



An Oshkosh Corporation Company



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Service & Maintenance Manual

Models

1930ES

2032ES

2632ES

2646ES

3246ES

PVC 1910

31215074

January 8, 2020 - Rev A

ANSI

CE



AS/NZS



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SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

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 AN 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.

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.



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 SCISSOR UNTIL PLATFORM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR 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

Original Issue

A - January 8, 2020

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SECTION 1. SPECIFICATIONS

1.1 MACHINE SPECIFICATIONS

Description	1930ES	2032ES	2632ES	2646ES	3246ES
Maximum Stowed Travel Grade (Gradeability)	25%	25%	25%	25%	25%
Maximum Stowed Travel Grade (Sideslope)*	3°	3°	3°	3°	3°
Maximum Operating Slope (Fully Elevated)					
Front to Back*	3°	3°	3°	3°	3°
Side to Side*	1.5°	1.5°	1.5° (Dual Capacity), 3° (Single Capacity)	2°	2°
Maximum Platform Height	18.8 ft. (5.7 m)	20 ft. (6 m)	25.4 ft. (7.75 m)	26 ft. (7.9 m)	31.8 ft. (9.7 m)
Maximum Tire Load:					
ANSI:	1365 lb (620 kg)	1660 (755)	1835 lb (832 kg)	2070 lb (939 kg)	2070 lb (939 kg)
CE:	1540 lb (699 kg)	1835 lb (832 kg)	1835 lb (832 kg)	2320 lb (1052 kg)	2320 lb (1052 kg)
Ground Bearing Pressure (ANSI)	109 psi (7.7 kg/cm ²)	81 psi (5.7 kg/cm ²)	90 psi (6.3 kg/cm ²)	87 psi (6.1 kg/cm ²)	87 psi (6.1 kg/cm ²)
Ground Bearing Pressure (CE)	8.7 kg/cm ² (123 psi)	6.3 kg/cm ² (90 psi)	6.3 kg/cm ² (90 psi)	6.9 kg/cm ² (98 psi)	6.9 kg/cm ² (98 psi)
Maximum Drive Speed	3 mph (4.8 kmph)	3 mph (4.8 kmph)	2.75 mph (4.4 kmph)	2.5 mph (4 kmph)	2.5 mph (4 kmph)
Maximum Wind Speed	28 mph (12.5 m/s) (Depending on model, market, and indoor/outdoor selection, for details see platform capacities)				
Maximum Horizontal Manual Side Force:					
ANSI/CSA:	100 lb force (445 N)	120 lb force (533 N)	N/A	150 lb force (667 N)	N/A
ANSI/CSA (Indoor):	N/A	N/A	N/A	N/A	N/A
ANSI/CSA (Outdoor):	N/A	N/A	N/A	N/A	N/A
ANSI/CSA (Zone A):	N/A	N/A	120 lb force (533 N)	N/A	150 lb force (667 N)
ANSI/CSA (Zone B):	N/A	N/A	100 lb force (445 N)	N/A	105 lb force (467 N)
CE (Indoor):	90 lb force (400 N)	90 lb force (400 N)	90 lb force (400 N)	90 lb force (400 N)	90 lb force (400 N)
CE (Outdoor):	45 lb force (200 N)	45 lb force (200 N)	N/A	90 lb force (400 N)	45 lb force (200 N)
AUS (Indoor):	90 lb force (400 N)	90 lb force (400 N)	N/A	90 lb force (400 N)	N/A
AUS (Indoor Zone A):	N/A	N/A	90 lb force (400 N)	N/A	90 lb force (400 N)
AUS (Indoor Zone B):	N/A	N/A	90 lb force (400 N)	N/A	90 lb force (400 N)
AUS (Outdoor):	45 lb force (200 N)	45 lb force (200 N)	N/A	90 lb force (400 N)	N/A
AUS (Outdoor Zone A):	N/A	N/A	N/A	N/A	N/A
AUS (Outdoor Zone B):	N/A	N/A	N/A	N/A	45 lb force (200 N)
Inside Steer Angle	90°	90°	90°	90°	90°
Outside Steer Angle	69°	73°	73°	67°	67°
Electrical System Voltage (DC)	24V	24V	24V	24V	24V
Approximate Gross Machine Weight - ANSI/CSA	2825 lb	3610 lb	4635 lb (Single) 4610 lb (Dual)	4975 lb	5025 lb
Approximate Gross Machine Weight - CE/Australia	1558 kg	1966 kg	2102 kg (Single) 2091 kg (Dual)	2737 kg	2926 kg
Approximate Gross Machine Weight - Japan	1821 kg	1637 kg	2102 kg (Single) 2091 kg (Dual)	2257 kg	2257 kg
Ground Clearance with pot hole protection system up	3.5 in (8.9 cm)			5 in. (12.7 cm)	
Ground Clearance with pot hole protection system down	1 in (2.5 cm)	0.75 in (1.9 cm)			
NOTE:	*For Japanese specification machine labeled "Ministry of Labor Notification #70," Tilt Setting is 5 degree (front to back and side to side) regardless of elevated platform height.				

SECTION 1 - SPECIFICATIONS

Capacities

NOTE: All platform extension capacities are 250 lb (120 kg)

Model	ANSI/CSA		CE INDOOR		CE OUTDOOR		AUSTRALIAN INDOOR		AUSTRALIAN OUTDOOR	
	Max Capacity	Max Persons	Max Capacity	Max Persons	Max Capacity	Max Persons	Max Capacity	Max Persons	Max Capacity	Max Persons
1930ES	500 lb (227 kg)	2	230 kg	2	120 kg	1	230 kg	2	120 kg	1
2032ES	800 lb (363 kg)	2	360 kg	2	160 kg	1	360 kg	2	160 kg	1
2632ES single cap	500 lb (227 kg)	2	230 kg	2	N/A	N/A	230 kg	2	N/A	N/A
2632ES dual cap to 20ft	800 lb (363 kg)	2	360 kg	2	N/A	N/A	360 kg	2	N/A	N/A
2632ES dual cap to 26ft	500 lb (227 kg)	2	230 kg	2	N/A	N/A	230 kg	2	N/A	N/A
2646ES	1000 lb (454 kg)	2	450 kg	2	230 kg	2	450 kg	2	230 kg	2
3246ES to 26ft	1000 lb (454 kg) Zone A	2	450 kg	2	320 kg	1	450 kg	2	320 kg	1
3246ES to 32ft	700 lb (317 kg) Zone B	2	320 kg	2	320 kg	1	320 kg	2	320 kg	1

Fluid Capacities

Description	1930ES	2032ES	2632ES	2646ES	3246ES
Hydraulic Tank	2 Gal (7.6L)	2 Gal (7.6L)		3 Gal (11.3L)	
Hydraulic System (Including Tank)	2.2 Gal (8.3L)	2.8 Gal (10.6L)		5.3 Gal (19.9L)	

Tires

Description	1930ES	2032ES	2632ES	2646ES	3246ES
Size	323mm x 100mm	406 mm x 125 mm			
Max Tire Load	2500lb (1134kg)	4000lb (1814 kg)			
Wheel Bolt Torque	105 - 120 ft. lbs. (142-163 Nm)				

Batteries

NOTICE

JLG MACHINES EQUIPPED WITH DELTA Q BATTERY CHARGERS ARE DESIGNED FOR THE BEST PERFORMANCE WITH OEM FACTORY APPROVED BATTERIES.

APPROVED JLG REPLACEMENT BATTERIES ARE AVAILABLE THROUGH JLG'S AFTERMARKET PARTS DISTRIBUTION CENTERS OR JLG'S AFTERMARKET PROGRAMS. FOR ASSISTANCE WITH PROPER BATTERY REPLACEMENT, PLEASE CONTACT YOUR LOCAL JLG SUPPORT OFFICE.

BATTERIES APPROVED BY JLG HAVE BEEN TESTED FOR COMPATIBILITY WITH THE ALGORITHM PROGRAMMING OF THE DELTA Q BATTERY CHARGER TO OPTIMIZE BATTERY LIFE AND MACHINE CYCLE TIMES. THE USE OF NON APPROVED BATTERIES IN YOUR JLG EQUIPMENT MAY RESULT IN PERFORMANCE ISSUES OR BATTERY CHARGER FAULT CODES. JLG ASSUMES NO RESPONSIBILITY FOR SERVICE OR PERFORMANCE ISSUES ARISING FROM THE USE OF NON APPROVED BATTERIES.

Motors

Drive Motor

Type: Shunt Wound, Sepex 24V DC
Power: 0.65 Horsepower @ 3750 rpm

Hydraulic Pump/Electric Motor Assembly (All Models)

Type: Series Wound Permanent Magnet 24V DC
Power: 3kW

Battery Charger/AC Inverter

Table 1-1. Battery Charger Specifications

DESCRIPTION	Delta-Q 1001253952
OUTPUT	
Nominal DC Output Voltage	24V
Maximum DC Output Voltage	36V
Maximum DC Output Current	27.1A
Maximum Interlock Current	1A @24V
INPUT	
AC Input Voltage	85-270VAC
Nominal AC Input Voltage	100 - 240VAC
AC Input Frequency	50-60 HZ
Maximum AC Input Current	7.5A
OPERATION	
AC Power Indicator	Solid Blue
Battery Charging Indicator (Bottom Half)	
Low State of Charge	Flashing Green
High State of Charge	Solid Green
Charge Completed	Solid Green
Battery Charging Indicator (Top Half)	
Low State of Charge	Off
High State of Charge	Flashing Green
Charge Completed	Solid Green
Fault/error/USB Indicator	
Charger Fault	Solid Red
External Error Condition - Caution	Flashing Amber
USB Port Active	Flashing Green
Safe to Remove USB	Solid Green
Charging Output Indicator	
Output Inactive	Off
Output Active	Solid Yellow

SECTION 1 - SPECIFICATIONS

Table 1-1. Battery Charger Specifications

DESCRIPTION	Delta-Q 1001253952
Charge Profile/error Display	
'F' Code	Internal Fault - Charging Stopped
'E' Code	External Fault - Charging Stopped
'P' Code	Displaying Algorithm Number
'USB' Code	USB Interface Active - Do Not Remove USB
MECHANICAL	
Operating Temperature	-40° to +65°
Housing	Shock and Water Resistant Aluminum
Mounting Orientation	Any Orientation
DC Battery Output Connection	
Wire Size	12AWG
Torx Screw Size	T30
Torque	4.5 NM ±5%
Interlock/temp Sensor Connection	
Wire Size	18AWG
Cable Clamp and Dc Block Cover	
Torx Screw Size	T10
PROTECTION	
Output Reverse Polarity	Electronic Protection With Auto Reset
Output Short Circuit	Current Limited
Ac Overload	Current Limited
Dc Overload	Current Limited

Table 1-2. Battery Charger Specifications

DESCRIPTION	Eagle Performance 1001177842
OUTPUT	
Nominal DC Output Voltage	24V
Maximum DC Output Voltage	31.92V
Maximum DC Output Current	25A
INPUT	
AC Input Voltage	108-132VAC
Nominal AC Input Voltage	120VAC
AC Input Frequency	45-65 HZ
Maximum AC Input Current	12A @108VAC
OPERATION	
Charging Indicator	Red - 30/60/90%
100% Charge Indicator	Green LED
Fault Indicator	Various LED
Battery Type Indicator	Yellow LED
PROTECTION	
Output Reverse Polarity	Electronic Protection - Auto Reset
Output Short Circuit	Electronic Protection - Auto Reset
AC Overload	Branch Circuit Protection
DC Overload	Current Limited
MECHANICAL	
Operating Temperature	-22° F to +122° F (-30° C to +50° C)
Storage Temperature	-40° F to +185° F (-40° C to +85° C)
Housing	Shock and Water Resistant Aluminum

Table 1-3. Battery Charger Specifications

DESCRIPTION	Green Power 1001218595
OUTPUT	
Nominal DC Output Voltage	24V
Maximum DC Output Voltage	34V
Maximum DC Output Current	30A
INPUT	
AC Input Voltage	100-240V
AC Input Frequency	45-65 HZ
Maximum AC Input Current	8.5A
OPERATION	
Charging Indicator	Yellow LED
100% Charge Indicator	Green LED

Table 1-4. Battery Charger/AC Inverter Specifications

DESCRIPTION	Xantrex 1001093839
AC INVERTER	
Output Power (Continuous)	1000W
Output Power (Surge)	3000W
AC Output Current	36 A
AC Output Voltage	115 to 125 VAC
Output Frequency	60Hz
DC Input Voltage	21.2 to 29VDC
Remote ON/OFF	Yes
Modified Sine Wave	-
CHARGER	
Nominal DC Output Voltage	28VDC
Maximum DC Output Voltage	33VDC
Maximum DC Output Current	23 to 27 ADC
Required Interlock Current	1 A
Input Voltage (AC)	100 to 130VAC
Nominal Input Voltage (AC)	120VAC
Input Frequency	54 to 66 Hz
OPERATION	
Charging Indicator	Yellow LED
100% Charge Indicator	Green LED
Fault Indicator	Red LED
PROTECTION	
Output Reverse DC Polarity	125 A Replaceable Fuse
Output AC Short Circuit	Internally Controlled
AC Overload	20 A Internal Slow Blow Charger Fuse

Table 1-4. Battery Charger/AC Inverter Specifications

DESCRIPTION	Xantrex 1001093839
DC Overload	Voltage Limited - Internally Controlled
MECHANICAL	
Operating Temperature	-40° F to + 185° F (-40° C to + 85° C)
Housing	Shock and Water Resistant Aluminum

Table 1-5. Battery AC Inverter Specifications

DESCRIPTION	Power Bright 1001136757
AC INVERTER	
Output Power (Continuous)	900 W
Output Power (Surge)	1800W
AC Output Current	7.5 A
AC Output Voltage	117 ± 10% VAC
Output Frequency	60Hz
DC Input Voltage	20 to 30VDC
Modified Sine Wave	Yes
PROTECTION	
Output Reverse DC Polarity	3 X 25A Replaceable Fuse
MECHANICAL	
Operating Temperature	-4° F to + 113° F (-20° C to + 45° C)

Lift Speed (No Load in Platform)

NOTE: No load in platform on measured lift speeds.

Table 1-6. Lift Speed

Model	Lift Up (Seconds)	Lift Down (Seconds)
1930ES	18-26	22-35
2032ES	25-36	30-46
2632ES	28-38	32-40
2646ES	38-50	40-55
3246ES	50-62	58-68

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Travel Speed

Model	Elevated Speed				Maximum Speed				
	Unit of Measure	Mph	Sec/25 ft	Kmph	Sec/7.6 m	Mph	Sec/25 ft	Kmph	Sec/7.6 m
1930ES		0.5	28-37	0.8	33-38	3	5.6-7.7	4.8	5.6-7.7
2032ES		0.5	28-37	0.8	33-38	3	6-7.9	4.8	6-7.9
2632ES		0.5	28-37	0.8	33-38	2.75	6-7.9	4.4	6-7.9
2646ES		0.5	28-37	0.8	33-38	2.5	6.4-8.3	4	6.4-8.3
3246ES		0.5	28-37	0.8	33-38	2.5	6.4-8.3	4	6.4-8.3

Model Dimensions

Model	1930ES	2032ES	2632ES	2646ES	3246ES
Platform Height - Elevated	18.75 ft (5.7m)	20 ft (6m)	25.6 ft (7.8m)	26 ft (7.9m)	31.8 ft (9.7m)
Platform Height - Stowed	2.9 ft (0.9m)	3.6 ft (1.1 m)	4 ft (1.2m)	4.2 ft (1.3 m)	4.2 ft (1.3 m)
Working Height	25 ft (7.6m)	26 ft (7.9m)	32 ft (9.8m)	32 ft (9.8m)	38 ft (11.6m)
Overall Stowed Machine Height - Rails Up	6.5 ft (2m)	7.2 ft (2.2m)	7.5 ft (2.3m)	7.9 ft (2.4m)	7.9 ft (2.4m)
Overall Stowed Machine Height - Rails Folded	5.6 ft (1.6m)	6 ft (1.8m)	6.2 ft (1.9m)	6.6 ft (2m)	6.6 ft (2m)
Rail Height (From platform floor)	3.6 ft (1.1 m)	3.6 ft (1.1 m)	3.6 ft (1.1 m)	3.6 ft (1.1 m)	3.6 ft (1.1 m)
Overall Machine Width	2.5 ft (0.8m)	2.66 ft (0.81 m)	2.66 ft (0.81 m)	3.7 ft (1.2m)	3.7 ft (1.2m)
Overall Machine Length - Platform Retracted	6 ft (1.9m)	7.5 ft (2.3m)	7.5 ft (2.3m)	8.2 ft (2.5m)	8.2 ft (2.5m)
Overall Machine Length - Platform Extended	9 ft (2.8m)	10.5 ft (3.2m)	10.5 ft (3.2m)	12.4 ft (3.8m)	12.4 ft (3.8m)
Platform Size - Length	6.1 ft (1.9m)	7.5 ft (2.3m)	7.5 ft (2.3m)	8.2 ft (2.5m)	8.2 ft (2.5m)
Platform Size - Width	2.5 ft (0.8m)	2.5 ft (0.8m)	2.5 ft (0.8m)	3.7 ft (1.1 m)	3.7 ft (1.1 m)
Platform Extension Length	3 ft (0.9m)	3 ft (0.9m)	3 ft (0.9m)	4.2 ft (1.3m)	4.2 ft (1.3m)
Wheelbase	63 in (160 cm)	74 in (188 cm)	74 in (188 cm)	82.30 in (209 cm)	82.30 in (209 cm)

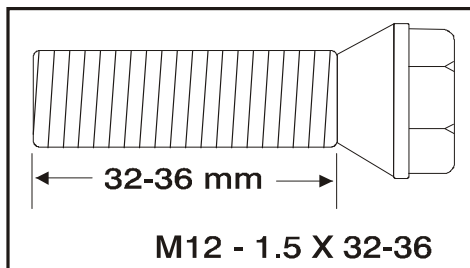
1.2 TORQUE REQUIREMENTS

Self locking fasteners, such as nylon insert and thread deforming locknuts, are not intended to be reinstalled after removal. Always use new replacement hardware when installing locking fasteners.

Table 1-7. Torque Requirements

Description	Torque Value (Dry)	Interval Hours
Rear Wheel Spindle Nut	30-40 ft. lbs. (40-54 Nm)	50
Wheel Bolts	105-120 ft. lbs. (142-163 Nm)	50

NOTE: Anytime a wheel bolt is replaced, be sure one of the same length is used. Use bolt shown below on wheels that use the 1/4" (6.4mm) ring.



NOTE: After tightening the spindle nut to the proper torque, loosen completely until you can turn by hand. Finger tighten nut by hand without rotating hub. Install cotter pin by backing nut off, if necessary, in order to line up slot.

When maintenance becomes necessary or a fastener has loosened, refer to Section 1.8, Thread Locking Compound to determine proper torque value.

1.3 LUBRICATION

Hydraulic Oil

NOTE: Hydraulic oils must have anti-wear qualities at least to API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service. JLG Industries recommends DTE 11M hydraulic oil.

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.

Table 1-8. Hydraulic Oil

Hydraulic System Operating Temperature Range	SAE Viscosity Grade
0°F to +23°F (-18°C to -5°C)	10W
0°F to 210°F (-18°C to +99°C)	10W-20, 10W-30
50°F to 210°F (+10°C to +99°C)	20W-20

Table 1-9. Lubrication Specifications

Key	Specifications
MPG	Multipurpose Grease having a minimum dripping point of 350°F. Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec MIL-L-2105.
HO	Hydraulic Oil. API service classification GL-3, e.g. DTE 11M.

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Table 1-10. Mobil DTE 10 Excel 15

ISO Viscosity Grade	#15
Density @ 59°F (15°C)	0.8375 kg/l
Pour Point, Max	-65.2°F (-54°C)
Flash Point, Min.	360°F (182°C)
Viscosity	
at 40°C	15.8 cSt
at 100°C	4.07 cSt
Viscosity Index	168

Table 1-11. Biodegradable Hydraulic Fluid

Specification	Mobil EAL Envirosyn H 32	Mobil SHC Hydraulic EAL 32
ISO Viscosity Grade	#32	
Density @ 59°F (15°C)	0.869 kg/l	0.936 kg/l
Pour Point, Max	-38°F (-39°C)	-27°F (-33°C)
Flash Point, Min.	514°F (268°C)	540°F (282°C)
Operating Temperature	-20 to 200°F (-29 to 93°C)	1.4 to 200°F (-17 to 93°C)
Viscosity Specifications		
at 40°C	33.1 cSt	31.1 cSt
at 100°C	6.36 cSt	6.2 cSt
Viscosity Index	147	152

Pressure Settings

Model	Lift Relief		Steer Relief
	USA Built	China Built	
1930ES	1800 psi ± 50 psi (124 bar ± 3.4 bar)	1900 psi ± 50 psi (131 bar ± 3.4 bar)	1500 psi (103 bar)
2032ES	1800 psi ± 50 psi (124 bar ± 3.4 bar)	1900 psi ± 50 psi (131 bar ± 3.4 bar)	1500 psi (103 bar)
2632ES	1950 psi +/- 50 psi (134 bar ± 3.4 bar)	1900 psi ± 50 psi (131 bar ± 3.4 bar)	1500 psi (103 bar)
2646ES	2000 psi +/- 50 psi (138 bar ± 3.4 bar)	1900 psi ± 50 psi (131 bar ± 3.4 bar)	1500 psi (103 bar)
3246ES	2000 psi +/- 50 psi (138 bar ± 3.4 bar)	1900 psi ± 50 psi (131 bar ± 3.4 bar)	1500 psi (103 bar)

NOTE: Check your nameplate at the left rear of the machine for country of origin. USA built machines, serial number prefix starts with a 02 (02XXXXXXXX), China built machines, serial number prefix starts with an B2 (B2XXXXXXXX).

1.4 LIMIT SWITCHES

Tilt Alarm

Illuminates a light on the platform, sounds an alarm and cuts out lift up and drive when the machine is out of level and above stowed depending on model and specifications.

Table 1-12. Tilt Setting

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

High Drive Speed Cutout

High drive speed is cut out when the platform is raised above the preset height per model as follows:

NOTE: These figures are given with a tolerance of ± 6 in (0.15 m).

Model	High Drive Speed Cutout
1930ES	54 in (1.4 m)
2032ES	66 in (1.7 m)
2632ES	76 in (1.9 m)
2646ES	76 in (1.9 m)
3246ES	76 in (1.9 m)

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1.5 CYLINDER SPECIFICATIONS

Description	1930ES	2032ES	2632ES	2646ES	3246ES
Lift Cylinder Bore	2.8 in (7.1 cm)	3.1 in (7.9 cm)	3.1 in (7.9 cm)	3.9 in (9.9 cm)	3.9 in (9.9 cm)
Lift Cylinder Stroke	43.2 in (108 cm)	48 in (122 cm)	48 in (122 cm)	44.9 in (114 cm)	56.8 in (144 cm)
Lift Cylinder Rod Diameter	1.8 in (4.5 cm)	2.1 in (5.5 cm)	2.1 in (5.5 cm)	2.4 in (6 cm)	2.4 in (6 cm)
Steer Cylinder (Stroke)	6.3 in (16 cm)	6.3 in (16 cm)	6.3 in (16 cm)	6.1 in (15.6 cm)	6.1 in (15.6 cm)

1.6 MAJOR COMPONENT WEIGHTS

Component	1930ES	2032ES	2632ES	2646ES	3246ES
Platform	100 lb (45 kg)	133 lb (61 kg)		176 lb (80 kg)	
Manual Platform Extension	45 lb (20 kg)				
Arm Assembly - (Includes Lift Cylinder)	620 lb (281 kg)	939 lb (426 kg)	1,213 lb (550 kg)	1,645 lb (746 kg)	
Chassis w/Wheel/Tire and Drive Assembly	1,067 lb (484 kg)	1,764 lb (800 kg)		1,554 lb (705 kg)	

1.7 CRITICAL STABILITY WEIGHTS

⚠ WARNING

DO NOT REPLACE ITEMS CRITICAL TO STABILITY, SUCH AS BATTERIES OR SOLID TIRES, WITH ITEMS OF DIFFERENT WEIGHT OR SPECIFICATION. DO NOT MODIFY UNIT IN ANY WAY TO AFFECT STABILITY.

Component	1930 ES	2032ES	2632ES	2646ES	3246ES
Counterweight(s) (CE, AUS)	586 lb (266 kg)	726 lb (329.5 kg)		1606.7 lb (728.8 kg)	1973.8 lb (895.3 kg)
Counterweight (ANSI, CSA, JPN)					
Wheel and Tire Assembly (each)	22 lb (9.8 kg)	39.7 lb (18 kg)			
Wheel/Tire and Drive Assembly (each)	117 lb (53 kg)	162 lb (73.4 kg)			
Lift Cylinder	176 lb (80 kg)	205 lb (93 kg)		263 lb (119 kg)	283 lb (128 kg)
Batteries: (each)					
220 Amp	67 lb (30.4 kg)	67 lb (30.4 kg)			
220 Amp (used with Inverter/Charger)	66 lb (30 kg)	66 lb (30 kg)			
245 Amp	N/A	70 lb (32 kg)			

1.8 THREAD LOCKING 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.

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SECTION 1 - SPECIFICATIONS

1.9 TORQUE CHARTS

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

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS

5000059K

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

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

5000059K

SECTION 1 - SPECIFICATIONS

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-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
		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		
		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
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

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

5000059K

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

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

5000059K

SECTION 1 - SPECIFICATIONS

SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SOCKET HEAD CAPSCREWS										
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-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474							
10	24	0.1900	0.01750							
	32	0.1900	0.02000							
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	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

- NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K
 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 CAPSCREWS										
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-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474							
10	24	0.1900	0.01750							
	32	0.1900	0.02000							
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	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

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

5000059K

SECTION 1 - SPECIFICATIONS

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
36	4	817	355.5	2560	1920	2300	2690
42	4.5	1120	487.0	4090	3070	3680	4290

- NOTES:
1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODSTOLERANCE = ±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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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 CAPSCREWS 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
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

- NOTES:
1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = $\pm 10\%$
 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 1 - SPECIFICATIONS

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
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
36	4	817	355.5	2176	2050	1920
42	4.5	1120	487.0	3477	3275	3070

- NOTES:
1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = $\pm 10\%$
 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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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 CAPSCREWS 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
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

- NOTES:
1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = $\pm 10\%$
 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

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 with any and all discrepancies corrected, this product will be fit for continued use.

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 platforms. The frequency of inspections and maintenance must be increased as environment, severity and frequency of usage requires.

Pre-Start Inspection

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

Pre-Delivery Inspection and Frequent Inspection

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

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

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

Annual Machine Inspection

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

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

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

Preventative Maintenance

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

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

Table 2-1. Inspection and Maintenance

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

2.2 SERVICE AND GUIDELINES

General

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

Safety and Workmanship

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

Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and foreign materials out of the vital components. Precautions have been taken to safeguard against this. Shields, covers, seals, and filters are provided to keep air, fuel, and oil supplies clean; however, these items must be maintained on a scheduled basis in order to function properly.
2. At any time when air, fuel, or oil lines are disconnected, clear adjacent areas as well as the openings and fittings themselves. As soon as a line or

component is disconnected, cap or cover all openings to prevent entry of foreign matter.

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

Components Removal and Installation

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

Component Disassembly and Reassembly

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

Pressure-Fit Parts

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

Bearings

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

Gaskets

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

Bolt Usage and Torque Application

1. Self locking fasteners, such as nylon insert and thread deforming locknuts, are not intended to be reinstalled after removal. Always use new replacement hardware when installing locking fasteners.
2. 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.
3. Unless specific torque requirements are given within the text, standard torque values should be used on heat-treated bolts, studs, and steel nuts, in accordance with recommended shop practices. (See Torque Chart Section 1.)

Hydraulic Lines and Electrical Wiring

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

Hydraulic System

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

Lubrication

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

Battery

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

Lubrication and Servicing

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

2.3 LUBRICATION AND INFORMATION

Hydraulic System

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

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

Hydraulic Oil

1. Refer to Section 1 for recommendations for viscosity ranges.
2. JLG recommends DTE11 hydraulic oil, which has an SAE viscosity of 10W-30 and a viscosity index of 152.

NOTE: *Start-up of hydraulic system with oil temperatures below -15°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, electrical heater to a minimum temperature of -15°F (-26°C).*

Changing Hydraulic Oil

1. Use of any of the recommended crankcase or hydraulic oils eliminates the need for changing the oil on a regular basis. However, filter elements must be changed annually unless operating in extreme conditions. If it is necessary to change the oil, use only those oils meeting or exceeding the specifications appearing in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils. JLG Industries recommends changing the hydraulic oil annually.
2. Use every precaution to keep the hydraulic oil clean. If the oil must be poured from the original container into another, be sure to clean all possible contaminants from the service container. Always replace the filter and clean magnet 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.

NOTE: *Refer to section 4 for oil checking and oil changing procedure.*

Lubrication Specifications

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

2.4 CYLINDER DRIFT TEST

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

Platform Drift

Measure the drift of the platform to the ground. Fully elevate the platform. Maximum allowable drift is 2 inches (5 cm) in 10 minutes. If the machine does not pass this test, proceed with the following.

Cylinder Drift

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

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

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

If the cylinder passes this test, it is acceptable.

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

2.5 PINS AND COMPOSITE BEARING REPAIR GUIDELINES

Filament wound bearings.

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

2.6 PREVENTIVE MAINTENANCE AND INSPECTION SCHEDULE

The preventive maintenance and inspection checks are listed and defined in the following table. This table is divided into two basic parts, the "AREA" to be inspected and the "INTERVAL" at which the inspection is to take place. Under the "AREA" portion of the table, the various systems along with the components that make up that system are listed. The "INTERVAL" portion of the table is divided into two columns representing the various inspection time periods. The numbers listed within the interval column represent the applicable inspection code for which that component is to be checked.

The checks and services listed in this schedule are not intended to replace any local or regional regulations that may pertain to this type of equipment nor should the lists be considered as all inclusive. Variances in interval times may occur due to climate and/or conditions and depending on the location and use of the machine.

NOTICE

JLG INDUSTRIES REQUIRES THAT A COMPLETE ANNUAL INSPECTION BE PERFORMED IN ACCORDANCE WITH THE "ANNUAL MACHINE INSPECTION REPORT" FORM.

NOTE: *This machine requires periodic safety and maintenance inspections by a JLG Dealer. Notify dealer if inspection is overdue.*

The inspection and maintenance code numbers are as follows:

1. Check for proper and secure installation.
2. Check for visible damage and legibility.
3. Check for proper fluid level.
4. Check for any structural damage; cracked or broken welds; bent or warped surfaces.
5. Check for leakage.
6. Check for presence of excessive dirt or foreign material.
7. Check for proper operation and freedom of movement.
8. Check for excessive wear or damage.
9. Check for proper tightness and adjustment.
10. Drain, clean and refill.
11. Check for proper operation while pump/motor is running.
12. Check for proper lubrication.
13. Check for evidence of scratches, nicks or rust and for straightness of rod.
14. Check for condition of element; replace as necessary.
15. Check for proper inflation.
16. Decals installed and legible.

Table 2-2. Preventive Maintenance and Safety Inspection

AREA	Interval	
	PRE-DELIVERY (a) OR FREQUENT (b) INSPECTION	ANNUAL (c) (YEARLY) INSPECTION
PLATFORM		
Controller	1,11	1,11
Switches	1,11	1,11
Placards and Decals	1,2	1,2
Control Tags	1,2	1,2
Hoses and Cables	4,8	4,8
Wear Pads	8,12	8,12
Handrails and Chains	1,4	1,4
Lanyard Anchorage Point	1,4,16	1,4,16
CHASSIS		
Battery	3,5	3,5
Hydraulic Pump	1,5	1,5
Valves	1,5	1,5
Hydraulic Filter	26	26
Hydraulic Hoses and Tubing	1,5	1,5
Hydraulic Oil Tank	3,4,5	3,4,5
Lift Cylinder	1,4,5,6,12,13	1,4,5,6,12,13
Limit Switch	1,7	1,7
Tilt Alarm Switch	1,7	1,7
Placards and Decals	1,2	1,2
Wheel and Tire Assemblies	1,8,9	1,8,9
Drive Motors	1,5,6	1,5,6
Drive Brakes	1,6,8	1,6,8
Drive Torque Hubs	1,3,5,6	1,3,5,6
Steer Cylinder	1,4,5,6,13	1,4,5,6,13
Steer Components	1,4,6,8	1,4,6,8
Wheel Bearings	8,12	8,12
Scissor Arms	1,4	1,4
Safety Props	1,4	1,4
Sliding Wear Pads	8,12	8,12
Pivot Pins/Bolts	1,4,7,8	1,4,7,8
Switches, Ground Control	1,11	1,11
Control Tags	1,2	1,2

Footnotes:

- (a) Prior to each sale, lease, or delivery
 (b) In service for 3 months; or Out of service for 3 months or more; or Purchased used
 (c) Annually, no later than 13 months from the date of the prior inspection

PARTS FINDER

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SECTION 3. CHASSIS & SCISSOR ARMS

3.1 TRACTION SYSTEM

Theory of Operation

The Armatures (rotating windings) of the separately-excited drive motors are wired in parallel to the Power Module's -T and +B terminals (ZAPI). The +B Terminal is always at the same voltage as the +B (Battery Voltage when the Line Contactor is closed) and allows the module to measure current with the internal shunt (extremely low impedance). The -T Terminal is pulled to Ground by the Armature Switch MOSFET's (connected to -B Terminal).

To provide variable speed control, the Armature MOSFET transistors switch On and Off at high frequencies (pulse-width modulation; 16kHz). The Duty Cycle (On & Off time) is varied to control the voltage applied to the Armatures. When the MOSFET's spend 50% of the period On and 50% Off, approximately $\frac{1}{2}$ of the available Battery Voltage will be applied to the Armatures. Similarly, the MOSFET are On continuously (100% Duty Cycle) to apply all available Battery Voltage to the Armatures (as in Driving at Full Speed).

Instead of permanent magnets, the separately-excited drive motors use electro-magnets (called Field Windings) located in the stator (non-rotating) portion of the motor. Field windings are preferable to permanent magnets because the Power Module can adjust the stator's magnetism for optimum motor performance. When climbing a grade at low speeds, the Power Module may apply as much as 40A to the field windings for more electro-motive force. On level terrain, the Power Module

will apply as little as 14A to the fields for higher rotational speeds and better electrical efficiency.

The Field Windings also provide direction reversal for traction. When driving forward, MOSFET switches 1 and 4 turn On to apply positive potential to F2 and ground potential to F1. In reverse, MOSFET switches 2 and 3 turn On to apply positive potential to F1 and ground potential to F2. These switches are pulse-width modulated by the Power Module to maintain a fixed relationship between Field and Armature Current (also called the Field Map).

Since the two 24V Armatures are wired in parallel, the drive motors will attempt to rotate at the same speed under all conditions. If one wheel slips, the wheel with traction will demand more current as it slows slightly (under load). In this manner, the system provides effective traction control with no added complexity.

It is essential that the same amount of field current is supplied to both drive motors, or one wheel will pull the vehicle (motor overheating and excessive tire wear would result). Independent field control would require a more complex Power Module, and parallel field windings would require impedance matching. For simplicity, the vehicle uses 12V field windings wired in series to ensure proper distribution of current.

Two electrically-released parking brakes are mounted to the rear of the drive motors. The Ground Module energizes the two 24V electro-magnets when appropriate to allow vehicle motion. The parking brakes can be released electrically for emergency vehicle towing

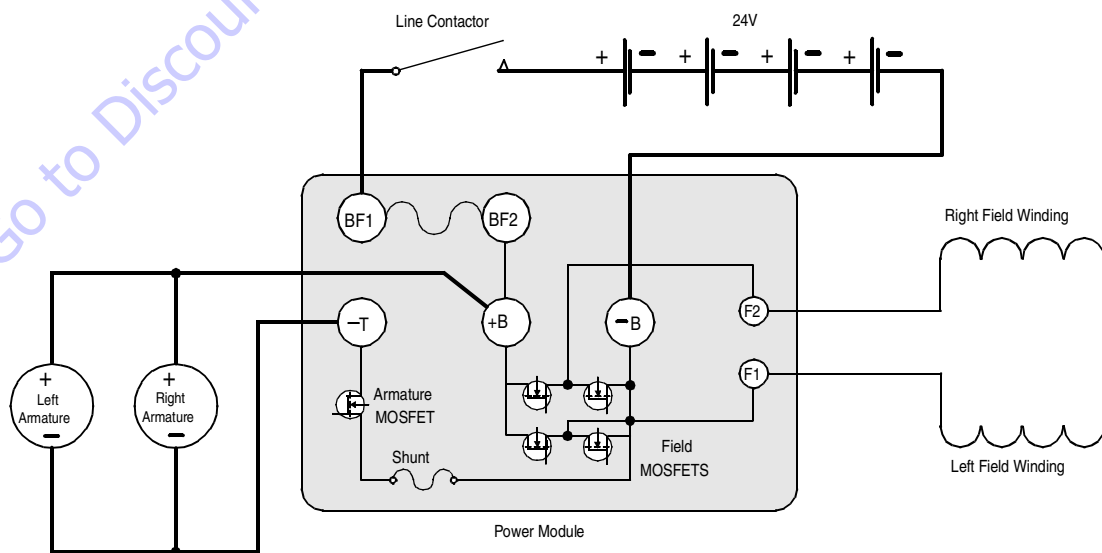


Figure 3-1. Traction Control Circuit - ZAPI Power Module

3.2 PUMP/MOTOR - THEORY OF OPERATION

The Power Module (see Figure 3-18., ZAPI Power Module Location on page 3-26) is essentially a "low-side" switch for the pump motor. The positive terminal of the pump is tied to Battery Positive after the Line Contactor. The negative terminal of the pump connects to the P Terminal of the Power Module, which switches current through MOSFET transistors to the Battery Negative.

For variable speed pump operation, the MOSFET transistors switch On and Off at high frequencies (16kHz). The Duty Cycle is varied to control the voltage applied to the pump motor. When the MOSFET's spend 50% of the period On and 50% Off, approximately 1/2 of the available Battery Voltage will be applied to the pump motor. Similarly, the MOSFET are On continuously (100% Duty Cycle) to apply all available Battery Voltage to the pump motor (as in Lift Up at full speed).

When the Control System is energized, the voltage at the P Terminal will be approximately +24V (referenced to -B) when the pump is static. The P Terminal will be approximately at +1V (referenced to -B) when the pump is running at full speed (Lift Up from Ground Mode).

Pump Motor Electrical Evaluation

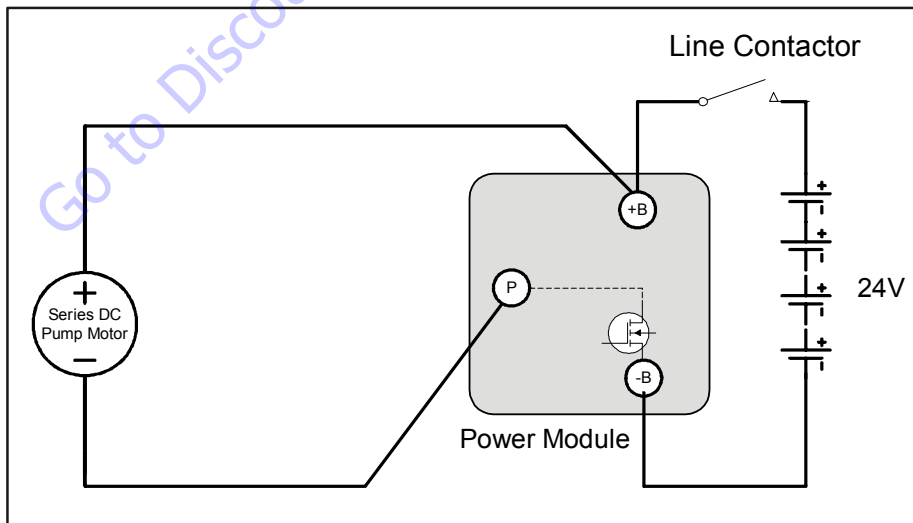
Several basic electrical tests can be performed on the Pump Motor. Failure of one of these evaluations is significant and may indicate that the device is physically damaged.

Refer to Figure 7-2., Resistance Measurement. Make all measurements with a voltmeter set to resistance scale (Ohms). Disconnect the Main Battery Disconnect and all pump motor cables during this analysis.

- **Resistance < 5 Ohms between Motor Terminals.** The internal windings are very low impedance and should appear to be a short-circuit for an ordinary voltmeter (other tests can determine if the windings are truly shorted). High resistance can signal worn brushes, a faulty commutator, or open windings.
- **Resistance > 1 MegaOhms between Motor Terminals and Motor Housing.** The internal windings should be electrically isolated from the motor housing. Low resistance may be an indication of a broken motor terminal, damaged brush, faulty commutator, or burned winding.

Common Difficulties

The following difficulties can be examined using the JLG Analyzer, a voltmeter, and simple hand tools. Unless otherwise noted, the Control System shall be energized in Ground Mode during testing. For a convenient Ground Reference, place the black meter lead on the negative post of the left battery in the left-side battery compartment. The vehicle should be placed on a firm, level surface for all analysis.



1. Open-Circuit between +B Terminal and Pump Motor Positive Terminal

This issue will allow the vehicle to drive, but Lift Up and Steer Functionality will be lost and the Pump Motor will not operate. Under DIAGNOSTICS - PUMP, the JLG Analyzer will show PUMP PWM 100% and PUMP CUR 0.0A when Lift Up is operated from Ground Mode.

As shown in the diagram, the voltage measured between the Pump Motor Positive Terminal and Ground Reference should be 24V. If it is not, examine the cable between the terminal and the Power Module compartment. Inspect crimps for corrosion and ensure that bolted connections are tight. Ensure that the cable is not crushed where it passes between the frame side sheets and the cylinder assembly.

2. Open-Circuit between Pump Motor Negative Terminal and P Terminal

This issue will allow the vehicle to drive, but Lift Up and Steer Functionality will be lost and the Pump Motor will not operate. Under DIAGNOSTICS - PUMP, the JLG Analyzer will show PUMP PWM 100% and PUMP CUR 0.0A when Lift Up is operated from Ground Mode.

After ensuring there is not an Open-Circuit between the +B Terminal and Pump Motor Positive Terminal, check that the voltage measured between the Pump Motor Negative Terminal and Ground Reference is 24V. If not, examine the issues within Open-Circuit Pump Motor. This voltage should ramp to approximately 0V when Lift Up is operated from Ground Mode. If not, examine the cable between the terminal and the Power Module compartment (P Terminal). Inspect crimps for corrosion and ensure that bolted connections are tight. Ensure that the cable is not crushed where it passes between the frame side sheets and the cylinder assembly.

3. Open-Circuit Pump Motor

This issue will allow the vehicle to drive, but Lift Up and Steer Functionality will be lost and the Pump Motor will not operate. Under DIAGNOSTICS - PUMP, the JLG Analyzer will show PUMP PWM 100% and PUMP CUR 0.0A when Lift Up is operated from Ground Mode.

Pull the Main Battery Disconnect to completely de-energize the Control System. Next, detach the cable from Pump Motor Positive Terminal. Using a voltmeter set for resistance measurement (Ohms), ensure that the resistance between the Pump Motor Positive and Negative Terminals is less than 2 Ohms. If not, examine the pump motor for worn

brushes or broken terminals. After examination, re-connect the Pump Motor Positive Terminal and the Main Battery Disconnect.

4. Short-Circuit between Pump Motor Positive and Negative Terminals

This issue will allow the vehicle to drive, but Lift Up and Steer Functionality will be lost and the Pump Motor will not operate. Under DIAGNOSTICS - PUMP, the JLG Analyzer will show an erratic reading for PUMP PWM % and PUMP CUR will hover around 150A when Lift Up is operated from Ground Mode.

Pull the Main Battery Disconnect to completely de-energize the Control System. Next, detach both Pump Motor Terminals and insulate them independently. Re-connect the Main Battery Disconnect and re-try Lift Up. If the same symptoms persist (erratic PUMP PWM%, PUMP CUR around 150A), examine the cabling between the Pump Motor and Power Module compartment for a short-circuit (most likely near area where cylinder retracts between frame side sheets or near pot-hole mechanism). If the symptoms change, suspect a short-circuited (or mechanically frozen) pump motor.

A clamp-on ammeter (set for 200A DC) can be placed on either Pump Motor Cable for verification. During Lift Up, the ammeter will read approximately 150A.

3.3 DRIVE MOTOR ELECTRICAL EVALUATION

Several basic electrical tests can be performed on the Drive Motors. Failure of one of these evaluations is significant and may indicate that the device is physically damaged.

Refer to Figure 7-2., Resistance Measurement. Disconnect the Main Battery Disconnect and all drive motor cables during this analysis.

- **Resistance < 2 Ohms Red to Black Armature Wires.** The heavy red and black conductors are connected to the motor's armature winding. The winding is a very low impedance and should appear to be a short-circuit for an ordinary voltmeter. High resistance can signal corrosion, improper crimps, damaged cabling, worn brushes, a faulty commutator, or an open armature winding.
- **Resistance < 2 Ohms Blue to Orange Field Wires.** The blue and orange conductors are connected to the motor's field winding. In order to make this measurement, it will be necessary to disconnect the butt-splice on the two orange wires or use a piercing meter probe. As with the armature, the field is a very low impedance and should appear to be a short-circuit for an ordinary voltmeter. High resistance can signal corrosion, improper crimps, damaged connectors, damaged cabling, or an open field winding.
- **Resistance 15-25 Ohms Yellow to Brown Brake Wires.** The yellow and brown wires are connected to the integral brake. Improper resistance can signal corrosion, improper crimps, damaged cabling, or a faulty solenoid.
- **Resistance > 1 MegaOhms Red Armature Wire to Motor Housing.** The armature winding should be electrically isolated from the motor housing. Low resistance may be an indication of a crushed cable, a burned cable, or a burned armature winding. Investigate by disconnecting the drive motor cable from the motor and re-measure resistance (isolation).
- **Resistance > 1 MegaOhms Blue Field Wire to Motor Housing.** The field winding should also be electrically isolated from the motor housing. Low resistance may be an indication of a crushed cable, a burned cable, or a burned field winding. Investigate by disconnecting the drive motor cable from the motor and re-measure resistance (isolation).
- **Resistance > 1 MegaOhms Red Armature Wire to Blue Field Wire.** The armature and field windings should also be electrically isolated from one another. Low resistance may be an indication of a crushed cable, a burned cable, damaged windings. Investigate by disconnecting the drive motor cable from the motor and re-measure resistance (isolation).

Common Traction System Difficulties

1. Short-Circuit Motor Armature

This issue will allow the vehicle to drive very slowly or not at all. Rapid motor overheating (one motor) will result.

This situation can be detected by elevating the vehicle's front wheels and engaging drive (platform stowed). Under DIAGNOSTICS - TRACTION, the JLG Analyzer's ARM CUR display (Armature Current Reading) will exceed 120A. The FLD CUR display (Field Current Reading) will hover around 40A. Neither wheel will rotate at normal speed, but it will be possible to rotate the drive wheel by hand. The Power Module's self-diagnostics cannot detect this fault since the situation appears identical to climbing a steep grade.

To find the source of the difficulty, pull the Main Battery Disconnect and disconnect the Armature Wiring (heavy red and black conductors) from the suspected drive motor leading to the Power Module's M1 and M2 Terminals. Re-test the traction function. If the remaining drive motor is able to reach full speed (and Armature Current is less than 50A), the drive motor that has been disconnected is fault. Investigate for crushed and burned cables. Note if the drive motor smells burned.

2. Short-Circuit Brake Release

This issue will not allow the vehicle to drive. Rapid motor overheating (both motors) will result. Continued attempts to drive the vehicle may result in armature damage.

This situation can be detected by elevating the vehicle's front wheels and engaging drive (platform stowed). Under DIAGNOSTICS - TRACTION, the JLG Analyzer's ARM CUR display (Armature Current Reading) will exceed 120A. The FLD CUR display (Field Current Reading) will hover around 40A. Neither wheel will rotate, and it will be impossible to rotate either drive wheel by hand. The Ground Module cannot detect this fault during power-up or self-test since energizing the brakes could pose a hazard. However, it may detect this issue during Drive (investigate using JLG Analyzer).

To find the source of the difficulty, remove the rear cover from either drive motor. Insert voltmeter leads into the white connector leading to the brake solenoid (yellow and brown wires) and attempt to drive (Platform Mode). The Ground Module will apply approximately 24V to the brake release solenoids (wired in parallel) during drive, but will reduce this voltage in the event of a short-circuit. If this voltage is improper (less than 8V), investigate using resistance measurement (refer to

Drive Motor Electrical Evaluation). Suspect damaged cabling, burned cabling, or faulty brake release solenoids. Trace the brake release cabling from the Power Module Compartment to the Ground Module Connector J1-24.

3. Open-Circuit Brake Release

This issue will not allow the vehicle to drive. Rapid motor overheating (both motors) will result. Continued attempts to drive the vehicle may result in armature damage.

This situation can be detected by elevating the vehicle's front wheels and engaging drive (platform stowed). Under DIAGNOSTICS - TRACTION, the JLG Analyzer's ARM CUR display (Armature Current Reading) will exceed 120A. The FLD CUR display (Field Current Reading) will hover around 40A. It is possible that one wheel may rotate, or neither may rotate (depending on the location of the open-circuit). Listen for the brake release solenoid when activating drive. The Ground Module cannot detect this fault during power-up or self-test since energizing the brakes could pose a hazard. However, it may detect this issue during Drive (investigate using JLG Analyzer).

If one wheel rotates, the open-circuit is located in the wiring for that specific drive motor (Power Module compartment or Drive Motor Cable). Investigate for improper crimps, unlatched connectors, damaged cables, or open brake release solenoids (refer to Drive Motor Electrical Evaluation).

If neither wheel rotates, the open-circuit is located in the wiring between the Power Module compartment and Ground Module. Using a voltmeter, measure the brake release voltage on either brake connector in the Power Module compartment during drive (should be approximately 24V). Investigate for improper crimps, unlatched connectors, damaged harnessing, or a faulty Ground Module. As an alternative, insert a short piece of wire with a Deutsch Female Crimp directly into Ground Module's J1-24 and measure voltage as a diagnostic measure (eject vehicle harness from that pin).

Power Module Electrical Evaluation

Several basic electrical tests can be performed on the Power Module. Failure of one of these evaluations is significant and may indicate that the device is physically damaged. If a Power Module is suspected to be faulty, thoroughly examine the rest of the system for possible damage.

Refer to Figure 7-2., Resistance Measurement. Disconnect the Main Battery Disconnect and all cables from the Power Module during this analysis. Wait 60 seconds

after power is disconnected to allow internal charge to dissipate (risk of hazard, improper readings otherwise).

- **Resistance >100kOhms all Terminals to Housing.** Ensure that there is an open-circuit between all terminals of the Power Module and the module's aluminum housing. The device is fully potted and all electronics are insulated from the housing. Place the Black meter lead on the housing and use the Red meter lead to probe all terminals.
- **Resistance < 2 Ohms between +B and M1.** Ensure that there is a short-circuit between the +B and M1 Terminals. Internally, there is a low-impedance current measurement shunt for the Armature portion of Traction. Place the Red meter lead on +B, and the Black meter lead on M1.
- **Resistance >1 MegaOhms between F1 and -B; F2 and -B.** Ensure that there is an open-circuit between the two Field Terminals (F1 & F2) and -B. Internally, there are MOSFET transistors between these terminals that should be high-impedance when the module is un-powered. Place the Black meter lead on -B and the Red meter lead on F1 / F1.
- **Resistance >1 MegaOhms between F1 and +B; F2 and +B.** Ensure that there is an open-circuit between the two Field Terminals (F1 & F2) and +B. Internally, there are MOSFET transistors between these terminals that should be high-impedance when the module is un-powered. Place the Black meter lead on +B and the Red meter lead on F1 / F1.
- **Resistance >100kOhms between P and -B.** Ensure that there is an open-circuit between the P and the -B Terminals. Internally, there are MOSFET transistors between these terminals that should be high-impedance when the module is un-powered. Place the Black meter lead on -B, and the Red meter lead on P. Note that a measurement of increasing resistance (capacitor charge) is normal, but a persistently low impedance is not.
- **Resistance >1kOhms between M2 and -B.** Ensure that there is an open-circuit between the M2 and -B Terminals. Internally, there are MOSFET transistors between these terminals that should be high-impedance when the module is un-powered. Place the Black meter lead on -B, and the Red meter lead on M2. Note that a measurement of increasing resistance (capacitor charge) is normal, but a persistently low impedance is not.
- **Resistance 120 Ohms between Pins 10 & 11.** Ensure that the resistor that terminates the CANbus is within tolerance between pins 10 and 11 on the 12 position Mini-Fit Jr (Connector "B"). Place the Red meter lead on pin 10, and the Black meter lead on pin 11. The resistance should measure between 110 - 130 Ohms.

3.4 TORQUE HUB

NOTICE

THE PROCEDURES WITHIN THIS SECTION APPLY TO ALL MACHINES AND TORQUE HUBS. PROCEDURES THAT APPLY TO SPECIFIC MACHINES AND TORQUE HUBS WILL BE SO NOTED BY PROPER SERIAL NUMBERS.

NOTE: *These instructions will cover how to completely assemble and disassemble the Torque-Hub unit. However, if the unit is under warranty you should contact JLG Industries, Inc. for a replacement unit. The warranty will no longer be valid if the unit is disassembled by non-JLG personnel.*

NOTICE

TORQUE HUB UNITS SHOULD ALWAYS BE ROLL AND LEAK TESTED BEFORE DISASSEMBLY AND AFTER ASSEMBLY TO MAKE SURE THAT THE UNIT'S GEARS AND SEALANTS ARE WORKING PROPERLY.

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

⚠ WARNING

IF THE MACHINE IS ON ANY INCLINE, THE WHEELS MUST BE ADEQUATELY BLOCKED PRIOR TO MANUALLY DISENGAGING THE BRAKES. FAILURE TO DO SO MAY RESULT IN INJURY OR EVEN DEATH.

NOTE: *The brake must be released before performing the roll test. This can be accomplished by connecting the brake release cable and depressing button. The brake can also be released by following the manual disengage procedures outlined in this section.*

⚠ CAUTION

RETURN BRAKE RELEASE CABLE BEFORE RETURNING TO NORMAL OPERATION.

Roll Test

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

Leak Test

The purpose of a leak test is to make sure the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your leak checking fitting starts to fall after the unit has been pressurized and allowed to equalize. Leaks will most likely occur at the pipe plugs, the main seal or wherever o-rings are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where the o-rings or gaskets meet on the exterior of the unit, then checking for air bubbles. If a leak is detected in a seal, o-ring or gasket, the part must be replaced, and the unit rechecked. Leak test at **10 psi** for 20 minutes.

NOTE: *Due to the small air volume inside this Torque-Hub, it will pressurize to 10 psi very quickly. If the pressure becomes excessive in the unit the seals will be destroyed.*

Oil Check/Fill Procedure

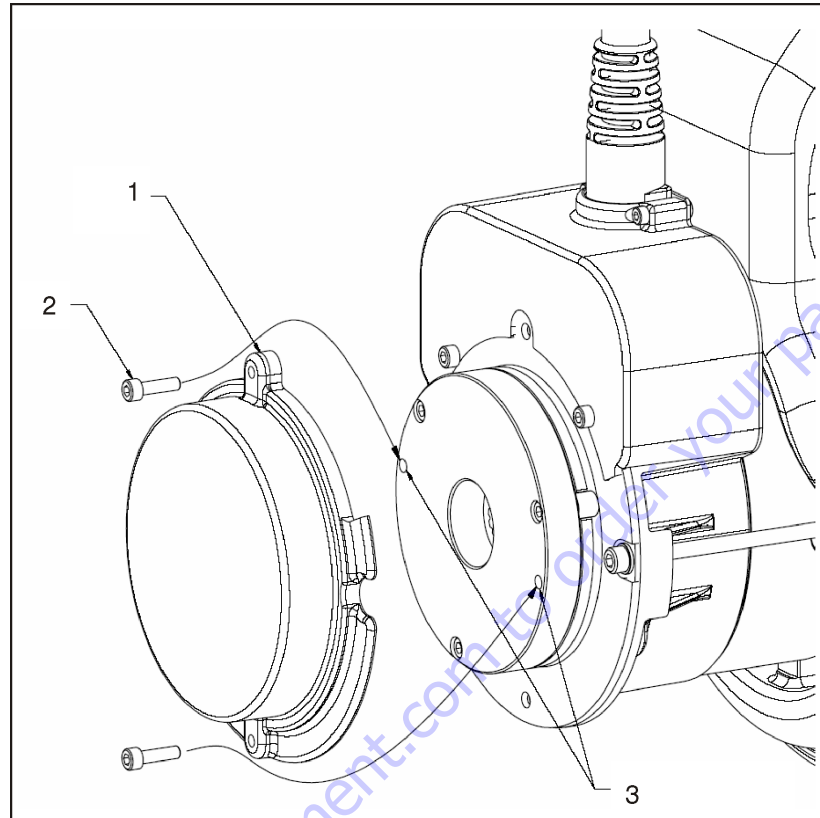
The torque hub unit is shipped with ISO 68 viscosity oil (hydraulic fluid). It is designed to utilize the same oil throughout its service life. However, should it need to be checked/serviced use the following procedure.

In the event of servicing, fill the unit with ISO grade 68 hydraulic oil (80W gear oil or 20W engine oil).

NOTE: *The gearbox capacity is 10 oz of oil.*

1. To check the oil level, rotate the wheel so that the plugs in the cover are at 12 o'clock and 3 o'clock.
2. Allow the oil to settle then slowly remove the plug at 3 o'clock.
3. If oil begins to come out the oil level is sufficient.
4. If no oil is noticed at the 3 o'clock plug remove both plugs.
5. Slowly add oil at the 12 o'clock plug location until oil begins to seep out at the 3 o'clock plug location.
6. Apply pipe dope or teflon tape to the cover plugs and reinstall into the cover.
7. Tighten to 6 ft. lbs. - 8 ft. lbs. (8.4 Nm to 11.2 Nm).

Brakes - Manual Disengage Procedure



- | | |
|----------------|--------------------|
| 1. Brake Cover | 3. Disengage Holes |
| 2. Cover Bolts | |

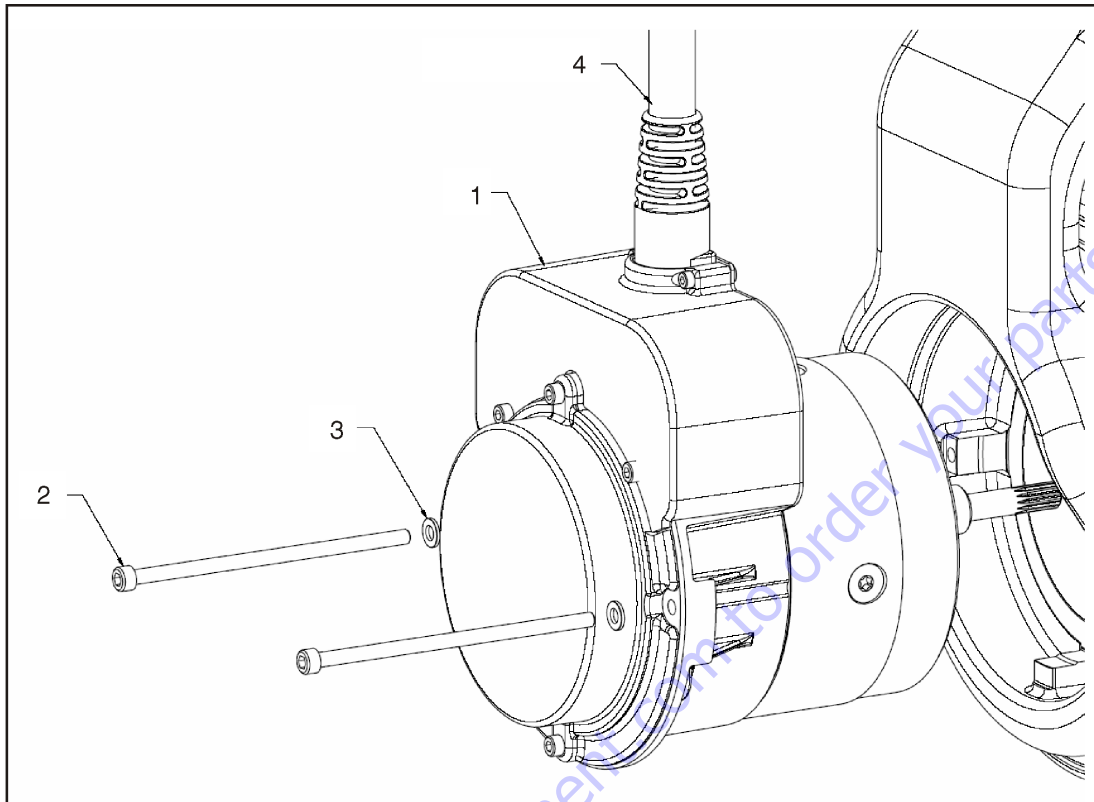
Figure 3-2. Disengage Procedure

1. Chock wheels or secure machine with tow vehicle.
2. Ensure battery disconnect switch is in to the "OFF" position.
3. Remove the two Cover Bolts and Brake Cover.
4. Insert the Cover Bolts into the two Disengage Holes in the brake housing.
5. Tighten down the Cover Bolts and the brake on that drive motor will disengage.
6. Repeat this procedure on opposite wheel drive. With both drive motor brakes now disengaged, the machine can be moved manually.
7. After towing is complete, chock wheels and remove Cover Bolts from Disengage Holes.
8. Reinstall Brake Cover.

⚠ CAUTION

AFTER THE MACHINE IS TOWED, THE DISENGAGE BOLTS MUST BE REMOVED FROM THE BRAKE DISENGAGE HOLES. THE BRAKES CANNOT BE ENGAGED WITH THE DISENGAGE BOLTS IN THE BRAKE DISENGAGE HOLES. THIS WILL CAUSE THE MACHINE TO ROLL WHEN PARKED ON AN INCLINE.

Drive Motor Removal



- | | |
|-------------------------|----------------|
| 1. Drive Motor | 3. Washers |
| 2. Motor Mounting Bolts | 4. Motor Cable |

Figure 3-3. Motor Removal

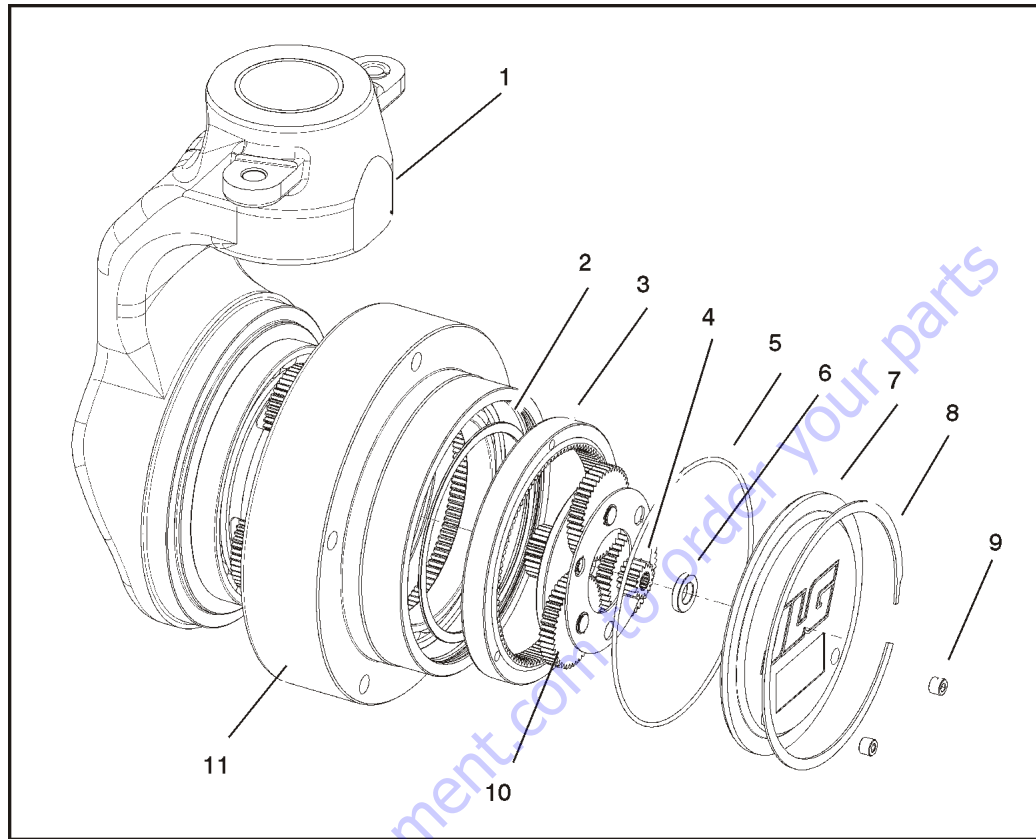
CAUTION

ENSURE THE BATTERY DISCONNECT SWITCH IS IN THE OFF POSITION BEFORE REMOVING DRIVE MOTOR.

1. Disconnect the motor cable from the power control module.
2. Drain the oil out of the unit by removing the cover plug. Note the condition of the oil, replace if necessary.

3. Remove the two motor mounting bolts and washers.
4. Gently remove the drive motor (1).

Main Gearbox Disassembly



- | | | |
|-------------------------|------------------------|--------------------------------|
| 1. Spindle Sub-Assembly | 5. Cover O-Ring | 9. Pipe Plug |
| 2. Spiral Snap Ring | 6. Cover Thrust Washer | 10. Input Carrier Sub-Assembly |
| 3. Input ring Gear | 7. Cover | 11. Hub Sub-Assembly |
| 4. Input Sun Gear | 8. Cover Snap Ring | |

Figure 3-4. Main Gearbox Disassembly

1. Using a screwdriver, pry off the cover snap ring.
2. Remove cover. Cover Thrust washer should be in the inner counterbore of the cover.

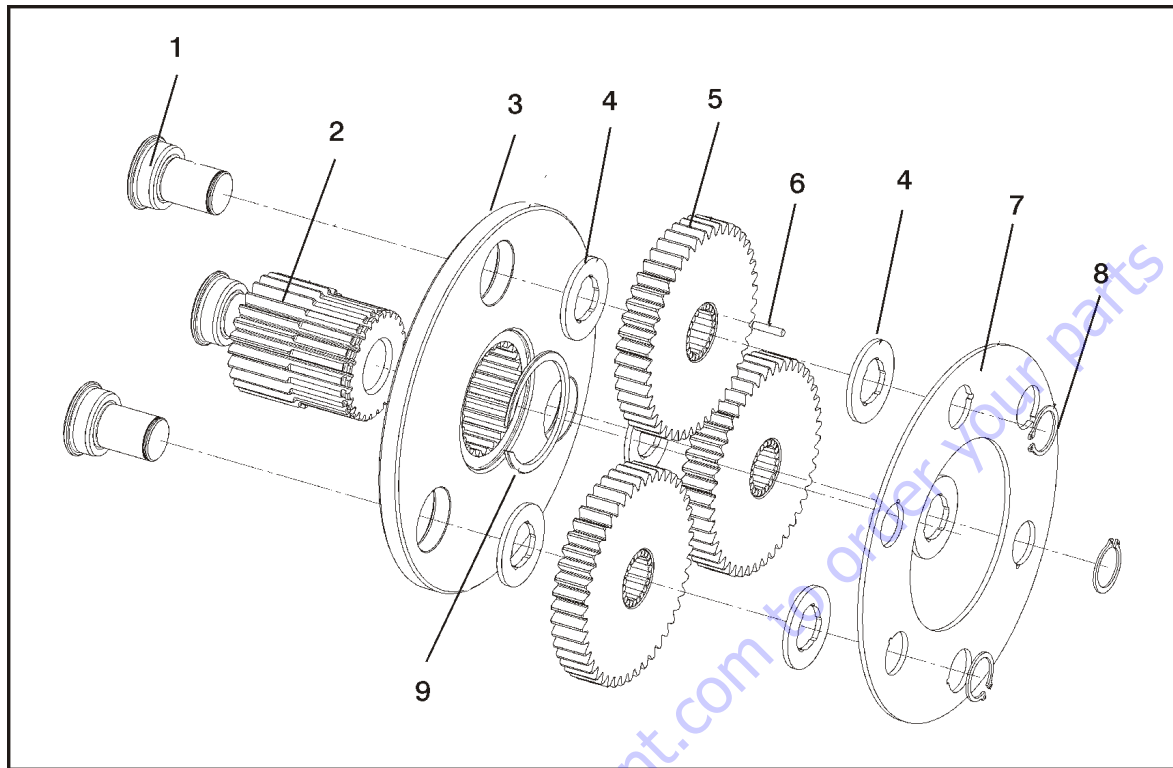
NOTE: To grip the cover for removal a pipe may need to be inserted into the pipe plug holes.

3. Remove input sun gear.
4. Remove input carrier sub-assembly.
5. Remove cover o-ring.
6. Remove input ring gear.

NOTE: The input ring gear is held in with a press fit on its outside diameter. Insert jacking screws (1/4-20UNC grade 8) with at least 1.5 inches of thread length into each of the three tapped holes to force the ring gear out. Be sure and alternate between the jacking screws to keep the ring gear from becoming misaligned in the bore. The screws will push against the outer race of the main bearing. This bearing will have to be replaced afterwards.

7. Using a screwdriver remove spiral snap ring.
8. Pull hub sub-assembly off of the spindle sub-assembly.

Input Carrier Disassembly



- | | | |
|---------------------|----------------------|-------------------|
| 1. Planet Gears | 4. Thrust washer | 7. Thrust Plate |
| 2. Output Sun Gears | 5. Input Planet Gear | 8. Snap Ring |
| 3. Input Carrier | 6. Needle Bearings | 9. Retaining Ring |

Figure 3-5. Input Carrier Disassembly

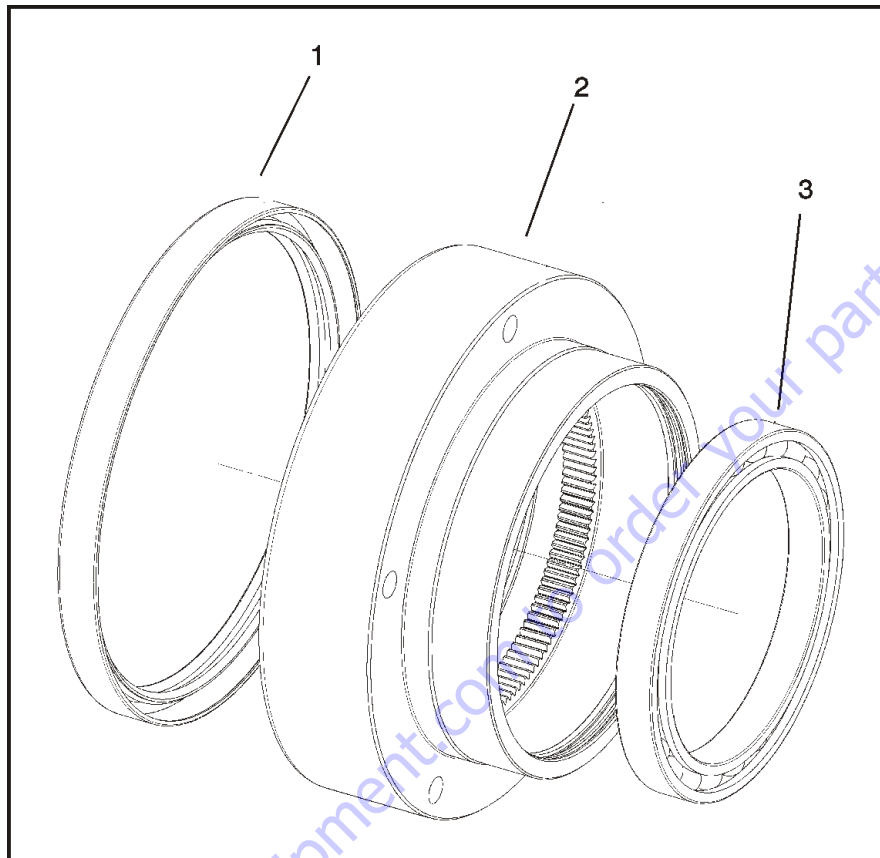
1. Remove retaining rings from each of the 3 planet shafts.

NOTE: Do not overstress these retaining rings when removing them.

2. Remove thrust plate.
3. Remove a thrust washer from each planet shaft.
4. Slide each input planet gear off the planet shaft.
5. Remove 22 needle bearings from the bore of each planet gear.
6. Remove the thrust washer from each planet gear.
7. Remove retaining ring from output sun gear.
8. Slide output sun gear out from the center of the input carrier.
9. Remove the three planet shafts from the input carrier.

NOTE: The planet pins are held in with a press fit. To avoid damage to the parts, use an arbor or hydraulic press to remove the planet pins.

Hub Disassembly



1. Seal
2. Hub
3. Main Bearing

Figure 3-6. Hub Disassembly

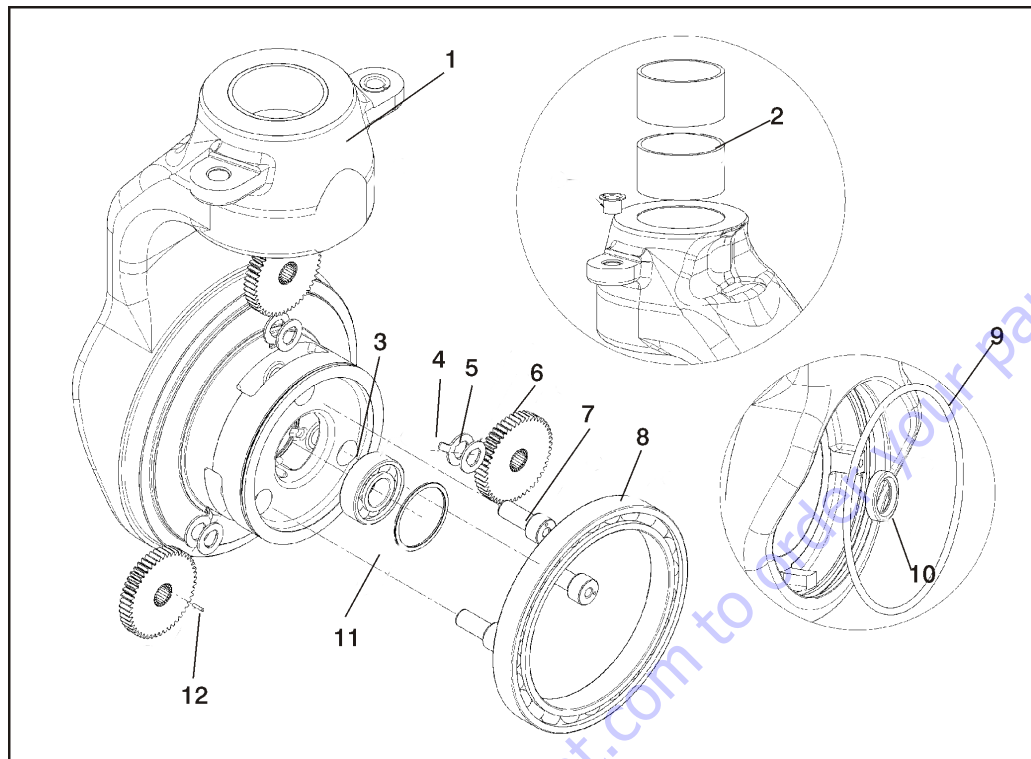
1. Remove main wheel bearing.

NOTE: This part is held in the hub with a press. To remove have the hub sitting seal side up. Use a plate or rod with a large enough diameter push in the inner race of the bearing. Apply force to the push the bearing out. This bearing will need to be replaced upon reassembly.

2. Remove main lip seal.

NOTE: This lip seal is also held in with a press fit. Remove the lip seal only if the hub or seal needs to be replaced. The lip seal will most likely become damaged during removal. Try not to damage the hub bore.

Spindle Disassembly



- | | | |
|-------------------------|-----------------------|----------------------------|
| 1. Spindle Sub-Assembly | 5. Thrust Washer | 9. O-Ring |
| 2. Main Bushing | 6. Output Planet Gear | 10. Shaft Seal |
| 3. Shaft Ball Bearing | 7. Output Planet Pins | 11. Snap Ring |
| 4. Tanged Washer | 8. Main Bearing | 12. Needle Roller Bearings |

Figure 3-7. Spindle Disassembly

1. Place unit on bench with planet gears facing up.
 2. Remove 3 output planet shafts.
- NOTE:** These planet shafts are held in with a press fit. Use the tapped hole in the end of the pin in conjunction with a slide hammer or similar tool to remove them.
3. Remove the output planet gear, thrust washer, and tanged washer out of each gear "window" of the spindle.
- NOTE:** The output planet gears are a very similar size to the input planet gears, tag or label the planet gears to avoid confusion.
4. Using a screwdriver remove the shaft bearing snap ring.
 5. Remove the shaft ball bearing from the center bore.
 6. Press out the motor shaft seal from the center bore.
 7. Remove the main bearing from the outside diameter of the spindle.
- NOTE:** This bearing is held in with a press fit. You will need to pry against the spindle to remove it. The bearing will need to be replaced when this is done.
8. Press out the main bushings at the top of the spindle neck.
 9. Remove the motor O'ring from the groove on side opposite from the carrier side.

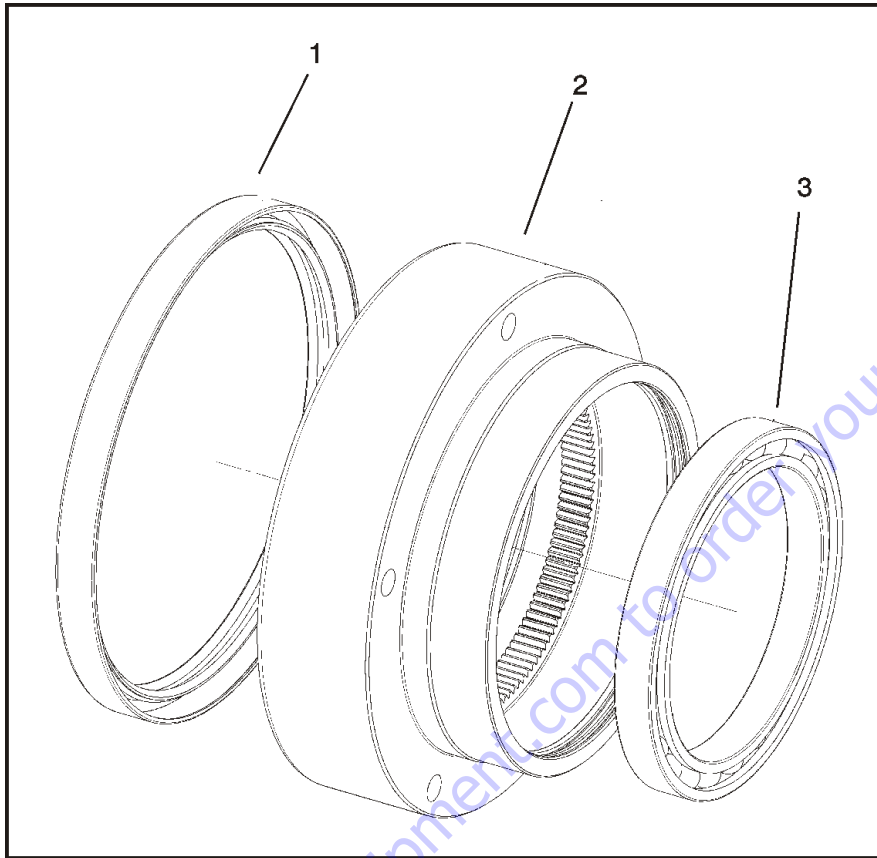
Spindle Sub-Assembly

1. Using an appropriate pressing tool, press in the 2 main bushings in the upper bore of the spindle. The lower bushing needs to be flush with the bottom of the bore and the upper bushing needs to be flush with the bottom of the bore.
2. Using the clevis pin from the steering linkage or an M12 bolt, drive the flanged steer link bushing into the appropriate spindle ear hole. If the wheel drive is for the left wheel then, with the carrier side up and kingpin bore oriented to the top, put the steer link bushing in the left ear.
3. Using the appropriate pressing tool, press on main bearing until it is fully seated.
4. Insert the motor shaft bearing into the center bore of the spindle. The bearing is a slight slip fit, but it may require some press to assemble if the bearing becomes misaligned.
5. Retain the bearing with the spiral retaining ring.
6. Line the bore of the output planet gear with 22 needle rollers. Use grease to retain the needle rollers in the bore.
7. Place tanged thrust washer into each planet "window" of the spindle. Make sure the tang sits in the cast groove on the inside of the window.
8. Place a thrust washer onto the plane gear. Line up the bores as best as you can. Use grease to hold the thrust washer in place.
9. Slide the planet gear into the window with the tanged washer until the bores line up.
10. Insert an output planet pin into the planet pin hole of the spindle and through the bores of the thrust washers and the planet gear.
11. Before pressing the planet pin into the spindle make sure the gear spins freely.
12. Press the planet pin into the spindle until it bottoms out. Make sure the planet gear turns freely after the planet pin is pressed in.
13. Repeat Steps 6-12 for the other two output planet gears.
14. Turn the spindle over so that the carrier is down.
15. Using a flat plate or rod, press the motor shaft seal into the center bore so that it is flush with the face of the spindle.
16. Grease and install the motor O'ring into the groove.

⚠ WARNING

CARE SHOULD BE TAKEN TO PREVENT ANY OIL FROM MAKING CONTACT WITH THE BRAKE DISCS. IF THIS OCCURS IT WILL DEGRADE THE BRAKES PERFORMANCE.

Hub Sub-Assembly



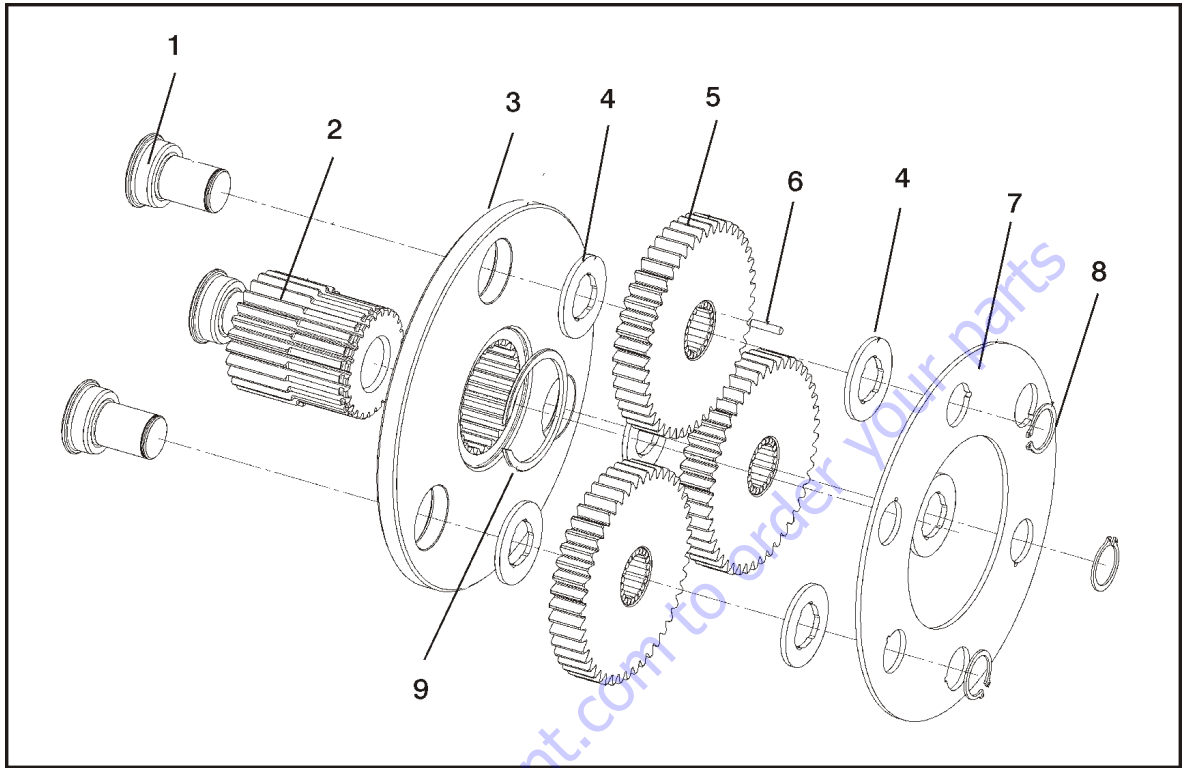
1. Seal
2. Hub
3. Main Bearing

Figure 3-8. Hub Disassembly

1. Put hub on a table with the tapped holes facing down.
2. Using a flat plate in conjunction with a pressing tool, press in the seal so it is flush with the edge of the hub.
3. Flip the hub over.
4. Using an appropriate pressing tool, press the main bearing into the bore until it bottoms out.

NOTE: The seal has a thin outer shell that can be easily damaged if not installed with care. It is a good idea to start the seal into the bore with a rubber mallet before pressing.

Input Carrier Sub-Assembly



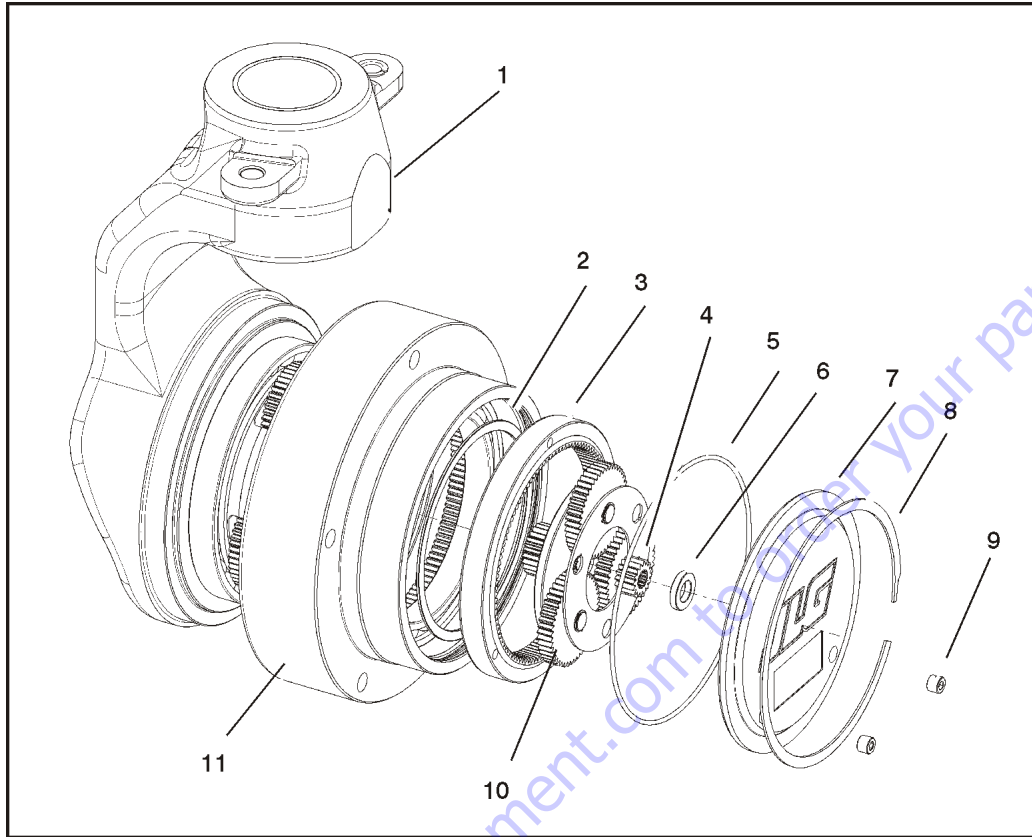
- | | | |
|---------------------|----------------------|-------------------|
| 1. Planet Gears | 4. Thrust washer | 7. Thrust Plate |
| 2. Output Sun Gears | 5. Input Planet Gear | 8. Snap Ring |
| 3. Input Carrier | 6. Needle Bearings | 9. Retaining Ring |

Figure 3-9. Input Carrier Disassembly

- Press 3 input planet shafts into the 3 holes of the input carrier. The head of the input planet shaft needs to sit flush in the counterbore of the input carrier hole.
- Insert output sun gear into the splined bore of the input carrier. The gear tooth end of the output sun gear should protrude in the opposite direction of the input planet shaft.
- Using retaining ring pliers. Install the retaining ring into the groove of the output sun gear. Make sure that the ring is correctly seated in the groove and that the output sun gear cannot be pulled out of the input carrier.
- Load 22 needle rollers into the bore of each input planet gear. Retain the needle bearings in the bore with a coating of grease.
- Place a thrust washer on each side of the input planet gear. Line up the bores as well as you can visually. Additional grease may help hold everything together.
- Place the input planet gear and thrust washers onto the input planet shaft sticking out from the carrier. When you slide the input planet shafts into the bores, the needle bearings will try to push out. If you have the thrust washers lined up properly they will contain the needle bearings within the input planet-gear.
- Repeat 5 & 6 for the other 2 planet gears.
- Put the thrust plate onto the three input planet shafts. Use the 3 holes on the innermost bolt circle. The other 3 holes are for a different gear ratio.
- Using the appropriate retaining ring pliers put a retaining ring into the groove of each planet shaft.

NOTE: Do not overstress the snap ring.

Main Gearbox Assembly



- | | | |
|-------------------------|------------------------|--------------------------------|
| 1. Spindle Sub-Assembly | 5. Cover O-Ring | 9. Pipe Plug |
| 2. Spiral Snap Ring | 6. Cover Thrust Washer | 10. Input Carrier Sub-Assembly |
| 3. Input ring gear | 7. Cover | 11. Hub Sub-Assembly |
| 4. Input Sun Gear | 8. Cover Snap Ring | |

Figure 3-10. Main Gearbox Disassembly

1. Inspect seal surface of spindle. Remove any debris that may be present.
2. Apply a coating of grease to the lip seal of the hub sub-assembly.
3. Place Spindle Sub-Assembly on table with carrier side up.
4. Carefully install the hub sub-assembly (seal side down) onto the spindle. This installation should be a slip fit and takes place in 3 stages.
 - a. *Stage 1:* The hub slides together until the gear teeth of the hub hit the gear teeth of the 3 output planets.
 - b. *Stage 2:* Find the planet gear that is tight and turn it until you feel it go into mesh with the hub gear teeth, apply slight downward pressure to the hub and then find the next gear that is tight and do the same.
 - c. *Stage 3:* Once all the planet gears are in mesh apply pressure to the hub, it should go on the rest of the way.
5. Install retaining ring into the groove on the OD of the spindle carrier. This is a spiral retaining ring so it will not require pliers. You will need to pull the retaining ring apart and work it into the groove.

6. Using an appropriate pressing tool, press the Input Ring gear (**recessed side down**) into the hub sub-assembly.

NOTE: *Do not use excessive pressing force because it will be reacted by the main wheel bearings.*

7. Install the input carrier sub-assembly into mesh. The output sun portion of the sub-assembly will mesh with the output planet gears and the planet gears mounted on the sub assembly will mesh with the input ring gear.
8. Install the input sun gear into the area between the 3 input planet gears.
9. Apply a coating of grease to the cover o’ring and install it into the o’ring groove of the hub.

NOTE: *It may be helpful to stretch the o’ring out prior to assembly to avoid pinching or shearing when the cover is assembled.*

10. Apply a heavy coating of grease to the cover thrust washer and place it in the center counterbore of the cover. The grease will help keep it in the bore during assembly.

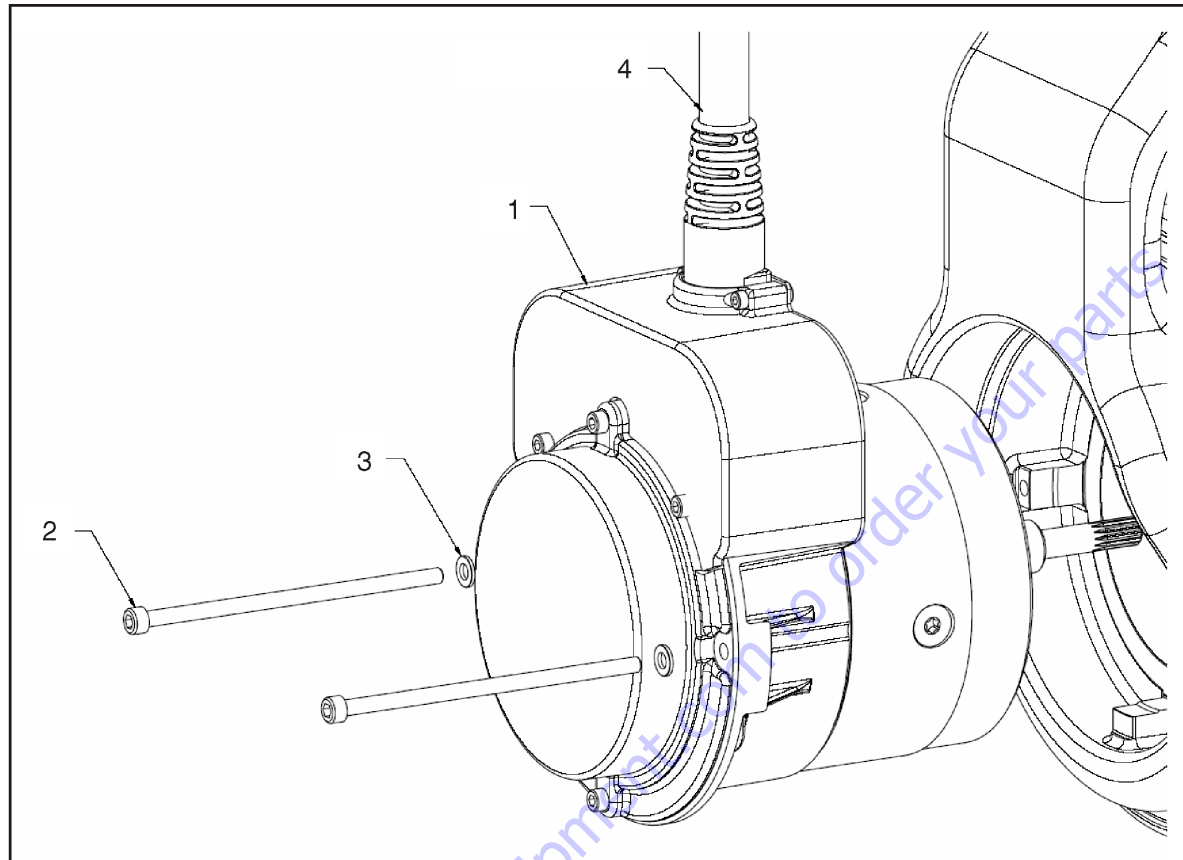
11. Center the cover in the hub bore so that the “JLG” logo is up. Push it into the bore.

NOTE: *Do not hit the cover with a hammer or mallet, shocks may cause the cover thrust washer to dislodge and drop into the gear cavity prior to the cover getting positioned properly. If all the parts are to size and assembled properly, the cover should not need excessive force to assemble.*

12. Install the cover retaining ring into the hub groove.

Go to Discount-Equipment.com to order your parts

Motor and Brake Assembly



- | | |
|-------------------------|----------------|
| 1. Drive Motor | 3. Washers |
| 2. Motor Mounting Bolts | 4. Motor Cable |

Figure 3-11. Drive Motor Assembly

1. Insert the drive motor into the back of the gearbox. The drive motor will pilot on the four bosses in the gearbox. Try to keep the end of the motor shaft from causing damage to the lip seal in the gearbox.
2. Install the two motor mounting bolts and washers. Torque to 9 - 11 ft. lbs. (12 - 15 Nm).
3. Connect the end of the Motor Cable to the Power Module.
4. Fill the gearbox with oil ISO grade 68 oil or oil of a similar viscosity (80W gear oil or 20W engine oil). The gearbox will need to be filled with 10 oz of oil.

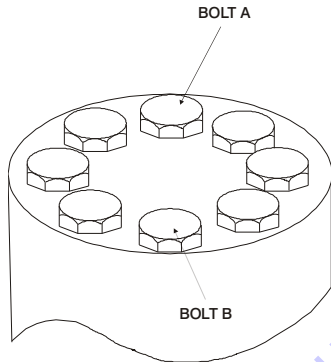
NOTE: The motor may need to be rotated to line up the sun gear splines with the motor shaft splines.

Tightening and Torquing Bolts

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

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

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



Assembly Tools

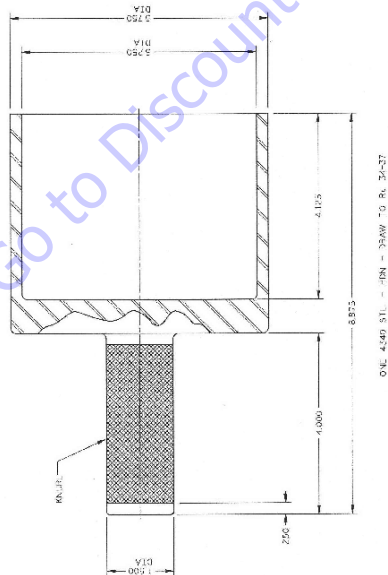


Figure 3-12. Assembly Tool 1

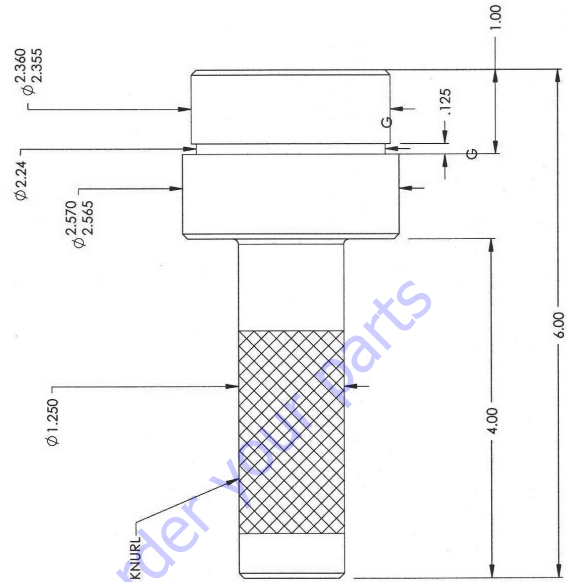


Figure 3-13. Assembly Tool 2

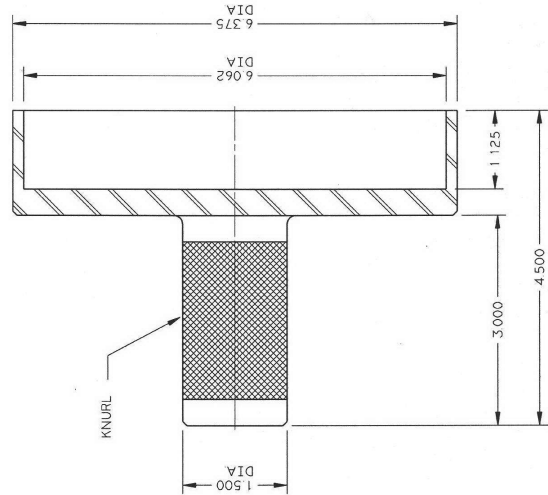


Figure 3-14. Assembly Tool 3

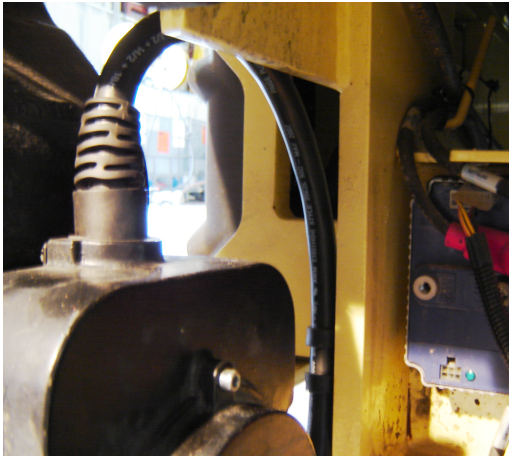
3.5 DRIVE MOTOR CABLE ROUTING

1930ES Only

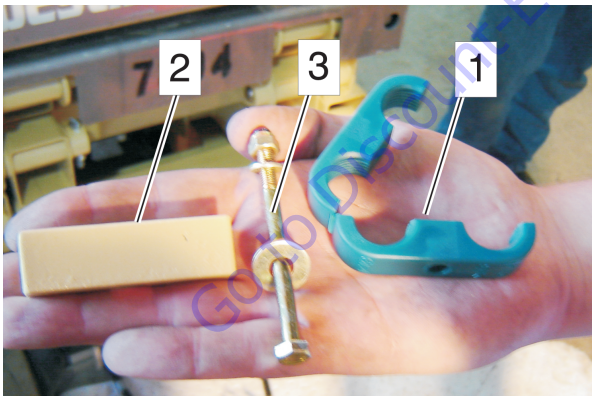
CAUTION

BE SURE TO PULL THE BATTERY DISCONNECT ANYTIME WORK IS BEING PERFORMED ON THE DRIVE MOTORS OR DRIVE MOTOR CABLING.

1. Orient the drive cables going back towards the rear of the machine as shown below.

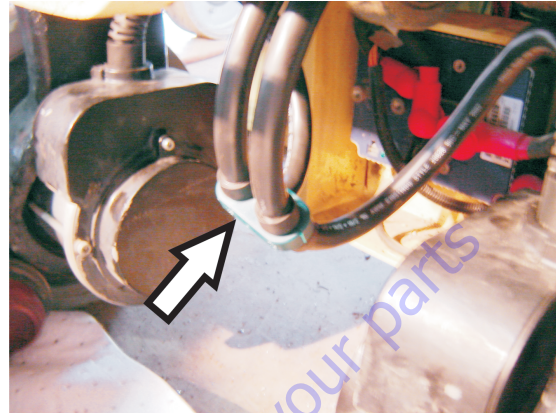


2. Loop the cables forward towards the front of the machine then up and back so that the clamping rings on the cables are aligned together.
3. Obtain the Cable Clamp and hardware.

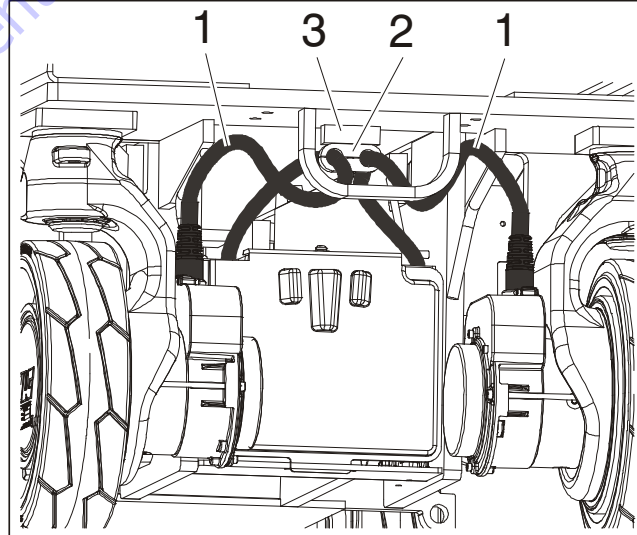


- | | |
|-----------------|-------------------------------|
| 1. Cable Clamp | 3. Capscrew, Washers, and Nut |
| 2. Spacer Plate | |

4. Place the Green Clamp on the clamping rings as shown below.



5. Bolt the clamp onto the underside of the frame.
 - a. The Spacer goes between the frame and the Clamp.
 - b. Place the Larger Washer against the clamp.
6. Connect the drive motor cables to the power module.
7. Tuck all wires into the power module compartment and install cover.



- | |
|-----------------|
| 1. Drive Cables |
| 2. Cable Clamp |
| 3. Spacer Plate |

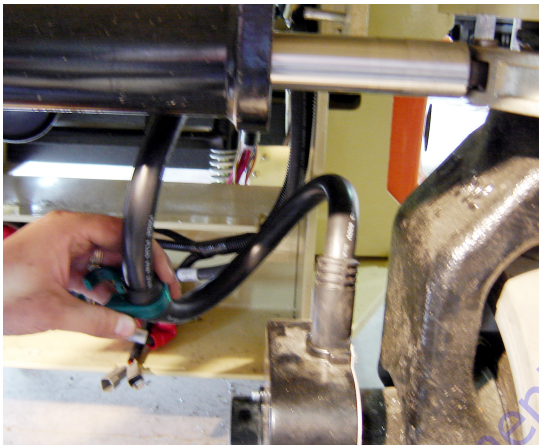
8. Reconnect battery cable plug. Power up machine and operate the drive function to ensure drive motors operate properly.

2032ES/2632ES/2646ES/3246ES Only

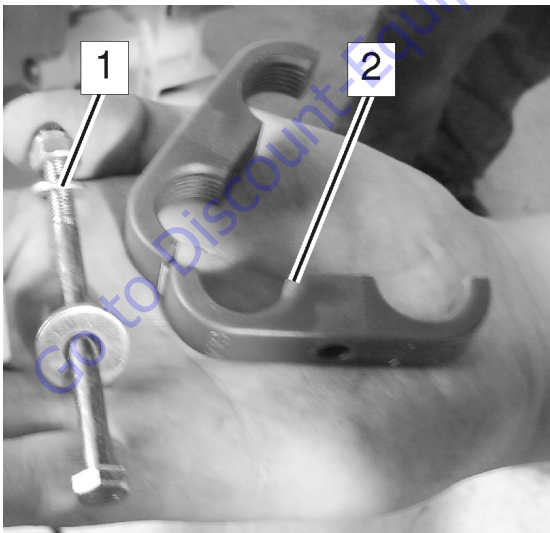
⚠ CAUTION

BE SURE TO PULL THE BATTERY DISCONNECT ANYTIME WORK IS BEING PERFORMED ON THE DRIVE MOTORS OR DRIVE MOTOR CABLING.

1. Orient the drive cables going back towards the rear of the machine. Loop the cables forward towards the front of the machine then up and back. Place the Green Clamp on the clamping ring as shown below.

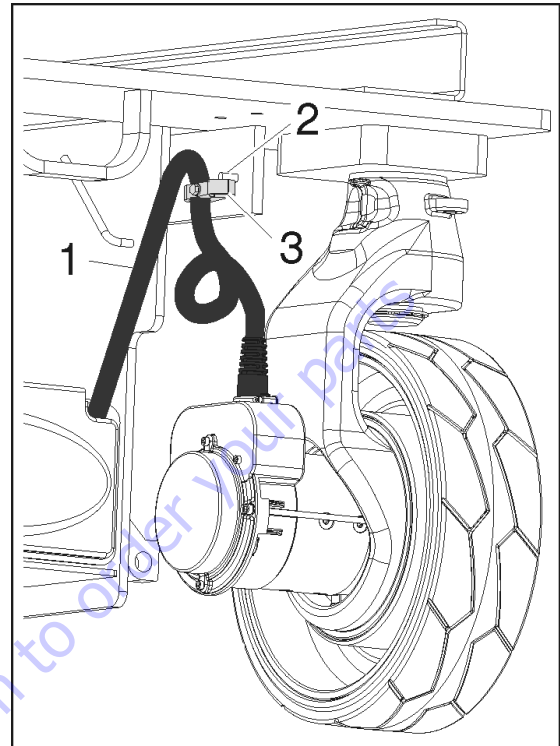


2. Obtain the Cable Clamp and hardware.



1. Bolt, Washers, and Nut
2. Cable Clamp

3. Bolt the Green Clamp onto the backside of the frame using the the back hole drilled in step #4. The roll pins inserted in the front-most holes act as a stop to prevent the clamp from turning.

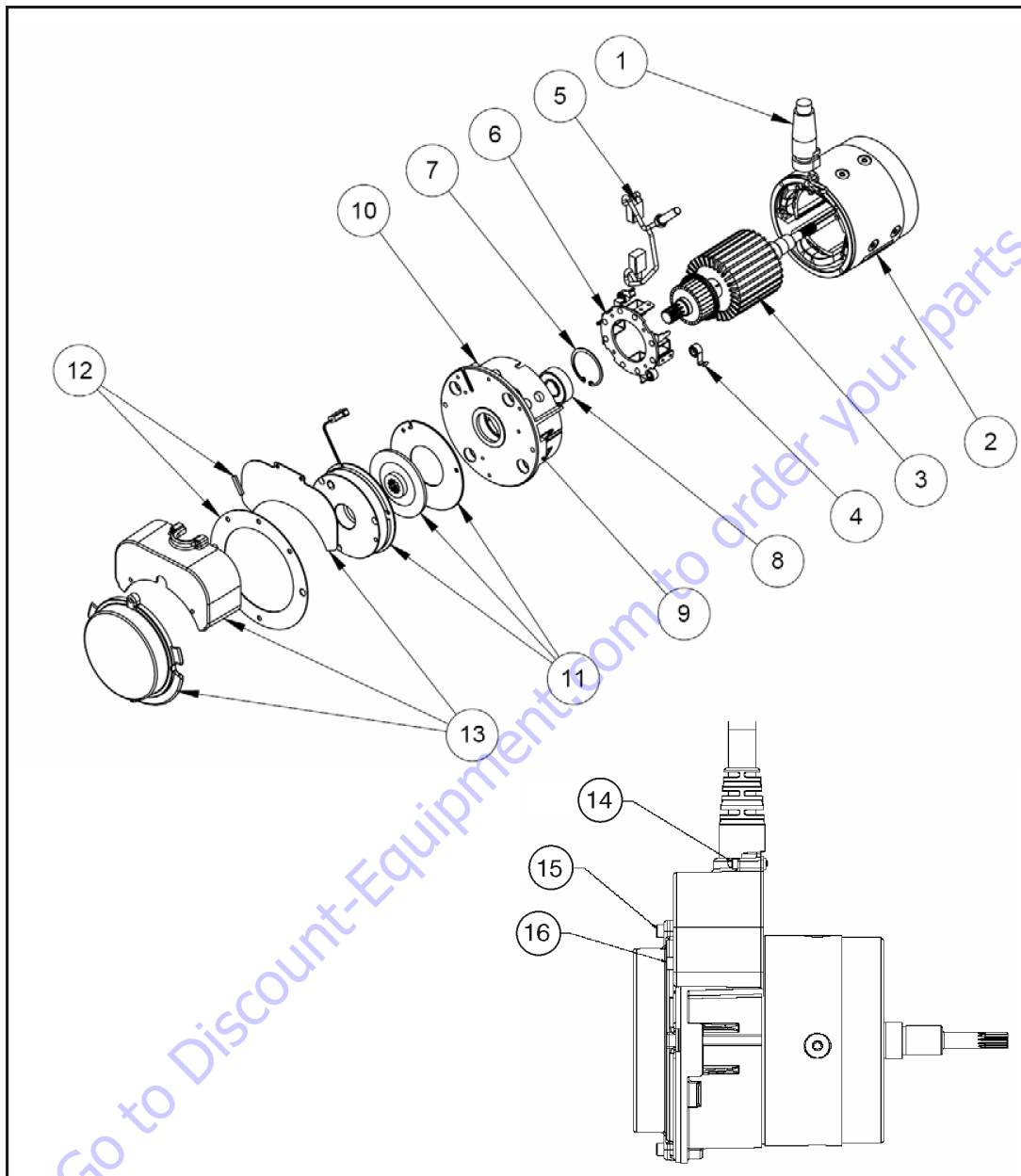


1. Drive Cable
2. Roll Pin
3. Cable Clamp

NOTE: When bolting the green clamp onto the frame, place the larger washer against the clamp on the outside of the clamp.

4. Connect the drive motor cables to the power module.
5. Tuck all wires into the power module compartment and install cover.
6. Reconnect battery cable plug. Power up machine and operate the drive function to ensure drive motors operate properly.

3.6 ELECTRIC DRIVE MOTOR SERVICE



- | | | |
|------------------------------|------------------------|------------------------------------|
| 1. Wire Harness | 7. Retaining Ring | 13. Cover Plate Kit |
| 2. Frame & Field Assembly | 8. Bearing | 14. Cover Plate Mounting Screws |
| 3. Armature Assembly | 9. Commutator End Head | 15. Brake Cover Mounting Screws |
| 4. Brush Spring | 10. Grommet | 16. Terminal Cover Mounting Screws |
| 5. Brush & Terminal Assembly | 11. Brake Assembly | |
| 6. Brush Box Assembly | 12. Gasket Seal Kit | |

Figure 3-15. Drive Motor Components

NOTE: Reference Figure 3-15., Drive Motor Components for part names and locations when servicing the Drive Motor.

Periodic maintenance consisting of inspections of motors, batteries and wiring circuitry is recommended.



ALWAYS WEAR EYE PROTECTION DURING ANY MAINTENANCE OPERATION.

Servicing Guidelines

Since the operating environment of industrial equipment varies widely, the following are suggested for periodic maintenance inspection intervals.

- **Normal Service** – Perform routine inspection (outlined in the Inspection and Service portion of this section) every 1,000 hours of drive time.
- **Severe Service** – Perform routine inspection every 500 hours of drive time. Severe service environments are listed below:
 - a. Dusty or dirty locations like cement plants, lumber and flour mills, coal mining, stone quarries, etc.
 - b. High temperature areas like steel mills, foundries, etc.
 - c. Environments with sudden temperature change, such as in refrigeration plant, etc.

Drive Motor Troubleshooting

1. Turn off power to unit and disconnect main battery power. Disconnect drive motor connections from the Power Module.
2. Verify field continuity between the blue and orange wires. If available, use a 4-wire ohmmeter to verify the field resistance per the applicable motor specification below.
3. Verify armature continuity between the red and black wires. If available, use a 4-wire ohmmeter to verify the field resistance per the applicable motor specification below.

Model	Field Resistance @ 75°F (24°C)	Armature Resistance @ 75°F (24°C)
1930ES	0.210hms	0.0370hms
2032ES/2632ES/2646ES/3246ES	0.1270hms	0.0510hms

4. Using a dielectric tester, verify that there are no shorts between the following items:
 - a. Field connector pins and the case of the motor.
 - b. Armature terminals and the case of the motor.
 - c. Field connector pins to the armature terminals.
5. Verify continuity in 2 pin brake connector (yellow and brown wires). Measure the brake resistance and verify that it is between 18 and 22 Ohms.

Drive Motor Disassembly

NOTE: Refer to Figure 3-15.

1. Remove the two Cover Plate Mounting Screws (14) holding the Cover Plate (13) in place and remove the cover plate from the motor.
2. Remove the Brake Cover Mounting Screws (15) holding the Brake (11) in place and set aside. These screws are used to manually release the brakes.
3. Remove the two Terminal Cover Mounting Screws (16). Slide the strain relief of the Wire Harness (1) out of the cover and remove the cover from the motor.
4. Discard the Gasket (12) that was located under the brake and terminal covers.
5. Remove the wire harness from the motor by disconnecting the brake connection and armature connections. Cut the field connection close to the crimp connection on the motor side.
6. Install the two Brake Cover Mounting Screws (15) into the threaded holes in the brake assembly and tighten to manually release the brake (see Figure 3-3.).
7. Remove the three screws holding the brake assembly to the motor. Carefully remove the brake assembly, brake disc and reaction disc from the motor by sliding off of the shaft.
8. Remove the screws holding the Commutator End Head (9) in place and remove the commutator end head from the frame and field assembly. The Armature (2) will be attached to the commutator end head.
9. Pull back the Brush Springs (4) in the commutator end head, pull the brush back and rest the springs on the side of the brush. The brushes should move freely within the holders.
10. Use an arbor press or a bearing puller to remove the armature from the commutator end head assembly.
11. Remove the Snap Ring (7) and Bearing (8) from the commutator end head. Discard the bearing.

Drive Motor Inspection and Service

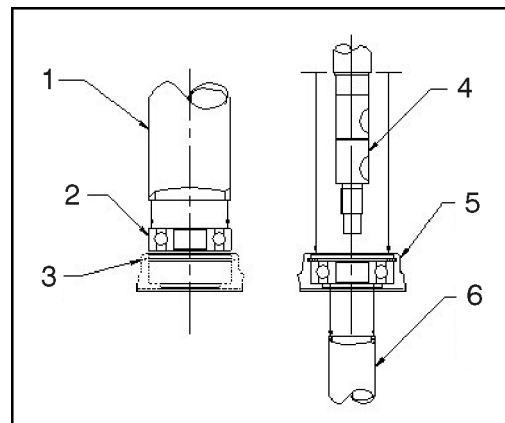
NOTE: Refer to Figure 3-15.

1. Carefully blow out any accumulated carbon dust and dirt from the Commutator End Head (9) and the Frame & Field Assembly (2) using clean, oil free, compressed air.
2. Replace Brushes (5) that are worn below their usable length of 0.6 in (1.5 cm), show signs of uneven wear or signs of overheating, such as discolored brush shunts and brush springs. Brushes should always be replaced in complete sets of four. Use identical replacement parts; do not substitute brush grades as the brushes are matched to the motor type and application to provide the best service. Substituting brushes of the wrong grade can cause premature commutator failure and excessive brush wear.
3. Make sure the Brush Box Assembly (6) is tight on the commutator end head. Replace brush box assemblies in the commutator end head if they are physically damaged or brush holders are loose on the brush plate.
4. Visually inspect the frame and field assembly for overheating or other signs of damage. Check all wiring to ensure that the insulation is in good condition. Verify that pole screws are torqued to 250 - 300 in-lb (28.2 - 33.9 Nm). Verify field resistance using a suitable ohmmeter per the appropriate motor specification. Verify that the field is electrically isolated from the frame using a dielectric tester. Replace as necessary.
5. Visually inspect the Armature Assembly (3) for signs of overheating or physical damage. Visually inspect the seal surface of the shaft for excessive wear. Check for grounded circuits using a dielectric tester by applying voltage between the commutator and the shaft. Visually inspect the commutator for excessive wear and overheating. Replace as necessary.
6. Visually inspect the brake surfaces for excessive wear. Replace Brake Assembly (11) if necessary.
7. Visually inspect the Wire Harness (1) for frayed insulation, loose terminals, or other damage. Replace as necessary.

Drive Motor Reassembly

NOTE: Refer to Figure 3-15.

1. After inspection and servicing, reassemble the wiring in the Commutator End Head (9) as originally found. Ensure the wiring does not contact metal parts and that it allows the brushes to move unrestricted in the holders. Motor terminals must be assembled as shown Figure 3-16. Torque bottom terminal nut to 110 - 140 in-lb (12.4 - 15.8 Nm).
2. After the motor has been disassembled, it is recommended that new bearings be installed because bearings may have been damaged during removal. Although the bearings may appear and feel good, the bearing races could be "brinelled" (races or balls deformed) and may exhibit noise and vibration problems or fail within a relatively short period of service. Press a new bearing into the commutator end head, pressing on the outer race only. See Figure 3-16. Replace the Retaining Ring (7) in the retaining ring groove.
3. Press the Armature (3) commutator end into the commutator end head and bearing assembly, carefully supporting the inner-race of the bearing. See Figure 3-16.
4. Carefully release the Brush Springs (4) allowing the Brushes (5) to contact the commutator. Make sure brush shunts do not interfere with spring movement.



1. Press Fixture must press against Outer Race
2. Bearing
3. End Head (held stationary)
4. Armature Assembly
5. Assembled End Head, Bearing, and Retaining Ring
6. Press Fixture must press against Inner Race (held stationary)

Figure 3-16. Bearing Pressure Guidelines

5. Assemble the commutator end head to the Frame & Field Assembly (2) and tighten the screws to 120 - 140 in-lb (13.6 - 15.8 Nm). Make sure to align the field connection with the notch in the commutator end head. Seal wires where they exit from commutator end head with the Grommet (10).
6. Place the Gasket Seal (12) in the bottom of the notch in the commutator end head. Align wires from the Brake Assembly (11) into the notch in the commutator end head. Secure brake assembly to commutator end head using three bolts.
7. Install Wire Harness (1) to motor by connecting the brake connectors and securing the armature terminals to the terminal studs. Crimp the field connection (red/orange to orange and blue to blue) together and heat shrink. Motor terminals must be assembled as shown in **Always secure the bottom nut with a wrench as you tighten the top nut**. Torque top nut to 90 - 110 in-lb (10.2 - 12.4 Nm).
8. Remove manual release screws from brake assembly. Apply new Gasket (12) and affix brake cover to motor using the 2 manual release screws.
9. Attach terminal cover to the commutator end head using two terminal cover screws.
10. Slide the strain relief of the wire harness into the slot of the terminal cover. Align cover plate with groove in frame and field and affix using two cover plate screws.

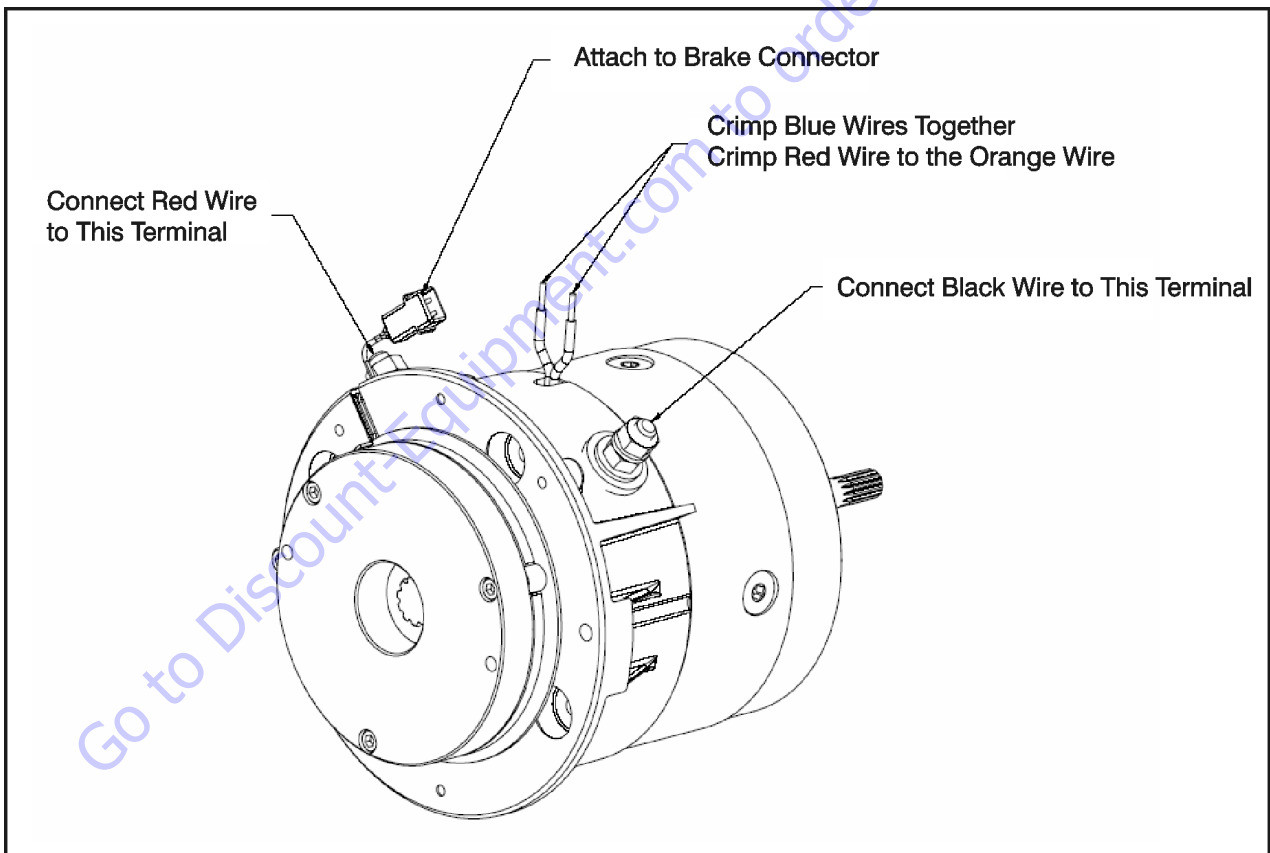


Figure 3-17. Wire Harness Connections

3.7 POWER MODULE - ZAPI

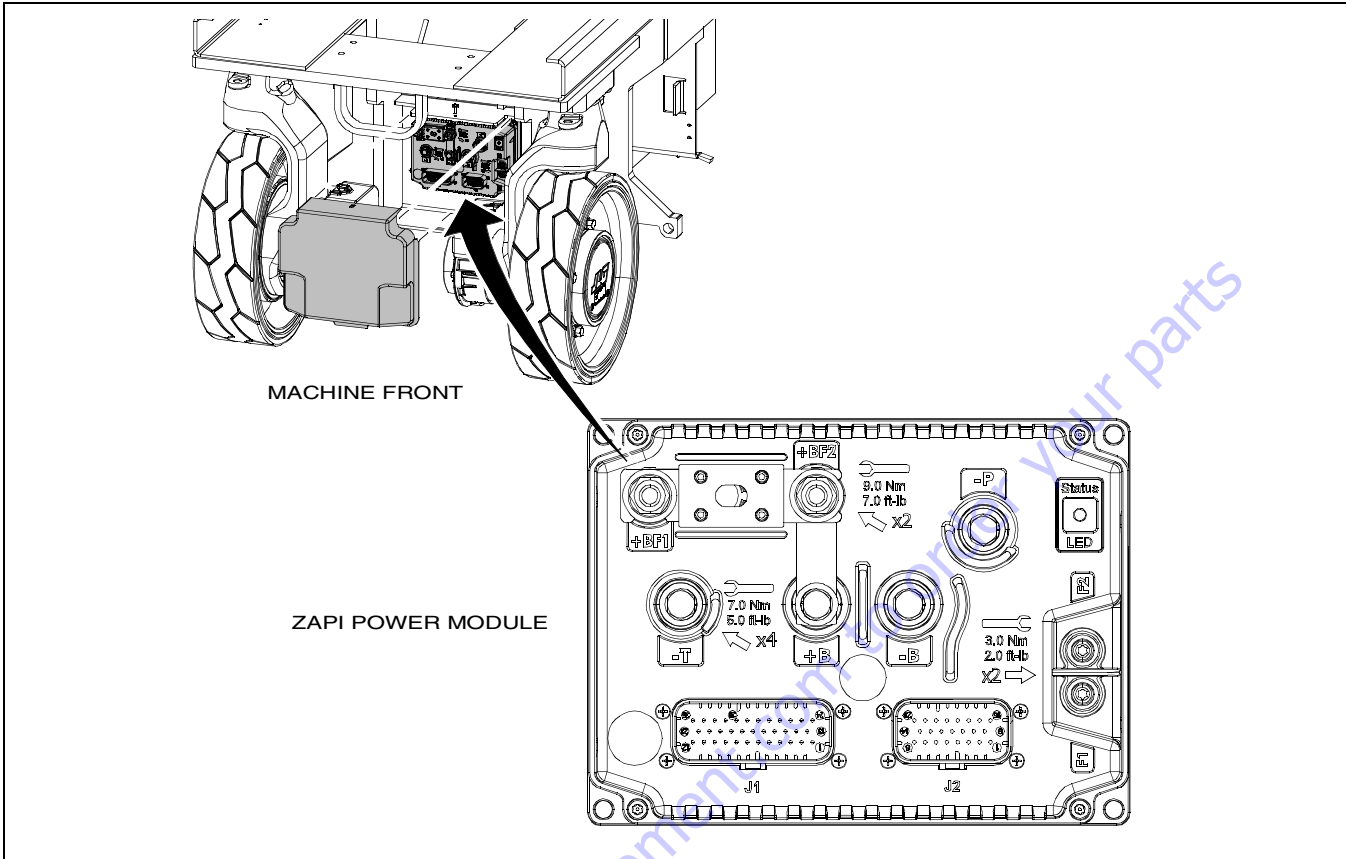


Figure 3-18. ZAPI Power Module Location

Table 3-1. ZAPI Power Module Specs

Operating Voltage (B+)	14.5 to 40VDC
Maximum Current Limits:	
Armature	300 A
Field	40 A
Pump	180 A
Standby Current	150 mA
Temperature Range:	
Operating	-40°C to 75°C
Storage	-40°C to 125°C
Thermal Limit	75°C to 90°C
Switching Frequency	16 kHz

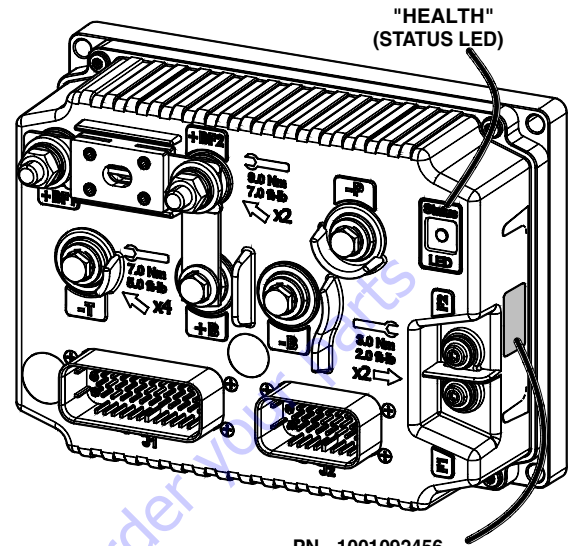
The power module is located behind a protective cover at the front of the machine as shown in Figure 3-18., ZAPI Power Module Location. Use the following instructions when replacing the power module.

1. Turn machine power off and disconnect the batteries.
2. Locate and remove the power module protective cover from the machine.
3. Note the wire terminal locations when removing the old power module.
4. Disconnect all wire connectors and cables from the old power module and remove it from the machine.
5. When installing the new power module, be sure that the terminals are oriented as shown in Figure 3-18.
6. After installing the new power module, begin connecting the wire connectors/cables to the module.
7. Torque all terminal bolts to torque specifications shown on the front of the module.
8. After all connections to the power module are made, the batteries can be reconnected.
9. Reinstall the power module cover, then check for normal machine operation.

ZAPI Power Module Electrical Evaluation

INTEGRATED HEALTH INDICATOR

The ZAPI Power Module provides a green STATUS LED that shines through the cover to indicate module "health" status. The LED shall be illuminated when the device is powered on. The LED blinks (2Hz) when an internal issue is detected that cannot be repaired by a technician. It should be noted that this will trigger replacement of the device.



PN - 1001092456

ZAPI Power Module - "HEALTH" (Status LED)

3.8 MDI (MULTIFUNCTION DIGITAL INDICATOR) AND BRAKE RELEASE



MDI and Brake Release Bracket

Installation:

NOTICE

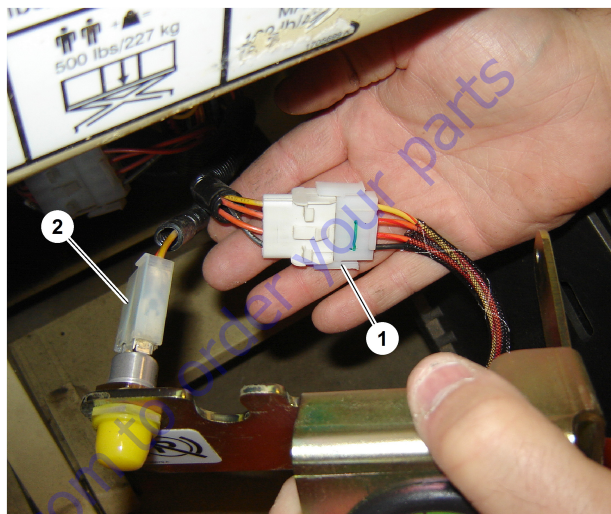
ENSURE EMS BUTTONS ON THE CONTROL STATIONS ARE PUSHED IN TO THE OFF POSITION BEFORE CONNECTING AND MOUNTING THE MDI AND BRAKE RELEASE BRACKET.

1. Open the Battery Cover on the right side of the machine (ground control station side). Lifting up on the battery tray and pulling out will allow for maximum extension.
2. Locate the Diagnostic Port (1) and Brake Release Plugs (2).

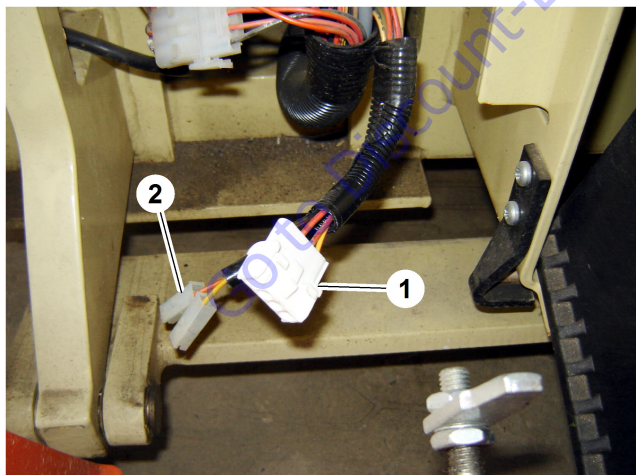
3. Apply di-electric grease to the two Brake Release Plugs. Connect the Brake Release Plugs to the Brake Release Button on the backside of the mounting bracket.

NOTE: The brake release plugs have no polarity, therefore, can be connected to either post on the button.

4. Connect the MDI harness to the Diagnostic Port.

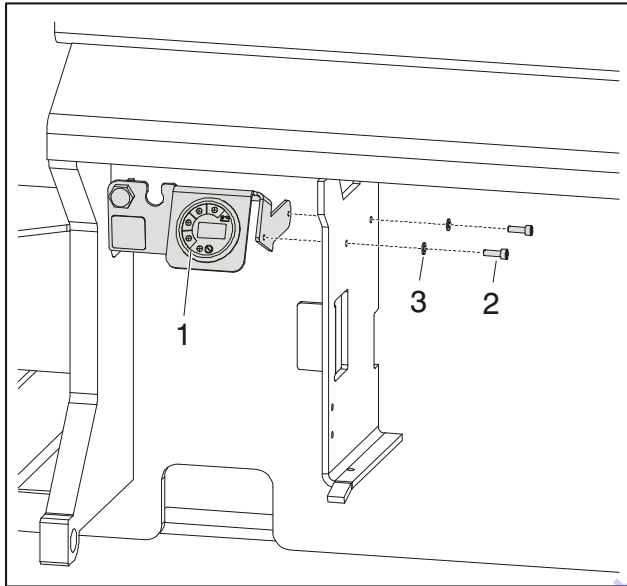


1. MDI Connected
2. Brake Release Connected



1. Diagnostic Port
2. Brake Release Plugs

- Using a 5/32" allen wrench, mount the MDI and Brake Release Bracket onto the wall of the battery compartment. (appropriate mounting holes are pre-existing) Apply medium strength threadlocking compound to the screws and torque to 3.6 ft-lb (5 Nm). (Refer to Figure 3-19.)



- MDI & Brake Release Bracket
- Screw, M5 x 16
- Washer, 5mm

Figure 3-19. MDI Installation/Removal

- Power machine and check to ensure LEDs on MDI work. Check to ensure Brake Release Button works. If the Software Version is not P1.13 or higher, "Error" will display on the LCD. If a fault exists, the trouble code will display on the LCD. (Refer to Section 6.)

- Using zip ties, tie back cables and wires to prevent damage to the cables and wires.



Removal:

NOTICE

ENSURE EMS BUTTONS ON THE CONTROL STATIONS ARE PUSHED IN TO THE OFF POSITION BEFORE DISCONNECTING THE MDI AND BRAKE RELEASE BRACKET.

- Remove the two Screws (2) and Washers (3).
- Disconnect Brake Release and MDI from the electrical harnesses.
- Remove Bracket.

3.9 BATTERY REMOVAL

NOTICE

JLG MACHINES EQUIPPED WITH DELTA Q BATTERY CHARGERS ARE DESIGNED FOR THE BEST PERFORMANCE WITH OEM FACTORY APPROVED BATTERIES.

APPROVED JLG REPLACEMENT BATTERIES ARE AVAILABLE THROUGH JLG'S AFTERMARKET PARTS DISTRIBUTION CENTERS OR JLG'S AFTERMARKET PROGRAMS. FOR ASSISTANCE WITH PROPER BATTERY REPLACEMENT, PLEASE CONTACT YOUR LOCAL JLG SUPPORT OFFICE.

BATTERIES APPROVED BY JLG HAVE BEEN TESTED FOR COMPATIBILITY WITH THE ALGORITHM PROGRAMMING OF THE DELTA Q BATTERY CHARGER TO OPTIMIZE BATTERY LIFE AND MACHINE CYCLE TIMES. THE USE OF NON APPROVED BATTERIES IN YOUR JLG EQUIPMENT MAY RESULT IN PERFORMANCE ISSUES OR BATTERY CHARGER FAULT CODES. JLG ASSUMES NO RESPONSIBILITY FOR SERVICE OR PERFORMANCE ISSUES ARISING FROM THE USE OF NON APPROVED BATTERIES.

WARNING

BEFORE BATTERY REMOVAL CAN BEGIN, ENSURE THAT THE BATTERIES HAVE BEEN PROPERLY DISCONNECTED TO AVOID SERIOUS INJURY OR POSSIBLE DEATH.

1. Pull the battery door completely out and disconnect the batteries.
2. Rest the battery door onto the forks of a fork truck, or suitable lifting device. Be sure the forks or lifting device are properly centered over the weight of the battery door.
3. Using a phillips screwdriver, remove the battery door rollers located at the rear corners of the battery door.

4. Adjust the lifting device to take the weight of the battery door and remove door from under the machine.
5. Once the battery door is removed from the machine, battery replacement/maintenance can begin.
6. After any maintenance on the batteries or replacement of the batteries is complete lift the battery door back onto the machine.
7. Make sure the rollers are replaced and tight.
8. Reconnect batteries and check for proper operation.



Battery Maintenance and Safety Practices

⚠ CAUTION

ENSURE THAT BATTERY ACID DOES NOT COME INTO CONTACT WITH SKIN OR CLOTHING. WEAR PROTECTIVE CLOTHING AND EYEWEAR WHEN WORKING WITH BATTERIES. NEUTRALIZE ANY BATTERY ACID SPILLS WITH BAKING SODA AND WATER.

BATTERY ACID RELEASES AN EXPLOSIVE GAS WHILE CHARGING, ALLOW NO OPEN FLAMES, SPARKS OR LIGHTED TOBACCO PRODUCTS IN THE AREA WHILE CHARGING BATTERIES. CHARGE BATTERIES ONLY IN A WELL VENTILATED AREA.

ADD ONLY DISTILLED WATER TO BATTERIES. WHEN ADDING WATER TO THE BATTERIES, A NON-METALLIC CONTAINER AND/OR FUNNEL MUST BE USED.

⚠ WARNING

DO NOT REPLACE ITEMS CRITICAL TO STABILITY, SUCH AS BATTERIES, WITH ITEMS OF DIFFERENT WEIGHT OR SPECIFICATION. DO NOT MODIFY UNIT IN ANY WAY TO AFFECT STABILITY.

Check the electrolyte level of the batteries often, adding only distilled water when required. When fully charged, battery fluid level should be 1/8" below vent tubes. (See Figure 3-20.).

- DO NOT fill to bottom of vent tubes.
- DO NOT allow fluid level to go below the top of the plates when charging or operating.

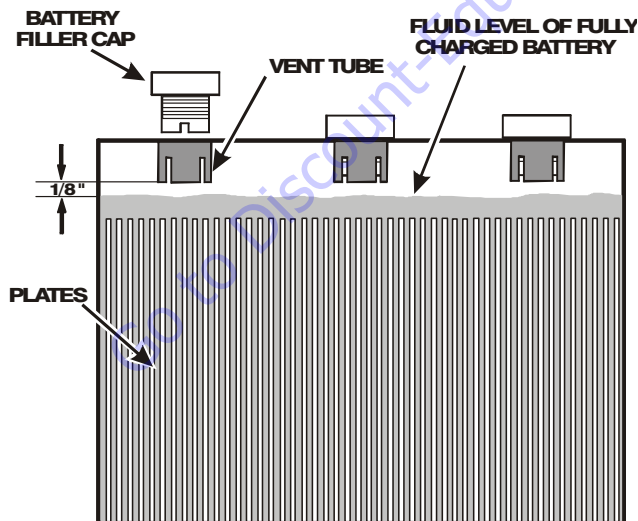


Figure 3-20. Battery Fluid Level

3.10 BATTERY CHARGER

The Battery Charger is located on the top of the chassis at the rear of the machine. Raise and secure scissor arms with arm prop to gain access to the charger.

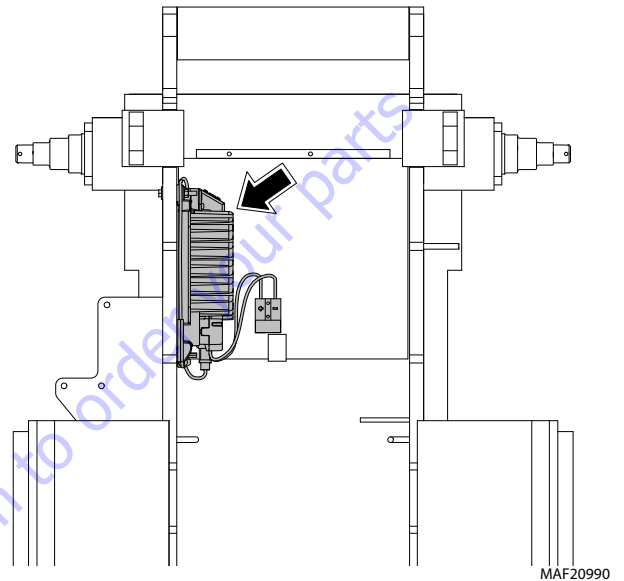
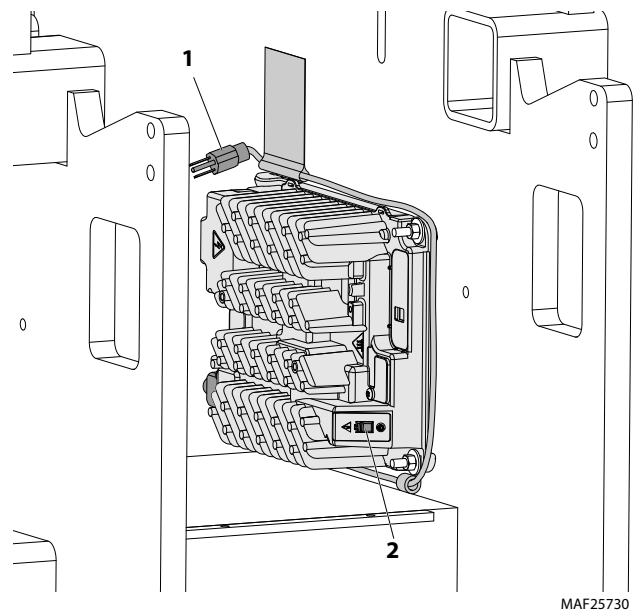
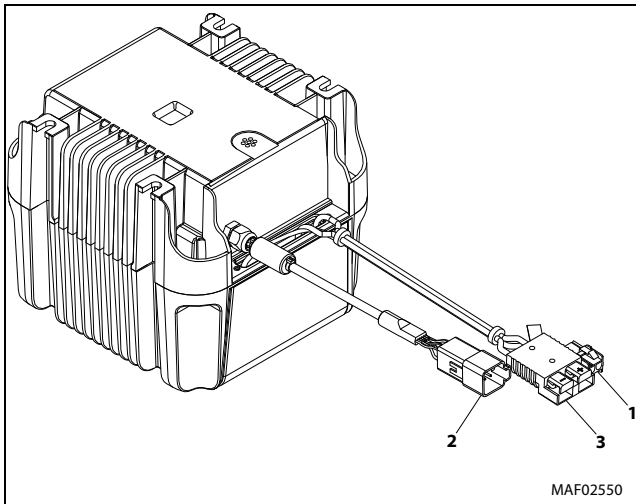


Figure 3-21. Battery Charger Location



- 1. AC Voltage - Input Plug
- 2. Charge Indicator LEDs

Figure 3-22. Battery Charger (Delta-Q)



- 1. Charger Interlock Cable
- 2. LED Indicator Cable
- 3. Power Cable

Figure 3-23. Battery Charger (Green Power)

1. For flooded lead-acid batteries, regularly check water levels of each battery cell after charging and add distilled water as required to level specified by battery manufacturer. Follow the safety instructions recommended by the battery manufacturer.
2. Make sure charger connections to battery terminals are tight and clean.
3. Do not expose charger to oil or to direct heavy water spraying when cleaning vehicle.

Battery Charger Maintenance

⚠ WARNING

USE CHARGER ONLY ON BATTERY SYSTEMS WITH AN ALGORITHM SELECTED THAT IS APPROPRIATE TO THE SPECIFIC BATTERY TYPE. OTHER USAGE MAY CAUSE PERSONAL INJURY AND DAMAGE.

LEAD ACID BATTERIES MAY GENERATE EXPLOSIVE HYDROGEN GAS DURING NORMAL OPERATION. KEEP SPARKS, FLAMES, AND SMOKING MATERIALS AWAY FROM BATTERIES. PROVIDE ADEQUATE VENTILATION DURING CHARGING. NEVER CHARGE A FROZEN BATTERY.

STUDY ALL BATTERY MANUFACTURERS' SPECIFIC PRECAUTIONS SUCH AS RECOMMENDED RATES OF CHARGE AND REMOVING OR NOT REMOVING CELL CAPS WHILE CHARGING.

⚠ DANGER

RISK OF ELECTRIC SHOCK. CONNECT CHARGER POWER CORD TO AN OUTLET THAT HAS BEEN PROPERLY INSTALLED AND GROUNDED IN ACCORDANCE WITH ALL LOCAL CODES AND ORDINANCES. A GROUNDED OUTLET IS REQUIRED TO REDUCE RISK OF ELECTRIC SHOCK - DO NOT USE GROUND ADAPTERS OR MODIFY PLUG. DO NOT TOUCH UNINSULATED PORTION OF OUTPUT CONNECTOR OR UNINSULATED BATTERY TERMINAL. DISCONNECT THE AC SUPPLY BEFORE MAKING OR BREAKING THE CONNECTIONS TO THE BATTERY WHILE CHARGING. DO NOT OPEN OR DISASSEMBLE CHARGER. DO NOT OPERATE CHARGER IF THE AC SUPPLY CORD IS DAMAGED OR IF THE CHARGER HAS RECEIVED A SHARP BLOW, BEEN DROPPED, OR OTHERWISE DAMAGED IN ANY WAY - REFER ALL REPAIR WORK TO QUALIFIED PERSONNEL. NOT FOR USE BY CHILDREN.

Table 3-2. Diagnostic Trouble Codes (Delta Q Battery Charger)

DTC	Fault	Solution
E-0-0-1 E-0-2-1	Battery high voltage	Check the battery voltage and cable connections. Check battery size and condition. This error will automatically clear once the condition has been corrected.
E-0-0-2 E-0-2-2	Battery low voltage	Check the battery voltage and cable connections. Check battery size and condition. This error will automatically clear once the condition has been corrected.
E-0-0-3	Charge timeout caused by battery pack not reaching required voltage within safe time limit.	Possible causes: Charger output reduced due to high temperatures, poor battery health, very deeply discharged battery and /or poorly connected battery. Possible solutions: Operate at lower ambient temperature. Replace battery pack. Check DC connections. This error will automatically clear once the charger is reset by cycling DC or AC.
E-0-0-4	Battery could not meet minimum voltage	Possible causes: Check for shorted or damaged cells. Possible solutions: Replace battery pack. Check DC connections. This error will automatically clear once the charger is reset by cycling DC or AC.
E-0-0-7	Battery amp hour limit exceeded	Possible causes include poor battery health, very deeply discharged battery, poorly connected battery, and / or high parasitic loads on battery while charging. Possible solutions: Replace battery pack. Check DC connections. Disconnect parasitic loads. This error will automatically clear once the charger is reset by cycling DC or AC.
E-0-0-8	Battery temperature is out of range	Possible battery temperature sensor error. Check temperature sensor and connections. Reset charger. This error will automatically clear once the condition has been corrected.
E-0-1-2	Reverse polarity error	Battery is connected to the charger incorrectly. Check the battery connections. This error will automatically clear once the condition has been corrected.
E-0-1-6 E-0-1-8 E-0-2-6	USB operation failed	Software upgrade failure or script operation failure. Ensure the USB flash drive is properly formatted and retry inserting the USB flash drive into the charger.
E-0-2-3	High AC voltage error (>270VAC)	Connect charger to an AC source that provides stable AC between 85 - 270VAC / 45 - 65 Hz. This error will automatically clear once the condition has been corrected.
E-0-2-4	Charger failed to initialize	The charger has failed to turn on properly. Disconnect AC input and battery for 30 seconds before retrying.
E-0-2-5	Low AC voltage oscillation error	AC source is unstable. Could be caused by undersized generator and /or severely undersized input cables. Connect charger to an AC source that provides stable AC between 85 - 270VAC / 45-65 Hz. This error will automatically clear once the condition has been corrected.
F-0-0-1, F-0-0-2, F-0-0-3, F-0-0-4, F-0-0-6		Internal charger fault. Remove AC and battery for minimum 30 seconds and retry charger. If it fails again, please contact the manufacturer of your vehicle or machine.

Table 3-3. Fault Codes (Green Power)

Flash Code	Cause	Solution
1	Connection Issue	1) Check battery connection is correct. 2) Check charger connection is correct. 3) Check each battery is good.
2	Abnormal AC Power Input (Voltage)	1) Check AC input cord is connected between charger and AC outlet. 2) Make sure AC plug is tightly secured into AC outlet.
3	Charger High Temperature Protection	1) Charger shuts down and goes into protection mode due to charger/environmental temperature is too high for charger to function properly. Please place the charger into an area with ambient air flow or to a cooler place. 2) Disconnect the charger and wait for 15-20 mins before reconnecting for charging.
4	Battery High Temperature Protection	1) Charger will reduce or even stop charging when the battery temperature exceeds 50° C. This is to avoid battery overheating. 2) Disconnect the charger and wait for 15-20 mins before reconnecting for charging.
5	Output Current is too high	Return to factory for repair.
6	Battery Voltage is too high(>30.5V)	Check and assure that the correct output battery voltage is connected.
7	Battery Voltage is too low(<18V)	Check and assure that the correct output battery voltage is connected.

Table 3-4. Fault Codes (Eagle Battery Charger)

LED Indications	Fault	Solution
30% RED LED BLINKING	NO BATTERY DETECTED	This indication occurs whenever the charger circuitry cannot detect a battery. The charger circuitry will not allow charge current to flow under this condition. With the AC power supply cord unplugged, check the connection to the batteries for proper polarity (black wire to negative). Also check for corrosion free secure connections to the battery.
30 & 60% RED LEDS BLINKING	FORMING STAGE TIMEOUT SHUTDOWN	This indication occurs if the battery voltage has not risen above 1.75 volts per cell within the first 3 hours of charging. This indicates that a possible battery problem exists and that the charge cycle has been terminated at this point.
30, 60 & 90% RED LEDS BLINKING	OVERALL TIMER SHUTDOWN	This indication occurs if the charger has not completed the charge cycle within the allowable factory set time period. This indicates that a possible battery problem exists and that the charge cycle has been terminated at this point.
30 & 90% RED LEDS BLINKING	INTERNAL OVERTEMP SHUTDOWN	This indication occurs if the charger circuitry has detected operating temperatures inside the charger enclosure that are above factory specified levels. This could indicate that a possible charger problem exists and that the charge cycle has been terminated.
30% RED & 100% GREEN LEDS BLINKING	BULK STAGE SHUTDOWN	This indication occurs if the battery voltage does not rise properly during the Bulk Stage. This indicates that a possible battery problem exists and that the charge cycle has been terminated at this point.
30% RED & 100% GREEN LEDS ALTERNATE BLINKING ON OFF	DELTAVIEW SIGNAL OR NO BATTERY DETECTED	This will be the NORMAL indication when the charger is plugged into A/C but not connected to a battery pack, allowing the DeltaView signal to be retrieved with a DeltaView Reader. This can also be considered the NO BATTERY DETECTED fault code.
NOTE: Disconnecting and reconnecting the AC power supply cord will reset the charger.		

Excessive Battery Watering Requirements or Strong Sulphur (Rotten Egg) Smell

These symptoms indicate over-charging or high battery temperature. These symptoms are unlikely to be caused by too high a charge current since the maximum charge current of the charger will be small compared to even a moderately sized battery pack. The most likely cause for this problem is incorrect charge algorithm setting and/or high ambient temperatures.

1. Confirm that the battery pack is not too small - usually > 50Ah.
2. Confirm that the nominal battery voltage matches the charger output voltage.
3. Confirm the correct battery charge algorithm. If the battery pack is new, the algorithm will need to be changed if the pack is not the same as the old one. For instructions on how to determine and change the battery charge algorithm see the following sub-section.
4. If the output voltage of the charger seems excessive, return the charger for service. Contact JLG to get the expected battery voltage settings for the charger in question. Be sure to have the charger's serial number and charge algorithm setting available when calling.

Checking/Changing the Battery Charge Algorithm

The charger is pre-loaded with programming algorithms for the specific batteries detailed in Table 3-5, Battery Algorithms. Contact JLG if your specific battery model is not listed.

Each time AC power is applied with the battery pack not connected, the charger enters an algorithm select/display mode for approximately 11 seconds. During this time, the current Algorithm # is indicated on the Yellow Charging LED. A single digit Algorithm # is indicated by the number of blinks separated by a pause. A two digit Algorithm # is indicated by the number of blinks for the first digit followed by a short pause, then the number of blinks for the second digit followed by a longer pause.

To check/change the charging algorithm:

1. Disconnect the charger positive connector from the battery pack. Apply AC power and after the LED test, the Algorithm # will display for 11 seconds.

2. To change the algorithm, touch the connector to the battery's positive terminal for 3 seconds during the 11 second display period and then remove. The Algorithm # will advance after 3 seconds. Repeat this procedure until the desired Algorithm # is displayed. A 30 second time-out is extended for every increment. Incrementing beyond the last Algorithm will recycle back to the first Algorithm. When the desired Algorithm is displayed, touch the charger connector to the battery positive terminal until the output relay makes a clicking noise (approx. 10 seconds). The algorithm is now in the permanent memory.
3. Remove the AC power from the charger and reconnect the charger's positive connector to the battery. It is recommended to check a newly changed algorithm by repeating the above steps 1 and 3.

Table 3-5. Battery Algorithms

Algorithm #	Battery Type
43	Harris Battery Discover EVGC6A-A (AGM)
35	JLG PN 0400242
23	Douglas Flooded (JLG default) GES Battery A1055 Trojan T105 East Penn GC-110-WNL Trojan T105 PLUS Champion CHGC2 GC2 US BATTEV-145-WNL USBATT2200XC
8	Concorde 10xAh AGM
7	J305 DV/DT CP
6	DEKA 8G31 GeI
5	Trojan 30/31XHS
4	US Battery USB2200
3	T105 DV/DT CP
2	Trojan T105 tapped
1	Trojan T105

3.11 BATTERY CHARGER/INVERTER (OPTION)

The Battery Charger/Inverter is located on the top of the chassis at the rear of the machine. Raise and secure scissor arms with arm prop to gain access to the charger.

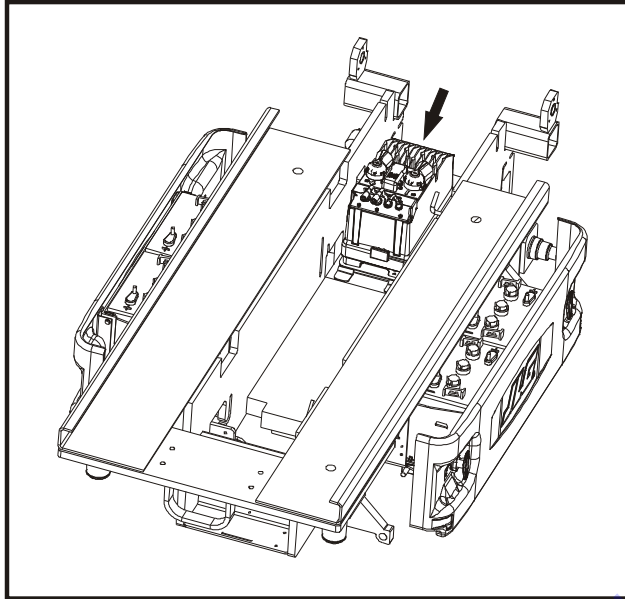
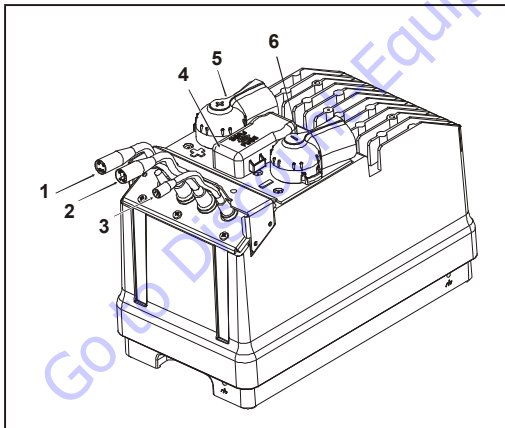


Figure 3-24. Battery Charger/Inverter Location



- | | |
|-------------------------------|------------------------------|
| 1. AC Output Connector | 4. External DC Fuse Location |
| 2. AC Input Connector | 5. DC (+) Connection |
| 3. Remote On/Off Switch Cable | 6. DC (-) Connection |

Figure 3-25. Battery Charger/Inverter

Battery Charger/Inverter Troubleshooting

The Fault LED Flash Codes are the same as the Battery Charger (see Battery Charger Troubleshooting on pages 3-29 and 3-30).

For further specification and troubleshooting information refer to the manufacturers' Charger/Inverter Owner's Guide shipped with the machine. Publication - RM1024-JLG - Part # 3128406.

Use the information below to supplement the information in the Inverter/Charger manual. First, go through the troubleshooting in the Owner's Guide (JLG part number 3128406), then use the procedures below. For control of the Inverter/Charger there is an 8 position connector on a cable entering the case of the Inverter/Charger. Looking at the pins of the connector, terminals are numbered clockwise starting with number 1 nearest the notch. Terminal 8 is in the center.

No charge voltage:

1. Disconnect control cable from Inverter/charger.
2. Turn on machine.
3. Inverter/charger control cable 8 position connector socket 1 should have V_{batt} present. If it is not, check charger interlock connector, 2 position, socket 1. If voltage is present there replace the Inverter/Charger data interface harness. If V_{batt} is not present at the 2 position connector socket 1, check the circuit through the chassis harness back to Ground Module terminal J1-19.

Loads will not start when there is no external AC/ Inverter will not produce AC power:

1. Check that Inverter/Charger switch is in ON position.
2. Disconnect control cable from the Inverter/Charger.
3. Turn on machine.
4. Inverter/Charger control cable socket 2 should have V_{batt} present when the switch is ON. If not check that there is V_{batt} on the switch Yellow/Red wire. V_{batt} signal originates from Ground module pin J1-19 then goes to harness Interlock connector terminal 1 (Yellow/Red wire), then to switch.

LED(s) suspected to be bad:

1. Disconnect Inverter/Charger control cable from the charger (8 position connector) and the 6 position connector at the chassis harness. There should be continuity between the following:
 - a. 8 pos. terminal 3 to 6 pos. terminal 3
 - b. 8 pos. terminal 4 to 6 pos. terminal 5
 - c. 8 pos. terminal 5 to 6 pos. terminal 4
 - d. 8 pos. terminal 6 to 6 pos. terminal 6

SECTION 3 - CHASSIS & SCISSOR ARMS

2. Disconnect Inverter/Charger control cable at the 6 position connector and the chassis harness at the 4 position connector at the Ground Box. There should be continuity between the following:
 - a. 6 pos. terminal 3 to 4 pos. terminal 1
 - b. 6 pos. terminal 4 to 4 pos. terminal 3
 - c. 6 pos. terminal 5 to 4 pos. terminal 2
 - d. 6 pos. terminal 6 to 4 pos. terminal 4
3. If wiring is found to be good, the LED printed circuit card is likely to be bad.

Interlock Cable suspected to be bad or vehicle thinks charging is in progress, but it is not:

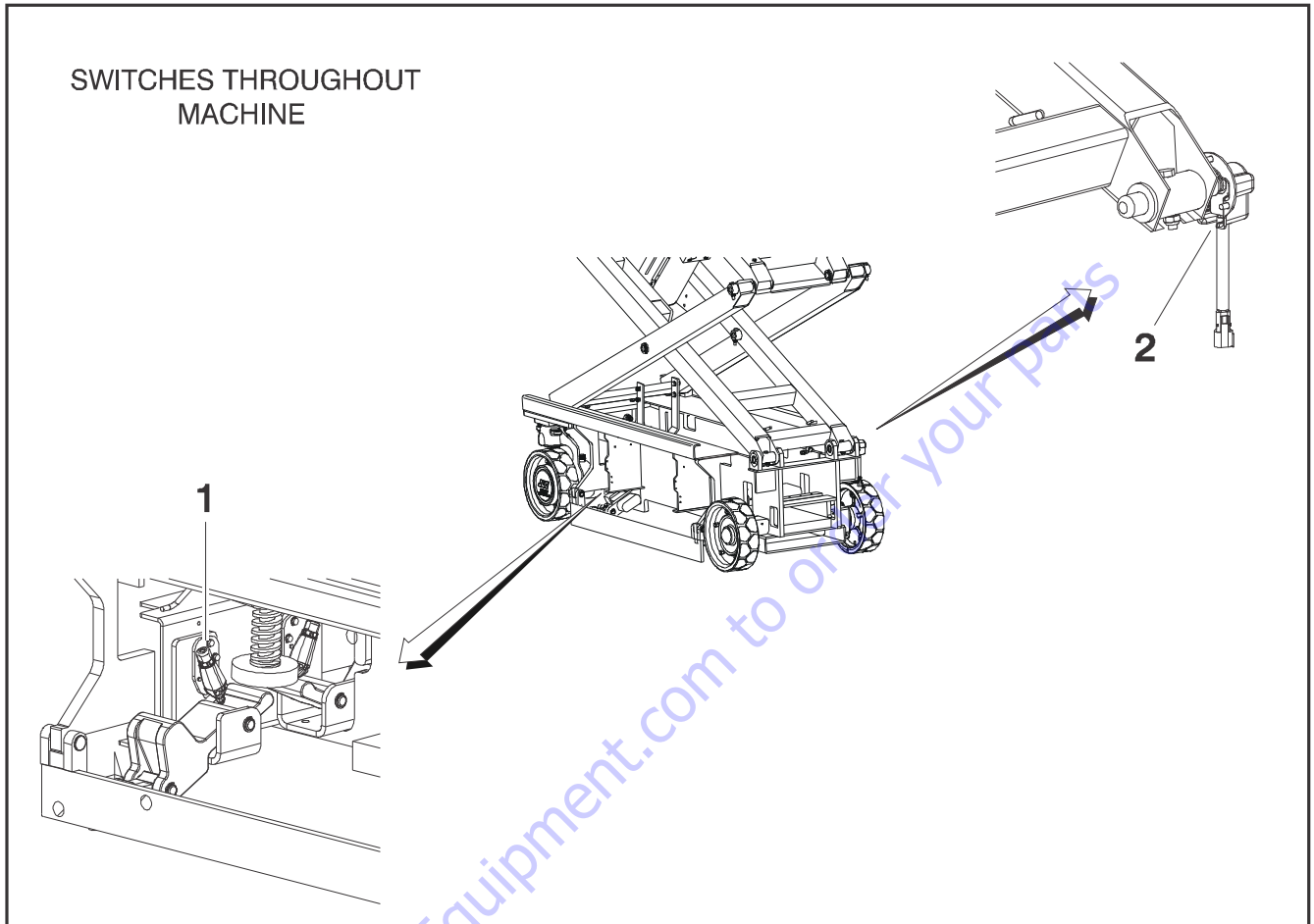
1. Disconnect Interlock (2 position) connector on the Inverter/Charger control cable.
2. Turn on machine.
3. There should be Vbatt present on the Interlock connector socket 1.
4. Turn off machine.
5. Disconnect Inverter/Charger control cable at the charger.
6. Inverter/Charger connector (8 position) pin 6 should have continuity to Interlock connector pin 2 and then to ground module socket J1-29.

Ground Module powered while key is off or similar behavior:

This condition can be caused by various ground module outputs getting shorted to battery. If not done already, cycle power and check for fault codes. If no fault codes, perform the following:

1. Disconnect the Inverter/Charger control cable at the 8 position connector and the 2 position Interlock connector.
2. Set digital multimeter to diode check or continuity check to check diode in Inverter/Charger control harness. If the meter does not have these features a low range Ohm scale (20 Ohms for example) will work.
3. Place red lead on 8 position connector pin 1. Place black lead on Interlock connector pin 1.
4. Meter should read an open. Swap leads. Meter should read a short. If either condition is not good, replace Inverter/Charger control cable.

3.12 LIMIT SWITCH LOCATIONS



1. Pothole Switch (Typical on opposite side of machine)
2. Rotary Angle Switch

Figure 3-26. Limit Switch Locations

Pothole Switch Replacement

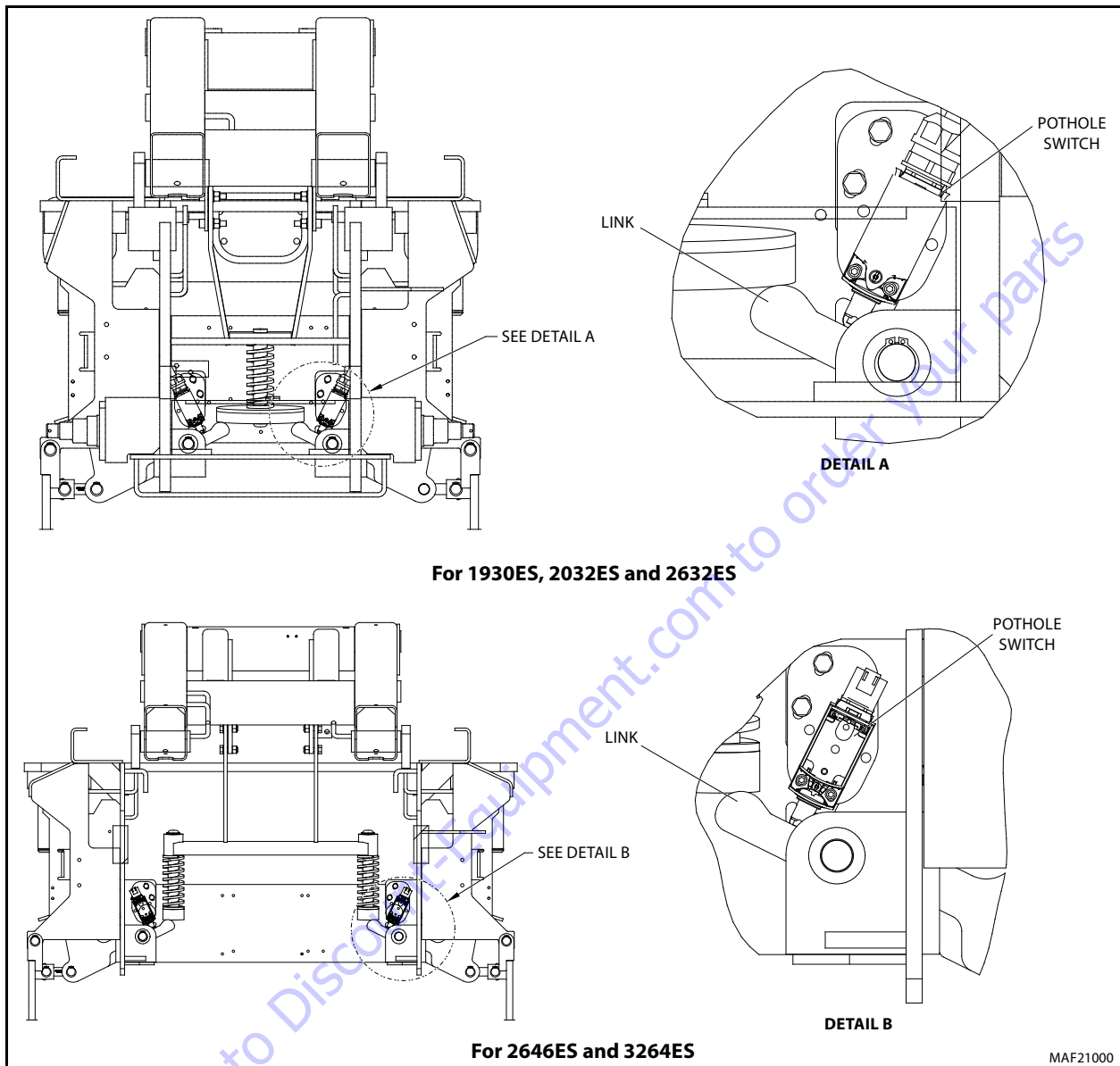


Figure 3-27. Pothole Switch Adjustment

1. With the machine in the stowed position and the battery door open, remove the old pothole switch.
2. Mount the new limit switch and harness to crank with the washer placed behind the switch.
3. Adjust the switch by inserting an 0.25 in. shim between the link and the switch plunger.
4. Push the switch to fully depress the plunger and tighten the switch screws.
5. Repeat this procedure on the opposite side.
6. Raise and lower the machine from the ground control several times to ensure that the switch is functioning properly.

NOTE: From the platform, raise and lower the machine and check that the switch is operating properly by cutting back to elevated speed when the pothole is deployed. Drive will be cutout if pothole is not set.

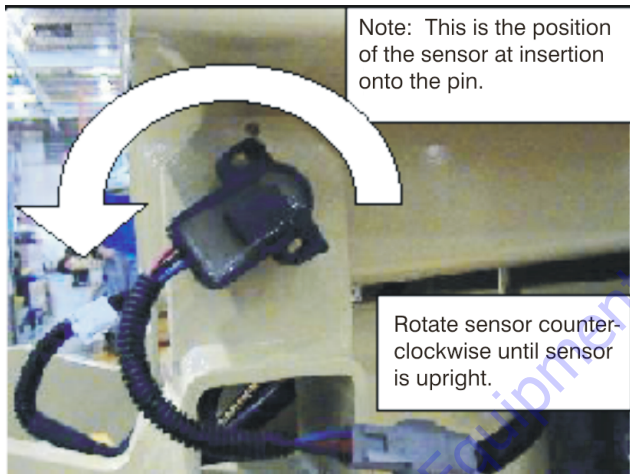
Rotary Angle Sensor Replacement

Removal:

1. Lower platform to the stowed position.
2. Disable the machine and disconnect the batteries.
3. Remove the screws securing the sensor cover to the frame and remove the sensor cover.
4. Disconnect the wiring harness from old/existing rotary angle sensor. Disconnect the sensor from the arm pin and remove the sensor.

Installation:

1. Connect the wiring harness to the new rotary angle sensor.
2. Position and connect rotary angle sensor to the arm pin as shown below.



3. Rotate the sensor as described in the image above.

NOTE: The sensor is spring loaded. DO NOT rotate past its internal stops.

4. Install the rotary angle sensor cover and secure to the frame with the two screws.
5. Reconnect the batteries.

3.13 GROUND CONTROL STATION

NOTE: Anytime the ground control box is removed, the tilt sensor must be re-calibrated. Refer to Section 5.3, Tilt Sensor Calibration to re calibrate the tilt.

Box Disassembly



1. Disconnect the batteries.
2. Remove the three bolts at the bottom of the ground control station.

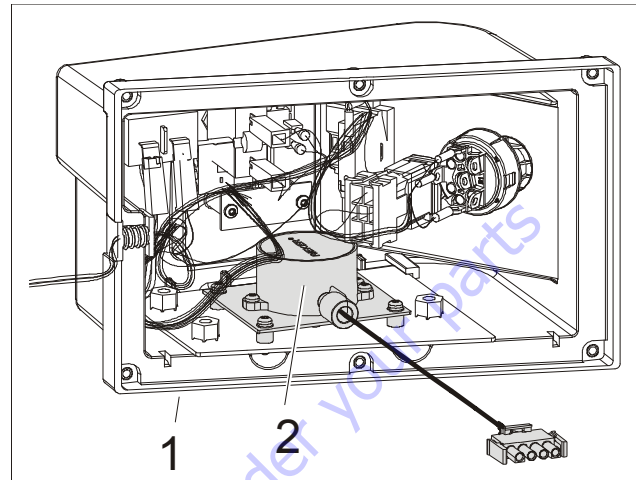


3. Remove the four bolts where the control cable enters into the control box.
4. Remove plug and place control box face down on a suitable work bench.



5. Remove the six bolts at the back of the ground control and separate.

Tilt Sensor Replacement



1. Ground Control Station
2. Tilt Sensor (JLG PN 4000021 or 1001114936)

Figure 3-28. Tilt Sensor Location

Tilt Sensor Removal:

1. Disconnect the batteries.
2. Open the Ground Control Station to gain access to the Tilt Sensor Assembly. (refer to prior mentioned procedures)
3. Remove the four Screws (3), to remove the Tilt Sensor (1) and Sensor Mount (2) from the Ground Control Box.
4. The Tilt Sensor (1) can be removed from the Sensor Mount (2) by removing the three Screws (4).

NOTE: Follow the above procedures in reverse order when installing the tilt sensor assembly. After installing, be sure to calibrate the tilt sensor (refer to Section 5.3, Tilt Sensor Calibration).

3.14 SCISSOR ARMS AND PLATFORM POSITIONING AND SUPPORT

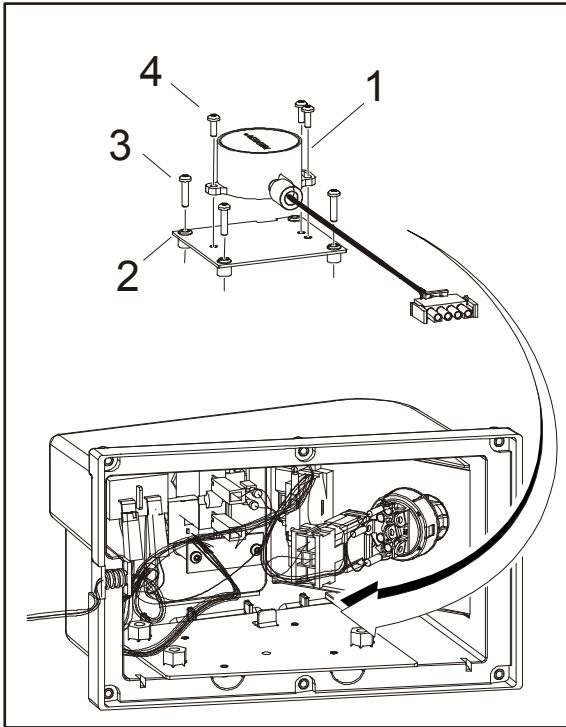
⚠ CAUTION

PLATFORM IS HEAVY AND PRESENTS A CRUSHING HAZARD. TAKE GREAT CARE WHEN REMOVING PLATFORM OR SCISSOR ARM ASSEMBLY

The arm stack can be supported by using an overhead crane,(See Figure 3-30.). If an overhead crane is not available the stack may also be lifted by using a forktruck using the following instructions:

1. With the forks on the forktruck slid close together, enter from the front of the machine and place the forks on the cross tube of the second arm weldment below the platform.
2. Slowly lift the arm stack with the forktruck while the manual descent valve is being engaged (this allows the oil to drain back into the tank).
3. Place machine on safety prop and leave the forktruck in place.
4. At this point the lift cylinder removal may begin. (Refer to Section 4.7, Lift Cylinder Removal)

If removal of the platform becomes necessary use the above procedure to stabilize the platform for pin and platform removal.



1. Tilt Sensor
2. Sensor Mount
3. Screw, 3.5 x 0.6 x 16 LG
4. Screw, 3.5 x 0.6 x 10 LG

Figure 3-29. Tilt Sensor Removal

Table 3-6. Tilt Sensor Harness

Wire Color	Function	Connector Pin
Red	VCC	1
White	CANH	2
Green	CANL	3
Black	Ground	4

3.15 PLATFORM REMOVAL

1. Support the platform using an overhead crane with straps capable of lifting at least 439 lb (199 kg) (See Figure 3-30.). Refer to Section 3.14, Scissor Arms and Platform Positioning and Support.
2. Disconnect the battery plug at the chassis. Disconnect platform cable and foot switch cable, if applicable, from railing. Route the cables out through the hole at the rear of the platform to free platform of any constraints. If platform is equipped with an outlet plug, disconnect and route cable out of platform.
3. Remove the bolts attaching the pins and slide blocks at each corner to the arm stack. Carefully remove the four pins attaching the platform to the arm stack.
4. Lift the platform from the armstack and set aside.

NOTE: When attaching platform back onto scissor arm assembly, follow removal procedures in reverse order.

NOTICE

FOR MACHINES EQUIPPED WITH LOAD SENSING SYSTEM (LSS), ENSURE ARROWS ON THE LSS PIN ARE POINTING DOWN BEFORE INSERTING BOLTS INTO PIN. NOT APPLICABLE FOR MACHINES WITHOUT LSS.



3.16 SCISSOR ARMS REMOVAL

1. Remove platform (refer to Section 3.15, Platform Removal).
2. Disconnect all wiring and cables attached to scissor arm assembly.
3. Remove lift cylinder (refer to Section 4.7, Lift Cylinder Removal).
4. The scissor arms can be removed as a complete unit or individually.

Removing scissor arm assembly as a complete unit:

1. Remove the pin attaching the bottom scissor arms to the rear of the frame by removing the bolt.
2. Place two straps around each end of the the entire scissor arm assembly. Using an overhead crane, slowly and carefully move the arm stack forwards so that slide blocks at front of machine slide out the front of the slide channel on the frame.

NOTE: Overhead crane and straps must be capable of lifting at least 1953 lb (886 kg).

3. Once slide blocks are clear of machine, the scissor stack can be moved to a more desirable location for further arm disassembly.

Removing scissor arms individually:

1. Start with the top arms (closest to platform).
2. Secure each arm section being removed using an overhead crane with suitable lifting straps.
3. Remove the bolts securing the connecting pins in place.
4. Remove the pins from the arms.
5. Remove the arm section from the machine using the overhead crane.
6. Repeat previous steps for remaining arm sections.

NOTE: When attaching scissor arm assembly back onto frame, follow removal procedures in reverse order.

Self locking fasteners, such as nylon insert and thread deforming locknuts, are not intended to be reinstalled after removal. Always use new replacement hardware when installing locking fasteners.

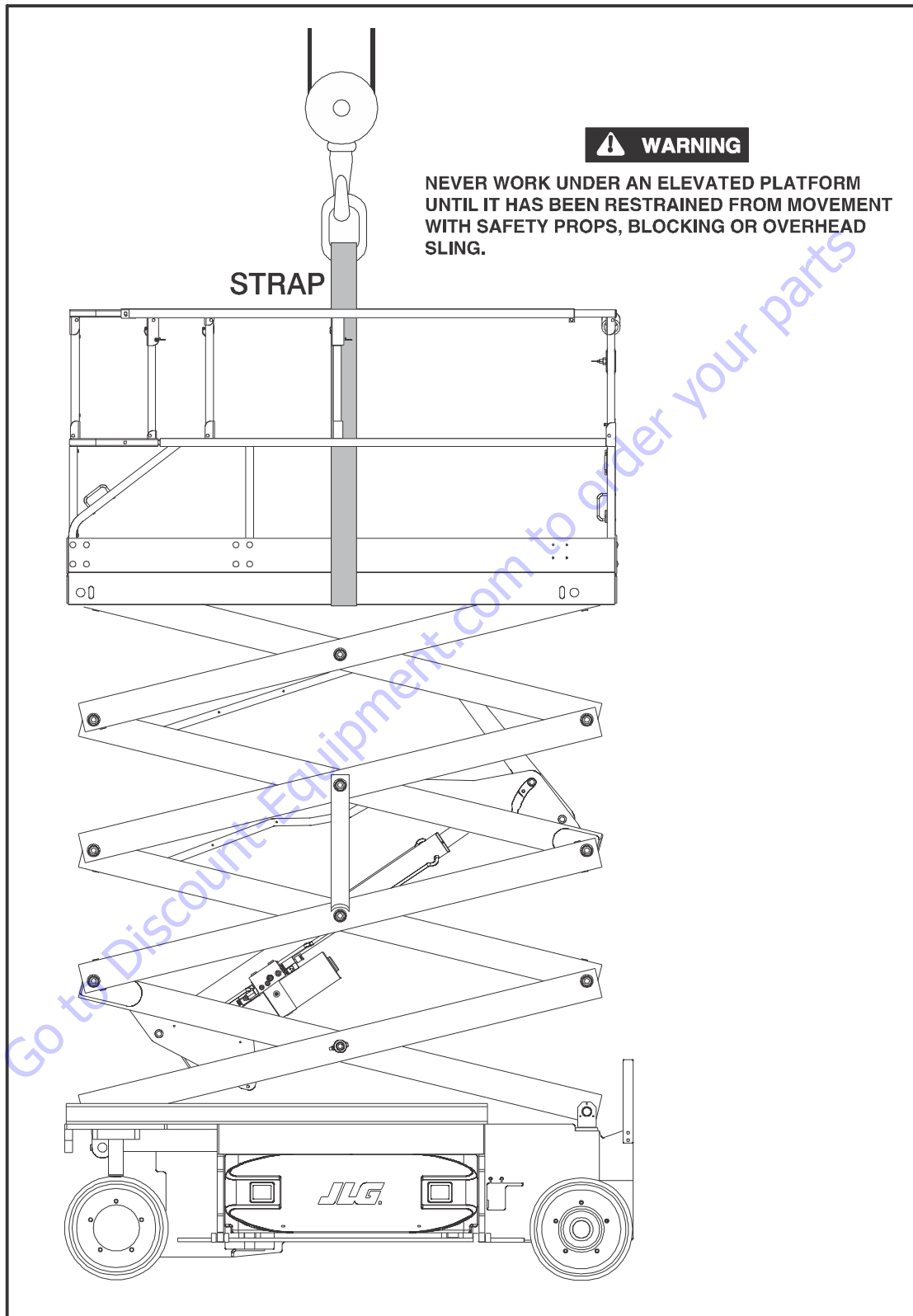
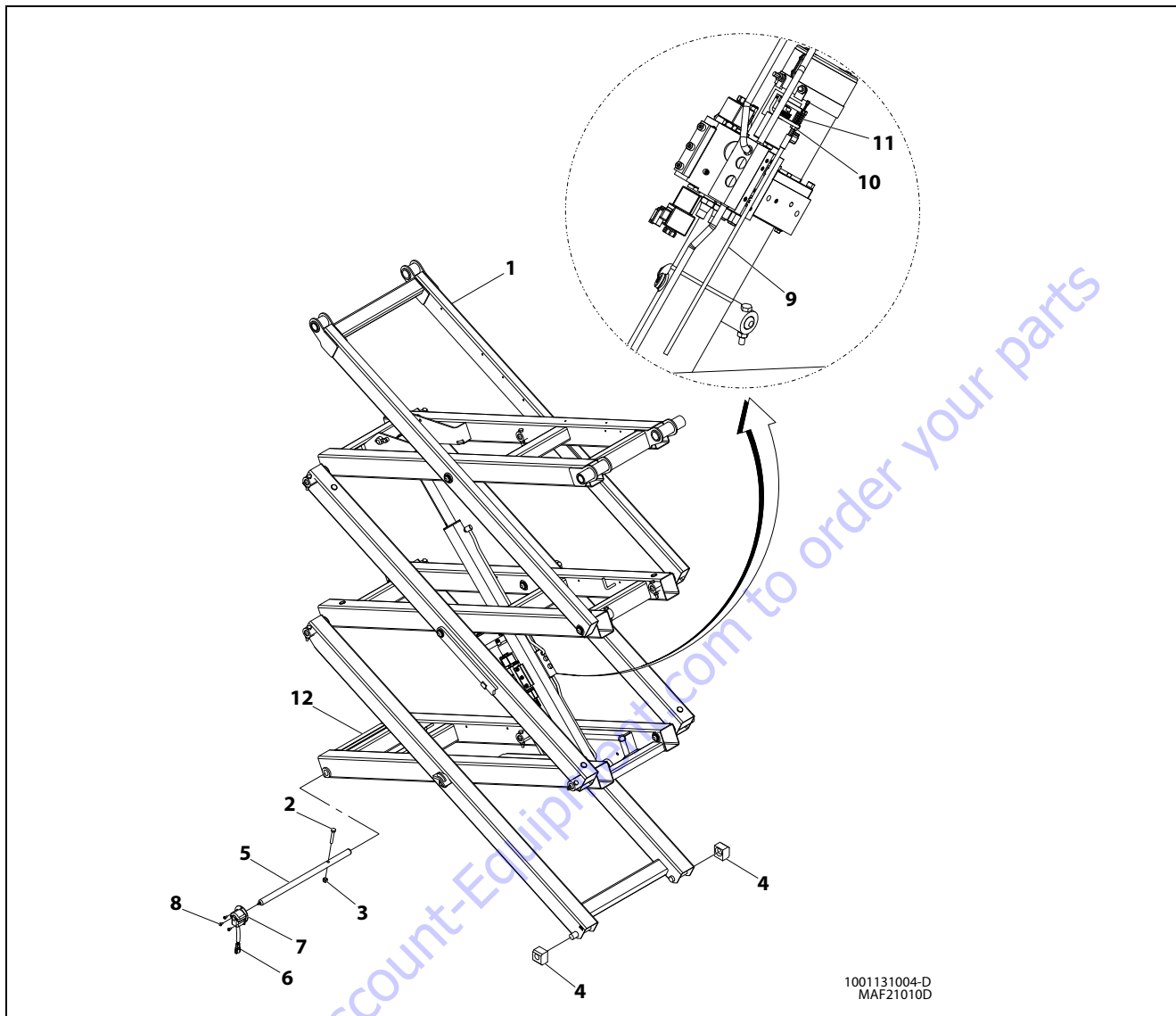


Figure 3-30. Arms and Platform Positioning and Support

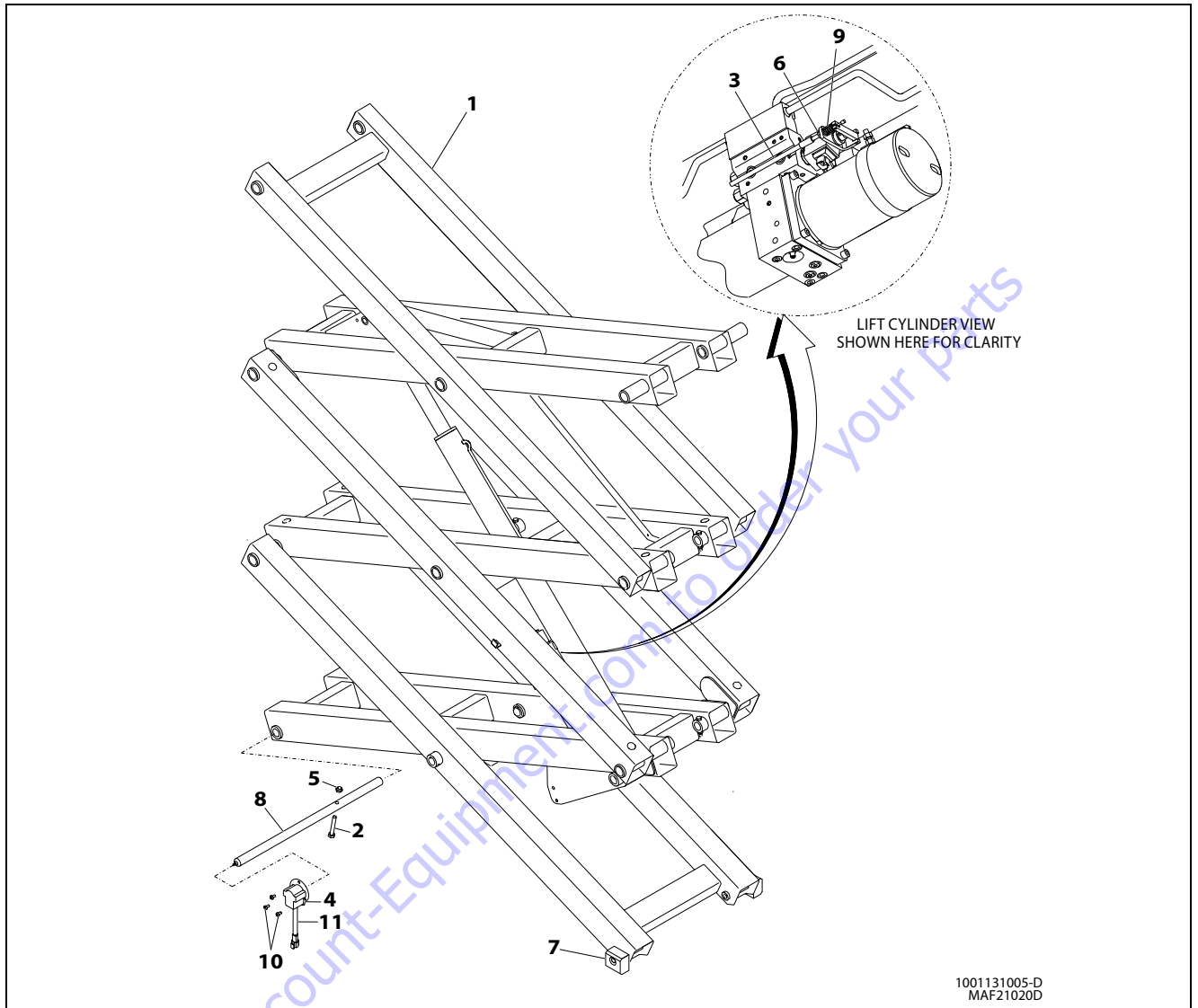
SECTION 3 - CHASSIS & SCISSOR ARMS



1001131004-D
MAF21010D

- | | | |
|-------------------|------------------------|--------------|
| 1. Arm Assembly | 5. Arm Pivot Pin | 9. Cable |
| 2. Capscrew | 6. Angle Sensor Switch | 10. Lock Nut |
| 3. Lock Nut | 7. Angle Sensor Mount | 11. Spring |
| 4. Lower Side Pad | 8. Capscrew | 12. Tape |

Figure 3-31. Scissors Arms Assembly - 1930ES



1001131005-D
MAF21020D

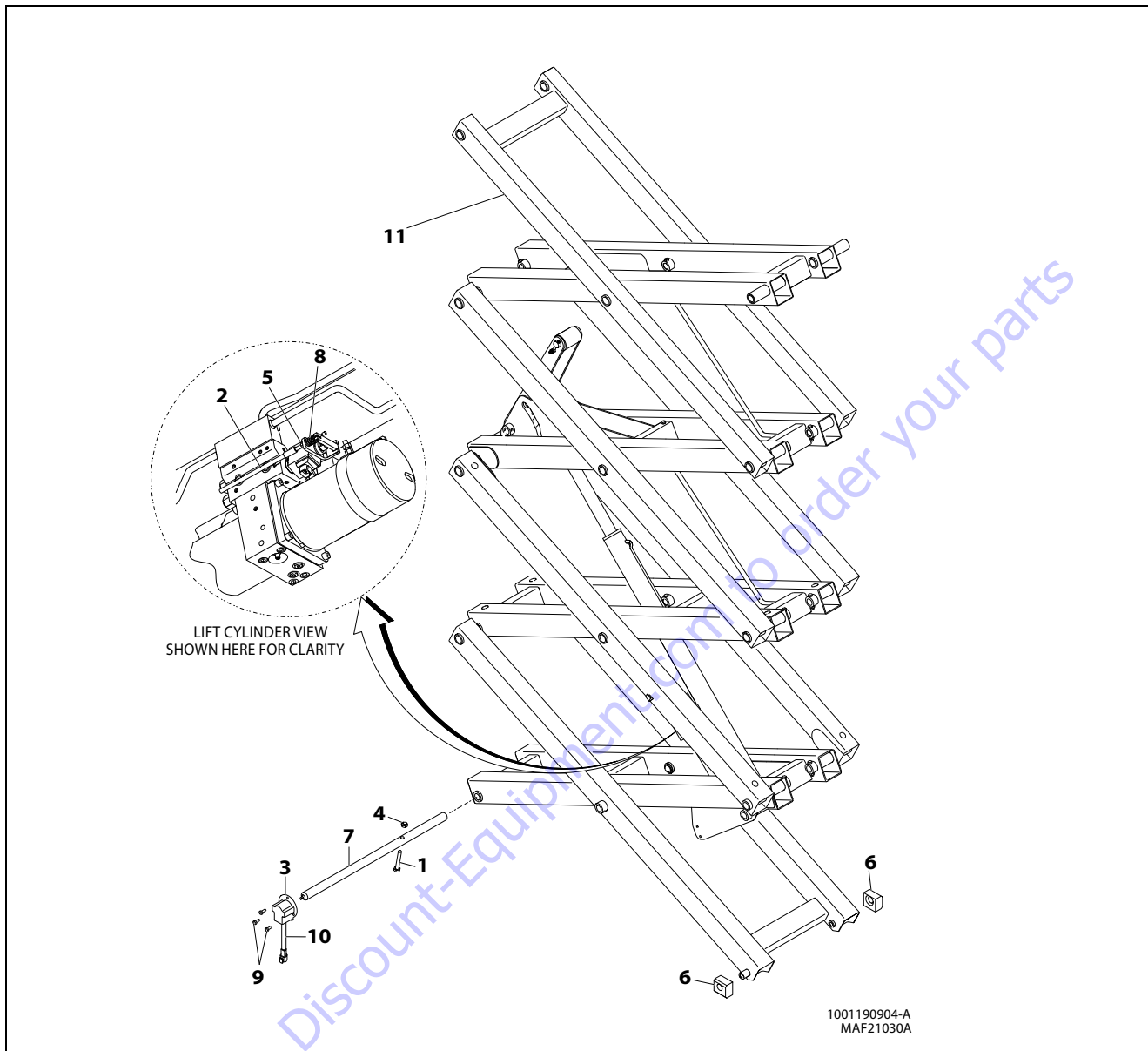
- 1. Arm Assembly
- 2. Capscrew
- 3. Cable
- 4. Angle Sensor Mount

- 5. Lock Nut
- 6. Lock Nut
- 7. Lower Side Pad
- 8. Arm Pivot Pin

- 9. Spring
- 10. Capscrew
- 11. Angle Sensor Switch

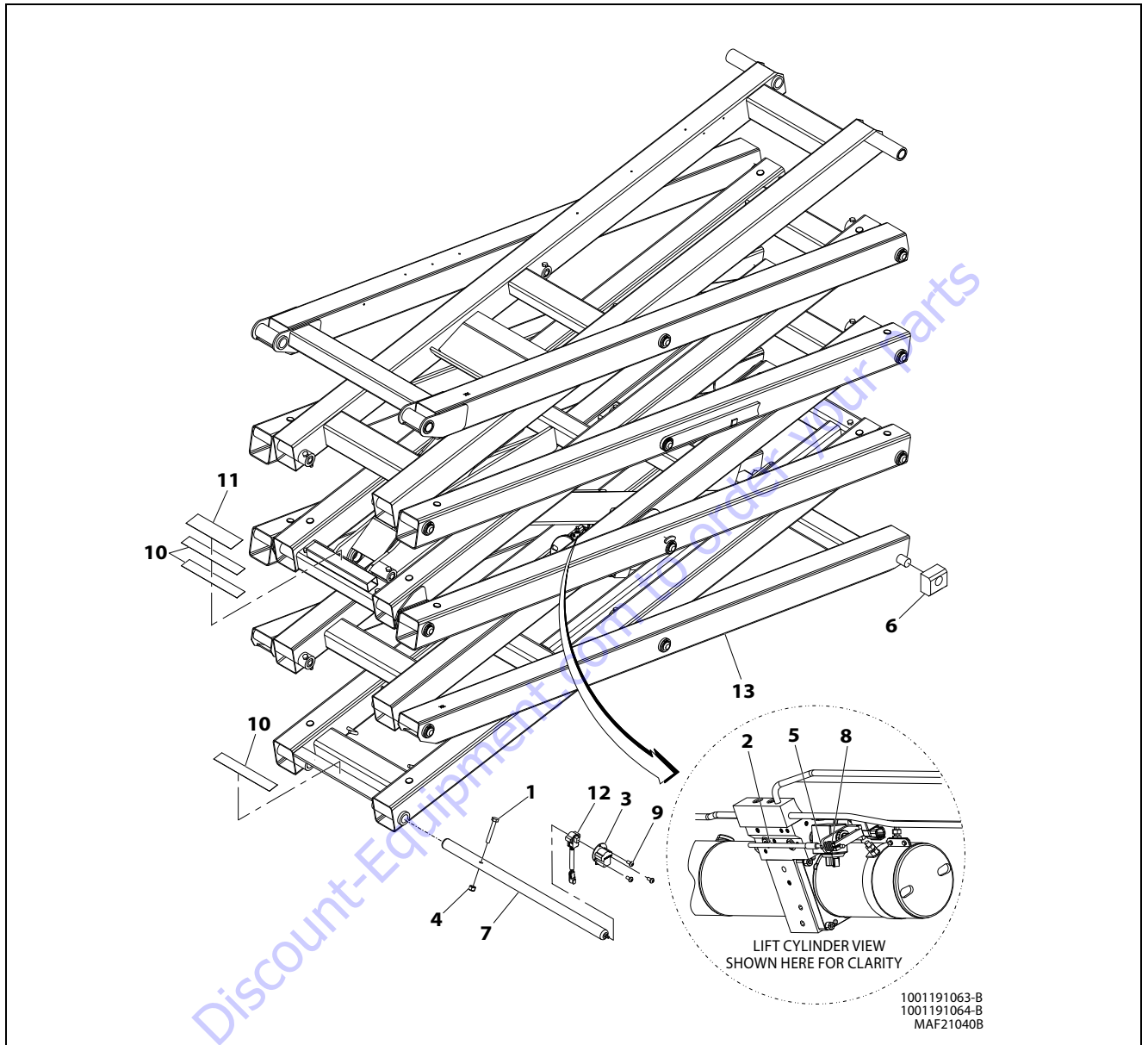
Figure 3-32. Scissors Arms Assembly - 2032ES

SECTION 3 - CHASSIS & SCISSOR ARMS



- | | | |
|-----------------------|-------------------|-------------------------|
| 1. Capscrew | 5. Lock Nut | 9. Capscrew |
| 2. Cable | 6. Lower Side Pad | 10. Angle Sensor Switch |
| 3. Angle Sensor Mount | 7. Arm Pivot Pin | 11. Arm Assembly |
| 4. Lock Nut | 8. Spring | |

Figure 3-33. Scissors Arms Assembly - 2632ES



- | | | |
|-----------------------|-------------------|-------------------------|
| 1. Capscrew | 6. Lower Side Pad | 11. Tape |
| 2. Cable | 7. Arm Pivot Pin | 12. Angle Sensor Switch |
| 3. Angle Sensor Mount | 8. Spring | 13. Arm Assembly |
| 4. Lock Nut | 9. Capscrew | |
| 5. Lock Nut | 10. Tape | |

Figure 3-34. Scissors Arms Assembly - 2646ES and 3246ES

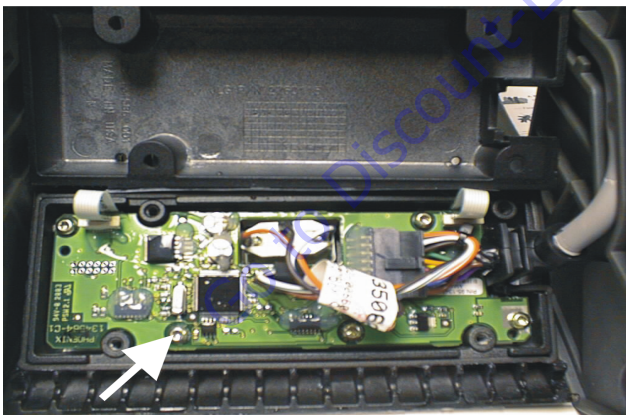
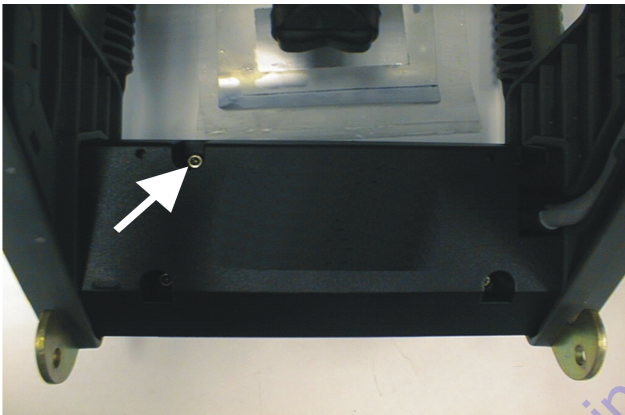
3.17 PLATFORM CONTROL STATION

Printed Circuit Board Replacement

1. Disconnect the platform control box and remove from the machine.
2. Place the platform control box on a suitable work bench.
3. Loosen and remove the long through bolts that hold the two side control housings together.

NOTE: You may have to only loosen the two power bolts and remove the two closest the top in order to get to the printed circuit board located in the top of the control box where the drive/lift select switch is located.

4. Loosen and remove the four bolts that hold the bottom of the control box.
5. Disconnect the plug from the printed circuit board.
6. Remove the bolts attaching the printed circuit board to the control box.
7. Replace board and reassemble control box.



Joystick Controller

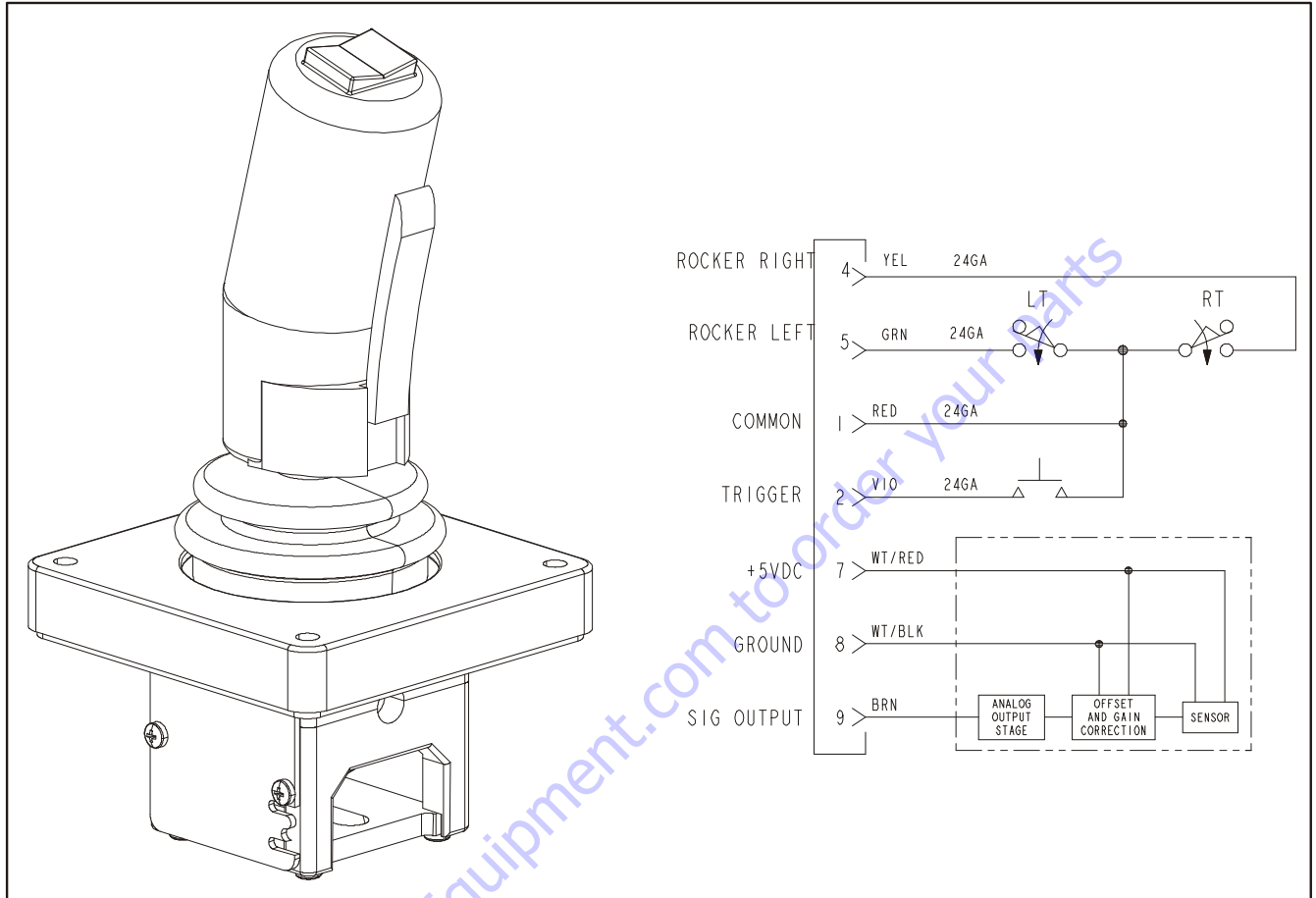


Figure 3-35. Joystick

Table 3-7. Joystick Specifications

Input Voltage	+5 (±0.1)VDC
Current Consumption	10 mA @ 12VDC
Output: Handle Centered	2.5 (±0.1)VDC
Output: Full Positive (Reverse) Deflection	4 (±0.1)VDC
Output: Full Negative (Forward) Deflection	1 (±0.1)VDC

Table 3-8. Connector Chart

CONNECTOR PINOUT		
Term	Color	Function
1	RED	HANDLE COM
2	VIOLET	TRIGGER N.O.
3	--	SPARE
4	YELLOW	ROCKER RT
5	GREEN	ROCKER LT
6	--	SPARE
7	WHITE/RED	+5VDC
8	WHITE/BLACK	GROUND
9	BROWN	SIG OUTPUT

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We sell worldwide for the brands: Genie, Terex, JLG, MultiQuip, Mikasa, Essick, Whiteman, Mayco, Toro Stone, Diamond Products, Generac Magnum, Airman, Haulotte, Barreto, Power Blanket, Nifty Lift, Atlas Copco, Chicago Pneumatic, Allmand, Miller Curber, Skyjack, Lull, Skytrak, Tsurumi, Husquvarna Target, , Stow, Wacker, Sakai, Mi-T- M, Sullair, Basic, Dynapac, MBW, Weber, Bartell, Bennar Newman, Haulotte, Ditch Runner, Menegotti, Morrison, Contec, Buddy, Crown, Edco, Wyco, Bomag, Laymor, Barreto, EZ Trench, Bil-Jax, F.S. Curtis, Gehl Pavers, Heli, Honda, ICS/PowerGrit, IHI, Partner, Imer, Clipper, MMD, Koshin, Rice, CH&E, General Equipment, ,AMida, Coleman, NAC, Gradall, Square Shooter, Kent, Stanley, Tamco, Toku, Hatz, Kohler, Robin, Wisconsin, Northrock, Oztec, Toker TK, Rol-Air, Small Line, Wanco, Yanmar

SECTION 4. HYDRAULICS

4.1 CYLINDERS - THEORY OF OPERATION

Cylinders are of the double acting type. The Lift and Steer systems incorporate double acting cylinders. A double acting cylinder is one that requires oil flow to operate the cylinder rod in both directions. Directing oil (by actuating the corresponding control valve to the piston side of the cylinder) forces the piston to travel toward the rod end of the barrel, extending the cylinder rod (piston attached to rod). When the oil flow is stopped, movement of the rod will stop. By directing oil to the rod side of the cylinder, the piston will be forced in the opposite direction and the cylinder rod will retract.

NOTE: *The lift cylinder is a single acting cylinder which takes hydraulic pressure to extend and gravity to retract.*

A holding valve is used in the Lift circuit to prevent retraction of the cylinder rod should a hydraulic line rupture or a leak develop between the cylinder and its related control valve.

4.2 VALVES - THEORY OF OPERATION

Solenoid Control Valves (Bang-Bang)

Control valves used are four-way, three-position solenoid valves of the sliding spool design. When a circuit is activated and the control valve solenoid energizes, the spool is shifted and the corresponding work port opens to permit oil flow to the component in the selected circuit, with the opposite work port opening to reservoir. Once the circuit is deactivated (control returned to neutral), the valve spool returns to neutral (center) and oil flow is then directed through the valve body and returns to reservoir. A typical control valve consists of the valve body, sliding spool, and two solenoid assemblies. The spool is machine fitted in the bore of the valve body. Lands on the spool divide the bore into various chambers, which, when the spool is shifted, align with corresponding ports in the valve body open to common flow. At the same time other ports would be blocked to flow. The spool is spring-loaded to center position, therefore when the control is released, the spool automatically returns to neutral, prohibiting any flow through the circuit.

Relief Valves

Main relief valves are installed at various points within the hydraulic system to protect associated systems and components against excessive pressure. Excessive pressure can be developed when a cylinder reaches its limit of travel and the flow of pressurized fluid continues from the system control. The relief valve provides an alternate path for the continuing flow from the pump, thus preventing rupture of the cylinder, hydraulic line or fitting. Complete failure of the system pump is also avoided by relieving circuit pressure. The relief valve is installed in the circuit between the pump outlet (pressure line) and the cylinder of the circuit, generally as an integral part of the system valve bank. Relief pressures are set slightly higher than the load requirement, with the valve diverting excess pump delivery back to the reservoir when operating pressure of the component is reached.

Crossover Relief Valves

Crossover relief valves are used in circuits where the actuator requires an operating pressure lower than that supplied to the system. When the circuit is activated and the required pressure at the actuator is developed, the crossover relief diverts excess pump flow to the reservoir. Individual, integral reliefs are provided for each side of the circuit.

Proportional Valve

Flow is proportional to the amount of voltage supplied to the valve coil. Voltage is gained by the machine controller and determined by the position of the joystick.

Manual Descent Valve

The manual descent valve is located on top of the holding valve on the lift cylinder. The holding valve is a normally closed solenoid valve, and holds the platform in place when raised. When activated, the valve opens to permit lift down. The holding valve is connected to the manual descent valve, which is connected to a cable which, when pulled, manually opens the lift down port of the valve and allows the platform to be lowered in the event hydraulic power is lost.

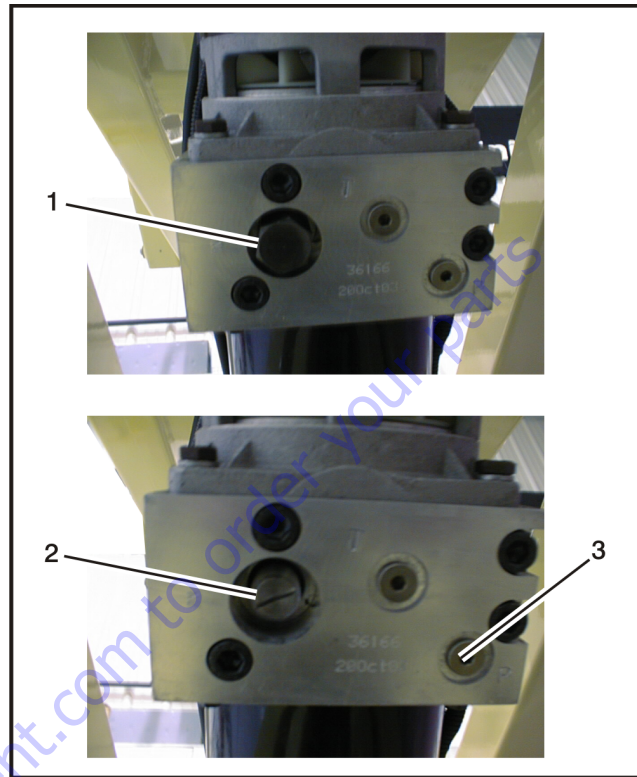
4.3 CYLINDER CHECKING PROCEDURE

NOTE: Cylinder check must be performed anytime a system component is replaced or when improper system operation is suspected.

Cylinders Without Counterbalance Valves and Steer Cylinder

1. Using all applicable safety precautions, activate pump motor and fully extend cylinder to be checked.
2. Carefully disconnect hydraulic hoses from retract port of cylinder. There will be some initial weeping of hydraulic fluid which can be caught in a suitable container. After the initial discharge, there should be no further drainage from the retract port.
3. Activate pump motor and extend cylinder.
4. If cylinder retract port leakage is less than 6-8 drops per minute, carefully reconnect hose to port and retract cylinder. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repair must be made.
5. With cylinder fully retracted, shut down machine power and carefully disconnect hydraulic hose from cylinder extend port.
6. Activate pump motor and retract cylinder. Check extend port for leakage.
7. If extend port leakage is less than 6-8 drops per minute, carefully reconnect hose to extend port, than activate cylinder through one complete cycle and check for leaks. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repairs must be made.

4.4 LIFT PRESSURE SETTING PROCEDURE



1. Large Nut
2. Pressure Setting Screw
3. P port

Figure 4-1. Lift Pressure Setting

1. Place 120% of the rated load of the machine on the platform.
2. Increase lift pressure to raise the platform and set the safety prop.
3. Locate the Large Nut (1) on the underside of the valve block.
4. Using a 7/8 in. wrench, remove the large nut (1). This will expose the Pressure Setting Screw (2).
5. Remove plug from P port (3) and install a pressure gauge.
6. Raise the platform and take a pressure reading.
7. Adjust the Pressure Setting Screw to reach the proper lift pressure per model as listed in Table 4-1.

Table 4-1. Pressure Settings

Model	Lift Relief		Steer Relief
	USA Built	China Built	
1930ES	1800 psi \pm 50 psi (124 bar \pm 3.4 bar)	1900 psi \pm 50 psi (131 bar \pm 3.4 bar)	1500 psi (103 bar)
2032ES	1800 psi \pm 50 psi (124 bar \pm 3.4 bar)	1900 psi \pm 50 psi (131 bar \pm 3.4 bar)	1500 psi (103 bar)
2632ES	1950 psi \pm 50 psi (134 bar \pm 3.4 bar)	1900 psi \pm 50 psi (131 bar \pm 3.4 bar)	1500 psi (103 bar)
2646ES	2000 psi \pm 50 psi (138 bar \pm 3.4 bar)	1900 psi \pm 50 psi (131 bar \pm 3.4 bar)	1500 psi (103 bar)
3246ES	2000 psi \pm 50 psi (138 bar \pm 3.4 bar)	1900 psi \pm 50 psi (131 bar \pm 3.4 bar)	1500 psi (103 bar)

NOTE: Check your nameplate at the left rear of the machine for country of origin. USA built machines, serial number prefix starts with a 02 (02XXXXXXXX), China built machines, serial number prefix starts with an B2 (B2XXXXXXXX).

8. Remove pressure gauge and replace the plug into the P port.
9. Replace the bronze washer with a new bronze washer and large nut over the pressure setting screw. Do not use old bronze washer. Using the old bronze washer will cause leakage.
10. Torque the large nut to 160 in. lb (16 Nm).

Alternate Lift Pressure Setting Procedure:

1. Increase lift pressure to raise the platform and set the safety prop.
2. Remove plug from port P (3) and install a pressure gauge.
3. Remove the solenoid from the lift valve.
4. Set the pressure actuating lift function from the ground or platform.
5. Remove the pressure gauge from port P (3) and replace plug.
6. Replace the solenoid on the lift valve.

4.5 HYDRAULIC OIL FILL

NOTE: The hydraulic oil level should be checked every 6 months. Always check the oil level any time any maintenance is performed that would effect the hydraulic oil level.

Oil Check Procedure

1. With the scissor lift on a flat and level surface and the platform empty, elevate machine and swing safety prop out of it's stowed position.
2. Continue to elevate the platform until the fill plug, located on the right side of the tank attached to the lift cylinder, is fully accessible.

CAUTION

ENSURE THE SCISSOR ARMS ARE PROPERLY SUPPORTED.

NOTE: The 2632ES/2646ES/ 3246ES platforms will have to be raised higher than the 1930ES and 2032ES in order to access the oil plug.



3. Wipe all dirt and debris from the filler plug area.
4. Slowly remove the fill plug venting any pressure that may be built up in the reservoir.
5. To check the oil level, lower platform so it rests on the safety prop.

CAUTION

THERE MAY BE UP TO 10 PSI OF PRESSURE IN THE TANK.

6. With the plug removed, the oil level should be completely full, at the top of the fill port with scissor arms resting on the safety prop. from the fill port.
7. If additional oil is required, add proper grade of oil by using a funnel with a flexible spout or a plastic squeeze bottle. Fill until oil weeps out of opening.

SECTION 4 - HYDRAULICS

NOTE: Care should be taken not to introduce any impurities (dirt, water etc.) while plug is removed.

8. Replace plug and torque to 40 ft. lbs. (56 Nm).
9. Any time a hydraulic component is removed or replaced, cycle the scissor arms several times and refer to steps 3 and 4 to recheck oil level.

Slide Block Lubrication

Lube - White Lithium Grease (GREDAG 741)

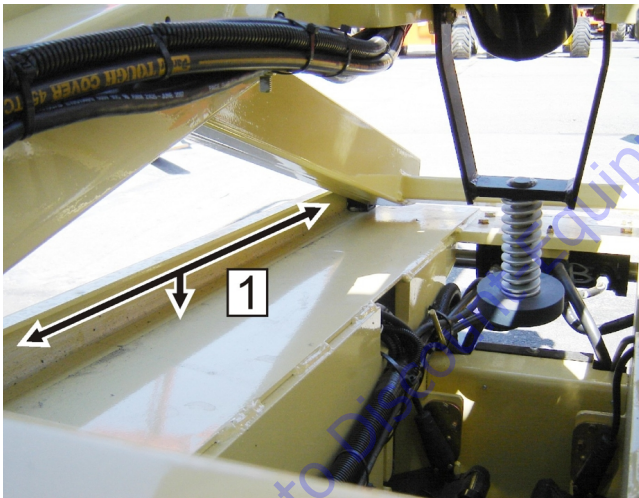
Interval - Every 6 months

1. With the platform empty, elevate machine and swing safety prop out of it's stowed position.

CAUTION

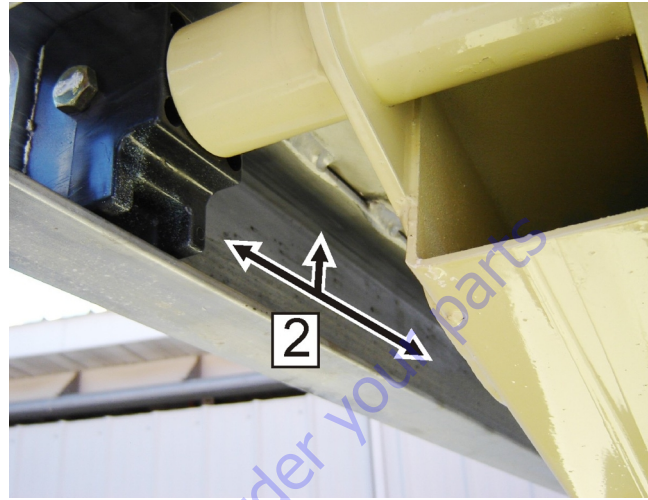
ENSURE THE SCISSOR ARMS ARE PROPERLY SUPPORTED.

2. Locate the Lower and Upper Slide Pads and wipe/pressure wash all dirt and debris from the slide channel area (1, 2).
3. Apply a layer of grease along the inside and bottom of the lower slide channel (1) on both sides of the machine.



Upper Slide Pad Channel

4. Apply a layer of grease along the inside and top of the upper slide channel (2) on both sides of the machine.



Upper Slide Pad Channel

4.6 LIFT CYLINDER REMOVAL

NOTE: *If there is a pump failure, a crane or a forklift can be used to raise the platform. Refer to Figure 3-47., Arms and Platform Positioning and Support.*

Self locking fasteners, such as nylon insert and thread deforming locknuts, are not intended to be reinstalled after removal. Always use new replacement hardware when installing locking fasteners.

1. Raise the platform and place on the safety prop. It may be necessary to use an overhead crane or forklift to secure the platform and scissor arms before lift cylinder removal begins. (See Figure 3-47.)
2. Cut any wire ties that attach any cables or hoses to the lift cylinder.

NOTICE

PULL THE BATTERY DISCONNECT BEFORE REMOVING ANY COMPONENTS FROM THE LIFT CYLINDER ASSEMBLY.

3. Remove the valves connectors, the two battery cables and the manual descent cable.

NOTE: *To avoid having to readjust the manual descent, remove the large nut located behind the manual descent bracket as shown. (See Figure 4-2.)*

4. Ensuring that the platform and scissor arms are properly secure, remove the top lift cylinder pin and rest the top of the cylinder on the arm cross tube directly below the cylinder.
5. Remove the bolt from the lower cylinder pin and have someone assist you in lifting the cylinder from the scissor arms.
6. Set the cylinder with pump and motor assembly intact on a clean workbench.
7. Remove the 4 bolts that attach the pump/motor assembly to the lift cylinder.
8. Remove the bolt from the bracket that attaches the hydraulic reservoir to the lift cylinder.
9. Separate the cylinder from the pump/motor assembly.

SECTION 4 - HYDRAULICS



Figure 4-2. Lift Cylinder Removal

4.7 CYLINDER REPAIR

NOTE: The following are general procedures that apply to all of the cylinders on this machine. Procedures that apply to a specific cylinder will be so noted.

Disassembly

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the port block fitting in the manifold located on the cylinder.

WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. If applicable, remove the cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

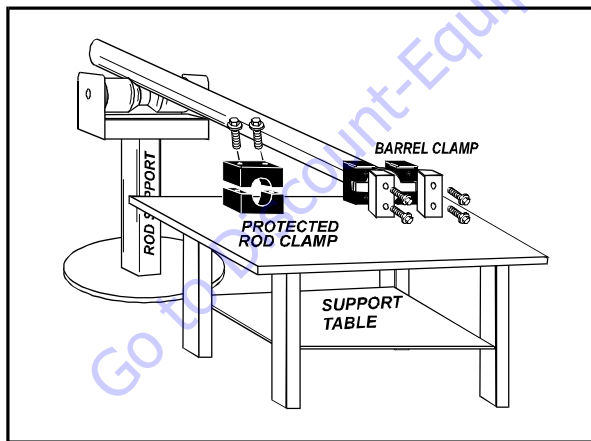


Figure 4-3. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Loosen the cylinder head setscrew.

NOTE: Steps 6 and 7 apply only to the steer cylinder.

6. Using a spanner wrench, loosen the spanner nut retainer, and remove spanner nut from cylinder barrel.

7. Being careful not to mark the surface of the rod, use a punch or wooden dowel and hammer to drive the rod guide about one inch down into the cylinder bore. Using a screw driver, carefully push one end of the round retaining ring back towards the inside of the cylinder and then slip the screwdriver tip under that end. Pull the ring out of the groove toward the wall mouth. Once one end of the retaining ring is free from the groove, the remainder can be easily pried free using ones fingers or pliers.
8. 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.

9. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

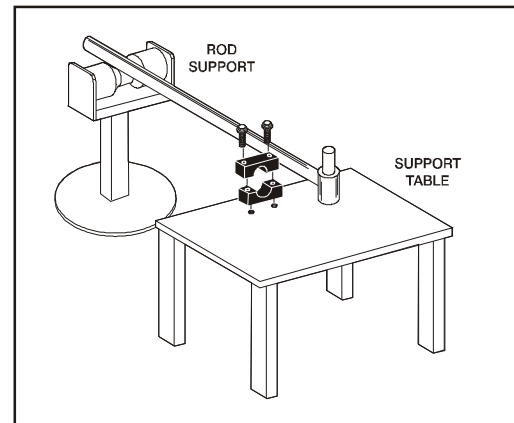


Figure 4-4. Cylinder Rod Support

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

NOTE: For steer cylinder piston removal, see Steer Cylinder Piston Removal on page 4-8 following.

11. Loosen and remove the capscrews, if applicable, which attach the tapered bushing to the piston.
12. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loose on the piston.
13. Remove the bushing from the piston.
14. Screw the piston CCW, by hand, and remove the piston from cylinder rod.