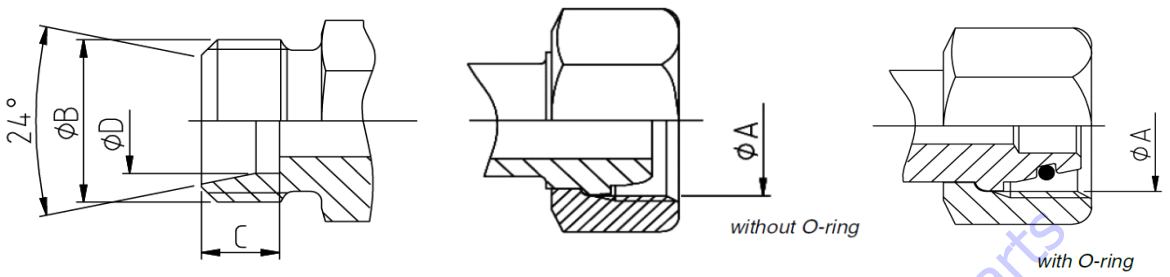
Table 5-9. DIN 24°Cone (MBTL & MBTS)



TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)						
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Nom	Max	Torque [N-m] Min	Nom	Max	Flats from Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12x1.5	10.50	12.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the						1.5 to 1.75
		8	M14x1.5	12.50	14.00	7.00	8.20							1.5 to 1.75
		10	M16x1.5	14.50	16.00	7.00	10.20							1.5 to 1.75
		12	M18x1.5	16.50	18.00	7.00	12.20							1.5 to 1.75
		15	M22x1.5	20.50	22.00	7.00	15.20							1.5 to 1.75
		18	M26x1.5	24.50	26.00	7.50	18.20							1.5 to 1.75
		22	M30x2	27.90	30.00	7.50	22.20							1.5 to 1.75
		28	M36x2	33.90	36.00	7.50	28.20							1.5 to 1.75
		35	M45x2	42.90	45.00	10.50	35.30							1.5 to 1.75
		42	M52x2	49.90	52.00	11.00	42.30							1.5 to 1.75
	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Nom	Max	Torque [N-m] Min	Nom	Max	Flats from Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14x1.5	12.50	14.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the						1.5 to 1.75
		8	M16x1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
		10	M18x1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
		12	M20x1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
		14	M22x1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
		16	M24x1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
		20	M30x2	27.90	30.00	10.50	20.20							1.5 to 1.75
		25	M36x2	33.90	36.00	12.00	25.20							1.5 to 1.75
		30	M42x2	39.90	42.00	13.50	30.20							1.5 to 1.75
		38	M52x2	49.90	52.00	16.00	38.30							1.5 to 1.75

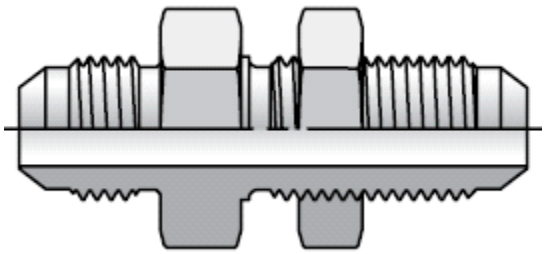
* ØA, ØB, C, & ØD thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

Assembly Instructions for Bulkhead (BH) Fittings

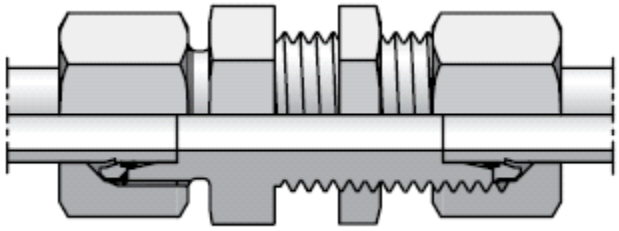
1. Ensure threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary replace fitting or adapter.
2. Remove the locknut from the bulkhead assembly.
3. Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
4. Hand thread the locknut onto the bulkhead end of the fitting body.
5. Torque nut onto fitting per Table 5-10 and Table 5-11 while using the Double Wrench Method.

Table 5-10. Bulkhead Fittings (BH) - INCH



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	O-RING FACE SEAL (ORFS) BULKHEAD FITTING	4	9/16-18	15	16	17	20	22	23
		6	11/16-16	25	27	28	34	37	38
		8	13/16-16	55	58	61	75	79	83
		10	1-14	85	90	94	115	122	127
		12	13/16-12	135	142	149	183	193	202
		14	15/16-12	170	179	187	230	243	254
		16	17/16-12	200	210	220	271	285	298
		20	111/16-12	245	258	270	332	350	366
		24	2-12	270	284	297	366	385	403
	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
	37° FLARE (JIC) BULKHEAD FITTING	3	3/8-24	8	9	9	11	12	12
		4	7/16-20	13	14	14	18	19	19
		5	1/2-20	20	21	22	27	28	30
		6	9/16-18	25	27	28	34	37	38
		8	3/4-16	50	53	55	68	72	75
		10	7/8-14	85	90	94	115	122	127
		12	11/16-12	135	142	149	183	193	202
		14	13/16-12	170	179	187	230	243	254
		16	15/16-12	200	210	220	271	285	298
		20	15/8-12	245	258	270	332	350	366
		24	17/8-12	270	284	297	366	385	403
		32	21/2-12	310	326	341	420	442	462

Table 5-11. Bulkhead Fittings (BH) - METRIC



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTL) BULKHEAD FITTING	6	M12x1.5	14	15	16	19	20	22
		8	M14x1.5	17	18	19	23	24	26
		10	M16x1.5	22	23	24	30	31	33
		12	M18x1.5	35	37	39	47	50	53
		15	M22x1.5	44	47	50	60	64	68
		18	M26x1.5	70	75	80	95	102	108
		22	M30x2	115	120	125	156	163	169
		28	M36x2	150	157	164	203	213	222
		35	M45x2	155	162	169	210	220	229
		42	M52x2	220	230	240	298	312	325
	DIN 24° CONE FLARELESS BITE (MBTS) BULKHEAD FITTING	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
		6	M14x1.5	17	15	16	23	20	22
		8	M16x1.5	22	18	19	30	24	26
		10	M18x1.5	35	23	24	47	31	33
		12	M20x1.5	40	35	37	54	47	50
		14	M22x1.5	44	47	50	60	64	68
		16	M24x1.5	70	75	80	95	102	108
		20	M30x2	115	120	125	156	163	169
		25	M36x2	150	157	164	203	213	222
		30	M42x2	155	162	169	210	220	229
		38	M52x2	220	230	240	298	312	325

Assembly Instructions for O-Ring Boss (ORB) Fittings

1. Inspect components to ensure that male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).

⚠ CAUTION

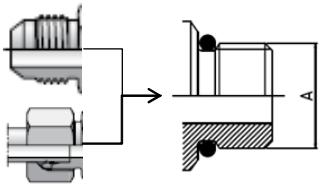
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-12 thru Table 5-17 while using the Double Wrench Method.
   a. The table headings identify the straight thread O-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread O-ring port.
   b. Torque values provided in Table 5-12 thru Table 5-17 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

Table 5-12. O-ring Boss (ORB) - Table 1 of 6



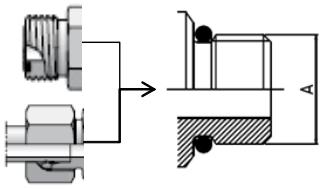
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-13. O-ring Boss (ORB) - Table 2 of 6



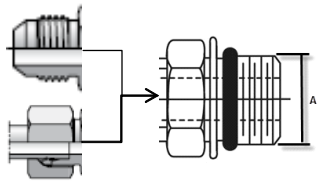
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	26	27	28	35	37	38
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	17	18	18	23	24	24
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-14. O-ring Boss (ORB) - Table 3 of 6

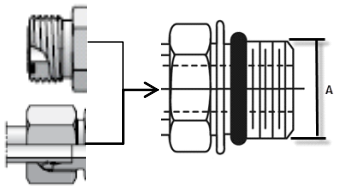


TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	7	7
	3	3/8-24	0.37	9.52	(100)	(105)	(110)	11	12	12
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	21	22	23	28	30	31
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(39)	(41)	(43)	4	5	5
	3	3/8-24	0.37	9.52	(65)	(69)	(72)	7	8	8
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	15	19	20	20
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-15. O-ring Boss (ORB) - Table 4 of 6



TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

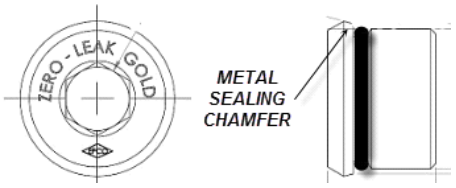
Table 5-16. O-ring Boss (ORB) - Table 5 of 6

TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	16	19	20	22
	6	9/16-18	0.56	14.28	34	36	38	46	49	52
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(20)	(21)	(21)	2	2	2
	3	3/8-24	0.37	9.52	(36)	(38)	(40)	4	4	5
	4	7/16-20	0.44	11.11	6	7	7	8	9	9
	5	1/2-20	0.50	12.70	9	10	10	12	14	14
	6	9/16-18	0.56	14.28	22	24	25	30	33	34
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-17. O-ring Boss (ORB) - Table 6 of 6



TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	11/16-12	1.06	27.00	51	54	57	69	73	77
	14	13/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	15/16-12	1.31	33.30						
	20	15/8-12	1.63	41.30						
	24	17/8-12	1.87	47.60						
	32	21/2-12	2.50	63.50						

TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	11/16-12	1.06	27.00	51	54	57	69	73	77
	14	13/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	15/16-12	1.31	33.30						
	20	15/8-12	1.63	41.30						
	24	17/8-12	1.87	47.60						
	32	21/2-12	2.50	63.50						

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Assembly Instructions for Adjustable Port End Metric (MFF) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

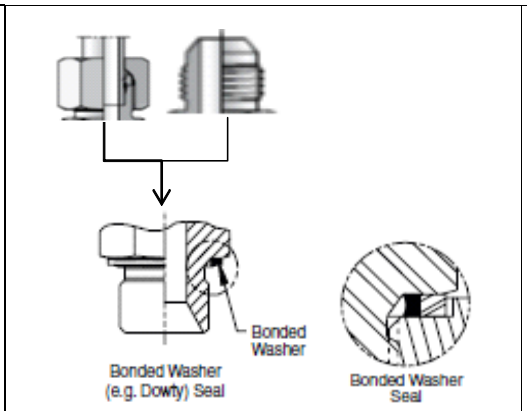
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

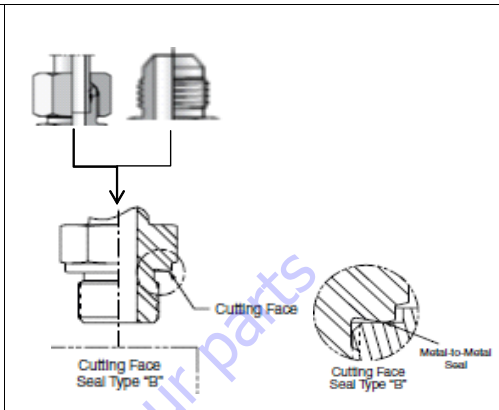
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, or Table 5-23 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, and Table 5-23 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

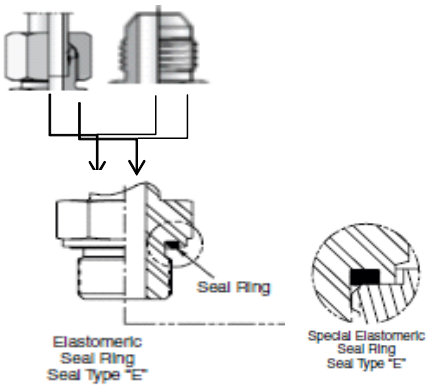
Table 5-18. Metric Flat Face Port (MFF) - L Series - Table 1 of 3

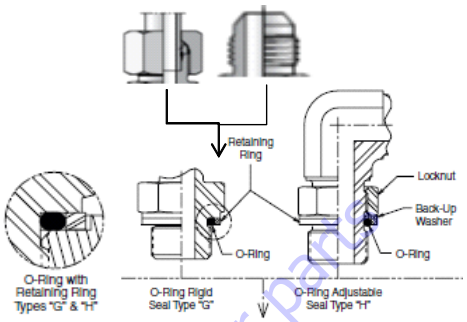




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	7	8	8	9	11	11	13	14	14	18	19	19
	M12x1.5	8	15	16	17	20	22	23	22	23	24	30	31	33
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	33	35	36	45	47	49	48	51	53	65	69	72
	M18x1.5	15	41	43	45	55	58	61	59	62	65	80	84	88
	M22x1.5	18	48	51	53	65	69	72	103	108	113	140	146	153
	M27x2	22	66	70	73	90	95	99	140	147	154	190	199	209
	M33x2	28	111	117	122	150	159	165	251	264	276	340	358	374
	M42x2	35	177	186	195	240	252	264	369	388	406	500	526	550
	M48x2	42	214	225	235	290	305	319	465	489	512	630	663	694
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	4	5	5	5	7	7	8	9	9	11	12	12
	M12x1.5	8	10	11	11	14	15	15	14	15	16	19	20	22
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	21	22	23	28	30	31	31	33	34	42	45	46
	M18x1.5	15	27	28	29	37	38	39	38	40	42	52	54	57
	M22x1.5	18	31	33	34	42	45	46	67	70	73	91	95	99
	M27x2	22	43	45	47	58	61	64	91	96	100	123	130	136
	M33x2	28	72	76	79	98	103	107	163	171	179	221	232	243
	M42x2	35	115	121	127	156	164	172	240	252	264	325	342	358
	M48x2	42	139	146	153	188	198	207	302	318	332	409	431	450

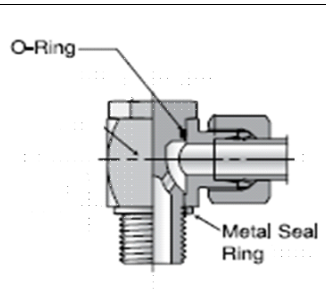
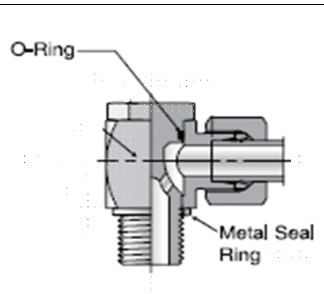
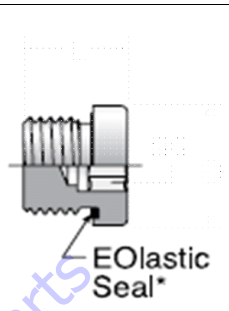
Table 5-19. Metric Flat Face Port (MFF) - L Series - Table 2 of 3





TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	15	18	19	20
	M12x1.5	8	18	19	20	25	26	27	18	19	20	25	26	28
	M14x1.5	10	33	35	36	45	47	49	30	31	32	40	42	44
	M16x1.5	12	41	43	45	55	58	61	41	43	45	55	58	61
	M18x1.5	15	52	55	57	70	75	77	52	54	57	70	74	77
	M22x1.5	18	92	97	101	125	132	137	66	70	73	90	95	99
	M27x2	22	133	140	146	180	190	198	133	139	146	180	189	198
	M33x2	28	229	241	252	310	327	342	229	240	252	310	326	341
	M42x2	35	332	349	365	450	473	495	332	348	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12
	M12x1.5	8	12	13	13	16	18	18	12	13	13	16	18	18
	M14x1.5	10	21	22	23	28	30	31	19	20	21	26	27	29
	M16x1.5	12	27	28	29	37	38	39	26	28	29	36	38	39
	M18x1.5	15	34	36	37	46	49	50	34	35	37	46	48	50
	M22x1.5	18	60	63	66	81	85	89	43	45	47	59	61	64
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

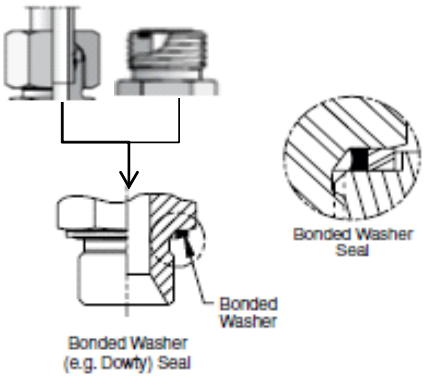
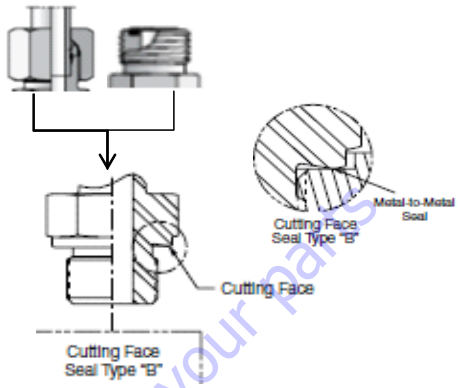
Table 5-20. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

			
TYPE/FITTING IDENTIFICATION	**BANJO FITTINGS with L series DIN (MBTL) opposite end**	**HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end**	**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**

MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	14	18	19	19	9	10	10	12	14	14
	M12x1.5	8	26	28	29	35	38	39	33	35	36	45	47	49	18	19	20	25	26	27
	M14x1.5	10	37	39	41	50	53	56	41	43	45	55	58	61	26	28	29	35	38	39
	M16x1.5	12	44	46	48	60	62	65	59	62	65	80	84	88	41	43	45	55	58	61
	M18x1.5	15	59	62	65	80	84	88	74	78	81	100	106	110	48	51	53	65	69	72
	M22x1.5	18	89	94	98	120	127	133	103	108	113	140	146	153	66	70	73	90	95	99
	M27x2	22	96	101	106	130	137	144	236	248	260	320	336	353	100	105	110	135	142	149
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	166	175	183	225	237	248
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	266	280	293	360	380	397
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	266	280	293	360	380	397

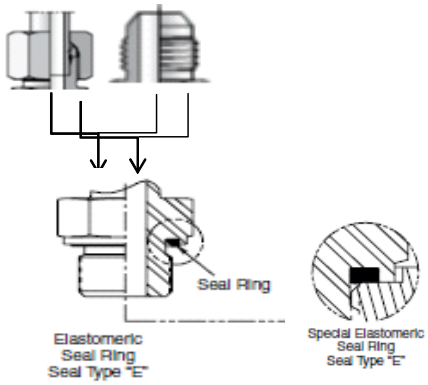
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	M12x1.5	8	17	18	19	23	24	26	21	22	23	28	30	31	12	13	13	16	18	18
	M14x1.5	10	24	26	27	33	35	37	27	28	29	37	38	39	17	18	19	23	24	26
	M16x1.5	12	29	30	31	39	41	42	38	40	42	52	54	57	27	28	29	37	38	39
	M18x1.5	15	38	40	42	52	54	57	48	51	53	65	69	72	31	33	34	42	45	46
	M22x1.5	18	58	61	64	79	83	87	67	70	73	91	95	99	43	45	47	58	61	64
	M27x2	22	62	66	69	84	89	94	153	161	169	207	218	229	65	69	72	88	94	98
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	108	114	119	146	155	161
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	173	182	190	235	247	258
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	173	182	190	235	247	258

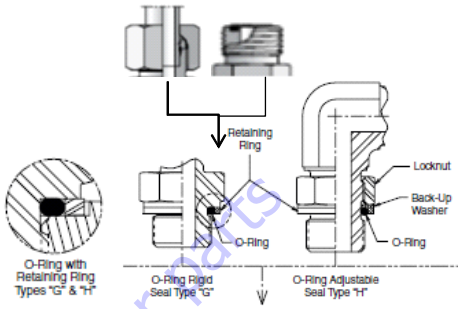
Table 5-21. Metric Flat Face Port (MFF) - S Series - Table 1 of 3

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	15	16	17	20	22	23	26	28	29	35	38	39
	M14x1.5	8	26	28	29	35	38	39	41	43	45	55	58	61
	M16x1.5	10	33	35	36	45	47	49	52	55	57	70	75	77
	M18x1.5	12	41	43	45	55	58	61	81	85	89	110	115	121
	M20x1.5	14	41	43	45	55	58	61	111	117	122	150	159	165
	M22x1.5	16	48	51	53	65	69	72	125	132	138	170	179	187
	M27x2	20	66	70	73	89	95	99	199	209	219	270	283	297
	M33x2	25	111	117	122	150	159	165	302	317	332	410	430	450
	M42x2	30	177	186	195	240	252	264	398	418	438	540	567	594
	M48x2	38	214	225	235	290	305	319	516	542	568	700	735	770
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	10	11	11	14	15	15	17	18	19	23	24	26
	M14x1.5	8	17	18	19	23	24	26	27	28	29	37	38	39
	M16x1.5	10	21	22	23	28	30	31	34	36	37	46	49	50
	M18x1.5	12	27	28	29	37	38	39	53	56	58	72	76	79
	M20x1.5	14	27	28	29	37	38	39	72	76	79	98	103	107
	M22x1.5	16	31	33	34	42	45	46	81	86	90	110	117	122
	M27x2	20	43	45	47	58	61	64	129	136	142	175	184	193
	M33x2	25	72	76	79	98	103	107	196	206	216	266	279	293
	M42x2	30	115	121	127	156	164	172	259	272	285	351	369	386
	M48x2	38	139	146	153	188	198	207	335	352	369	454	477	500

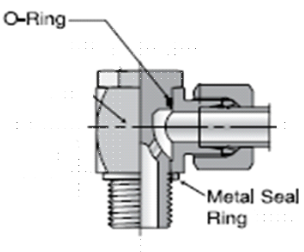
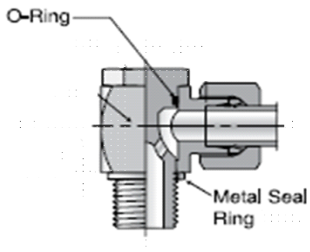
Table 5-22. Metric Flat Face Port (MFF) - S Series - Table 2 of 3





TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	26	28	29	35	38	39
	M12x1.5	8	33	35	36	45	47	49	41	43	45	55	58	61
	M14x1.5	10	52	55	57	70	75	77	52	55	57	70	75	77
	M16x1.5	12	66	70	73	90	95	99	66	70	73	90	95	99
	M18x1.5	15	92	97	101	125	132	137	92	97	101	125	132	137
	M22x1.5	18	100	105	110	135	142	149	100	105	110	135	142	149
	M27x2	22	133	140	146	180	190	198	133	140	146	180	190	198
	M33x2	28	229	241	252	310	327	342	229	241	252	310	327	342
	M42x2	35	332	349	365	450	473	495	332	349	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	17	18	19	23	24	26
	M12x1.5	8	21	23	23	29	31	32	27	28	29	37	38	39
	M14x1.5	10	34	36	37	46	49	50	34	36	37	46	49	50
	M16x1.5	12	43	45	47	58	61	64	43	45	47	58	61	64
	M18x1.5	15	60	63	66	81	85	89	60	63	66	81	85	89
	M22x1.5	18	65	69	72	88	94	98	65	69	72	88	94	98
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 5-23. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

																		
TYPE/FITTING IDENTIFICATION			**BANJO FITTINGS with S series DIN (MBTS) opposite end**						**HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end**						**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**					
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	33	35	36	45	47	49	--	--	--	--	--	--
	M12x1.5	8	37	39	41	50	53	56	41	43	45	55	58	61	--	--	--	--	--	--
	M14x1.5	10	44	46	48	60	62	65	59	62	65	80	84	88	--	--	--	--	--	--
	M16x1.5	12	59	62	65	80	84	88	74	78	81	100	106	110	--	--	--	--	--	--
	M18x1.5	15	81	85	89	110	115	121	92	97	101	125	132	137	59	62	65	80	84	88
	M22x1.5	18	89	94	98	120	127	133	100	105	110	135	142	149	--	--	--	--	--	--
	M27x2	22	100	105	110	135	142	149	236	248	260	320	336	353	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	--	--	--	--	--	--
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	21	22	23	28	30	31	--	--	--	--	--	--
	M12x1.5	8	24	26	27	33	35	37	27	28	29	37	38	39	--	--	--	--	--	--
	M14x1.5	10	29	30	31	39	41	42	38	40	42	52	54	57	--	--	--	--	--	--
	M16x1.5	12	38	40	42	52	54	57	48	51	53	65	69	72	--	--	--	--	--	--
	M18x1.5	15	53	56	58	72	76	79	60	63	66	81	85	89	38	40	42	52	54	57
	M22x1.5	18	58	61	64	79	83	87	65	69	72	88	94	98	--	--	--	--	--	--
	M27x2	22	65	69	72	88	94	98	153	161	169	207	218	229	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	--	--	--	--	--	--

Assembly Instructions for Metric ISO 6149 (MPP) Port Assembly Stud Ends

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not preinstalled, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

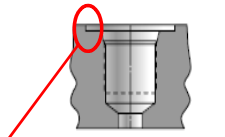
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-24 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-24 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

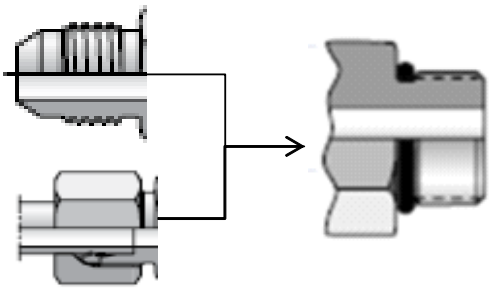
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

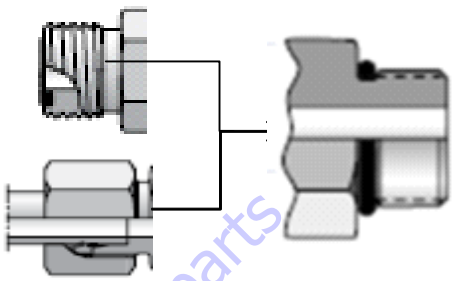
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)



Note: Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB),**but is not interchangeable.**





TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10x1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12x1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18x1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20x1.5	--	--	--	--	--	--	--	59	62	65	80	84	88
	M22x1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27x2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30x2	--	95	100	105	130	136	142	175	184	193	237	249	262
	M33x2	25	120	126	132	160	171	179	230	242	253	310	328	343
	M38x2	--	135	142	149	183	193	202	235	247	259	319	335	351
	M42x2	30	155	163	171	210	221	232	245	258	270	330	350	366
	M48x2	38	190	200	209	260	271	283	310	326	341	420	442	462
	M60x2	50	230	242	253	315	328	343	370	389	407	500	527	552
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10x1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12x1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18x1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20x1.5	--	--	--	--	--	--	--	30	40	42	41	54	57
	M22x1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27x2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30x2	--	62	65	68	84	88	92	114	120	125	155	163	169
	M33x2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38x2	--	88	93	97	119	126	132	153	161	168	207	218	228
	M42x2	30	101	106	111	137	144	150	159	168	176	216	228	239
	M48x2	38	124	130	136	168	176	184	202	212	222	274	287	301
	M60x2	50	150	157	164	203	213	222	241	253	265	327	343	359

Assembly instructions for Adjustable Port End (BSPP) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not preinstalled, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

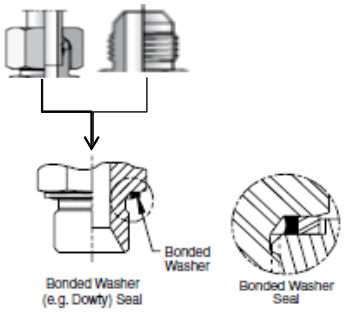
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

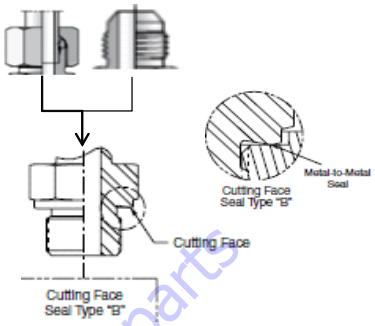
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, or Table 5-30 while using the Double Wrench Method.
   a. The table headings identify the BSPP port and the type on the other side of the fitting. The torque will be applied to the BSPP port.
   b. Torque values provided in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, and Table 5-30 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

Table 5-25. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3





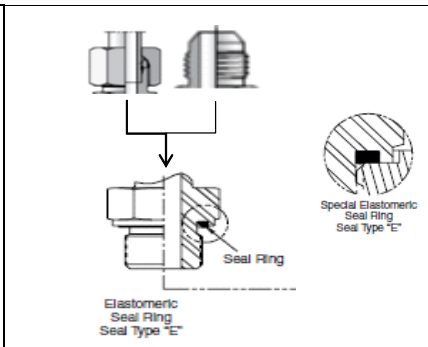
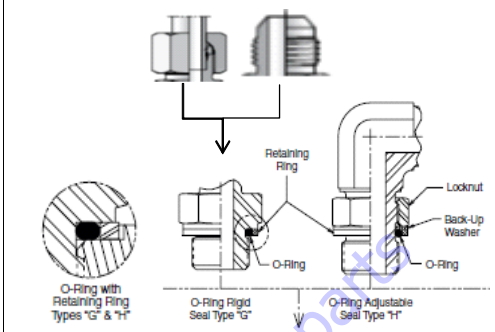
TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B** (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G 1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G 1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G 3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G 1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G 1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G 1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G 1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G 3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G 1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G 1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	42	139	146	153	188	198	207	302	318	333	409	431	451

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-26. British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3

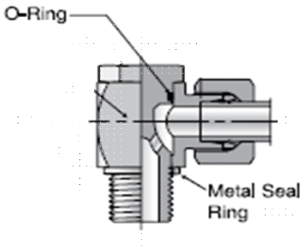
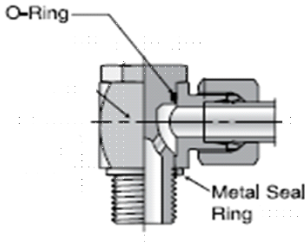
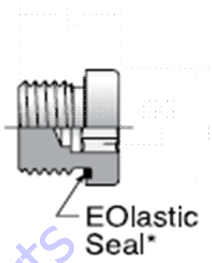
TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19
	G1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G3/8A	12	52	55	57	70	75	77	52	55	57	70	75	77
	G1/2A	15	66	70	73	90	95	99	66	70	73	90	95	99
	G1/2A	18	66	70	73	90	95	99	66	70	73	90	95	99
	G3/4A	22	133	140	146	180	190	198	133	140	146	180	190	198
	G1A	28	229	241	252	310	327	342	229	241	252	310	327	342
	G1-1/4A	35	332	349	365	450	473	495	332	349	365	450	473	495
	G1-1/2A	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12
	G1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G3/8A	12	34	36	37	46	49	50	34	36	37	46	49	50
	G1/2A	15	43	45	47	58	61	64	43	45	47	58	61	64
	G1/2A	18	43	45	47	58	61	64	43	45	47	58	61	64
	G3/4A	22	86	91	95	117	123	129	86	91	95	117	123	129
	G1A	28	149	157	164	202	213	222	149	157	164	202	213	222
	G1-1/4A	35	216	227	237	293	308	321	216	227	237	293	308	321
	G1-1/2A	42	259	272	285	351	369	386	259	272	285	351	369	386

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-27. British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3

			
TYPE/FITTING IDENTIFICATION	**BANJO FITTINGS with L series DIN (MBTL) opposite end**	**HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end**	**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**

MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15
	G1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65
	G1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153
	G1A	28	--	--	--	--	--	--	236	248	260	320	336	353	148	156	163	200	212	221
	G1-1/4A	35	--	--	--	--	--	--	398	418	438	540	567	594	295	313.5	332	400	425	450
	G1-1/2A	42	--	--	--	--	--	--	516	542	568	700	735	770	332	349	365	450	473	495

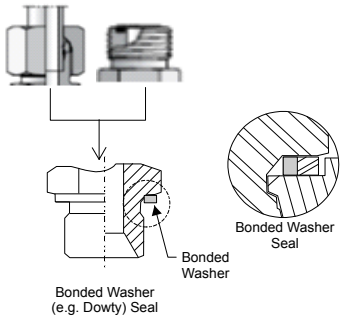
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	G1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42
	G1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99
	G1A	28	--	--	--	--	--	--	153	161	169	207	218	229	96	101	106	130	137	144
	G1-1/4A	35	--	--	--	--	--	--	259	272	285	351	369	386	216	227	237	293	308	321
	G1-1/2A	42	--	--	--	--	--	--	335	352	369	454	477	500	216	227	237	293	308	321

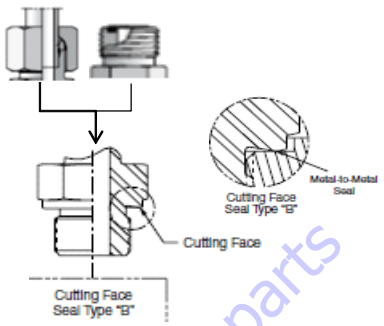
* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-28. British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3





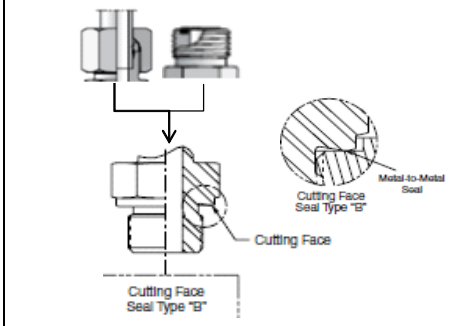
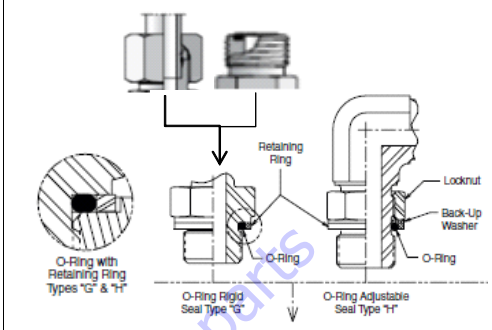
TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	26	28	29	35	38	39	41	43	45	55	58	61
	G1/4A	8	26	28	29	35	38	39	41	43	45	55	58	61
	G3/8A	10	33	35	36	45	47	49	66	70	73	90	95	99
	G3/8A	12	33	35	36	45	47	49	66	70	73	90	95	99
	G1/2A	14	48	51	53	65	69	72	111	117	122	150	159	165
	G1/2A	16	48	51	53	65	69	72	96	101	106	130	137	144
	G3/4A	20	66	70	73	90	95	99	199	209	219	270	283	297
	G1A	25	111	117	122	150	159	165	251	264	276	340	358	374
	G1-1/4A	30	177	186	195	240	252	264	398	418	438	540	567	594
	G1-1/2A	38	214	225	235	290	305	319	516	542	568	700	735	770
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	17	18	19	23	24	26	27	28	29	37	38	39
	G1/4A	8	17	18	19	23	24	26	27	28	29	37	38	39
	G3/8A	10	21	22	23	28	30	31	43	45	47	58	61	64
	G3/8A	12	21	22	23	28	30	31	43	45	47	58	61	64
	G1/2A	14	31	33	34	42	45	46	72	76	79	98	103	107
	G1/2A	16	31	33	34	42	45	46	62	66	69	84	89	94
	G3/4A	20	43	45	47	58	61	64	129	136	142	175	184	193
	G1A	25	72	76	79	98	103	107	163	171	179	221	232	243
	G1-1/4A	30	115	121	127	156	164	172	259	272	285	351	369	386
	G1-1/2A	38	139	146	153	188	198	207	335	352	369	454	477	500

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-29. British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3

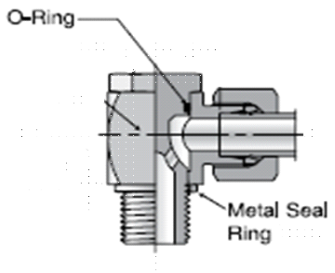
TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	41	43	45	55	58	61	26	28	29	35	38	39
	G 1/4A	8	41	43	45	55	58	61	26	28	29	35	38	39
	G 3/8A	10	59	62	65	80	84	88	52	55	57	70	75	77
	G 3/8A	12	59	62	65	80	84	88	52	55	57	70	75	77
	G 1/2A	14	85	90	94	115	122	127	66	70	73	90	95	99
	G 1/2A	16	85	90	94	115	122	127	66	70	73	90	95	99
	G 3/4A	20	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	25	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	30	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	38	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	27	28	29	37	38	39	17	18	19	23	24	26
	G 1/4A	8	27	28	29	37	38	39	17	18	19	23	24	26
	G 3/8A	10	38	40	42	52	54	57	34	36	37	46	49	50
	G 3/8A	12	38	40	42	52	54	57	34	36	37	46	49	50
	G 1/2A	14	55	58	61	75	79	83	43	45	47	58	61	64
	G 1/2A	16	55	58	61	75	79	83	43	45	47	58	61	64
	G 3/4A	20	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	25	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	30	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	38	259	272	285	351	369	386	259	272	285	351	369	386

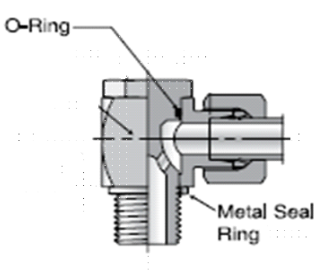
* Typical for JLG Straight Male Stud Fittings

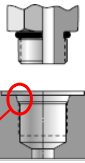
** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-30. British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3







Note: BSPP O-ring only style (ISO 228-1) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB), **but is not interchangeable. Not typically used on JLG machines.**

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						JIS/BSPP O-RING ONLY					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	30	32	33	40	43	45	33	35	36	45	47	49	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G 3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G 1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G 1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						
	G 3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254						
	G 1A	25	--	--	--	--	--	--	236	248	260	320	336	353						
	G 1-1/4A	30	--	--	--	--	--	--	398	418	438	540	567	594						
	G 1-1/2A	38	--	--	--	--	--	--	516	542	568	700	735	770						
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	20	21	21	27	28	28	22	22	23	30	30	31	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G 3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G 1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G 1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G 3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G 1A	25	--	--	--	--	--	--	153	161	169	207	218	229						
	G 1-1/4A	30	--	--	--	--	--	--	259	272	285	351	369	386						
	G 1-1/2A	38	--	--	--	--	--	--	335	352	368	454	477	499						

* Typical for JLG Straight Male Stud Fittings

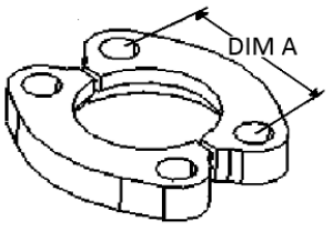
** Non typical for JLG Straight Male Stud Fittings, reference only.

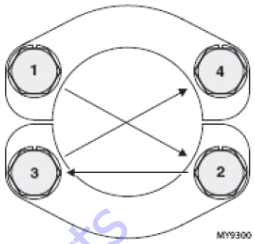
*** Typical for JLG Adjustable Fittings

Assembly Instructions for Flange Connections: (FL61 and FL62)

1. Make sure sealing surfaces are free of rust, splits, scratches, dirt, foreign matter, or burrs.
2. See Figure for O-ring installation instructions.
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Position flange and clamp halves.
5. Place lock washers on bolt and bolt through clamp halves.
6. Tighten all bolts by hand.
7. Torque bolts in diagonal sequence in two or more increments to the torque listed on Table Table 5-31and Table 5-32.

Table 5-31. Flange Code (FL61 & FL62) -Inch Fasteners

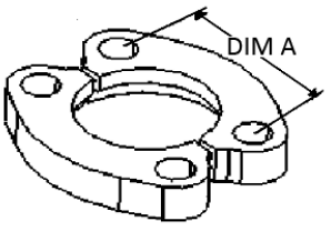


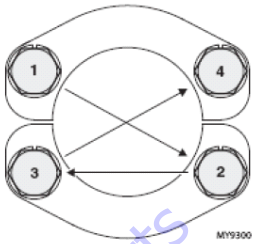


TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)													
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	5/16-18	18	19	19	24	25	26	24	25	26	32	34	35
	12	0.75	19	1.88	47.75	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	16	1.00	25	2.06	52.32	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	20	1.25	32	2.31	58.67	7/16-14	52	54	57	70	74	77	68	71	75	92	97	101
	24	1.50	38	2.75	69.85	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	32	2.00	51	3.06	77.72	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	40	2.50	64	3.50	88.90	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	48	3.00	76	4.19	106.43	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	56	3.50	89	4.75	120.65	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	64	4.00	102	5.13	130.30	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	80	5.00	127	6.00	152.40	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	5/16-18	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	3/8-16	--	--	--	--	--	--	44	46	49	60	63	66
	16	1.00	25	2.25	57.15	7/16-14	--	--	--	--	--	--	68	71	75	92	97	101
	20	1.25	32	2.62	66.55	1/2-13	--	--	--	--	--	--	111	116	122	150	158	165
	20	1.25	32	2.62	66.55	--	--	--	--	--	--	--	--	--	--	--	--	--
	24	1.50	38	3.12	79.25	5/8-11	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	3/4-10	--	--	--	--	--	--	332	348	365	450	473	495

* A dimension for reference only.

Table 5-32. Flange Code (FL61 & FL62) - Metric Fasteners





TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)													
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
	12	0.75	19	1.88	47.75	M8x1.25	18	19	19	24	25	26	18	19	19	24	25	26
	16	1.00	25	2.06	52.32	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	20	1.25	32	2.31	58.67	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	24	1.50	38	2.75	69.85	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	32	2.00	51	3.06	77.72	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	40	2.50	64	3.50	88.90	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	48	3.00	76	4.19	106.43	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	56	3.50	89	4.75	120.65	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	64	4.00	102	5.13	130.30	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	80	5.00	127	6.00	152.40	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	M8x1.25	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	M10x1.5	--	--	--	--	--	--	52	54	57	70	74	77
	16	1.00	25	2.25	57.15	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M14x2	--	--	--	--	--	--	133	139	146	180	189	198
	24	1.50	38	3.12	79.25	M16x2	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	M20x2.5	--	--	--	--	--	--	406	426	446	550	578	605

* A dimension for reference only.

Double Wrench Method

To prevent undesired hose or connector rotation, two wrenches must be used; one torque wrench and one Backup wrench. If two wrenches are not used, inadvertent component rotation may occur which absorbs torque and causes improper joint load and leads to leaks. For hose connections, the 'layline' printed on the hose is a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted. See Figure 5-12. for double wrench method requirements.

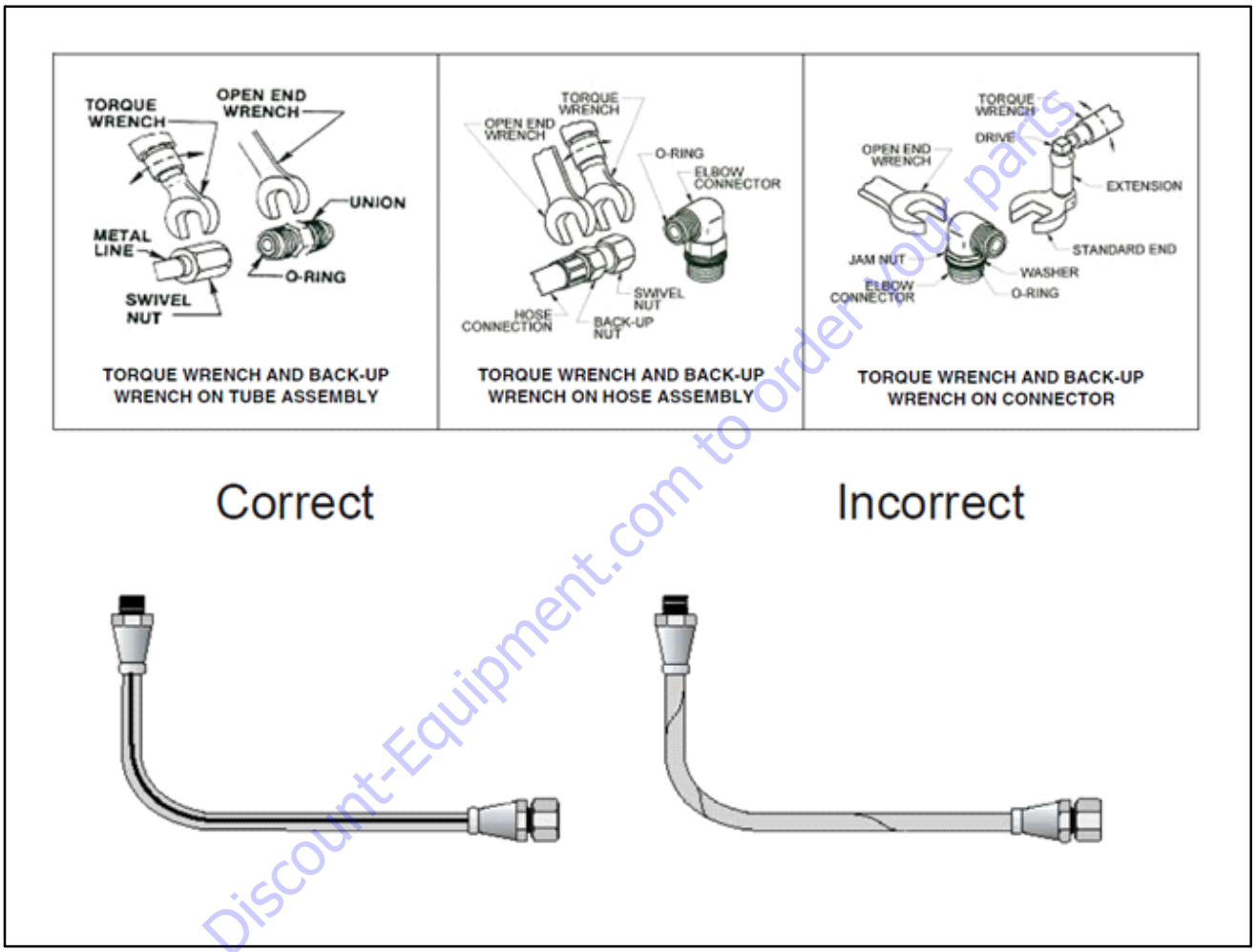


Figure 5-12. Double Wrench Method

FFWR and TFFT Methods

FFWR (FLATS FROM WRENCH RESISTANCE METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter. See Figure B.1.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten as shown in Figure B.1. The nut is to be rotated clockwise the number of hex flats as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened. See Figure 5-13.

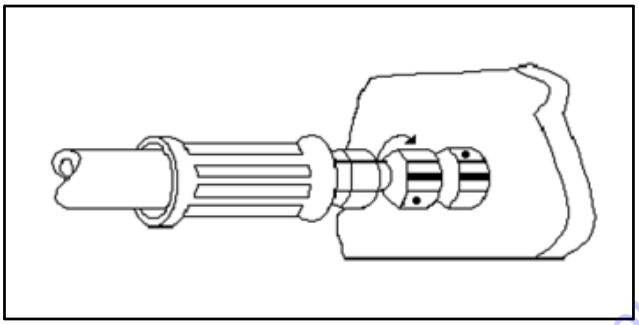


Figure 5-13. FFWR Method

TFFT (TURNS FROM FINGER TIGHT METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of turns as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

Adjustable Stud End Assembly

For Adjustable Stud End Connections; the following assembly steps are to be performed:

1. Lubricate the o-ring with a light coat of hydraulic oil.
2. Position #1 – The o-ring should be located in the groove adjacent to the face of the Backup washer. The washer and o-ring should be positioned at the extreme top end of the groove as shown.
3. Position #2 – Position the locknut to just touch the Backup washer as shown. The locknut in this position will eliminate potential back up washer damage during the next step.
4. Position #3 – Install the connector into the straight thread box port until the metal Backup washer contacts the face of the port as shown.
5. Position #4 – Adjust the connector to the proper position by turning out (counterclockwise) up to a maximum of one turn as shown to provide proper alignment with the mating connector, tube assembly, or hose assembly.
6. Position #5 – Using two wrenches, use the backup wrench to hold the connector in the desired position and then use the torque wrench to tighten the locknut to the appropriate torque.
7. Visually inspect, where possible, the joint to ensure the o-ring is not pinched or bulging out from under the washer and that the backup washer is properly seated flat against the face of the port.

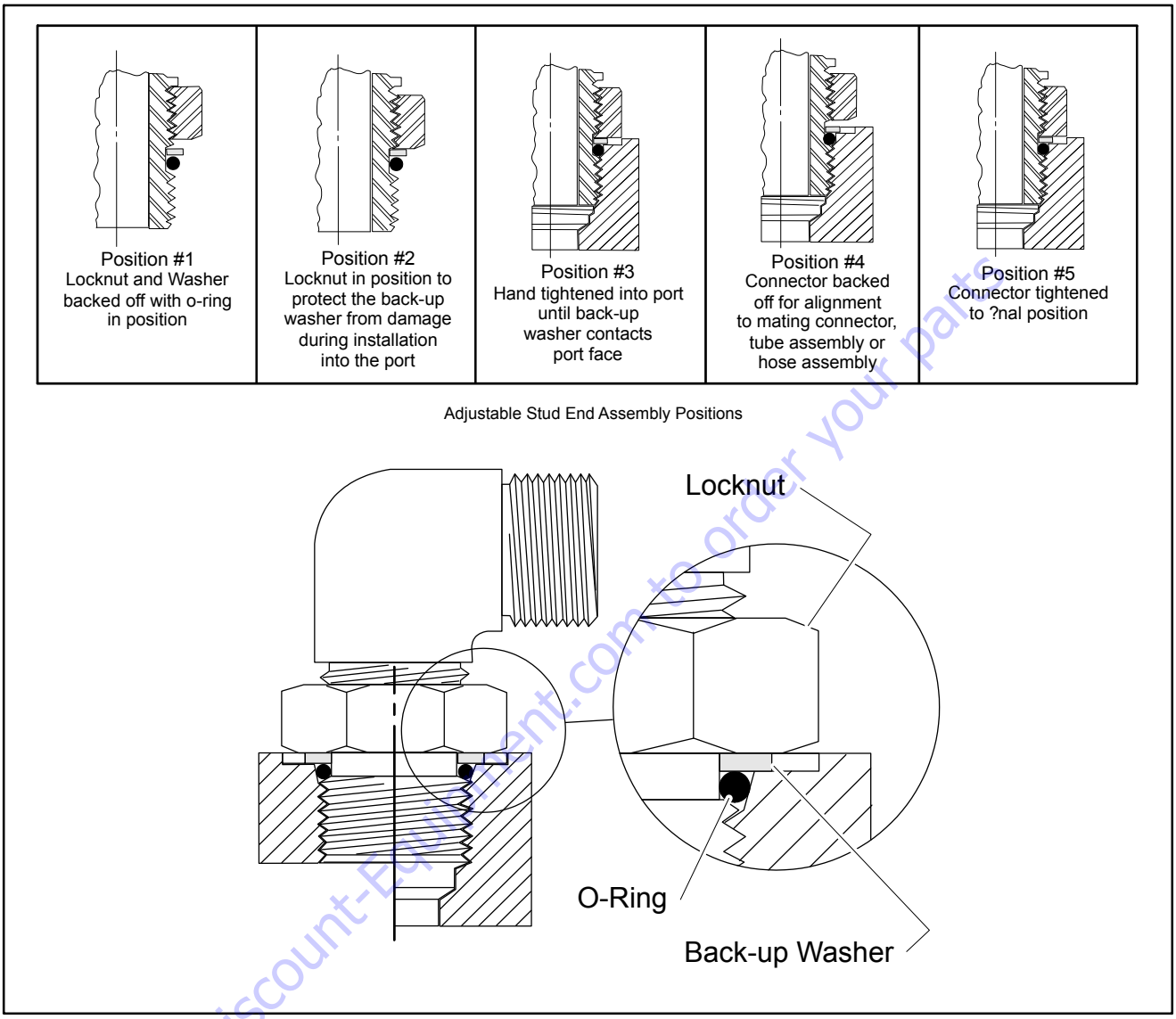


Figure 5-14. Adjustable Stud End Assembly

O-ring Installation (Replacement)

Care must be taken when installing O-rings over threads during replacement or installation. O-rings could become nicked or torn. A damaged O-ring could lead to leakage problems.

1. Inspect O-ring for tears or nicks. If any are found replace O-ring.
2. Ensure proper O-ring to be installed. Many O-rings look the same but are of different material, different hardness, or are slightly different diameters or widths.
3. Use a thread protector when replacing O-rings on fittings.
4. In ORB; ensure O-ring is properly seated in groove. On straight threads, ensure O-ring is seated all the way past the threads prior to installation.
5. Inspect O-ring for any visible nicks or tears. Replace if found.

5.3 CYLINDER REPAIR

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

Disassembly

NOTICE

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

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

NOTICE

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. If applicable, remove the cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

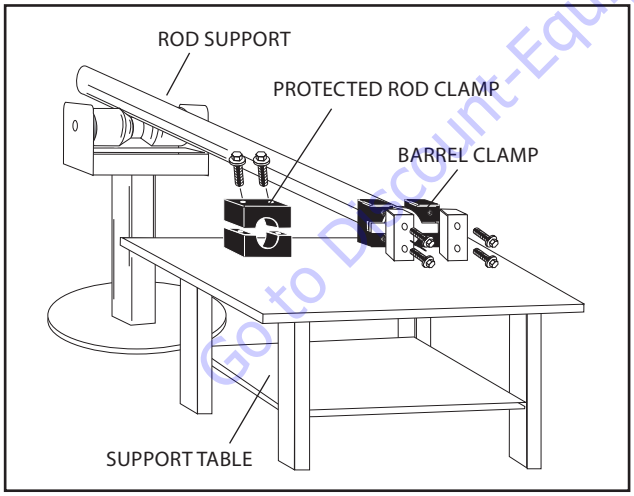


Figure 5-15. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the eight (8) cylinder head retainer cap screws, and remove cap screws from cylinder barrel.

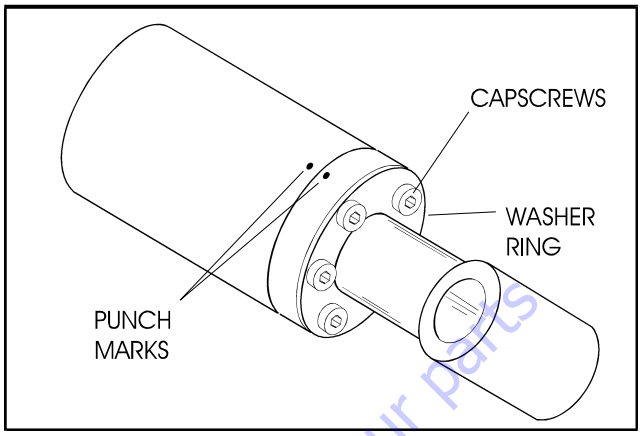


Figure 5-16. Cap Screw Removal

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.

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

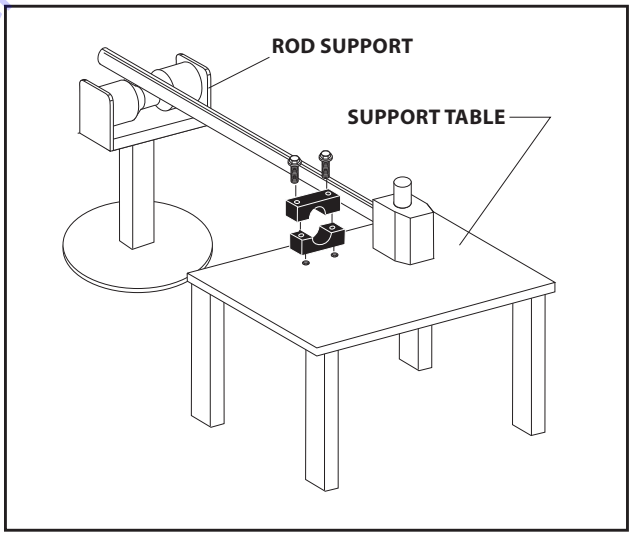
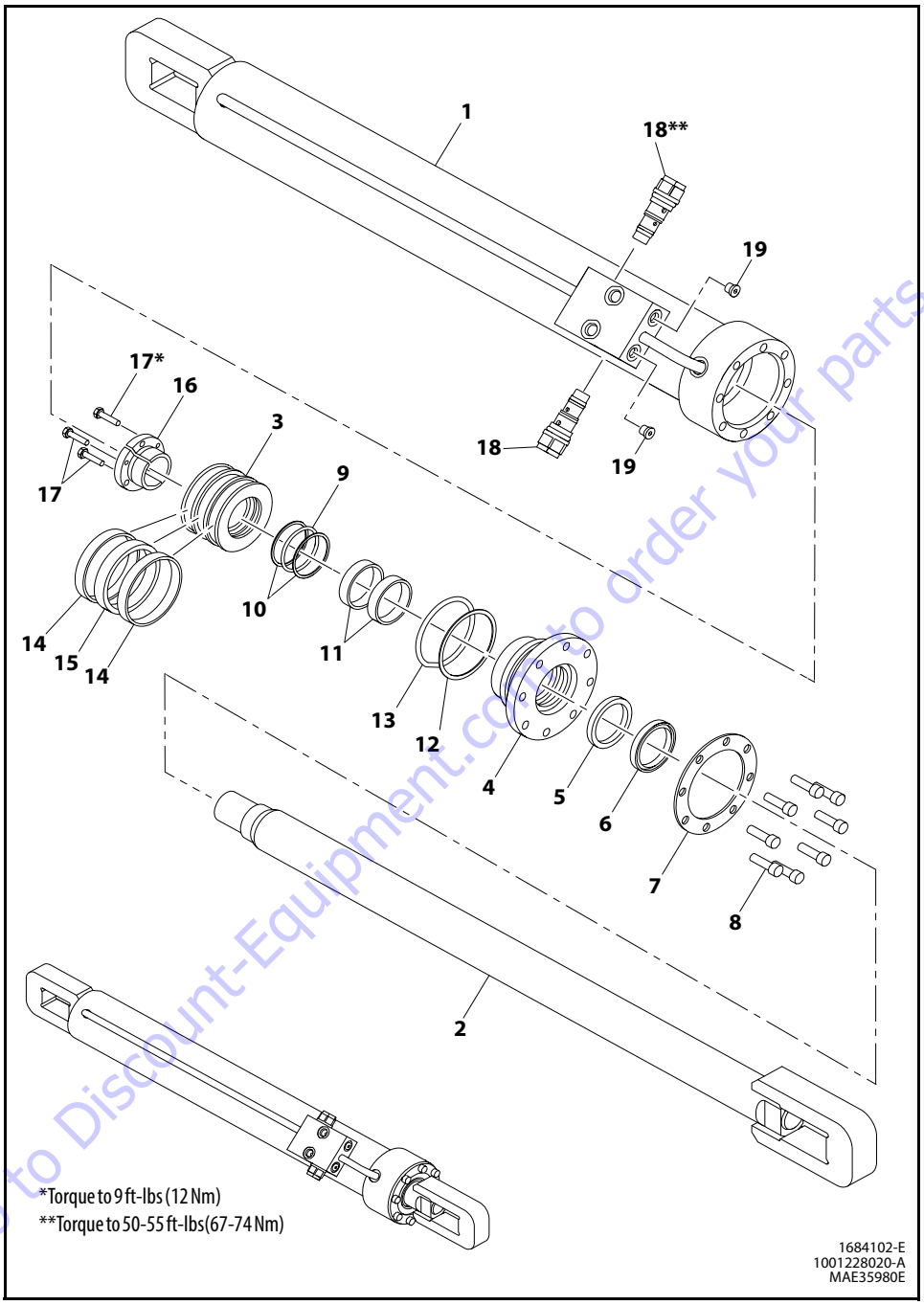
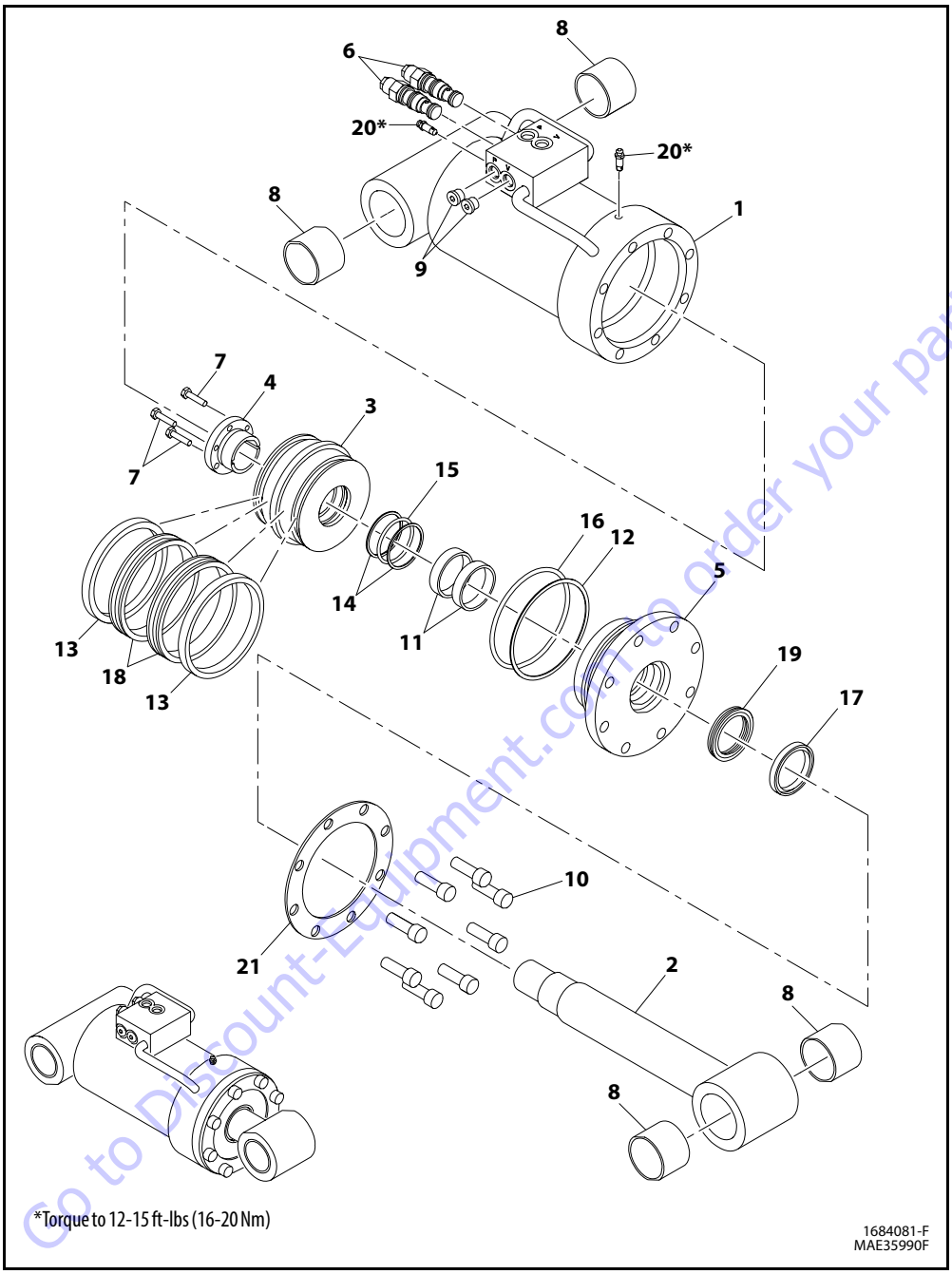


Figure 5-17. Cylinder Rod Support



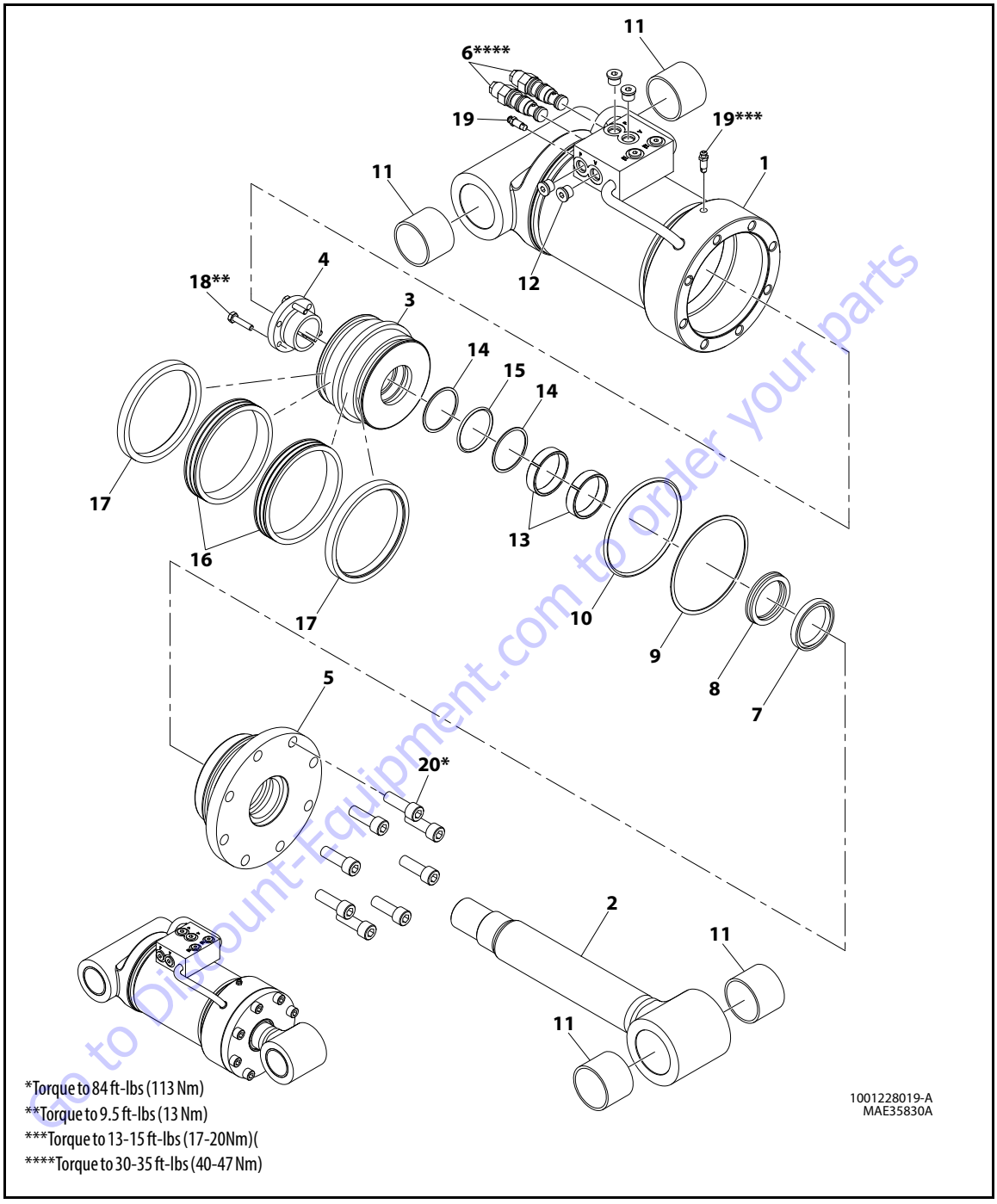
1. Barrel
2. Rod
3. Piston
4. Head
5. Seal
6. Rod Wiper
7. Washer Ring
8. Capscrew
9. O-Ring
10. Backup Ring
11. Wear Ring
12. Backup Ring
13. O-Ring
14. Wear Ring
15. T-Seal
16. Tapered Bushing
17. Capscrew
18. Holding Valves
19. O-Ring Plug

Figure 5-18. Axle Extension Cylinder (SN 0300196322 through 0300238565, SN B300002238 through B300002404, SN 0300238566 to Present, SN B300002405 to Present)



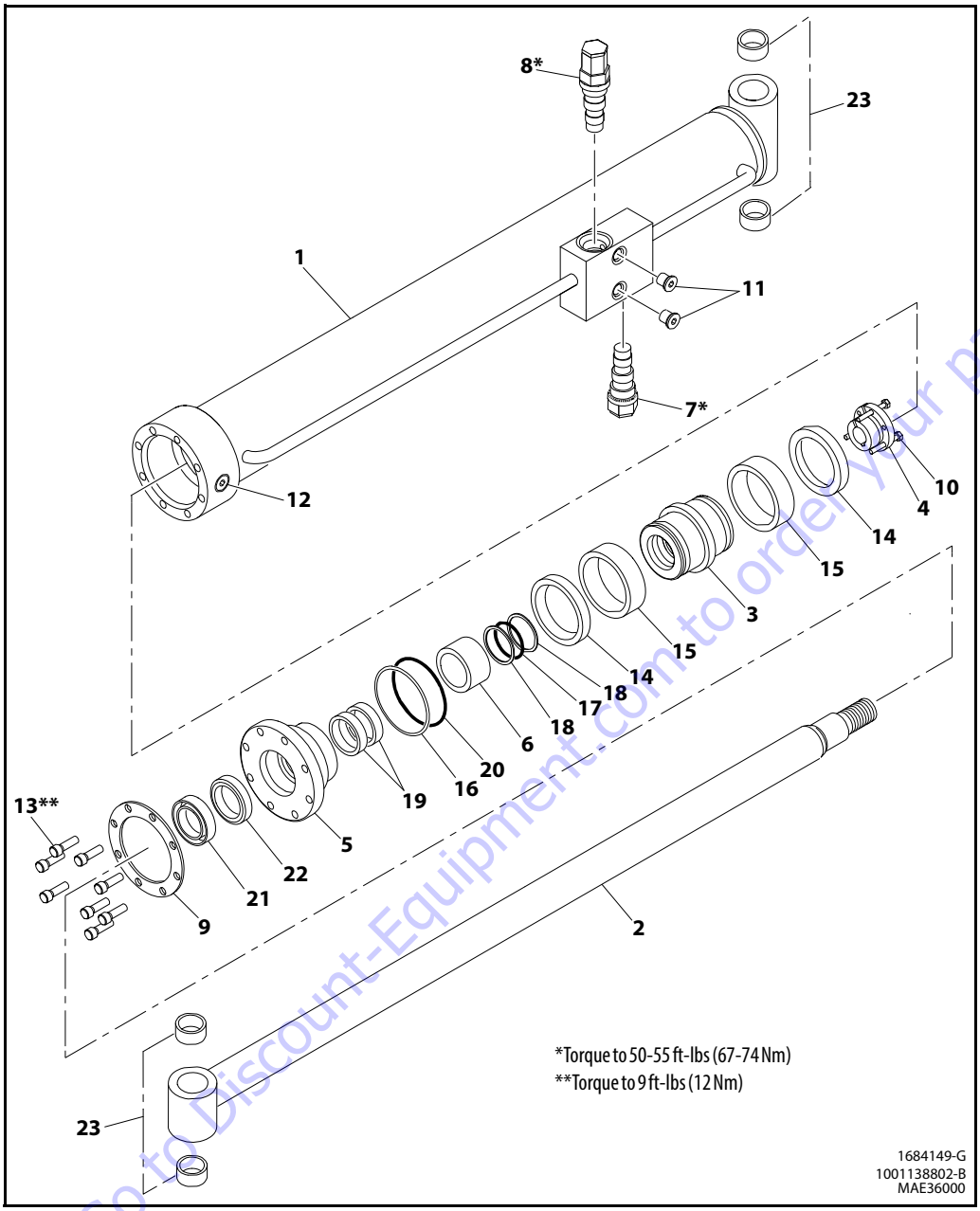
1. Barrel
2. Rod
3. Piston
4. Tapered Bushing
5. Head
6. Counterbalance Valve
7. Capscrew
8. Bushing
9. O-ring Plug
10. Capscrew
11. Wear ring
12. Backup ring
13. Lock ring
14. Backup ring
15. O-ring
16. O-ring
17. Wiper
18. Seal
19. Rod Seal
20. Bleeder Valve
21. Ring washer

Figure 5-19. Axle Lockout Cylinder (SN 0300207701 through 0300239161, SN B300002238 through B300002449)



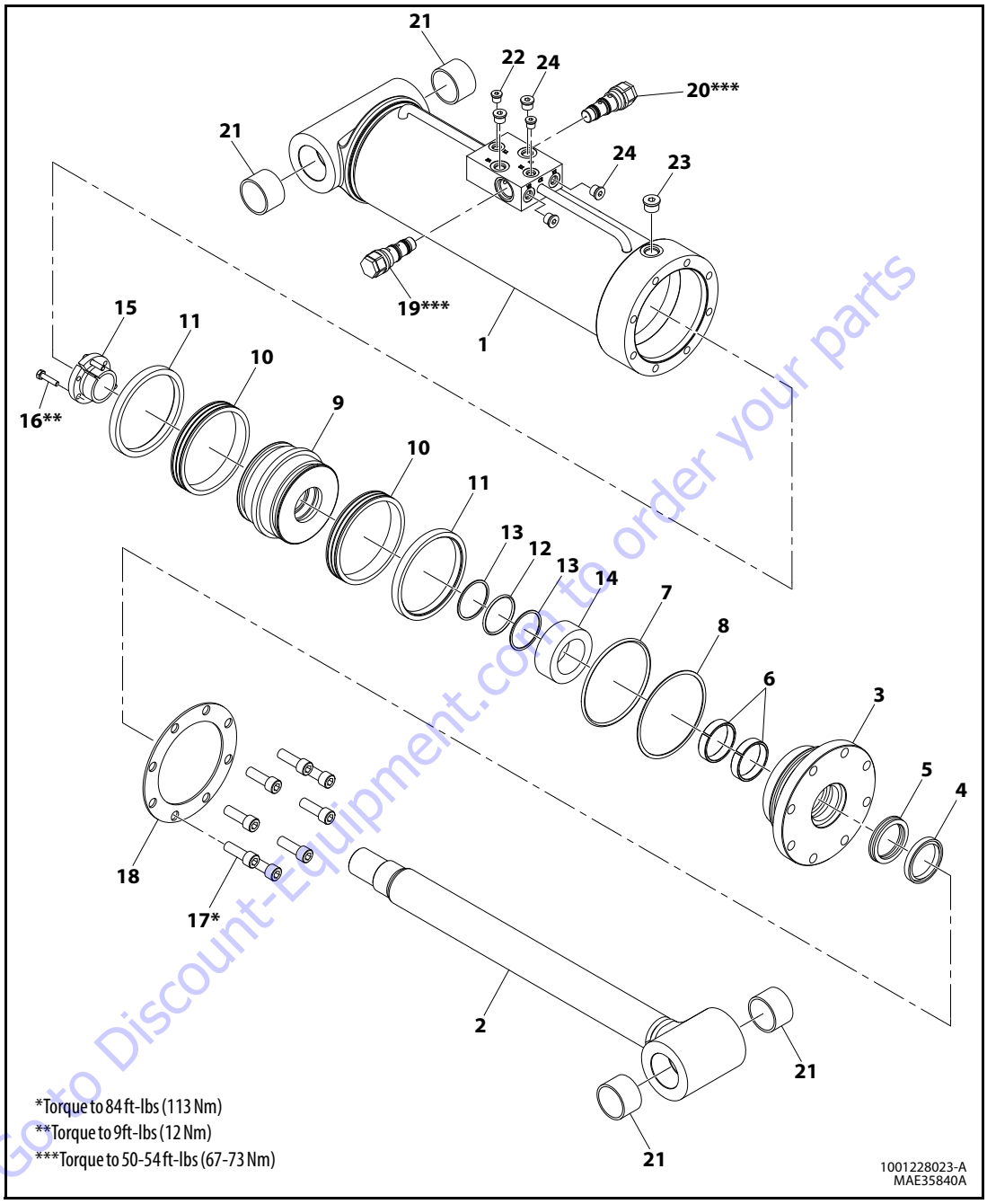
1. Barrel
2. Rod
3. Piston
4. Tapered Bushing
5. Head
6. Counterbalance Valve
7. Wiper
8. Rod Seal
9. Backup ring
10. O-ring
11. Bushing
12. O-ring Plug
13. Wear Ring
14. Backup ring
15. O-ring
16. Seal
17. Lock Ring
18. Capscrew.
19. Bleeder Valve
20. Capscrew

Figure 5-20. Axle Lockout Cylinder (SN 0300239162 to Present, SN B300002450 to Present)



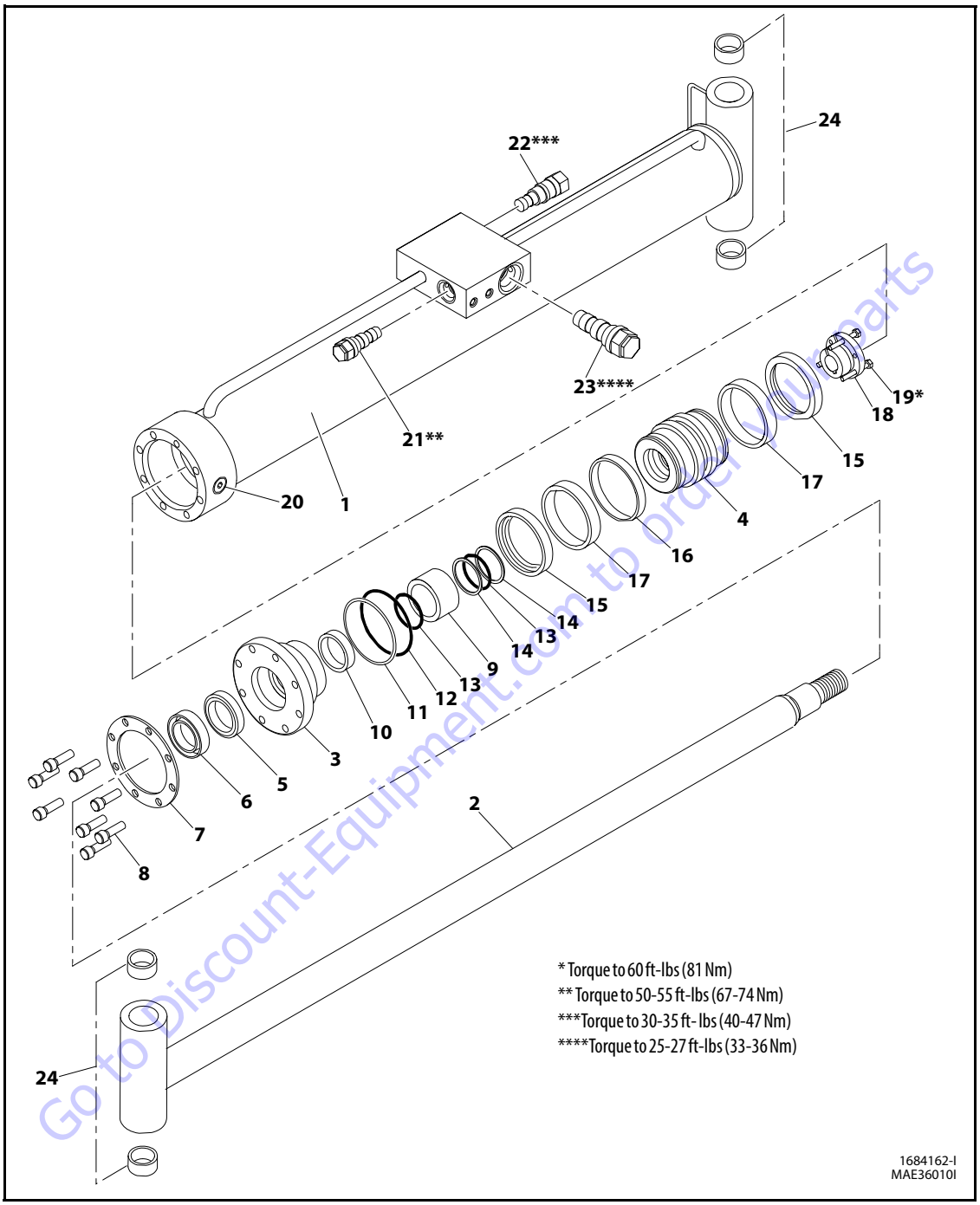
1. Barrel
2. Rod
3. Piston
4. Tapered Bushing
5. Head
6. Spacer
7. Holding Valve
8. Counterbalance Valve
9. Ring Washer
10. Capscrew
11. O-Ring Plug
12. O-Ring Plug
13. Capscrew
14. Lock Ring
15. Guide Ring
16. Backup Ring
17. O- ring
18. Ring, Backup
19. Wear Ring
20. O-Ring
21. Wiper,
22. Rod Seal
23. Bushing

Figure 5-21. Level Cylinder (Without Cold Weather Plus Package - SN 0300201016 through 0300239161, SN B300002238 through B300002449) and (With Cold Weather Plus Package - SN 0300201016 through 0300239980)



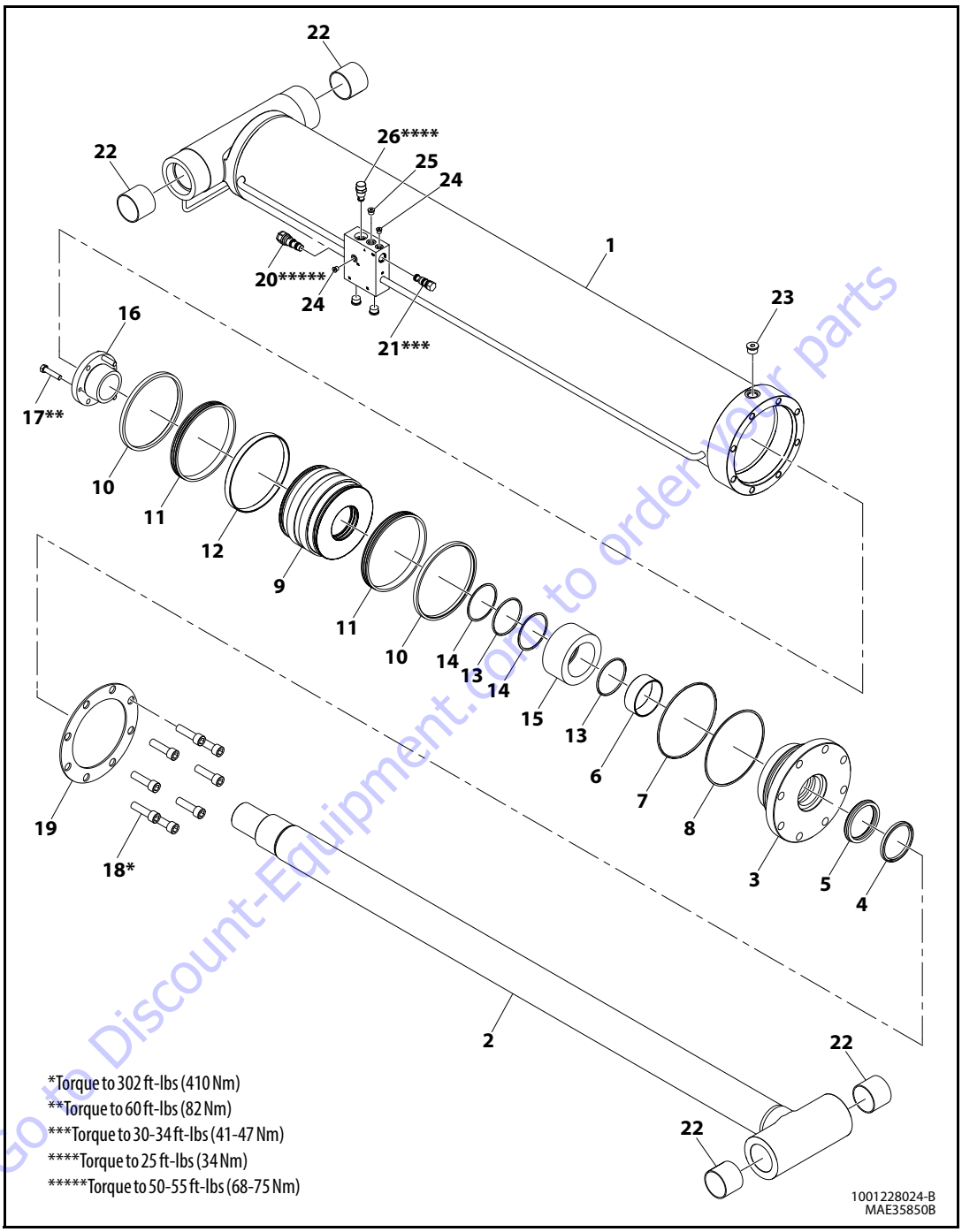
1. Barrel
2. Rod
3. Head
4. Wiper
5. Rod seal
6. Wear Ring
7. O-Ring
8. Backup Ring
9. Piston
10. Guide Ring
11. Lock Ring
12. O-Ring
13. Backup Ring
14. Spacer
15. Tapered Bushing
16. Capscrew
17. Capscrew
18. Ring washer
19. Counterbalance valve
20. Cartridge Valve
21. Bushing
22. O-Ring
23. O-Ring
24. O-Ring

Figure 5-22. Level Cylinder (Without Cold Weather Plus Package - SN 0300239162 to Present, SN B300002450 to Present)



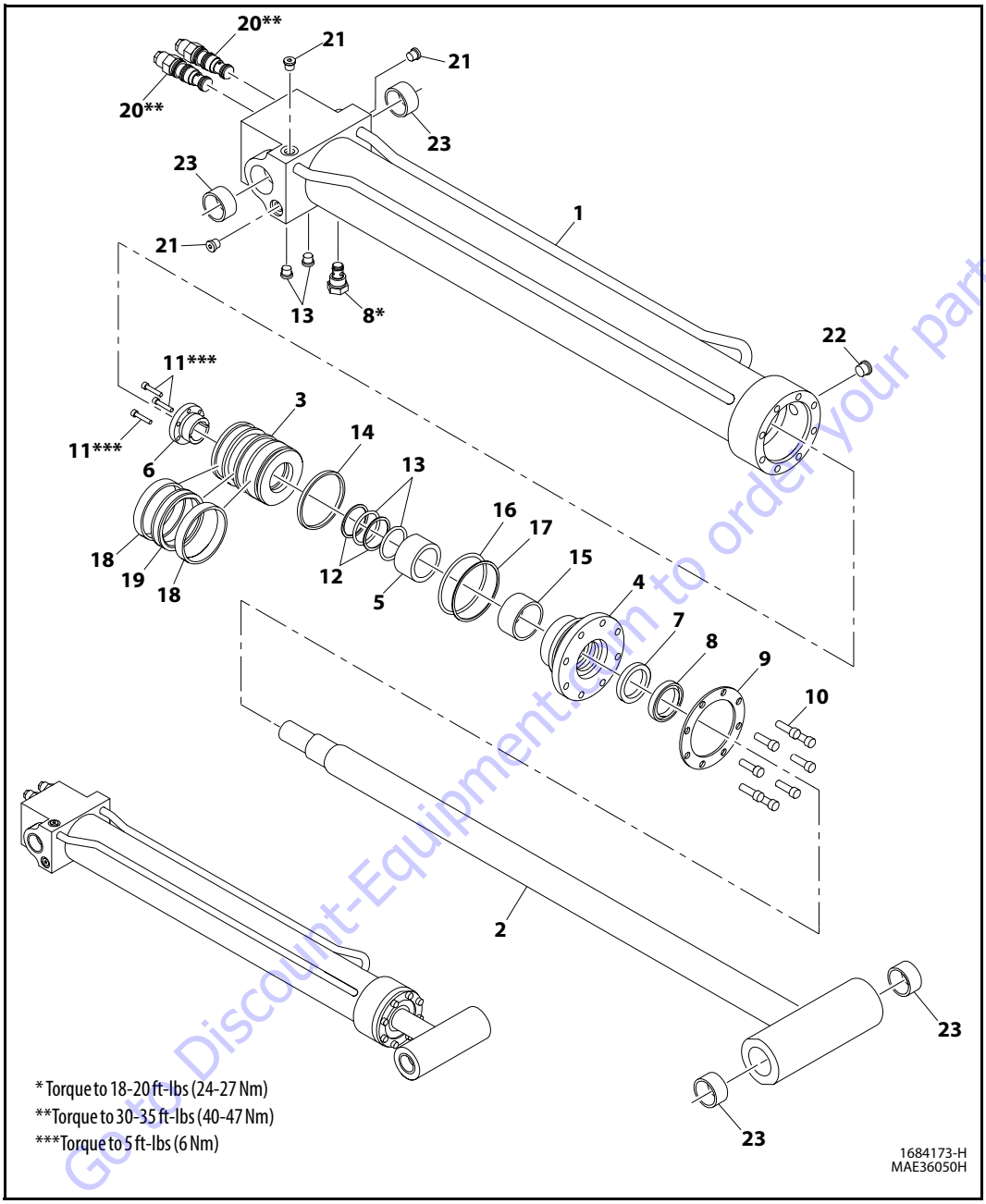
1. Barrel
2. Rod
3. Head
4. Piston
5. Rod Seal
6. Rod Wiper
7. Washer Ring
8. Capscrew
9. Spacer
10. Wear Ring
11. Backup Ring
12. O- Ring
13. O-Ring
14. Back Up Ring
15. Lock Ring
16. Wear Ring
17. Guide Ring
18. Tapered Bushing
19. Capscrew
20. O-Ring Plug
21. Check Valve Cartidge
22. Holding Valve Cartridge
23. Pressure Regulator Valve
24. Bushing

Figure 5-23. Lift Cylinder (SN 0300201016 through 0300239470, SN B300002238 through B300002473)



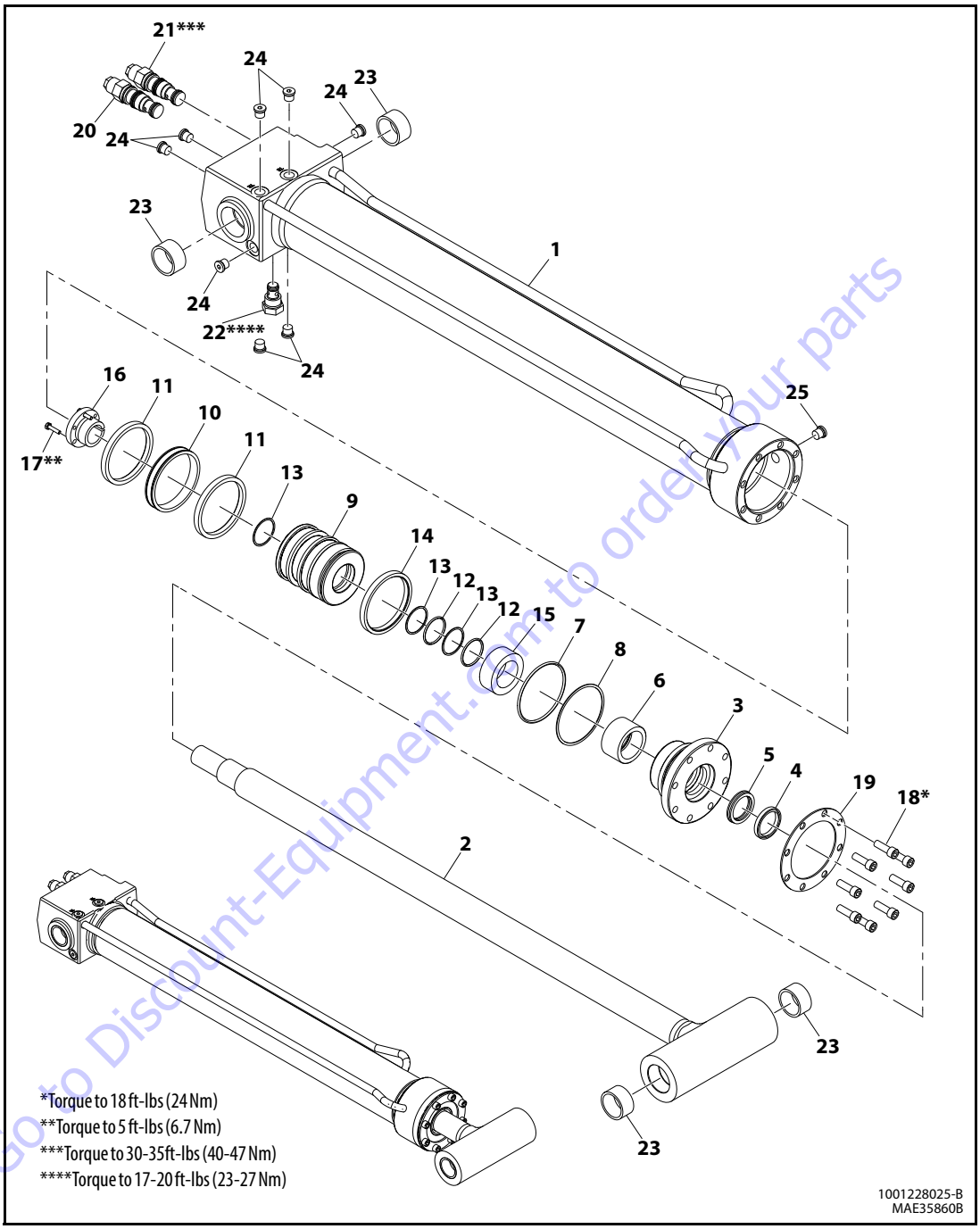
1. Barrel
2. Rod
3. Head
4. Wiper
5. Rod Seal
6. Wear Ring
7. O-Ring
8. Backup Ring
9. Piston
10. Lock Ring
11. Guide Ring
12. Wear Ring
13. O-Ring
14. Back Up Ring
15. Spacer
16. Tapered Bushing
17. Capscrew
18. Capscrew
19. Ring washer
20. Holding Valve
21. Check Valve
22. Bushing
23. O-ring Plug
24. O-ring Plug
25. O-ring Plug
26. Pressure Regulator Valve

Figure 5-24. Lift Cylinder (SN 0300239471 to Present, SN B300002474 to Present)



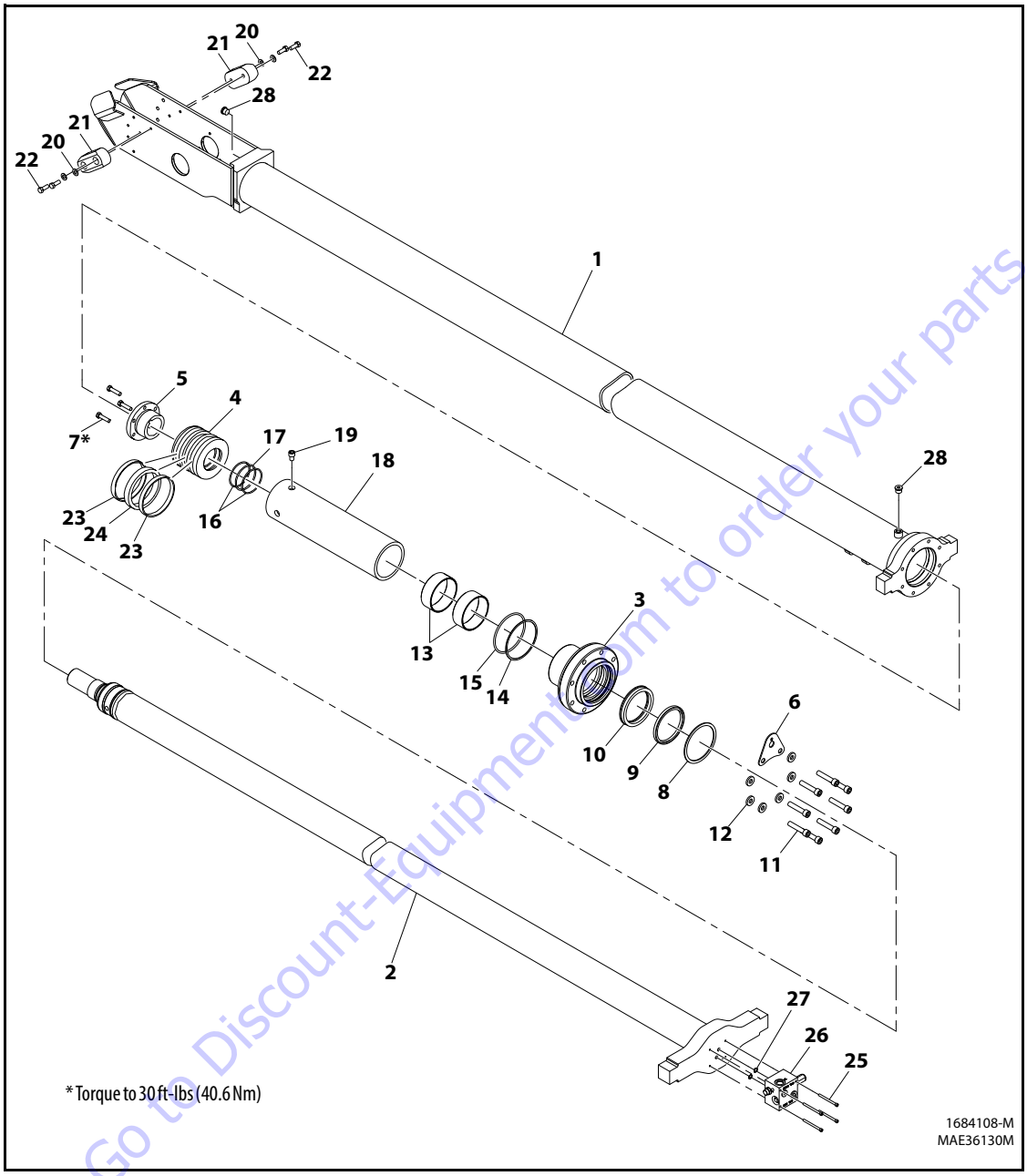
1. Barrel
2. Rod
3. Piston
4. Head
5. Spacer
6. Tapered Bushing
7. Seal
8. Rod Wiper
9. Washer Ring
10. Capscrew
11. Capscrew
12. Backup Ring
13. O-ring
14. Seal
15. Wear Ring
16. O-ring
17. Backup Ring
18. Wear Ring
19. Seal
20. Cartridge Valve
21. O-ring Plug
22. O-ring Plug
23. Bushing

Figure 5-25. Jib Cylinder (SN 0300201016 through 0300239161, SN B300002238 through B300002449)



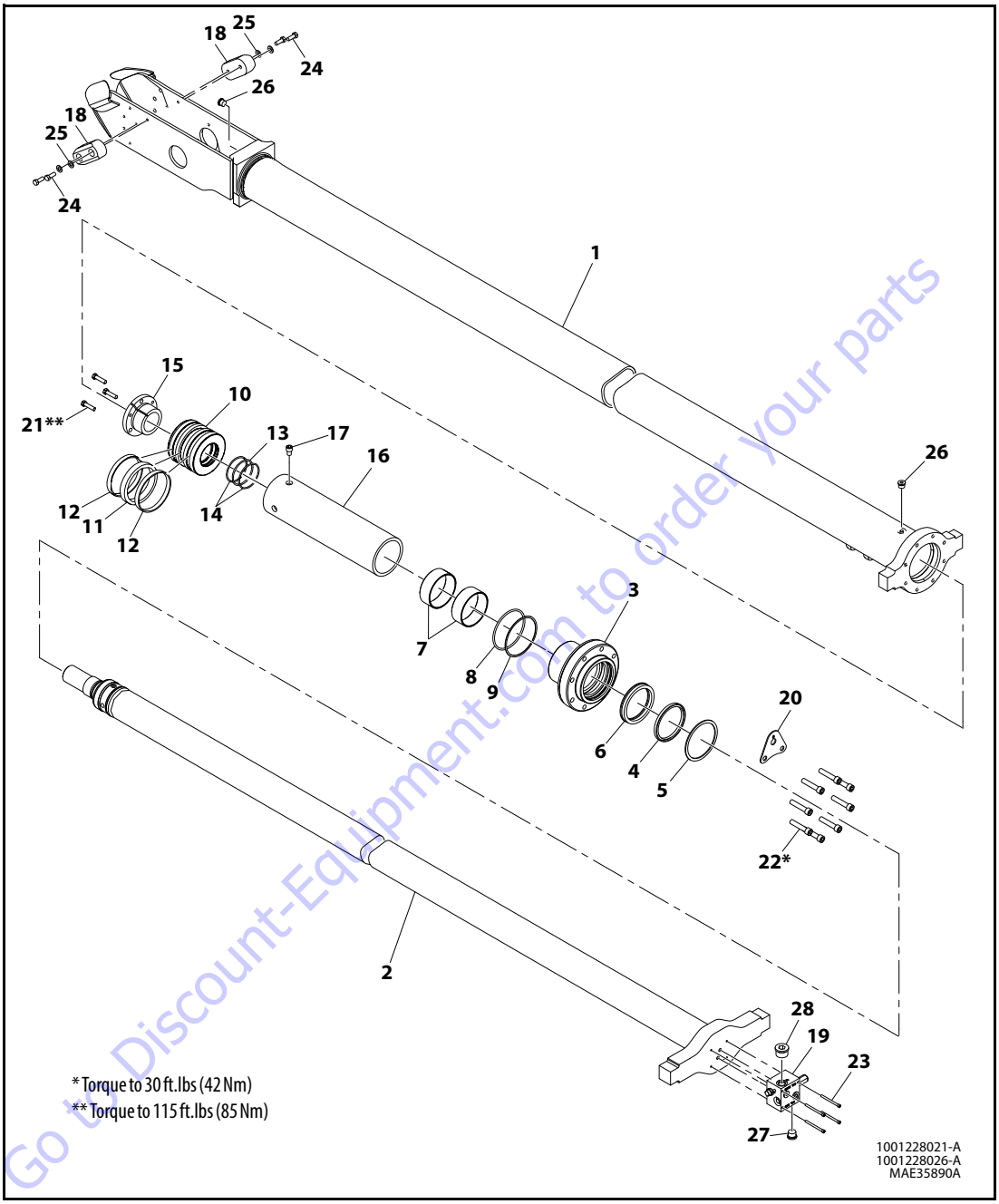
1.	Barrel	7.	O-Ring	13.	Backup Ring	19.	Ring Washer	25.	O-Ring
2.	Rod	8.	Backup Rig	14.	Seal	20.	Counterbalance valve		
3.	Head	9.	Piston	15.	Spacer	21.	Cartridge Valve		
4.	Rod Wiper	10.	Seal	16.	Tapered Bushing	22.	Cartridge Valve		
5.	Seal	11.	Wear Ring	17.	Capscrew	23.	Bushing		
6.	Wear Ring	12.	O-Ring	18.	Capscrew	24.	O-ring		

Figure 5-26. Jib Cylinder (SN 0300239162 to Present, SN B300002450 to Present)



1. Barrel
2. Rod
3. Head
4. Piston
5. Tapered Bushing
6. Bracket
7. Capscrew
8. Retaining Ring
9. Rod Wiper
10. Rod Seal
11. Capscrew
12. Compound Locking
13. Wear Ring
14. Backup ring
15. O-Ring
16. Backup Ring
17. O- ring
18. Spacer
19. Capscrew
20. Washer
21. Wear Pad
22. Bolt
23. Wear Ring
24. T - Seal
25. Capscrew
26. Valve Assembly
27. O-ring
28. Primer Locking

Figure 5-27. Telescope Cylinder(1200SJP - SN 0300201016 through 0300243437, SN B300002238 through B300002718) and (1350SJP - SN 0300201016 through 0300243473, SN B300002238 through B300002646)



1. Barrel
2. Rod
3. Head
4. Wiper
5. Retaining Ring
6. Rod seal
7. Wear Ring
8. O-Ring
9. Backup Ring
10. Piston
11. Seal
12. Wear Ring
13. O-Ring
14. Backup Ring
15. Tapered Bushing
16. Spacer
17. Capscrew
18. Wear Pad
19. Valve Assembly
20. Bracket
21. Capscrew
22. Capscrew
23. Capscrew
24. Bolt
25. Washer
26. O-Ring
27. O-Ring
28. O-Ring

Figure 5-28. Telescope Cylinder -1200SJP (SN 0300243438 to Present, SN B300002719 to Present) and 1350SJP (SN 0300243474 to Present, SN B300002647 to Present)

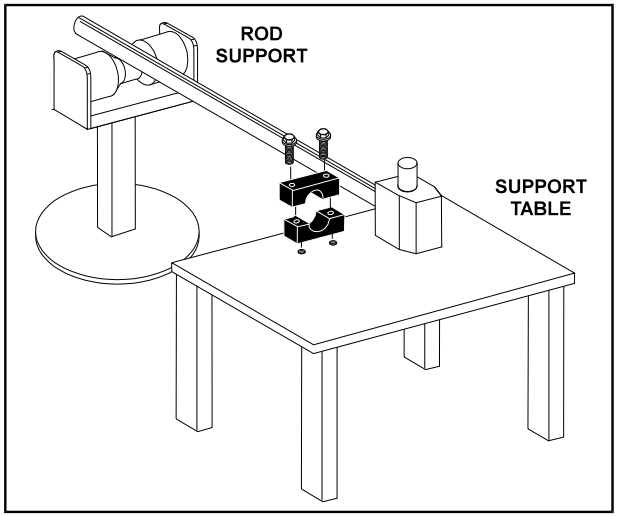


Figure 5-29. Cylinder Rod Support

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Loosen and remove the cap screw(s), if applicable, which attach the tapered bushing to the piston.
9. Insert the cap screw(s) in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the cap screw(s) until the bushing is loose on the piston.
10. Remove the tapered bushing from the piston.

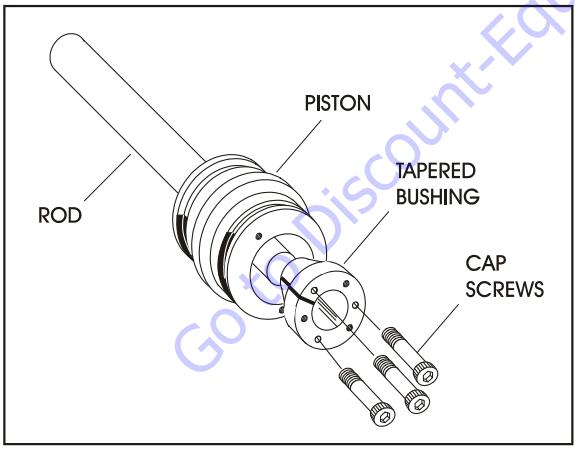


Figure 5-30. Tapered Bushing Removal

11. Screw the piston CCW, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove piston spacer, if applicable, from the rod.
14. Remove the rod from the holding fixture. Remove the cylinder head gland and retainer plate, if applicable. Discard the o-rings, Backup rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*

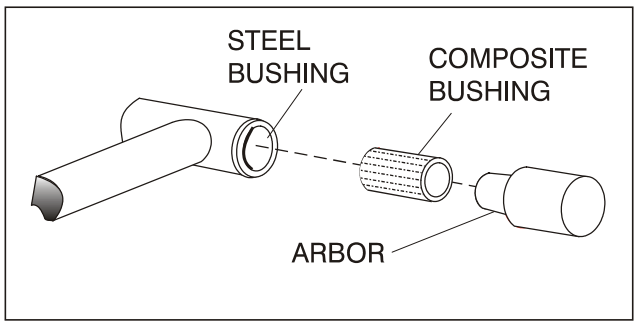


Figure 5-31. Composite Bearing Installation

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

Apply a light film of hydraulic oil to all components prior to assembly.

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

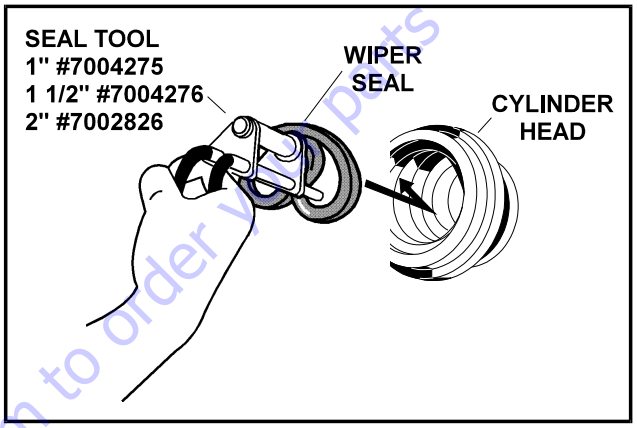


Figure 5-32. Rod Seal Installation

NOTICE

WHEN INSTALLING 'POLY-PAK' PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

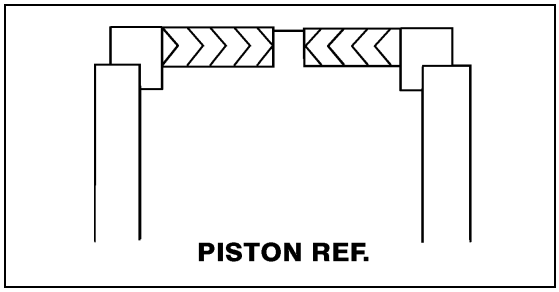


Figure 5-33. Poly-Pak Piston Seal Installation

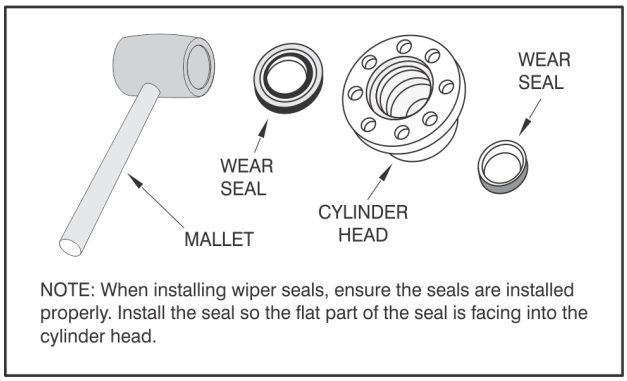


Figure 5-34. Wiper Seal Installation

3. Place a new O-ring and Backup seal in the applicable outside diameter groove of the cylinder head.

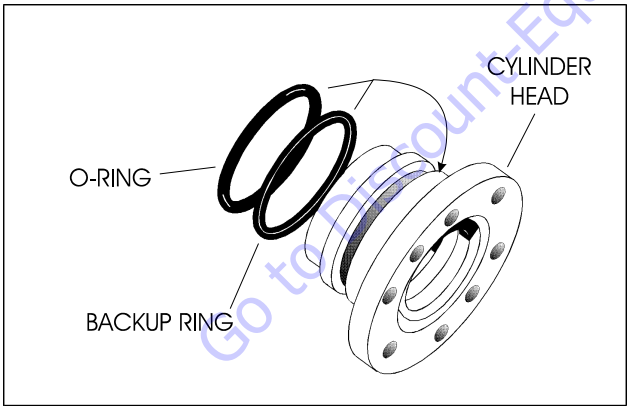


Figure 5-35. Installation of Head Seal Kit

4. Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.

5. Carefully slide the piston spacer on the rod.

NOTE: *Main telescope cylinder piston has an o-ring installed inside the spacer.*

6. If applicable, correctly place new o-ring in the inner piston diameter groove. (The backup ring side facing the O-ring is grooved.)

7. If applicable, correctly place new seals and guide lock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D.of the piston is recommended to install the solid seal.)

NOTE: *The backup rings for the solid seal have a radius on one side. This side faces the solid seal.(See magnified insert in Figure 5-36.)The split of seals and backup rings are to be positioned so as not to be in alignment with each other.*

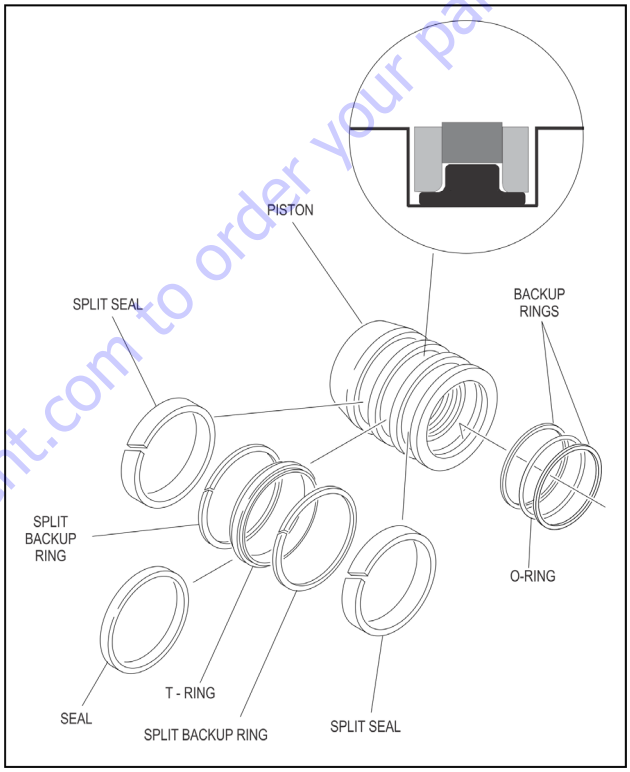


Figure 5-36. Piston Seal Kit Installation

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

9. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and Backup rings are not damaged or dislodged.

10. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

NOTE: *When installing the tapered bushing, piston and mating end of rod must be free of oil.*

NOTICE

WHEN REBUILDING THE TELESCOPE, LIFT, JIB, LEVEL, AXLE LOCKOUT OR AXLE EXTENSION CYLINDERS, TIGHTEN SECURELY. (SEE TABLE 5-33)

11. Assemble the tapered bushing loosely into the piston and insert JLG capscrews (not vendor capscrews) through the drilled holes in the bushing and into the tapped holes in the piston.

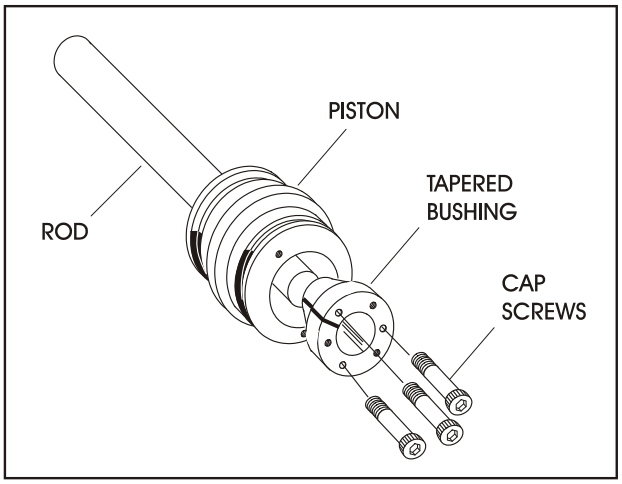


Figure 5-37. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to the specified torque value. (See Table 5-33, Cylinder Head and Tapered Bushing Torque Specifications).

13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

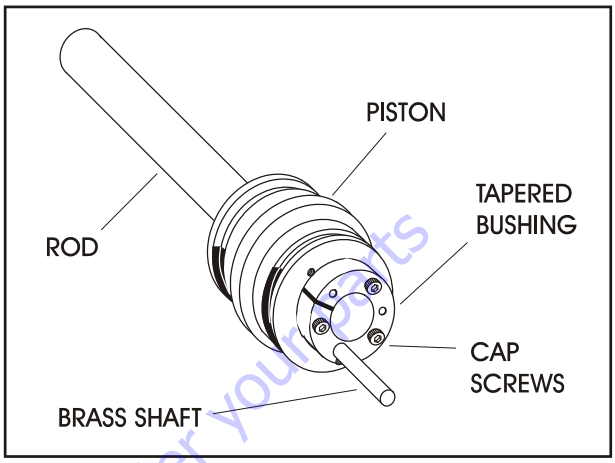


Figure 5-38. Seating the Tapered Bearing

14. Retorque the capscrews evenly and progressively in rotation to the specified torque value. (See Table 5-33, Cylinder Head and Tapered Bushing Torque Specifications).

15. Remove the cylinder rod from the holding fixture.

16. Place new guide locks and seals in the applicable outside diameter grooves of the cylinder piston. (See Figure 5-36., Piston Seal Kit Installation)

17. Position the cylinder barrel in a suitable holding fixture.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

19. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

20. Secure the cylinder head gland using the washer ring and socket head bolts. (See Table 5-33, Cylinder Head and Tapered Bushing Torque Specifications and Table 5-34, Holding Valve Torque Specifications)

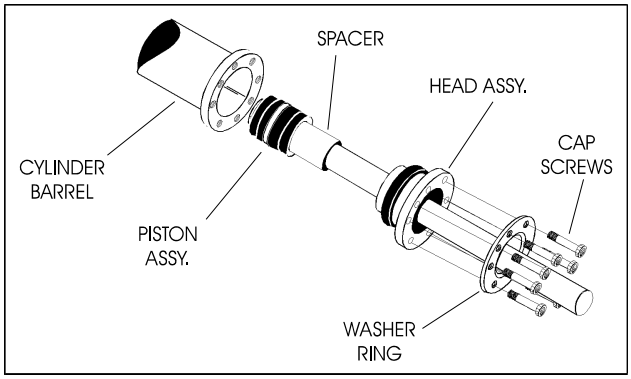


Figure 5-39. Rod Assembly Installation

21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.

22. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. (See Table 5-34, Holding Valve Torque Specifications).

Table 5-33. Cylinder Head and Tapered Bushing Torque Specifications

Description	Head Torque Value (Wet)	Tapered Bushing Torque Value (Wet)
Tele Cylinder (1200SJP)	120 ft. lbs. (163 Nm)	30 ft. lbs. (40.5 Nm)
Tele Cylinder (1350SJP)	120 ft. lbs. (163 Nm)	45 ft. lbs. (63 Nm)
Level Cylinder	120 ft. lbs. (163 Nm)	9 ft. lb.s (12.6 Nm)
Jib Cylinder	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Lift Cylinder	300 ft. lbs. (410 Nm)	120 ft. lbs. (168 Nm)
Axle Oscillation Cylinder	120 ft. lbs. (163 Nm)	9 ft. lb.s (12.6 Nm)
Axle Extend Cylinder	50 ft. lbs. (70 Nm)	9 ft. lb.s (12.6 Nm)

Table 5-34. Holding Valve Torque Specifications

Description	Torque Value
SUN - 7/8 HEX M20 X 1.5 THDS.	30-35 ft. lbs. (41-48 Nm)
SUN - 1 1/8 HEX 1 - 14 UNS THDS.	45-50 ft. lbs. (61-68 Nm)
SUN - 1 1/4 HEX M36 X 2 THDS.	150-160 ft. lbs. (204-217 Nm)
RACINE - 1 1/8 HEX 1 1/16 - 12 THDS.	50-55 ft. lbs. (68-75 Nm)
RACINE - 1 3/8 HEX 1 3/16 - 12 THDS.	75-80 ft. lbs. (102-109 Nm)
RACINE - 1 7/8 HEX 1 5/8 - 12 THDS.	100-110 ft. lbs. (136-149 Nm)

Steer Cylinder

DISASSEMBLY

NOTICE

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

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

NOTICE

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

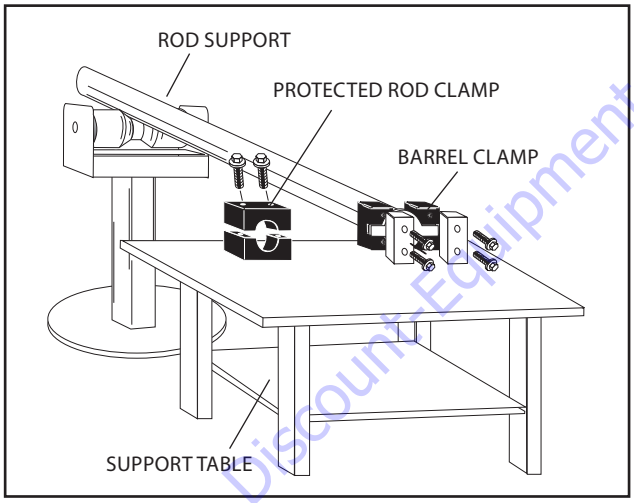


Figure 5-40. Cylinder Barrel Support

4. Mark cylinder cap and barrel with a center punch for easy realignment. Unscrew the cylinder cap from the barrel.
5. Using a hook spanner, loosen the cylinder cap on Barrel. Remove the cylinder head from the barrel and the rod.

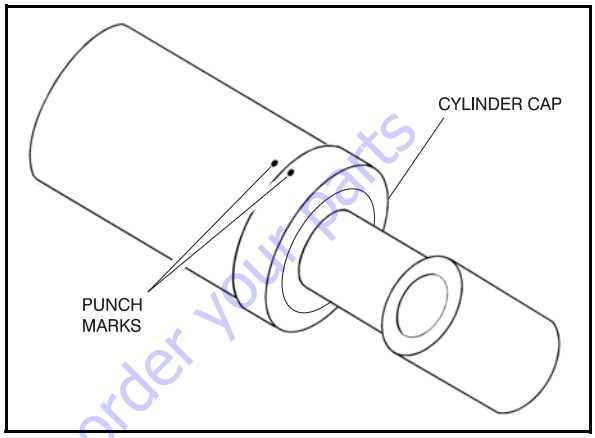


Figure 5-41. Cylinder cap removal

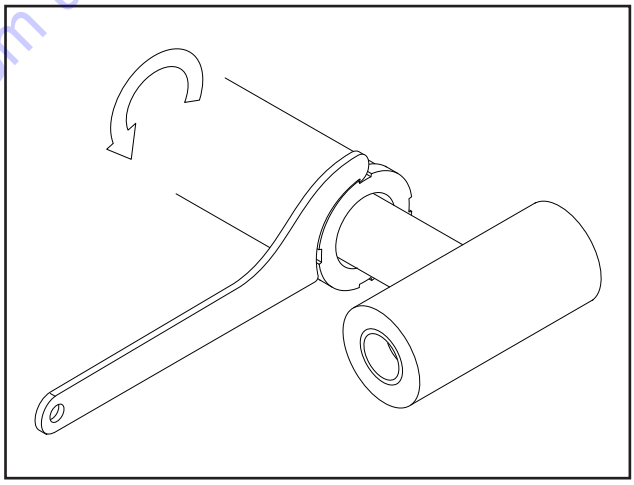
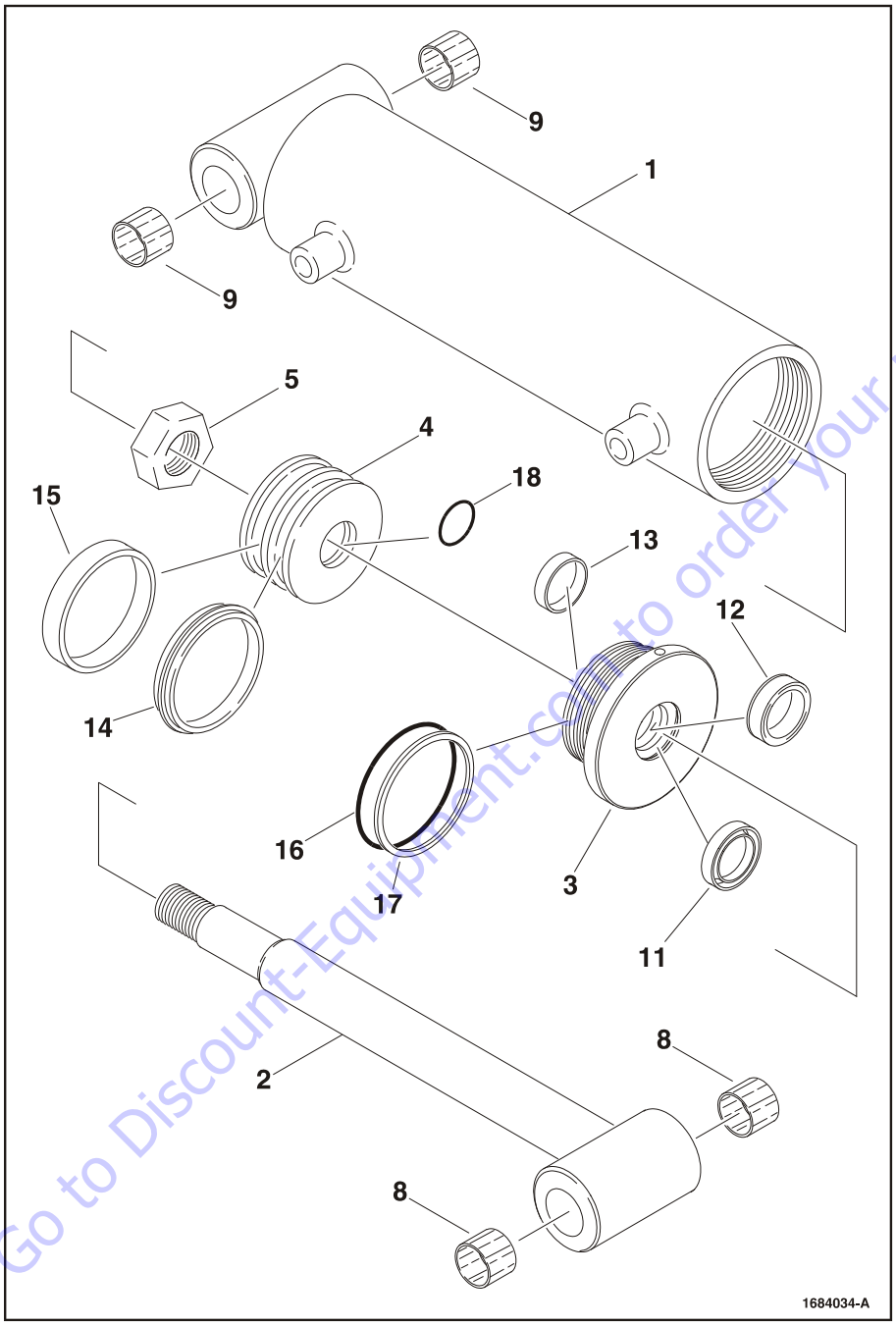


Figure 5-42. Cylinder cap removal

NOTICE

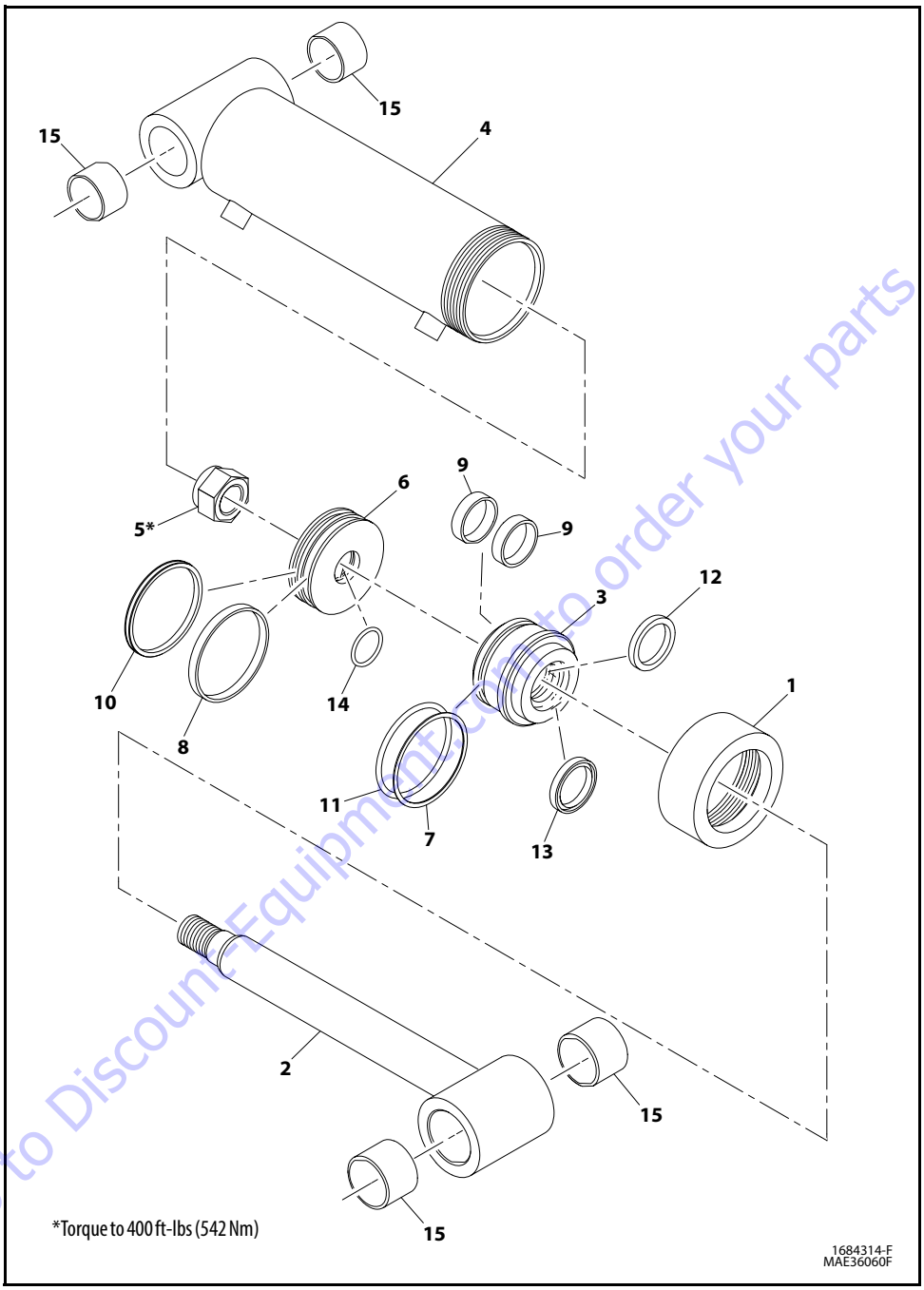
EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

6. Clamp barrel securely. Pull rod assembly and cylinder head from barrel.
7. Protect cylinder rod from damage and clamp in a vise or holding fixture as close to piston as possible.



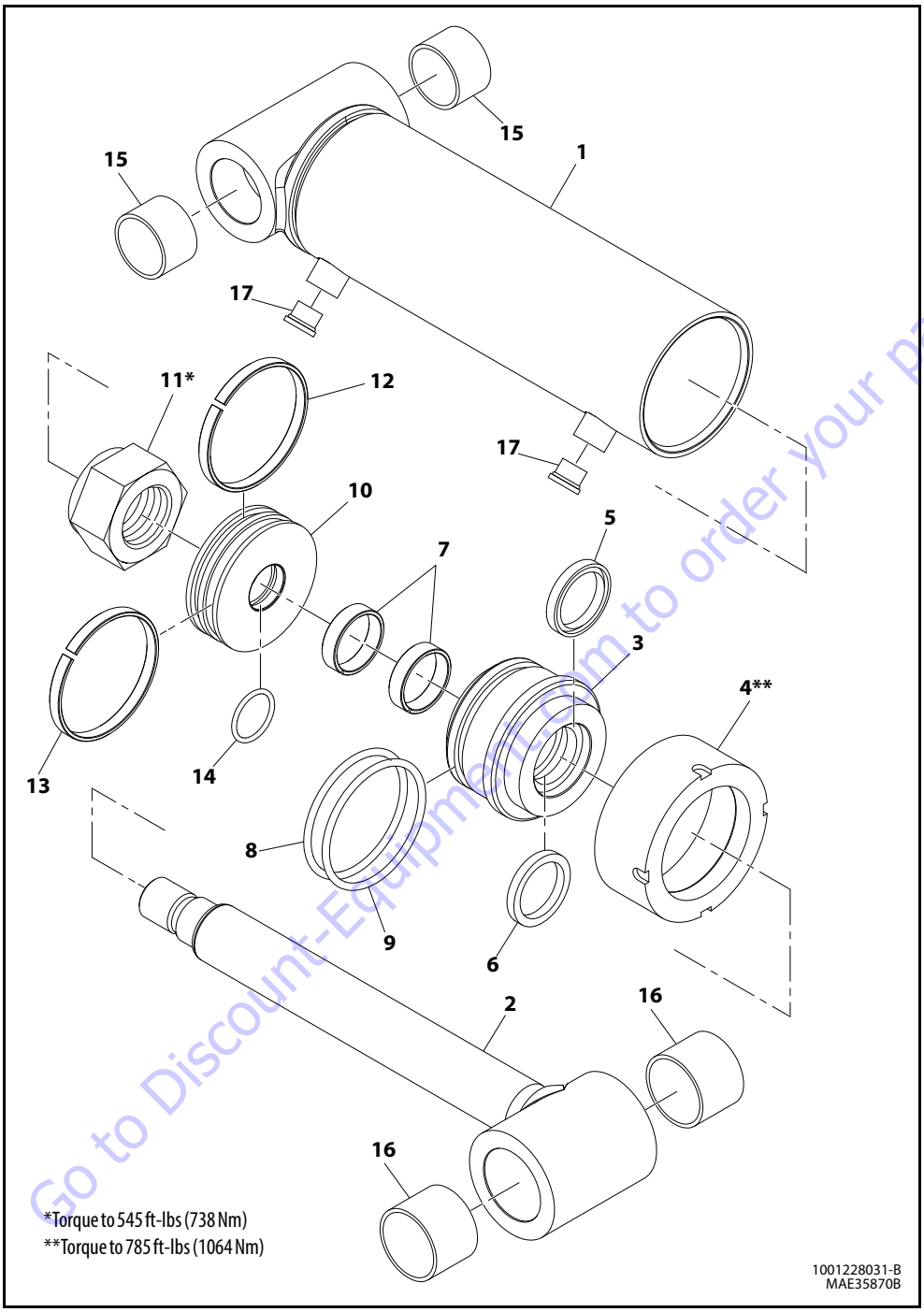
1. Barrel
2. Rod
3. Head
4. Piston
5. Nut
6. Loctite #222 (not shown)
7. Not Used
8. Rod End Bushing
9. Barrel End Bushing
10. Not Used
11. Wiper
12. Rod Seal
13. Wear Ring
14. Piston Seal
15. Wear Ring
16. O-ring
17. Back Up Ring
18. O-ring

Figure 5-43. Steer Cylinder (Prior to S/N 0300073367)



1. Cylinder Cap
2. Rod
3. Head
4. Barrel
5. Nut
6. Piston
7. Backup Ring
8. Wear Ring
9. Wear Ring
10. O-ring
11. O-ring
12. Wiper
13. Seal
14. Piston Seal
15. Bushing

Figure 5-44. Steer Cylinder (SN 0300073367 through 0300238011, SN B300002238 through B300002376)



1. Barrel
2. Rod
3. Head
4. Cylinder Cap
5. Wiper
6. Piston Seal
7. Wear Ring
8. O-Ring
9. Backup Ring
10. Piston
11. Nut
12. Wiper
13. Wear Ring
14. O-Ring
15. Bushing
16. Bushing
17. Plug

Figure 5-45. Steer Cylinder (SN 0300238012 to Present, SN B300002377 to Present)

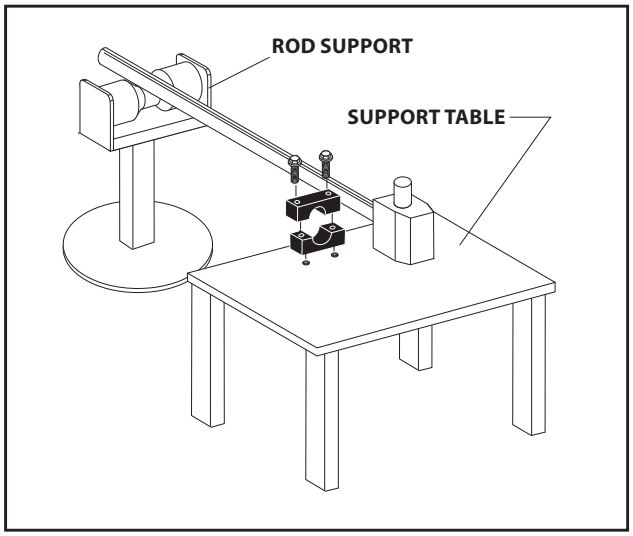


Figure 5-46. Cylinder Rod Support

8. Using suitable protection, clamp the cylinder rod in a vise or holding fixture as close to the piston as possible.
9. Loosen and remove the lock nut that secures the piston to the cylinder rod.
10. Remove the piston from the cylinder rod.
11. Remove and discard the piston o-rings, seal rings.
12. Remove the rod from the holding fixture. Remove the cylinder head. Discard all seals on the cylinder head.

Cleaning And Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*

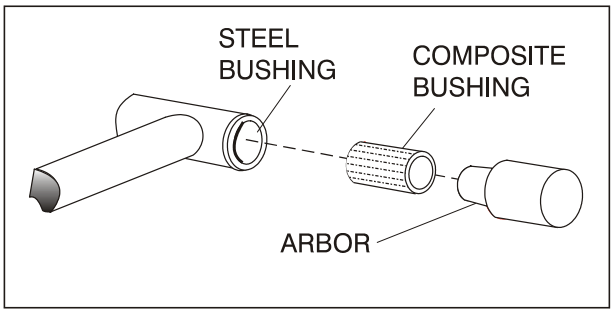


Figure 5-47. Composite Bearing Installation

14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

NOTE: *Apply a light film of hydraulic oil to all components prior to assembly.*

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

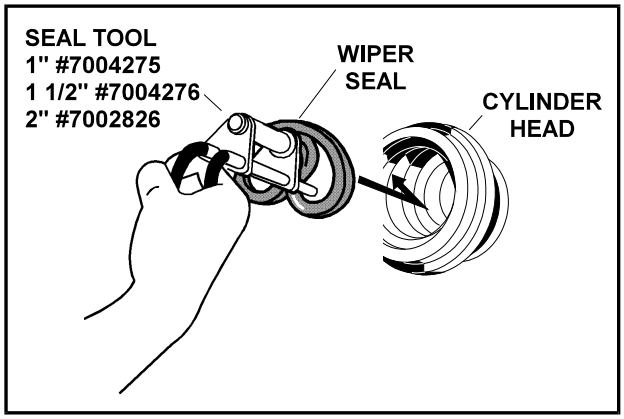


Figure 5-48. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

2. Use a soft mallet to tap a new wiper seal into the cylinder head gland groove. Install new wear rings into the cylinder head gland groove.

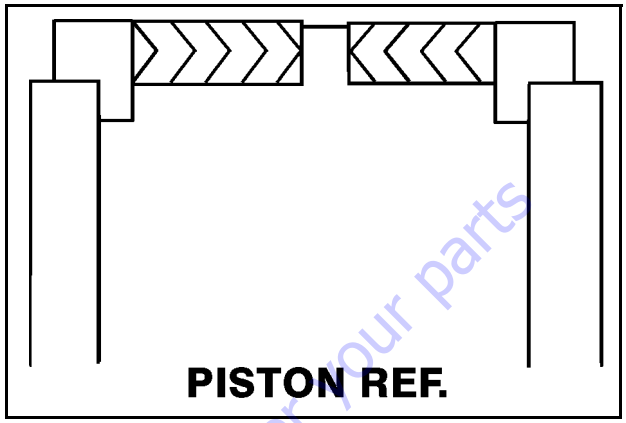


Figure 5-49. Poly-Pak Piston Seal Installation

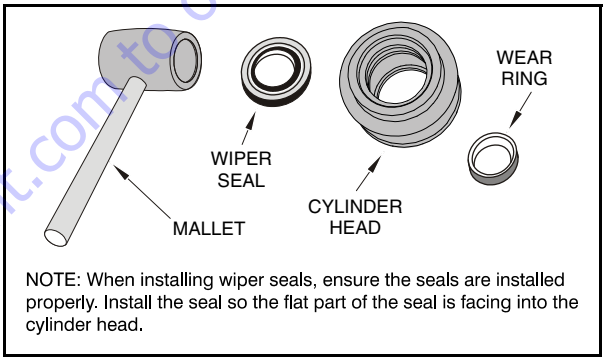


Figure 5-50. Wiper Seal Installation

3. Place a new O-ring and backup ring in the outside diameter groove of the cylinder head.

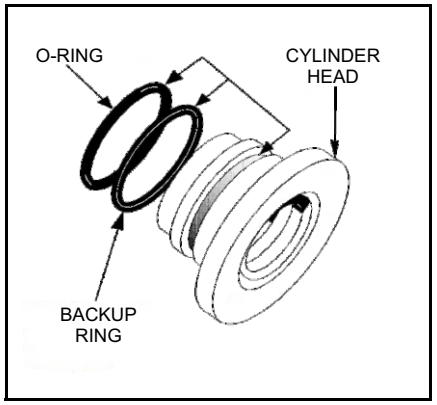


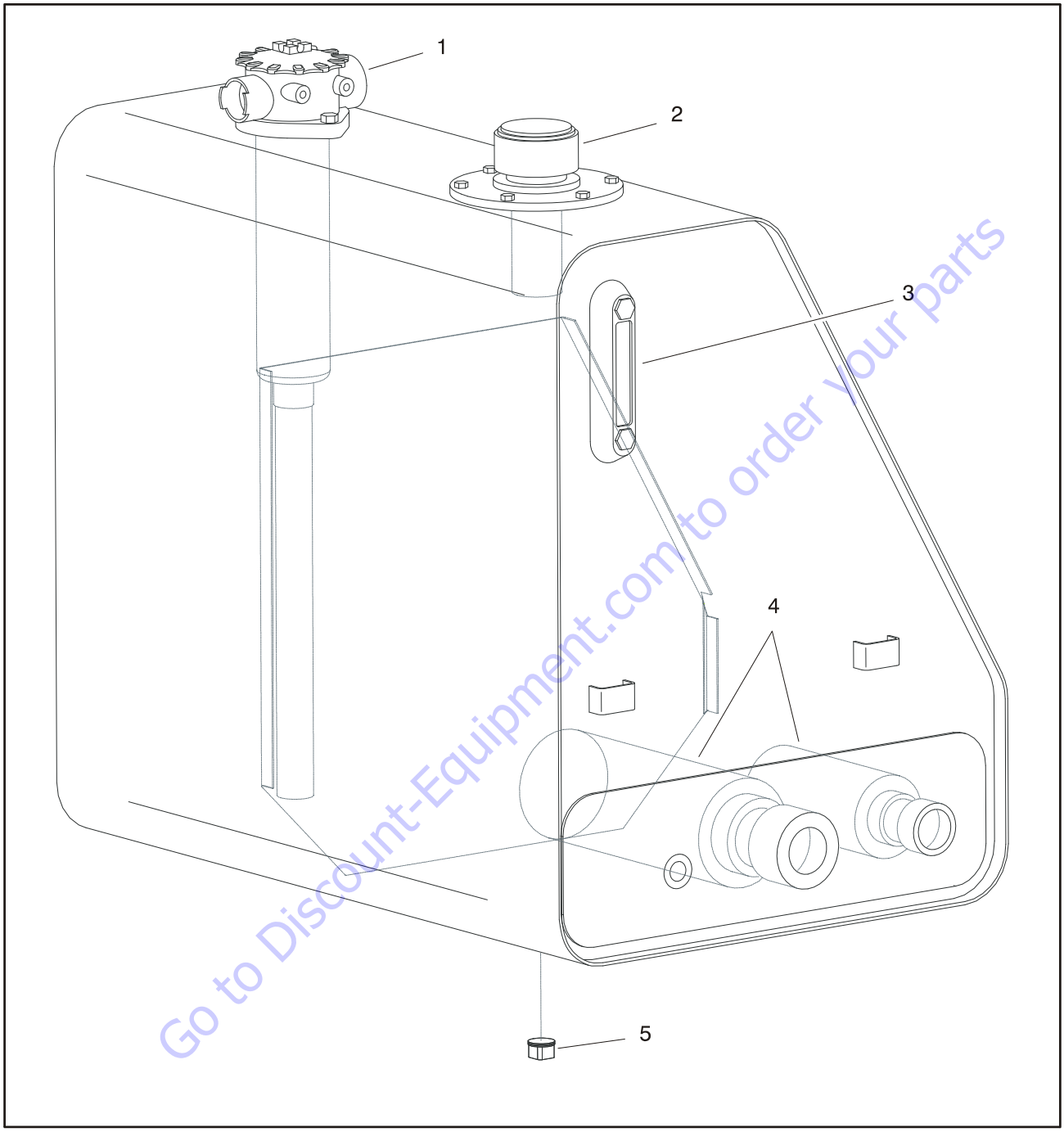
Figure 5-51. Installation of Head Seal Kit

4. Place the cylinder cap over the rod and carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end.
5. Place a new O-ring in the inner piston diameter groove.
6. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston threads as possible.
7. Install the piston on the cylinder rod hand tight, ensuring that the o-ring and Backup rings are not damaged or dislodged.
8. Place a new wear ring in the outer piston diameter grooves.
9. Carefully thread the lock nut onto the rod to secure the piston in place.
10. Remove the cylinder rod from the holding fixture.
11. Position the cylinder barrel in a suitable holding fixture.

NOTICE

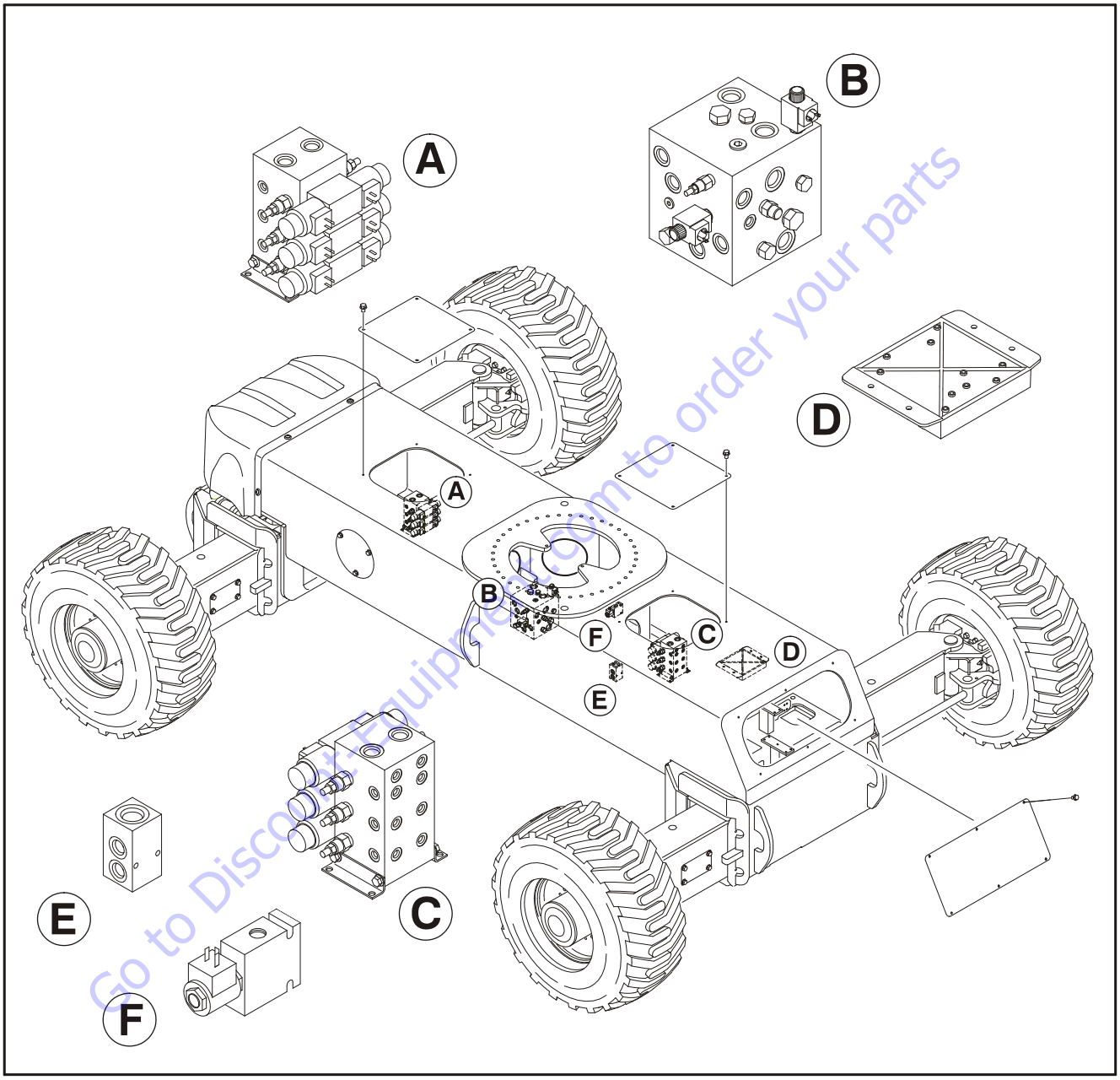
EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

12. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston seals are not damaged or dislodged.
13. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
14. Secure the cylinder head using JLG Threadlocker (PN 0100035 and the cylinder cap.
15. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted).



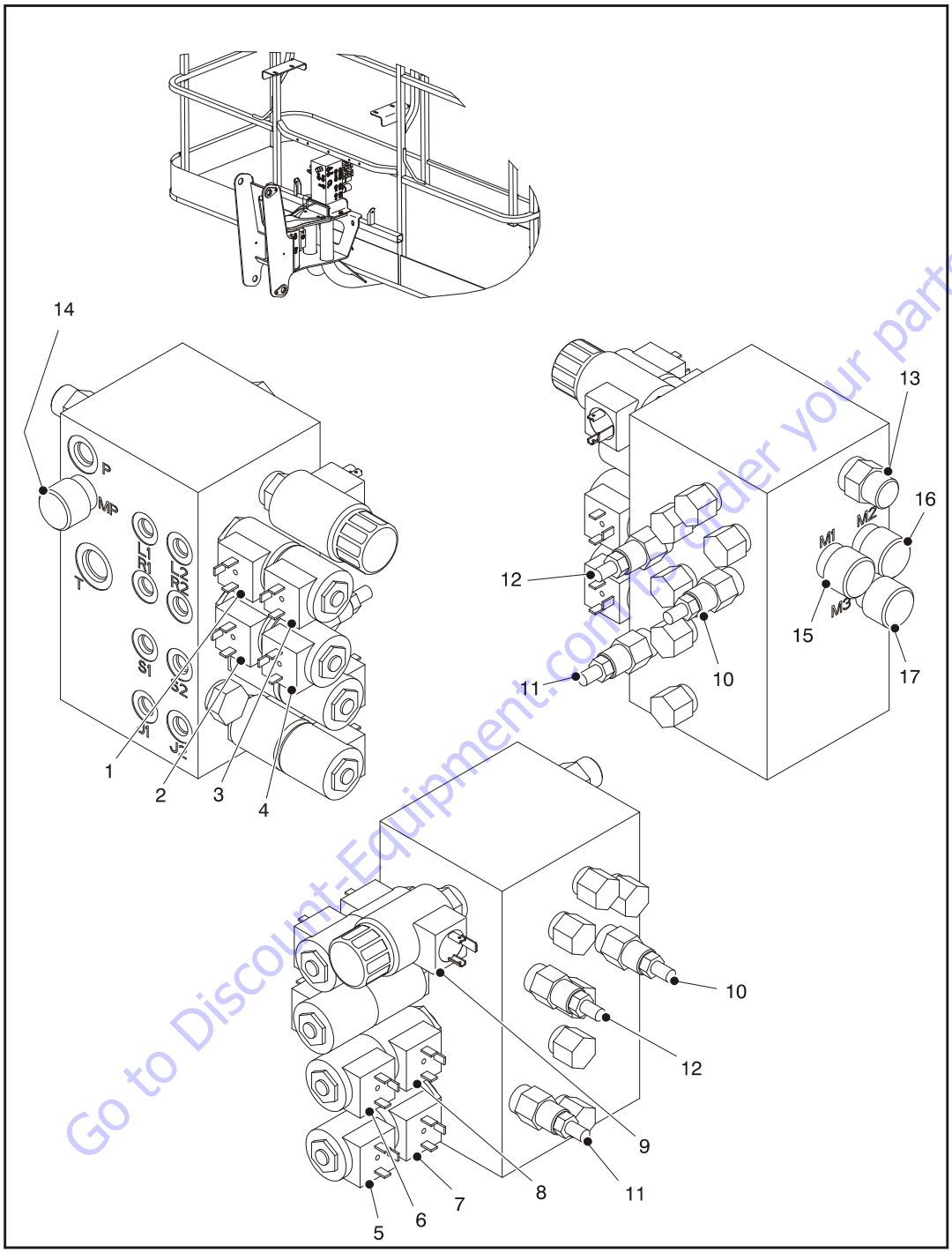
1. Return Filter
2. Vented Fill Cap
3. Sight/Temperature Gauge
4. Suction Strainer
5. Magnetic Drain Plug

Figure 5-52. Hydraulic Tank



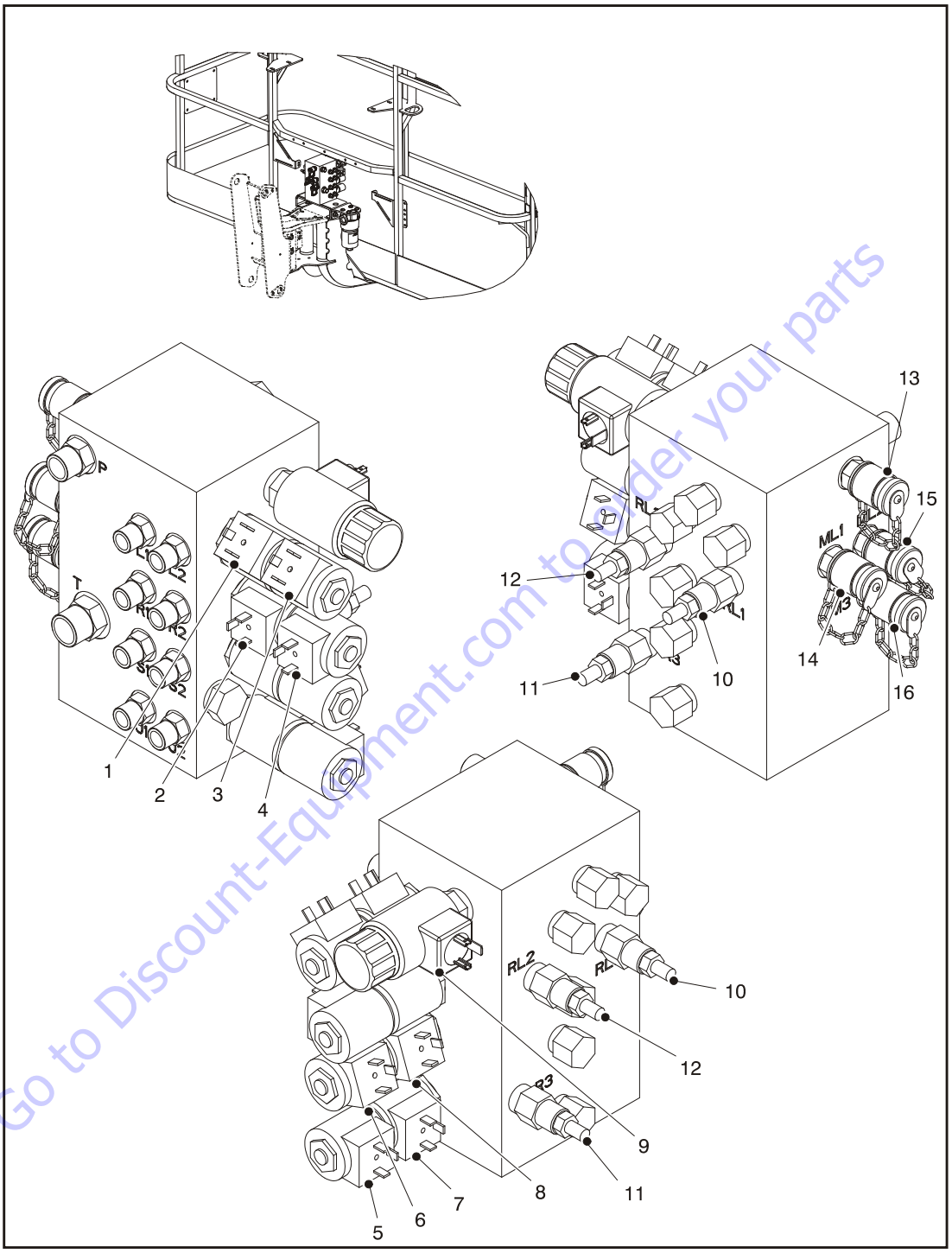
A. Front Steer Valve/Axle Extend
B. Traction Valve
C. Rear Steer Valve/Axle Extend
D. Chassis Module Controller
E. Junction Manifold Valve
F. Axle Oscillation Valve

Figure 5-53. Chassis Control Valve Locations



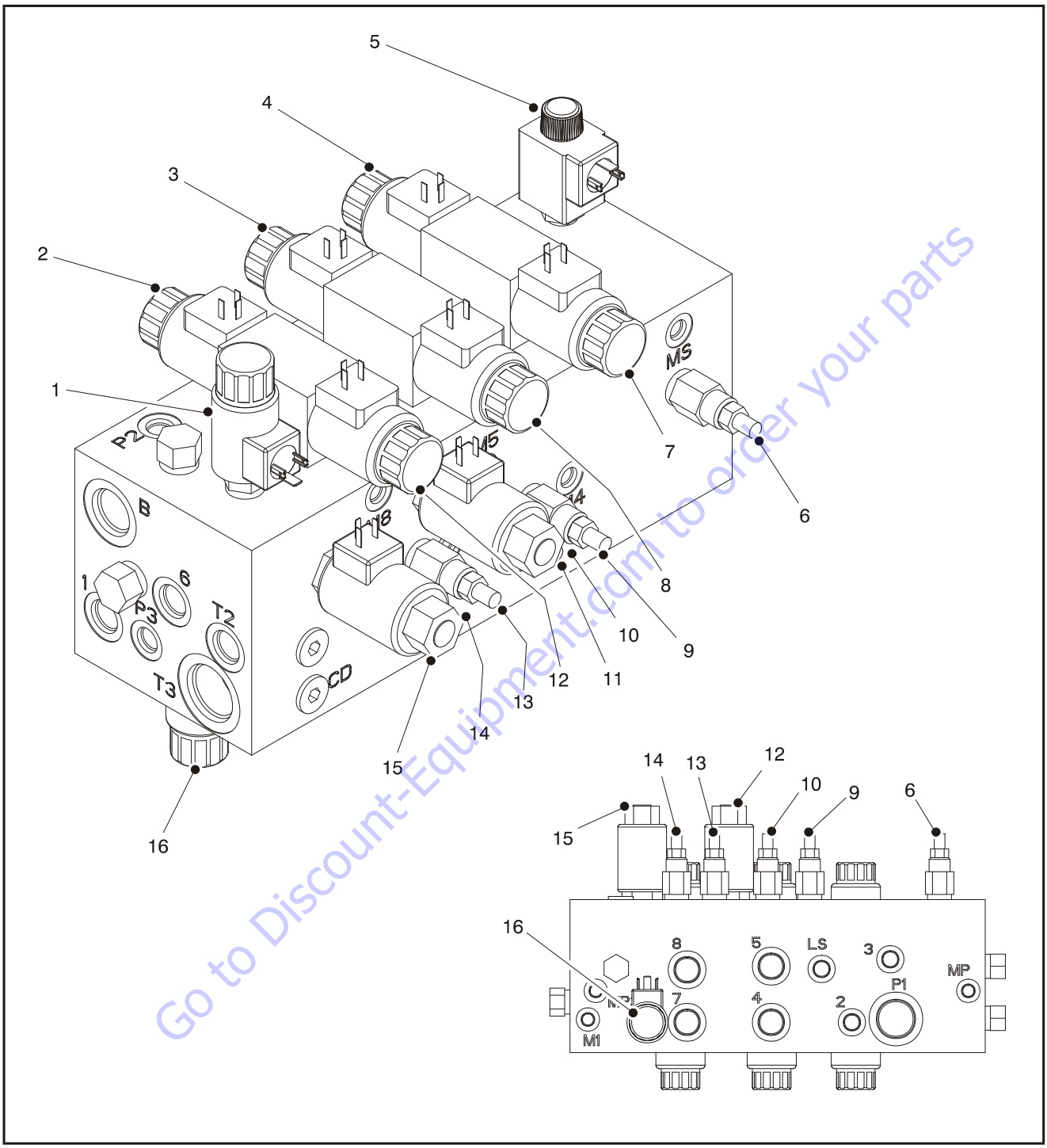
1. Level Up
2. Rotate Right
3. Level Down
4. Rotate Left
5. Jib Down
6. Jib Swing Left
7. Jib Up
8. Jib Swing Right
9. Platform Dump
10. Level Up Relief
11. Jib Up/Down Relief
12. Level Down Relief
13. Filter or Plug
14. Main Pressure Check Port
15. Level Up Test Port
16. Level Down Test Port
17. Jib Up/Down Test Port

Figure 5-54. Platform Valve Identification - JLG PN 4641266



1. Level Up
2. Rotate Right
3. Level Down
4. Rotate Left
5. Jib Down
6. Jib Swing Left
7. Jib Up
8. Jib Swing Right
9. Platform Dump
10. Level Up Relief
11. Jib Up/Down Relief
12. Level Down Relief
13. Main Pressure Check Port
14. Level Up Test Port
15. Level Down Test Port
16. Jib Up/Down Test Port

Figure 5-55. Platform Valve Identification - JLG PN 4641460



1. Aux Lift Down
2. Tele Out
3. Lift Up
4. Swing Right
5. Dump
6. Swing Relief
7. Swing Left
8. Lift Down
9. Lift Up Relief
10. Lift Down Relief
11. Lift Flow
12. Tele In
13. Tele Out Relief
14. Tele In Relief
15. Tele Flow
16. Lift Down/Aux Select

Figure 5-56. Main Valve Identification

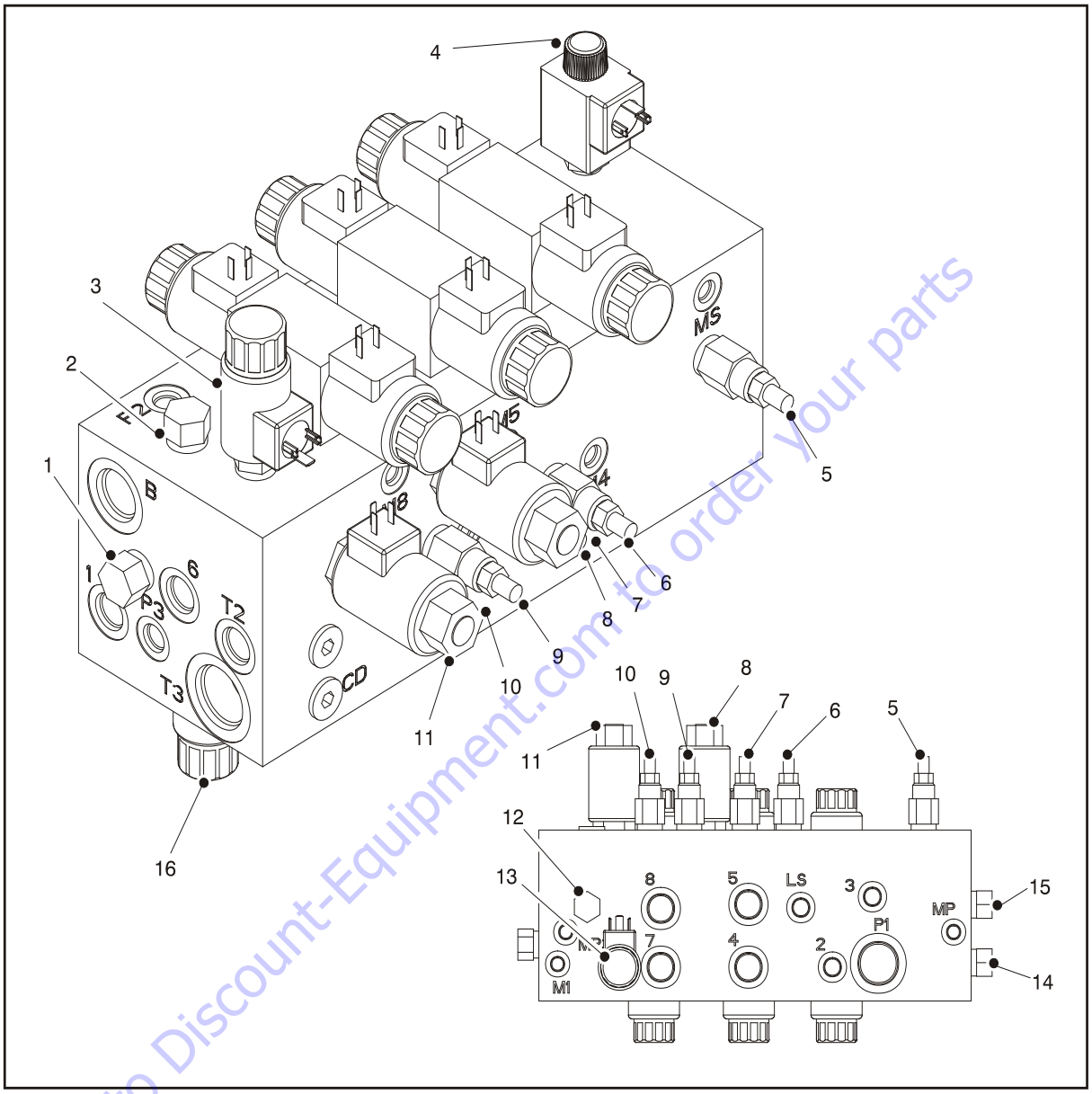


Table 5-35. Cartridge Torque Values

	Ft-Lbs.	Nm		Ft-Lbs.	Nm
1	25-30	33.9-40.6	9	30-35	40.6-47.4
2	25-30	33.9-40.6	10	30-35	40.6-47.4
3	30-35	40.6-47.4	11	30	40.6
4	30-35	40.6-47.4	12	30-35	40.6-47.4
5	30-35	40.6-47.4	13	30-35	40.6-47.4
6	30-35	40.6-47.4	14	30-35	40.6-47.5
7	30-35	40.6-47.4	15	30-35	40.6-47.5
8	30	40.6			

Figure 5-57. Main Valve Cartridge Torque Values

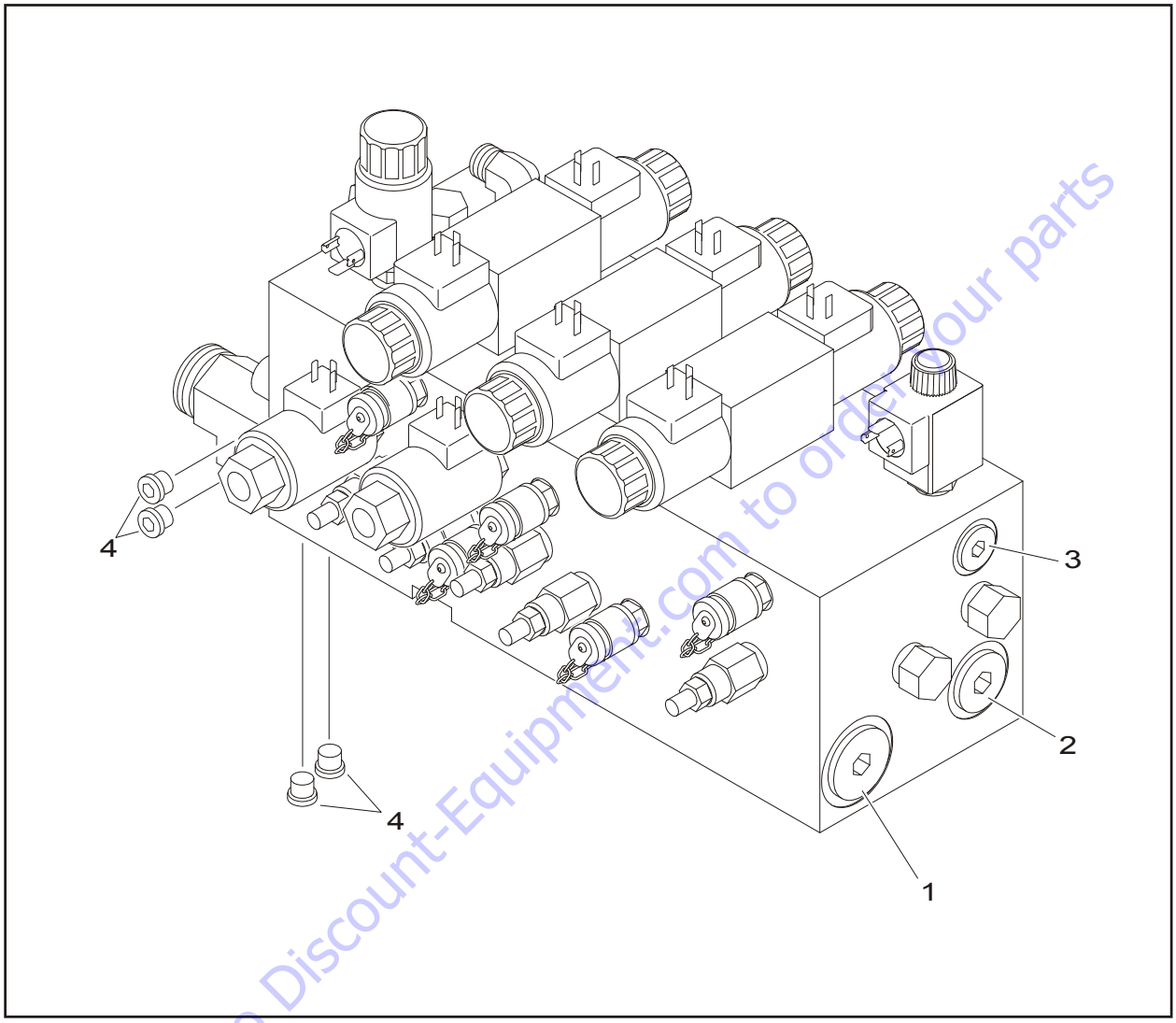


Table 5-36. Plug Torque Values

	Ft-Lbs.	Nm
1	115	156
2	100	135.5
3	40	54
4	13	17.5

Figure 5-58. Main Valve Plug Torque Values

5.4 HYDRAULIC TANK

The hydraulic tank has a capacity of 55 gallons (208 liters) and includes the hydraulic return filter and two suction strainers. It is normal for the oil level to appear low when the boom is raised and should only be checked with the machine on level ground and with the boom fully retracted and lowered. The hydraulic oil should be maintained at the full level as shown by the decal and hydraulic oil level gauge located on the side of the tank as shown in Figure 5-59., Hydraulic Oil Level Gauge. This decal shows the proper full level for both hot and cold oil. Do not fill the hydraulic tank past the appropriate full mark. Overfilling can cause the oil to overflow from the top of the hydraulic tank during emergency lowering operations.

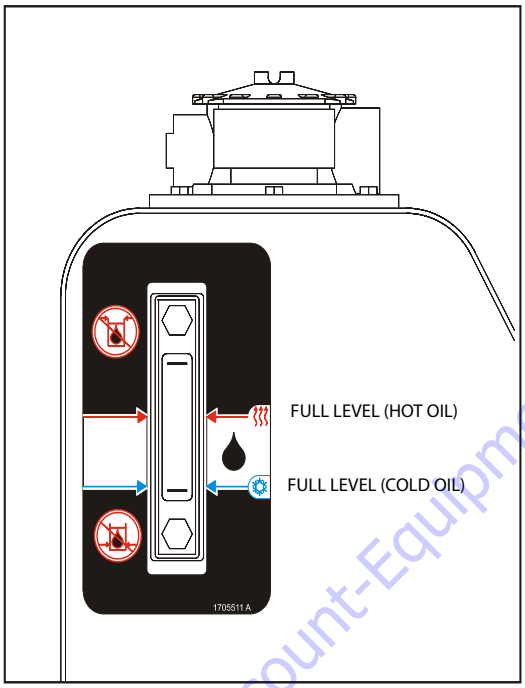


Figure 5-59. Hydraulic Oil Level Gauge

5.5 PRESSURE SETTING PROCEDURE

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within ± 5% of specified pressures.

To ensure all pressures are set correctly, the following procedures must be followed in order.

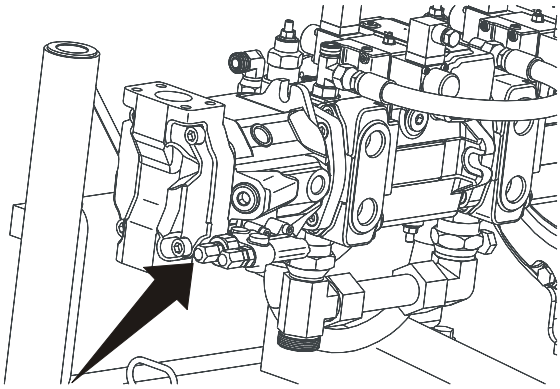
1. All applicable steps in Section 5.11, Drive & Function Pump Start Up Procedures must be followed.
2. Set up of the function pump.
3. Adjustments made at the main valve bank.
4. Adjustments made at the platform valve.

Set Up of the Function Pump

HIGH PRESSURE RELIEF - 3400 PSI (234.4 BAR)

1. Install a high pressure gauge at the MP port of the main valve block.
2. Using a screwdriver, remove the Din connector from the lift down coil.
3. Activate lift down. The gauge should read 3400 psi (234 bar).

4. To make an adjustment to this pressure, go back to the engine compartment to the function pump which is the back pump. The high pressure relief adjustment is the adjustment closest to the pump. Using a 17 mm wrench, remove the cover nut. Be careful not to lose the O-ring washer inside the cover nut.



5. Loosen the jam nut at the setscrew with the 17 mm wrench. Using a 3 mm allen wrench, adjust clockwise to increase, or counterclockwise to decrease.

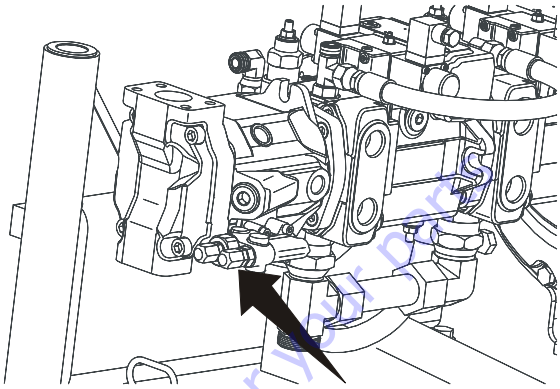
6. After adjusting the pressure, tighten the jam nut and the cover nut. This is the **maximum** relief pressure for all the functions governed by this pump.

STAND BY PRESSURE OR LOW PRESSURE RELIEF - 300 PSI (20.6 BAR)

1. Install a low pressure gauge at port MP of the main valve block capable of reading 300 psi (20.6 bar).

2. Start the engine, the gauge should read 300 psi (20.6 bar).

3. To make an adjustment to this pressure, go to the engine compartment, locate the function pump. The stand by adjustment is the adjustment outside adjustment, closest to the turntable. Use the same tools that were used in the Hi pressure adjustment procedure.



Adjustments made at the Main Valve Bank

LIFT UP - 2750 PSI (189.6 BAR)

1. Install a high pressure gauge at the M5 port of the main valve block. Plug and cap the hose on port 5.

2. Activate lift up. The gauge should read 2750 psi (189.6 Bar).

3. The adjustment cartridge is located below the M5 gauge port. Turn clockwise to increase, counterclockwise to decrease.

LIFT DOWN - 1500 PSI (103.4 BAR)

1. Install a high pressure gauge at the M4 port of the main valve block.

2. Activate lift down to the end of the stroke. The gauge should read 1500 psi (103.4 bar).

3. The adjustment cartridge is located to the left of the M4 gauge port. Turn clockwise to increase, counterclockwise to decrease.

SWING - 1500 PSI (103.4 BAR)

NOTE: *Left and right are done with one adjustment.*

1. Install a high pressure gauge at port MS.
2. Lock the turntable pin.
3. Activate swing, the gauge should read 1500 psi (103.4 Bar). The adjustment cartridge is located below the MS gauge port.
4. Turn clockwise to increase, counterclockwise to decrease.

TELESCOPE OUT - 3000 PSI (206.8 Bar)

1. Install a high pressure gauge at the M8 port of the main valve bank. Plug the telescope out hose either at the valve bank (port #8) or at the inlet of the telescope cylinder (V1).
2. Activate telescope out. The gauge should read 3000 psi (206.8 Bar).
3. The adjustment cartridge is located below the M8 gauge port. Turn clockwise to increase, counterclockwise to decrease.

TELESCOPE IN - 3200 PSI (220.6 BAR)

1. Install a high pressure gauge at the M7 port of the main valve block.
2. Activate Telescope In. The gauge should read 3200 psi (220.6 Bar).
3. The adjustment cartridge is located to the left of the M7 gauge port. Turn clockwise to increase, counterclockwise to decrease.

Adjustments Made at the Frame Valve Bank

AXLE EXTEND AND RETRACT, FRONT AND REAR - 2500 PSI (172.3 BAR)

1. To extend the axles, drive the machine back and forth until extended. A machine that cannot be driven must be jacked up.
2. On both the front and rear frame valve banks, install a high pressure gauge on ports MA1 for extend and MA2 for retract. The gauge should read 2500 psi (172.3 Bar) in both directions.
3. The axle extend/retract cylinders are connected hydraulically in parallel. In order to get the correct pressure of the circuit being adjusted, unscrew the solenoid coil from the circuit not being adjusted and pull it away from the valve.
4. Turn clockwise to increase, counterclockwise to decrease.

STEERING, FRONT AND REAR

NOTE: *The following procedure requires 2 people to perform. One is needed for verifying / adjusting pressure readings and wheel spindle alignment the other for operating the steer functions and using the Analyzer from the platform.*

The Analyzer is required to perform the pressure check procedure through access of the calibration menu. The calibration menu will allow for extending and retracting the steer cylinders individually, verifying pressures, and proper steer sensor calibration. Verification of the steer sensor calibration will require one of two types of measuring methods; using a square and ruler or using string as explained in Section 6 - JLG Control System. The purpose of these measuring tools is to assure that the wheel spindle is aligned "straight" with the extended axle weldment.

1. Position the machine with both front and rear axles fully extended.
2. Install the Analyzer in the platform control box and scroll menu's to Access Level 2 and insert password (33271) to get into Access Level 1.

3. Scroll to the calibration mode. Once in the calibration mode, press "ENTER" and scroll to steer. Once in the steer calibration mode, the Analyzer is going to ask to calibrate the steer sensors, this is going to allow extending and retracting each steer cylinder individually during this process. The JLG control system will ask to calibrate the left front sensor, the left rear sensor, the right front sensor and finally the right rear sensor in that order. During this calibration mode each individual steer cylinder will be extended and retracted to verify correct pressures with the marked MS (Measure Steer) ports on the steer / axle valve that pertains to that steer cylinder. Refer to the Hydraulic Schematic in Section 7 - Schematics.

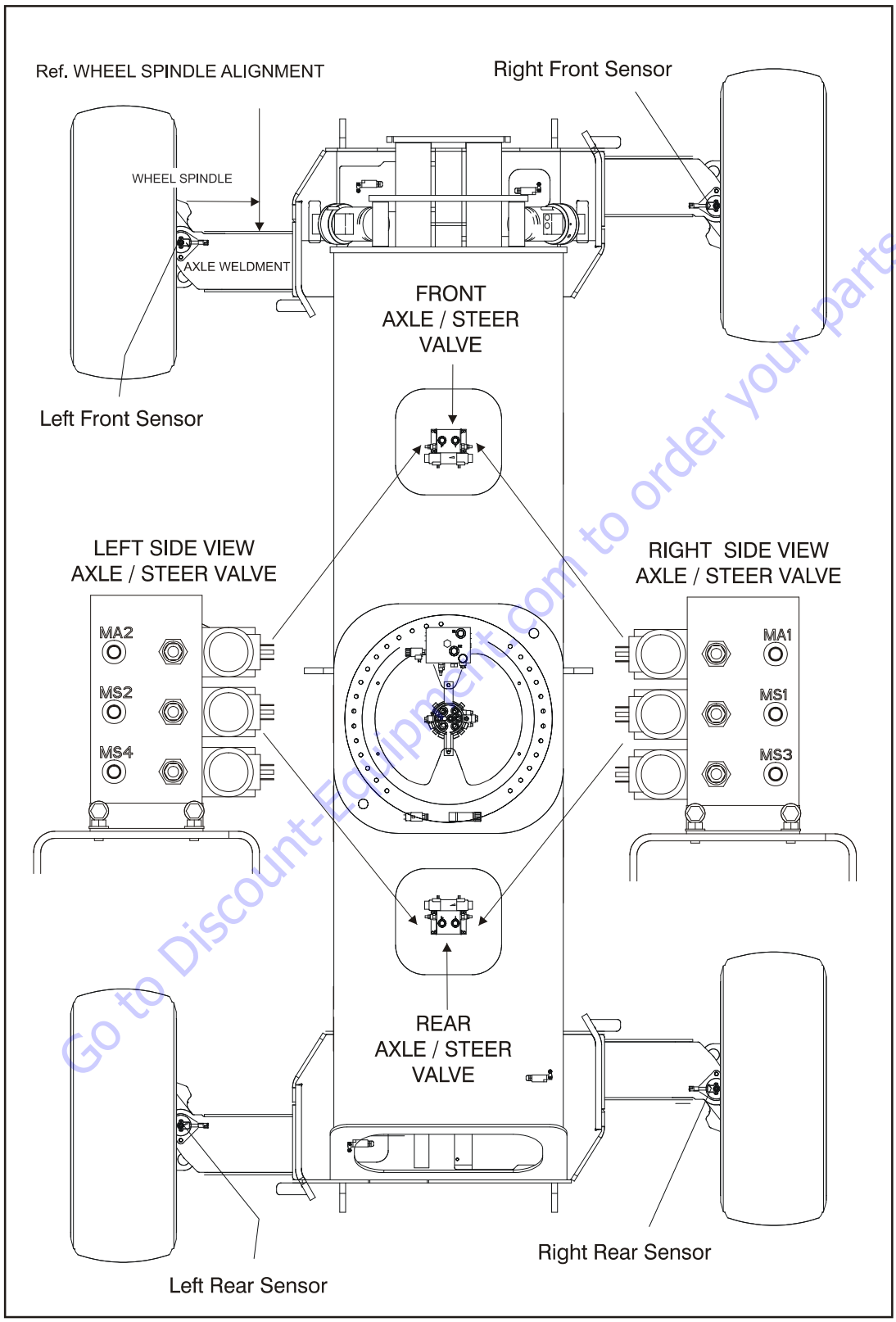
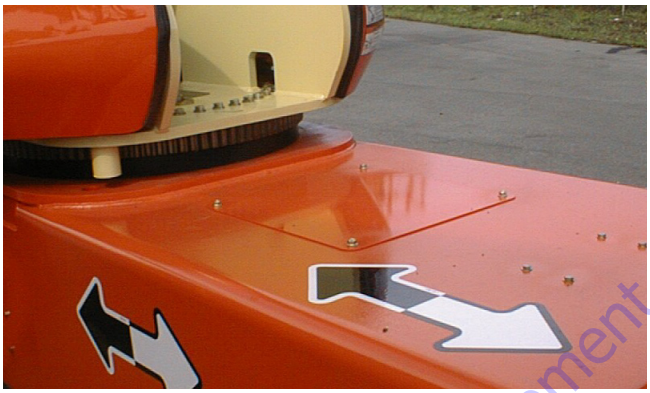
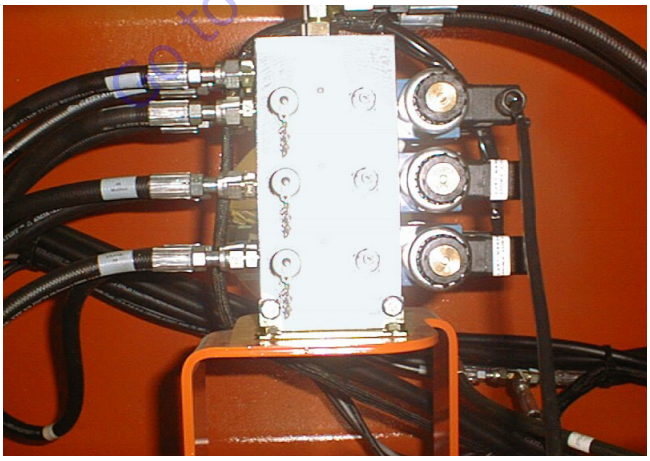


Figure 5-60. Steer Pressure Adjustments

4. Remove the front circular steer/axle access covers at the front of the chassis, and the rear square cover at the top rear of the chassis to gain access to the axle/steer valves.



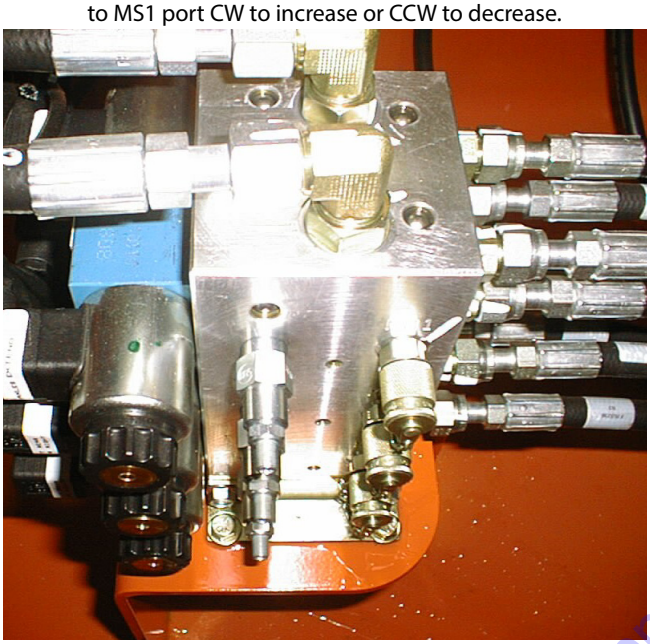
5. Install a pressure gauge at the front axle/steer valve at MS2 port. This should be located on the left side of the valve closest to the left front wheel spindle. Position the steer switch to activate the left front steer cylinder until the rod is in the fully extended position and hold the switch for a few seconds after the rod has been fully extended. The MS2 port should read 2000 psi (138 Bar). If the pressure is not 2000 psi (138 Bar) adjust relief valve mounted next to the MS2 port, CW to increase or CCW to decrease.



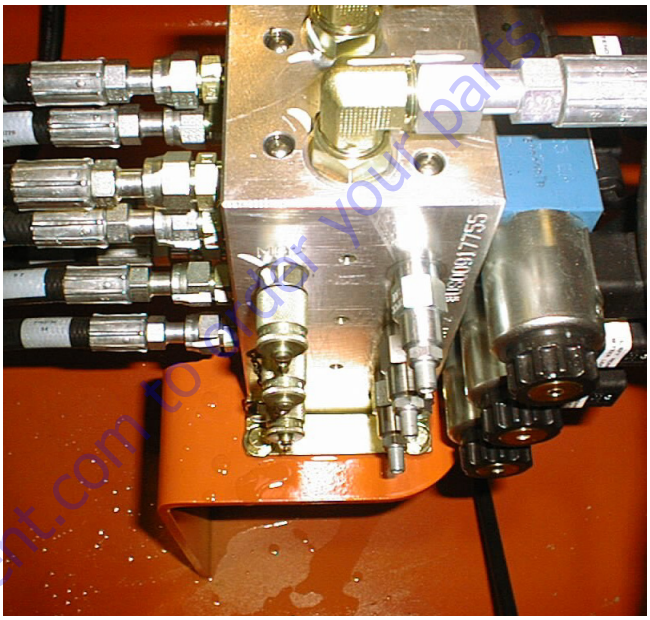
6. Remove the pressure gauge from MS2 port and install on the MS1 port, which is on the right side of the front axle/steer valve, closest to the right front wheel spindle. Position the steer switch to activate the left front steer cylinder until the rod is in the fully retracted position and hold the switch for a few seconds after the rod has stopped. The MS1 port should read 2600 psi (179 Bar). If the pressure is not correct, adjust relief valve next to MS1 port, CW to increase or CCW to decrease.

7. This step involves aligning the left front wheel spindle with the axle weldment. Position the left front wheel spindle “straight” using a square and rule or string for proper alignment (Refer to Section 6 - JLG Control System). Once the left front wheel spindle has been properly measured, press “ENTER” on the Analyzer. This is calibrating data to the JLG Control System that the left front steer sensor is centered.

8. Checking the left rear steer cylinder is identical to the procedure for left front steer cylinder, except now we are checking pressures at the rear axle/steer valve location. Install pressure gauge at MS1 port. This should be located on the left side of the valve closest to the left rear wheel spindle. MS1 port should read 2600 psi (179 Bar) when the left rear steer cylinder is activated with the rod in the fully retracted position. If the pressure is not 2600 psi (179 Bar) adjust relief valve mounted next to MS1 port CW to increase or CCW to decrease.



9. Remove the gauge from MS1 port and install on MS2 port, which is on the right side of the rear axle/steer valve, closest to the right rear wheel spindle. Position the steer switch to activate the left rear steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has been fully extended. The MS2 port should read 2000 psi (179 Bar). If the pressure is not correct, adjust the relief valve mounted next to MS2 port CW to increase or CCW to decrease.



10. The next step is identical to the left front step mentioned above. Make sure the left rear wheel spindle is straight and press "ENTER" to accept the new calibration settings, now press "ESC" (escape) and scroll to the right front steer calibration step.

11. Checking the right front steer cylinder is identical to the procedure laid out for the left front steer cylinder, except the pressures are now checked at MS3 port of the front axle/steer valve. This should be at the right side of the valve closest to the right front wheel spindle. Install the gauge at MS3 port. Position the steer switch to activate the right front steer cylinder until the rod is in the fully retracted position and hold the steer switch for a few seconds after the rod has been fully retracted. If the pressure is not 2600 psi (179 Bar), adjust the relief valve mounted next to the MS3 port CW to increase or CCW to decrease.

12. Remove the gauge from MS3 port and install on MS4 port, which is on the left side of the front axle/steer valve, closest to the left front wheel spindle. Position the steer switch to activate the right front steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has stopped extending. The MS4 port should read 2000 psi (138 Bar). If the pressure is not correct, adjust relief valve mounted next to the MS4 port CW to increase or CCW to decrease.

13. The next step is identical to the left front step mentioned above. Make sure the right front wheel spindle is straight and press "ENTER" to accept the new calibration settings. Scroll over to right rear steer calibration step.

14. Checking the right rear steer cylinder is identical to the procedure laid out for the left rear steer cylinder. Install gauge at MS4 port of the rear axle/steer valve. This should be at the right side of the valve closest to the right rear wheel spindle. Position the steer switch to activate the right rear steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has stopped extending. The MS4 port should read 2000 psi (138 Bar. If the pressure is not correct, adjust relief valve next to the MS4 port CCW to increase or CCW to decrease.

15. Remove gauge from MS4 port and install on MS3 port, which is on the left side of the rear axle/steer valve, closest to the left rear wheel spindle. Position the steer switch to activate the right rear steer cylinder until the rod is in the fully retracted position and hold the steer switch for a few seconds after the rod stops retracting. If the pressure is not 2600 psi (179 Bar), adjust the relief valve mounted next to the MS3 port CW to increase or CCW to decrease.

16. The next step is identical to the left front step mentioned above, make sure the right rear wheel spindle is straight and press "ENTER" to accept the new calibration settings, now escape out of the calibration menu and remove the Analyzer and pressure gauge.

Adjustments Made at the Platform Valve Bank

PLATFORM LEVEL UP - 2500 PSI (172.3 BAR)

1. Install a high pressure gauge at the gauge port M1.
2. Activate level up to the end of stroke, it should read 2500 psi (172.3 Bar).
3. All the relief valves are located on the same face. The level up relief valve is located closest to the M1 gauge port. Turn clockwise to increase, counterclockwise to decrease.

PLATFORM LEVEL DOWN - 1500 PSI (103.4 BAR)

1. Install a high pressure gauge at gauge port M2.
2. Activate level down to the end of stroke, it should read 1500 psi (103.4 Bar).
3. The level down relief valve is located to the left of the level up relief valve. Turn clockwise to increase, counterclockwise to decrease.

ARTICULATING JIB UP AND DOWN - 2750 PSI (189.6 BAR)

1. Install a high pressure gauge on gauge port M3. The jib relief valve is located below the level down relief valve. Activate jib up or down, it should read 2750 psi (189.6 Bar). Turn clockwise to increase, counterclockwise to decrease.

5.6 DRIVE PUMPS (REXROTH)

Troubleshooting Procedure

To aid in troubleshooting, refer also to the pressure measuring port connections for test gauge installation information as shown on the hydraulic circuit diagram. Procedure assumes proper gauges are installed. (Minimum gauges required: (2) 0-6000 psi, (1) 0-3000 psi & (1) 0-1000 psi [{2} 0-415 bar, {1} 0-210 bar & {1} 0-70 bar]). This procedure was written to aid the troubleshooter in following a logical approach to a hydraulic system fault.

1. Transmission does not propel the machine, diesel engine running properly
   - **a.** Is there oil in the reservoir?
     No - Fill reservoir
     Yes - If yes, proceed to step 1.b
   - **b.** Is the pump input shaft connected to the engine flex plate or rear of forward pump?
     No - Connect pump input shaft
     Yes - If yes, proceed to step 1.c
   - **c.** Are the hydraulic hoses and tubing connected in accordance with the hydraulic circuit diagram?

     No - Correct the hoses/tubing
     Yes - If yes, proceed to step 1.d
   - **d.** Is the pump direction of rotation correct? (clockwise as looking at the shaft)

     No - Fit pump having the correct direction of rotation
     Yes - If yes, proceed to step 1.e
   - **e.** Are there "O"-rings missing from fittings (as example - suction leak), pinched hoses, broken tubing, etc?

     No - Proceed to step 1.f
     Yes - Repair damage or fault
   - **f.** Are the electrical connectors/wiring intact and secure to the pump control solenoids?
     No - Repair damage or fault
     Yes - If yes, proceed to step 1.g
   - **g.** Does the engine "labor" when attempting drive, are the brakes released?
     No - Proceed to step 1.h
     Yes - Check brake release circuit, measure pressure at port "MP" on Traction Control manifold
   - **h.** Are all four wheel drive planetary reduction gearboxes engaged?
     No - Engage wheel drive(s)
     Yes - If yes, proceed to step 2.a

2. Transmission does not propel the machine, diesel engine running properly - Charge Pump/Relief Valve
   - **a.** Is there any charge pressure at port G or indicated by measuring pressure at Ma and Mb?
     No - Proceed to step 2.d
     Yes - Proceed to step 2.b
   - **b.** Is the charge pressure at least 500 psi while running at high engine speed?
     No - Proceed to step 2.c
     Yes - Proceed to step 3.a
   - **c.** Can the charge pressure be raised by removing dirt/debris from charge relief poppet or by adding or removing shims from the charge pressure relief valve mounted in the second pump of the triple?
     No - Proceed to step 2.d
     Yes - Adjust pressure to 500 psi +50 psi, -0 psi (34.4 bar +3.4 bar, -0 bar)

NOTE: *The propulsion circuit uses a hot oil flushing valve to obtain brake release pressure. The hot oil flushing valve cartridge (#120) is mounted in the Traction Control Manifold. The flushing valve receives its oil from the "left side" wheel drive pump; the middle pump of the triple. With the engine running and propelling the machine forward or reverse, the "hot oil flushing valve" and the brake release pressure must be adjusted to 475 psi, +25 psi, -0 psi (32.7 bar, +1.7 bar, -0 bar), as set by adjusting pressure relief cartridge (#130). The brake release pressure must be 25 psi less than the charge pump pressure. Measure pressure at port "MP" using a 0-1000 psi (0 - 70 bar) pressure gauge.*

   - **d.** Is the transmission pumps suction hose pinched shut?
     No - Proceed to step 2e
     Yes - Repair damaged hose
   - **e.** Is the charge pump suction pressure/vacuum within recommended limits? (0.8 bar absolute or 6.3 inches of mercury)
     No - Proceed to step 2.f
     Yes - Proceed to step 2.g
   - **f.** Is the suction strainer inside the reservoir blocked, clogged, restricted?
     No - Proceed to step 2.g
     Yes - Repair/replace with a clean suction strainer
   - **g.** Is the reservoir air breather blocked or restricted?
     No - Proceed to step 2.h
     Yes - Clean or replace air breather

h. Remove charge pressure relief valve from the middle pump and inspect. Is it damaged?
No - Refit cartridge and proceed to step 2.i
Yes - Clean & inspect cartridge, poppet, springs, seals to determine cause of damage. Repair or fit a new cartridge and return to step 2.a

i. Remove and inspect charge pump assemblies. Are they damaged?
No - Proceed to step 2.j
Yes - Repair and/or replace damaged components and return to step 2.a

j. Is the charge pump installed for the clockwise rotation?
No - Refit charge pump. Return to step 2.a
Yes - With proper charge pressure and transmission still does not operate, proceed to step 3.a

3. Transmission does not propel the machine, diesel engine running properly - Pump Control: (Insure Generator Drive option is not turned "on")

a. Are the electrical connectors & wiring connected properly to the pump control solenoids?
No - Connect a ammeter in series with solenoid wiring. Is a current of 400 mA to 1060 mA being applied. (Current signal varies with joystick position)
Yes - Proceed to step 3.b

b. Are all four of the two-speed motors, mounted in the wheel drive planetary reduction gearboxes, shifted to maximum displacement (high torque - low speed)?
No - Select maximum displacement
Yes - Proceed to step 3.c

c. Actuate the pump control in both directions. Do the pumps stroke? Do they go to full stroke?
No - Refer to the pump service manual and then proceed to step 3.d
Yes - Operate the transmission

d. Remove stroking orifices in X_1 and X_2. Install pressure gauges in X_1 and X_2 (0-500 psi [0 - 35 bar]). Stroke the pump in both directions. Do the pressures at X_1 and X_2 alternate between 30 & 250 psi (2 & 17 bar)?
No - Remove the EP control module & replace it with a new unit. Repeat step 3.c
Yes - Proceed to step 3.e.

e. Is the pressure at port "R", case pressure, less than 15 psi (1 bar) gauge pressure?
No - Correct problem restricting case drain oil flow (oil cooler blockage, pinched hoses, etc)
Yes - Proceed to step 3.f

f. Stroke pump in both directions, while measuring pressure at Ma & Mb ports of the pump. Does any pressure greater than charge pressure alternate between ports Ma & Mb?
No - Verify that loading the pump will cause system pressure to increase above charge pressure. Proceed to step 3.a
Yes - Proceed to step 3.g

g. Is it possible to adjust high pressure relief valves using 0-6000 psi (0 - 415 bar) gauges to monitor pressure at Ma & Mb? (Refer to relief valve adjustment)
No - Replace high pressure relief valve and return to step 3.c
Yes - Adjust high pressure relief valves to 5000 psi +50 psi, -0 psi (344.7 bar +3.4 bar, -0 bar)

h. Actuate control in both directions. Does transmission operate?
No - Check that minimum displacement stops on the wheel drive motors are adjusted properly, check that the motors stroke between maximum to minimum.
Yes - Operate the transmission

4. Transmission Drive is Sluggish or Erratic

a. Does the "EP" proportional pump control current vary with joystick movement?
No - Rectify the problem - broken wires, electrical connector, open solenoid coil, etc.
Yes - Proceed to step 4.b

b. Are all four (4) brakes fully released?
No - Check brake release pressure and insure each wheel receives correct release pressure.
Yes - Proceed to step 4.c

c. Are the pumps stroking time orifices installed tight and clean?
No - Remove the Plugs in ports X_1 and X_2. Remove orifices with a 3mm allen wrench. Check that orifices are clean & re-install.
Yes - Proceed to step 4.d

d. Is an motor displacement stroking time orifice plugged or is the two-speed shift hose pinched?
Yes - Inspect and clean stroking orifice, check two-speed hose routing

e. Is a flow divider/combiner cartridge stuck in the Traction Control Manifold? Flow divider/combiner cartridge # 111 controls the right side wheels, # 112 controls the left side wheels. Also check to insure bypass orifices #151 (right side) and # 152 (left side are not plugged.

5. Transmission Drives in one direction only

a. Are electrical connections to pump control proportional solenoids correct, intact and without defects?
Yes - Proceed to step 5.b
No - Rectify the problem

b. Check hot oil flushing valve cartridge #120 located in the Traction Control Manifold.
Remove and inspect flushing valve cartridge for stuck spool or damaged cartridge "O"-ring seals & backup rings.

c. Inspect "Make-Up" check valve cartridges, #190.1-190.4, installed in the Traction Control Manifold. Is a cartridge "stuck" open with debris or is an "O"-ring failed?
No - Proceed to step 5.d
Yes - Clean/repair or replace Make-Up check cartridge.

d. Swap high pressure relief valves in the transmission. Does the transmission drive in the other direction?
No - Proceed to step 5.e
Yes - Repair/clean/adjust or replace high pressure relief valve on the non-driving side

e. Replace "EP" control module. Does pump operate properly?
No - Replace or repair pump
Yes - Operate the transmission

6. Transmission Drives in Wrong Direction

a. Check to see if electrical connectors or wiring have been swapped on the pump.

b. Check to determine want end of the machine the boom is swung over.

7. Transmission Does Not Find or Hold Neutral

a. Does pump remain in neutral with electrical connectors removed?
No - proceed to step 7.b
Yes - Check electrical system for signal problem

b. With electrical connectors removed and machines wheels jacked off the ground and engine running, momentarily apply 12 volt DC signal (battery voltage) to a pump control solenoid. Does the pump return to neutral after the 12 volt signal is removed?
No - Apply 12 volts to opposite solenoid & recheck.
No - Replace pump control module, repeat step 7.a
Yes - Possibly dirt was dislodged from control module, re-check thoroughly to determine problem has definitely been resolved.

c. Check mechanical centering of the pumps

8. Transmission Drives at a High Noise Level

a. Are the wheel drive planetary reduction gearboxes filled to the correct level and do they have the proper lubricant?
No - Fill gearbox with correct grade of oil to the prescribed level.
Yes - Proceed to step 8.b

b. Is the engine flex plate and drive coupling correctly installed and aligned with the transmission pump?
No - Install flex plate and bell housing per manufacturer's instructions
Yes - proceed to step 8.c

c. Is a rigid item or object contacting the resilient mounted engine/pump assembly?
No - Proceed to step 8.d
Yes - Insure no item is contacting the unit, transmitting air borne noise.

d. Is the suction pressure/vacuum at the charge pumps inlets within recommended limits?
No - Return to step 1.h
Yes - Proceed to step 8.e

e. Is there air in the hydraulic fluid? This may be indicated by foaming or milky colored oil.
No - Proceed to step 8.f
Yes - Deaerate the oil and inspect system for cause of air induction. Check for loose or missing "O"-rings on face seal connections.

f. Is a wheel drive hydraulic motor operating at excessive speed?
Yes - Check minimum displacement stop screw adjustments on the motors. Should be 0.433" or 11mm above the stop screw lock nut. Is one or more motors "stuck" at minimum displacement, check for plugged/blocked two-speed stroking orifice(s).

9. Transmission Operates at a Higher than Normal Temperature

a. Is the reservoir temperature above 195°F (90.5° C)?
No - 195°F (90.5° C) is the upper limit. If temperature is over 195°F (90.5° C), the oil cooler may need to be cleaned.
Yes - Proceed to step 9.c

b. Are the hydraulic motor(s) stalling (wheels not turning) intermittently?
No - Proceed to step 9.c
Yes - Hydraulic fluid is being heated through system pressure relief valves. Shut down system and rectify the cause of motor stall.

c. Does oil temperature remain above 195°F (90.5° C), after cleaning the oil cooler?
No - Operate transmission. Check oil cooler more often.
Yes - Proceed to step 8.a

10. Transmission Operates at a Higher than Normal Temperature

a. Check for differential temperature across the oil cooler. Is there a temperature difference?
No - Check to determine if the bypass check valve (10 psi [0.7 bar] crack pressure) is stuck open. Check to determine if the oil cooler is restricted internally, causing oil flow to pass across the bypass check valve.
Yes - Proceed to step 8.b

NOTE: *Oil cooler flow is received from the transmission pumps cases, max. continuous pump case pressure is 15 psi gauge pressure. Higher pressure will prematurely damage pump shaft seals*

b. Disconnect pump case drain from oil cooler & check flow rate from charge pumps. Is the flow rate 3.8 GPM (14.4 LPM) with diesel idle speed of 1200 rpm?
No - Refer to charge pump removal & inspection procedure

11. Transmission Pump(s) Do Not Develop Maximum Horsepower (Flow & Pressure)

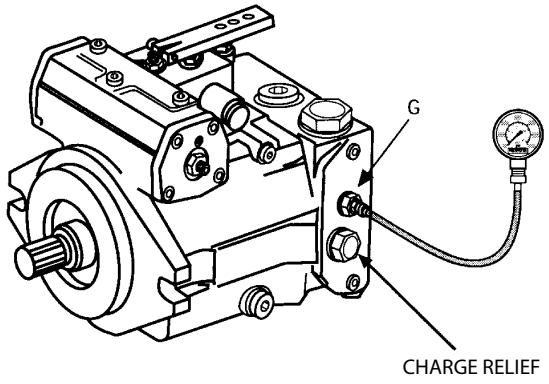
a. Does the charge pump pressure meet specification?
No - Return to step 2.a
Yes - Proceed to step 11.b

b. Does the pump case pressure exceed 15 psi gauge pressure?
No - Proceed to step 11.c
Yes - Check case drain hoses, oil cooler, etc. for pinched or restricted oil flow

c. Are the pump(s) high pressure cross port relief valves adjusted to the required pressure (5000 psi) so they do not bypass prematurely?
No - Inspect/clean/adjust and or replace valve cartridge
Yes - Replace the pump, after blocking the "A" & "B" ports, running the pump and measuring pressure developed at "A" & "B". This must be done to insure that flow & pressure loss in not elsewhere in the system. (motors, swivel coupling, etc)

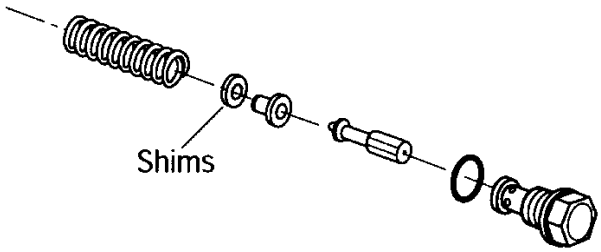
d. Is the diesel engine capable of developing horsepower at design rpm?
Follow recommended troubleshooting procedures to insure the engine is developing full power at specified rpms.

Charge Pressure Relief Valve Adjustment



With a low pressure (0 – 1000 psi [0 - 70 bar]) pressure gauge tee'd into the "G" port or two (2) low pressure gauges installed into "Ma" and "Mb", run pump at engine idle speed. Do not place the pump on stroke – low pressure gauges installed in "Ma" & "Mb" will be damaged! Prior to adjusting pressure, insure charge pressure relief valve is clean of any dirt or debris. The charge pressure relief valve does not wear appreciably over time. If charge pressure was normal and then has decayed, check for other causes of low charge pressure. If pressure is low, remove relief valve and add shim(s). If pressure is high, remove relief valve and take out shim(s).

NOTE: *Shim thickness 1 mm = 56 psi (3.86 bar). Shims are available in 0.3, 0.5, and 1.0 mm thickness.*



Mechanical Centering of Pump

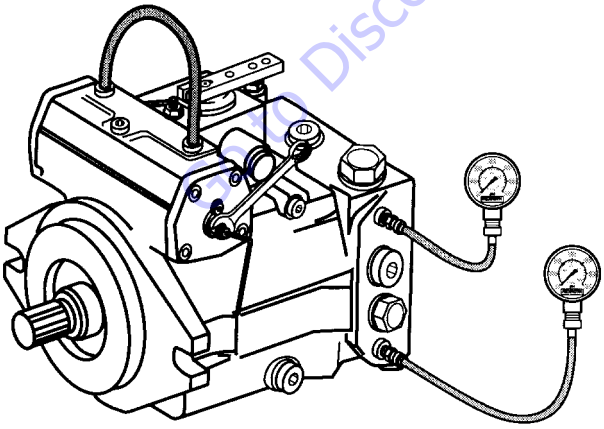
PREPARATION FOR ADJUSTMENT

The control piston has strong centering springs to ensure that once the pump is adjusted for the neutral position it will always return to neutral. If an adjustment is necessary follow the steps listed below.

To ensure there is equal pressure on both sides of the control module during the centering operation, it is necessary to connect the X_1 and X_2 ports together by means of hose or tubing. (No less than a 1/4 inch ID) The port sizes are:

Pump Size	Allen Wrench	Wrench
28	5 mm	17 mm

With pressure gages installed at M_A, and M_B, and with A and B ports blocked (or motor stalled), and with the pump running, loosen the jam nut. Turn the mechanical centering adjusting screw until 1000 psi is read on M_A, or M_B then turn screw opposite direction until 1000 psi is read on other pressure port. Turn the screw back, splitting the distance between the previous two positions. This should be the neutral position. Pressure on M_A, and M_B should be equal.

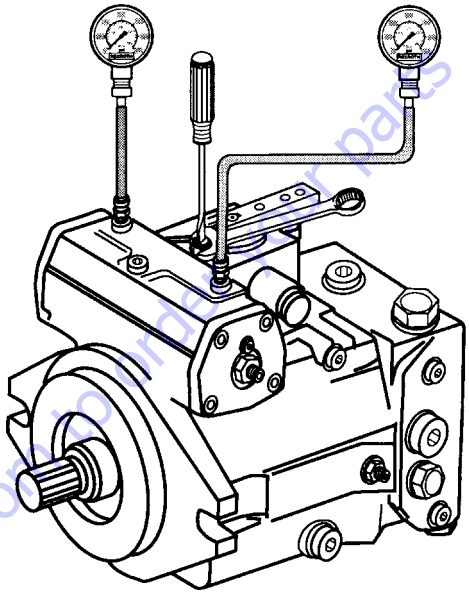


Tighten jam nut, stop the pump drive, remove the hose connecting ports X_1 and X_2.

Hydraulic Centering of Control Modules

PREPARATION FOR ADJUSTMENT

When control modules are exchanged or replaced, it is generally necessary to center the new module. This is done by running the pump with gauges installed at ports X_1, X_2, M_A, and M_B Release the jam nut and turn the adjustment screw on top of the control module valve body.



The adjustment screw is an eccentric, therefore, turning more than 90' in either direction will have no further centering effect, and could cause damage to the eccentric pin.

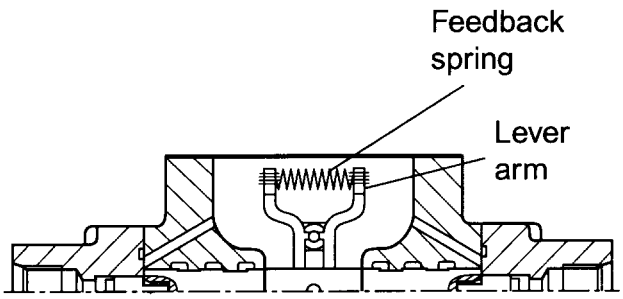
Pump Size	Tool Required	Wrench
28	Screwdriver	10 mm

CENTERING THE EP CONTROL MODULE

With no electrical signal to solenoids A and B, (remove both plug-in connectors), the EP control module is correctly adjusted when any or all of the following conditions exist:

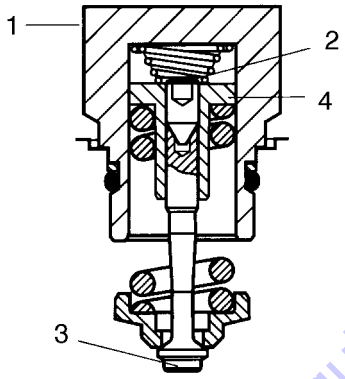
1. Approximately, when equal control pressures are obtained at control pressure ports X_1 and X_2.
2. The hydraulic motor does not turn when the brake is released.
3. Charge pressure is registered equally at ports M_A and M_B, when the flow output of the pump is deadheaded against a locked motor or a valve.

If difficulties are encountered in obtaining neutral position of the HD or EP control modules, check that the ends of the control spring are correctly located in the grooves near the end of the feedback lever arms.



High Pressure Relief Valve Adjustments

1. Remove relief valve cover from pump (ref. item 1).



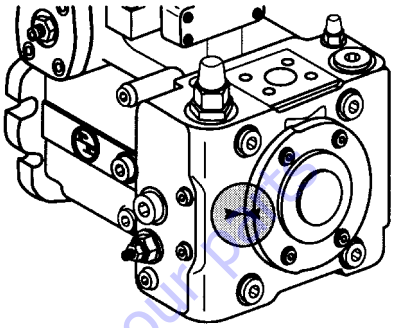
2. Loosen jam screw (ref. item 2).
3. Holding spring loading nut (ref. item 4) rotate valve spindle (ref. item 3). For high range relief valve, one turn equals approximately 630 psi (44 bar). For low range relief valve, one turn equals approximately 377 psi (26 bar).
4. After adjustment is completed torque jam screw (ref. item 4) to 5 ft.lb. (7 Nm).
5. Install relief valve assembly into pump, reinstall cover (ref. item 1) to proper torque.

Table 5-37. Torque Specs for Relief Valves into Port Block

Pump Size	Wrench Size	Torque
28	32 mm	66 ft.lb. (90 Nm)

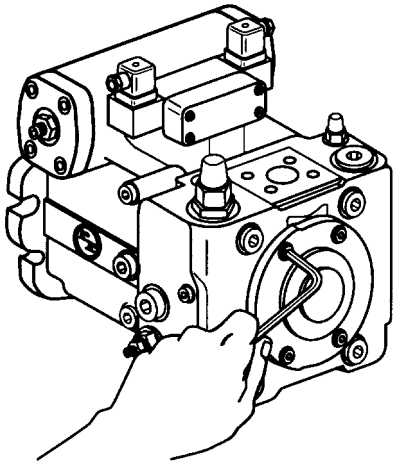
Removal and inspection of charge pump

Before removing cap screws, mark the position of the charge pump housing and separator plate in relation to the port block.

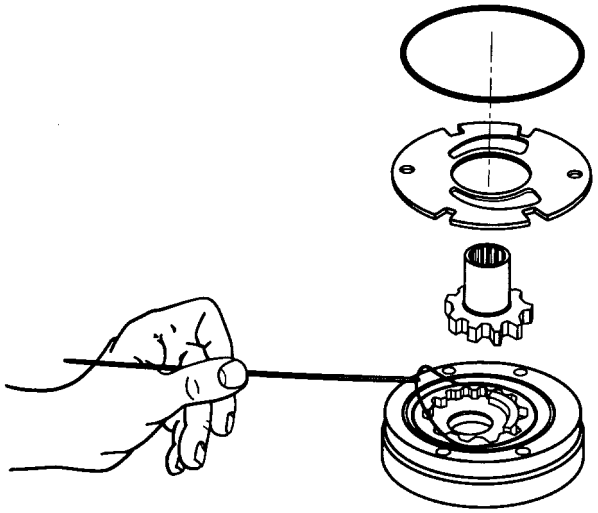


Loosen screws with metric allen wrench.

Pump Size	Allen Wrench
28	8 mm

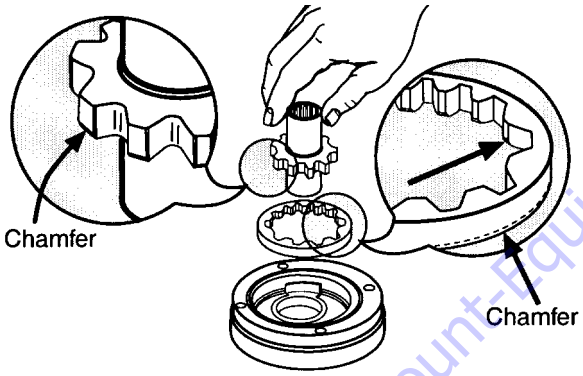


Remove charge pump housing and inspect for wear or damage to gear set and 0-ring seals. Grease 0-rings prior to reassembly. Make sure 0-rings are completely seated in their grooves.



Withdraw pinion shaft and inspect gear teeth and bearing surfaces for abnormal wear.

When reassembling, make sure chamfer (on outer edge of driven gear and drive gear) is installed into housing per illustration.



Torque value for bolts when replacing charge pump.

Pump Size	Torque
28	18 ft.lb. (24 Nm)

NOTE: *If serious wear or damage has occurred to one component, the complete charge pump assembly must be replaced because they are matched components.*

Routine Maintenance

The Variable Displacement Hydrostatic Transmission Pumps are relatively maintenance free. Maintenance work is confined to the system, by way of maintaining hydraulic fluid condition, the "life blood" of the machine. Oil monitoring, changes and filter renewal promote system cleanliness. This will prevent premature breakdown and repairs. Under normal application conditions, the following maintenance intervals are suggested:

1. Renewal of Filter Elements
   - **a.** After commissioning or re-build.
   - **b.** At every 500 operating hours or when filter indicator shows a dirty element.
   - **c.** With the suction strainer, the strainer should be renewed as soon as charge pump inlet pressure is less than -3.2 psi, 6.3"Hg or 0.8 bar absolute.
   - **d.** Only JLG recommended filter elements are to be used. Paper elements cannot be cleaned; use throw-away cartridges.
2. Hydraulic Fluid Change
   - **a.** After 2000 operating hours (1st oil change)
   - **b.** Thereafter, every 2000 operating hours or annually, irrespective of operating hours achieved.
   - **c.** Oil change should be performed with the system in warm running condition. Before re-filling, the reservoir interior should be inspected and cleaned to remove any sludge.
   - **d.** Rags or threaded material must not be used.
   - **e.** This machine has been designed & manufactured to operate on an Exxon-Mobil Oil Co. hydraulic fluid, Mobilfluid #424, Product #52233-4. Consult JLG Industries prior to introducing any other type of fluid to prevent interaction or possible contamination.
   - **f.** The recommended interval between oil changes is based on various factors and should be carried out according to the degree of aging, contamination and water content.
   - **g.** Under application conditions with a heavy occurrence of dust or severe temperature fluctuations, the intervals between fluid maintenance should be shortened accordingly.

NOTICE

PRACTICAL EXPERIENCE SHOWS THAT MOST FLUID MAINTENANCE ERRORS OCCUR DURING AN OIL CHANGE DUE TO:

- **USE OF AN UNSUITABLE HYDRAULIC FLUID**
- **USE OF OIL CONTAMINATED DUE TO POOR STORAGE PRACTICES**
- **FAILURE TO CLEAN THE RESERVOIR**
- **INADEQUATE CLEANLINESS WHEN FILLING THE RESERVOIR (DIRTY DRUMS, CONTAINERS, WATER, ETC)**

3. Leakage Inspection

a. After commissioning

b. The complete transmission drive system (pumps, motors, hosing, filters, valves, etc) should be checked for leakage at regular intervals.

c. Leaking joints & connections must only be tightened when pressureless.

4. Cleanliness Inspection

a. The oil tank breather should be regularly cleaned of dirt and dust to prevent clogging. With each cylinder movement, gallons of oil pumped, an equal amount of air exchange occurs across the reservoir breather. A dirty or clogged breather will affect **all** machine functions!

b. The air/oil cooler surfaces and engine radiator should be cleaned at the same time.

c. If hose connections are disassembled, it is imperative that the utmost care be taken that no foreign bodies infiltrate the oil circuit. Catastrophic component failure may occur.

5. Oil Level Inspection

a. Inspect oil level in the reservoir daily.

b. If "topping off" is required, use only the same Mobilfluid #424, Product #52233-4.

c. Do Not Mix Fluids.

6. Hydraulic Fluid - The "Life Blood" of the Machine

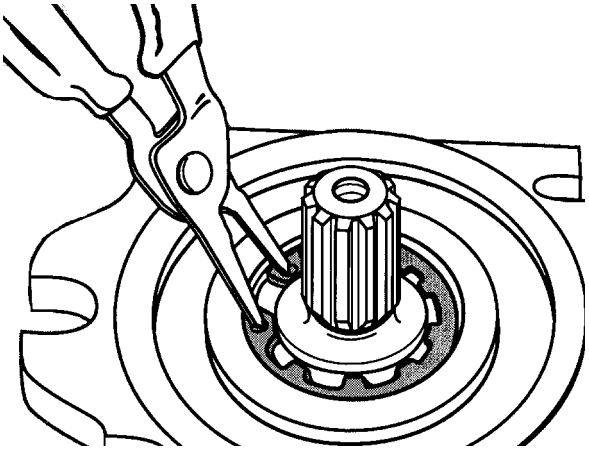
a. The type of hydraulic fluid supplied in the machine from the factory was selected after extensive testing and development. The fluid was selected to perform under "most" applications and conditions. Should this machine be in service for extended time periods at the extremes (hot or cold), JLG should be consulted for assistance in selection of the most suitable fluid type and grade for your application.

b. When operating at temperatures below 0^{o}F, allow a warm-up period, if at all possible, to a temperature of 40^{o}F.

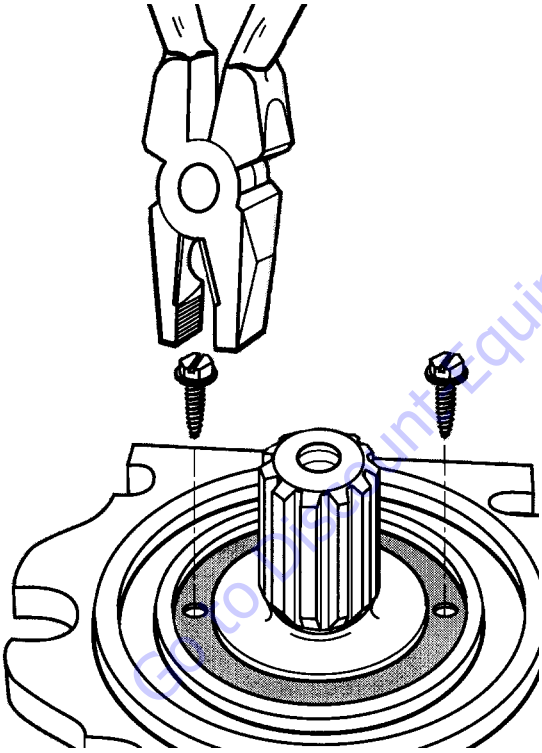
c. When beginning motion of a "cold" machine, operate all functions at reduced speeds until the "cold" oil has circulated out of the drive loop.

Removal and Installation of Shaft Seal

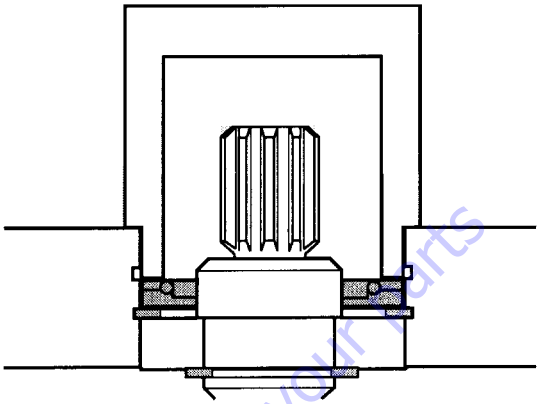
Remove the retaining ring with snap ring pliers.



Screw in sheet metal screw into the holes fitted with rubber. Pull out shaft seal with pliers.



Press in shaft seal with bushing to the stop. Then replace snap ring.



5.7 FUNCTION PUMP (REXROTH)

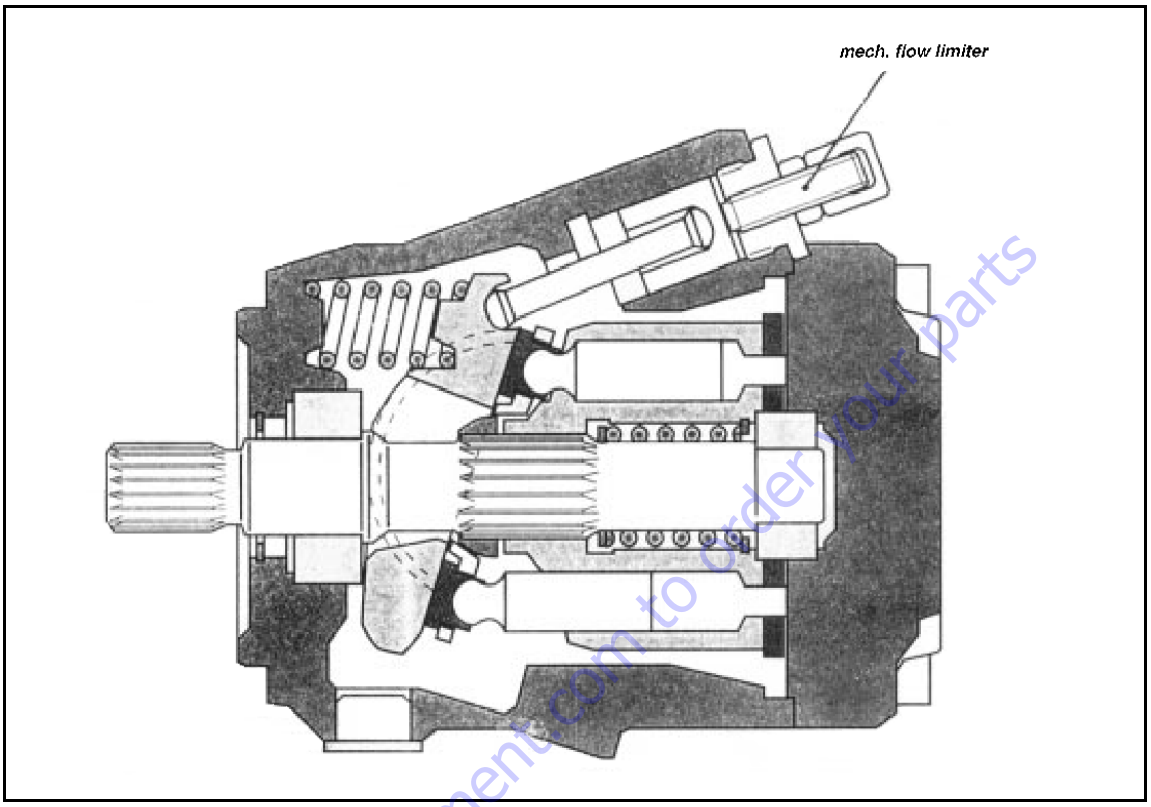
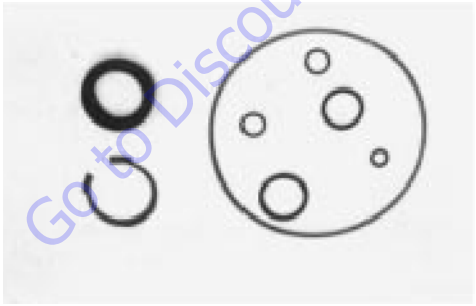


Figure 5-61. Function Pump - Sectional View

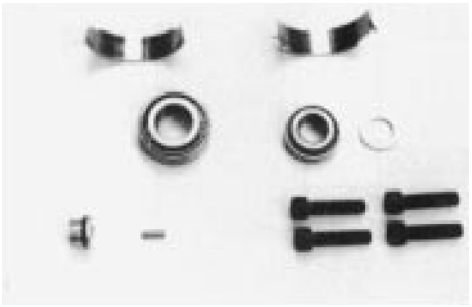
Spare Parts

1. Sealing kit, existing spare parts: shaft sealing ring, o-rings, and a circlip.

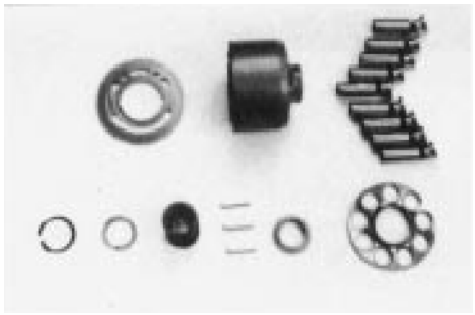


2. Drive Shaft

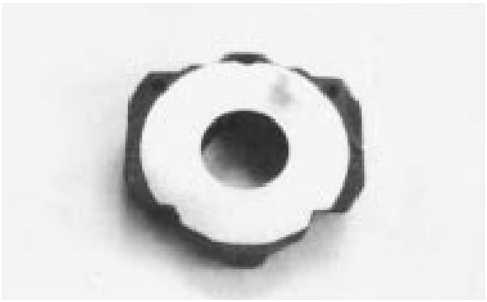
3. Bearing set, miscellaneous parts.



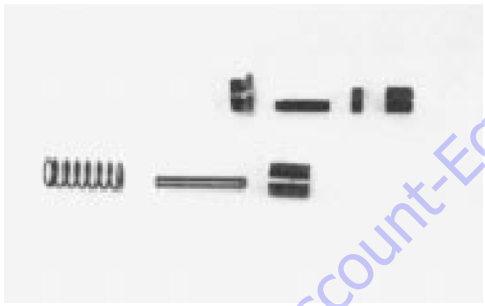
4. Rotary Group complete: 9 pistons, cylinder subassembly, valve plate, retaining plate, and retaining ball.



5. Swash Plate.



6. Parts of the control valve: control piston, piston rod, plug, spring stopper max flow, hex nut, and hex head nut.



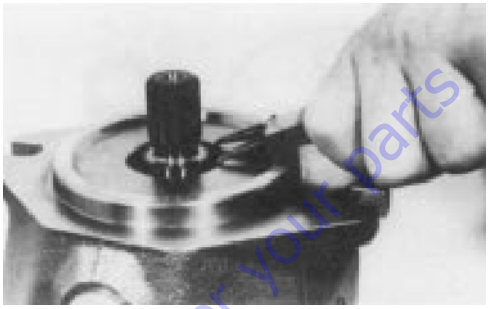
7. DFR pilot valve.

Sealing the Drive Shaft

NOTICE

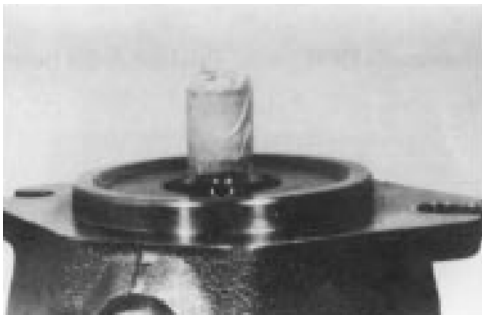
BE VERY CAREFUL SO THE DRIVE SHAFT IS NOT DAMAGED DURING THE REMOVAL OF THE SHAFT SEALING RING.

1. Remove the snap ring.



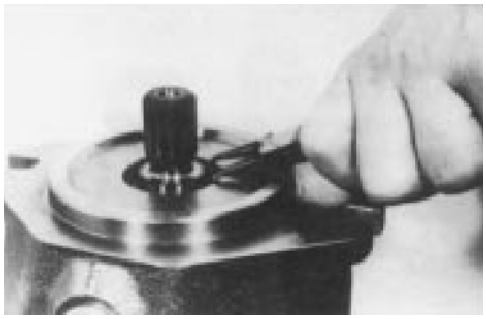
2. Change the shaft seal and check its' sliding surface (drive shaft) and housing. Grease the sealing ring.

3. Be careful while you seal the drive shaft. Use an adhesive tape to prevent the shaft splines from damaging the seal.



4. Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.

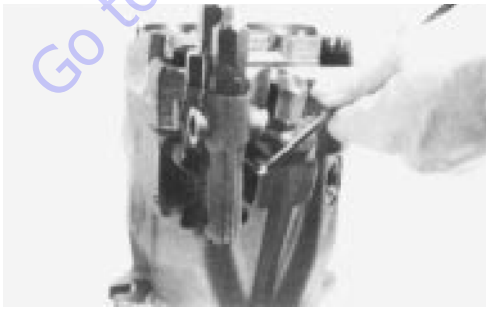
5. Assemble the snap ring.



6. Assemble the snap ring in the correct position.

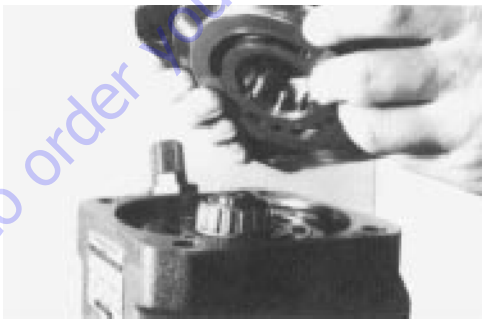
Disassembly and Assembly of the Complete Unit

1. Disassemble the pilot valve.



2. Mark the position of the port plate and remove the socket screw of the port plate.

3. Remove the port plate together with the valve plate (hold the valve plate so the plate can't fall down).

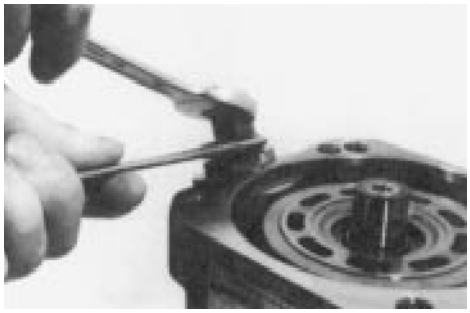


4. Remove the o-ring.

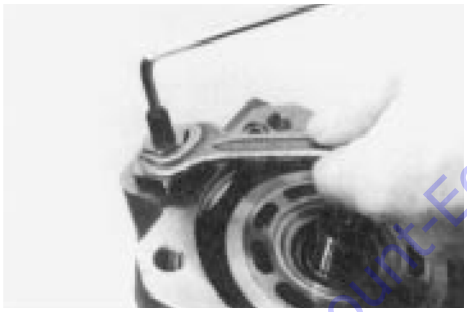
5. Disassemble the taper roller bearing (nearby port plate).

6. Remove the adjustment shim.

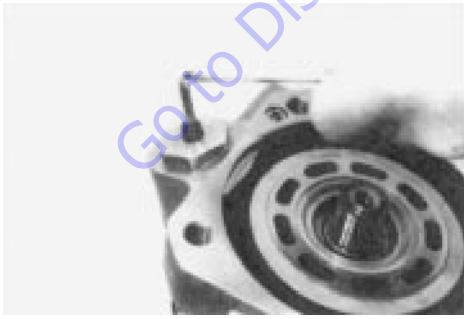
7. Unscrew the cap nut and remove it.



8. Loosen the fixing nut of the stopper max flow and disassemble it.



9. Turn in the stopper max flow to get swivel angle zero.



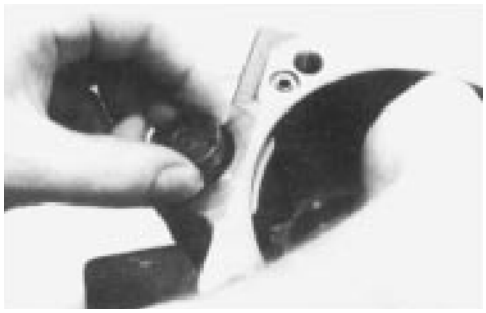
10. Disassemble the rotary group in horizontal position.

11. Disassemble the stopper max flow.

12. Remove the threaded pin.

13. Disassemble the plug.

14. Disassemble the control piston while moving the swash plate.



15. The swash plate must be lifted a little bit to disassemble the piston rod.

16. Remove the swash plate.

17. Remove the spring.

18. Remove both bearing shells.

19. Remove the drive shaft.

20. Disassemble the snap ring.

21. Disassemble the sealing ring.

22. The external front bearing ring is pulled out of the pump housing.

23. Remove the o-ring. Lifting of the valve plate isn't shown.

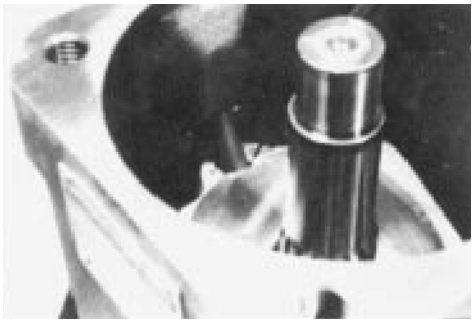
24. A bearing puller is used to disassemble the external bearing ring of the taper roller bearing inside the port plate. Take care of the surface of the port plate.

25. The spring has additional pretension while you disassemble the three pressure pins inside the cylinder.

Assembly

1. Measurement of the taper roller bearing pretention.

2. Ensure there is a correct connection of the piston rod and the swash plate.



3. Pumps clockwise driven must have a position of the valve plate 4 degrees out of center in the same direction decentered like drive direction.

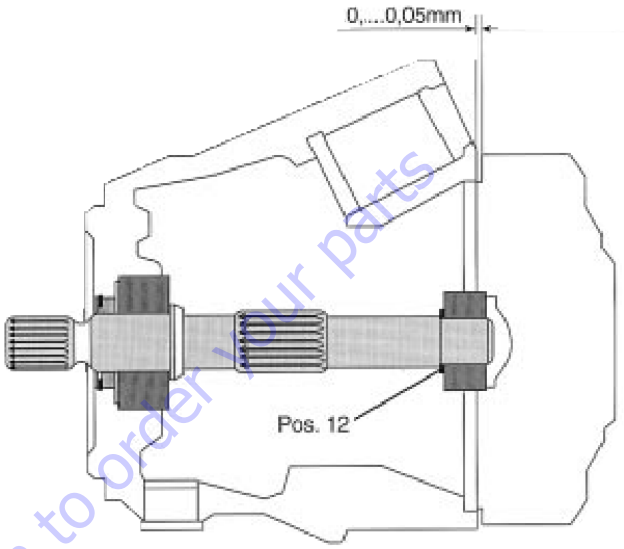
4. Pumps counterclockwise driven must have a position of the valve plate 4 degrees decentered in the ccw position.

5. Note the correct position of the drilling that connects high pressure to the control valve. Check control valve drilling position at the pump housing and fit together.

Adjustments

TAPER ROLLER BEARING INITIAL TENSION

Cast Iron pump housing must have initial tension of the bearings: 0 to 0.05 mm.



MECHANICAL FLOW LIMITER

Differential volume if you are rotating the threaded pin - each rotation is approximately 3.1 cm3.

Tightening Torques

For break-off plugs, use Loctite #601.
For all other parts, use JLG Threadlocker PN 0100011.

Table 5-38. Tightening Torques

	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M30
8.8	2.3	5.0	8.5	21	41	72	115	176	240	350	600	1220
10.9	3.2	7.2	12	29	58	100	165	250	350	490	840	1670
12.9	4.1	8.5	14.5	35	70	121	195	300	410	590	990	2000

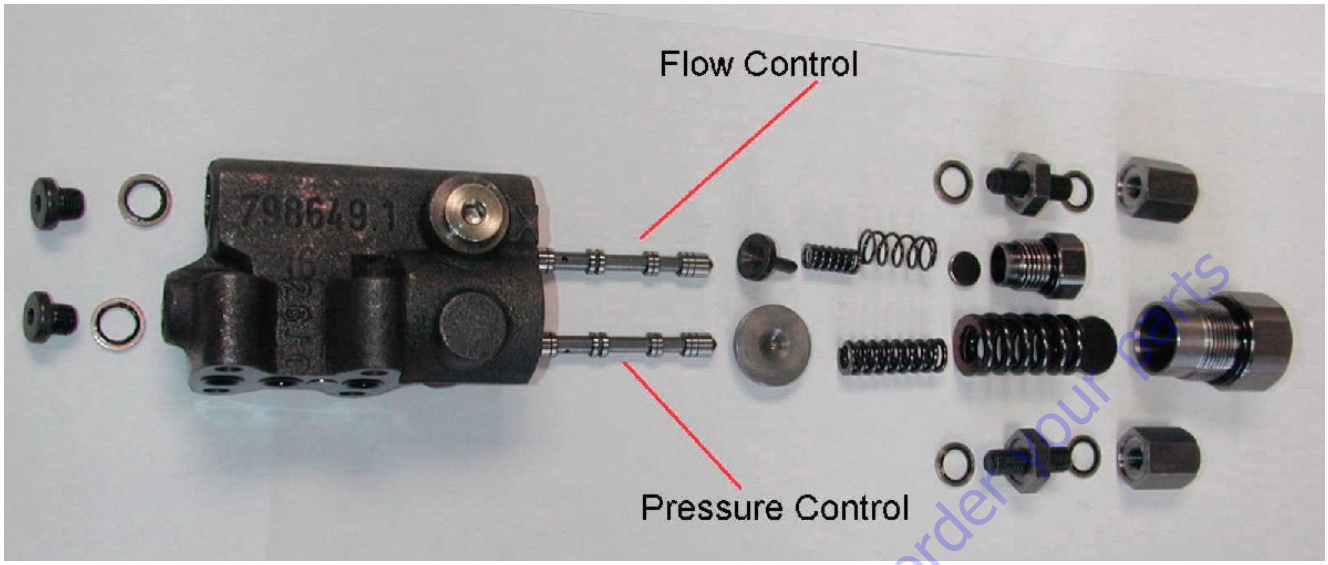


Figure 5-62. Function Pump, Pressure and Flow Control - Sheet 1

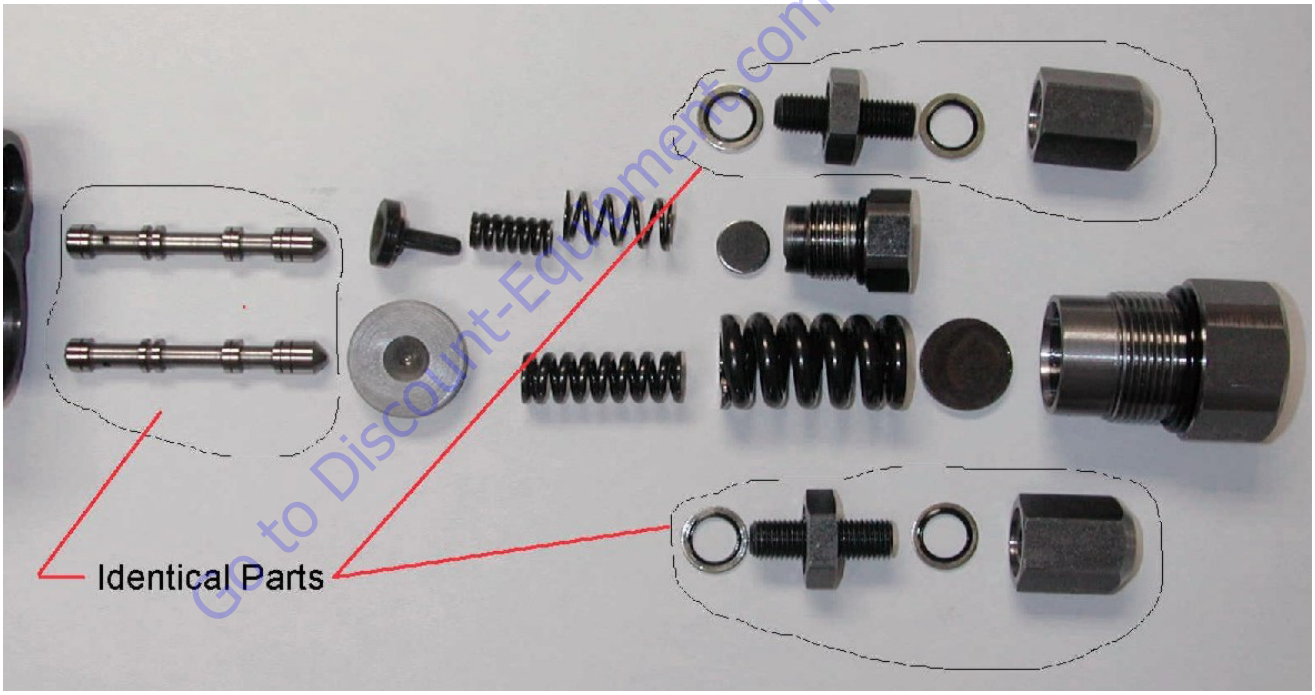


Figure 5-63. Function Pump, Pressure and Flow Control - Sheet 2

Figure 5-64. Function Pump, Pressure and Flow Control - Sheet 3

Pump Control Disassembly For Cleaning

NOTE: If the Function Pump does not perform correctly after following the pre-start start-up procedures, it is possible that a contaminate particle has lodged in the pump control preventing proper operation. The pump control's internal parts are not provided as spare parts due to the close tolerances required between the mating parts. However, the control can be disassembled, cleaned and placed back in service should the only problem prove to be contamination. Disassembly, inspection, cleaning and reassembly MUST BE done in a clean well-illuminated area.

Pump Control removal:

1. Disconnect plug the hose attached to the pump control Port "X".
2. Remove the four (4) socket head cap screws that attach the control to the pump. Insure that the three (3) "0"-rings are also removed with the control.
3. Hydraulic fluid may drip from the pump. Wiping the surface clean and installing some adhesive tape should prevent oil from seeping from the pump control.
4. Work on a clean, lint free area.

NOTE: *The pump control can be equipped with either O-rings or a sealing plate. These components are NOT interchangeable.*

5. Remove the three (3) "0"-rings (Parker # 2-011, Viton 90 shore)
6. Remove both the adjustment hex caps and bonded seal rings. (17 mm wrench)
7. Remove both the adjustment lock nuts and bonded seal rings. (17 mm wrench)
8. Remove both the adjusting screws. (3-mm Allen wrench)
9. Remove the spring cover hex cap for the "outer" flow regulation adjustment this requires a 19-mm wrench.

10. Remove the spring disc.

11. Remove the adjusting springs (two springs, one "nested" inside the other) and spring follower.

12. The flow regulation spool should slide from the control housing, (a magnet should aid in removal). If it does not, remove the hollow hex head plug at the rear of the flow regulation spool and carefully push the spool from the housing - do not scratch/mar the spool's bore.

13. Remove the spring cover hex cap for the "inner" pressure compensation adjustment – this requires a 30-mm wrench.

14. Remove the spring disc.

15. Remove the adjusting springs (two springs, one "nested" inside the other).

16. Remove the spring follower.

17. The pressure compensation spool should slide from the control housing, (a magnet should aid in removal). If it does not, remove the hollow hex head plug at the rear of the flow regulation spool and carefully push the spool from the housing - do not scratch/mar the spool's bore.

18. The spools are identical.

19. Wash the housing and all parts in a clean JLG approved solvent such as non-chlorinated brake cleaner, Stoddard solvent, etc.

20. Blow off all the parts with clean, dry compressed air.

21. Inspect the housing for contamination or plugged orifices. Clean orifices carefully with a dead soft steel wire to insure they are open. Inspect all parts for burrs, scoring, debris, etc.

NOTE: *On the mounting surface of the control housing, between the oil ports is what appears to be a slotted head screw. IT IS NOT A SCREW. This is a bleed orifice, which must be orientated to allow proper control operation. The slot in the head should be oriented to fall in-line with the oil ports, NOT PERPENDICULAR to the oil ports. If the slot is oriented perpendicular to the three ports, the pump pressure will not return from load pressure to stand-by pressure at the end of operating a function! The pump pressure will remain at the last highest pressure generated.)*

22. After all parts are clean and dry, lightly oil a control spool and install in its bore. The spool must slide smoothly and easily within the housing. If it does not, check for contamination. If contamination cannot be found check for "scoring" or "burring" of the control housing. If the spool does not slide smoothly & freely, the control must be replaced with a new unit.

23. Lightly oil and check operation of the second spool. The spools are installed correctly when there "pointed" end faces the spring followers

24. Re-assemble in reverse order.

25. Bench set the pressure adjustments as described in "C. 4" of the Operating Instructions.

NOTE: *The pump control can be equipped with either O-rings or a sealing plate. These components are NOT interchangeable.*

26. Re-install on the Function Pump, insure the "0"-rings are installed properly and tighten the four (4) M6 socket head cap screws to 105 inch pounds.

5.8 DRIVE PUMPS (SAUER)

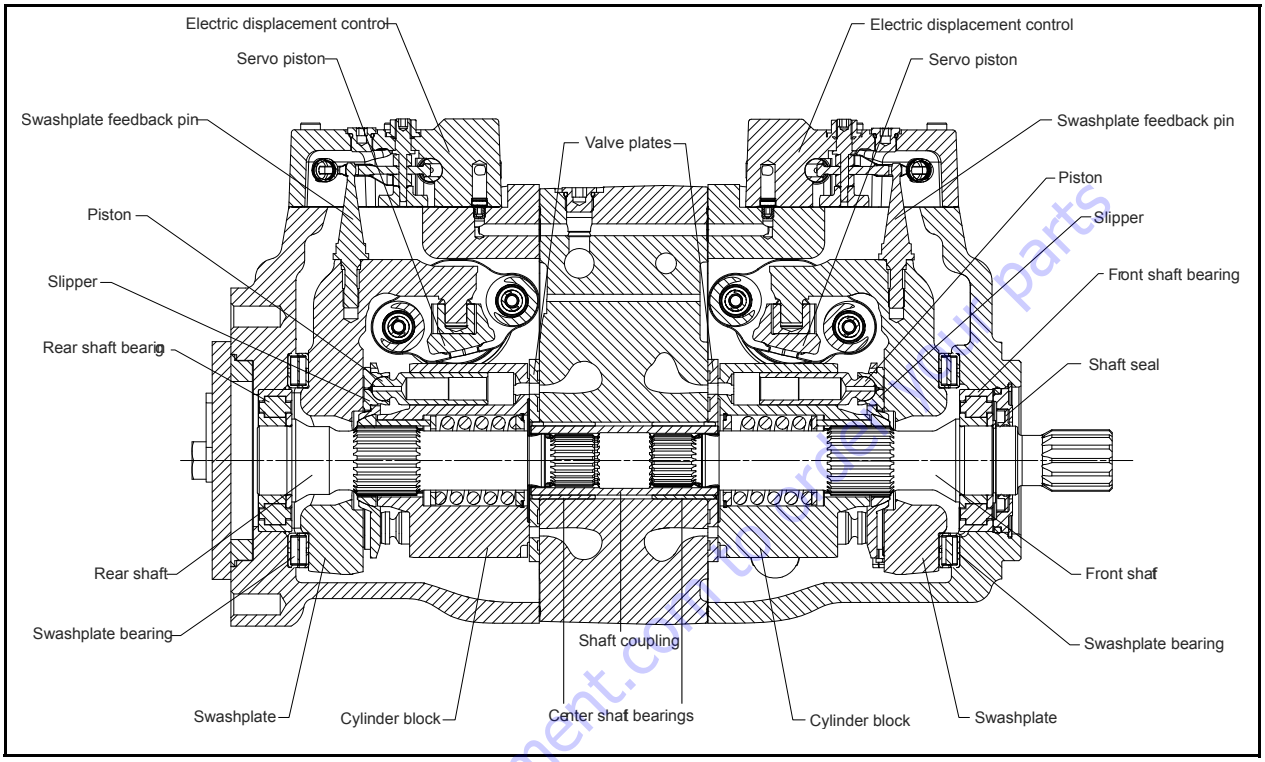


Figure 5-65. Piston Pump Cross Sectional View

Port Locations and Gauge Installation

Table 5-39. Port information

Port identifier	Port size	Wrench size	Reading	Gauge size, bar [psi]
L1, L2, L3	1 1/16-12 UNF 2B	9/16 internal hex	Case drain	10 bar [100 psi]
MA, MB, MC, MD	9/16-18 UNF	1/4 internal hex	System pressure	600 bar [10,000 psi]
M3	9/16-18 UNF 2B	1/4 internal hex	Charge pressure	50 bar [1000 psi]
M4, M5	7/16-20 UNF 2B	3/16 internal hex	Servo pressure	50 bar [1000 psi]
X7	9/16-18 UNF 2B	1/4 internal hex	Brake pressure	50 bar [1000 psi]

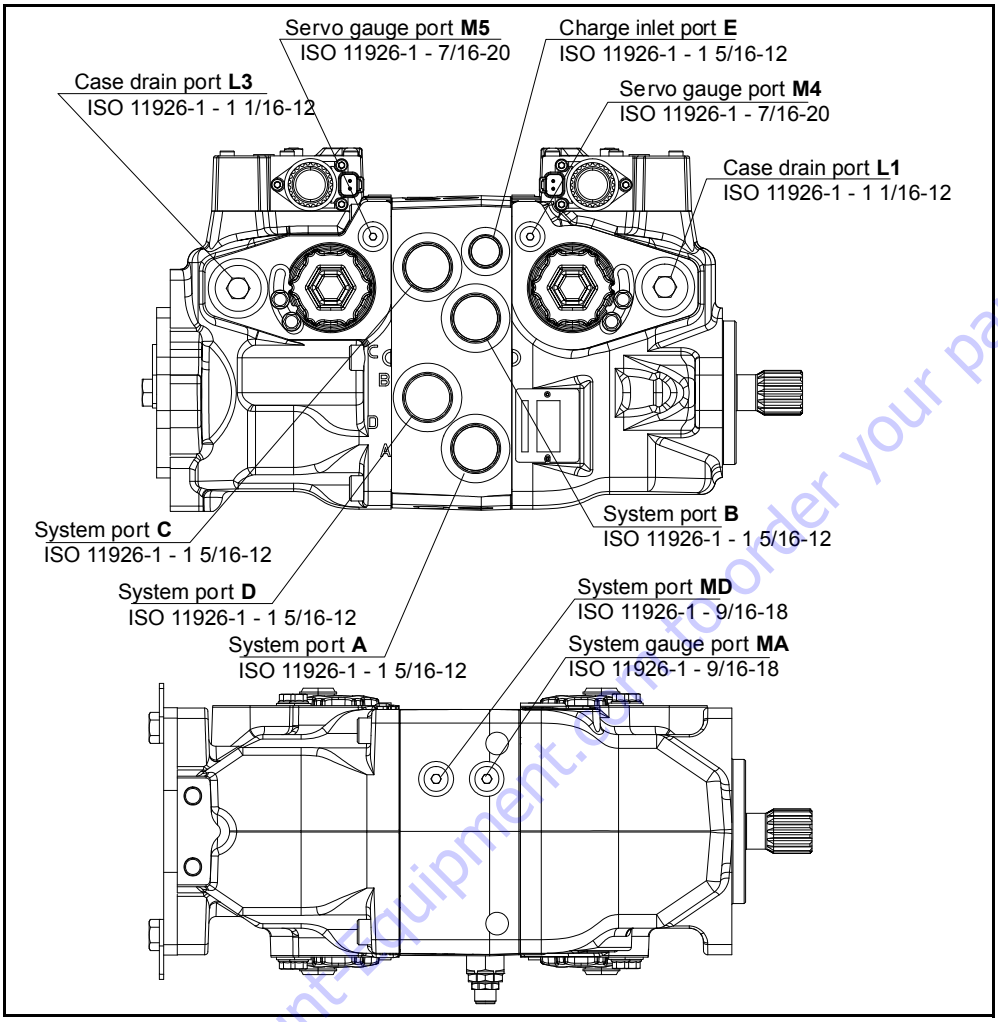


Figure 5-66. Port locations - Sheet 1 of 2

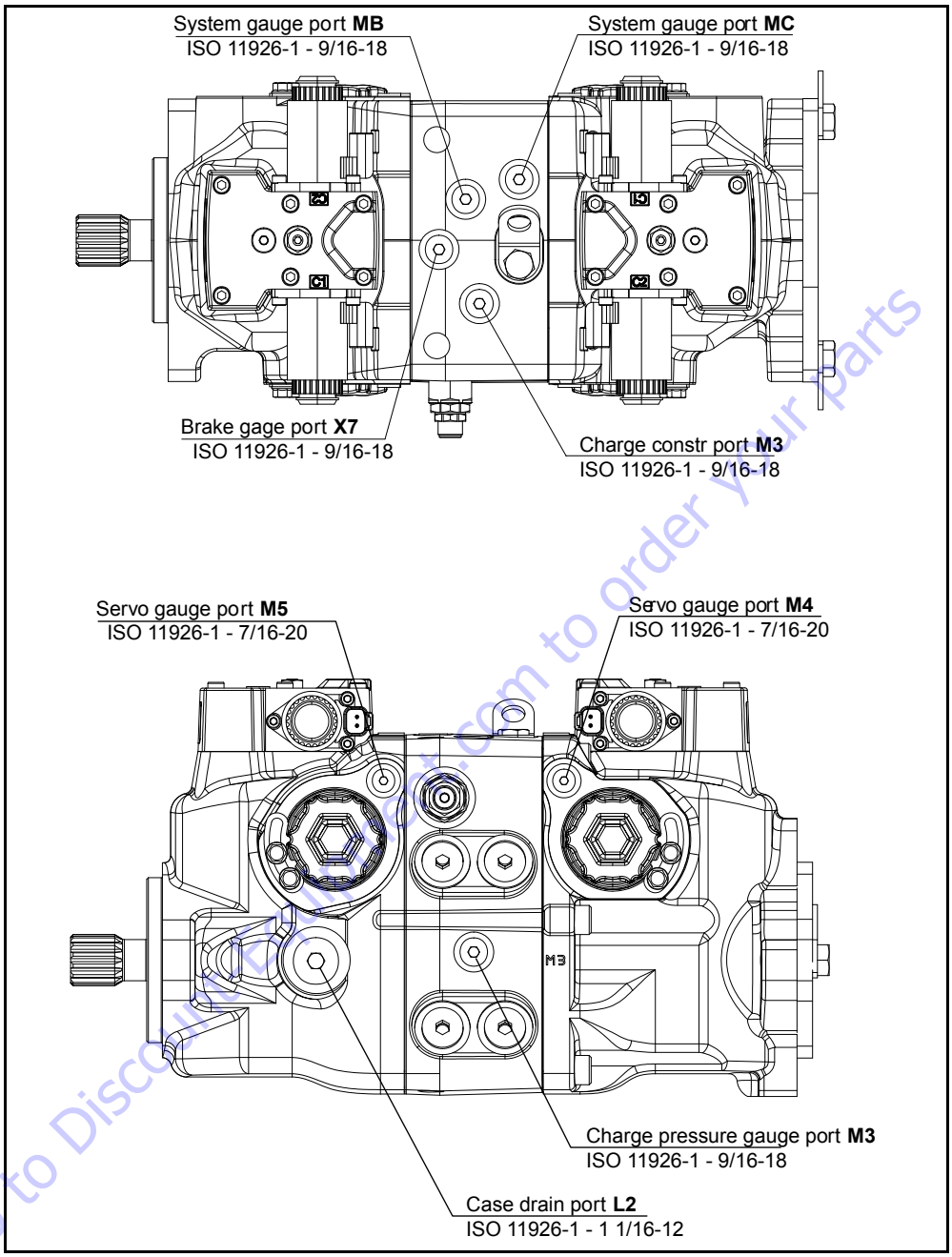


Figure 5-67. Port locations - Sheet 2 of 2

Initial Startup Procedures

Follow this procedure when starting-up a new pump or when restarting a pump that has been removed. Ensure the pump is thoroughly tested on a test stand before installing.

Prior to installing the pump, inspect for damage that may have occurred during shipping.

1. Ensure that the machine hydraulic oil and system components (reservoir, hoses, valves, fittings, and heat exchanger) are clean and free of any foreign material.
2. Install new system filter element(s) if necessary. Check that inlet line fittings are properly tightened and free of air leaks.
3. Install the pump. Install a 50 bar [1000 psi] gauge in the charge pressure gauge port M3.
4. Fill the housing by adding filtered hydraulic fluid to the upper case drain port. If the controls are installed on top, open the construction plugs in the top of the controls to assist in air bleed.
5. Fill the reservoir with hydraulic fluid of the recommended type and viscosity. Use a 10-micron filler filter. Ensure construction plug is closed after filling is complete.
6. Disconnect the pump from all control input signals.

⚠ CAUTION

AFTER START-UP THE FLUID LEVEL IN THE RESERVOIR MAY DROP DUE TO SYSTEM COMPONENTS FILLING DAMAGE TO HYDRAULIC COMPONENTS MAY OCCUR IF THE FLUID SUPPLY RUNS OUT. ENSURE RESERVOIR REMAINS FULL OF FLUID DURING START-UP.

⚠ CAUTION

AIR ENTRAPMENT IN OIL UNDER HIGH PRESSURE MAY DAMAGE HYDRAULIC COMPONENTS. CHECK CAREFULLY FOR INLET LINE LEAKS.

⚠ CAUTION

DO NOT RUN AT MAXIMUM PRESSURE UNTIL SYSTEM IS FREE OF AIR AND FLUID HAS BEEN THOROUGHLY FILTERED.

7. Use a common method to disable the engine to prevent it from starting. Crank the starter for several seconds. Do not to exceed the engine manufacturer's recommendation. Wait 30 seconds and then crank the engine a second time as stated above. This operation helps remove air from the system lines. Refill the reservoir to recommended full oil level.
8. When the gauge begins to register charge pressure, enable and start engine. Let the engine run for a minimum of 30 seconds at low idle to allow the air to work itself out of the system. Check for leaks at all line connections and listen for cavitation. Check for proper fluid level in reservoir.
9. When adequate charge pressure is established (as shown in model code), increase engine speed to normal operating rpm to further purge residual air from the system.
10. Shut the off engine. Connect the pump control signal. Start the engine, checking to be certain the pump remains in neutral. Run the engine at normal operating speed and carefully check for forward and reverse control operation.
11. Continue to cycle between forward and reverse for at least five minutes to bleed all air and flush system contaminants out of the system loop.

NOTE: *Normal charge pressure fluctuation may occur during forward and reverse operation.*

12. Check that the reservoir is full. Remove charge pressure gauge and cap port. The pump is now ready for operation.

Troubleshooting

⚠ CAUTION

HIGH INLET VACUUM CAUSES CAVITATION WHICH CAN DAMAGE INTERNAL PUMP COMPONENTS.

⚠ WARNING

ESCAPING HYDRAULIC FLUID UNDER PRESSURE CAN HAVE SUFFICIENT FORCE TO PENETRATE YOUR SKIN CAUSING SERIOUS INJURY AND/OR INFECTION AND MAY BE HOT ENOUGH TO CAUSE BURNS. RELIEVE PRESSURE IN THE SYSTEM BEFORE REMOVING HOSES, FITTINGS, GAUGES, OR COMPONENTS. SEEK IMMEDIATE MEDICAL ATTENTION IF YOU ARE CUT OR BURNED BY HYDRAULIC FLUID.

⚠ CAUTION

CONTAMINATION CAN DAMAGE INTERNAL COMPONENTS. TAKE PRECAUTIONS TO ENSURE SYSTEM CLEANLINESS WHEN REMOVING AND REINSTALLING SYSTEM COMPONENTS AND LINES

Table 5-40. Electrical troubleshooting

Item	Description	Action
Control operates pump in one direction only	Control coil failure.	Measure resistance at coil pins. Resistance should be 14.2W (24V) or 3.66W (12V) at 20°C [70°F]. Replace coil.
No pump function	No power to controller.	Restore power to controller.
Erratic pump function	Electrical connection to pump is bad.	Disconnect connection, check wires, reconnect wires.
Erratic or no machine function	External controller malfunction or hydraulic system problem.	Verify external controller problem using spare controller. Replace controller. Check hydraulic system fluid level/pressures/filters/etc. Fix hydraulic system problems.

Table 5-41. Neutral difficult or impossible to find

Item	Description	Action
Input to pump control	Input to control module is operating improperly.	Disconnect input and check to see if pump comes back to neutral. If Yes, input fault, replace/repair external controller. If No, go to next step.
Pump control neutral	Neutral set improperly.	Shunt servo gauge ports M4 and M5 together with external hose and see if pump comes back to neutral. If Yes: control neutral improperly set. If no: balance swashplate (see Mechanical neutral adjustment). If you still cannot set neutral, replace control.

Table 5-42. System operating hot

Item	Description	Action
Oil level in reservoir	Insufficient hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level.
Heat exchanger	Heat exchanger not sufficiently cooling the system.	Check air flow and input air temperature for heat exchanger. Clean, repair or replace heat exchanger.
Charge pressure	Low charge pressure will overwork system.	Measure charge pressure. Inspect and adjust or replace charge relief valve. Inspect charge pump. Repair or replace charge pump.
Charge pump inlet vacuum	High inlet vacuum will overwork system. A dirty filter will increase the inlet vacuum. Inadequate line size will restrict flow.	Check charge inlet vacuum. If high, inspect inlet filter and replace as necessary. Check for adequate line size, length or other restrictions.
System relief pressure settings	If the system relief valves are worn, contaminated, or valve settings are too low, the relief valves will be overworked.	Verify settings of high pressure relief valves and replace valves as necessary.
System pressure	Frequent or long term operation over system relief setting will create heat in system.	Measure system pressure. If pressure is too high, reduce loads.

Table 5-43. System will not operate

Item	Description	Action
Oil level in reservoir	Insufficient hydraulic fluid to supply system loop.	Fill reservoir to proper level.
Control orifices	Control orifices are blocked.	Clean control orifices.
Control screens	Control screens are blocked.	Clean or replace control screens.
Charge pressure with pump in neutral	Low charge pressure insufficient to recharge system loop.	Measure charge pressure with the pump in neutral. If pressure is low, go to next step.
Pump charge relief valve	A pump charge relief valve that is leaky, contaminated, or set too low will depressurize the system.	Adjust or replace pump charge relief valve as necessary.
Charge pump inlet filter	A clogged filter will under supply system loop.	Inspect filter and replace if necessary.
Charge pump	A malfunctioning charge pump will provide insufficient charge flow.	Repair or replace the charge pump.
System pressure	Low system pressure does not provide enough power to move load.	Measure system pressure. Continue to next step.
Charge check / HPRVs	Defective charge check / HPRVs cause system pressure to be low.	Repair or replace charge check / HPRVs.
Input to control	Input to control module is operating improperly.	Repair or replace control.
Optional control cutoff valve	Control cutoff valve coil not energized.	Ensure charge pressure to control via port X7. If none, confirm control cutoff valve coil is energized. If still no pressure, repair or replace control cutoff valve.

Table 5-44. System noise or vibration

Item	Description	Action
Reservoir oil level	Low oil level leads to cavitation.	Fill reservoir.
Aeration of the oil/pump inlet vacuum	Air in system decreases efficiency of units and controls. Air in system is indicated by excessive noise in pump, foaming in oil, and hot oil.	Find location where air is entering into the system and repair. Check that inlet line is not restricted and is proper size.
Cold oil	If oil is cold, it may be too viscous for proper function and pump cavitates.	Allow the oil to warm up to its normal operating temperature with engine at idle speed.
Pump inlet vacuum	High inlet vacuum causes noise/cavitation.	Check that inlet line is not restricted and is proper size. Check filter and bypass switch.
Shaft couplings	A loose input shaft to prime mover coupling will cause excessive noise.	Replace loose shaft coupling.
Shaft alignment	Misaligned input and prime mover shafts create noise.	Correct misalignment.
Charge/system relief valves	Unusual noise may indicate sticking valves. Possible contamination.	Clean/replace valves and test pump. May be a normal condition.

Table 5-45. Sluggish system response

Item	Description	Action
Oil level in reservoir	Low oil level will cause sluggish response.	Fill reservoir.
Charge check / HPRVs	Incorrect pressure settings will affect system reaction time.	Replace charge check / HPRVs.
Low prime mover speed	Low engine speed will reduce system performance.	Adjust engine speed.
Charge and control pressures	Incorrect pressures will affect system performance.	Measure and adjust charge and control pressures.
Air in system	Air in system will produce sluggish system response.	Fill tank to proper level. Cycle system slowly for several minutes to remove air from system.
Contaminated control orifices	Control orifices are plugged.	Clean control orifices.
Contaminated control screens	Control screens are plugged.	Clean or replace control screens.
Pump inlet vacuum	Inlet vacuum is too high resulting in reduced system pressure.	Measure charge inlet vacuum. Inspect line for proper sizing. Replace filter. Confirm proper bypass operation.

Adjustments

⚠ CAUTION

CONTAMINATION CAN DAMAGE INTERNAL COMPONENTS AND VOID YOUR WARRANTY. TAKE PRECAUTIONS TO ENSURE SYSTEM CLEANLINESS WHEN REMOVING AND REINSTALLING SYSTEM LINES

1. Thoroughly clean the outside of the pump.
2. If removing the pump, tag each hydraulic line. When you disconnect hydraulic lines, cap them and plug each open port to prevent contamination.
3. Ensure the surrounding area is clean and free of contaminants like dirt and grime.
4. Inspect the system for contamination.
5. Check the hydraulic fluid for signs of contamination: oil discoloration, foam in the oil, sludge, or metal particles.
6. If there are signs of contamination in the hydraulic fluid, replace all filters and drain the hydraulic system. Flush the lines and refill the reservoir with the correct filtered hydraulic fluid.
7. Before reinstalling the pump, test for leaks.

CHARGE PRESSURE RELIEF VALVE.

1. Install a 50 bar [1000 psi] pressure gauge in charge pressure gauge port M3. Install a 10 bar [100 psi] gauge at case pressure port L1, L2, or L3. Operate the system with the pump in neutral (zero displacement) when measuring charge pressure.
2. The table below shows the acceptable pump charge pressure range for some nominal charge relief valve settings (refer to model code located on serial number plate). These pressures assume 1800 min-1 (rpm) pump speed and a reservoir temperature of 50°C [120°F], and are referenced to case pressure.

NOTE: *Listed pressures assume a pump speed of 1800 min-1 (rpm) and charge flow of 26.5 l/min [7 US gal/min]. At higher pump speeds or higher charge flows the charge pressure will rise over the rated setting.*

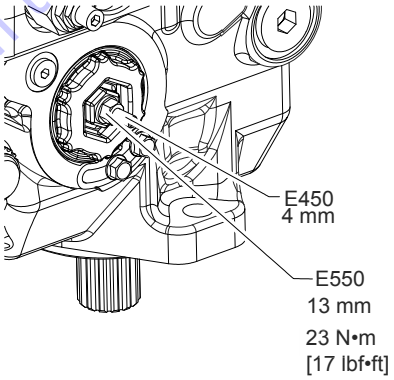
3. Loosen the locknut and rotate the adjusting screw clockwise to increase the setting; counterclockwise to decrease it. Subtract the case pressure reading to compute the actual charge pressure.

NOTE: *Pressure change per turn is dependent on charge flow entering pump.*

4. While holding the adjusting screw, torque locknut to 12 Nm [9 lbft].
5. When you achieve the desired charge pressure setting, remove the gauges and plug the ports.

DISPLACEMENT LIMITER ADJUSTMENT

1. Mark servo cylinder location in case it rotates during displacement limiter adjustment.
2. Loosen the locknut (E550).



3. Rotate the adjusting screw (E450) based on the following table. Rotating the adjusting screw clockwise decreases the maximum displacement of the pump while rotating the adjusting screw counterclockwise increases the maximum displacement.

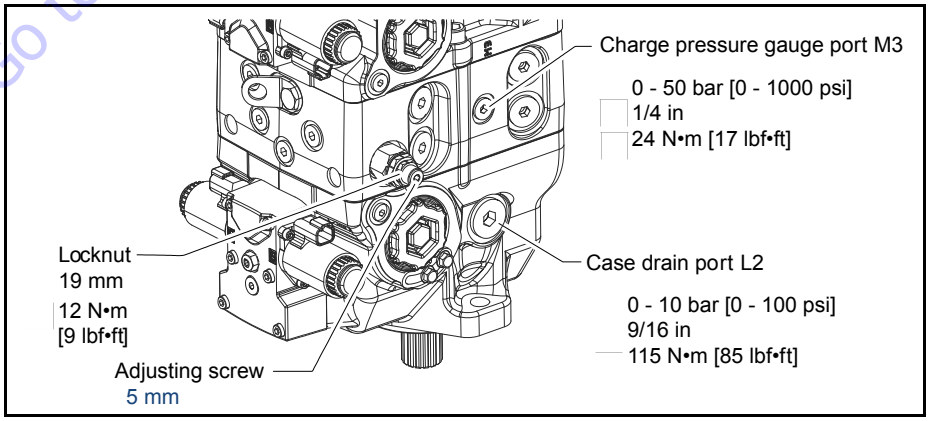


Figure 5-68. Charge Pressure Adjustment

4. After establishing the desired maximum displacement setting, hold adjusting screw in place and tighten the locknut. Torque to 23 Nm [17 lbft]. C

⚠ CAUTION

BE SURE SERVO CYLINDER DOES NOT ROTATE WHEN DISPLACEMENT LIMITER LOCKNUT (E550) IS TORQUED.

5. One turn of the adjusting screw will change the maximum displacement approximately as follows.

Table 5-46. Displacement Limiter Adjustment Data

Displacement	Locknut wrench size and torque	Adjusting screw size	Approximate displacement change per revolution of adjusting screw
45	13 mm 23 Nm [17 lbft]	4 mm internal hex	5.1 cc / turn

CONTROL NEUTRAL ADJUSTMENT

All functions of the Electric Displacement Control (EDC) are preset at the factory. Adjust the pump to neutral with the pump running on a test stand or on the vehicle/machine with the prime mover operating. If adjustment fails to give satisfactory results, you may need to replace the control or coils.

1. Install a 50 bar [1000 psi] gauge in each of the two servo gauge ports (M4 and M5). Disconnect the external control input (electrical connections) from the control. Start the prime mover and operate at normal speed.
2. Use a 4mm internal hex wrench to hold the neutral adjusting screw stationary while loosening the locknut with a 13mm wrench.
3. Observe pressure gauges. If necessary, turn adjusting screw to reduce any pressure differential.

NOTE: *Adjustment of the EDC is very sensitive. Be sure to hold the hex wrench steady while loosening the locknut. Total adjustment is less than 120 degrees.*

4. Rotate the neutral adjusting screw clockwise until the pressure increases on the gauge. Note the angular position of the wrench. Then rotate the neutral adjusting screw counterclockwise until the pressure increases by an equal amount on the other gauge. Again note the angular position of the wrench.

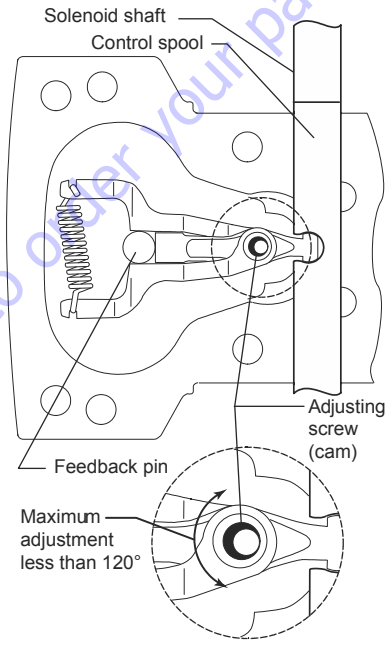


Illustration shows how eccentric cam on adjusting screw rotates to adjust neutral.

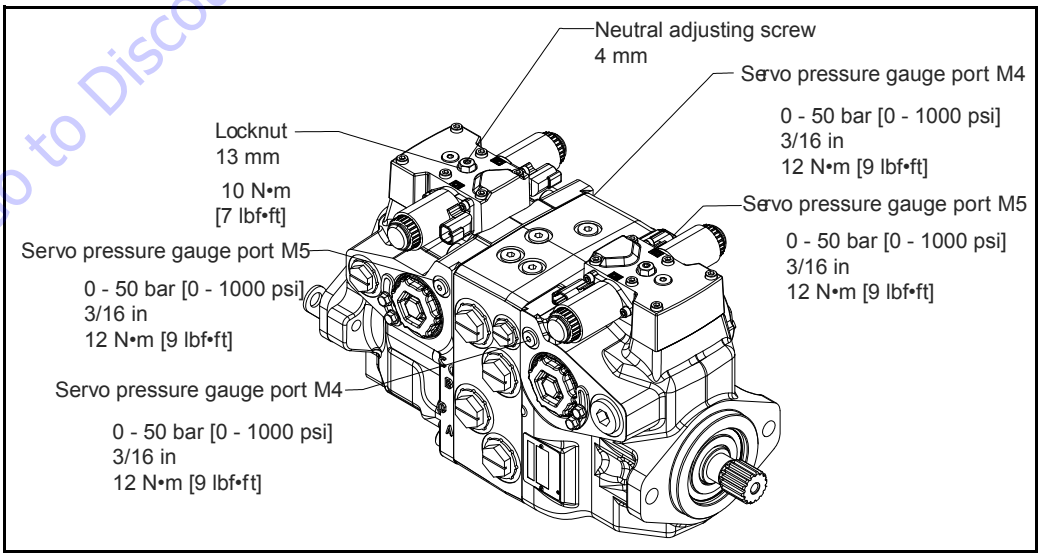


Figure 5-69. Control Neutral Adjustment

5. Rotate the neutral adjusting screw clockwise half the distance between the wrench positions noted above. The gauges should read the same pressure, indicating that the control is in its neutral position.
6. Hold the neutral adjusting screw stationary and tighten the lock nut. Torque to 10.Nm [7 lbft]. Do not over torque the nut.
7. When the neutral position is set, stop the prime mover, remove the gauges, and install the gauge port plugs. Reconnect the external control input.

NOTE: *A small pressure differential of 1.5 bar [22 psi] or less is acceptable. Zero differential is usually not possible.*

MECHANICAL NEUTRAL ADJUSTMENT

Mechanical neutral is set with the pump running at 1800 min (rpm). To set neutral, you must stroke the pump in each direction.

This procedure details setting neutral for the entire pump, one side at a time. The procedure is the same for each side of each pump so you will need to repeat it four times to set mechanical neutral for both the front and rear sections. Alternate M4/M5 and MA/MB to zero out forward and reverse directions of the front unit, then move the gauges to M4/M5 of the rear unit and MC/MD (system gauge ports for the rear unit). Refer to the drawing that follows to identify all ports. The front and rear sections are basically mirror images of each other. The control solenoids C1 and C2 are marked on each control.

While performing this adjustment, you monitor the following pressures.:

- Servo pressure at M4 and M5
- System pressure at MA and MB or MC and MD
- Pressure differential between M4 and M5 (optional)
- Pressure differential between A and B or C and D (optional)

PUMP SETUP

1. Attach a 50 bar [1000 psi] gauge to each servo pressure port M4 and M5.
2. Attach a 600 bar [10 000 psi] gauge to each system pressure port (MA and MB for front pump, MC and MD for rear pump).
3. Remove servo cylinder locking screws (E350) and plates (E300) from both sides of the pump.
4. Disconnect the control solenoids from the vehicle wiring harness.
5. If using a PWM signal to set mechanical neutral, connect the control solenoids C1 and C2 to the signal source. Ensure the source supplies no current to the solenoids until required in the following procedure.

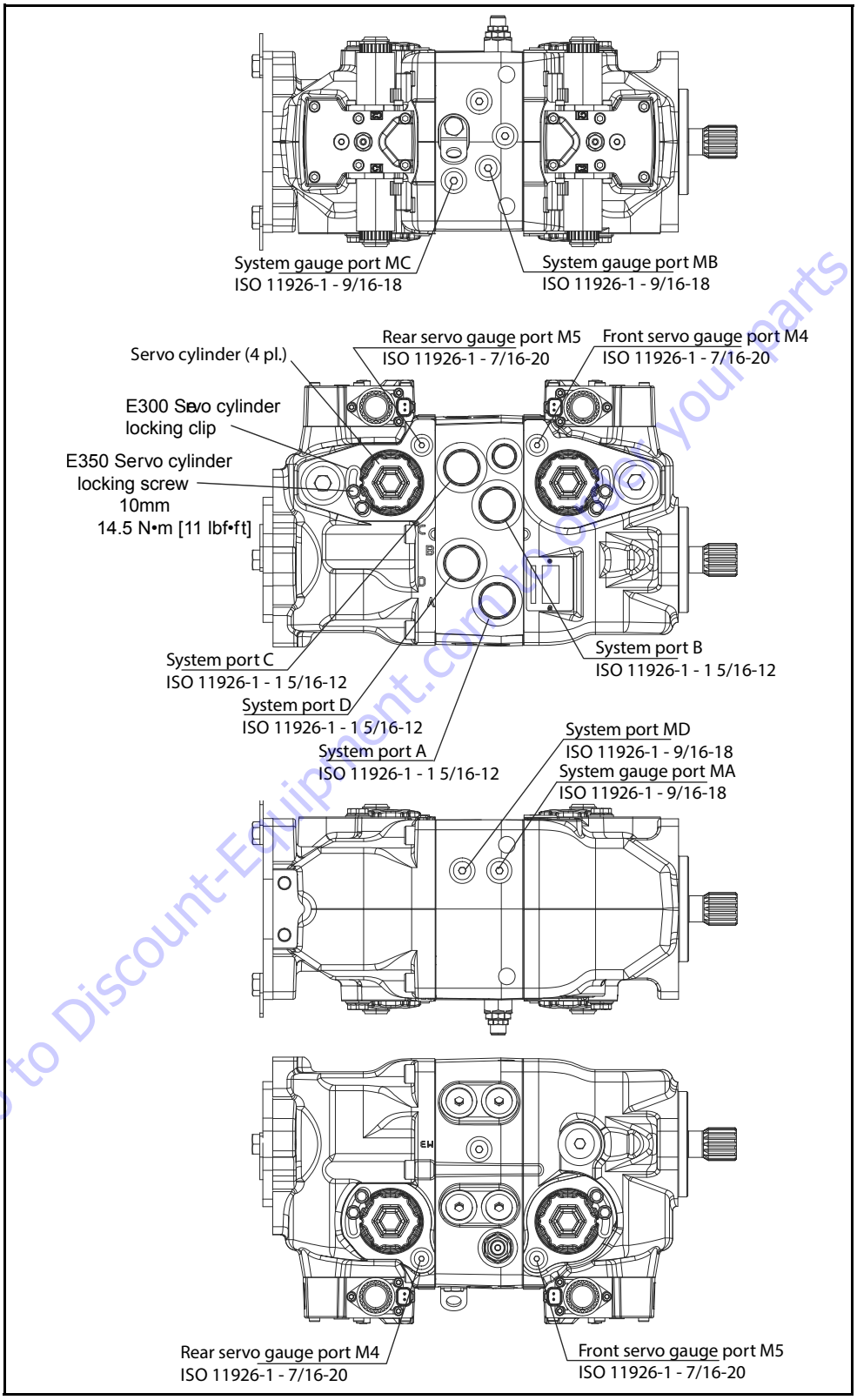


Figure 5-70. Servo and System Pressure Gauge Port Locations

SERVO ADJUSTMENT

6. Run prime mover at 1800 min (rpm).
7. If using a PWM signal, ensure the signal is off. Check the servo pressure gauges. Ensure the differential between M4 and M5 is less than 1.5 bar [22 psi].
8. Using a 3/4 in deep socket, unthread both servo cylinders 2-3 turns. This step ensures the servo cylinders have no contact with the servo piston.
9. Stroke the pump by turning the control eccentric screw (or supplying current to solenoid C1) until the servo pressure at port M4 is 1 to 2 bar [14 -29 psi] greater than at port M5 and the system pressure gauges indicate displacement. Pressure should be greater at port MA for clockwise rotation, or MB for counterclockwise rotation. This also indicates the servo piston is in contact with the servo cylinder on side M5.
10. Slowly thread the servo cylinder on the M5 side in until the system pressure differential starts to decrease. Maintain servo pressure differential between 1-2 bar [14-29 psi] during this step. Continue turning the servo cylinder in until the system pressure differential (between ports MA/MB or MC/MD) is less than 1.5 bar [22 psi]. This procedure sets the servo and swashplate to mechanical neutral on the M5 side.
11. To complete setting neutral, repeat steps 1-5 but stroke the pump in the opposite direction by turning the eccentric screw in the opposite direction, or by supplying current to solenoid C2. Reverse gauge locations (M4 for M5, MB for MA etc.) from those stated above since the pump is now stroking the other direction.
12. Set neutral for the rear pump by repeating steps 1-6 on the rear pump. Remember that the rear pump is a mirror image of the front pump and therefore the locations of the servo gauge ports (M4/M5) and the control solenoids (C1/C2) are opposite.
13. Remove all gauges and replace gauge port plugs.

Removing The Pump

Before working on the pump, thoroughly clean the outside. If the pump has an auxiliary pump attached, remove both pumps as a single unit. Tag and cap all hydraulic lines as you disconnect them, and plug all open ports to ensure that dirt and contamination do not get into the system.

⚠ CAUTION

CONTAMINATION CAN DAMAGE INTERNAL COMPONENTS. TAKE PRECAUTIONS TO ENSURE SYSTEM CLEANLINESS WHEN REMOVING AND INSTALLING SYSTEM LINES.

1. Thoroughly clean all dirt and grime from the outside of the pump.
2. Tag, disconnect, and cap each hydraulic line connected to the pump. As hydraulic lines are disconnected, plug each open port, to ensure that dirt and contamination do not get into the pump.
3. Remove the pump and its auxiliary pump (if applicable) as a single unit.

NOTE: *Be careful, do not damage solenoids and electrical connections when using straps or chains to support the pump.*

Inspection

1. Ensure the work surface and surrounding area are clean and free of contaminants such as dirt and grime.
2. Inspect the system for contamination.
3. Look at the hydraulic fluid for signs of system contamination, oil discoloration, foam in the oil, sludge, or metal particles.

Replacement

1. Before replacing the pump, replace all filters and drain the hydraulic system. Flush the system lines and fill the reservoir with the correct, filtered hydraulic fluid.
2. Fill the pump with clean, filtered hydraulic fluid.
3. Attach the pump to the prime mover. Torque mounting screws according to the manufacturers recommendation.
4. Replace all hydraulic lines. Ensure the charge inlet line is filled with fluid.

Electric Control Module

REMOVAL

Refer to exploded diagram, next page.

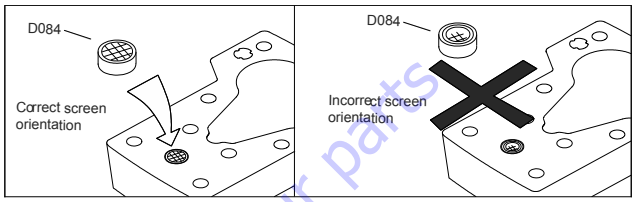
1. Using a 5 mm internal hex wrench, remove the six cap screws (D250).
2. Remove the control module and gasket (D150). Discard the gasket.
3. If necessary, remove orifices (F100) using a 3 mm internal hex wrench. Tag and number them for reinstallation.
4. Inspection
5. Inspect the machined surfaces on the control and top of the pump. If you find any nicks or scratches, replace the component.

NOTE: *Remove plug on top of control to ensure the swashplate feedback pin is properly positioned in the center of the control module when installing control.*

REASSEMBLY

NOTE: *Ensure you install dowel pins (D300) in housing before installing control.*

1. Install a new gasket (D150).
2. If you removed screen (D084), install a new one. Install with the mesh facing outward.



3. If previously removed, install orifices (F100) using a 3 mm internal hex wrench. Torque to 2.5 Nm [1.8 lbft].
4. Install the control module and six cap screws (D250).
5. Using a 5 mm internal hex wrench, torque the cap screws (D250) to 13.5 Nm [10.lbft].

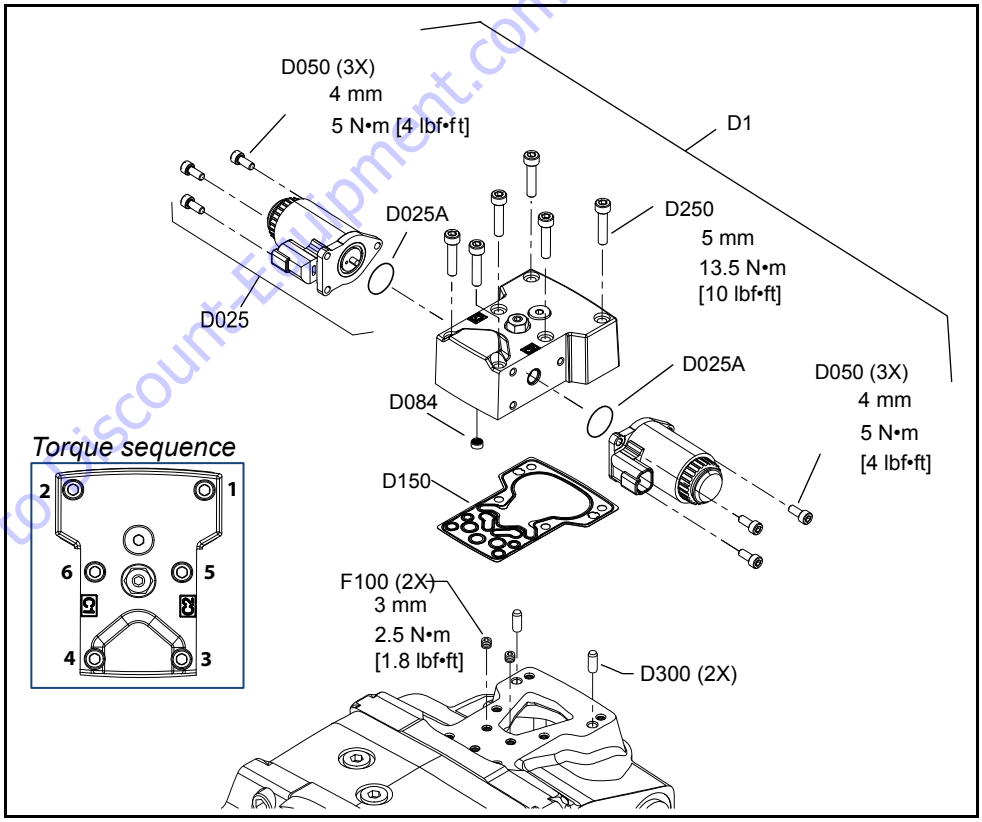


Figure 5-71. Control Module And Solenoid Removal/installation

CONTROL SOLENOIDS REMOVAL

1. Disconnect electrical connection and remove the three cap screws (D050) using a 4.mm internal hex wrench.
2. Remove the solenoid (D025) and O-ring (D025A). Discard the O-ring.
3. If necessary, remove the coil using a 12 point 26 mm socket.

CONTROL SOLENOIDS INSPECTION

1. Inspect the machined surface on the control. If you find any nicks or scratches, replace the component.

CONTROL SOLENOIDS REASSEMBLY

1. Lubricate new O-ring (D025A) using petroleum jelly and install.
2. Install solenoid with three cap screws (D050) using a 4 mm internal hex wrench. Torque screws to 5 Nm [4 lbft].
3. Install coil using a 12 point 26 mm socket. Torque coil nut to 5 Nm [3.7 lbft].
4. Reconnect electrical connections and test the pump for proper operation.

Shaft, Seal, and Bearing

The front pump input shaft assembly is serviceable without disassembling the pump, the rear shaft is not. Orient the pump on the work surface so the shaft is pointing to the side.

REMOVAL

1. Unwind the spiral ring (J300) from the housing to release the shaft/seal/bearing subassembly.
2. Pry on the lip of the seal carrier (J275) to remove it from the pump. Remove the seal carrier. Remove and discard O-ring (J260). Press the seal (J250) out of the carrier and discard.
3. Pull the shaft (J100) with bearing (J150) out of the pump. If necessary, tap lightly on the shaft to dislodge it from the cylinder block. C

⚠ CAUTION

DO NOT DAMAGE THE HOUSING BORE, SHAFT OR BEARING WHEN REMOVING THE SHAFT AND BEARING.

4. Remove the retaining ring (J200) using retaining ring pliers. Press the bearing off the shaft.

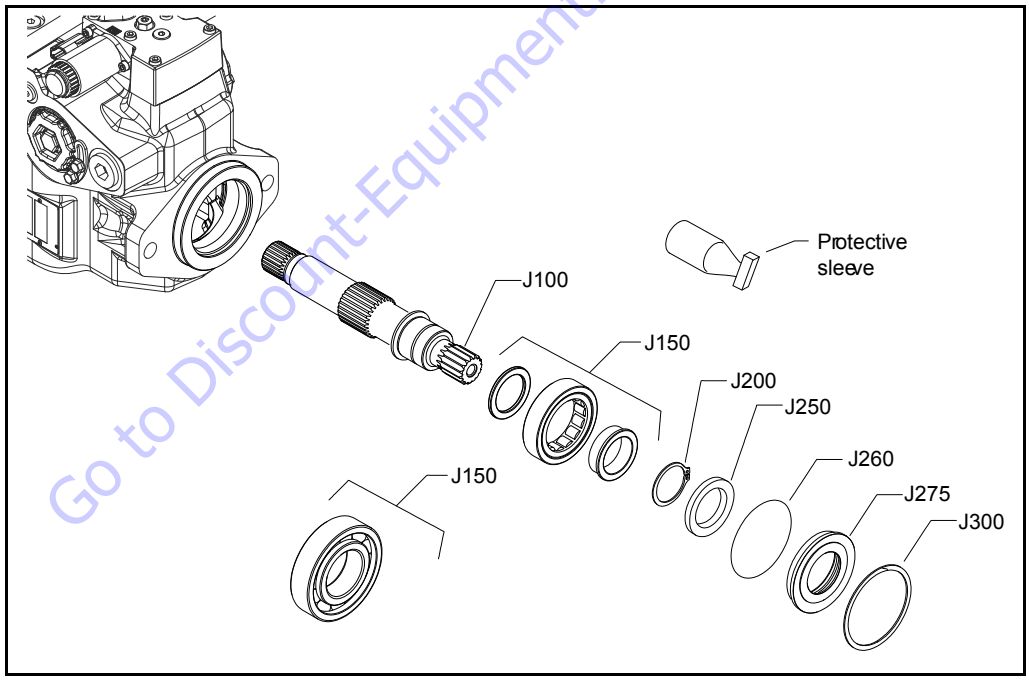


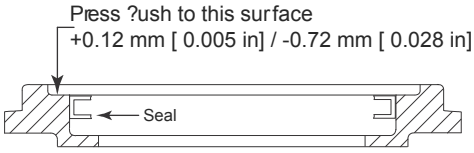
Figure 5-72. Shaft Assembly

INSPECTION

1. Inspect the shaft journals for wear, scratching, and pits. Check the splines for fretting; replace if damaged. Rotate the bearing, if it does not rotate smoothly, replace it.

REASSEMBLY

1. Press the bearing (J150) onto the shaft (J100) and replace the retaining ring (J200). Ensure the retaining ring diameter is less than 38.84 mm [1.53.in] when installed on the shaft.
2. Install the shaft/bearing assembly into the pump.
3. Lubricate and install a new O-ring (J260) onto seal carrier (J275). Press a new seal (J250) into the seal carrier. Press the seal until it is flush within +0.12mm [0.005 in] or -0.72 mm [0.0028 in] of the inside lip of the carrier: see illustration.



4. Cover the shaft with a protective sleeve while installing the seal carrier. Hand press the seal carrier into the housing. Ensure the seal carrier clears the spiral ring groove in the housing. Remove the protective sleeve.
5. Wind the spiral ring into the housing. Ensure the inside diameter of the spiral ring is greater than 68 mm [2.677 in] after installation.

Charge Pump

Position pump with front shaft pointing downward. Attach securely to a proper work stand. If an auxiliary pump is attached, remove auxiliary pump before servicing charge pump.

REMOVAL

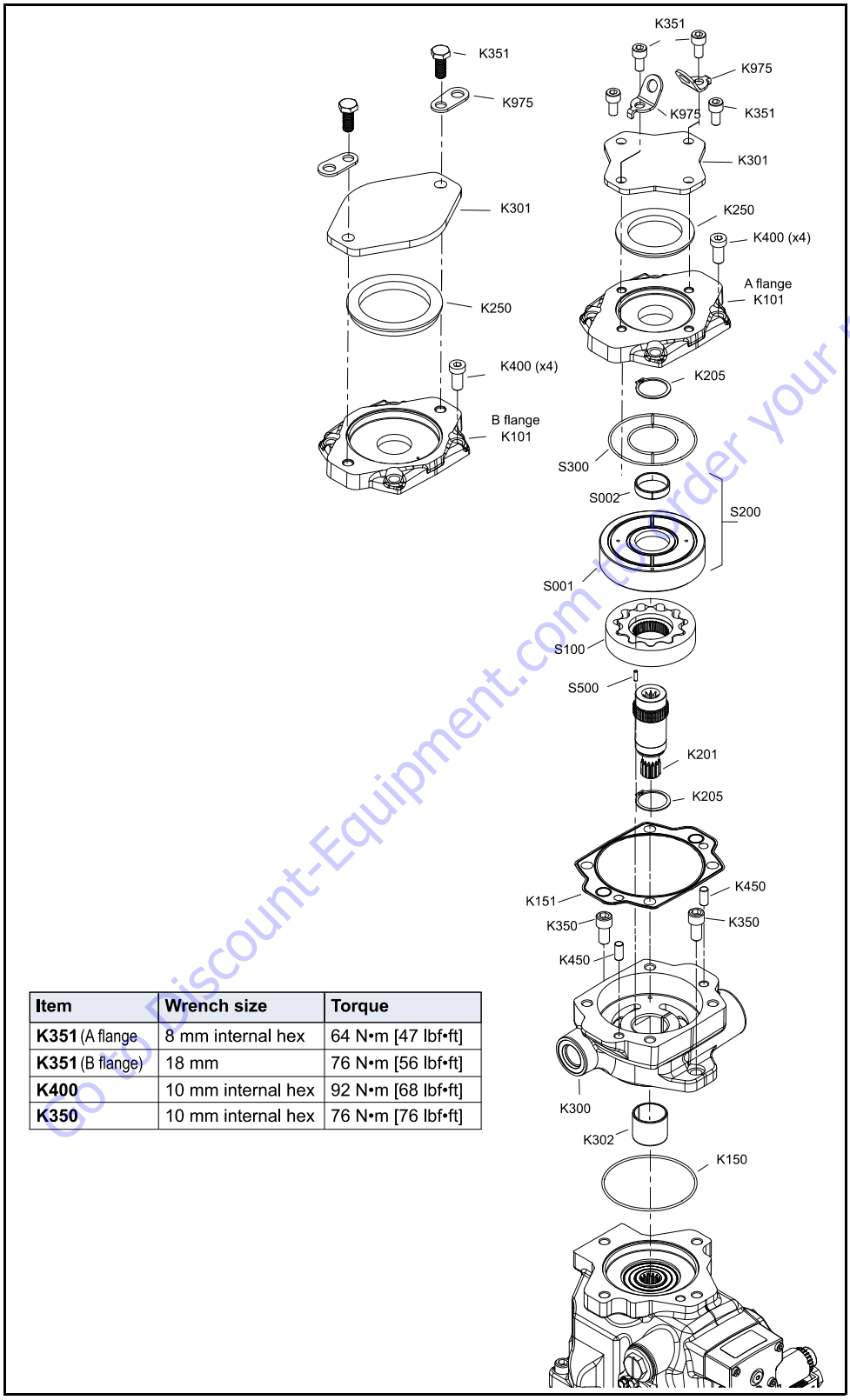
1. Remove screws (K351), and hangers (K975).
2. Remove running cover (K301). Remove and discard seal ring (K250).
3. Using a 10 mm internal hex, remove screws (K400). Remove cover (K101).
4. Remove charge pump assembly with shaft.

NOTE: *Note position of alignment pin (S500) in housing. Alignment pin position will change for clockwise or counter-clockwise rotation.*

5. Remove and discard seal (S300).
6. Using a snap ring pliers, remove two clips (K205).
7. Remove geroter cover (S200). Remove geroter assembly (S100).
8. Remove and discard gasket (K151). Remove alignment pins (K450).
9. If it is necessary to remove housing (K300), use a 10 mm internal hex to remove screws (K350).
10. Remove housing (K300).
11. Remove and discard seal (K150).

INSPECTION

1. Inspect all machined surfaces. If you find any nicks or scratches, replace the component.
2. Inspect geroter and cover for wear or damage. If wear or damage is found, replace geroter kit.
3. Inspect shaft for wear or damage. If found, replace shaft.
4. Inspect journal bearings in aux pad and housing. If worn or damaged, replace journal bearings or aux pad or housing assembly.

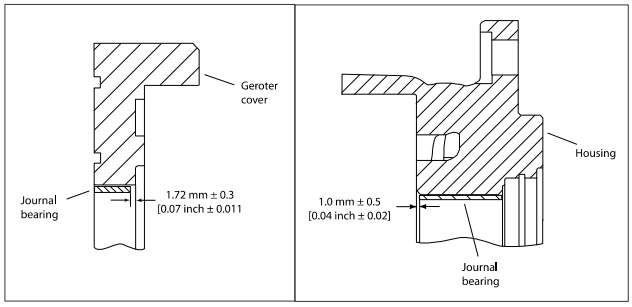


Item	Wrench size	Torque
K351 (A flange	8 mm internal hex	64 N•m [47 lbf•ft]
K351 (B flange)	18 mm	76 N•m [56 lbf•ft]
K400	10 mm internal hex	92 N•m [68 lbf•ft]
K350	10 mm internal hex	76 N•m [76 lbf•ft]

Figure 5-73. Charge Pump

REPLACING CHARGE PUMP JOURNAL BEARINGS

Use a suitable press to remove and replace the journal bearings. Refer to the drawings below for installation dimensions.



ASSEMBLY

1. Lubricate and install new seal (K150).
2. Install housing (K300). Install screws (K350). Using a 10 mm internal hex, torque screws per listing in table.
3. Install alignment pins (K450). Install new gasket (K151).
4. Lubricate and reassemble charge pump assembly [shaft (K201), pin (S500), geroter (S100), cover (S200), two clips (K205)].
5. Install charge pump assembly into housing in original position.
6. Lubricate and install seal (S300).
7. Install aux pad (K101).
8. Using a 10 mm internal hex, install screws (K400). Torque screws per listing in table.
9. Lubricate and install seal (K250). Install running cover (K301).
10. Install screws (K351) and brackets (K975). Torque screws per listing in the table.

Charge Check / HPRV

The high pressure relief and charge check valve assembly may be removed for cleaning and replacement of the O-rings. These valves are factory set and are not field adjustable. Refer to the pump model code for the factory setting when ordering replacements.

REMOVAL

1. Using an 8 mm internal hex wrench, remove the valve seat plugs (K007).
2. Carefully lift the valve (H002) and spring (H003) assemblies from the center section using a magnet.

INSPECTION

1. Inspect the valves and mating seats in the valve seat plugs (K007) for damage or foreign material.

REASSEMBLY

1. Lubricate and install new O-rings (K008, K010) and backup ring (K009) on valve seat plug (K007).
2. Verify that the conical springs (H003) are properly retained on the check relief valves (H002). Install the valve assemblies into the center section. Ensure each valve assembly moves freely in its bore.
3. Install the valve seat plugs into the center section and torque to 80 Nm [59.lbft].
4. Operate machine through full range of controls to ensure proper operation. Check for leaks.

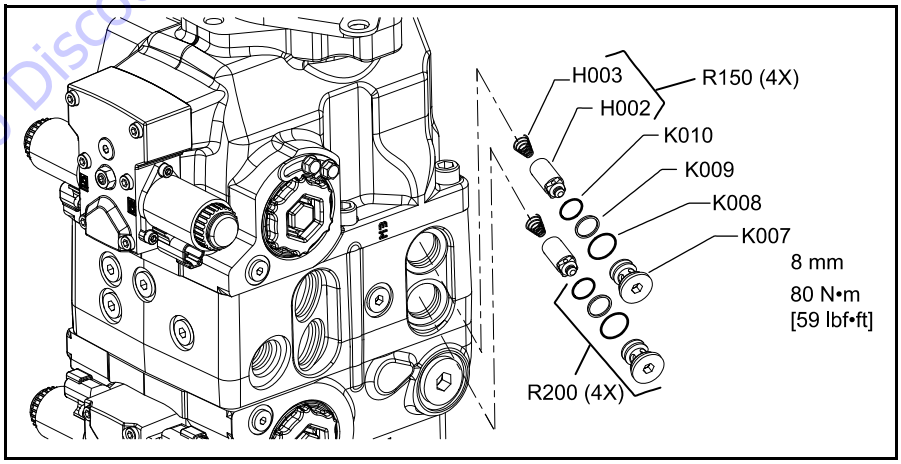


Figure 5-74. Charge Check / HPRV

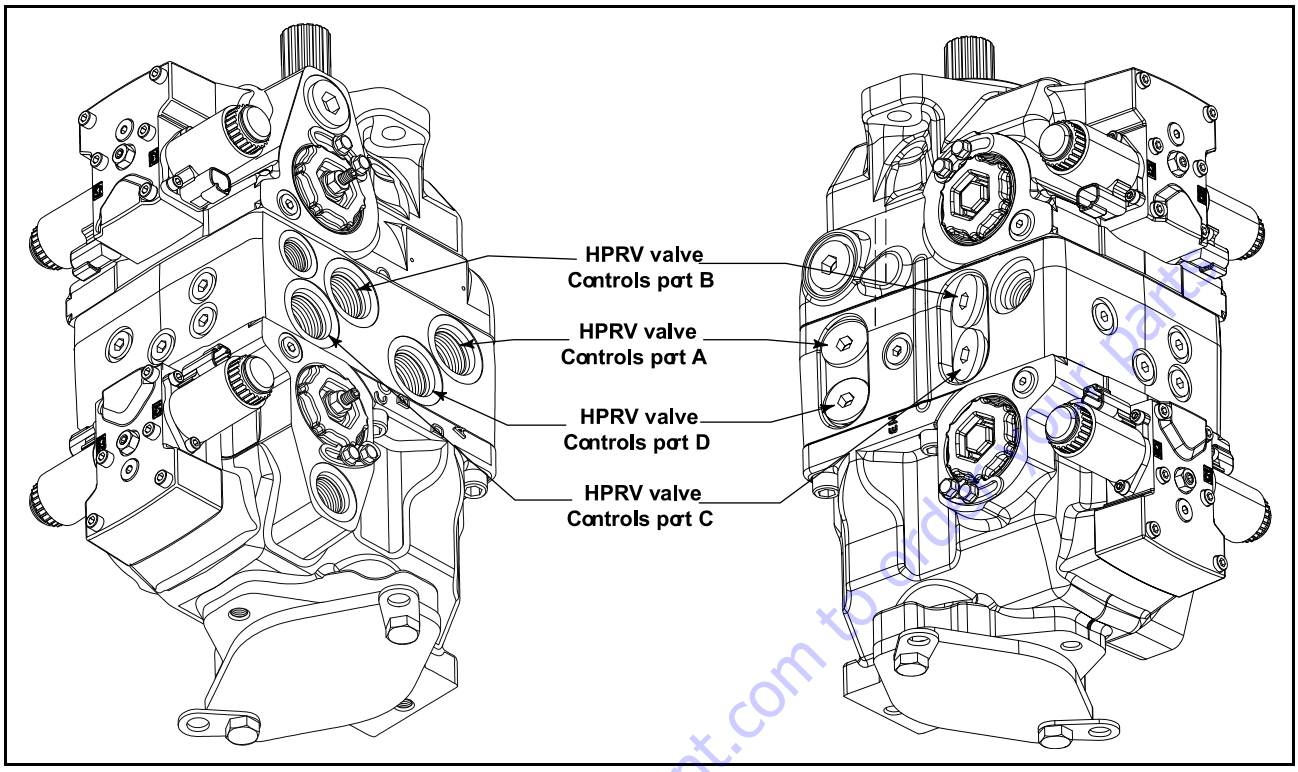


Figure 5-75. Charge Check / HPRV

Charge Pressure Relief Valve

Replace the charge pressure relief valve (V10-1) or (V10-2) as a complete unit. Do not attempt to repair the internal components of the valve.

REMOVAL

1. Using a 27 mm (V10-1) or a 1 in (V10-2) wrench, remove the charge pressure relief valve. Discard the O-rings (V10A).

INSPECTION

1. Inspect the sealing surfaces of the pump and charge pressure relief valve for nicks or scratches, replace components as necessary.

REASSEMBLY

1. Lubricate and install new O-rings (V10A).
2. Install the charge pressure relief valve (V10). Torque to 52 Nm [38 lbft].
3. Operate vehicle/machine through full range of controls to ensure proper operation.

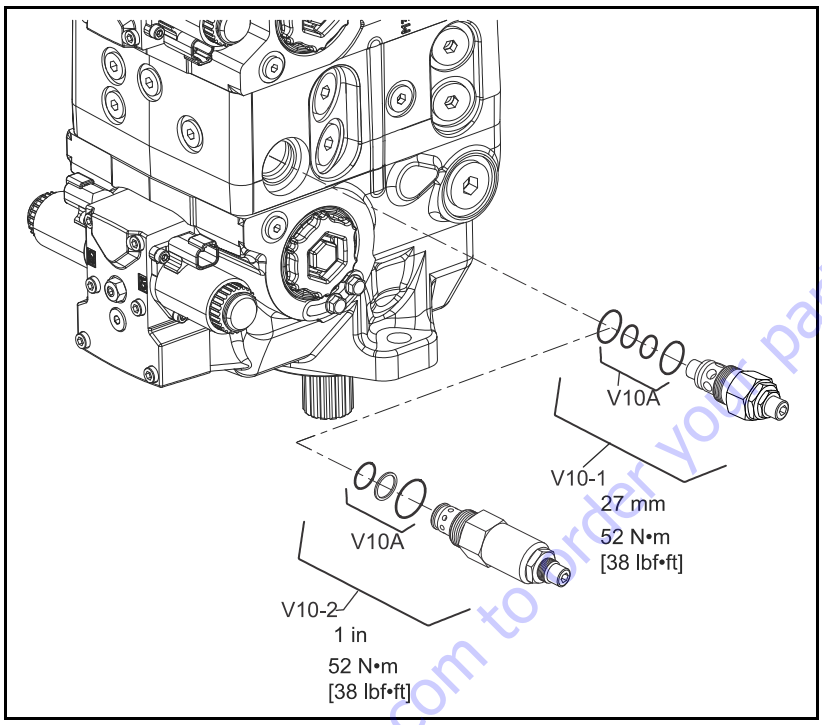


Figure 5-76. Charge Pressure Relief Valve

Control Cutoff Valve

Replace the control cutoff valve as a complete unit. Do not attempt to repair the internal components of the valve.

REMOVAL

1. Disconnect the coil from the vehicle/machine wire harness.
2. Using a 24 mm hex wrench, remove the control cutoff valve coil nut (G30). Remove the coil (G20).
3. Use a 1 1/16 in hex wrench to remove the control cutoff valve (G10). Remove and discard the O-rings and backup rings (G10A).

INSPECTION

1. Inspect the sealing surfaces of the pump and control cutoff valve for nicks or scratches. Replace components as necessary.

REASSEMBLY

1. Lubricate and install new O-rings (G10A) onto the valve.
2. Install the control cutoff valve (G10). Torque to 46 Nm [34 lbft]. Slide the coil (G20) onto the valve.
3. Install the coil nut (G30). Torque to 9 Nm [7.lbft]. Do not overtorque.
4. Operate vehicle/machine through full range of controls to ensure proper operation

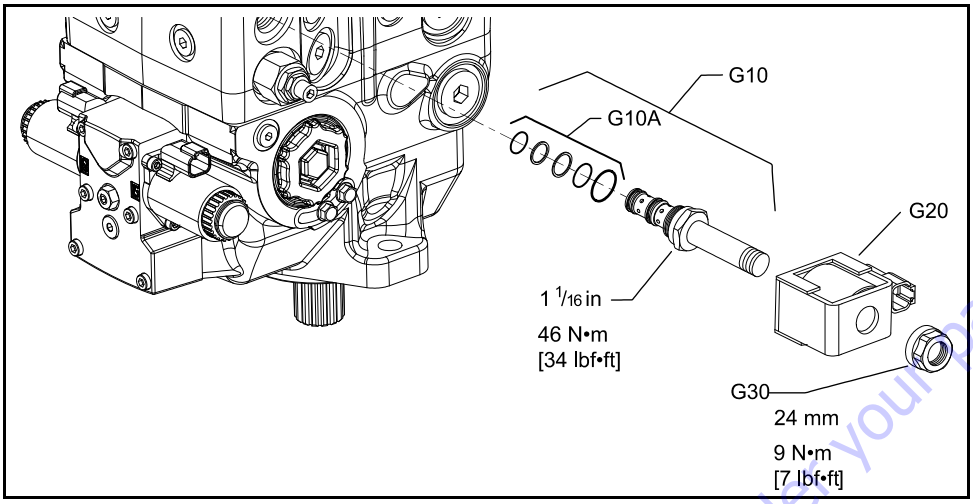


Figure 5-77. Control Cutoff Valve

Table 5-47. Fastener Size and Torque Chart

Item	Fastener	Wrench size	Torque
D015	Neutral adjust screw	4 mm internal hex	NA
D050	Control coil mounting screw	4 mm internal hex	8 Nm [5.9 lbft]
D060	Neutral adjust locking nut	13 mm hex	10 Nm [7 lbft]
D200	Swash plate feedback pin (not shown)	13 mm hex	25 Nm [18.4 lbft]
D250	Electric control mounting screw	5 mm internal hex	13 Nm [9.5 lbft]
E350	Servo cylinder locking screw	10 mm hex	14.5 Nm [11 lbft]
G10	Control cutoff valve	1 1/16 in hex	45 Nm [33 lbft]
G10B	Control cutoff valve coil nut	24 mm hex	9 Nm [7 lbft]
K007	Charge check / HPRV	8 mm internal hex	80 Nm [60 lbft]
K350	A pad cover mounting screw	17 mm hex	70 Nm [52 lbft]
	B pad cover mounting screw	8 mm hex	111 Nm [82 lbft]
V10-1	Charge relief valve	27 mm hex	52 Nm [38 lbft]
V10-2	Charge relief valve	1 in hex	52 Nm [38 lbft]

Table 5-48. Plug Size and Torque Chart

Item	O-ring plug	Wrench size	Torque
B015	7/16 - 20	3/16 internal hex	20 Nm [15 lbft]
B020	1-1/16 - 12	9/16 internal hex	48 Nm [35 lbft]
D065	7/16 - 20	3/16 internal hex	12 Nm [9 lbft]
G250	9/16 - 18	1/4 internal hex (hardened plug)	45 Nm [33 lbft]

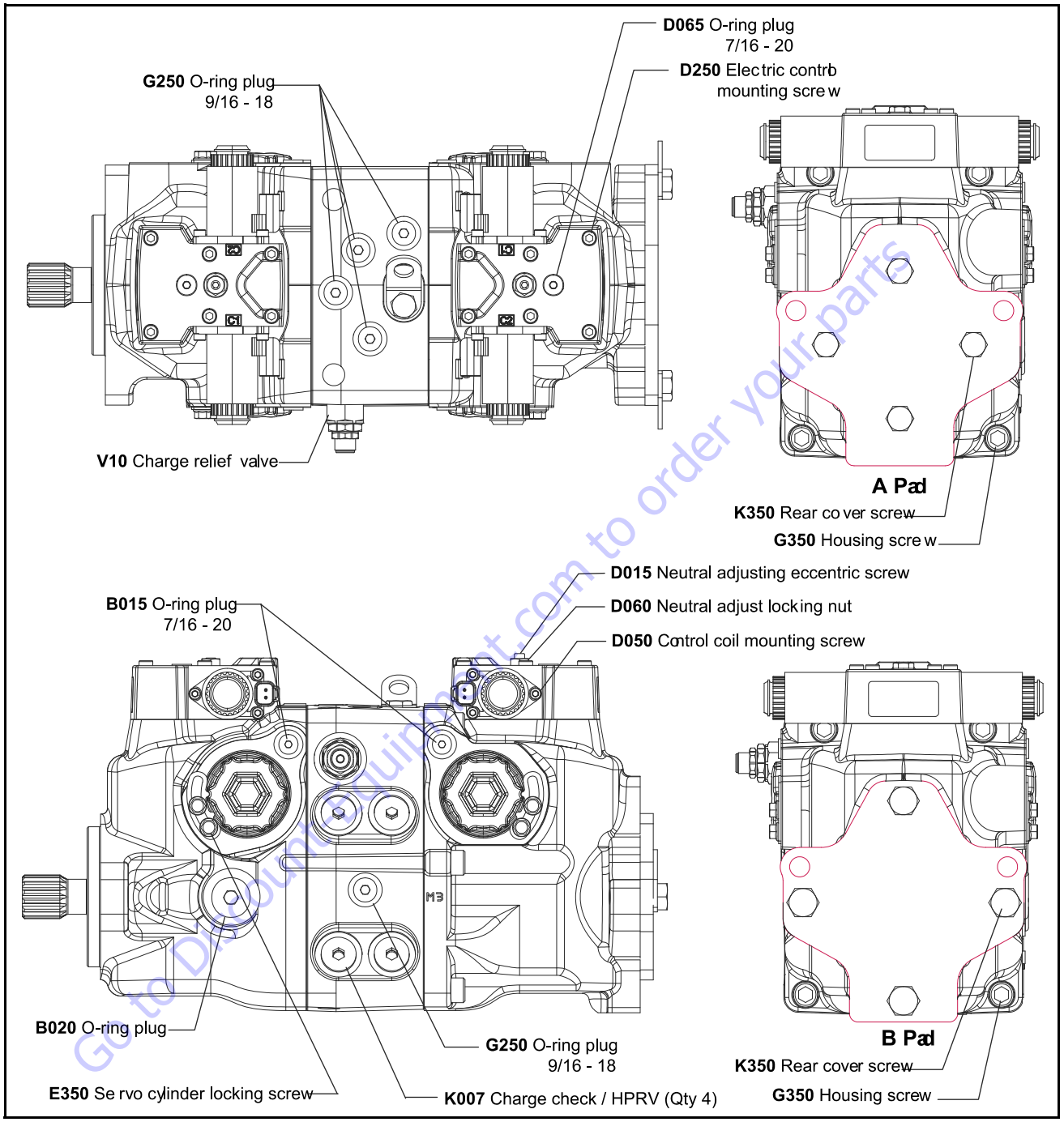
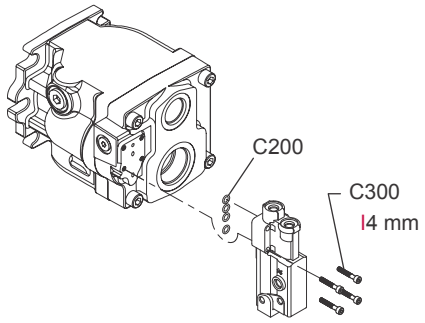


Figure 5-78. Fastener and Plug Locations

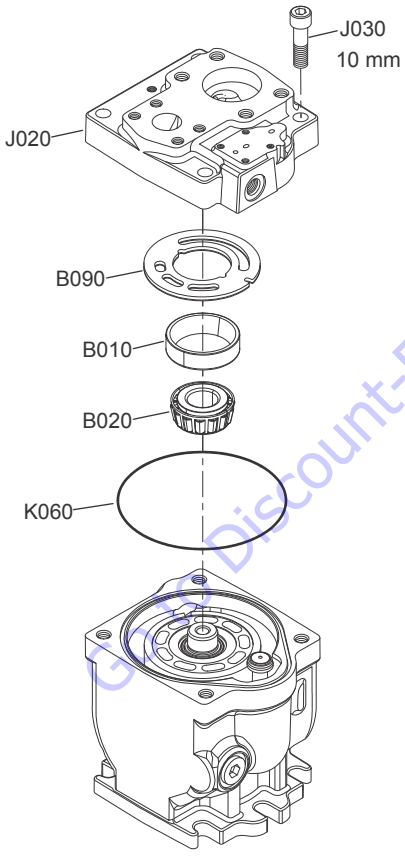
5.9 FUNCTION PUMP (SAUER)

Disassembly

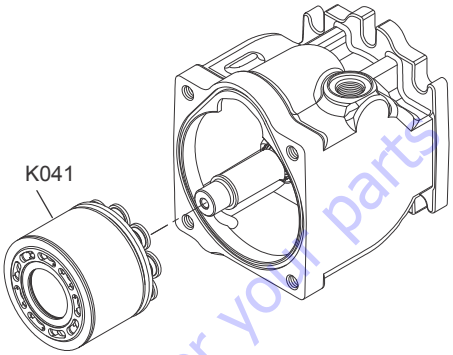
1. Remove the control from the endcap by removing the 4 control bolts (C300), using a 4 mm internal hex wrench.



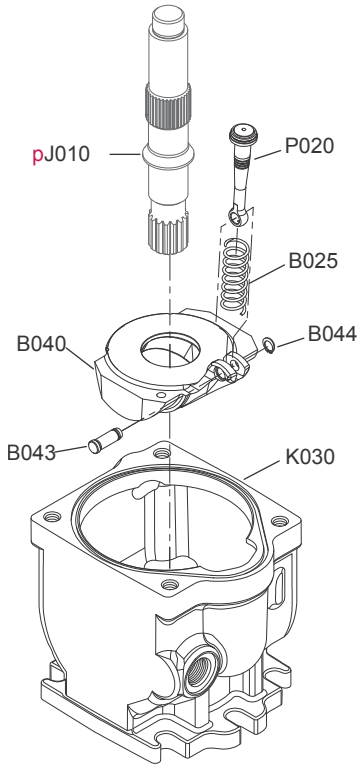
2. Remove and discard the 4 O-rings (C200).
3. Remove the 4 endcap screws (J030) using a 10 mm internal hex wrench.



4. Carefully remove the endcap (J020). Prevent the valve (B090) plate from falling off.
5. Place the endcap and valve plate in a clean area, protecting them from contamination.
6. Remove the bearing cup (B010), bearing cone (B020) and housing O-ring (K060). Discard the O-ring.
7. Tilt the housing on its side to allow fluid to drain.
8. Remove the cylinder block kit while holding onto the front shaft.



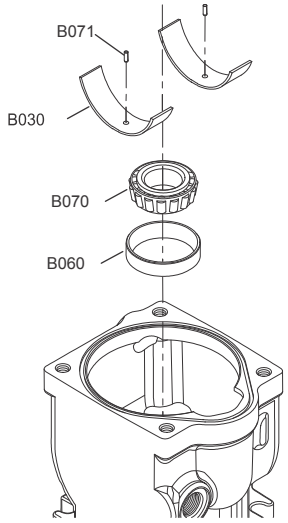
9. Set cylinder block on a clean dry surface.
10. Rotate pump back to a position so that the shaft is pointing down.
11. Pull the shaft (J010) from the shaft seal.



12. Compress the bias spring (B025) and rotate the servo piston assembly (P020) towards the swashplate (B040).
13. Lift the swashplate/servo piston assembly up at an angle and remove it from the housing.

14. Remove the servo piston (P020) and bias spring (B025) from the swashplate by removing the clevis pin (B043) and snap ring (B044). Discard the snap ring.

15. Pull to remove the front tapered roller bearing cup (B060) and cone (B070).



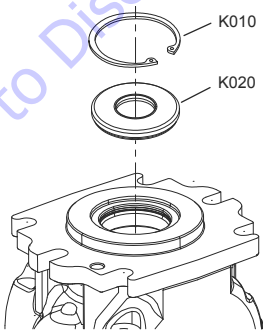
16. Examine the cradle bearings (B030) to determine if they need replacement.

NOTE: *Removing the pins (B071) will likely damage the cradle bearings, so make sure you have replacement bearings before you remove them.*

17. If cradle bearings need replacing, remove the 2 pins (B071) holding the cradle bearings, and then remove the cradle bearings. Note the location and orientation of the bearings for re-installation.

18. Orient the housing with the flange facing up.

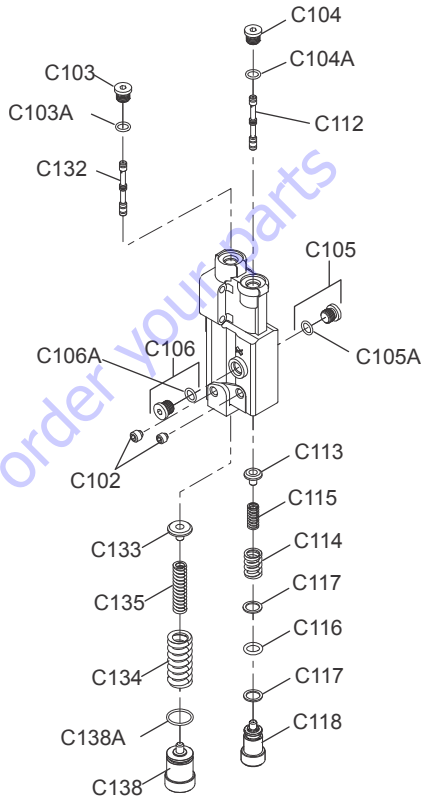
19. Using snap-ring pliers, remove the snap ring (K010).



20. Carefully pry out the shaft seal (K020).

If you are unable to pull the shaft seal out, try to push the seal out by going through the inside of the housing.

21. Remove the 4 plugs (C103, C104, C105, C106) and their O-rings (C103A, C104A, C105A, C106A). Discard the O-rings. Remove the 2 set screws (C102). Remove the spools (C112, C132). Note which bore each spool came out of. Also note the orientation of each spool for reinsertion. There may be differences in reinserting into the same bore.

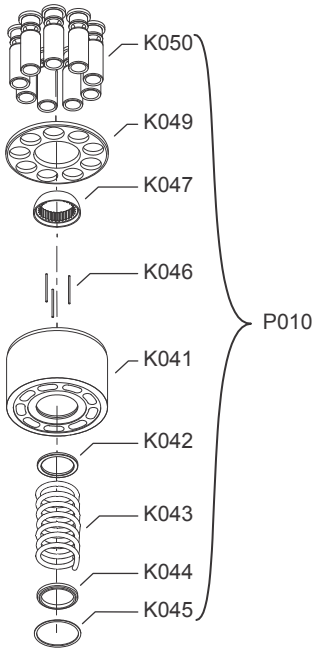


22. Remove the adjusting screw (C138) and the O-ring (C138A). Discard the O-ring. Remove the springs (C134, C135) and spring guide (C133).

23. Remove the adjusting screw (C118), O-ring (C116) and 2 backup rings (C117). Discard the O-ring and backup rings. Remove the springs (C114, C115) and spring guide (C113).

24. Pull to remove the slipper retainer (K049) with the pistons (K050) from the cylinder kit.

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



25. Remove the ball guide (K047).

26. Remove the 3 pins (K046).

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

27. Turn the block over. Using a press, apply pressure on the block spring washer (K044) to compress the block spring (K043). Compress the spring enough to safely remove the spiral retaining ring (K045). While maintaining pressure, unwind the spiral retaining ring. Carefully release the pressure and remove the outer block spring washer, block spring, and inner block spring washer (K042) from the cylinder block.

⚠ WARNING

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

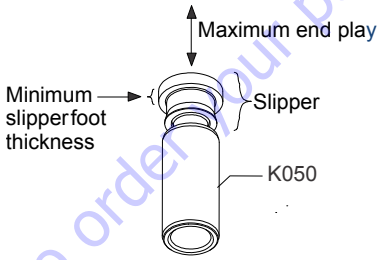
Inspection

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

PISTONS AND SLIPPERS

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

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

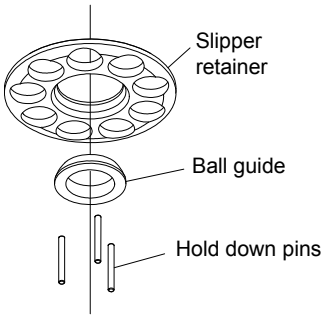


Minimum slipper foot thickness and maximum axial end-play are given in the table below.

J Frame	
Slipper foot thickness	3.23 mm [0.127 in]
Piston/slipper end play	0.05 mm [0.002 in]

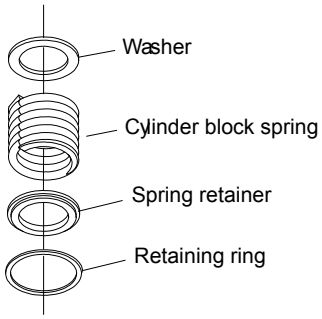
BALL GUIDE, SLIPPER RETAINER, AND HOLD-DOWN PINS

The ball guide should be free of nicks and scratches, and should not be excessively scored. Examine for discoloration that may indicate excessive heat or lack of lubrication. The slipper retainer should be flat, and slippers should fit in the retainer with minimal side play. Place the hold-down pins on a flat surface and roll them to make sure they are straight. Discard and replace any damaged parts.



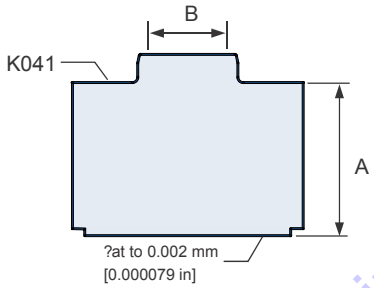
BLOCK SPRING, AND WASHERS

If cylinder kit was fully dissembled, visual inspection of the cylinder block, spring, and washers should indicate minimal wear. Replace if cracks or other damage is present.



CYLINDER BLOCK

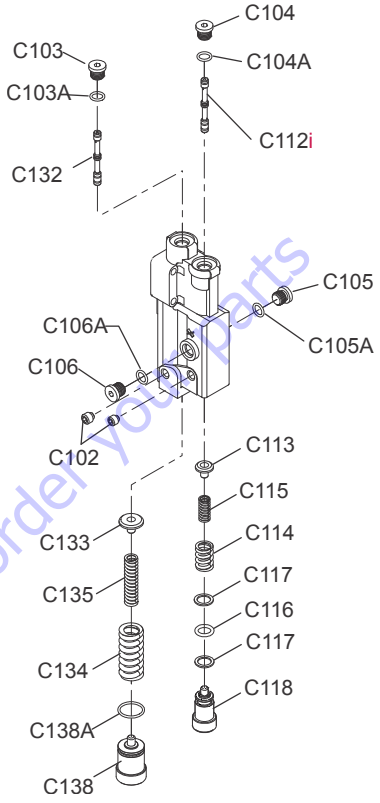
Examine the running face of the cylinder block. The surface should be smooth and free of nicks and burrs. Ensure that no scratches or grooves exist; these may drastically reduce output flow.



J Frame	45-60 cc	65-75 cc
Minimum cylinder block height (A)	62.25 mm [2.45 in]	
Maximum block bore diameter (B)	19.8 mm [0.785 in]	21.57 mm [0.85 in]

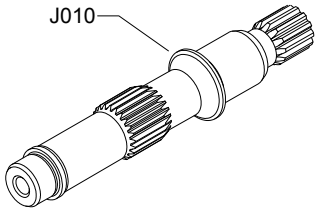
CONTROL

Carefully examine the plug(s) for signs of wear. Also check the small tip of the plug(s) for heavy wear and replace if necessary. Inspect each spool's springs to make sure they are intact. Check the inside and outside surfaces of the springs for wear and replace if necessary. Check the spool's outside diameter for scratches and / or burrs. Clean and coat all spools, bores, and seals with a light coating of hydraulic oil.



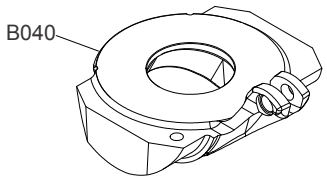
INPUT SHAFT

Check to see that the shaft (J010) and its splines are straight and free of damage or heavy wear. Inspect the shaft surface where it meets the shaft seal. Replace the shaft if a groove exists at the sealing land surface that may let dirt into or hydraulic fluid out of the unit. Clean the sealing area with a nonabrasive material if necessary. Lubricate the shaft with a light coat of hydraulic fluid.



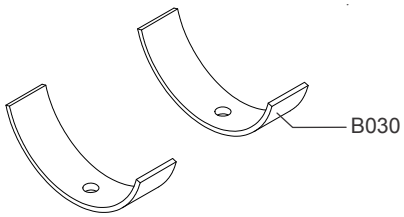
SWASHPLATE

Carefully inspect each surface of the swashplate for wear. All swashplate surfaces should be smooth. Inspect the swashplate's slipper running surface for damage and brass transfer. Excessive brass transfer from slippers may indicate that the slippers should be replaced. Finally, check the swashplate bearing journal for scratches. Replace swashplate if necessary.



JOURNAL BEARINGS

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

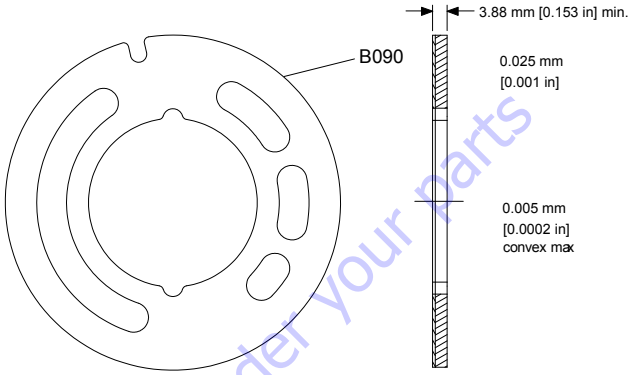


VALVE PLATE

Inspect the valve plate for scratches and grooves. Check the plate for evidence of any cavitation along the running face of the valve plate. If pitting from cavitation exists, replace the valve plate. Check for excess wear on the brass running face. If any discoloration or burn marks are observed, replace the valve plate.

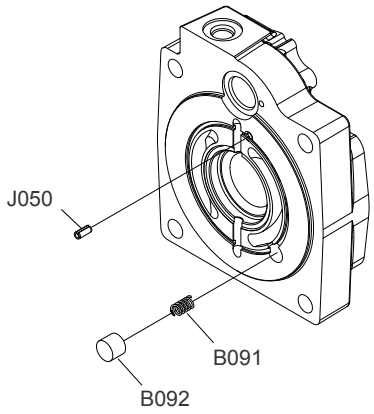
Run a fingernail or pencil tip across the diameter of the sealing land surface (see illustration). No deep or outstanding grooves should be felt, as these may decrease pump flow. Lap or replace if grooves or nicks are present. Inspect the mating surfaces of the endcap and valve plate for any possible contamination; even a few thousandths of an inch may affect pump operation.

Measure the thickness of the valve plate. Ensure that valve plate parallelism is equal to or less than 0.025 mm [0.001 in]. Appearance should be flat and smooth on both the running face and the bottom surface. The valve plate should be flat to 0.005 mm [0.0002.in] convex. A magnetic particle inspection is recommended to detect cracks. The valve plate must be replaced if any cracks exist.



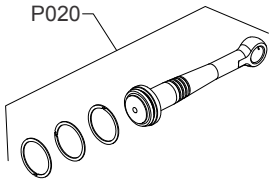
ENDCAP

Inspect the endcap. Remove the check valve (B092) to expose the spring (B091). Check and record orientation of the timing pin (J050) The split in the timing pin should be facing into or out of the slot in the valve plate. Inspect the check valve for wear on its sealing face and replace if necessary. Make sure the spring is undamaged. Replace any components if excess wear is present.



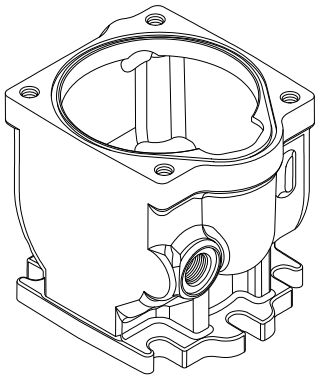
SERVO PISTON

Check the servo piston assembly (P020) for any obvious wear or damage. Check the corresponding endcap bore for galling or excessive wear. Discard the piston if damaged. Replace the servo piston-rings.



HOUSING

Inspect the housing to ensure that it is clean and free of foreign material. Inspect the swashplate bearing surfaces, and endcap mating surfaces.

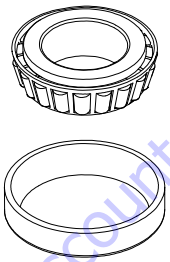


SHAFT BEARING KITS

The tapered roller bearing kit consists of a cup and cone. Make sure the cup and cone are free of excessive wear or contamination. Rotate the bearings to check for smoothness. If a contaminated bearing is suspected, clean with a solvent and lubricate with hydraulic fluid.

NOTE: *Replace the bearing if the problem is not remedied by cleaning.*

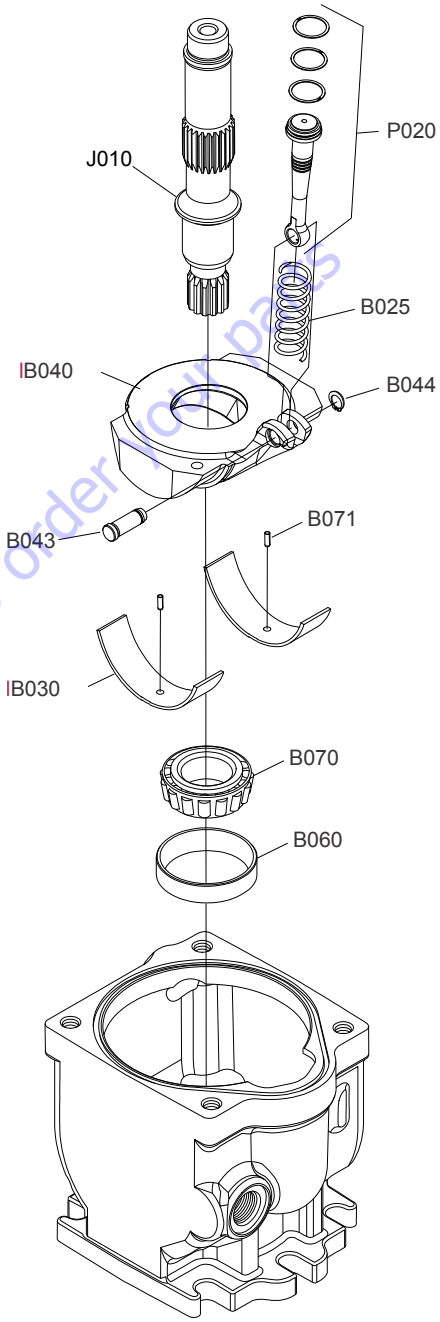
Inspect for uneven wear. If abnormal wear is found, replace the bearing kit.



Assembly

1. Coat the journal bearings (B030) with hydraulic fluid and install them into the pump housing. Punch in retaining pins (B071) a minimum of 0.5 mm [0.002 in] below the bearing surface.

NOTE: *If journal bearings are reused, reinstall them in their original orientation and position.*



2. Reinstall shaft bearing cup (B060) and cone (B070). Before replacing the bias spring (B025), coat the curved surface of the swashplate with hydraulic fluid.

3. Reinstall the swashplate/servo piston/bias spring assembly in its original orientation in the housing. Rotate the servo piston perpendicular to the swashplate, and at the same time compress the bias spring to fit into housing pocket. Lubricate all sides of the servo piston and its respective bore liberally with hydraulic oil. Also, lubricate the flat face of the swashplate to prevent premature wear during start-up.

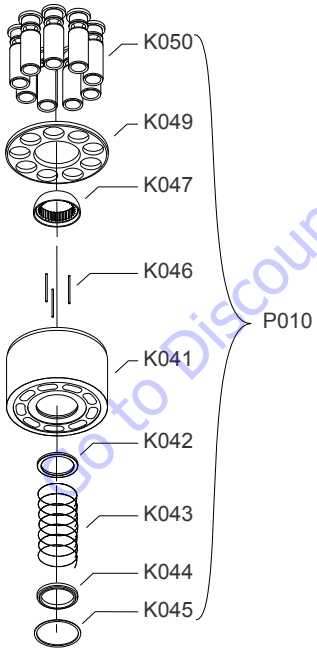
4. Insert the input shaft (J010) through the bearing into the housing. You may need to push on the servo piston to rotate the swashplate in order to put the shaft in properly.

5. Coat all parts with hydraulic fluid prior to reassembly.

⚠ WARNING

COMPRESSING THE BLOCK SPRING REQUIRES ABOUT 350 TO 400 N [80 TO 90 LBF]. USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO INSTALL.THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS INSTALLED.

6. Install the inner block spring washer (K042), block spring (K043), and outer washer (K044) into the cylinder block. Using a press, compress the block spring enough to expose the retaining ring groove. Wind the spiral retaining ring (K045) into the groove in the cylinder block.

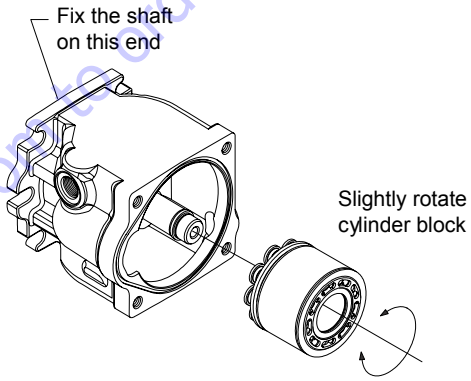


7. Turn the block over and install the hold-down pins (K046), and ball guide (K047) to the cylinder block.

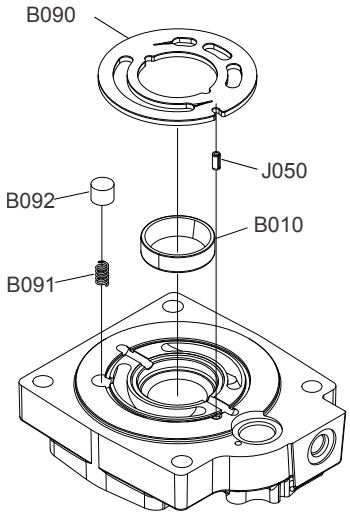
8. Install the pistons (K050) to the slipper retainer (K049). Install the piston/retainer assembly into the cylinder block. Ensure the concave surface of the retainer seats on the ball guide. If you're reusing the pistons, install them to the original block bores. Lubricate the pistons, slippers, retainer, and ball guide before assembly. Set the cylinder kit aside on a clean surface until needed.

NOTE: *Be sure to install the slipper retainer so it mates correctly with the ball guide (concave side of the slipper retainer against the convex side of the ball guide).*

9. Set the pump on its side. Secure the end of the shaft with one hand and keep it horizontal. Insert the cylinder kit onto the shaft. While holding the shaft still, slightly rotate the cylinder block kit to help start the shaft splines over the ball guide and align it with the block splines. When the cylinder block kit slides completely over the shaft splines, reposition the unit with the flange facing downward.

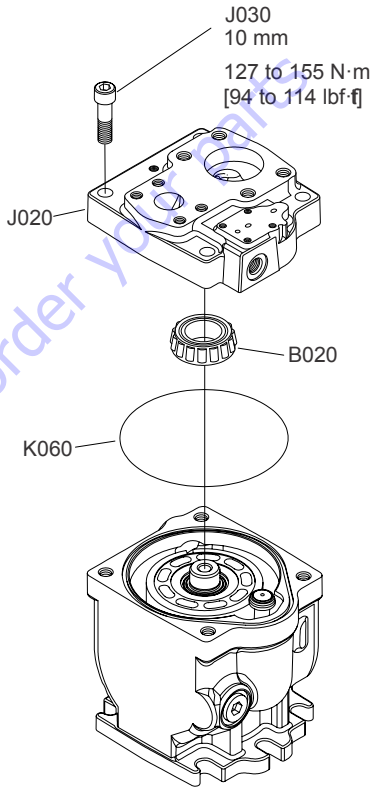


10. Clean the valve plate (B090) and endcap. Install the timing pin (J050) in the endcap and verify that it is properly oriented with the split facing into or out of the slot in the valve plate. The timing pin should be installed to 3.61 ? 0.25.mm [0.14.?.0.01 in] above the valve plate surface. Apply a liberal amount of assembly grease to the backside of the valve plate surface to hold it in position. Install the valve plate over the timing pin, check valve (B092), and bearing cup (B010).

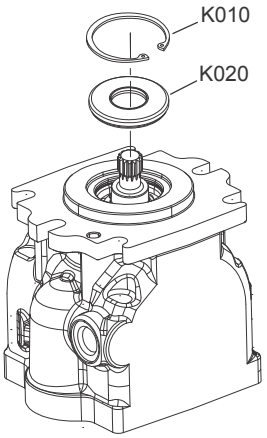


NOTE: *To insure proper pump operation, it is extremely important to ensure that there is no contamination between the endcap and valve plate.*

11. Install the bearing cone (B020) onto the shaft. Using assembly grease to hold the seal (K060), install the endcap to the housing. Ensure that seals remain properly seated and are not pinched during assembly. With a 10 mm internal hex wrench, install and torque endcap screws at 127 to 155 Nm [94.to.114.lbft], using the criss cross pattern. Retorque the first screw to ensure proper torque retention.

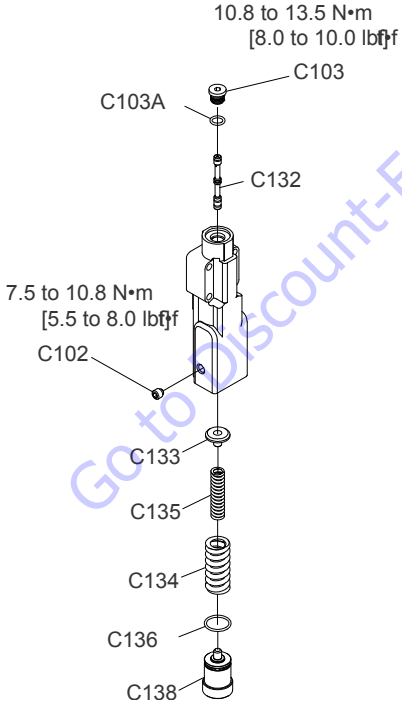


12. Lubricate the lip of the new shaft seal (K020) with clean hydraulic fluid. Place a protective sleeve over the shaft end to prevent damage to the seal during installation. Keeping the seal perpendicular to the shaft, press the new seal into the housing just far enough to clear the retaining ring groove. Install seal with the cupped side toward the shaft bearing. Do not damage the seal during installation. Using the appropriate snap ring pliers, install the seal retaining ring (K010). Remove the installation sleeve.

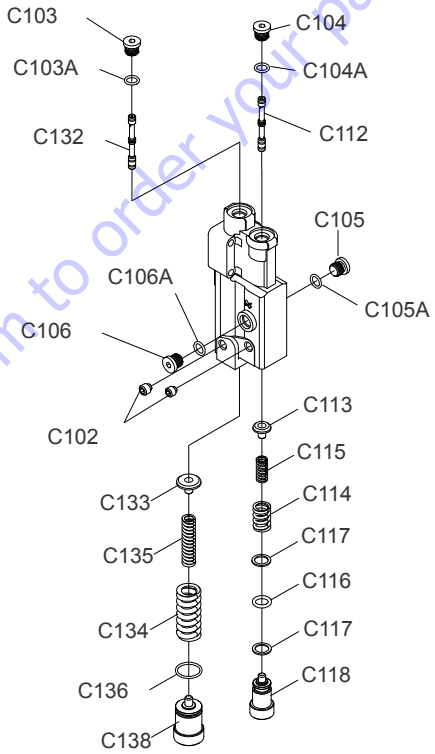


13. Clean all control parts and cover with a light coating of hydraulic fluid prior to reassembly.

14. Install the spherical end of the PC spool (C132) into the PC bore (refer to illustration). Install the PC plug (C103) using a new O-ring (C103A). Torque at 10.8 to 13.5 Nm [8.to.10.lbft]. Place the two PC springs (C134, C135) onto the PC spring guide (C133) and install into the PC bore. Place a new O-ring onto the PC plug and install it so that it sits one turn below the surface of the control housing. Install and tighten set screw (C102) at 7.5 to 10.8 Nm [5.5 to 8.0 lbft] to retain the adjusting plug.

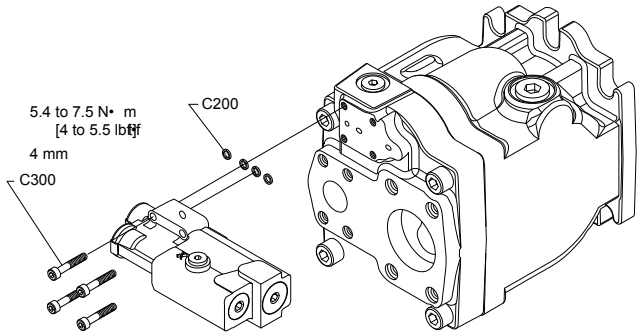


15. Hold the control in a horizontal position. Install the spherical end of the LS spool (C112) into the LS bore (see illustration). Using a new O-ring, install the LS plug (C104), torque at 10.8 to 13.5 Nm [8 to 10 lbft]. Place the 2 LS springs (C114, C115) onto the LS spring guide (C113) and install into the LS bore. Place a new O-ring (C116) and Backup rings (C117) onto the LS adjustment screw (C118). Install the LS plug assembly so that it sits one turn below the surface of the control housing. Install and tighten set screw (C102) at 7.5 to 10.8 Nm [5.5.to 8.0 lbft]. Also, install the plugs (C105, C106) with new O-rings. Torque the plugs at 10.8 to 13.5 Nm [8 to 10 lbft].



NOTE: *PC and LS spools need to be adjusted to proper setting according to tag nomenclature.*

16. Using petroleum jelly to retain them, install 4 new seal rings (C200) in the recesses on the control housing. Install the control assembly onto the endcap using the 4 screws (C300). Torque at 5.4 to 7.5 Nm [4.0 to 5.5 lbft] using a criss cross pattern and retorque the first screw to ensure proper torque retention.



5.10 GEAR PUMP (SAUER)

Disassembly

Prior to proceeding it may be necessary to prepare some subassemblies separately.

The details for preparing each subassembly are given in the following section.

Also, some general recommendations are given below.

CLEANLINESS

Cleanliness is a primary factor for reliable pump performance. Wash the outside of the pump thoroughly before disassembly and all pieces prior to assembly. Cleaning parts with clean shop solvent and air drying is usually adequate.

LUBRICATION OF MOVING PARTS

During assembly, it is imperative to provide lubrication with clean hydraulic oil to all the running parts of the pump.

It is also necessary to coat the seals with grease. The absence of lubrication during assembly can cause the unit to seize after a few minutes of running.

CARE OF SURFACE TREATMENT

Be careful when handling all the internal surfaces, especially bearings, gears, and body faces. Do not touch or score them with metal tools or cutting edges.

MARKING THE PARTS

Mark the parts before completely disassembling a pump. The marks allow components to be reassembled in the same relative position. This action should be applied to the body, bearings, and gears. Scribing, bluing, or using a felt tip pen to mark the outside of the body on the inlet side is suggested to indicate the relative position of the front flange and the rear cover to the body. Mark the bearing blocks also on the inlet side and the gears position relative to each other. DO NOT scribe internal surfaces.

PROCEDURE

1. Clamp the unit.

   Clamp the unit in a vice from the flange side.

   Make sure the vice jaws are clean and have smooth surfaces to prevent damage to the pump.

NOTE: *Clamping the pump on the body is not recommended because serious damage to the surfaces, on which the ports are located, may occur.*

2. Remove capscrews. (Except Units with 03 Flange).

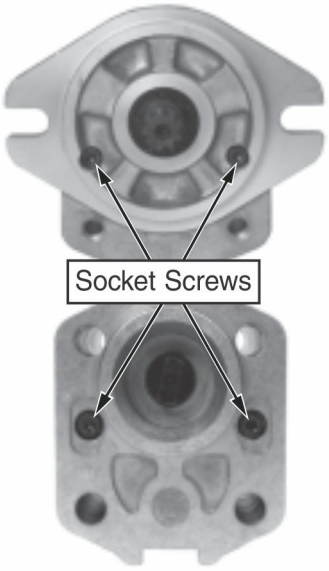
   Use a 17 mm socket wrench and loosen the four capscrews on the cover. Next completely unscrew the capscrews and remove them.

   Inspect the threads of the capscrews for damage.

3. Remove socket head capscrews. (03 Flange or Multiple Pump Stages Only).

Using a 4 mm internal hex wrench, loosen and remove the two small socket screws placed in the center of the cover. Repeat the same operation for the corresponding screws on the rear flange.

06 Flange (first stage of multiple pump)



03 Flange

4. Remove front flange.

Place the pump on the table and slowly remove the front flange.

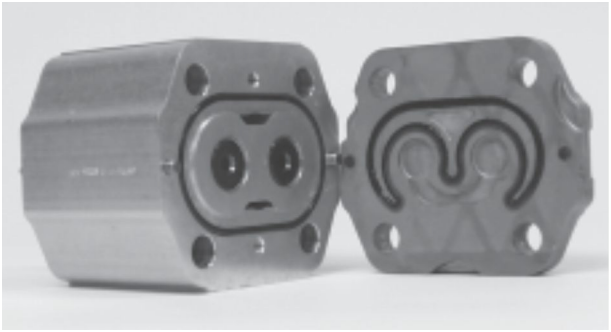
Be careful not to damage the shaft seal when removing the flange. Avoid contact of the shaft seal lips with key-way edges (in tapered and parallel shafts) or splined shaft teeth.

Inspect the front flange and seal area.

Clean with shop solvent, dry, and set aside.

5. Remove rear cover.

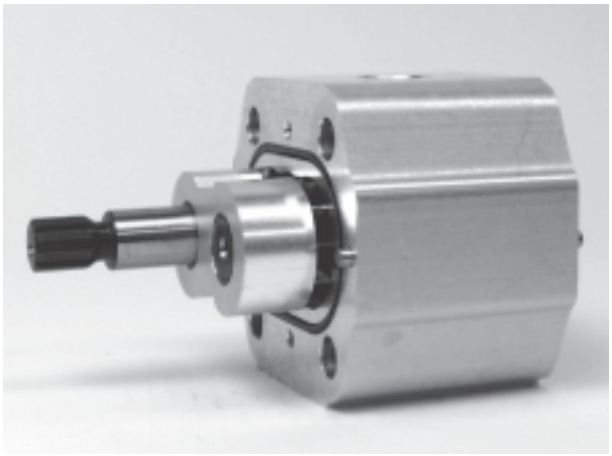
Remover rear cover. Clean with shop solvent, dry, and set aside. Visually inspect rear cover and seal area.



6. Remove bearing blocks and gears.

Place the pump on its side and carefully remove the bearing block and gear set. To accomplish this, hold the pump body and push with your fingers on the rear bearing block.

Mark the relative positions of the gear mesh (drive gear tooth to idler gear tooth) and the bearing blocks to the body so they can be reassembled in the same position.

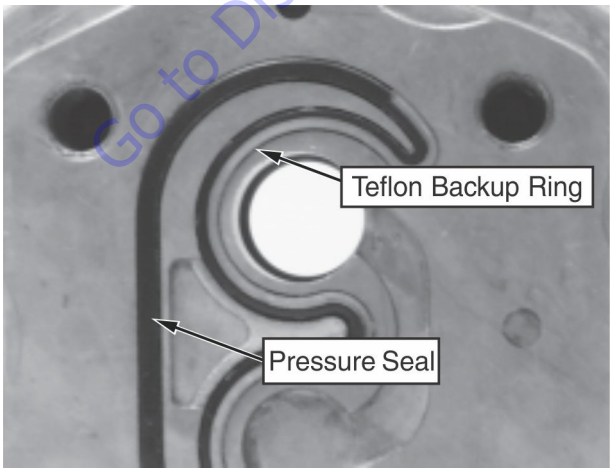


7. Remove pressure seals.

Check the seal quality. Replacement is recommended whenever there are burrs, evidence of extrusion, or marks caused by overheating. If the seals need to be replaced, carefully remove them from the flange cover, beginning with the backup ring and then the pressure seal.

Do not use tools with sharp edges to remove the seals, as damage to the cover can result.

After removal, dispose of damaged seals.

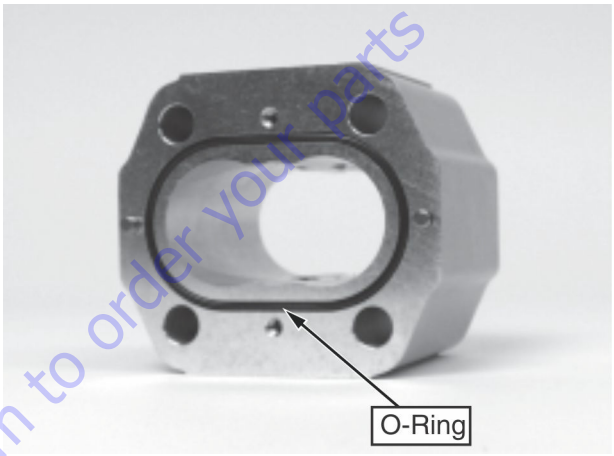


8. Remove Outer O-Ring Seal

Check the quality of this seal. If necessary, replace it. Follow the same removal recommenda?tions given in step 7.

After removal, discard the damaged seal.

Do not use tools with sharp edges to remove the seals, as damage to the cover can result.



9. Remove the snap ring.

Place the flange on the work surface. Using internal snap ring pliers, remove the snap ring.

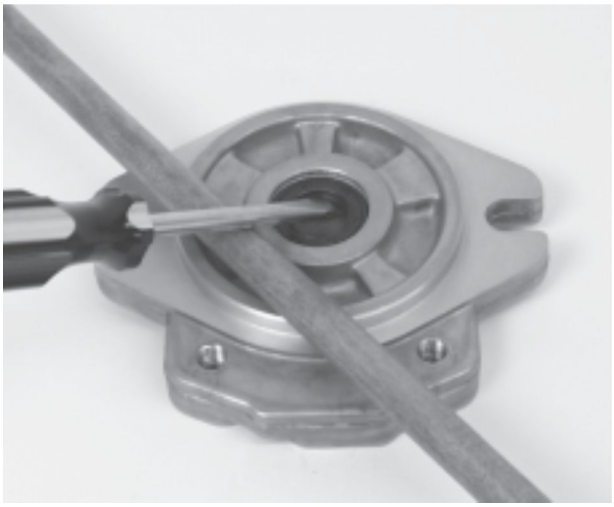
10. Remove the shaft seal.

Check the shaft seal quality and remove if necessary.

To remove, pry the bottom of the shaft seal and force it out while rotating the flange to lift it out evenly.

Do not use the flange pilot to gain leverage, damage may result. Use a plastic rod or wooden dowel as a fulcrum.

After removal, dispose of damaged seal.



Assembly

1. Prepare the seals.

Have the entire seal kit available.

Lightly coat all seals with seal grease. The grease is needed to adhere the seals to their grooves.

Do not install dry seals.

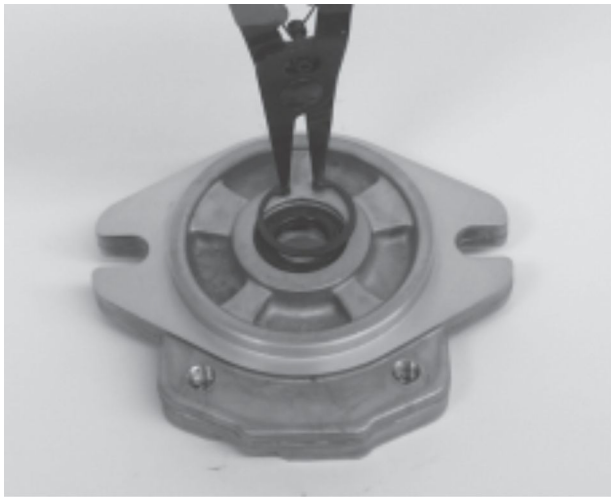
2. Install shaft seal into front flange.

Prepare the flange and shaft seal by lightly lubricating with grease.

Seat the seal in the flange by hand. Then, using the shaft seal installation tool, press the seal until the tool stops on the flange. This will insure the seal is inserted to the proper depth.

3. Install snap ring.

Install the snap ring using internal snap ring pliers. Ensure the snap ring fits securely in its groove. This is necessary to retain the shaft seal.

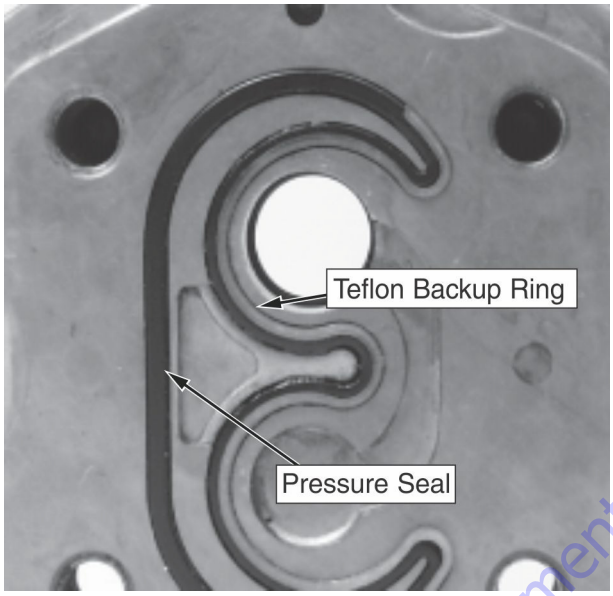


4. Install pressure seals.

   Prepare the pressure seals by lightly lubricating them with grease.

   Install pressure seals into the grooves on the front flange and rear cover. Then install the teflon backup ring.

   Ensure that the seals are located in the grooves, as shown.



5. Prepare the body.

   Clean the body.

   Inspect the internal and mating surfaces. Ensure the surfaces are free of burrs and scratches. Check both the bearing block mating surface and the cut-in path. The cut-in path should be no deeper than 0.1 mm (0.004 in).

6. Install outer seal.

   Prepare the outer seal by lightly lubricating with grease.

   Install outer seals in the grooves on both sides of the body.

7. Prepare the gears.

⚠ CAUTION

THE GEAR SURFACES ARE SUPER-FINISHED. RESIDUE ON HANDS AND FINGERS MAY BE CORROSIVE TO THIS SURFACE. DO NOT TOUCH.

Carefully clean the two gears. If the gears are new, wash them with shop solvent to remove any anticorrosive grease on the surfaces.

Inspect the journals and the flat faces on the top and bottom of the gears. Ensure these surfaces are free from burrs or scratches. If scratches or burrs are found, clean them with a flat stone and/or very fine emery paper. Rewash the gears after this operation.

8. Prepare the bearing blocks.

Clean the two bearing blocks.

Inspect the flat surfaces of the bearing blocks for burrs or scratches on the edges. If necessary, remove burrs with very fine emery paper. Then rewash the bearings.

Inspect the DU bushings for wear. There should be no bronze showing.

Using clean hydraulic oil, lubricate the internal and external surfaces of the bearing blocks.

9. Assemble the bearing blocks and gears.

Lubricate the journals and the gear faces.

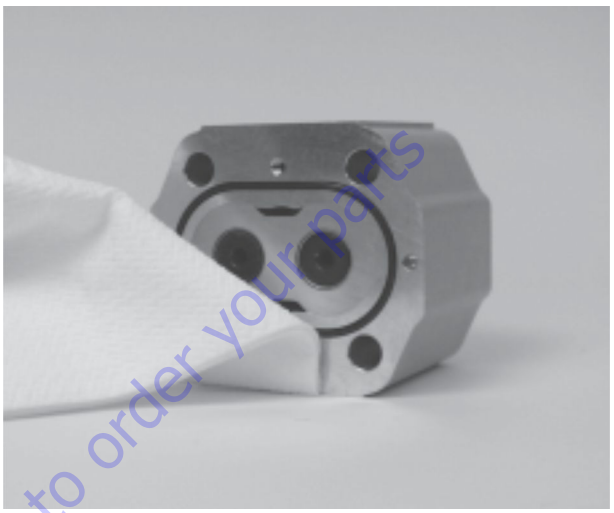
Assemble the bearing blocks and gears. Ensure that the recessed bearing faces are installed adjacent to the gear faces. Align all assembly marks made during disassembly. Ensure the front and rear bearing blocks occupy the same location with respect to the housing as before disassembly. Ensure that the relative position of the gear mesh is maintained as before disassembly. Misalignment of the gear teeth may increase operating noise.

10. Install the gear block assembly.

Install the bearing block and gear assembly into the body cavity. Align the assembly marks to ensure that the gear block assembly is installed with the same orientation as before disassembly.

11. Clean the mating surfaces.

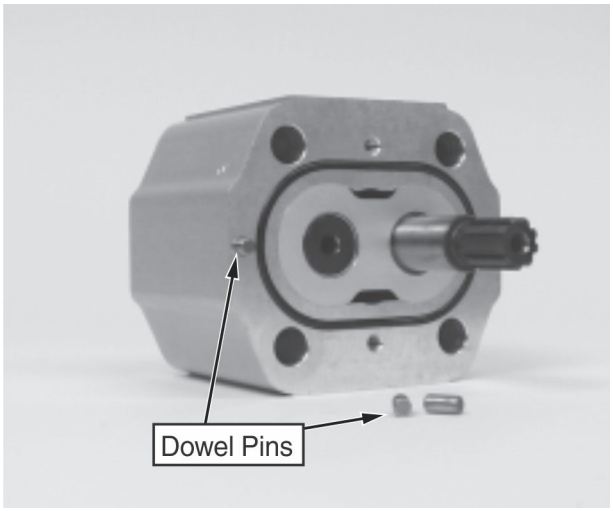
Remove any excess lubrication and grease from the mating surfaces of the pump body. Ensure that these surfaces are dry and free of contamination before moving on to the next step.

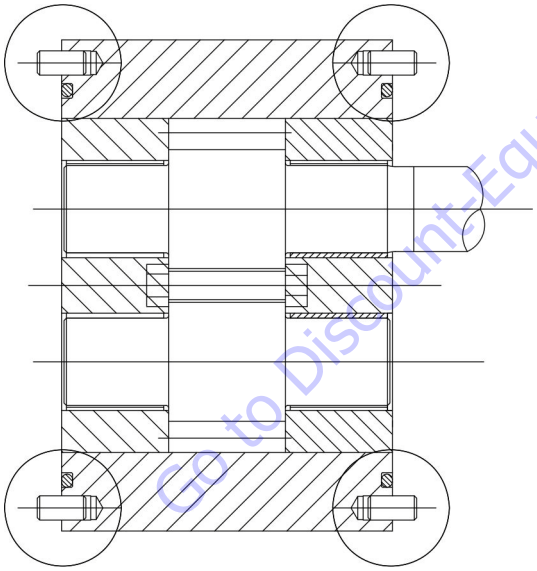


12. Install the dowel pins.

Install four 5 mm dowel pins into the proper cavities on both sides of the body (refer to the illustration). Swab the pins with assembly grease or petroleum jelly to retain them during assembly.

Do not install dowel pins to the rear cover or flange, as one of them may drop inside the pump during assembly.

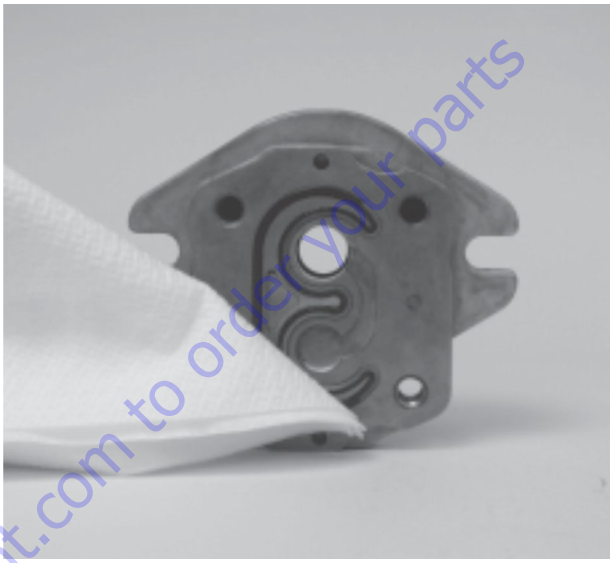




13. Clean the mating surfaces.

Remove any excess lubrication and grease from the mating surfaces of the front flange and rear cover. Ensure that these surfaces are dry and free of contamination before moving on to the next step.

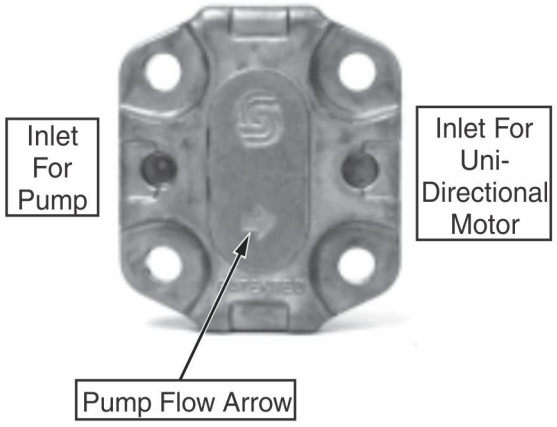
Ensure the pressure seals are seated properly after this operation.



14. Install Rear Cover.

Mount the cover on the body. Ensure the arrow on the back is oriented properly. The arrow should be In the same direction as the flow.

Ensure that all the pressure seals stay in place during this operation.



15. Prepare pump for front flange assembly.

Place the pump with the rear cover downwards.

Ensure that the assembly marks on the bearing block / body are properly aligned.

16. Install the front flange.

Install a protective sleeve over the shaft. The sleeve is used to protect the shaft seal from damage by the shaft splines / keyway during front flange assembly.

Install the flange onto the body, then remove the protective sleeve.

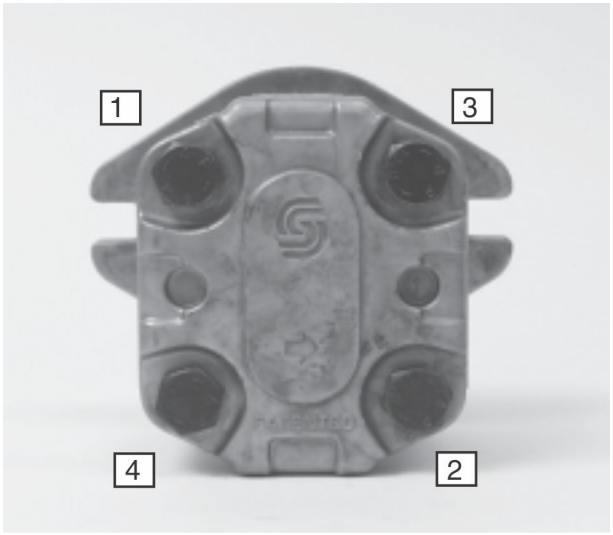
Ensure that the seals remain seated in their grooves during this operation.

17. Torque sequence.

When assembling units with 01 flange and short coupled tandems, wash the capscrews and apply JLG Threadlocker PN 0100011 or equivalent thread lock compound to the threads before assembly.

Install capscrews. While observing the torque sequence shown, pre tighten the capscrews. Then, using a torque wrench, tighten them to the proper torque.

Torque 44-54 Nm (32-40 ft.lbs.).



18. Install socket head capscrews. (03 flange and first stage of multiple).

Using a 4 mm internal hex wrench, install the socket head capscrews to the front flange and rear cover.

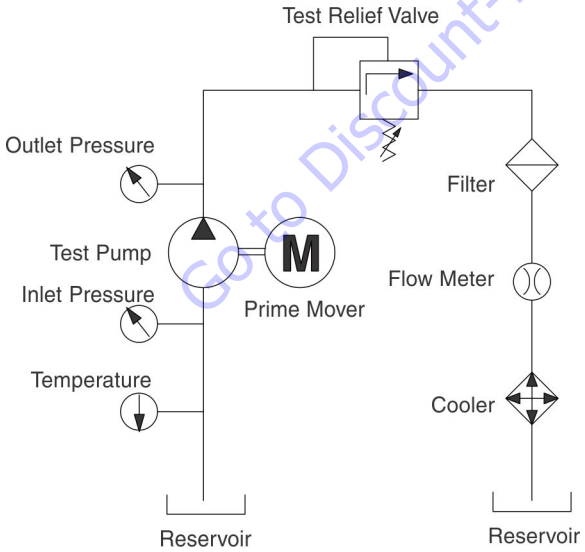
Torque 2.5-3.4 Nm (22-30 ft.lbs.).

If used, install new o-ring to flange pilot.

19. Testing

After pump has been disassembled and reassembled, it is suggested that the pump be run in and tested on an appropriate test stand. This is done to verify the volumetric efficiency and the integrity of the unit.

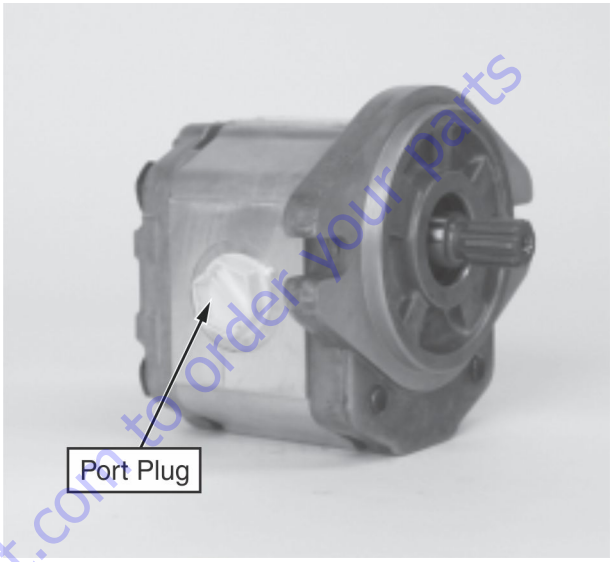
Test specifications and procedure are given in Testing the Pump.



20. Prepare the unit for shipment or storage.

Clean the exterior of the pump and install the following:

- **a.** Port Plugs
- **b.** Key (CI and CO shafts)
- **c.** Shaft protective cap (CI and CO shafts)
- **d.** Nut and washer (CO shaft)



Trouble Shooting

Table 5-49. Troubleshooting

Low or No Flow From Gear Pump		
Item	Description	Action
1. Check oil level in reservoir.	Description Insufficient oil to supply gear pump.	Fill reservoir to proper level.
2. Check input spline condition.	Input shaft broken or stripped.	Repair or replace gear pump.
3. Check pressure at pump inlet. Recommended inlet pressure: 0.8 to 3.0 bar absolute. 0.6 Minimum at cold start.	Clogged suction filter or inlet screen.	Replace filter or clean suction screen.
4. Check condition of gear faces and bearing blocks.	Scored bearing block and gear faces will reduce pump efficiency.	Repair or replace gear pump.
5. Check bushings.	Overpressure of gear pump will cause idler gear bushing to fail.	Repair or replace gear pump.
Excessive Noise		
Item	Description	Action
1. Check oil level in reservoir.	Excessive air will cause cavitation sound.	Fill reservoir to proper level .
2. Check inlet line for leaks.	Excessive air will cause cavitation sound.	Repair inlet line.
3. Check pressure at pump inlet. Recommended inlet pressure: 0.8 to 3.0 bar absolute. 0.6 Minimum at cold start.	Lower than normal inlet pressure causes excessive pump noise.	Return inlet pressure to recommended levels.
External Leakage		
Item	Description	Action
1. Check for pinched o-rings or backup ring seal.	Pinched seal will allow leakage.	Replace pinched seal.
2. Check pressure seals.	Damage to pressure seals is typically caused by reduced stack-up in the pump assembly. This may be due to under-torqued assembly fasteners, or more commonly is attributed to excessive wear on the bearing blocks. Reduced stack-up will affect seal efficiency possibly to the point of seal extrusion.	Inspect condition of bearing blocks. If they are found to be worn, repair or replace the pump. If bearing blocks are not worn, replace pressure seals and re-torque pump assembly fasteners.

5.11 DRIVE & FUNCTION PUMP START UP PROCEDURES

Start-Up Procedure

The 1200/1350 Boom Lift utilizes a Triple Combination Pump coupled to the Deutz diesel engine. The pumps are connected in-line to each other as follows:

1. The front hydrostatic transmission pump, or drive pump, is coupled directly to the diesel engine and provides oil flow to operate the machine's right side wheels.
2. The middle hydrostatic transmission pump, or drive pump, is coupled to the back of the front pump and provides oil flow to operate the machine's left side wheels.
3. The third or rear pump is the function pump. It is coupled to the back of the middle pump and provides oil flow to operate the boom, axle, steer and platform functions.

The transmission pumps share some common connections. Each pumps charge oil suction ports are connected by steel tubing, the charge pumps discharge oil flows are connected and flow to a common charge pump inline oil filter, cleaned & filtered oil flows back to the transmission pumps "G" ports. The pumps case drain ports are connected (T1 & T2), oil flow from the middle pumps T1 port also provides flows to the oil cooler. The charge pumps oil pressure is regulated by a single boost oil pressure relief valve installed in the middle pump. The front pump has an orifice cartridge (0.047" diameter) installed in place of a charge oil pressure relief cartridge. This insures that only one valve controls charge pressure & provides an amount of charge oil flow to the front pump's case to insure flushing & removal of hot oil.

Each pump has its own separate electrical proportional directional control valve to control oil flow and direction. The signals or command values to each pump are similar except when steering. During steering and propel of the machine the pump supplying oil to the "inside turning radius" has a command less than the pump supplying oil flow to the "outside turning radius" pump.

"Posi-Traction" control, front to rear on a given side of the machine, is accomplished by a flow divider/combiner cartridge installed in the Traction Control Manifold. There is a flow divider/combiner for each side. Each flow divider/combiner also has a "bleed orifice" to limit the amount of flow splitting or combining.

The middle transmission pump also supplies oil to a hot oil flushing valve cartridge, #120, in the Traction Control Manifold. This cartridge provides a means to obtain brake release oil pressure. The brake release pressure is controlled by a pressure relief valve cartridge # 130 and a solenoid operated brake release directional control cartridge, #170, also located in the Traction Control Manifold. This is important to note as the brake release oil pressure must be set 25 psi (1.7 bar) below the boost oil pressure relief valve. If the brake release pressure is set too low, brake drag and pump control will be affected. If set too high, damage to the wheel drive parking brakes could result. Prior to start, connect appropriate pressure gauges to the unit.

FOR THE START-UP OF NEW OR OVERHAULED INSTALLATIONS:

1. Insure all electrical checks have been performed & the machine is set up correctly with the JLG Analyzer.
2. Insure the machine has all four wheels jacked & blocked off the ground per JLG procedures.
3. Insure the triple pump assembly is installed and connected correctly per the hydraulic circuit diagram.
4. Disconnect the electrical connector from the diesel's throttle actuator, to prevent engine start.
5. Crank the engine until charge pressure reaches 50 psi or more.
6. Re-connect throttle actuator electrical connector and start engine. Allow engine to run at idle speed only for at least 5 minutes. This will allow the hydrostatic system to filled.
7. Listen for any abnormal noises.
8. Check for oil leaks.
9. Check charge pressure (500 psi +50psi, - 0 psi [34.4 bar +3.4 bar, - 0 bar]). Pressure can be measured a pump ports Ma & Mb or by "teeing" into the inlet for the charge oil filter. Charge pressure is checked with the joystick in neutral. A 0-1000 psi (0-70 bar) pressure gauge must be used. (If pressure gauges were installed in Ma & Mb to check charge pressure, disconnect the gauges installed in Ma & Mb, as they will be damaged if loop pressure rises above 1000 psi [34.4 bar].)

10. Operate the drive system in the "turtle mode", forward and reverse.
11. De-aerate the system by bleeding fluid from the Ma & Mb ports.
12. Switch the drive mode speed control from "turtle" to "rabbit". Gradually increase drive speed forward & reverse, still with no load - wheels off the ground.
13. With the joystick in neutral, check for creep in neutral. If evident, most likely dirt is present in the proportional pump control, an incorrect electrical signal is present on the pump's electrical control(s) or the control was not centered properly when overhauled. See service manual for centering instructions.
14. Check that the controls are connected so that the transmissions operate in the correct direction related to control input.
15. Continue to monitor all pressure gauges & correct any irregularities.
16. Remove the brake coil (leaving the electrical connection intact) from the brake release solenoid cartridge located on the Traction Manifold. This disables the machine's ability to release the brakes! Stroke the transmission pumps slightly (less than 20%) and check the setting of the high pressure cross port relief valves. Setting should be 5000 psi +50 psi, - 0 psi (344.7 bar +3.4 bar, -0 bar). Install 0-6000 psi (0 - 415 bar) gauges on Pump ports Ma & Mb.
17. Check oil level & temperature.
18. Remove and inspect charge pressure oil filter, replace with new element.
19. Operate the transmission under no load conditions for about 15 minutes to stabilize the temperature and remove any residual air from the fluid.
20. Set the machine back on the ground. Operate the transmissions under full and normal conditions.
21. Erratic operation may indicate there is still air trapped in the system. By working the pump controls forward and reverse the remaining air can be eliminated. The system is free of air when all functions can be operated smoothly and when the oil in the reservoir is no longer aerated. (Usually less than one hour of operation)

NOTE: *If the transmissions do not perform correctly after following the pre-start & start-up procedures, refer to the relevant sections of the trouble-shooting procedures.*

5.12 HYDRAULIC SCHEMATICS

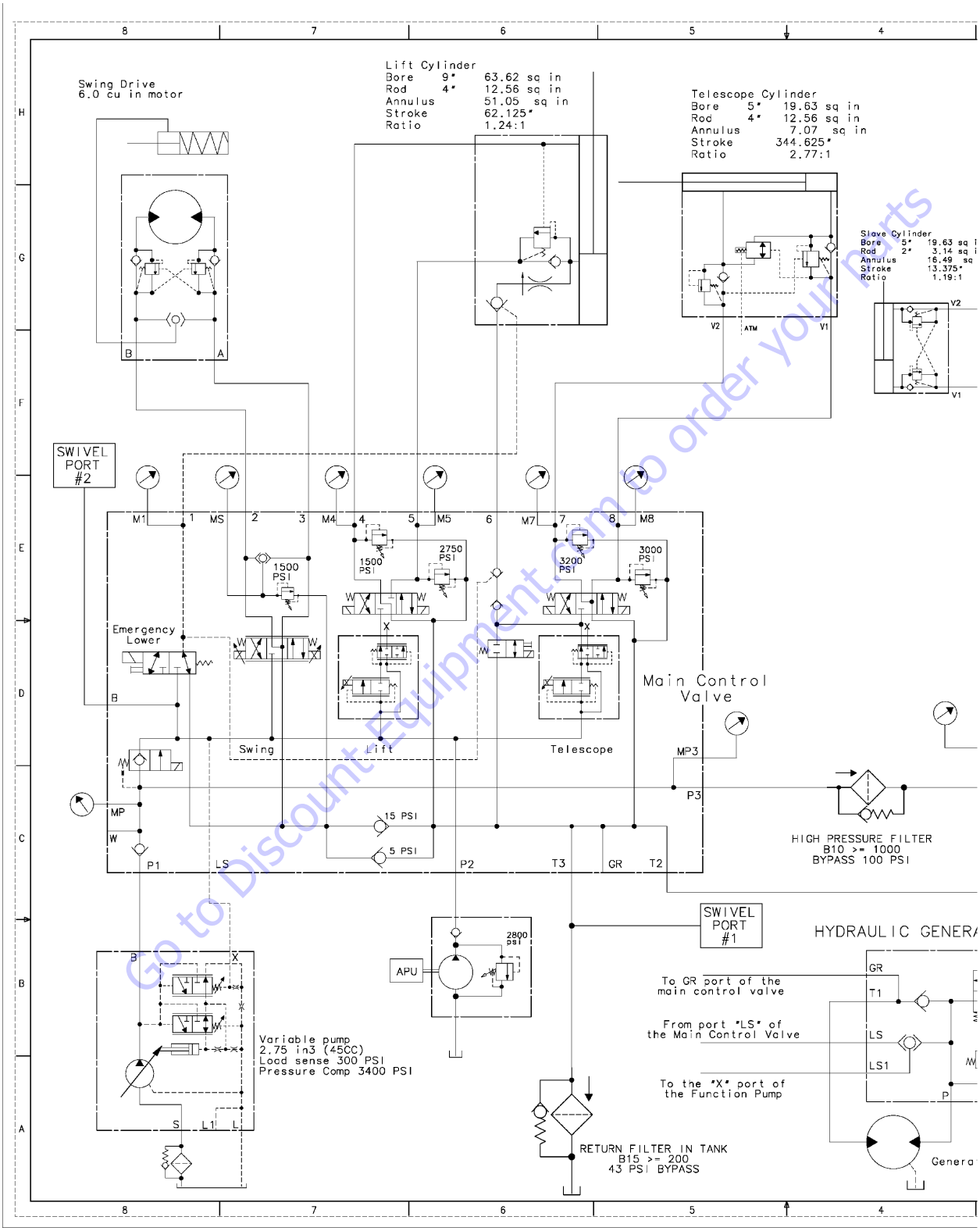


Figure 5-79. Hydraulic Schematic - Boom Functions - Sheet 1 of 2

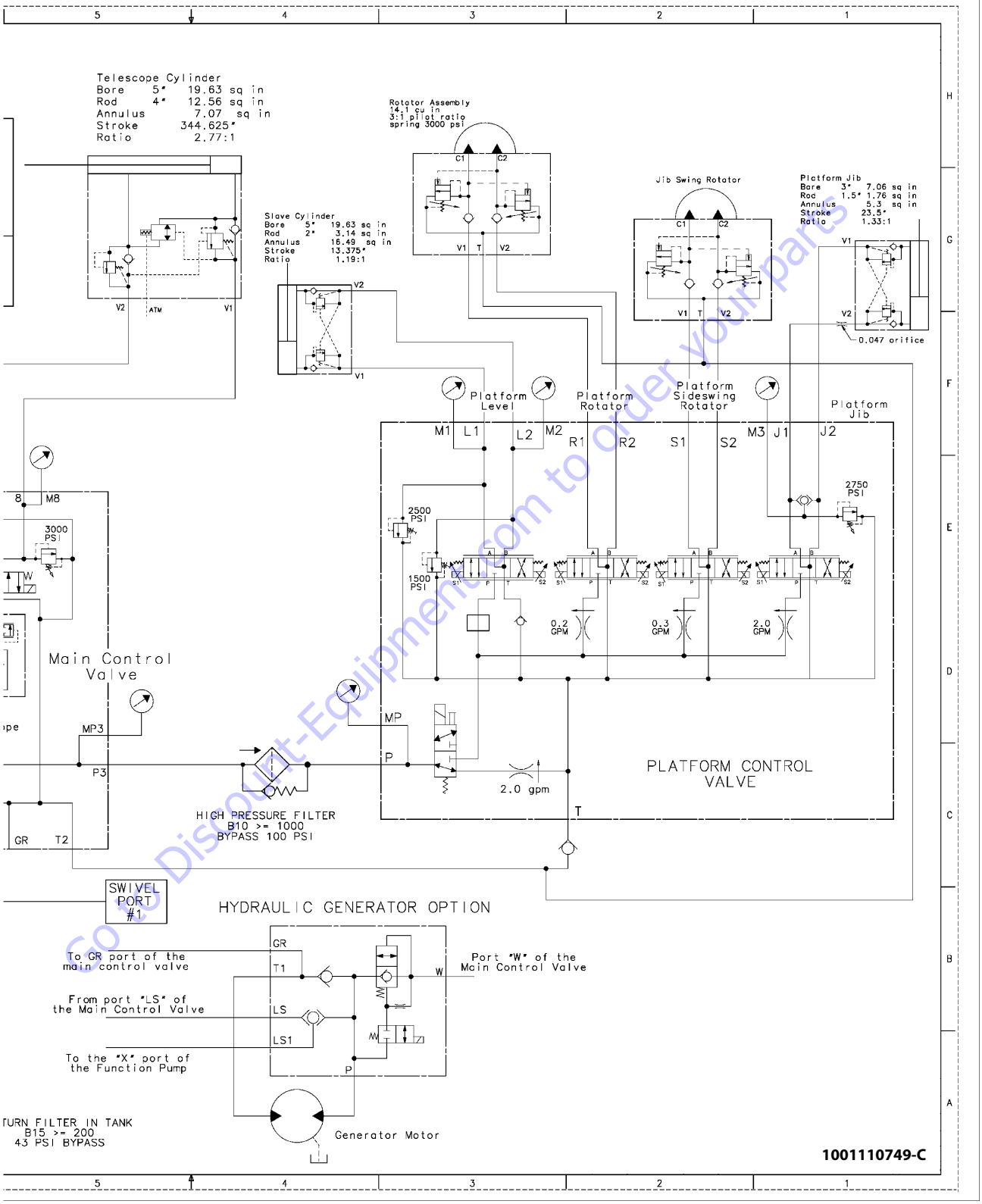


Figure 5-80. Hydraulic Schematic - Boom Functions - Sheet 2 of 2

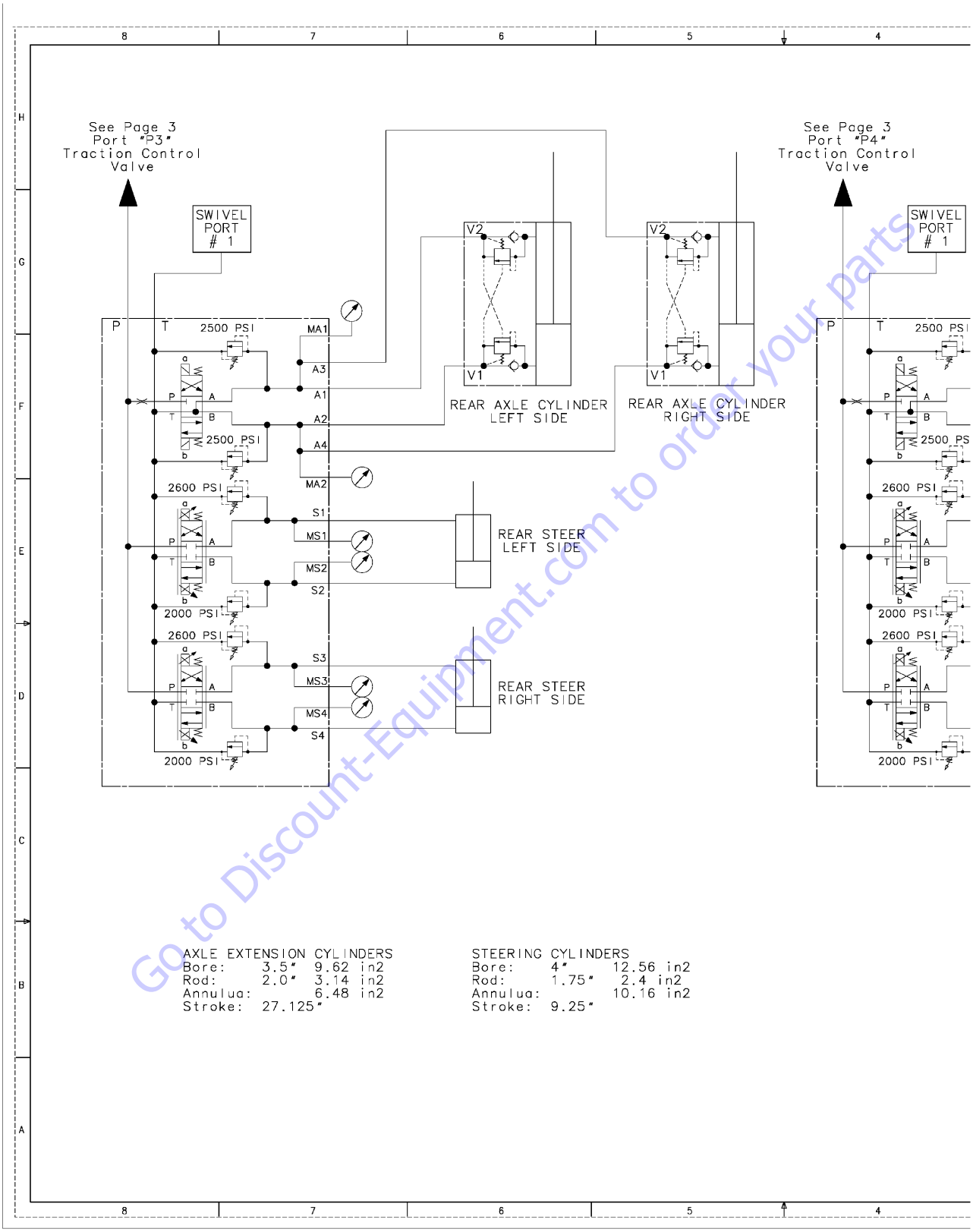


Figure 5-81. Hydraulic Schematic - Axle/Steer Control - Sheet 1 of 2

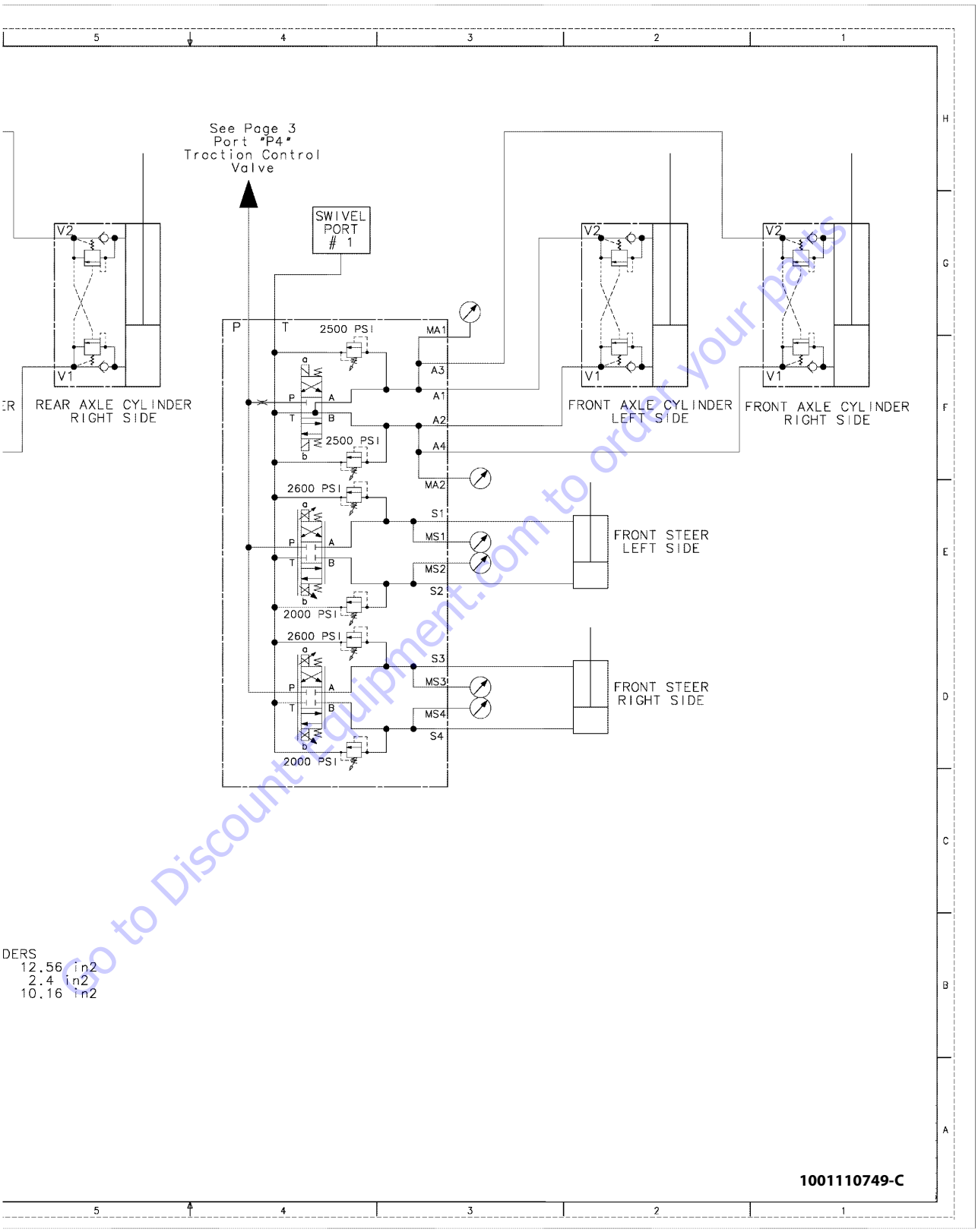


Figure 5-82. Hydraulic Schematic - Axle/Steer Control - Sheet 2 of 2

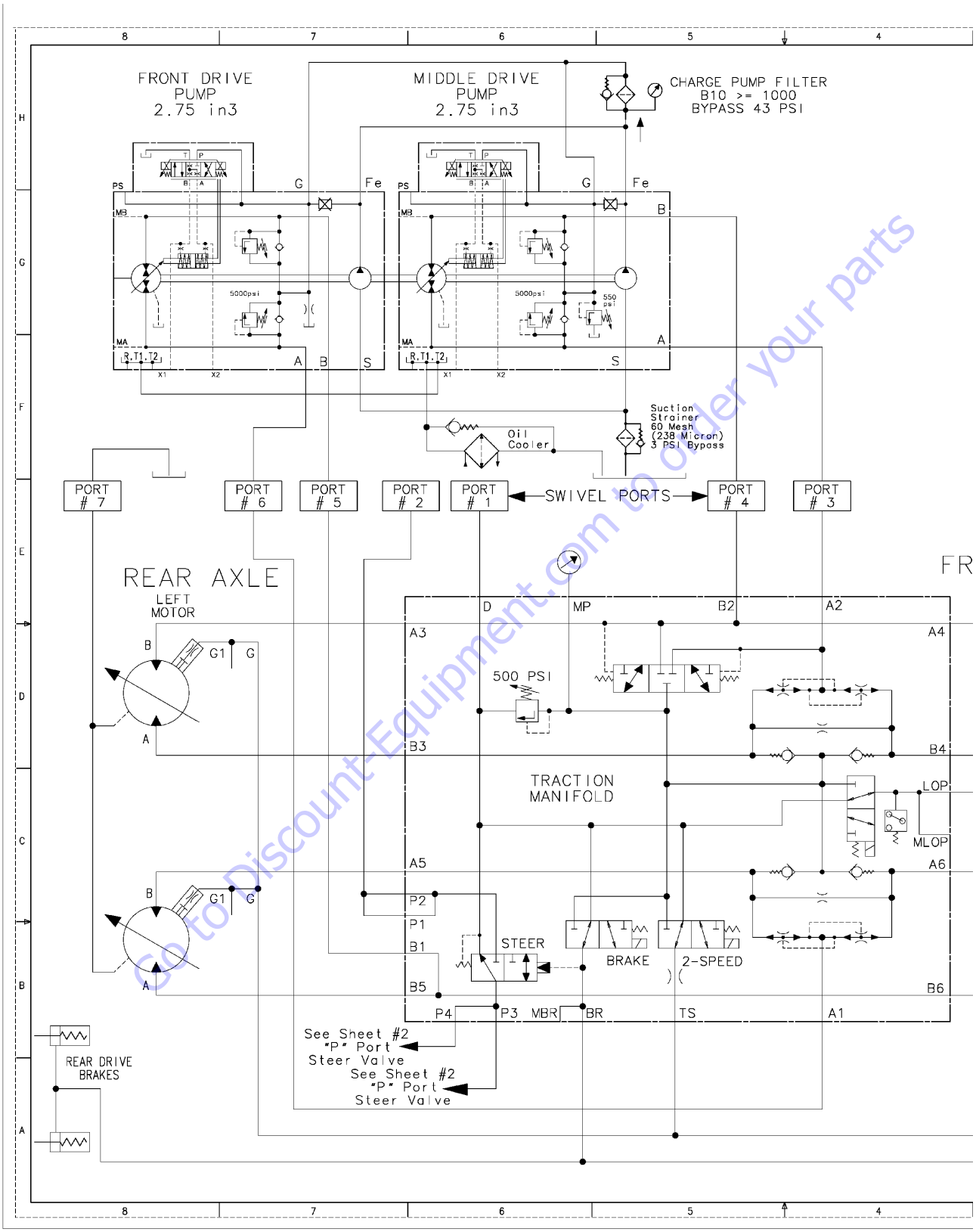


Figure 5-83. Hydraulic Schematic - Drive System Bosch/Rexroth Pumps - Sheet 1 of 2

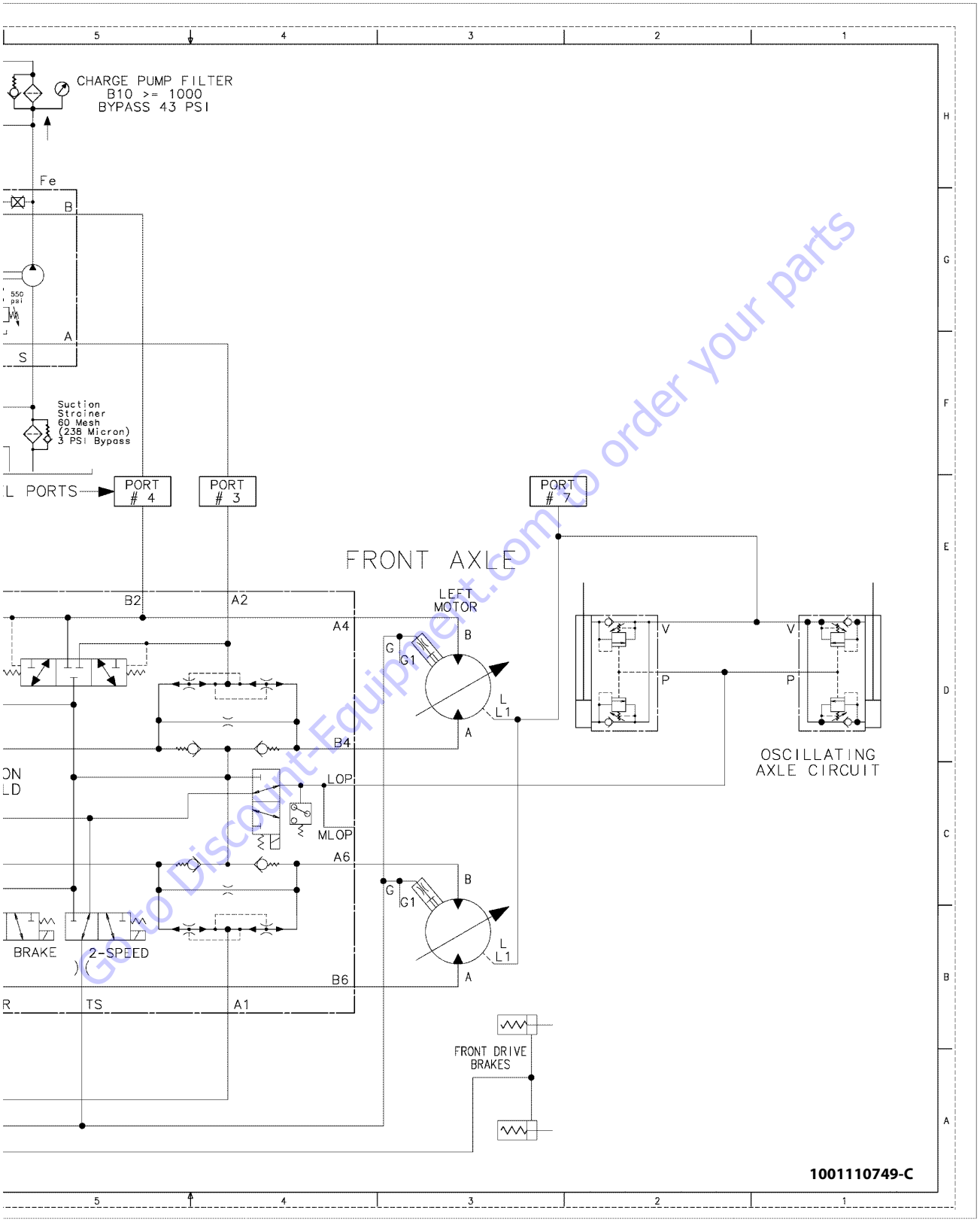


Figure 5-84. Hydraulic Schematic - Drive System Bosch/Rexroth Pumps - Sheet 2 of 2

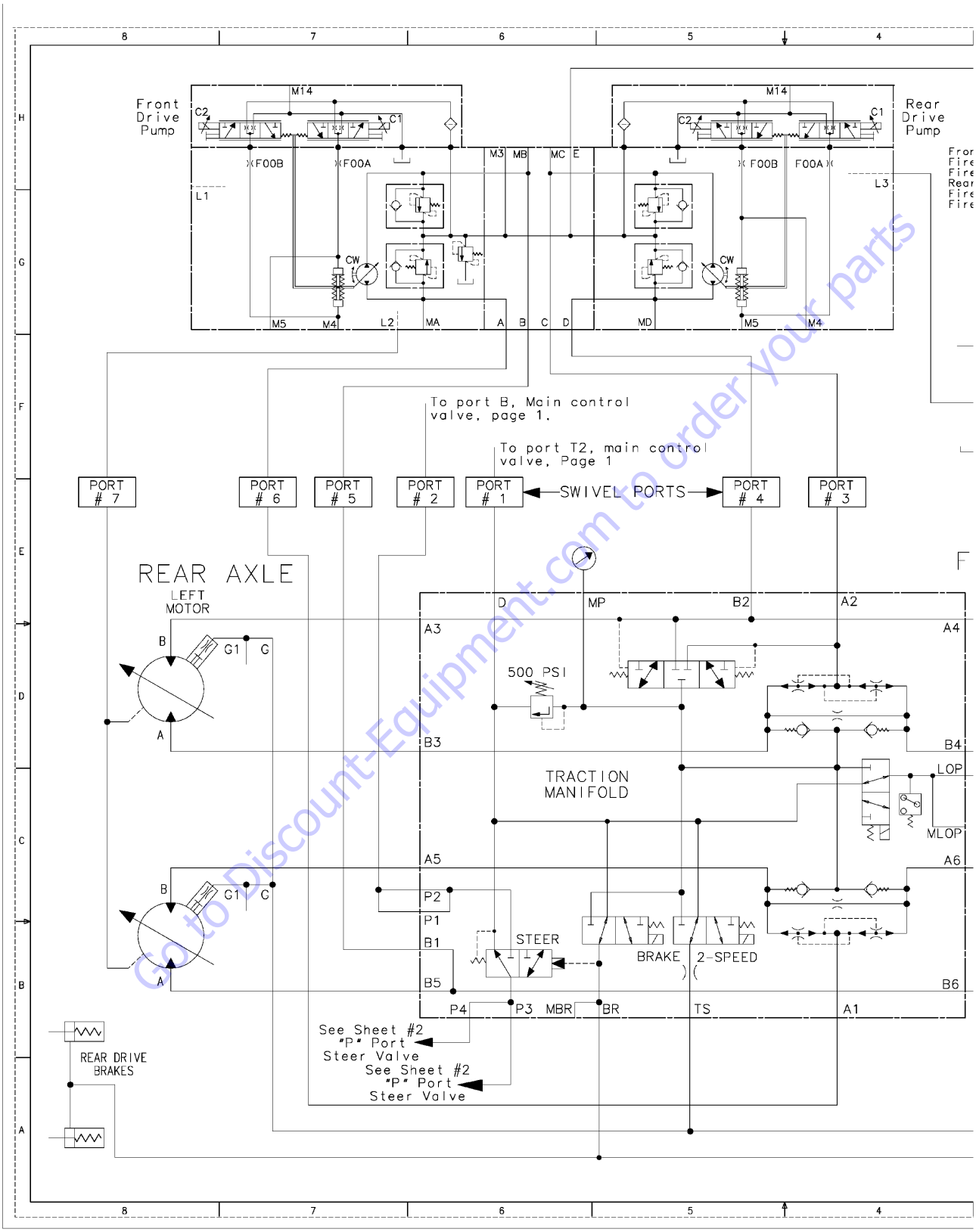


Figure 5-85. Hydraulic Schematic - Drive System Sauer/Danfoss Pumps - Sheet 1 of 2

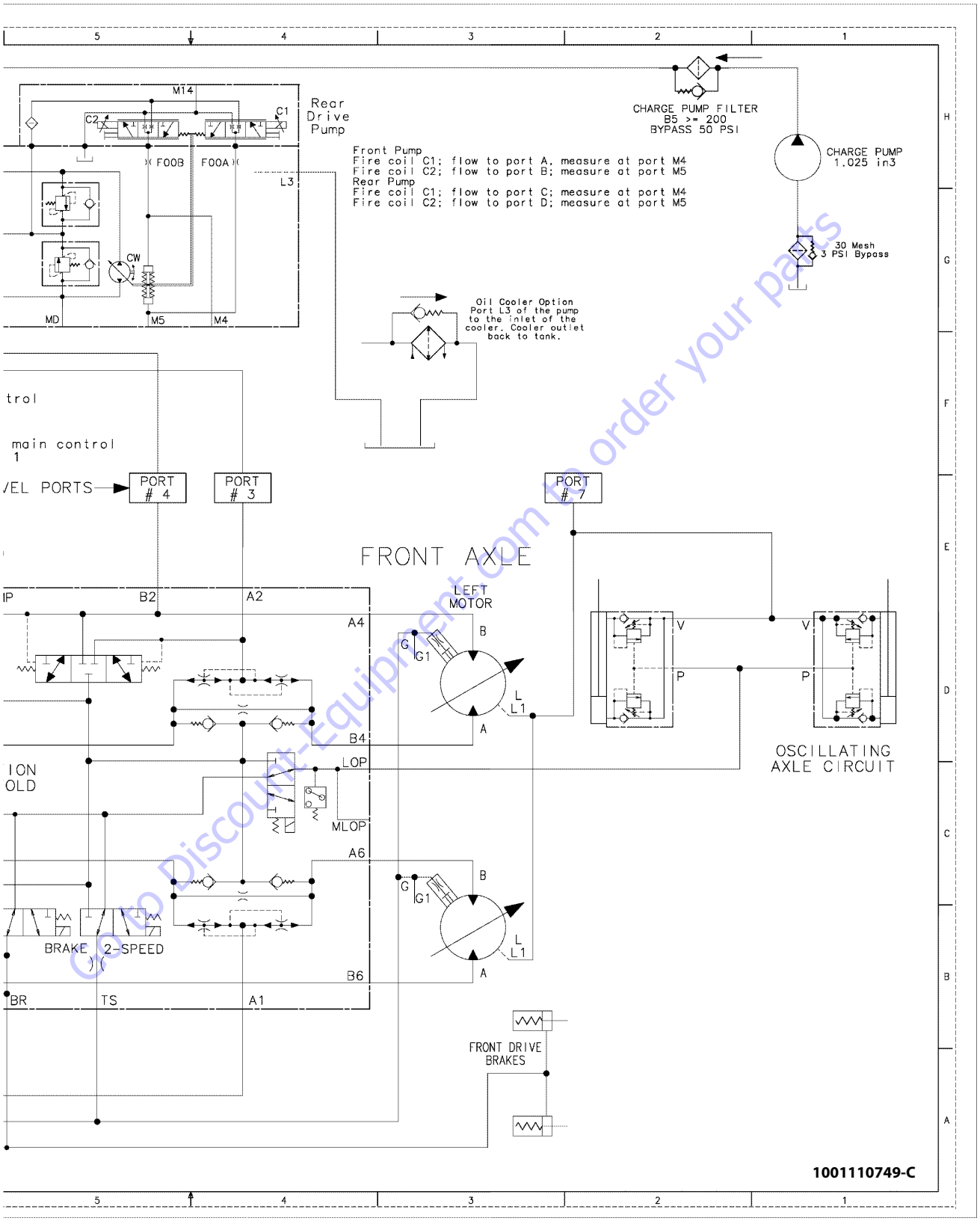


Figure 5-86. Hydraulic Schematic - Drive System Sauer/Danfoss Pumps - Sheet 2 of 2

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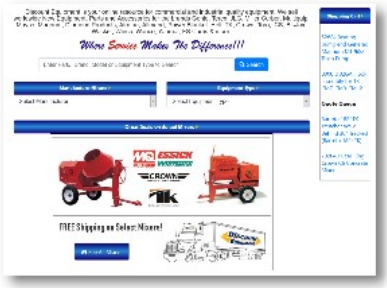

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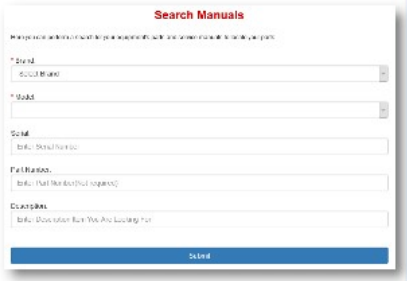

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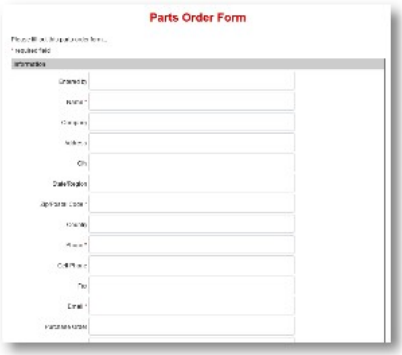

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SECTION 6. JLG CONTROL SYSTEM

6.1 INTRODUCTION

NOTICE

WHEN INSTALLING ANY NEW MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS AND PROPERLY CALIBRATE THE TILT SENSOR.

NOTICE

IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

The main lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer Kit, JLG part no. 2901443) which will display two lines of information at a time, by scrolling through the program.

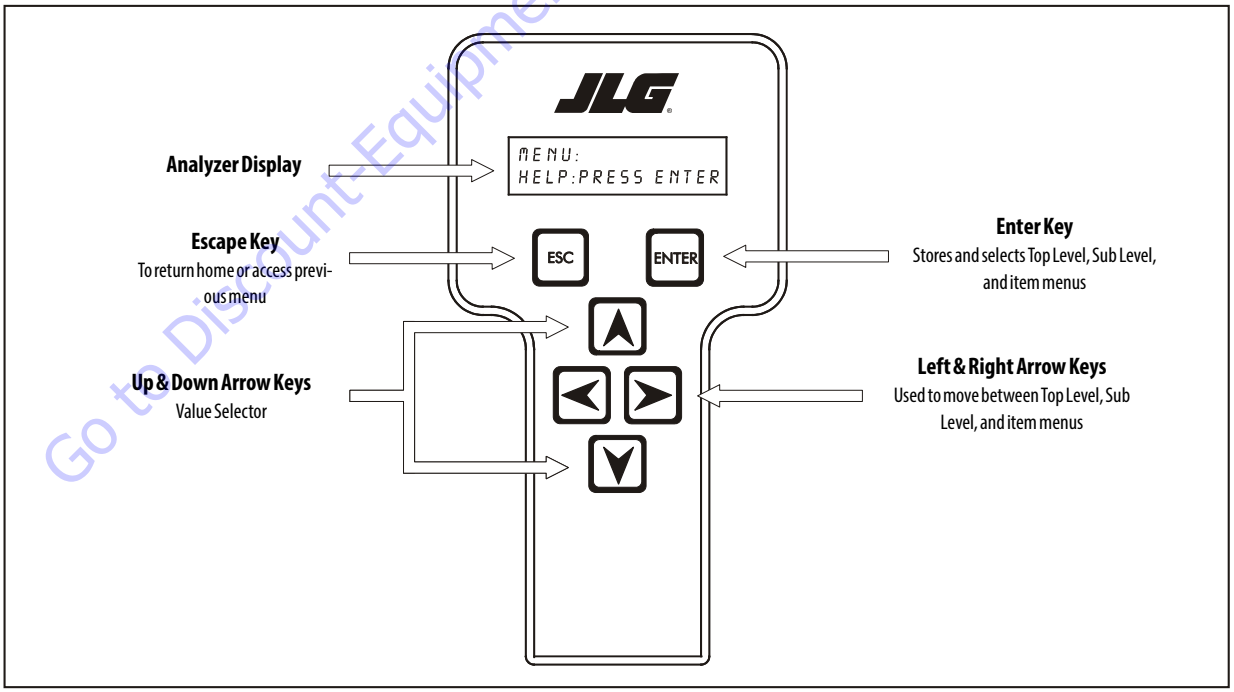


Figure 6-1. Hand Held Analyzer

6.2 CANBUS COMMUNICATIONS

CANbus: CAN (Control Area Network) is a two wire differential serial link between the Platform Module, Ground Module, Boom Length Angle Module and the Chassis Module providing bi-directional communications.

Two-wire: One wire (red) is driven high (5v) and the other low (black) (0v) to send a signal; both wires "float" (2.5v) when no signal is being sent.

Differential: Any electrical line noise can affect the high or the low wires but never both, so communications is not corrupted.

Serial Link: Messages are being sent bit by bit along the wires; the high bus speed allow all modules to be constantly updated around 20 times per second. Typical traffic is 300 - 500 messages per second.

A complete CANbus circuit is approximately 60 ohms, which can be verified at the "T" fitting inside the ground station or below the BLAM. Each individual circuit from the modules is approximately 120 ohms.

The GROUND MODULE is the master system controller. Most functions are dispatched and coordinated from this module, all other system modules (PLATFORM, BLAM L CHASSIS) handle sub-tasks. All characterized information (values) are stored into the ground module (i.e., Personalities or Calibrations).

Interlocks: Any device that sends an electrical input. (For an example a limit switch, proximity switch, etc;)

Platform Level: The GROUND MODULE stores the default values and handles interlocks. The PLATFORM MODULE reads the sensors mounted on the platform assembly and controls the Level Up / Down valves to maintain setpoint sent from the GROUND MODULE.

Steer: The GROUND MODULE stores crack points, sends desired drive direction, sends steering mode and sends axle extend / retract commands. The PLATFORM MODULE reports the steering switch position to the GROUND MODULE. The CHASSIS MODULE modulates each steer left / right valve to maintain commanded wheel position.

Drive: The GROUND MODULE stores crack points, sends commands for each drive pump to the BLAM. (Command is computed from drive joystick input, interlocks, wheel angle, etc). BLAM maintains proper current for the drive pumps by modulating PWM outputs.

Lift, Tele, & Swing: The GROUND MODULE stores default values, handles interlocks and calibration information. Lift, Telescope and Swing commands are dependent upon interlocks through out the machine. Boom angle, length and swing are controlled by the GROUND MODULE. The BLAM monitors and communicates (CANbus) to the GROUND MODULE boom angle and boom length via two angle sensors, a length sensor and a load moment pin.

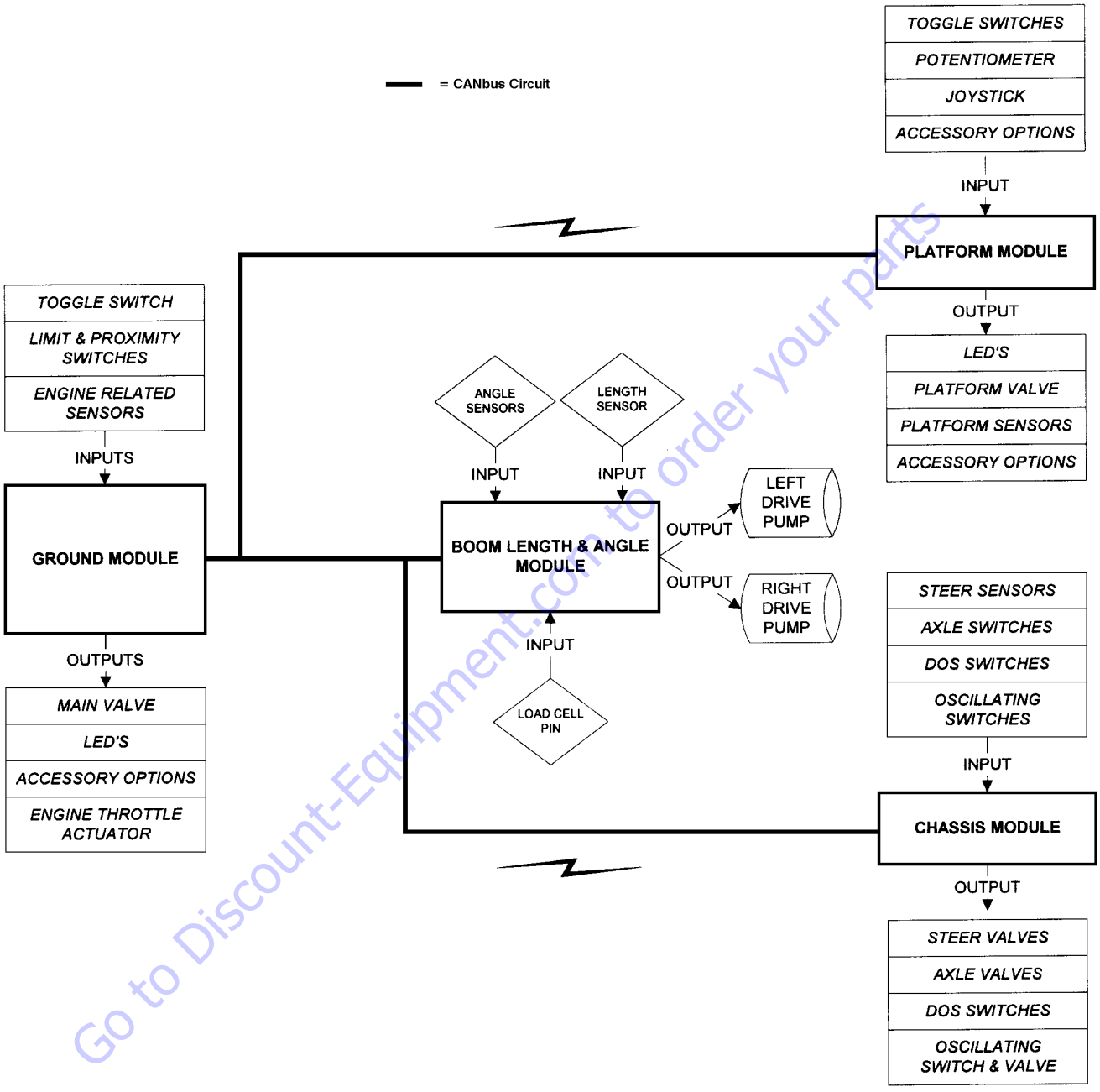


Figure 6-2. Control System Block Diagram

6.3 CALIBRATION INSTRUCTIONS

This machine incorporates a variety of sensors and a high degree of function interaction. For safety and proper machine functionality, the calibration procedures must be repeated for any control module replacement, system calibration related fault, or removal or replacement of any sensors, valves, coils, motors, or pumps. The chart below lists the calibrations required and potential reasons for re-calibration. All calibration procedures are menu driven through the use of the standard analyzer. With the exception of steering calibration, no external tools are required to complete the calibration procedures. The user is prompted to exercise the machine in a specific order to use the machines physical properties to consistently establish sensor response and the interaction of valves, pumps, and motors. Steering calibration also uses the analyzer and is performed on one side of the machine at a time requiring the use of a string or other means to determine when the tires are in line with each other. With the exception of the load control calibration, all calibrations are accessed by connecting the analyzer into the control system inside the main terminal box or on the bottom of the platform control box.

Table 6-1. Calibration Instructions

Calibration Procedure	Reasons for Re-calibration
Steering Calibration	Ground module replacement Chassis module replacement Steer sensor removal or replacement Persistent wheel misalignment
Drive Calibration	Ground module replacement BLAM module replacement Drive pump/coil replacement Drive pulls to one side Drive lugs engine Poor slow speed control
Platform Leveling Calibration	Ground module replacement Platform module replacement Platform level sensor removal or replacement Platform level sensor calibration fault
Platform Level Crack Point Calibration	Platform module replacement Ground module replacement Platform level valve/coil replacement Erratic platform leveling
Lift Crack Point Calibration	Ground module replacement Lift proportional valve/coil replacement Erratic controlled arc operation Erratic controlled boom angle operation
Telescope Crack Point Calibration	Ground module replacement Telescope proportional valve replacement Erratic controlled arc operation Erratic controlled boom angle operation
Chassis Tilt Calibration	Ground module removal or replacement Main terminal box removal or replacement Tilt indication inaccuracy
Boom Sensors Calibration	Ground module removal or replacement BLAM module removal or replacement Boom angle sensor removal or replacement Boom length sensor removal or replacement Moment pin removal or replacement Boom angle sensor calibration fault Boom length sensor calibration fault Moment pin fault Failed BCS functional check Boom control system inaccuracies Installing or removing approved accessories Changing Platform Size

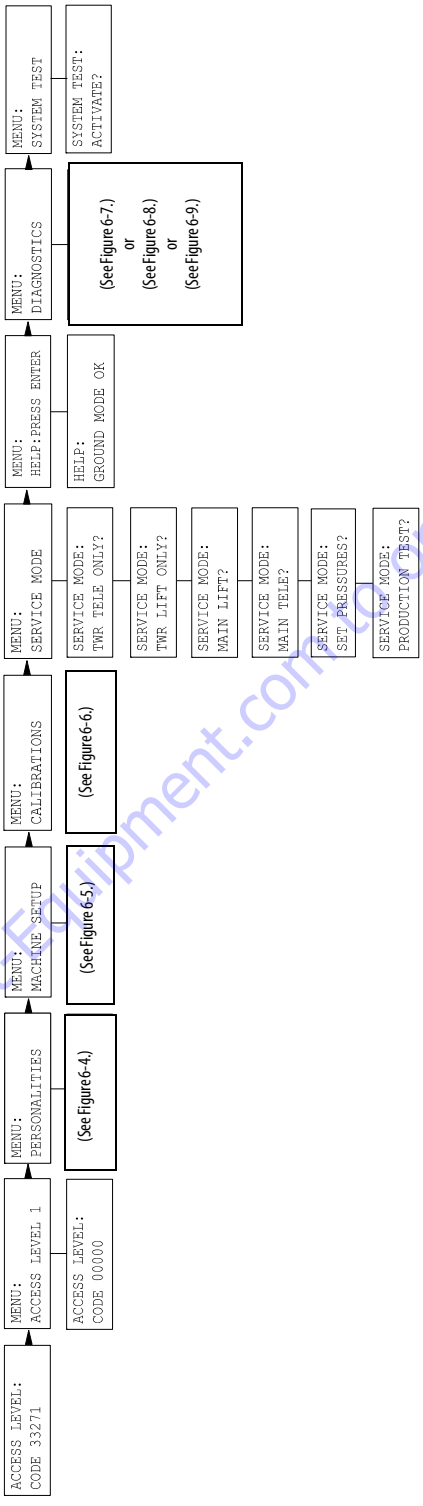
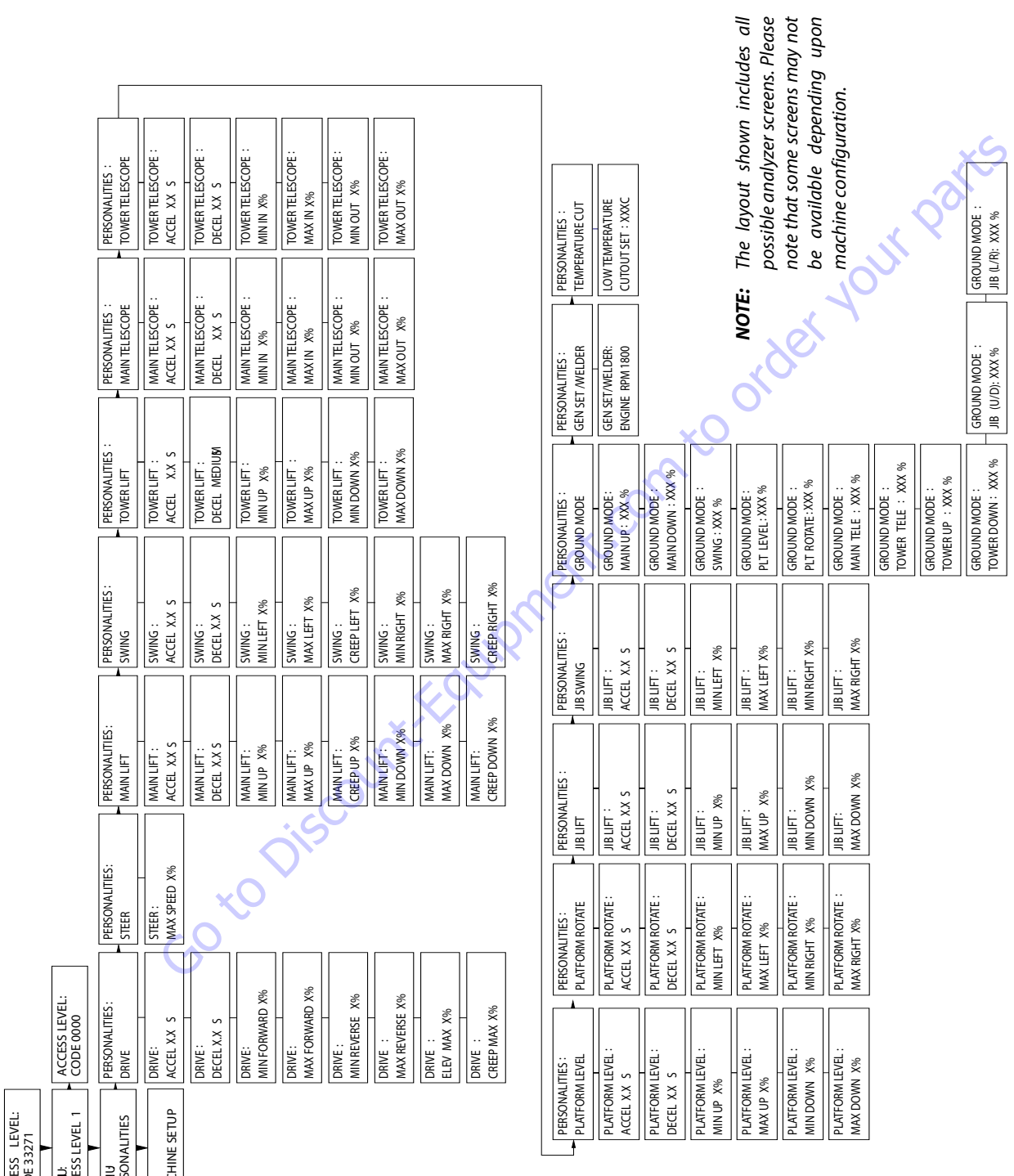


Figure 6-3. Analyzer Flow Chart

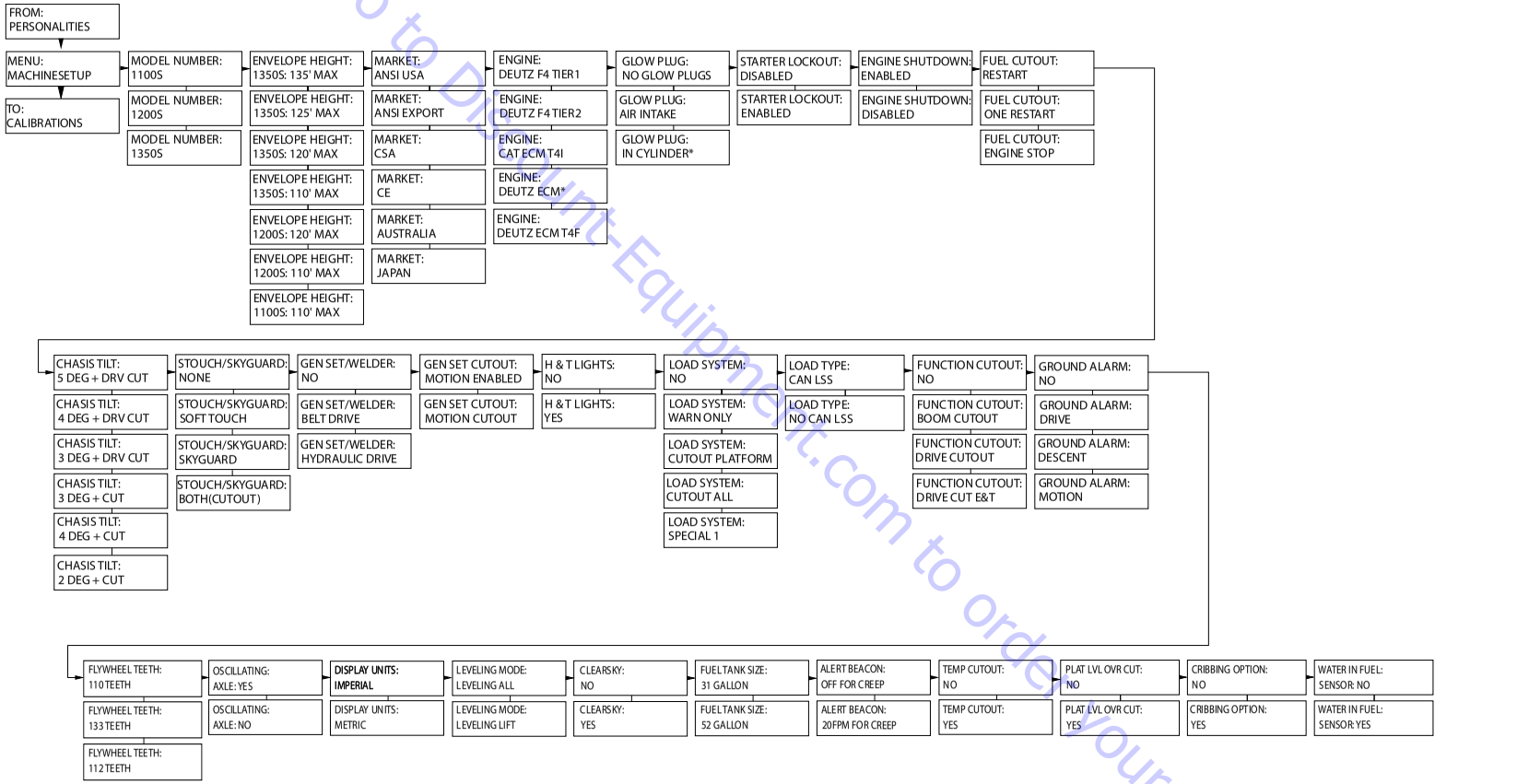
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

1001110093-P
MAE35170P

Figure 6-4. Analyzer Flow Chart - Personalities (Software Version 7.29)



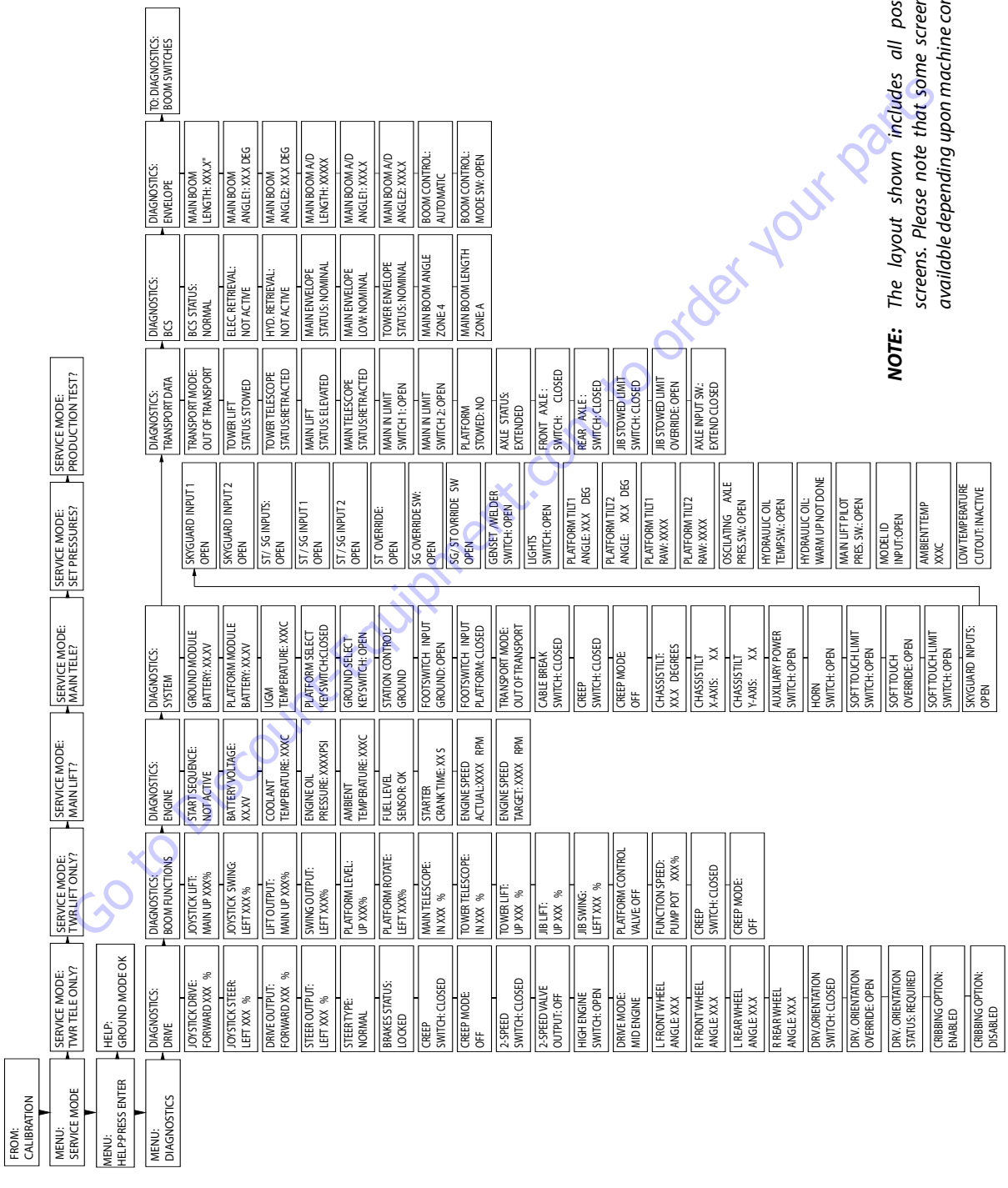
1001110093-P
MAE35180P

NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

Figure 6-5. Analyzer Flow Chart - Machine Setup (Software Version 7.29)

Figure 6-6. Analyzer Flow Chart - Calibrations (Software Version 7.29)

NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

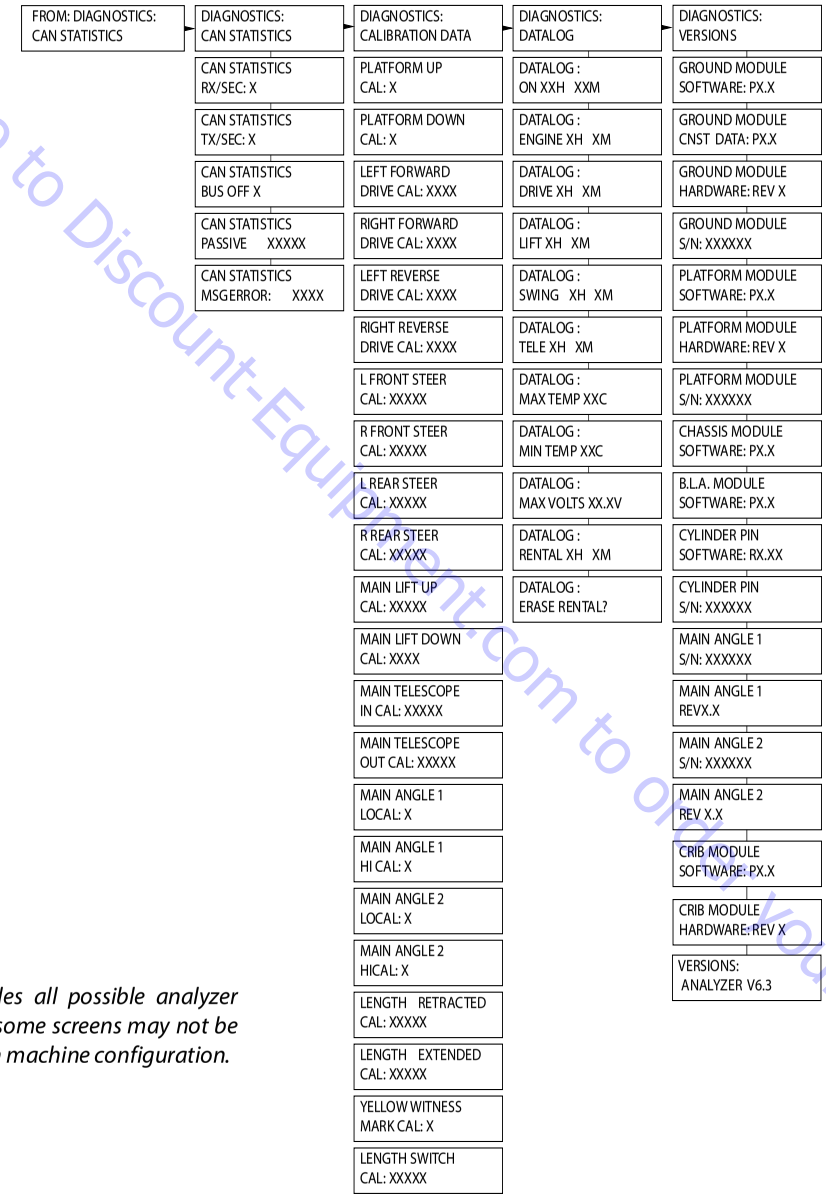
1001110093-P
MAE35200P

Figure 6-7. Analyzer Flow Chart - Diagnostics (Software Version 7.29) - Sheet 1 of 3

NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

1001110093-P
MAE35210P

Figure 6-8. Analyzer Flow Chart - Diagnostics (Software Version 7.29) - Sheet 2 of 3



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration.*

Figure 6-9. Analyzer Flow Chart - Diagnostics (Software Version 7.29) - Sheet 3 of 3

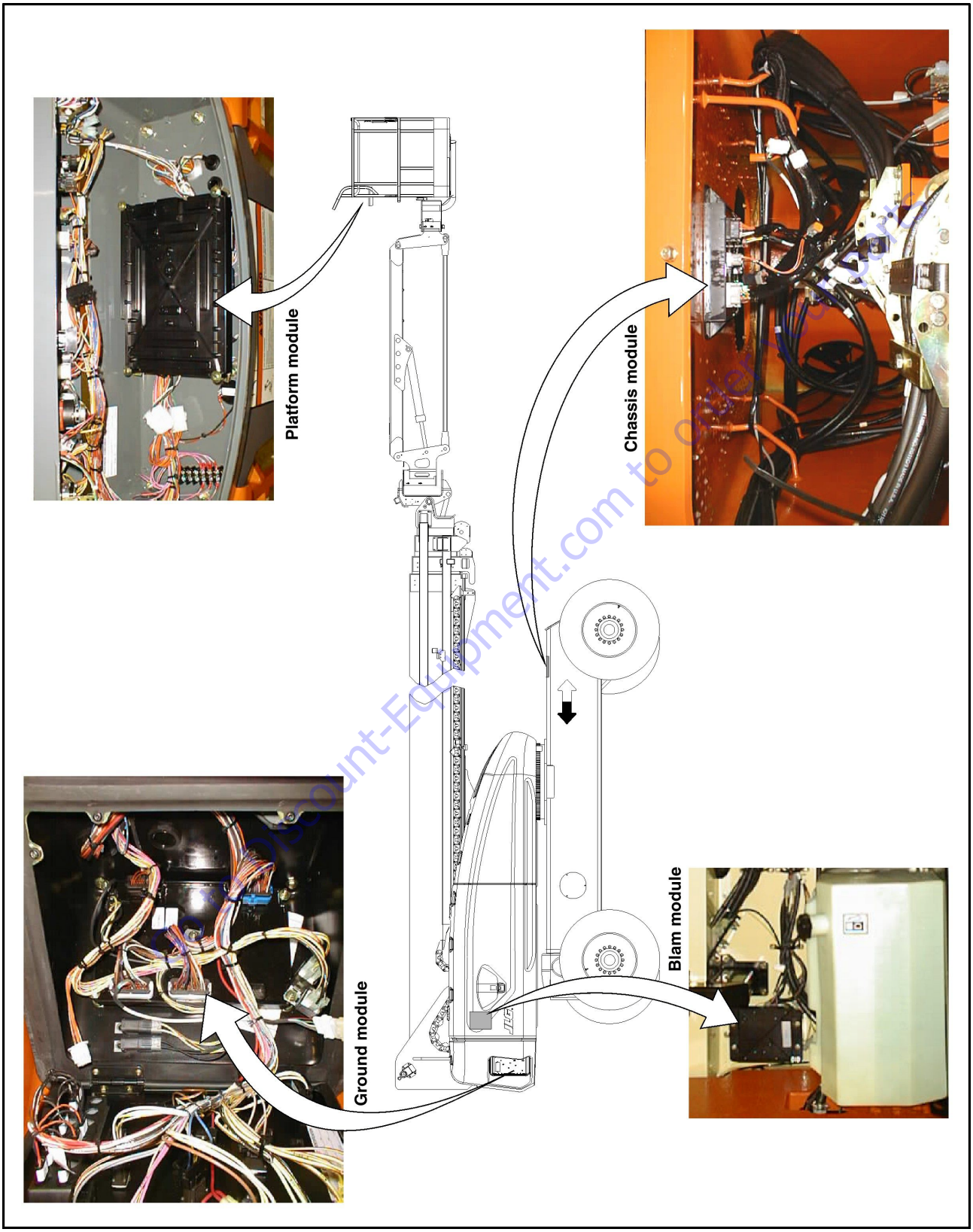
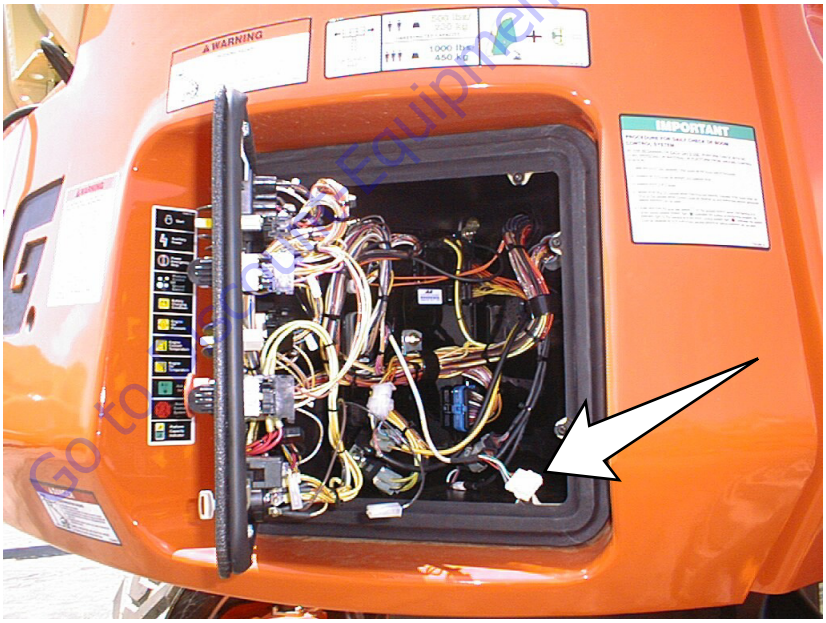


Figure 6-10. Control Module Location

PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 6-11. Analyzer Connecting Points

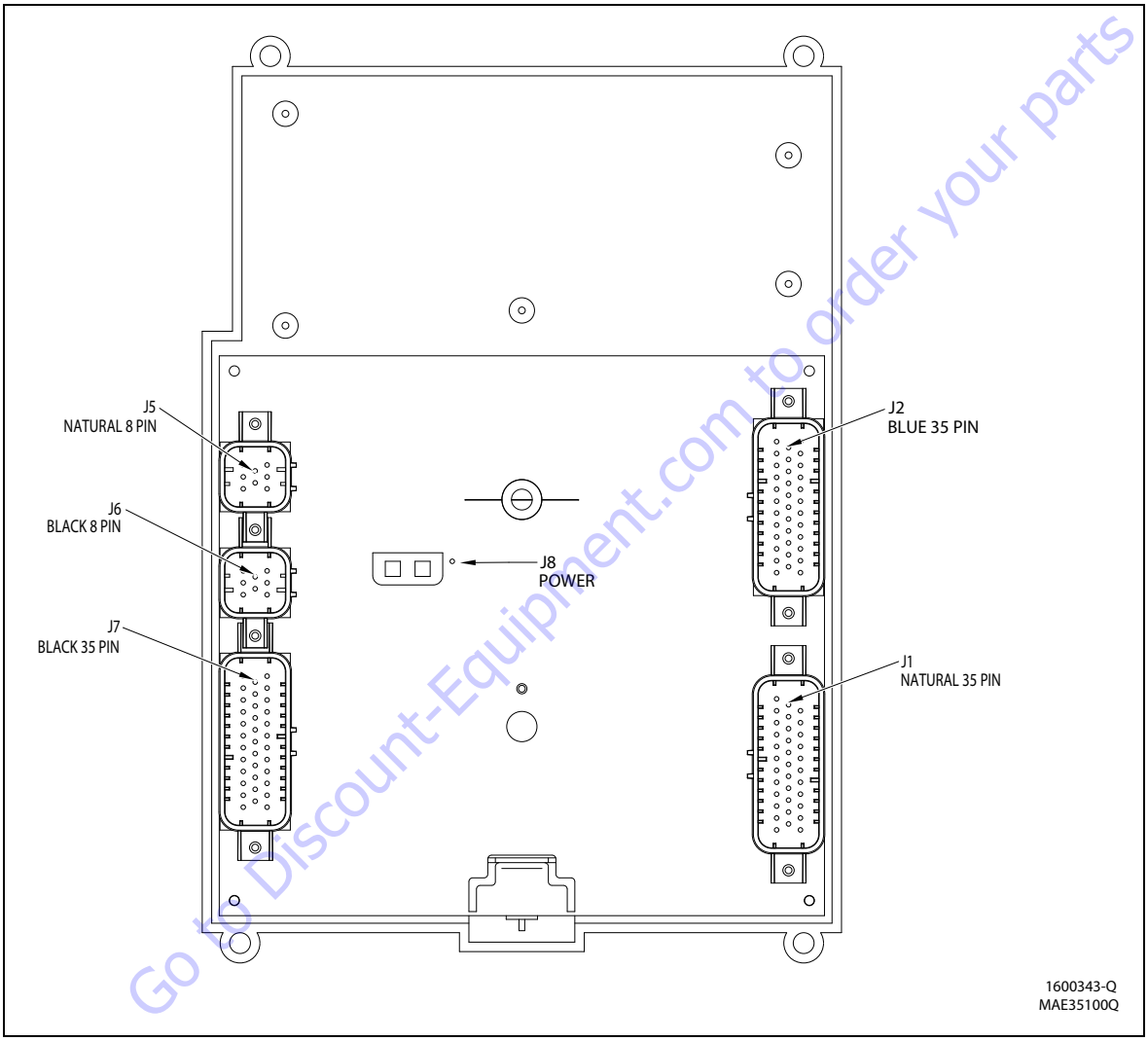


Figure 6-12. Platform Control Module

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J1NATURAL	1	TOWER LIFT UP	HSDIGITAL INPUT
	2	TOWER LIFT DOWN	HSDIGITAL INPUT
	3	TOWER TELESC OPEIN	HSDIGITAL INPUT
	4	TOWER TELESCOPE OUT	HSDIGITAL INPUT
	5	MAIN TELESCOPE IN	HSDIGITAL INPUT
	6	MAIN TELESCOPEOUT	HSDIGITAL INPUT
	7	PLATFORM ROTATE RIGHT	HSDIGITAL INPUT
	8	PLATFORM ROTATE LEFT	HSDIGITAL INPUT
	9	PLATFORM LEVEL UP	HSDIGITAL INPUT
	10	PLATFORM LEVEL DOWN	HSDIGITAL INPUT
	11	JIB UP	HSDIGITAL INPUT
	12	JIB DOWN	HSDIGITAL INPUT
	13	SPEED PUMP POTENTIOMETER GROUND	GROUND
	14	ENGINE START	HSDIGITAL INPUT
	15	AUXILIARY POWER	HSDIGITAL INPUT
	16	CRAB STEER SELECT	HSDIGITAL INPUT
	17	COORDINATED STEER SELECT	HSDIGITAL INPUT
	18	SWITCH POWER	BATTERY VOLTAGE
	19	JIB 1000LB ENABLE	HSDIGITAL INPUT
	20	EIM PLATFORMOVER LOAD	HSDIGITAL INPUT
	21	500/1000LB.CAPACITY SELECT	HSDIGITAL INPUT
	22	DRIVE ORIENTATION SYSTEM FEATURE ENABLE	HSDIGITAL INPUT
	23	SPARE PIN	HSDIGITAL INPUT
	24	SPARE PIN	HSDIGITAL INPUT
	25	LEVEL SENSOR1 SIGNAL	HSDIGITAL INPUT
	26	LEVEL SENSOR2 SIGNAL	HSDIGITAL INPUT
	27	TWO SPEED VALVE(HIGH ENGINE)	HSDIGITAL INPUT
	28	TORQUEMODE	HSDIGITAL INPUT
	29	SOFTTOUCH OVERRIDE	HSDIGITAL INPUT
	30	HEAD/TAILLIGHT	HSDIGITAL INPUT
	31	HORN	HSDIGITAL INPUT
	32	CREEPMODE	HSDIGITAL INPUT
	33	DUAL-FUELSELECT	HSDIGITAL INPUT
	34	SPEED PUMP POTENTIOMETER REFERENCE VOLTAGE	+7REFERENCE VOLTAGE
	35	SPEED PUMPPOTENTIOMETER	ANALOG INPUT

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J2BLUE	1	SPARE PIN	HS DIGITAL INPUT
	2	SPARE PIN	HS DIGITAL INPUT
	3	BATTERY VOLTAGE	BATTERY VOLTAGE
	4	DRIVE ORIENTATION SYSTEM OVERRIDE SWITCH	HS DIGITAL INPUT
	5	PLATFORM STOWED	HS DIGITAL INPUT
	6	CHASSIS TILTED INDICATOR	LAMP OUTPUT
	7	FUNCTION ENABLE INDICATOR	LAMP OUTPUT
	8	VEHICLE SYSTEM DISTRESS INDICATOR	LAMP OUTPUT
	9	CREEP SPEED INDICATOR	LAMP OUTPUT
	10	BROKEN CABLE INDICATOR	LAMP OUTPUT
	11	PLATFORM OVERLOADED INDICATOR	LAMP OUTPUT
	12	500LB CAPACITY INDICATOR	LAMP OUTPUT
	13	1000LB CAPACITY INDICATOR	LAMP OUTPUT
	14	DRIVE ORIENTATION SYSTEM INDICATOR	LAMP OUTPUT
	15	GENERATOR ON INDICATOR	LAMP OUTPUT
	16	SOFT TOUCHT RIGGERED INDICATOR	LAMP OUTPUT
	17	GLOW PLUG ENGAGED INDICATOR	LAMP OUTPUT
	18	LAMP RETURN	GROUND
	19	SPARE PIN	LAMP OUTPUT
	20	UPRIGHTTILTED INDICATOR	LAMP OUTPUT
	21	LOW FUEL INDICATOR	LAMP OUTPUT
	22	1/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	23	3/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	24	1/2 FUEL LEVEL INDICATOR	LAMP OUTPUT
	25	FUEL LEVEL INDICATORS RETURN	GROUND
	26	ANALYZER POWER	ANALYZER POWER
	27	ANALYZER GROUND	ANALYZER GROUND
	28	ANALYZER RX	ANALYZER RX
	29	ANALYZER TX	ANALYZER TX
	30	SPARE PIN	LAMP OUTPUT
	31	SPARE PIN	DIGITAL OUTPUT
	32	BATTERY VOLTAGE	BATTERY VOLTAGE
	33	BATTERY VOLTAGE	BATTERY VOLTAGE
	34	SWITCH POWER	BATTERY VOLTAGE
	35	FULL FUEL LEVEL INDICATOR	LAMP OUTPUT

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J5 NATURAL	1	LIFT/SWINGJOYSTICKSUPPLYVOLTAGE	SUPPLYVOLTAGE
	2	LIFTCENTERTAP	ANALOGINPUT
	3	LIFTSIGNAL	ANALOGINPUT
	4	SWINGSIGNAL	ANALOGINPUT
	5	SWINGCENTERTAP	ANALOGINPUT
	6	NOTCONNECTED	ANALOGINPUT
	7	LIFT/SWINGJOYSTICKRETURN	GROUND
	8	SPAREPIN	BLANK

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J6 BLACK	1	DRIVE/STEERJOYSTICKSUPPLYVOLTAGE	SUPPLYVOLTAGE
	2	DRIVECENTERTAP	ANALOGINPUT
	3	DRIVESIGNAL	ANALOGINPUT
	4	STEERSIGNAL	ANALOGINPUT
	5	STEERLEFT	ANALOGINPUT
	6	STEERRIGHT	ANALOGINPUT
	7	DRIVE/STEERJOYSTICKRETURN	GROUND
	8	SPAREPIN	BLANK

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J8	1	MODULEGROUND	GROUND
	2	MODULEPOWER	BATTERYVOLTAGE

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J7 BLACK	1	GROUND MODE	GROUND MODE
	2	PLATFORM EMS	PLATFORM EMS
	3	PLATFORM EMS TO GROUND MODULE	PLATFORM MODE
	4	FOOT SWITCH (FUNCTION ENABLE SWITCH)POWER	BATTERY VOLTAGE
	5	PLATFORM ROTAT ELEFT	ME DIGITAL OUTPUT
	6	PLATFORM ROTATE RIGHT	ME DIGITAL OUTPUT
	7	SOFTTOUCH LIMITSWITCH POWER	BATTERY VOLTAGE
	8	FOOT SWITCH SIGNAL	DIGITAL INPUT
	9	GENERATOR ON SIGNAL	DIGITAL INPUT
	10	+7 REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	11	SPARE PIN	+5V REFERENCE VOLTAGE
	12	SPARE PIN	+5V REFERENCE VOLTAGE
	13	SPARE PIN	ANALOG INPUT
	14	GROUND RETURN	GROUND
	15	PLATFORMLEVEL UP	HS DIGITAL OUTPUT
	16	PLATFORMLEVEL DOWN	HS DIGITAL OUTPUT
	17	JIB BLOCK LIMIT SWITCH	HS DIGITAL INPUT
	18	SOFT TOUCH LIMIT SWITCH	HS DIGITAL INPUT
	19	PLATFORM ALARM	LAMPOUTPUT
	20	ALARM RETURN	GROUND
	21	SPARE PIN	GROUND
	22	SPARE PIN	GROUND
	23	SPARE PIN	ANALOG INPUT
	24	SPARE PIN	DIGITAL OUTPUT
	25	JIB UP	ME DIGITAL OUTPUT
	26	JIB DOWN	ME DIGITAL OUTPUT
	27	JIB RIGHT	ME DIGITAL OUTPUT
	28	JIB LEFT	ME DIGITAL OUTPUT
	29	GROUND RETURN	GROUND
	30	CAN LOW	CAN LOW
	31	CAN HIGH	CAN HIGH
	32	CAN SHIELD	CAN SHIELD
	33	SPARE PIN	GROUND
	34	SPARE PIN	GROUND
	35	SPARE PIN	ANALOG INPUT

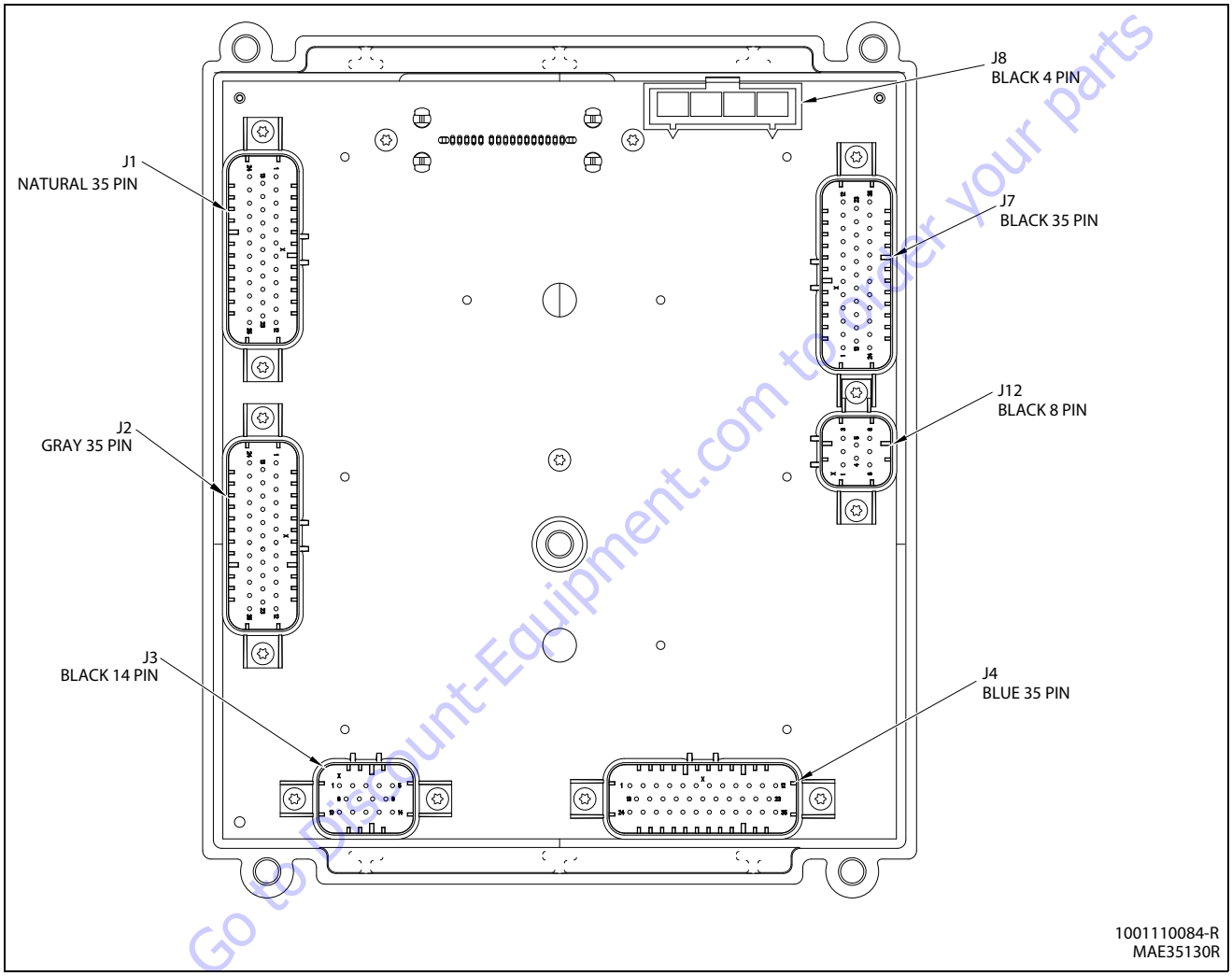


Figure 6-13. Ground control module

Connector	Pin	Function	Type	
J1 (Natural)	1	THROTTLE ACTUATOR (DIESELONLY)	DIGITAL	OUTPUT
	2	SPARE (LPNOTUSED)	DIGITAL	OUTPUT
	3	TOWER BOOM LIFT POWER	DIGITAL	OUTPUT
	4	GROUND	GROUND	INPUT
	5	GROUND	GROUND	INPUT
	6	TOWER TELESCOPE ENABLE	DIGITAL	OUTPUT
	7	SPARE (LPNOTUSED)	DIGITAL	OUTPUT
	8	GROUND	GROUND	INPUT
	9	GROUND	GROUND	INPUT
	10	IGNITION ON RELAY	DIGITAL	OUTPUT
	11	START SOLENOID (DIESELONLY)	DIGITAL	OUTPUT
	12	GLOW PLUG (DIESELONLYOPTION)	DIGITAL	OUTPUT
	13	AUXILIARY POWER	DIGITAL	OUTPUT
	14	COOLAN TTEMP (DIESELONLY)	ANALOG	INPUT
	15	OIL PRESSURE (DIESELONLY)	ANALOG	INPUT
	16	FLY WHEEL SPEED PICKUP(DIESELONLY)	FREQUENCY	INPUT
	17	GROUND	GROUND	INPUT
	18	SPARE GROUND	GROUND	INPUT
	19	SPARE GROUND	GROUND	INPUT
	20	TWO SPEED	DIGITAL	OUTPUT
	21	MAIN LIFT PILOT PRESSURE SWITCH	DIGITAL	INPUT
	22	GENERATOR/WELDER(OPTION)	DIGITAL	OUTPUT
	23	PARKING BRAKE	DIGITAL	OUTPUT
	24	CONSTANT BATTERY	N/C	N/C
	25	RS-485HI	SERIAL	I/O
	26	RS-485LO	SERIAL	I/O
	27	GROUND	GROUND	INPUT
	28	ANALYZER POWER	VOLTAGE	OUTPUT
	29	ANALYZER RS-232Rx	SERIAL	INPUT
	30	ANALYZER RS-232Tx	SERIAL	OUTPUT
	31	ANALYZER GROUND	GROUND	INPUT
	32	ALTERNATOR EXCITATION	DIGITAL	OUTPUT
	33	GROUND SHIELD	GROUND	INPUT
	34	SPARE	DIGITAL	INPUT
	35	HYDRAULIC OIL TEMPERATURE SWITCH	DIGITAL	INPUT

Connector	Pin	Function	Type	
J3 (Black)	1	SPARE VAVLE RETURN 1	GROUND	INPUT
	2	SPARE VAVLE RETURN 2	GROUND	INPUT
	3	GROUND	GROUND	INPUT
	4	SPARE VAVLE RETURN 4	GROUND	INPUT
	5	SPARE VAVLE RETURN 5	GROUND	INPUT
	6	SPARE VAVLE RETURN 6	GROUND	INPUT
	7	VBAT	VBAT	OUTPUT
	8	SPARE HS DIGITALIN(FREQ.CAPABLE)	DIGITAL	INPUT
	9	ALTERNATOR EXCITATION INPUT	DIGITAL	INPUT
	10	SPARE HS SWITCH INPUT (MODELINPUTFOR1100S)	DIGITAL	INPUT
	11	SPARE LS DIGITAL INPUT	DIGITAL	INPUT
	12	ANALOG REF.VOLTAGE	VOLTAGE	OUTPUT
	13	SPARE ANALOG INPUT 8	ANALOG	INPUT
	14	SPARE VALVE RETURN 3	GROUND	INPUT

Connector	Pin	Function	Type	
J12 (Black)	1	FREQUENCY INPUT 2	FREQUENCY	INPUT
	2	FREQUENCY INPUT 2 RETURN	FREQUENCY	INPUT
	3	CAN 2H	SERIAL	I/O
	4	CAN 2L	SERIAL	I/O
	5	CAN 2SHIELD	GROUND	INPUT
	6	CAN2 TERMINATOR	TERM	I/O
	7	CAN2 TERMINATOR	TERM	I/O
	8	SPARE LS DIGITAL INPUT	DIGITAL	INPUT

Connector	Pin	Function	Type	
J2 (Gray)	1	MAIN LIFT PILOT	DIGITAL	OUTPUT
	2	HORN	DIGITAL	OUTPUT
	3	PLATFORM CONTROL VALVE	DIGITAL	OUTPUT
	4	UPPER TELESCOPE IN	DIGITAL	OUTPUT
	5	BASKET LEVEL UP OVERRIDE	DIGITAL	OUTPUT
	6	GROUND	GROUND	INPUT
	7	BASKET LEVEL DOWN OVERRIDE	DIGITAL	OUTPUT
	8	TOWER TELESCOPE POWER	DIGITAL	OUTPUT
	9	TELESCOPEF LOW CONTROL	DIGITAL	OUTPUT
	10	LIFT PILOT	DIGITAL	OUTPUT
	11	UPPER LIFT UP	DIGITAL	OUTPUT
	12	LIFT DOWN AUXILIARY	DIGITAL	OUTPUT
	13	MAIN DUMP	DIGITAL	OUTPUT
	14	GROUND	GROUND	INPUT
	15	NOT CONNECTEDRS232 BACKUP COMM.ENABLE	DIGITAL	OUTPUT
	16	UPPER TELESCOPE OUT	DIGITAL	OUTPUT
	17	GROUND	GROUND	INPUT
	18	SPARE PIN	GROUND	INPUT
	19	LIFT FLOW CONTROL	DIGITAL	OUTPUT
	20	SPARE OUTPUT	DIGITAL	OUTPUT
	21	MAIN BOOM ANGLE SENSOR#2 POWER	DIGITAL	OUTPUT
	22	UPPER LIFT DOWN	DIGITAL	OUTPUT
	23	MAIN BOOM LIFTENABLE	DIGITAL	OUTPUT
	24	TOWER CYLINDER TYPE	DIGITAL	INPUT
	25	FUEL SENSOR	ANALOG	INPUT
	26	HEAD/TAILLIGHT	DIGITAL	OUTPUT
	27	ALARM	DIGITAL	OUTPUT
	28	SPAREPIN	GROUND	INPUT
	29	GROUND	GROUND	INPUT
	30	GROUND	GROUND	INPUT
	31	PVGENABLE	DIGITAL	OUTPUT
	32	TOWER BOOM TELESCOPEPILOT	DIGITAL	OUTPUT
	33	TOWER BOOM LIFT ENABLE	DIGITAL	OUTPUT
	34	SWING LEFT	DIGITAL	OUTPUT
	35	SWING RIGHT	DIGITAL	OUTPUT

Connector	Pin	Function	Type	
J4 (Blue)	1	AXLES SET LAMP	DIGITAL	OUTPUT
	2	500# CAPACITY LAMP	DIGITAL	OUTPUT
	3	BOOM CONTROL SYSTEM LAMP	DIGITAL	OUTPUT
	4	START SWITCH	DIGITAL	INPUT
	5	BASKET LEVEL DOWN	DIGITAL	INPUT
	6	BASKET LEVEL DOWN	DIGITAL	INPUT
	7	UPPER TELESC OPEIN	DIGITAL	INPUT
	8	JIB DOWN	DIGITAL	INPUT
	9	JIB LEFT	DIGITAL	INPUT
	10	TOWER UP	DIGITAL	INPUT
	11	MAIN TOWER TRANSPORT ANGLE OPEN	DIGITAL	INPUT
	12	HOUR METER	DIGITAL	OUTPUT
	13	BCS CALIBRATED LAMP	DIGITAL	OUTPUT
	14	OVERLOAD LAMP	DIGITAL	OUTPUT
	15	SPARE	DIGITAL	OUTPUT
	16	AUXILIARY POWER	DIGITAL	INPUT
	17	BASKET LEVEL UP	DIGITAL	INPUT
	18	BASKET ROTATE RIGHT	DIGITAL	INPUT
	19	JIB UP	DIGITAL	INPUT
	20	JIB RIGHT	DIGITAL	INPUT
	21	TOWER DOWN	DIGITAL	INPUT
	22	MAIN BOOM TRANSPORTANGLECLOSED	DIGITAL	INPUT
	23	UPPER LIFT UP	DIGITAL	INPUT
	24	V BAT	VBAT	OUTPUT
	25	V BAT	VBAT	OUTPUT
	26	NO CHARGE LAMP	DIGITAL	OUTPUT
	27	1000#CAPACITY LAMP	DIGITAL	OUTPUT
	28	ENGINE HIGH TEMPERATURE LENGTH	DIGITAL	OUTPUT
	29	ENGINE LOW OIL PRESSURE LAMP	DIGITAL	OUTPUT
	30	UPPER TELESCOPE OUT	DIGITAL	INPUT
	31	GROUND	GROUND	INPUT
	32	SPAREPIN	GROUND	INPUT
	33	UPPER LIFT DOWN	DIGITAL	INPUT
	34	SWING LEFT	DIGITAL	INPUT
	35	SWING RIGHT	DIGITAL	INPUT

Connector	Pin	Function	Type	
J7 (Black)	1	PLATFORM EMS	DIGITAL	INPUT
	2	PLATFORM MODE	DIGITAL	INPUT
	3	GROUND MODE	DIGITAL	INPUT
	4	TOWER CYLINDER PRESSURE	ANALOG	INPUT
	5	REFERENCE VOLTAGE	VOLTAGE	OUTPUT
	6	CAN TERMINATION	TERM	I/O
	7	SPARE	ANALOG	INPUT
	8	SPARE ANALOGINPUT 2	ANALOG	INPUT
	9	GROUND	GROUND	INPUT
	10	GROUND	GROUND	INPUT
	11	BOOM RETRACTED CLOSED	DIGITAL	INPUT
	12	BROKEN CABLE SWITCH		INPUT
	13	CANHI	SERIAL	I/O
	14	GROUND MODEOUT TO PLATFORM	DIGITAL	INPUT
	15	FOOT SWITCH ENGAGE	DIGITAL	INPUT
	16	REFERENCE VOLTAGE	VOLTAGE	OUTPUT
	17	CAN TERMINATION	TERM	I/O
	18	CANSHEILD	GROUND	INPUT
	19	SPARE PIN	GROUND	INPUT
	20	SPARE ANA LOGINPUT 1	ANALOG	INPUT
	21	PUSH TO TEST	DIGITAL	INPUT
	22	TOWER BOOMTRANSPORTANGLE	DIGITAL	INPUT
	23	GROUND CONTROLE NABLE	DIGITAL	INPUT
	24	CAN LO	SERIAL	I/O
	25	GROUND	GROUND	INPUT
	26	REFERENCE VOLTAGE	VOLTAGE	OUTPUT
	27	REFERENCE VOLTAGE	VOLTAGE	OUTPUT
	28	GROUND(RESERVEDFORCRIBBINGOPTION)	GROUND	INPUT
	29	V BAT	VBAT	OUTPUT
	30	V BAT	VBAT	OUTPUT
	31	V BAT	VBAT	OUTPUT
	32	V BAT	VBAT	OUTPUT
	33	V BAT(RESERVEDFORCRIBBINGOPTION)	VBAT	OUTPUT
	34	CLEARSKY POWER(VBAT)	VBAT	OUTPUT
	35	BOOM RETRACT OPEN	DIGITAL	INPUT

Connector	Pin	Function	Type	
J8 (Black)	1	GROUND FROM BATTERY	GROUND	INPUT
	2	GROUND EMS	GROUND	INPUT
	3	GROUND TO PLATFORM	GROUND	OUTPUT
	4	GROUND EMS OUT TO PLATFORM	GROUND	OUTPUT

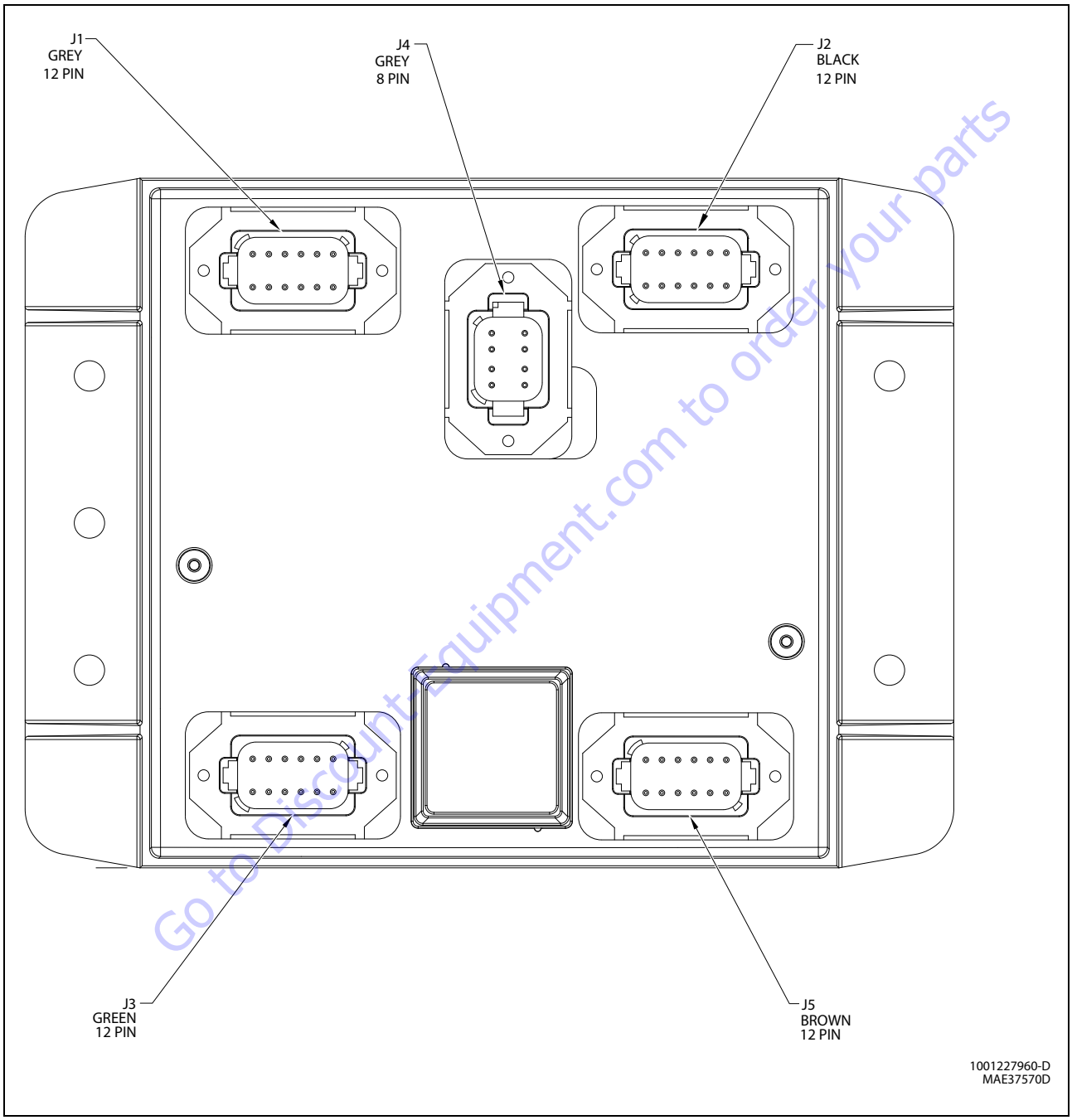


Figure 6-14. BLAM Controller

Connector	Pin	Function			Type	
		1100/1200/1350	1250	1500		
J1(Grey)	1	PowerFeedThrutoJ2-1	PowerFeedThrutoJ2-1	PowerFeedThrutoJ2-1	Power	I/O
	2	PowerFeedThrutoJ2-2	PowerFeedThrutoJ2-2	PowerFeedThrutoJ2-2	Power	I/O
	3	SignalFeedThrutoJ2-4	SignalFeedThrutoJ2-4	SignalFeedThrutoJ2-4	Digital	Input
	4	MasterGroundConnect	MasterGroundConnect	MasterGroundConnect	Power	Input
	5	MasterIgnitionConnect	MasterIgnitionConnect	MasterIgnitionConnect	Power	Input
	6	CANbusHigh	CANbusHigh	CANbusHigh	Serial	I/O
	7	CANbusLow	CANbusLow	CANbusLow	Serial	I/O
	8	CANbusShield	CANbusShield	CANbusShield	Serial	I/O
	9	CANbusTerminator	CANbusTerminator	CANbusTerminator	Serial	I/O
	10	CANbusTerminator	CANbusTerminator	CANbusTerminator	Serial	I/O
	11	Ignition	Ignition	Ignition	Power	Output
	12	Ground	Ground	Ground	Power	Output
J2(Black)	1	PowerFeedThrutoJ1-1	PowerFeedThrutoJ1-1	PowerFeedThrutoJ1-1	Power	I/O
	2	PowerFeedThrutoJ1-2	PowerFeedThrutoJ1-2	PowerFeedThrutoJ1-2	Power	I/O
	3	Ground	Ground	Ground	Power	Output
	4	SpareInput	LoadPinPushtoTest	SpareInput	Digital	Input
	5	SpareInput	PlatformRotateRight	SpareInput	Digital	Input
	6	SpareInput	PlatformRotateLeft	SpareInput	Digital	Input
	7	SpareInput	SpareInput	SpareInput	Digital	Input
	8	MainBoomAng1(Gravity)	TowerBoomAng1(Gravity)	MainBoomAng1(Gravity)	Digital	Input
	9	MainBoomAng2(Gravity)	TowerBoomAng2(Gravity)	MainBoomAng2(Gravity)	Digital	Input
	10	SpareAnalogInput	SpareAnalog	SpareAnalog	Analog	Input
	11	RightDrivePumpForward	RightDrivePumpForward	RightDrivePumpForward	Digital	Output
	12	RightDrivePumpReverse	RightDrivePumpReverse	RightDrivePumpReverse	Digital	Output
J3(Green)	1	+5VAnalogReference	+5VAnalogReference	+5VAnalogReference	Power	Output
	2	RefVoltagefromJ3-1	RefVoltagefromJ3-1	RefVoltagefromJ3-1	Analog	Input
	3	Ground	Ground	Ground	Power	Output
	4	+5VAnalogReference	+5VAnalogReference	+5VAnalogReference	Power	Output
	5	SpareAnalogInput	TowerBoomCylinderAngle	MainCylAngle#1(Absolute)	Analog	Input
	6	Ground	Ground	Ground	Power	Output
	7	+5VAnalogReference	+5VAnalogReference	+5VAnalogReference	Power	Output
	8	BoomLengthSensor	TowerBoomLengthSnsr#1	BoomLengthSensor	Analog	Input
	9	Ground	Ground	Ground	Power	Output
	10	+5VAnalogReference	+5VAnalogReference	+5VAnalogReference	Power	Output
	11	SpareAnalogInput	TowerBoomLengthSnsr#2	MainCylAngle#2(Absolute)	Analog	Input
	12	Ground	Ground	Ground	Power	Output

6.4 TO CONNECT THE JLG CONTROL SYSTEM ANALYZER

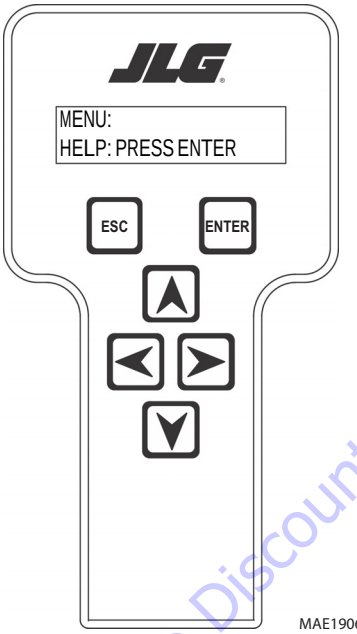
1. Connect the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

NOTE: *The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.*

2. Power up the Control System by turning the key to the platform or ground position and pulling both emergency stop buttons on.

6.5 USING THE ANALYZER

With the machine power on and the analyzer connected properly, the analyzer will display the following:



HELP:
PRESS ENTER

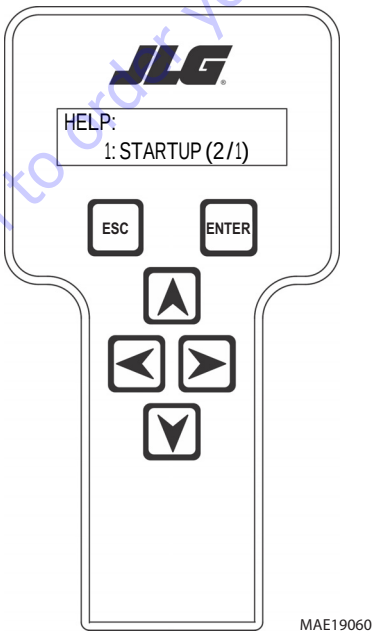
At this point, using the **RIGHT** and **LEFT** arrow keys, you can move between the top level menu items. To select a displayed menu item, press **ENTER**. To cancel a selected menu item, press ESC.; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

HELP
DIAGNOSTICS
SYSTEM TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
CALIBRATIONS (view only)

If you press **ENTER**, at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display will scroll the fault across the screen. If there was no fault detected, the display will read: **HELP: EVERYTHING OK.** If powered up at the ground station, the display will read: **GROUND OK.**

If **ENTER** is pressed again, the display moves to the following display:



LOGGED HELP
1: POWER CYCLE (0/0)

At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESC.** two times. **POWER CYCLE (0/0)** indicates a power up.

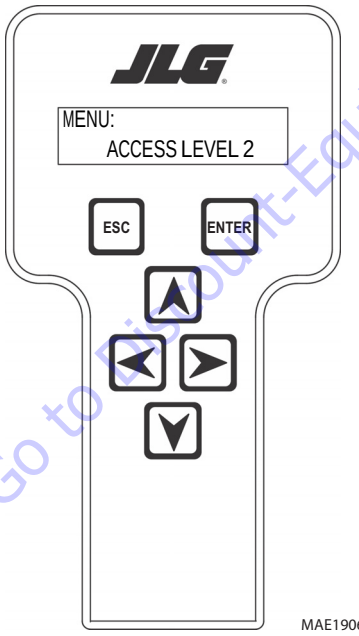
When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

Pressing **ENTER** with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected menu item by pressing the **ESC.** key.

6.6 CHANGING THE ACCESS LEVEL OF THE HAND HELD ANALYZER

When the analyzer is first connected, you will be in access level 2 which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change the access level, the correct password must be entered. To enter the password, scroll to the **ACCESS LEVEL** menu. For example:



MENU:
ACCESS LEVEL 2

Press **ENTER** to select the **ACCESS LEVEL** menu.

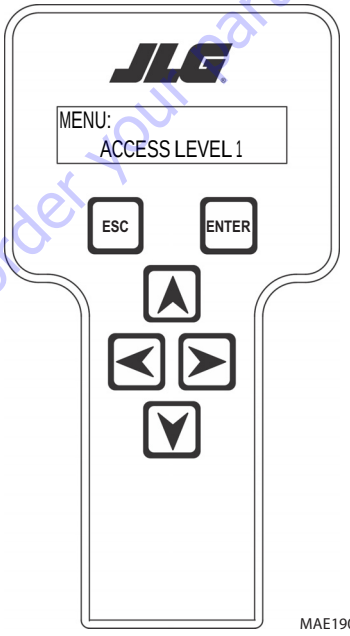
Using the **UP** or **DOWN** arrow keys, enter the first digit of the password, 3.

Then using the **RIGHT** arrow key, position the cursor to the right one space to enter the second digit of the password.

Use the **UP** or **DOWN** arrow key to enter the second digit of the password which is 33271.

Continue using the arrow keys until all the remaining digits of the password is shown.

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:

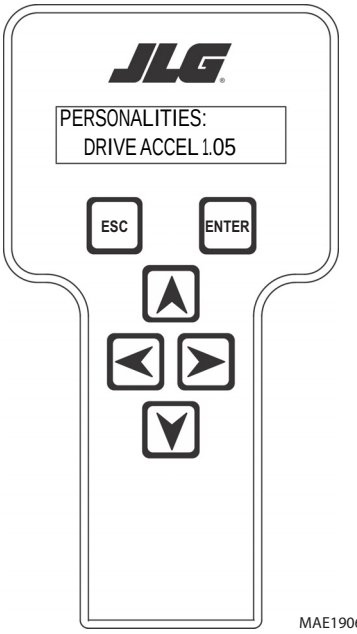


MENU:
ACCESS LEVEL 1

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

6.7 ADJUSTING PARAMETERS USING THE HAND HELD ANALYZER

Once you have gained access to level 1, and a personality item is selected, press the UP or DOWN arrow keys to adjust its value, for example:

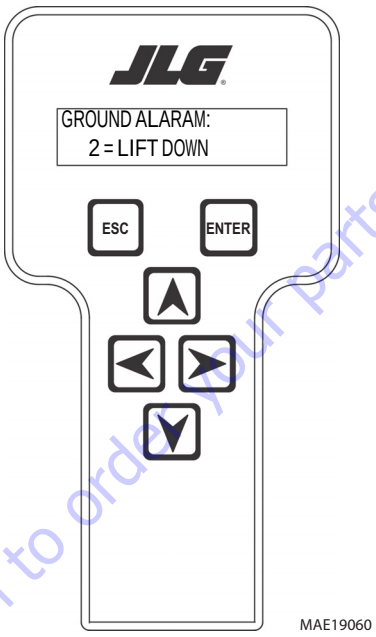


PERSONALITIES:
DRIVE ACCEL 1.0s

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at access level 1.

6.8 MACHINE SETUP

When a machine digit item is selected, press the UP or DOWN arrow keys to adjust its value, for example:



GROUND ALARM:
2 = LIFT DOWN

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when lifting down. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

NOTE: *Refer to Table 6-5, Personality Ranges/Defaults, and in this Service Manual for the recommended factory settings.*

NOTE: *Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.*

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

ELEVATION CUTBACK

NOTICE

CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.

Table 6-2. Machine Configuration Programming Information - Version P7.29

Configuration Digit	Number	Description	Default Number
NOTE: *The machine configuration must be completed before any personality settings can be changed. Changing the personality settings first and then changing the model number of the machine configuration will cause the personality settings to return to default*			
MODEL NUMBER: 1	**1** 2 3 4	**1200S** 1250A 1350S 1100S	**1**
ENVELOPE HEIGHT: 2	1 2 3 4 **5** 6 7 8 9	1350S: 135' MAX 1350S: 125' MAX 1350S: 120' MAX 1350S: 110' MAX **1200S: 120' MAX** 1200S: 110' MAX 1250A: 125' MAX 1250A: 100' MAX 1250A: 80' MAX	**5**
Note: The default settings (bold) will vary depending on the model selection with selection # 5 being the initial default setting.			
MARKET: 3	**0** 1 2 3 4 5	**ANSI USA** ANSI EXPORT CSA CE AUSTRALIA JAPAN	**0**
ENGINE: 4	1 2 **3** 4 5	DEUTZ F4 TIER1: Deutz BF4M1011 Diesel (Tier 1) DEUTZ F4 TIER2: Deutz BF4M2011 Diesel (Tier 2) **DEUTZ ECM: Engine Control Module** CAT ECM: Engine Control Module DEUTZ ECM T4F: Engine Control Module (Tier 4 Final)	**3**

Table 6-2. Machine Configuration Programming Information - Version P7.29

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0 1 **2**	NO GLOW PLUGS: No glow plugs installed. AIR INTAKE: Glow plugs installed in the air intake on the manifold. **IN-CYLINDER: Glow plugs installed in each cylinder.**	**2**
STARTER LOCKOUT: 6	**0** 1	**DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.** ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	**0**
ENGINE SHUTDOWN: 7	0 **1**	DISABLED: No engine shutdown. **ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.**	**1**
FUEL CUTOUT: 8*	**0** 1 2	**RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached** ONE RESTART: Engine allowed to be restarted once for 2 minutes when very low fuel level is reached. ENGINE STOP: Engine not able to restart when very low fuel level is reached.	**0**
* This menu item is only visible if non dual fuel engines are selected.			
CHASSIS TILT: 9	**1** 2 3 4 5 6	**5 DEGREES + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also cuts out drive** 4 DEGREES + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also cuts out drive 3 DEGREES + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also cuts out drive 5 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up. 4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up. 3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	**1**
Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.			

Table 6-2. Machine Configuration Programming Information - Version P7.29

Configuration Digit	Number	Description	Default Number
JIB: 10	0 1 **2**	NO: No Jib installed. YES: Jib installed. **SIDESWING: Jib with Sideswing installed**	**2**
4WS: 11	0 **1**	NO: 2WS mode enabled. **YES: 4WS mode enabled.**	**1**
DRIVE: 12	0 **1**	2WD drive mode enabled. **4WD drive mode enabled.**	**1**
STOUCH/SKYGUARD: 13	0 1 **2** 3	None: No soft touch or SkyGuard system installed. SOFT TOUCH - Soft touch only installed **SKYGUARD - Skyguard only installed** BOTH(CUTOUT) - Soft touch and Skyguard installed	**2**
GEN SET/WELDER: 14	0 **1** 2	NO: No generator installed. **BELT DRIVE: Belt driven setup.** HYDRAULIC DRIVE: Hydraulic driven setup.	**1**
GEN SET CUTOUT: 15*	**0** 1	**MOTION ENABLED: Motion enabled when generator is ON.** MOTION CUTOUT: Motion cutout in platform mode only.	**0**
* Only visible if Gen Set / Welder Menu selection is not 0.			
H & T LIGHTS: 16	**0** 1	**NO: No head and tail lights installed.** YES: Head and tail lights installed.	**0**

Table 6-2. Machine Configuration Programming Information - Version P7.29

Configuration Digit	Number	Description	Default Number
LOAD SYSTEM: 17*	**0** 1 2 3 4	**NO: No load sensor installed.** WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF). SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	**0**
* Only visible under certain market selections.			
* Certain market selections will limit load system options or alter default setting.			
LOAD TYPE: 18	0 **1**	NON CAN LSS: Non CAN based LSS installed **CAN LSS: CAN based LSS is installed.**	**1**
FUNCTION CUTOUT: 19*	**0** 1 2 3	**NO: No drive cutout.** BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive cutout above elevation. DRIVE CUT E&T: Drive cutout above elevation and tilted.	**0**
* Only visible under certain market selections.			
* Certain market selections will limit function cutout options or alter default setting.			
GROUND ALARM: 20*	**0** 1 2 3	**NO: No ground alarm installed.** DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). MOTION: Motion alarm sounds when any function is active (Option).	**0**
* Certain market selections will alter default setting.			
FLYWHEEL TEETH: 21*	**0** 1 2	**110 TEETH - The engine is configured to calculate speed using 110 teeth** 133 TEETH - The engine is configured to calculate speed using 133 teeth 112 TEETH - The engine is configured to calculate speed using 112 teeth.	**0**
* Only visible when Engine Setup is DEUTZ F4 Tier 1 or Tier 2.			

Table 6-2. Machine Configuration Programming Information - Version P7.29

Configuration Digit	Number	Description	Default Number
OSCILLATING AXLE: 22	0 **1**	NO: No oscillating axle system installed. **YES: Oscillating axle system installed.**	**1**
DISPLAY UNITS: 23*	**0** 1	**IMPERIAL: DEG F, PSI, LBS.** METRIC: DEG C, KPA, KGS.	**0**
* Certain market selections will alter default setting.			
LEVELING MODE: 24	0 **1**	LIFT: Platform leveling during lift only. **ALL: Platform leveling during all functions.**	**1**
CLEARSKY: 25	**0** 1	**NO: ClearSky Telematics system not installed.** YES: ClearSky Telematics system installed	**0**
FUEL TANK: 26	**0** 1 2	**31 Gallon Fuel Tank** 52 Gallon Fuel Tank 62 Gallon Fuel Tank	**0**
ALERT BEACON: 27	**0** 1	**OFF FOR CREEP** 20FPS FOR CREEP	**0**
TEMP CUTOUT: 28	**0** 1	**NO: Temp Cutout is Disabled** YES: Temp Cutout is Enabled	**0**

Table 6-2. Machine Configuration Programming Information - Version P7.29

Configuration Digit	Number	Description	Default Number
PLAT LVL OVR CUT: 29	**0** 1	**NO: Platform Level Override will always be functional** YES: Platform Level Override will only be functional when In Transport	**0**
CRIBBING OPTION: 30	**0** 1	**NO: Cribbing Option is disabled.** YES: Cribbing Option is enabled.	**0**
* Only visible under certain market selections.			
WATER IN FUEL SENSOR: 31	**0** 1	**NO: Water in fuel sensor Disabled.** YES: Water in fuel sensor Enabled.	**0**
* Only visible under certain market selections.			
			4150364-X

Table 6-3. Machine Configuration Programming Settings - Version P7.29

1200SJP	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Model Number	1	1	1	1	1	1
Envelope Height	5	5	5	5	5	5
Market	0	1	2	3	4	5
Engine	3	3	3	3	3	3
Glow Plug	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Starter Lockout	0	0	0	0	0	0
	1	1	1	1	1	1
Engine Shutdown	0	0	0	0	0	0
	1	1	1	1	1	1
Fuel Cutout	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Tilt	1	1	1	1	1	1
	2	2	2	2	2	2
	3	3	3	3	3	3
	4	4	4	4	4	4
	5	5	5	5	5	5
	6	6	6	6	6	6
Jib	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
4 Wheel Steer	0	0	0	0	0	0
	1	1	1	1	1	1
Drive Type	0	0	0	0	0	0
	1	1	1	1	1	1
Soft Touch/SkyGuard	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
	3	3	3	3	3	3
Gen Set / Welder	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Gen Set Cutout	0	0	0	0	0	0
	1	1	1	1	1	1
Head & Taillights	0	0	0	0	0	0
	1	1	1	1	1	1

Table 6-3. Machine Configuration Programming Settings - Version P7.29

1200SJP	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Load System	0	0	0	0	0	0
	X	1	X	X	X	1
	X	2	X	2	2	2
	X	3	X	3	X	3
	X	4	X	X	X	4
Load Type	0	0	0	0	0	0
	1	1	1	1	1	1
Function Cutout	0	0	0	0	0	0
	X	1	1	1	1	1
	X	2	2	X	2	2
	X	3	3	X	3	3
Ground Alarm	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
	3	3	3	3	3	3
Flywheel Teeth	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Oscillating Axle	0	0	0	0	0	0
	1	1	1	1	1	1
Display Units	0	0	0	0	0	0
	1	1	1	1	1	1
Leveling Mode	0	0	0	0	0	0
	1	1	1	1	1	1
ClearSky	0	0	0	0	0	0
	1	1	1	1	1	1
Fuel Tank	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Alert Beacon	0	0	0	0	0	0
	1	1	1	1	1	1
Temperature Cutout	X	0	X	0	X	X
	X	1	X	1	X	X
Platform Cutout	0	0	0	0	0	0
	1	1	1	1	1	1
Cribbing Option	0	0	0	X	X	0
	1	1	1	X	X	1
Water In Level Sensor	0	0	0	0	0	0
	1	1	1	1	1	1

Table 6-3. Machine Configuration Programming Settings - Version P7.29

1200SJP	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Water In Level Sensor	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1

BOLD TEXT indicates the default setting. Plain text indicates another available selection. ***ITALIC TEXT*** indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

Table 6-4. Machine Configuration Programming Settings - Version P7.29

1350SJP	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Model Number	**3**	**3**	**3**	**3**	**3**	**3**
Envelope Height	**1**	**1**	**1**	**1**	**1**	**1**
Market	**0**	**1**	**2**	**3**	**4**	**5**
Engine	**3**	**3**	**3**	**3**	**3**	**3**
Glow Plug	0	0	0	0	0	0
	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**
Starter Lockout	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1
Engine Shutdown	0	0	0	0	0	0
	1	**1**	**1**	**1**	**1**	**1**
Fuel Cutout	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1
	2	2	2	2	2	2
Tilt	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2
	3	3	3	3	3	3
	4	4	4	4	4	4
	5	5	5	5	5	5
	6	6	6	6	6	6
Jib	0	0	0	0	0	0
	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**
4 Wheel Steer	0	0	0	0	0	0
	1	**1**	**1**	**1**	**1**	**1**
Drive Type	0	0	0	0	0	0
	1	**1**	**1**	**1**	**1**	**1**

Table 6-4. Machine Configuration Programming Settings - Version P7.29

1350SJP	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Soft Touch/SkyGuard	0	0	0	0	0	0
	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**
	3	3	3	3	3	3
Gen Set / Welder	0	0	0	0	0	0
	1	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2
Gen Set Cutout	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1
Head & Taillights	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1
Load System	**0**	**0**	**0**	0	0	0
	X	***1***	X	X	X	**1**
	X	2	X	**2**	***2***	2
	X	3	X	3	X	3
	X	4	X	X	X	4
Load Type	0	0	0	0	0	0
	1	**1**	**1**	**1**	**1**	**1**
Function Cutout	**0**	**0**	**0**	0	**0**	**0**
	X	1	1	**1**	1	1
	X	2	2	X	2	2
	X	3	3	X	3	3
Ground Alarm	**0**	**0**	0	0	**0**	0
	1	1	1	1	1	1
	2	2	2	2	2	2
	3	3	**3**	**3**	3	**3**
Fly Wheel Teeth	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1
	2	2	2	2	2	2
Oscillating Axle	0	0	0	0	0	0
	1	**1**	**1**	**1**	**1**	**1**
Display Units	**0**	**0**	0	0	0	0
	1	1	**1**	**1**	**1**	**1**
Leveling Mode	0	0	0	0	0	0
	1	**1**	**1**	**1**	**1**	**1**
ClearSky	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1
Fuel Tank	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1
	2	2	2	2	2	2

Table 6-4. Machine Configuration Programming Settings - Version P7.29

1350SJP	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Alert Beacon	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1
Temperature Cutout	X	**0**	X	**0**	X	X
	X	1	X	1	X	X
Platform Cutout	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1
Cribbing Option	**0**	**0**	**0**	X	X	**0**
	1	1	1	X	X	1
Water In Level Sensor	**0**	**0**	**0**	**0**	**0**	**0**
	1	1	1	1	1	1

BOLD TEXT indicates the default setting. Plain text indicates another available selection. ***ITALIC TEXT*** indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

6.9 MACHINE PERSONALITY SETTINGS/FUNCTION SPEEDS

NOTE: *Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.*

Table 6-5. Personality Ranges/Defaults

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PARAMETER (DISPLAYED ON ANALYZER 2ND LINE)	DESCRIPTION	RANGE	DEFAULT VALUES		TIME RANGE (SEC) (SEE SECTION 6.10 FOR MACHINE ORIENTATION WHEN SETTING SPEEDS)	
				1200	1350	1200S	1350S
DRIVE:	ACCEL X.Xs	Displays/adjusts drive acceleration	0.1 to 5.0 sec	2.0	2.0		
	DECEL X.Xs	Displays/adjusts drive deceleration	0.1 to 3.0 sec	1.3	1.3		
	MIN forward XX%	Displays/adjusts minimum forward drive speed	0 to 35%	1	1		
	MAX forward XXX%	Displays/adjusts maximum forward drive speed	0 to 100%	100	100	44-48	44-48
	MIN reverse XX%	Displays/adjusts minimum reverse drive speed	0 to 35%	1	1		
	MAX reverse XXX%	Displays/adjusts maximum reverse drive speed	0 to 100%	100	100		
	ELEV. MAX XX%	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed	0 to 50%	25	25	93-104	93-104
	CREEP MAX XX%	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active	0 to 50%	35	35	79-87	79-87
STEER:	max SPEED XXX%	Displays/adjusts maximum steer speed.	0 to 100%	100	100		
MAIN LIFT:	ACCEL X.Xs	Displays/adjusts main lift acceleration	0.1 to 5.0 sec	1.0	1.0		
	DECEL X.Xs	Displays/adjusts main lift deceleration	0.1 to 3.0 sec	1.0	1.0		
	MIN Up XX%	Displays/adjusts minimum main lift up speed	0 to 60%	20	20		
	MAX UP XX%	Displays/adjusts maximum main lift up speed	0 to 100%	50	50	75-100	75-100
	MIN DOWN XX%	Displays/adjusts minimum main lift down speed	0 to 60%	10	10		
	MAX DOWN XXX%	Displays/adjusts maximum main lift down speed	0 to 100%	50	50	85-110	85-110
	CREEP UP XX%	Displays/adjusts maximum main lift up speed NOTE: used when creep switch on pump pot is active	0 to 65%	50	50		
	CREEP DOWN XX%	Displays/adjusts maximum main lift down speed NOTE: used when creep switch on pump pot is active	0 to 75%	45	45		

Table 6-5. Personality Ranges/Defaults

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PARAMETER (DISPLAYED ON ANALYZER 2ND LINE)	DESCRIPTION	RANGE	DEFAULT VALUES		TIME RANGE (SEC) (SEE SECTION 6.10 FOR MACHINE ORIENTATION WHEN SETTING SPEEDS)	
				1200	1350	1200S	1350S
SWING:	ACCEL X.Xs	Displays/adjusts swing acceleration	0.1 to 5.0 sec	2.0	2.0		
	DECEL X.Xs	Displays/adjusts swing deceleration	0.1 to 3.0 sec	1.5	1.5		
	MIN LEFT XX%	Displays/adjusts minimum swing left speed	0 to 50%	40	40		
	MAX LEFT XXX%	Displays/adjusts maximum swing left speed	0 to 100%	65	65	115-125	115-125
	MIN RIGHT XX%	Displays/adjusts minimum swing right speed	0 to 50%	40	40		
	MAX RIGHT XXX%	Displays/adjusts maximum swing right speed	0 to 100%	65	65	115-125	115-125
	CREEP LEFT XX%	Displays/adjusts maximum swing left speed NOTE: used when creep switch on pump pot is active	0 to 65%	50	50		
	CREEP RIGHT XX%	Displays/adjusts maximum swing right speed NOTE: used when creep switch on pump pot is active	0 to 65%	50	50		
MAIN TELESCOPE:	ACCEL X.Xs	Displays/adjusts main telescope acceleration	0.1 to 5.0 sec	1.5	1.5		
	DECEL X.Xs	Displays/adjusts main telescope deceleration	0.1 to 3.0 sec	1.0	1.0		
	MIN IN XX%	Displays/adjusts minimum main telescope in speed. Same as Creep speed	0 to 65%	15	15		
	MAX IN XXX%	Displays/adjusts maximum main telescope in speed	0 to 100%	65	65	58-68	65-75
	MIN OUT XX%	Displays/adjusts minimum main telescope out speed. Same as Creep speed	0 to 65%	15	15		
	MAX OUT XXX%	Displays/adjusts maximum main telescope out speed	0 to 100%	60	60	45-55	50-60
BASKET LEVEL:	ACCEL X.Xs	Displays/adjusts basket level acceleration	0.1 to 5.0 sec	1.5	1.5		
	DECEL X.Xs	Displays/adjusts basket level deceleration	0.1 to 3.0 sec	0.5	0.5		
	MIN UP XX%	Displays/adjusts minimum basket level up speed. Same as Creep speed	0 to 65%	40	40		
	MAX UP XXX%	Displays/adjusts maximum basket level up speed	0 to 100%	70	70		
	MIN DOWN XX%	Displays/adjusts minimum basket level down speed. Same as Creep speed	0 to 65%	40	40		
	MAX DOWN XXX%	Displays/adjusts maximum basket level down speed	0 to 100%	70	70		

Table 6-5. Personality Ranges/Defaults

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PARAMETER (DISPLAYED ON ANALYZER 2ND LINE)	DESCRIPTION	RANGE	DEFAULT VALUES		TIME RANGE (SEC) (SEE SECTION 6.10 FOR MACHINE ORIENTATION WHEN SETTING SPEEDS)	
				1200	1350	1200S	1350S
BASKET ROTATE:	ACCEL X.Xs	Displays/adjusts basket rotate acceleration	0.1 to 5.0 sec	1.0	1.0		
	DECEL X.Xs	Displays/adjusts basket rotate deceleration	0.1 to 3.0 sec	0.5	0.5		
	MIN LEFT XX%	Displays/adjusts minimum basket rotate left speed. Same as Creep speed	0 to 100%	60	60		
	MAX LEFT XXX%	Displays/adjusts maximum basket rotate left speed	0 to 100%	60	60	24-30 (180°)	24-30 (180°)
	MIN RIGHT XX%	Displays/adjusts minimum basket rotate right speed. Same as Creep speed	0 to 100%	60	60		
	MAX RIGHT XXX%	Displays/adjusts maximum basket rotate right speed	0 to 100%	60	60	24-30 (180°)	24-30 (180°)
JIB LIFT:	ACCEL X.Xs	Displays/adjusts jib lift acceleration	0.1 to 5.0 sec	1.5	1.5		
	DECEL X.Xs	Displays/adjusts jib lift deceleration	0.1 to 3.0 sec	1.0	1.0		
	MIN UP XX%	Displays/adjusts minimum jib up speed. Same as Creep speed	0 to 65%	40	40		
	MAX UP XXX%	Displays/adjusts maximum jib up speed	0 to 100%	65	65	30-36	30-36
	MIN DOWN XX%	Displays/adjusts minimum jib down speed. Same as Creep speed	0 to 65%	40	40		
	MAX DOWN XXX%	Displays/adjusts maximum jib down speed	0 to 100%	60	60	30-36	30-36
JIB SWING:	ACCEL X.Xs	Displays/adjusts jib swing acceleration	0.1 to 5.0 sec	1.5	1.5		
	DECEL X.Xs	Displays/adjusts jib swing deceleration	0.1 to 3.0 sec	0.5	0.5		
	MIN LEFT XX%	Displays/adjusts minimum jib left speed. Same as Creep speed	0 to 65%	40	40		
	MAX LEFT XXX%	Displays/adjusts maximum jib left speed	0 to 100%	70	70	60-68 (180°)	60-68 (180°)
	MIN RIGHT XX%	Displays/adjusts minimum jib right speed. Same as Creep speed	0 to 65%	40	40		
	MAX RIGHT XXX%	Displays/adjusts maximum jib right speed	0 to 100%	70	70	60-68 (180°)	60-68 (180°)

Table 6-5. Personality Ranges/Defaults

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PARAMETER (DISPLAYED ON ANALYZER 2ND LINE)	DESCRIPTION	RANGE	DEFAULT VALUES		TIME RANGE (SEC) (SEE SECTION 6.10 FOR MACHINE ORIENTATION WHEN SETTING SPEEDS)	
				1200	1350	1200S	1350S
GROUND MODE:	U. LIFT UP XXX%	Displays/adjusts fixed main lift up speed	0 to 100%	60	60		
	U. LIFT DN XXX%	Displays/adjusts main lift down speed	0 to 100%	60	60		
	SWING XXX%	Displays/adjusts fixed swing speed	0 to 100%	60	60		
	BASKET LVL XXX%	Displays/adjusts fixed basket level speed	0 to 100%	75	75		
	BASKET ROT XXX%	Displays/adjusts fixed basket rotate speed	0 to 100%	75	75		
	MAIN TELE XXX%	Displays/adjusts fixed main telescope speed	0 to 100%	60	60		
	TOWER TELE XXX%	Displays/adjusts fixed tower telescope speed Not displayed if TOWER TELE=NO	0 to 100%	100	100		
	T. LIFT UP XXX%	Displays/adjusts fixed tower lift up speed Not displayed if TOWER LIFT=NO	0 to 100%	100	100		
	T. LIFT DN XXX%	Displays/adjusts fixed tower lift down speed Not displayed if TOWER LIFT=NO	0 to 100%	100	100		
	JIB (U/D) XXX%	Displays/adjusts jib lift speed Not displayed if JIB = 0	0 to 100%	60	60		
	JIB (L/R) XXX%	Displays/adjusts jib swing speed Displayed if JIB = 2	0 to 100%	70	70		
GEN SET/WELDER:	ENGINE XXXX RPM	Control generator/welder RPM. Not displayed if GEN SET/WELDER = 0	1200-2800	1800	1800		

4150453-H

6.10 MACHINE ORIENTATION WHEN SETTING FUNCTION SPEEDS

Lift Up: From platform control, lowest elevation up to maximum elevation, boom retracted.

Lift Down: From platform control, maximum elevation down to minimum elevation, boom retracted.

Swing Right (Max): 360 Degrees, from platform control, boom approximately 45° elevation, boom retracted.

Swing Left (Max): 360 Degrees, from platform control, boom approximately 45° elevation, boom retracted.

Telescope Out: From platform control, boom horizontal, 500 lb. (230 kg) capacity selected.

Telescope In: From platform control, boom horizontal, 500 lb. (230 kg) capacity selected.

Drive Forward (Max): Test should be done on a smooth level surface. High Speed - Low Torque setting, drive 200 ft. (61 m) front wheels to front wheels. Timed after machine has obtained maximum speed.

Drive Reverse (Max): Test should be done on a smooth level surface. High Speed - Low Torque setting, drive 200 ft. (61 m) front wheels to front wheels. Timed after machine has obtained maximum speed.

Drive Forward (Creep Max): Test should be done on a smooth level surface. High Torque - Low Speed setting, platform speed knob at full creep.

Drive Reverse (Creep Max): Test should be done on a smooth level surface. High Torque - Low Speed setting, platform speed knob at full creep.

Drive Forward (Elevated Max - Boom Beyond Transport): Test should be done on a smooth level surface. High speed - Low Torque setting, platform speed knob out of creep, Lift boom above transport, drive forward 50 ft. (15.2 m).

Drive Reverse (Elevated Max - Boom Beyond Transport): Test should be done on a smooth level surface. High speed - Low Torque setting, platform speed knob out of creep, Lift boom above transport, drive forward 50 ft. (15.2 m).

Platform Rotate: Platform level and completely rotated one direction. Rotate the opposite direction, Record Time. Rotate the other direction, Record Time.

Articulating Jib: Platform level and centered with the boom. Start with the Jib down. Jib Up, Record Time. Jib Down, Record Time.

Test Notes

1. Personality settings can be adjusted anywhere within the adjustment range in order to achieve optimum machine performance.
2. Stop watch should be started when the function is activated.
3. Unless noted, all speed tests are run from the platform. These speeds do not reflect the ground control operation.
4. The platform speed knob control must be at full speed (turned clockwise completely).
5. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).

6.11 SYSTEM TEST

The Control System Incorporates a built-in system test to check the system components and functions. To use this function, use the following procedures.

Test from the Platform

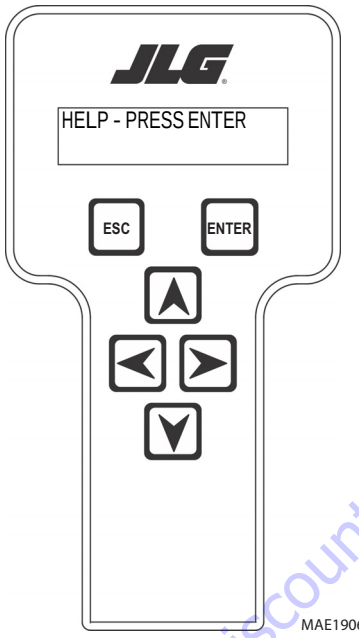
1. Position the Platform/Ground select switch to the Platform position.

2. Plug the analyzer into the connector at the base of the platform control box.

3. Before proceeding, ensure that the switches on the platform console are in the following positions:
   a. Drive speed switch is in the Middle position. (Turtle Icon)
   b. 4WS switch is in the Middle position. (2WS mode)
   c. Capacity select switch in the 1000 lb. (450 kg) mode.
   d. Function speed potentiometer out of creep mode switch.
   e. Generator (if equipped) switched to the off position.
   f. Head and Tail lights (if equipped) switched to the off position.

4. Pull out the Emergency Stop switch and Start the engine.

5. The analyzer screen should read:



6. Use the arrow button to reach SYSTEM TEST. Hit Enter. The analyzer will prompt you asking if you want to activate the system test; hit Enter again to activate.

7. Follow the flow path in Figure 6-15., System Test Flow Chart - Platform Tests and go through the component tests. Hit the ESC key during any part of the test to return to the main menu without completing all tests or wait until all tests are complete. During the TEST ALL INPUTS sequence, the analyzer allows control switches to be operated and shows if they are closed (CL) or open (OP).

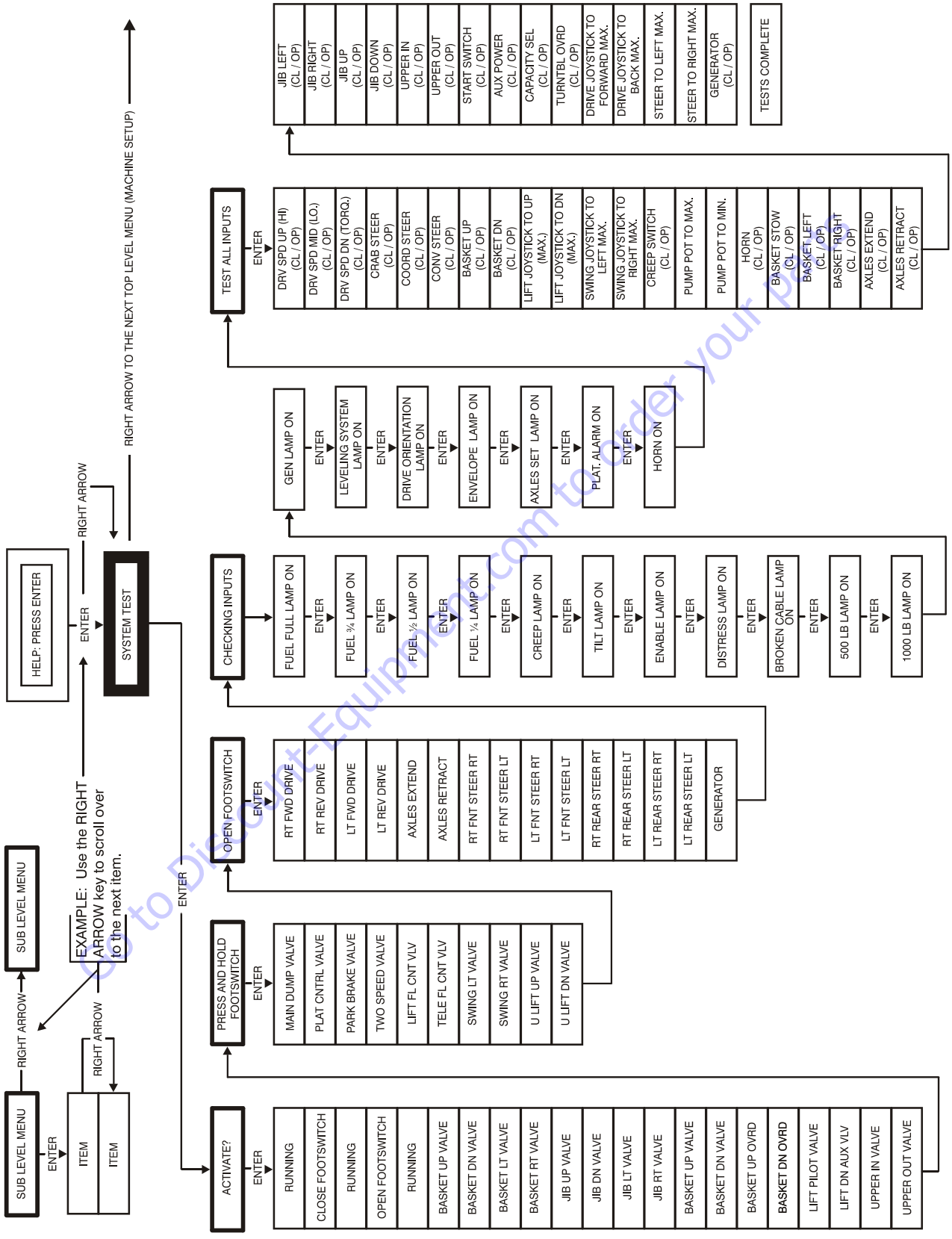


Figure 6-15. System Test Flow Chart - Platform Tests