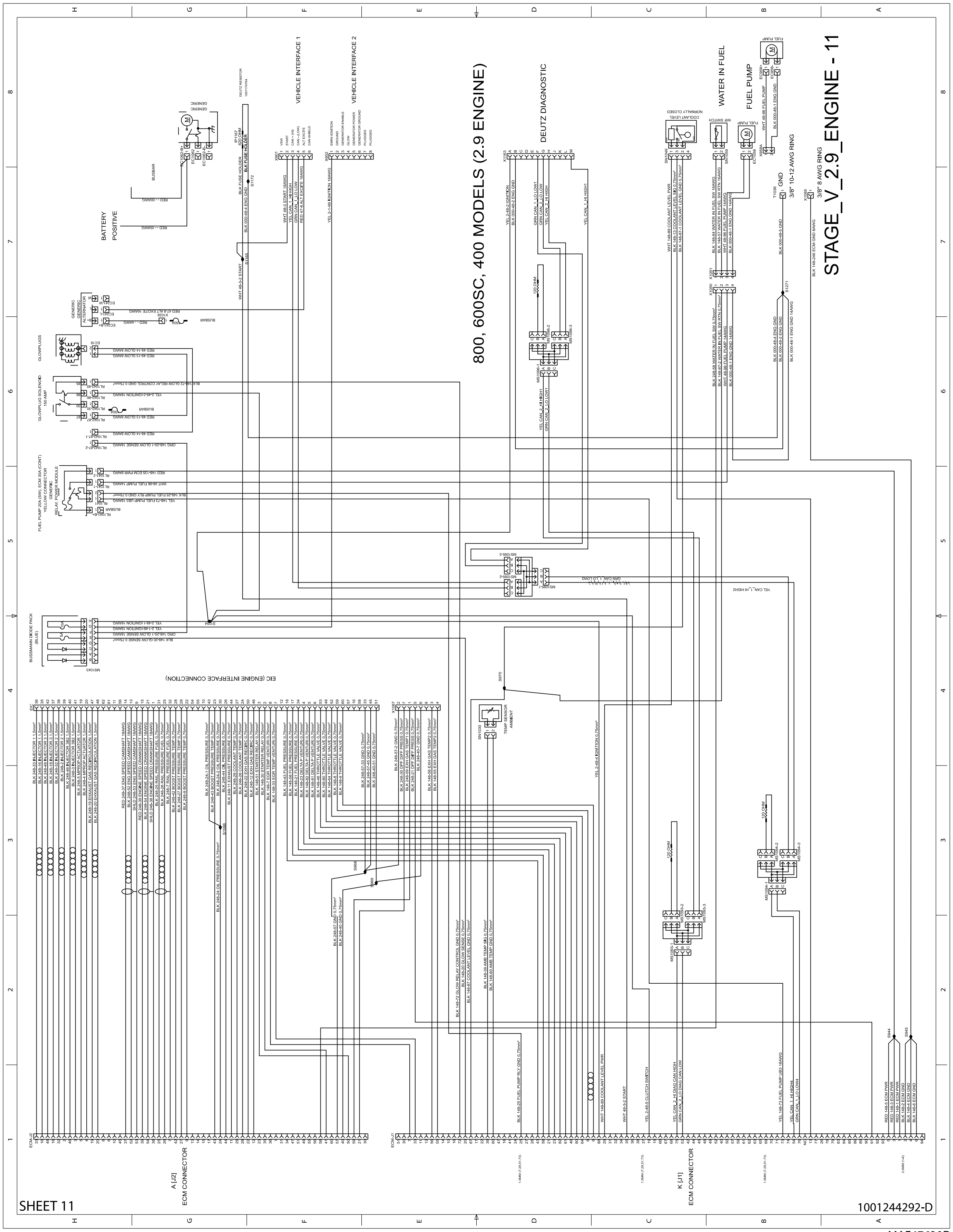


Figure 377. Electrical Schematic - Sheet 11 of 11

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