11-01-878
EN-0201

Char-Lynn®

Disc Valve Hydraulic Motors

EATON

10,000 Series
Hydraulic Motors

We Manufacture **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

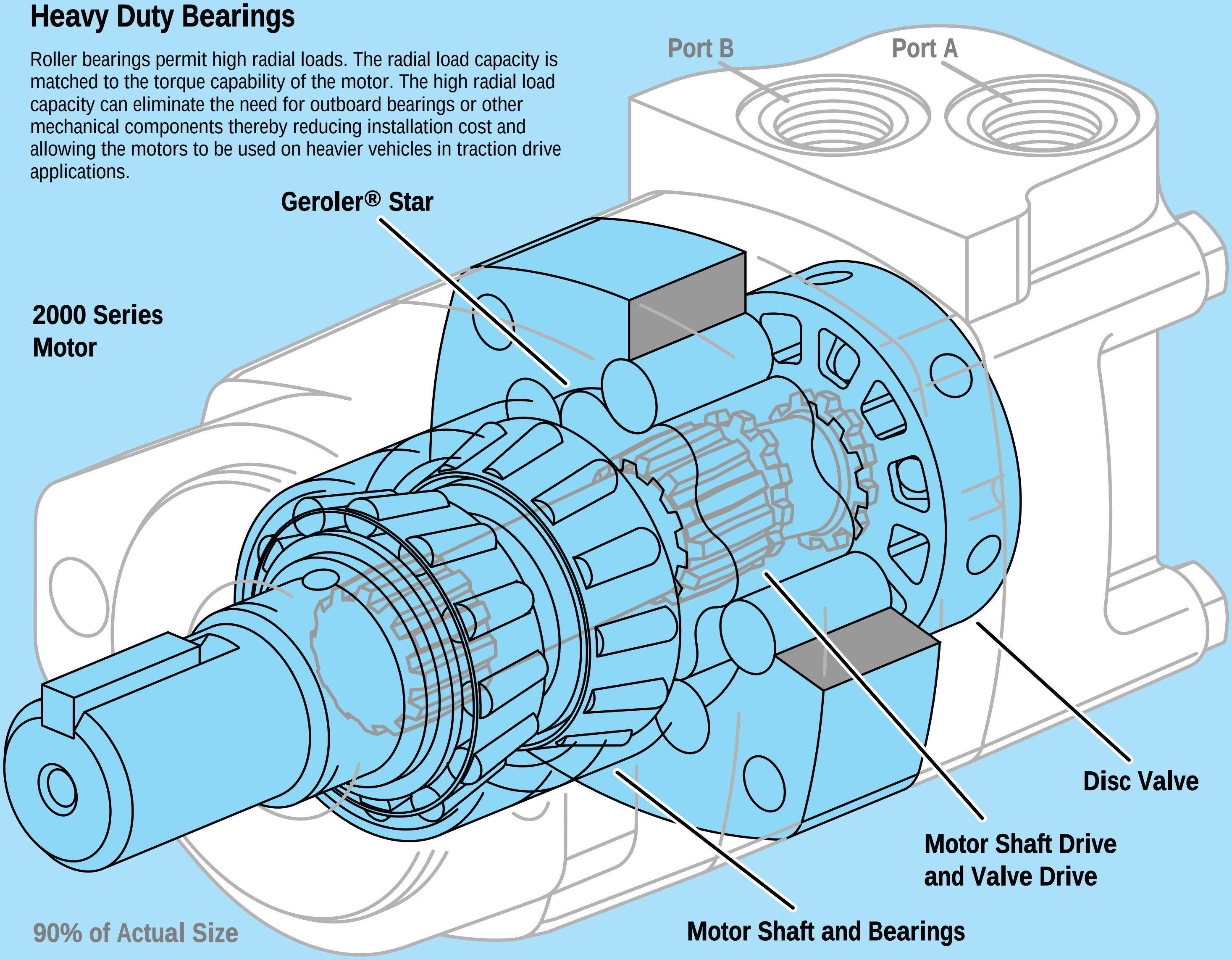
Motors with the Geroler element provide high starting and running torque. The Geroler element minimizes friction and thereby increases efficiency while providing smooth output shaft rotation even at very low speeds. Motor shaft rotation can be instantly reversed by changing direction of input/output 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.



90% of Actual Size

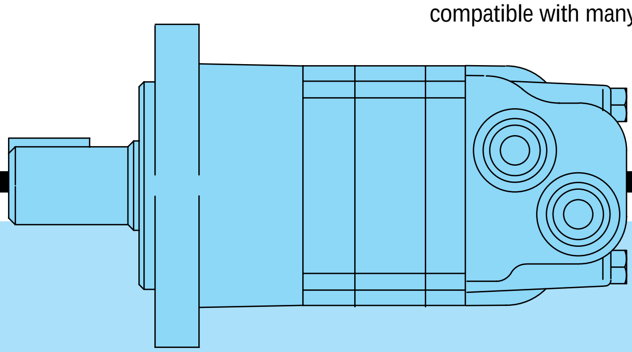
Design Features

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

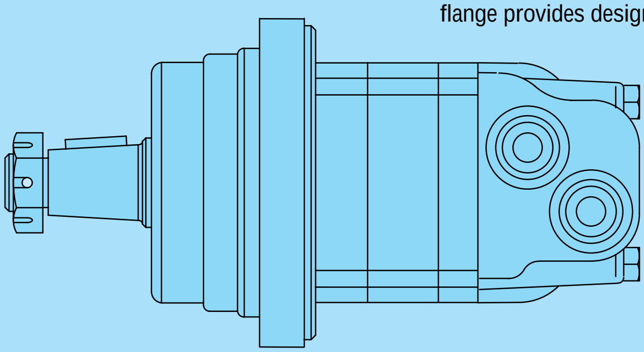
Standard Motor

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.



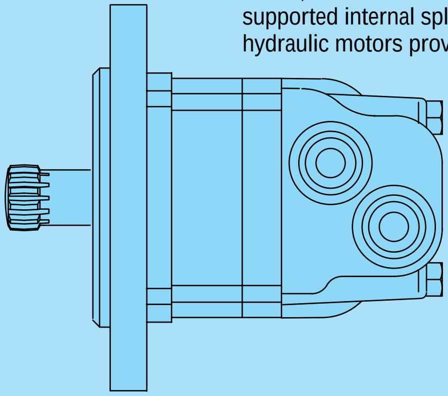
Wheel Motor

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.

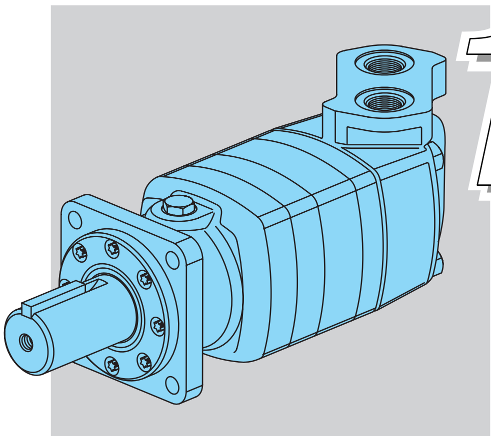


Bearingless Motor

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.



10,000 Series



10,000

10,000 Series

Geroler® Element .... 4 Displacements
Flow LPM [GPM] ..... 170 [45] Continuous**
265 [70] Intermittent*
Speed........................ Up to 784 RPM
Pressure Bar [PSI] ... 200 [3000] Cont.
270 [4000] Inter.
Torque Nm [lb-in] ... 2700 [23910] Cont.
3440 [30460] Inter.

10,000 Series Displacement Size = cubic centimeter per shaft revolution (cm^3/r)
= cubic inch per shaft revolution ([in^3/r])

- 345 [21.0]
- 480 [29.2]
- 665 [40.6]
- 940 [57.4]

Mounting Flange

- 4 Bolt (Bearingless) 152,4 [6.00] Pilot Dia. and 20,88 [.522] Dia. Mounting Holes 228,6 [9.00] Dia. B.C.
- 4 Bolt (Standard) 127,0 [5.00] Pilot Dia. and 17,02 [.670] Mounting Holes on 161,9 [6.37] Dia. B.C.
- 4 Bolt (Wheel) 177,8 [7.00] Pilot Dia. and 17,02 [.670] Dia. Mounting Holes on 209,5 [8.25] Dia. B.C.

Output Shaft

- Bearingless
- 2-1/4 inch Dia. Straight with Straight Key, 1/2-20 Threaded Hole and 97,5[3.84] Max. Coupling Length
- 2-1/4 inch Dia. Tapered with Straight Key and 1-1/2—18 UNEF Slotted Hex. Nut
- 2-1/8 inch Dia. Splined 16 T with 52,1 [2.05] Min. Full Spline Length and 1/2-20 UNF Threaded Hole

Port Type

- 1-5/16-12 O-ring with 9/16-18 O-ring Case Drain
- 1-1/4 Split Flange with 9/16-18 O-ring Case Drain

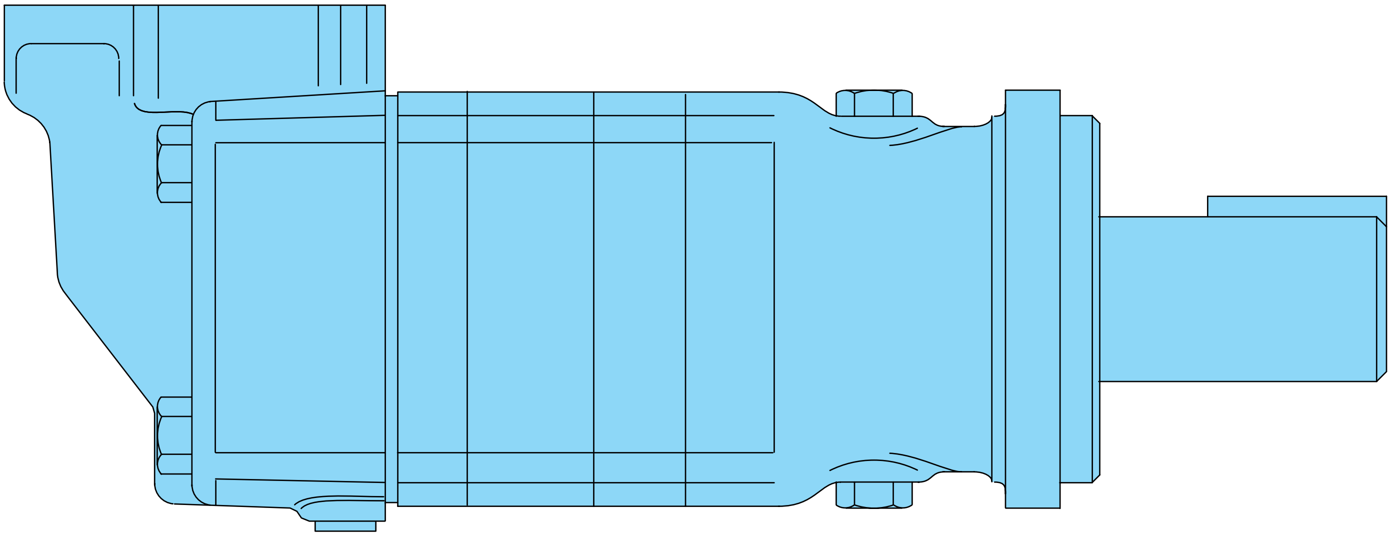
Special Features

- Viton Shaft Seal
- Viton Seals
- Two Speed Option
- Corrosion Protected

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

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

Specifications 10,000 Series



Specification Data—10,000 Series

Displ. cm³/r [in³/r]		345 [21.0]	480 [29.3]	665 [40.6]	940 [57.4]
Max. Speed (RPM) @ .... Flow	Continuous	501	354	254	179
	Intermittent	784	552	396	279
Flow LPM [GPM]	Continuous	170 [45]	170 [45]	170 [45]	170 [45]
	Intermittent	265 [70]	265 [70]	265 [70]	265 [70]
Torque Nm [lb-in]	Continuous	1040 [9220]	1475 [13050]	2085 [18450]	2700 [23910]
	Intermittent	1390 [12310]	1965 [17410]	2610 [23080]	3440 [30460]
Pressure Δ Bar [Δ PSI]	Continuous	205 [3000]	205 [3000]	205 [3000]	190 [2750]
	Intermittent	275 [4000]	275 [4000]	260 [3750]	240 [3500]
	Peak	275 [4000]	275 [4000]	275 [4000]	260 [3750]
Maximum Case Pressure - without Case Drain * — 20 Bar [300 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 65-66.

* For back pressure over 20 Bar [300 PSI] use an external case drain. Install case drain lines so that the motor case remains filled at all times.

Maximum inlet pressure — 275 Bar [4000 PSI]. Do not exceed Δ pressure rating (see chart above).

* **Maximum return pressure** — 275 Bar [4000 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
10,000 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.

345 cm³/r [21.0 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
[1] **3,8**	[600] 70 **3**	[1310] 150 **1**							
[2] **7,5**	[740] 85 **21**	[1510] 170 **19**	[3050] 345 **15**	[4600] 520 **11**	[6140] 695 **8**	[7680] 865 **4**			
[4] **15**	[730] 80 **43**	[1500] 170 **41**	[3040] 345 **37**	[4590] 520 **33**	[6140] 695 **30**	[7680] 870 **26**	[9220] 1040 **22**	[10770] 1215 **18**	[12310] 1390 **14**
[8] **30**	[720] 80 **87**	[1490] 170 **86**	[3030] 340 **82**	[4580] 515 **78**	[6120] 690 **74**	[7670] 865 **70**	[9210] 1040 **66**	[10750] 1215 **62**	[12300] 1390 **58**
[12] **45**	[700] 80 **131**	[1470] 165 **129**	[3020] 340 **127**	[4560] 515 **123**	[6100] 690 **118**	[7650] 865 **114**	[9190] 1040 **110**	[10740] 1215 **106**	[12280] 1385 **102**
[16] **61**	[680] 75 **175**	[1450] 165 **174**	[3000] 340 **172**	[4540] 515 **167**	[6080] 685 **163**	[7630] 860 **158**	[9170] 1035 **154**	[10720] 1210 **149**	[12260] 1385 **145**
[20] **76**	[660] 75 **219**	[1430] 160 **218**	[2970] 335 **217**	[4520] 510 **212**	[6060] 685 **207**	[7600] 860 **202**	[9150] 1035 **198**	[10690] 1210 **193**	[12230] 1380 **189**
[24] **91**	[630] 70 **263**	[1400] 160 **262**	[2950] 335 **261**	[4490] 505 **256**	[6030] 680 **252**	[7580] 855 **246**	[9120] 1030 **242**	[10660] 1205 **237**	[12210] 1380 **232**
[28] **106**	[600] 70 **307**	[1370] 155 **306**	[2920] 330 **305**	[4460] 505 **301**	[6000] 680 **296**	[7550] 855 **291**	[9090] 1025 **286**	[10640] 1200 **280**	[12180] 1375 **275**
[32] **121**	[570] 65 **351**	[1340] 150 **350**	[2890] 325 **349**	[4430] 500 **345**	[5970] 675 **340**	[7520] 850 **335**	[9060] 1025 **329**	[10610] 1200 **324**	[12150] 1370 **319**
[36] **136**	[540] 60 **395**	[1310] 150 **394**	[2850] 320 **393**	[4400] 495 **388**	[5940] 670 **384**	[7480] 845 **379**	[9030] 1020 **373**	[10570] 1195 **368**	[12120] 1370 **362**
[40] **151**	[500] 55 **439**	[1270] 145 **438**	[2820] 320 **437**	[4360] 495 **433**	[5910] 670 **429**	[7450] 840 **423**	[8990] 1015 **417**	[10540] 1190 **412**	
[45] **170**	[460] 50 **494**	[1220] 140 **493**	[2760] 310 **492**	[4300] 485 **490**	[5840] 660 **486**	[7380] 835 **480**	[8910] 1005 **473**	[10450] 1180 **467**	
[60] **227**		[1080] 130 **659**	[2620] 295 **658**	[4160] 470 **655**	[5710] 645 **651**	[7250] 820 **644**	[8800] 995 **637**		
[70] **265**		[960] 110 **769**	[2510] 285 **768**	[4050] 460 **765**	[5590] 630 **761**	[7140] 805 **754**	[8680] 980 **746**		

480 cm³/r [29.3 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
[1] **3,8**	[760] 85 **6**	[1540] 175 **5**	[3120] 355 **4**	[4640] 525 **2**					
[2] **7,5**	[1040] 120 **15**	[2140] 240 **13**	[4320] 490 **11**	[6500] 735 **8**	[8690] 980 **5**	[10870] 1230 **2**			
[4] **15**	[1040] 120 **31**	[2130] 240 **29**	[4310] 485 **27**	[6490] 735 **24**	[8680] 980 **21**	[10860] 1225 **18**	[13050] 1475 **16**	[15230] 1720 **13**	[17410] 1965 **10**
[8] **30**	[1020] 115 **62**	[2110] 240 **61**	[4290] 485 **58**	[6480] 730 **55**	[8660] 980 **53**	[10840] 1225 **50**	[13030] 1470 **47**	[15210] 1720 **44**	[17390] 1965 **42**
[12] **45**	[990] 110 **94**	[2080] 235 **93**	[4270] 480 **90**	[6450] 730 **87**	[8630] 975 **84**	[10820] 1220 **81**	[13000] 1470 **78**	[15180] 1715 **75**	[17370] 1965 **73**
[16] **61**	[960] 110 **125**	[2060] 235 **124**	[4240] 480 **122**	[6420] 725 **119**	[8600] 970 **116**	[10790] 1220 **113**	[12970] 1465 **110**	[15150] 1710 **107**	[17340] 1960 **104**
[20] **76**	[930] 105 **156**	[2020] 230 **155**	[4200] 475 **154**	[6390] 720 **150**	[8570] 970 **147**	[10750] 1215 **144**	[12940] 1460 **141**	[15120] 1710 **138**	[17300] 1955 **135**
[24] **91**	[890] 100 **188**	[1980] 225 **187**	[4170] 470 **185**	[6350] 715 **182**	[8530] 965 **179**	[10720] 1210 **175**	[12900] 1460 **172**	[15080] 1705 **169**	
[28] **106**	[850] 95 **220**	[1940] 220 **219**	[4130] 465 **217**	[6310] 715 **214**	[8490] 960 **210**	[10680] 1205 **207**	[12860] 1455 **203**	[15040] 1700 **200**	
[32] **121**	[810] 90 **251**	[1900] 215 **250**	[4080] 460 **249**	[6270] 710 **245**	[8450] 955 **242**	[10630] 1200 **238**	[12820] 1450 **235**	[15000] 1695 **231**	
[36] **136**	[760] 85 **283**	[1850] 210 **282**	[4040] 455 **280**	[6220] 705 **277**	[8400] 950 **273**	[10590] 1195 **270**	[12770] 1445 **266**		
[40] **151**	[710] 80 **314**	[1800] 205 **313**	[3990] 450 **312**	[6170] 695 **308**	[8350] 945 **305**	[10540] 1190 **301**	[12720] 1440 **297**		
[45] **170**	[647] 75 **354**	[1740] 195 **353**	[3920] 445 **351**	[6110] 690 **348**	[8290] 935 **344**	[10470] 1185 **340**	[12660] 1430 **336**		
[60] **227**	[430] 50 **472**	[1520] 170 **471**	[3710] 420 **469**	[5890] 665 **467**	[8070] 910 **462**	[10260] 1160 **458**	[12440] 1405 **454**		
[70] **265**		[1360] 155 **551**	[3540] 400 **550**	[5730] 645 **546**	[7910] 895 **541**	[10100] 1140 **536**	[12280] 1385 **532**		

[2510] } Torque [lb-in]
285 } Nm
768 } **Speed RPM**

Continuous (light blue)
Intermittent (darker blue)

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

Performance Data
10,000 Series

665 cm³/r [40.6 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
[1] 3,8	[1470] 165 **4**	[3010] 340 **3**	[4550] 515 **3**	[6100] 690 **2**	[7630] 860 **1**										
[2] 7,5	[1480] 165 **10**	[3020] 340 **9**	[4560] 515 **8**	[6110] 690 **7**	[7650] 865 **7**	[9200] 1040 **6**	[10740] 1215 **5**	[12280] 1385 **4**	[13830] 1565 **3**	[15370] 1735 **2**	[16910] 1910 **1**				
[4] 15	[1470] 165 **22**	[3010] 340 **21**	[4550] 515 **20**	[6100] 690 **19**	[7640] 865 **18**	[9190] 1040 **17**	[10730] 1210 **16**	[12270] 1385 **15**	[13820] 1560 **14**	[15360] 1735 **13**	[16900] 1910 **12**	[18450] 2085 **11**	[19990] 2260 **10**	[21540] 2435 **9**	[23080] 2610 **8**
[8] 30	[1440] 165 **44**	[2980] 335 **43**	[4530] 510 **42**	[6070] 685 **41**	[7610] 860 **40**	[9160] 1035 **39**	[10700] 1210 **38**	[12250] 1385 **37**	[13790] 1560 **36**	[15330] 1730 **35**	[16880] 1905 **34**	[18420] 2080 **33**	[19960] 2255 **32**	[21510] 2430 **32**	[23050] 2605 **31**
[12] 45	[1400] 160 **67**	[2950] 335 **66**	[4490] 505 **65**	[6040] 680 **64**	[7580] 855 **63**	[9120] 1030 **62**	[10670] 1205 **61**	[12210] 1380 **60**	[13750] 1555 **59**	[15300] 1730 **58**	[16840] 1905 **57**	[18380] 2075 **56**	[19930] 2255 **55**	[21470] 2425 **54**	[23020] 2600 **53**
[16] 61	[1360] 155 **89**	[2910] 330 **88**	[4450] 505 **87**	[5990] 675 **86**	[7540] 850 **85**	[9080] 1025 **84**	[10620] 1200 **83**	[12170] 1375 **82**	[13710] 1550 **81**	[15260] 1725 **80**	[16800] 1900 **79**	[18340] 2070 **78**	[19890] 2245 **77**	[21430] 2420 **76**	
[20] 76	[1310] 150 **112**	[2860] 375 **111**	[4400] 495 **110**	[5940] 670 **109**	[7490] 845 **108**	[9030] 1020 **107**	[10580] 1195 **106**	[12120] 1370 **104**	[13660] 1545 **103**	[15210] 1720 **102**	[16750] 1890 **101**	[18300] 2070 **100**	[19840] 2240 **99**		
[24] 91	[1260] 140 **135**	[2800] 315 **134**	[4350] 490 **132**	[5890] 665 **131**	[7440] 840 **130**	[8980] 1015 **129**	[10520] 1190 **128**	[12070] 1365 **127**	[13610] 1540 **126**	[15150] 1710 **124**	[16700] 1885 **123**	[18240] 2060 **122**			
[28] 106	[1200] 135 **157**	[2750] 310 **156**	[4290] 485 **155**	[5840] 660 **154**	[7380] 835 **153**	[8920] 1010 **151**	[10470] 1185 **150**	[12010] 1355 **149**	[13550] 1530 **148**	[15100] 1705 **147**	[16640] 1880 **146**				
[32] 121	[1140] 130 **180**	[2690] 305 **179**	[4230] 480 **177**	[5770] 650 **176**	[7320] 825 **175**	[8860] 1000 **174**	[10400] 1175 **173**	[11950] 1350 **172**	[13490] 1525 **170**	[15040] 1700 **169**	[16580] 1875 **168**				
[36] 136	[1080] 120 **202**	[2620] 295 **201**	[4160] 470 **200**	[5710] 645 **199**	[7250] 820 **198**	[8800] 995 **196**	[10340] 1170 **195**	[11880] 1340 **194**	[13430] 1515 **193**	[14970] 1690 **191**	[16510] 1865 **190**				
[40] 151	[1010] 115 **225**	[2550] 290 **224**	[4100] 465 **222**	[5640] 635 **221**	[7180] 810 **220**	[8730] 985 **219**	[10270] 1160 **217**	[11810] 1335 **216**	[13360] 1510 **215**	[14900] 1685 **214**	[16440] 1855 **212**				
[45] 170	[920] 105 **254**	[2460] 280 **252**	[4000] 450 **251**	[5550] 625 **249**	[7090] 800 **248**	[8630] 975 **247**	[10180] 1150 **245**	[11720] 1325 **244**	[13260] 1500 **243**	[14810] 1675 **242**					
[60] 227	[610] 70 **338**	[2150] 245 **336**	[3700] 420 **335**	[5240] 590 **334**	[6780] 765 **332**	[8330] 940 **331**	[9870] 1115 **329**	[11420] 1290 **328**	[12960] 1465 **327**						
[70] 265	[380] 45 **396**	[1930] 220 **393**	[3470] 390 **391**	[5010] 565 **390**	[6560] 740 **388**	[8100] 915 **387**	[9640] 1090 **385**	[11190] 1265 **384**							

[3470] 390 **391** } Torque [lb-in] Nm **Speed RPM**

Continuous
Intermittent

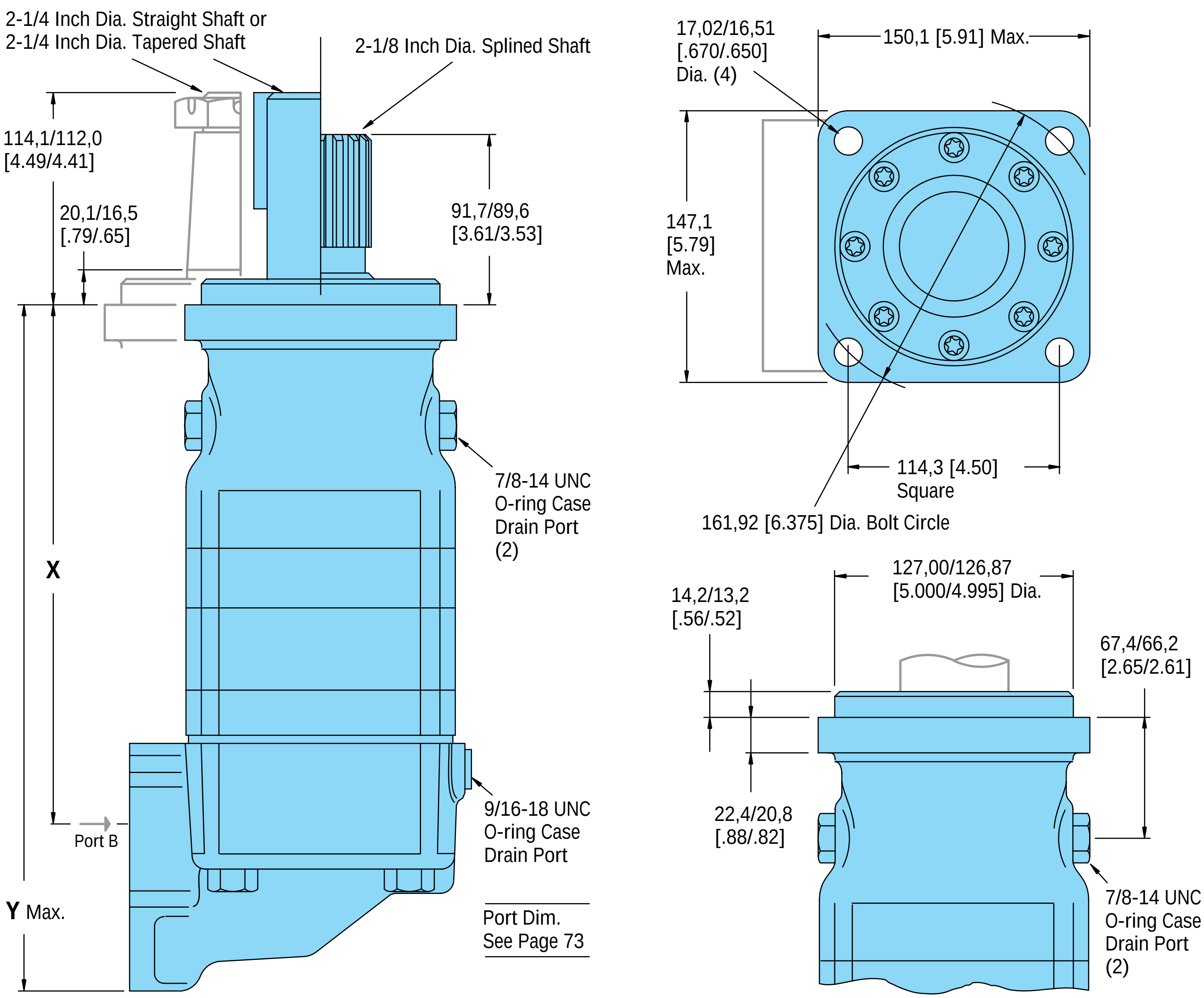
940 cm³/r [57.4 in³/r]
Δ Pressure Bar [PSI]

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
[1] 3,8	[2080] 235 **3**	[4260] 480 **2**	[6440] 730 **1**											
[2] 7,5	[2090] 235 **7**	[4270] 480 **6**	[6450] 730 **5**	[8640] 975 **5**	[10820] 1220 **4**	[13000] 1470 **3**	[15190] 1715 **2**	[17370] 1965 **1**						
[4] 15	[2080] 235 **15**	[4260] 480 **14**	[6440] 730 **13**	[8620] 975 **13**	[10810] 1220 **12**	[12990] 1470 **11**	[15170] 1715 **10**	[17360] 1960 **9**	[19540] 2210 **8**	[21720] 2455 **7**	[23910] 2700 **7**	[26090] 2950 **6**	[28270] 3195 **5**	[30460] 3440 **4**
[8] 30	[2040] 230 **31**	[4220] 475 **30**	[6400] 725 **29**	[8590] 970 **28**	[10770] 1215 **28**	[12950] 1465 **27**	[15140] 1710 **26**	[17320] 1955 **25**	[19500] 2200 **24**	[21690] 2450 **23**	[23870] 2695 **22**			
[12] 45	[1990] 225 **47**	[4170] 470 **46**	[6350] 715 **45**	[8540] 965 **44**	[10720] 1210 **43**	[12900] 1460 **43**	[15090] 1705 **42**	[17270] 1950 **41**	[19450] 2200 **40**	[21640] 2445 **39**				
[16] 61	[1930] 220 **63**	[4110] 465 **62**	[6290] 710 **61**	[8480] 960 **60**	[10660] 1205 **59**	[12840] 1450 **58**	[15030] 1700 **58**	[17210] 1945 **57**	[19390] 2190 **56**					
[20] 76	[1860] 210 **79**	[4040] 455 **78**	[6220] 705 **77**	[8410] 950 **76**	[10590] 1195 **75**	[12770] 1445 **74**	[14960] 1690 **73**	[17140] 1935 **72**	[19320] 2185 **72**					
[24] 91	[1780] 200 **95**	[3970] 450 **94**	[6150] 695 **93**	[8330] 940 **92**	[10520] 1190 **91**	[12700] 1435 **90**	[14880] 1680 **89**	[17070] 1930 **88**						
[28] 106	[1700] 190 **111**	[3890] 440 **110**	[6070] 685 **109**	[8250] 930 **108**	[10440] 1180 **107**	[12620] 1425 **106**	[14800] 1675 **105**	[16990] 1920 **104**						
[32] 121	[1620] 185 **127**	[3800] 430 **126**	[5980] 675 **125**	[8160] 920 **124**	[10350] 1170 **123**	[12530] 1415 **122**	[14720] 1665 **121**							
[36] 136	[1520] 170 **143**	[3710] 420 **142**	[5890] 665 **141**	[8070] 910 **140**	[10260] 1160 **139**	[12440] 1405 **138**	[14620] 1650 **137**							
[40] 151	[1420] 160 **159**	[3610] 410 **158**	[5790] 655 **157**	[7970] 900 **156**	[10160] 1150 **155**	[12340] 1395 **154**	[14520] 1640 **153**							
[45] 170	[1290] 145 **179**	[3480] 395 **178**	[5660] 640 **177**	[7840] 885 **176**	[10020] 1130 **174**	[12210] 1380 **174**	[14400] 1625 **173**							
[60] 227	[860] 95 **239**	[3040] 345 **238**	[5230] 590 **236**	[7410] 835 **235**	[9600] 1085 **234**	[11780] 1330 **233**								
[70] 265	[540] 60 **279**	[2720] 305 **278**	[4910] 555 **276**	[7090] 800 **275**	[9270] 1045 **274**	[11460] 1295 **273**								

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 — 10,000 Series Standard Motor

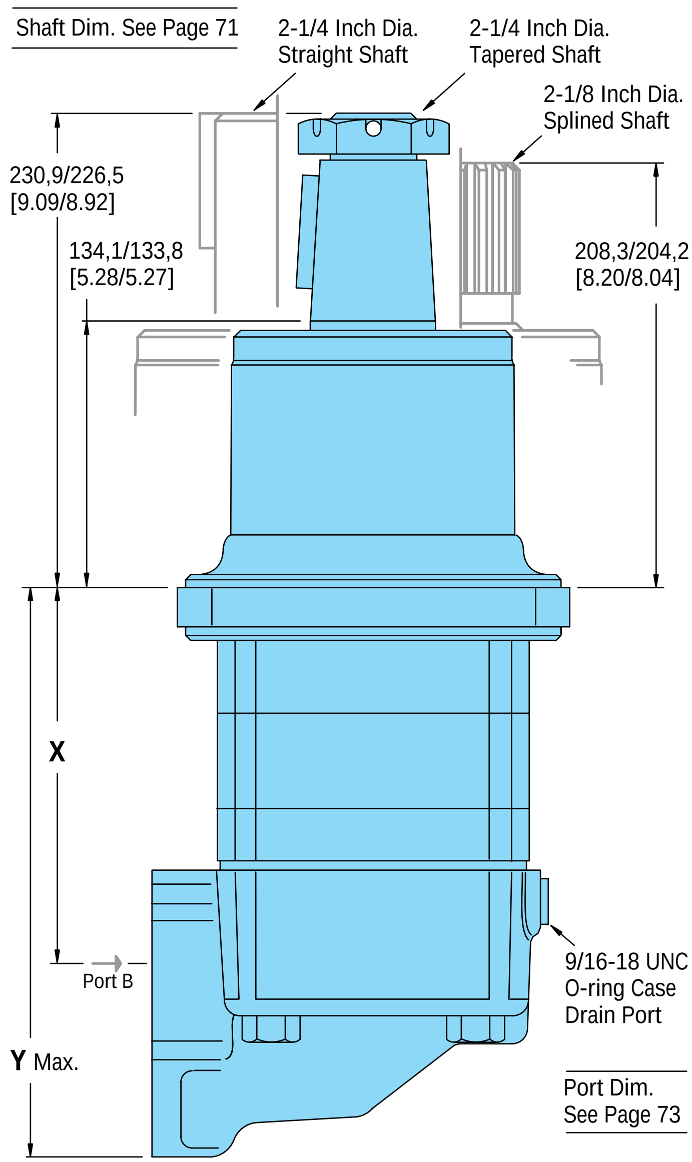


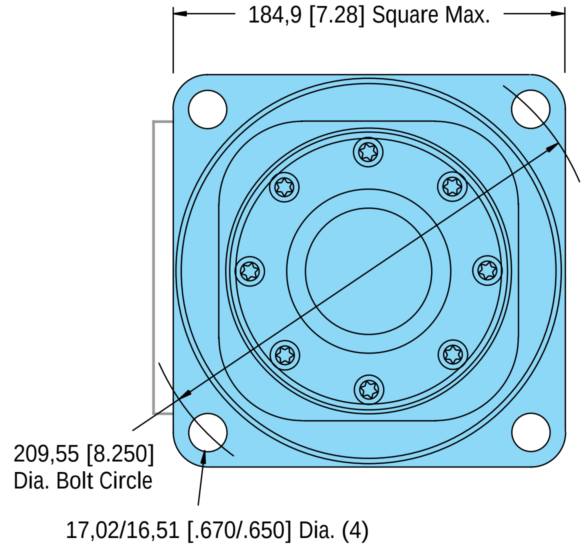
10,000 Series Standard Motor

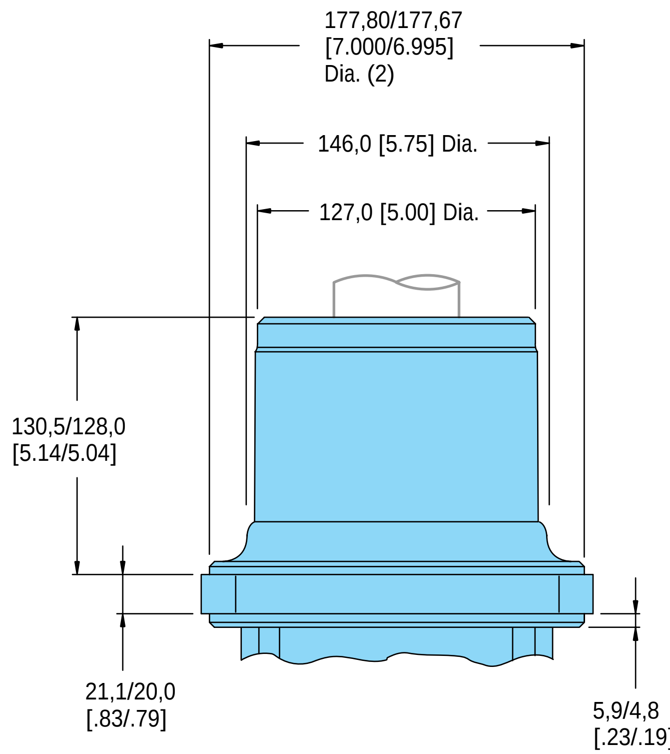
Displ. cm³/r [in³/r]	345 [21.0]	480 [29.2]	665 [40.6]	940 [57.4]
X Dim. mm [inch]	282,4 [11.12]	295,1 [11.62]	295,1 [11.62]	313,4 [12.34]
Y Dim. mm [inch]	381,0 [15.00]	393,7 [15.50]	393,7 [15.50]	412,0 [16.22]

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

Dimensions —
10,000 Series Wheel Motor





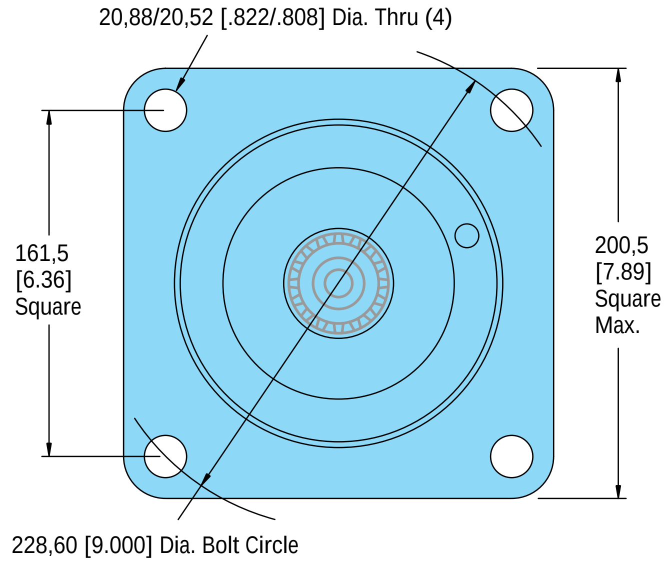


10,000 Series Wheel Motor

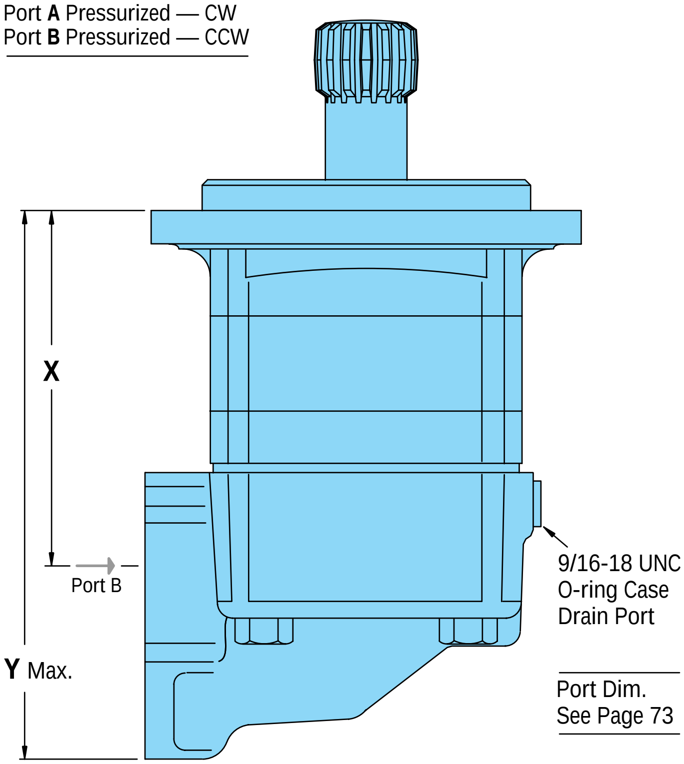
Displ. cm³/r [in³/r]	345 [21.0]	480 [29.2]	665 [40.6]	940 [57.4]
X Dim. mm [inch]	166,9 [6.57]	179,6 [7.07]	179,6 [7.07]	197,8 [7.79]
Y Dim. mm [inch]	266,2 [10.48]	278,9 [10.98]	278,9 [10.98]	297,5 [11.71]

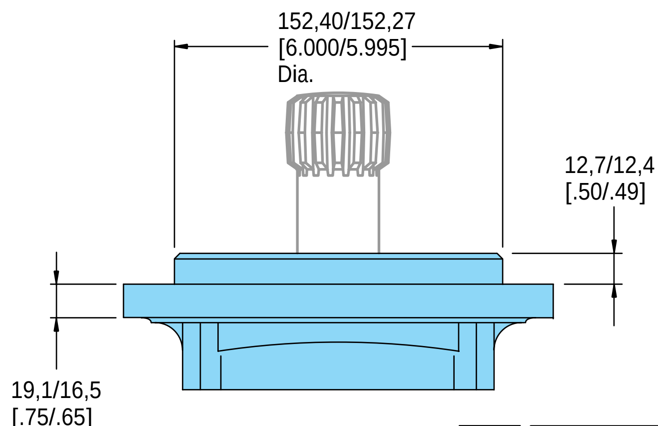
Standard Rotation
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

Dimensions — 10,000 Series Bearingless Motor

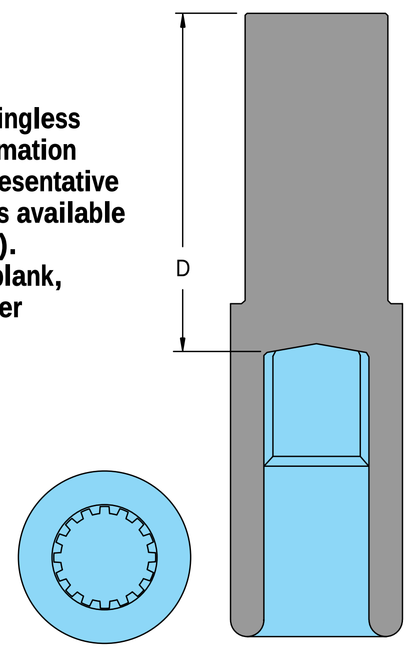


Standard Rotation
Viewed from Drive End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW





For 10,000 Series bearingless motor application information contact your Eaton representative (mating coupling blanks available from Eaton Corporation). Note: After machining blank, part must be hardend per Eaton specification.

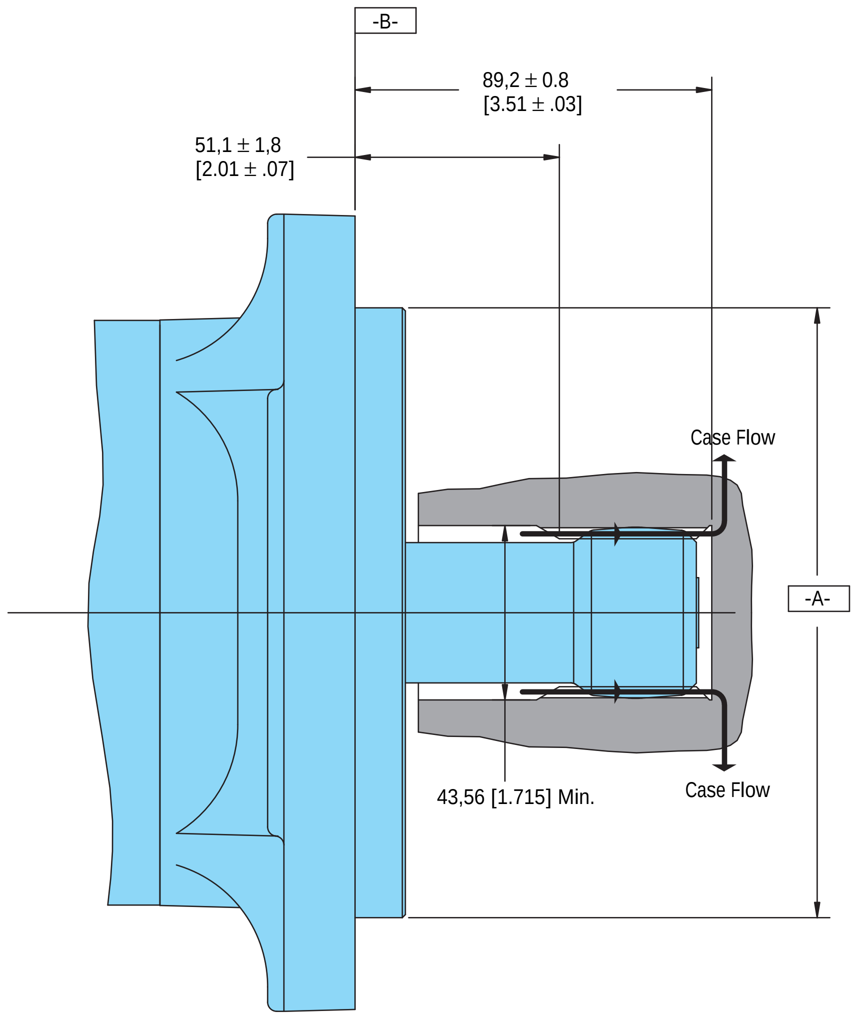


10,000 Series Bearingless Motor

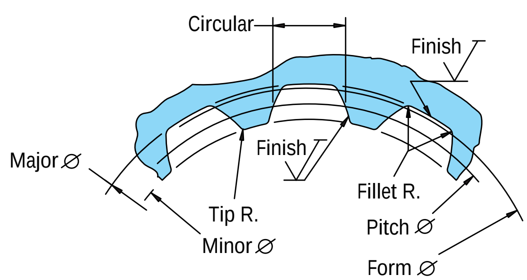
Displ. cm³/r [in³/r]	345 [21.0]	480 [29.2]	665 [40.6]	940 [57.4]
X Dim. mm [inch]	189,5 [7.46]	202,2 [7.96]	202,2 [7.96]	221,0 [8.70]
Y Dim. mm [inch]	288,5 [11.36]	301,0 [11.85]	301,0 [11.85]	319,5 [12.58]

Mating Coupling Blank	Dimension D mm [inch]
Eaton Part No. 13280-001	133,6/128,5 [5.26/5.06]
13280-002	156,0/150,9 [6.14/5.94]

Bearingless Installation —
10,000 Series

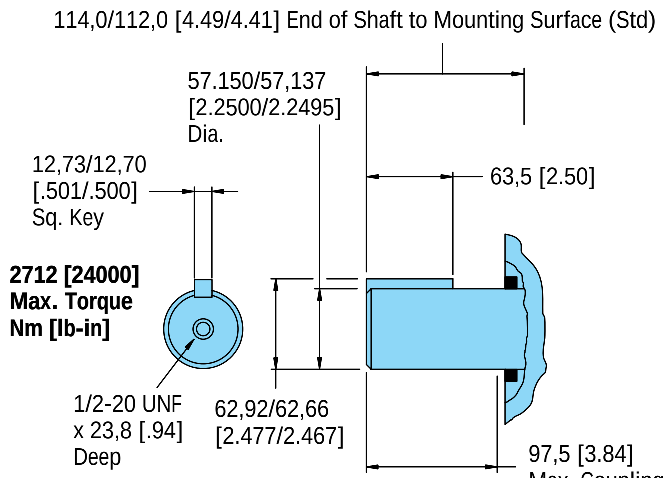


Spline Pitch — 10/20
Pressure Angle — 30°
Number of teeth — 16
Class of Fit — Ref. 5
Type of Fit — Side
Pitch Diameter — Ref. 40,640000 [1.6000000] | ◎ | 0,25 [.010] | D |
Base Diameter — Ref. 35,195272 [1.3856406]
Major Diameter — 43,56 [1.715] Max. 43,18 [1.700] Min.
Minor Diameter — 36,83 - 37,08 [1.450 - 1.460]
Form Diameter, Min. — 42,47 [1.672]
Fillet Radius — 0,64 - 0,76 [.025 - .030]
Tip Radius — 0,25 - 0,51 [.010 - .020]
Finish — 1,6 [63]
Involute Profile Variation — +0,000 -0,028 [+.0000 -.0011]
Total Index Variation — 0,041 [.0016]
Lead Variation — 0,013 [.0005]
Circular Space Width:
Maximum Actual — 4,105 [.1616]
Minimum Effective — 3,995 [.1573]
Maximum Effective — Ref. 4,056 [.1597]
Minimum Actual — Ref. 4,018 [.1582]
Dimension Between Two Pins — Ref. 34,272 - 34,450 [1.3493 - 1.3563]

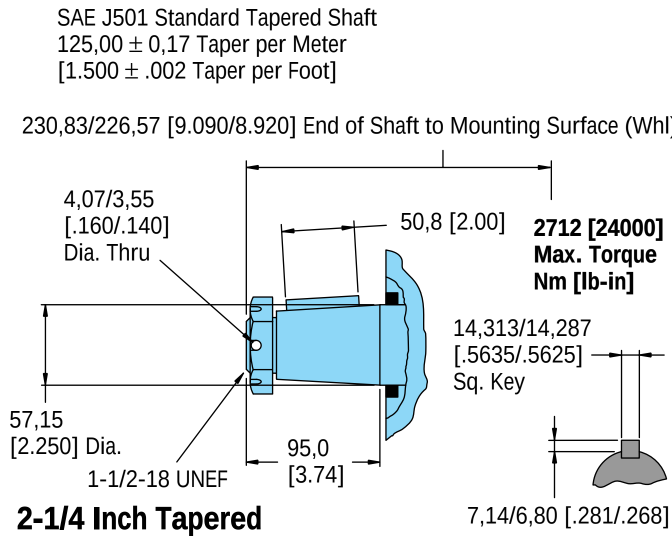


1 Internal spline in mating part to be as follows:
Material to be ASTM A304, 8620H.
Carborize to a hardness of 58-64 HRc with case depth (to 50HRc) of 0,076 - 1,02 [.030 - .040] (dimensions apply after heat treat).

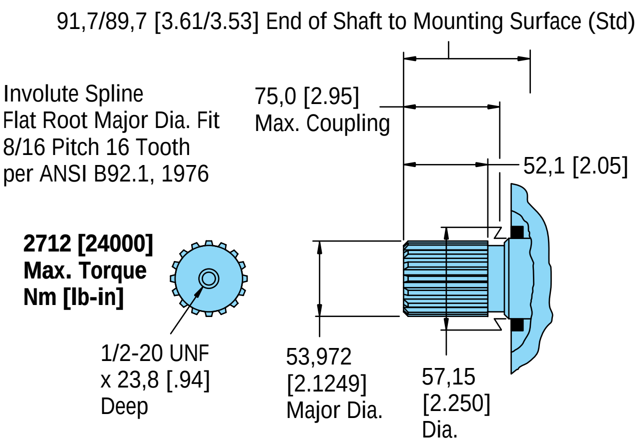
Dimensions — Shafts
10,000 Series



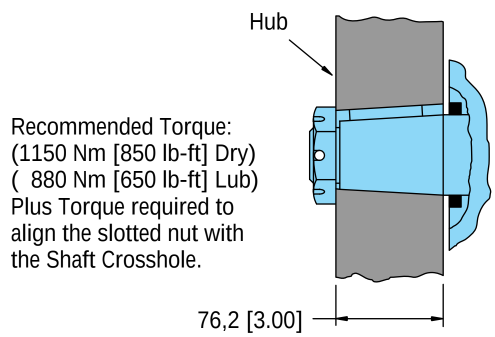
2-1/4 Inch Straight



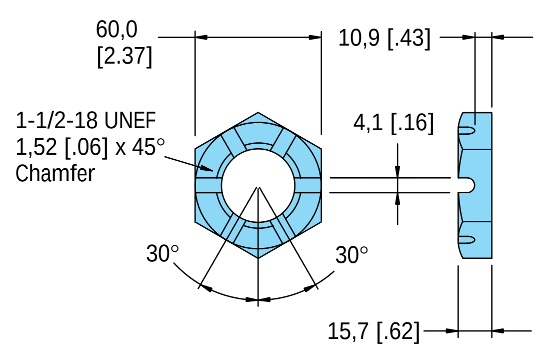
2-1/4 Inch Tapered



2-1/8 Inch 16 Tooth Splined



Tapered Shaft Hub Data



Slotted Hexagon Nut

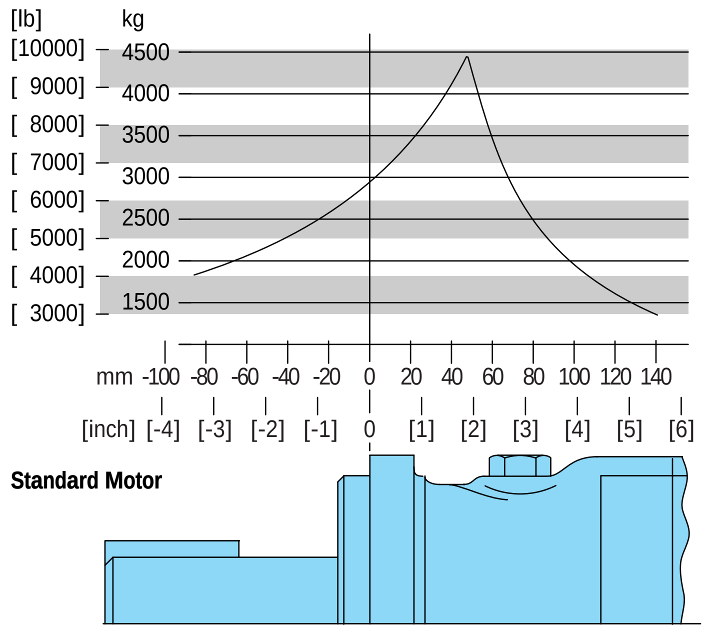
Shaft Side Load Capacity
10,000 Series

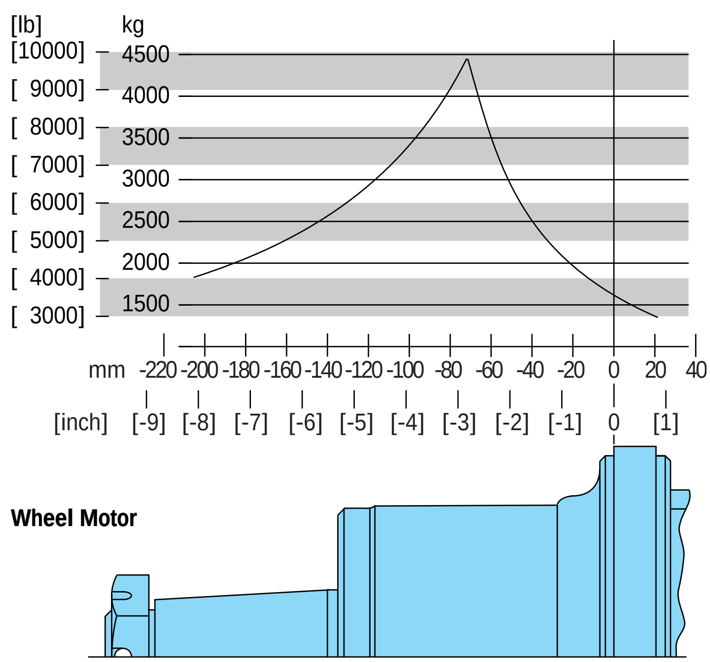
This curve indicates the radial load capacity on the motor shaft(s) at various locations.

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

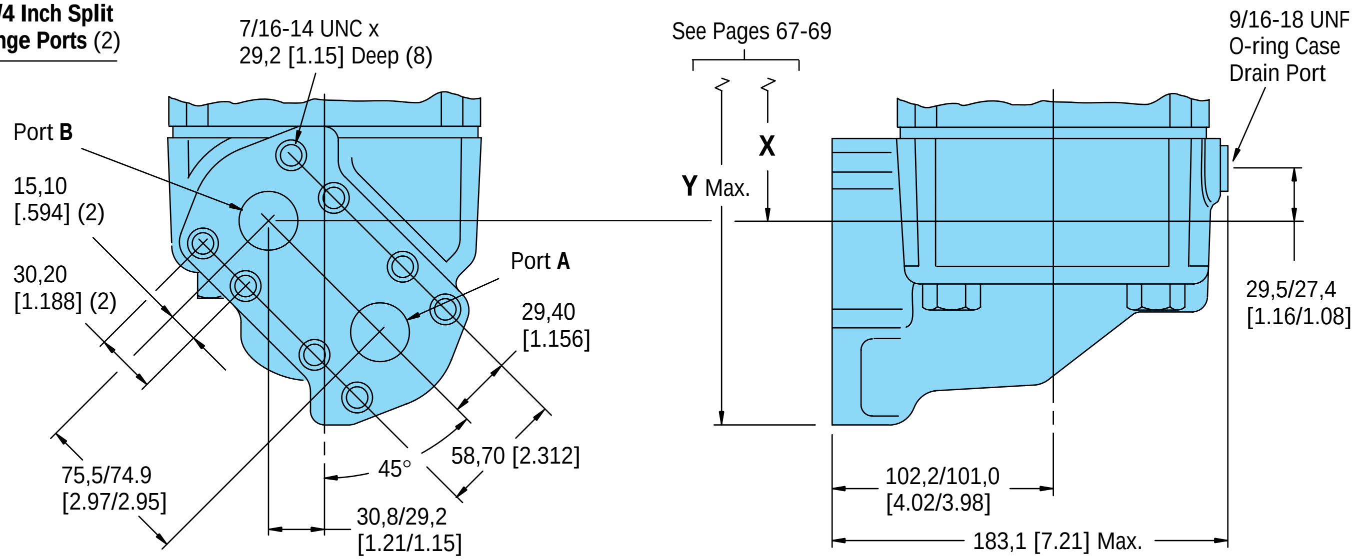
For 3,000,000 Shaft revolutions or 500 hours — Increase these shaft loads 52%.



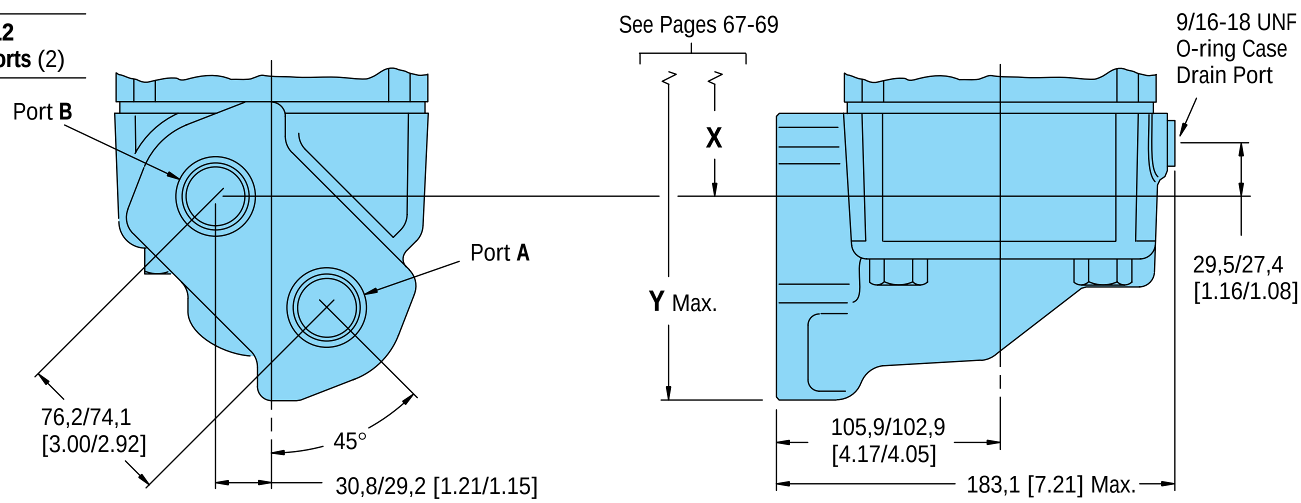


Dimensions —Ports 10,000 Series

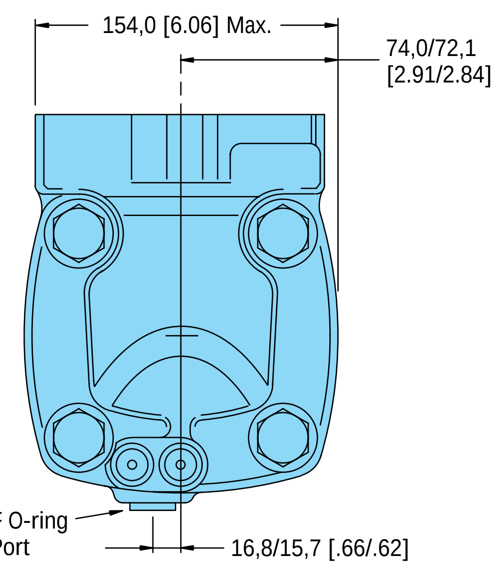
1-1/4 Inch Split Flange Ports (2)



1-5/16 -12
O-ring Ports (2)



10,000 Series
Motor End View—
Common Dim.



Standard Rotation 10,000 Series
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

Product Numbers
10,000 Series

Product Numbers—10,000 Series Motors

Use digit prefix —**119**-, **120**-, or **121**- plus four digit number from charts for complete product number—Example **121**-1014.
Orders will not be accepted without three digit prefix.

Mounting	Shaft	Ports	Displacement cm^3/r [in^3/r] and Product Number 345 [21.0]	480 [29.3]	665 [40.6]	940 [57.4]
Standard	2-1/4 inch Straight	1-5/16 O-ring	**119**-1028	-1029	-1030	-1031
		1-1/4 Split Flange	**119**-1040	-1041	-1042	-1043
	2-1/8 Inch 16 T Splined	1-5/16 O-ring	**119**-1032	-1033	-1034	-1035
		1-1/4 Split Flange	**119**-1044	-1045	-1046	-1047
	2-1/4 Inch Tapered	1-5/16 O-ring	**119**-1036	-1037	-1038	-1039
		1-1/4 Split Flange	**119**-1048	-1049	-1050	-1051
Wheel Motor	2-1/4 inch Straight	1-5/16 O-ring	**120**-1005	-1006	-1007	-1008
		1-1/4 Split Flange	**120**-1017	-1018	-1019	-1020
	2-1/8 Inch 16 T Splined	1-5/16 O-ring	**120**-1009	-1010	-1011	-1012
		1-1/4 Split Flange	**120**-1021	-1022	-1023	-1024
	2-1/4 Inch Tapered	1-5/16 O-ring	**120**-1013	-1014	-1015	-1016
		1-1/4 Split Flange	**120**-1025	-1026	-1027	-1028
Bearingless		1-5/16 O-ring	**121-**1007	-1008	-1009	-1010
		1-1/4 Split Flange	**121-**1011	-1012	-1013	-1014

121-1014

For 10,000 Series motors with a configuration *Not Shown* in the charts above: Contact your Eaton representative.

Model Code for 10,000 Series Motors

The following 14-digit coding system has been developed to identify all of the configuration options for the 10000 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 — 10,000 Series Disc Valve Motors

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

Position 1 **Product Series**

M .... Motor

Position 2, 3 **10 000 Series**

10 .... 10 000 Series

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

20 .... 345 [21.0]

29 .... 480 [29.2]

40 .... 665 [40.6]

57 .... 940 [57.4]

Position 6 **Mounting Flange**

A .... 4 Bolt (Std.): Dia. 127,0 [5.00] Pilot 16,76 [.660] Mounting Holes on 161,92 [6.375] Dia. Bolt Circle

B .... 4 Bolt (Whl.): Dia. 177,8 [7.00] Pilot 16,76 [.660] Mounting Holes on 209,55 [8.250] Dia. Bolt Circle

C .... 4 Bolt (Brgl.): Dia. 152,4 [6.00] Pilot 20,70[.815] Mounting Holes on 228,60 [9.000] Dia. Bolt Circle

Position 7, 8 **Output Shaft**

01 .... 2–1/4 inch Dia. Straight with 12,7 [.50] Square Key x 63,5 [2.50] and 1/2 - 20 Threaded Hole

02 .... 2–1/4 inch Dia. Tapered with 14,3 [.56] Square Key x 50,8 [2.00] and 1–1/2 - 18 UNEF-2A Threaded Shaft End and Slotted Hex Nut

03 .... 2–1/8 inch 16 Tooth Splined with 52,1 [2.05] Min. Full Spline Length 1/2 - 20 UNF Threaded Hole

Position 9 **Port Type**

A .... 1–5/16—12 UN O-ring End Ports (Size -16), 9/16-18 UNF O-ring Case Drain Port (Size -6)

B .... 1–1/4 Inch Split Flange Ports, 9/16 - 18 UNF O-ring Case Drain Port (Size -6)

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

00 .... None

01 .... Free Running Geroler

03 .... Reverse Rotation

Position 12 **Paint/Special Packaging**

0 .... No Paint

A .... Painted Low Gloss Black

Position 13 **Eaton Assigned Code when Applicable**

0 .... Assigned Code

Position 14 **Eaton Assigned Design Code**

0 .... Assigned Design Code

Two Speed Motor — 10,000 Series

The Eaton 10,000 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 10,000 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 75).

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].

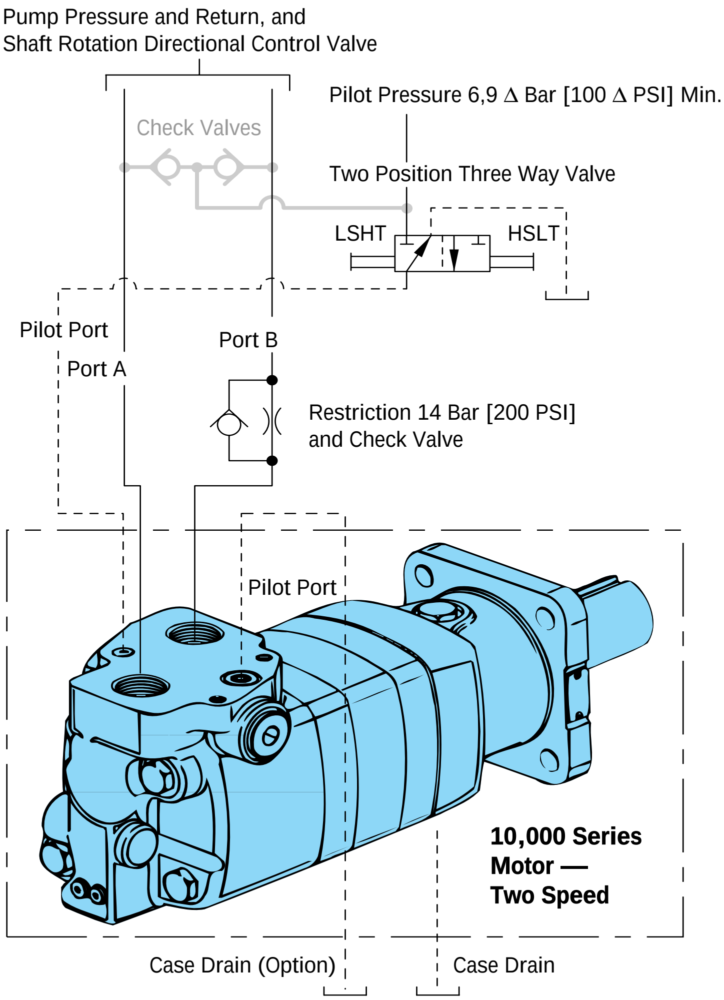
Note: Be certain in closed loop applications that the charge pump when used for back pressure on the B port, has sufficient displacement to maintain charge pressure especially in dynamic braking or overrunning load conditions.

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 — 10,000 Series

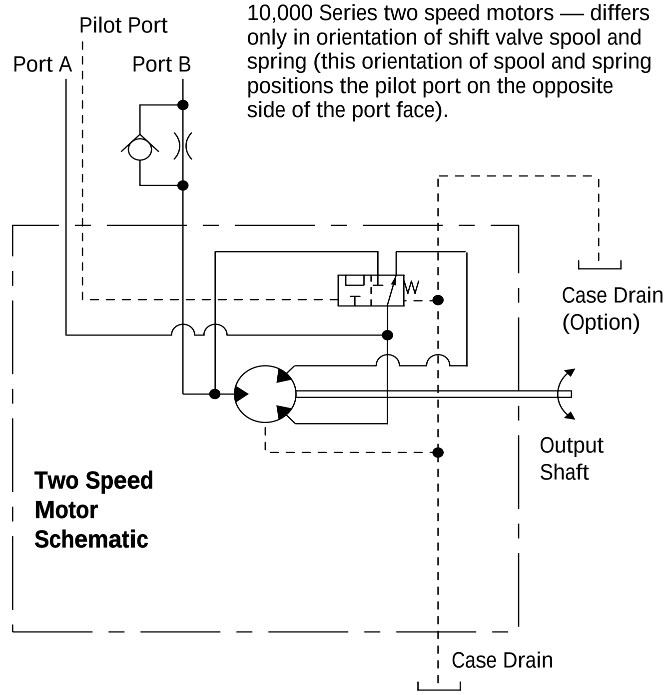
In the high speed mode torque values are approximately one half with twice the speed of the conventional 10,000 Series single speed motors. **In the low speed mode torque and speed values are the same as the conventional**

Two Speed Motor — 10,000 Series

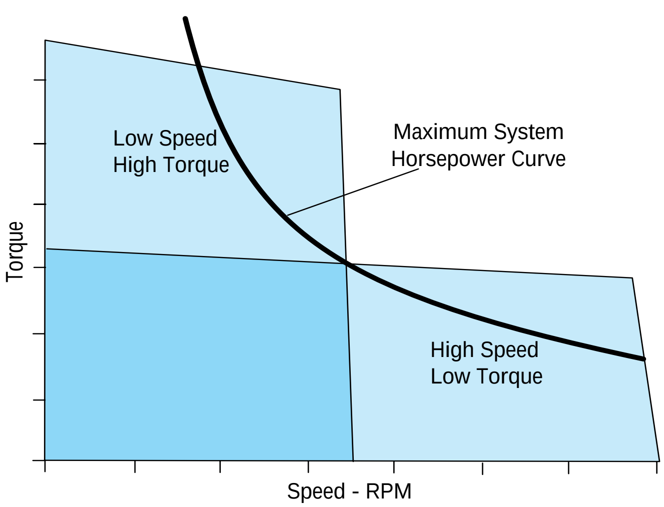


10,000 Series Motor — Two Speed

Schematic diagram below applies to 10,000 Series two speed motors — differs only in orientation of shift valve spool and spring (this orientation of spool and spring positions the pilot port on the opposite side of the port face).

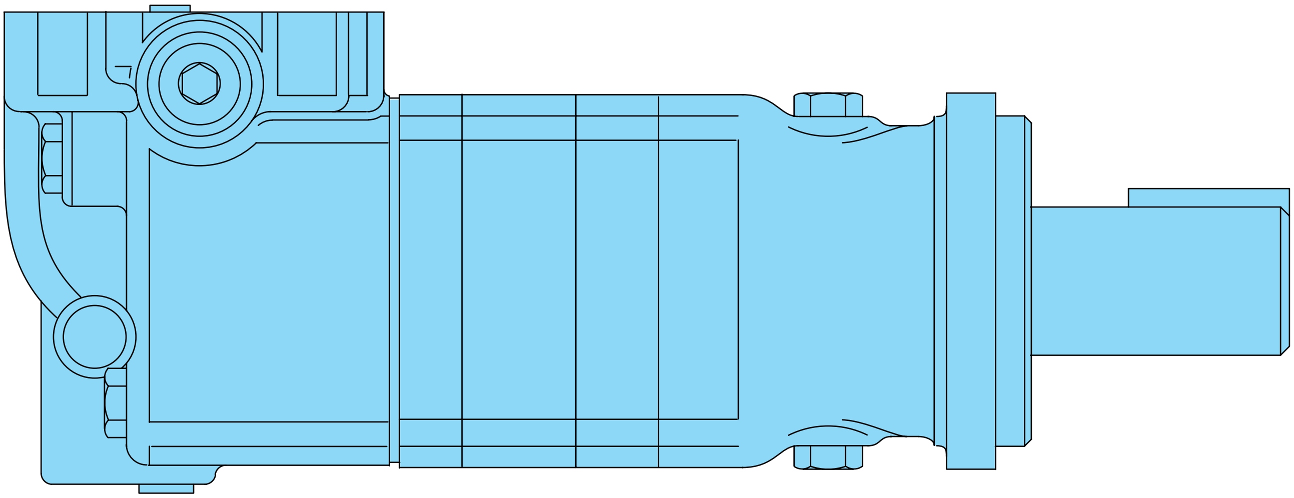


Two Speed Motor Schematic



2 - Speed Operating Range

Specifications — Two Speed 10,000 Series



Specification Data—10,000 Series Two Speed

Displ. cm³/r. [in³/r]	High Speed Mode		169 [10.3]	239 [14.6]	332,7 [20.3]	470 [28.7]
	Low Speed Mode		345 [21.0]	480 [29.3]	665 [40.6]	940 [57.4]
Max. Speed (RPM) @ Continuous Flow	High Speed Mode		750	630	500	400
	Low Speed Mode		375	315	250	200
Flow LPM [GPM]	High Speed Mode		130 [35]	170 [45]	170 [45]	170 [45]
	Low Speed Mode		130 [35]	170 [45]	170 [45]	170 [45]
Torque Nm [lb-in]	High Speed Mode	Continuous	440 [3900]	630 [5600]	905 [8000]	1175 [10400]
		Intermittent	585 [5200]	845 [7500]	1130 [10000]	1470 [13000]
Torque Nm [lb-in]	Low Speed Mode	Continuous	1015 [9000]	1470 [13000]	2090 [18500]	2710 [24000]
		Intermittent	1355 [12000]	1965 [17400]	2600 [23000]	3445 [30500]
Pressure Δ Bar [Δ PSI]		Continuous	205 [3000]	205 [3000]	205 [3000]	190 [2750]
		Intermittent	275 [4000]	275 [4000]	260 [3750]	240 [3500]

Maximum Case Pressure - without Case Drain * — 20 Bar [300 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 65-66 (LSHT only).

* For back pressure over 20 Bar [300 PSI] use an external case drain. Install case drain lines so that the motor case remains filled at all times.

Maximum inlet pressure — 275 Bar [4000 PSI]. Do not exceed Δ pressure rating (see chart above).

* **Maximum return pressure** — 275 Bar [4000 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 10,000 Series Standard, Wheel, and Bearingless

Two Speed Standard Motor

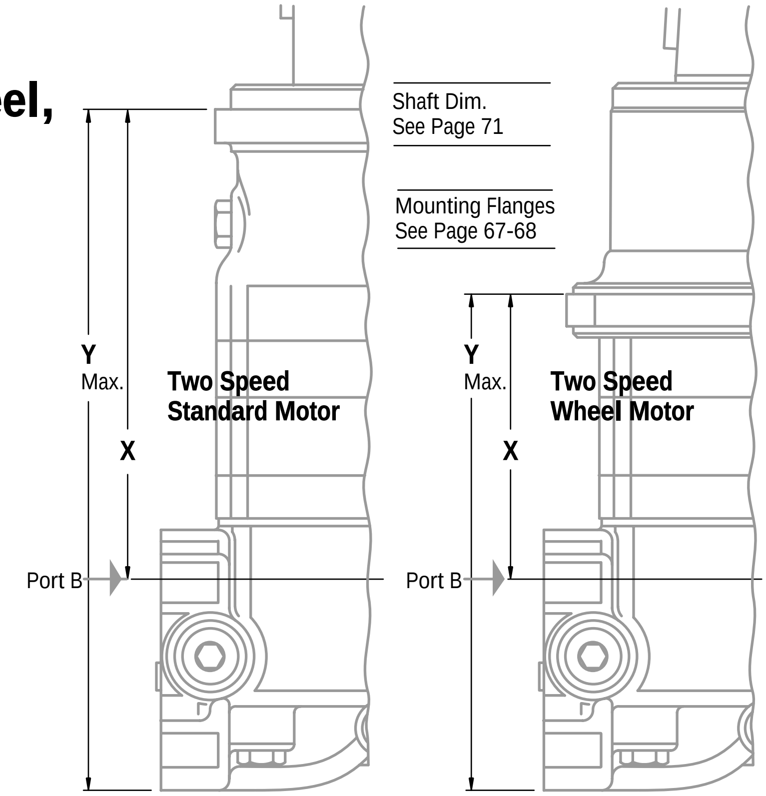
Displ. cm³/r [in³/r]	345 [21.0]	480 [29.2]	665 [40.6]	940 [57.4]
X Dim. mm [inch]	270,8 [10.66]	283,5 [11.16]	283,5 [11.16]	301,8 [11.88]
Y Dim. mm [inch]	392,7 [15.46]	405,4 [15.96]	405,4 [15.96]	423,9 [16.69]

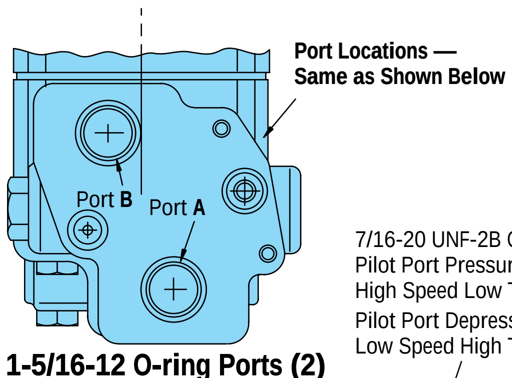
Two Speed Wheel Motor

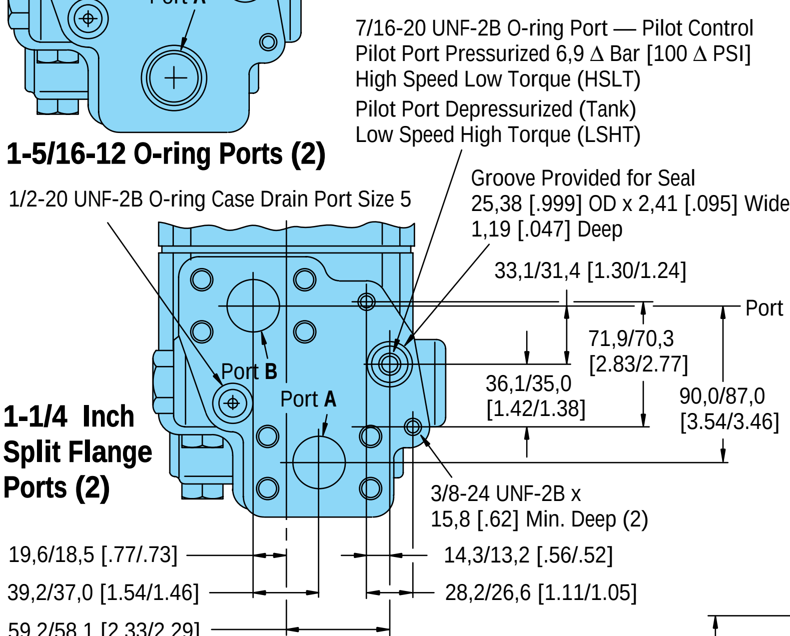
X Dim. mm [inch]	155,2 [6.11]	167,6 [6.60]	167,6 [6.60]	186,2 [7.33]
Y Dim. mm [inch]	278,1 [10.95]	290,8 [11.45]	290,8 [11.45]	309,1 [12.17]

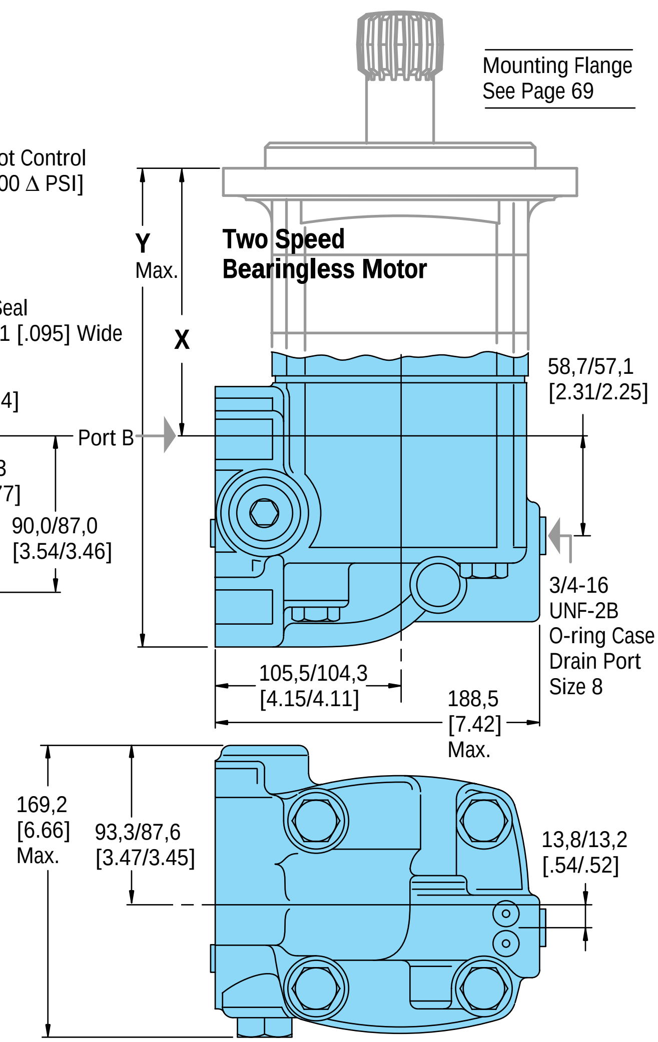
Two Speed Bearingless Motor

X Dim. mm [inch]	146,0 [5.75]	159,0 [6.26]	159,0 [6.26]	177,5 [6.99]
Y Dim. mm [inch]	265,5 [10.57]	281,2 [11.07]	281,2 [11.07]	299,5 [11.79]









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

Product Numbers — Two Speed 10,000 Series

Product Numbers—10,000 Series Motors—2 Speed

Use digit prefix —**119**-, **120**-, or **121**- plus four digit number from charts for complete product number—Example **121**-2002.
Orders will not be accepted without three digit prefix.

Mounting	Shaft	Ports	Displ. cm^3/r [in^3/r] Product Number 345 [21.0]	480 [29.3]	665 [40.6]	940 [57.4]
Standard	2-1/4 inch Straight	1-5/16 O-ring	**119**-2013	-2014	-2015	-2016
		1-1/4 Split Flange	**119**-2001	-2002	-2003	-2004
	2-1/4 Inch Tapered	1-5/16 O-ring	**119**-2017	-2018	-2019	-2020
		1-1/4 Split Flange	**119**-2005	-2006	-2007	-2008
	2-1/8 Inch 16 T Splined	1-5/16 O-ring	**119**-2021	-2022	-2023	-2024
		1-1/4 Split Flange	**119**-2009	-2010	-2011	-2012
Wheel Motor	2-1/4 inch Straight	1-1/4 Split Flange	**120**-2005	-2006	-2007	-2008
	2-1/4 Inch Tapered	1-5/16 O-ring	**120-**2013	-2014	-2015	-2016
		1-1/4 Split Flange	**120**-2001	-2002	-2003	-2004
	2-1/8 Inch 16 T Splined	1-1/4 Split Flange	**120**-2009	-2010	-2011	-2012
Bearingless		1-5/16 O-ring	**121-**2005	-2006	-2007	-2008
		1-1/4 Split Flange	**121**-2001	-2002	-2003	-2004

121-2002

10,000 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)

$$RPM = \frac{2.65 \times KPH \times G}{R_m} \quad RPM = \frac{168 \times MPH \times G}{R_l}$$

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)

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

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

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.

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

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

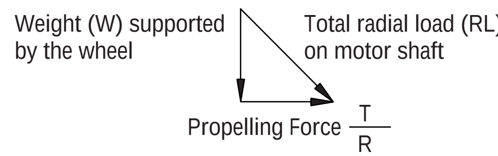
Where: f = coefficient of friction
W = loaded vehicle weight over drive wheel

	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

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

$$\frac{\text{bar x cm}^3\text{/rev}}{62.8} \text{ Nm} = \frac{\text{PSI x in}^3\text{/rev}}{6.28} = \text{lb – in}$$

Shaft Speed

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

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

Power (into motor)

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

Power (out of motor)

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

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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Information contained in this catalog is accurate as of the publication date and is subject to change without notice. Performance values are typical values. Customers are responsible for selecting products for their applications using normal engineering methods.

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DET NORSKE VERITAS INDUSTRY BV, THE NETHERLANDS

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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