No. 11-608
January 1997

Eaton®
Heavy Duty Hydrostatic Pumps

Series 2

Contents

Hydraulics

We Manufacture Solutions

Features

- **430 Bar Pressure Rating**
- **Speeds to 4510 RPM**
- **3 Year Warranty**
- **Electronic Controls**
- **1 Year Warranty on Electronics**

The Eaton® Series 2 Heavy Duty Pump

Many off-highway mobile equipment manufacturers rely on Eaton for their hydrostatic drives for a variety of applications. The Advanced Series 2 Heavy Duty pump, with a cradle swashplate design, combines the time-tested reliability you expect from Eaton with compact packaging, exceptional control and quieter operation. New, pump mounted, electronic controls range from the simple Electronic Proportional (EP) Displacement Control to the sophisticated CAN (Controller Area Network) Multiplex (MUX) Displacement and Pressure Control.

The Series 2 Pump's single piece pump housing provides exceptional strength and soundproofing. Eaton's cast iron housing has only one major opening versus two openings for competitive pumps. This provides a stronger, more rigid pump housing and reduces the number of gasketed joints.

Several available drive shaft configurations–straight keyed, splined, or tapered–ensures the proper shaft for your application.

The high-strength, one-piece swashplate has the swashlever and servo-pin integrated into the swashplate, delivering increased reliability without adding extra weight.

The large diameter single-servo piston permits pump operation at lower charge pressures, minimizing parasitic charge pump losses for increased overall pump efficiency. A large centering spring, housed within the servo piston, returns the pump to neutral in the event of control pressure loss.

The new integral gerotor-type charge pump combines excellent suction/speed capabilities in a compact design. Several displacement options are available to suit the needs of every application, including tandem pumps.

The pump-mounted electronics and sensors have been specially designed to resist electromagnetic interference or emissions.

The serviceable bi-metal bearing plate has steel for high pressure capability and a bronze bearing face for high speed capabilities.

SAE auxiliary mountings "A," "B," "B-B" and "C" are available.

The main system ports – SAE code 61 and code 62 – are available with SAE or Metric threads.

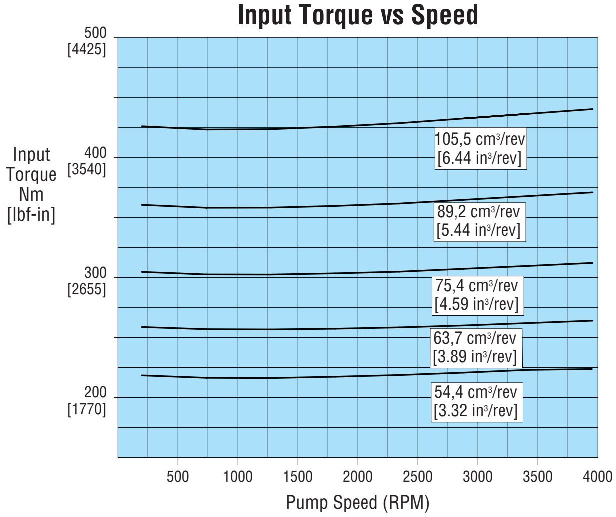
Performance Data - Hydrostatic Pump

Typical Pump Performance

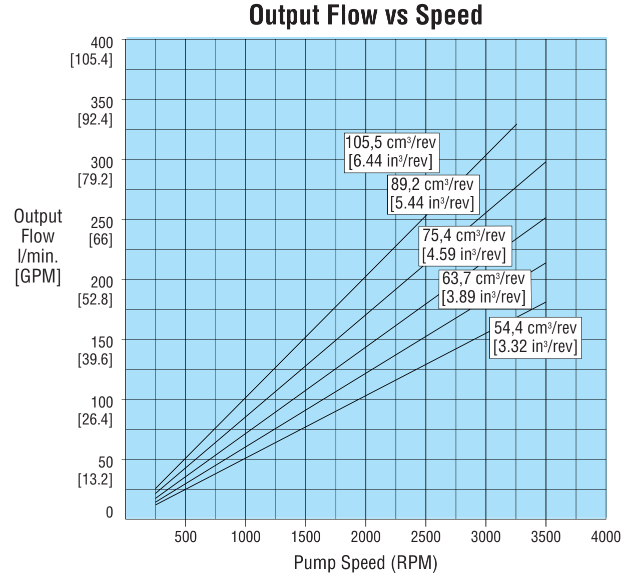
Model Number		33	39	46	54	64
Displacement	cm³/rev	54,4	63,7	75,4	89,2	105,5
	in³/rev	3.32	3.89	4.59	5.44	6.44
Maximum Shaft Speed*	RPM @ Maximum Displace.	4510	4165	4165	3720	3720
Rated Pressure	bar [PSI]	430 [6250]	430 [6250]	430 [6250]	430 [6250]	430 [6250]
Output Flow	LPM @ 240 bar	235	255	301	318	376
	GPM @ 3500 PSI	62.2	67.2	79.5	84.1	99.4
Input Torque	Nm @ 240 bar	218	256	303	358	424
	lbf-in @ 3500 PSI	1944	2278	2694	3189	3771

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

Input Torque vs Speed



Output Flow vs Speed



System Pressure	240 bar [3500 PSI]
Oil Viscosity	10 cSt [60 SUS]
Temperature	82°C [180°F]

Standard High Torque Charge Pump Performance Data (Available on all displacements)

Eaton offers a choice of five charge pump displacements to go with its heavy duty hydrostatic pump. This Charge Pump option allows for greater through torque for tandem applications. These charge pumps include a large standard suction port and a gauge-pilot pressure port. One or more of the following options are also available:

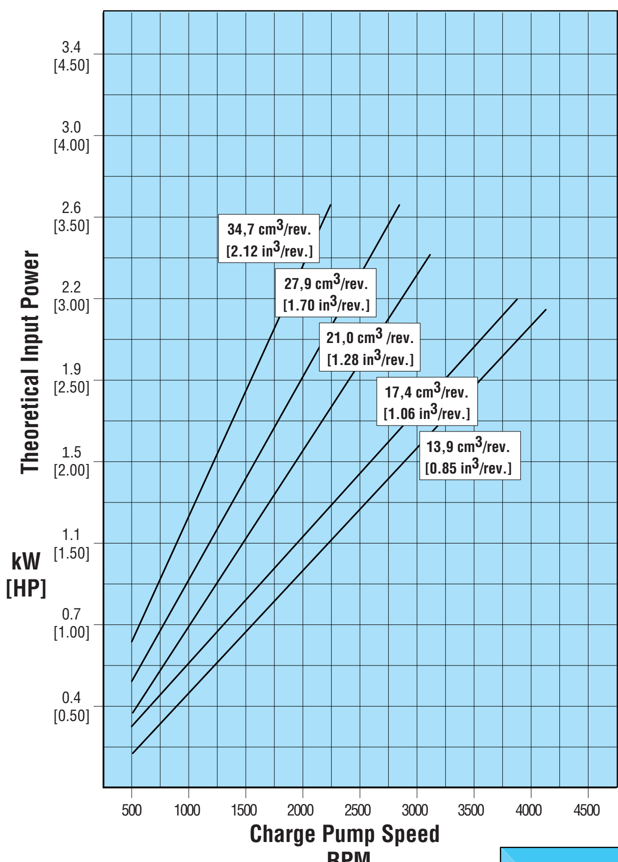
- A spin-on pressure side filter
- SAE Mounting flanges for auxiliary pumps

Charge Pump Performance

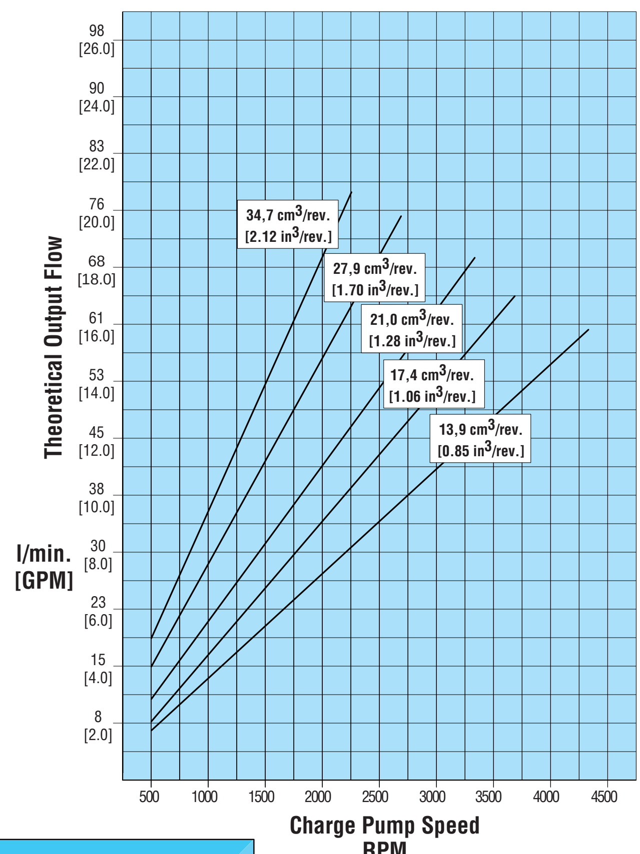
Displacement	cm^3/rev	13,9	17,4	21,0	27,9	34,7
	in^3/rev	0.85	1.06	1.28	1.70	2.12
Maximum Shaft Speed	RPM	4300	3700	3300	2700	2250
Output Flow* at Maximum Speed	LPM	59,9	64,3	69.2	75,2	78,2
	GPM	15.8	17.0	18.3	19.9	20.6
Input Power* at 21 bar [305 PSI] and Maximum Speed	kW	2,10	2,25	2,42	2,63	2,74
	HP	2.81	3.02	3.25	3.53	3.67

*Theoretical output flow and input power at 21 bar [305 PSI] and maximum input speed.

Charge Pump Power vs Speed



Charge Pump Flow vs Speed



Oil Viscosity	10 cSt [60 SUS]
Temperature	82°C [180°F]

Optional High Speed Charge Pump Performance Data (Available only on Models 33, 39 and 46 pumps)

Eaton offers a choice of five charge pump displacements to go with its heavy duty hydrostatic pump. This Charge Pump option allows for higher pump input speeds. These charge pumps include a large standard suction port and a gauge-pilot pressure port. One or more of the following options are also available:

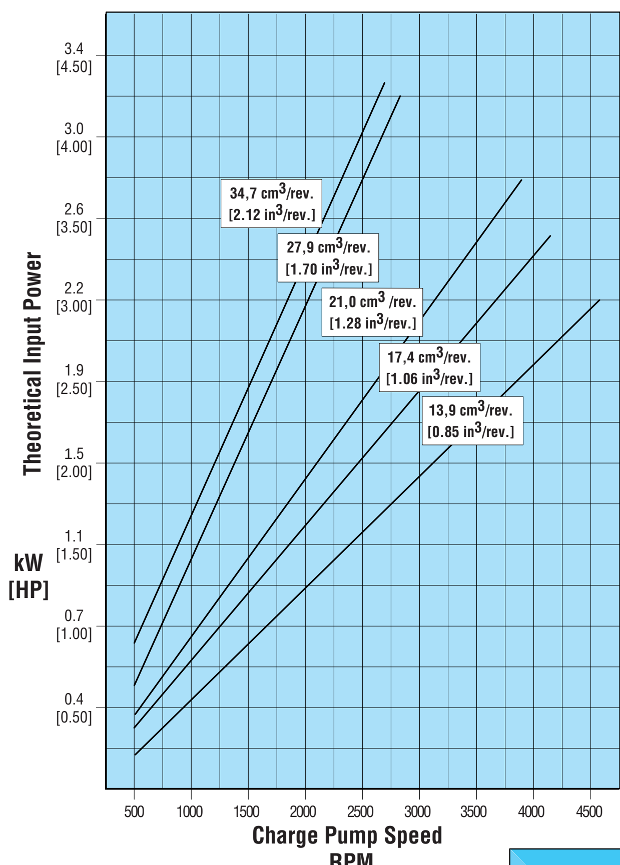
- A spin-on pressure side filter
- SAE Mounting flanges for auxiliary pumps

Charge Pump Performance

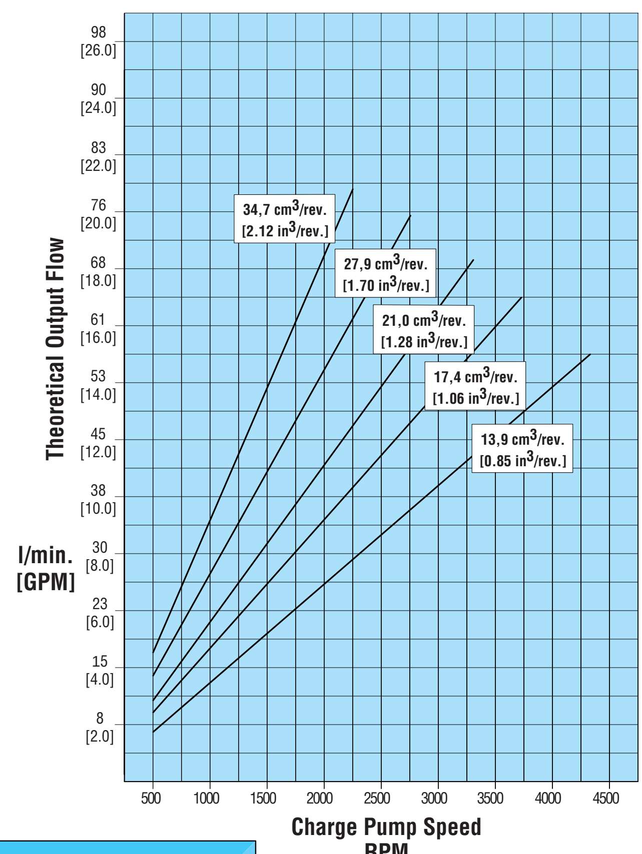
Displacement	cm^3/rev	13,9	17,4	21,0	27,9	34,7
	in^3/rev	0.85	1.06	1.28	1.70	2.12
Maximum Shaft Speed	RPM	4510	4165	3800	3100	2650
Output Flow* at Maximum Speed	LPM	62,8	72,3	79,7	86,4	92,1
	GPM	16.6	19.1	21.1	22.8	24.3
Input Power* at 21 bar [305 PSI] and Maximum Speed	kW	2,2	2,53	2,79	3,02	3,22
	HP	2.95	3.39	3.74	4.05	4.32

*Theoretical output and input power at 21 bar [305 PSI] and maximum input speed.

Charge Pump Power vs Speed



Charge Pump Flow vs Speed



Oil Viscosity	10 cSt [60 SUS]
Temperature	82°C [180°F]

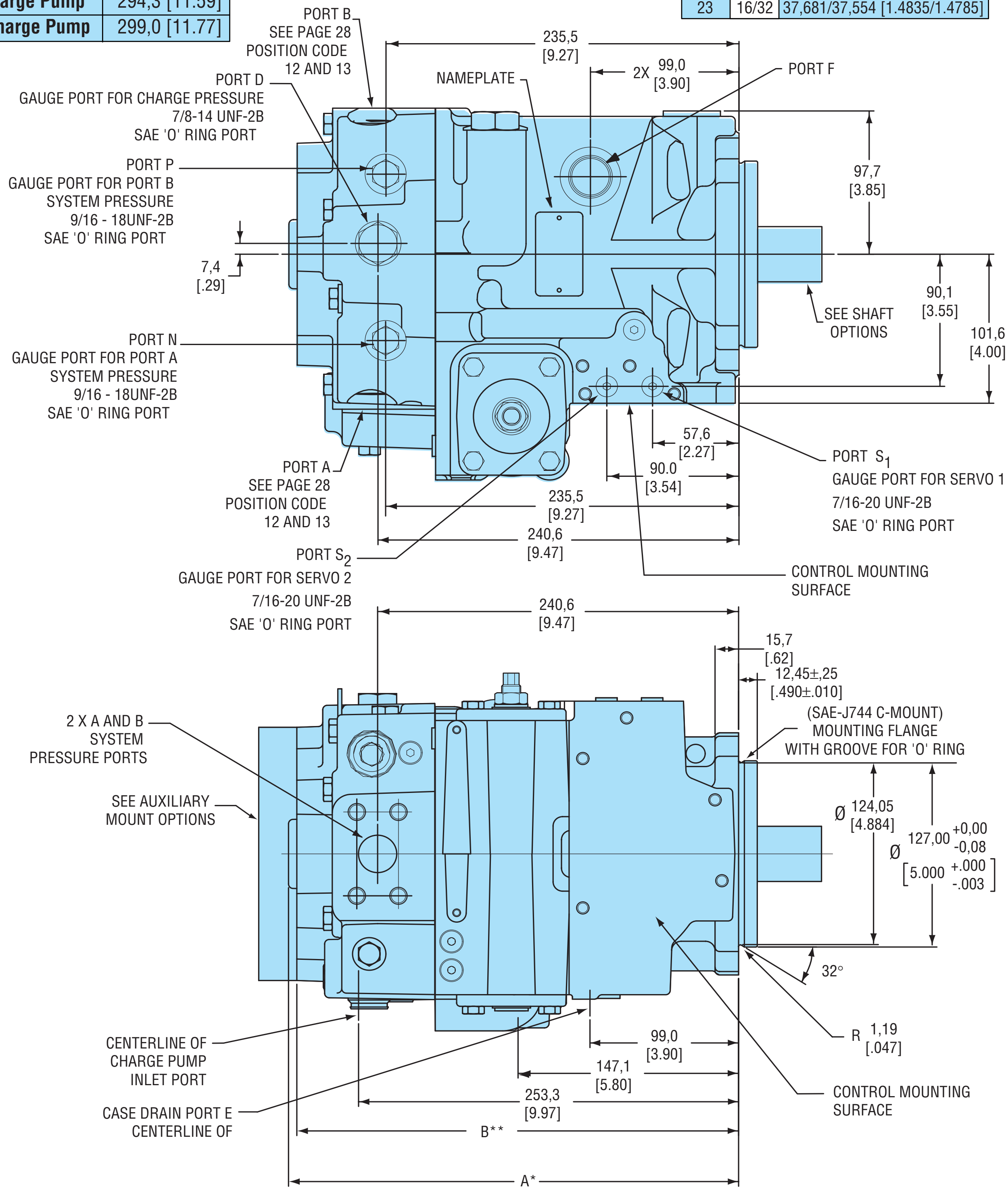
Charge Pump Displacement	*Dimension A High Speed Charge Pump	*Dimension A High Torque Charge Pump
13,9 cm³/r [.85 in³/r]	296,8[11.69]	300,3[11.82]
17,4 cm³/r [1.06 in³/r]	300,0[11.81]	303,7[11.96]
21.0 cm³/r [1.28 in³/r]	303,2[11.94]	307,2[12.10]
27,9 cm³/r [1.70 in³/r]	309,5[12.19]	314,1[12.37]

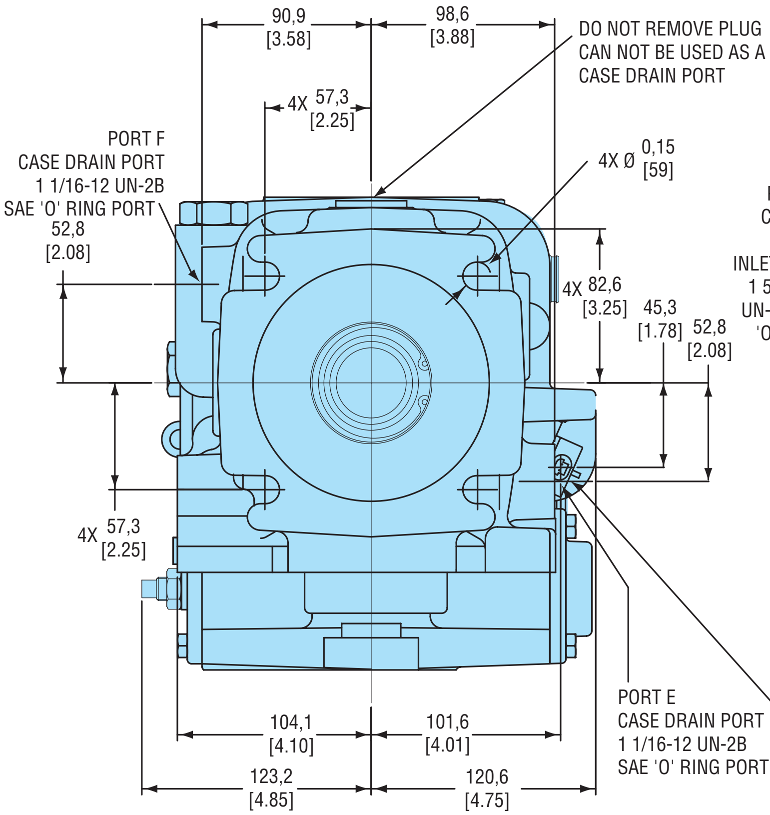
** Dimension B	
High Speed Charge Pump	294,3 [11.59]
High Torque Charge Pump	299,0 [11.77]

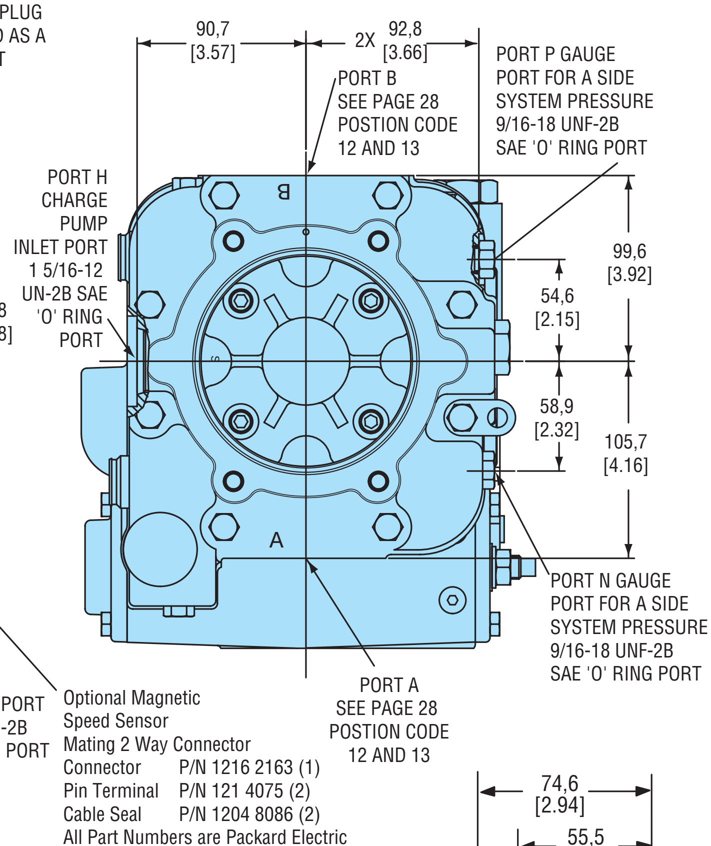
Pump Dimensions

54,4 – 63,7 – 75,4 cm³/rev
[3.32] – [3.89] – [4.6] in³/rev

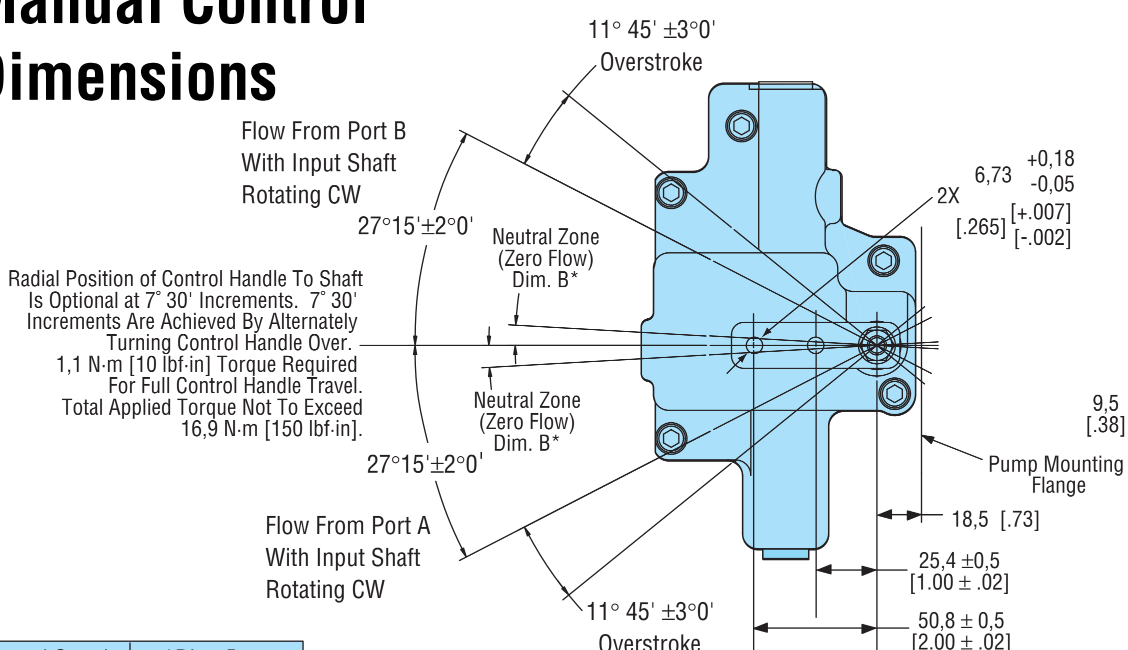
Tooth	Pitch	Shaft Diameter
14	12/24	31,224/31,097 [1.2293/1.2243]
21	16/32	43,506/34,379 [1.3585/1.3535]
23	16/32	37,681/37,554 [1.4835/1.4785]

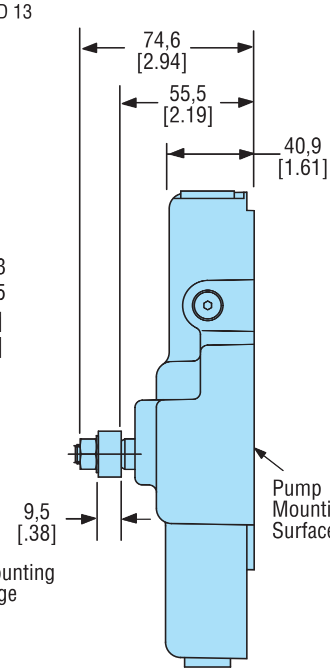






Manual Control Dimensions



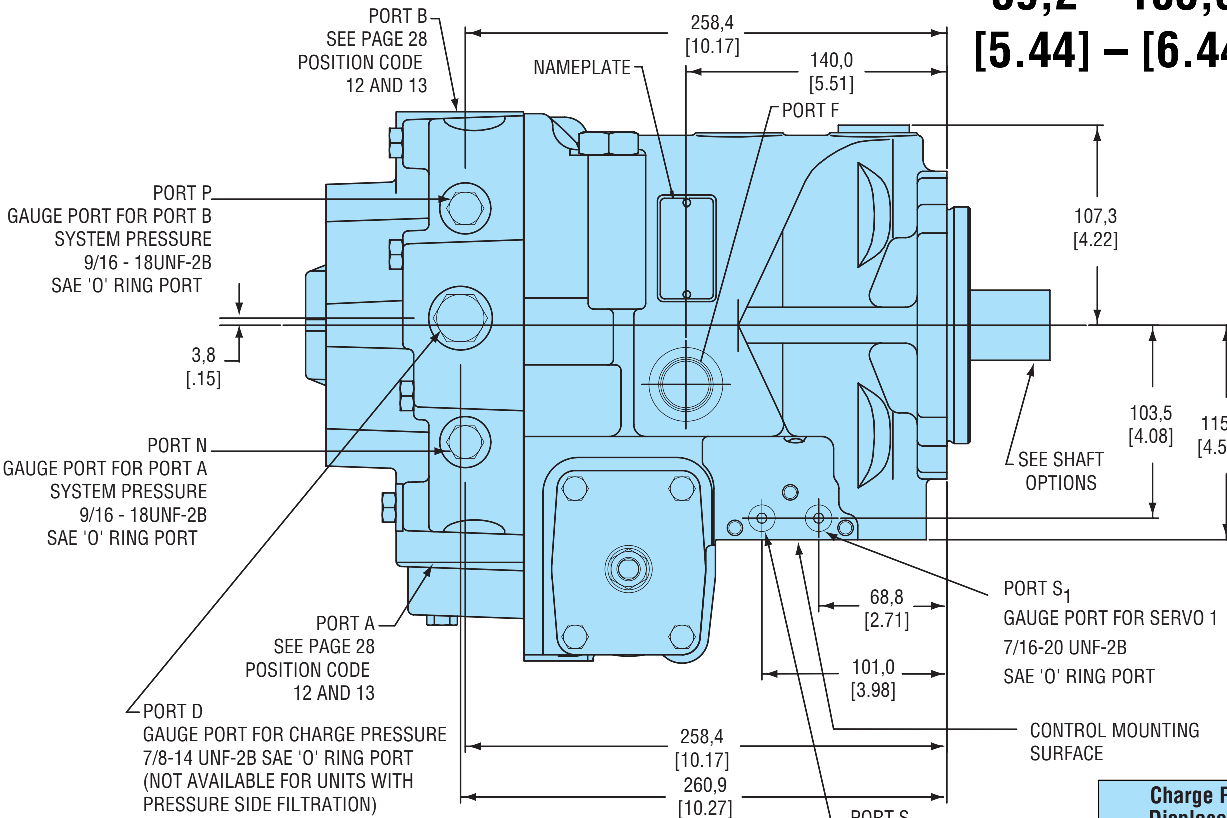


Control Handle Detail

Control Spool	*Dim. B
Standard	2° 30' ±1° 45'
Wide Band	4° 15' ±1° 45'

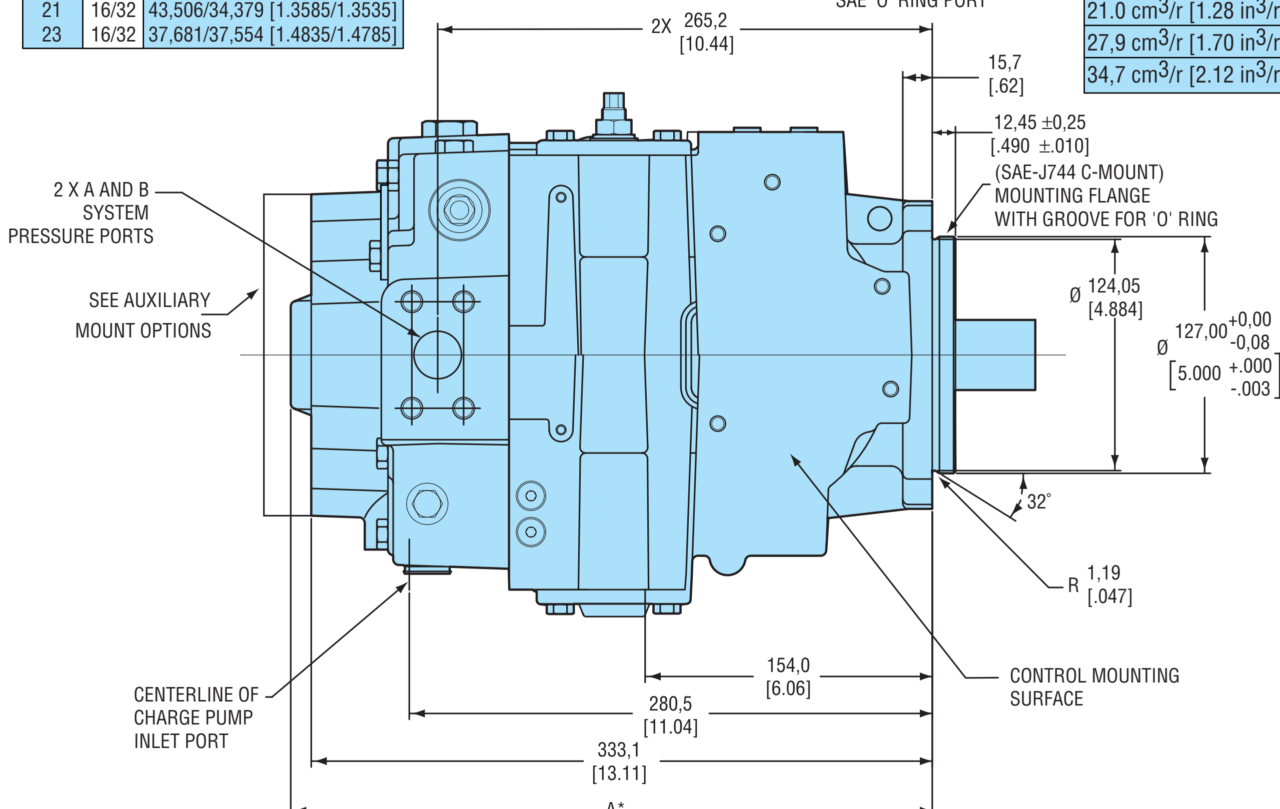
Pump Dimensions

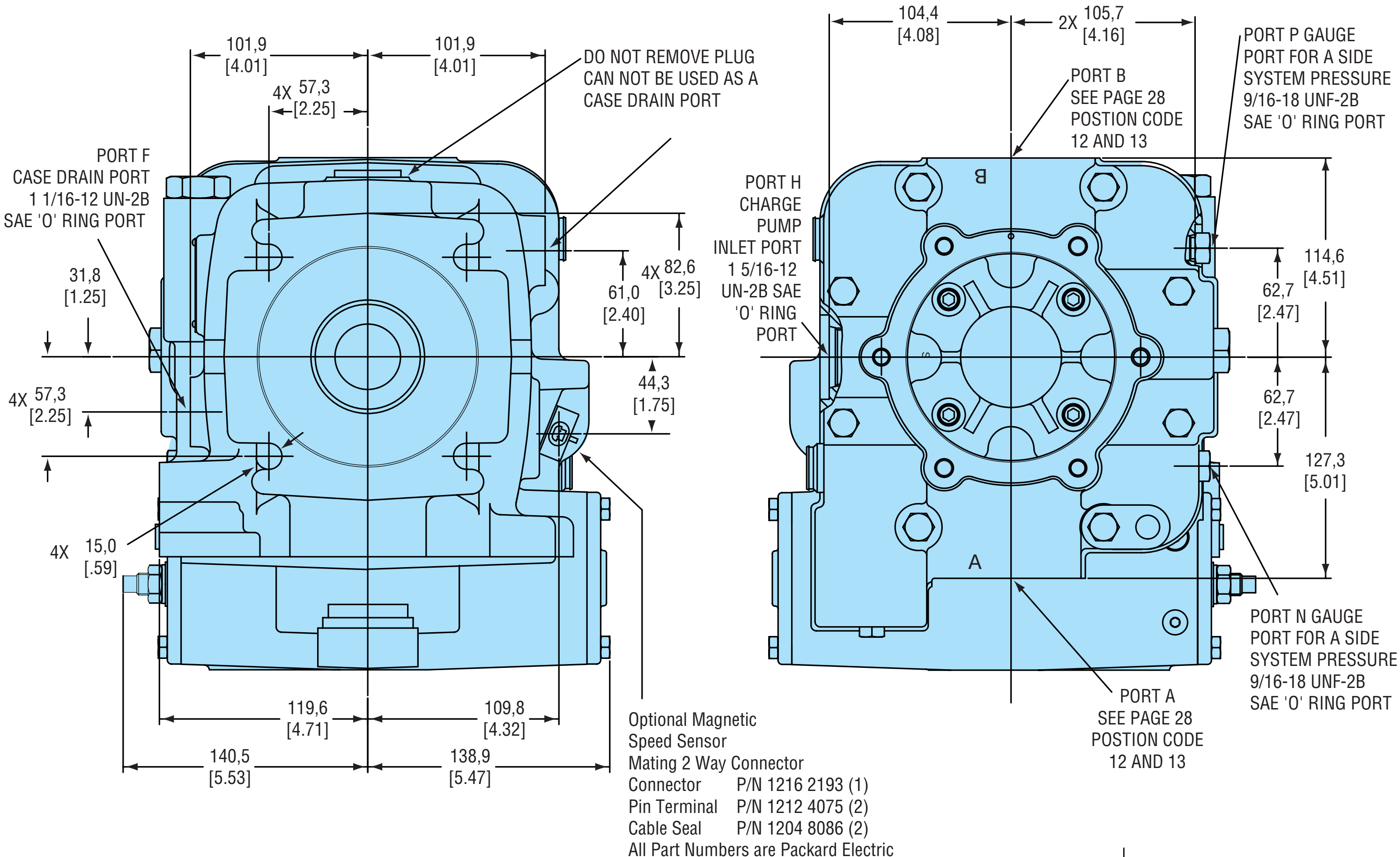
89,2 – 105,5 cm^3/rev
[5.44] – [6.44] in^3/rev



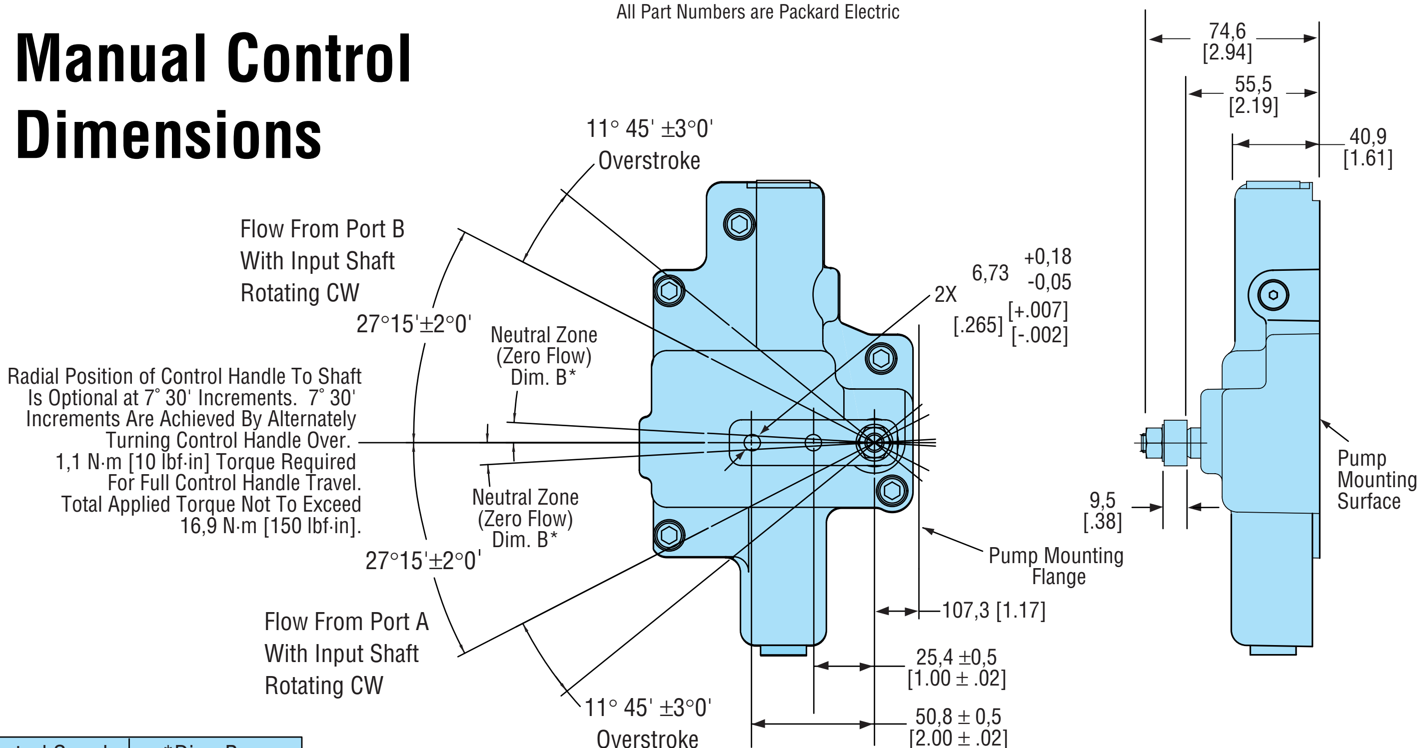
Charge Pump Displacement	*Dimension A
13,9 cm^3/r [.85 in^3/r]	337,1 [13.27]
17,4 cm^3/r [1.06 in^3/r]	340,5 [13.40]
21.0 cm^3/r [1.28 in^3/r]	344,0 [13.55]
27,9 cm^3/r [1.70 in^3/r]	350,9 [13.81]
34,7 cm^3/r [2.12 in^3/r]	357,7 [14.08]

Tooth	Pitch	Shaft Diameter
14	12/24	31,224/31,097 [1.2293/1.2243]
21	16/32	43,506/34,379 [1.3585/1.3535]
23	16/32	37,681/37,554 [1.4835/1.4785]





Manual Control Dimensions



Control Handle Detail

Control Spool	*Dim. B
Standard	2° 30' ±1° 45'
Wide Band	4° 15' ±1° 45'

Application Information

Component Descriptions

The operational diagram on page 12 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:

Variable Displacement Axial Piston Pump

The pump provides a flow of high pressure oil. The typical transmission employs a variable displacement piston pump. The variable displacement feature allows the amount of oil pumped to be varied, which controls the motor's 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.

Eaton's Series 2 Pump offers High Pressure Relief Valves and Pressure Override Control for system high pressure protection. (see page 26 for a description of these features).

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

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 an 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.

Important: Remember, the pump generates flow, and the load on the motor's output shaft causes resistance to that flow. That resistance to flow is what creates the high pressure. Hence, the oil flowing in the lines that connect the pump and motor, (illustrated in "red") is called "high pressure flow."

The pump and motor are contained in separate housings. This configuration provides maximum flexibility in vehicle design and transmission installation. The drawing on page 12 illustrates a typical closed loop hydrostatic circuit.

The Charge Pump

The charge pump generates a low pressure flow of oil to perform the following functions:

1. Supplies a positive boost pressure to the pistons of the piston pump and piston motor.
2. Keeps the closed loop circuit full of oil.
3. Provides cool, clean oil from the reservoir to keep the transmission pump and motor well lubricated and cooled.
4. Provides control pressure to the pump's displacement control servo valve for easy control of the transmission's output speed.

The charge pump is integrated into the piston pump and it's drive shaft and is driven by the shaft of the piston pump. The drawing shows the charge pump draws oil through a filter mounted downstream from the reservoir. Eaton recommends a suction filter without a bypass valve. The charge pump has a Low Pressure Relief Valve that regulates the output pressure.

The Composite Valve Block

A hydrostatic system can also be specified with High Pressure Relief Valves located in a Composite Valve Block, bolted directly to the motor. This Valve Block contains two High Pressure Relief Valves, the Shuttle Valve and the Low Pressure Relief Valve.

The advantage with this transmission is that the motor is shorter, requiring less space.

Heat Exchanger, Reservoir, Filter, and Oil Lines

The heat exchanger, reservoir, filter, and oil lines are all necessary for heavy duty hydrostatic transmission operation.

The heat exchanger interconnects the case flow outlet and the reservoir,

Application Information (Cont.)

cooling the oil before it enters the reservoir. The heat exchangers must be fitted with a bypass valve that opens when case drain pressure gets too high. The bypass valve is especially important during cold starts when the oil is thick.

The reservoir provides space for the oil to expand as it gets hot and for entrapped air to escape. The filter is installed between the reservoir and the charge pump inlet. It removes contaminants from the oil. Eaton recommends a filter without a bypass valve, and that it be selected so that the inlet pressure of the charge pump suction port be not less than 0.8 bar [11.6 psi] absolute.

The oil lines provide passage ways for the oil flowing between the transmission components. They must be strong enough to withstand the pressures generated and may be rigid or flexible.

Description of Operation

A hydrostatic transmission is a dynamic system that operates through a wide range of conditions. These operating conditions can be divided into three operating modes: neutral, forward and reverse.

The color schematic on page 12 and the accompanying explanations will describe the three operating modes.

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.

When the control lever is in the neutral position it centers the control valve. Centering the control valve connects both pilot servo piston ports to pump case drain and blocks the control pressure port. Connecting the servo piston ports to case allows the oil to drain from the servo pistons and the pump servo springs to center the variable swashplate. With the swashplate centered the pistons don't reciprocate as the cylinder barrel is rotated, and no flow is generated.

In neutral the charge pump flow passes through the check valves in the pump's end cover and fills the pump pistons, the high pressure lines, and the motor pistons. This oil flow replaces internal leakage and keeps the closed circuit charged.

Excess charge pump flow is vented through the charge pressure relief valve. This oil travels through the pump case and back to the reservoir, flushing and cooling the pump.

Please note the oil flow direction arrow in the operational diagram. Oil flow leaves the reservoir through the suction filter to the charge pump. The charge pump fills the passages shown in the "orange" color. When these passages and the hydraulic lines are filled, the charge pump relief valve relieves the charge pump flow into the piston pump housing. After the piston pump housing is filled the charge pump flow returns to the reservoir through the heat exchanger.

Forward/Reverse

The hydrostatic transmission is in the forward/reverse condition when flow in the closed loop circuit cause the motor shaft to rotate.

Flow in the closed loop circuit is created by tilting the pump's variable swashplate from its center, or neutral position. With the swashplate tilted the pistons reciprocate as the cylinder barrel rotates and flow is generated.

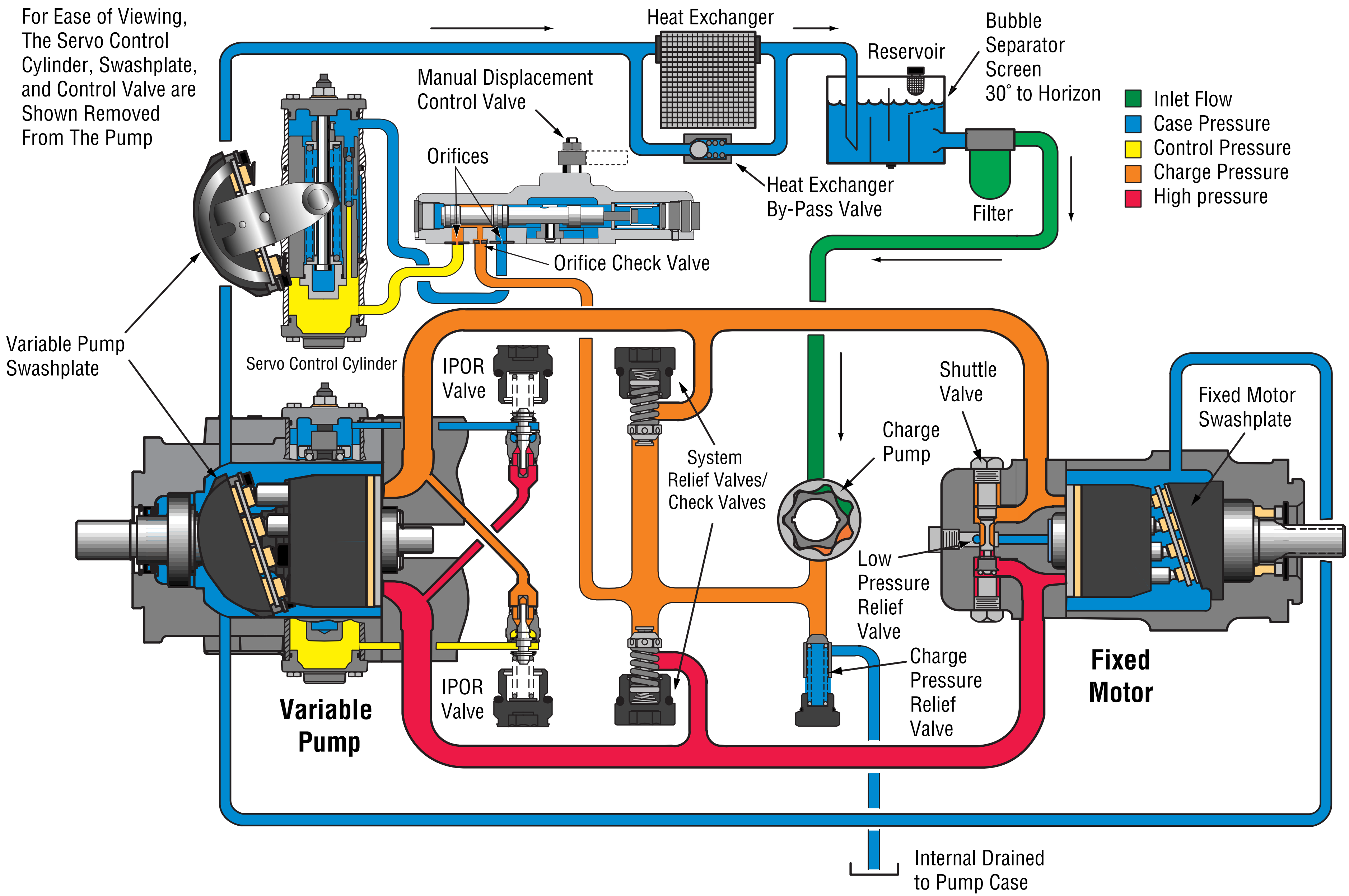
The swashplate may be tilted to either side of center. Tilting it one way generates flow that makes the transmission go forward. Tilting it the other way reverses flow and the motor shaft rotates in the opposite direction.

In addition to controlling direction, the swashplate angle also controls output speed. Swashplate angle affects speed by changing the pump's displacement. The largest swashplate angle produces the largest displacement and the fastest motor speed.

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

Operational Diagram

Note:
For Ease of Viewing, The Servo Control Cylinder, Swashplate, and Control Valve are Shown Removed From The Pump



Typical Series 2 Variable Displacement Pump/Fixed Displacement Motor Schematic

Application Information (Cont.)

The control lever varies the swashplate angle by directing control pressure to either end of the servo piston. Control pressure, regulated by the charge pressure relief valve is supplied to the control valve by the charge pump. In the diagram on the opposite page the control pressure is directed to one end of the servo piston which causes the swashplate to tilt. Oil in the opposite end of the servo piston drains to the pump case, through the control valve as the swashplate tilts.

The feedback linkage, between the swashplate and control valve, holds the swashplate at the angle set by the control lever. As the swashplate moves to the desired angle the feedback link moves the control spool so that it opens/closes the lines to the servo piston. The swashplate will hold the commanded 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 providing charge pressure to the motor pistons and the pump pistons.

The spring centered shuttle valve, located in the motor, moves by high pressure and connects the low pressure side of the closed loop to the low pressure relief valve. The low pressure relief valve is set at a pressure that is 4 bar [60 psi] lower than the charge pump relief valve. This lower pressure setting causes the low pressure relief valve in the motor to relieve excess charge pump flow into the motor case. This action flushes the closed circuit with clean, cool oil.

Component Selection

The long service life of Eaton hydrostatic transmission is largely dependent on the proper selection and installation of the components necessary for transmission operation.

The following components are necessary for transmission operation:

1. Variable Displacement Pump
2. Fixed or Variable Displacement Motor
3. Reservoir
4. Filter
5. Charge Pump Inlet Line
6. Pump and Motor Case Drain Lines
7. High Pressure Lines
8. Heat Exchanger
9. Heat Exchanger Bypass Valve
10. Reservoir Return Line

Refer to the operational drawing on page 12 as you read this section.

1. Variable Displacement Pump

Eaton heavy duty hydrostatic variable displacement pumps are an axial piston design. They are equipped with standard SAE mounts, shafts and port connections.

2. Fixed or Variable Displacement Motor

Eaton heavy duty hydrostatic motors are an axial piston design. They are equipped with standard SAE mounts, shafts and port connections.

3. 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.

Application Information (Cont.)

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.

4. 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 12.

System oil particulate levels should not exceed ISO 18/13. Refer to Eaton Hydraulic Fluid Recommendations on page 16.

Recommended beta ratios for each filter type are listed below:

Suction Filter β_{10} = 1.5 to 2.0

Pressure Side Filter β_{10} = 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.

5. 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.

6. Pump and Motor Case Drain

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.

7. 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.

8. 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.

9. 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.

10. Reservoir Return Line

The same general requirements that apply to case drain lines apply to the reservoir return line.

Application Information (Cont.)

Shaft Couplings and Mounting Brackets

Shaft couplings must be able to with stand 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 .050 mm [.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.

Pump Valve Plates

Eaton Heavy duty pumps may be fitted with either a V-groove valve plate or a propel valve plate. Propel valve plates should be used in applications where overrunning loads may be present.

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.

Installation

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.

Hydraulic Fluid Recommendations

Introduction

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.

One of the most important characteristics to consider when choosing a fluid to be used in a hydraulic system is viscosity. Viscosity choice is always a compromise; 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

Fluid temperature affects viscosity. In general, as the fluid warms it gets thinner and its viscosity decreases. The opposite is true when fluid cools. When choosing a fluid, it is important to consider the start-up and operating temperatures of the hydrostatic 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.

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.

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

Premium grade petroleum based 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.

SAE grade crankcase oils may be used in systems that employ Eaton hydrostatic components, but it should be noted that these oils may not contain all of the recommended additives. This means using crankcase oils may increase fluid maintenance requirements.

Hydraulic fluids that contain V.I. (viscosity index) improvers, sometimes called multi-viscosity oils, may be used in systems that employ Eaton hydrostatic components. These V.I. improved fluids are known to "shear-down" with use. This means that their actual viscosity drops below the rated value. Fluid maintenance must be increased if V.I. improved fluids are used. Automotive automatic transmission fluids contain V.I. improvers.

Synthetic fluids may be used in Eaton hydrostatic components. A reputable fluid supplier can provide information on synthetic fluids. Review applications that require the use of synthetic fluids with your Eaton representative.

Hydraulic Fluid Recommendations (Cont.)

Viscosity and Cleanliness Guidelines

Product Line	Minimum	Optimum Range	Maximum	ISO Cleanliness Requirements	Comments
Heavy Duty Piston Pumps and Motors	10cSt [60 SUS]	16 - 39 cSt [80 - 180 SUS]	2158 cSt [10,000 SUS]	18/13	

Additional 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.
- Contact your Eaton representative if you have specific questions about the fluid requirements of Eaton hydrostatic components.

Biodegradable Oil (Vegetable) Guidelines

Product Line	Rating With Biodegradable Oil	Comments
Heavy Duty Piston Pumps and Motors	80% of normal pressure rating listed for mineral oils.	82° C (180° F) max fluid temp (unit) 71° C (160° F) max fluid temp (reservoir)

Additional Notes:

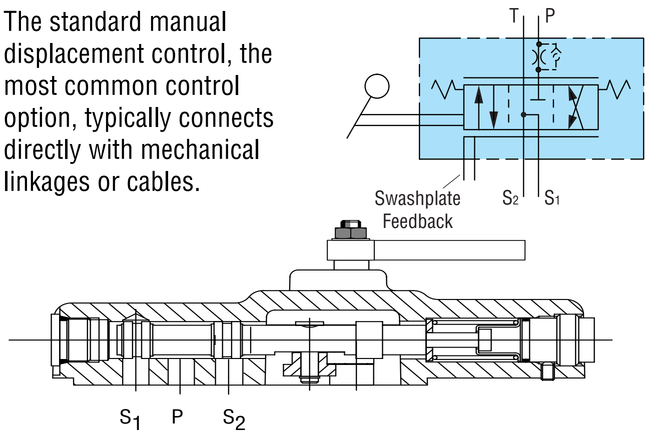
- Viscosity and ISO cleanliness requirements must be maintained as outlined on page 14.
- Based on limited product testing to date, no reduction in unit life is expected when operating at the pressure ratings indicated above.
- Vegetable oil is miscible with mineral oil. However, only the vegetable oil 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.

Control Option Descriptions (Model Code Positions 18 & 19)

The wide variety of available controls on the Eaton® Heavy Duty Series 2 Pump and options on the charge pump offer vehicle designers the controls necessary for optimal vehicle performance. Many of these controls are combined as single control options; please refer to the model code for the specific option configuration. For combinations other than shown, contact an Eaton representative

Standard Manual Displacement Control (MA)

The standard manual displacement control, the most common control option, typically connects directly with mechanical linkages or cables.

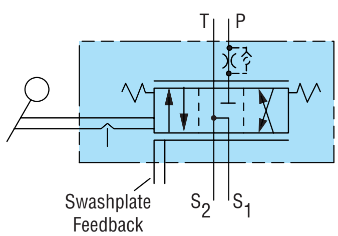


Manual Displacement Control with Wide Band Neutral Detent (ML)

This control is the same as the above with an increased netural band.

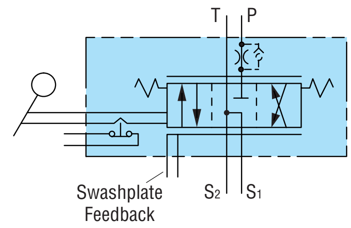
Manual Control with Neutral Detent (MC)

The neutral detent feature provides a more positive feel when finding neutral. This option is ideal for transmissions with long control linkages or cables, or in other situations where there is a great deal of space between the operator station and the pump.

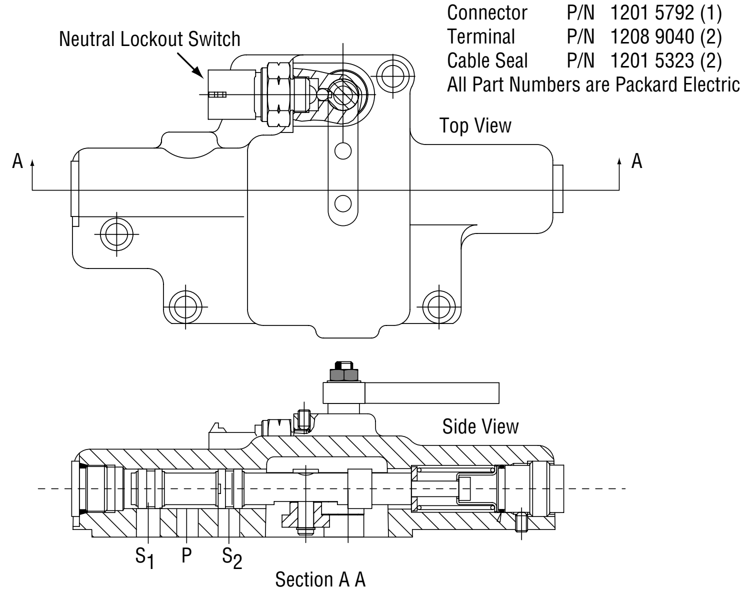


Manual Control with Neutral Lockout (MB)

The neutral lock-out feature is an electrical switch that is closed or open 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. 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.



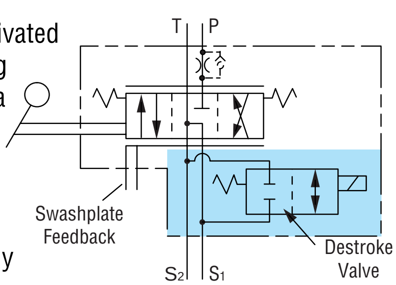
(Normally Closed Switch Shown)



Control Special Features (Model Code Position 23)

Destroke Valve (3)

The destroke solenoid valve, when activated, causes the pump to destroke and go to zero displacement. This valve may be used as a safety device. Typically, the valve is activated by a seat switch detecting operator presence or by a remote emergency stop switch on the operator's console. It is available in 12 or 24 Vdc and either normally open or normally closed configurations.



Electronic Proportional Displacement Control (EE, EF, EG, EH, EJ, EK, EL, EM)

Model Code	Model Code Description		Typical Input Devices
	Command Input Signal	Power Supply	
EE	1 to 5 Vdc Potentiometric	12 Vdc	Joysticks or Potentiometers with a resistance between 500 ohms and 50K ohms.
EF		24 Vdc	
EG	4 to 20 mA Current Loop	12 Vdc	Programmable Logic Controllers (PLC)
EH		24 Vdc	
EJ	± 5 Vdc differential	12 Vdc	PLC and PC analog cards
EK		24 Vdc	
EL	± 100 mA differential	12 Vdc	Torque motor servo valve current drivers
EM		24 Vdc	

The Electronic Proportional (EP) displacement control is ideal for applications that are replacing mechanical cables. The EP displacement control provides the flexibility of four command input choices. The control consists of a proportional solenoid actuated valve assembly and a pulse width modulated (PWM) control driver module mounted on the pump. The PWM control driver module converts the command input signal to a proportional current output. The proportional solenoid actuated valve assembly converts the current output of the PWM control driver into a proportional pump displacement.

The EP displacement control has been designed to withstand the rigors of off-highway equipment environmental conditions.

EP Displacement Control Features

- Ease of installation
- Automotive style environmentally sealed Metri-Pack connectors
- Operates from 12 or 24 Vdc power supply
- External fuse (customer supplied): 2A for 12 Vdc system, 1A for 24 Vdc system
- Four choices for command input signal
- Operating temperature range -40° to +85° C
- PWM control driver module encapsulated for environmental protection
- Closed loop current control compensates for resistance change of the proportional solenoid temperature variations
- 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
- PWM control drive module qualification per SAE J1455, SAE J1113, CISPR 25

PWM Control Driver Module Qualification

(Contact Eaton for Specific Levels)

- *SAE J1455 - Recommended Environmental Practices for Electronic Equipment Design*

  Humidity/Temperature Extreme Cycling
  Salt Spray
  Splash & Immersion
  Steam Cleaning/High Pressure Wash
  Vibration
  Mechanical Shock
  Temperature Cycling
  Load Dump Transients
  Inductive Load Switching Transients

- *SAE J1113 - Electromagnetic Susceptibility Measurement Procedures for Vehicle Components*

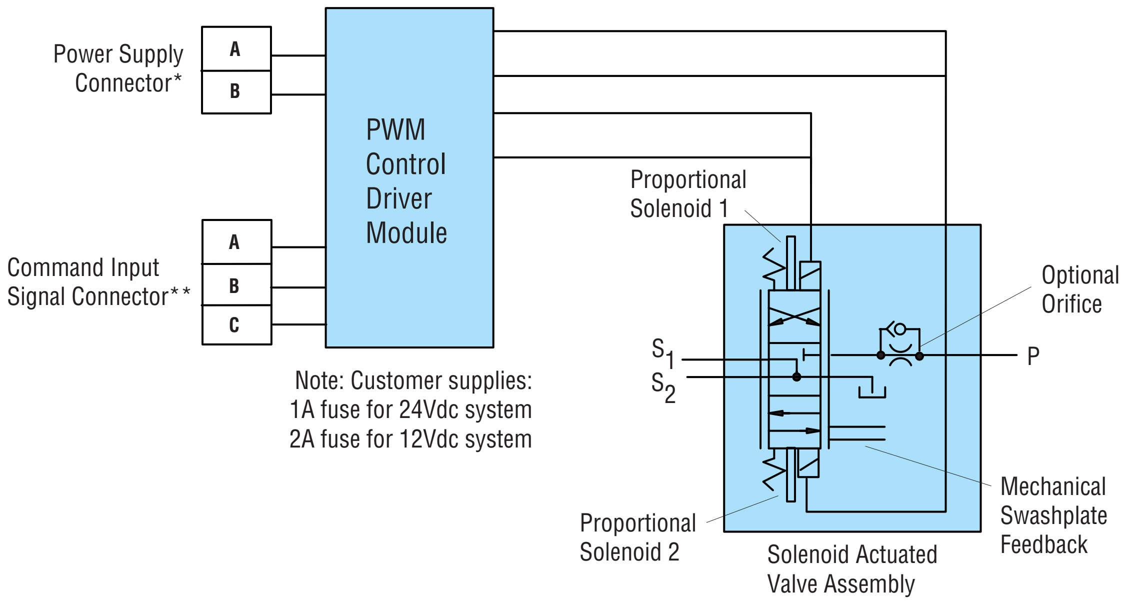
  EMI/EMC - Conducted & Radiated Immunity

- *CISPR 25 - International Electrotechnical Commission "Limits and Methods of Measurement of Radio Disturbance Characteristics for the Protection of Receivers used on Board Vehicles".*

  EMI /EMC - Conducted & Radiated Emissions

Electronic Proportional Displacement Control (EE, EF, EG, EH, EJ, EK, EL, EM) Cont.

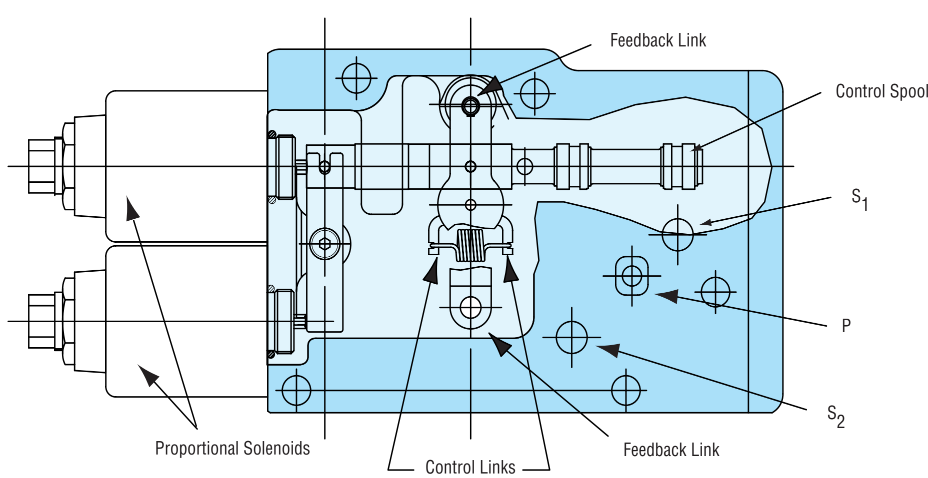
Interface Schematic



**Command Input Signal Connector			
Command Input Signal	Pins	Wire Color	Signal
1 to 5 Vdc Potentiometric	A	Black	Ref Low - 1 Vdc
	B	Green	Command (wiper)
	C	Red	Ref Hi - 5 Vdc
4 to 20 mA Current Loop	A	Orange	Loop Return
	B	White	Loop In
	C	No Connection Required	
± 5 Vdc Differential	A	Brown	Input Low
	B	White	Input Hi
	C	No Connection Required	
± 100 mA Differential	A	Blue	Loop Return
	B	White	Loop In
	C	No Connection Required	

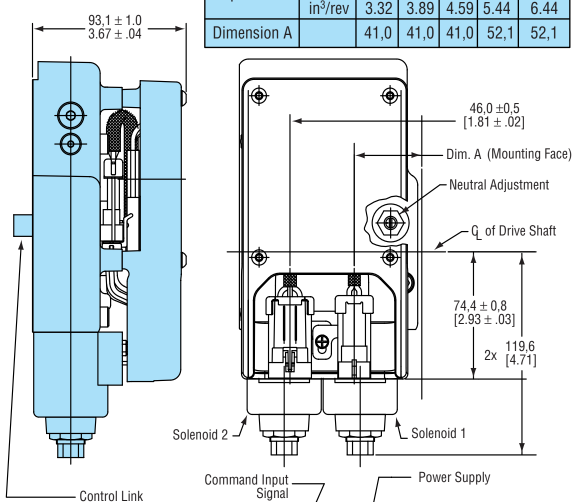
*Power Supply Connector		
Pins	Wire Color	Signal
A	Red	+ Supply Voltage
B	Black	Supply Return

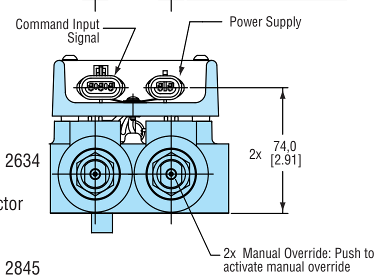
Solenoid Actuated Valve Assembly



Electronic Proportional Displacement Control (EE, EF, EG, EH, EJ, EK, EL, EM) Cont.

Displacement	cm³/rev	54,4	63,7	75,4	89,2	105,5
	in³/rev	3.32	3.89	4.59	5.44	6.44
Dimension A		41,0	41,0	41,0	52,1	52,1



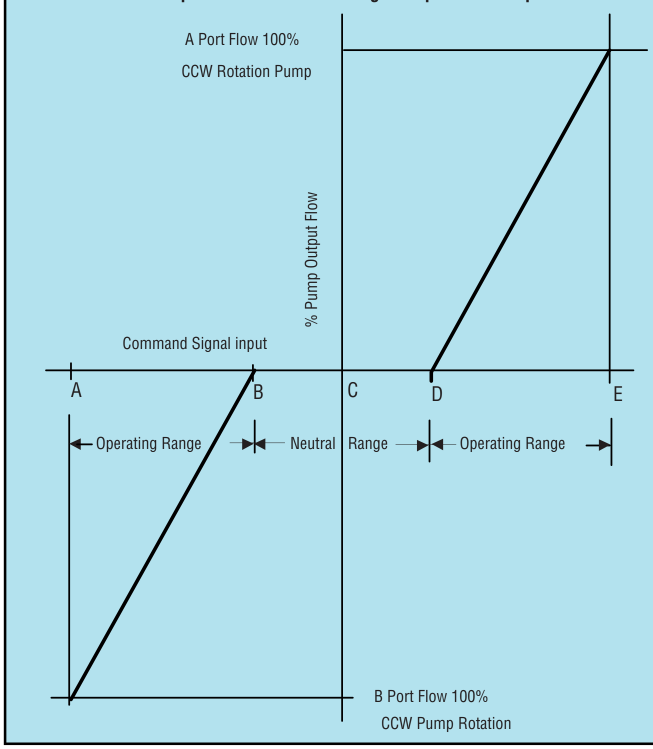


Mating Connectors:
Power Supply 2- pin connector
Connector P/N 1205 2641
Terminal P/N 1204 8074
2 Way TPA (Conn & Mate) P/N 1205 2634

Command Input Signal 3 Pin Connector
Connector P/N 1211 0293
Terminal P/N 1204 8074
3 Way TPA (Conn & Mate) P/N 1205 2845
All part numbers are Delphi/Packard

Command Input Signal	A	B	C	D	E
1 to 5 Vdc	1 Vdc	2.8 Vdc	3 Vdc	3.2 Vdc	5 Vdc
4 to 20 ma	4 mA	11.2 mA	12 mA	12.8 mA	20 mA
± 5 Vdc	-5 Vdc	-0.5 Vdc	0 Vdc	+0.5 Vdc	+5 Vdc
± 100 mA	-100 mA	-10 mA	0 mA	+10 mA	+100 mA

General Relationship between Command Signal Input and Pump Flow



CAN Multiplex Control (EB)

Type of Control	Control Model Code	Model Code Description
Displacement Control	**EB** (position 18,19)	CAN Multiplex Electronic Displacmenet Control
Pressure Control	**EB** (position 18,19)	CAN Multiplex Electronic Displacement Control
Note: This option can provide both displacement and pressure control.	**A** (position 14)	Pressure Transducer - Port A
	A (position 15)	Pressure Transducer - Port B
	02 (position 16,17)	Magnetic Speed Sensor

The CAN Multiplex (MUX) Control is a fast and accurate electronic control for displacement and/or pressure control. The CAN Multiplex control is designed to interface with a main vehicle computer containing software for the desired vehicle characteristics and system diagnostics.

The CAN Multiplex Control for displacement and/or pressure control includes a Solenoid Control with a rotary potentiometer for swashplate feedback. The pressure control option also includes two pressure transducers and a speed sensor.

Potential CAN Multiplex Control applications include automotive drive control, motor output torque or pressure control, motor output speed control, multiple pump control and programmed pump control.

The MUX control has been designed to withstand the rigors of off-highway equipment environmental conditions.

CAN Multiplex Control Features

- Ease of installation - single external connector
- Pump mounted electronics and sensors
- Automatically accommodates for 12 or 24 Vdc power supply
- External 5A fuse (customer supplied)
- Operating temperature -40°C to +105°C
- Environmentally sealed
- Electric short and open protection
- Reverse voltage protection
- Diagnostics accessible from CAN
- Dual-error channel design for return to neutral
- Return to neutral for loss of electrical swashplate feedback, loss of pressure sensor, loss of solenoid or loss of CAN communication
- Continuous calibration for improved temperature compensation
- Multiplex design for simpler cable harnesses and sharing of sensor data
- CAN electrical interface options include J1939/11 (Bosch layer)
- CAN protocol per SAE J1939
- CAN Multiplex electronics qualification per SAE J1455, SAE J1113, CISPR/D/WG2, ISO 7637.

CAN Multiplex Electronics Qualification

(Contact Eaton for Specific Levels)

- SAE J1455 - Recommended Environmental Practices for Electronic Equipment Design

  Humidity/Temperature Extreme Cycling
  Salt Spray
  Splash and Immersion
  Steam Cleaning/High Pressure Wash
  Vibration
  Mechanical Shock
  Temperature Cycling
  Inductive Switching Transients
  ESD Unpowered

- SAE J1113 - Electromagnetic Susceptibility Measurement Procedures for Vehicle Components

  EMI/EMC - Conducted & Radiated Immunity
  ESD Powered

- CISPR/D/WG2 Subcommittee D - *International Electrotechnical Commission "Limits and Methods of Measurement of Radio Disturbance Characteristics for the Protection of Receivers used on Board Vehicles".*

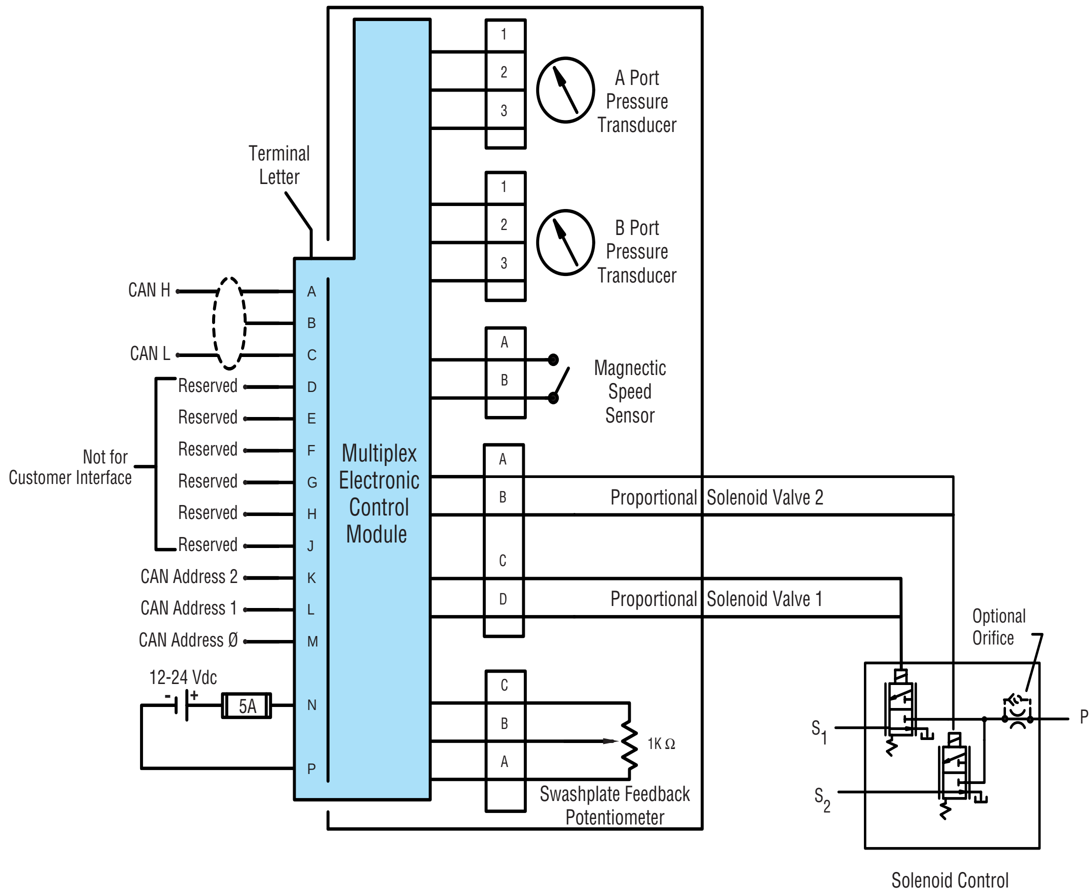
  EMI/EMC Conducted & Radiated Emissions

- ISO 7637 - Road Vehicles - Electrical Disturbance by Conduction & Coupling

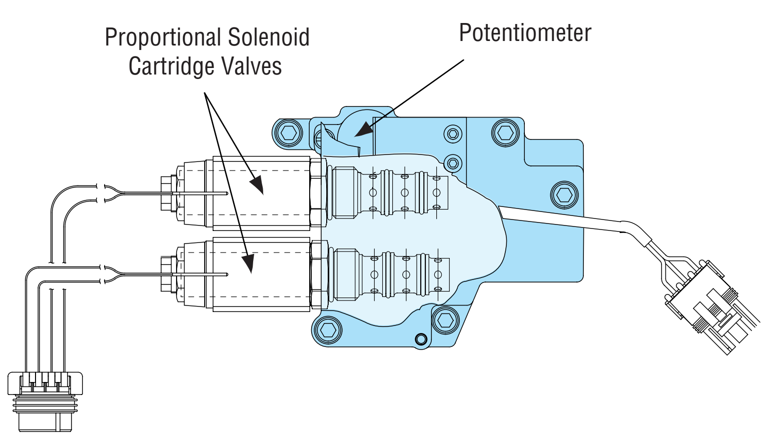
  Load Dump Transients

CAN Multiplex Control (EB) Cont.

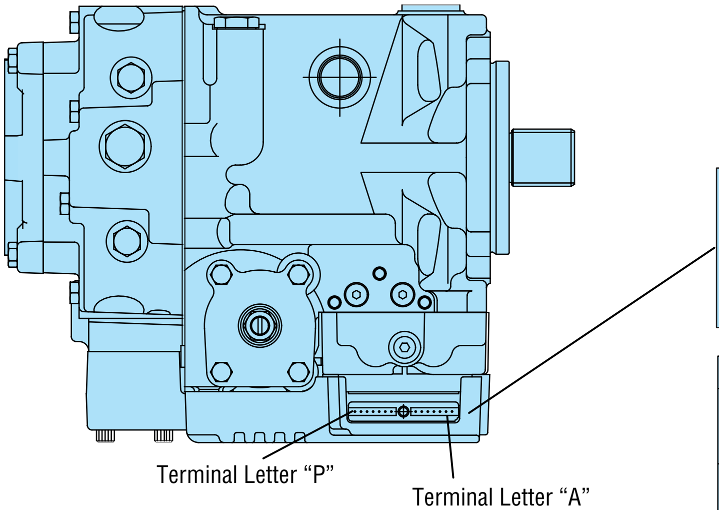
Interface Schematic



Solenoid Control with Potentiometer



CAN Multiplex Control (EB) Cont.

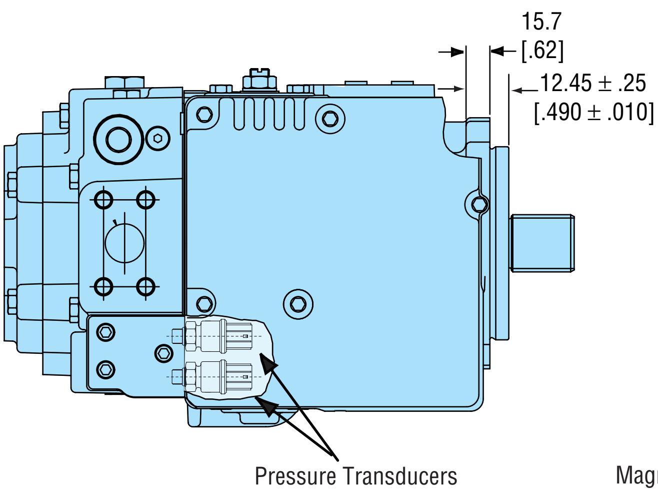


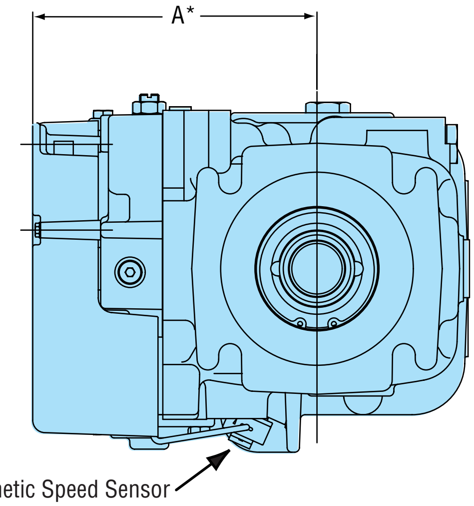
Mating 14 Way Connector

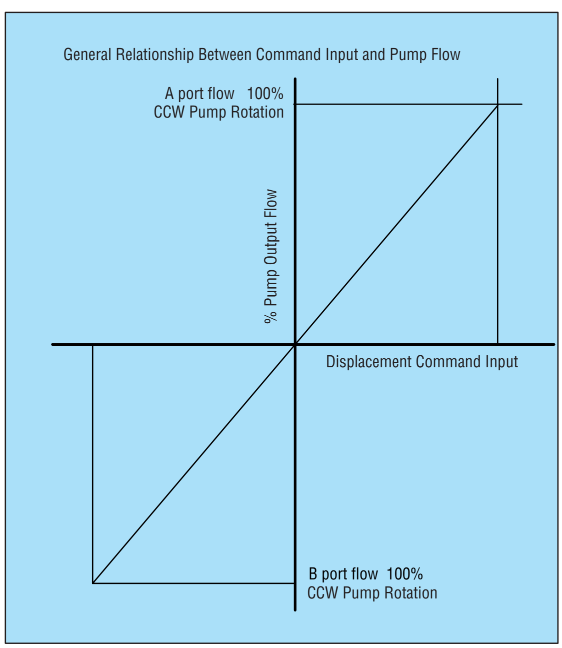
Housing	P/N 1203 4163 (1)
Housing Terminal	P/N 1204 7680 (8)
Housing Plug	P/N 1203 4413 (6)

All Numbers are Packard Electric

Displacement	*Dimension A
54,3; 63,7; 75,3 cm^3/rev [3.32, 3.89, 4.59 in^3/rev	187,5 [7.38]
89,1; 105,4 cm^3/rev [5.44, 6.43 in^3/rev]	213,5 [84.05]







Hydraulic Remote Control (HA)

The hydraulic remote pump control makes it possible for the machine operator to control speed by changing pump displacement via a remote pilot pressure signal. The angle of the swashplate, that determines pump displacement, is proportional to the pilot pressure. Typical pressure requirements are 5-15 bar [72.5 -217.5 psi] with a swashplate angle from 0° to 18°, (15.5˚ for the Model 33).

The direction of flow, and therefore the direction of the vehicle, is reversed by applying the control pressure to the opposite inlet port of the hydraulic remote pump control.

The hydraulic remote pump control is readily adaptable in the following applications:

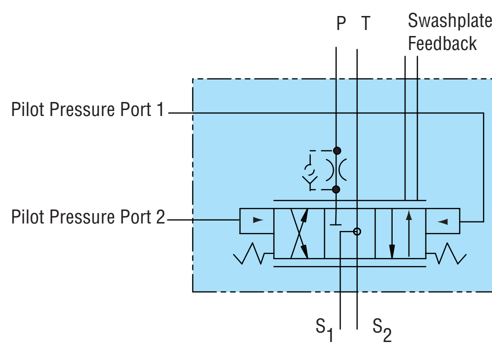
- Where remote transmission control is needed
- Where control cables or linkages are not feasible
- Where electronic controls cannot be used.

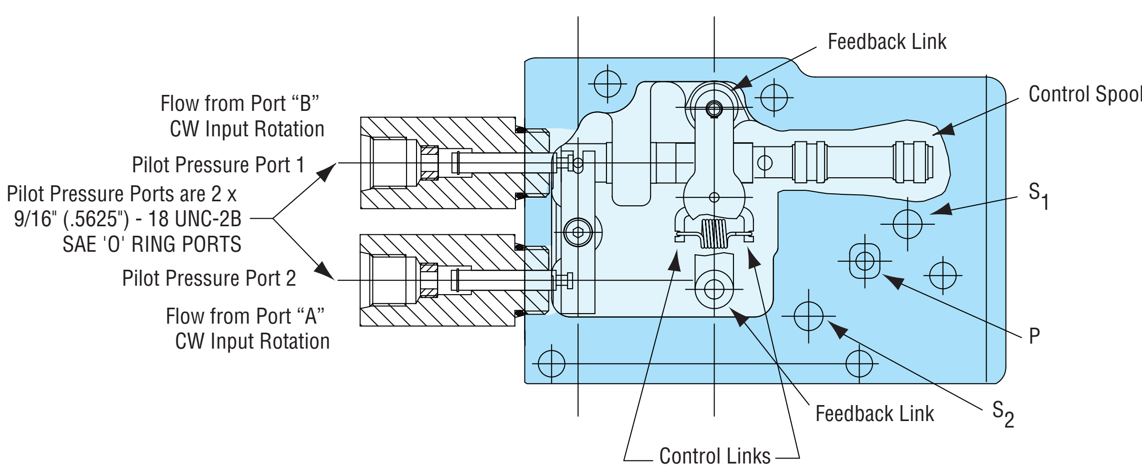
The Eaton hydraulic remote pump control is compatible with:

- All Eaton Series 2 Variable Pumps (Models 33-64)
- Other Eaton control options such as the destroke control, inching control, and pressure override
- Most commercially available hydraulic command stations

The hydraulic remote pump control is a three position, four-way closed center (spring centered) hydraulically activated servo control. This control, like the manual displacement control uses the feedback linkage connected directly to the swashplate.

The control spool is activated to position the swashplate by regulating the remote pilot pressure to the control piston. There are various manufacturers of command stations that can be used to supply this remote pilot pressure.





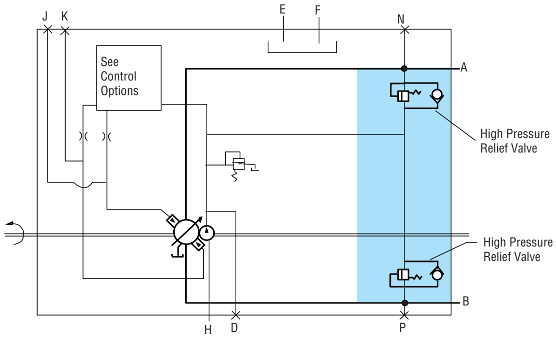
Hydraulic Remote Control

Pump Features and Options

High Pressure Relief Valve

(Model Code Position 12 & 13)

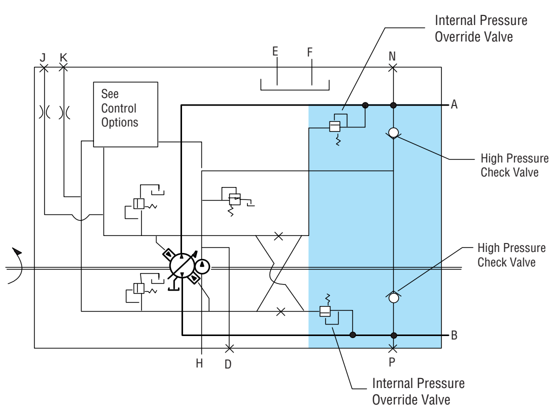
The High Pressure Relief Valves for ports A and B activate whenever system pressure equals the relief valve setting. The valves are direct acting and help protect system components from excessive pressure spikes.



Pressure Override

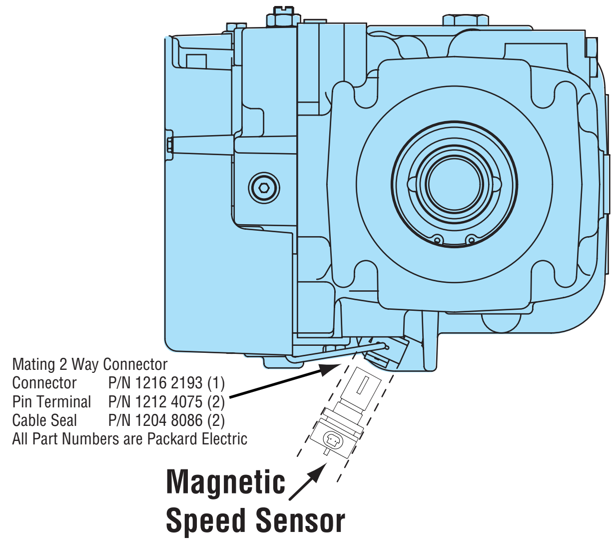
(Model Code Position 14 & 15)

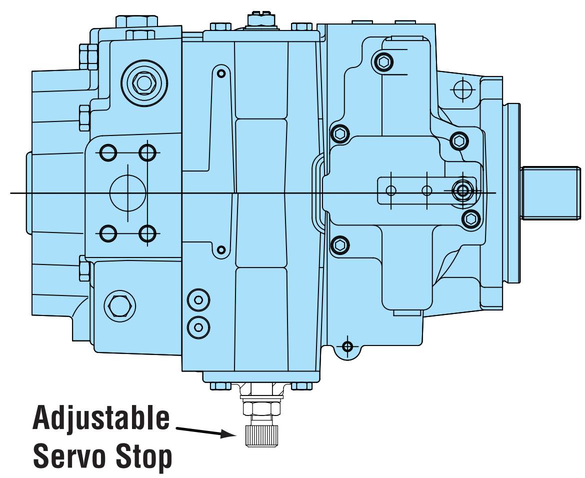
The Pressure Override Control (POR) can be used in combination with most of the variable pump controls. The POR protects the transmission when operated for extended periods at overload pressures. If the system pressure reaches a preset limit, the pump destrokes and adjusts its displacement to the load. The POR is available in a number of pressure settings.



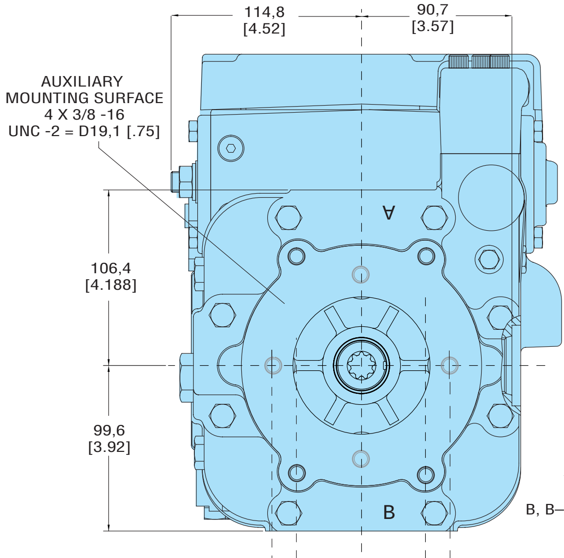
Special Pump Features

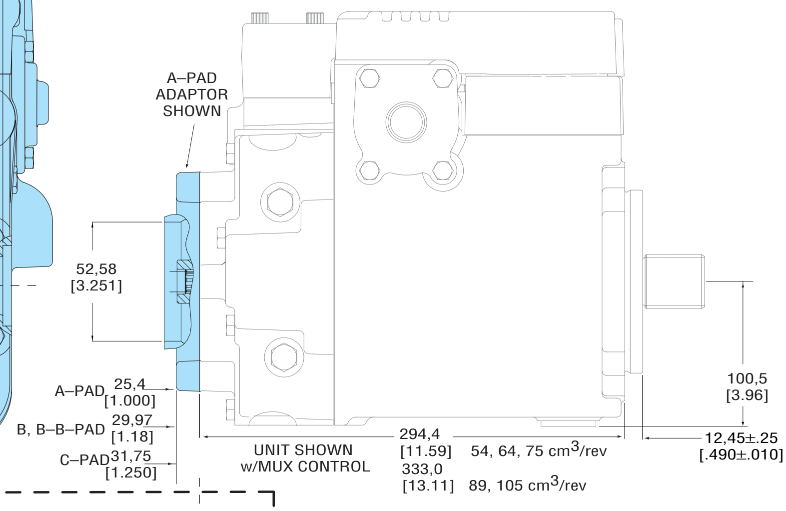
(Model Code Position 16 & 17)

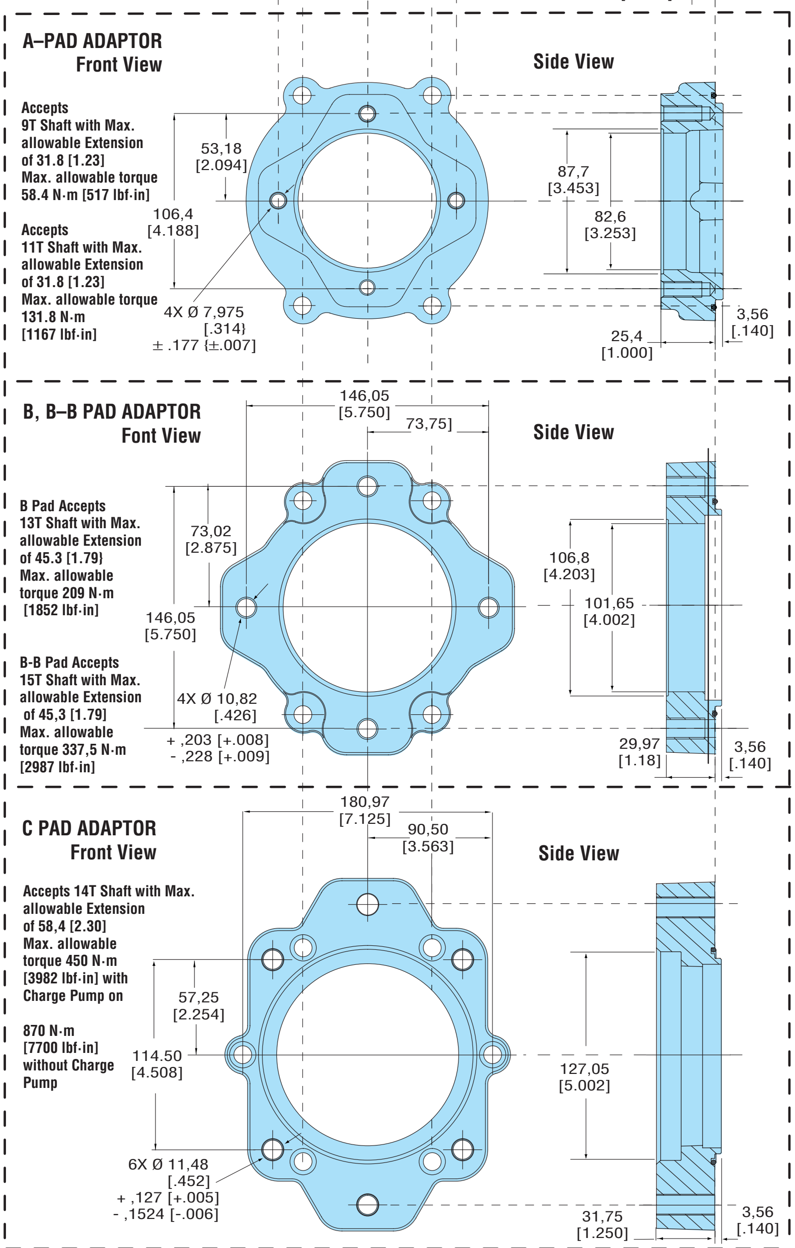




Auxiliary Mount Options
(Model Code Position 25)







Pump Features/Options

The Series 2 Hydrostatic Pump contains an integral charge pump that may be provided with various filtration options. A standard charge pump will use suction filtration where practical. This arrangement is detailed in the diagram on page 12 and followed by the filter recommendations on page 14. For applications where suction filtration is not practical, the option below may be selected.

Remote Filter Ports (Optional)

Remote pressure filter ports allow you to mount a pressure side filter in a more easily accessible location. The filter ports accept 7/8-14 UNF-2B SAE ‘O’ Ring fittings. The filter and lines must be able to withstand pressures up to 70 bar [1000 PSI].

Model Code

The following 31-digit coding system has been developed to identify all of the configuration options for the Series 2 hydrostatic pump. Use this model code to specify a pump with the desired features. All 31-digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

Model Code—Heavy Duty Series 2 Pump

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
A	C	L																				0								A

Position 1, 2, 3 Product Series

ACL .... Hydrostatic-Heavy Duty Variable Pump (Series II)

Position 4, 5, 6 Displacement

054 .... 54 cm^3/r [3.3 in^3/r]
064 .... 64 cm^3/r [3.9 in^3/r]
075 .... 75 cm^3/r [4.6 in^3/r]
089 .... 89 cm^3/r [5.4 in^3/r]
105 .... 105 cm^3/r [6.4 in^3/r]

Position 7, 8 Input Shaft †

14 .... 14 Tooth 12/24 Pitch Spline
21 .... 21 Tooth 16/32 Pitch Spline
23 .... 23 Tooth 16/32 Pitch Spline

† Ask your Eaton representative for additional shaft options

Position 9 Input Rotation

L .... Counterclockwise (Lefthand)
R .... Clockwise (Righthand)

Position 10 Valve Plate

0 .... V-groove
1 .... Propel

Position 11 Main Ports (Includes Gage Ports)

A .... 25,4 [1.00] - Code 61 Per SAE J518
B .... 25,4 [1.00] - Code 62 Per SAE J518
C .... 25,4 [1.00] - Code 61 with M10 X 1 Threaded Holes
D .... 25,4 [1.00] - Code 62 with M12 X 1.75 Threaded Holes

Position 12 & 13 High Press Relief Valve Setting Ports A & B

NOTE: You must choose relief valve settings for both ports A & B

0 None
B .... 205 bar [3000 lbf/in^2]
C .... 240 bar [3500 lbf/in^2]
D .... 275 bar [4000 lbf/in^2]
E .... 310 bar [4500 lbf/in^2]
F .... 345 bar [5000 lbf/in^2]
G .... 380 bar [5500 lbf/in^2]
H .... 415 bar [6000 lbf/in^2]
L .... 430 bar [6250 lbf/in^2]

Position 14 and 15 Press Override (POR) Setting Ports A & B

NOTE: You must choose pressure override settings for both ports A and B. The pressure override setting should be 35 bar less than the high pressure relief valve.

0 .... None
A .... Pressure Transducer (No pressure override valve)
B .... 205 bar [3000 lbf/in^2]
C .... 240 bar [3500 lbf/in^2]
D .... 275 bar [4000 lbf/in^2]
E .... 310 bar [4500 lbf/in^2]
F .... 345 bar [5000 lbf/in^2]
G .... 380 bar [5500 lbf/in^2]
M .... 395 bar [5725 lbf/in^2]
H .... 415 bar [6000 lbf/in^2]

Position 16,17 Special Pump Features

00 .... No Special Features
01 .... Plugged Magnetic Speed Sensor Port
02 .... Magnetic Speed Sensor
03 .... Adjustable Servo Stop (one direction)

Position 18,19 Control

EB .... CAN Multiplex Electronic Control
EE .... Electronic Proportional Control 12 Vdc and Electronic Driver with 1 to 5 Vdc Potentiometric Command Input
EF .... Electronic Proportional Control 24 Vdc and Electronic Driver with 1 to 5 Vdc Potentiometric Command Input
EG .... Electronic Proportional Control 12 Vdc and Electronic Driver with 4 to 20 mA Command Input
EH .... Electronic Proportional Control 24 Vdc and Electronic Driver with 4 to 20 mA Command Input
EJ .... Electronic Proportional Control 12 Vdc and Electronic Driver with +/- 5 Vdc Differential Command Input
EK .... Electronic Proportional Control 24 Vdc and Electronic Driver with +/- 5 Vdc Differential Command Input

EL .... Electronic Proportional Control 12 Vdc and Electronic Driver with +/- 100 mA Command Input
EM .... Electronic Proportional Control 24 Vdc and Electronic Driver with +/- 100 mA Command Input
HA .... Hydraulic Remote Control with 5-15 bar control range
MA .... Manual Displacement Control
MB .... Manual Displacement Control (up to 24 Vdc) Normally Closed Neutral Lockout
MC .... Manual Displacement Control with Neutral Detent
ML .... Manual Displacement Control w/Wide Band Neutral.

Position 20* Control Orifice Supply (P)

Position 21* Control Orifice Servo (S_1)

Position 22* Control Orifice Servo (S_2)

0 .... None
A .... 0,53 [.021] Diameter
B .... 0,71 [.028] Diameter
C .... 0,91 [.036] Diameter
D .... 1,12 [.044] Diameter
E .... 1,22 [.048] Diameter
F .... 1,32 [.052] Diameter
G .... 1,45 [.057] Diameter
H .... 1,65 [.065] Diameter
J .... 1,85 [.073] Diameter
K .... 2,06 [.081] Diameter
L .... 2,39 [.094] Diameter
M .... 2,59 [.102] Diameter

* Eaton recommends you chose an orifice for control orifice supply (P). The servo orifice (S_1) and the servo orifice (S_2) are optional, except when specifying a pressure override.

Position 23 Control Special Features

0 .... No Control Special Features
3 .... Destroke valve

Position 24 Charge Pump Displacement

0 .... None
1 .... 13,9 cm³/r [0.85 in³/r] (Pump Disp. 54-89 cm³/rev)
2 .... 17,4 cm³/r [1.06 in³/r] (Pump Disp. 54-105 cm³/rev Std for 105)
3 .... 21,0 cm³/r [1.28 in³/r] (Pump Disp. 54-105 cm³/rev)
4 .... 27,9 cm³/r [1.70 in³/r] (Pump Disp. 54-105 cm³/rev)
5 .... 34,7 cm³/r [2.12 in³/r] (Pump Disp. 89-105 cm³/rev)

Position 25 Auxiliary Mounting

0 .... None, High Speed Charge Pump (Models 54 to 75 cm³/rev)
1 .... None, High Torque Charge Pump (Models 54 to 105 cm³/rev)
A .... A-pad, High Speed Charge Pump, Dual 2 Bolt Mount, No Shaft Seal, 9 Tooth 16/32 Pitch Spline (Available For 54-75 cm³/rev Only)
B .... B-pad, High Speed Charge Pump, Dual 2 Bolt Mount, No Shaft Seal, 13 Tooth 16/32 Pitch Spline (Available For 54-75 cm³/rev Only)
C .... A-pad, High Torque Charge Pump, Dual 2 Bolt Mount, No Shaft Seal, 9 Tooth 16/32 Pitch Spline (Available For All Models)
D .... B-pad, High Torque Charge Pump, Dual 2 Bolt Mount, No Shaft Seal, 13 Tooth 16/32 Pitch Spline (Available For All Models)
E .... B-B-pad, High Torque Charge Pump, Dual 2 Bolt Mount, No Shaft Seal, 15 Tooth 16/32 Pitch Spline (Available For All Models)
F .... C-pad, High Torque Charge Pump, 4 Bolt Mount, No Shaft Seal, 14 Tooth 12/24 Pitch Spline (Available For All Models)

Position 26 Charge Pump Options

0 .... None
A .... Remote Pressure Side Filter Ports

Position 27 Charge Pressure Relief Valve Setting

0 .... None
A .... 21 bar [304.5 lbf/in²] - Standard
B .... 22,5 bar [326.3 lbf/in²]
C .... 24 bar [348 lbf/in²]
D .... 25,5 bar [369.8 lbf/in²]
E .... 27 bar [391.5 lbf/in²]
F .... 28,5 bar [413.3 lbf/in²]
G .... 30 bar [435 lbf/in²]

Position 28 Charge Pump Special Features

0 .... No Charge Pump Special Features

Position 29 Paint and Packaging

0 .... Painted Primer Blue (Standard)

Position 30 Identification On Unit

0 .... Standard

Position 31 Design Code

A .... A

Application Notes:

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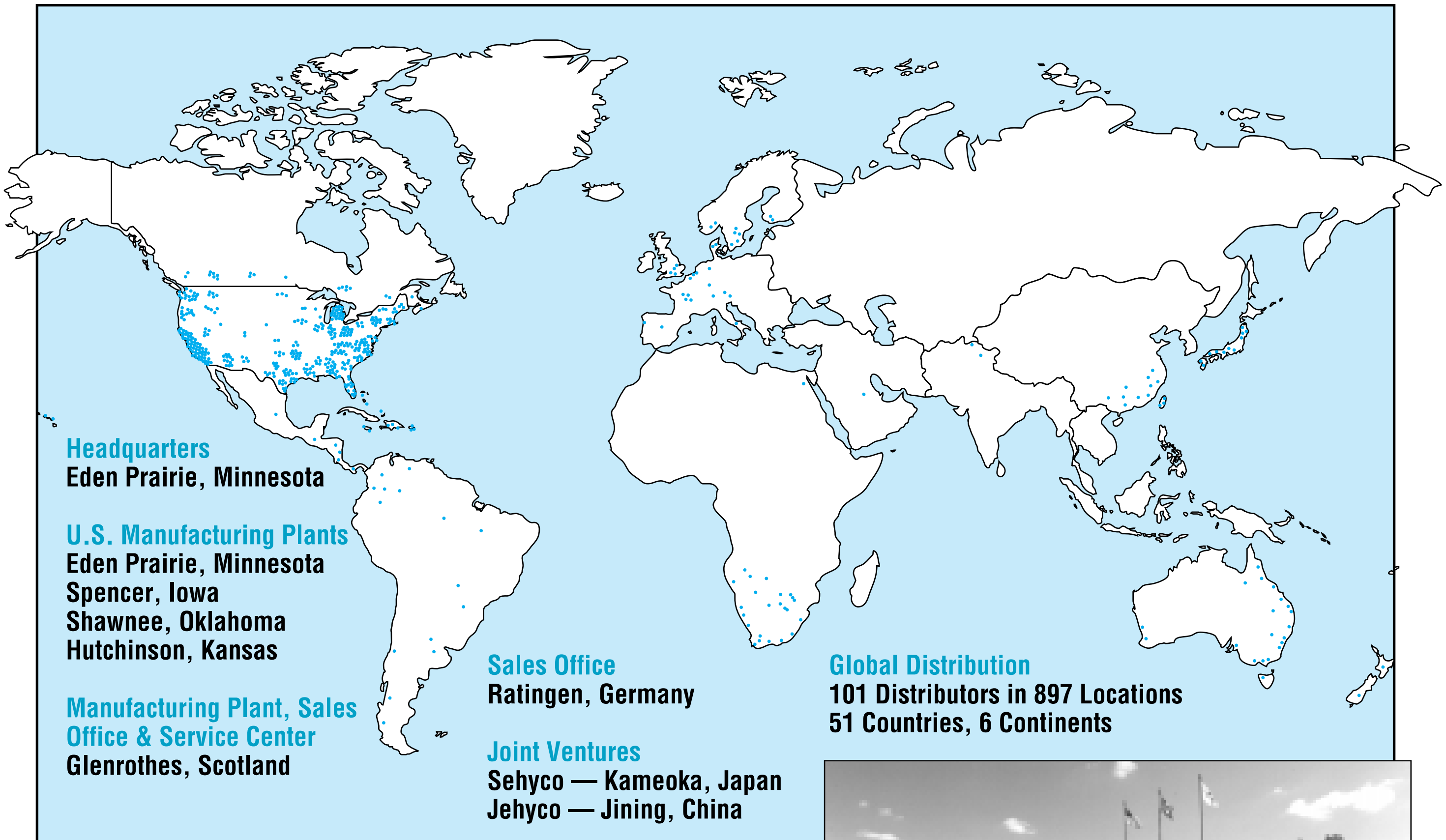

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