Heavy Duty Hydrostatic Transmissions

Series 1 Variable Displacement Piston Pumps (ACA) and Motors (ACE) Fixed Displacement Motors (HHD)

Peak pressure 480 bar (7000 psi)
Displacement 64-125 cm³/r (3.9-7.6 in³/r)

EATON
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Heavy Duty Hydrostatic Transmissions
Features and Benefits

Drive shafts – a wide variety of options are available to suit every need.

High strength swashplates on variable pumps and motors – resist deflection under high load.

High strength cast iron housings – provide greater noise damping and wall strength.

High flow check valves in pumps – keep the system primed with minimal pressure drop.

Charge pumps on pumps – gerotor type, several displacement options are available to suit the needs of every application. All cast iron construction.

Cartridge shaft seal – lends itself to easy serviceability. Mechanical face seal design tolerates high speed and high case pressures.

Typical Applications
Construction
• Transit Mixer
• Road Roller
• Paver
• Motor Grader
• Loader
• Dozer

Material Handling & Utility
• Crane
• Sweeper
• Lift Truck

Agriculture
• Tractor
• Harvester
• Windrower
• Sprayer
• Planter

Industrial Applications
• Oil & Gas
• Marine

Variable Pump ACA

Variable Pump and Fixed Motor

Tandem Variable Pump
Heavy Duty Hydrostatic Transmissions

Features and Benefits

Variable Motor ACE

- **Bi-metal bearing plate** – has steel for high speed and pressure. Bronze provides greater bearing properties.
- **Valve plate** – hardened steel for long life.
- **End cover** – large passages minimizes losses. Both side and rear ports are available on Models 39 through 64 fixed motors.
- **C-Pad rear mount** – available on Models 39 through 64 variable pumps for tandem units or for a through shaft.
- **Relief valves** – pilot operated cartridge and fast acting direct types available.
- **Controls** – a wide variety of control options are available for pumps and motors to meet application needs.
- **Ports** – SAE code 61 and code 62 as well as o-ring boss ports are available.

Fixed Motor HDD

- **Advanced cylinder barrel design** – permits high speed and pressure.
- **Fixed clearance slipper hold down** – on Models 39 through 64 allows operation at high speed and reduces friction. Model 76 is a ball guide unit.
- **Pistons** – have long engagement with cylinder bore resulting in low leakage.
- **Hydraulic servo control** – provides low effort operation with low control pressure. Large servo pistons hold swashplate position and provide damping.
- **Large case drain ports** – minimize case back pressure.

Fixed Motor

Variable Motor
## Model Code

### ACA Series 1 Variable Pump

The following 33 digit coding system has been developed to identify standard configuration options for the Series 1 Hydrostatic Variable Displacement Pump. Use this model code to specify a pump with the desired features. All 33 digits of the code must be present to release a new product number for ordering.

### Pump Series
**ACA** – Hydrostatic - Heavy Duty Variable Pump

### Displacement
- **39** – 63.66 cm³/r (3.885 in³/r)
- **46** – 75.28 cm³/r (4.594 in³/r)
- **54** – 89.13 cm³/r (5.439 in³/r)
- **64** – 105.4 cm³/r (6.431 in³/r)
- **76** – 124.8 cm³/r (7.616 in³/r)

### Design Type
- **0** – Ball-Guide (Model 76)
- **1** – Series 1 (Models 39-64)
- **2** – Variable Displacement Pump

### Input Shaft
- **3** – (1.500) Diameter straight with (.3750) x (2.5) square key (Models 39-64)
- **4** – (1.750) Diameter straight with (.4375) x (3.0) square key (Model 76)
- **7** – 13 Tooth 8/16 pitch spline (Model 76)
- **14** – 14 Tooth 12/24 pitch spline (Models 33-64)
- **21** – 21 Tooth 16/32 pitch spline (Models 39-64)
- **22** – 21 Tooth 16/32 pitch spline with (3.22) extension (Models 46-64)
- **23** – 23 Tooth 16/32 pitch spline (Models 39-64)
- **24** – 23 Tooth 16/32 pitch spline with 3/8-24 UNF hole (Models 39-64)
- **25** – 21 Tooth 16/32 pitch spline with 3/8-24 UNF hole (Models 39-64)
- **27** – 27 Tooth 16/32 pitch spline (Model 76)

### Input Rotation
- **L** – Counterclockwise (Left-hand)
- **R** – Clockwise (Right-hand)

### Valve Plate
- **0** – Standard (V-groove)
- **1** – Propel

### Main Ports
- **A** – 25.4 (1.00) - Code 61 per SAE J518
- **B** – 25.4 (1.00) - Code 62 per SAE J518
- **C** – 103 bar (1500 lbf/in²)
- **D** – 138 bar (2000 lbf/in²)
- **E** – 172 bar (2500 lbf/in²)
- **F** – 207 bar (3000 psi)
- **G** – 241 bar (3500 psi)
- **H** – 276 bar (4000 psi)
- **J** – 310 bar (4500 psi)
- **K** – 345 bar (5000 psi)
- **L** – 379 bar (5500 psi)
- **M** – 414 bar (6000 psi)
- **N** – 448 bar (6500 psi)

### Control Option
**0B** – Shipping cover, with control feedback link

### Electro-proportional
**EJ** – Electronic proportional control 12 volt DC
**EK** – Electronic proportional control 24 volt DC
**FD** – Electronic proportional control, 12VDC, swash plate electronic sensor feedback, de-stroking valve
**FE** – Electronic proportional control, 24VDC, swash plate electronic sensor feedback, de-stroking valve
**SC** – Electric control 12 volt with swashplate feedback sensor, with electrical connectors DIN 43650

### Forward-Neutral-Reverse
**FR** – Forward-neutral-reverse control 12 volt DC with 2-pin weatherpack connector
**FS** – Forward-neutral-reverse control 24 volt DC with 2-pin weatherpack connector

### Hydraulic Remote
**HA** – Hydraulic remote 1.4-14.1 bar (20-205 psi)
**HB** – Hydraulic remote 1.4-14.1 bar (20-205 psi) with wide band neutral
**HC** – Hydraulic remote 3.1-14.5 bar (45-210 psi)
**HD** – Hydraulic remote 4.5-20.0 bar (65-290 psi)
**HF** – Hydraulic remote 4.5-20.0 bar (65-290 psi) with wide band neutral
**HG** – Hydraulic remote 4.5-20.0 bar (65-290 psi) with 12vdc (NC) destroke valve (non-manifold) with electrical connector (male only) per din 43650
**HH** – Hydraulic remote 11.0-32.4 bar (160-470 lbf/in²)
**HJ** – Hydraulic remote 3.1-14.5 bar (45-210 psi) with wide band neutral
**HK** – Hydraulic remote 4.5-20.0 bar (65-290 bar/ in²) with 12vdc (NC) destroke valve (non-manifold) with electrical connectors (male & female) per din 43650 for 6.0-10.0 (.24-.39) diameter cable

### Power Limiter Valve Setting
**Port A** (position 13) and **Port B** (position 14)

### Note: Options in bold fonts are commonly used.
The following 33 digit coding system has been developed to identify standard configuration options for the Series 1 Hydrostatic Variable Displacement Pump. Use this model code to specify a pump with the desired features. All 33 digits of the code must be present to release a new product number for ordering.

### Model Code
ACA Series 1 Variable Pump

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACA</td>
<td>Manual with (NC) destroke valve, (1) 12vdc with (1) 2 pin weatherpack connectors, no displacement limiter, with 0.33 (.013) control supply orifice</td>
</tr>
<tr>
<td>MZ</td>
<td>Manual with (NC) neutral lockout switch (wide band neutral) and destroke valve (manifold) 12vdc (NO) with 2 pin weatherpack connector</td>
</tr>
<tr>
<td>NA</td>
<td>Manual with destroke valve (manifold) 12vdc (NO) with 2 pin weatherpack connector</td>
</tr>
<tr>
<td>MB</td>
<td>Manual with wide band neutral and destroke valve 12vdc (NO), (non-manifold), no manual override, 2 pin weatherpack connector mounted connector down</td>
</tr>
<tr>
<td>MC</td>
<td>Manual with wide band neutral and 3/4-16UN plug in neutral lockout port</td>
</tr>
<tr>
<td>MD</td>
<td>Manual With (NC) neutral lockout switch (wide band neutral)</td>
</tr>
<tr>
<td>ME</td>
<td>Manual with neutral detent (wide band neutral)</td>
</tr>
<tr>
<td>MJ</td>
<td>Manual with destroke valve (manifold) 12vdc (NO) 3 pin weatherpack connector</td>
</tr>
<tr>
<td>MS</td>
<td>Manual with wide band neutral and 24vdc (NC) destroke valve (non-manifold) with electrical connectors (male &amp; female) per DIN 43650 for 4.5-8.0(18-31) diameter cable</td>
</tr>
<tr>
<td>MT</td>
<td>With wide band neutral and inching valve with seal</td>
</tr>
<tr>
<td>MU</td>
<td>Manual with wide band neutral, inching valve with seal and neutral detent</td>
</tr>
<tr>
<td>MV</td>
<td>With wide band neutral, inching valve with seal and neutral lockout switch (NC)</td>
</tr>
<tr>
<td>MW</td>
<td>Manual with destroke valve (manifold) 12vdc (NO) with 2 pin weatherpack connector</td>
</tr>
<tr>
<td>NW</td>
<td>Manual with (NC) neutral lockout switch (wide band neutral) and weatherpack (2) pin connector and destroke valve (manifold) 12vdc (NC) with 2 pin weatherpack connector</td>
</tr>
<tr>
<td>PA</td>
<td>Port plate, no control feedback link</td>
</tr>
<tr>
<td>RD</td>
<td>Remote electric with (NC) destroke valve, (3) 12vdc with (3) 2 pin weatherpack connectors, no displacement limiter, with 0.33 (.013) control supply orifice</td>
</tr>
<tr>
<td>RE</td>
<td>Remote electric with (NC) destroke valve, (3) 12vdc with (3) 2 pin weatherpack connectors, no displacement limiter, with 0.33 (.013) control supply orifice</td>
</tr>
<tr>
<td>RG</td>
<td>Remote electric with (NC) destroke valve, including 3,58 (.141) orifice, (3) 12vdc with (3) 2 pin weatherpack connectors, no displacement limiter, with 0.33 (.013) control supply orifice</td>
</tr>
</tbody>
</table>

Note: Options in bold fonts are commonly used.
Model Code

ACA Series 1 Variable Pump

The following 33 digit coding system has been developed to identify standard configuration options for the Series 1 Hydrostatic Variable Displacement Pump. Use this model code to specify a pump with the desired features. All 33 digits of the code must be present to release a new product number for ordering.

| ACA | 39 | 2 | 03 | 02 | L | 1 | A | C | C | EA | A | A | 2 | C | N | A | 1 | 0 | D | A | 15 | 0 | 0 | B |
|     |    |   |    |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

Note: Options in bold fonts are commonly used.

- RH – Remote electric with (NC) destroke valve including 3,18 (.125) orifice, (3) 12vdc with (1) 2 pin and (1) 4 pin weatherpak connectors, no displacement limiter, with 0.33 (.013) control supply orifice
- RJ – Remote electric with (NO) destroke valve including 3,58 (.141) orifice, (3) 12vdc with (3) 2 pin weatherpak connectors, no displacement limiter, with 0.33 (.013) control supply orifice
- RK – Remote electric with (NC) destroke valve, (3) 12vdc with wireleads, no displacement limiter, with 0.33 (.013) control supply orifice

**[Pressure Setting for Pressure Override]**

- 0 – None
- 1 – 196 bar (2850 lbf/in²)
- 2 – 136 bar (2000 psi)
- 3 – 172 bar (2500 psi)
- 4 – 207 bar (3000 psi)
- 5 – 241 bar (3500 psi)
- 6 – 276 bar (4000 psi)
- 7 – 310 bar (4500 psi)
- 8 – 345 bar (5000 psi)
- 9 – 379 bar (5500 psi)
- A – 414 bar (6000 psi)
- B – 362 bar (5250 lbf/in²)

**[Control Special Features]**

- 0 – No control special features
- 1 – Manual control lever with attachment holes located 66.7 (2.625) and 82.6 (3.25) from control shaft mounting hole
- 2 – Manual control lever with severe duty coils with boots for electronic proportional control
- 3 – Manual control lever with severe duty coils with weather-pack connector
- 4 – Manual control lever with control shaft mounting hole
- 5 – Manual control lever with control shaft mounting hole
- 6 – Manual control lever with control shaft mounting hole
- 7 – Manual control lever with control shaft mounting hole
- 8 – Manual control lever with control shaft mounting hole
- 9 – Manual control lever with control shaft mounting hole
- A – Manual control lever with control shaft mounting hole
- B – Manual control lever with control shaft mounting hole
- C – Manual control lever with control shaft mounting hole
- D – Manual control lever with control shaft mounting hole
- E – Manual control lever with control shaft mounting hole
- F – Manual control lever with control shaft mounting hole
- G – Manual control lever with control shaft mounting hole
- H – Manual control lever with control shaft mounting hole
- I – Manual control lever with control shaft mounting hole
- J – Manual control lever with control shaft mounting hole
- K – Manual control lever with control shaft mounting hole
- L – Manual control lever with control shaft mounting hole
- M – Manual control lever with control shaft mounting hole
- N – Manual control lever with control shaft mounting hole
- O – Manual control lever with control shaft mounting hole
- P – Manual control lever with control shaft mounting hole

**[Pressure Override]**

- 0 – None
- 2 – Internal Pressure Override
- 5 – Internal Pressure Override
- 8 – Manual control lever mounted parallel to the pump drive shaft towards the mounting flange
- 9 – Manual control lever mounted parallel to the pump drive shaft towards the mounting flange

- W – Manual control lever mounted 1 to 2 spline teeth from vertical with external torsion spring mechanism for neutral return
- Y – Manual control lever with two 1/4-28 UNF attachment holes located at 85.7 (3.375) and 98.4 (3.875) from control shaft mounting hole

**[Charge Pump]**

- 0 – Charge pump included
- 2 – Charge pump with integral pressure filter mounted on the -A- port side
- 3 – Charge pump with short element integral pressure filter mounted on the -A- port side and external discharge port for 7/8-14 UNF-2B SAE O-ring fitting with steel hex plug
- A – Charge pump with remote pressure filter ports on the -A- port side
- B – Charge pump with integral pressure filter mounted on the -B- port side
- C – Charge pump with J.Deere integral pressure filter mounted on the -B- port side. Diagnostic fitting included
- D – Charge pump with external discharge port for 7/8-14 UNF SAE O-ring fitting. With steel hex plug
- E – No charge pump

**[Control Supply Orifice]**

- P (pos. 17)
- Upper Servo (S1 pos. 18)
- Lower Servo (S2 pos. 19)
- 0 – None
- A – 0.71 (.028) Diameter
- B – 0.91 (.036) Diameter
- C – 1.12 (.044) Diameter
- D – 1.32 (.052) Diameter
- E – 1.45 (.057) Diameter
- F – 1.65 (.066) Diameter
- G – 1.85 (.073) Diameter
- H – 2.39 (.094) Diameter
- J – 2.59 (.102) Diameter

**[Ordering]**

- Note: Options in bold fonts are commonly used.
The following 33 digit coding system has been developed to identify standard configuration options for the Series 1 Hydrostatic Variable Displacement Pump. Use this model code to specify a pump with the desired features. All 33 digits of the code must be present to release a new product number for ordering.

### Model Code

ACA Series 1 Variable Pump

<table>
<thead>
<tr>
<th>ACA</th>
<th>39</th>
<th>2</th>
<th>03</th>
<th>02</th>
<th>L</th>
<th>1</th>
<th>A</th>
<th>C</th>
<th>C</th>
<th>EA</th>
<th>A</th>
<th>A</th>
<th>2</th>
<th>C</th>
<th>N</th>
<th>A</th>
<th>A</th>
<th>1</th>
<th>0</th>
<th>D</th>
<th>A</th>
<th>15</th>
<th>0</th>
<th>0</th>
<th>B</th>
</tr>
</thead>
</table>

#### Auxiliary Mounting

- **F** – Charge pump with external discharge port with 90 degree; 7/8-14 UNF; 37 degree flare tube fitting
- **G** – Charge pump with integral pressure filter and diagnostic fitting mounted on the -B- port side plus inlet gage port with hex plug
- **H** – Charge pump with remote pressure filter ports on -A- port side and inlet gage port on -B- port side
- **J** – Charge pump with integral pressure filter and diagnostic fitting; mounted on the -B- port side and external discharge port with 90 degree; 7/8-14 UNF; 37 degree flare; tube fitting
- **K** – Charge pump with remote pressure filter ports on the -B- port side and external discharge port with 90 degree; 7/8-14 UNF; 37 degree flare; tube fitting
- **L** – Charge pump with integral pressure filter and diagnostic fitting; mounted on the -B- port side and external discharge port with straight 7/8-14 UNF; 37 degree flare; tube fitting
- **M** – Charge pump with remote pressure filter ports on the -B- port side and external discharge port with straight 7/8-14 UNF SAE O-ring; 37 degree flare; tube fitting
- **P** – Charge pump with remote pressure filter ports on the -B- port side and external discharge port with straight 7/8-14 UNF-2B SAE O-ring fitting; with steel hex plug
- **S** – Charge pump with integral pressure filter and diagnostic fitting; mounted on the -B- port side and external discharge port for 7/8-14 UNF-2B SAE O-ring fitting; with steel hex plug
- **T** – Charge pump with external discharge port with straight 7/8-14 UNF SAE O-ring fitting with steel hex plug
- **U** – Charge pump with integral pressure filter; mounted on the -B- port side and external discharge port for 7/8-14 UNF-2B SAE O-ring fitting with steel hex plug
- **Y** – Charge pump with remote pressure filter ports on the -B- port side and external discharge port for 7/8-14 UNF-2B SAE O-ring fitting with steel hex plug
- **Z** – Charge pump with remote pressure filter ports on the -B- port side

#### Charge Pump Displacement

- **0** – No Charge Pump
- **1** – 13.9 cm³/r (0.85 in³/r)
- **2** – 17.4 cm³/r (1.06 in³/r)
- **3** – 21.0 cm³/r (1.28 in³/r)
- **4** – 27.9 cm³/r (1.70 in³/r)
- **5** – 34.7 cm³/r (2.12 in³/r)

**Note:** Options in bold fonts are commonly used.
Model Code
ACA Series 1 Variable Pump

The following 33 digit coding system has been developed to identify standard configuration options for the Series 1 Hydrostatic Variable Displacement Pump. Use this model code to specify a pump with the desired features. All 33 digits of the code must be present to release a new product number for ordering.

| ACA | 39 | 2 | 03 | 02 | L | 1 | A | C | C | EA | A | A | 2 | C | N | A | A | 1 | 0 | D | A | 15 | 0 | 0 | B |

Note: Options in bold fonts are commonly used.

20 2nd Displacement of Dual Element
0 – No Dual Element

27 Charge Pressure Rel Valve Setting
0 – None
D – 15 bar (220 psi) - Standard
E – 16 bar (240 lbf/in²)
F – 18 bar (260 lbf/in²)
G – 19 bar (280 psi)
H – 21 bar (300 lbf/in²)
J – 22 bar (320 lbf/in²)
K – 23 bar (340 psi)
L – 24 bar (350 lbf/in²)
M – 26 bar (380 lbf/in²)
N – 28 bar (410 lbf/in²)

28 Charge Pump Special Features
0 – No charge pump special features
A – Steel core charge pump gasket
B – Steel core charge pump gasket and 90 degree inlet fitting; 1 5/8-12 UN threaded end for 37 degree flare tubing (1.25 OD tubing; 1.25 ID hose)
J – Steel core charge pump gasket; needle bearing
M – Charge inlet manifold with charge relief valve
N – Steel core charge pump gasket and charge inlet manifold with charge relief valve
P – Charge inlet manifold with external discharge port for 7/8-14 UN SAE O-ring port and steel hex plug in inlet port

29 Special Pump Assembly Features
00 – No special features
05 – Bottom servo piston with 0.0 degree stop
11 – Both servo sleeves have 1/2-20 UNF-2B thread and steel hex bolts
12 – Bottom servo sleeve has 7/8-14 UNF SAE O-ring port with hex steel plug
13 – Model 76 shaft seal and grade 8 bolts in mounting flange to pump housing (models 54-64)
14 – Special thick section end cover gasket
15 – Rear pump unit for tandem pump assembly (no shaft seal)
18 – Hi-Speed rotating group (model 76)
32 – Both servo sleeves have 7/8-14 UNF SAE O-Ring ports and steel hex plugs
39 – Bottom servo piston with externally adjustable stop
40 – Both servo pistons with externally adjustable stops
53 – Model 76 shaft seal
58 – 1350 Series end yoke assembled to drive shaft (Pos 8.9 must be Code 40)
59 – 1310 Series end yoke assembled to drive shaft (Pos 8.9 must be Code 40)
67 – Metal case drain plug in both ports
79 – Rear pump unit for tandem pump assembly (no shaft seal), both servo pistons with externally adjustable stops
82 – Rear pump unit for tandem assembly (no shaft seal), top servo piston with externally adjustable stop
83 – Externally adjustable displacement stops set at 3.32 in³/rev (54.4cc/rev)

29 Paint and Packaging
0 – Painted primer blue (standard)
A – Painted finish black

32 Identification on Unit
0 – Standard

33 Design Code
A – A
B – B
## Model Code

### HHD Fixed Motor

The following 23 digit coding system has been developed to identify standard configuration options for the Series 1 Hydrostatic Fixed Displacement Motor. Use this model code to specify a motor with the desired features. All 23 digits of the code must be present to release a new product number for ordering.

<table>
<thead>
<tr>
<th>HHD</th>
<th>3</th>
<th>9</th>
<th>3</th>
<th>0</th>
<th>0</th>
<th>1</th>
<th>A</th>
<th>A</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19, 20</td>
<td>21</td>
<td>22</td>
</tr>
</tbody>
</table>

### Key:

**HHD** – Heavy Duty Hydrostatic Fixed Displacement Motor

**Displacement**
- 33 – 54 cm³/r (3.3 in³/r) at 15.5 deg. swashplate angle
- 39 – 64 cm³/r (3.9 in³/r) at 18 deg. swashplate angle
- 46 – 75 cm³/r (4.6 in³/r) at 18 deg. swashplate angle
- 54 – 89 cm³/r (5.4 in³/r) at 18 deg. swashplate angle
- 64 – 105 cm³/r (6.4 in³/r) at 18 deg. swashplate angle
- 76 – 125 cm³/r (7.6 in³/r) at 18 deg. swashplate angle

**Type**
- 3 – Fixed displacement motor

**Input Shaft**
- 01 – (1.50) Diameter straight with (.38) x (2.5) square key (models 39-64)
- 02 – (1.75) Diameter straight with (.44) x (3.0) square key (model 76)
- 06 – (1.50) Diameter straight with (.38) x (2.5) square key with 3/8-24 UNF x (.75) DP hole in end of shaft (models 39-64)
- 07 – (1.75) Diameter straight with (.44) x (3.0) square key with 3/8-24 UNF x (.75) dp hole in end of shaft (model 76)
- 13 – 13 Tooth 8/16 pitch spline (model 76)
- 14 – 14 Tooth 12/24 pitch spline (models 39-64)
- 21 – 21 Tooth 16/32 pitch spline (models 39-64)
- 23 – 23 Tooth 16/32 pitch spline (models 39-64)
- 24 – 23 Tooth 16/32 pitch spline with (1.92) extension (models 39-64)
- 25 – 23 Tooth 16/32 pitch spline with 3/8-24 UNF x (.75) DP hole in end of shaft (models 39-64)
- 27 – 27 Tooth 16/32 pitch spline (model 76)
- 29 – 14 Tooth 12/24 pitch spline with 3/8-24 UNF x (.75) DP hole in end of shaft (models 39-64)
- 30 – 21 Tooth 16/32 pitch spline with 3/8-24 UNF x (.75) DP hole in end of shaft (models 39-64)
- 31 – 17 Tooth 12/24 pitch spline with (2.54) extension (model 76)
- 32 – (1.50) Diameter tapered with (.38) x (1.00) square key (models 39-64)
- 33 – 21 Tooth 16/32 pitch spline with M10 x 1.5 threaded hole (models 39-64)
- 34 – (1.38) Diameter tapered with (.38) x (1.00) square key (models 39-64)
- 35 – 14 Tooth 12/24 pitch spline (models 39-64) shot peened shaft
- 37 – 13 Tooth 8/16 pitch spline with (2.93) extension and for 76 seal (models 54-64)
- 38 – (1.75) Diameter tapered with (.44) x (1.00) square key (model 76)
- 39 – (1.75) diameter straight with (.38) x (2.00) square key with (2.22) extension (model 39-64 with 76 seal)
- 41 – 27 tooth 16/32 pitch spline with 2.19 extension and for 76 seal (models 39-64)

### Main Ports

- **A** – (1.00) SAE 4-bolt split flange port, standard pressure series (code 61)
- **B** – (1.00) SAE 4-bolt split flange port, high pressure series (code 62)
- **C** – 15/16-12 UN-2B SAE O-ring port
- **D** – (1.00) SAE 4-bolt split flange port, high pressure series (code 62)
- **E** – (1.00) SAE 4-bolt split flange port, high pressure series (code 62)

### End Cover and Composite Valve Block Assy

- **A** – Standard end cover, composite valve block with high-rate shuttle valve springs and charge pressure relief valve
- **B** – Standard end cover, composite valve block with low-rate shuttle valve springs and charge pressure relief valve, but with high pressure relief valves
- **C** – Standard end cover, composite valve block with low-rate shuttle valve springs and charge pressure relief valve, valve block with high pressure relief valve on side -A-only
- **D** – Standard end cover, composite valve block with high-rate shuttle valve springs and charge pressure relief valve, valve block with high pressure relief valves with threaded retainer
- **E** – Standard end cover, composite valve block with high-rate shuttle valve springs and charge pressure relief valve, but with high pressure relief valve with threaded retainer on side -A-only
- **F** – Standard end cover, composite valve block with low-rate shuttle valve springs and charge pressure relief valve, but with high pressure relief valve with threaded retainer on side -A-only
- **G** – Integral shuttle valve with low-rate shuttle valve springs and charge pressure relief valve

### Charge Pressure Relief Valve

- **0** – No relief valve
- **1** – Standard
- **2** – Orificed charge pressure relief valve (for composite valve blocks only)
- **3** – Plugged, no relief valve function

---

**Note:** Options in bold fonts are commonly used.
Model Code

HHD Fixed Motor

The following 23 digit coding system has been developed to identify standard configuration options for the Series 1 Hydrostatic Fixed Displacement Motor. Use this model code to specify a motor with the desired features. All 23 digits of the code must be present to release a new product number for ordering.

| HHD | 39 | 3 | 0 | 01 | A | A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | B |

| 12.13 | **High Pressure Relief Valve Setting** –
<table>
<thead>
<tr>
<th>Port A (Pos. 15)</th>
<th>Port B (Pos. 17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – None</td>
<td>1 – 11 bar (160 lbf/in²)</td>
</tr>
<tr>
<td>2 – 12,4 bar (180 lbf/in²)</td>
<td>3 – 13,8 bar (200 lbf/in²)</td>
</tr>
<tr>
<td>4 – 15,2 bar (220 lbf/in²)</td>
<td>5 – 16,6 bar (240 lbf/in²)</td>
</tr>
<tr>
<td>6 – 17,9 bar (260 lbf/in²)</td>
<td>7 – 19,3 bar (280 lbf/in²)</td>
</tr>
<tr>
<td>8 – 20,7 bar (300 lbf/in²)</td>
<td>9 – 22,5 bar (326.6 lbf/in²)</td>
</tr>
</tbody>
</table>

| 14.16 | **High Pressure Relief Valve –**
<table>
<thead>
<tr>
<th>Port A (Pos. 14)</th>
<th>Port B (Pos. 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – None</td>
<td>1 – Remote pilot operated relief valve</td>
</tr>
<tr>
<td>2 – Standard</td>
<td>3 – Standard with threaded retainer</td>
</tr>
<tr>
<td>4 – Remote pilot operated relief valve with o-ring face seal fitting</td>
<td>5 – Remote pilot operated relief valve with threaded retainer</td>
</tr>
<tr>
<td>6 – Remote pilot operated relief valve with special orifice and spring, with o-ring face seal fitting</td>
<td>7 – Remote pilot operated relief valve with o-ring face seal fitting</td>
</tr>
<tr>
<td>8 – Anti-cavitation check valve</td>
<td>9 – Speed Sensor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>18</th>
<th><strong>Speed Sensor</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – No speed sensor</td>
<td>A – Magnetic sensor with 2 wire weather pack connector</td>
</tr>
<tr>
<td>B – Digital sensor with 3 wire weather pack connector</td>
<td>C – Speed sensor hole (5/8-18 UNF thread) plugged (for digital or magnetic sensor)</td>
</tr>
<tr>
<td>D – Quadrature speed sensor with 4 wire weather pack connector (one 24 pulse per rev speed signal and one directional signal)</td>
<td>E – Quadrature speed sensor with 4 wire weather pack connector (two 12 pulse per rev speed signal in quadrature)</td>
</tr>
<tr>
<td>F – Speed sensor hole (9/16-32 UN thread) plugged (for quadrature sensor)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>19</th>
<th><strong>Special Features</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>00 – No special features</td>
<td>03 – Bypass valve-spool stem is on the opposite side from the low pressure relief valve in the composite valve block</td>
</tr>
<tr>
<td>04 – Int hex case drain plug in motor housing</td>
<td>05 – Case drain plug located opposite the swashplate dowel plug</td>
</tr>
<tr>
<td>22 – Nametag opposite dowel</td>
<td>23 – High speed rotating group</td>
</tr>
<tr>
<td>26 – Lightweight pistons and nametag opposite dowel</td>
<td>31 – Lightweight pistons</td>
</tr>
<tr>
<td>32 – Metal case drain plug in both ports</td>
<td>33 – Nametag opposite dowel and bar code label</td>
</tr>
<tr>
<td>34 – Shot peened barrel splines</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>21</th>
<th><strong>Paint and Packaging</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – Painted primer blue (standard)</td>
<td>J – Rust preventative spray</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>22</th>
<th><strong>Identification on Unit</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – Standard</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>23</th>
<th><strong>Design Code</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A – A</td>
<td>B – B</td>
</tr>
</tbody>
</table>

Note: Options in bold fonts are commonly used.
The following 23 digit coding system has been developed to identify standard configuration options for the Series 1 Hydrostatic Variable Displacement Motor. Use this model code to specify a motor with the desired features. All 29-digits of the code must be present to release a new product number for ordering.

<table>
<thead>
<tr>
<th>1 2 3</th>
<th>Pump series</th>
<th>ACE Variable Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 5 6</td>
<td>Displacement</td>
<td>39 – 64 cm³/r (3.9 in³/r)</td>
</tr>
<tr>
<td>7 8 9</td>
<td>Type</td>
<td>4 – Variable displacement motor</td>
</tr>
<tr>
<td>0 1 2</td>
<td>Design Type</td>
<td>0 – Ball-guide (model 76)</td>
</tr>
<tr>
<td>3 4 5</td>
<td>Output Shaft</td>
<td>01 – (1.500) Diameter straight with (.3750) x (2.5) square key (models 33-64)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Angle</th>
<th>Minimum Swashplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – 18 degrees</td>
<td></td>
</tr>
<tr>
<td>B – 17 degrees</td>
<td></td>
</tr>
<tr>
<td>C – 16 degrees</td>
<td></td>
</tr>
<tr>
<td>D – 15 degrees</td>
<td></td>
</tr>
<tr>
<td>E – 14 degrees</td>
<td></td>
</tr>
<tr>
<td>F – 13 degrees</td>
<td></td>
</tr>
<tr>
<td>G – 12 degrees</td>
<td></td>
</tr>
<tr>
<td>H – 11 degrees</td>
<td></td>
</tr>
<tr>
<td>J – 10 degrees</td>
<td></td>
</tr>
<tr>
<td>K – 9 degrees</td>
<td></td>
</tr>
<tr>
<td>L – 8 degrees</td>
<td></td>
</tr>
<tr>
<td>M – 7 degrees</td>
<td></td>
</tr>
<tr>
<td>N – 6 degrees</td>
<td></td>
</tr>
<tr>
<td>P – 5 degrees</td>
<td></td>
</tr>
<tr>
<td>Q – 4 degrees</td>
<td></td>
</tr>
<tr>
<td>R – 3 degrees</td>
<td></td>
</tr>
<tr>
<td>S – 2 degrees</td>
<td></td>
</tr>
<tr>
<td>T – 1 degrees</td>
<td></td>
</tr>
<tr>
<td>U – 0 degrees</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valve Block Assy</th>
<th>End Cover and Composite Valve Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – Standard end cover, composite valve block with high-rate shuttle valve springs</td>
<td></td>
</tr>
<tr>
<td>B – Standard end cover, composite valve block with low-rate shuttle valve springs</td>
<td></td>
</tr>
<tr>
<td>C – No composite valve block</td>
<td></td>
</tr>
<tr>
<td>D – No composite valve block</td>
<td></td>
</tr>
<tr>
<td>J – High pressure relief valves only - no shuttle or charge pressure relief valves</td>
<td></td>
</tr>
<tr>
<td>L – Standard end cover, composite valve block with high-rate shuttle valve springs, remote pilot operated relief valves with O-ring face seal fittings, and O-ring face seal fittings opposite remote pilot operated relief valves</td>
<td></td>
</tr>
<tr>
<td>M – Standard end cover, shuttle valve block with high-rate shuttle valve springs</td>
<td></td>
</tr>
<tr>
<td>N – Standard end cover, shuttle valve block with low-rate shuttle valve springs</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relief Valve</th>
<th>Charge Pressure Relief</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – None</td>
<td>0 – None</td>
</tr>
<tr>
<td>1 – Standard</td>
<td>B – 11 bar (160 lbf/in²)</td>
</tr>
<tr>
<td>2 – Remote pilot operated relief valve</td>
<td>C – 12.4 bar (180 lbf/in²)</td>
</tr>
<tr>
<td>3 – Standard with threaded retainer</td>
<td>D – 13.8 bar (200 lbf/in²)</td>
</tr>
<tr>
<td>4 – Remote pilot operated relief valve with threaded retainer</td>
<td>E – 15.2 bar (220 lbf/in²)</td>
</tr>
<tr>
<td>7 – Remote pilot operated relief valve with O-ring face seal fitting</td>
<td>F – 16.6 bar (240 lbf/in²)</td>
</tr>
<tr>
<td>8 – Remote pilot operated relief valve with threaded retainer, special orifice and spring, with O-ring face seal fitting</td>
<td>G – 17.9 bar (260 lbf/in²)</td>
</tr>
<tr>
<td>H – 19.3 bar (280 lbf/in²)</td>
<td>J – 20.7 bar (300 lbf/in²)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relief Valve</th>
<th>Composite Valve Block High Pressure Relief Valve –</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – None</td>
<td>Port A (Pos. 15)</td>
</tr>
<tr>
<td>1 – Standard</td>
<td>Port B (Pos. 17)</td>
</tr>
<tr>
<td>2 – Remote pilot operated relief valve</td>
<td>0 – None</td>
</tr>
<tr>
<td>3 – Standard with threaded retainer</td>
<td>B – 11 bar (160 lbf/in²)</td>
</tr>
<tr>
<td>4 – Remote pilot operated relief valve with threaded retainer</td>
<td>C – 12.4 bar (180 lbf/in²)</td>
</tr>
<tr>
<td>7 – Remote pilot operated relief valve with O-ring face seal fitting</td>
<td>D – 13.8 bar (200 lbf/in²)</td>
</tr>
<tr>
<td>8 – Remote pilot operated relief valve with threaded retainer, special orifice and spring, with O-ring face seal fitting</td>
<td>E – 15.2 bar (220 lbf/in²)</td>
</tr>
<tr>
<td>H – 19.3 bar (280 lbf/in²)</td>
<td>J – 20.7 bar (300 lbf/in²)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main Ports</th>
<th>Charge Press Relief Valve – Composite Valve Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – (1.00) SAE 4-bolt split flange port, standard pressure series (code 61)</td>
<td>0 – No relief valve</td>
</tr>
<tr>
<td>B – (1.00) SAE 4-bolt split flange port, high pressure series (code 62)</td>
<td>1 – Standard</td>
</tr>
<tr>
<td>D – (1.00) SAE 4-bolt split flange port, standard pressure series (code 61) with A and B gauge ports</td>
<td>2 – Orificed charge pressure relief valve</td>
</tr>
<tr>
<td>E – (1.00) SAE 4-bolt split flange port, high pressure series (code 62) with A and B gauge ports</td>
<td>3 – Remote pilot operated relief valve</td>
</tr>
</tbody>
</table>

Note: Options in bold fonts are commonly used.


**Model Code**

**ACE Variable Motor**

The following 23 digit coding system has been developed to identify standard configuration options for the Series 1 Hydrostatic Variable Displacement Motor. Use this model code to specify a motor with the desired features. All 29 digits of the code must be present to release a new product number for ordering.

<table>
<thead>
<tr>
<th>Port B (Pos. 18)</th>
<th>Port A (Pos. 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ACE</strong></td>
<td><strong>39</strong></td>
</tr>
<tr>
<td>1</td>
<td>11.0 bar (160 lbf/in²)</td>
</tr>
<tr>
<td>J</td>
<td>310 bar (4500 lbf/in²)</td>
</tr>
</tbody>
</table>

**High Pressure Relief Valve Setting**

- **0** – None
- **1** – 11.0 bar (160 lbf/in²)
- **2** – 12.4 bar (180 lbf/in²)
- **3** – 13.8 bar (200 lbf/in²)
- **4** – 15.2 bar (220 lbf/in²)
- **5** – 16.6 bar (240 lbf/in²)
- **6** – 17.9 bar (260 lbf/in²)
- **7** – 19.3 bar (280 lbf/in²)
- **C** – 103 bar (1500 lbf/in²)
- **D** – 138 bar (2000 lbf/in²)
- **E** – 172 bar (2500 lbf/in²)
- **F** – 207 bar (3000 lbf/in²)
- **G** – 241 bar (3500 lbf/in²)
- **H** – 276 bar (4000 lbf/in²)
- **J** – 310 bar (4500 lbf/in²)
- **K** – 345 bar (5000 lbf/in²)
- **L** – 379 bar (5500 lbf/in²)
- **M** – 414 bar (6000 lbf/in²)
- **N** – 448 bar (6500 lbf/in²)
- **P** – 483 bar (7000 lbf/in²)
- **Q** – 155 bar (2250 lbf/in²)
- **R** – 362 bar (5250 lbf/in²)
- **S** – 465 bar (6750 lbf/in²)
- **T** – 359 bar (5200 lbf/in²)
- **U** – 365 bar (5300 lbf/in²)
- **V** – 400 bar (5800 lbf/in²)

**Control**

- **0A** – Shipping plate without control link
- **HA** – Hydraulic remote with pump linkage 4.5-20.0 bar (65-290 lbf/in²)
- **HB** – Hydraulic remote 4.5-20.0 bar (65-290 lbf/in²)
- **HC** – Hydraulic remote 11.0-32.4 bar (160-470 lbf/in²)
- **HD** – Hydraulic remote 1.4-14.1 bar (20-205 lbf/in²)
- **MA** – Manual
- **PA** – Port plate
- **RA** – Pressure response with stroking valve 12 vdc (NC) with 2 pin amp connector
- **RB** – Pressure response with stroking valve 24 vdc (NC) with wire leads
- **RC** – Pressure response with stroking valve 24 vdc (NC) with wire leads
- **RD** – Pressure response with stroking valve 12 vdc (NC) with 2 pin amp connector - special 90 deg diagnostic fitting assembly
- **RE** – Pressure response with stroking valve 12 vdc (NC) - solenoid coil with diode, 2 pin metripak connector - special 90 deg diagnostic fitting assembly
- **RG** – Pressure response with stroking valve 24 vdc (NC) with wire leads and 9/16-18 fittings and hoses
- **SA** – Stroking valve 12 vdc (NC) with 2 pin cannon sure-seal connector
- **SB** – Stroking valve 24 vdc (NC) with wire leads
- **SC** – Stroking valve 12 vdc (NC) with 2 pin weathered stroking valve 12 vdc (NC) with 2 pin weatherpack connector (shroud)
- **SE** – Stroking valve 12 vdc (no) with 2 pin dt04-2p connector

**Control Orifice**

- **0** – None
- **A** – 0.71 (.028) diameter
- **B** – 0.91 (.036) diameter
- **C** – 1.12 (.044) diameter
- **D** – 1.32 (.052) diameter
- **E** – 1.45 (.057) diameter
- **F** – 1.65 (.065) diameter
- **G** – 1.85 (.073) diameter
- **H** – 2.39 (.094) diameter
- **J** – 2.59 (.102) diameter

**Press Setting for Pressure Response**

- **0** – None
- **B** – 69 bar (1000 lbf/in²)
- **C** – 103 bar (1500 lbf/in²)
- **D** – 138 bar (2000 lbf/in²)
- **E** – 172 bar (2500 lbf/in²)
- **F** – 207 bar (3000 lbf/in²)
- **G** – 241 bar (3500 lbf/in²)
- **H** – 276 bar (4000 lbf/in²)
- **J** – 310 bar (4500 lbf/in²)
- **K** – 345 bar (5000 lbf/in²)
- **M** – 414 bar (6000 lbf/in²)
- **V** – 250 bar (3625 lbf/in²)
- **W** – 228 bar (3300 lbf/in²)

**Control Special Features**

- **0** – No special features

**Speed Sensor**

- **0** – No speed sensor
- **A** – Magnetic speed sensor with 2-wire weather pack connector
- **B** – Digital speed sensor with 3-wire weather pack connector
- **C** – Quadrature speed sensor with 4 wire weather pack connector (one 24 pulse per rev speed signal and one directional signal)

**Displacement**

- **00** – No special features
- **03** – Externally adjustable servo piston stop - top servo sleeve
- **06** – Bypass valve - spool stem is on the opposite side from the low pressure relief valve in the composite valve block
- **08** – Model 76 seal in model 54 with grade 8 mounting flange assembly bolts
- **22** – High speed rotating group
- **23** – High speed rotating group and externally adjustable servo piston stop - top servo sleeve
- **24** – High speed rotating group and plug in top case drain port
- **25** – Model 76 seal in model 64
- **27** – Externally adjustable servo piston stops - top and bottom servo sleeves
- **30** – Bypass valve - spool stem is on the opposite side from the low pressure relief valve in the composite valve block, and charge pressure gauge port with internal hex plug

**Paint and Packaging**

- **B** – Painted primer blue (standard)
- **J** – Rust preventative spray

**Identification**

- **0** – Standard
- **A** – A
- **B** – B

Note: Options in bold fonts are commonly used.
## Performance – Pump

### Pump Performance

<table>
<thead>
<tr>
<th>Model</th>
<th>Displacement</th>
<th>Maximum Shaft Speed†</th>
<th>Nominal Pressure*</th>
<th>Peak Pressure**</th>
<th>Output Flow</th>
<th>Input Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in³/rev</td>
<td>rpm</td>
<td>psi</td>
<td>psi</td>
<td>gpm @ 180°C</td>
<td>lb-in @ 220°C</td>
</tr>
<tr>
<td></td>
<td>cm³/rev</td>
<td></td>
<td>(bar)</td>
<td>(bar)</td>
<td>3500 psi</td>
<td>3500 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>241 bar</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>3.89</td>
<td>4160</td>
<td>6000</td>
<td>7000</td>
<td>67.3</td>
<td>2346</td>
</tr>
<tr>
<td>46</td>
<td>4.60</td>
<td>4160</td>
<td>6000</td>
<td>7000</td>
<td>79.2</td>
<td>2786</td>
</tr>
<tr>
<td>54</td>
<td>5.44</td>
<td>3720</td>
<td>6000</td>
<td>7000</td>
<td>84.1</td>
<td>3285</td>
</tr>
<tr>
<td>64</td>
<td>6.44</td>
<td>3720</td>
<td>6000</td>
<td>7000</td>
<td>99.1</td>
<td>3900</td>
</tr>
<tr>
<td>76</td>
<td>7.62</td>
<td>2775</td>
<td>6000</td>
<td>7000</td>
<td>87.9</td>
<td>4552</td>
</tr>
</tbody>
</table>

Pump performance calculated at 96% efficiency.

† The maximum pump shaft speed may be limited by the charge pump speed rating.

* Nominal Pressure: Max delta system pressure at which component fatigue does not occur (pump life estimated by bearing life).

** Peak Pressure: Max operation pressure which is permissible for a short duration of time (t < 1 sec).

---

**Graphs:**

**Input Torque vs Speed**

- System Pressure: 3500 psi (240 bar)
- Charge Pressure: 220 psi (15 bar)
- Oil Viscosity: 60 SUS
- Temperature: 180°F (82°C)

**Output Flow vs Speed**

- System Pressure: 3500 psi (240 bar)
- Charge Pressure: 220 psi (15 bar)
- Oil Viscosity: 60 SUS
- Temperature: 180°F (82°C)
## Motor Performance

<table>
<thead>
<tr>
<th>Model</th>
<th>39</th>
<th>46</th>
<th>54</th>
<th>64</th>
<th>76</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement in³/rev</td>
<td>3.89</td>
<td>4.60</td>
<td>5.44</td>
<td>6.44</td>
<td>7.62</td>
</tr>
<tr>
<td>Nominal Pressure psi</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
</tr>
<tr>
<td>Peak Pressure psi</td>
<td>7000</td>
<td>7000</td>
<td>7000</td>
<td>7000</td>
<td>7000</td>
</tr>
<tr>
<td>Maximum rpm @ 18°</td>
<td>4160</td>
<td>4160</td>
<td>3720</td>
<td>3720</td>
<td>2775</td>
</tr>
<tr>
<td>Shaft Speed rpm @ 10°</td>
<td>5380*</td>
<td>5380*</td>
<td>4810*</td>
<td>4810*</td>
<td>3425*</td>
</tr>
<tr>
<td>Maximum lb-in</td>
<td>3511</td>
<td>4149</td>
<td>4916</td>
<td>5807</td>
<td>6911</td>
</tr>
<tr>
<td>Output Torque Nm</td>
<td>397</td>
<td>469</td>
<td>556</td>
<td>656</td>
<td>781</td>
</tr>
</tbody>
</table>

* These shaft speeds require maximum charge pressure relief: 340 psi (23 bar) pump and 280 psi (19 bar) motor.

† Maximum output torque is measured at 6000 psi (415 bar).

* Nominal Pressure: Max delta system pressure at which component fatigue does not occur (pump life estimated by bearing life).

** Peak Pressure: Max operation pressure which is permissible for a short duration of time (t < 1 sec).

### Output Torque vs Speed

- 10 hp (7.5 kW) - 15 kW
- 20 hp (15 kW) - 200 hp (150 kW)

### Input Flow vs Speed

- 100 GPM (365 LPM)
- 1500 (1786) LPM

System Pressure: 3500 psi (240 bar)
Charge Pressure: 220 psi (15 bar)
Oil Viscosity: 60 SUS
Temperature: 180° F (82° C)

Note: Operating the motor below 50 rpm is not recommended for best performance.
Eaton offers a choice of four charge pump displacements to go with their heavy duty transmission line: .85, 1.28, 1.70, and 2.12 in³/rev (13.9; 21.0; 27.8; 34.7 cm³/rev).

These charge pumps are available with one or more of the following options:

- a pressure sensing port
- remote pressure side filter ports
- a spin-on pressure side filter
- mounting flanges for auxiliary pumps

### Charge Pump Performance

<table>
<thead>
<tr>
<th>Displacement</th>
<th>in³/rev</th>
<th>cm³/rev</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.85</td>
<td>4600</td>
<td>13.9</td>
</tr>
<tr>
<td>1.28</td>
<td>3800</td>
<td>21.0</td>
</tr>
<tr>
<td>1.70</td>
<td>3100</td>
<td>27.9</td>
</tr>
<tr>
<td>2.12</td>
<td>3000</td>
<td>34.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum Shaft Speed</th>
<th>rpm</th>
<th>Maximum Speed*</th>
<th>lpm</th>
<th>Input Power @ 220 psi (15 bar) and Maximum Speed*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4600</td>
<td>1.70 in³/rev</td>
<td>79.5</td>
<td>1.62 hp</td>
</tr>
<tr>
<td></td>
<td>3800</td>
<td>1.28 in³/rev</td>
<td>64.0</td>
<td>2.93 hp</td>
</tr>
<tr>
<td></td>
<td>3100</td>
<td>1.28 in³/rev</td>
<td>95.0</td>
<td>2.93 hp</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>1.28 in³/rev</td>
<td>104.2</td>
<td>3.54 hp</td>
</tr>
</tbody>
</table>

*Theoretical Values

### Charge Pump Power vs Speed

- Oil Viscosity: 60 SUS
- Temperature: 180°F (82°C)
- * Theoretical Values
Control Options – Pump
Electronic Proportional Displacement Control with
Swashplate Mechanical Feedback
Model Code EJ & EK Position 15,16

The Electronic Proportional displacement control is ideal for applications requiring electronic pump displacement control. The EP displacement control has been designed to withstand the rigors of off-highway equipment environmental conditions.

Electronic Proportional Control Features
- Ease of installation
- Automotive style environmentally sealed Metri-Pack connectors
- Return to neutral for loss of power, or loss of command input signal
- Mechanical feedback of swashplate position for closed loop control
- External neutral adjustment
- Manual override capability

Input Shaft Rotation

<table>
<thead>
<tr>
<th>Solenoid Energized</th>
<th>Port A Flow</th>
<th>Port B Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCW 1, 2</td>
<td>Out, In, In</td>
<td>Out, In</td>
</tr>
<tr>
<td>CW 1, 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Neutral Adjustment

Control Valve Mounting Surface

Mating Connector for Proportional Valve (IP66)
Packard 4 Pin, Weatherpack
P/N 1218 6568 Connector, Qty 1
P/N 1204 8074 PIN Terminal, Qty 4
P/N 1204 8086 Cable Seal, Qty 1
P/N 1204 7948 TPA, Qty 1

<table>
<thead>
<tr>
<th>Pin</th>
<th>Color</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Yellow</td>
<td>Coil 1 PWM</td>
</tr>
<tr>
<td>B</td>
<td>White</td>
<td>Coil 1 Return</td>
</tr>
<tr>
<td>C</td>
<td>Orange</td>
<td>Coil 2 PWM</td>
</tr>
<tr>
<td>D</td>
<td>Black</td>
<td>Coil 2 Return</td>
</tr>
</tbody>
</table>

Electronic Proportional Control Features

Electronic Proportional Control Features

Pump Displacement vs. Coil Current

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Coil Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V</td>
<td>0.5, 1.25</td>
</tr>
<tr>
<td>24V</td>
<td>0.25, 0.625</td>
</tr>
</tbody>
</table>

Note:
- Coils have no internal Diodes. A-B Polarity and C-D Polarity Does Not affect operation
- 100 Hz recommended when PWM driver does not have built-in dither capabilities

Proportional Valve Specification

<table>
<thead>
<tr>
<th>EJ</th>
<th>Voltage</th>
<th>Resistance</th>
<th>Inductance</th>
<th>Current</th>
<th>Threshold Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 VDC</td>
<td>5.2 Ohms</td>
<td>70 mH</td>
<td>1500 mA</td>
<td>200-600 mA</td>
</tr>
</tbody>
</table>

Typical Electronic Controller

Contact Eaton for TCA, Maestro, and EFX controller available from Eaton; or customer supplied controller.

* 100 Hz recommended when PWM driver does not have built-in dither capabilities

Input Shaft Rotation

<table>
<thead>
<tr>
<th>Solenoid Energized</th>
<th>Port A Flow</th>
<th>Port B Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCW 1, 2</td>
<td>Out, In, In</td>
<td>Out, In</td>
</tr>
<tr>
<td>CW 1, 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Neutral Adjustment

Control Valve Mounting Surface

Mating Connector for Proportional Valve (IP66)
Packard 4 Pin, Weatherpack
P/N 1218 6568 Connector, Qty 1
P/N 1204 8074 PIN Terminal, Qty 4
P/N 1204 8086 Cable Seal, Qty 1
P/N 1204 7948 TPA, Qty 1

<table>
<thead>
<tr>
<th>Pin</th>
<th>Color</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Yellow</td>
<td>Coil 1 PWM</td>
</tr>
<tr>
<td>B</td>
<td>White</td>
<td>Coil 1 Return</td>
</tr>
<tr>
<td>C</td>
<td>Orange</td>
<td>Coil 2 PWM</td>
</tr>
<tr>
<td>D</td>
<td>Black</td>
<td>Coil 2 Return</td>
</tr>
</tbody>
</table>

Electronic Proportional Control Features

Electronic Proportional Control Features

Pump Displacement vs. Coil Current

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Coil Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V</td>
<td>0.5, 1.25</td>
</tr>
<tr>
<td>24V</td>
<td>0.25, 0.625</td>
</tr>
</tbody>
</table>

Note:
- Coils have no internal Diodes. A-B Polarity and C-D Polarity Does Not affect operation
- 100 Hz recommended when PWM driver does not have built-in dither capabilities

Proportional Valve Specification

<table>
<thead>
<tr>
<th>EJ</th>
<th>Voltage</th>
<th>Resistance</th>
<th>Inductance</th>
<th>Current</th>
<th>Threshold Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 VDC</td>
<td>5.2 Ohms</td>
<td>70 mH</td>
<td>1500 mA</td>
<td>200-600 mA</td>
</tr>
</tbody>
</table>

Typical Electronic Controller

Contact Eaton for TCA, Maestro, and EFX controller available from Eaton; or customer supplied controller.

* 100 Hz recommended when PWM driver does not have built-in dither capabilities
Control Options – Pump Electronic Proportional Displacement Control with Swashplate Mechanical and Electronic Sensor Feedback

Model Code FD & FE Position 15,16

The Electronic Proportional displacement control with both swashplate mechanical and electronic sensor feedback is ideal for applications requiring both precise electronic pump displacement control and inherently safe operation. The dual feedback enables safety integrity level (SIL) compliance.

Input Shaft Rotation

<table>
<thead>
<tr>
<th></th>
<th>CCW</th>
<th>CW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solenoid Energized</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Port A Flow</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Port B Flow</td>
<td>Out</td>
<td>In</td>
</tr>
</tbody>
</table>

Port A Flow

<table>
<thead>
<tr>
<th></th>
<th>In</th>
<th>Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port B Flow</td>
<td>Out</td>
<td>In</td>
</tr>
</tbody>
</table>

Pump Displacement vs Coil Current

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Coil Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V</td>
<td>A 0.5 B 1.25</td>
</tr>
<tr>
<td>24V</td>
<td>A 0.25 B 0.625</td>
</tr>
</tbody>
</table>

Swashplate Sensor Electrical Data

- Supply Voltage: 5±0.50 VDC
- Supply Current: 10mA
- Sensor Gain: 10°/V, CW Shaft rotation increases output
- Angle Sweep: -20° at 0.5V, +20° at 4.5V, 0° (pump neutral) at 2.5V
- Max Output Error*: ±3%

*Error includes thermal linearity, and sensitivity drift

Proportional Valve Specification

<table>
<thead>
<tr>
<th></th>
<th>FD</th>
<th>FE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>12 VDC</td>
<td>24 VDC</td>
</tr>
<tr>
<td>Resistance</td>
<td>5.2 Ohms</td>
<td>20.8 Ohms</td>
</tr>
<tr>
<td>Inductance</td>
<td>70 mH</td>
<td>277 mH</td>
</tr>
<tr>
<td>Current</td>
<td>1500 mA</td>
<td>750 mA</td>
</tr>
<tr>
<td>Threshold Current</td>
<td>200-600 mA</td>
<td>100-300 mA</td>
</tr>
<tr>
<td>PWM Frequency*</td>
<td>70-200 Hz</td>
<td>70-200 Hz</td>
</tr>
<tr>
<td>Dither Frequency</td>
<td>75 Hz</td>
<td>75 Hz</td>
</tr>
<tr>
<td>Dither Amplitude</td>
<td>250 mA</td>
<td>125 mA</td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>-65°F to 140°F (-54°C to 60°C)</td>
<td></td>
</tr>
</tbody>
</table>

*100 Hz recommended when PWM driver doesn’t have built-in dither capabilities

Mating Connector for Sensor (IP66)

Packard 3 Pin, Weatherpack, P/N 12015793 Connector
P/N 12089188, PIN Terminal, Qty 3
P/N 12015323, Cable Seal, Qty 3

Mating Connector for Proportional Valve (IP66)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Color</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Black</td>
<td>Return</td>
</tr>
<tr>
<td>B</td>
<td>Blue</td>
<td>V Out (Signal)</td>
</tr>
<tr>
<td>C</td>
<td>Red</td>
<td>+5 VDC</td>
</tr>
</tbody>
</table>

Connector Description

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>S1 Solenoid Return</td>
</tr>
<tr>
<td>B</td>
<td>Not Used</td>
</tr>
<tr>
<td>C</td>
<td>Not Used</td>
</tr>
<tr>
<td>D</td>
<td>S2 Solenoid Return</td>
</tr>
<tr>
<td>E</td>
<td>S2 Solenoid PWM</td>
</tr>
<tr>
<td>F</td>
<td>Not Used</td>
</tr>
<tr>
<td>G</td>
<td>Not Used</td>
</tr>
<tr>
<td>H</td>
<td>S1 Solenoid PWM</td>
</tr>
</tbody>
</table>

Contact Eaton for TCA, Maestro, and EFX controller available from Eaton; or customer supplied controller.
Control Options – Pump Electric Displacement Control with Swashplate Electronic Sensor Feedback

Model Code SC & SD Position 15,16

### Swashplate Sensor Electrical Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>5±0.50 VDC</td>
</tr>
<tr>
<td>Supply Current</td>
<td>10mA</td>
</tr>
<tr>
<td>Sensor Gain</td>
<td>10°/V, CW Shaft rotation increases output</td>
</tr>
<tr>
<td>Angle Sweep</td>
<td>-20° at 0.5V; +20° at 4.5V; 0° (pump neutral) at 2.5V</td>
</tr>
<tr>
<td>Max Output Error*</td>
<td>±3%</td>
</tr>
</tbody>
</table>

*Error includes thermal linearity, and sensitivity drift

### Valve Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SC</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>12 VDC</td>
<td>24 VDC</td>
</tr>
<tr>
<td>Resistance</td>
<td>4.0 Ohms</td>
<td>16.0 Ohms</td>
</tr>
<tr>
<td>Inductance</td>
<td>12.3 mH</td>
<td>49.4 mH</td>
</tr>
<tr>
<td>Current</td>
<td>1750 mA</td>
<td>875 mA</td>
</tr>
<tr>
<td>Ambient Temp</td>
<td>-65°F to 140°F (−54°C to 60°C)</td>
<td></td>
</tr>
</tbody>
</table>

### Typical Electronic Controller

Contact Eaton for TCA, Maestro, and EFX controller available from Eaton; or customer supplied controller.

### Controller Dimensions

<table>
<thead>
<tr>
<th>Displacement in³/r</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>39, 46</td>
<td>74.9 (2.95)</td>
<td>36.6 (1.44)</td>
</tr>
<tr>
<td>54, 64</td>
<td>93.7 (3.69)</td>
<td>45.0 (1.77)</td>
</tr>
<tr>
<td>76</td>
<td>110.2 (4.34)</td>
<td>45.2 (1.78)</td>
</tr>
</tbody>
</table>

### Input Shaft Rotation

<table>
<thead>
<tr>
<th>Solenoid Energized</th>
<th>CCW</th>
<th>CW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Port A Flow</th>
<th>Out</th>
<th>In</th>
<th>In</th>
<th>Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port B Flow</td>
<td>In</td>
<td>Out</td>
<td>Out</td>
<td>In</td>
</tr>
</tbody>
</table>

### Mating Connector for Valve

DIN 43650, Form A (IP65)
(Deutsch connector available upon request)

### Mating Connector for Sensor (IP66)

Packard 3 Pin Weatherpack
P/N 12015793, Connector Qty 1
P/N 12089188, PIN Terminal, Qty 3
P/N 12015323, Cable Seal, Qty 3
Control Options – Pump

Pump Control Options

Port Plate

The port plate is the simplest control option available. It fits all Eaton heavy duty pumps and motors.

Standard Variable Pump Control

The port plate is commonly used as a slave control that receives commands from other controls in the same system.

The standard variable pump control is the most common type of control used on heavy duty hydrostatic variable displacement pumps. It is normally actuated by direct mechanical linkages or cables.

A wide band neutral zone controller is available. It expands the center lever position where the pump output is zero flow.

---

System Pressure Port B
System Pressure Port A

Swashplate Feedback

---

EATON Heavy Duty Hydrostatic Transmissions Catalog E-TRHD-MC001-E2 July 2011 21
The inching valve is an option that is used in conjunction with the standard variable pump control. This control option would typically be used on a vehicle propel transmission. When the inching valve is operated with a foot pedal it functions like a clutch. A metering orifice in the inching valve’s rotary spool cross ports the servo pressure lines providing the operator with smooth acceleration and deceleration.

The neutral detent feature on the standard control valve provides a more positive feel when finding neutral. This control is a good choice for transmissions that have long control linkages or cables with varying amounts of free play.
Control Options – Pump

**Standard Control with Neutral Lock-out**

The neutral lock-out feature is an electrical switch that is closed when the transmission is in neutral. This switch can be used to prevent the activation of certain functions that require the pump to be in neutral.

**Internal Pressure Override Control (IPOR)**

The lock-out feature is commonly used to prevent starting the prime mover or activating auxiliary functions. The electrical switch is available as normally open or normally closed.

The internal pressure override (IPOR) protects the transmission from running at overload conditions for extended periods. It senses system pressure and allows the pump to destroke if pressures exceed a preset limit. The override pressure setting is shim adjustable. Since the IPOR is built into the pump end cover it is not a field conversion option.
Remote Pressure Override

The remote pressure override control provides a means to remotely adjust the pressure setting of the pressure override valve. This control may be used in applications requiring variable system pressure protection to prevent overloads and excessive heat generation. This valve operates similarly to the IPOR control.
Control Option – Pump

Hydraulic Remote Control
Pump Control

The hydraulic remote control uses a remote pilot pressure signal to move the control spool. This control can be used where cables or mechanical linkages are not feasible.
Control Options – Pump

Destroke Control

The heavy duty Destroke Control is a solenoid valve mounted on the standard variable pump control. When energized, the valve cross-ports control pressure allowing centering springs to bring the pump out of stroke. It can be energized with a single switch, push-button, or dead man’s switch. The solenoid coil is available in 12 volt or 24 volt DC and normally open and normally closed configurations.

Destroke Solenoid

The heavy duty Destroke Solenoid is available to field convert the standard variable pump control into a destroke control. An Anti-Stall Electronics Module is available to drive a normally closed destroke valve. The electronic circuit monitors engine speed. When engine speed drops the anti-stall electronic reduce the pump’s displacement.

Anti-Stall Electronics Module
Control Options – Variable Motor

Manual Control

The manual displacement control for variable motors permits remote control of motor displacement using mechanical links or cables. The control operates similarly to the pump manual control, except the motor is biased to maximum displacement when the control handle is in a "neutral" position. Motor displacement may be controlled between maximum and minimum by moving the control lever.

Stroking Valve Control

The variable motor stroking control provides a means of controlling motor displacement remotely via an electrical signal. When no electrical signal is supplied to the solenoid valve, the motor will be commanded to maximum displacement to provide maximum torque. Conversely, providing an electrical signal to the solenoid valve will command minimum displacement for maximum output speed. The control is available in 12 volt and 24 volt DC configurations.
Control Options – Variable Motor

The variable motor pressure response control automatically adjusts motor displacement to meet torque requirements by sensing system pressure. The motor is biased to minimum displacement until system pressure reaches the pressure response setting. The control will then increase motor displacement to maintain the control pressure setting until maximum motor displacement is reached or the load on the system is reduced.

This control valve is a combination of the pressure response control and the stroking valve. With the stroking valve solenoid energized it works like the variable motor pressure response control. De-energize the stroking valve solenoid and the motor goes to full stroke. The control is available in 12 volt and 24 volt configurations.
The hydraulic remote control uses a remote pilot pressure to move the control spool. There are two versions of the control available for variable motors. The first version contains a feedback linkage that biases the motor to minimum angle when the pilot pressure is below the control range. The second version contains a feedback linkage that biases the motor to full displacement when the pilot pressure is below the control range. This version permits the use of a single pilot signal to control the displacement of both the pump and motor. The operating pressure ranges of the hydraulic remote controls on pump and motor are selected such that the pump reaches full displacement before the pilot signal begins to reduce the displacement of the variable motor. This system provides infinitely variable speed control range and maximum motor output torque at lower speeds.
Dimensions – Charge Pump

### Charge Pump with SAE A Auxiliary Mount

**Charge Pump Inlet**

| 1 5/16-12 Straight Thread O-ring Fitting |

| Auxiliary Mounting Surface |

| 31.8 [1.25] Maximum Allowable Shaft Protrusion |

| Gasket supplied as loose item to be installed on mounting surface prior to assembly of auxiliary pump. |

**Spline to mate with internal involute flat root side fit, 9 tooth 16/32 pitch, 30° pressure angle, per ANSI B-92.1-1970**

### Charge Pump with SAE B Auxiliary Mount

**Charge Pump Inlet**

| 1 5/16-12 Straight Thread O-ring Fitting |

| Auxiliary Mounting Surface |

| 41.4 [1.63] Maximum Allowable Shaft Protrusion |

| Gasket supplied as loose item to be installed on mounting surface prior to assembly of auxiliary pump. |

**Spline to mate with internal involute flat root side fit, 13 tooth 16/32 pitch, 30° pressure angle, per ANSI B-92.1-1970**

### Charge Pump Options

| Displacement Dimension 'G' cu.in./rev. cc/rev in.mm |

| .85 1.28 1.70 2.12 |

| 1.28 2.25 3.25 4.50 |

| 1.70 2.78 3.86 5.00 |

### Charge Pump Dimensions – Charge Pump

**Dimensions in mm (in)**

---

*Refer to page 18 for SAE B torque ratings.*

---

*Refer to page 16 for SAE A torque ratings.*
Dimensions – Charge Pump

Charge Pump with Auxiliary Pressure Port

**Charge Pump Options**

<table>
<thead>
<tr>
<th>Displacement</th>
<th>Dimension 'G'</th>
</tr>
</thead>
<tbody>
<tr>
<td>cu.in./rev.</td>
<td>in.mm</td>
</tr>
<tr>
<td>0.85</td>
<td>13.9</td>
</tr>
<tr>
<td>1.28</td>
<td>31.0</td>
</tr>
<tr>
<td>1.70</td>
<td>47.8</td>
</tr>
<tr>
<td>2.12</td>
<td>54.7</td>
</tr>
</tbody>
</table>

*Note: This option supplied with filter.*

Charge Pump with Remote Filter Ports

**Charge Pump Options**

<table>
<thead>
<tr>
<th>Displacement</th>
<th>Dimension 'G'</th>
</tr>
</thead>
<tbody>
<tr>
<td>cu.in./rev.</td>
<td>in.mm</td>
</tr>
<tr>
<td>0.85</td>
<td>13.9</td>
</tr>
<tr>
<td>1.28</td>
<td>31.0</td>
</tr>
<tr>
<td>1.70</td>
<td>47.8</td>
</tr>
<tr>
<td>2.12</td>
<td>54.7</td>
</tr>
</tbody>
</table>

Charge Pump with Spin-On Pressure Side Filter Pad

*Note: This option supplied with filter.*

Dimensions in mm (in)
The variable pumps and motors are shown with standard controls. Installation drawings of other controls are available from your Eaton representative. Optional controls are shown on page 23.

The variable pumps are shown with standard charge pumps. Installation drawings of other charge pumps are available from your Eaton representative. The lever on the standard control has linkage connection holes at 1 and 2 inch radii from the control shaft center. Detailed drawings of available shafts and ports are shown on page 21.

All dimensions are given in millimeters (inches).
**Dimensions**

**Models 54 and 64**

---

**Variable Pump**

- Case Drain Port - 1 5/16-12 Straight Thread O-ring Fitting
- 4 Places
- **DIA:** 57.2 [2.25] TYP.
- **B:** 130.8 [5.15]
- **A:** 92.5 [3.64]

---

**Fixed Motor**

- Case Drain Port - 1 5/16-12 Straight Thread O-ring Fitting
- 2 Places
- **DIA:** 57.2 [2.25] TYP.
- SAE C 4-Bolt Mounting Flange
- 4 Places
- **DIA:** 14.53/14.14 [572.397] TYP.
- **B:** 99.5 [3.91]
- **A:** 114.3 [4.50]

---

**Variable Motor**

- Case Drain Port - 1 5/16-12 Straight Thread O-ring Fitting
- 2 Places
- **DIA:** 57.2 [2.25] TYP.
- **B:** 130.6 [5.15]
- **A:** 92.5 [3.64]

---

All dimensions are given in millimeters (inches).
### Dimensions

#### Models 54 and 64

#### Variable Pump

- **Case Drain Port**: 1 1/16-12 Straight Thread O-ring Fitting
- **SAE D 4-Bolt Mounting Flange**: 
- **Charge Pump Inlet**: 1 5/16-12 Straight Thread O-ring Fitting

#### Fixed Motor

- **Gauge Port for Charge Pressure**: 7/16-20 Straight Thread O-ring Fitting
- **Control Pressure Port**: 7/16-20 Straight Thread O-ring Fitting

#### Variable Motor

- **Case Drain Port**: 1 1/16-12 Straight Thread O-ring Fitting

### Weight Kg (lb)

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable Pump</th>
<th>Fixed Motor</th>
<th>Variable Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>138 (62.6)</td>
<td>83 (37.6)</td>
<td>140 (63.5)</td>
</tr>
<tr>
<td>39</td>
<td>138 (62.6)</td>
<td>83 (37.6)</td>
<td>140 (63.5)</td>
</tr>
<tr>
<td>46</td>
<td>138 (62.6)</td>
<td>83 (37.6)</td>
<td>140 (63.5)</td>
</tr>
<tr>
<td>54</td>
<td>188 (85.3)</td>
<td>106 (48.1)</td>
<td>190 (86.2)</td>
</tr>
<tr>
<td>64</td>
<td>188 (85.3)</td>
<td>106 (48.1)</td>
<td>190 (86.2)</td>
</tr>
<tr>
<td>76</td>
<td>226 (101.7)</td>
<td>121 (54.5)</td>
<td>228 (102.6)</td>
</tr>
</tbody>
</table>
Power Limiter Pumps and Integral Shuttle Valve Motors

Models 39 through 64

Power Limiter Pump

Power limiter valves (PLV) are high pressure relief valves built into the pump’s end cover. When pressure in the high pressure loop gets too high, the PLV opens to the pump case. Besides an immediate drop in the loop high pressure, the open PLV also causes control pressure to drop. This in turn allows the centering springs on the servo pistons to bring the pump out of stroke until the pressure drops to the relief valve setting and the PLV closes.

The PLV will also act as a check valve to prevent cavitation in the event of a rapid pressure rise and hose expansion.

A motor with integral shuttle valve is used in conjunction with the power limiter valve pump.

Note: Power limiter valves are not recommended for applications with large overrunning loads.

Feature/Benefits

- The motor is shorter and lighter allowing it to fit in tighter spaces.
- The motor’s integral shuttle valve and low pressure relief assure good loop flushing.
- The motor is available with side ports, end ports, or both allowing maximum mounting flexibility.
- The power limiter valves (PLV) are quick, direct acting relief valves that prevent high pressure spikes.
- The power limiter pump is ideally suited for use with motors that do not have valve blocks because it eliminates the need for a remote valve block.

Power Limiter Valve Operation*

Power limiter valve option not available on Model 54 and Model 64 pumps with SAE C auxiliary option.

Integral Shuttle Valve

Power Limiter Valve

Integral Shuttle Motor

Power Limiter Valves
Dimensions – Power Limiter Pump
Models 39 and 46

<table>
<thead>
<tr>
<th>Charge Pump Options</th>
<th>Displacement</th>
<th>Dimension &quot;G&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>cu.in./rev</td>
<td>cc/rev</td>
<td>mm</td>
</tr>
<tr>
<td>0.85</td>
<td>13.9</td>
<td>92.2</td>
</tr>
<tr>
<td>1.28</td>
<td>21.0</td>
<td>98.6</td>
</tr>
<tr>
<td>1.70</td>
<td>27.8</td>
<td>104.3</td>
</tr>
<tr>
<td>2.12</td>
<td>34.7</td>
<td>111.6</td>
</tr>
</tbody>
</table>
Dimensions – Power Limiter Pump

Models 54 and 64

- Charge pump mounting surface
- Gauge port for charge pressure, 7/16-20 straight thread o-ring fitting.
- Charge pump inlet port, 1 5/16-12 straight thread o-ring fitting.
- Case drain ports, 1 1/16-12 straight thread o-ring fitting.
- Charge supply centerline

Dimensions:

- Power Limiter Pump Models 54 and 64
- Dimsions and measurements for parts such as pump body, ports, and mounting surfaces.

Note: Dimensions are in millimeters [mm] and inches [in].
Dimensions – Integral Shuttle Motor
Models 39, and 46

Notes: All dimensions are given in millimeters (inches).
The variable pumps are shown with standard controls. Installation drawings of other controls are available from your Eaton representative. Optional controls are shown on page 23.
The variable pumps are shown with standard charge pumps. Installation drawings of other charge pumps are available from your Eaton representative.
The lever on the standard pump control has linkage connection holes at 1 and 2 inch radii from the control shaft center.
Detailed drawings of available shafts and ports are shown on page 21.

PL Pump and IS Motor
Approximate Weights
lb (Kg)

<table>
<thead>
<tr>
<th>Model</th>
<th>PL Pump</th>
<th>IS Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>138 [62,6]</td>
<td>70 [31,8]</td>
</tr>
<tr>
<td>46</td>
<td>138 [62,6]</td>
<td>70 [31,8]</td>
</tr>
<tr>
<td>54</td>
<td>188 [85,3]</td>
<td>93 [42,2]</td>
</tr>
<tr>
<td>64</td>
<td>188 [85,3]</td>
<td>93 [42,2]</td>
</tr>
</tbody>
</table>
Dimensions – Integral Shuttle Motor

Models 54 and 64

Notes: All dimensions are given in millimeters (inches).

The variable pumps are shown with standard controls. Installation drawings of other controls are available from your Eaton representative. Optional controls are shown on page 23.

The variable pumps are shown with standard charge pumps. Installation drawings of other charge pumps are available from your Eaton representative.

The lever on the standard pump control has linkage connection holes at 1 and 2 inch radii from the control shaft center.

Detailed drawings of available shafts and ports are shown on page 21.
Tandem Pump Applications

Tandem pumps are most typically used in applications where two independent sources of hydraulic power are required while taking advantage of using only one power source to drive the two pumps. This saves on the expense of driving two pumps by eliminating the split drive gearbox or eliminating another power source such as a second engine or motor. Tandem pumps can be used on machines such as track drive equipment where independent power is required at each track. Speed and power can be controlled to each side of the vehicle for steering and vehicle speed control both in forward and reverse directions.

Tandem pumps can also be used to create the equivalent flow of one larger displacement pump by combining the flows of the two pumps. This is an economic advantage over using a single large displacement pump.

Tandem pumps may also be used in industrial, construction or mining applications where several sources of hydraulic power are required while taking advantage of using only one power source to drive the two pumps.

Features/Benefits

- Pumps mounted in tandem save the expense of a pump drive.
- Tandem pumps, in some applications, are required because of space limitations.
- The rear pump may be the same displacement or smaller than the front pump.
- A tandem pump may be used as an economical alternative for a larger displacement pump by combining the flow of both pumps. For example, combining the flows of two 6.4 in³/rev pumps connected in tandem provides the flow equivalent to a 12.8 in³/rev pump.
- Charge pumps with SAE A or SAE B auxiliary mounts are available.
- Pump has standard SAE C flange mount.
- Rear pump can be the same displacement or smaller than front pump.
**Dimensions – Tandem Pumps**

**Models 39 and 46 Tandem Pumps**

**Notes:**
- The variable pumps are shown with standard controls. Installation drawings of other controls are available from your Eaton representative. Optional controls are shown on page 23.
- The variable pumps are shown with standard charge pumps. Installation drawings of other charge pumps are available from your Eaton representative.
- The lever on the standard pump control has linkage connection holes at 1 and 2 inch radii from the control shaft center.
- Detailed drawings of available shafts and ports are shown on page 21.

**Charge Pump Options**

<table>
<thead>
<tr>
<th>Displacement cu.in./rev.</th>
<th>Dimension 'G' cu.in./rev</th>
<th>Dimension 'G' mm</th>
<th>Dimension 'G' in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.85</td>
<td>13.9</td>
<td>22.2</td>
<td>3.63</td>
</tr>
<tr>
<td>1.28</td>
<td>21.0</td>
<td>98.6</td>
<td>3.88</td>
</tr>
<tr>
<td>1.70</td>
<td>27.8</td>
<td>104.9</td>
<td>4.13</td>
</tr>
<tr>
<td>2.12</td>
<td>34.7</td>
<td>111.6</td>
<td>4.38</td>
</tr>
</tbody>
</table>

**Port Listings:**
- Port-A: Charge supply to front pump
- Port-B: Charge supply port
- Port-C: Charge supply port
- Port-D: Charge supply port
- Port-E: Charge supply port
- Port-F: Charge supply port
- Port-G: Charge supply port
- Port-H: Charge supply port
- Port-I: Charge supply port
- Port-J: Charge supply port
- Port-K: Charge supply port
- Port-L: Charge supply port
- Port-M: Charge supply port
- Port-N: Charge supply port
- Port-O: Charge supply port
- Port-P: Charge supply port
- Port-Q: Charge supply port
- Port-R: Charge supply port
- Port-S: Charge supply port
- Port-T: Charge supply port
- Port-U: Charge supply port
- Port-V: Charge supply port
- Port-W: Charge supply port
- Port-X: Charge supply port
- Port-Y: Charge supply port
- Port-Z: Charge supply port

All dimensions are given in millimeters (inches).
### Dimensions – Tandem Pumps

**Models 54 and 64 Tandem Pumps**

#### Charge Pump Options

<table>
<thead>
<tr>
<th>Displacement cu.in./rev.</th>
<th>cc/rev</th>
<th>Dimension 'G' mm</th>
<th>Dimension 'G' in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.85</td>
<td>13.9</td>
<td>92.2</td>
<td>3.63</td>
</tr>
<tr>
<td>1.28</td>
<td>21.0</td>
<td>99.6</td>
<td>3.88</td>
</tr>
<tr>
<td>1.70</td>
<td>27.8</td>
<td>104.9</td>
<td>4.13</td>
</tr>
<tr>
<td>2.12</td>
<td>34.7</td>
<td>111.6</td>
<td>4.38</td>
</tr>
</tbody>
</table>

#### Tandem Pump Application Information

Some tandem applications require larger displacement charge pumps. Refer to the Heavy Duty Application manual (no. 5-401) for more information on heavy duty pump and motor applications.

#### Tandem Pump Approximate Weights

<table>
<thead>
<tr>
<th>Front Pump</th>
<th>Rear Pump</th>
<th>Weight lb (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 54 - 64</td>
<td>Model 33 - 46</td>
<td>276 (125.2)</td>
</tr>
<tr>
<td>Model 54 - 64</td>
<td>Model 54 - 64</td>
<td>376 (170.6)</td>
</tr>
<tr>
<td>Model 54 - 64</td>
<td>Model 33 - 46</td>
<td>326 (147.9)</td>
</tr>
</tbody>
</table>
**Application Information – Tandem Pump**

Tandems, Model 54 or 64 Front Pump with Model 39, or 46 Rear Pump

**Maximum Shaft Torque Limitations**

The total input torque, as well as, the torque at each of the drive shaft coupling points must be considered in a tandem pump system. Torque calculation formulas and the maximum allowable shaft torque limits, for each shaft coupling point in the tandem pump, are given below. For longest shaft life, use the largest shaft possible.

**Charge Pump Options**

<table>
<thead>
<tr>
<th>Displacement cu.in./rev.</th>
<th>Dimension 'G' (mm/in.)</th>
<th>Dimension 'G' (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.85</td>
<td>13.9</td>
<td>3.63</td>
</tr>
<tr>
<td>1.28</td>
<td>21.0</td>
<td>3.88</td>
</tr>
<tr>
<td>1.70</td>
<td>27.8</td>
<td>3.47</td>
</tr>
<tr>
<td>2.12</td>
<td>34.7</td>
<td>3.38</td>
</tr>
</tbody>
</table>

**Shaft Coupling Point**

<table>
<thead>
<tr>
<th>Shaft Coupling Point</th>
<th>lb-in.</th>
<th>Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Shaft Models 54 – 64</td>
<td>11150</td>
<td>1260</td>
</tr>
<tr>
<td>Input Shaft Models 33 – 46</td>
<td>8550</td>
<td>966</td>
</tr>
<tr>
<td>Front/Rear Pump Coupler</td>
<td>6600</td>
<td>746</td>
</tr>
<tr>
<td>Charge Pump</td>
<td>2050</td>
<td>232</td>
</tr>
<tr>
<td>B-Pad Auxiliary Pump</td>
<td>1852</td>
<td>209</td>
</tr>
<tr>
<td>A-Pad Auxiliary Pump</td>
<td>517</td>
<td>58</td>
</tr>
</tbody>
</table>

**Shaft Torque Formulas**

Max. Aux Pump Torque = \[
\frac{(\text{Max Displ aux pmp})(\text{Max Pressure aux pmp})}{(6.28)(.9)}
\]

Max. Chg Pump Torque = \[
\frac{(\text{Max Displ chg pmp})(\text{Max Pressure chg pmp})}{(6.28)(.9)} + \text{Max. Aux Pump Torque}
\]

Max. Front/Rear Pump Coupler Torque = \[
\frac{(\text{Max Displ pmp 2})(\text{Max Pressure pmp 2})}{(6.28)(.9)} + \text{Max. Chg Pump Torque}
\]

Max. Input Shaft Torque = \[
\frac{(\text{Max Displ pmp 1})(\text{Max Pressure pmp 1})}{(6.28)(.9)} + \text{Max. Front/Rear Pump Coupler Torque}
\]
Heavy Duty Pumps with C-Pad Rear Mount
Models 39 through 64

**Features/Benefits**

- The heavy duty pump with a C-Pad rear mount is the front half of the tandem unit.
- Pump has standard SAE C flange mount.
- Rear pump can be the same displacement or smaller than front pump.
- The rear mount accepts a standard SAE C flange.
- This pump is ideal for applications that require two different pumps. Road rollers and some construction equipment are applications that employ two different pumps.

**Application Information**

**Maximum Shaft Torque Limitations**

The total input torque, as well as, the torque at the drive shaft coupling point must be considered when the pump with the SAE C rear mount is used. Maximum torque values and formulas are given on page 18.

**Pumps with SAE C Rear Mount**

A 14 tooth, 12/24 pitch, internal spline coupling (Part No. 105853) is required between front and rear pump. A coupling is provided with each SAE C Pump. Optional couplings with 21 tooth, 16/32 pitch; and 23 tooth, 16/32 pitch, are also available.

Pump requires remote charge pump and charge pressure relief. (Charge pressure relief may be built into pump.)

Refer to the Heavy Duty Application manual (no. 5-401) for more information on heavy duty pump and motor applications.

**Rear Pump Mounting Information**

When an Eaton heavy duty pump is used as the rear pump, remove its shaft seal so part of the case flow will flow past the bearing into the front pump. It is also necessary to connect the rear pump’s upper case drain port to the front pump’s lower case drain port, otherwise high case pressures may result.

In all cases, check case pressures and ensure that they do not exceed 40 PSI (3 bar).

Heavy Duty Application manual (no. 5-401) gives more information on proper case flow routing.

See previous page for shaft torque ratings.
Dimensions – Pumps with C-Pad Rear Mount
Models 39 and 46

Optional couplings with 21 tooth 16/32 pitch and 23 tooth 16/32 pitch also available.

Notes: The variable pumps are shown with standard controls. Installation drawings of other controls are available from your Eaton representative. Optional controls are shown on page 23.

The lever on the standard pump control has linkage connection holes at 1 and 2 inch radii from the control shaft center.

Detailed drawings of available shafts and ports are shown on page 21.
Dimensions – Pumps with C-Pad Rear Mount

Models 54 and 64 Pumps

Notes: The variable pumps are shown with standard controls. Installation drawings of other controls are available from your Eaton representative. Optional controls are shown on page 23.

The lever on the standard pump control has linkage connection holes at 1 and 2 inch radii from the control shaft center. Detailed drawings of available shafts and ports are shown on page 21.
Dimensions – Shaft and Port

Models 39 through 64

**Keyed Shaft Option**
Compatible with ISO 3019/1 (SAE-J744) Specifications

**Splined Shaft Options**
Compatible with ISO 3019/1 (SAE-J744) Specifications

**Tapered Shaft Options**
Compatible with ISO 3019/1 (SAE-J744) Specifications

**Split Flange Port Options**
Per SAE-J518 Specifications

---

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Pitch</th>
<th>Shaft Dia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>14*</td>
<td>12/24</td>
<td>31,224/31,097 (1.2293/1.2243)</td>
</tr>
<tr>
<td>19</td>
<td>16/32</td>
<td>31,331/31,204 (1.2335/1.2285)</td>
</tr>
<tr>
<td>20</td>
<td>16/32</td>
<td>32,918/32,791 (1.2960/1.2910)</td>
</tr>
<tr>
<td>21</td>
<td>16/32</td>
<td>34,506/34,379 (1.3585/1.3535)</td>
</tr>
<tr>
<td>23</td>
<td>16/32</td>
<td>37,681/37,554 (1.4835/1.4785)</td>
</tr>
</tbody>
</table>

* Not recommended for Model 64 or tandem pumps.
Dimensions – Shaft and Port
Model 76

Keyed Shaft Option
Compatible with ISO 3019/1
(SAE-J744) Specifications

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Pitch</th>
<th>Shaft Dia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>8/16</td>
<td>43.713/43.586 (1.7210/1.7160)</td>
</tr>
<tr>
<td>27</td>
<td>16/32</td>
<td>44.031/43.904 (1.7335/1.7285)</td>
</tr>
</tbody>
</table>

Dimensions in mm (in)

Splined Shaft Options
Compatible with ISO 3019/1
(SAE-J744) Specifications
Dimensions – Shaft and Port

Model 76

**Tapered Shaft Option**
Compatible with ISO 3019/1 (SAE-J744) Specifications

1 1/4-18 UNEF-2B slotted hex locknut per SAE J-501 (except 47.7 [1.88] across flats). Lubricate shaft and threads. Torque to 178 Nm [132 lb-ft] plus torque required to align slotted nut with shaft cross hole.

**Split Flange Port Options**
Per SAE-J518 Specifications

**O-ring Port Option**
Per SAE-J514 Specifications

<table>
<thead>
<tr>
<th>Code</th>
<th>Dia.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>61</td>
<td>25.4 (1.00)</td>
<td>26.19 (1.031)</td>
<td>52.37 (2.062)</td>
<td>3/8-16</td>
<td>22.4 (.88)</td>
</tr>
<tr>
<td>62</td>
<td>25.4 (1.00)</td>
<td>27.76 (1.093)</td>
<td>57.15 (2.250)</td>
<td>7/16-14</td>
<td>27.0 (1.06)</td>
</tr>
</tbody>
</table>

Dimensions in mm (in)
Component Descriptions
The Operational Diagram on page 46 shows a typical heavy duty hydrostatic transmission. The axial piston pump and axial piston motor are the main components. The filter, reservoir, heat exchanger, and oil lines make up the rest of the system. The function of each of these components is described below:

A separate energy source, such as an electric motor or internal combustion engine, turns the input shaft of the pump.

Variable Displacement Axial Piston Pump
The variable displacement pump provides a flow of high pressure oil. Pump output flow can be varied to obtain the desired motor output speed. For example, when the pump’s displacement is zero, no oil is pumped and the transmission’s motor output shaft is stopped. Conversely, maximum pump displacement produces maximum motor shaft speed. The direction of high pressure flow can also be reversed; doing so reverses the direction the motor output shaft rotates.

A charge pump is integrated into the piston pump and driven by the shaft of the piston pump. The drawing illustrates a suction filtration circuit. Eaton recommends a suction filter without a bypass valve. The charge pump has a Low Pressure Relief Valve that regulates the output pressure.

Power limiter valves and high pressure relief valves are available as options.

Fixed Displacement Axial Piston Motor
The motor uses the high pressure oil flow from the pump to produce transmission output. The high pressure oil comes to the motor through one of the high pressure lines. It enters the motor, turns the output shaft, then returns to the pump. Eaton piston motors integrate a hot oil shuttle and low pressure relief valve into the end cover. The shuttle valve and low pressure relief valve direct excess charge pump flow into the motor case. The shuttle valve is activated by high pressure and directs excess charge pump flow over the low pressure relief valve. This flushing action allows the charge pump to provide clean, cool oil to the closed loop circuit.

Reservoir
The reservoir is an important part of the hydrostatic transmission system. It should provide adequate oil storage and allow easy oil maintenance.

The reservoir must hold enough oil to provide a continuous oil supply to the charge pump inlet. It must also have enough room for the hydraulic oil to expand as the system warms up. Consider charge pump flow when sizing the reservoir: One half (.5) minute times (X) the maximum charge pump flow should be the minimum oil volume in the reservoir. Maintaining this oil volume will give the oil a minimum of thirty (30) seconds in the reservoir. This will allow any entrained air to escape and contamination to settle out of the oil.

To allow for oil expansion, the reservoir’s total volume should be at least six tenths (.6) minute times (X) the maximum charge pump flow.

The reservoir’s internal structure should cut down turbulence and prevent oil aeration.

The line returning flow to the reservoir should be fitted with a diffuser to slow the incoming oil to 1 to 1.2 meters (3-4 feet) per second to help reduce turbulence. The return flow line should also be positioned so that returning oil enters the reservoir below the liquid surface. This will help reduce aeration and foaming of the oil.

The reservoir should have baffles between the return line and suction line. Baffles prevent return flow from immediately reentering the pump. A sixty mesh screen placed across the suction chamber of the reservoir will act as a bubble separator. The screen should be placed at a thirty degree angle to the horizon.

The entrance to the suction line should be located well below the fluid surface so there is no chance of air being sucked into the charge pump inlet. However, the suction line entrance should not be located on the bottom of the reservoir where there may be a buildup of sediment. The suction line entrance should be flared and covered with a screen.

The reservoir should be easily accessible. The fill port should be designed to minimize the possibility of contamination during filling and to help prevent over filling. There should be a drain plug at the lowest point of the reservoir and it should also have a clean-out and inspection cover so the reservoir can be thoroughly cleaned after prolonged use. A vented reservoir should have a breather cap with a micronic filter.

Sealed reservoirs must be used at altitudes above 2500 feet. These reservoirs should be fitted with a two way micronic filter pressure cap to allow for fluid expansion and contraction.

In both cases the caps must be designed to prevent water from entering the reservoir during bad weather or machine washing. A hydrostatic transmission with a well designed reservoir will run quieter, stay cleaner and last longer.
Application Information

Filter
A filter must be used to keep the hydraulic fluid clean. Either a suction filter or a pressure side filter may be used. The filter must be a no-bypass type. A suction filter is shown in the operational diagram on page 46. System oil particulate levels should not exceed ISO 18/13. Refer to Eaton Hydraulic Fluid Recommendations on page 54. Recommended beta ratios for each filter type are listed below:

- Suction Filter $\beta_1 = 1.5$ to 2.0
- Pressure Side Filter $\beta_1 = 10$ to 20

When a suction filter is used, its flow capacity must be large enough to prevent an excessive pressure drop between the reservoir and charge pump inlet. The pressure at the charge pump inlet port must not be less than 0.8 bar (11.6 psi) absolute at normal continuous operating temperatures.

Charge Pump Inlet Line
The inlet line to the charge pump should be large enough to keep the pressure drop between the reservoir and charge pump inlet within the limits described in the filter section. Fittings will increase the pressure drop, so their number should be kept to a minimum. It is best to keep fluid velocities below 1.25 meters (4 feet) per second.

Fluid and temperature compatibility must be considered when selecting the inlet line.

Pump and Motor Case Drain Lines
The case drain lines should be large enough to limit the pump and motor case pressures to 2.8 bar (40 psi) at normal operating temperatures. Fluid and temperature compatibility must also be considered when selecting the case drain lines.

High Pressure Lines
The high pressure lines that connect the pump and motor must be able to withstand the pressures generated in the high pressure loop.

Heat Exchanger
Use of a heat exchanger is dependent on the transmission’s duty cycle and on machine layout. The normal continuous operating fluid temperature measured in the pump and motor cases should not exceed 80°C (180°F) for most hydraulic fluids. The maximum fluid temperature should not exceed 105°C (220°F).

The heat exchanger should be sized to dissipate 25% of the maximum input power available to the transmission. It must also be sized to prevent the case pressures in the pump and motor from getting too high. Case pressure up to 2.8 bar (40 psi), at normal operating temperatures, are acceptable.

Heat Exchanger Bypass Valve
The heat exchanger bypass valve is a pressure and/or temperature valve in parallel with the heat exchanger. Its purpose is to prevent case pressures from getting too high. The heat exchanger bypass valve opens when the oil is thick, especially during cold starts.

Reservoir Return Line
The same general requirements that apply to case drain lines apply to the reservoir return line.
Shaft Couplings and Mounting Brackets

Shaft couplings must be able to withstand the torque that will be transmitted to the pump or motor. If the pump or motor is to be directly coupled to the drive, the misalignment should not exceed 0.050 mm (0.002 in.) total indicator run-out for the combination of perpendicularity and concentricity measurements.

The hardness of the couplings connected to Eaton pump or motor shafts should be 35 Rc for tapered or straight keyed shafts and 50-55 Rc for splined shafts.

Open Loop Circuits

Eaton heavy duty pumps and heavy duty motors may be used in open loop circuits under certain operating conditions. Consult your Eaton representative for details.

Orientation

The mounting orientation of Eaton heavy duty pumps and motors is unrestricted. The case drain line that carries the flow leaving the pump or motor should be connected to the highest drain port on each of the units. This assures that the pump and motor cases remain full.

Multiple Pump or Motor Circuits

Multiple pumps or motors can be combined in the same circuit. When two pumps are used in a parallel circuit, their swashplate controls can be operated in phase or in sequence. The following precautions should be observed whenever multiple pumps and/or motors are connected in the same circuit:

1. Charge pump flow must be greater than the sum of the charge pump flow requirements of the individual units.
2. The possibility of motor overspeeding increases in multiple motor circuits. The parallel motor circuit will act as a frictionless differential. Should one of the motors stall the other could overspeed. The motors used in parallel circuits should, therefore, be sized to prevent overspeeding. Valves that will limit the flow to each of the motors may be used to prevent overspeeding. This will allow the use of smaller motors, however the flow limiting valves will create heat.
3. When using one pump with multiple motors, the case drain lines should be connected in series. The case flow should be routed from the most distant motor, through the remaining motors, to the pump, and finally back to the reservoir. The most distant motor should have the valve block or integral shuttle valve while the additional motors do not need a valve block or integral shuttle valve. A remote valve block is also available for multiple motor circuits. A series-parallel drain line circuit may be needed for the high case flow created in multiple pump circuits. In either case, each pump and motor should be checked for proper cooling when testing the prototype circuit.

4. Series circuits present a unique problem for axial piston motors. Pressure applied to the input port and discharge port are additive as regards to the load and life of the drive shaft and the drive shaft bearings. Please consult with your Eaton representative regarding series circuits.
Description of Operation

Direction of case flow and charge pump inlet flow.

1 – Variable Displacement Pump
2 – Fixed or Variable Displacement Motor
3 – Reservoir
4 – Shut-off Valve (Optional)
5 – Filter
6 – Charge Pump Inlet Line
7 – Pump and Motor Case Drain Lines
8 – High Pressure Lines
9 – Heat Exchanger
10 – Heat Exchanger By-pass Valve
11 – Reservoir Return Line
12 – Reservoir Fill Cap and Breather
A hydrostatic transmission is a dynamic system that operates through a wide range of conditions. Nevertheless, this wide operating range can conveniently be divided into three basic modes: neutral, forward and reverse.

The following color schematics and their accompanying explanations will help you visualize what's going on inside the transmission during each of the operating modes.

**Important:** As you study the following flow descriptions remember that in all modes of operation the input shaft of the pump is being turned by an external power source.

### Neutral

The hydrostatic transmission is in neutral when the variable pump's displacement is zero. With zero displacement no high pressure oil is pumped to the motor and its output shaft is stopped. Refer to the “Neutral” color schematic as you read this explanation.

Putting the control lever in the neutral position centers the control spool. Centering the control spool connects both lines to the servo pistons to case and blocks the control pressure line. Connecting the servo piston lines to case allows the oil to drain from the servo pistons and the servo springs center the variable swashplate. With the swashplate centered the pistons don’t reciprocate as the cylinder barrel is rotated, and no high pressure oil is pumped.

The charge pump, which is connected to the input shaft, pumps oil in all modes of transmission operation. In neutral it takes cooled, filtered oil from the reservoir and fills the system. Charge pump flow passes through the check valves in the pump’s end cover and fills the pump's pistons, the high pressure lines, and the motor's pistons. This oil flow is intended to make up for internal leakage and keep the circuit primed.

After the high pressure circuit has been primed the charge pump pressure opens the charge pressure relief valve located in the charge pump. This directs the charge pump flow through the pump case and back to the reservoir. This oil flow flushes and cools the pump.
Flow Description – Neutral

Axial Piston Variable Displacement Pump & Fixed Displacement Motor Schematic
The forward mode and the reverse mode are similar, so henceforth they will be grouped and called the forward/reverse mode.

**Forward/Reverse**

The hydrostatic transmission is in forward/reverse mode when flow in the high pressure circuit causes the motor shaft to rotate. Refer to the forward/reverse color schematic as you can read this explanation.

Flow in the high pressure circuit is created by tilting the pump’s variable swash plate from its center, or neutral, position. With the swash plate tilted the pistons reciprocate as the cylinder barrel rotates and flow is generated.

The swash plate may be tilted to either side of center. Tilting it one way generates flow that makes the transmission go forward. And tilting it the other way reverses flow and the motor shaft rotates in the opposite direction.

Besides controlling direction, the swash plate angle also controls output speed. Swash plate angle affects speed by changing the pump’s displacement. The largest swash plate angle produces the largest displacement and the fastest motor speed.

The standard control circuit has a single lever that sets both speed and direction. Center the lever for neutral. Move it to one side of center for forward, the other side for reverse. Motor speed is controlled by how far the lever is moved.

The control circuit varies the swash plate angle by directing control pressure to either of the servo pistons. Control pressure, at the charge pressure relief valve setting, is supplied to the control valve by the charge pump. In the forward/reverse schematic control pressure is directed to the lower servo piston which causes the swash plate to tilt. Oil in the upper servo sleeve drains to case, through the control valve, as the swash plate tilts.

The follow-up link, between the swash plate and control valve, holds the swash plate at the angle set by the control lever. As the swash plate moves to the desired angle the follow-up link moves the control spool so that it opens/closes the lines to the servo pistons. The swash plate will hold that position until the control lever is moved.

Charge pump flow that is not used by the control circuit passes through the end cover check valve into the low pressure side of the loop. There it provides back pressure to the motor pistons.

The spring centered shuttle valve, located in the motor’s valve block, moves to connect the low pressure side of the loop to the charge pressure relief valve. When back pressure gets high enough the charge pressure relief valve, in the valve block, opens and charge pump flow enters the motor case.

Case flow flushes the pump and motor cases and helps keep the transmission cool. The charge pressure relief valve in the motor’s valve block typically has a lower setting than the charge pressure relief valve in the charge pump. This is so case flow will begin at the motor, go to the pump, and return to the reservoir. The arrows on the drawing show case flow’s path.

The charge pressure relief valve in the charge pump opens when the transmission is in neutral and the shuttle valve is centered. Compare the shuttle valve in each of the color schematics to better understand its operation.

The high pressure relief valves in the motor’s valve block open to connect the high pressure side of the loop to the low pressure side if the motor stalls and the pressure gets too high. There are two high pressure relief valves; one works in forward and the other in reverse.
Flow Description – Forward/Reverse

Axial Piston Variable Displacement Pump & Fixed Displacement Motor Schematic
Hydraulic Fluid Recommendations

Objective
The ability of Eaton hydrostatic components to provide the desired performance and life expectancy depends largely on the fluid used. The purpose of this document is to provide readers with the knowledge required to select the appropriate fluids for use in systems that employ Eaton hydrostatic components.

Selecting a Hydraulic Fluid
The hydraulic fluids in hydraulic systems are bound to perform in different dimensions. They serve as the power transmission medium, lubricate the moving components and carry away the heat produced within the system. Therefore the fluids must have adequate properties to give the assurance of adequate wear protection, effective power transmission and excellent chemical stability under the most adverse operating conditions. The multi dimensional performance establishes that the hydraulic fluid is a vital factor in a hydraulic system; proper selection of oil assures satisfactory life and operation of the system components / lubricants.

Viscosity
The most important characteristics to consider when choosing a fluid to be used in a hydraulic system are viscosity. The fluid must be thin enough to flow easily but thick enough to seal and maintain a lubricating film between bearing and sealing surfaces. Viscosity requirements for Eaton's Heavy Duty Hydrostatic product line are specified later in this document.

Viscosity and Temperature
Temperature and viscosity are related inversely. As the fluid warms, it gets thinner and its viscosity decreases. When fluid cools, the fluid viscosity increases. It is important to consider the entire operating temperature window for selecting the right viscosity for a hydraulic system. Calculate the viscosity of the fluid temperatures at startup, normal operating conditions and maximum possible point, and compare the same with the recommendation of the hydraulic system.

Generally, the fluid is thick when the hydraulic system is started. With movement, the fluid warms to a point where the cooling system begins to operate. From then on, the fluid is maintained at the temperature for which the hydrostatic system was designed. In actual applications this sequence varies; hydrostatic systems are used in many environments from very cold to very hot. Cooling systems also vary from very elaborate to very simple, so ambient temperature may affect operating temperature. Equipment manufacturers who use Eaton hydrostatic components in their products should anticipate temperature in their designs and make the appropriate fluid recommendations to their customers.

In general, a lower ISO viscosity grade fluid is recommended for operation in cold to moderate climates. Higher ISO viscosity grade fluid is recommended for operation in moderate to hot climates.

Cleanliness
Cleanliness of the fluid in a hydrostatic system is extremely important. Eaton recommends that the fluid used in its hydrostatic components be maintained at ISO Cleanliness Code 18/13 per SAE J1165. This code allows a maximum of 2500 particles per milliliter greater than 5 µm and a maximum of 80 particles per milliliter greater than 15 µm. When components with different cleanliness requirements are used in the same system, the cleanest standard should be applied. OEM's and distributors who use Eaton hydrostatic components in their products should provide for these requirements in their designs. A reputable filter supplier can supply filter information.
Hydraulic Fluid Recommendations

Viscosity and Cleanliness Guidelines

<table>
<thead>
<tr>
<th>Product Line</th>
<th>Minimum</th>
<th>Optimum Range</th>
<th>Maximum</th>
<th>ISO Cleanliness Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Duty Piston</td>
<td>10cSt</td>
<td>16 - 39 cSt</td>
<td>2158 cSt</td>
<td>18/13</td>
</tr>
<tr>
<td>Pumps and Motors</td>
<td>(60 SUS)</td>
<td>(80 - 180 SUS)</td>
<td>(10,000 SUS)</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- Fluids too thick to flow in cold weather start-ups will cause pump cavitation and possible damage. Motor cavitation is not a problem during cold start-ups. Thick oil can cause high case pressures which in turn cause shaft seal problems.
- If the natural color of the fluid has become black it is possible that an overheating problem exists.
- If the fluid becomes milky, water contamination may be a problem.
- Take fluid level reading when the system is cold.
- Viscosity modified fluid may lose viscosity due to shearing of viscosity improvers.
- Contact your Eaton representative if you have specific questions about the fluid requirements of Eaton hydrostatic components.
Hydraulic Fluid Recommendations

**Fluid Maintenance**
Maintaining correct fluid viscosity and cleanliness level is essential for all hydrostatic systems. Since Eaton hydrostatic components are used in a wide variety of applications it is impossible for Eaton to publish a fluid maintenance schedule that would cover every situation. Field testing and monitoring are the only ways to get accurate measurements of system cleanliness. OEM’s and distributors who use Eaton hydrostatic components should test and establish fluid maintenance schedules for their products. These maintenance schedules should be designed to meet the viscosity and cleanliness requirements laid out in this document.

**Fluid Selection**

**AW Hydraulic Oil**
Premium grade petroleum based AW hydraulic fluids will provide the best performance in Eaton hydrostatic components. These fluids typically contain additives that are beneficial to hydrostatic systems. Eaton recommends fluids that contain anti-wear agents, rust inhibitors, anti-foaming agents, and oxidation inhibitors. Premium grade petroleum based hydraulic fluids carry an ISO VG rating. Pump performance and reliability are directly affected by the anti-wear additive formulation contained in the oil. Oils providing a high level of anti-wear protection are recommended for optimum performance and long life. Eaton has its own method to estimate Mineral / Petroleum based AW hydraulic oils for their anti-wear property. The fluid must pass Eaton Vickers® 35VQ25 pump test or meet the performance specification Eaton Vickers M 2950 S.

**Engine Oils / Motor Oils**
Engine oils using for hydraulic applications, must meet API SF / SG / SH or higher performance specifications. Appropriate SAE Grade to be selected based on the operating temperatures.

**Additional Notes:**
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- If the natural color of the fluid has become black it is possible that an overheating problem exists.
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Hydraulic Fluid Recommendations

Biodegradable Oil (Vegetable) Guidelines

<table>
<thead>
<tr>
<th>Product Line</th>
<th>Rating With Biodegradable Oil</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Duty Piston Pumps and Motors</td>
<td>80% of normal pressure rating listed for mineral oils</td>
<td>82° C (180° F) max fluid temp (unit) 71° C (160° F) max fluid temp (reservoir)</td>
</tr>
</tbody>
</table>

Additional Notes:

- Viscosity and ISO cleanliness requirements must be maintained as outlined on previous page.
- For any system where the fluid is non-petroleum oil, set the target one Range Code cleaner for each particle size, than that of petroleum fluids.
  
  If the cleanest code required was 19/17/15 and HETG is the system fluid, the target becomes 18/16/14.
  
- Based on limited product testing to date, no reduction in unit life is expected when operating at the pressure ratings indicated above.
- Vegetable oil is miscible with mineral oil. However, only the vegetable oil content is biodegradable. Systems being converted from mineral oil to vegetable oil should be repeatedly flushed with vegetable oil to ensure 100% biodegradability.
- Specific vegetable oil products may provide normal unit life when operating at pressure ratings higher than those indicated above.
- Vegetable oils oxidize more quickly than petroleum based hydraulic fluid. Care must be taken to maintain fluid temperature within specified limits and to establish more frequent fluid change intervals.
- All seals must be Fluorocarbon (FKM) / Viton / HNBR.
- Specific gravity of the fluid is 0.92. Design circuit with reservoir oil level sufficiently above the pump inlet to assure a minimum of 1.0 bar absolute pressure at pump.
- Water contamination may degrade the fluid - 0.07% wt Maximum. Precaution to be taken to avoid water contamination.
- Foaming and aeration can be greater with this fluid than petroleum base oils. Reservoir may be designed to give maximum retention time for effective air release.
- TAN - 2.0 mg KOH/gm Max increase in total acid number from the start up value.

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