MOTORS

Technical Information

RS Orbital Motors

WHITE

together in motion

White is a leading global provider of motor and steering solutions that power the evolution of mobile and industrial applications around the world.

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General Data

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Operating Recommendations

Oil type

Hydraulic oils with anti-wear, anti-foam and demulsifiers are recommended for systems incorporating these motors. Straight oils can be used but may require VI (viscosity index) improvers depending on the operating temperature range of the system. Other water based and environmentally friendly oils may be used, but service life of the motor and other components in the system may be significantly shortened. Before using any type of fluid, consult the fluid requirements for all components in the system for compatibility. Testing under actual operating conditions is the only way to determine if acceptable service life will be achieved.

Fluid viscosity & Filtration

Fluids with a viscosity between 20 - 43 cSt [100 - 200 S.U.S.] at operating temperature is recommended. Fluid temperature should also be maintained below 85°C [180° F]. It is also suggested that the type of pump and its operating specifications be taken into account when choosing a fluid for the system. Fluids with high viscosity can cause cavitation at the inlet side of the pump. Systems that operate over a wide range of temperatures may require viscosity improvers to provide acceptable fluid performance.

We recommend maintaining an oil cleanliness level of ISO 17-14 or better.

Installation & Start- Up

When installing a motor, it is important that the mounting flange of the motor makes full contact with the mounting surface of the application. Mounting hardware of the ap- propriate grade and size must be used. Hubs, pulleys, sprockets and couplings must be properly aligned to avoid inducing excessive thrust or radial loads. Although the out- put device must fit the shaft snug, a hammer should never be used to install any type of output device onto the shaft. The port plugs should only be removed from the motor when the system connections are ready to be made. To avoid contamination, remove all matter from around the ports of the motor and the threads of the fittings. Once all system connections are made, it is recommended that the motor be run-in for 15-30 minutes at no load and half speed to remove air from the hydraulic system.

Motor protection

Over-pressurization of a motor is one of the primary causes of motor failure. To prevent these situations, it is necessary to provide adequate relief protection for a motor based on the pressure ratings for that particular model. For systems that may experience overrunning conditions, special pre- cautions must be taken. In an overrunning condition, the motor functions as a pump and attempts to convert kinetic energy into hydraulic energy. Unless the system is properly configured for this condition, damage to the motor or system can occur. To protect against this condition a counterbalance valve or relief cartridge must be incorporated into the circuit to reduce the risk of over pressurization. If a relief cartridge is used, it must be installed upline of the motor, if not in the motor, to relieve the pressure created by the over-running motor. To provide proper motor protection for an over-running load application, the pressure setting of the pressure relief valve must not exceed the intermittent rating of the motor.

Hydraulic Motor Safety Precaution

A hydraulic motor must not be used to hold a suspended load. Due to the necessary internal tolerances, all hydraulic motors will experience some degree of creep when a load induced torque is applied to a motor at rest. All applications that require a load to be held must use some form of mechanical brake designed for that purpose.

Motor/Brake Precaution

Caution*! - The motors/brakes are intended to operate as static or parking brakes. System circuitry must be designed to bring the load to a stop before applying the brake.*

Caution*! - Because it is possible for some large displacement motors to overpower the brake, it is critical that the maximum system pressure be limited for these applications. Failure to do so could cause serious injury or death. When choosing a motor/brake for an application, consult the performance chart for the series and displacement chosen for the application to verify that the maximum operating pressure of the system will not allow the motor to produce more torque than the maximum rating of the brake. Also, it is vital that the system relief be set low enough to insure that the motor is not able to overpower the brake.*

To ensure proper operation of the brake, a separate case drain back to tank must be used. Use of the internal drain option is not recommended due to the possibility of return line pressure spikes. A simple schematic of a system utilizing a motor/brake is shown on page 4. Although maximum brake release pressure may be used for an application, a 34 bar [500 psi] pressure reducing valve is recommended to promote maximum life for the brake release piston seals. However, if a pressure reducing valve is used in a system which has case drain back pressure, the pressure reducing valve should be set to 34 bar [500 psi] over the expected case pressure to ensure full brake release. To achieve proper brake release operation, it is necessary to bleed out any trapped air and fill brake release cavity and hoses before all connections are tightened. To facilitate this operation, all motor/brakes feature two release ports. One or both of these ports may be used to release the brake in the unit. Motor/brakes should be configured so that the release ports are near the top of the unit in the installed position.

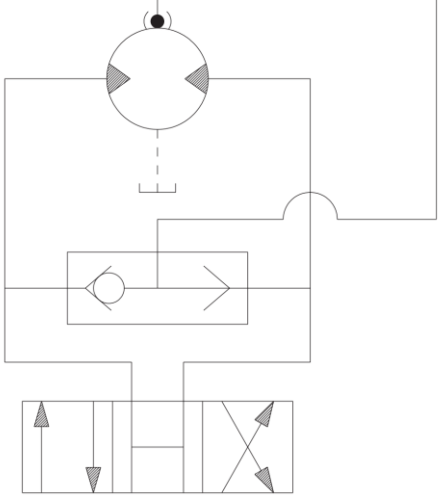

Figure 1 Typical Motor/Brake Schematic

Once all system connections are made, one release port must be opened to atmosphere and the brake release line carefully charged with fluid until all air is removed from the line and motor/brake release cavity. When this has been accomplished the port plug or secondary release line must be reinstalled. In the event of a pump or battery failure, an external pressure source may be connected to the brake release port to release the brake, allowing the machine to be moved.

Note*:*

It is vital that all operating recommendations be followed. Failure to do so could result in injury or death.

Motor circuits

There are two common types of circuits used for connecting multiple numbers of motors – series connection and parallel connection.

Series connection

When motors are connected in series, the outlet of one motor is connected to the inlet of the next motor. This allows the full pump flow to go through each motor and provide maximum speed.

Pressure and torque are distributed be- tween the motors based on the load each motor is subjected to. The maximum system pressure must be no greater than the maximum inlet pressure of the first motor. The allowable back pressure rating for a motor must also be considered. In some series circuits the motors must have an external case drain connected. A series connection is desirable when it is important for all the motors to run the same speed such as on a long line conveyor.

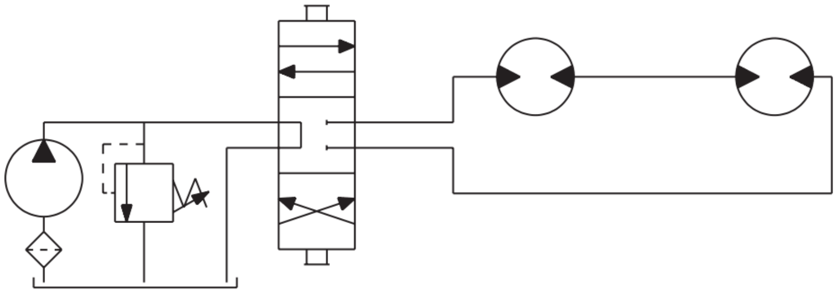

Figure 2 Series Circuit

Parallel Connection

In a parallel connection all of the motor inlets are connected. This makes the maximum system pressure available to each motor allowing each motor to produce full torque at that pressure. The pump flow is split between the individual motors according to their loads and displacements. If one motor has no load, the oil will take the path of least resistance and all the flow will go to that one motor. The others will not turn. If this condition can occur, a flow divider is recommended to distribute the oil and act as a differential.

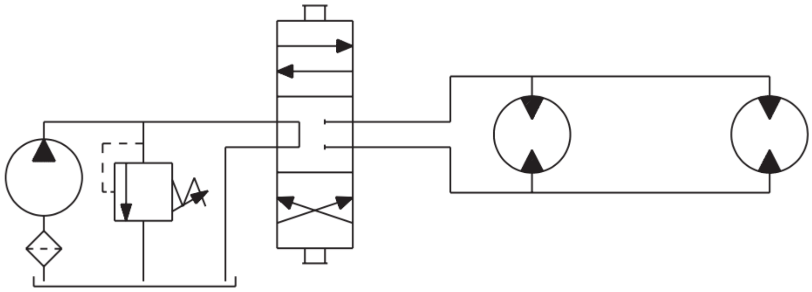

Figure 3 Series Circuit

Note:

The motor circuits shown above are for illustration purposes only. Components and circuitry for actual applications may vary greatly and should be chosen based on the application.

Product testing

Performance testing is the critical measure of a motor’s ability to convert flow and pressure into speed and torque. All product testing is conducted using a state of the art test facility. This facility utilizes fully automated test equipment and custom designed software to provide accurate, reliable test data. Test routines are standardized, including test stand calibration and stabilization of fluid temperature and viscosity, to provide consistent data. The example below provides an explanation of the values pertaining to each heading on the performance chart.

080

76 cc [4.6 in^3/rev.]

Pressure - bars [psi] — Max. Cont. / Max. Inter.

(6) Torque - Nm [lb-in], **Speed rpm** — **Intermittent Ratings** - 10% of Operation

Flow - lpm [gpm]	17 [250]	35 [500]	69 [1000]	104 [150 (2)	38 [2000]	173 [2500]	207 [3000]	242 [3500]	Theoretical rpm
2 [0.5]	14 [127] **25**	30 [262] **24**	61 [543] **21**	91 [806] **18**	120 [1062] **17**	145 [1285] **11**	169 [1496] **11**	191 [1693] **9**	26
4 [1]	16 [140] **50**	32 [286] **50**	63 [559] **43**	95 [839] **43**	124 [1099] **34**	151 [1340] **32**	178 [1579] **32**	203 [1796] **31**	51
8 [2]	16 [139] **100**	32 [280] **100**	64 [563] **99**	97 [857] **92**	129 [1139] **87**	157 [1390] **79**	187 [1652] **78**	211 [1865] **77**	101
15 [4]	14 [127] **200**	31 [275] **200**	65 [572] **199**	99 [872] **191**	131 [1155] **181**	160 [1420] **174**	186 [1643] **160**	216 [1911] **154**	201
23 [6]	13 [113] **301**	30 [262] **300**	63 [557 (7) **297**	96 [853] **295**	130 [1149] **284**	160 [1420] **271**	186 [164 (3) **253**	18 [1930] **245**	302
(1)	10 [91] **401**	27 [243] **400**	61 [536] **398**	93 [826] **390**	127 [1125] **384**	159 [1409] **372**	187 [1654] **346**	220 [1945] **339**	(4)
38 [10]		24 [212] **502**	58 [511] **500**	89 [790] **499**	123 [1087] **498**	156 [1379] **485**	185 [1638] **443**	213 [1883] **433**	503
45 [12]		20 [177] **602**	54 [482] **601**	87 [767] **600**	120 [1060] **597**	164 [1451] **540**	193 [1711] **526**	228 [2021] **510**	603
Max. Cont. 53 [14]		14 [127] **690**	50 [445] **689**	84 [741] (5)	124 [1098] **658**	155 [1369] **644**	185 [1640] **631**	217 [1918] **613**	704
61 [16]									804
Max. Inter. 64 [17]									904

Overall Efficiency - 70 - 100% ☐ 40 - 69% ☐ 0 - 39% ☐

Theoretical Torque - Nm [lb-in]

21 [183]	41 [366]	83 [732]	124 [109 (8)	66 [1465]	207 [1831]	248 [2197]	290 [2564]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

1. Flow represents the amount of fluid passing through the motor during each minute of the test.

2. Pressure refers to the measured pressure differential between the inlet and return ports of the motor during the test.

3. The maximum continuous pressure rating and maximum intermittent pressure rating of the motor are separated by the dark lines on the chart.

4. Theoretical RPM represents the RPM that the motor would produce if it were 100% volumetrically efficient. Measured RPM divided by the theoretical RPM give the actual volumetric efficiency of the motor.

5. The maximum continuous flow rating and maximum intermittent flow rating of the motor are separated by the dark line on the chart.

6. Performance numbers represent the actual torque and speed generated by the motor based on the corresponding input pressure and flow. The numbers on the top row indicate torque as measured in Nm [lb-in], while the bottom number represents the speed of the output shaft.

7. Areas within the white shading represent maximum motor efficiencies.

8. Theoretical Torque represents the torque that the motor would produce if it were 100% mechanically efficient. Actual torque divided by the theoretical torque gives the actual mechanical efficiency of the motor.

Allowable Bearing & Shaft Loading

This catalog provides curves showing allowable radial loads at points along the longitudinal axis of the motor. They are dimensioned from the mounting flange. Two capacity curves for the shaft and bearings are shown. A vertical line through the centerline of the load drawn to intersect the x-axis intersects the curves at the load capacity of the shaft and of the bearing.
In the example below the maximum radial load bearing rating is between the internal roller bearings illustrated with a solid line. The allowable shaft rating is shown with a dotted line.
The bearing curves for each model are based on labratory analysis and testing results constructed at the organization. The shaft loading is based on a 3:1 safety factor and 330 Kpsi tensile strength. The allowable load is the lower of the curves at a given point. For instance, one inch in front of the mounting flange the bearing capacity is lower than the shaft capacity. In this case, the bearing is the limiting load. The motor user needs to determine which series of motor to use based on their application knowledge.

ISO 281 Ratings Vs. Manufacturers Ratings

Published bearing curves can come from more than one type of analysis. The ISO 281 bearing rating is an international standard for the dynamic load rating of roller bearings. The rating is for a set load at a speed of 33 1/3 RPM for 500 hours (1 million revolutions). The standard was established to allow consistent comparisons of similar bearings between manufacturers. The ISO 281 bearing ratings are based solely on the physical characteristics of the bearings, removing any manufacturers specific safety factors or empirical data that influences the ratings.
Manufacturers' ratings are adjusted by diverse and systematic laboratory investigations, checked constantly with feed- back from practical experience. Factors taken into account that affect bearing life are material, lubrication, cleanliness of the lubrication, speed, temperature, magnitude of the load and the bearing type.
The operating life of a bearing is the actual life achieved by the bearing and can be significantly different from the calculated life. Comparison with similar applications is the most accurate method for bearing life estimations.

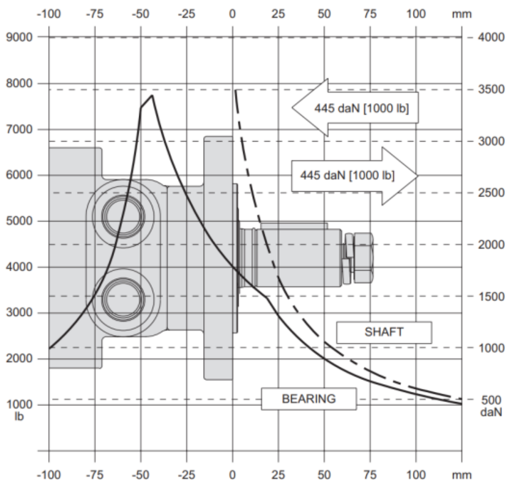

Figure 4 Allowable Bearing & Shaft Loading

Example Load Rating For Mechanically Retained Needle Roller Bearing

Bearing Life $L_{10} = (C/P)^p$ *[10^6 revolutions]*

L_{10} = *nominal rating life*

C = *dynamic load rating*

P = *equivalent dynamic load*

Life Exponent p = *10/3 for needle bearings*

Bearing load multiplication factor table			
Rpm	**Factor**	**Rpm**	**Factor**
50	1.23	**500**	0.62
100	1.00	**600**	0.58
200	0.81	**700**	0.56
300	0.72	**800**	0.50
400	0.66		

Table 1 Bearing load multiplication factor table

Vehicle Drive Calculations

When selecting a wheel drive motor for a mobile vehicle, a number of factors concerning the vehicle must be taken into consideration to determine the required maximum motor RPM, the maximum torque required and the maximum load each motor must support. The following sections contain the necessary equations to determine this criteria. An example is provided to illustrate the process.

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Sample application (vehicle design criteria)

Vehicle description....................4-wheel vehicle
Vehicle drive.............................2-wheel drive
GVW..1,500 lbs.
Weight over each drive wheel ....425 lbs.
Rolling radius of tires..............................16 in.
Desired acceleration................0-5 mph in 10 sec.
Top speed...5 mph
Gradeability..20%
Worst working surface....................poor asphalt

To determine maximum motor speed

$$RPM = \frac{2.65 \text{ x KPH x G}}{rm} \qquad RPM = \frac{168 \text{ x MPH x G}}{ri}$$

MPH = max. vehicle speed (miles/hr)
KPH = max. vehicle speed (kilometers/hr)
ri = rolling radius of tire (inches)
G= gear reduction ratio (if none, G = 1)
rm = rolling radius of tire (meters)

Example $RPM = \frac{168 \text{ x } 5 \text{ x } 1}{16} = 52.5$

To determine maximum torque requirement of motor

To choose a motor(s) capable of producing enough torque to propel the vehicle, it is necessary to determine the Total Tractive Effort (TE) requirement for the vehicle. To determine the total tractive effort, the following equation must be used:

TE = RR + GR + FA + DP (lbs or N)

Where:

TE = *Total tractive effort*
RR = *Force necessary to overcome rolling resistance*
GR = *Force required to climb a grade*
FA = *Force required to accelerate*
DP = *Drawbar pull required*

The components for this equation may be determined using the following steps:

Step One: Determine Rolling Resistance

Rolling Resistance (RR) is the force necessary to propel a vehicle over a particular surface. It is recommended that the worst possible surface type to be encountered by the vehicle be factored into the equation.

$$RR = \frac{GVW}{1000} \text{ x R (lb or N)}$$

Where:

GVW = gross (loaded) vehicle weight (lb or kg)
R = surface friction (value from Table 1)

Example $RR = \frac{1500}{1000} \text{ x 22 lbs} = 33$

Rolling Resistance	
Concrete (excellent)	10
Concrete (good)	15
Concrete (poor)	20
Asphalt (good)	12
Asphalt (fair)	17
Asphalt (poor)	22
Macadam (good)	15
Macadam (fair)	22
Macadam (poor)	37
Cobbles (ordinary)	55
Cobbles (poor)	37
Snow (2 inch)	25
Snow (4 inch)	37
Dirt (smooth)	25
Dirt (sandy)	37
Mud	37 to 150
Sand (soft)	60 to 150

Table 2 Rolling Resistance

Step Two: Determine Grade Resistance

Grade Resistance (GR) is the amount of force necessary to move a vehicle up a hill or "grade." This calculation must be made using the maximum grade the vehicle will be expected to climb in normal operation.

To convert incline degrees to % Grade:

% Grade = [tan of angle (degrees)] x 100

$$GR = \frac{\% \text{ Grade}}{100} \text{ x GVW(lb or N)}$$

Example $GR = \frac{20}{100} \text{ x 1500 lbs} = 300 \text{ lbs}$

Step Three: Determine Acceleration Force

Acceleration Force (FA) is the force necessary to accelerate from a stop to maximum speed in a desired time.

$$FA = \frac{MPH \text{ x } GVW \text{ (lb)}}{22 \text{ x } t} \qquad FA = \frac{KPH \text{ x } GVW \text{ (N)}}{35.32 \text{ x } t}$$

Where:

t = time to maximum speed (seconds)

Example $FA = \frac{5 \text{ x } 1500 \text{ lbs}}{22 \text{ x } 10} = 34$

Step Four: Determine Drawbar Pull

Drawbar Pull (DP) is the additional force, if any, the vehicle will be required to generate if it is to be used to tow other equipment. If additional towing capacity is required for the equipment, repeat steps one through three for the towable equipment and sum the totals to determine DP.

Step Five: Determine Total Tractive Effort

The Tractive Effort (TE) is the sum of the forces calculated in steps one through three above. On low-speed vehicles, wind resistance can typically be neglected. However, friction in drive components may warrant the addition of 10% to the total tractive effort to insure acceptable vehicle performance.

TE = RR + GR + FA + DP (lb or N)

Example TE = 33 + 300 + 34 + 0 (lbs) = 367 lbs

Step Six: Determine Motor Torque

The Motor Torque (T) required per motor is the Total Tractive Effort divided by the number of motors used on the machine. Gear reduction is also factored into account in this equation.

$$T = \frac{TE \text{ x } ri}{M \text{ x } G} \text{ lb} - \text{in per motor}$$

$$T = \frac{TE \text{ x } rm}{M \text{ x } G} \text{ Nm per motor}$$

Where:

M = number of driving motors

Example $T = \frac{367 \text{ x } 16}{2 \text{ x } 1}$ lb-in/motor = 2936 lb-in

Step Seven: Determine Wheel Slip

To verify that the vehicle will perform as designed in regard to tractive effort and acceleration, it is necessary to calculate wheel slip (TS) for the vehicle. In special cases, wheel slip may actually be desirable to prevent hydraulic system overheating and component breakage should the vehicle become stalled.

$$TS = \frac{W \text{ x } f \text{ x } ri}{G} (\text{lb} - \text{in per motor})$$

$$TS = \frac{W \text{ x } f \text{ x } rm}{G} (\text{N} - \text{m per motor})$$

Where:

f = coefficient of friction (see table 2)

W = loaded vehicle weight over driven wheel (lb or N)

Example $TS = \frac{425 \text{ x } .06 \text{ x } 16}{1}$ lb-in/motor = 4080 lbs

Coefficient of friction (f)	
Steel on steel	0.3
Rubber tire on dirt	0.5
Rubber tire on a hard surface	0.6 - 0.8
Rubber tire on cement	0.7

Table 3 Coefficient of friction

To determine radial load capacity requirement of motor

When a motor used to drive a vehicle has the wheel or hub attached directly to the motor shaft, it is critical that the radial load capabilities of the motor are sufficient to support the vehicle. After calculating the Total Ra- dial Load (RL) acting on the motors, the result must be compared to the bearing/shaft load charts for the chosen motor to determine if the motor will provide acceptable load capacity and life.

$$RL = \sqrt{W^2 + \left(\frac{T}{ri}\right)^2} \; lb \qquad RL = \sqrt{W^2 + \left(\frac{T}{rm}\right)^2} \; kg$$

Example $RL = \sqrt{425^2 + \left(\frac{2936}{16}\right)^2} \; lbs$

Once the maximum motor RPM, maximum torque requirement, and the maximum load each motor must support have been determined, these figures may then be compared to the motor performance charts and to the bearing load curves to choose a series and displacement to fulfill the motor requirements for the application.

Induced Side Load

In many cases, pulleys or sprockets may be used to transmit the torque produced by the motor. Use of these components will create a torque induced side load on the motor shaft and bearings. It is important that this load be taken into consideration when choosing a motor with sufficient bearing and shaft capacity for the application.

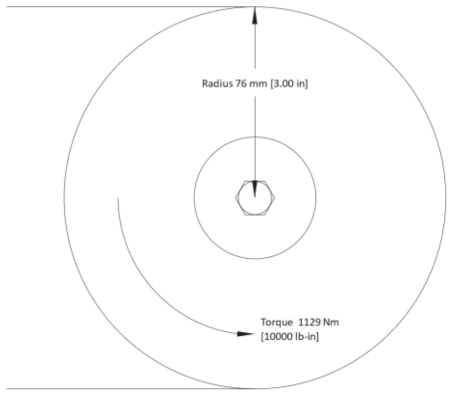
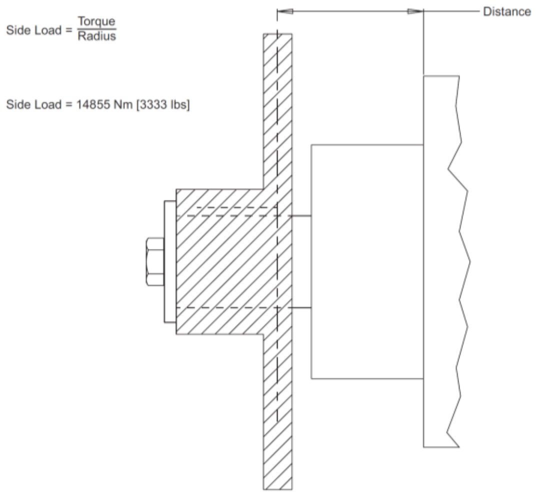


Figure 5 Induced side load

To determine the side load, the motor torque and pulley or sprocket radius must be known. Side load may be calculated using the formula below. The distance from the pulley/sprocket centerline to the mounting flange of the motor must also be determined. These two figures may then be compared to the bearing and shaft load curve of the desired motor to determine if the side load falls within acceptable load ranges.



Hydraulic Equations

Multiplication Factor	Abbrev.	Prefix
10^{12}	T	tera
10^{9}	G	giga
10^{6}	M	mega
10^{3}	K	kilo
10^{2}	h	hecto
10^{1}	da	deka
10^{-1}	d	deci
10^{-2}	c	centi
10^{-3}	m	milli
10^{-6}	u	micro
10^{-9}	n	nano
10^{-12}	p	pico
10^{-15}	f	femto
10^{-18}	a	atto

$$\textbf{Theo. Speed}\ (\text{RPM}) = \frac{1000 \text{ x LPM}}{\text{Displacement } (\text{cm}^3/\text{rev})} \quad \text{or} \quad \frac{231 \text{ x GPM}}{\text{Displacement } (\text{in}^3/\text{rev})}$$

$$\textbf{Theo. Torque}\ (\text{lb} - \text{in}) = \frac{\text{Bar x Disp. } (cm^3/\text{rev})}{20 \text{ pi}} \quad \text{or} \quad \frac{\text{PSI x Displacement } (\text{in}^3/\text{rev})}{6.28}$$

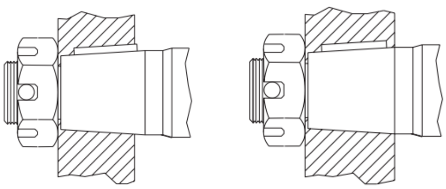
$$\textbf{Power in}\ (\text{HP}) = \frac{\text{Bar x LPM}}{600} \quad \text{or} \quad \frac{\text{PSI x GPM}}{1714}$$

$$\textbf{Power out}\ (\text{HP}) = \frac{\text{Torque (Nm)x RPM}}{9543} \quad \text{or} \quad \frac{\text{Torque } (\text{lb} - \text{in})\text{x RPM}}{63024}$$

Shaft nut information

Precaution

The tightening torques listed with each nut should only be used as a guideline. Hubs may require higher or lower tightening torque depending on the material. Consult the hub manufacturer to obtain recommended tightening torque. To maximize torque transfer from the shaft to the hub, and to minimize the potential for shaft breakage, a hub with sufficient thickness must fully engage the taper length of the shaft.

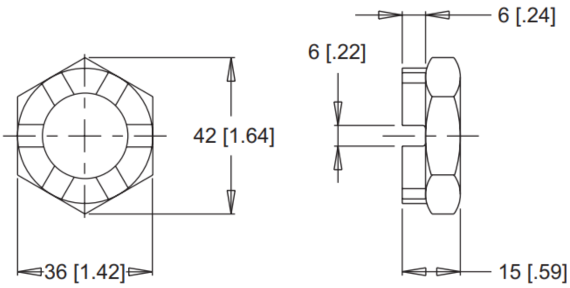


incorrect correct

35 mm Tapered Shafts

M24x1.5 Thread

A Slotted Nut

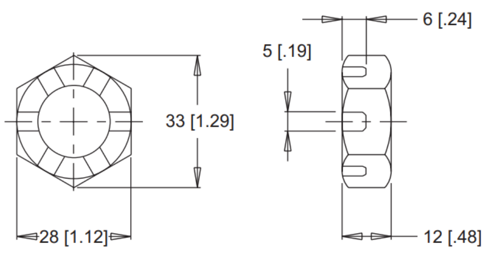


Torque Specifications: 32.5 daNm [240 ft.lb.]

1"Tapered Shafts

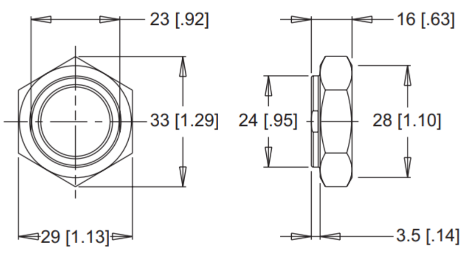
3/4-28 Thread

A Slotted Nut



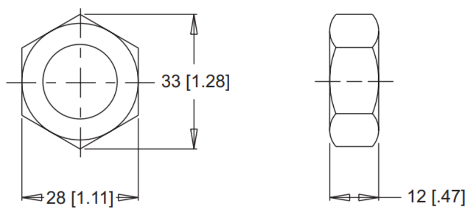
Torque Specifications: 20 - 23 daNm [150 - 170 ft.lb.]

B Lock Nut



Torque Specifications: 24 - 27 daNm [180 - 200 ft.lb.]

C Solid Nut

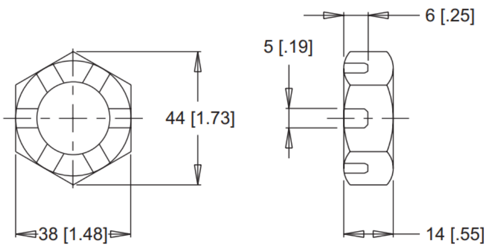


Torque Specifications: 20 - 23 daNm [150 - 170 ft.lb.]

1-1/4"Tapered Shafts

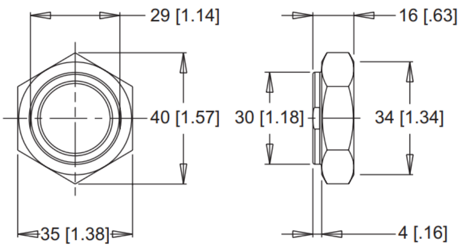
1-20 Thread

A Slotted Nut



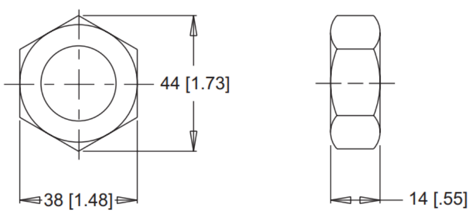
Torque Specifications: 38 daNm [280 ft.lb.] Max.

B Lock Nut



Torque Specifications: 33 - 42 daNm [240 - 310 ft.lb.]

C Solid Nut

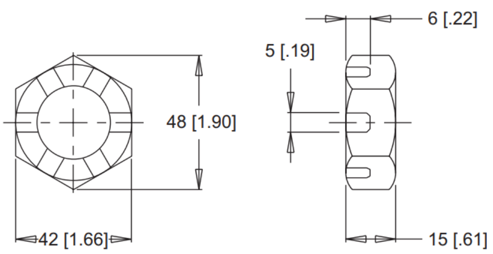


Torque Specifications: 38 daNm [280 ft.lb.] Max.

1-3/8" & 1-1/2""Tapered Shafts

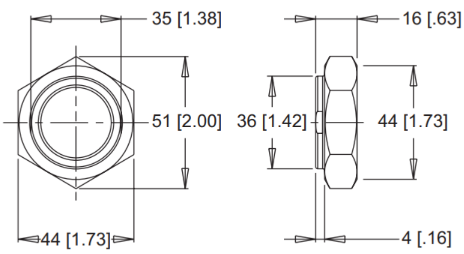
1 1/8-18 Thread

A Slotted Nut



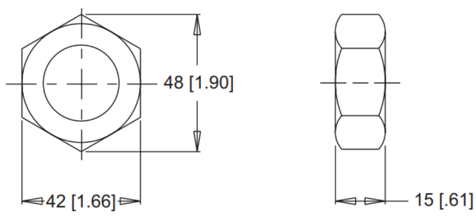
Torque Specifications: 41 - 54 daNm [300 - 400 ft.lb.]

B Lock Nut



Torque Specifications: 34 - 48 daNm [250 - 350 ft.lb.]

C Solid Nut



Torque Specifications: 41 - 54 daNm [300 - 400 ft.lb.]

Chapter 2
Optional Motor Features

Topics:

- *Speed sensors*
- *Features / Benefits*
- *Sensor options*
- *Valve cavity*

Speed sensors

We offer both single and dual element speed sensor options providing a number of benefits to users by incorporating the latest advancements in sensing technology and materials. The 700 & 800 series motors single element sensors provide 60 pulses per revolution with the dual element providing 120 pulses per revolution, with all other series providing 50 & 100 pulses respectively. Higher resolution is especially beneficial for slow speed applications, where more information is needed for smooth and accurate control. The dual sensor option also provides a direction signal allowing end-users to monitor the direction of shaft rotation .

Unlike competitive designs that breach the high pressure area of the motor to add the sensor, the speed sensor option utilizes an add-on flange to locate all sensor components outside the high pressure operating environment. This eliminates the potential leak point common to competitive designs. Many improvements were made to the sensor flange including changing the material from cast iron to acetal resin, incorporating a Buna-N shaft seal internal to the flange, and providing a grease zerk, which allows the user to fill the sensor cavity with grease. These improvements enable the flange to withstand the rigors of harsh environments.

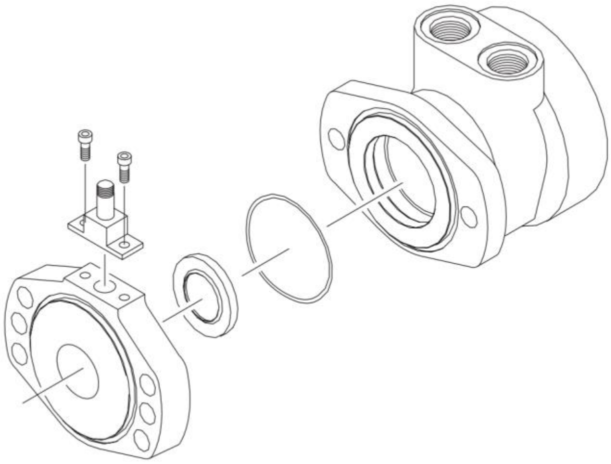


Figure 6 Speed sensor

Another important feature of the new sensor flange is that it is self-centering, which allows it to remain concentric to the magnet rotor. This produces a consistent mounting location for the new sensor module, eliminating the need to adjust the air gap between the sensor and magnet rotor. The o- ring sealed sensor module attaches to the sensor flange with two small screws, allowing the sensor to be serviced or upgraded in the field in under one minute. This feature is especially valuable for mobile applications where machine downtime is costly. The sensor may also be serviced without exposing the hydraulic circuit to the atmosphere. Another advantage of the self-centering flange is that it allows users to rotate the sensor to a location best suited to their application. This feature is not available on competitive designs, which fix the sensor in one location in relationship to the motor mounting flange.

Features / Benefits

- Grease fitting allows sensor cavity to be filled with grease for additional protection.
- Internal extruder seal protects against environmental elements.
- M12 or weatherpack connectors provide installation flexibility.
- Dual element sensor provides up to 120 pulses per revolution and directional sensing.
- Modular sensor allows quick and easy servicing.
- Acetal resin flange is resistant to moisture, chemicals, oils, solvents and greases.
- Self-centering design eliminates need to set magnet- to-sensor air gap.
- Protection circuitry

Sensor options

Z - 4-pin M12 male connector

This option has 50 pulses per revolution on all series except the DT which has 60 pulses per revolution. This option will not detect direction.

Y - 3-pin male weatherpack connector*

This option has 50 pulses per revolution on all series except the DT which has 60 pulses per revolution. This option will not detect direction.

X - 4-pin M12 male connector

This option has 100 pulses per revolution on all series except the DT which has 120 pulses per revolution. This option will detect direction.

W - 4-pin male weatherpack connector*

This option has 100 pulses per revolution on all series except the DT which has 120 pulses per revolution. This option will detect direction.

**These options include a 610mm [2 ft] cable.*

SINGLE ELEMENT SENSOR - Y & Z

Supply voltages .... .7.5-24 Vdc

Maximum output off voltage V

Maximum continuous output current .... < 25 ma

Signal levels (low, high) .... 0.8 to supply voltage

Operating Temp..............................-30°C to 83°C [-22°F to 181°F]

DUAL ELEMENT SENSOR - X & W

Supply voltages .... .7.5-18 Vdc

Maximum output off voltage V

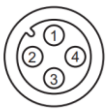
Maximum continuous output current...................................< 20 ma

Signal levels (low, high).. 0.8 to supply voltage

Operating Temp.....................................-30°C to 83°C [-22°F to 181°F]

Sensor connectors

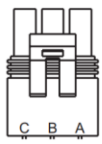
Z Option



1	positive	brown or red
2	n/a	white
3	negative	blue
4	pulse out	black

Figure 7 Z Option

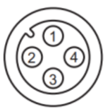
Y Option



A	positive	brown or red
B	negative	blue
C	pulse out	black
D	n/a	white

Figure 8 Y Option

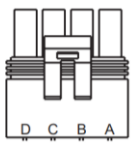
X Option



1	positive	brown or red
2	direction out	white
3	negative	blue
4	pulse out	black

Figure 9 X Option

W Option



A	positive	brown or red
B	negative	blue
C	pulse out	black
D	direction out	white

Figure 10 W Option

Protection Circuitry

The single element sensor has been improved and incorporates protection circuitry to avoid electrical damage caused by:

- reverse battery protection
- overvoltage due to power supply spikes and surges (60 Vdc max.)
- power applied to the output lead

The protection circuit feature will help "save" the sensor from damage mentioned above caused by:

- faulty installation wiring or system repair
- wiring harness shorts/opens due to equipment failure or harness damage resulting from accidental conditions (i.e. severed or grounded wire, ice, etc.)
- power supply spikes and surges caused by other electrical/electronic components that may be intermittent or damaged and "loading down" the system.

While no protection circuit can guarantee against any and all fault conditions. The single element sensor from us with protection circuitry is designed to handle potential hazards commonly seen in real world applications.

Unprotected versions are also available for operation at lower voltages down to 4.5V.

Free Turning Rotor

The 'AC' option or "Free turning" option refers to a specially prepared rotor assembly. This rotor assembly has increased clearance between the rotor tips and rollers allowing it to turn more freely than a standard rotor assembly. For spool valve motors, additional clearance is also provided between the shaft and housing bore. The 'AC' option is available for all motor series and displacements.

There are several applications and duty cycle conditions where 'AC' option performance characteristics can be beneficial. In continuous duty applications that require high flow/high rpm operation, the benefits are twofold. The additional clearance helps to minimize internal pressure drop at high flows. This clearance also provides a thicker oil film at metal to metal contact areas and can help extend the life of the motor in high rpm or even over speed conditions. The 'AC' option should be considered for applications that require continuous operation above 57 LPM [15 GPM] and/ or 300 rpm. Applications that are subject to pressure spikes due to frequent reversals or shock loads can also benefit by specifying the 'AC' option. The additional clearance serves to act as a buffer against spikes, allowing them to be bypassed through the motor rather than being absorbed and transmitted through the drive link to the output shaft. The trade-off for achieving these benefits is a slight loss of volumetric efficiency at high pressures.

Valve cavity

The valve cavity option provides a cost effective way to incorporate a variety of cartridge valves integral to the motor. The valve cavity is a standard 10 series (12 series on the 800 series motor) 2-way cavity that accepts numerous cartridge valves, including overrunning check valves, relief cartridges, flow control valves, pilot operated check fuses, and high pressure shuttle valves. Installation of a relief cartridge into the cavity provides an extra margin of safety for applications encountering frequent pressure spikes. Relief cartridges from 69 to 207 bar [1000 to 3000 psi] may also be factory installed.

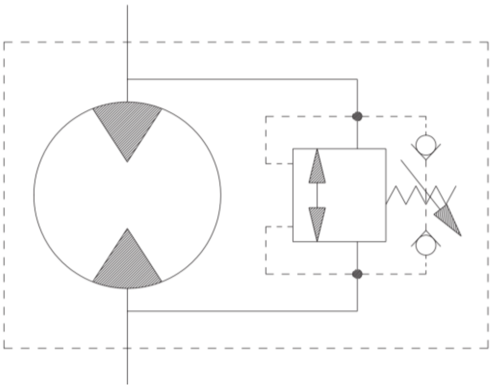


Figure 11 Valve cavity

For basic systems with fixed displacement pumps, either manual or motorized flow control valves may be installed into the valve cavity to provide a simple method for con- trolling motor speed. It is also possible to incorporate the speed sensor option and a programmable logic controller with a motorized flow control valve to create a closed loop, fully automated speed control system. For motors with internal brakes, a shuttle valve cartridge may be installed into the cavity to provide a simple, fully integrated method for supplying release pressure to the pilot line to actuate an integral brake. To discuss other alternatives for the valve cavity option, contact an authorized distributor.

Slinger Seal

Slinger seals are available on select series offered by us. Slinger seals offer extendes shaft/shaft seal protection by prevented a buildup of material around the circumference of the shaft which can lead to premature shaft seal failures. The slinger seals are designed to be larger in diameter than competitive products, providing greater surface speed and 'slinging action'.

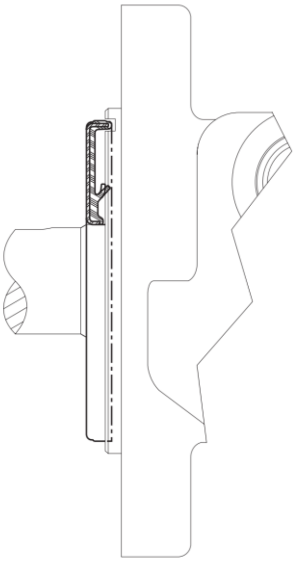


Figure 12 Slinger Seal

Slinger seals are also available on 4-hole flange mounts on select series. Contact a Customer Service Representative for additional information.

Chapter 3
Light Duty Hydraulic Motor

Topics:

- *Overview*
- *Specification*
- *Displacement performance*
- *RS (200/ 201 Series)*
- *Technical Information*

Overview

RS Series motors are the most economical model in our product line, but are not low-tech. Unlike competitive products using power robbing, two-piece rotor set designs with sliding contact points, RS Series motors utilize the patented Roller Stator® design. Seven precision rollers for the contact points reduce friction, providing more power and longer life for your application. Each output shaft is custom ground to maintain exact tolerances between the housing and shaft, producing high volumetric efficiencies. Industry standard mounting flanges and output shafts allow the RS Series motors to interchange with competitive designs.

Series Descriptions

200/201 - Hydraulic Motor
Standard

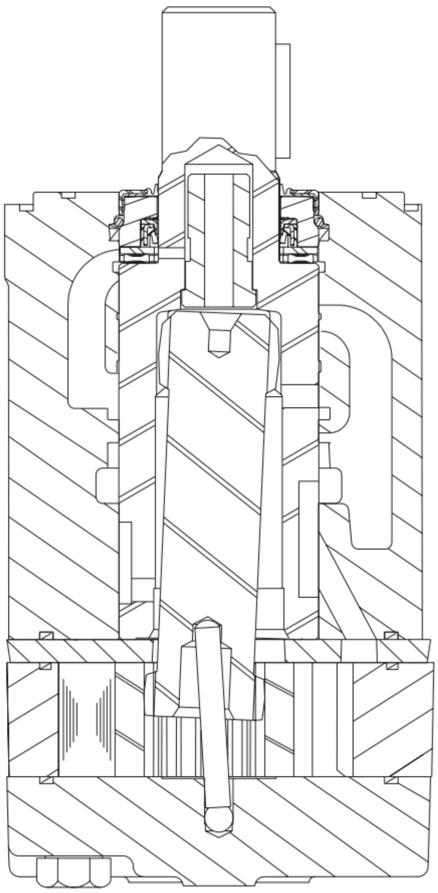


Figure 13 200/201 Hydraulic Motor

Features / Benefits

- The shaft is match ground to the housing bore to maintain highest volumetric efficiencies.
- A high pressure shaft seal offers superior seal life and performance and eliminates the need for a case drain.
- Pressure fed bearing surface receives positive flow of clean, cool oil.
- A heavy-duty drive link receives full flow lubrication to provide long life.
- The Roller Stator® motor design increases efficiency and life by using roller contact versus a solid, sliding contact design.

Typical Applications

- Conveyors,
- Carwashes,
- Positioners,
- Light-duty wheel drives,
- Sweepers,
- Machine tool indexers,
- Grain augers,
- Spreaders,
- Feed rollers,
- Screw drives,
- Brush drives
- More.

Specification

CODE	Displacement cm^3 [in^3/rev]	Max. Speed rpm		Max. Flow lpm [gpm]		Max. Torque Nm [lb-in]		Max. Pressure bar [psi]		
		cont.	inter.	cont.	inter.	cont.	inter.	cont.	inter.	peak
050	52 *[3.2]*	430	720	23 [6]	38 [10]	82 [730]	95 [840]	121 [1750]	138 [2000]	155 [2250]
080	76 *[4.6]*	500	600	38 [10]	45 [12]	121 [1070]	138 [1230]	121 [1750]	138 [2000]	155 [2250]
090	89 *[5.4]*	420	500	38 [10]	45 [12]	147 *[1300]*	167 *[1480]*	121 [1750]	138 [2000]	155 [2250]
100	103 *[6.3]*	500	570	53 *[14]*	61 *[16]*	169 *[1500]*	195 *[1725]*	121 *[1750]*	138 *[2000]*	155 *[2250]*
110	111 *[6.8]*	460	600	53 *[14]*	68 *[18]*	184 *[1630]*	214 *[1900]*	121 *[1750]*	138 *[2000]*	155 *[2250]*
125	127 *[7.7]*	410	530	53 *[14]*	68 *[18]*	181 *[1600]*	208 *[1850]*	103 *[1500]*	121 *[1750]*	155 [2250]
160	164 *[10.0]*	370	460	61 *[16]*	76 *[20]*	222 *[1970]*	265 *[2350]*	103 *[1500]*	121 *[1750]*	155 [2250]
200	205 *[12.5]*	300	370	61 *[16]*	76 *[20]*	297 *[2640]*	345 *[3050]*	103 *[1500]*	121 *[1750]*	155 [2250]
250	254 *[15.5]*	300	360	76 *[20]*	91 *[24]*	287 *[2540]*	344 *[3040]*	86 *[1250]*	104 *[1500]*	121 *[1750]*
300	293 *[17.9]*	250	280	76 *[20]*	91 *[24]*	277 *[2460]*	350 *[3100]*	69 *[1000]*	86 *[1250]*	130 *[1500]*
400	409 *[24.9]*	190	220	76 *[20]*	91 *[24]*	377 *[3350]*	463 *[4100]*	69 *[1000]*	86 *[1250]*	130 *[1500]*

Table 4 Specification

Performance data is typical. Performance of production units varies slightly from one motor to another. Running at intermittent ratings should not exceed 10% of every minute of operation.

Displacement performance

Performance data is typical. Performance of production units varies slightly from one motor to another. Operating at maximum continuous pressure and maximum continuous flow simultaneously is not recommended. For additional information on product testing please refer to *Product testing*.

050

52 cm³ [3.2 in³] / rev

Pressure - bar [psi] (Max. Cont. = 121 [1750]; Max. Inter. = 138 [2000])

Torque - Nm [lb-in], **Speed rpm** — **Intermittent Ratings -** 10% of Operation

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]	Theoretical rpm
2 [0.5]	10 [89] **35**	15 [133] **33**	25 [223] **26**	33 [290] **24**	42 [375] **24**	49 [435] **12**			37
4 [1]	10 [92] **69**	18 [163] **68**	29 [253] **68**	39 [348] **67**	49 [438] **54**	59 [523] **49**	55 [483] **4**		73
8 [2]	10 [90] **142**	20 [181] **140**	31 [274] **138**	41 [366] **136**	52 [464] **127**	63 [556] **103**	74 [653] **78**	78 [690] **34**	145
15 [4]	10 [85] **288**	17 [154] **285**	28 [251] **283**	40 [355] **282**	53 [465] **275**	65 [572] **258**	76 [669] **227**	86 [764] **193**	289
Max. Cont. 23 [6]		19 [168] **433**	27 [243] **432**	39 [342] **430**	50 [445] **429**	62 [549] **408**	74 [656] **380**	85 [755] **346**	434
30 [8]		17 [148] **576**	27 [243] **574**	36 [318] **570**	47 [417] **568**	59 [526] **554**	71 [631] **535**		578
Max. Inter. 38 [10]		13 [119] **718**	25 [218] **711**	35 [307] **701**	48 [429] **700**	56 [499] **689**	67 [593] **682**		722

Overall Efficiency - 70 - 100% (white) 40 - 69% (light) 0 - 39% (dark)

Rotor Width 8.0 [.316] mm [in]

Theoretical Torque - Nm [lb-in]

17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]
14 [127]	29 [255]	43 [382]	58 [510]	72 [637]	86 [764]	101 [892]	115 [1019]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

080

76 cm³ [4.6 in³] / rev

Pressure - bar [psi] (Max. Cont. = 121 [1750]; Max. Inter. = 138 [2000])

Torque - Nm [lb-in], **Speed rpm** — **Intermittent Ratings -** 10% of Operation

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]	Theoretical rpm
2 [0.5]	12 [107] **25**	26 [227] **21**	39 [341] **20**	51 [456] **9**	58 [509] **5**				26
4 [1]	12 [110] **50**	29 [252] **50**	43 [381] **42**	59 [522] **35**	75 [661] **34**	81 [720] **11**			51
8 [2]	14 [122] **100**	29 [260] **99**	46 [405] **99**	63 [560] **93**	80 [707] **82**	96 [848] **73**	110 [973] **48**	115 [1016] **20**	101
15 [4]		30 [263] **200**	47 [416] **196**	65 [574] **193**	82 [726] **184**	98 [871] **168**	118 [1046] **150**	134 [1184] **121**	201
23 [6]		28 [252] **301**	46 [403] **297**	64 [562] **293**	82 [721] **287**	98 [869] **271**	115 [1020] **252**	134 [1183] **218**	302
30 [8]		25 [221] **400**	43 [379] **399**	63 [555] **393**	79 [703] **390**	97 [860] **375**	115 [1014] **355**	132 [1172] **330**	402
Max. Cont. 38 [10]			39 [341] **502**	57 [502] **500**	74 [657] **498**	93 [819] **496**	111 [980] **472**	128 [1135] **443**	503
Max. Inter. 45 [12]			35 [314] **602**	50 [446] **600**	71 [625] **599**	92 [816] **598**	105 [932] **580**		603

Overall Efficiency - 70 - 100% (white) 40 - 69% (light) 0 - 39% (dark)

Rotor Width 11.7 [.462] mm [in]

Theoretical Torque - Nm [lb-in]

17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]
21 [183]	41 [366]	62 [549]	83 [732]	103 [916]	124 [1099]	145 [1282]	166 [1465]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

090

89 cm³ [5.4 in³] / rev

Pressure - bar [psi] (Max. Cont. = 121 [1750]; Max. Inter. = 138 [2000])

Torque - Nm [lb-in], **Speed rpm** — **Intermittent Ratings -** 10% of Operation

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]	Theoretical rpm
2 [0.5]	23 [206] **20**	43 [376] **19**	63 [559] **17**	84 [743] **14**	98 [864] **10**	105 [933] **1**			22
4 [1]		43 [383] **41**	64 [566] **40**	86 [760] **37**	108 [953] **32**	127 [1123] **25**	138 [1225] **12**		43
8 [2]		44 [388] **85**	63 [561] **84**	83 [739] **81**	106 [937] **75**	127 [1121] **66**	151 [1336] **51**	169 [1495] **31**	86
15 [4]			61 [538] **169**	85 [754] **166**	104 [920] **159**	128 [1134] **149**	148 [1309] **133**	168 [1484] **115**	172
23 [6]				81 [720] **251**	102 [902] **244**	125 [1105] **229**	144 [1275] **213**	164 [1450] **191**	257
30 [8]				78 [686] **338**	98 [867] **330**	122 [1080] **318**	141 [1251] **300**	164 [1448] **278**	343
Max. Cont. 38 [10]					93 [824] **417**	113 [1004] **406**	137 [1210] **386**	161 [1422] **365**	428
Max. Inter. 45 [12]					81 [715] **504**	87 [766] **491**	113 [998] **478**		514

Overall Efficiency - 70 - 100% (white) 40 - 69% (light) 0 - 39% (dark)

Rotor Width 13.7 [.541] mm [in]

Theoretical Torque - Nm [lb-in]

17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]
24 [215]	49 [430]	73 [645]	97 [860]	121 [1075]	146 [1290]	170 [1505]	194 [1720]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

100

103 cm³ [6.3 in³] / rev

Pressure - bar [psi] — Max. Cont. 121 [1750]; Max. Inter. 138 [2000]

Intermittent Ratings - 10% of Operation

Torque - Nm [lb-in], **Speed rpm**

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]	Theoretical rpm
2 [0.5]	25 [221] **17**	52 [461] **16**	76 [676] **15**	98 [870] **12**	115 [1020] **7**				19
4 [1]	26 [233] **36**	51 [449] **36**	77 [680] **34**	103 [914] **32**	126 [1116] **28**	146 [1295] **23**	166 [1473] **13**	151 [1336] **1**	37
8 [2]		49 [433] **72**	77 [682] **71**	101 [893] **69**	125 [1108] **65**	150 [1331] **59**	174 [1538] **50**	199 [1758] **37**	74
15 [4]			73 [648] **143**	99 [873] **135**	123 [1088] **124**	146 [1291] **118**	170 [1504] **94**	195 [1721] **75**	147
23 [6]			69 [606] **219**	94 [830] **213**	120 [1062] **203**	145 [1279] **190**	165 [1463] **177**	194 [1717] **154**	220
30 [8]				89 [789] **288**	113 [999] **278**	142 [1254] **264**	161 [1429] **249**	187 [1658] **230**	294
38 [10]				78 [693] **363**	102 [905] **353**	127 [1124] **341**	156 [1380] **322**	182 [1612] **301**	367
45 [12]					85 [755] **433**	119 [1049] **421**	147 [1299] **405**	172 [1526] **384**	440
Max. Cont. 53 [14]					84 [746] **507**	118 [1040] **497**	135 [1198] **484**	141 [1250] **465**	514
Max. Inter. 61 [16]						108 [957] **574**	135 [1197] **566**		587

Overall Efficiency - 70 - 100% ☐ 40 - 69% ☐ 0 - 39% ☐

Rotor Width 19.7 [.776] mm [in]

Theoretical Torque - Nm [lb-in]

17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]
28 [251]	57 [502]	85 [752]	113 [1003]	142 [1254]	170 [1505]	198 [1756]	227 [2006]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

110

111 cm³ [6.8 in³] / rev

Pressure - bar [psi] — Max. Cont. 121 [1750]; Max. Inter. 138 [2000]

Intermittent Ratings - 10% of Operation

Torque - Nm [lb-in], **Speed rpm**

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]	Theoretical rpm
2 [0.5]	26 [227] **16**	54 [481] **14**	78 [689] **11**	100 [888] **7**	109 [961] **1**				17
4 [1]	29 [253] **33**	55 [489] **32**	83 [733] **30**	110 [974] **26**	134 [1183] **20**	153 [1356] **10**			34
8 [2]		57 [503] **67**	82 [727] **64**	110 [969] **60**	135 [1199] **52**	162 [1431] **40**	184 [1631] **20**	180 [1590] **1**	68
15 [4]		54 [479] **135**	80 [706] **133**	107 [951] **128**	134 [1190] **120**	162 [1437] **104**	186 [1643] **88**	216 [1911] **58**	136
23 [6]			76 [669] **201**	106 [934] **193**	129 [1144] **183**	153 [1357] **165**	185 [1636] **141**	206 [1826] **114**	204
30 [8]			70 [621] **271**	97 [862] **267**	123 [1092] **256**	151 [1336] **242**	177 [1569] **220**	202 [1788] **196**	272
38 [10]				88 [779] **335**	116 [1025] **324**	146 [1294] **307**	170 [1505] **289**	201 [1783] **254**	340
45 [12]				86 [764] **405**	109 [963] **396**	139 [1226] **376**	168 [1482] **351**	190 [1683] **330**	408
Max. Cont. 53 [14]					102 [901] **463**	129 [1142] **449**	156 [1378] **427**	184 [1626] **406**	476
61 [16]					95 [844] **535**	121 [1075] **523**	147 [1297] **505**		544
Max. Inter. 68 [18]						111 [984] **595**	136 [1205] **579**		612

Overall Efficiency - 70 - 100% ☐ 40 - 69% ☐ 0 - 39% ☐

Rotor Width 17.3 [.681] mm [in]

Theoretical Torque - Nm [lb-in]

17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	138 [2000]
31 [271]	61 [541]	92 [812]	122 [1083]	153 [1354]	184 [1624]	214 [1895]	245 [2166]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

125

127 cm³ [7.7 in³] / rev

Pressure - bar [psi] (Max. Cont. = 104 [1500], Max. Inter. = 121 [1750])

Torque - Nm [lb-in], **Speed rpm**

Intermittent Ratings - 10% of Operation

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	Theoretical rpm
2 [0.5]	29 [225] **14**	60 [534] **12**	86 [758] **10**	112 [990] **7**	129 [1145] **2**			15
4 [1]	28 [251] **29**	62 [545] **28**	93 [819] **26**	121 [1073] **23**	149 [1319] **18**	173 [1531] **10**	176 [1559] **1**	30
8 [2]		61 [537] **58**	92 [816] **57**	125 [1103] **54**	153 [1356] **49**	182 [1609] **41**	210 [1856] **29**	60
15 [4]		61 [538] **118**	90 [797] **115**	123 [1084] **108**	151 [1338] **99**	181 [1602] **84**	210 [1860] **65**	120
23 [6]			87 [771] **177**	117 [1032] **168**	149 [1321] **158**	177 [1566] **145**	208 [1838] **123**	180
30 [8]			82 [722] **234**	112 [987] **229**	142 [1257] **215**	175 [1548] **203**	201 [1781] **186**	240
38 [10]				105 [927] **290**	137 [1214] **277**	167 [1474] **263**	194 [1720] **244**	300
45 [12]				97 [859] **349**	120 [1066] **339**	157 [1386] **322**	183 [1622] **306**	360
Max. Cont. 53 [14]				89 [787] **409**	119 [1051] **385**	146 [1295] **376**	174 [1536] **367**	420
61 [16]					99 [879] **471**	131 [1163] **459**		480
Max. Inter. 68 [18]					100 [885] **528**	119 [1053] **512**		540

Overall Efficiency - 70 - 100% ☐ 40 - 69% ☐ 0 - 39% ☐

Theoretical Torque - Nm [lb-in]

Rotor Width mm [in]							
19.7 [.776]	35 [307]	69 [613]	104 [920]	139 [1226]	173 [1533]	208 [1839]	242 [2146]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

160

164 cm³ [10.0 in³] / rev

Pressure - bar [psi] (Max. Cont. = 104 [1500], Max. Inter. = 121 [1750])

Torque - Nm [lb-in], **Speed rpm**

Intermittent Ratings - 10% of Operation

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	Theoretical rpm
2 [0.5]	32 [281] **11**	71 [630] **10**	103 [908] **8**	141 [1247] **6**	167 [1481] **2**			12
4 [1]	35 [308] **22**	76 [677] **21**	111 [983] **20**	141 [1245] **20**	182 [1615] **16**	211 [1867] **11**	234 [2070] **3**	24
8 [2]	36 [320] **45**	78 [694] **45**	116 [1023] **44**	159 [1403] **42**	193 [1707] **39**	223 [1974] **34**	257 [2279] **27**	47
15 [4]		72 [633] **91**	114 [1007] **90**	155 [1375] **86**	190 [1679] **80**	226 [1998] **71**	262 [2319] **56**	93
23 [6]		69 [608] **138**	109 [961] **137**	149 [1318] **132**	188 [1667] **125**	224 [1979] **114**	267 [2359] **101**	139
30 [8]		65 [573] **184**	104 [921] **183**	139 [1233] **180**	181 [1597] **171**	219 [1941] **161**	258 [2284] **148**	185
38 [10]			95 [837] **230**	134 [1184] **229**	173 [1531] **221**	212 [1874] **211**	251 [2220] **197**	231
45 [12]			83 [736] **276**	124 [1095] **275**	162 [1432] **270**	203 [1796] **259**	241 [2133] **245**	278
53 [14]			73 [643] **322**	114 [1010] **321**	154 [1366] **320**	194 [1714] **310**	231 [2045] **295**	324
Max. Cont. 61 [16]				102 [901] **369**	142 [1255] **368**	179 [1585] **362**	219 [1936] **345**	370
68 [18]				93 [824] **415**	127 [1121] **414**	164 [1447] **410**		416
Max. Inter. 76 [20]					111 [980] **460**	152 [1348] **460**		462

Overall Efficiency - 70 - 100% ☐ 40 - 69% ☐ 0 - 39% ☐

Theoretical Torque - Nm [lb-in]

Rotor Width mm [in]							
25.4 [1.000]	45 [398]	90 [796]	135 [1194]	180 [1592]	225 [1990]	270 [2389]	315 [2787]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

200

205 cm³ [12.5 in³] / rev

Pressure - bar [psi] (Max. Cont. 104 [1500]; Max. Inter. 121 [1750])

Torque - Nm [lb-in], **Speed rpm** — **Intermittent Ratings -** 10% of Operation

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	121 [1750]	Theoretical rpm
2 [0.5]	47 [414] **8**	96 [846] **7**	141 [1250] **6**	183 [1621] **5**	224 [1983] **3**			10
4 [1]	49 [432] **17**	98 [865] **17**	154 [1360] **15**	196 [1732] **14**	241 [2136] **11**	284 [2517] **9**	318 [2811] **5**	19
8 [2]	47 [416] **36**	105 [927] **36**	157 [1386] **34**	204 [1809] **31**	245 [2166] **29**	299 [2642] **23**	341 [3019] **17**	37
15 [4]	43 [380] **73**	96 [849] **73**	152 [1349] **72**	203 [1798] **68**	249 [2204] **65**	298 [2641] **60**	350 [3094] **52**	74
23 [6]		90 [795] **110**	149 [1322] **110**	194 [1721] **106**	249 [2207] **103**	298 [2634] **96**	340 [3007] **90**	111
30 [8]		83 [734] **147**	139 [1228] **146**	192 [1697] **144**	238 [2102] **142**	296 [2621] **133**	339 [2997] **126**	148
38 [10]		75 [666] **184**	128 [1134] **183**	175 [1546] **183**	227 [2013] **181**	280 [2482] **172**	329 [2910] **166**	185
45 [12]			116 [1026] **221**	167 [1475] **220**	217 [1924] **218**	262 [2322] **214**	316 [2795] **205**	222
53 [14]			97 [862] **258**	153 [1358] **257**	205 [1811] **256**	251 [2218] **252**	300 [2656] **249**	259
Max. Cont. 61 [16]			85 [752] **295**	137 [1212] **295**	191 [1687] **294**	240 [2127] **291**	292 [2583] **284**	296
68 [18]				122 [1079] **332**	174 [1541] **331**	224 [1981] **330**		333
Max. Inter. 76 [20]				104 [924] **369**	154 [1366] **368**	207 [1833] **367**		370

Overall Efficiency - 70 - 100% ☐ 40 - 69% ☐ 0 - 39% ☐

Theoretical Torque - Nm [lb-in]

Rotor Width mm [in]							
31.8 [1.251]	56 [498]	112 [995]	169 [1493]	225 [1990]	281 [2488]	337 [2986]	394 [3483]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

250

254 cm³ [15.5 in³] / rev

Pressure - bar [psi] (Max. Cont. 86 [1250]; Max. Inter. 104 [1500])

Torque - Nm [lb-in], **Speed rpm** — **Intermittent Ratings -** 10% of Operation

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	104 [1500]	Theoretical rpm
2 [0.5]	52 [457] **6**	104 [919] **4**	150 [1327] **2**				8
4 [1]	52 [458] **14**	112 [988] **12**	168 [1491] **10**	222 [1966] **7**	267 [2361] **4**	300 [2658] **1**	15
8 [2]	55 [490] **29**	115 [1018] **27**	171 [1512] **24**	231 [2041] **20**	288 [2547] **14**	323 [2856] **9**	30
15 [4]	49 [437] **59**	116 [1028] **58**	171 [1517] **56**	233 [2064] **51**	288 [2551] **44**	344 [3040] **34**	60
23 [6]	45 [398] **88**	105 [930] **88**	163 [1440] **87**	222 [1966] **82**	284 [2512] **76**	345 [3051] **62**	90
30 [8]		90 [795] **118**	147 [1305] **117**	186 [1649] **115**	268 [2372] **106**	330 [2918] **96**	120
38 [10]		76 [676] **148**	142 [1253] **147**	196 [1738] **146**	256 [2263] **140**	311 [2754] **133**	150
45 [12]		25 [225] **178**	124 [1098] **177**	186 [1642] **176**	234 [2071] **173**	282 [2499] **163**	179
53 [14]			89 [784] **208**	157 [1386] **206**	222 [1962] **204**	278 [2460] **194**	209
61 [16]			82 [722] **237**	142 [1256] **236**	202 [1786] **234**	261 [2306] **228**	239
68 [18]				124 [1096] **266**	183 [1618] **264**	240 [2126] **259**	269
Max. Cont. 76 [20]				95 [842] **297**	157 [1387] **295**	217 [1919] **293**	299
83 [22]					130 [1147] **327**		328
Max. Inter. 91 [24]					99 [874] **356**		358

Overall Efficiency - 70 - 100% ☐ 40 - 69% ☐ 0 - 39% ☐

Theoretical Torque - Nm [lb-in]

Rotor Width mm [in]						
39.4 [1.551]	70 [617]	139 [1234]	209 [1851]	279 [2468]	349 [3085]	418 [3702]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

300

293 cm³ [17.9 in³] / rev

Pressure - bar [psi] (Max. Cont. = 69 [1000]; Max. Inter. = 86 [1250])

Intermittent Ratings - 10% of Operation

Torque - Nm [lb-in], **Speed rpm**

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	Theoretical rpm
2 [0.5]	58 [516] **5**	126 [1111] **5**	185 [1638] **5**			7
4 [1]	64 [563] **12**	124 [1096] **12**	189 [1673] **11**	263 [2325] **10**	329 [2912] **9**	13
8 [2]	64 [564] **25**	133 [1180] **25**	199 [1758] **24**	268 [2375] **23**	343 [3033] **21**	26
15 [4]	59 [524] **51**	135 [1193] **51**	200 [1773] **50**	269 [2384] **50**	355 [3145] **47**	52
23 [6]	53 [468] **76**	126 [1116] **76**	195 [1728] **75**	278 [2463] **75**	350 [3096] **74**	78
30 [8]		108 [954] **102**	186 [1650] **101**	251 [2218] **101**	339 [3000] **100**	104
38 [10]		100 [887] **128**	170 [1503] **128**	241 [2132] **127**	319 [2824] **126**	130
45 [12]		79 [698] **154**	156 [1381] **154**	220 [1944] **153**	301 [2660] **152**	155
53 [14]		63 [558] **180**	136 [1206] **180**	201 [1780] **179**	284 [2512] **179**	181
61 [16]			113 [1000] **205**	184 [1630] **204**	250 [2213] **203**	207
68 [18]				156 [1382] **231**	216 [1915] **230**	233
Max. Cont. 76 [20]				119 [1054] **257**	190 [1679] **256**	259
83 [22]				83 [738] **283**		284
Max. Inter. 91 [24]						310

Overall Efficiency - 70 - 100% ☐ 40 - 69% ☐ 0 - 39% ☐

Theoretical Torque - Nm [lb-in]

Rotor Width	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]
45.5 [1.790] mm [in]	81 [713]	161 [1425]	242 [2138]	322 [2850]	403 [3563]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

400

409 cm³ [24.9 in³] / rev

Pressure - bar [psi] (Max. Cont. = 69 [1000]; Max. Inter. = 86 [1250])

Intermittent Ratings - 10% of Operation

Torque - Nm [lb-in], **Speed rpm**

Flow - lpm [gpm]	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]	Theoretical rpm
2 [0.5]	87 [767] **3**	187 [1656] **2**				5
4 [1]	90 [793] **8**	180 [1597] **8**	274 [2425] **6**	369 [3270] **6**	446 [3951] **3**	10
8 [2]	88 [777] **18**	175 [1550] **17**	286 [2528] **16**	374 [3309] **15**	466 [4124] **12**	19
15 [4]	85 [753] **37**	177 [1565] **36**	287 [2540] **35**	382 [3384] **33**	469 [4153] **29**	38
23 [6]	71 [631] **55**	169 [1498] **55**	280 [2477] **54**	370 [3273] **52**	466 [4122] **49**	56
30 [8]	58 [516] **73**	158 [1396] **71**	257 [2274] **70**	352 [3119] **69**	441 [3901] **68**	75
38 [10]		141 [1247] **92**	238 [2103] **91**	328 [2906] **90**	434 [3837] **87**	93
45 [12]		118 [1042] **110**	225 [1989] **109**	303 [2682] **108**	408 [3613] **107**	112
53 [14]		89 [792] **129**	189 [1670] **128**	278 [2463] **126**	367 [3251] **124**	130
61 [16]		59 [520] **147**	154 [1359] **146**	249 [2204] **144**	334 [2954] **143**	149
68 [18]			116 [1027] **166**	219 [1934] **165**	320 [2746] **164**	167
Max. Cont. 76 [20]			89 [790] **185**	188 [1663] **184**	264 [2336] **183**	186
83 [22]				140 [1242] **204**		205
Max. Inter. 91 [24]				93 [824] **222**		223

Overall Efficiency - 70 - 100% ☐ 40 - 69% ☐ 0 - 39% ☐

Theoretical Torque - Nm [lb-in]

Rotor Width	17 [250]	35 [500]	52 [750]	69 [1000]	86 [1250]
63.5 [2.500] mm [in]	112 [991]	224 [1982]	336 [2974]	448 [3965]	560 [4956]

Displacement tested at 54°C [129°F] with an oil viscosity of 46cSt [213 SUS]

RS (200/ 201 Series)

Housings

Dimensions shown are without paint. Paint thickness can be up to 0.13 [0.005]

2-hole, SAE A Mount, Aligned Ports

A10 1/2-14 NPT **A11** 7/8-14 UNF **A18** G 1/2 **A68** G 1/2 (TP)

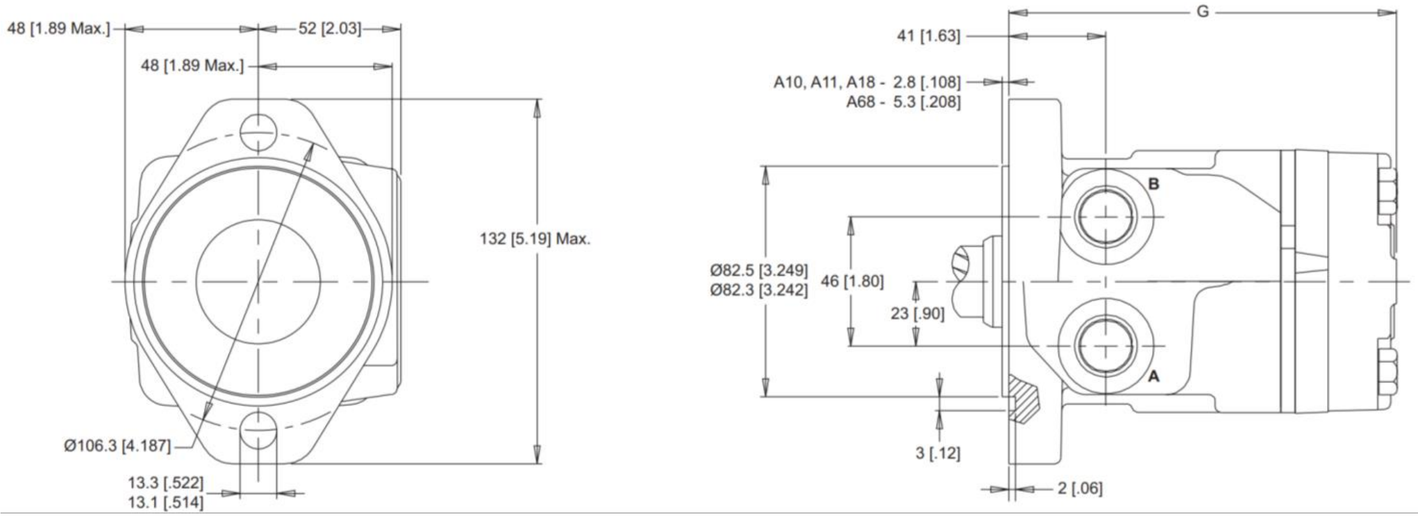


Figure 14 2-hole, SAE A Mounts, Aligned Ports

2-hole, SAE A Mount, Offset Ports

A12 G 1/2 **A62** G 1/2 (TP)

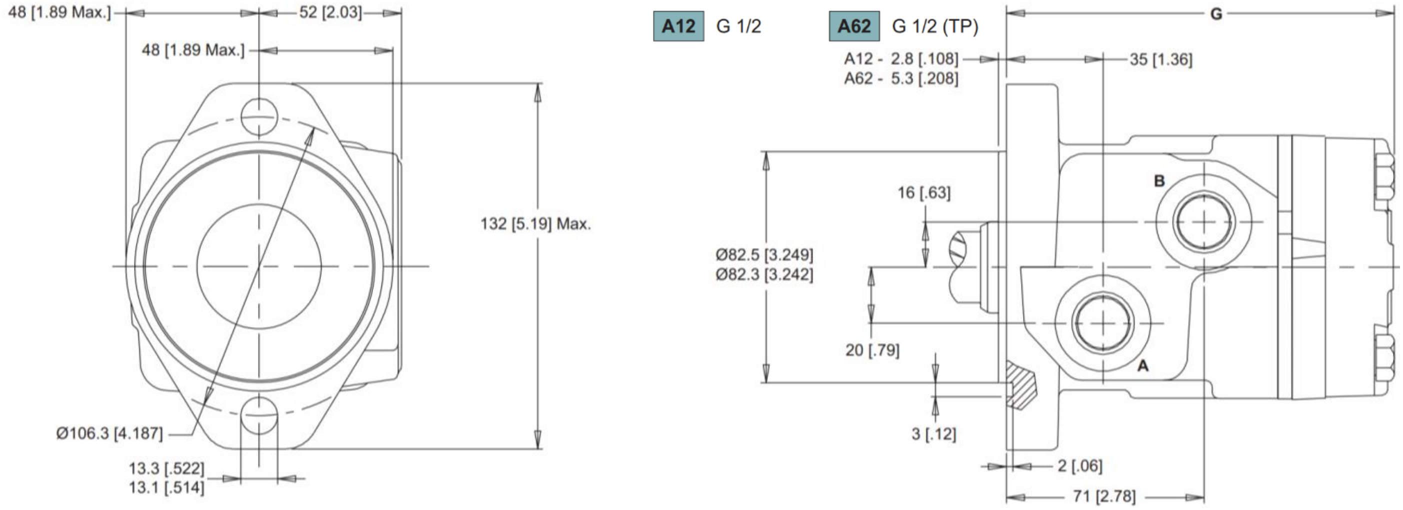


Figure 15 2-hole, SAE A Mount, Offset Ports

2-hole, SAE A Mounts, Aligned Manifold Ports

A17 1/2" Drilled **A67** 1/2" Drilled (TP)

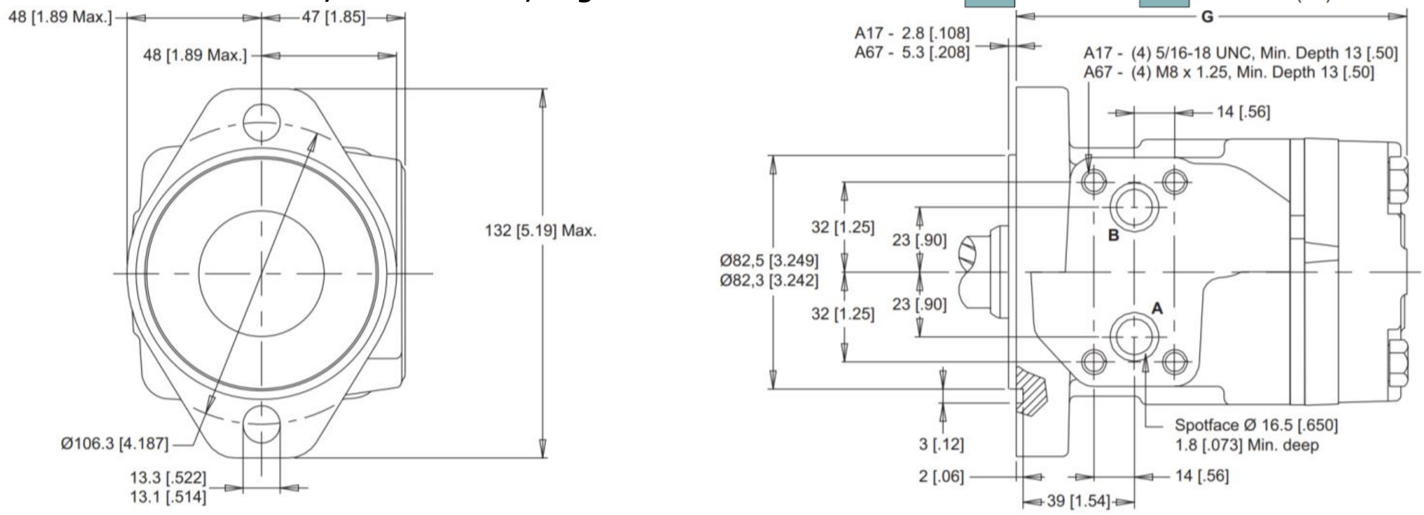


Figure 16 2-hole, SAE A Mounts, Aligned Manifold Ports

2-hole, SAE A Mount, Offset Manifold Ports

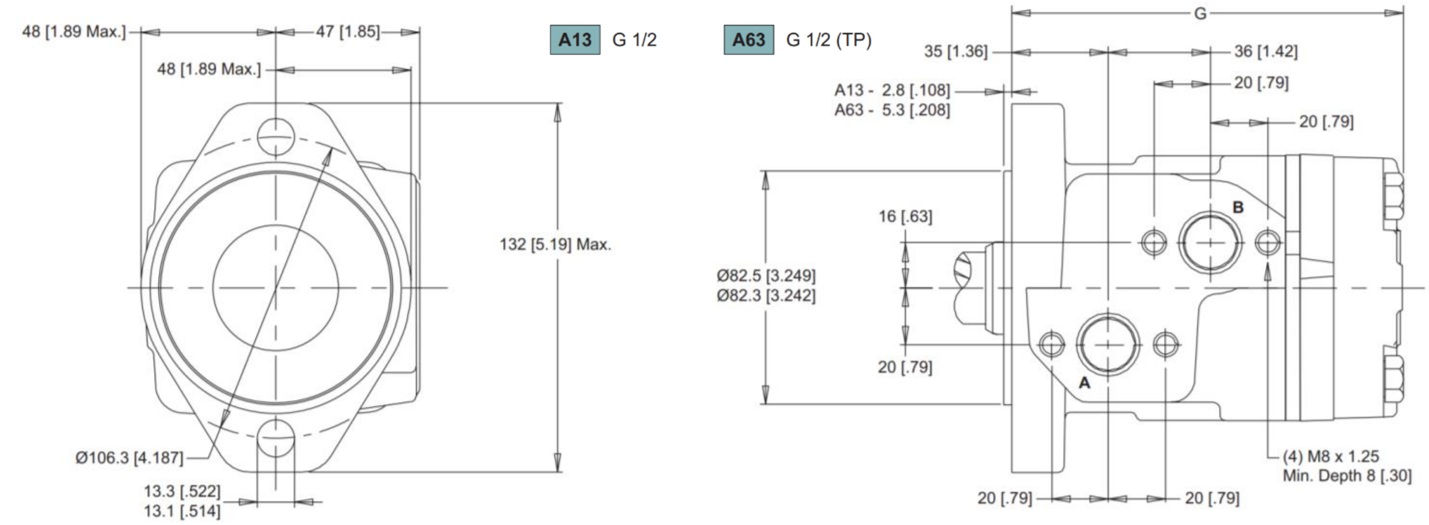


Figure 17 2-hole, SAE A Mount, Offset Manifold ports

2-hole, SAE A Mount, Side Ports

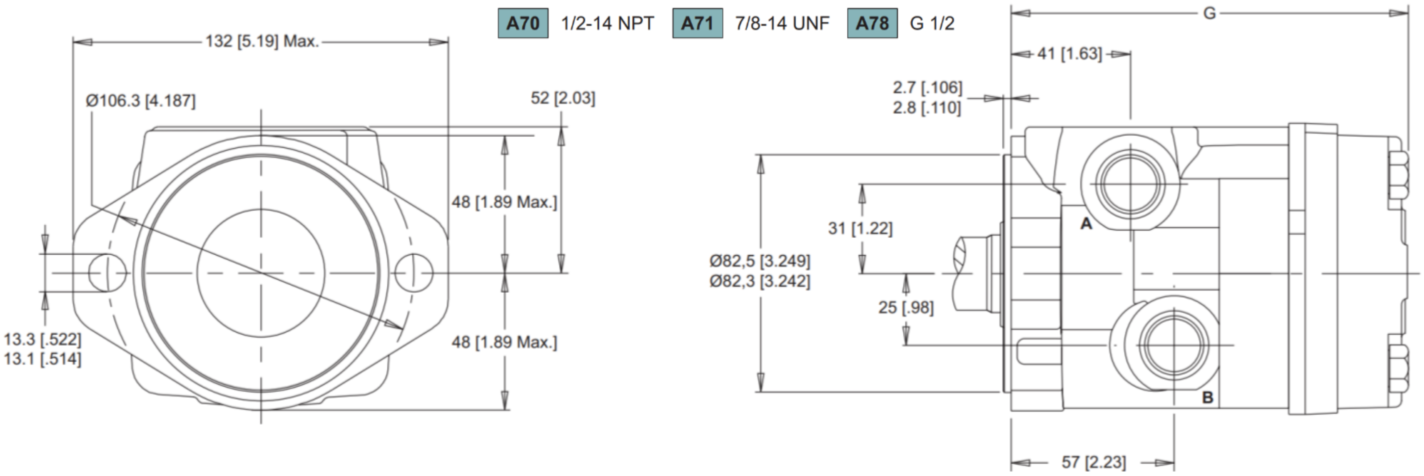


Figure 18 2-hole, SAE A Mount, Side Ports

2-hole, SAE A Mount, Offset Ports, Valve Cavity

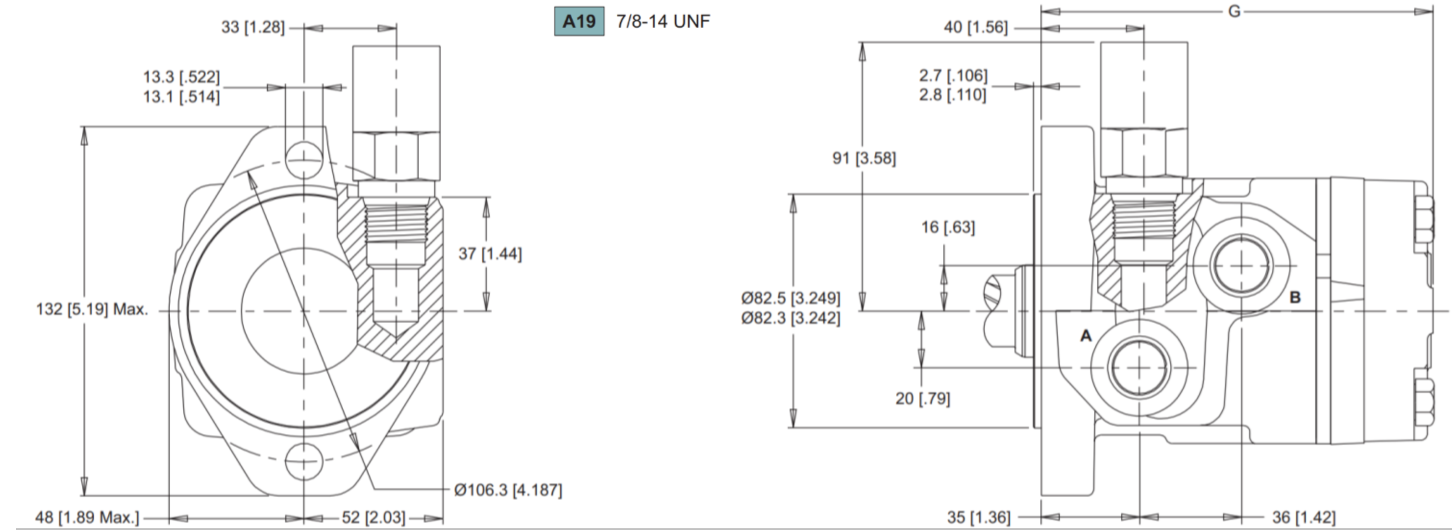


Figure 19 2-hole, SAE A Mount, Offset Ports, Valve Cavity

4-hole, Square Mount, Aligned Ports

F30 1/2-14 NPT **F31** 7/8-14 UNF

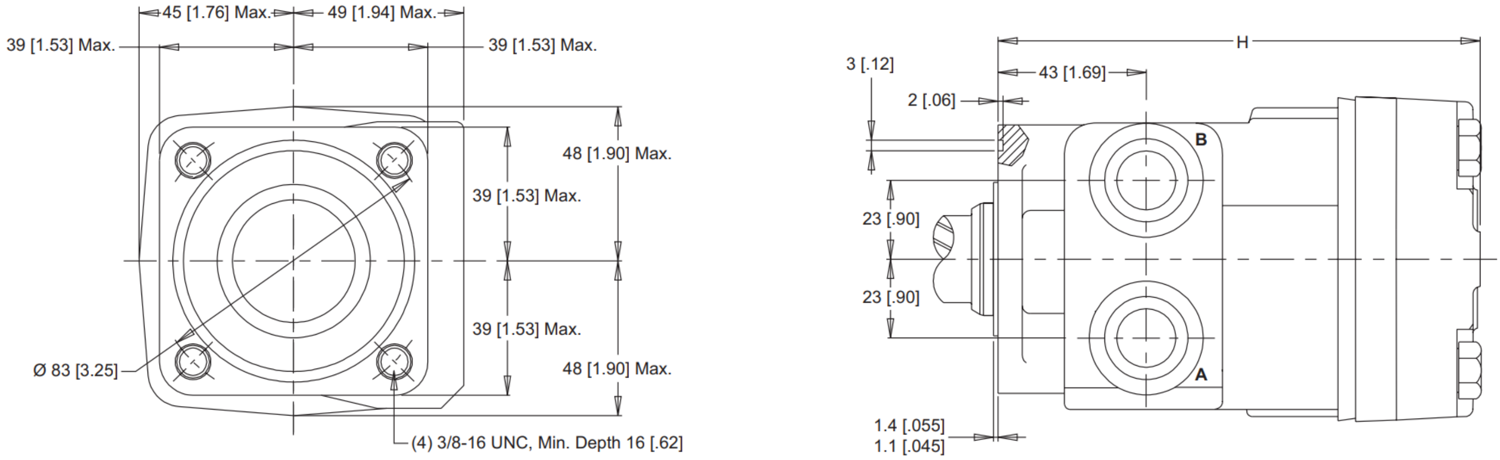


Figure 20 4-hole, Square Mount, Aligned Ports

4-hole, Square Mount, Aligned Manifold Ports

F37 1/2" Drilled

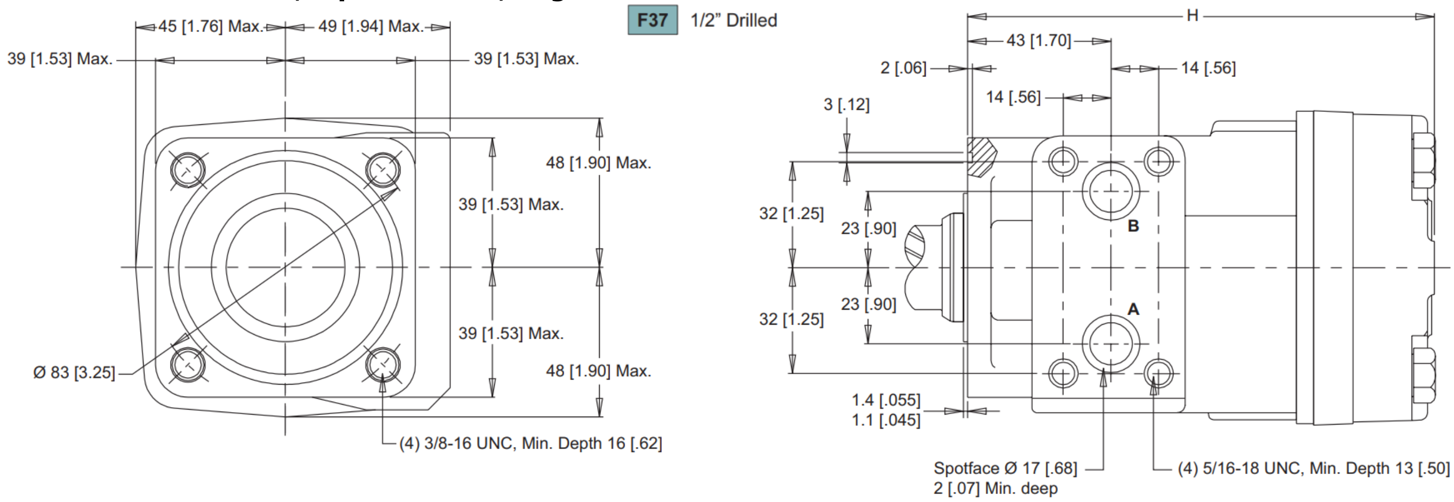


Figure 21 4-hole, Square Mount, Aligned Manifold Ports

4-hole, Square Mount, Offset Manifold Ports, Valve Cavity

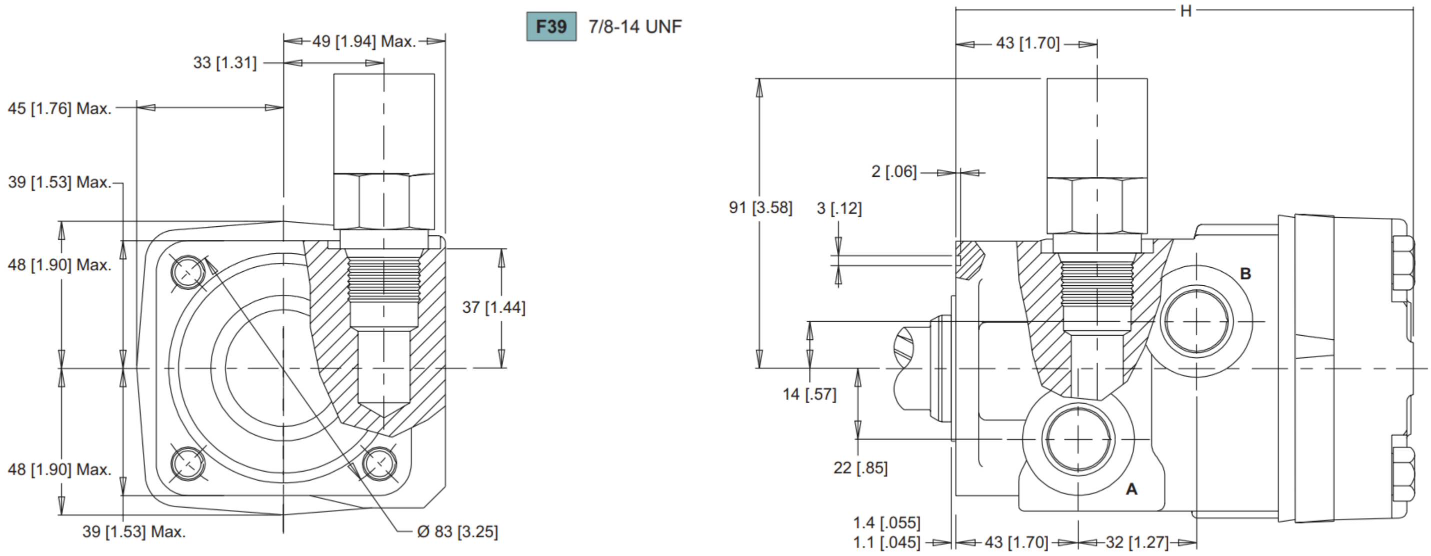


Figure 22 4-hole, Square Mount, Offset Manifold Ports, Valve Cavity

2-hole, SAE B Mount, Aligned Ports

B10 1/2-14 NPT | B11 7/8-14 UNF | B18 G 1/2

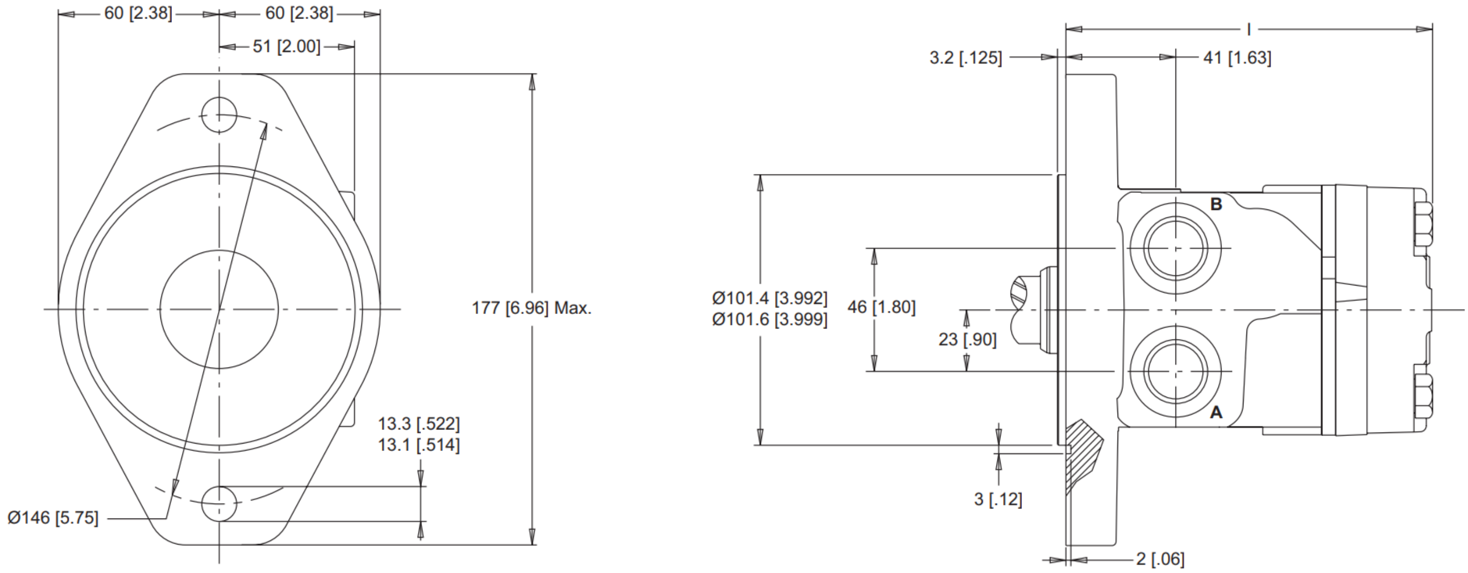


Figure 23 2-hole, SAE B Mount, Aligned Ports

2-hole, SAE B Mount, Side Ports

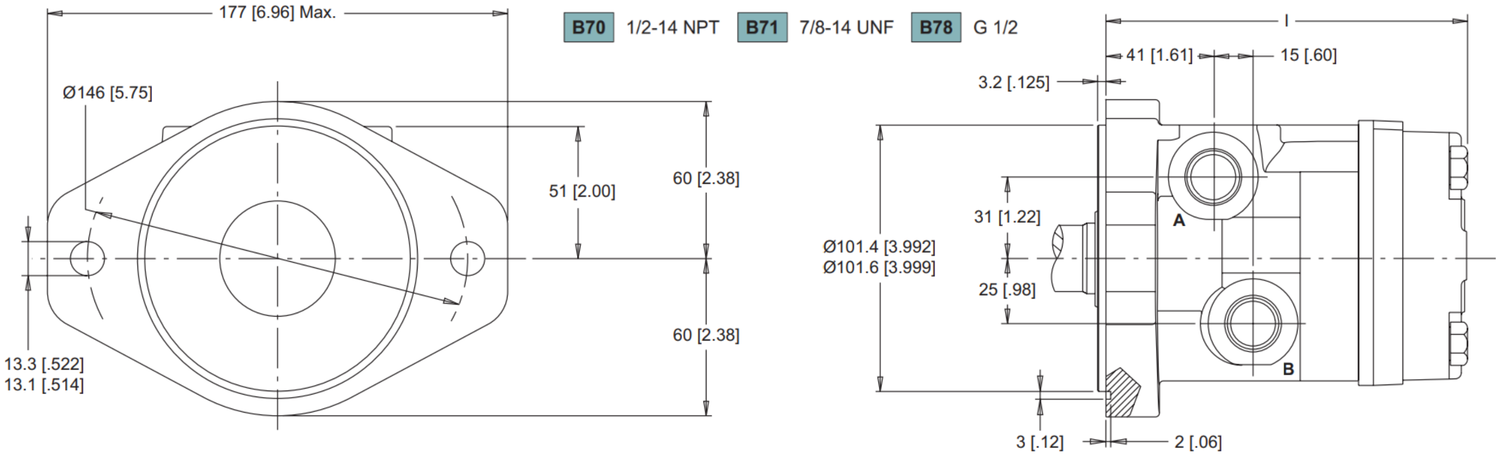


Figure 24 2-hole, SAE B Mount, Side Ports

Technical Information

Allowable Shaft Load / Bearing Curve

The bearing curve below represents the side load capacity of the motor at the centerline of the key for various motor speeds. Operating conditions within the shaded area will maintain acceptable oil film lubrication with recommended fluids. Operating conditions outside the shaded area are susceptible to motor failure due to oil starvation and/or excessive heat generation. Fluids with low lubricity or low viscosity may require the maximum load and speed ratings to be derated to provide acceptable motor life and performance.

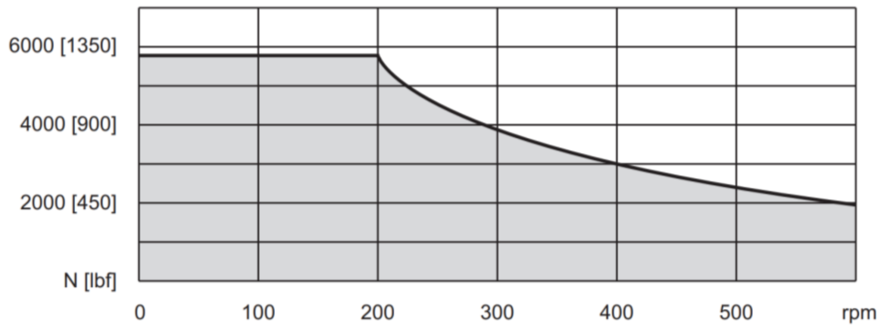


Figure 25 Allowable Shaft Load / Bearing Curve

Length & Weight Charts

200 & 201 series motor weights can vary ± 0.5 kg [1 lb] depending on model configurations such as housing, shaft, endcover, options etc.

	G		H		I	
	Length mm [in]	Weight kg [lb]	Length mm [in]	Weight kg [lb]	Length mm [in]	Weight kg [lb]
050	134 *[5.29]*	7.3 *[16.1]*	136 *5.36*	6.1 *13.4*	134 *5.29*	8.5 *18.6*
080	138 *[5.44]*	7.5 *[16.5]*	140 *5.50*	6.3 *13.9*	138 *5.44*	8.6 *19.0*
090	140 *[5.51]*	7.6 *[16.8]*	142 *5.58*	6.4 *14.1*	140 *5.51*	8.8 *19.3*
100	- -	- -	148 *5.82*	6.9 *15.1*	146 *5.75*	9.2 *20.2*
110	144 *[5.65]*	8.0 *[17.7]*	145 *5.72*	6.6 *14.6*	144 *5.65*	8.9 *19.7*
125	146 *[5.75]*	7.8 *[17.2]*	148 *5.82*	6.9 *15.1*	146 *5.75*	9.2 *20.2*
160	152 *[5.97]*	8.3 *[18.2]*	153 *6.04*	7.0 *15.4*	152 *5.97*	9.4 *20.7*
200	158 *[6.22]*	8.5 *[18.8]*	160 *6.29*	7.3 *16.0*	158 *6.22*	9.7 *21.3*
250	166 *[6.53]*	9.0 *[19.8]*	167 *6.59*	7.8 *17.1*	166 *6.53*	10.1 *22.3*
300	172 *[6.76]*	9.3 *[20.5]*	173 *6.83*	8.1 *17.9*	172 *6.76*	10.5 *23.0*
400	190 *[7.47]*	10.3 *[22.7]*	192 *7.54*	9.2 *20.2*	190 *7.47*	11.5 *25.2*

Figure 26 G,H,I dimension

Thrust Load

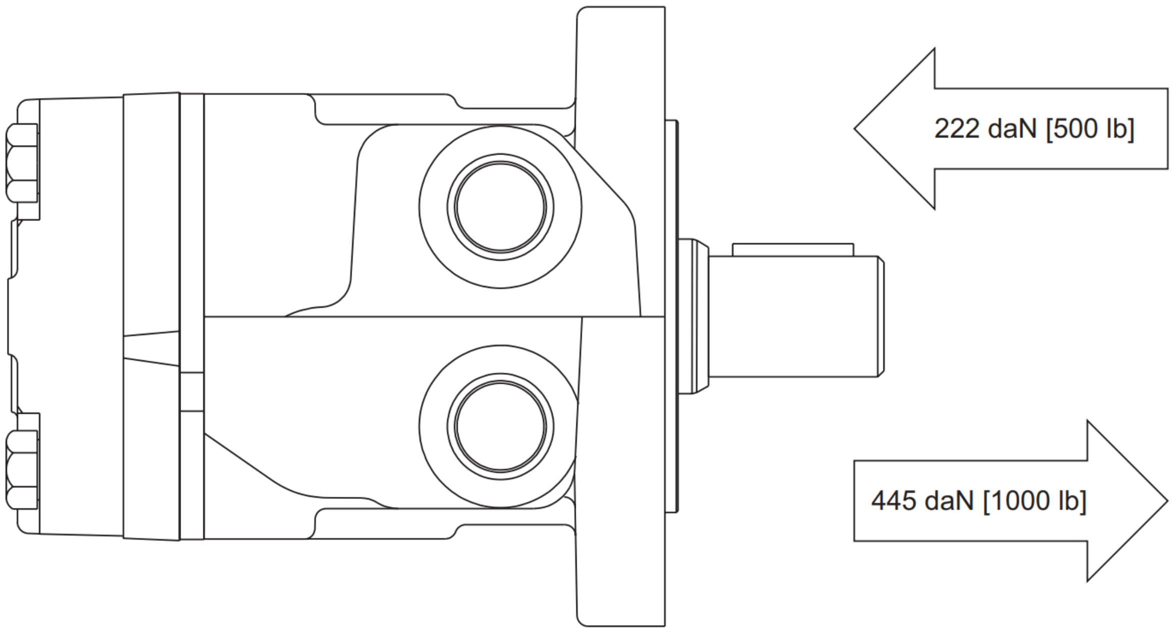
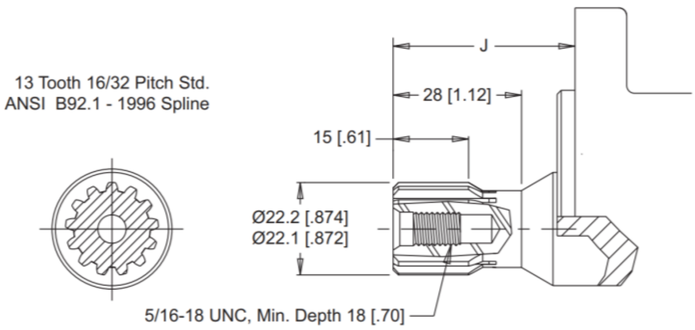


Figure 27 Thrust Load

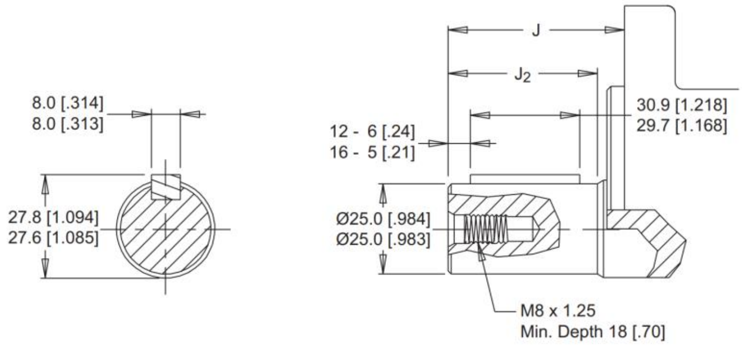
Shafts

01 7/8" 13 Tooth Spline



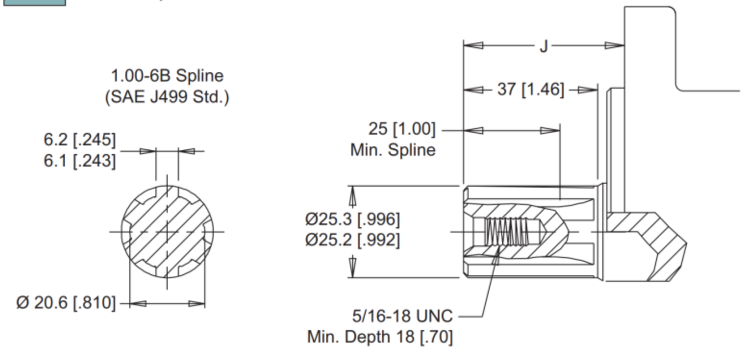
Max. Torque: 170 Nm [1500 lb-in]

12 25mm Straight **16** 25mm Straight Extended



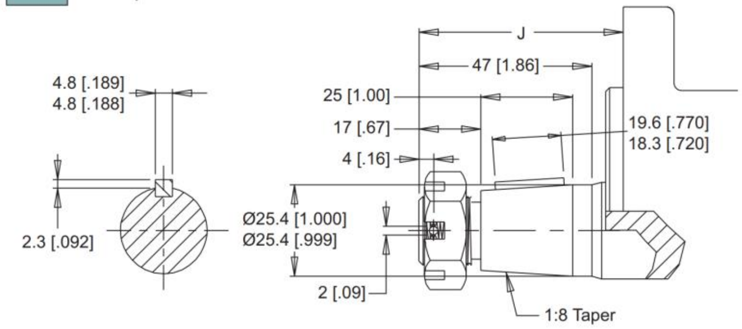
Max. Torque: 678 Nm [6000 lb-in]

02 1" 6B Spline



Max. Torque: 678 Nm [6000 lb-in]

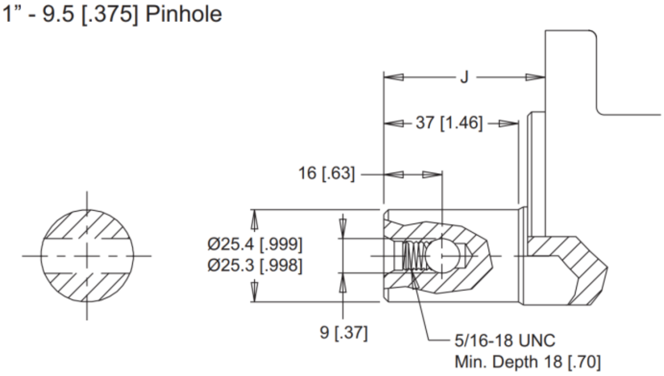
13 1" Tapered



▶ A slotted hex nut is standard on this shaft.

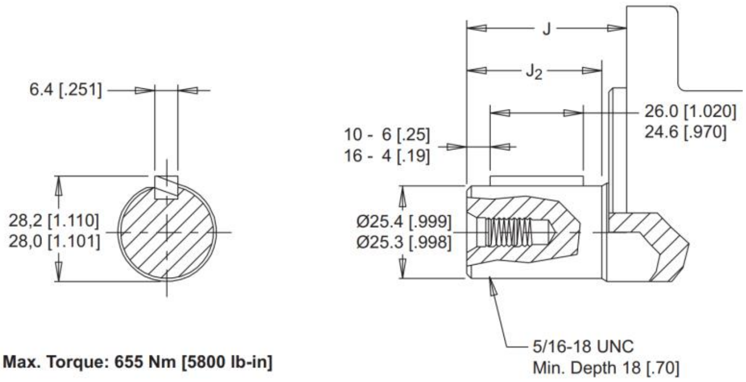
Max. Torque: 655 Nm [5800 lb-in]

05 1" - 9.5 [.375] Pinhole



Max. Torque: 678 Nm [6000 lb-in]

10 1" Straight **15** 1" Straight Extended



Max. Torque: 655 Nm [5800 lb-in]

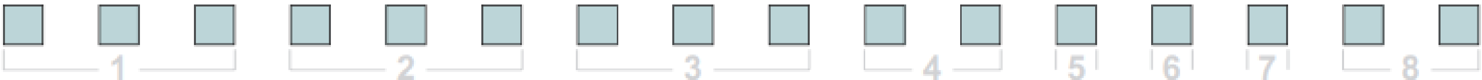
MOUNTING / SHAFT LENGTH CHART

Dimension J is the overall distance from the motor mounting surface to the end of the shaft. Additional shaft length information, if necessary, is noted as J2 and does not increase or decrease the listed J dimensions in this chart. The overall shaft lengths are already factored into the overall distance from the mounting surface to the end of the shaft.

J	SAE A & B Mounts mm [in]	Square Mounts mm [in]	J_2 mm [in]
01	42 *1.65*	40 *1.58*	N/A
02	45 *1.76*	43 *1.69*	N/A
05	45 *1.76*	43 *1.69*	N/A
10	45 *1.76*	43 *1.69*	37 *1.46*
12	55 *2.16*	53 *2.09*	43 *1.70*
13	57 *2.23*	55 *2.16*	N/A
15	58 *2.29*	56 *2.22*	51 *1.99*
16	58 *2.29*	56 *2.22*	50 *1.98*

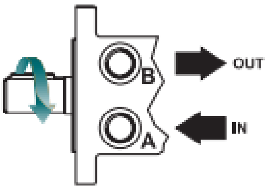
Figure 28 J dimension

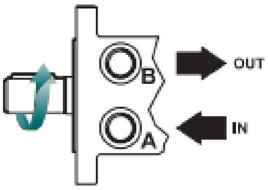
Ordering Information



1. CHOOSE SERIES DESIGNATION

200	Standard Rotation	201	Reverse Rotation





▶ The 200 & 201 series are bi-directional. For applications requiring the motor to rotate in only one direction, shaft seal life may be prolonged by pressurizing the B port of the motor.

2. SELECT A DISPLACEMENT OPTION

050	52 cm^3/rev	[3.2 in^3/rev]	160	164 cm^3/rev	[10.0 in^3/rev]
080	76 cm^3/rev	[4.6 in^3/rev]	200	205 cm^3/rev	[12.5 in^3/rev]
090	89 cm^3/rev	[5.4 in^3/rev]	250	254 cm^3/rev	[15.5 in^3/rev]
100	103 cm^3/rev	[6.3 in^3/rev]	300	293 cm^3/rev	[17.9 in^3/rev]
110	111 cm^3/rev	[6.8 in^3/rev]	400	409 cm^3/rev	[24.9 in^3/rev]
125	127 cm^3/rev	[7.7 in^3/rev]			

3. SELECT A MOUNT & PORT OPTION

A10	2-Hole, SAE A Mount, Aligned Ports, 1/2-14 NPT
A11	2-Hole, SAE A Mount, Aligned Ports, 7/8-14 UNF
A12	2-Hole, SAE A Mount, Offset Ports, G 1/2
A13	2-Hole, SAE A Mount, Offset Manifold Ports, G 1/2
A17	2-Hole, SAE A Mount, Aligned Manifold Ports, 1/2" Drilled
A18	2-Hole, SAE A Mount, Aligned Ports, G 1/2
A19	2-Hole, SAE A Mount, Offset Ports, Valve Cavity 7/8-14 UNF
A62	2-Hole, SAE A Mount, Offset Ports, G 1/2 (TP)
A63	2-Hole, SAE A Mount, Offset Manifold Ports, G 1/2 (TP)
A67	2-Hole, SAE A Mount, Aligned Manifold Ports, 1/2" Drilled (TP)
A68	2-Hole, SAE A Mount, Aligned Ports, G 1/2 (TP)
A70	2-Hole, SAE A Mount, Side Ports, 1/2-14 NPT
A71	2-Hole, SAE A Mount, Side Ports, 7/8-14 UNF
A78	2-Hole, SAE A Mount, Side Ports, G 1/2
B10	2-Hole, SAE B Mount, Aligned Ports, 1/2-14 NPT
B11	2-Hole, SAE B Mount, Aligned Ports, 7/8-14 UNF
B18	2-Hole, SAE B Mount, Aligned Ports, G 1/2
B70	2-Hole, SAE B Mount, Side Ports, 1/2-14 NPT

▶ (TP) - Tall pilot. Speed sensor option is not available on housings with a tall pilot or SAE B mounts.

3. SELECT A MOUNT & PORT OPTION

B71	2-Hole, SAE B Mount, Side Ports, 7/8-14 UNF
B78	2-Hole, SAE B Mount, Side Ports, G 1/2
F30	4-Hole, Square Mount, Aligned Ports, 1/2-14 NPT
F31	4-Hole, Square Mount, Aligned Ports, 7/8-14 UNF
F37	4-Hole, Square Mount, Aligned Manifold Ports, 1/2" Drilled
F39	4-Hole, Square Mount, Offset Ports, Valve Cavity, 7/8-14 UNF

4. SELECT A SHAFT OPTION

01	7/8" 13 Tooth Spline	12	25mm Straight
02	1" 6B Spline	13	1" Tapered
05	1" - 9.5 [.375] Pinhole	15	1" Straight Extended
10	1" Straight	16	25mm Straight Extended

▶ The 15 & 16 extended shafts are designed for use with one of the speed sensor options listed in STEP 7.

5. SELECT A PAINT OPTION

A	Black
B	Black, Unpainted Mounting Surface
Z	No Paint

6. SELECT A VALVE CAVITY / CARTRIDGE OPTION

A	None	E	104 bar [1500 psi] Relief
B	Valve Cavity Only	F	121 bar [1750 psi] Relief
C	69 bar [1000 psi] Relief	G	138 bar [2000 psi] Relief
D	86 bar [1250 psi] Relief		

▶ Valve cavity is only available on the A19 & F39 housings.

7. SELECT AN ADD-ON OPTION

A	Standard
B	Lock Nut
C	Solid Hex Nut
W	Speed Sensor, Dual, 4-Pin Male Weatherpack Connector
X	Speed Sensor, Dual, 4-Pin M12 Male Connector
Y	Speed Sensor, Single, 3-Pin Male Weatherpack Connector
Z	Speed Sensor, Single, 4-Pin M12 Male Connector

8. SELECT A MISCELLANEOUS OPTION

AA	None
AC	Freeturning Rotor

Figures

Tables

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