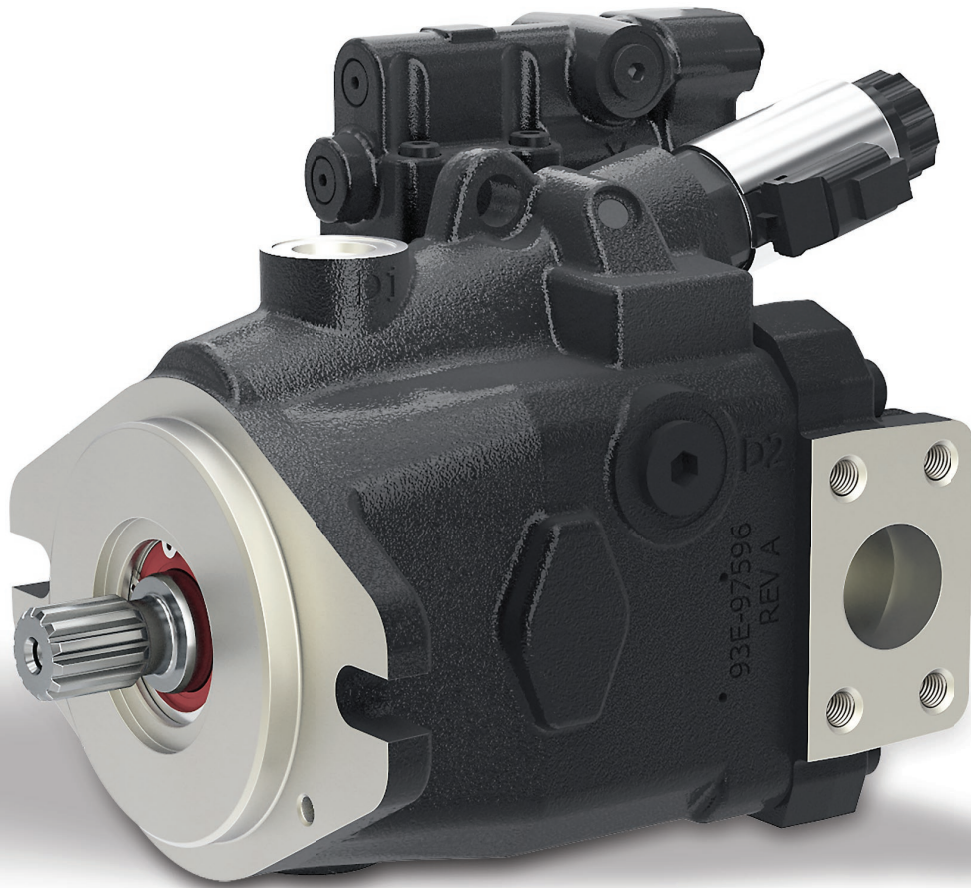




<https://parker.com/P1M>



P1M SERIES

B-MOD SERVICE INFORMATION MOBILE OPEN CIRCUIT

Variable Displacement Axial Piston Pumps
Bulletin MSG28-2718-01/P1M/SVC/EN
Effective: May 2026 | Replaces: March 2026



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If you have questions about the products contained in this catalog, or their applications, please contact:
Parker Hannifin Corporation
Hydraulic Pump and Motor Division
parker.com/hpm

GENERAL INFORMATION

Pump Information

For information on pump performance, functionality, or dimensional data, see P1M Sales Catalog MSG28-2717-01/P1M/US

Mounting

These pumps are designed to operate with the shaft horizontal or pointing downward. For shaft-up mounting, consult factory. The pump shaft must be in alignment with the shaft of the source driver and should be checked with a dial indicator. The mating pilot bore and coupling must be concentric. This concentricity is particularly important if the shaft is rigidly connected to the driven load without a flexible coupling.

Shaft Information

The spline shafts can accept a maximum misalignment of 0.15mm total indicator reading. Angular misalignment must be less than ± 0.12 degrees. The coupling interface must be lubricated. PARKER HANNIFIN recommends lithium molydisulfide or similar grease. The internal coupling should be hardened to Rc 27-34 and must conform to SAE-J498c, class 5 flat root side fit.

Fluid Connections

Connect inlet and outlet lines to the port block of the pump. Plumb the case drain line to the reservoir. The pump has three case drain ports for various installation orientations. Use the uppermost case drain port. DO NOT undersize the case drain line. It should be the same size as the case drain port or larger. Make sure there are no restrictions in the case drain line. The case pressure must never exceed inlet pressure by more than 0.5 bar (7 psi). When connecting case drain line make certain that drain plumbing passes above highest point excess of the pump before draining to the reservoir. The case leakage line must be of sufficient size to prevent excess back pressure and returned to the reservoir below the surface of the oil as far from the supply inlet as possible. All fluid lines, whether pipe, tubing, or hose must be adequate size and strength to assure free flow through the pump. An undersize inlet line will prevent the pump from operating properly at full rated speed. An undersize outlet line will cause back pressure and cause heat generation and increased noise. Flexible hose lines are recommended. If rigid piping is used, the workmanship must be accurate to eliminate strain on the pump port block or to the fluid connections. Sharp bends in the lines must be eliminated wherever possible, especially in the suction line. They could cause a pressure drop which can create noise and affect pump longevity. All system piping must be cleaned and flushed before installing pump. Make sure the entire hydraulic system is free of dirt, lint, scale, or other foreign material.

CAUTION: Do not use galvanized pipe. Galvanized coating can flake off with continued use.

System Relief Valves

Although the P1M series pumps have very fast off-stroke compensator response, system relief valves are recommended in all cases for safety considerations.

Recommended Fluids

The fluid used in these pumps should have a petroleum base and contain agents which provide oxidation inhibition and anti-rust, anti-foam and de-aerating properties as described in PARKER HANNIFIN standard HF-1. Where anti-wear additive fluids are specified, see PARKER HANNIFIN standard HF-0. Fluid must be compatible with FKM seals and have a temperature vs viscosity profile such that the viscosity of the fluid remains within catalog limits during operation. Parker Hannifin is not responsible for selecting the appropriate fluid. That is the responsibility of the machine designer or end user.

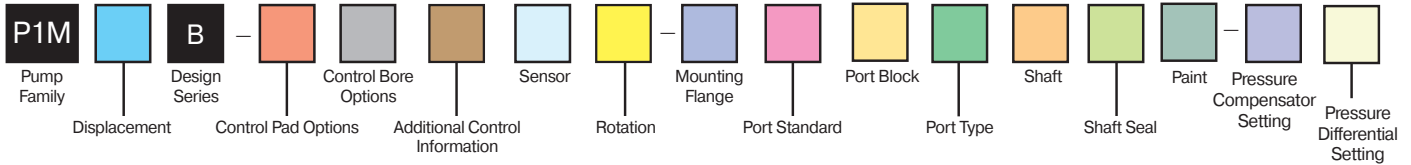
Fluid Cleanliness

Fluid must be cleaned before and continuously during operation, by filters that maintain a cleanliness level of ISO 20/18/14. Better cleanliness levels will significantly extend the life of the components. As contaminant generation may vary with each application, each must be analyzed to determine proper filtration to maintain the required cleanliness level.

Maintenance

The pump is self-lubricating and preventative maintenance is limited to keeping system fluid clean by changing filters frequently. Keep all fittings and screws tight. Do not operate at pressures and speeds in excess of the recommended limit. If the pump does not operate properly, check the troubleshooting guide before attempting to overhaul the unit.

P1M MODEL CODE



Displacement	
018	18cc/rev (in development)
028	28cc/rev
045	45cc/rev
054	54cc/rev
065	65cc/rev
073	73cc/rev
085	85cc/rev
105	105cc/rev

Control Options - Control Pad	
PC	Pressure Compensator
PU	Pressure Compensator with Unload Valve
LS	Load Sense with Pressure Compensator
LU	Load Sense with Unload Valve
LB	Load Sense with Bleed Orifice
RC	Remote Compensator
FD*	Electronic Fan Drive

*Not available with 105cc

Control Options - Control Bore	
00	None
ED	Electronic Displacement
TL	Torque Limiter (45, 54, 65, 73 & 85 cc)
VS	Maximum Volume Stop

Additional Electronic Control Information	
00	Not Applicable
1H	12 VDC; Max Default
1L*	12 VDC; Min Default
2H	24 VDC; Max Default
2L*	24 VDC; Min Default

* Not available with FD or Unload control

Sensor	
0	None
D	Displacement Sensor

Rotation	
R	Clockwise from Shaft End
L	Counterclockwise from Shaft End

Mounting Flange	
B2	SAE-B 2-bolt (28, 45, 54, 65, & 73cc)
C6	SAE-C 2/4-bolt (65, 73, 85, & 105cc)

Port Standard	
S	SAE Work & Aux Ports
M	Metric Work & Aux Ports

Port Block	
S	Side Ports, no thru-drive
E	End Ports, no thru-drive
A	SAE-A 2-bolt Thru-Drive; 9T coupling
H	SAE-A 2-bolt Thru-Drive; 11T coupling
B	SAE-B 2-bolt Thru-Drive; 13T coupling
Q	SAE-B 2-bolt Thru-Drive; 15T coupling
C	SAE-C 2/4-bolt Thru-Drive; 14T coupling
N	SAE-C 2/4-bolt Thru-Drive; 17T coupling
P	Thru-Drive (SAE-A) with Cover: no coupling
T	Thru-Drive with Cover, no coupling

Port Type	
F	Flanged
T	Threaded*

* Not available with 85, 105, or 45, 54, 65, & 73 thru-drive

Shaft	
B	SAE-B, 13T (28, 45, 54, 65, & 73cc)
Q	SAE-BB, 15T (28, 45, 54, 65 & 73cc)
C	SAE-C, 14T (65, 73, 85, & 105cc)
N	SAE-CC, 17T (85 & 105cc)

Shaft Seal	
S	Single FKM Shaft Seal
D	Dual FKM Shaft Seal

Paint	
0	No Paint
P	Standard Black Paint

Pressure Compensator Setting	
XX*	Setting in bar times 10 (Range 07-28)

*FD Control has min setting of 100 bar

Pressure Differential Setting	
00	No Setting (PC, PU, & FD controls)
15	15 bar (Required for RC control)
XX*	Setting in bar (Range 10-35)

*Factory default is 15 bar



Thru-Drive Options Per Displacement					
Code	28cc	45/54cc	65/73cc	85cc	105cc
A	✓	✓	✓	✓	✓
H	✓	✓	✓	✓	✓
B	✓	✓	✓	✓	✓
Q		✓	✓	✓	✓
C			✓	✓	✓
N					✓

TYPICAL CHARACTERISTICS

Model	28cc	45cc	54cc	65cc	73cc	85cc	105cc
Displacement, cm³/rev (cu.in./rev)	28 (1.71)	45 (2.75)	54 (3.29)	65 (3.97)	73 (4.45)	85 (5.19)	105 (6.41)
Outlet Pressure – Continuous, bar (psi)	280 (4060)	280 (4060)	250 (3625)	280 (4060)	250 (3625)	280 (4060)	280 (4060)
Intermittent*, bar (psi)	320 (4640)	320 (4640)	290 (4205)	320 (4640)	290 (4205)	320 (4640)	320 (4640)
Peak, bar (psi)	350 (5075)	350 (5075)	320 (4640)	350 (5075)	320 (4640)	350 (5075)	350 (5075)
Maximum Speed (1.0 bar abs inlet), rpm	3300	3000	2900	2800	2800	2700	2600
Maximum Speed (0.8 bar abs inlet), rpm	3200	2900	2800	2700	2700	2500	2400
Inlet Pressure – Maximum	11 bar absolute (160 psi)						
Rated	1.0 bar absolute (14.5 psi)						
Minimum	0.8 bar absolute (11.6 psi)						
Case Pressure – Peak, bar	4.0 bar absolute (58 psi) and less than 0.5 bar (7.3 psi) above inlet pressure						
Rated, bar	2.0 bar absolute (29 psi) and less than 0.5 bar (7.3 psi) above inlet pressure						
Fluid Temperature Range, °C	-40 to +95						
Fluid Temperature Range, °F	-40 to +203						
Fluid Viscosity – Rated, cSt	7 to 160						
Optimum Range, cSt	14-50 cSt.						
Max. Intermittent, cSt	5000 (cold start only)						
Min. Intermittent, cSt	6 (less than 1% of duty cycle)						
Weight** – End Port, kg (lb)	16.2 (36)	19.8 (44)	19.9 (44)	24.3 (53)	24.2 (53)	30.2 (66)	37.0 (81)
Side Port, kg (lb)	16.2 (36)	20.0 (44)	20.1 (44)	24.7 (54)	24.6 (54)	30.8 (68)	37.7 (83)
Thru-Drive, kg (lb)***	19.8 (44)	23.6 (52)	23.7 (52)	28.7 (63)	28.6 (63)	34.6 (76)	41.5 (91)
Moment of Inertia kg-mm²	1359	2874	3167	5010	4843	7979	10267
Moment of Inertia Thru-Drive, kg-mm²	1395	2937	3230	5151	4985	8168	10491

*Intermittent is defined as less than 10% of operation time, not exceeding 20 successive seconds.

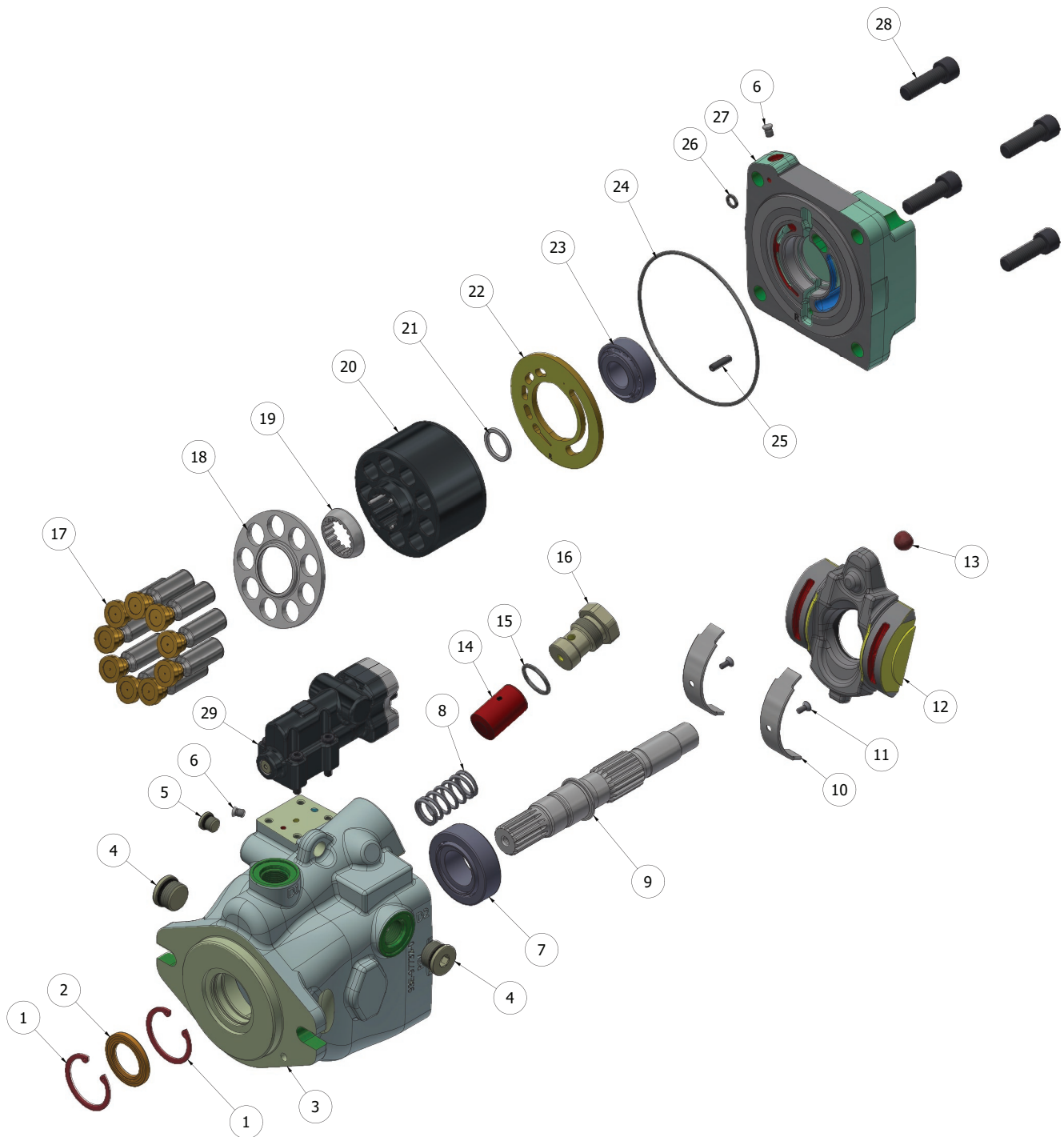
**Add 1.4 kg (3 lbs) for SAE-C mount for 65 & 73cc

***Add 2.9 kg (6 lbs) for SAE-C thru adapter

Note: For additional information include the P1M eConfigurator, visit the P1M homepage: <https://discover.parker.com/P1M>

Note: Contact factory for part number of desired model code configuration. Setting information will be required for part number release

P1M PUMP EXPLODED VIEW



P1M Torque Specs (Nm)					
Item	28	45/54	65/73	85	105
4	81 +/-5	81 +/-5	81 +/-5	115 +/-5	115 +/-5
5 (SAE)	N/A	20 +/-2	20 +/-2	20 +/-2	20 +/-2
5 (metric)	N/A	35 +/-3	35 +/-3	35 +/-3	35 +/-3
11	2.4 +/- 0.2	2.4 +/- 0.2	2.4 +/- 0.2	2.4 +/- 0.2	2.4 +/- 0.2
16	185 +/-10	185 +/-10	185 +/-10	185 +/-10	185 +/-10
28	70 +/-4	118 +/-7	136 +/-5	136 +/-5	229 +/-7

P1M PUMP PARTS

Item	Qty	Description	P1M-028	P1M-045	P1M-054	P1M-065	P1M-073	P1M-085	P1M-105
1	1 or 2	Snap Ring (Qty 1 with option "D") (Kits of 10)	03E-96995-0K			256X544K		356-65155-0K	
2*	1 or 2	Shaft Seal (Qty 2 with option "D")	03E-96890-0			620-82118-5		03E-97902-5	620-82121-5
3	1	Housing	Consult Factory						
4*	2	Drain Plug & O-ring - SAE (Kits of 25)	108X8VK	108X10VK				108X12VK	
		Drain Plug & O-ring - Metric (Kits of 25)	788516-10VK				788516-12VK		
5*	1	Gauge Plug & O-ring - SAE (Kit of 25)	N/A	108X4VK					
		Gauge Plug & O-ring - Metric (Kit of 25)	N/A	788516-04VK					
6	2-5	Break-off Plugs (Kits of 25)	03E-97006-0K						
7	1	Front Shaft Bearing - Cup	03E-97639-0	03E-96915-0		230-82235-0		03E-97942-0	03E-97931-0
		230-82236-0							
8	1	Bias Spring (Kits of 10)	03E-97624-0K	03E-96351-0K		03E-97895-0K		03E-98008-0K	03E-98355-0K
9	1	Shaft - SAE-B 13T (no thru-drive)	03E-97636-0	03E-97939-001-0		03E-97845-009-0		N/A	
		Shaft - SAE-B 13T (thru-drive)	03E-97620-0	03E-97939-002-0		03E-97845-010-0		N/A	
		Shaft - SAE-BB 15T (no thru-drive)	03E-97780-0	03E-97939-005-0		03E-97845-001-0		N/A	
		Shaft - SAE-BB 15T (thru-drive)	03E-97781-0	03E-97939-006-0		03E-97845-002-0		N/A	
		Shaft - SAE-C 14T (no thru-drive)	N/A		03E-97845-003-0		03E-97823-001-0	03E-97919-001-0	
		Shaft - SAE-C 14T (thru-drive)	N/A		03E-97845-004-0		03E-97823-002-0	03E-97919-002-0	
		Shaft - SAE-CC 17T (no thru-drive)	N/A				03E-97823-005-0	03E-97919-005-0	
		Shaft - SAE-CC 17T (thru-drive)	N/A				03E-97823-006-0	03E-97919-006-0	
10	2	Cam Bushing	03E-98147-0	03E-97859-0		03E-97733-0		03E-97817-0	03E-98319-0
11	2	Cam Bushing Screw (Kit of 50)	03E-96791-0K						
12	1	Cam - CW	03E-97682-0	03E-97736-0		03E-97638-001-0		03E-97819-001-0	03E-97907-001-0
		03E-97638-002-0				03E-97819-002-0	03E-97907-002-0		
13	1	Cam button	03E-97622-0						
14	1	Control Piston	03E-97623-0	03E-97788-0		03E-97761-0		03E-97838-0	03E-97936-0
15*	1	Control Bore Plug O-ring	Seal Kit Only						
16	1	Control Bore Plug	03E-97625-0						
17	9	Piston-Shoe Assembly	S2E-29083-0	S2E-20485-0	S2E-20484-0	S2E-20458-0	S5E-10445-0	S5E-10937-0	S5E-10909-0
18	1	Retainer	03E-97611-0	03E-96988-0	03E-96989-0	03E-97886-0		03E-97824-0	03E-97922-0
19	1	Spherical Washer	03E-97771-0	03E-96852-0		03E-97113-0		03E-98009-0	03E-97923-0
20	1	Barrel	RKP1M028-BRLB	RKP1M045-BRLB	RKP1M054-BRLB	RKP1M065-BRLB	RKP1M073-BRLB	RKP1M085-BRLB	RKP1M105-BRLB
21	1	Shim Kit	S5E-11035-0K	S5E-11036-0K		S5E-11037-0K		S5E-11038-0K	S5E-11039-0K
22	1	Port Plate - CW	03E-98274-0	03E-98211-0		03E-98281-0		03E-98283-0	03E-98286-0
		Port Plate - CCW	03E-98275-0	03E-98212-0		03E-98282-0		03E-98284-0	03E-98287-0
23	1	Rear Shaft Bearing - Cup	03E-97640-0	03E-96917-0		230-82237-0		03E-97943-0	230-82244-0
		Rear Shaft Bearing - Cone							230-82518-0
24*	1	Port Block O-ring - FKM 75 Duro	Seal Kit Only						
25	1	Locating Pin (Kit of 20)	03E-96894-0K						
26*	1	Square Cut Face Seal	Seal Kit Only						
27	1	Port Block	Consult Factory						
28	4	Port Block SHCS (Kits of 20)	210X210K	210X236K		361-13250-0K			361-14290-0K
29	1	Hydromechanical Control	See Controls Section						

* Seal Included in Pump Seal Kit

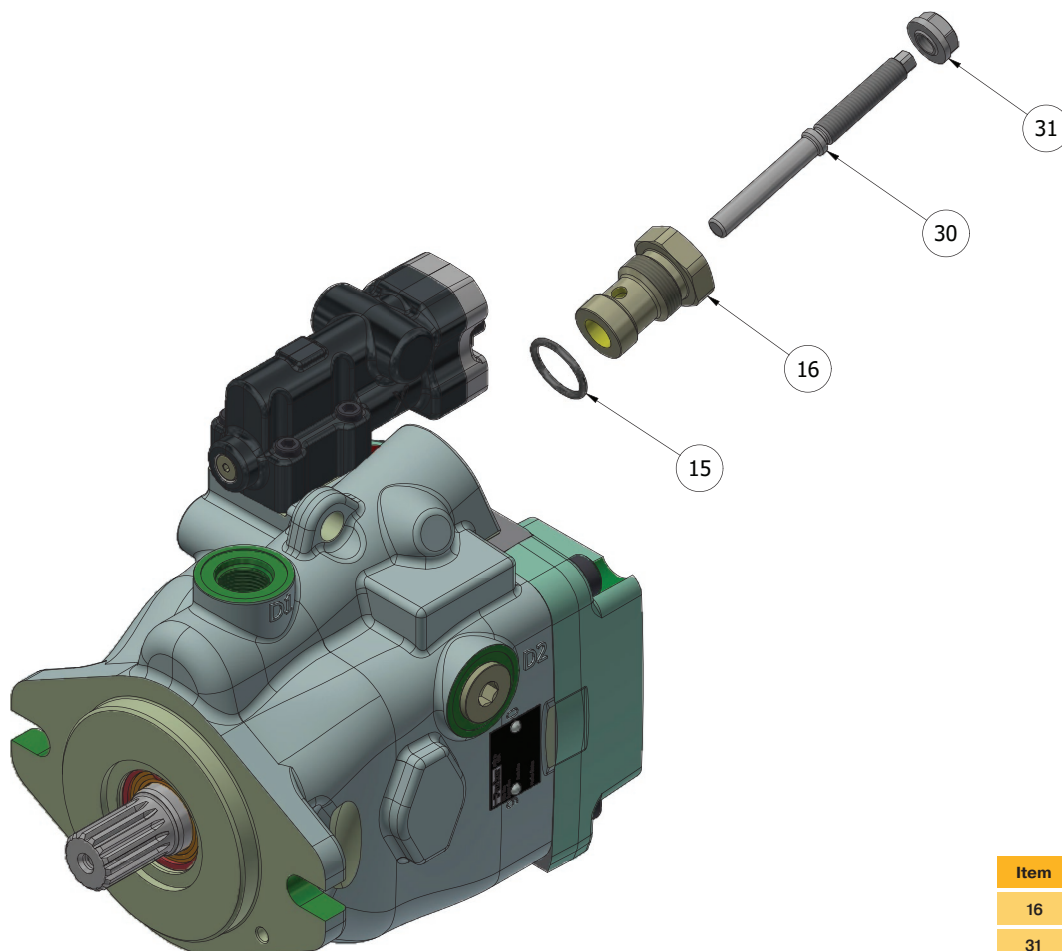
P1M Seal Kits					
Port Standard	P1M-028	P1M-045/054	P1M-065/073	P1M-085	P1M-105
SAE	SKP1M028-SVB	SKP1M045-SVB	SKP1M065-SVB	SKP1M085-SVB	SKP1M105-SVB
Metric	SKP1M028-MVB	SKP1M045-MVB	SKP1M065-MVB	SKP1M085-MVB	SKP1M105-MVB

Rotating Group Repair Kits							
	P1M-028	P1M-045	P1M-054	P1M-065	P1M-073	P1M-085	P1M-105
CW Rotation	RKP1M028-RGRB	RKP1M045-RGRB	RKP1M054-RGRB	RKP1M065-RGRB	RKP1M073-RGRB	RKP1M085-RGRB	RKP1M105-RGRB
CCW Rotation	RKP1M028-RGLB	RKP1M045-RGLB	RKP1M054-RGLB	RKP1M065-RGLB	RKP1M073-RGLB	RKP1M085-RGLB	RKP1M105-RGLB

Includes items 10, 11, 17, 18, 19, 20, & 22

MAXIMUM VOLUME STOP PARTS

Description	Part Number	Parts Included
Max Volume Stop Kit	RKP1M-VSHVB	All Items



Item	Torque (Nm)
16	185 +/- 10
31	80 +/- 6

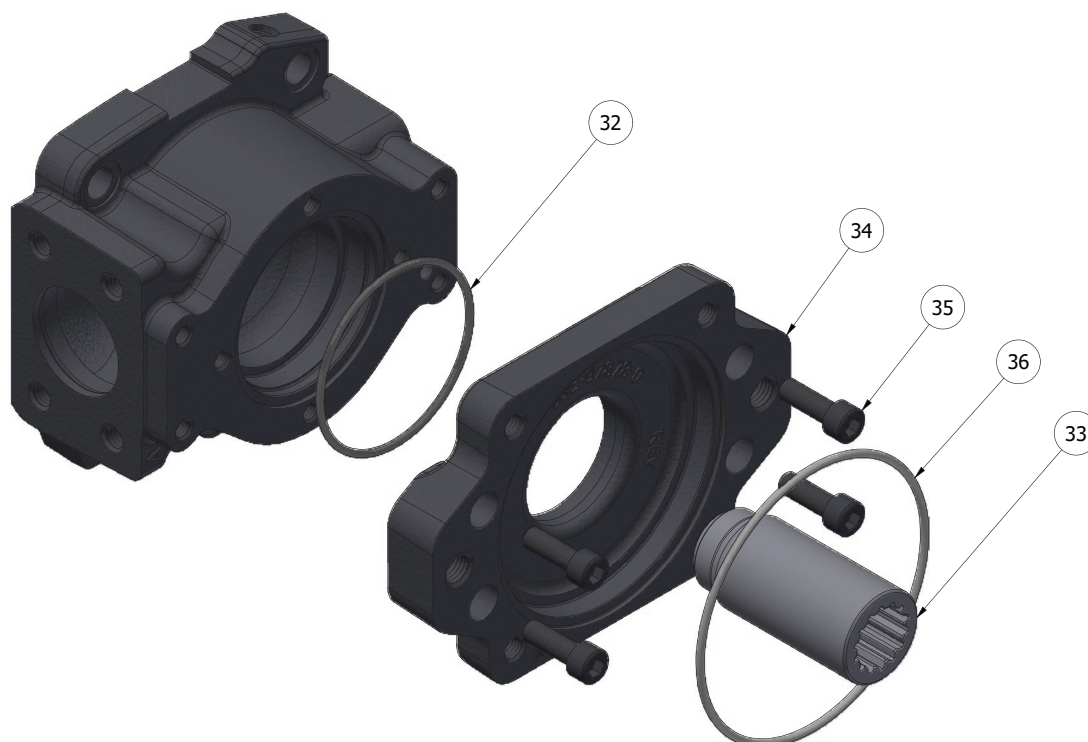
Max Volume Stop Parts		
Item	Qty	Description
15*	1	Control Bore O-ring
16	1	Max Volume Stop Plug
30	1	Max Stop Adjustment Screw - M12
31*	1	Seal lock nut - M12

* Seal Included in Pump Seal Kit

P1M Max Volume Stop		
Size	Range	Adjustability
P1M-028	8-28cc	2.5 cc/turn
P1M-045	10-45cc	3.6 cc/turn
P1M-054	12-54cc	4.3 cc/turn
P1M-065	18-65cc	4.9 cc/turn
P1M-073	21-73cc	5.5 cc/turn
P1M-085	34-85cc	5.9 cc/turn
P1M-105	50-105cc	6.7 cc/turn

THRU-DRIVE COUPLINGS & O-RINGS

Item	Torque (Nm)
35	70 +/- 4



Thru-Drive Parts				
Item	Qty	Description	Part Number	Notes
32*	1	SAE-A Thru-Drive O-ring - ARP-237 FKM 75 Duro	136X237-75VK	Kit of 10
		SAE-B Thru-Drive O-ring - ARP-243 FKM 75 Duro	136X243-75VK	Kit of 10
33	1	Thru-Drive Coupling	See table	
34	1	SAE-C Thru-Drive Adapter Plate - SAE thread	03E-97879-031-0	
		SAE-C Thru-Drive Adapter Plate - Metric thread	03E-97879-032-0	
35	4	SAE-C Adapter Cap Screws - M10x30	210X208K	Kit of 20
36*	1	SAE-C Thru-Drive O-ring - ARP-251 FKM 75 Duro	136X251-75VK	Kit of 10

* Seal Included in Pump Seal Kit

Thru-Drive Couplings						
Thru-Drive Option	Description	028	045/054	065/073	085	105
"A"	SAE-A 9T	03E-97770-0	03E-97766-0	03E-93278-0	03E-97945-0	03E-98103-0
"H"	SAE-A 11T	03E-97769-0	03E-97463-0	03E-94724-0	03E-97946-0	03E-98104-0
"B"	SAE-B 13T	03E-97768-0	03E-97389-0	03E-93277-0	03E-97947-0	03E-98105-0
"Q"	SAE-BB 15T	N/A	03E-97651-0	03E-93279-0	03E-97948-0	03E-98106-0
"C"	SAE-C 14T	N/A	N/A	03E-97320-0	03E-97949-0	03E-98107-0
"N"	SAE-CC 17T	N/A	N/A	N/A	N/A	03E-98108-0

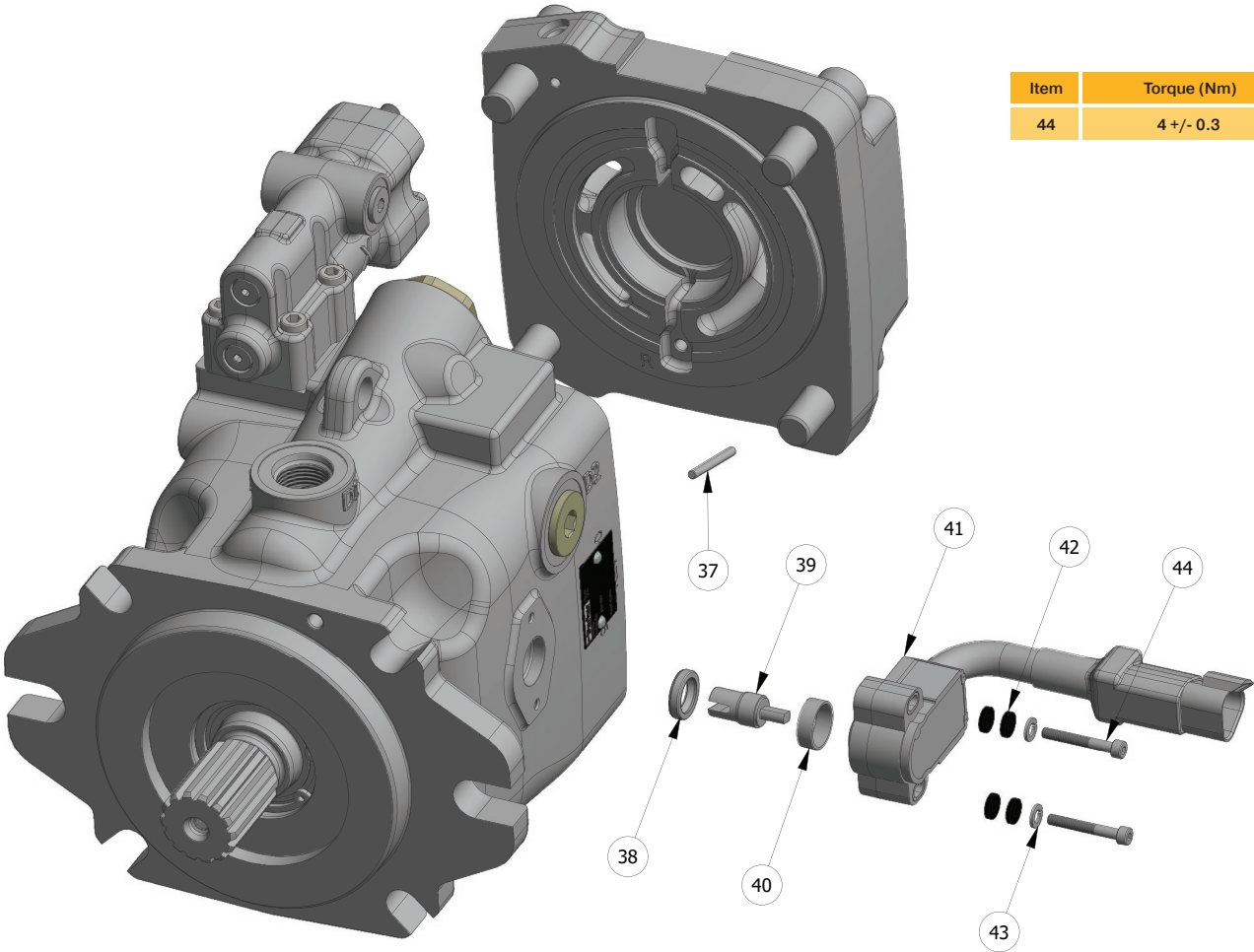
DISPLACEMENT SENSOR PARTS

Displacement Sensor Kit		
Description	Part,Number	Parts Included
Sensor Kit	RKP1M-DSVB	All Items

Displacement Sensor Parts			
Item	Qty	Description	Part Number
37	1	Sensor Cam Pin	Kit Only
38*	1	Sensor Seal	Kit Only
39	1	Sensor Shaft Connector	Kit Only
40	1	Sensor Spacer	Kit Only
41	1	Displacement Sensor	788-80020-0
42	4	M4 Washers	Kit Only
43	2	M4 Lock Washers	Kit Only
44	2	M4 x 30 SHCS (Kit of 20)	210X73K

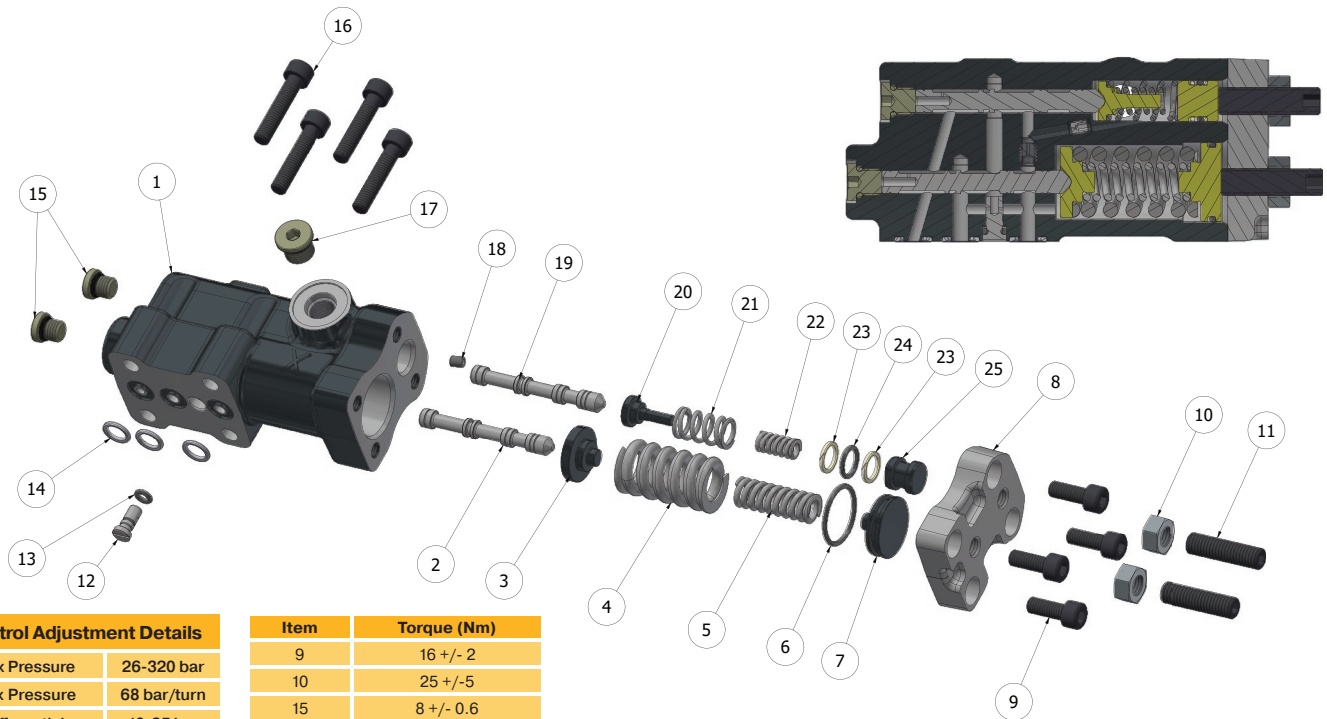
* Seal Included in Pump Seal Kit

Item	Torque (Nm)
44	4 +/- 0.3



“LS”/“LB”/“RC” CONTROLS

LOAD SENSE & REMOTE COMPENSATOR



Control Adjustment Details

Max Pressure	26-320 bar
Max Pressure	68 bar/turn
Differential	10-35 bar
Differential	21 bar/turn

Item	Torque (Nm)
9	16 +/- 2
10	25 +/- 5
15	8 +/- 0.6
16	16 +/- 2
17 (SAE)	20 +/- 2
17 (metric)	35 +/- 3
18	2 +/- 0.2

Load Sense & Remote Comp

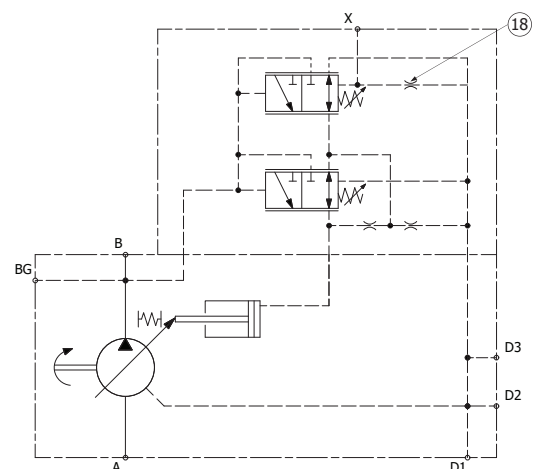
Item	Qty	Description	Part Number
1	1	Housing - "LS/RC" Control	Assembly Only
		Housing - "LB" Control	Assembly Only
2	1	Pmax Spool	03E-97696-0
3	1	Pmax Spring Retainer Guide	Assembly or Kit Only
4	1	Pmax Outer Spring	Assembly or Kit Only
5	1	Pmax Inner Spring	Assembly or Kit Only
6*	1	O-ring - ARP-019 FKM 90 Duro	Assembly or Kit Only
7	1	Pmax Spring Plug	Assembly or Kit Only
8	1	Compensator Cover	03E-97864-0
9	4	Screws - M6x16 (Kit of 20)	210X129K
10	2	Adjustment Lock Nut	Assembly or Kit Only
11	2	Adjustment Screw - M8X30	Assembly or Kit Only
12	1	Compensator Orifice Plug	Assembly or Kit Only
13*	1	O-ring - ARP-007 FKM 75 Duro	Assembly or Kit Only
14*	3	O-ring - ARP-011 Teflon	Assembly or Kit Only
15*	2	Plug & O-ring - SAE -2 (Kit of 25)	108X2VK
16	4	Mounting Screws - M6x30 (Kit of 20)	210X134K
17*	1	X Port Plug & O-ring - SAE -4 (Kit of 25)	108X4VK
		X Port Plug & O-ring - Metric (Kit of 25)	788516-04VK
18	1	"LB" M4 Bleed Orifice - 0.4 mm (Kit of 20)	03E-97699-0K
19	1	LS/LB Differential Spool	03E-97696-0
		RC Differential Spool	03E-97991-0
20	1	Differential Spring Guide	Assembly or Kit Only
21	1	Differential Outer Spring	Assembly or Kit Only
22	1	Differential Inner Spring	Assembly or Kit Only
23*	2	Teflon Single Turn Back-up Ring	Assembly or Kit Only
24*	1	O-ring - ARP-012 FKM 90 Duro	Assembly or Kit Only
25	1	Differential Spring Plug	Assembly or Kit Only

* Seal Included in Pump and Controls Seal Kit

LS/LB/RC Control Assemblies & Kits

Description	Part Number	Parts Included
LS Control Assembly	S5E-10852-00*N-5T-07015	Items 1-17, 19-25
LB Control Assembly	S5E-10852-00*B-5T-07015	All Items
RC Control Assembly	S5E-10853-00*-5T-07015	Items 1-17, 19-25
Pmax Kit	RKP1M-PCVB	Items 2-7, 10-13
Differential Kit	RKP1M-CDVB	Items 10, 11, 18-25
Control Adjustment Kit	RKP1M-CAB	Item 10 & 11 (10 each)
P1M Controls Seal Kit	SKP1M-CTL*VB	Items 6, 13-15, 17, 23, 24

*S = SAE, M = Metric



LB Schematic

“*U” CONTROL

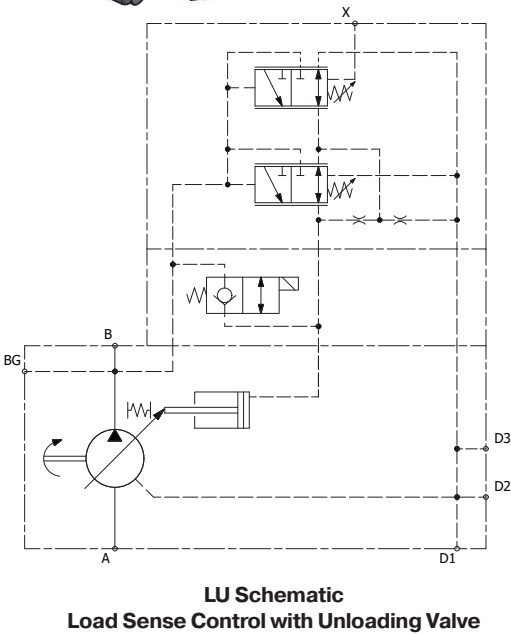
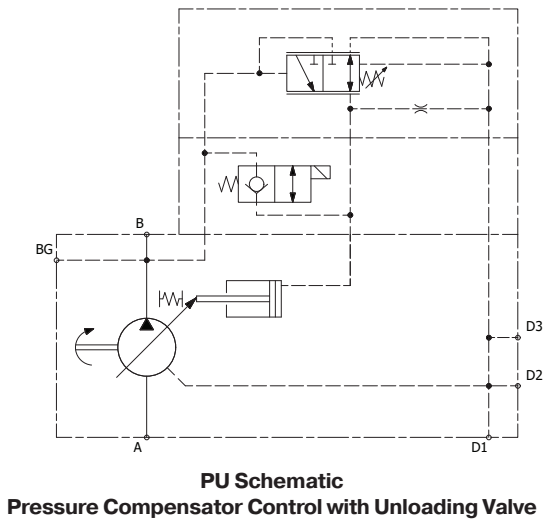
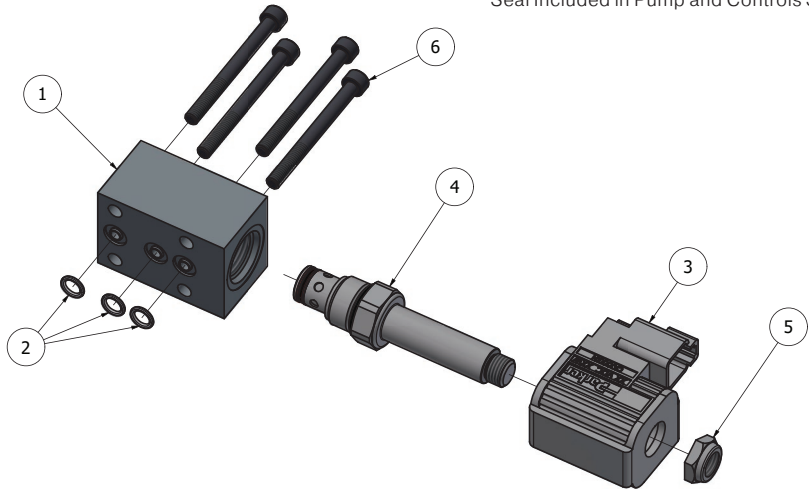
ELECTRONIC UNLOAD

Unload Control Part Numbers	
Description	Part Number
U1H Unload Assembly - 12V	S5E-10942-121-5T
U2H Unload Assembly - 24V	S5E-10942-241-5T
P1M Controls Seal Kit	SKP1M-CTLSVB

Unload Control Parts			
Item	Qty	Description	Part Number
1	1	Unload Housing	Assembly Only
2*	3	Teflon O-rings - ARP-011	Assembly or Kit Only
3	1	Coil - 12VDC	03E-98193-121-0
		Coil - 24VDC	03E-98193-241-0
4*	1	Cartridge Body & O-ring	03E-98194-5
5	1	Cartridge Nut	Included with Item 4
6	4	Mounting Screws - M6x65 (Kit of 16)	210X141K

* Seal Included in Pump and Controls Seal Kit

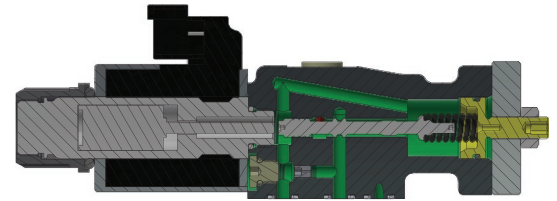
Item	Torque (Nm)
4	72 +/-3
5	8.5 +/-1.5



“FD” CONTROL

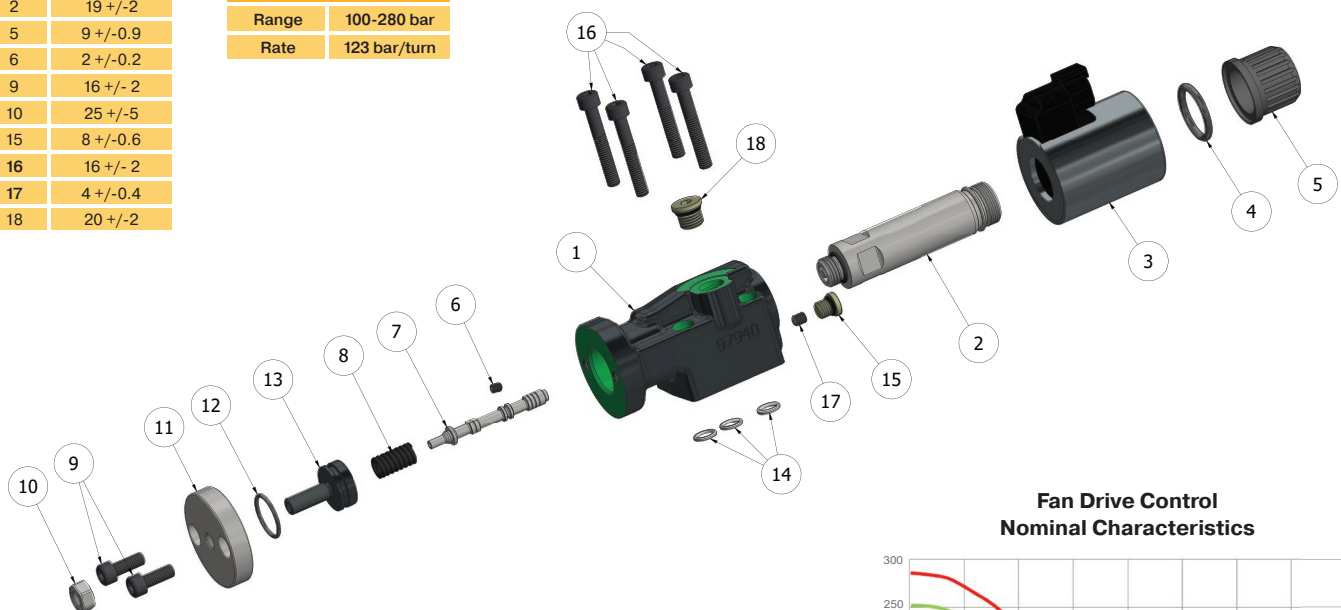
ELECTRONIC PROPORTIONAL PRESSURE FOR FAN DRIVES

FD Control Assemblies & Kits		
Description	Part Number	Parts Included
FD1H Control Assembly - 12V	S5E-10764-090012-5T-25000	All
FD2H Control Assembly - 24V	S5E-10764-090024-5T-25000	All
FD Control Parts Kit	RKP1M-FDB	Items 7, 8, 10, 12, 13, 14
12V Coil Kit	RKP1M-FD12VB	Items 3-5
24V Coil Kit	RKP1M-FD24VB	Items 3-5
P1M Controls Seal Kit	SKP1M-CTLSVB	Items 2 (seals only), 4, 12, 14, 15, 18



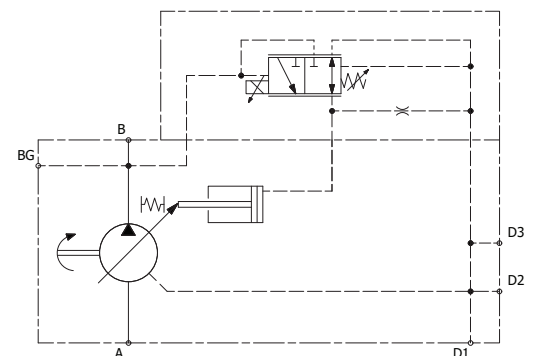
Item	Torque (Nm)
2	19 +/-2
5	9 +/-0.9
6	2 +/-0.2
9	16 +/- 2
10	25 +/-5
15	8 +/-0.6
16	16 +/- 2
17	4 +/-0.4
18	20 +/-2

FD Adjustment Details	
Range	100-280 bar
Rate	123 bar/turn



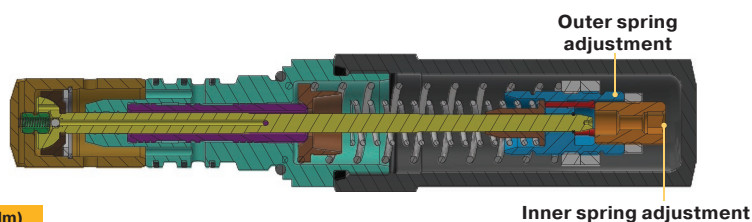
FD Control Assembly Parts List			
Item	Qty	Description	Part Number
1	1	Control Housing	Assembly Only
2*	1	Solenoid Tube with O-ring	03E-98210-0
3	1	Coil - 12 VDC	Assembly or Kit Only
		Coil - 24 VDC	Assembly or Kit Only
4*	1	Coil Cap O-ring - ARP-212 FKM 75 Duro	Assembly or Kit Only
5	1	Coil Cap	Assembly or Kit Only
6	1	Set Screw - M4x5	Assembly or Kit Only
7	1	FD Control Spool	Assembly or Kit Only
8	1	Spring	Assembly or Kit Only
9	2	Screws - M6x16 (Kit of 20)	210X129K
10	1	Pmax Adjustment Lock Nut - M8	Assembly or Kit Only
11	1	Control Cover	03E-97953-0
12*	1	Control Cover O-ring - ARP-018 FKM 90 Duro	Assembly or Kit Only
13	1	Pmax Adjustment	Assembly or Kit Only
14*	3	Teflon O-rings - ARP-011	Assembly or Kit Only
15*	1	Plug & O-ring - SAE -2 (Kit of 25)	108X2VK
16	4	Mounting Screw - SHCS M6x40 (Kit of 20)	210X136K
17	1	Orifice - 0.9mm - M5x6 Set Screw	Assembly or Kit Only
18*	1	Plug & O-ring - SAE -4 (Kit of 25)	108X4VK

* Seal Included in Pump and Controls Seal Kit



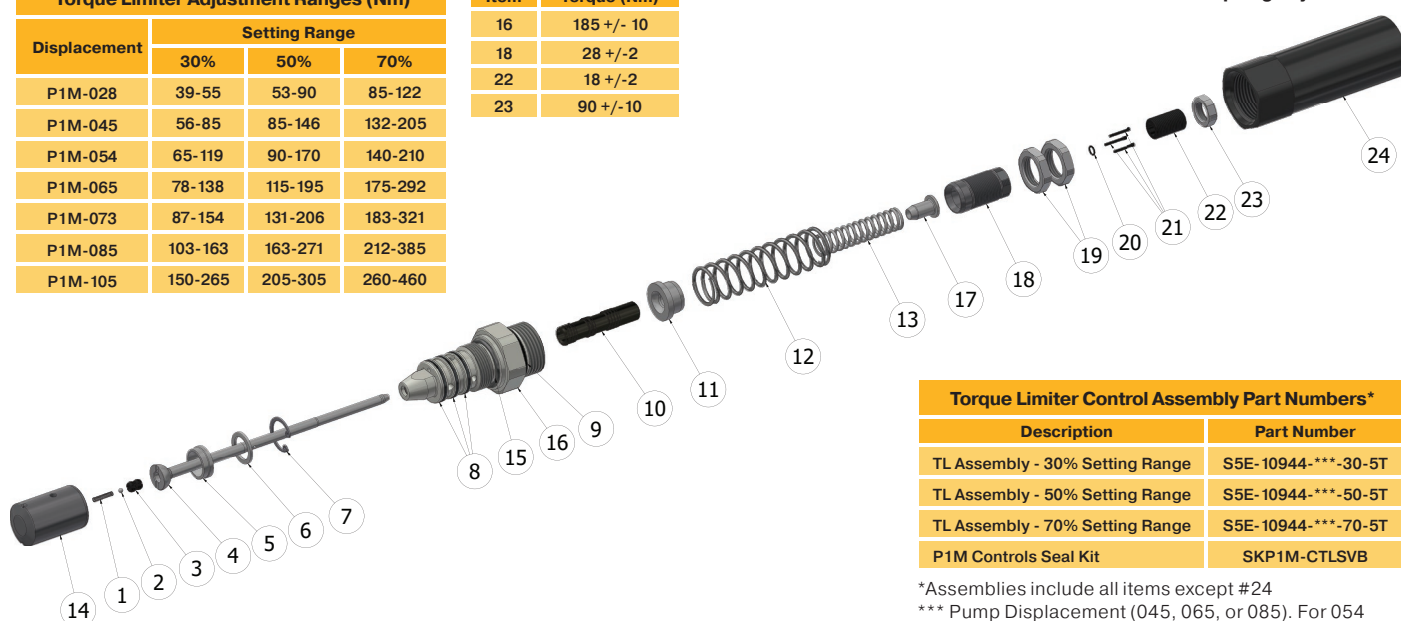
FD Control Schematic

“TL” CONTROL TORQUE LIMITER



Torque Limiter Adjustment Ranges (Nm)			
Displacement	Setting Range		
	30%	50%	70%
P1M-028	39-55	53-90	85-122
P1M-045	56-85	85-146	132-205
P1M-054	65-119	90-170	140-210
P1M-065	78-138	115-195	175-292
P1M-073	87-154	131-206	183-321
P1M-085	103-163	163-271	212-385
P1M-105	150-265	205-305	260-460

Item	Torque (Nm)
16	185 +/- 10
18	28 +/- 2
22	18 +/- 2
23	90 +/- 10



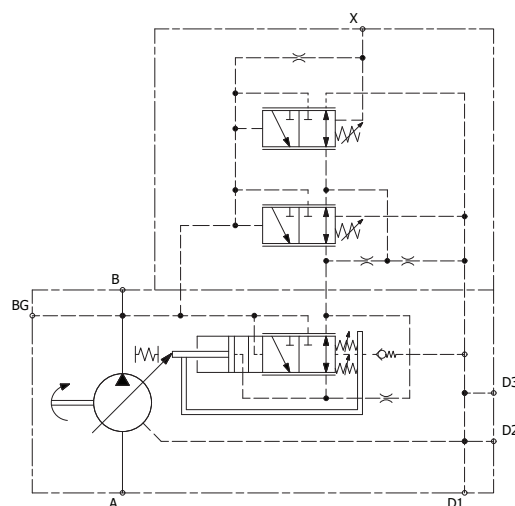
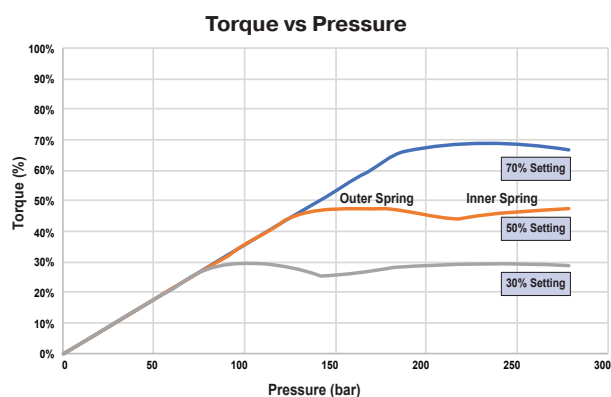
Torque Limiter Control Assembly Part Numbers*

Description	Part Number
TL Assembly - 30% Setting Range	S5E-10944-***-30-5T
TL Assembly - 50% Setting Range	S5E-10944-***-50-5T
TL Assembly - 70% Setting Range	S5E-10944-***-70-5T
P1M Controls Seal Kit	SKP1M-CTLSVB

*Assemblies include all items except #24
 *** Pump Displacement (045, 065, or 085). For 054 use 045. For 073 use 065.

Torque Limiter Control Parts			
Item	Qty	Description	Part Number
1	1	Torque Limiter Control Piston Spring	Assembly Only
2	1	Torque Limiter Ball	Assembly Only
3	1	Torque Limiter Coupling	Assembly Only
4	1	Tension Rod	03E-98051-0
5	1	Torque Limiter Spherical Seal	Assembly Only
6	1	Torque Limiter Washer	Assembly Only
7	1	Torque Limiter Retainer	Assembly Only
8	3	Control Sleeve Piston Rings (Kit of 15)	03E-97992-0K
9*	1	Torque Limiter Cap O-ring	Assembly Only or Kit
10	1	Torque Limiter Spool	Assembly Only
11	1	Torque Limiter Outer Spring Guide	Assembly Only
12	1	70% Outer Spring - 28-54 (Kit of 10)	RKP1M045-TLS70B
		70% Outer Spring - 65-85 (Kit of 10)	RKP1M065-TLS70B
		50% Outer Spring - 28-54 (Kit of 10)	RKP1M045-TLS50B
		50% Outer Spring - 65-85 (Kit of 10)	RKP1M065-TLS50B
		30% Outer Spring - 28-54 (Kit of 10)	RKP1M045-TLS30B
		30% Outer Spring - 65-85 (Kit of 10)	RKP1M065-TLS30B
13	1	Inner Spring	Included with Item #12
14	1	TL Control Piston - 045/054	03E-98083-0
		TL Control Piston - 065/073	03E-98046-0
		TL Control Piston - 085	03E-98084-0
15*	1	Control Sleeve O-ring - M27	Assembly or Kit Only
16	1	Torque Limiter Control Sleeve (Includes items 8, 9, & 15)	RKP1M-TLCSVB
17	1	Torque Limiter Inner Spring Guide	Assembly Only
18	1	Torque Limiter Adjustment Guide	Assembly Only
19	2	Torque Limiter Adjustment Lock Nut	Assembly Only
20	1	Torque Limiter Tension Rod Retainer	Assembly Only
21	3	Pin Hold Down	Assembly Only
22	1	Torque Limiter Set Screw	Assembly Only
23	1	Torque Limiter Set Screw Lock Nut	Assembly Only
24	1	Torque Limiter Cap	03E-98064-0

* Seal Included in Pump and Controls Seal Kit

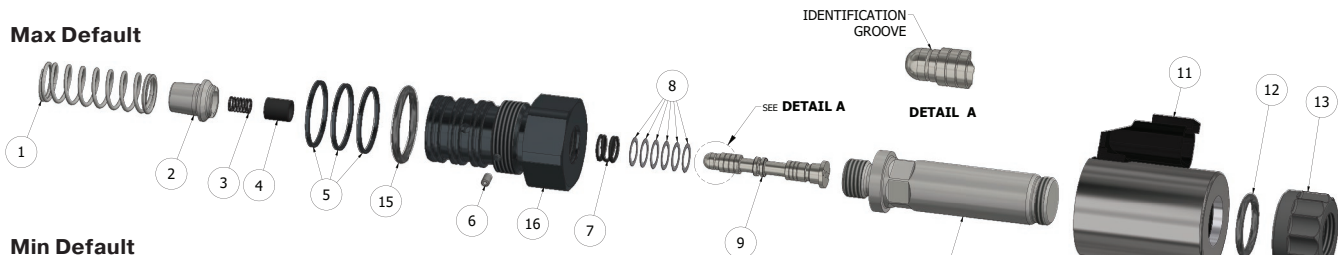


RCTL Schematic

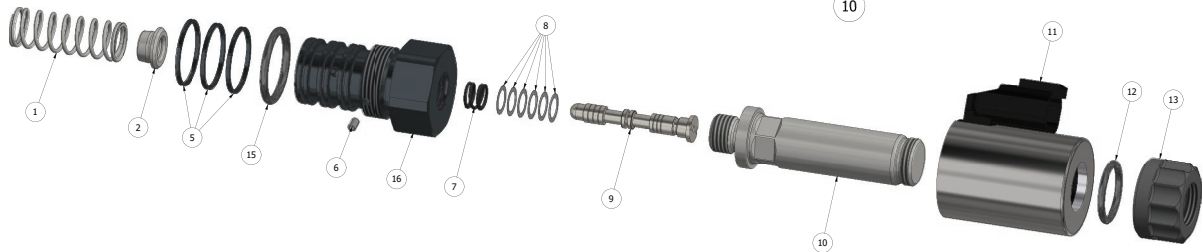
“ED” CONTROL

ELECTRONIC PROPORTIONAL DISPLACEMENT

Max Default



Min Default

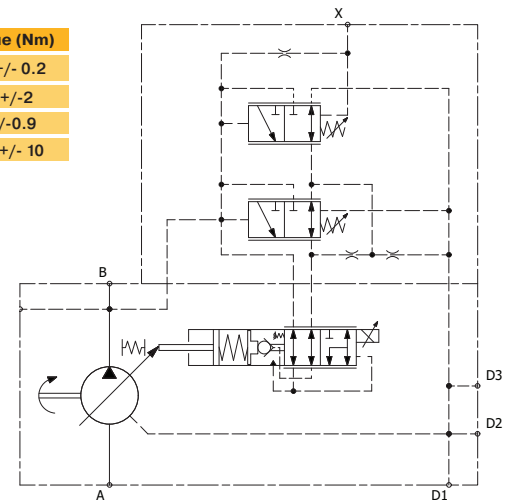


ED Complete Control Kits

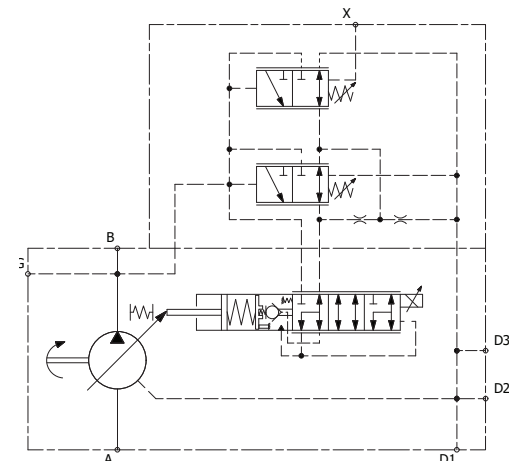
Description	Part Number	Parts Included
"ED1H" - 12 VDC Max Default	S5E-11004-***-MAX-12-5	All items
"ED2H" - 24 VDC Max Default	S5E-11004-***-MAX-24-5	All items
"ED1L" - 12 VDC Min Default	S5E-11004-***-MIN-12-5	All except items 3 & 4
"ED2L" - 24 VDC Min Default	S5E-11004-***-MIN-24-5	All except items 3 & 4
Max Default Parts Kit	RKP1M-EDHB	Items 2, 3, 4, 7, 8, 9
Min Default Parts Kit	RKP1M-EDLB	Items 2, 7, 8, 9
P1M Controls Seal Kit	SKP1M-CTLSVB	Items 10 (seals only), 12, 15

*** Pump Displacement (045, 065, or 085). For 054 use 045. For 073 use 065.

Item	Torque (Nm)
6	0.8 +/- 0.2
10	19 +/- 2
13	9 +/- 0.9
16	185 +/- 10



RCED*L Schematic



LSED*H Schematic

ED Control Assembly Parts List			
Item	Qty	Description	Part Number
1	1	Feedback Spring - 028 (Kit of 10)	03E-98236-0K
		Feedback Spring - 045/054 (Kit of 10)	03E-98237-0K
		Feedback Spring - 065/073 (Kit of 10)	03E-98238-0K
		Feedback Spring - 085 (Kit of 10)	03E-98239-0K
		Feedback Spring - 105 (Kit of 10)	03E-98240-0K
2	1	Feedback Spring Guide - Min	Kit Only
		Feedback Spring Guide - Max	Kit Only
3	1	Max Default Spring Seat	Kit Only
4	1	Max Default Spring	Kit Only
5	3	Control Sleeve Piston Rings (Kit of 15)	03E-97992-0K
6	1	Set Screw - M3 x 5 mm	Kit Only
7	1	EDC Threshold Spring	Kit Only
8	6-8	Shims	Kit Only
9	1	Control Spool - Min Default	Kit Only
		Control Spool - Max Default	Kit Only
10*	1	Solenoid Tube with O-ring	03E-98196-5
11	1	EDC Proportional Coil - 12 VDC	RKP1M-ED12VB
		EDC Proportional Coil - 24 VDC	RKP1M-ED24VB
12*	1	Coil Cap O-ring	Included with Item #11
13	1	Coil Cap	Included with Item #11
15*	1	Control Sleeve O-ring - M27	Kit Only
16	1	Control Sleeve Cartridge (Includes items 5 & 15)	RKP1M-EDCSVB

* Seal Included in Pump and Controls Seal Kit

ASSEMBLY AND DISASSEMBLY TOOLS

Allen/Socket Head Wrenches

#	Size	Part
1	1/8"	PC/LS/RC/FD Housing Plug (#15)
2	3/16"	SAE Gauge Port (#5) PC/LS/RC SAE X-port Plug (#18) FD Control Housing Plug (#18)
3	5/16"	P1M-028 SAE Case Drain Plug (#4)
4	3/8"	P1M-045/054/065/073 SAE Case Drain Plug (#4)
5	9/16"	P1M-085/105 SAE Case Drain Plug (#4)
6	1.5mm	ED Control Sleeve Set Screw (#6)
7	2mm	LB Control Bleed Orifice (#20) FD Control Set Screw (#6)
8	2.5mm	Swashplate Bushing Screws (#11) FD Control Set Screw (#17)
9	3mm	Swashplate Sensor Screws (#44)
10	4mm	PC/LS/RC/FD Compensator Adjustment Screws (#9)
11	5mm	PC/LS/RC/FD Control Mounting Screws (#16) PC/LS/RC/FD Control Cover Screws (#9)
12	6mm	Metric Gauge Port Plug (#5) PC/LS/RC Metric X-Port Plug (#18) TL Inner Spring Adjustment (#22)
13	8mm	P1M-028 Port Block SHCS (#28) SAE-C Thru-Drive Adapter SHCS (#35)
14	10mm	P1M-028/045/054/065/073 Metric Case Drain Plug (#4) P1M-045/054 Port Block SHCS (#28)
15	12mm	P1M-085/105 Metric Case Drain Plug (#4) P1M-065/073/085 Port Block SHCS (#28)
16	14mm	P1M-105 Port Block SHCS (#28)

Crescent/Socket Wrenches

#	Size	Part
1	3/4"	PU/LU Control Coil Nut (#5)
2	1"	PU/LU Control Cartridge (#4)
3	8mm	Break-off Plugs (#6)
4	13mm	PC/LS/RC/FD Control Adjustment Locknut (#10)
5	17mm	FD/ED Control Solenoid Tube (#2) TL Control Inner Spring Locknut (23)
6	19mm	Max Volume Stop Locknut (#31)
7	24mm	TL Control Outer Spring Locknut (#19)
8	32mm	Control Bore Plug (#16)
9	32mm	Control Bore Plug (#16)

Other Tools Required & Optional

#	Tools
1	Channel Locks
2	Snap ring pliers
3	O-ring hook tool
4	Flat head screwdriver
5	Cordless Impact Gun
6	Rubber mallet
7	Bearing Puller
8	Shim Gauge
9	Press mechanism

P1M DISASSEMBLY INSTRUCTIONS

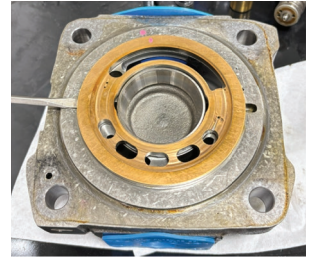
Notes:

1. Disassembly and reassembly of the pump should only be performed in a clean environment.
2. After disassembly, the internal parts should be coated with a film of clean hydraulic fluid and protected from moisture and contamination. Take care to avoid dropping or damaging the internal parts. Tolerances are such that a part could be damaged from dropping or impact even if no damage or marks are visible.

Disassembly Instructions:

1. Identify the pump from the information on the nameplate. See pages 4 to identify the configuration.
2. Drain the hydraulic fluid from the housing. Make sure to properly dispose of the hydraulic fluid.
3. Mount the pump shaft down in a fixture to prevent movement during disassembly.
4. If the pump has the displacement sensor (#41), unscrew the two sensor screws (#44) and remove the displacement sensor, spacer (#40), link (#39), and seal (#38).
5. Remove the compensator (#29) on the control pad of the housing by unscrewing the four compensator mounting screws. Additional fluid may drain out of the compensator or housing passages when the compensator is removed. See Controls Disassembly section for further details on taking apart the compensator.
6. Remove the parts in the pump control bore. If the pump has the electronic displacement control or torque limiter, refer to the "ED" or "TL" sections of the Controls Disassembly. If the pump has a maximum displacement limiter, unscrew the volume stop plug (#16) and remove plug assembly with the displacement limiter screw (#30) and locknut (#31). If the pump has no control in the control bore, then unscrew the control bore plug (#16). Then remove the control piston (#14) from the control bore.

7. Remove the four port block mounting bolts (#28) that secure the port block (#27) to the housing. Remove the port block assembly from the housing. The port plate (#22) may stick to the port block. If so, use a flathead screwdriver to separate it from the port block.



The rear shaft bearing (#23) race will still be pressed into the port block. If it is damaged and needs replaced, the race will need to be pulled out using a bearing puller.

8. Remove the O-rings (#24 & #26) from the housing (#3) face.
9. Remove the rear shaft bearing (#23) and shim (#21) from around the shaft (#9).



10. Turn the pump on its side and remove the rotation group from the housing. Hold the front of the shaft in place while removing the rotating group.



11. Remove pistons (#17), retainer (#18), and spherical washer (#19) from the barrel assembly.
WARNING: Do not disassemble the barrel assembly because there is a risk of injury since the barrel spring is in compression.



12. Remove the cam/swashplate (#12) assembly from the housing.



P1M DISASSEMBLY INSTRUCTIONS

13. Remove the bias spring (#8) from the housing.
14. Turn the pump housing so that the shaft is facing down and pull the shaft assembly out of the housing. If replacing the front shaft bearing (#7), the shaft (#9) will need to be pressed out of the bearing.

15. Using a 2.5mm allen wrench, unscrew the cam bushing screws (#11) and remove the cam bushings (#10) from the housing.

NOTE: The cam bearings screws are secured with Loctite, so removal may be difficult. They may need to be tapped on to break free otherwise the hex could get rounded when trying to unscrew them. If reusing the bearings, note the orientation and which side they are on so that they are reinstalled in the same location and orientation.



16. Remove internal snap ring (#1). Then turn the housing over and remove the other snap ring (#1) from the pilot face of the housing. For dual shaft seal pumps, one of the shaft seals will need to be removed before the internal snap ring can be accessed.



17. Once that snap ring is removed, remove the shaft seal (#2) through the pilot face of the housing. It may need to be pressed to tapped out.

18. If the front shaft bearing race is damaged or needs replaced, it will need to be pulled out using a bearing puller.

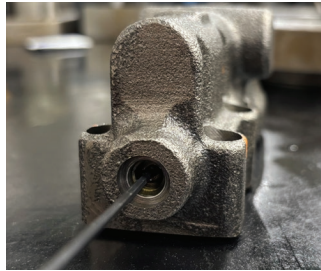


P1M CONTROL DISASSEMBLY

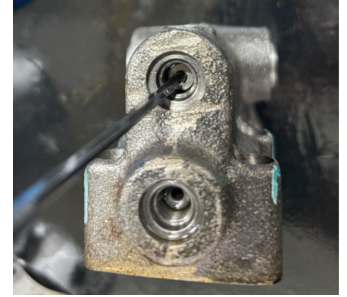
“PC”, “LS”, “LB”, “RC” Control



1. Remove the compensator from the pump housing by unscrewing the four screws (#16) holding the compensator to the pump housing.
2. Remove cover plate (#8) by unscrewing the screws (#9) holding it to the compensator housing (#1)
3. Unscrew and remove the hex plugs (#15) from the control housing.
4. For the “PC” control, remove the Pmax bore plug (#7) and O-ring (#6) assembly, inner spring (#5), outer spring (#4), spring retainer (#3), and control spool (#2) from the Pmax control bore. The components may need to be pushed out by pushing on the control spool. Use a small allen wrench that fits in the hole on the side of the spool so that when pushing out the control housing bore is not scratched.
5. Remove the O-ring (#6) from the Pmax bore plug (#7).



6. For the “LS”, “LB”, and “RC” controls, in addition to removing the “PC” control components in step #3, also remove the pressure differential components from the pressure differential bore. This includes the differential bore plug (#25) assembly, inner spring (#22), outer spring (#21), spring retainer (#20), and differential spool (#19). Again, the components may need to be pushed out, so use a small allen wrench that fits in the hole on the side of the spool so that when pushing out the control housing bore is not scratched.
7. For the “LS”, “LB”, and “RC” controls, remove the O-ring (#24) and back up rings (#23) from the differential bore plug (#25)
8. For the “LB” control, the bleed orifice (#19) can also be removed from the differential bore.
9. Remove the three O-rings (#14) from the bottom of the control housing face.



P1M CONTROL DISASSEMBLY

“FD” Control



1. Remove the control from the pump housing by unscrewing the four screws (#16) holding it to the pump housing.
2. Unscrew the solenoid coil cap (#5) and remove the cap, O-ring (#4), and the coil (#3) from around the solenoid tube (#2)
3. Unscrew the solenoid tube from the control housing (#1) and remove the O-ring from the solenoid tube.
4. To access and remove orifice (#17), unscrew hex plug (#15) from the control housing.
5. Unscrew the Pmax adjustment locknut (#10)
6. Remove the control cover (#11) by unscrewing the two screws (#9) holding it to the control housing and then by unscrewing it from the adjustment guide (#13).
7. Remove the control adjustment screw (#13) and O-ring (#12) assembly, spring (#8), and spool (#7) from the control housing bore.
8. Remove the three O-rings (#14) from the bottom of the control housing face.

“ED” Control



1. Unscrew the coil cap (#13) and remove the cap, O-ring (#12), and coil (#11) from around the solenoid tube (#10).
2. Unscrew the solenoid tube from the control sleeve (#16).
3. Unscrew the control sleeve assembly from the pump housing and remove the control spool (#9) assembly that includes the shims (#8) and threshold spring (#7).
4. Remove the control sleeve O-ring (#15) from the control sleeve.
5. Remove the feedback spring guide (#2) and feedback spring (#1) from the pump housing control bore. For the max default option, remove the max default spring (#3) and max default spring seat (#4) from the feedback spring guide.

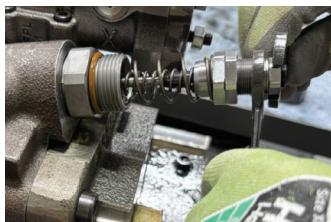
P1M CONTROL DISASSEMBLY

“TL” Control

1. Unscrew the torque limiter cap (#24) from the torque limiter control bore sleeve (#16).



2. Unscrew the locknut (#23) from the torque limiter set screw (#22) and unscrew the torque limiter set screw from the torque limiter outer spring adjustment guide (#18).



3. Next, in order to gain access to the tension rod retainer (#20), the outer spring adjustment guide (#18) will need to be compressed and held in place. This can be done by using a tool that screws into the torque limiter sleeve (#16) M27x1.5 threads and a pin to hold the guide in the compressed condition. Tool details can be found on page 38.

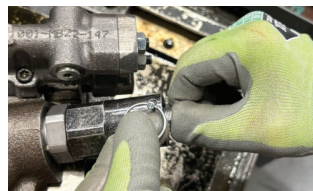


4. Remove the tension rod retainer (#20) from the tension rod (#4). It cannot be removed without being deformed, so it will not be able to be re-used once removed.



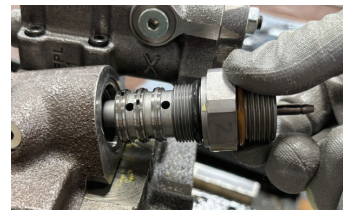
5. Next, the pin can be removed from the compression tool, and the adjustment guide assembly can be removed. CAUTION: When removing the pin from the tool in order to decompress the springs, hold the

adjustment guide assembly in place, and then slowly release allow the springs to decompress. If the decompression is not controlled and releases too fast, the hold down pins (#21) can shoot out. Once the springs and guide assembly have decompressed, the outer spring adjustment guide assembly, consisting of the adjustment guide (#18), hold down pins, and locknuts (#19) can be removed.

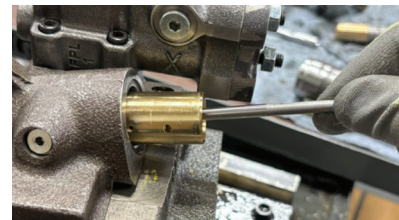


6. Remove the outer spring (#12), inner spring guide (#17), inner spring (#13), outer spring guide (#11), and control spool (#10) from inside the torque limiter sleeve.

7. Unscrew and remove the torque limiter sleeve assembly from the pump housing control bore. The assembly consists of the torque limiter sleeve (#16), piston rings (#8) and O-rings (#9 & #15). Be careful not to damage the three piston rings on the sleeve during removal from the control bore.



8. Remove the tension rod (#4) and torque limiter control piston (#14) assembly from the pump housing control bore.



9. If desired, the tension rod and torque limiter control piston assembly can be disassembled. First, remove the snap ring (#7) from inside the control piston. Then the tension rod, with the washer (#6), spherical seat (#5), spring (#1), ball (#2), and coupling (#3), can be removed from the control piston.

P1M ASSEMBLY INSTRUCTIONS

Notes:

1. Before starting, make sure all components have been thoroughly cleaned and are free of particle contamination.
2. Any seals (including the shaft seal) or O-rings that were removed or exposed during the disassembly process should be replaced.
3. Do not use bearing grease during installation. It does not dissolve in hydraulic fluid and may plug orifices or filters in the system. Clean hydraulic fluid or petroleum jelly is preferred to lubricate and adhere seals and O-rings during assembly. NOTE: For fluids other than petroleum-based hydraulic oil, ensure they are compatible with petroleum jelly. If they are not compatible, then another product should be used on the seals and O-rings instead.
4. See exploded views for proper torques.

Assembly Procedures:

1. For the single shaft seal option, install the inner snap ring (#1) into the inner groove in the housing (#3). Ensure the snap ring is fully engaged into the groove.



2. Insert the shaft seal (#2) into the housing through the pilot face with the seal lip facing down. Make sure shaft seal is pre-lubricated with some hydraulic fluid. Lightly tap down on the shaft seal if necessary, until it is completely below the outer snap ring groove.



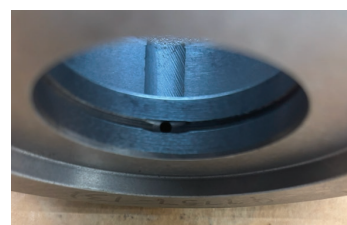
3. Install the outer snap ring (#1) into the shaft seal bore snap ring groove. Ensure the snap ring is fully engaged into the groove.



4. For dual shaft seal option, there is only a single inner snap ring (#1). Install it first, then install the inner shaft seal (#2) from the inside of the pump housing with the lip facing the proper direction. Then install the second shaft seal (#2) into the housing through the pilot face. This time the seal lip should be facing up out of the housing. Make sure shaft seal is pre-lubricated with some hydraulic fluid.



Note: Make sure a dual shaft seal housing is being used. It will have a weep hole machined from the bottom of the housing to in between the two shaft seals as shown in the pictures.



5. If the front shaft bearing (#7) race was removed during disassembly, press a new front shaft bearing race into the housing. Make sure the race is fully pressed in. It should be completely recessed into the housing.



6. Install cam/swashplate bushings (#10) by placing them into the pockets in the housing and fixing them to the housing via the bushing screws (#11). Screws come with threadlocking adhesive, so don't re-use existing screws. Make sure hydraulic fluid is applied to both sides of the bushings before installing. Ensure screws are properly torqued. Be careful not to over torque, which could round the hex.

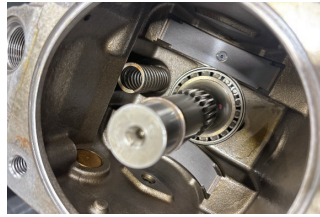


P1M ASSEMBLY INSTRUCTIONS

7. If the shaft (#9) and front bearing (#7) are not being reused, press the shaft into the front shaft bearing cone.



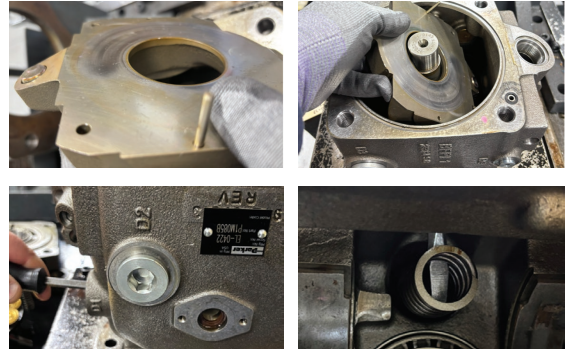
8. Place the shaft-bearing assembly into the housing so that the shaft bearing sits snugly in the race. Place bias spring (#8) into its recessed pocket of the housing as shown in the picture below.



9. If either the housing (#3), port block (#27), front bearing (#7), rear bearing (#23), or shaft (#9) are not being reused, use a shim gauge and measure the shaft height with respect to the housing. This is dimension "H" shown on page 37. Ensure the shaft is fully seated to the roller bearing race before measuring. Record the measurement in order to select the proper shim thickness later in the assembly procedure.



10. If a new cam/swashplate (#12) is being used, install the cam button (#13) into cam button pocket. Install the cam assembly into the housing by sliding it down at an angle. The cam must go down under the lip inside the housing and the cone on the back of the cam must be fully engaged with the bias spring. In order to get the edge of the cam below the lip inside the housing and allow the cam to sit flush on the cam bearings, compress the bias spring so that there is enough room for the cam to go under the lip in the housing and for the nose on the back of the cam to be fully engaged with the bias spring. It may be easiest to stick a screwdriver through the D1 case drain port like shown in the pictures above.



Cam should sit on the bushings and be able to be swiveled while feeling some resistance from the bias spring. Check bias spring to ensure seated and riding on the cone on the back of the cam and did not get dislodged during assembly.



Look through the control bore to verify the cam button is oriented properly such that the flat surface is facing up.

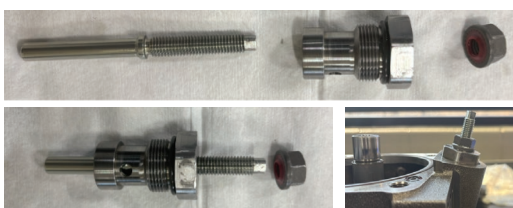


11. If the pump uses the torque limiter "TL" control, follow the "TL" Control Assembly instructions using the torque limiter control piston (#14); otherwise, install the standard control piston (#14) into the control bore, closed end first. The closed end should be engaged with the flat surface of the cam button.
12. If the pump has the electronic displacement control or torque limiter control, refer to those sections of the Control Assembly instructions before proceeding to the next step.

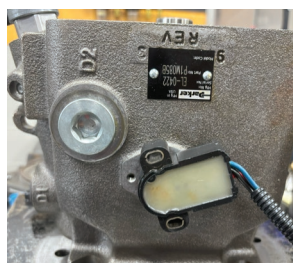


P1M ASSEMBLY INSTRUCTIONS

13. For configurations with the maximum displacement stop, install O-ring (#15) around the max displacement stop control bore plug (#16). Then insert max displacement adjustment screw (#30) into the control bore plug and screw it into the control bore plug. Next, screw in the control plug assembly into the control bore of the housing and torque properly. Then screw the seal nut (#31) onto the displacement adjustment screw and torque properly once desired displacement is set. The adjustment will not be completely sealed until the seal nut is torqued, so there may be some leakage while adjusting the max displacement stop.



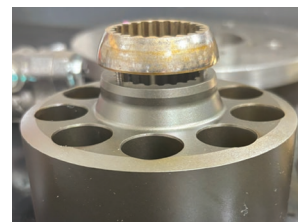
14. If there is no control bore control, place O-ring (#15) around the control bore plug (#16), screw it into the control bore, and torque properly.
15. If the pump has a displacement sensor, place the sensor seal (#38) on one side of the sensor connecting piece (#39) and the sensor spacer (#40) on the other side of the connecting piece as shown in the exploded view. Then insert the connecting piece assembly into the sensor (#41) and install the sensor assembly into the housing such that the orientation of the connecting piece engages with the post (#37) that is fixed to the cam. This can be visually verified by looking into the housing.



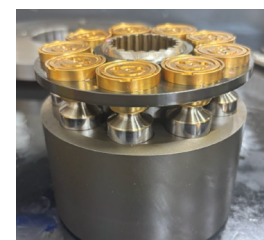
Once the sensor is engaged, place the two washers (#42) and lock washer (#43) onto the screws (#44) in the order shown by the exploded view and rotate the sensor so it can be screwed into place torquing the screws properly. Make sure the sensor is pointing as straight up as possible and is not at an angle.



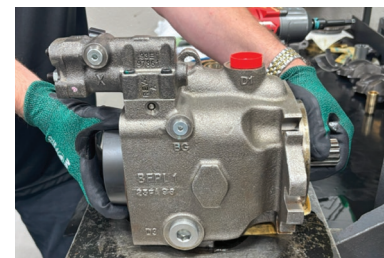
16. Place the spherical washer (#19) on the barrel assembly (#20) pins such that it is centered on the pins.



17. With the retainer (#18) oriented as shown in the picture, place a piston (#17) in each of the retainer holes, and carefully place the completed piston-retainer assembly into the barrel. Lubricate the top of the piston shoes with hydraulic fluid.



18. Carefully install the rotating group (piston and barrel assembly) into the housing and onto the shaft. It is easiest to do this by turning the housing on its side.



When turning the housing and when inserting the barrel assembly into the housing, make sure the shaft is being held in place so it does not come loose. When installing the barrel, it may have to be rotated slightly in order for the barrel splines to align with and slide over the shaft splines. Once it is installed on the shaft, make sure that it is fully engaged and all components in the assembly are seated correctly. Once properly installed, the housing can be stood up right again. Make sure the shaft is still being held in place when standing up the housing, so that the shaft does not come loose.

19. Next, if the rear shaft bearing (#23) race was removed during disassembly, press a new rear shaft bearing race into the port block (#27).



P1M ASSEMBLY INSTRUCTIONS

If either the housing (#3), port block (#27), front bearing (#7), rear bearing (#23), or shaft (#9) were replaced, a new rear bearing shim (#21) may need to be used, so place the rear shaft bearing into the race and using a shim gauge, measure the rear bearing race height. This is dimension "C" shown on page 37. Ensure the gauge is all the way down on the port block. Record that value, add it to the value recorded in Step #9, and select the appropriate shim from the shim chart on page 37.



20. Next, place the rear shim (#21) around the end of the shaft and then place the rear shaft bearing (#23) over the end of the shaft on top of the shim. Select the appropriate shim thickness based on the shim chart and previously measured shaft height from Step #13.



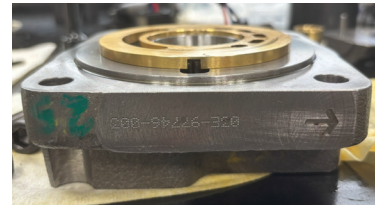
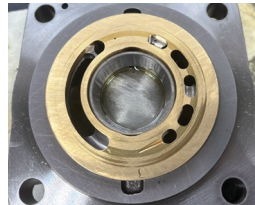
21. Install port plate locating pin (#25) into the port block (#27)



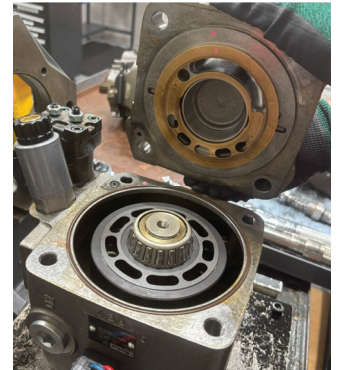
22. Lubricate and install the port block O-ring (#24) and the communication port O-ring (#26) into their appropriate locations.



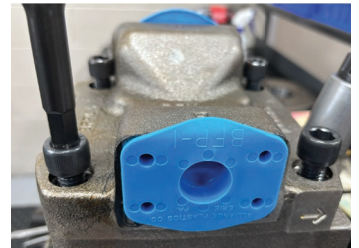
23. Install the port plate (#22) onto the port block such that the slot in the port plate fits around the locating pin. Make sure the port plate is installed such that the bleed notches are facing up like shown in the picture below. Ensure the port plate is seated all the way down on the port block such that no space exists between the port block and the back of the port plate.



24. Place the port block sub-assembly onto the housing. Be sure to orient the port block such that the housing communication port hole and port block communication port hole are aligned.

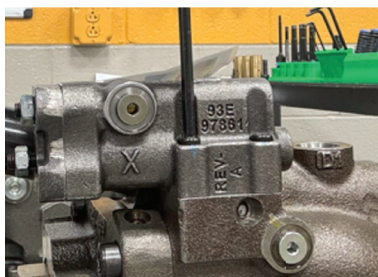


25. Once the port block is properly seated on the housing, install the port block socket head cap screws (#28) and torque properly. Be sure to torque the bolts in an X pattern so that the port block tightens evenly. After the fourth bolt is torqued, return to the first bolt and verify that it is still torqued to the appropriate level.



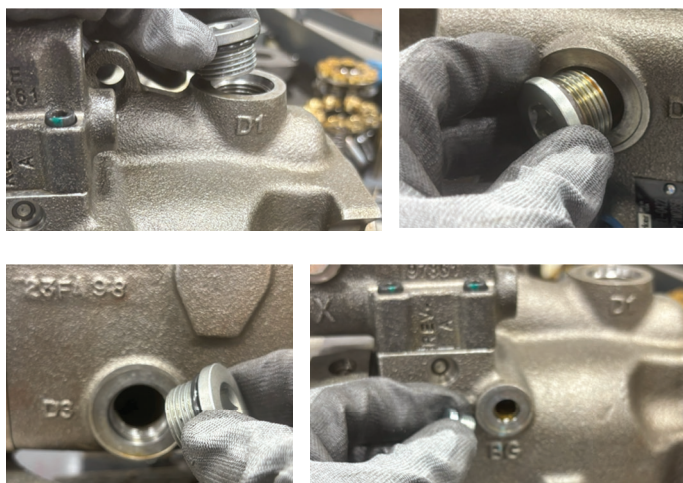
P1M ASSEMBLY INSTRUCTIONS

26. Install the control pad control (#29) to the pump housing by screwing in the four screws (Item #16 in the controls section). Don't forget to make sure the three control pad O-rings (Item #14 in the controls section) are in their proper positions on the control mating surface. Torque the screws in an X pattern and return to first screw to torque it again after all four have been properly torqued.



28. For pumps with thru-drive, install O-ring (#32) on the port block and insert coupling (#33) into the port block and around the end of the shaft. Make sure the coupling splines are fully engaged with the splines on the end of the shaft. For pumps with an SAE-C thru-drive, install the adapter block (#34) onto the port block via the four mounting screws (#35). Torque in an X pattern, going back to the first screw after all four are torqued. Next, install O-ring (#36) onto the adapter block.

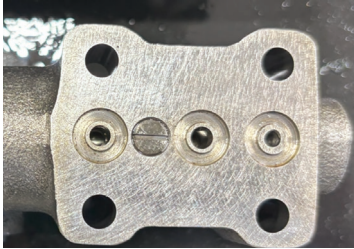
27. If the case drain (#4) and outlet gauge port (#5) plugs were removed during disassembly, they will need to be re-installed. The case drain ports are labeled D1, D2, & D3. The outlet gauge port is labeled BG. Install new O-rings around the plugs and screw the two case drain plugs into the two unused case drain ports. Based on pump installation orientation, the upper most case drain port should be used as the case drain. Screw the gauge port plug into the BG port if the gauge port is not going to be used. NOTE: The P1M-028 does not have a gauge port.



P1M CONTROL ASSEMBLY

Pressure Compensator “PC” Control

1. Install O-ring (#13) onto the orifice plug (#12). Install the orifice plug into the bottom of the compensator. Make sure the slot is oriented per the picture (+/- 15 degrees).
5. Assemble the outer spring guide (#3), outer spring (#4), and inner spring (#5) and insert them into the control housing bore in the orientation shown in the picture.



2. Insert the Pmax spool (#2) into the control housing bore in the orientation shown in the picture.



3. Install hex plug (#15) into compensator housing (#1) and torque properly.



4. Install O-ring (#6) over Pmax bore plug (#7).



6. Insert the Pmax bore plug (#7) and O-ring assembly into the control housing bore in the order and orientation as shown in the picture. The plug may have to be pushed in with some force so that it's not sticking out of the control bore.



7. Place the compensator cover (#8) on the control housing, screw in the four cover mounting screws (#9), and torque properly. Torque in an X pattern and after all four screws are torqued, go back to the first screw and torque it again.



P1M CONTROL ASSEMBLY

8. Install the Pmax adjustment screw (#11) into the Pmax hole in the compensator cover until it comes in contact with the Pmax bore plug.



9. Screw the locknut (#10) onto the adjustment screw.



10. Apply a thin film of oil or petroleum jelly to the three control interface O-rings (#14), and install them in three ports on the bottom of the compensator housing face.



11. After installing the control on the pump and adjusting the compensator to the desired pressure, torque the locknut properly. To adjust the pressure, turn the adjustment screw clockwise to increase and counterclockwise to decrease.

P1M CONTROL ASSEMBLY

Load Sense “LS” & “LB” Controls

1. Follow Step #1 of the “PC” Control assembly instructions.
2. Install hex plugs (#15) into compensator housing (#1) and torque properly.
7. Assemble the differential spring guide (#20), differential outer spring (#21), and differential inner spring (#22), and install them into the differential bore of the control housing as shown in the picture.



3. If the X-port plug (#17) was removed during disassembly, install it into either X-port (whichever side is not being used to connect to the load sense line) on the compensator housing (#1) and torque properly.
4. For the “LB” option, install set screw orifice (#18) into the differential bore and torque properly. Location shown in Figure 1.
8. Install the two back-up rings (#23) and O-ring (#24) onto the differential spring plug (#25). The O-ring should go in between the two back-up rings.

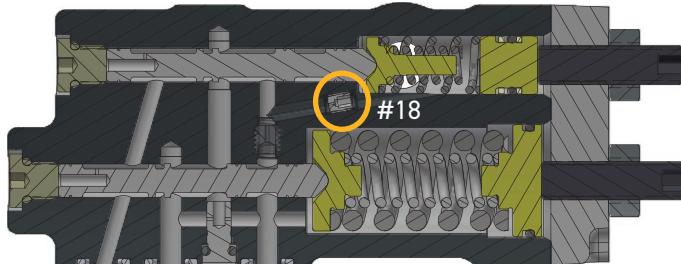


Figure 1



5. Follow Step #2-6 of the “PC” Control assembly instructions
6. Install the differential spool (#19) into the differential bore in the orientation shown in the picture. Make sure the correct differential spool is chosen. The load sense spool does not have holes drilled on each end like the remote compensator spool does.
9. Follow Steps #7 & 8 of the “PC” Control assembly instructions. Then install the differential adjustment screw (#11) into its hole in the compensator cover as shown in the picture until it comes in contact with the differential plug.



P1M CONTROL ASSEMBLY

10. Thread the locknuts (#10) onto the Pmax and differential adjustment screws, and after adjusting the pressure compensator and load sense differential to the desired settings, torque the locknuts properly.



11. Follow Step #10 of the "PC" Control assembly instructions.
12. After installing the control on the pump and adjusting the compensator and the differential to the desired pressures, torque the locknuts properly. To adjust the pressures, turn the adjustment screws clockwise to increase and counterclockwise to decrease.

Remote Compensator "RC" Control

1. Follow Steps #1-5 of the "LS" Control assembly instructions steps omitting Step #4.

2. Install the remote differential spool (#20) into the differential spool bore in the orientation shown in the picture. Make sure the correct differential spool is chosen. The remote spool has holes drilled on each end to provide the orificing function as shown in the picture.

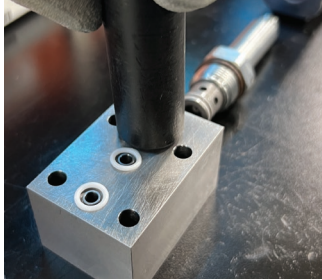


3. Follow Steps #7-12 of the "LS" Control assembly instructions.

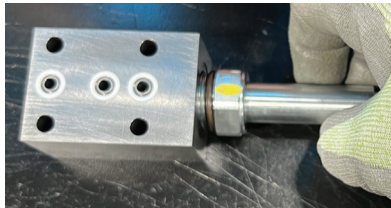
P1M CONTROL ASSEMBLY

Unload “PU” & “LU” Controls

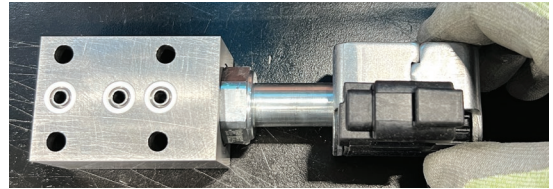
1. Apply a thin film of oil or petroleum jelly to the three control interface O-rings (#2), and install them in three ports on the bottom of the unload back.



2. Screw in the cartridge valve (#4) into the unload block (#1) and torque properly.



3. Place the coil (#3) over the cartridge valve, screw on the cartridge valve nut (#5) and torque properly.



Electronic Fan Drive “FD” Control

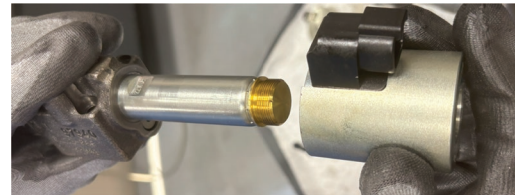
1. If hex plug (#18) or set screw (#6) were removed during disassembly, then install them into their respective control housing (#1) locations as shown in the exploded view on page 14. and torque properly.
2. Install set screw orifice (#17) and hex plug (#15) in the control housing and torque properly.



3. Install the solenoid tube (#2) into the control housing bore in the location and orientation shown on the exploded view and torque properly.



4. Place the coil (#3) over the tube in the orientation shown on the exploded view. Then place the coil O-ring (#4) around the tube, screw the coil cap (#5) onto the tube. Use channel locks and tighten the cap until it is snug to the coil. NOTE: The coil should be rotated such that the connector is on top as shown in the exploded view.



P1M CONTROL ASSEMBLY

5. Install the control spool (#7) into the control bore in the orientation shown in the picture, and then install the spring (#8) into the control bore.



6. Install O-ring (#12) over pressure adjustment guide (#13) and install the adjustment guide assembly into the control bore.



7. Spin the control cover (#11) onto the adjustment guide threads until the cover is flush with the control housing. Then screw in the two cover mounting screws (#9), and torque properly.



8. Thread the locknut (#10) onto the pressure adjustment screw



9. Apply a thin film of oil or petroleum jelly to the three control interface O-rings (#14), and install them in three ports on the bottom of the compensator housing face.



10. After installing the control on the pump and adjusting the compensator to the desired pressure, torque the locknut properly. To adjust the pressure, turn the adjustment screw clockwise to increase and counterclockwise to decrease.

P1M CONTROL ASSEMBLY

Electronic Displacement “ED” Control

1. For the max default control option, place the max default spring (#3) into the max default spring seat (#4), and then place them in the max default spring guide (#2).



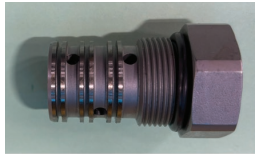
2. Place the max default spring guide subassembly or min default spring guide (#2) (depending on which option is being assembled) into the feedback spring (#1) as shown in the picture and place them inside the control piston in the control bore.



3. Install the control sleeve set screw (#6) into the control sleeve (#16) and torque properly.



4. Install the control sleeve O-ring (#15) onto the control sleeve.



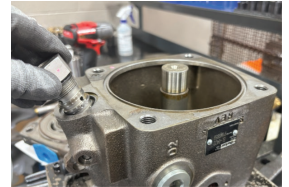
5. Next, install the 3 piston rings (#5) into their respective slots on the control sleeve. It may be easiest to make special tools like shown in the picture below that allows the rings to more easily slide into place. Each tool has a different depth to correspond with each piston ring slot distance. See Assembly Tools section for details.



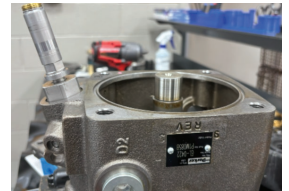
6. Place the six shims (#8) and threshold spring (#7) onto the control spool (#9) and insert the control spool into the control sleeve. Be sure to use the correct spool. The control max default spool has the indentation groove at the end as shown in the picture below as well as the ED exploded view. NOTE: Based on performance testing, one or two more shims may need to be added in order to get the saturation (full stroke) current within it's allowable range of 1150-1220 mA for the 12VDC option and half of that for the 24VDC option.



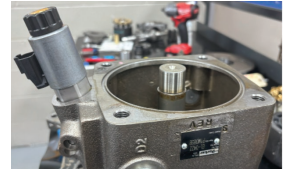
7. Install the control sleeve assembly into the control bore. When installing the control sleeve (#16), start it in at angle and push down in a circular motion so that the piston rings don't get caught and come out of their grooves. Once the sleeve is in far enough so that the threads are touching the control bore threads, the sleeve can be screwed all the way in and torqued properly.



8. Screw the solenoid tube (#10) into the control sleeve and torque properly.



9. With the coil connector properly oriented, Place the coil (#11) over the tube, place the coil O-ring (#12) over the solenoid tube, screw the coil cap (#13) onto the solenoid tube. Use channel locks and tighten the cap until it is snug to the coil.



P1M CONTROL ASSEMBLY

Torque Limiter “TL” Control

1. Layout the parts as shown the picture.



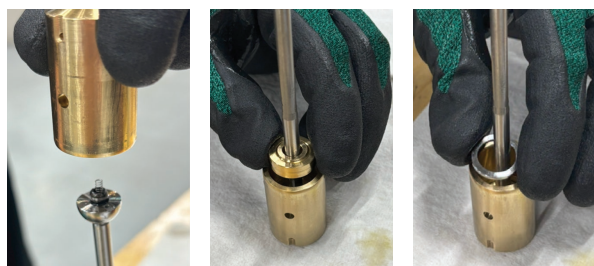
2. Insert the coupling (#3) into the tension rod (#4).



3. Insert the ball (#2) into the coupling and then the spring (#1) into the coupling around the ball.



4. Place the control piston (#14) over the tension rod assembly, and then flip over the assembly and place the spherical seat (#5) and washer (#6) around the tension rod and into the control piston.



5. Install the tension rod retainer (#7) around the tension rod and into the groove into the control piston. Make sure it is completely within the groove.



6. Install the tension rod control piston assembly into the pump housing control bore.



7. Next, place O-ring (#9) and O-ring (#15) around their respective ends of the control sleeve (#16). Install the three piston rings (#8) into their respective slots on the control sleeve. Refer to Step #5 of the “ED” Control Assembly instructions for the easiest method to install the rings. Install the control sleeve assembly around the tension rod and into the control bore. When installing the control sleeve, push down in a circular motion so that the piston rings don't get caught and come out of their grooves. Once the sleeve is in far enough so that the threads are touching the control bore threads, the sleeve can be screwed all the way in and torqued properly.

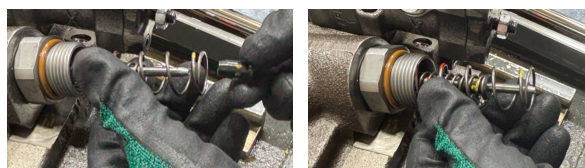


8. Install the control spool (#10) and then the outer spring guide (#11) over the tension rod and into the control sleeve in the orientation shown in the picture.



9. Select the appropriate springs based on the pump size and desired torque limiter setting range, and install the inner spring (#13) over the tension rod and inside the outer spring guide. Install the outer spring (#12) over the tension rod and around the outer spring guide.

10. Install the inner spring guide (#17) around the tension rod and into the inner spring.

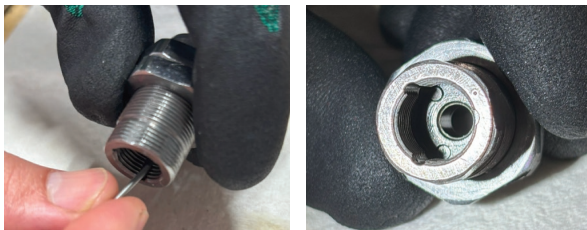


P1M CONTROL ASSEMBLY

11. Next, get the adjustment guide (#18), hold down pins (#21), and lock nuts (#19).

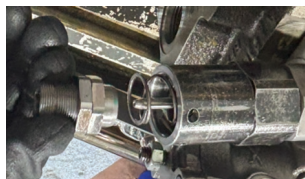
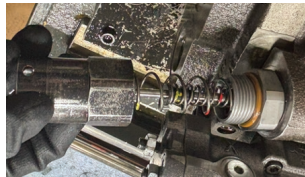


Thread the locknuts onto the adjustment guide and insert the hold down pins into their respective slots inside the adjustment guide. The pins should all the way into the guide like shown in the picture.



12. In order to install the adjustment guide retainer, compress and hold the springs. It may be easiest to use a tool that threads onto the control sleeve like shown in the picture. Tool details can be found on page 38.

Once the tool is in place, install the adjustment guide assembly into the outer spring.



Push in the adjustment guide assembly to compress the springs until the end of the tension rod is exposed such that the groove in the tension rod where the adjustment guide retainer (#20) sits is accessible. Insert a locking pin in the tool to hold the springs and guide assembly in compression.



13. Install the adjustment guide retainer into the groove in the tension rod. Make sure it is completely in the groove.



14. While holding the adjustment guide in compression, remove the pin or whatever mechanism was used to hold the adjustment guide in compression. Slowly, allow the springs to decompress. CAUTION: If the springs decompress too quickly, the hold pins could be dislodged from their proper location. Unscrew and remove the hold down tool that threaded into the torque limiter control sleeve.



15. Thread inner spring adjustment locknut (#23) onto the inner spring adjustment screw (#22), and then thread the inner spring adjustment screw into the out spring adjustment.



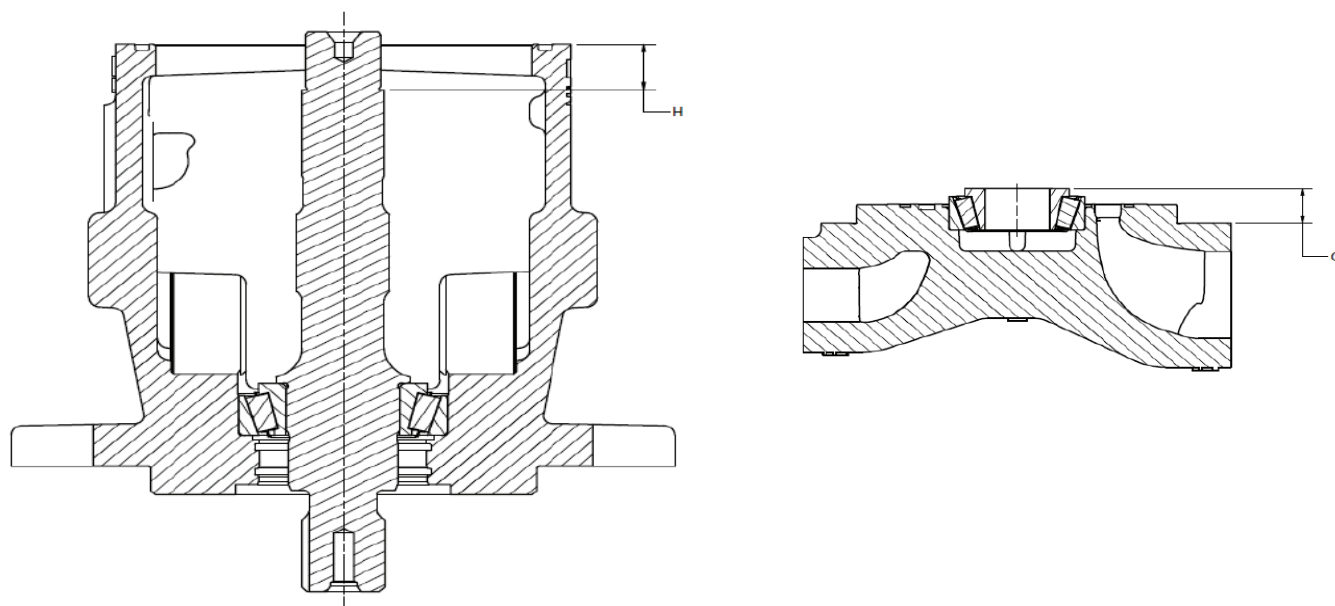
16. Install the torque limiter cap (#24) onto the torque limiter control sleeve. It does not need to be torqued at this time.



17. After the pump is installed, the cap will need to be removed to access the setting adjustments. Set the inner spring first by turning the inner spring adjustment screw (#22) clockwise to increase the setting. Once the desired setting is reached, properly torque the locknut (#23). Then set the outer spring by turning the outer spring adjustment guide (#18) clockwise to increase the setting. Once the desired setting is reached, properly torque the locknut (#19).

18. After the desired settings have been reached and the locknuts properly torqued, reinstall the torque limiter cap over the torque limiter assembly, thread it onto the torque limiter control sleeve, and torque properly.

P1M BEARING SHIM SELECTION



P1M Shim Thickness Selection Table			
P1M-028-085		P1M-105	
Shim Thickness (mm)	Color Coding	Shim Thickness (mm)	Color Coding
2.88*	Green-Green-Green	4.16	Green-Green
2.80	Red-Red	4.08	Blue-Blue
2.72	Green-Green	4	Green-Black
2.64	Blue-Blue	3.92	Red-Black
2.56	Green-Black	3.84	Red-Green
2.48	Red-Black	3.76	Blue-Black
2.40	Red-Green	3.68	Blue-Green
2.32	Blue-Black	3.6	Blue-Red
2.24	Blue-Green	3.52	Black
2.16	Blue-Red	3.44	Green
2.08	Black	3.36	Red
2.00	Green	3.28	Blue
1.92	Red	3.2	Red-Red
1.84	Blue	3.12	Black-Black
1.76	Black-Black	3.04	Blue-Blue-Blue
1.68**	Red-Red-Red	1.68	Red-Red-Red
1.60**	Blue-Blue-Blue	1.60	Blue-Blue-Blue

*Only for P1M-065/073

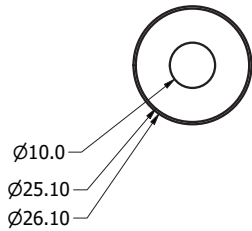
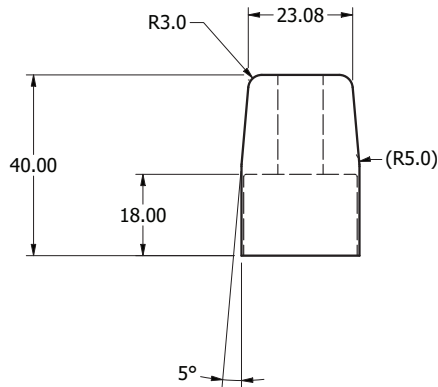
**Only for P1M-028 & 045

P1M Shim Selection Parameters (mm)					
Pump Size	28	45/054	65/073	85	105
Max Press Depth (D)	0.040	0.045	0.033	0.060	0.010
Max Gap (G)	0.060	0.060	0.067	0.040	0.090
Shim Tolerance (T)	0.020	0.020	0.020	0.020	0.020

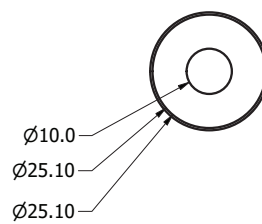
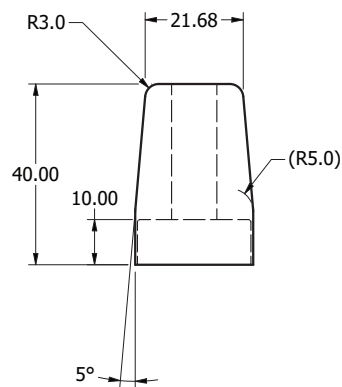
Select shim with thickness greater than $(H-C+T-G)$ and less than $(H-C+D)$
All checks MUST be made to 3 decimal places

ASSEMBLY TOOLS

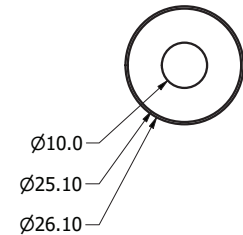
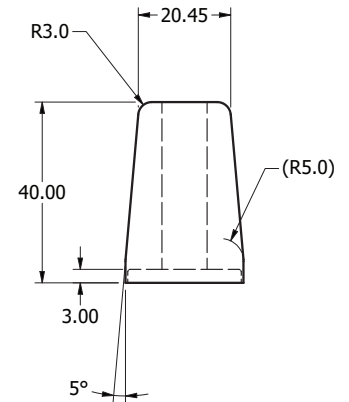
Control Sleeve Piston Ring Installation Tool



3600-00706-001

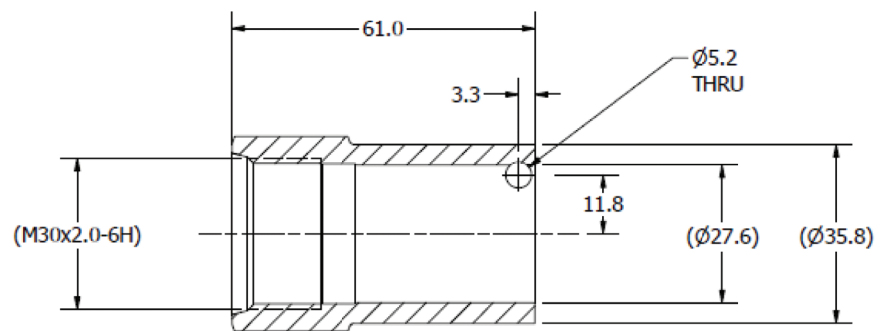
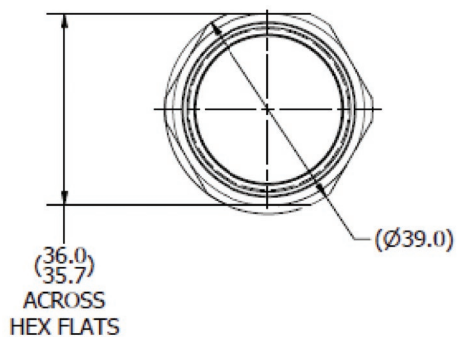


3600-00706-002



3600-00706-003

Torque Limiter Compression Tool



TROUBLESHOOTING

Component problems and circuit problems are often interrelated. An improper circuit may operate with apparent success but will cause failure of a particular component within it. The component failure can be the effect, not the cause of the problem. This general guide is offered to help in locating and eliminating the cause of problems by studying their effects.

Effect of Trouble	Possible Cause	Fault Which Needs Remedy
Noisy pump	Air in fluid	Leak in inlet line
		Low fluid level
		Turbulent fluid
		Return lines above fluid level
		Gas leak from accumulator
		Excessive pressure drop in the inlet line from a pressurized reservoir
		Inlet line strainer acting as air trap
	Cavitation in rotating group	Fluid too cold
		Fluid too viscous
		Fluid too heavy
		Shaft speed too high
		Inlet line too small
		Inlet strainer too small
		Inlet strainer too dirty
		Operating altitude too high
	Misaligned shaft	Inlet pressure too low
		Faulty installation
		Distortion in mounting
		Axial interference
		Faulty coupling
Erosion on barrel ports and port plate	Air in fluid	Excessive overhung loads
		Piston and shoe looseness or failure
	Cavitation	Bearing failure
		Incorrect port plate rotation
		Eroded or worn parts in the displacement control
		See noisy pump above
		See noisy pump above
		See noisy pump above
		See noisy pump above
Pressure shocks	Cogging load	Mechanical considerations
	Worn relief valve	Needed repairs
	Worn compensator	Replace
	Slow response in check valves	Replace or relocate
	Excessive decompression energy rates	Improve decompression control
	Barrel blow-off	Rotating group worn, excessive case pressure
Compensator instability	Line capacitance (line volume, line stretch, accumulator effects)	Change line size or lengths
		Add or remove hose
		Add orifice in load sense line
		Increase load sense differential pressure
		Install on-stroking orifice to reduce compensator response
	Outlet port check valve	Relocate check valve further from outlet port

TROUBLESHOOTING

Effect of Trouble	Possible Cause	Fault Which Needs Remedy
High wear in pump	Excessive loads	Reduce pressure settings
		Reduce speeds
	Contaminant particles in fluid	Improper filter maintenance
		Filters too coarse
		Introduction of dirty fluid to system
		Reservoir openings
		Improper reservoir breather
		Improper line replacement
	High Case Pressure	Case drain line not plumbed directly back to reservoir
		Case drain lines or fittings too small
	Improper fluid	Fluid too thin or thick for operating temperature range
		Breakdown of fluid with time/temperature/heating effects
		Incorrect additives in new fluid
		Destruction of additive effectiveness with chemical aging
	Improper repair	Incorrect parts
		Incorrect procedures, dimensions, finishes
	Unwanted water in fluid	Condensation
		Faulty breather/strainer
		Heat exchanger leakage
		Faulty clean-up practice
		Water in makeup fluid
Heating of fluid	Excessive pump leakage	Recheck case drain flow and repair as required
		Fluid too thin
		Improper assembly, port timing
	Relief valve	Set too low (compared to load or to compensator)
		Instability caused by back pressure, worn parts
	Compensator	Set too high (compared to relief)
		Worn parts
	Heat exchanger	Water turned off or too little flow
		Water too hot
		Fan clogged or restricted
		Efficiency reduced by mud or scale deposits
		Intermittent hydraulic fluid flow
	Reservoir	Too little fluid
		Improper baffles
		Insulating air blanket that prevents heat rejection
		Heat pickup from adjacent equipment

CONVERSIONS & FORMULAS

Conversion Factors

DEFINITION & UNIT

Displacement	$\text{in}^3/\text{rev} \times 16.387 = \text{cm}^3/\text{rev}$	$\text{cm}^3/\text{rev} \times 0.06102 = \text{in}^3/\text{rev}$
Flow	$\text{gpm} \times 3.78 = \text{L}/\text{min}$	$\text{L}/\text{min} \times 0.2642 = \text{gpm}$
Power	$\text{hp} \times 0.7457 = \text{kW}$	$\text{kW} \times 1.341 = \text{hp}$
Torque	$\text{lb-ft} \times 1.3567 = \text{Nm}$	$\text{Nm} \times 0.7376 = \text{lb-ft}$
Pressure	$\text{lbs}/\text{in}^2 (\text{psi}) \times 0.06895 = \text{bar}$ $\text{lbs}/\text{in}^2 (\text{psi}) \times 6.895 = \text{kPa}$	$\text{bar} \times 14.50 = \text{lbs}/\text{in}^2 (\text{psi})$ $\text{kPa} \times 0.1450 = \text{lbs}/\text{in}^2 (\text{psi})$
Weight	$\text{lb} \times 0.4536 = \text{kg}$	$\text{kg} \times 2.205 = \text{lbs}$
Force	$\text{lb} \times 4.448 = \text{N}$	$\text{N} \times 0.2248 = \text{lbs}$
Volume	$\text{in}^3 \times 16.387 = \text{cm}^3$	$\text{cm}^3 \times 0.06102 = \text{in}^3$
Area	$\text{in}^2 \times 6.452 = \text{cm}^2$	$\text{cm}^2 \times 0.1550 = \text{in}^2$
Length	$\text{in} \times 25.4 = \text{mm}$	$\text{mm} \times 0.03937 = \text{in}$
Temperature	$\frac{\text{degree F} - 32}{1.8} = \text{°C}$	$1.8 \times \text{°C} + 32 = \text{°F}$
Viscosity	$\text{cSt} \times 1.0 = \text{mm}^2/\text{sec}$ $\text{SSU} = \text{cSt} \times 4.25 + 14$	$\text{mm}^2/\text{sec} \times 1.0 = \text{cSt}$ $20 \text{ cSt} = 99 \text{ SSU}$

FLUID POWER FORMULAS

Pump output flow	U.S. gpm	$\frac{\text{rpm} \times \text{displacement (in}^3/\text{rev)} \times \text{volumetric eff.}}{231}$
Pump input torque	ft lbs	$\frac{\text{pressure (psi)} \times \text{displacement (in}^3/\text{rev)}}{24\pi \times \text{mech. eff.}}$
Pump input power	hp	$\frac{\text{rpm} \times \text{torque (ft-lbs)} \times 2\pi}{33000} = \frac{\text{flow (GPM)} \times \text{pressure (psi)}}{1714 \times \text{overall eff.}}$
Fluid motor speed	rpm	$\frac{231 \times \text{flow rate (U.S. gpm)} \times \text{volumetric eff.}}{\text{displacement (in}^3/\text{rev)}}$
Fluid motor torque	ft lbs	$\frac{\text{pressure (psi)} \times \text{displacement (in}^3/\text{rev)} \times \text{mech. eff.}}{24\pi}$
Fluid motor power	hp	$\frac{\text{rpm} \times \text{torque (ft-lbs)} \times 2\pi}{33000} = \frac{\text{flow (GPM)} \times \text{pressure (psi)} \times \text{overall eff.}}{1714}$
(Metric)		
Pump output flow	Lpm	$\frac{\text{rpm} \times \text{displacement (cm}^3/\text{rev)} \times \text{volumetric eff.}}{1000}$
Pump input torque	Nm	$\frac{\text{pressure (bar)} \times \text{displacement (cm}^3/\text{rev)}}{20\pi \times \text{mech. eff.}}$
Pump input power	kW	$\frac{\text{rpm} \times \text{torque (Nm)} \times 2\pi}{60000} = \frac{\text{flow (Lpm)} \times \text{pressure (bar)}}{600 \times \text{overall eff.}}$
Fluid motor speed	rpm	$\frac{1000 \times \text{flow rate (Lpm)} \times \text{volumetric eff.}}{\text{displacement (cm}^3/\text{rev)}}$
Fluid motor torque	Nm	$\frac{\text{pressure (bar)} \times \text{displacement (cm}^3/\text{rev)} \times \text{mech. eff.}}{20\pi}$
Fluid motor power	kW	$\frac{\text{rpm} \times \text{torque (Nm)} \times 2\pi}{60000} = \frac{\text{flow (Lpm)} \times \text{pressure (bar)} \times \text{overall eff.}}{600}$



WARNING - USER RESPONSIBILITY

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