Hydraulics

industrial hydraulics

Char-Lynn®

Disc Valve Hydraulic Motors

11-01-878
EN-0201

EATON

2000 Series
Hydraulic Motors

We Manufacture

Solutions

Solutions

Catalog of Disc Valve Hydraulic Motors from One of the World's Leading Manufacturers of Off Highway Mobile Components — Eaton Hydraulics

In the late 1950's the original low speed, high torque hydraulic motor was developed from a pump gerotor element consisting of an internal gear ring and a mating gear or star. While attaching the internal gear ring to the housing as a non moving part, oil was ported to pressurize and turn the internal star in an orbit around a center point. This slow turning star coupled with a splined drive to the output shaft became the Char-Lynn® Orbit® motor. A few years after this original Char-Lynn Orbit motor was introduced another original motor concept went into production. This motor had rolls incorporated into the internal gear ring, this element was identified by the name Geroler® and is a registered trade name of Eaton Hydraulics. From these early years the Geroler motor has seen many design changes to make these Geroler motors the best the industry has to offer. Examine the simplicity of these Geroler disc valve motors shown below. Also examine all the following pages for high value Char-Lynn disc valve motors from Eaton Hydraulics.

Geroler® Displacement Mechanism

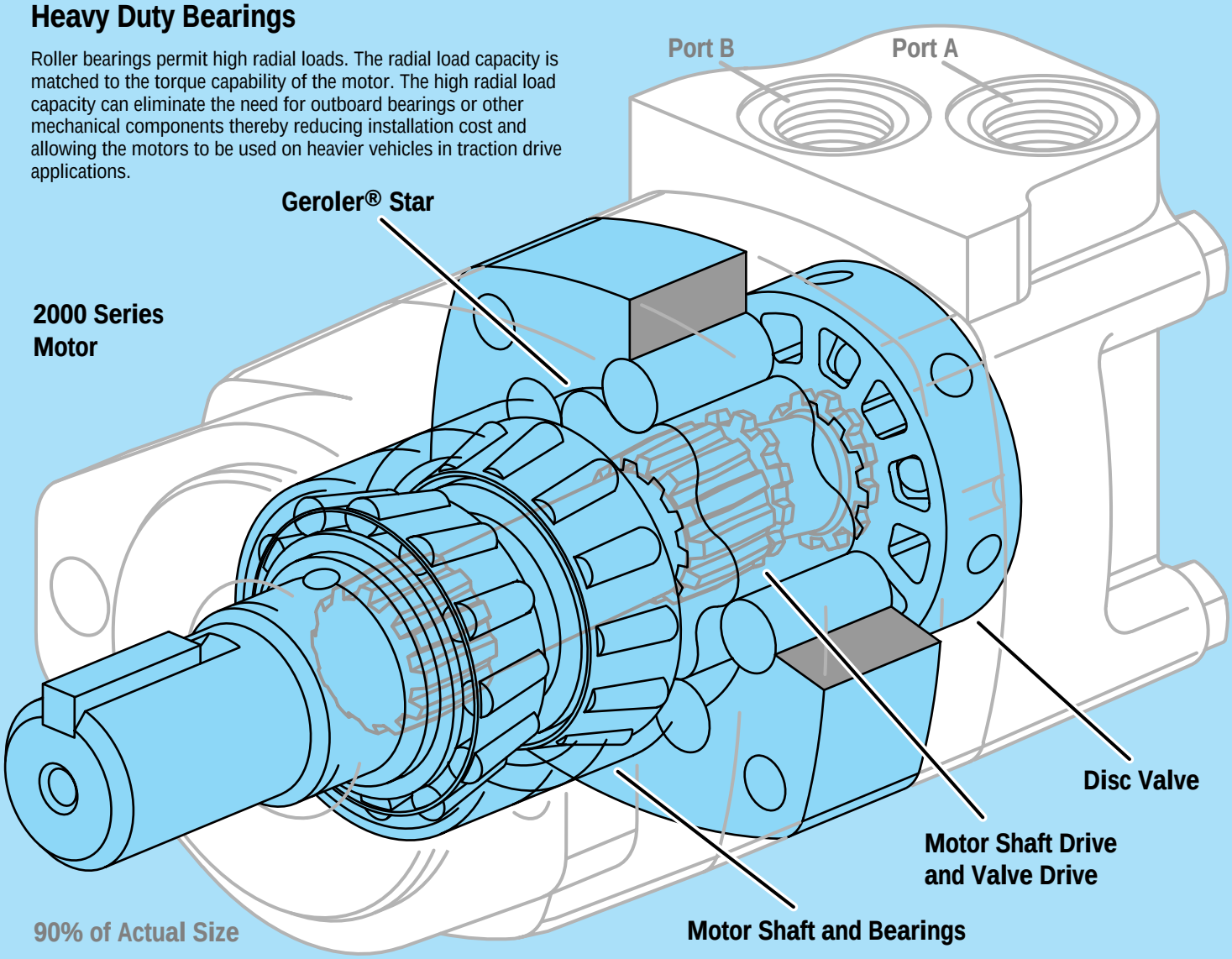
Motors with the Geroler element provide high starting and running torque. The Geroler element minimizes friction and thereby increases efficiency while providing smooth output shaft rotation even at very low speeds. Motor shaft rotation can be instantly reversed by changing direction of input/output flow while generating equal torque in either direction. The displacements available provide a wide variety of speeds and torques from any Series motor.

Disc Valve

The function of the disc valve is to distribute fluid to the Geroler pockets. The pressure balanced sealing surface on the valve face maintains minimal leakage. Char-Lynn disc valve motors can be used in the same system with a radial piston pump and also in closed loop systems. The patented wear compensated disc valve provides top performance.

Heavy Duty Bearings

Roller bearings permit high radial loads. The radial load capacity is matched to the torque capability of the motor. The high radial load capacity can eliminate the need for outboard bearings or other mechanical components thereby reducing installation cost and allowing the motors to be used on heavier vehicles in traction drive applications.



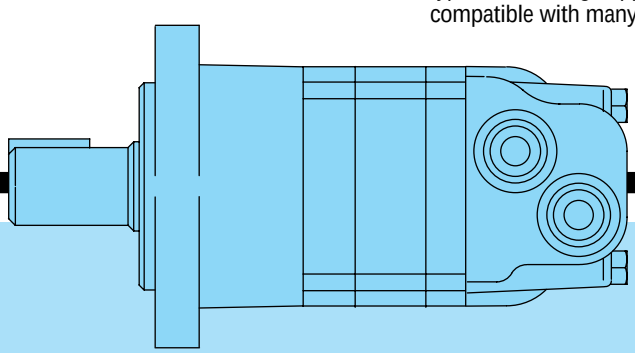
Design Features

Char-Lynn Hydraulic motors provide design flexibility. All disc valve motors are available with various configurations consisting of:

- Displacement (Geroler size)
- Output Shaft
- No Shaft and Bearing Assembly (Bearingless Motor)
- Port Configuration
- Mounting Flange
- Other Special Features

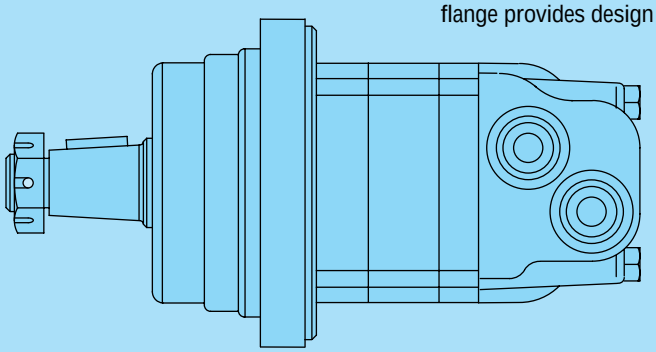
Standard Motor

The standard motor mounting flange is located as close to the output shaft as possible. This type of mounting supports the motor close to the shaft load. This mounting flange is also compatible with many standard gear boxes.



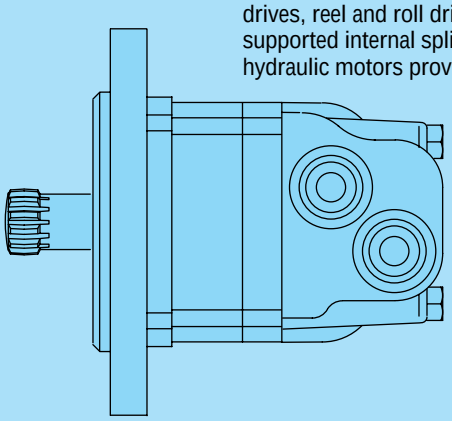
Wheel Motor

The wheel motor mounting flange is located near the center of the motor which permits part or all of the motor to be located inside the wheel or roller hub. In traction drive applications, loads can be positioned over the motor bearings for best bearing life. This wheel motor mounting flange provides design flexibility in many applications.

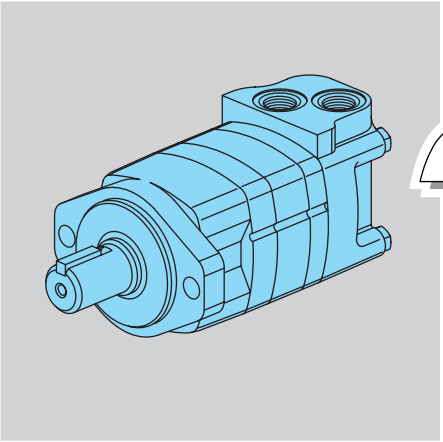


Bearingless Motor

This bearingless motor has the same drive components as the standard and wheel motors (with the exception that the motor is assembled without the output shaft, bearings and bearing housing). The bearingless motor is especially suited for applications such as gear boxes, winch drives, reel and roll drives. Bearingless motor applications must be designed with a bearing supported internal spline to mate with the bearingless motor drive. Product designs using these hydraulic motors provide considerable cost savings.



2000 Series



2000

2000 Series

Geroler® Element..... 9 Displacements
Flow LPM [GPM] ..... 75 [20] Continuous**
115 [30] Intermittent*
Speed ..... Up to 924 RPM
Pressure Bar [PSI] ... 200 [3000] Cont.
300 [4500] Inter.
Torque Nm [lb-in] .... 845 [7470] Cont.
930 [8225] Inter.

2000 Series Displacement Size = cubic centimeter per shaft revolution (cm^3/r)
= cubic inch per shaft revolution ([in^3/r])

- 80 [4.9]
- 100 [6.2]
- 130 [8.0]
- 160 [9.6]
- 195 [11.9]
- 245 [14.9]
- 305 [18.7]
- 395 [24.0]
- 490 [29.8]

Mounting Flange

- 4 Bolt (Bearingless) 101,6 [4.00] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 127,0 [5.00] Dia. B.C.
- 2 Bolt (SAE A) (Standard) 82,5 [3.25] Pilot Dia. and 13,59 [.535] Mounting Holes on 106,4 [4.19] Dia. B.C.
- 4 Bolt (Wheel) 107,9 [4.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 147,6 [5.81] Dia. B.C.
- 4 Bolt (Standard) 82,5 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 106,4 [4.19] Dia. B.C.
- 4 Bolt Magneto 82,5 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 106,4 [4.19] Dia. B.C.
- 2 Bolt (SAE B) 101,6 [4.00] Pilot Dia. and 14,27 [.562] Dia. Mounting Holes on 146,0 [5.75] Dia. B.C.

Output Shaft

- Bearingless
- 1 inch Dia. Straight with Woodruff Key, 1/4-20 Threaded Hole and 38,4 [1.51] Max. Coupling Length
- 1-1/4 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and 47,3 [1.86] Max. Coupling Length
- 32 mm Dia. Straight with Straight Key, M8 x 1,25 -6H Threaded Hole and 56,4 [2.22] Max. Coupling Length
- 1-1/4 inch Dia. Splined 14 T, 3/8-16 Threaded Hole and 33,0 [1.30] Min. Full Spline Length and 45,5 [1.79] Max. Coupling Length
- 1-1/4 inch Dia. Tapered with Straight Key and Nut
- SAE 6B Splined 6 T, 1/4-20 Threaded Hole and 22,8 [.90] Min. Full Spline Length and 28,8 [1.13] Max. Coupling Length
- 7/8 inch Dia. Splined 13 T, 15,2 [.60] Min. Full Spline Length and 30,8 [1.21] Max. Coupling Length
- 25 mm Dia. Straight with Straight Key, M8 x 1,25 -6H Threaded Hole and 38,1 [1.50] Max. Coupling Length

Port Type

- 7/8-14 O-ring (Staggered) with 7/16-20 O-ring Case Drain
- G 1/2 (BSP) (Staggered) with G 1/4 (BSP) Case Drain
- Manifold Mount with 3/8-16 UNC Mounting Threads (3) and 7/16-20 O-ring Case Drain
- Manifold Mount with M10 x 1,5 -6H Mounting Threads (3) and G 1/4 (BSP) Case Drain
- 1-1/16—12 O-ring (Positioned 180° Apart) with 7/16-20 O-ring Case Drain
- 7/8-14 O-ring (End Ports) with 7/16-20 O-ring Case Drain (Rear)

Special Features

- Viton® Shaft Seal
- Viton Seals
- Free Running Geroler
- Speed Sensor
- Two Speed Option
- Hot Oil Shuttle
- Corrosion Protected
- Seal Guard Package

** Continuous— (Cont.) Continuous rating, motor may be run continuously at these ratings.

* Intermittent— (Inter.) Intermittent operation, 10% of every minute.

Viton® is a Registered Trade Name of Dupont Corp.

Design Flexibility

Char-Lynn motors are truly built for high torque low speed. A lot of power is derived from this small package. This power advantage provides the designer with a product that can be used for overall compactness in addition to taking full advantage of the high pressure ratings typical of present day hydraulic components.

Char-Lynn Disc Valve hydraulic motors allow the designer to put the power where it is needed. Indeed, these motors are small in size, big in output power. Hence, the small package can eliminate a lot of installation problems. Furthermore, the motors can be mounted directly on the driven device away from the original power source which eliminates other mechanical linkages such as chains, sprockets, belts, pulleys, gears, rotating drive shafts, and universal joints. Several motors can be driven from the same power source and can be connected in series or parallel to each other.

Durability

The design and method of manufacture of three critical drive train components, valve drive, shaft drive, and output shaft, give these motors durability. Consequently, these durable disc valve motors stand up against high hydraulic pressures. Other built in features, such as the rugged **Tapered** roller bearings provide a good match to this tough design.

Performance Rating

Our method of rating these motors recognizes that at slower speeds and flow, higher pressures and torque are permitted. Hence, our performance data shows the complete flow range (down to 1 liter per minute or 1/4 gallon per minute) and speed range (down to one revolution per minute depending on application).

Controllable Speeds

Char-Lynn motors operate at low speeds that remain very near constant even when load varies. Shaft speed is varied smoothly, easily and economically using simple inexpensive controls. Also, these motors are reversible. Consequently, direction of shaft rotation can be changed instantly with equal output torque in either direction.

Dependable Performance

Highly precise manufacturing of parts and the disc valve's unique wear compensating design provide consistent, dependable performance and long life even under varying conditions.

Reliability

Char-Lynn motors are self contained, with hydraulic fluid providing lubrication. These motors are completely sealed so they can operate safely and reliably in hostile environments such as dust, dirt, steam, water, and heat and provide reliable performance.

High Efficiencies

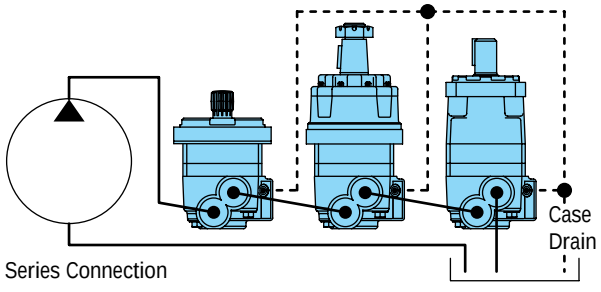
Char-Lynn disc valve motors have high efficiencies providing high output for the pressure and flow supplied. The high mechanical efficiency enables you to obtain a given torque with a smaller displacement motor.

Volumetric efficiency is high and speed is relatively constant with little variation due to changes in load. Speed is controlled easily and smoothly.

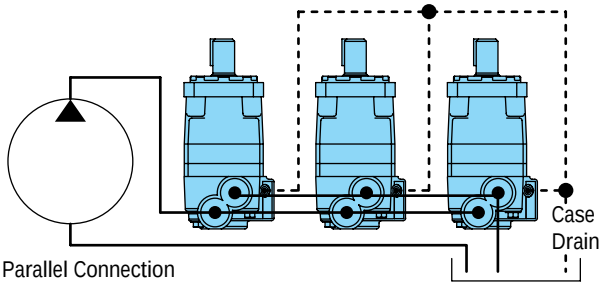
In conclusion, these efficiencies mean less heat buildup in the hydraulic system.

Case Drain and Shuttle Valve Options

Many hydraulic systems can benefit from the use of a system case drain. Char-Lynn disc valve motors provide this feature built in. One of the advantages for case drain flow is that contamination is flushed from the system. This flushing also aids in cooling the system and lowering the case pressure which will extend motor seal life. With a case drain line in place, oil pressure in the gear box (Bearingless motor applications) can also be controlled. In applications where more system cooling and flushing is required, a shuttle valve option is available in 2000, 4000, and 6000 Series motors.

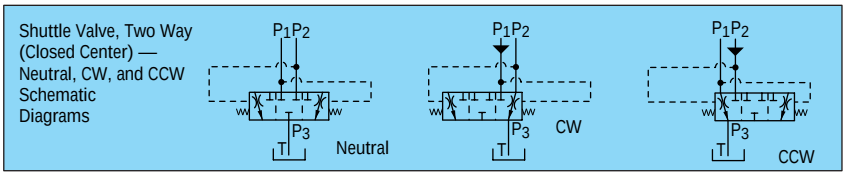


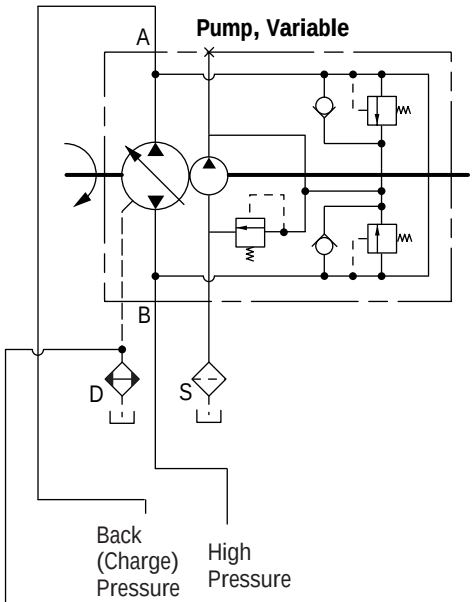
Series Connection

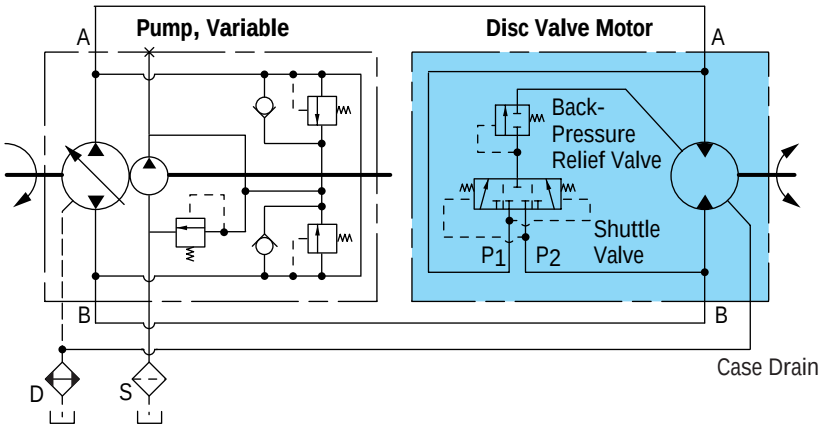


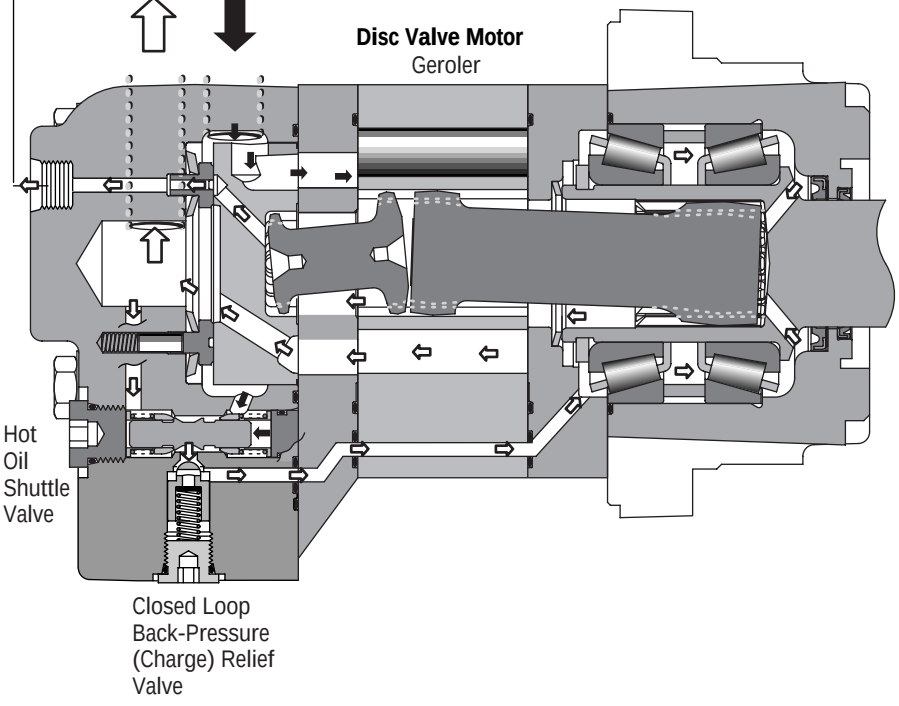
Parallel Connection

Typical (Closed Loop) Hydraulic Circuit
Shuttle Flow 2000, 4000, 6000 Series



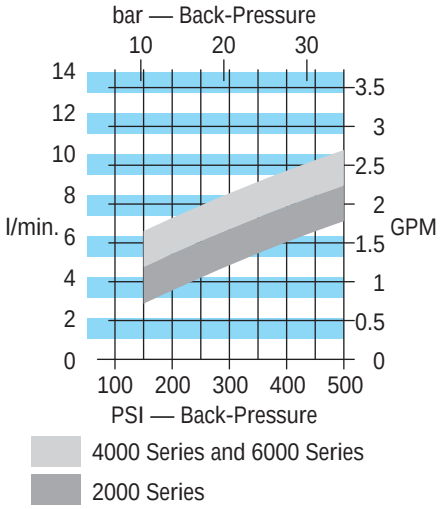






Typical Disc Valve Motor
Shuttle Flow with 4,5 bar [65 PSI]
Back-Pressure Relief Valve (Typical Data)

Due to Machining Tolerances, Flow May be More or Less



Disc Valve Motor with shuttle valve **must have a case drain to tank**, without this drain line the internal drive splines will not have adequate lubrication.

Low Speed High Torque Hydraulic Motors with Shuttle and Charge Pressure Relief Valve — Patent No. U.S. 4,645,438.

Speed Sensor 2000, 4000 and 6000 Series

Eaton has developed a speed sensor specifically designed for LSHT motors. The design is rugged and fully protected against accidental reverse polarity or short circuit hook up. A built in pull up resistor simplifies installation with control systems.

This sensor is fully compatible with mobile vehicle electrical systems and gives a reliable digital on/off signal over a wide speed range and temperature range. The sensor is field-serviceable; no factory setting or shimming is required.

Supply Voltage: 8 to 24 Vdc (compatible with 12V vehicle systems)

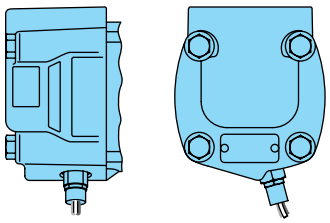
Supply Current: 20 mA max. (Vs) (including internal pull-up resistor)

Output Voltage: Low < .5 Vdc @ 10 mA; output is open collector with 10kΩ pull-up resistor.

Connection — standard 3 prong Weatherpack connector with 18 AWG (american wire gage) cables:
Position A (red) = power supply
Position B (white) = signal output
Position C (black) = common

2000 Series

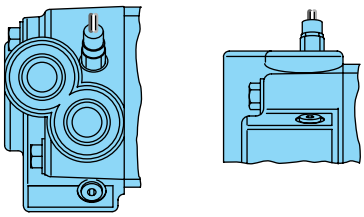
Output
Speed Sensor — digital on/off signal from a Hall Effect switch; 30 pulses/revolution



Output Quadrature Speed Sensor — 60 pulses/revolution

4000 Series

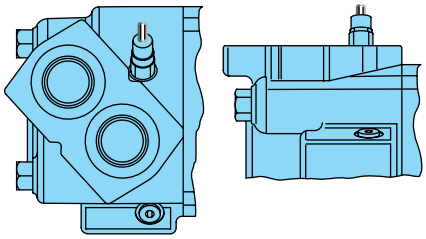
Output
Speed Sensor — digital on/off signal from a Hall Effect switch; 36 pulses/revolution



Output Quadrature Speed Sensor — 72 pulses/revolution

6000 Series

Output
Speed Sensor — digital on/off signal from a Hall Effect switch; 40 pulses/revolution



Output Quadrature Speed Sensor — 80 pulses/revolution

Quadrature Speed Sensor 2000, 4000 and 6000 Series

Eaton has developed a new **speed** and **direction** sensor, based on the field proven technology of our standard sensor, designed for off road environments. The new sensor is based on the principle of quadrature and has two output versions.

- The first version has two output signals 90° out of phase. Each output provides one pulse per target tooth.
- The second version has a speed signal that is twice the output pulses per revolution and it also has a direction signal. For example, the 2000 Series versions provide 60 symmetrical pulses per revolu tion with the 30-tooth target.

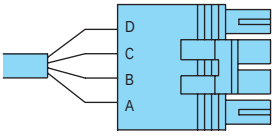
Outputs — Digital signals from NPN transistors (open collector output with internal 10K pull-up resistors).

Supply Voltage: 8 to 24 Vdc* (compatible with 12V vehicle conditions)

Supply Current: 40 mA max. (Including internal pull-up resistors)

Output
Low Voltage: 0.5 Vdc maximum @ 10 mA

The sensor has reverse polarity protection, short circuit protection, load dump protection and EMC (Electricalmagnetic Compatibility) protection (the customer should qualify the EMC protection in their specific application).



Weatherpack Tower Connector

Connections —
Standard 4 prong Weatherpack connector with 18 AWG (American Wire Gage) cables or M12 threaded connector:

Weatherpack (Version 1)	**M12 Connector (Version 1)**
Position A (red) = power supply	Pin 1 = power supply
Position B (black) = common	Pin 2 = output one
Position C (orange) = output one	Pin 3 = common
Position D (yellow) = output two	Pin 4 = output two

Weatherpack (Version 2)	**M12 Connector (Version 2)**
Position A (red) = power supply	Pin 1 = power supply
Position B (black) = common	Pin 2 = direction
Position C (blue) = speed signal	Pin 3 = common
Position D (white) = direction	Pin 4 = speed signal

Note: The speed sensor or quadrature speed sensor option does **NOT** include read-out display.
Possible sources for read-out display include:

Eaton Corporation
Durant Products
901 South 12th Street
Watertown, WI 57094
1-800-289-3866

Shaft Seal

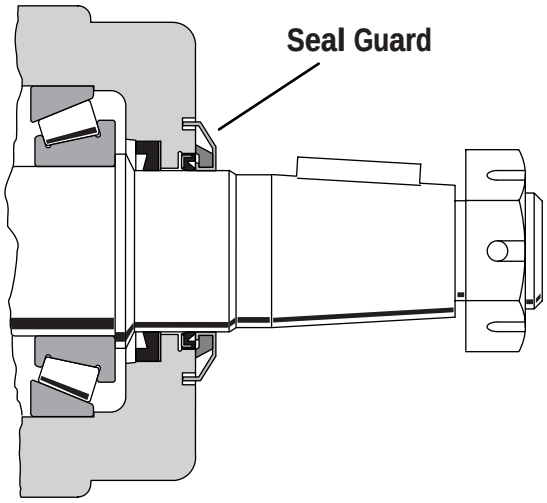
This time proven shaft seal design has a patented feature which allows the seal lip to follow shaft deflection under high side loads and therefore provides better sealing. Additionally, these seals can withstand case pressure up to: 140 Bar [2000 PSI] 2000 Series, 100 Bar [1500 PSI] 4000 Series, 70 Bar [1000 PSI] 6000 Series, and 20 Bar [300 PSI] 10,000 Series.

To optimize seal life, reduce case pressures (with case drain) at shaft speeds greater than 250 RPM.

Internal Check Valves

An internal check valve is provided to relieve case pressure to the low pressure side of the motor. This check valve system is adequate for most applications. In addition, motors have an external case pressure drain port for use when continuous back pressure exceeds: 140 Bar [2000 PSI] 2000 Series, 100 Bar [1500 PSI] 4000 Series, 70 Bar [1000 PSI] 6000 Series, and 20 Bar [300 PSI] 10,000 Series.

Optional Seal Guard Package for 2000, 4000, and 6000 Series



In response to the need for robust seal protection requirements, Eaton now offers a seal guard package. This feature consists of a metal shield that protects an internal wiper seal. The shield is interference-fit on the output shaft and rotates with the output shaft. For added protection, the shield is recessed into a special groove in the bearing housing face.

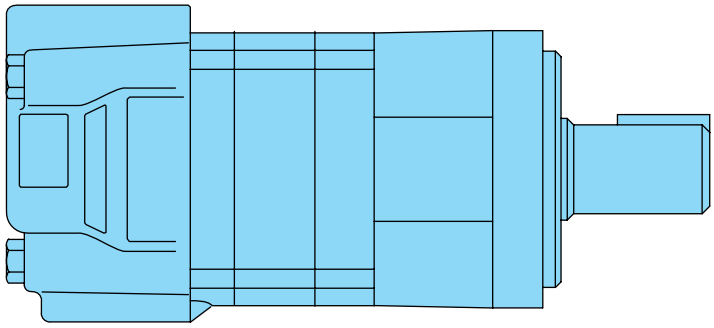
Centrifugal force causes foreign debris to be forced away from the high pressure shaft and dust seal area. The seal guard does not seal hydraulic fluid. Instead, it protects the standard seals from damage caused by foreign debris. Typical applications benefiting from this feature include street sweepers, industrial sweepers, and harvesting machinery.

NOTE: This option is used in conjunction with the special front retainer with shield groove. Special feature (Hardware) option code “28” for 2000, “13” for 4000, and “14” for 6000 Series, **these motors include the seal guard package, special front retainer and a special shaft with additional length** (6000 Series with design code -006 (effective December 1, 1995) will not require a special front retainer and standard shafts will accept the seal guard).

Corrosion Protected Disc Valve Motors

2000, 4000, 6000, and 10,000 Series motors are available with a corrosion resistant coating for use in hostile environments. This coating protects the motor from salt water, and various chemicals and is especially effective in marine, food processing, cleansing, fishing, and agricultural applications. Motor output shaft plating helps eliminate seal damage caused by these caustic or acid materials. Char-Lynn disc valve motors are available with just the output shaft plated, or with plated shaft and entire motor exterior coating.

Specifications
2000 Series



Specification Data—2000 Series

Displ. cm³/r [in³/r]		80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
Max. Speed (RPM) @ ..... Flow	Continuous	799	742	576	477	385	308	246	191	153
	Intermittent	908	924	720	713	577	462	365	287	230
Flow LPM [GPM]	Continuous	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]
	Intermittent	75 [20]	95 [25]	95 [25]	115 [30]	115 [30]	115 [30]	115 [30]	115 [30]	115 [30]
Torque Nm [lb-in] ☆ 1-1/4 Inch or 32 mm Dia. Shaft	Continuous	235 [2065]	295 [2630]	385 [3420]	455 [4040]	540 [4780]	660 [5850]	765 [6750]	775 [6840]	845 [7470]
	Intermittent	345 [3035]	445 [3950]	560 [4970]	570 [5040]	665 [5890]	820 [7250]	885 [7820]	925 [8170]	930 [8225]
Pressure Δ Bar [Δ PSI] ☆ 1-1/4 Inch or 32 mm Dia. Shaft	Continuous	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	155 [2250]	120 [1750]
	Intermittent	310 [4500]	310 [4500]	310 [4500]	260 [3750]	260 [3750]	260 [3750]	240 [3500]	190 [2750]	140 [2000]
	Peak	310 [4500]	310 [4500]	310 [4500]	310 [4500]	310 [4500]	310 [4500]	310 [4500]	225 [3250]	170 [2500]

Maximum Case Pressure - without Case Drain * — 140 Bar [2000 PSI]

A simultaneous maximum torque and maximum speed NOT recommended. For permissible continuous and intermittent operating combinations of pressure and flow refer to performance data on pages 15-19.

☆ **Maximum torque for 1 inch shaft** — 395 Nm [3500 lb-in] Continuous and 485 Nm [4300 lb-in] intermittent.

* For back pressure over 140 Bar [2000 PSI] use an external case drain. Install case drain lines so that the motor case remains filled at all times.

Maximum inlet pressure — 310 Bar [4500 PSI]. Do not exceed Δ pressure rating (see chart above).

* **Maximum return pressure** — 310 Bar [4500 PSI]. Do not exceed Δ pressure rating (see chart above).

Δ Bar [Δ PSI] — True pressure difference between inlet port and outlet port.

Continuous Rating — Motor may be run continuously at these ratings.

Intermittent Operation — 10% of every minute.

Peak Operation — 1% of every minute.

Recommended Fluids — Premium quality, anti-wear type hydraulic oil with a viscosity of not less than 70 SUS at operating temperature (see page 81).

Recommended Maximum System Operating Temp. — Is 82° C [180° F]

Recommended Filtration — per ISO Cleanliness Code, level 18/13

To assure best motor life, run motor for approximately one hour at 30% of rated pressure before application to full load. Be sure motor is filled with fluid prior to any load applications.

Performance Data
2000 Series

Motors run with high efficiency in all areas designated with a number for torque and speed, however for best motor life select a motor to run with a torque and speed range shown in the light blue area.

80 cm³/r [4.9 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.25] ,95	[210] 25 **3**	[420] 45 **1**							
[.5] 1,9	[250] 30 **17**	[500] 50 **8**	[740] 85 **3**						
[1] 3,8	[330] 35 **44**	[670] 75 **40**	[990] 110 **37**	[1300] 145 **34**	[1550] 175 **28**	[1800] 205 **22**	[1950] 220 **14**	[2110] 240 **2**	
[2] 7,5	[330] 35 **90**	[670] 75 **85**	[995] 110 **81**	[1310] 150 **78**	[1580] 180 **72**	[1840] 210 **65**	[2100] 235 **57**	[2365] 265 **49**	[2630] 295 **42**
[4] 15	[325] 35 **182**	[670] 75 **176**	[1005] 115 **170**	[1330] 150 **166**	[1620] 185 **159**	[1920] 215 **152**	[2200] 250 **140**	[2480] 280 **128**	[2765] 310 **117**
[6] 23	[320] 35 **273**	[665] 75 **267**	[1010] 115 **259**	[1340] 150 **254**	[1655] 185 **246**	[1975] 225 **238**	[2270] 255 **223**	[2570] 290 **207**	[2880] 325 **192**
[8] 30	[310] 35 **365**	[660] 75 **375**	[1015] 115 **349**	[1345] 150 **341**	[1685] 190 **333**	[2020] 230 **325**	[2330] 265 **306**	[2640] 300 **286**	[2960] 335 **266**
[10] 38	[300] 35 **456**	[650] 75 **448**	[1010] 115 **439**	[1350] 155 **429**	[1700] 190 **420**	[2050] 230 **411**	[2370] 270 **388**	[2690] 305 **364**	[3010] 340 **341**
[12] 45	[285] 30 **547**	[640] 70 **537**	[1005] 115 **530**	[1350] 155 **516**	[1705] 195 **507**	[2065] 235 **497**	[2390] 270 **470**	[2715] 305 **442**	[3035] 345 **415**
[14] 53	[270] 30 **638**	[625] 70 **629**	[990] 110 **622**	[1340] 150 **603**	[1705] 195 **593**	[2065] 235 **584**	[2395] 270 **553**	[2720] 305 **521**	[3030] 340 **490**
[16] 61	[255] 30 **729**	[610] 70 **720**	[975] 110 **714**	[1330] 150 **689**	[1690] 190 **679**	[2055] 230 **670**	[2385] 270 **635**	[2700] 305 **599**	[2995] 340 **564**
[18] 68	[230] 25 **818**	[590] 65 **810**	[955] 110 **795**	[1310] 150 **775**	[1680] 190 **765**	[2025] 230 **756**	[2355] 265 **717**	[2660] 300 **677**	[2935] 330 **638**
[20] 76	[210] 25 **908**	[570] 65 **901**	[930] 105 **880**	[1290] 145 **861**	[1645] 185 **851**	[1985] 225 **842**	[2305] 260 **799**	[2600] 295 **755**	[2845] 320 **712**

[570] 65 } Torque [lb-in] Nm
901 } Speed RPM

Continuous
Intermittent

100 cm³/r [6.2 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.25] ,95	[140] 15 **4**	[260] 30 **2**								
[.5] 1,9	[150] 15 **13**	[300] 35 **9**	[620] 70 **5**	[940] 105 **2**						
[1] 3,8	[170] 20 **35**	[390] 45 **34**	[830] 95 **31**	[1210] 135 **28**	[1570] 175 **23**	[1870] 210 **15**	[2130] 240 **6**			
[2] 7,5	[170] 20 **73**	[390] 45 **71**	[830] 95 **68**	[1220] 140 **63**	[1590] 180 **59**	[1920] 215 **51**	[2220] 250 **38**	[2520] 285 **24**	[2810] 315 **14**	[3120] 355 **4**
[4] 15	[170] 20 **148**	[380] 45 **145**	[820] 90 **141**	[1240] 140 **136**	[1640] 185 **131**	[2010] 225 **121**	[2380] 270 **104**	[2750] 310 **94**	[3120] 355 **80**	[3490] 395 **69**
[6] 23	[160] 20 **222**	[380] 45 **219**	[820] 90 **215**	[1260] 140 **209**	[1670] 190 **202**	[2080] 235 **192**	[2480] 280 **172**	[2880] 325 **163**	[3280] 370 **149**	[3680] 415 **134**
[8] 30	[150] 15 **297**	[370] 40 **294**	[810] 90 **288**	[1260] 140 **281**	[1700] 190 **273**	[2130] 240 **261**	[2560] 290 **243**	[2990] 340 **231**	[3420] 385 **216**	[3840] 435 **200**
[10] 38	[140] 15 **371**	[368] 40 **90**	[810] 90 **362**	[1270] 145 **354**	[1720] 195 **344**	[2160] 245 **330**	[2610] 295 **316**	[3020] 340 **300**	[3440] 390 **283**	[3850] 435 **266**
[12] 45	[120] 15 **445**	[350] 40 **442**	[800] 90 **436**	[1270] 145 **427**	[1730] 195 **415**	[2180] 245 **399**	[2630] 295 **389**	[3070] 345 **369**	[3510] 395 **350**	[3950] 445 **332**
[14] 53	[110] 10 **519**	[330] 35 **516**	[800] 90 **509**	[1260] 140 **500**	[1740] 195 **486**	[2180] 245 **469**	[2630] 295 **463**	[3070] 345 **437**	[3500] 395 **417**	[3940] 445 **378**
[16] 61	[90] 10 **594**	[320] 35 **591**	[780] 90 **583**	[1260] 140 **573**	[1720] 195 **558**	[2160] 245 **540**	[2610] 295 **537**	[3060] 345 **506**	[3500] 395 **485**	[3940] 445 **463**
[18] 68	[70] 10 **668**	[300] 35 **665**	[770] 85 **657**	[1240] 140 **646**	[1700] 190 **630**	[2140] 240 **611**	[2580] 290 **609**	[3020] 340 **574**	[3460] 390 **552**	[3900] 440 **529**
[20] 76	[60] 5 **742**	[280] 30 **739**	[730] 80 **731**	[1180] 135 **715**	[1630] 185 **703**	[2090] 235 **684**	[2550] 290 **662**	[2980] 335 **643**	[3440] 390 **619**	[3830] 435 **595**
[22] 83	[40] 5 **816**	[260] 30 **813**	[720] 80 **805**	[1180] 135 **794**	[1620] 185 **777**	[2070] 235 **758**	[2500] 280 **749**	[2930] 330 **712**	[3360] 380 **687**	
[24] 91	[20] 1,0 **890**	[230] 230 **887**	[690] 80 **879**	[1140] 130 **868**	[1540] 175 **852**	[2020] 230 **834**	[2460] 280 **814**	[2900] 330 **782**	[3340] 375 **754**	
[25] 95		[220] 25 **924**	[670] 75 **916**	[1120] 125 **905**	[1560] 175 **890**	[1990] 225 **873**	[2450] 275 **846**	[2890] 325 **817**		

Performance data is typical at 120 SUS. Actual data may vary slightly from unit to unit in production

Performance Data
2000 Series

Motors run with high efficiency in all areas designated with a number for torque and speed, however for best motor life select a motor to run with a torque and speed range shown in the light blue area.

130 cm³/r [8.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.25] ,95	[170] 20 **3**									
[.5] 1,9	[190] 20 **12**	[410] 45 **8**	[870] 100 **2**							
[1] 3,8	[230] 25 **28**	[510] 60 **27**	[1070] 120 **23**	[1580] 180 **19**	[2050] 230 **16**	[2520] 285 **13**	[2920] 330 **9**	[3310] 375 **3**		
[2] 7.5	[230] 25 **56**	[510] 60 **56**	[1080] 120 **53**	[1600] 180 **47**	[2090] 235 **42**	[2580] 290 **39**	[2930] 330 **36**	[3320] 375 **28**	[3640] 410 **21**	[3990] 450 **13**
[4] 15	[220] 25 **114**	[500] 55 **113**	[1080] 120 **111**	[1620] 185 **104**	[2150] 245 **97**	[2660] 300 **95**	[3100] 350 **92**	[3540] 400 **85**	[3980] 450 **77**	[4420] 500 **70**
[6] 23	[220] 25 **172**	[490] 55 **171**	[1080] 120 **169**	[1640] 185 **161**	[2190] 245 **153**	[2740] 310 **149**	[3260] 370 **146**	[3770] 425 **132**	[4280] 485 **118**	[4800] 540 **104**
[8] 30	[200] 25 **230**	[480] 55 **224**	[1080] 120 **222**	[1650] 185 **219**	[2220] 250 **210**	[2780] 315 **204**	[3310] 375 **201**	[3840] 435 **192**	[4360] 495 **184**	[4890] 550 **175**
[10] 38	[180] 20 **287**	[470] 55 **286**	[1070] 120 **282**	[1650] 185 **276**	[2230] 250 **269**	[2800] 315 **261**	[3420] 385 **255**	[3940] 445 **243**	[4450] 505 **231**	[4970] 560 **219**
[12] 45	[160] 20 **345**	[460] 50 **344**	[1060] 120 **338**	[1640] 185 **333**	[2230] 250 **327**	[2800] 315 **317**	[3350] 380 **307**	[3910] 440 **295**	[4440] 500 **284**	[4960] 560 **272**
[14] 53	[150] 15 **403**	[440] 50 **402**	[1030] 115 **395**	[1620] 185 **391**	[2220] 250 **385**	[3000] 340 **373**	[3350] 380 **360**	[3910] 440 **348**	[4440] 500 **336**	
[16] 61	[130] 15 **461**	[420] 45 **460**	[1010] 115 **452**	[1600] 180 **447**	[2200] 250 **443**	[2780] 315 **430**	[3330] 375 **411**	[3890] 440 **397**	[4440] 500 **384**	
[18] 68	[110] 10 **518**	[400] 45 **517**	[990] 110 **509**	[1580] 180 **504**	[2160] 245 **500**	[2750] 310 **484**	[3300] 375 **471**	[3860] 435 **456**	[4410] 500 **440**	
[20] 76	[90] 10 **576**	[380] 45 **575**	[960] 110 **568**	[1550] 175 **560**	[2130] 240 **551**	[2710] 305 **539**	[3280] 370 **524**	[3840] 435 **508**		
[22] 83	[60] 5 **634**	[350] 40 **633**	[940] 105 **624**	[1520] 170 **619**	[2100] 235 **604**	[2680] 305 **597**	[3250] 365 **579**	[3820] 430 **560**		
[24] 91	[40] 5 **692**	[325] 35 **691**	[920] 105 **682**	[1490] 170 **676**	[2070] 235 **665**	[2650] 300 **651**	[3220] 365 **633**	[3780] 425 **616**		
[25] 95	[20] 1,0 **720**	[310] 35 **719**	[900] 100 **712**	[1480] 165 **705**	[2050] 230 **692**	[2630] 295 **679**	[3200] 360 **682**	[3700] 420 **656**		

160 cm³/r [9.6 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[3750] 260
[.25] ,95	[200] 25 **3**								
[.5] 1,9	[240] 25 **9**	[490] 55 **7**	[990] 110 **5**	[1570] 175 **3**	[2140] 240 **1**				
[1] 3,8	[280] 30 **23**	[590] 65 **21**	[1170] 130 **19**	[1730] 195 **17**	[2290] 260 **13**	[2830] 320 **8**	[3330] 375 **3**	[3820] 430 **2**	[4070] 460 **1**
[2] 7.5	[300] 35 **46**	[610] 70 **45**	[1210] 135 **42**	[1790] 200 **39**	[2350] 265 **35**	[2920] 330 **34**	[3480] 395 **33**	[4050] 460 **28**	[4330] 490 **22**
[4] 15	[320] 35 **93**	[630] 70 **92**	[1260] 140 **89**	[1890] 215 **85**	[2530] 285 **79**	[3170] 360 **77**	[3820] 430 **75**	[4460] 505 **59**	[4780] 540 **43**
[6] 23	[320] 35 **142**	[650] 75 **140**	[1300] 145 **137**	[1960] 220 **131**	[2620] 295 **124**	[3280] 370 **118**	[3940] 445 **113**	[4600] 520 **104**	[4930] 560 **96**
[8] 30	[310] 35 **190**	[650] 75 **187**	[1330] 150 **184**	[2010] 225 **178**	[2670] 300 **170**	[3330] 375 **166**	[4000] 450 **164**	[4660] 525 **153**	[4990] 565 **142**
[10] 38	[290] 35 **237**	[640] 70 **235**	[1340] 150 **231**	[2030] 230 **226**	[2850] 320 **217**	[3410] 385 **212**	[4030] 455 **205**	[4700] 530 **193**	[5030] 570 **187**
[12] 45	[270] 30 **286**	[620] 70 **283**	[1320] 150 **279**	[2030] 230 **274**	[2700] 305 **265**	[3370] 380 **254**	[4040] 455 **246**	[4710] 530 **235**	[5040] 570 **224**
[14] 53	[240] 25 **334**	[590] 65 **331**	[1300] 145 **326**	[2020] 230 **322**	[2690] 305 **312**	[3360] 380 **305**	[4030] 455 **297**	[4700] 530 **286**	
[16] 61	[220] 25 **382**	[570] 65 **378**	[1270] 145 **374**	[1980] 225 **369**	[2660] 300 **360**	[3330] 375 **349**	[4010] 455 **339**	[4680] 530 **326**	
[18] 68	[190] 20 **429**	[540] 60 **426**	[1240] 140 **422**	[1960] 220 **416**	[2640] 300 **407**	[3320] 375 **394**	[3990] 450 **387**		
[20] 76	[170] 20 **477**	[510] 60 **474**	[1210] 135 **469**	[1920] 215 **462**	[2630] 300 **451**	[3310] 375 **440**	[3940] 445 **430**		
[22] 83	[150] 15 **525**	[480] 55 **522**	[1170] 130 **517**	[1880] 210 **510**	[2600] 295 **501**	[3290] 370 **484**	[3920] 445 **473**		
[24] 91	[120] 15 **572**	[450] 50 **569**	[1150] 130 **564**	[1860] 210 **556**	[2570] 290 **546**	[3260] 370 **531**	[3900] 440 **522**		
[25] 95	[90] 10 **596**	[440] 50 **593**	[1140] 130 **587**	[1840] 210 **580**	[2560] 290 **566**	[3230] 365 **553**	[3880] 440 **544**		
[30] 114		[330] 35 **713**	[1040] 120 **706**	[1750] 200 **696**	[2470] 280 **682**	[3140] 355 **672**	[3800] 430 **658**		

[330] 35 **713** } Torque [lb-in] Nm **Speed RPM**

Continuous
Intermittent

Performance data is typical at 120 SUS. Actual data may vary slightly from unit to unit in production

Performance Data 2000 Series

195 cm³/r [11.9 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170	[2750] 190	[3000] 205	[3250] 225	[3500] 240	[3750] 260
[.25] ,95	[240] 25 **4**	[590] 65 **2**													
[.5] 1,9	[290] 35 **8**	[640] 70 **6**	[990] 110 **5**	[1340] 150 **2**											
[1] 3,8	[380] 45 **17**	[730] 80 **16**	[1100] 125 **15**	[1430] 160 **14**	[1790] 200 **13**	[2120] 200 **11**	[2450] 275 **9**	[2720] 305 **7**	[2990] 340 **5**	[3260] 370 **4**	[3540] 400 **3**	[3810] 430 **2**	[4080] 460 **2**	[4350] 490 **1**	[4620] 520 **1**
[2] 7,5	[390] 45 **37**	[755] 85 **35**	[1135] 130 **34**	[1470] 165 **33**	[1860] 210 **32**	[2195] 250 **31**	[2535] 285 **28**	[2880] 325 **26**	[3120] 355 **24**	[3680] 415 **21**	[4090] 460 **20**	[4500] 510 **19**	[4800] 540 **17**	[5100] 575 **14**	[5400] 610 **14**
[4] 15	[405] 45 **76**	[795] 90 **74**	[1185] 135 **73**	[1540] 175 **72**	[1970] 225 **71**	[2310] 260 **70**	[2675] 300 **66**	[3040] 345 **64**	[3420] 385 **62**	[3790] 430 **61**	[4160] 470 **59**	[4520] 510 **57**	[4890] 550 **55**	[5260] 595 **51**	[5630] 635 **45**
[6] 23	[405] 45 **115**	[815] 90 **113**	[1220] 140 **111**	[1590] 180 **110**	[2035] 230 **109**	[2395] 270 **108**	[2780] 315 **104**	[3170] 360 **102**	[3560] 400 **100**	[3940] 445 **99**	[4320] 490 **96**	[4700] 530 **94**	[5070] 570 **91**	[5450] 615 **87**	[5830] 660 **81**
[8] 30	[400] 45 **154**	[820] 90 **151**	[1230] 140 **149**	[1625] 185 **148**	[2065] 235 **147**	[2450] 275 **146**	[2850] 320 **143**	[3260] 370 **140**	[3670] 415 **137**	[4040] 455 **135**	[4410] 500 **132**	[4780] 540 **130**	[5150] 580 **127**	[5520] 625 **123**	[5890] 665 **117**
[10] 38	[380] 45 **193**	[810] 95 **190**	[1230] 140 **188**	[1645] 185 **187**	[2095] 235 **186**	[2480] 280 **184**	[2895] 325 **181**	[3310] 375 **177**	[3730] 420 **175**	[4100] 465 **173**	[4470] 505 **170**	[4840] 545 **168**	[5210] 590 **164**	[5590] 630 **160**	
[12] 45	[355] 40 **231**	[790] 90 **229**	[1215] 135 **227**	[1650] 185 **226**	[2100] 235 **224**	[2485] 280 **221**	[2915] 330 **219**	[3340] 375 **218**	[3760] 425 **215**	[4120] 465 **211**	[4480] 505 **208**	[4850] 550 **204**			
[14] 53	[320] 35 **269**	[765] 85 **267**	[1190] 135 **267**	[1645] 185 **264**	[2090] 235 **261**	[2475] 280 **260**	[2915] 330 **257**	[3350] 380 **254**	[3770] 425 **250**	[4130] 465 **248**	[4480] 505 **245**	[4860] 550 **241**			
[16] 61	[290] 30 **308**	[730] 80 **306**	[1160] 130 **305**	[1625] 185 **303**	[2070] 235 **299**	[2455] 275 **296**	[2900] 330 **294**	[3340] 375 **290**	[3760] 425 **286**	[4130] 465 **283**	[4490] 505 **279**	[4860] 550 **276**			
[18] 68	[290] 30 **346**	[690] 80 **345**	[1120] 125 **345**	[1590] 180 **342**	[2035] 230 **337**	[2420] 270 **334**	[2870] 325 **333**	[3310] 375 **327**	[3730] 420 **321**	[4100] 465 **315**	[4480] 505 **308**				
[20] 76	[210] 25 **385**	[650] 75 **384**	[1080] 120 **383**	[1550] 175 **380**	[1995] 225 **375**	[2380] 270 **372**	[2830] 320 **371**	[3270] 370 **367**	[3690] 415 **363**	[4070] 460 **359**	[4450] 500 **355**				
[22] 83	[170] 20 **424**	[610] 70 **423**	[1040] 120 **422**	[1500] 170 **418**	[1955] 220 **414**	[2340] 265 **410**	[2785] 315 **408**	[3220] 365 **404**	[3640] 410 **399**	[4050] 460 **395**					
[24] 91	[135] 15 **462**	[570] 65 **461**	[1000] 115 **460**	[1440] 165 **457**	[1910] 215 **453**	[2300] 260 **449**	[2740] 310 **446**	[3170] 360 **441**	[3590] 405 **436**	[3980] 450 **432**					
[25] 95	[120] 15 **484**	[550] 60 **482**	[980] 110 **479**	[1410] 160 **476**	[1890] 215 **473**	[2280] 260 **469**	[2720] 305 **464**	[3150] 355 **459**	[3570] 405 **454**	[3960] 445 **449**					
[30] 114		[420] 45 **577**	[860] 95 **575**	[1290] 145 **571**	[1700] 190 **567**	[2120] 240 **562**	[2530] 285 **556**	[2940] 330 **550**	[3400] 385 **542**						

[2120] 240 **562** } Torque [lb-in] Nm **Speed RPM**

Continuous
Intermittent

245 cm³/r [14.9 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170	[2750] 190	[3000] 205	[3250] 225	[3500] 240	[3750] 260
[.5] 1,9	[410] 45 **4**	[850] 95 **2**													
[1] 3,8	[450] 50 **14**	[930] 105 **13**	[1420] 160 **12**	[1850] 210 **11**	[2320] 260 **10**	[2780] 315 **9**	[3250] 365 **8**	[3650] 410 **6**	[4100] 465 **5**	[4540] 515 **4**	[4980] 560 **4**	[5430] 615 **3**	[5870] 665 **2**	[6310] 715 **1**	
[2] 7,5	[460] 50 **29**	[960] 110 **28**	[1460] 165 **27**	[1900] 215 **26**	[2400] 270 **25**	[2860] 325 **23**	[3340] 375 **22**	[3780] 425 **20**	[4320] 490 **19**	[4770] 540 **18**	[5210] 590 **17**	[5660] 640 **15**	[6110] 690 **14**	[6570] 740 **12**	[6950] 785 **10**
[4] 15	[470] 55 **60**	[1000] 115 **59**	[1540] 175 **58**	[1980] 225 **56**	[2510] 285 **54**	[3010] 340 **53**	[3480] 395 **51**	[3980] 450 **49**	[4450] 505 **48**	[4910] 555 **47**	[5380] 610 **47**	[5850] 660 **46**	[6320] 715 **45**	[6780] 765 **44**	[7250] 820 **42**
[6] 23	[460] 50 **91**	[1020] 115 **90**	[1550] 175 **89**	[2040] 230 **87**	[2580] 290 **84**	[3110] 350 **83**	[3590] 405 **81**	[4120] 465 **78**	[4580] 515 **76**	[5050] 570 **73**	[5520] 625 **71**	[5980] 675 **69**	[6440] 730 **67**	[6910] 780 **65**	
[8] 30	[460] 50 **122**	[1010] 115 **121**	[1560] 175 **120**	[2080] 235 **118**	[2630] 295 **115**	[3170] 360 **113**	[3670] 415 **111**	[4210] 475 **108**	[4680] 530 **106**	[5160] 585 **104**	[5630] 635 **102**	[6110] 690 **101**	[6590] 745 **99**		
[10] 38	[440] 50 **153**	[1000] 115 **152**	[1550] 175 **150**	[2110] 240 **148**	[2650] 300 **146**	[3200] 360 **144**	[3730] 420 **142**	[4250] 480 **139**	[4730] 535 **137**	[5210] 560 **135**	[5720] 645 **133**	[6230] 705 **103**			
[12] 45	[410] 45 **184**	[960] 110 **183**	[1530] 175 **182**	[2100] 235 **180**	[2640] 300 **177**	[3190] 360 **175**	[3760] 425 **173**	[4260] 480 **170**	[4740] 535 **168**	[5220] 600 **165**	[5730] 645 **162**				
[14] 53	[380] 40 **215**	[910] 105 **214**	[1500] 170 **213**	[2080] 235 **211**	[2600] 295 **209**	[3160] 355 **207**	[3760] 425 **204**	[4230] 480 **201**	[4710] 530 **198**	[5190] 585 **195**					
[16] 61	[340] 40 **246**	[860] 95 **245**	[1460] 165 **244**	[2040] 230 **242**	[2570] 290 **240**	[3120] 355 **238**	[3740] 425 **235**	[4180] 470 **232**	[4660] 525 **227**	[5140] 580 **223**					
[18] 68	[290] 30 **277**	[810] 90 **276**	[1420] 160 **275**	[2000] 225 **273**	[2520] 285 **271**	[3060] 345 **269**	[3700] 420 **266**	[4130] 465 **263**	[4610] 520 **258**	[5090] 575 **253**					
[20] 76	[250] 30 **308**	[800] 90 **306**	[1350] 155 **304**	[1910] 215 **302**	[2460] 280 **300**	[3010] 340 **298**	[3630] 410 **295**	[4110] 465 **291**	[4610] 520 **288**						
[22] 83	[200] 25 **339**	[710] 80 **337**	[1300] 145 **337**	[1870] 210 **334**	[2390] 270 **332**	[2940] 330 **330**	[3560] 400 **327**	[4010] 455 **323**	[4510] 510 **318**						
[24] 91	[150] 15 **370**	[670] 75 **369**	[1240] 140 **367**	[1790] 200 **364**	[2330] 265 **362**	[2880] 325 **360**	[3460] 390 **357**	[3960] 445 **353**	[4460] 505 **344**						
[25] 95	[120] 15 **385**	[660] 75 **384**	[1210] 135 **382**	[1750] 200 **379**	[2300] 260 **377**	[2860] 325 **375**	[3410] 385 **372**	[3950] 445 **367**	[4470] 505 **363**						
[30] 114		[520] 60 **462**	[1080] 120 **460**	[1620] 185 **458**	[2180] 245 **456**	[2720] 305 **453**	[3260] 370 **450**	[3790] 430 **447**							

Motors run with high efficiency in all areas designated with a number for torque and speed, however for best motor life select a motor to run with a torque and speed range shown in the light blue area.

Performance data is typical at 120 SUS. Actual data may vary slightly from unit to unit in production

Performance Data 2000 Series

305 cm³/r [18.7 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170	[2750] 190	[3000] 205	[3250] 225	[3500] 240
[.5] 1,9	[500] 55 **4**	[1050] 120 **2**												
[1] 3,8	[610] 70 **12**	[1180] 135 **11**	[1750] 200 **11**	[2330] 260 **10**	[2870] 325 **10**	[3440] 390 **9**	[3930] 445 **8**	[4410] 500 **6**	[4900] 555 **3**	[5380] 610 **1**				
[2] 7,5	[620] 70 **24**	[1210] 135 **24**	[1800] 205 **23**	[2400] 270 **22**	[2970] 335 **22**	[3510] 395 **20**	[4050] 460 **19**	[4600] 520 **18**	[5140] 580 **17**	[5680] 640 **15**	[6220] 705 **13**	[6750] 765 **11**	[7290] 825 **8**	[7820] 885 **6**
[4] 15	[680] 75 **49**	[1250] 140 **49**	[1880] 210 **48**	[2500] 280 **47**	[3120] 355 **47**	[3690] 415 **45**	[4260] 480 **43**	[4840] 545 **42**	[5410] 610 **40**	[5980] 675 **38**	[6550] 740 **36**	[7120] 805 **34**	[7690] 870 **33**	
[6] 23	[620] 70 **74**	[1270] 145 **74**	[1920] 215 **72**	[2560] 290 **72**	[3230] 365 **71**	[3810] 430 **69**	[4390] 495 **66**	[4970] 560 **64**	[5560] 630 **61**	[6130] 695 **58**	[6710] 760 **55**	[7290] 825 **52**		
[8] 30	[600] 70 **98**	[1270] 145 **98**	[1940] 220 **97**	[2600] 295 **96**	[3290] 370 **95**	[3880] 440 **93**	[4470] 505 **90**	[5070] 575 **86**	[5660] 640 **83**	[6250] 705 **80**	[6840] 775 **77**			
[10] 38	[570] 65 **123**	[1250] 140 **122**	[1940] 220 **121**	[2610] 295 **120**	[3310] 375 **119**	[3920] 440 **117**	[4530] 510 **113**	[5150] 580 **110**	[5760] 650 **106**	[6370] 720 **102**				
[12] 45	[530] 60 **148**	[1220] 140 **147**	[1920] 215 **145**	[2600] 295 **144**	[3300] 375 **143**	[3920] 440 **142**	[4530] 510 **138**	[5150] 580 **133**	[5760] 650 **128**	[6370] 720 **124**				
[14] 53	[480] 55 **172**	[1180] 135 **172**	[1870] 210 **170**	[2560] 290 **168**	[3260] 370 **167**	[3900] 440 **165**	[4510] 510 **160**	[5120] 580 **156**	[5730] 645 **152**					
[16] 61	[430] 50 **196**	[1120] 125 **196**	[1820] 205 **194**	[2500] 280 **192**	[3210] 365 **191**	[3870] 440 **188**	[4480] 505 **183**	[5080] 575 **178**	[5690] 645 **174**					
[18] 68	[370] 40 **221**	[1060] 120 **221**	[1760] 200 **218**	[2440] 275 **217**	[3140] 355 **215**	[3800] 440 **212**	[4420] 500 **207**	[5050] 570 **202**						
[20] 76	[320] 35 **246**	[980] 110 **245**	[1680] 190 **243**	[2360] 265 **241**	[3050] 345 **239**	[3710] 420 **236**	[4370] 495 **231**	[5020] 565 **226**						
[22] 83	[240] 25 **271**	[920] 105 **270**	[1620] 185 **268**	[2300] 260 **266**	[2990] 340 **263**	[3560] 400 **260**	[4190] 475 **258**	[4820] 545 **255**						
[24] 91	[180] 20 **296**	[870] 100 **294**	[1550] 175 **293**	[2240] 255 **290**	[2920] 330 **288**	[3420] 385 **285**	[4020] 455 **283**	[4630] 525 **280**						
[25] 95	[150] 15 **308**	[840] 95 **307**	[1520] 170 **305**	[2200] 250 **303**	[2890] 325 **300**	[3340] 375 **298**	[3930] 445 **295**	[4520] 510 **293**						
[30] 114		[680] 75 **365**	[1360] 155 **362**	[2040] 230 **360**	[2720] 305 **357**	[3140] 355 **356**	[3810] 430 **352**							

[2040] 230 **360** } Torque [lb-in] Nm **Speed RPM**

Continuous
Intermittent

Motors run with high efficiency in all areas designated with a number for torque and speed, however for best motor life select a motor to run with a torque and speed range shown in the light blue area.

395 cm³/r [24.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170	[2750] 190
[.5] 1,9	[560] 65 **4**	[1310] 150 **3**									
[1] 3,8	[770] 85 **9**	[1540] 175 **9**	[2290] 260 **9**	[3080] 350 **8**	[3780] 430 **8**	[4480] 505 **7**	[5170] 585 **7**	[5880] 665 **6**	[6580] 745 **5**	[7270] 820 **4**	[7980] 900 **3**
[2] 7,5	[790] 90 **18**	[1580] 180 **18**	[2360] 265 **18**	[3180] 360 **17**	[3930] 445 **17**	[4680] 530 **16**	[5430] 615 **15**	[6180] 700 **14**	[6840] 775 **13**	[7500] 845 **11**	[8170] 925 **10**
[4] 15	[810] 90 **37**	[1660] 190 **37**	[2480] 280 **37**	[3320] 375 **36**	[4130] 465 **36**	[4940] 560 **35**	[5740] 650 **34**	[6550] 740 **33**	[7230] 815 **31**	[7880] 890 **28**	
[6] 23	[820] 90 **57**	[1700] 190 **56**	[2550] 290 **56**	[3420] 385 **55**	[4250] 480 **54**	[5080] 575 **52**	[5920] 670 **50**	[6750] 765 **49**	[7420] 840 **47**	[8000] 905 **45**	
[8] 30	[820] 90 **76**	[1700] 190 **75**	[2580] 290 **75**	[3460] 390 **74**	[4300] 485 **73**	[5130] 580 **71**	[5960] 675 **69**	[6800] 770 **68**			
[10] 38	[800] 90 **95**	[1700] 190 **94**	[2590] 295 **94**	[3480] 395 **93**	[4320] 490 **92**	[5160] 585 **90**	[6000] 680 **88**	[6840] 775 **86**			
[12] 45	[770] 85 **114**	[1680] 190 **113**	[2570] 290 **113**	[3470] 390 **112**	[4310] 485 **111**	[5150] 580 **109**	[5990] 675 **106**	[6830] 770 **103**			
[14] 53	[740] 85 **133**	[1640] 185 **132**	[2530] 285 **132**	[3430] 390 **131**	[4280] 485 **129**	[5120] 580 **127**	[5960] 675 **124**				
[16] 61	[690] 80 **153**	[1590] 180 **152**	[2480] 280 **152**	[3370] 380 **150**	[4220] 475 **149**	[5060] 570 **146**	[5910] 670 **144**				
[18] 68	[640] 70 **172**	[1530] 170 **171**	[2420] 275 **171**	[3310] 375 **170**	[4160] 470 **169**	[5010] 565 **167**	[5870] 665 **164**				
[20] 76	[580] 65 **191**	[1470] 165 **190**	[2370] 270 **190**	[3260] 370 **189**	[4110] 465 **188**	[4960] 560 **186**	[5820] 660 **184**				
[22] 83	[510] 60 **210**	[1390] 155 **209**	[2290] 260 **209**	[3170] 360 **208**	[4030] 455 **207**	[4880] 550 **206**					
[24] 91	[440] 50 **230**	[1330] 150 **229**	[2220] 250 **228**	[3100] 350 **227**	[3950] 445 **225**	[4800] 540 **224**					
[26] 98	[350] 40 **249**	[1240] 140 **248**	[2130] 240 **247**	[3020] 340 **246**	[3880] 440 **244**	[4730] 535 **242**					
[28] 106	[270] 30 **268**	[1150] 130 **267**	[2050] 230 **265**	[2930] 330 **264**	[3790] 430 **261**	[4650] 525 **259**					
[30] 114	[180] 20 **287**	[1060] 120 **286**	[1960] 220 **284**	[2850] 320 **283**	[3710] 420 **281**	[4570] 515 **277**					

Performance data is typical at 120 SUS. Actual data may vary slightly from unit to unit in production

Performance Data
2000 Series

490 cm³/r [29.8 in³/r]

Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140
[.5] **1,9**	[670] 75 **2**	[1600] 180 **1**						
[1] **3,8**	[920] 105 **7**	[2000] 225 **6**	[2990] 340 **5**	[3900] 440 **4**	[4880] 550 **2**			
[2] **7,5**	[950] 105 **14**	[2060] 235 **13**	[3110] 350 **12**	[4080] 460 **10**	[5110] 575 **9**	[6320] 715 **7**		
[4] **15**	[980] 110 **30**	[2130] 240 **29**	[3230] 365 **28**	[4270] 480 **27**	[5350] 605 **26**	[6370] 720 **24**	[7380] 835 **22**	[7980] 900 **20**
[6] **23**	[980] 110 **45**	[2120] 240 **44**	[3230] 365 **43**	[4300] 485 **42**	[5370] 605 **41**	[6420] 725 **39**	[7470] 845 **37**	[8225] 930 **35**
[8] **30**	[980] 110 **61**	[2110] 240 **60**	[3220] 365 **59**	[4330] 490 **58**	[5400] 610 **57**	[6470] 730 **55**	[7550] 855 **52**	
[10] **38**	[920] 105 **76**	[2050] 230 **75**	[3170] 360 **74**	[4300] 485 **73**	[5390] 610 **72**	[6460] 730 **70**	[7550] 855 **68**	
[12] **45**	[860] 95 **91**	[1990] 225 **90**	[3120] 355 **90**	[4260] 480 **89**	[5370] 605 **87**	[6460] 730 **85**	[7560] 855 **84**	
[14] **53**	[790] 90 **106**	[1930] 220 **105**	[3055] 345 **105**	[4185] 475 **104**	[5300] 600 **102**	[6400] 725 **100**		
[16] **61**	[720] 80 **122**	[1870] 210 **121**	[2990] 340 **120**	[4110] 465 **119**	[5230] 590 **118**	[6340] 715 **116**		
[18] **68**	[630] 70 **137**	[1770] 200 **136**	[2890] 325 **135**	[4020] 455 **134**	[5140] 580 **133**	[6260] 705 **131**		
[20] **76**	[550] 60 **153**	[1670] 190 **152**	[2800] 315 **151**	[3940] 445 **150**	[5060] 570 **149**	[6180] 700 **146**		
[22] **83**	[450] 50 **168**	[1570] 175 **168**	[2700] 305 **167**	[3830] 435 **165**	[4960] 560 **164**	[6070] 685 **161**		
[24] **91**	[360] 40 **184**	[1480] 165 **184**	[2600] 295 **183**	[3730] 420 **181**	[4860] 550 **179**	[5970] 675 **177**		
[26] **98**	[270] 30 **199**	[1390] 155 **195**	[2510] 285 **194**	[3640] 410 **192**	[4770] 540 **190**			
[28] **106**		[1260] 140 **212**	[2370] 270 **211**	[3520] 400 **209**	[4630] 525 **207**			
[30] **114**		[1130] 125 **230**	[2240] 255 **229**	[3400] 385 **277**	[4500] 510 **224**			

[1130] 125 **230** } Torque [lb-in] Nm **Speed RPM**

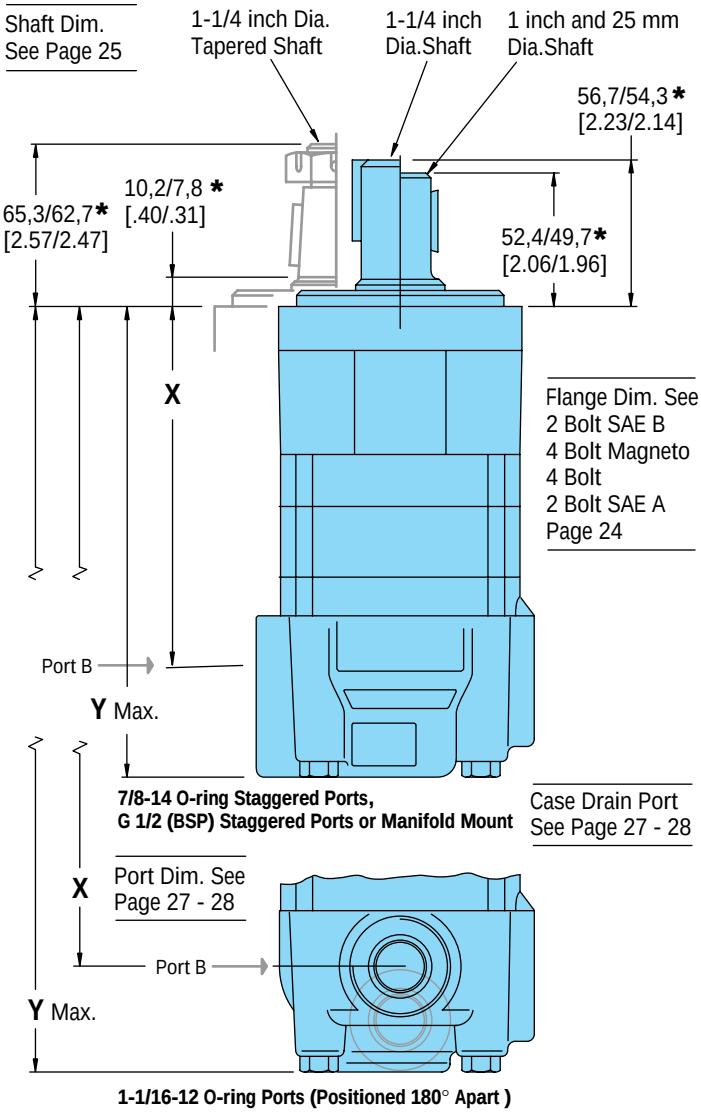
Continuous

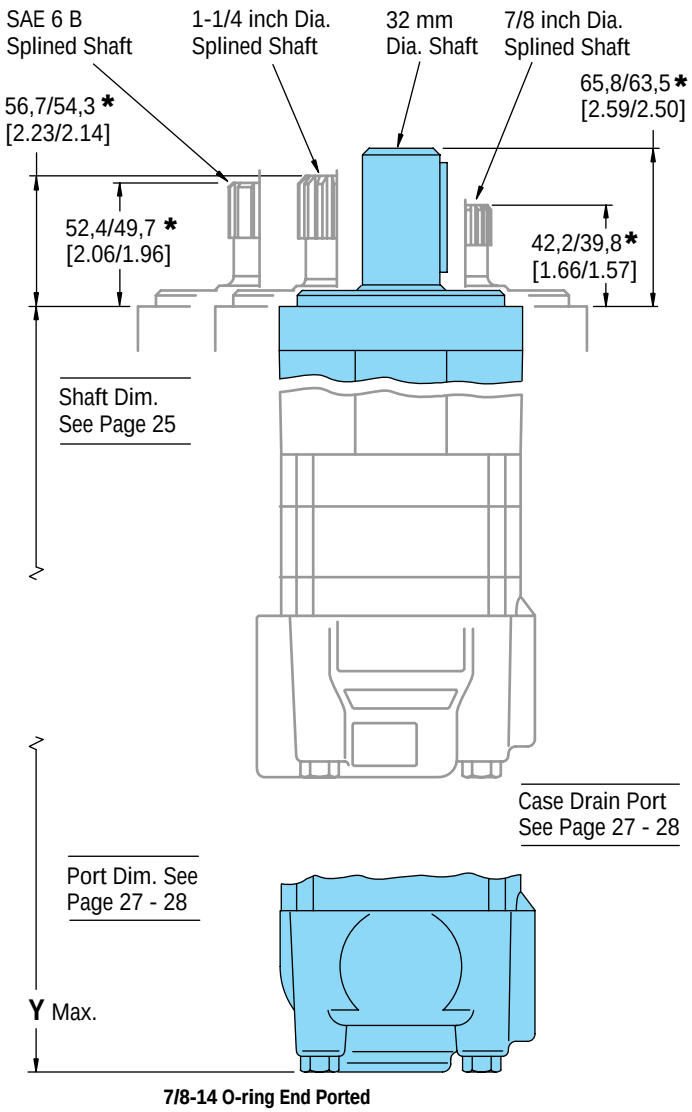
Intermittent

Motors run with high efficiency in all areas designated with a number for torque and speed, however for best motor life select a motor to run with a torque and speed range shown in the light blue area.

Performance data is typical at 120 SUS. Actual data may vary slightly from unit to unit in production

Dimensions — 2000 Series Standard Motor





2000 Series Standard Motor with 7/8-14 O-ring Staggered Ports, G 1/2 (BSP) Staggered Ports or Manifold Mount

Displ. cm³/r [in³/r]	80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
Dim. X mm	137,0	141,6	147,9	147,9	154,8	163,7	175,1	191,1	208,4
Dim. X [inch]	[5.40]	[5.58]	[5.83]	[5.83]	[6.10]	[6.45]	[6.90]	[7.53]	[8.21]
Dim. Y mm	184,5	189,0	195,4	195,4	202,2	211,1	222,6	238,6	255,8
Dim. Y [inch]	[7.26]	[7.44]	[7.69]	[7.69]	[7.96]	[8.31]	[8.76]	[9.39]	[10.07]

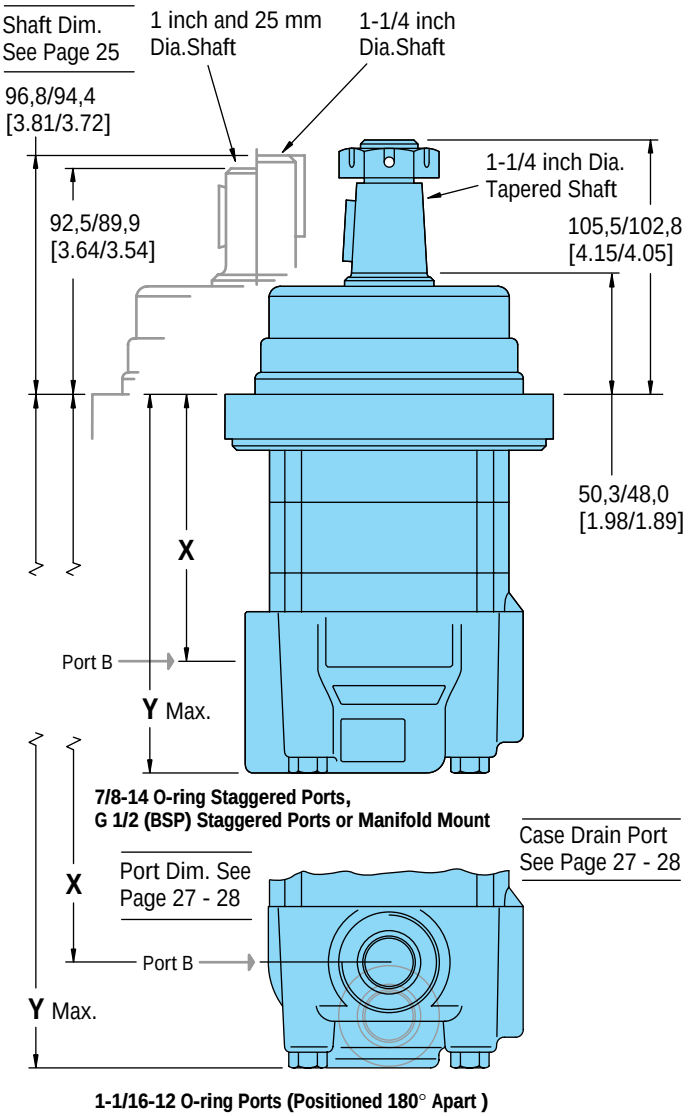
2000 Series Standard Motor with 1-1/16-12 O-ring Ports (Positioned 180° Apart) and use Only Dim. Y for 7/8-14 O-ring End Ported Motors

Dim. X mm	139,3	143,9	150,2	150,2	157,1	166,0	177,4	193,4	210,7
Dim. X [inch]	[5.49]	[5.67]	[5.92]	[5.92]	[6.19]	[6.54]	[6.99]	[7.62]	[8.30]
Dim. Y mm	185,7	190,3	196,6	196,6	203,5	212,4	223,8	239,8	270,1
Dim. Y [inch]	[7.31]	[7.49]	[7.74]	[7.74]	[8.01]	[8.36]	[8.81]	[9.44]	[10.12]

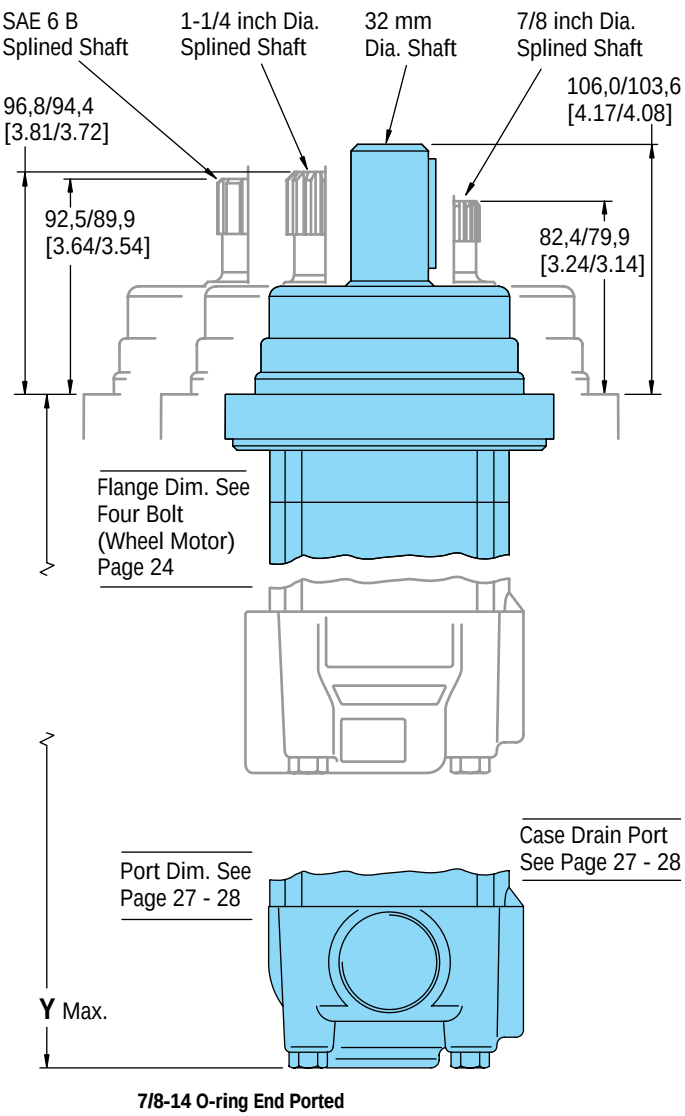
Standard Rotation
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

***Subtract 4,1/3,6 [.16/.14] when ordering motor with 4-bolt magneto flange**

Dimensions — 2000 Series Wheel Motor



1-1/16-12 O-ring Ports (Positioned 180° Apart)



7/8-14 O-ring End Ported

Standard Rotation
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

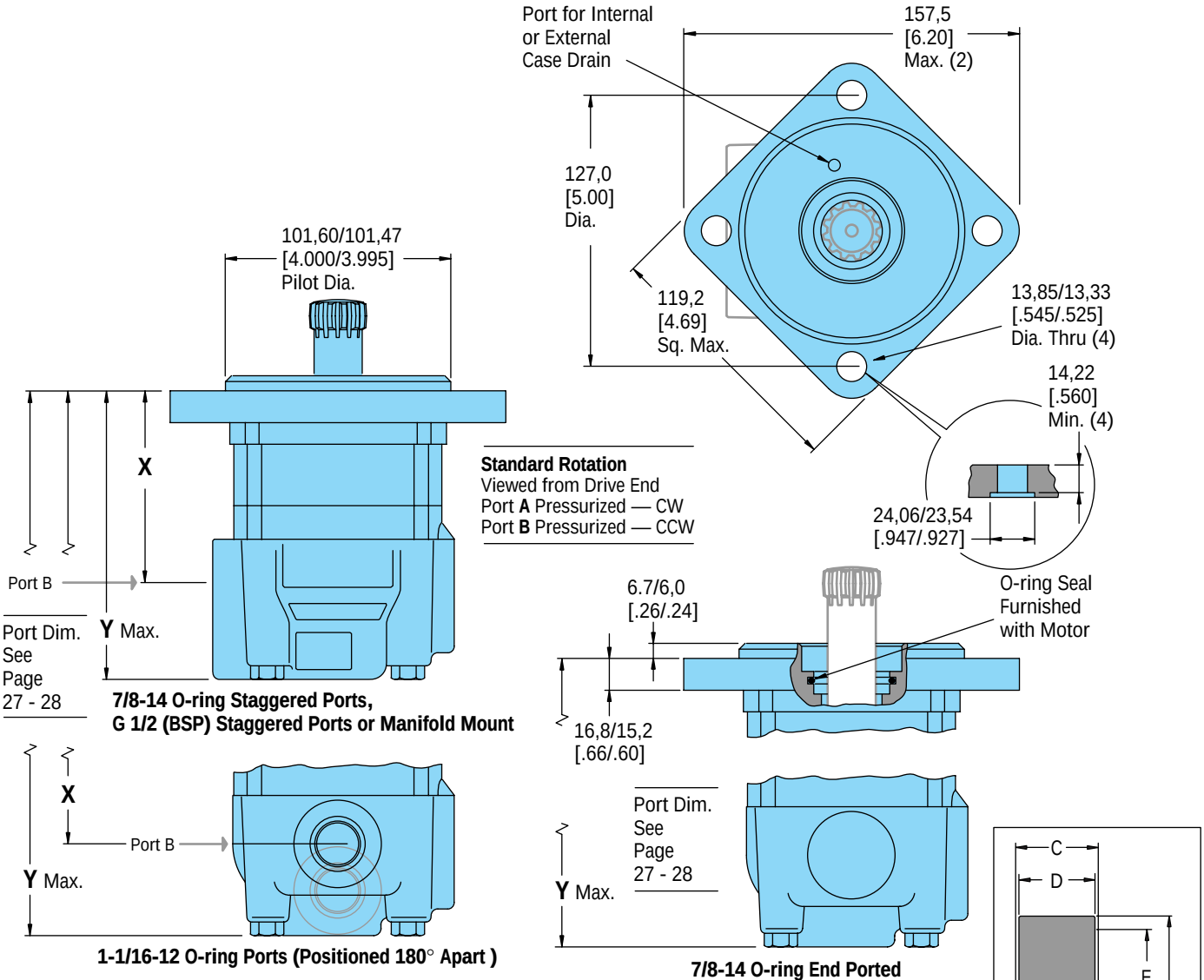
2000 Series Wheel Motor with 7/8-14 O-ring Staggered Ports, G 1/2 (BSP) Staggered Ports or Manifold Mount

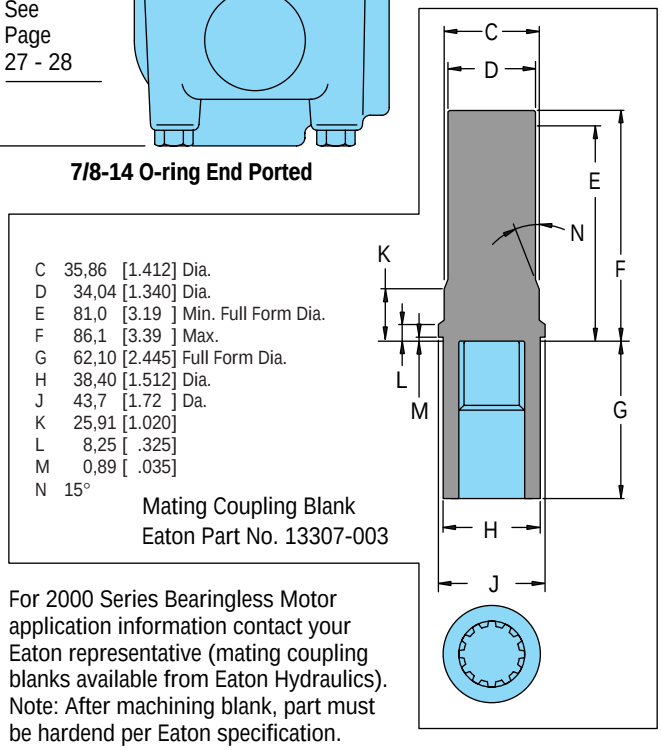
Displ. cm³/r [in³/r]		80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
Dim. **X**	mm	96,9	101,4	107,8	107,8	114,6	123,5	135,0	151,0	168,2
	[inch]	[3.82]	[4.00]	[4.25]	[4.25]	[4.52]	[4.87]	[5.32]	[5.95]	[6.63]
Dim. **Y**	mm	144,3	148,9	155,2	155,2	162,1	171,0	182,4	198,4	215,7
	[inch]	[5.68]	[5.86]	[6.11]	[6.11]	[6.38]	[6.73]	[7.18]	[7.81]	[8.49]

2000 Series Wheel Motor with 1-1/16-12 O-ring Ports (Positioned 180° Apart) and use Only Dim. Y for 7/8-14 O-ring End Ported Wheel Motors

Dim. **X**	mm	99,1	103,7	110,1	110,1	116,9	125,8	137,4	153,4	170,7
	[inch]	[3.90]	[4.09]	[4.34]	[4.34]	[4.61]	[4.96]	[5.41]	[6.04]	[6.72]
Dim. **Y**	mm	145,6	150,2	156,5	156,5	163,4	172,3	183,7	199,7	217,0
	[inch]	[5.73]	[5.91]	[6.16]	[6.16]	[6.43]	[6.78]	[7.23]	[7.86]	[8.54]

Dimensions — 2000 Series Bearingless Motor





2000 Series Bearingless Motor with 7/8-14 O-ring Staggered Ports, G 1/2 (BSP) Staggered Ports or Manifold Mount

Displ. cm³/r [in³/r]		80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
Dim. **X**	mm	79,0	83,5	89,9	89,9	96,8	105,6	117,1	133,1	150,3
	[inch]	[3.11]	[3.29]	[3.54]	[3.54]	[3.81]	[4.16]	[4.61]	[5.24]	[5.92]
Dim. **Y**	mm	126,8	131,4	137,7	137,7	144,6	153,5	164,9	180,9	198,2
	[inch]	[4.99]	[5.17]	[5.42]	[5.42]	[5.69]	[6.04]	[6.49]	[7.12]	[7.80]

2000 Series Bearingless Motor with 7/8-14 O-ring End Ports or 1-1/16-12 O-ring Ports (Positioned 180° Apart)

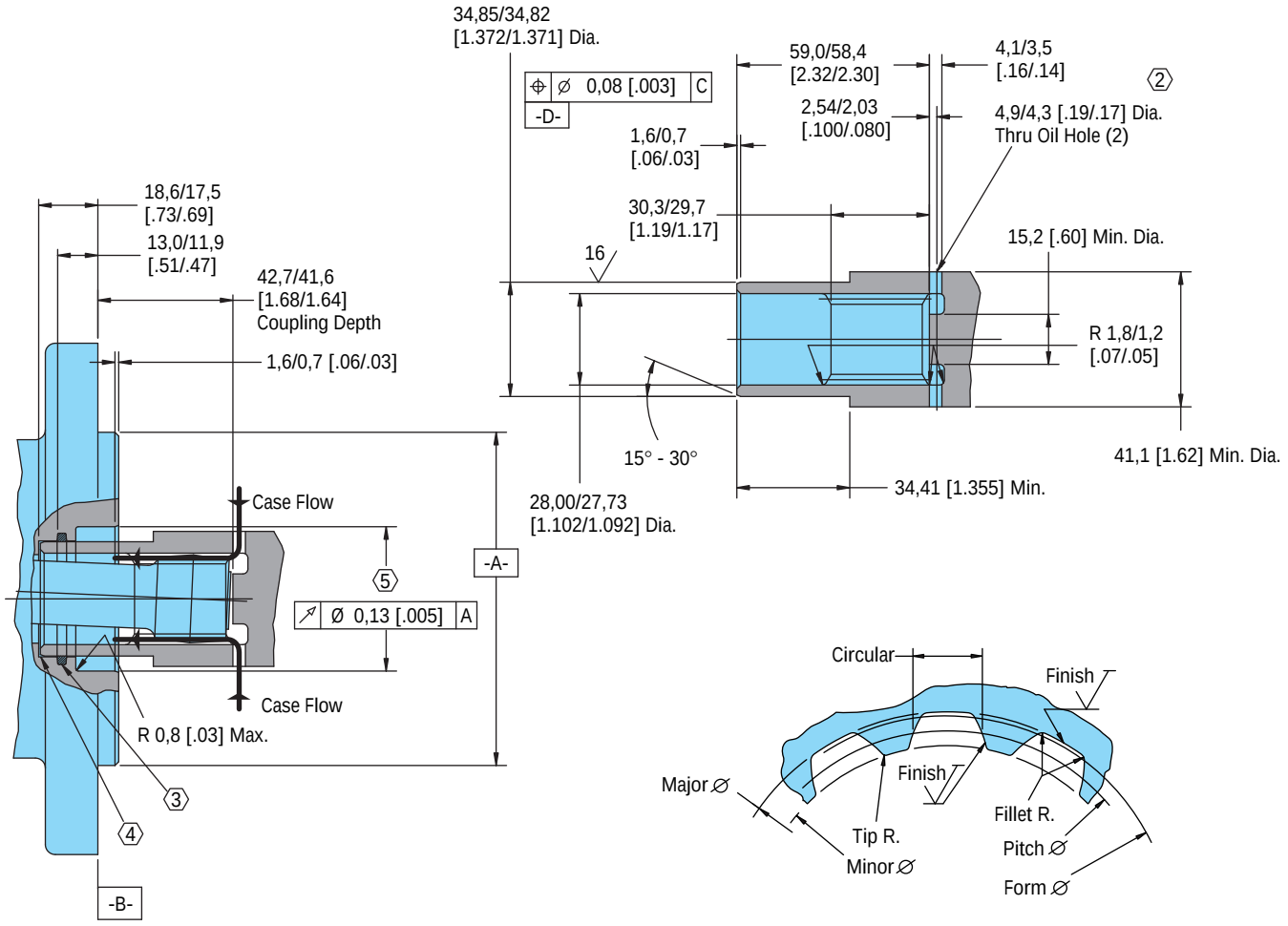
Dim. **X**	mm	81,3	85,8	92,2	92,2	99,0	107,9	119,4	135,4	152,5
	[inch]	[3.20]	[3.38]	[3.63]	[3.63]	[3.90]	[4.25]	[4.70]	[5.33]	[6.00]
Dim. **Y**	mm	128,0	132,6	139,0	139,0	145,8	154,7	166,1	182,1	199,3
	[inch]	[5.04]	[5.22]	[5.47]	[5.47]	[5.74]	[6.09]	[6.54]	[7.17]	[7.85]

C	35,86	[1.412] Dia.
D	34,04	[1.340] Dia.
E	81,0	[3.19] Min. Full Form Dia.
F	86,1	[3.39] Max.
G	62,10	[2.445] Full Form Dia.
H	38,40	[1.512] Dia.
J	43,7	[1.72] Da.
K	25,91	[1.020]
L	8,25	[.325]
M	0,89	[.035]
N	15°	

Mating Coupling Blank
Eaton Part No. 13307-003

For 2000 Series Bearingless Motor application information contact your Eaton representative (mating coupling blanks available from Eaton Hydraulics). Note: After machining blank, part must be hardend per Eaton specification.

Bearingless Installation — 2000 Series



Spline Pitch — 12/24
Pressure Angle — 30°
Number of teeth — 12
Class of Fit — Ref. 5
Type of Fit — Side
Pitch Diameter — Ref. 25,400000 [1.0000000] ◎ 0,21 [.008] D
Base Diameter — Ref. 21,997045 [.8660254]
Major Diameter — (27,74 [1.092] Max. 27,59 [1.086] Min.)
Minor Diameter — 23,097 - 23,224 [.9093 - .9143]
Form Diameter, Min. — 29,93 [1.060]
Fillet Radius — 0,64 - 0,76 [.025 - .030]
Tip Radius — 0,25 - 0,38 [.010 - .015]
Finish — 1,6 (63)
Involute Profile Variation — +0,000 -0,025 [+.0000 -.0010]
Total Index Variation — 0,038 [.0015]
Lead Variation — 0,013 [.0005]
Circular Space Width:
- Maximum Actual — 4,318 [.1700]
- Minimum Effective — 4,216 [.1660]
- Maximum Effective — Ref. 4,270 [.1681]
- Minimum Actual — Ref. 4,247 [.1672]

Dimension Between Two Pins — Ref. 19,020 - 19,190 [.7488 - .7555]
Pin Diameter — 4,496 [.1770] Pins to Have 3,38 [.133] Wide Flat for Root Clearance

1 Internal spline in mating part to be per spline data. Specification material to be ASTM A304, 8620H vacuum degassed alloy steel carborize to a hardness of 59-62 HRc with case depth (to 50HRc) of 0,076 - 1,02 [.030 - .040]. Dimensions apply after heat treat.

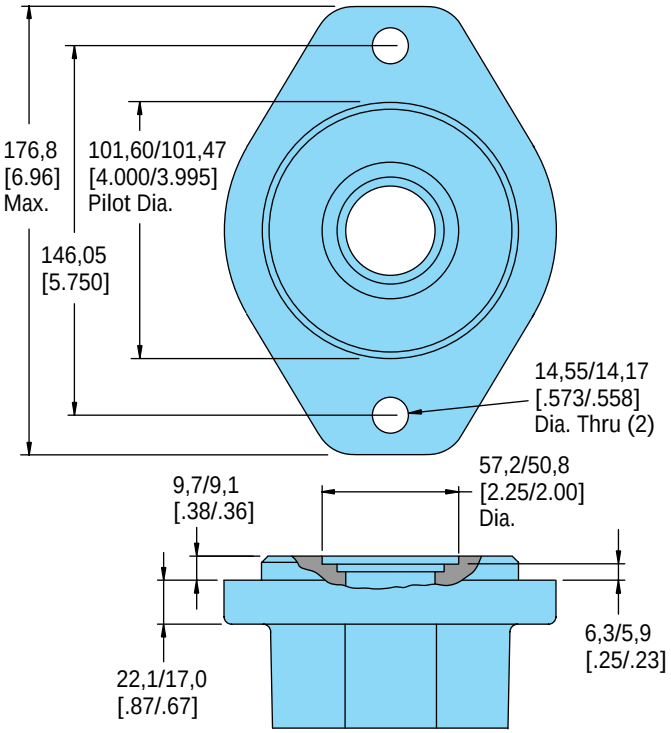
2 Mating part to have critical dimensions as shown. Oil holes must be provided and open for proper oil circulation.

3 Seal to be furnished with motor for proper oil circulation thru splines.

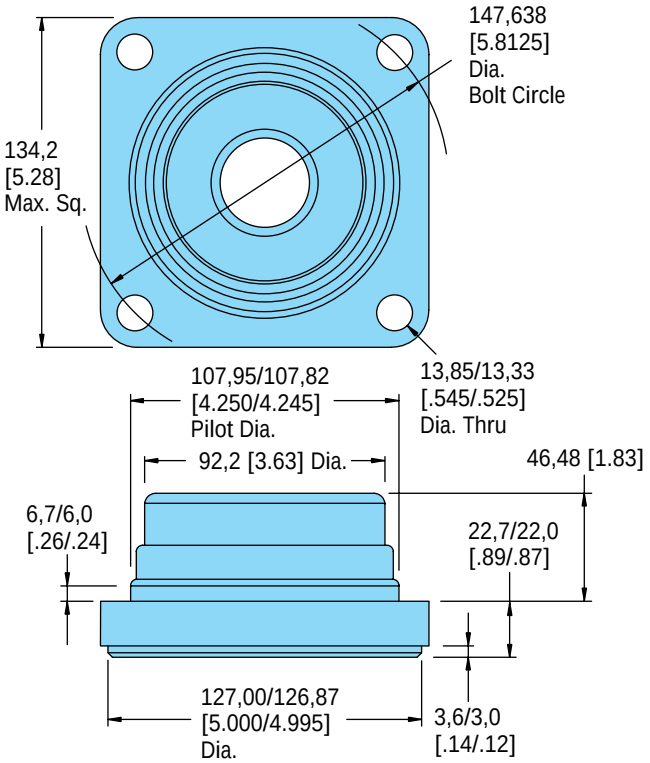
4 Some means of maintaining clearance between shaft and mounting flange must be provided.

5 Counterbore designed to adapt a standard sleeve bearing 35,010 - 35,040 [1.3784 - 1.3795] I.D. by 44,040 - 44,070 [1.7339 - 1.7350] O.D. (Oilite Bronze Sleeve Bearing AAM3544-22).

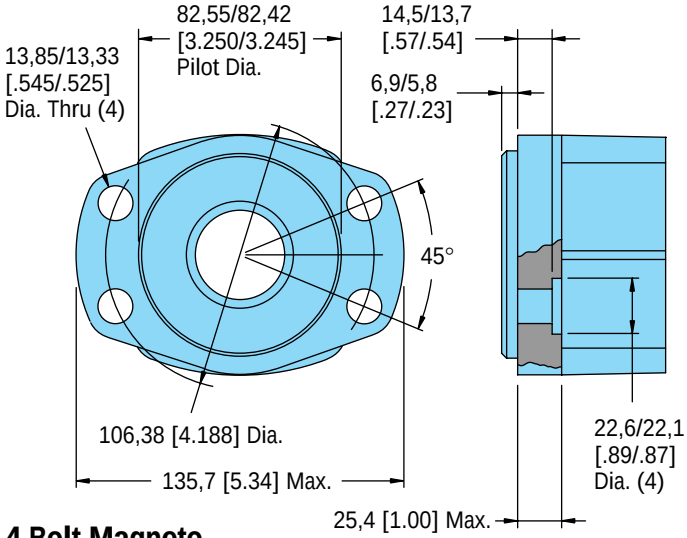
Dimensions — Mounting Options 2000 Series



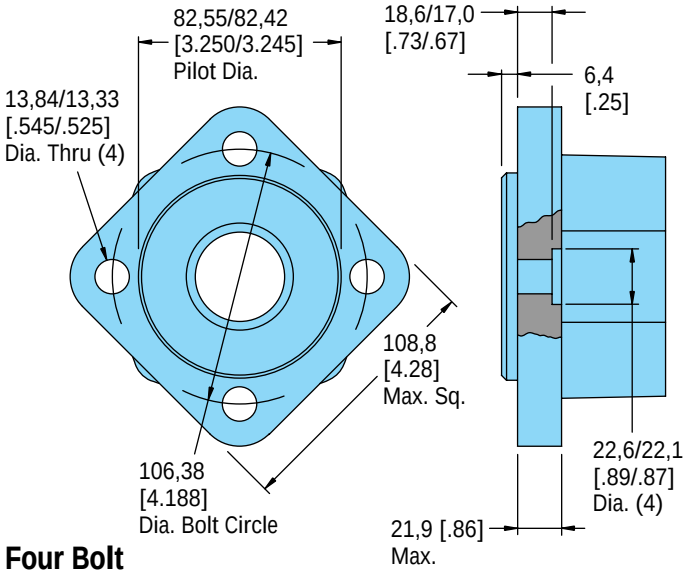
2 Bolt SAE B



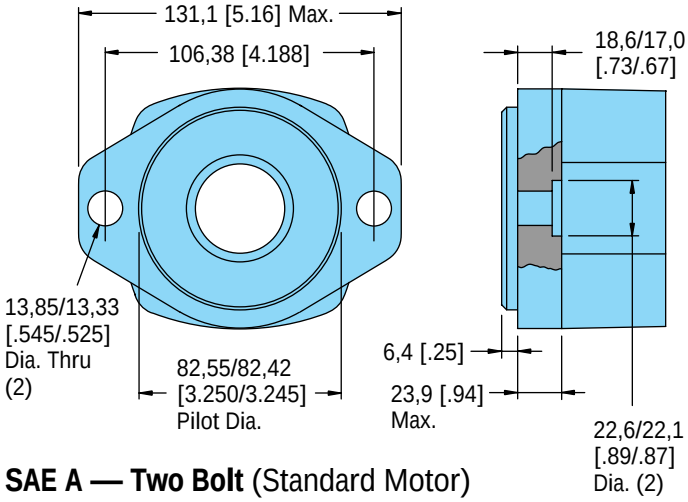
Four Bolt (Wheel Motor)



4 Bolt Magneto

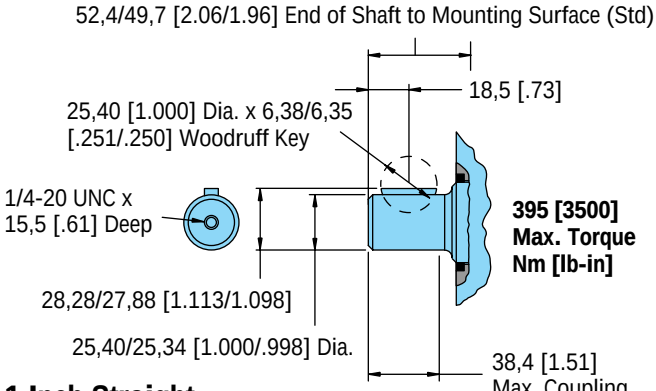


Four Bolt

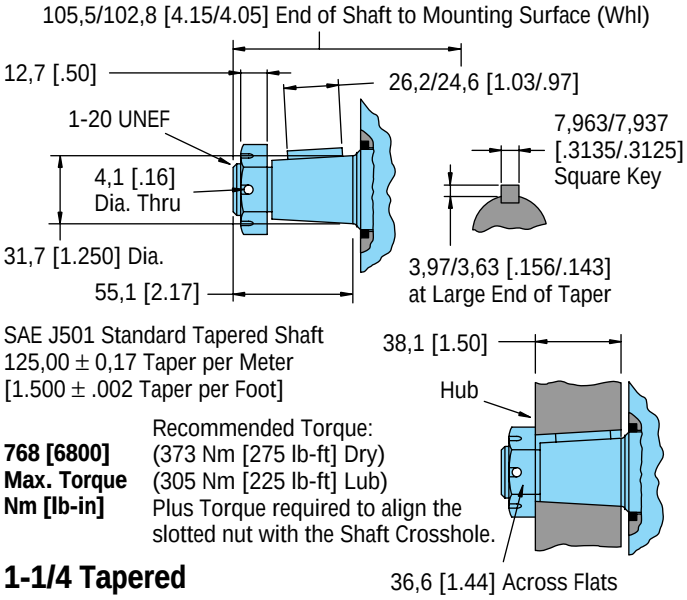


SAE A — Two Bolt (Standard Motor)

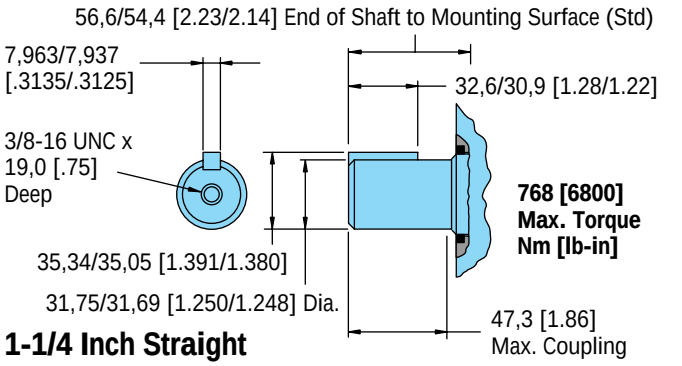
Dimensions — Shafts
2000 Series



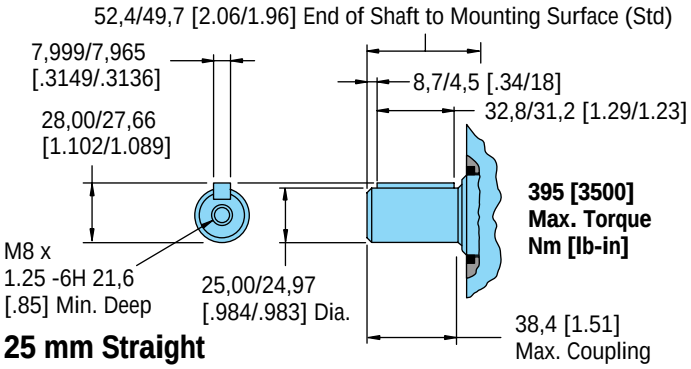
1 Inch Straight



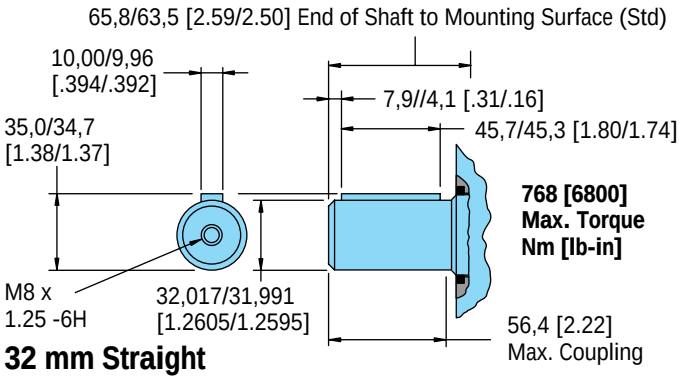
1-1/4 Tapered



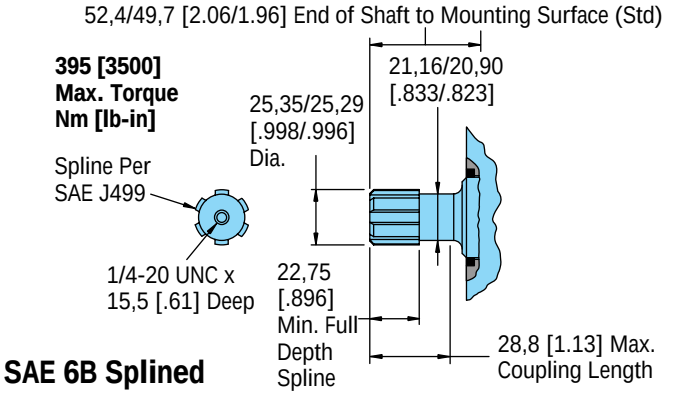
1-1/4 Inch Straight



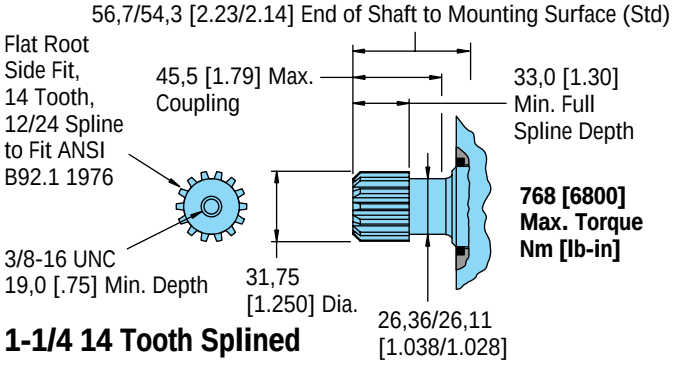
25 mm Straight



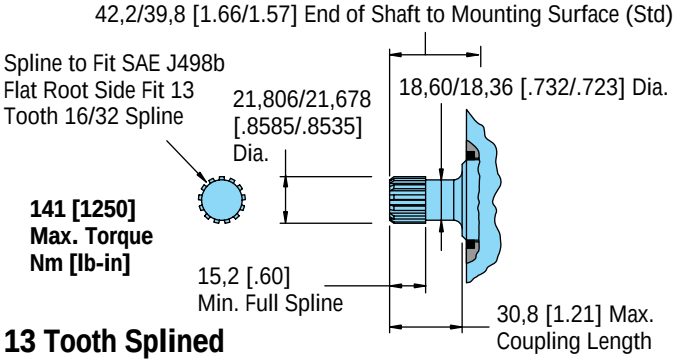
32 mm Straight



SAE 6B Splined



1-1/4 14 Tooth Splined



13 Tooth Splined

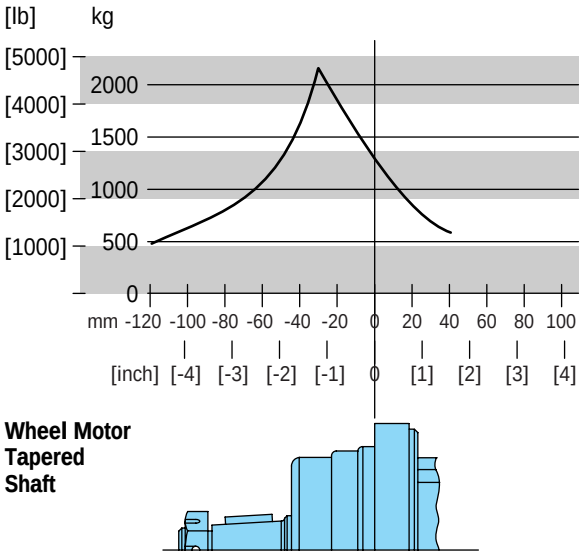
Shaft Side Load Capacity
2000 Series

These curves indicate the radial load capacity on the motor shaft(s) at various locations.

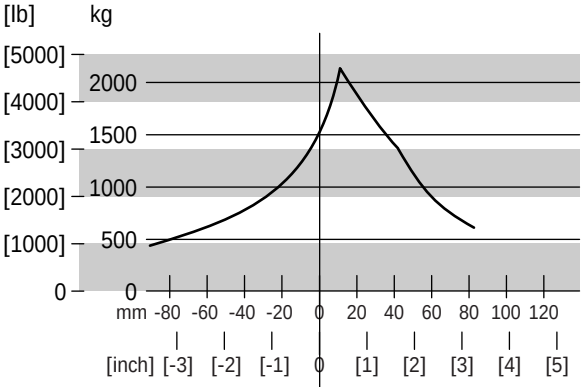
The curve is based on B 10 Bearing life (2000 hours or 12,000,000 shaft revolutions at 100 RPM) at rated output torque. To determine radial load at speeds other than 100 RPM, multiply the load values given on the bearing curve by the factors in the chart below.

RPM	Multiplication Factor
50	1.23
100	1.00
200	.81
300	.72
400	.66
500	.62
600	.58
700	.56
800	.54

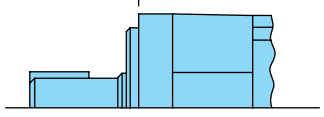
For 3,000,000 Shaft revolutions or 500 hours — Increase these shaft loads 52%.

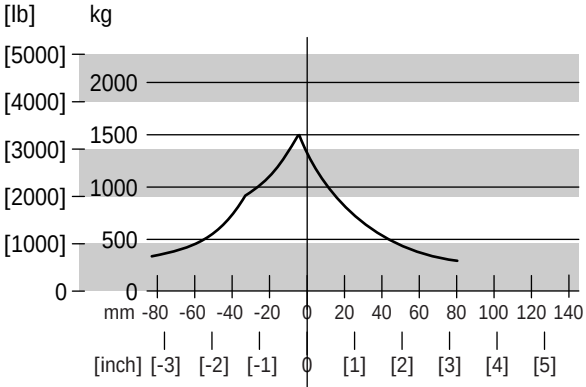


Wheel Motor Tapered Shaft

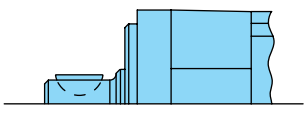


Standard Motor 1-1/4 Inch and 32 mm Straight Shaft





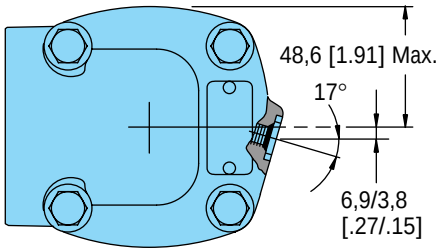
Standard Motor 1 Inch Straight Shaft



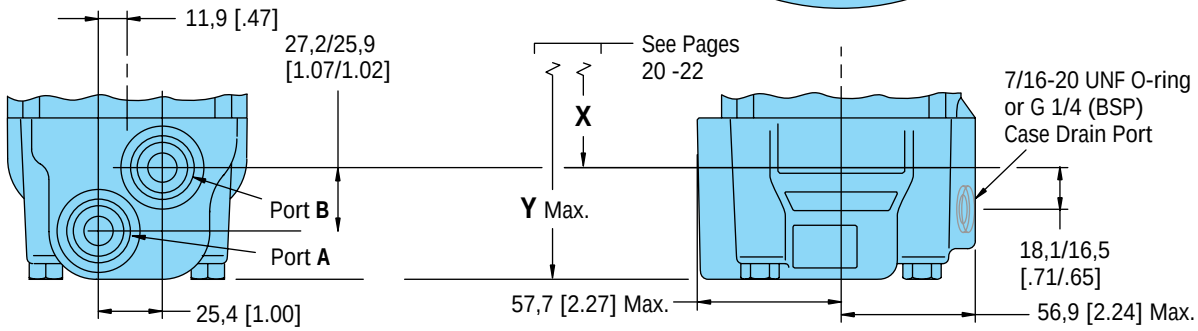
Dimensions — Ports
2000 Series

Standard Rotation — 2000 Series
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

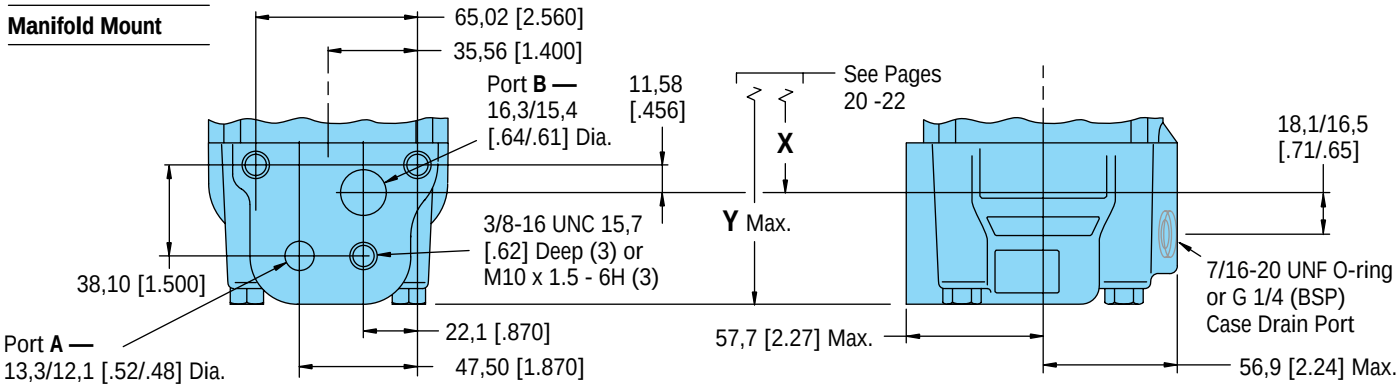
Case Drain Location — Staggered Ports (Including Manifold Mount)

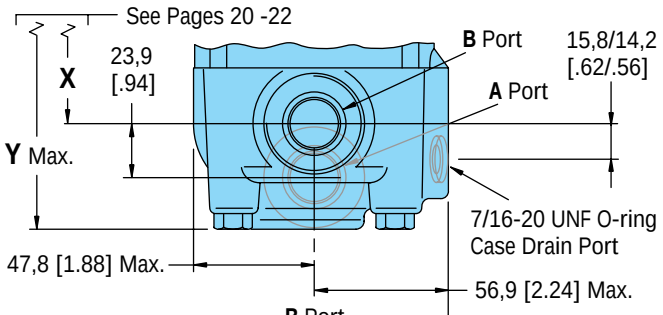


7/8-14 O-ring Ports (2)
or **G 1/2 (BSP) Ports** (2)



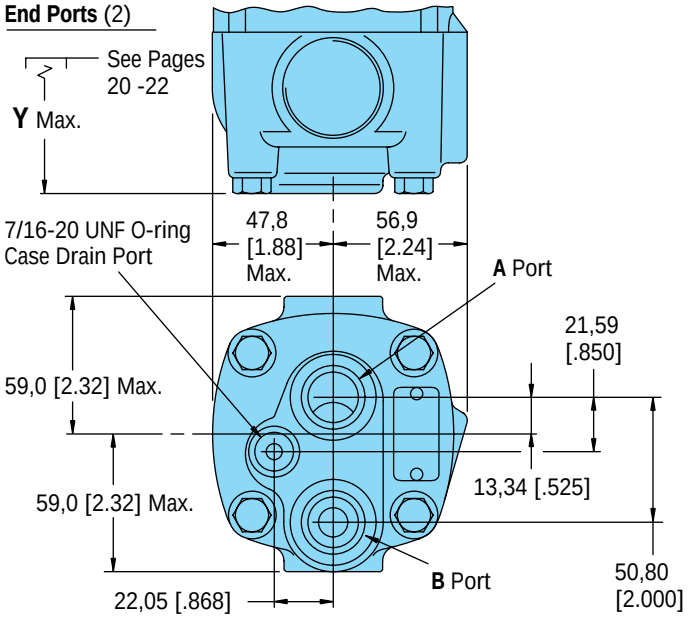
Manifold Mount



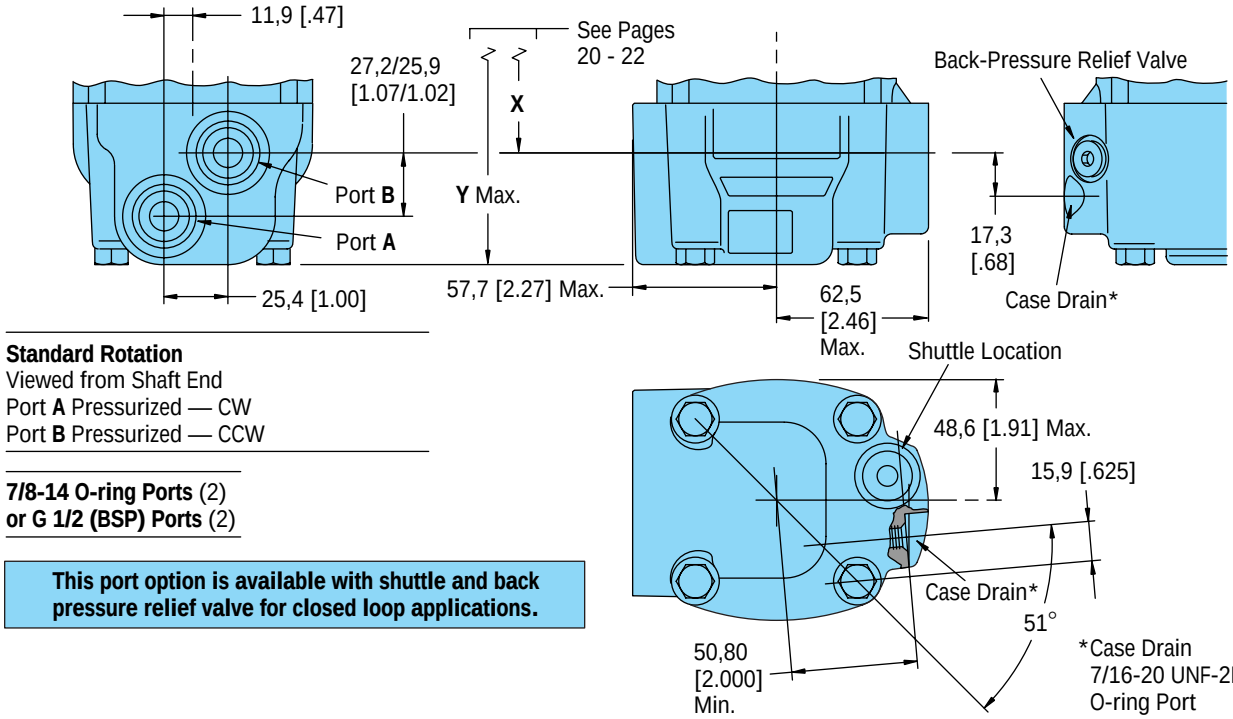


1-1/16-12 O-ring Ports (2)
Positioned
180° Apart

7/8-14 O-ring End Ports (2)



Dimensions — Ports
2000 Series with Shuttle

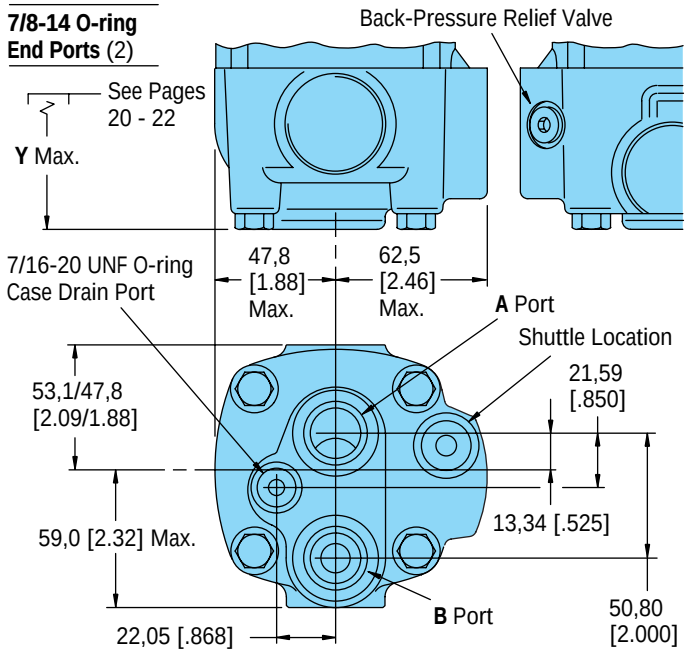


Standard Rotation
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

7/8-14 O-ring Ports (2)
or G 1/2 (BSP) Ports (2)

This port option is available with shuttle and back pressure relief valve for closed loop applications.

7/8-14 O-ring End Ports (2)



This port option is available with shuttle and back pressure relief valve for closed loop applications.

Product Numbers
2000 Series

Product Numbers—2000 Series

Use digit prefix —**104**-, **105**-, or **106**- plus four digit number from charts for complete product number—Example **106**-1043.
Orders will not be accepted without three digit prefix.

Mounting	Shaft	Ports	Displacement cm³/r [in³/r] and Product Number 80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
2 Bolt SAE A Flange	1 inch Straight	7/8-14 O-ring Staggered	**104**-1001	-1002	-1003	-1004	-1005	-1006	-1007	-1143	—
		1-1/16—12 O-ring 180° Apart	**104**-1037	-1038	-1039	-1040	-1041	-1042	-1043	-1044	—
	1-1/4 Inch Straight	7/8-14 O-ring Staggered	**104**-1022	-1023	-1024	-1025	-1026	-1027	-1028	-1228	-1420
		1-1/16—12 O-ring 180° Apart	**104**-1061	-1062	-1063	-1064	-1065	-1066	-1067	-1068	-1421
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	**104**-1029	-1030	-1031	-1032	-1033	-1034	-1035	-1229	-1422
		1-1/16—12 O-ring 180° Apart	**104**-1087	-1088	-1089	-1090	-1091	-1092	-1093	-1094	-1423
2 Bolt SAE B Flange	1-1/4 Inch Straight	7/8-14 O-ring Staggered	**104**-1200	-1201	-1202	-1203	-1204	-1205	-1206	-1207	—
	1-1/4 Inch Involute SAE C Splined	7/8-14 O-ring Staggered	**104**-1208	-1209	-1210	-1211	-1212	-1213	-1214	-1215	—
	1 Inch SAE 6B Splined	7/8-14 O-ring Staggered	**104**-1193	-1194	-1195	-1196	-1197	-1198	-1199	—	—
	7/8 Inch SAE B Splined	7/8-14 O-ring Staggered	**104**-1216	-1217	-1218	-1219	-1220	—	—	—	—
Standard with 4 Bolt Square Flange	32 mm Straight	G 1/2 (BSP)	**104**-1384	-1385	-1386	-1387	-1388	-1389	-1390	-1391	—
	1-1/4 Inch 14 T Splined	G 1/2 (BSP)	**104**-1376	-1377	-1378	-1379	-1380	-1381	-1382	-1383	—
Wheel Motor	1-1/4 Inch Straight	7/8-14 O-ring Staggered	**105**- —	—	—	—	—	—	—	—	-1148
		1-1/16—12 O-ring 180° Apart	**105**- —	—	—	—	—	—	—	—	-1149
	32 mm Straight	G 1/2 (BSP)	**105**-1134	-1135	-1136	-1137	-1138	-1139	-1140	-1141	—
	1-1/4 Inch Tapered	7/8-14 O-ring Staggered	**105**-1001	-1002	-1003	-1004	-1005	-1006	-1007	-1060	-1152
		1-1/16—12 O-ring 180° Apart	**105**-1071	-1072	-1073	-1074	-1075	-1076	-1077	-1078	—
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	**105-**1029	-1030	-1031	-1032	-1033	-1034	-1035	-1096	—
		1-1/16—12 O-ring 180° Apart	**105**-1079	-1080	-1081	-1082	-1083	-1084	-1085	-1086	—
Bearingless		7/8-14 O-ring Staggered	**106**-1008	-1009	-1010	-1011	-1012	-1013	-1014	-1015	-1047
		G 1/2 (BSP)	**106**-1038	-1039	-1040	-1041	-1042	-1043	-1044	-1045	—

106-1043

Product Numbers—2000 Series Motors with Corrosion Protection

Mounting	Shaft	Ports	Displacement cm³/r [in³/r] and Product Number 80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
2 Bolt SAE A Flange	1 inch Straight	7/8-14 O-ring Staggered	**104**-1528	-1529	-1530	-1531	-1532	-1533	-1534	-1519	-1535
	1-1/4 Inch Straight	7/8-14 O-ring Staggered	**104**-1516	-1536	-1537	-1538	-1539	-1452	-1479	-1509	-1489

For 2000 Series Motors with a configuration *Not Shown* in the charts above: Use model code number system on page 30 to specify product in detail.

Model Code for 2000 Series Motors

The following 14-digit coding system has been developed to identify all of the configuration options for the 2000 Series motor Use this model code to specify a motor with the desired features. All 14-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 — 2000 Series Disc Valve Motor

1	2	3	4	5	6	7	8	9	10	11	12	13	14
M	0	2										0	0

Position 1 **Product Series**

M ..... Motor

Position 2, 3 **2000 Series**

02 ..... 2000 Series

Position 4, 5 **Displacement cm³/r [in³/r]**

05 ..... 80 [4.9]
06 ..... 100 [6.2]
08 ..... 130 [8.0]
10 ..... 160 [9.6]
12 ..... 195 [11.9]
15 ..... 245 [14.9]
19 ..... 305 [18.7]
24 ..... 395 [24.0]
30 ..... 490 [29.8]

Position 6 **Mounting Flange**

D ..... 4 Bolt (Bearingless) 101,6 [4.00] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 127,0 [5.00] Dia. B.C.

C ..... 2 Bolt SAE A (Std.) 82,5 [3.25] Pilot Dia and 13,59 [.535] Dia. Mtg. Holes on 106,4 [4.19] Dia. B.C.

B ..... 4 Bolt (Wheel) 107,9 [4.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 147,6 [5.81] Dia. B.C.

H ..... 4 Bolt (Standard) 82,5 [3.25] Pilot Dia. and 14,59 [.535] Dia. Mounting Holes on 106,4 [4.19] Dia. B.C.

J ..... 4 Bolt Magneto (Std.) 82,5 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mtg. Holes on 106,4 [4.19] Dia. B.C.

F ..... 2 Bolt SAE B (Std.) 101,6 [4.00] Pilot Dia. and 14,35 [.565] Dia. Mtg. Holes on 146,0 [5.75] Dia. B.C.

P ..... 4 Bolt (wheel compatible for HAYES BRAKE) 107,9 [4.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 147,6 [5.81] Dia. B.C. with Turned Down Housing to 88,9 [3.50] Dia.

Position 7, 8 **Output Shaft**

00 ..... Bearingless

01 ..... 1 inch Dia. Straight with Woodruff Key, 1/4-20 Threaded Hole and 38,4 [1.51] Max. Coupling Length

02 ..... 1–1/4 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and 47,3 [1.86] Max. Coupling Length

23 ..... 32 mm dia. Straight with Straight Key, M8 x 1,25 -6H Threaded Hole and 56,4 [2.22] Max. Coupling Length

04 ..... 1-1/4 inch Dia. Splined 14 T, 3/8-16 Threaded Hole and 33,0 [1.30] Min. Full Spline Length and 45,5 [1.79] Max. Coupling Length

03 ..... 1-1/4 inch Dia. Tapered with Straight Key and Nut

05 ..... 1 inch SAE 6B Splined 6T, 1/4-20 Threaded Hole and 22,8 [.90] Min. Full Spline Length and 28,8 [1.13] Max. Coupling Length

07 ..... 7/8 inch Dia. Splined 13T, 15,2 [.60] Min. Full Spline Length and 30,8 [1.21] Max. Coupling Length

24 ..... 1–1/4 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and Corrosion Resistant (seal area to shaft end)

25 ..... 1–1/4 inch Dia. Tapered with Straight Key and Nut, Corrosion Resistant (seal area to shaft end)

26 ..... 25 mm Dia. Straight with Straight Key, M8 x 1,25 -6H Threaded Hole and 38,4 [1.51] Max. Coupling Length

Position 9 **Port Type**

A ..... 7/8-14 O-ring (Staggered) with 7/16-20 O-ring Case Drain

J ..... G 1/2 (BSP) (Staggered) with G 1/4 (BSP) Case Drain

B ..... Manifold Mount with 3/8-16 UNC Mounting Threads (3) and 7/16-20 O-ring Case Drain

G ..... Manifold Mount with M10 x 1,5 -6H Mounting Threads (3) and G 1/4 (BSP) Case Drain

H ..... 1–1/16 - 12 O-ring (Positioned 180° Apart) with 7/16-20 O-ring Case Drain

F ..... 7/8-14 O-ring (End Ports) with 7/16-20 O-ring Case Drain (Rear)

6 ..... 7/8-14 O-ring (End Ports) with 7/16-20 O-ring Case Drain (Rear) and Hot Oil Shuttle Valve (must be used with Special Features Code 77)

Position 10, 11 **Special Features (Hardware)**

00 ..... None

01 ..... Flange Rotated 90°

11 ..... Viton® Shaft Seals

02 ..... Viton Seals

21 ..... Reverse Rotation

28 ..... Seal Guard

45 ..... Speed Sensor (Std.)

77 ..... Low Pressure Relief Valve Set at 4,5 bar [65 PSI] (must be used with Port Code 6)

83 ..... Quadrature Speed Sensor Version 2 with Weatherpak

88 ..... Quadrature Speed Sensor Version 2 with M12

Position 12 **Paint/Special Packaging**

0 ..... No Paint

A ..... Painted Low Gloss Black

B ..... Corrosion Protected

Position 13 **Eaton Assigned Code when Applicable**

0 ..... Assigned Code

Position 14 **Eaton Assigned Design Code**

0 ..... Assigned Design Code

Two Speed Motor — 2000 Series

The Eaton 2000 Series motors are available with an integral two speed feature that changes the displacement in a ratio of 1 to 2 and shifts the motor from a low speed high torque (LSHT) mode to a high speed low torque (HSLT) mode. The open center selector valve shifts the speed mode from low to high speed when pilot pressure of 6.9 Δ Bar [100 Δ PSI] minimum is applied to the pilot port (6.9 Bar [100 PSI] higher than case pressure). In the high speed mode torque values are approximately one half with twice the speed of the conventional 2000 Series single speed motors.

An external two position three way valve is required for shifting the pilot pressure port between signal pressure (HSLT) and low pressure (LSHT)

Two speed motors are available with a return line closed center shuttle for closed circuit applications.

Low speed high torque mode is the normal position of the speed selector valve. When a differential pressure is supplied to the pilot port and 6,9 Bar [100 PSI] is reached, the selector valve overcomes the return spring force and the spool shifts to the high speed mode. The oil in the opposite side of the spool is drained internally. Pressure between the pilot supply and case drain or return line (depending on open or closed circuit system) must be maintained to keep the motor in the high speed mode.

When pilot pressure is removed from the pilot port the pressure in the pilot end of the spool valve is relieved and drained back through this three way valve, the spring force returns the spool valve to LSHT position.

Pilot pressure may come from any source that will provide uninterrupted pressure during the high speed mode operation. Pilot pressure 6,9 Δ Bar [100 Δ PSI] minimum, up to the full operating pressure of the motor.

In normal LSHT operation the Char-Lynn two speed motor will function with equal shaft output in either direction (CW or CCW), the same as the single speed Char-Lynn disc valve motors.

However, to prevent cavitation in the HSLT mode, the preferred direction of shaft rotation is counter clockwise (port B pressurized). This unique disc valve is not symmetrical in porting the fluid for the HSLT mode. Consequently, when the pressure is reversed for HSLT CW rotation, cavitation can occur. Installing a restriction (14 - 34 Bar [200 - 500 PSI]) in the hydraulic line that connects port B will prevent cavitation (see page 32).

If you are operating in a critical area and a restriction in the hydraulic line causes concern, these two speed motors can be ordered timed with CW preferred HSLT shaft rotation. Hence, with this option port B will have to be pressurized for CW preferred HSLT shaft rotation. The restriction recommended for the line connecting port B remains unchanged. Finally in closed circuit applications a hydraulic line restriction is not required. Instead, the charge pump can be used to supply and maintain a minimum pressure of 14 Bar [200 PSI].

Note: Be certain in closed loop applications that the charge pump when used for back pressure on the B port, has sufficient displacement to maintain charge pressure especially in dynamic braking or overrunning load conditions.

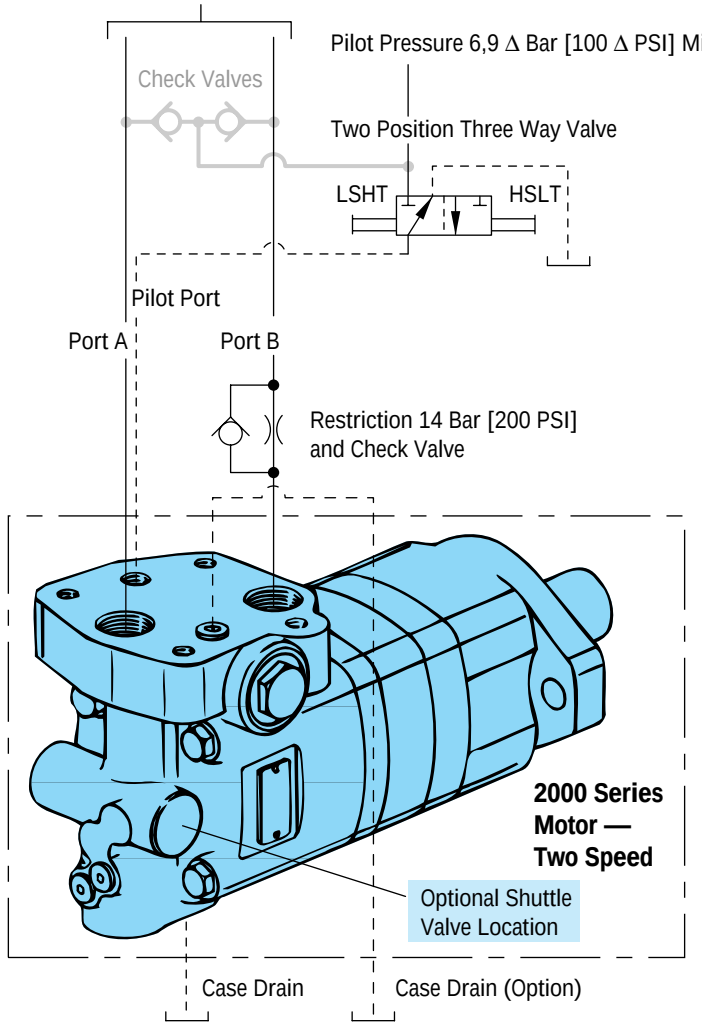
Important! Due to potential problems in maintaining charge pump pressure at port B for uninterrupted back pressure during dynamic braking, Eaton does not recommend the two speed motor where overrunning conditions may exist.

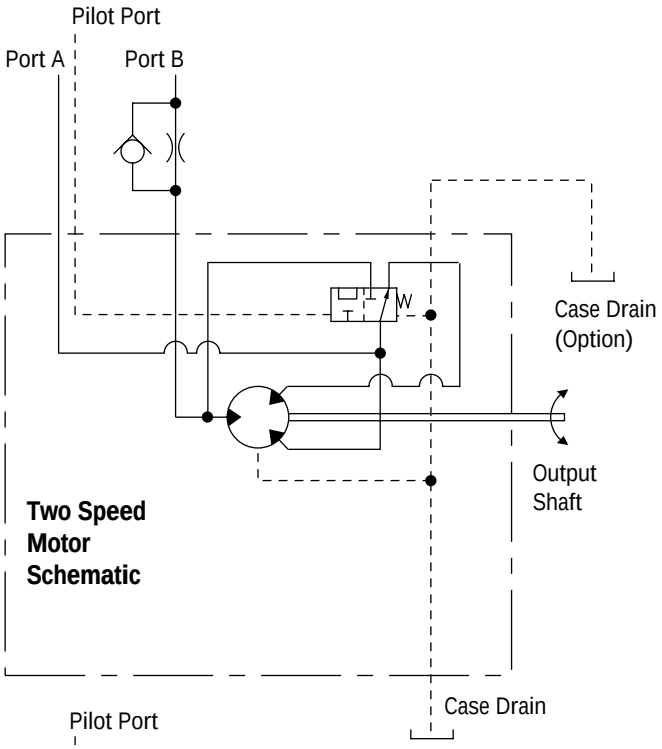
Performance Data Two Speed Motor — 2000 Series

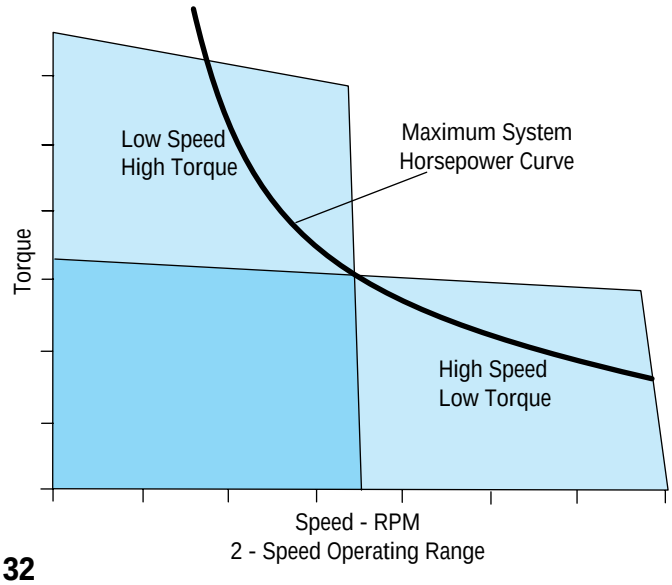
In the high speed mode torque values are approximately one half with twice the speed of the conventional 2000 Series single speed motors. **In the low speed mode torque and speed values are the same as the conventional 2000 Series motors (**see Performance Data on pages 15-19). For Two Speed Motor Specifications, Dimensions, and Product Numbers see pages 33 through 35.

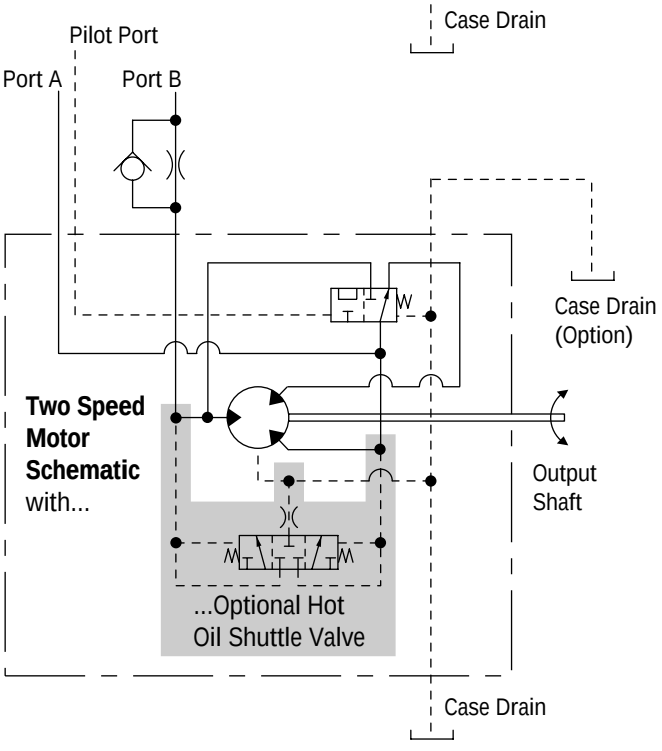
Two Speed Motor — 2000 Series

Pump Pressure and Return, and
Shaft Rotation Directional Control Valve

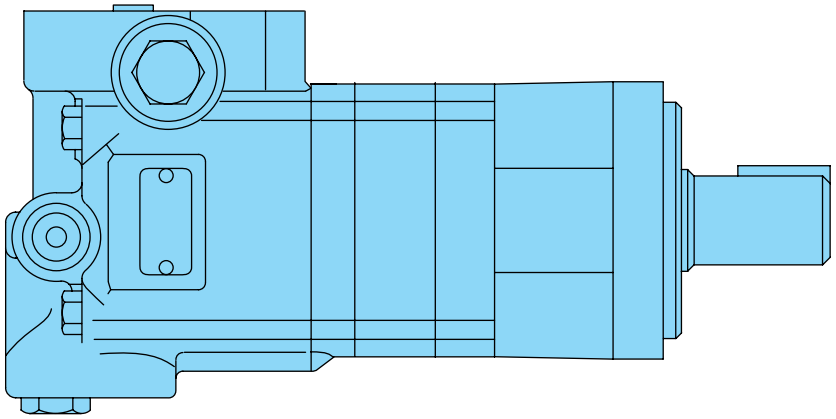








Specifications Two Speed Motor — 2000 Series



Specification Data—2000 Series Two Speed

Displ. cm³/r. [in³/r]	High Speed Mode		40 [2.45]	50 [3.1]	65 [4.0]	80 [4.8]	95 [5.95]	120 [7.45]	155 [9.35]	195 [12.0]	245 [15.0]
	Low Speed Mode		80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
Max. Speed (RPM) @ Continuous Flow	High Speed Mode		1000	1000	990	860	700	560	450	350	230
	Low Speed Mode		500	500	495	430	350	280	225	175	115
Flow LPM [GPM]	High Speed Mode		45 [12]	55 [15]	70 [19]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]
	Low Speed Mode		45 [12]	55 [15]	70 [19]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]
Torque Nm [lb-in] ☆ 1-1/4 Inch or 32 mm Dia. Shaft	High Speed Mode	Continuous	100 [880]	125 [1115]	165 [1450]	195 [1725]	240 [2150]	300 [2675]	380 [3350]	365 [3225]	448 [3970]
		Intermittent	145 [1300]	185 [1660]	240 [2150]	240 [2150]	300 [2650]	375 [3330]	440 [3900]	445 [3940]	486 [4300]
Torque Nm [lb-in] ☆ 1-1/4 Inch or 32 mm Dia. Shaft	Low Speed Mode	Continuous	235 [2065]	295 [2630]	385 [3420]	455 [4040]	540 [4780]	660 [5850]	760 [6750]	770 [6840]	845 [7470]
		Intermittent	345 [3040]	445 [3950]	560 [4970]	570 [5040]	665 [5890]	820 [7250]	885 [7820]	925 [8170]	930 [8225]
Pressure Δ Bar [Δ PSI] ☆ 1-1/4 Inch or 32 mm Dia. Shaft		Continuous	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	155 [2250]	120 [1750]
		Intermittent	310 [4500]	310 [4500]	310 [4500]	260 [3750]	260 [3750]	260 [3750]	240 [3500]	190 [2750]	140 [2000]

Maximum Case Pressure - without Case Drain * — 140 Bar [2000 PSI]

High Speed Mode (Reduced Motor Displacement)

Low Speed Mode (Full Motor Displacement)

Maximum torque and flow must not occure simultaneously. For permissible continuous and intermittent operating combinations of pressure and flow refer to performance data on pages 15-19 (LSHT only).

☆ **Maximum torque for 1 inch shaft** — 395 Nm [3500 lb-in] Continuous and 485 Nm [4300 lb-in] intermittent.

* For back pressure over 140 Bar [2000 PSI] use an external case drain. Install case drain lines so that the motor case remains filled at all times.

Maximum inlet pressure — 310 Bar [4500 PSI]. Do not exceed Δ pressure rating (see chart above).

* **Maximum return pressure** — 310 Bar [4500 PSI]. Do not exceed Δ pressure rating (see chart above).

Δ **Bar** [Δ **PSI**] — True pressure difference between inlet port and outlet port.

Continuous Rating — Motor may be run continuously at these ratings.

Intermittent Operation — 10% of every minute.

Recommended Fluids — Premium quality, anti-wear type hydraulic oil with a viscosity of not less than 70 SUS at operating temperature (see page 81).

Recommended Maximum System Operating Temp. — Is 82° C [180° F]

Recommended Filtration — per ISO Cleanliness Code, level 18/13

To assure best motor life, run motor for approximately one hour at 30% of rated pressure before application to full load. Be sure motor is filled with fluid prior to any load applications.

Dimensions — Two Speed Standard, Wheel, and Bearingless

Standard Rotation
Viewed from Shaft or Drive End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

Two Speed Standard Motor

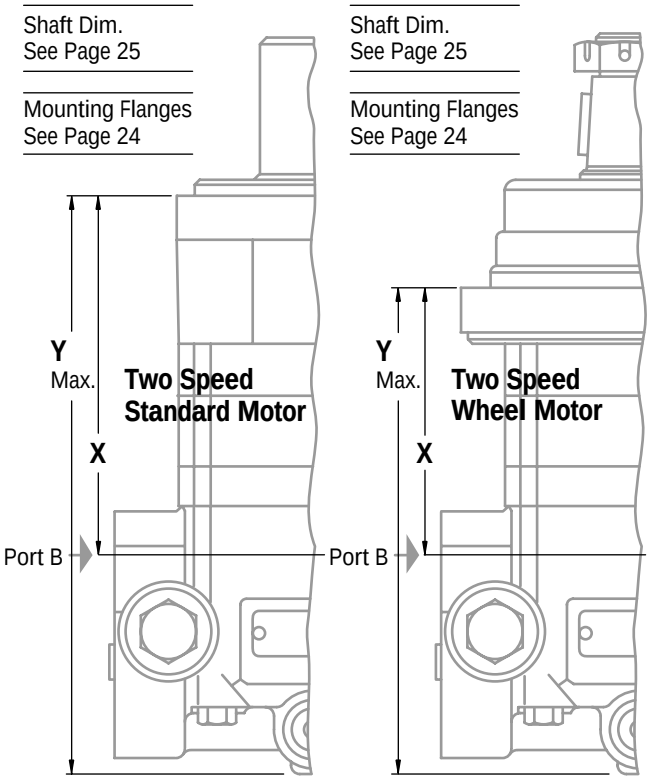
Displ. cm³/r [in³/r]	80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
Dim. **X** mm [inch]	137,4 [5.41]	142,0 [5.59]	148,5 [5.85]	148,5 [5.85]	155,2 [6.11]	164,2 [6.47]	175,7 [6.92]	191,5 [7.54]	209,0 [8.23]
Dim. **Y** mm [inch]	231,6 [9.12]	236,5 [9.31]	242,9 [9.56]	242,9 [9.56]	249,4 [9.82]	258,6 [10.18]	270,1 [10.63]	286,1 [11.26]	303,3 [11.94]

Two Speed Wheel Motor

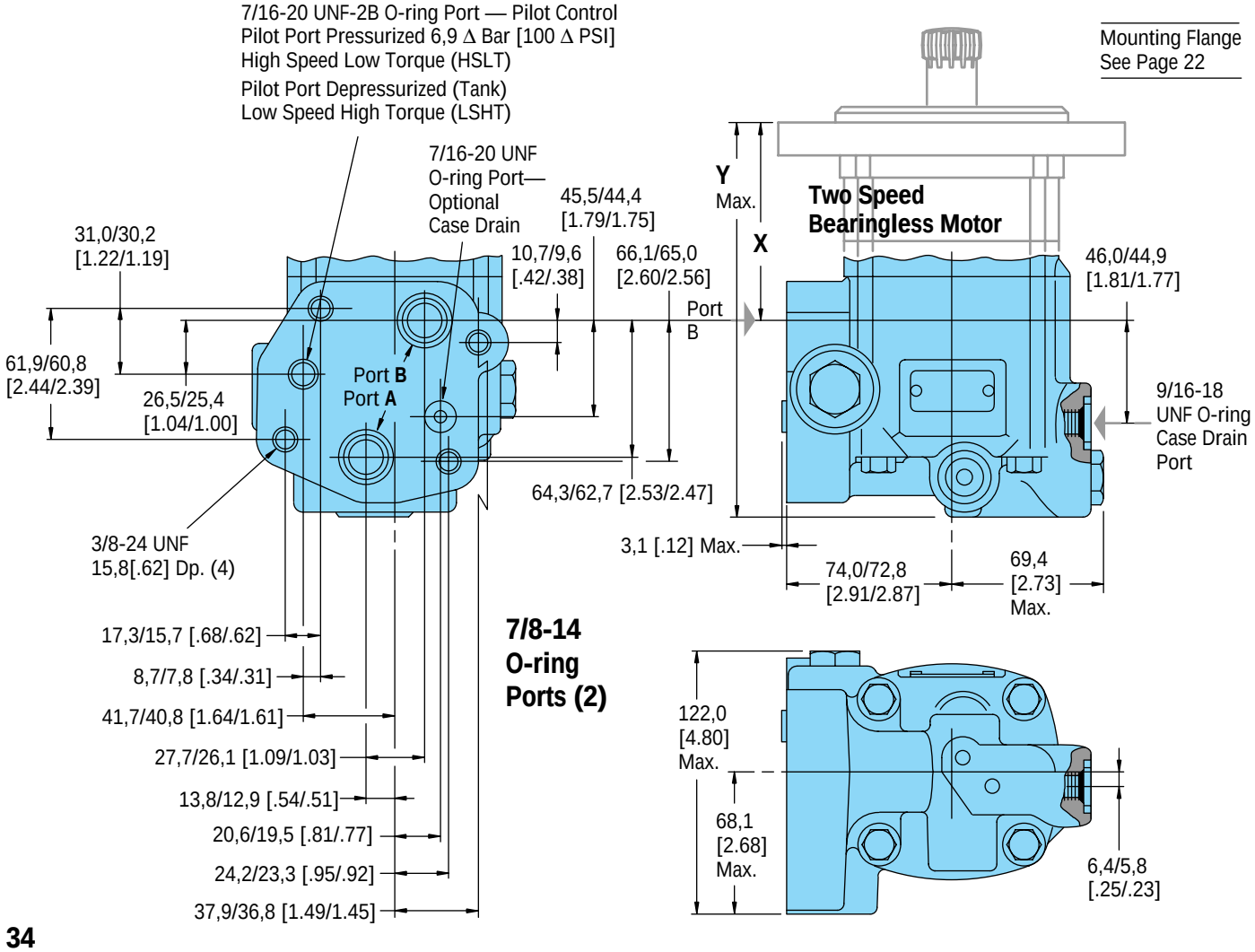
Dim. **X** mm [inch]	97,2 [3.83]	101,8 [4.01]	108,3 [4.27]	108,3 [4.27]	115,0 [4.53]	124,2 [4.89]	135,5 [5.34]	151,4 [5.96]	168,9 [6.65]
Dim. **Y** mm [inch]	191,5 [7.54]	196,4 [7.73]	202,7 [7.98]	202,7 [7.98]	209,3 [8.24]	218,5 [8.60]	229,9 [9.05]	245,9 [9.68]	263,1 [10.36]

Two Speed Bearingless Motor

Dim. **X** mm [inch]	79,3 [3.13]	83,8 [3.30]	90,3 [3.56]	90,3 [3.56]	97,0 [3.82]	106,2 [4.18]	117,8 [4.64]	133,6 [5.26]	150,9 [5.94]
Dim.**Y** mm [inch]	174,0 [6.85]	178,9 [7.04]	185,2 [7.29]	185,2 [7.29]	191,8 [7.55]	201,0 [7.91]	212,4 [8.36]	228,4 [8.99]	245,6 [9.67]



7/16-20 UNF-2B O-ring Port — Pilot Control
Pilot Port Pressurized 6,9 Δ Bar [100 Δ PSI]
High Speed Low Torque (HSLT)
Pilot Port Depressurized (Tank)
Low Speed High Torque (LSHT)



Product Numbers — Two Speed
2000 Series

Product Numbers—2000 Series Motors — Two Speed

Use digit prefix —**104**-, **105**-, or **106**- plus four digit number from charts for complete product number—Example **106**-2007.
Orders will not be accepted without three digit prefix.

			Displ. cm^3/r [in^3/r] Product Number								
Mounting	Shaft	Ports	80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
2 Bolt SAE A Flange	1 inch Straight	7/8-14 O-ring Staggered	**104**-2001	-2002	-2003	-2004	-2005	-2006	-2007	-2008	—
	1-1/4 Inch Straight	7/8-14 O-ring Staggered	**104**-2009	-2010	-2011	-2012	-2013	-2014	-2015	-2016	—
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	**104**-2017	-2018	-2019	-2020	-2021	-2022	-2023	-2024	—
Wheel Motor	1-1/4 Inch Tapered	7/8-14 O-ring Staggered	**105**-2001	-2002	-2003	-2004	-2005	-2006	-2007	-2008	—
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	**105**-2009	-2010	-2011	-2012	-2013	-2014	-2015	-2016	—
Bearingless		7/8-14 O-ring Staggered	**106**-2001	-2002	-2003	-2004	-2005	-2006	-2007	-2008	—

106-2007

2000 Series Motors with a configuration *Not Shown* in the charts above: Contact your Eaton Representative.

Fluid Recommendations
Char-Lynn Disc Valve Motors

Introduction
The ability of Eaton hydraulic components to provide the desired performance and life expectancy depends largely on the fluid used. The purpose of this section is to provide readers with the knowledge required to select the appropriate fluids for use in systems that employ Eaton hydraulic 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. See chart below for viscosity requirements.

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 hydraulic system. Generally, the fluid is thick when the hydraulic system is started. With movement, the fluid warms to a point where a cooling system begins to operate.
From then on, the fluid is maintained at the temperature for which the hydraulic system was designed. In actual applications this sequence varies; hydraulic 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 hydraulic 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 hydraulic system is extremely important. Eaton recommends that the fluid used in its hydraulic 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. Cleanliness requirements for specific products are given in the table below.
OEM's and distributors who use Eaton hydraulic 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 hydraulic systems. Since Eaton hydraulic 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 hydraulic 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 hydraulic components. These fluids typically contain additives that are beneficial to hydraulic 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 hydraulic 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 hydraulic 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 hydraulic components.
A reputable fluid supplier can provide information on synthetic fluids. Review applications that require the use of synthetic fluids with your Eaton representative.

	Viscosity		ISO Cleanliness Requirements
	Minimum	Best Range	
Char-Lynn Disc Valve Motors	70 SUS 13 cSt	100-200 SUS 20-43 cSt	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 (with one exception — two speed motors).**
- Minimum / Maximum operating temperatures are -29° C / 82° C [-20° F / 180° F].
- When choosing a hydraulic fluid, all the components in the system must be considered and the best viscosity range adjusted accordingly. For example, when a medium duty piston pump is combined with a Geroler motor the best viscosity range becomes 100 - 150 SUS [20 - 32 cSt] and viscosity should never fall below 70 SUS [13 cSt].
- If the natural color of the fluid has become black it is possible that an overheating problem exists.
- If the fluid becomes milky a water contamination problem may exist.
- Take fluid level reading when the system is cold.
- Contact your Eaton representative if you have specific questions about the fluid requirements of Eaton hydraulic components.

Motor Application Information — Vehicle Drive Calculations

Step One — Calculate Motor Speed (RPM)

$$RPM = \frac{2.65 \times KPH \times G}{R_m} \qquad RPM = \frac{168 \times MPH \times G}{R_1}$$

where KPH = vehicle speed (kilometers per hour)
where MPH = vehicle speed (miles per hour)
Rm = rolling radius of tires (meter)
R_1 = rolling radius of tires (inch)
G = gear reduction ratio (if any) between motors and wheels. If no gear box or other gear reduction devices are used G = 1.

If vehicle speed is expressed in m/second, multiply by 3.6 to convert to KPH.

If vehicle speed is expressed in ft./second, divide by 1.47 to convert to MPH.

Step Two — Determine Rolling Resistance
Rolling resistance (RR) is the force required to propel a vehicle over a particular surface. The values in Table 1 are typical of various surfaces per 1000 lb. of vehicle weight.

RR = GVW x ρ (kg) (lb)
where GVW = gross (loaded) vehicle weight lb/Kg
ρ = value from Table 1

Table 1 - Rolling Resistance Coefficients for Rubber Tires on Various Surfaces

Surface	ρ
Concrete, excellent	.010
Concrete, good	.015
Concrete, poor	.020
Asphalt, good	.012
Asphalt, fair	.017
Asphalt, poor	.022
Macadam, good	.015
Macadam, fair	.022
Macadam, poor	.037
Snow, 2 inch	.025
Snow, 4 inch	.037
Dirt, smooth	.025
Dirt, sandy	.040
Mud	.037 to .150
Sand, Gravel	.060 to .150
Sand, loose	.160 to .300

Step Three — Tractive Effort to Ascend Grade
The largest grade a vehicle can ascend is called its "gradability." Grade is usually expressed as a percent rather than in degrees. A rise of one meter in ten meters or one foot rise in ten feet of travel is a 1/10 or 10 percent grade.

$$GR = GVW (\sin \theta + \rho \cos \theta)$$

Table 2

Comparison Grade (%)	Table Slope (Degrees)
1%	0°35'
2%	1° 9'
5%	2°51'
6%	3°26'
8%	4°35'
10%	5°43'
12%	6°5'
15%	8°31'
20%	11°19'
25%	14° 3'
32%	18°
60%	31°

Step Four — Determine Acceleration Force (FA)
The force (FA) required to accelerate from stop to maximum speed (KPH) or (MPH) in time (t) seconds can be obtained from the following equation:

Step Five — Determine Drawbar Pull
Drawbar Pull (DP) is total force available at the drawbar or "hitch" after the above forces have been subtracted from the total propelling force produced by the hydraulic motors. This value is established as either:

$$FA = \frac{KPH \times GVW\ (kg)}{3.6\ t}$$

FA = Acceleration Force (Newton)
t = Time (Seconds)

$$FA = \frac{MPH \times GVW\ (lb)}{22\ t}$$

FA = Acceleration Force (lb)
t = Time (Seconds)

1. A goal or objective of the designer.
2. A force required to pull a trailer (Repeat steps two through four above using trailer weight and add the three forces together to obtain DP).

Step Six — Total Tractive Effort
The tractive effort (TE) is the total force required to propel the vehicle and is the sum of the forces determined in Steps 2 through 5.

TE = RR + GR + FA + DP (Kg. or lb.)

- DP — Drawbar pull desired
- FA — Force required to accelerate
- GR — Force required to climb a grade
- RR — Force required to overcome rolling resistance

Wind resistance forces can usually be neglected. However, it may be wise to add 10% to the above total to allow for starting resistances caused by friction in bearings and other mechanical components.

Step Seven — Calculate Hydraulic Motor Torque (T)

$$T = \frac{TE \times R_m}{N \times G \times Eg} (Nm / Motors)$$

$$T = \frac{TE \times R_l}{N \times G \times Eg} (lb-in / Motors)$$

where N = number of driving motors
Eg = gear box mechanical efficiency

Step Eight—Wheel Slip
If the torque required to slip the wheel (TS) is less than the torque calculated in Step 7, the performance objectives cannot be achieved.

$$TS = \frac{W \times f \times R_m}{G \times Eg} (Nm / Motor)$$

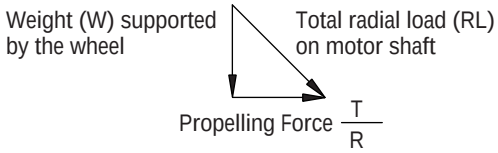
$$TS = \frac{W \times f \times R_l}{G \times Eg} (lb-in / Motor)$$

Where: f = coefficient of friction
W = loaded vehicle weight over drive wheel

	Coefficient of friction (f)
Steel on steel	0.15 to 0.20
Rubber tire on dirt	0.5 to 0.7
Rubber tire on asphalt	0.8 to 1.0
Rubber tire on concrete	0.8 to 1.0
Rubber tire on grass	0.4

It may be desirable to allow the wheel to slip to prevent hydraulic system overheating when excessive loads are imposed should the vehicle stall. In this case TS should be just slightly larger than T.

Step Nine — Motor Radial Load Carrying Capacity
When a motor is used to drive a vehicle with the wheel mounted directly on the motor shaft or rotating hub, the Total Radial Load (RL) acting on the motor shaft is the vector summation of two forces acting at right angles to each other.



$$RL = \sqrt{W^2 + \left(\frac{T}{R}\right)^2}$$

Refer to radial load rating of each motor (see table of catalog contents page 10 for page listing of the Shaft Side Load Capacity for each motor series).

Shaft Torque

$$T = \frac{q \Delta P}{2\pi}$$

$$\frac{bar \times cm^3/rev}{62.8} Nm = \frac{PSI \times in^3/rev}{6.28} = lb-in$$

Shaft Speed

$$= \frac{Flow}{Displacement}$$

$$RPM = \frac{1000 \times l/min}{cm^3/rev} \quad RPM = \frac{231 \times GPM}{in^3/rev}$$

Power (into motor)

$$Kw = \frac{bar \times l/min}{600} \quad HP = \frac{PSI \times GPM}{1714}$$

Power (out of motor)

$$Kw = \frac{Nm \times RPM}{9549} \quad HP = \frac{lb-in \times RPM}{63,025}$$

where: Kw = Kilowatt
HP = Horsepower
LPM = Liters per Minute
GPM = Gallons per Minute
Nm = Newton Meters
lb-in = Pound inch
Bar = 10 Newtons per Square Centimeter
PSI = Pounds per Square Inch
q = Displacement

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Eaton Hydraulics
14615 Lone Oak Road
Eden Prairie, MN 55344
Telephone: 952 937-7254
Fax: 952 937-7130
www.eatonhydraulics.com

46 New Lane, Havant
Hampshire PO9 2NB
England
Telephone: (44) 23 92-486-451
Fax: (44) 23 92-487-110

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